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The Alluvial Geoarchaeology of the Upper River Kennet in the Avebury Landscape: a Monumental Transformation of a Stable Landscape

By CHARLES FRENCH[1], CHRIS CAREY[2], MICHAEL J. ALLEN[2,3], PHILIP TOMS[4], JAMIE WOOD[4], PHILIPPE DE SMEDT[5], NICHOLAS CRABB[2], ROB SCAIFE[6], MARK GILLINGS[7] *and* JOSHUA POLLARD[8]

*Geoarchaeological research as part of the AHRC funded Living with Monuments (LwM) project investigated the upper Kennet river system across the Avebury World Heritage landscape. The results demonstrate that in the early–mid-Holocene (*c. *9500–1000* BC*) there was very low erosion of disturbed soils into the floodplain, with floodplain deposits confined to a naturally forming bedload fluvial deposit aggrading in a shallow channel of inter-linked deeper pools. At the time of the Neolithic monument building in the 4th–early 3rd millennium* BC*, the river was wide and shallow with areas of presumed braid plain. Between* c. *4000 and 1000* BC*, a human induced signature of soil erosion became a minor component of fluvial sedimentation in the Kennet palaeo-channel but it was small scale and localised. This strongly suggests that there is little evidence of widespread woodland removal associated with Neolithic farming and monument building, despite the evidently large timber requirements for Neolithic sites like the West Kennet palisade enclosures. Consequently, there was relatively light human disturbance of the hinterland and valley slopes over the* longue durée *until the later Bronze Age/Early Iron Age, with a predominance of pasture over arable land. Rather than large Neolithic monument complexes being constructed within woodland clearings, representing ancestral and sacred spaces, the substantially much more open landscape provided a suitable landscape with areas of sarsen spreads potentially easily visible. During the period* c. *3000–1000* BC*, the sediment load within the channel slowly increased with alluvial deposition of increasingly humic silty clays across the valley floor. However, this only represents small-scale landscape disturbance. It is from the Late Bronze Age–Early Iron Age when the anthropogenic signal of human driven alluviation becomes dominant and overtakes the bedload fluvial signal across the floodplain, with localised colluvial deposits on the floodplain margins. Subsequently, the alluvial archive describes more extensive human impact across this landscape, including the disturbance of loessic-rich soils in the catchment. The deposition of floodplain wide alluvium continues throughout the Roman, medieval, and post-medieval periods, correlating with the development of a low-flow, single channel, with alluvial sediments describing a decreasing energy in the depositional environment.*

[1]McBurney Laboratory, McDonald Institute for Archaeological Research, University of Cambridge, CB2 3ER. Email: caif2@cam.ac.uk
[2]School of Archaeology & Anthropology, Bournemouth University, Fern Barrow, Poole, BH12 5BB
[3]Allen Environmental Archaeology, Green Rd, Codford, BA12 0NW & School of Archaeology & Anthropology, Bournemouth University
[4]Luminescence Dating Laboratory, University of Gloucestershire, Swindon Road, Cheltenham, GL50 4HZ
[5]Depts of Archaeology & Engineering, University of Ghent, Campus Ufo, B-9000 Ghent, Belgium
[6]Dept of Geography, University of Southampton, Highfield, Southampton, SO17 1BJ
[7]Dept of Anthropology & Archaeology, University of Bristol, 43 Woodland Road, Bristol, BS8 1T
[8]Dept of Archaeology, University of Southampton, Avenue Campus, Southampton, SO17 1BF

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The construction of substantial ceremonial and funerary monuments during the Neolithic and Early Bronze Age represented a significant process of landscape modification, creating landmarks that were often (though not invariably) intended to endure as statements of memory, definitions of sacred space, and/or markers of lineage presence (eg, Bradley 1998; Harding 2013; Cummings & Fowler 2023). Their making involved the movement and relocation of materials, such as stone, timber, earth, and turf, sometimes on a considerable scale. Accumulating resources for big construction projects, whether plant foods or animals, ropes, antlers, timbers, and so forth, also left its traces upon landscapes through vegetation modification and associated soil erosion. Making monuments, to paraphrase Bradley (1993), involved acts of 'altering the earth'. Of especial note are events in the latest 4th and mid-3rd millennia cal. BC, which saw the creation of some of the greatest prehistoric ceremonial monuments in Europe; including those of Stonehenge, Dorchester, and Avebury landscapes, on Cranborne Chase, and Mainland Orkney for example (French *et al.* 2007; 2012; Brend *et al.* 2020; Greaney *et al.* 2020; Parker Pearson *et al.* 2020; 2022). In the case of Stonehenge, there were modifications not just to the local landscape but more distant locations through the quarrying and movement of non-local stone (Parker Pearson *et al.* 2020). This acknowledged, we still understand surprisingly little in detail of the scale and nature of the environmental impacts wrought on these landscapes through the process of monument construction (Whittle 1990; Gillings *et al.* 2002; 2008; Thomas 2020) and it is this matter to which this paper turns, focusing on the geoarchaeological record of the Avebury/upper Kennet valley region of central southern England building on the records of Evans *et al.* (1993), Whittle (1990), Pollard and Reynolds (2002), and Pollard *et al.* (2012).

Here, we are concerned to take a holistic view, recognising that landscapes such as that around Avebury were foci for occupation and other daily activity as well as monument building and ceremony during the 4th–early 2nd millennia cal. BC. Contemporary settlement and other non-monument focused activities have received much less archaeological attention, in part because of the difficulties encountered in their archaeological identification and interpretation, yet their understanding is central to the wider project of comprehending the past dynamics of such landscapes. Equally fundamental are considerations on the nature of the environment from the Early Neolithic onwards and how Neolithic societies interacted with, and had an impact on, the landscapes that they used and dwelt within. By understanding the human–landscape dynamic and the context of palaeo-environmental change by human agency it is possible to start to address *how* landscapes such as Avebury were being used in the Neolithic, alongside informing our interpretations of *why* such landscapes may have been monumentalised. Ideas and speculation centred upon Early Neolithic farmers clearing areas of woodland and creating locales that were special and different, which later become a focus for monument building through recognition of ancestral spaces, only work if this model of the Early Neolithic environment is correct. Indeed, it is now demonstrable that in some of the major monumental landscapes of southern Britain the degree of early Neolithic woodland cover and, by association, the level of human induced landscape impact caused by these early societies, has been significantly overestimated (Allen 2000; 2017; French *et al.* 2007; 2012). The Stonehenge landscape is now interpreted as an ostensibly open, largely grassland landscape with rendzina soils and minimal agricultural disturbance evident at the start of the Neolithic (French *et al.* 2012) and similar scenarios are also evident for the Dorchester monumental complex (Smith 1997; Bradley 1998) and the upper Allen valley area of Cranborne Chase (French *et al.* 2007).

The *Living with Monuments Project* (LwM) has undertaken extensive geoarchaeological and palaeoenvironmental analyses across the World Heritage landscape at Avebury (Fig. 1) in order to redress imbalances in our understanding of the dynamics of monument building and settlement, and human–environment relationships in their widest sense. This has been through a coherent and innovative programme of targeted fieldwork combined with extensive geoarchaeological survey and new analyses. These new data are used to re-assess the existing environmental frameworks mainly derived from the work of J.G. Evans and colleagues in the 1970s and 1980s (Evans 1972; 1975; Evans *et al.* 1985; 1993)

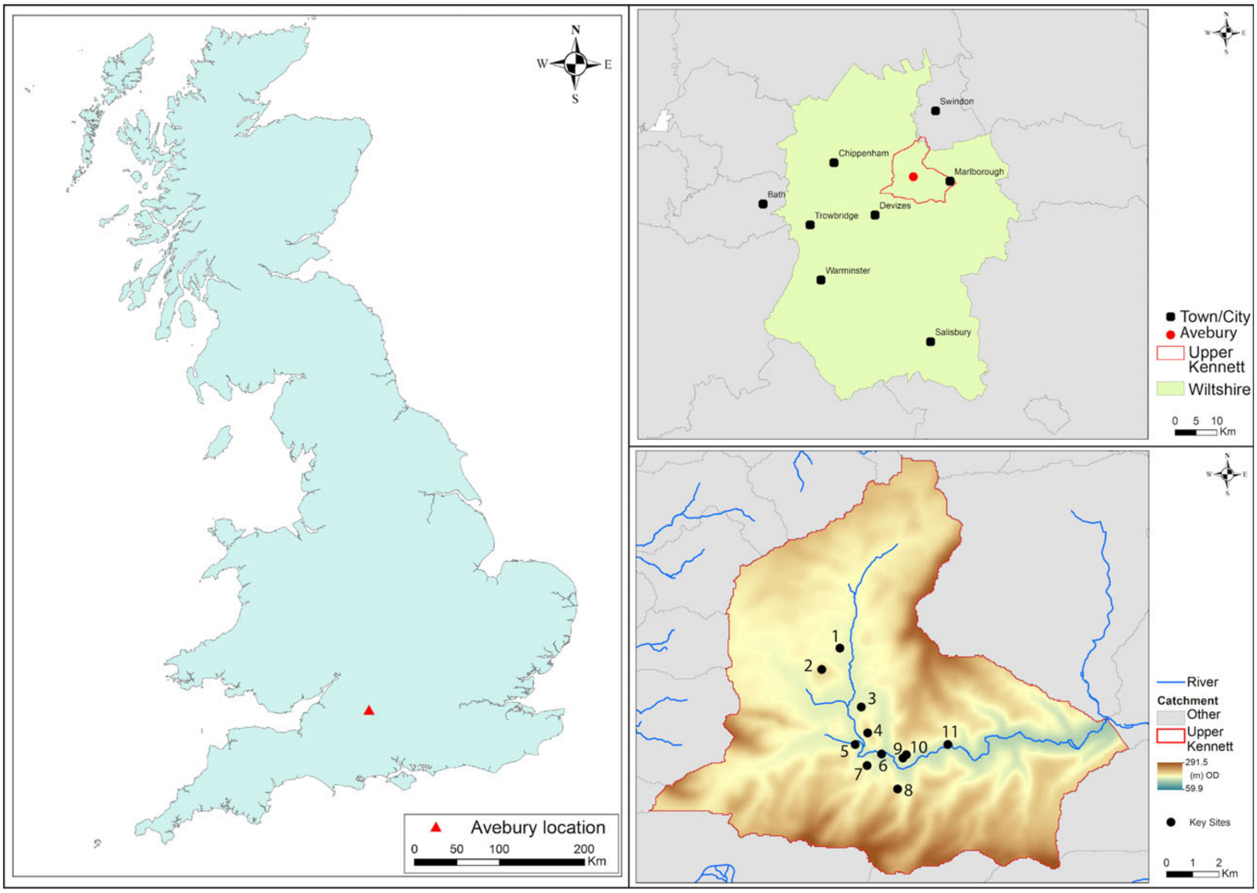


Fig. 1.
The location of Avebury at a national scale (left); within Wiltshire at a regional scale, highlighting the Upper Kennet catchment (top right), and the Upper Kennett catchment shown against topography at a local scale, with key sites highlighted (bottom right) (1 = Millbarrow; 2 = Windmill Hill; 3 = Avebury Henge; 4 = Waden Hill; 5 = Silbury Hill, 6 = Palisaded Enclosures; 7 = West Kennett Long Barrow, 8 = East Kennet Long Barrow; 9 The Sanctuary; 10 = Overton barrows; 11 = North Farm) (C. Carey)

and are used in conjunction with the results of the archaeological test excavation programme of Neolithic settlement sites and other locales within the Avebury landscape (Pollard *et al.* 2012; 2017; 2018a; 2018b; 2019; 2020a; 2020b; Gillings *et al.* 2015a; 2015b).

This paper documents the geoarchaeological study of the alluvial and colluvial histories of the Kennet floodplain in the Avebury landscape throughout the Holocene. In particular, it aims to provide new contextual data on the nature of the prehistoric landscape with respect to the development of the Neolithic monumental complex. As a companion paper to this (French *et al.* in prep.), the authors aim to draw together the geophysical, palaeosol, palynological, and molluscan data to develop a more detailed understanding of the extent, scale, character, and tempo of landscape change related to settlement and monument building in the core area of the Avebury landscape during the Neolithic and Early Bronze Age.

Alluviation: causes and inferences

The discussion of the causality between anthropogenic and climatic factors driving Holocene floodplain alluviation is a longstanding debate (eg, Tipping 2000; Macklin *et al.* 2012; 2014). Brown *et al.* (2013) defined the ‘Anthropocene’ through the onset of Holocene alluvial sediment stacks of different dates across multiple catchments, driven through anthropogenic soil erosion. Macklin *et al.* (2014) also recognised anthropogenically driven alluviation from radiocarbon dated fluvial units in 93 catchments in the UK, with the majority of this alluviation occurring in the Early Bronze Age and the Late Bronze Age/Early Iron Age during the 2nd and 1st millennia BC. Adding further complexity is the chronological relationship between alluviation relative to human landscape disturbance. In particular, the deposition of alluvial sediment on valley floors related to past societal activities such as woodland clearance, cultivation, and foraging may not necessarily be synchronous in some valleys and river reaches.

The supply of sediment to a river system can be affected by numerous factors including upslope storage of sediment as colluvium and its movement downslope as hillwash (de Moor & Verstraeten 2008), the scale, intensity, and type of impact (eg, woodland clearance, cultivation, and pastoral) (Brown 1997; Goldberg & Macphail 2006, 89–95; French 2017) and the size and physical characteristic of the catchment, the underlying bedrock, and surficial deposits (Houben *et al.* 2012; Macklin *et al.* 2014). Such factors can affect the synchronicity between human impacts leading to colluviation and then subsequent and associated alluviation. This relationship has been demonstrated as lagged in some catchments, caused by the overflow effect for upslope colluvial storage of eroded sediments (Houben *et al.* 2012) or through land-use practices. Time lags between woodland clearance, prehistoric and Roman cultivation, and later colluviation and alluviation, have been described for the River Nene catchment for example, a function of greater hydro-sedimentary connectivity in the Saxon period due to changes in agricultural practice (Brown 2009). Variations in hydro-sedimentary connectivity and the above floodplain storage of colluvium, question the synchronous correlation between alluvial deposition and climatic change (eg, Macklin *et al.* 2010). Instead, this focuses the perspective of geoarchaeologists to understand human impacts within river catchments through both erosive factors such as cultivation, and connectivity across a catchment (eg, drainage patterns), leading to more holistic models of human–environmental dynamics within catchments. For this reason, this paper considers both the deposition of colluvial deposits on the floodplain edge and valley sides, alongside floodplain alluviation in the upper Kennet valley.

GEOGRAPHICAL AND SOIL BACKGROUND

The River Kennet is a small upland chalk river with a catchment of 1138 km^2 which flows from a north-west direction eastwards to Marlborough and on to the River Thames near Reading over a length of *c.* 86 km (Whitehead & Edmunds 2012) (Fig. 1). The upper reach from just to the north of Avebury to Marlborough over a distance of *c.* 28 km is generally a small channel, as a stream to the north-west of Avebury, widening southwards towards Silbury Hill and then eastwards towards Marlborough. It has a relatively narrow floodplain varying between *c.* 50 m and 150 m in its upper part through to *c.* 150–200 m downstream. It is a highly localised small catchment of about 25 km^2 immediately and demonstrably interlinked with the monuments of the Avebury landscape. Consequently, it creates a sensitive sediment receptor with which to study prehistoric landscape impact and changes associated with this monumental landscape throughout the Holocene.

The present-day soils of the Avebury landscape include calcareous alluvial gley soils on the floodplains; typical brown calcareous earths on the clay-rich Lower Chalk, gravels, and Coombe Rock; common rendzinas on the Middle and Lower Chalk downland slopes, under both arable and grassland; and, less commonly, argillic brown earths in a few areas on Clay-with-Flints (Barron 1976; Findlay *et al.* 1984). These soils are all alkaline, with the possible exception of the argillic brown earths, and are situated on Upper, Middle, and Lower Chalk as well as periglacial deposits formed of mixtures of cryoturbated and soliflucted chalk, flint, and loess (known as Coombe Rock), and river gravels composed of flint and chalk pebbles. Alkaline groundwater emerges from numerous springs, mainly at the boundary of the more permeable Middle Chalk and the less permeable clay-rich Lower Chalk, such as along the southern edge of Waden Hill below the modern A4 road scarp and the western valley/Y-fork of the Kennet (the Oslip stream) beyond Avebury Trusloe to the north-west.

METHODS

Field survey, excavation, and sampling

The geoarchaeological survey of the Avebury World Heritage landscape area primarily involved conducting an extensive hand augering programme using a 4 cm diameter Edelman head and 0.5 m long gouge auger as appropriate. A total of 454 boreholes were

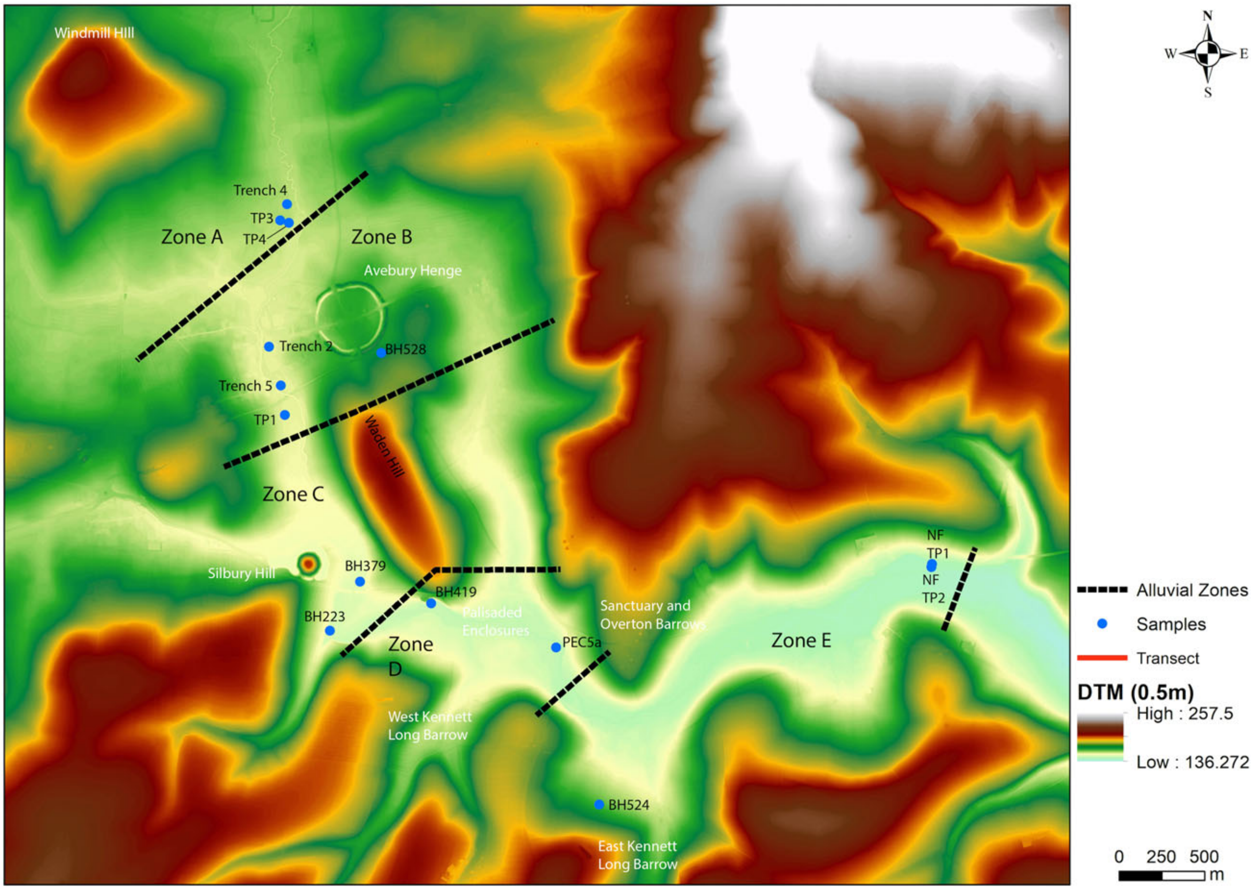


Fig. 2.
The alluvial zones used for the description of the results, with the location of key transects, test pits, and excavation areas shown against an unconstrained DEM (C. Carey)

made in 76 transects across the National Trust's Avebury World Heritage Landscape with a few specific outlier locations such as at North Farm, West Overton, and around East Kennett long barrow (Fig. 2). Of these, some 218 boreholes in 36 transects were placed across and through the Kennet floodplain deposits, followed up with 11 test pits/trenches and a handful of gouge core sample locations to target specific sequences of interest for primarily geoarchaeological and palaeo-environmental sampling. Although coverage is uneven in places due to various access difficulties, this survey provided a comprehensive record of the soils and sediments present in the landscape.

From these boreholes and test pits/trenches, a series of key transects has been constructed to provide an overview of key alluvial and/or colluvial stratigraphies in five valley zones (Fig. 2; Table 1). To cross-correlate between the stratigraphic units present in each borehole in each transect and zone, macro-stratigraphic units were identified, described, and used throughout the profile descriptions (Table S1).

The zones A–E used for the presentation and description of results in this study (Appendix S1) are:

- Zone A: the upper Kennet to the north and north-west of the Avebury henge;
- Zone B: along the western side of Avebury henge that is located on a slight knoll of chalk with Clay-with-Flints;
- Zone C: to the south and south-east of the Avebury henge, which contains the massive bulk of Waden Hill and the gigantic Silbury Hill, sat on the floodplain bottom;

TABLE 1. TRANSECTS AND BOREHOLES USED FOR THE ANALYSIS OF THE ALLUVIAL ZONES A–E

Zone	*Transect no.*	*Boreholes*	*Rationale*
Zone A	Transect 44	331–341	Investigate deposits from Windmill Hill to floodplain
Zone B	Transect 1000	291–288, 251–253	Investigate alluvial sequences in Zone B, adjacent to Avebury henge
	Transect 30	242–246	Investigate alluvial sequences in Zone B, adjacent to Avebury henge
	Transect 1	101–117	Investigate colluvial sequences in Zone B
Zone C	Transect 50	380, 381, 383–386	Investigate colluvial sequences in Zone C, Waden Hill
	Transect 65	373–376	Investigate alluvial sequences in Zone C, adjacent to Silbury Hill
	Transect 47	368–372	Investigate alluvial sequences in Zone C, adjacent to Silbury Hill
	Transect 7	150–154	Investigate colluvial and alluvial sequences in valley to the east of Waden Hill
Zone D	Transect 54	405–409, 411–413	Investigate the colluvial and alluvial sequences in Zone D, adjacent to the Palisaded Enclosures
	Transect 59	438, 440–443	Investigate alluvial sequences in Zone D
	Transect 15	183, 182, PEC5a, 191, 180, 429	Investigate alluvial sequences in Zone D, downstream of the Palisaded Enclosures
Zone E	Transect 62	444–447	Investigate alluvial and colluvial sequences at Zone E, North Farm and adjacent floodplain, with TP1 and TP2 excavated on the transect
	Transect 63	472–474, 449, 448, 450, 454, 451, 453, 452	Investigate alluvial and colluvial sequences at Zone E, North Farm and adjacent floodplain

- Zone D: the floodplain from south-east/east of Silbury Hill towards The Sanctuary;
- Zone E: the floodplain eastwards from The Sanctuary to West Overton.

Laboratory analyses of alluvial sediments

The alluvial/colluvial sequences were sampled at nine locations across the floodplain (Fig. 2; Tables 1 & 2), and subsequently analysed for particle size, organic and carbonate content, magnetic susceptibility, and soil micromorphology (Appendix S2). These locations were:

- Zone A: the alluvial-buried soil sequences in Test Pits 1, 3, and 4 in Spring Field immediately north-west of Avebury henge on the western bank of the Kennet;
- Zone B: the alluvial sediment sequence in Trench 2 in Butler's Field west of Avebury henge, associated with a basal palaeosol and medieval soil complex, the deep alluvial sequence associated with a low point depression within the floodplain in Trench 5 in Butler's Field, and the alluvial-buried soil sequence in Test Pit 4 located in the floodplain *c.* 100 m to the south;
- Zone C: borehole 375 in the floodplain near East Kennett;
- Zone D: the alluvial sediment sequence in borehole PEC5a downstream of the West Kennet palisaded enclosures between West Kennett Farm and East Kennett village;
- Zone E: Test Pit 1 at North Farm, West Overton, a buried soil associated with a colluvial/alluvial sequence towards the floodplain edge and adjacent Test Pit 2, a moderately deep alluvial sequence in a low point within the floodplain.

In addition, 16 samples were taken and processed for Optically Stimulated Luminescence (OSL) dating by Dr J.C. Wood and Prof P.S. Toms of the University of Gloucestershire's Luminescence Dating Laboratory from Trenches 2 and 5 in Butler's Field and Test Pits 1 and 2 at North Farm (Tables 3 & S2; Appendix S3; Toms 2018; Toms & Wood 2020). Given the texture of the deposits, only fine silt quartz OSL dating was possible. This fraction precludes investigation of inter-grain differences in age, using single (125–250 µm) grain analysis. Such variation may be rooted in partial resetting of the OSL signal prior to burial (Olley *et al.* 2004) or bioturbation (Gliganic *et al.* 2015), limiting the affiliation between average OSL age and the age of the event of interest. However, this uncertainty is moderated by the OSL ages presenting in stratigraphic order and the lack of diagnostic issues, on the whole. The exceptions

TABLE 2. VALLEY ZONES, WITH THE TRENCH, TEST PIT AND BOREHOLE NUMBERS SELECTED FOR FURTHER ANALYSES (SOIL THIN SECTION (TS), SEDIMENTS, MOLLUSCA, AND OSL) AND FIELD DESCRIPTIONS FROM THE UPPER KENNET FLOODPLAIN AREA IN THE LWM PROJECT

Zone	*Test pit (TP); excavation (Tr); borehole (BH)*	*Sampled for*	*Overview*
A North of Avebury henge	TP3 (Winterborne North)	Soils (TS), Mollusca	Upper Kennet floodplain, W of Avebury: brown silty clay loam; buried soil/old land surface, 33–42 cm, developed on chalky flint
A North of Avebury henge	TP4 (Winterborne North)	Soils (TS)	Upper Kennet floodplain, W of Avebury: orangey brown silty clay loam; buried soil/old land surface, 48–58 cm, developed on chalky silt
B North of Avebury henge	TP1 (Winterborne South)	Soils (TS)	Kennet floodplain, SW of Avebury: orangey brown silty clay loam; buried soil beneath alluvium, 143–153 cm, developed on weathered chalk
B Avebury Henge	Butler's Field TP3		Kennet floodplain, W of Avebury: 74 cm of silty clay alluvium over buried soil
B Avebury Henge	Butler's Field TP8		Kennet floodplain, W of Avebury: 95 cm of silty clay alluvium over buried soil
B Avebury Henge	Butler's Field: Tr 1		Kennet floodplain, W of Avebury: 62 cm of silty clay alluvium over rubble bank sealing buried soil
B Avebury Henge	Butler's Field: Tr 2	Sediments OSL	Kennet floodplain, W of Avebury henge: 116 cm of alluvium over buried soil
B Avebury Henge	Butler's Field: Tr 3	Soils (TS)	Kennet floodplain, W of Avebury: 106 cm of silty clay alluvium over buried soil
B Avebury Henge	Butler's Field: Tr 5	Sediments, soils (TS) Mollusca, OSL	Kennet floodplain, SW of Avebury: 104 cm of silty clay alluvium & 133 cm of calcitic silt palaeo–channel deposits
B Avebury Henge	BH251	Soils (TS)	Kennet floodplain, SW of Avebury: 104 cm of silty clay alluvium & 133 cm of calcitic silt palaeo–channel deposits
C Waden and Silbury Hill	BH375: between A361 & Silbury Hill		Kennet floodplain, SW of Avebury: 84 cm of silty clay alluvium & 29 cm of calcitic silt palaeo–channel deposits
C Waden and Silbury Hill	BH223: south of Silbury Hill	Mollusca	Kennet floodplain, S of Silbury Hill & N of Swallowhead Springs: 60 cm of silty clay alluvium & 225+ cm of calcitic silt palaeo–channel deposits
D Timber Palisades	PEC5 East Kennett floodplain	Sediments	Alluvial floodplain sequence (104 cm) over weakly preserved palaeosol
E North Farm	North Farm TP1	Soils, sediments, Mollusca, OSL	Kennet floodplain in Narrow Meadow, North Farm, West Overton: *c*. 50 cm of alluvium & 30 cm of hillwash over a buried soil
E North Farm	North Farm TP2	Soils, sediments, Mollusca, OSL	Kennet floodplain in Narrow Meadow, North Farm, West Overton: *c*. 80 cm of alluvium over 250 cm of palaeo–channel fill deposits

TABLE 3. OSL DATES FOR TRENCHES 2 AND 5 IN BUTLER'S FIELD AND NORTH FARM TEST PITS 1 AND 2

Trench	*Field code*	*Lab code*	*Total D_r ($Gy.ka^{-1}$)*	D_e *(Gy)*	Age *(ka)*	Date
Butler's Field Tr 2	ABRY08	GL18004	1.01±0.07	2.1±0.1	*2.0±0.2 (0.2)*	*210 BC–AD 150*
	ABRY07	GL18003	1.60±0.10	4.0±0.2	2.5±0.2 (0.2)	690 BC–310 BC
Butler's Field Tr 5	ABRY06	GL18075	0.81±0.06	2.1±0.1	2.6±0.2 (0.2)	820 BC–410 BC
	ABRY05	GL18002	0.72±0.05	4.3±0.2	6.0±0.5 (0.4)	4420 BC–3460 BC
	ABRY04	GL18074	0.85±0.06	5.1±0.2	6.0±0.5 (0.4)	4550 BC–3550 BC
	ABRY02	GL18073	0.75±0.05	7.0±0.2	9.4±0.7 (0.6)	8080 BC–6610 BC
	ABRY01	GL18001	0.59±0.04	8.8±0.3	15.0±1.3 (1.1)	14,270 BC–11,730 BC
North Farm Test Pit 2	ABRY18	GL19052	1.79±0.10	1.2±0.0	0.66±0.05 (0.04)	AD 1320–AD 1410
	ABRY16	GL19051	1.09±0.07	1.6±0.1	1.5±0.1 (0.1)	AD 400–AD 620
	ABRY15	GL19050	1.07±0.07	2.1±0.1	2.0±0.1 (0.1)	130 BC–AD 170
	ABRY10	GL19049	0.66±0.05	3.7±0.1	5.7±0.5 (0.4)	4090 BC–3180 BC
North Farm Test Pit 1	ABRY22	GL19055	2.38±0.13	1.6±0.1	0.68±0.04 (0.04)	AD 1300–AD 1390
	ABRY20	GL19054	2.36±0.12	4.9±0.2	2.1±0.1 (0.1)	200 BC–AD 60
	ABRY19	GL19053	2.24±0.13	5.4±0.2	2.4±0.2 (0.1)	550 BC–220 BC
	ABRY13	GL21113	0.92±0.06	2.9±0.1	*3.1±0.2 (0.2)*	*1330 BC–870 BC*

Dose Rate (D_r), Equivalent Dose (D_e) and Age data of OSL samples. D_r values are based on Gamma Spectrometry (*in situ* NaI and *ex situ* Ge), dose rate conversion factors (Adamiec & Aitken 1998), grain size (Mejdahl 1979), burial moisture content (Zimmerman 1971; assumed synonymous with present moisture content), depth, site surface altitude and a geomagnetic latitude of 51°N (Prescott & Hutton 1994). D_e values are based on conventional multi-grain, single-aliquot regenerative-dose (SAR) OSL measurements of fine silt quartz (Berger *et al.* 1980; Murray & Wintle 2000; 2003). Age estimates are based on the Central Age Model (Galbraith *et al.* 1999) and expressed relative to year of sampling (2018). Uncertainties in age are quoted at 1σ confidence, are based on analytical errors and reflect combined systematic and experimental variability and (in parenthesis) experimental variability alone. *Note*: italicised age estimates are accompanied by significant U disequilibrium (Olley *et al.* 1996), so are tentative only

are the significant (>50%) U disequilibrium detected within samples GL18004 and GL21113; these associated OSL ages should be accepted tentatively.

The location of all boreholes and test pits were recorded in the field using a Smartnet Leica GPS system. All data were imported into standard GIS file formats (.shp files) for integration with other project data (eg, lidar, aerial photographs, etc.).

Molluscan and palaeo-environment proxies

The analysis of the palaeo-environment data from this research forms a second paper for this project (French *et al.* in prep.). However, it is worth noting here that molluscan samples were taken from Zone A Test Pit 3, Zone B Trenches 2 and 5 in Butler's Field, Zone C calcitic palaeo-channel fill deposits in BH 223 to the south of Silbury Hill, and Test Pits 1 and 2 in Zone E at North Farm, West Overton, for the assessment of preservation and comparison with the previous sequences analysed by Evans *et al.* (1993) from North Farm (Zone E), beneath the Avebury henge bank (Evans 1972; Vatcher & Vatcher 1976), and in Butler's Field (Zone B) (Evans *et al.* 1985) and from buried soils beneath West Kennett and South Street long barrows (outliers to Zone C) and at the Windmill Hill causewayed enclosure (an outlier to Zone A) (Evans 1972).

The assessment and preliminary analysis of the land snails shows an almost total loss of preserved shells from locations and deposits almost identical to those previously sampled by Evans *et al.* (1985; 1993) such as in Butler's Field and North Farm. This strongly indicates that there have been significant changes in the chemical hydrology and hydrological dynamics of the upper Kennet valley in less than a generation. This is a significant loss for further palaeo-environmental enquiry and has forced this project to rely on and re-valuate previously published data (Evans 1972), and these results will be discussed in a forthcoming paper (French *et al.* in prep.). Furthermore, the new interpretations of this landscape from the geoarchaeological and soil surveys completely shift the fundamental interpretative platform on which the basis of the post-glacial woodland existed (cf. Allen 2017).

In addition, several sets of sub-samples were also taken from the palaeo-channel fills and buried soils for pollen preservation assessment by Prof R.G. Scaife. These include: the palaeosol in BH 528 to the south-east of Avebury henge; the palaeo-channel in Trench 5, Butler's Field and between Silbury Hill and Swallowhead Springs in BHs 223 and 379; the springhead at BH 419 at the southern base of Waden Hill; the palaeosol in BH 524 to the north of East Kennett long barrow; and the buried soil and palaeo-channel at North Farm Test Pits 1 and 2, respectively. Pollen preservation was extremely poor throughout. However, in the last month of the project, sink-hole deposits beneath two Roman wells were discovered in Zone A on the floodplain margin of Spring Field to the north-west of Avebury henge with good pollen preservation throughout an 11 m deep sequence in Trench 4, but which unfortunately only related to the Late Iron Age and Romano-British periods when radiocarbon dated.

RESULTS

The results will briefly describe the key transects and test pit/trench profiles for each valley zone (Table 2) to provide an overview of the colluvial and alluvial sediment sequences. The overviews presented below are based on more detailed descriptions in Appendices S4 and S5. All reported depths are given as depth below the current ground level (BGL).

Zone A

The borehole transects in Zone A to the north-west of Avebury henge contain very limited upslope storage of hillwash. This aspect is particularly evident in Transect 44 (Figs 2 & S1; Table S1), down slope from Windmill Hill to the Kennet floodplain north of Avebury henge. The transect consistently shows a thin (<0.25 m) rendzina or grassland soil developed on a calcareous parent material. Rendzinas are generally composed of an amorphous, earthworm reworked, turf and organic A (or Ah) horizon over a weathered, calcareous B/C horizon (Limbrey 1975, 128–30). However, at certain points on the downslope there are thin 'fingers' of pale brown silt loam hillwash underneath the present day rendzina topsoil (ie, in boreholes BH 335–338), essentially in localised pockets deposited on breaks of slope, which are undated.

The alluvial sequences in this zone of the western side of the upper Kennet floodplain to the north-west of Avebury henge are relatively thin, comprising *c.* 0.3–0.5 m of a pale grey brown silt loam as observed in Spring Field/Winterborne North Test Pits 1, 3, and 4 (Appendices S4 & S5; Figs 2, 3, & S10) which is probably hillwash derived alluvium. However, preserved beneath these alluvial units are palaeosols which are generally thin, probably truncated and/or modified, but occasionally are moderately well-developed argillic (or clay-enriched) brown earth soils (Fedoroff 1968; Bullock & Murphy 1979; Kuhn *et al.* 2010), grading to more ubiquitous rendzina soils upslope beyond the floodplain margins. The absence of more than a few pure (or limpid) clay coatings suggests that this soil was not particularly well-developed and therefore probably not indicative of a stable, long-lived woodland soil (Bullock & Murphy 1979; Fedoroff 1968; Appendix S5). However, the abundance of dusty (silty or impure) clay suggests that these buried soils have undergone repeated episodes of physical disturbance, followed by relative stability for some time in the past (cf. Slager & van de Wetering 1977; Macphail 1992; Lewis 2012). Moreover, the absence of illuvial dusty clay in the voids/channels suggests that there was a minimal effect of more recent alluviation on this buried soil. Thus, these pockets of well preserved buried soils define a reasonable floodplain margin stability. It is suspected that the alluvial aggradation did not occur within this zone until the Iron Age or later, based on stratigraphic correlation with the lower valley zones (see below).

Zone B

The investigations in Zone B focused on the alluvial sequences adjacent to the western side of Avebury henge, utilising profiles from Transects 1000, 30, and 1, Trenches 2 and 5 in Butler's Field, and Test Pit 1 about 100 m to the south in the floodplain between the A4361 and Silbury Hill (Figs 2–9, S2, & S3; Appendices S4 & S5).

The upslope part of Transect 1 beyond the floodplain to the east of Avebury henge revealed very limited storage of colluvial deposits. However, significantly, a brown earth soil with predominant coarse silt (*c.* 25–40%) and very fine quartz sand (*c.* 20–30%) components was discovered in boreholes BH 528 and

Fig. 3.
Zone A Test Pit field photographs of profiles TP3 (top left) and TP4 (bottom middle), and Zone B Test Pit profile TP1 (top right) (C. French)

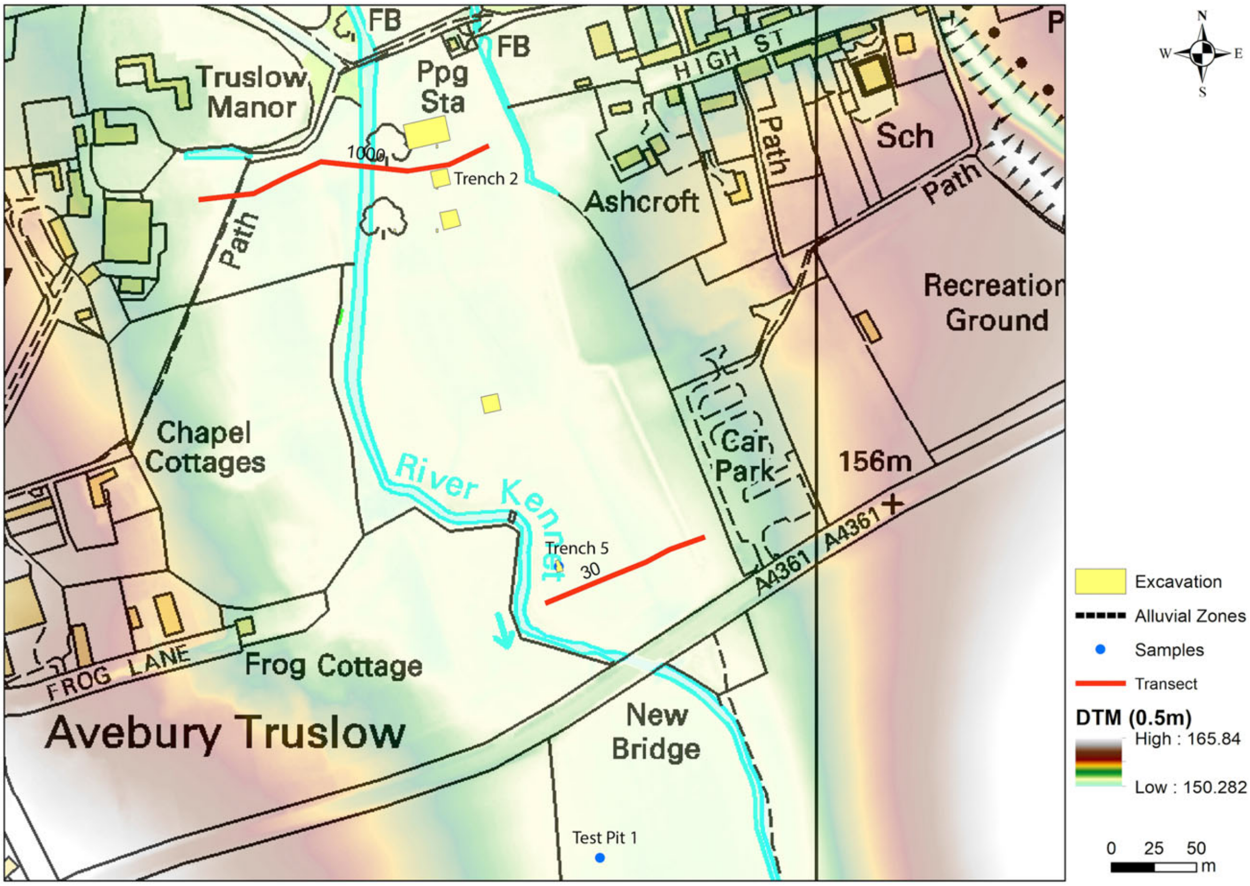


Fig. 4.
The location of test pit and excavation areas in Zone B Butler's Field (C. Carey)

536. This suggests an inherited loessic (or wind-blown) component to this soil (cf. Catt 1978; Pye 1995) with the presence of some former, long-standing woodland cover at this locale indicated by the birefringent pure clay (*c*. 5–15%) striae in the groundmass (cf. Bullock & Murphy 1979) but is unfortunately undated.

The floodplain deposit sequences are best revealed in Trenches 2 and 5 in Butler's Field (Figs 2–5). Trench 5 exhibited a deep alluvial sequence within a low point depression in the floodplain, reaching a depth of 2.48 m below ground surface (Figs 4–7 & S3; Tables 2–4, & S3). As such it constituted a somewhat atypically deep alluvial sequence with seven distinct alluvial units recorded. The detailed sediment descriptions are provided in Appendix S4.

The depression that has infilled in Trench 5 revealed five alluvial units divided in two distinct phases of alluviation (Figs 2–5 & S3; Tables 2–4 & S2; Appendices S4 & S5). The first phase of alluviation was fluvial deposition (units 501, 502, and most of 503), with calcite dissolution causing the deposition of fine-grained (silt-sized) calcitic alluvium with a significant fine sand component at low points in the floodplain. This form of mainly reprecipitation of calcium carbonates can only occur when parts of the chalk valley floor are 'exposed' with a considerable overflow of water to facilitate dissolution (Ahnert 1996, 152–4; Durand *et al*. 2010, 175–6). This then envisages a wider channel with areas of braid plain and little alluvial infilling. The basal pale grey calcitic silt (unit 501) demonstrates that this natural process occurred in moderate to high energy conditions from the very Late Pleistocene (14,270–11,730 BC; GL18001) (Tables 3 & S2) with *c*. 0.45 m of channel fill accumulation. This same process continued throughout unit 502 above with *c*. 0.27 m of grey calcitic silty clay alluvium deposited with a slight elevation in organic content and lowering of the

Fig. 5.
Zone B Butler's Field, photographs of alluvial sampling showing the sediment profiles in Trench 5 (left) and Trench 2 (right) (C. French)

energy of depositional environment (reduced sand fractions). There is an associated OSL date between 8080 and 6610 BC (GL18073) (Tables 3 & S2), across the Mesolithic and into the Late Mesolithic–Early Neolithic period.

Unit 503 above represents a significant change in the chronology and alluvial signature in this part of the upper Kennet floodplain with an Early Neolithic OSL date of 4420–3460 BC (GL18002) (Tables 3 & S2). The composition of the alluvium changed, albeit slowly to start with. A non-calcitic, minerogenic component becomes visible, with a reduction in clay and the very fine sand to coarse sand components and, conversely, an increase in the fine–coarse silt components. This began as a minor signal and was probably related to soil disturbance through the release of fine–coarse silt components in the catchment. The natural channel alluviation signature of high calcium carbonate and clay content decreases though the unit but is still dominant, describing a wide, shallow river channel, flowing over chalk, and redeposition of calcite within areas of deeper, lower energy water.

If unit 503 had formed throughout the period of *c.* 4000–1000 BC, then the intensity of landscape impact visible through alluvial deposition associated with monument construction is exceptionally low. However, it is also possible that unit 503 was deposited over a much shorter time period, for example at the time of construction of the adjacent Avebury henge, and as such represents landscape use and disturbance associated with specific monument construction and, therefore, discontinuous deposition. Either way, this alluvial deposit is not widespread and is only deposited in localised topographic low points. Therefore, it does not represent widespread Neolithic–Bronze Age alteration of the landscape. Rather it represents the same process of continued fluvial low point deposition visible throughout the late Pleistocene and into the Mesolithic and Neolithic but with a small, definable increase in the larger silt fractions, probably representing small-scale,

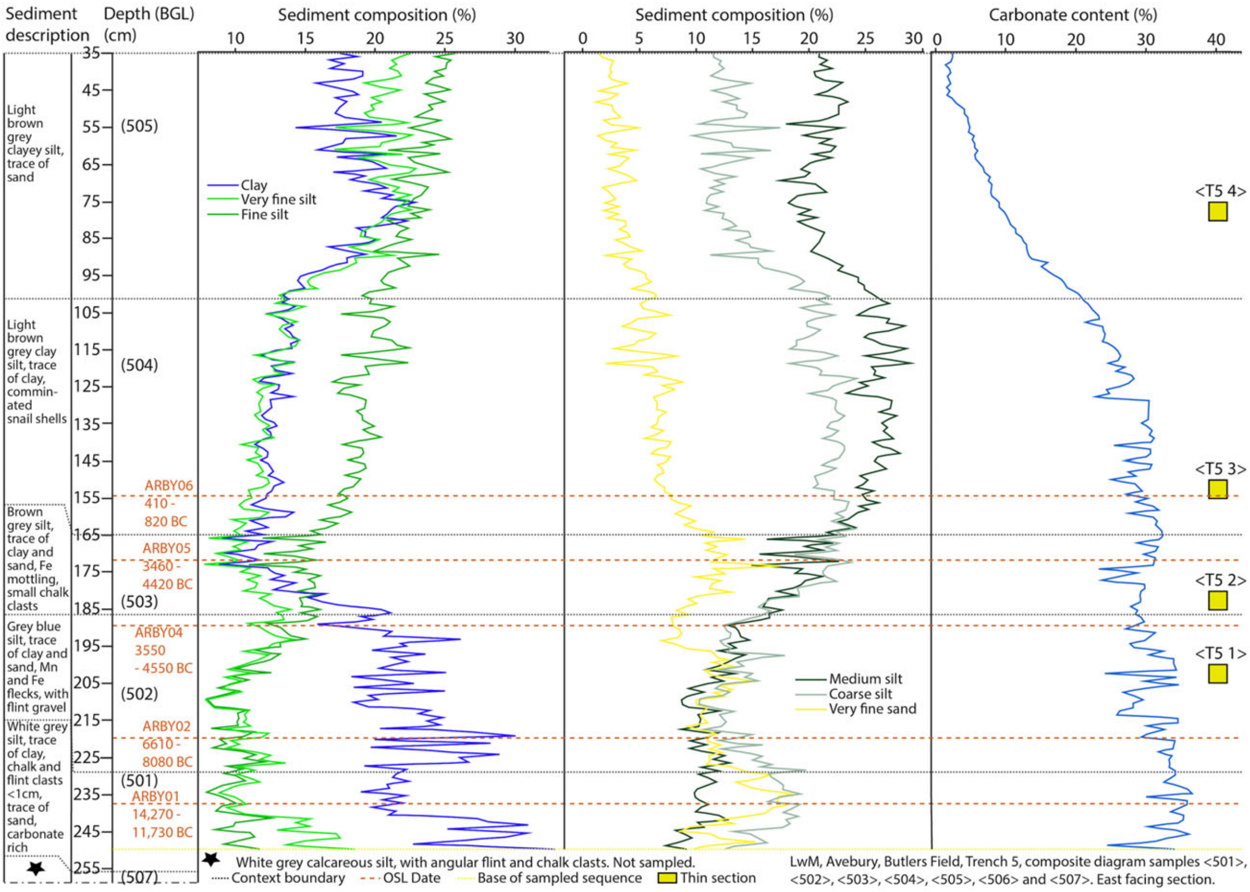


Fig. 6.
Zone B Butler's Field Trench 5 sediment data 1. Also refer to Table S3 (C. Carey/N. Crabb)

light touch, anthropogenic landscape impacts and associated minor soil erosion.

From unit 504 upwards, a calcitic but more humic, silty clay alluvium was deposited across a much wider swathe of the floodplain, not just in the localised low point depression. The minerogenic components of the coarse, medium, and fine silts increase, while calcium carbonate contents decrease, defining a floodplain that was infilling with sediments. Towards the top of unit 504, clay and very fine silt start increasing again, defining an overall lowering of energy of the river, associated with an overbank alluvial aggrading valley floodplain, with a meandering single thread channel. The OSL date toward the base of unit 504 is of the Early–Middle Iron Age (820–410 BC; GL18075; Tables 3 & S2). Given chronostratigraphic correlations with elsewhere in the valley (in Zones D and E), it is anticipated that unit 504 began to form from the Late Bronze Age at *c*. 900 BC and continued through to the Roman and medieval periods.

Finally, unit 505 demonstrates a river valley with significant deposits of well structured, humic, dark brown, silty clay alluvium aggrading across the floodplain and a single channel river system with relatively low energy defined through the higher clay and very fine silt fractions. This low energy alluvial unit is visible across the wider upper Kennet valley and most probably dates to the late medieval–post-medieval period (see North Farm also). Unit 505 has some elevated magnetic susceptibility values which may relate to medieval and post-medieval activity at this locale, as was observed in other trenches in Butler's Field.

The other trenches excavated in Butler's Field revealed archaeology interspersed within thinner alluvial deposit sequences that are more characteristic of the wider valley. Trench 2 contained this more

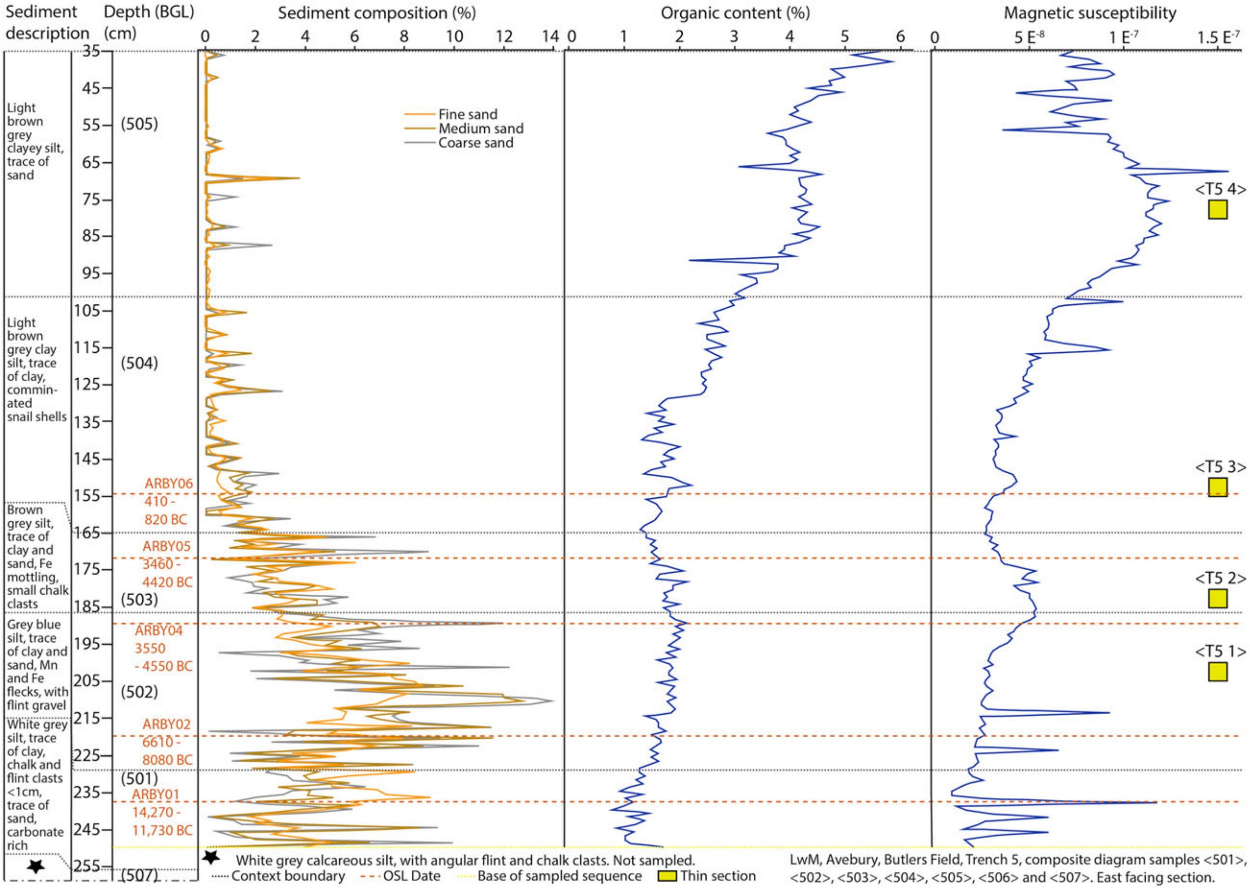


Fig. 7.
Zone B Butler's Field Trench 5 sediment data 2. Also refer to Table S3 (C. Carey/N. Crabb)

characteristic alluvial sequence, having a total alluvial sediment depth of *c.* 1.3 m, overlying a basal palaeosol (Figs 5, 8, & 9; Tables 2–4, S2, & S4; Appendices S4 & S5). In Trench 2, due to the thinner deposit sequence, a product of the slightly higher basal Pleistocene topography, there is no evidence for the natural alluvial infilling of calcite rich fluvial sediments in the early Holocene. Instead, the basal unit 639 is a floodplain palaeosol with evidence of pedogenic sorting alongside anthropogenic inclusions such as flint flakes and charcoal. It is apparent that this palaeosol was still in existence in the Early–Middle Iron Age with an OSL date of 690–310 BC (GL18003), although the top of the soil bears clear evidence of alluvial additions, until burial by minerogenic alluvium in the Late Iron Age/ Roman-British period with a caveated OSL date of 210 BC–AD 150 (GL18004; Tables 3 & S2). This alluvial aggradation continues throughout the medieval period when the alluvial sequence bears witness to considerable human activity at this locale (McOmish *et al.* 2005). This 'medieval soil complex' is not a widespread deposit and is not evident outside of Butler's Field, with post-medieval alluvium dominated by fine sediment fractions burying it. Of particular note is that the Trench 2 alluvial sequence reveals no evidence of anthropogenic landscape disturbance in either the Neolithic or Bronze Age when large monuments were being constructed. Instead, this phase of substantive landscape alteration and human impact (eg, cultivation) occurred much later during the Iron Age–Romano-British periods.

Also in zone B in the floodplain to the south of Trench 5, a buried soil was present in Test Pit 1 (Fig. 3; Tables 3 & 4), which was buried by *c.* 1.4 m of irregular blocky, humic silty clay alluvial material as in Trench 2 (above). The palaeosol is a calcitic silty clay loam mixed

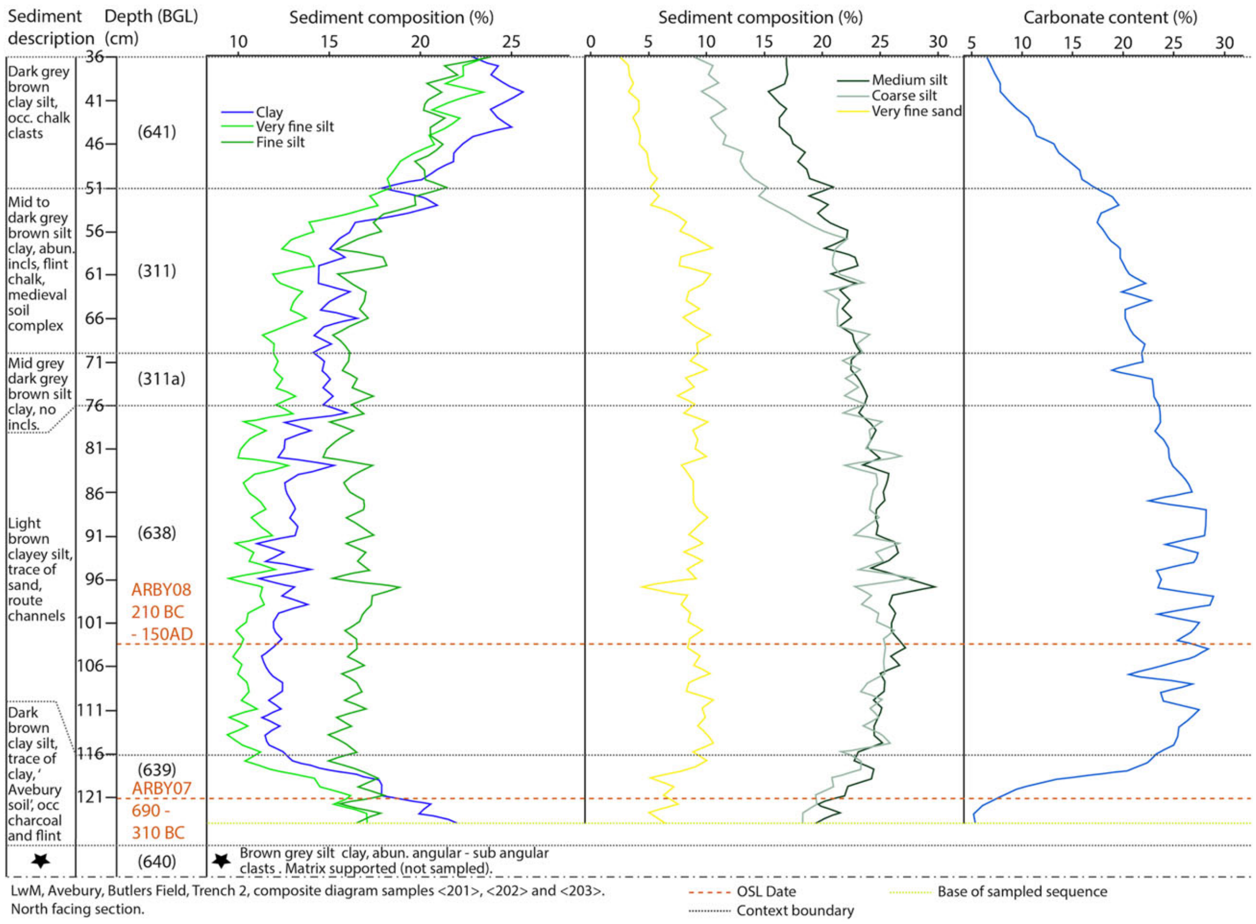


Fig. 8.
Zone B Butler's Field Trench 2 sediment data 1. Also refer to Table S4 (C. Carey/N. Crabb)

with fine chalk/flint gravel and exhibiting considerable oxidation mottling (Fig. S10d). It is suggested that this partially gleyed B horizon (or Bgk) appears to have undergone little pedogenesis prior to alluvial deposition. But it has undergone severe transformation through wetting and drying processes (Lindbo *et al*. 2010) and the solution/dissolution of silt-sized calcium carbonate (Ahnert 1996, 152–4; Durand *et al*. 2010), most probably derived from the underlying geology and available groundwater in this part of the Kennet valley.

Zone C

Zone C covers the Kennet floodplain to the north of Silbury Hill and the dry valley east of Waden Hill, up to the change in the direction of the River Kennet to a more easterly course downstream (Fig. 2). Borehole transects 50, 65, 47, and 7 provide the stratigraphic overviews of this part of the floodplain (Figs S4 & S5; Table S1; Appendix S4). Transect 50 traverses downslope from the top of Waden Hill, south-west to north-east. The transect describes a thin rendzina soil on the top of Waden Hill which slightly thickens downslope with an underlying orange brown/reddish brown silty clay horizon, probably an iron oxide rich Bw horizon of a palaeosol. Transect 7 traverses the valley on the east side of Waden Hill, on a broadly NNW–SSW alignment and records no alluvial deposits within the valley floor, although a thin deposit of colluvial deposits is visible beneath the current topsoil.

Zone C records an alluvial deposit sequence with localised Pleistocene depressions in the floodplain

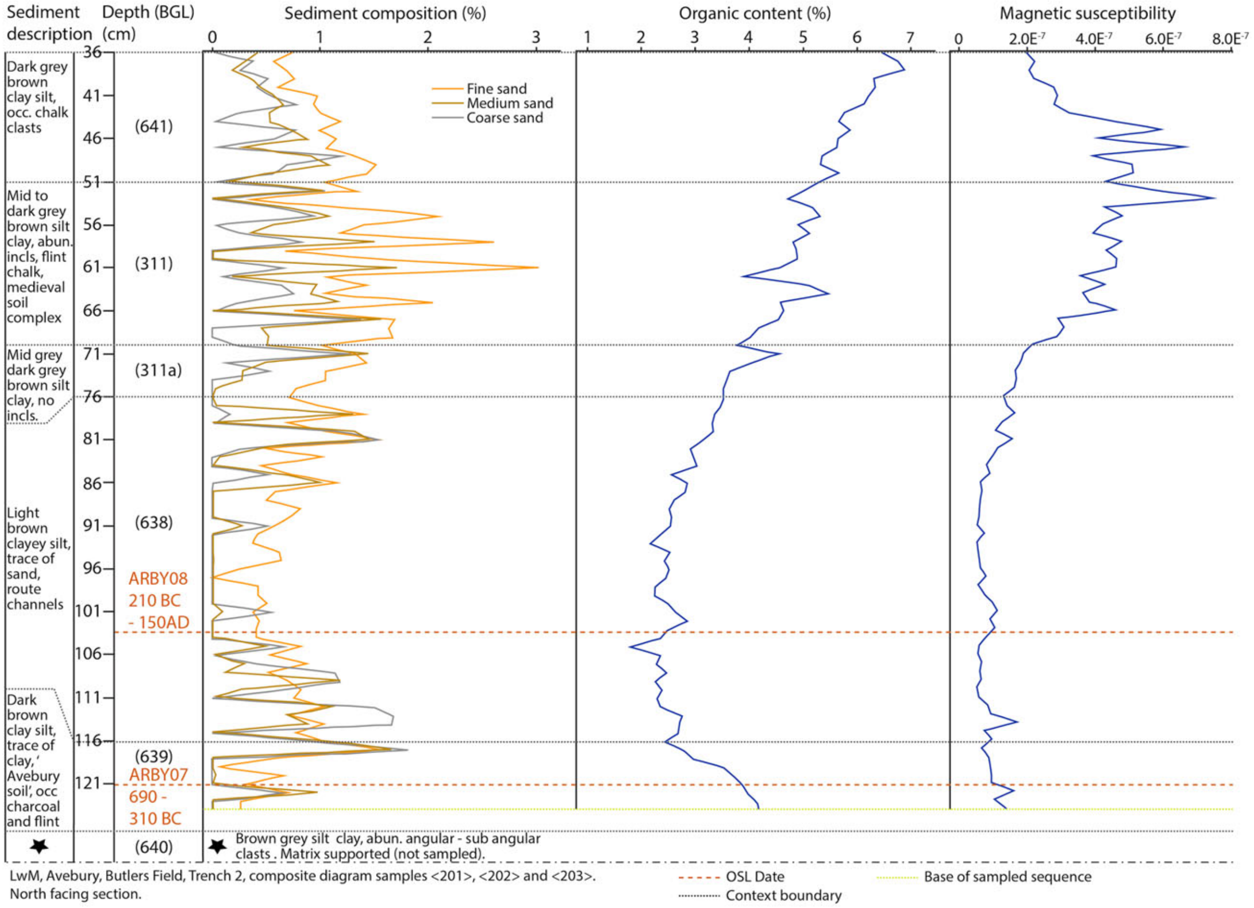


Fig. 9.
Zone B Butler's Field Trench 2 sediment data 2. Also refer to Table S4 (C. Carey/N. Crabb)

capturing longer alluvial sediment archives similar to Zone B. Transect 65 records a Pleistocene periglacial alluvial deposit, overlain by a rubbly hillwash deposit, before the more recent alluvial unit 3 (Roman–medieval) and alluvial unit 4 (post-medieval) (dated through chronostratigraphic correlation with Trench 5 in Zone B). The valley sides again record little upslope storage of colluvial sediments with only thin deposits evident in transect 50 across Waden Hill. The valley to the east of Waden Hill did not contain any alluvial deposits and the colluvial sediments that had washed into this valley sediment receptor were relatively thin (<0.25 m), although these are undated. These small pockets of low volume of colluvial material do not indicate widespread or intensive landscape (woodland) clearance and/or cultivation with associated destabilisation of soils and subsequent erosion.

Zone D

Once east of the sharp bend in the River Kennet south-east of Silbury Hill, the modern river takes on a gently meandering course with several relatively narrow 'pinch-points', such as at the southern end of Waden Hill and between the southern slope of Overton Hill and East Kennett village (Fig. 2). The alluvial sequences in this floodplain zone bear a remarkable similarity to those recorded and analysed in Zone B, with the same general deposition of major alluvial units and a general lack of colluvium observable on the valley sides and breaks of slope. The stratigraphic overview for Zone D is provided from transects 54, 59, and 15 (Figs 2 & S6; Table S1; Appendix S4). Transect 54 heads downslope on the south side of the Kennet valley, traversing from south to north, stopping just before the floodplain, through the

TABLE 4. SUMMARY DESCRIPTIONS, INTERPRETATIONS, AND WIDER IMPLICATIONS OF THE SOIL MICROMORPHOLOGICAL DATA FROM THE UPPER KENNET VALLEY

Sample area	*Micromorphological features*	*Interpretation*	*Wider implications & relative dating*
Avebury henge (E of Zones A & B)	*c.* 20–30 cm thick horizon of pale brown to yellowish/ reddish brown silt loam beneath the turf, over strong reddish brown silty clay loam with few fine chalk & flint gravel pebbles, all developed on weathered chalk	argillic buried soils with loessic component on clay-with-flints geology to the E & SE of henge; rendzinas to N, S, & W	long-lived, stable, well vegetated (& wooded) conditions in places; but mainly grassland elsewhere; argillic brown earths present on E side of henge
Winterborne North-west (Zone A)	(n/a)	this Oslip stream western fork of the upper Kennet is more of a low-lying spring-fed zone than a floodplain valley *per se* with often waterlogged rendzina pasture soils	natural spring-fed wet zone with no alluvial accumulation throughout
Winterborne North (Spring Field) & South in Kennet floodplain (Zone B)	brown, v. fine sandy/silty clay loam exhibiting irregular small blocky ped structure with few to common chalk & flint gravel pebbles, becoming more calcitic with depth, over well-structured golden brown, fine sandy/ silty clay loam buried soil with illuvial, well-oriented dusty & occasional pure clays	*c.* 35–50 cm of silty clay alluvium, increasingly calcitic, over thin, probably truncated, moderately well-developed argillic (clay-enriched) brown earth soils on W margin of floodplain, grading to rendzinas beyond W floodplain edge	reasonable floodplain margin stability & absence of significant alluvial aggradation probably until Roman or later times
Butler's Field in Kennet floodplain (Zone B)	up to a *c.* 2.5 m sequence depth of well-structured dark greyish brown silty clay upper alluvium ('Arion clay') over basal alluvium of pale grey/yellowish brown v. fine sandy silt with fine shell frags over either a buried soil of poorly developed greyish brown silt loam with few fine charcoal, chalk & flint frags, or over grey calcitic silts infilling a palaeo-channel	as above for floodplain margin soil, but subject to both calcitic silt (from *c.* 4400 BC) and silty clay (from after *c.* 690–310 BC) alluvial aggradation accumulating in interlinked small basins; as slope rises westwards & eastwards, rendzinas prevail	most of floodplain area affected by water ponding from Neolithic times; from Iron Age & Roman times subject to silty clay alluvial aggradation; from late 16th century most of area made into fishing ponds
Silbury Hill, Swallowhead Springs & Kennet floodplain to West Kennett Farm (Zone D)	thin dark brown silty clay alluvium over either a thin, poorly developed sandy loam buried soil or shallow calcitic silt fills of a palaeo-channel	sharp-angled river channel, with much avulsion only N of Swallowhead Springs, subject to both calcitic silt & silty clay alluvial aggradation; thin brown earth soils on SE flank of Silbury Hill & probably also where West Kennet palisade enclosures were built, which had already largely degraded to rendzinas before later 4th millennium BC when the palisaded enclosures were probably built	essentially 1 main channel occupying whole width of floodplain, with aggradation from later prehistoric & Roman/post-Roman times; defined by terrace on S flank & rising ground to N; abrupt transition to rendzina soils to S, but more mixed rendzina to brown earths on N & S banks beyond on floodplain margins & foot of downland slopes

(Continued)

Table 4. (Continued)

Sample area	*Micromorphological features*	*Interpretation*	*Wider implications & relative dating*
Floodplain from West Kennett Farm east to West Overton (Zones D & E)	well-structured dark brown silty clay alluvium over greyish brown calcitc silt with few v. fine chalk frags over brown sandy/silt loam buried soil	loessic-like brown earth development on N bank, probably disturbed by human activities; buried at *c.* 1400 BC by rubbly calcitic hillwash from downland slopes immediately to the E, & then silty clay loam eroded soil aggrading as alluvium from Roman times onwards	whole floodplain subject to both calcitic silt & silty clay alluvial aggradation through later prehistoric & historic times, respectively, with occasional small lobate zones of chalky hillwash accumulation on N margins of floodplain
Floodplain in Fyfield to Clatford area (east of Zone E)	shallowing dark brown silty clay alluvium over thin, brown sandy/silt loam with chalk rubble soils	W to Fyfield area as above, but by Clatford floodplain area almost no alluvial aggradation is evident	changes to wide, shallow, active floodplain with minimal alluvial aggradation, associated with rendzina soils on its N slopes

western edge of the West Kennet palisaded enclosures. The transect records a generally thin soil sequence downslope, although two instances of relatively thick (<1 m) colluvium are recorded. In common with Zones A–C, the upslope storage of colluvial deposits recorded in Zone D is minimal and localised.

Transect 59 traverses south-west to north-east on the southern side of the Kennet floodplain, just upstream and to the north-west of the location of the West Kennet palisade enclosures (Fig. S6; Table S1). The transect records a layer of basal pale greyish white calcitic silt, a channel deposit (unit 4), overlain by a dark greyish brown silty clay alluvium (unit 2), beneath the modern soil profile (unit 1). The alluvial deposit sequence is deepest on the southern edge of the floodplain and gets thinner as the basal topography increases in elevation towards the current river channel. Similar to transect 59, transect 15 traverses the Kennet floodplain on the southern side, south-west to north-east. The alluvial sequence thickens towards the river moving northward and reaches a maximum depth of 1.33 m. The deposit sequence has a thin, intermittent, basal dark grey brown clay silt with sand, abundant fine organic material, and small crushed shells. This is overlain by unit 3, a greyish brown calcitic silt with few very fine chalk fragments, a hillwash derived calcitic alluvium. The later interpreted medieval–post-medieval dark silty clay alluvium (unit 2) was intermittently visible in the transects and is present in core PEC5a (below). In general, the depth of the alluvial sediment sequence at this location varied between 0.75 m and 1.33 m BGL, demonstrating the same pattern of alluviation visible in zones B and C, outside of the localised deep deposit sequence such as observed in Trench 5 in Butler's Field. In addition, a single gouge core sample was collected and analysed from transect 15 at borehole PEC5a (Fig. 2).

Core PEC5a, located in the floodplain between West Kennett Farm and East Kennett village, provided a detailed analysis of the floodplain deposits present in Zone D (Figs 2, S7, & S8; Table S5; Appendix S4). Due to access restrictions, it was not possible to excavate a test pit at this locality to provide an OSL chronology for the deposit sequence alongside the sediment analyses. Therefore, after sediment characterisation of this deposit sequence, chronostratigraphic correlations were made between core PEC5a and the dated exposures in Zone B Butler's Field and Zone E North Farm (see below).

The depth and character of the alluvial sequence shows a remarkable correlation to the dated deposit

Fig. 10.
The location of test pit and excavation areas in Zone E North Farm (C. Carey)

sequences upstream in Zone B at Butler's Field and downstream in Zone E at North Farm. Therefore, there is a high degree of confidence in the interpreted chronostratigraphic sequence put forward. The sediment sequence shows the same character of later prehistoric (Late Bronze Age/Iron Age) alluviation above a weakly preserved land surface as observed in Trench 2 in Butler's Field Zone B. Alluviation continues through the Roman period, when the levels of calcium carbonate start to drop as the floodplain infills. This process continues into the medieval period when an alluviated valley floor and single channel river can be inferred before the presence of the late medieval/post-medieval alluvial aggradation. The high levels of coarse and medium silt components even in the early carbonate rich (but less than 30%) earliest alluvium, define a clear anthropogenic driver to the alluviation in this sequence. Again, the interpreted chronostratigraphy provides no definition of earlier phases of alluviation associated with the nearby upstream monuments, especially the nearby West Kennet palisaded enclosures.

Zone E

Zone E is the reach of floodplain heading eastwards along the River Kennet towards West Overton and Fyfield (Figs 2, 10, 11, & S9). The site of The Sanctuary, the terminus of the West Kennet Avenue, overlooks the floodplain on the north side alongside the Overton barrow cemetery. The stratigraphic overviews for this zone are provided by transects 63

Fig. 11.
Zone E North Farm, photographs of the sediment profiles during excavation, showing Test Pit 2 (left) and Test Pit 1 (right)

and 62 with detailed analyses of the floodplain stratigraphy in Test Pits 1 and 2 at North Farm (Appendices S4 & S5).

The analysis of Test Pit 2 describes an alluvial sequence with seven distinct sediment units (Figs 11–13 & S12, e–g; Tables 2–4, S2, & S6; Appendices S4 & S5). It exhibits direct parallels to the alluvial sequences already described in Zones B and D, and bears a remarkable similarity to the alluvial sequences analysed in Butler's Field Trenches 2 and 5 in Zone B and core PEC5a in Zone D. The deposit sequence has infilled a topographic low point in the floodplain, although this depression is not as deep as in Trench 5 in Zone B, but deeper than the deposits recorded in Trench 2 (Zone B) and the depth of the coring at PEC5a (Zone D).

As for Trench 5 in Butler's Field, the definition of both a Late Pleistocene and Mesolithic period alluvium in Test Pit 2 at North Farm are atypical for alluvial sequences in southern England. However, both basal units 107 and 106 (Appendix S4) have been deposited as a consequence of natural channel flow through a topographic low point in the floodplain and as such they represent a naturally forming, calcite rich fluvial deposit. They both describe a floodplain where there was exposed chalk within a wide shallow channel and presumable areas of braid plain, allowing dissolution of chalk and its subsequent reprecipitation in areas of lower energy flow. However, the base of unit 105 produced an Early–Middle Neolithic OSL date of 4090–3180 BC (GL19049; Tables 3 & S2), and demonstrates a change in the composition of the alluvial sediment character. While this unit is again predominantly a naturally forming, calcite rich fluvial channel deposit with a significant fine sand component, there is an unmistakable signature of increasing medium and coarse silt components. These may be derived from the erosion of soils that had incorporated some loessic material and, as such, may be a definable anthropogenic disturbance signal within the alluvium. Nonetheless, unit 105 does record some low level landscape disturbance, possibly localised. As such, it is tempting to define this weak alluviation signal with monument construction further upstream, although this interpretation is speculative.

Towards the top of unit 105, the signature of human driven alluviation becomes stronger and by unit 104 has an OSL date of the later 1st millennium BC/early 1st millennium AD (130 BC–AD 170; GL19050; Tables 3 & S2) with an increased rate of anthropogenically driven alluviation across the valley floor. It demonstrates the same pattern of increasing Late Iron Age–early Roman exploitation and impact across the valley catchment with a corresponding increase in alluvial sedimentation. Unit

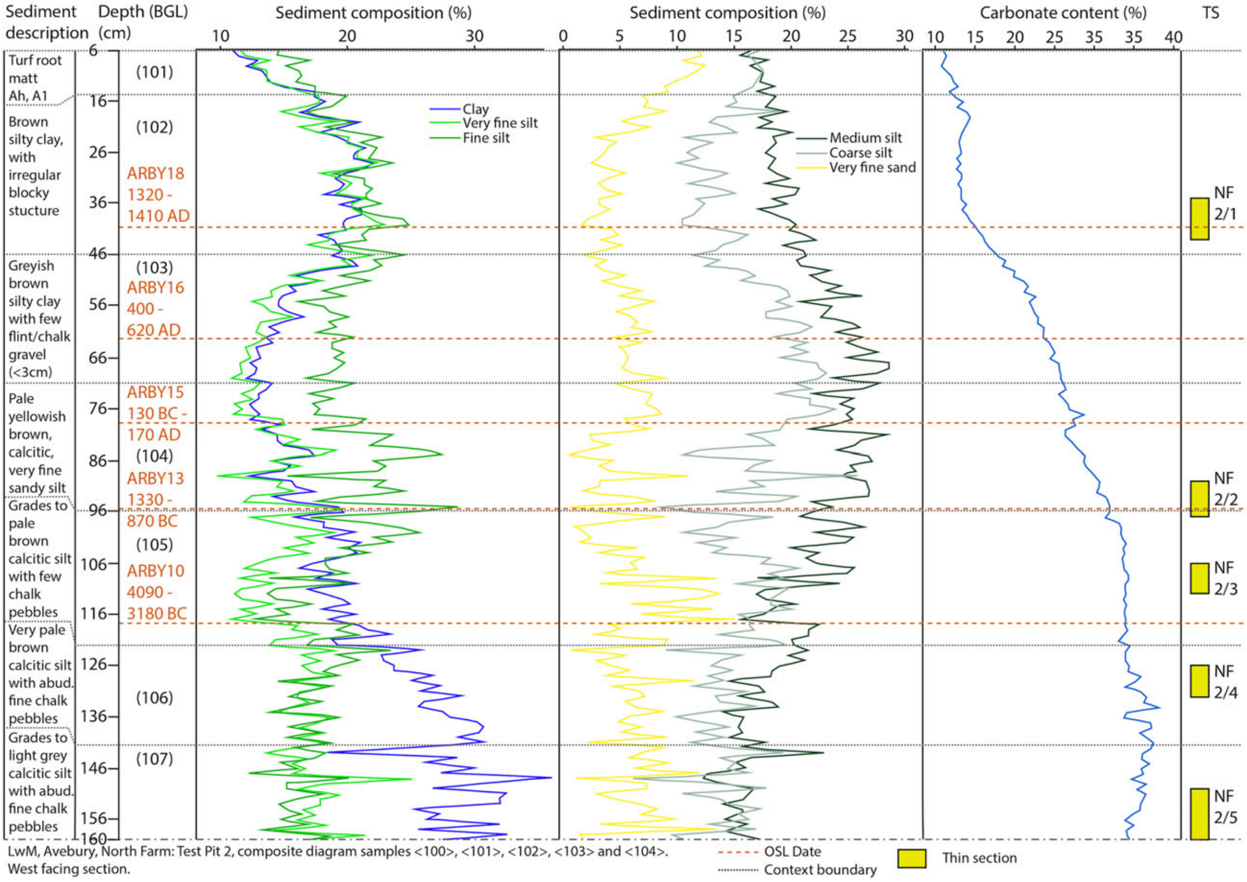


Fig. 12.
Zone E North Farm Test Pit 2 sediment data 1. Also refer to Table S6 (C. Carey/N. Crabb)

103 above demonstrates ongoing alluviation throughout the post-Roman and medieval periods. As the humic silty clay alluvium continued to be deposited within the floodplain, the river channel became increasingly constrained, with a corresponding reduction in the chalk dissolution reflected through redeposited calcite. By the late medieval–post-medieval period in unit 102 (AD 1300–1390; GL19055; Tables 3 & S2), the energy of deposition had substantially reduced with a clay and very fine silt rich alluvium, defining an infilled floodplain dominated by clay rich minerogenic alluvium.

In contrast, Test Pit 1 at North Farm describes a colluvially dominated sequence with three sediment units overlying a buried soil (Figs 10, 11, 14, 15, & S12, a–d; Tables 2–4, S2 & S7; Appendices S4 & S5). The North Farm Test Pit 1 sequence quantitatively describes the 'Avebury soil' as identified by Evans *et al.* (1993). It was originally thought to represent a Mesolithic–Neolithic soil typical of the Avebury area. However, the OSL dating shows this to be an extant soil through much of the Iron Age and into the early Roman period from 550–220 BC (GL19053) to 200 BC–AD 60 (GL19054; Tables 3 & S2), although this soil does exhibit some alluvial additions. The buried soil evidence (in unit 112) strongly suggests an open and stable brown earth soil, most probably associated with long-term pasture, rather than woodland soils on the river's northern margin. The profile also clearly demonstrates the onset of colluvial sediments reaching the valley floor, in this case covering the 'Avebury soil' from the Iron Age/early Roman period, potentially implying cultivation of areas of previous grassland/pasture just upslope. It is quite possible that this may relate to some form of landscape re-orientation in the Iron Age. Unit 111 is predominately colluvial but, towards the top, there is

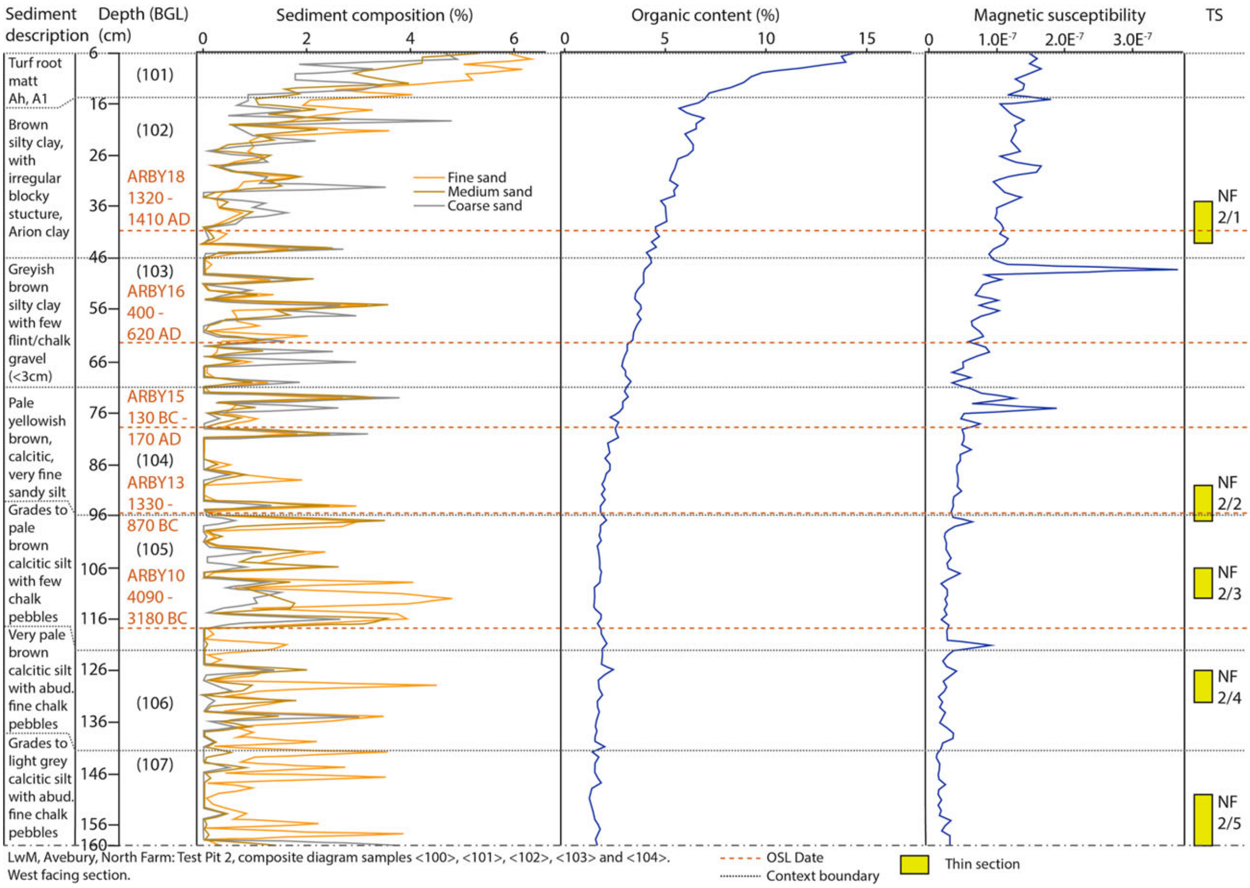


Fig. 13.
Zone E North Farm Test Pit 2 sediment data 2. Also refer to Table S6 (C. Carey/N. Crabb)

an increasing alluvial fine sediment component which demonstrates landscape use and impact from the medieval period. Above this, in unit 110, there was continuing widespread aggradation of late medieval–post-medieval clay and fine silt dominated alluvium with an OSL date of AD 1300–1390 (GL19055; Tables 3 & S2), although with some colluvial inputs, explaining the continued dominance of the fine-coarse silt fractions.

A CHRONOSTRATIGRAPHIC DEPOSIT MODEL FOR THE UPPER KENNET VALLEY

Alluvial deposit sequences were present along the whole length of the upper River Kennet valley from north-west of Avebury (Zone A) to North Farm, West Overton (Zone E). From immediately west of Avebury to North Farm (Zones B–E), the alluvial deposit sequence showed a remarkable cross-correlation, in both the characteristics of the wider sediment units and their chronological relationships. The field data has been necessarily detailed above and in Appendices S1–S5 but is essential to construct true chronostratigraphic deposit models of the wider floodplain reaches, especially when there is an intimate relationship between the river system and prehistoric monumental complexes. However, to simplify this dense data capture, the alluvial zones, key alluvial stratigraphic units, their key sedimentary characteristics, OSL dates (Tables 3 & S2), and associated interpretations are presented in a concise chronostratigraphic deposit model (cf. Carey *et al.* 2019), which has correlated equivalent sediment units across the valley based on their physical characteristics (Tables 5, S1, & S8).

From this model different phases of alluviation are observable that are associated with different phases of

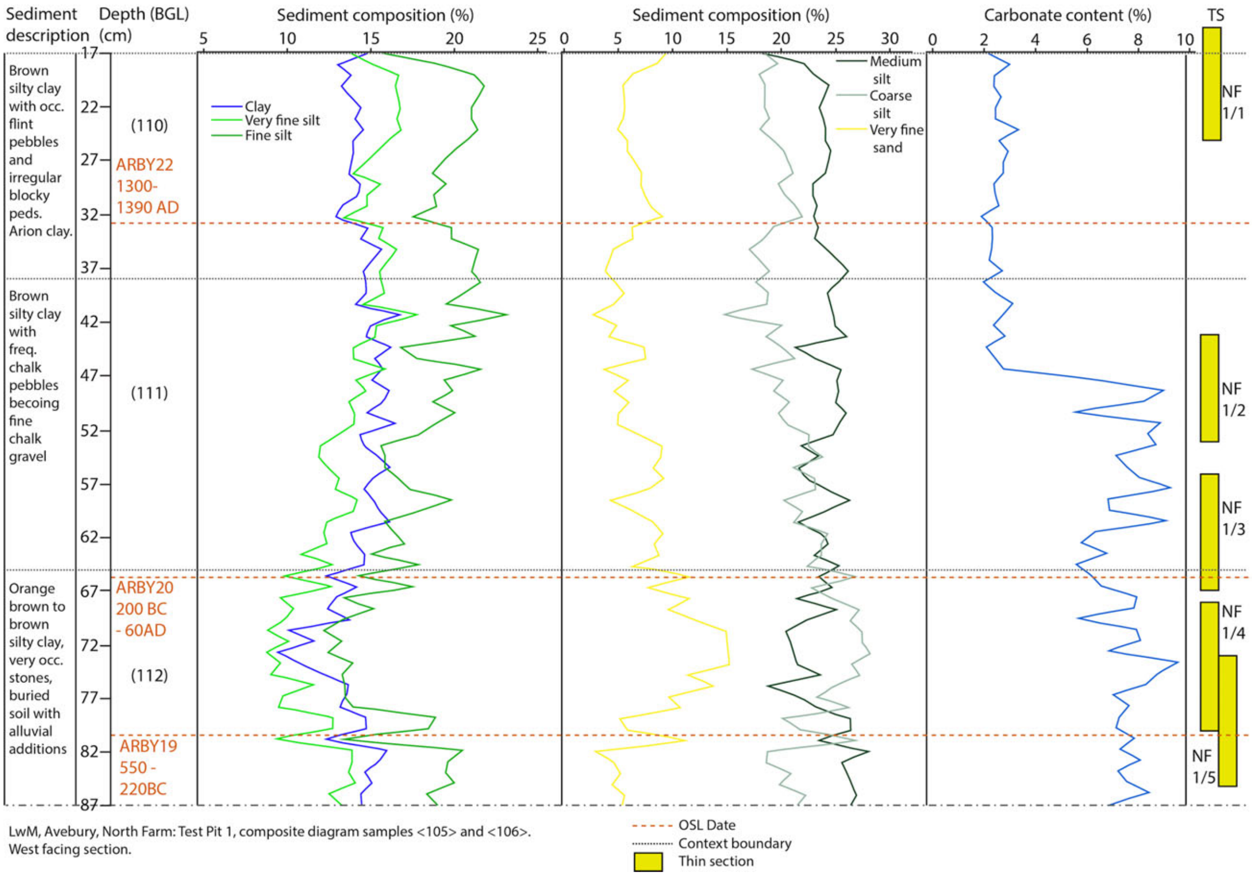
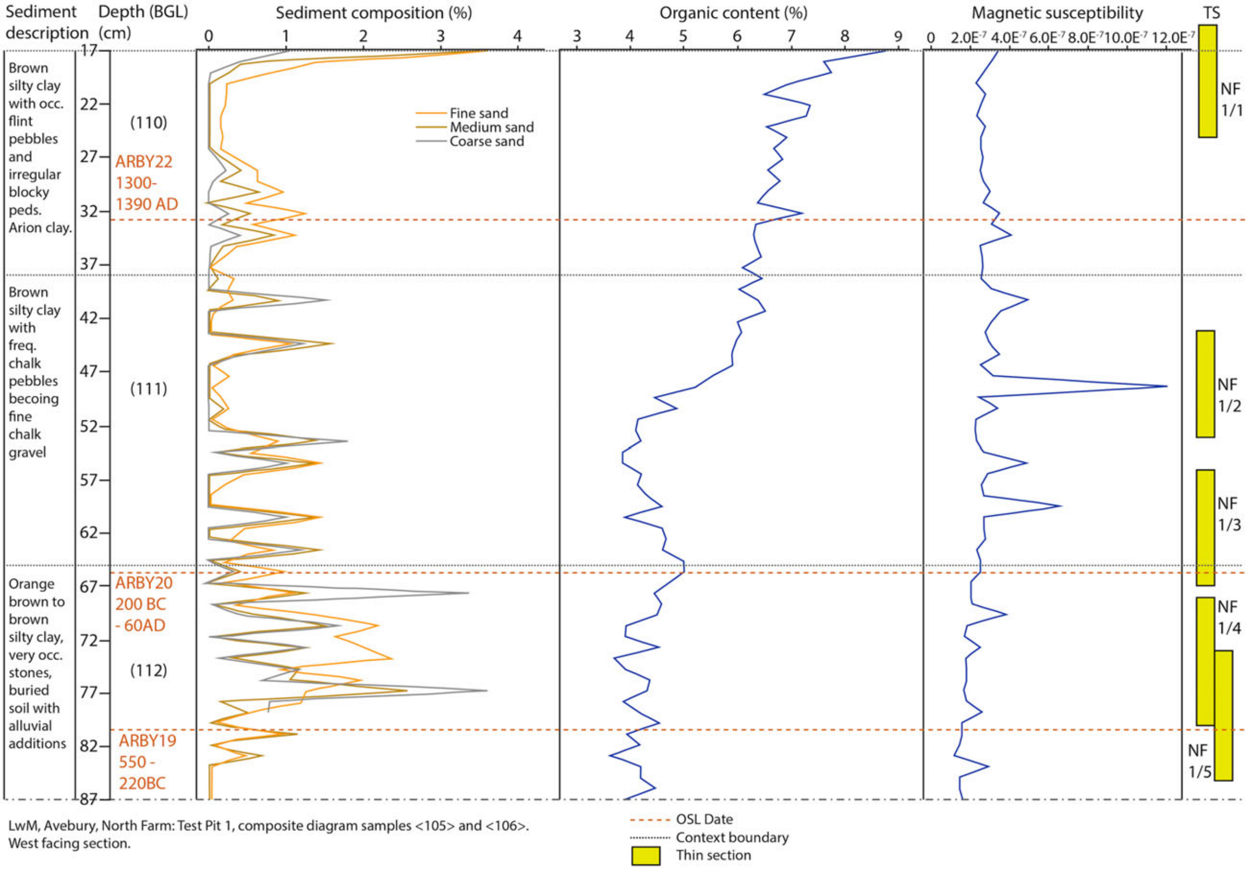


Fig. 14.
Zone E North Farm Test Pit 1 sediment data 1. Also refer to Table S7 (C. Carey/N. Crabb)

landscape utilisation and consequent impacts, with resultant changes in floodplain and channel morphology. The upper Kennet floodplain at both North Farm and Butler's Field contains areas of localised low topography formed during the Pleistocene which have acted as sediment traps for the first phase of channel bed alluviation in both the late Pleistocene and Early Holocene (pre-Neolithic). The composition of the fluvial units infilling these localised low point depressions is distinct, with high clay and carbonate contents and the presence of chalk and flint pebbles, forming through water flowing into and pooling in these depressions. Abundant areas of exposed chalk in other parts of the floodplain have facilitated bedrock dissolution through a wide, shallow channel, with some implied areas of braid plain. The relatively high clay content is interpreted as indicative of the differential erosion of soils, resulting from rain-splash, low energy erosion of open but relatively undisturbed topsoils, exaggerating the clay component of the early alluvial deposits. Within the topographic low point depressions, some of the channel bedload has been redeposited (ie, chalk/flint pebbles) alongside reprecipitation of calcite and the deposition of clay, through standing water.

The second phase from the Early Neolithic through to the Bronze Age was clearly critical within the development of the Avebury landscape. This period saw the creation of numerous monuments that provide this landscape with its special character, starting with long barrows (earthen and chambered) and enclosures in the 4th millennium BC and likely the earliest megalithic settings. Subsequently this was followed seemingly by a hiatus, then the creation from the mid-3rd millennium of the greatest monuments, among them Avebury, its Avenues, stone and wooden



LwM, Avebury, North Farm: Test Pit 1, composite diagram samples <105> and <106>. West facing section.

Fig. 15.
Zone E North Farm Test Pit 1 sediment data 2. Also refer to Table S7 (C. Carey/N. Crabb)

circles, the West Kennet palisade enclosures, and the gigantic mound of Silbury Hill. Even the region's round barrow cemeteries represent a considerable investment in labour. Unsurprisingly, it has been previously hypothesised that there had been widespread clearance of the post-glacial woodland at this time, facilitating monumentalisation of already cleared ancestral spaces within the landscape (Evans *et al*. 1993; Whittle *et al*. 1999). Therefore, understanding the signature of human induced alluviation in the Neolithic–Early Bronze Age is critical in understanding the human–environment context of landscape, land use and impact, and the context of monument construction and use. Those signatures could include soil and vegetation disturbance during the extraction and movement of stones (eg, in excess of 700 megalithic blocks: Gillings & Pollard 2016), the clearance and breaking of ground for monument building, the felling of trees to provide timber for The Sanctuary and West Kennet palisade enclosures, estimated at *c*. 15 ha of mature woodland by Whittle (1997, 154), and soil erosion through attendant gatherings of people and animals *en masse*.

It is therefore striking, and somewhat unexpected, that the signals of human induced alluviation caused by landscape impacts throughout this period are slight. Within the localised topographic low point depressions across the floodplain water continued to flow and deposited calcite rich sediments in a single channel. In many respects, this corroborates the previously modelled palaeo-hydrological study of river flow north of Silbury Hill to at least Avebury henge, rather than a winterbourne channel (Whitehead & Edmunds 2012). However, within these sediments there are increasing fine to coarse silt and very fine quartz sand (or loessic) components that

TABLE 5. A SUMMARY CHRONOSTRATIGRAPHIC MODEL FOR THE UPPER KENNET VALLEY

Period of alluviation	*OSL dates*	*Alluvial sediment*	*Sequence*	*Alluvial zone*	*Overview interpretation*
Late Pleistocene	14,270–11,730 BC	(501)	Trench 5	Zone B	**Natural fluvial deposition** in Pleistocene topographic low point depressions within channel. No definable anthropogenic impact within valley.
		(107)	North Farm TP2	Zone E	
Early Holocene (pre-Neolithic)	8080–6610 BC	(502)	Trench 5	Zone B	**Natural fluvial deposition** in Pleistocene topographic low point depressions within channel. No definable anthropogenic impact within valley.
		(106)	North Farm TP2	Zone E	
Neolithic–Middle Bronze Age	4550–3550 BC & 4420–3460 BC	(503)	Trench 5	Zone B	**Transitional.** Within channel deposition predominated with minor anthropogenic minerogenic alluviation signal, which slowly increased. Slight & small scale landscape impacts detectable.
	4090–3180 BC	(105)	North Farm TP2	Zone E	
Late Bronze Age, Iron Age & early Roman	820–410 BC	(504) (lower)	Trench 5	Zone B	**Anthropogenically driven alluviation** dominant, defining increased & widespread land surface disturbance on valley sides. Aggradation of valley floor with minerogenic silt rich alluvium began to constrain channel system. Alluvium buried previous extant land-surfaces (palaeosols) on valley floor.
	690–310 BC	(639)	Trench 2	Zone B	
		(PE6)	PEC5a	Zone D	
		(PE5)	PEC5a	Zone D	
	1330–870 BC (with caveat) to 130 BC–AD 170	(104)	North Farm TP2	Zone E	
	550 BC–220 BC to 200 BC–AD 60	(112)	North Farm TP1	Zone E	
Roman–medieval		(504) upper	Trench 5	Zone B	**Anthropogenically driven alluviation** continued. Decrease in overall particle size defining fluvial regime of decreasing energy, with increased infilling of floodplain with minerogenic silty clay alluvium. Extensive evidence for medieval activity on & adjacent to floodplain causing anthropogenic additions to medieval soil complex.
	210 BC–AD 150 (with caveat)	(638)	Trench 2	Zone B	
		(311)	Trench 2	Zone B	
		(PE4)	PEC5a	Zone D	
		(PE3)	PEC5a	Zone D	
	AD 400–620	(103)	North Farm TP2	Zone E	
	after 200 BC–AD 60 & before AD 1300–1390	(111)	North Farm TP1	Zone E	
Late medieval–Post-medieval		(505)	Trench 5	Zone B	**Anthropogenically driven alluviation** continued. Continued decrease in overall particle size, defining reduction in fluvial energy. Valley floor increasingly infilled with anthropogenic derived minerogenic humic silty clay alluvium, constraining river to single thread, relatively deep & narrow channel. **Anthropogenic modification of river channel and floodplain** (eg, fishponds)
		(641)	Trench 2	Zone B	
		(PE2)	PEC5a	Zone D	
	AD 1320–1410	(102)	North Farm TP2	Zone E	
	AD 1300–1390	(110)	North Farm TP1	Zone E	

signal a degree of human induced soil disturbance of soil surfaces within the catchment and limited wind and rain-splash erosion of soil material. This signal started by about 4000 BC and continued to at least the later Bronze Age between about 1330 and 870 BC (defined from North Farm Test Pit 1) over a period of *c*. 3000 years. The thickness of this second phase of alluvium deposited in this timeframe is relatively shallow (<0.4 m) and it is not widespread as it only forms within the valley floor depressions and does not overspill to other areas of the floodplain.

Considered together, these first two phases of alluviation must reflect slow, low volume and low velocity erosion in this landscape. This strongly suggests a very stable hinterland, whether under woodland or grassland, with minimal interference through clearance, agriculture, and erosion. The anthropogenic component in the second phase of alluviation during this critical timeframe is interpreted as representing relatively small scale (in a catchment context) landscape disturbance. This is certainly not a model of widespread woodland clearance and derived soil erosion caused through extensive farming on the valley slopes in the Neolithic and Bronze Age. The rate and volume of anthropogenically driven alluviation at this time is more commensurate with small scale soil disturbance, whether this was woodland clearance or simply soil disturbance within grasslands, potentially even at the scale of monument construction (eg, Avebury and Silbury Hill). These enormous prehistoric monuments are situated very close, or directly adjacent, to the river channel, both at the floodplain margins and as such demonstrate a direct connection between the river and these monuments (cf. Richards 1996). It is tempting, but speculative, to see the anthropogenic alluviation signature visible in this second phase of alluviation as a product of such localised monument construction and associated soil disturbance, rather than widespread agricultural disturbance and soil erosion.

Whatever is the driver for this minor anthropogenic driven alluviation between the Early Neolithic to Middle–Late Bronze Age, it is clear that the rate of alluvial deposition significantly increased from the Late Bronze–Early Iron Age. It is at the time that more sustained agrarian landscapes developed around the area of the former monument complex (Pollard & Reynolds 2002). The low point depressions on the floodplain floor had largely infilled by this period and areas of slightly higher topography within the valley bottom that previously had developed soils became inundated and buried by a third phase of alluviation. The alluvium is now defined by eroded soil material composed mainly of the fine–coarse silt and very fine quartz sand fractions, probably derived from inherent loessic soil components from the catchment.

This more widespread and increased intensity of alluviation was probably the product of anthropogenically driven soil erosion on the valley sides from the Middle–Late Bronze Age/Early Iron Age onwards. This implies the expansion of cultivated, or at least disturbed, land into areas that were previously undisturbed. Nonetheless, this use of the landscape through this time period unequivocally defined a landscape that was largely open grassland, not woodland. It would not have been possible to construct so many interconnected monuments within this landscape without clearing areas of woodland on a larger scale. Of course, the signature of alluviation does not provide a direct palaeo-environmental context for each locale of monument construction but it does provide a wider catchment view.

This is significant, as a predominantly grassland landscape would have been distinct to the more wooded river valleys off the chalk uplands (eg, the Greensand vales, such as in the Vale of Pewsey; Evans 1972, 274–7; Leary & Field 2012) and this has a potential interpretative value in explaining monumentalisation in the Avebury area. Either way, the signature of the fourth phase of alluviation from the Late Bronze Age–Early Iron Age continues throughout the Roman period and into the early medieval period. The rate of anthropogenically driven alluviation from the Late Bronze Age/Early Iron Age substantively increased, providing deeper and more widespread alluvial deposits across the valley floor. Throughout this time scale the level of calcite steadily decreased, defining a floodplain that was increasingly infilling with fine (silt and clay) alluvial sediments, slowly constraining the channel over time until it became a single thread channel, meandering across the floodplain.

By the later medieval period there is a very low carbonate content in the alluvium and the overall particle size has decreased, producing a valley wide, fine grained, clay rich alluvium in the fifth and final phase of alluviation. It comprises a very dark brown to dark greyish brown, silty clay loam with a very well developed columnar blocky ped structure. This deposit is very humic and probably topsoil derived from the catchment upstream and upslope and is associated with the seasonal overbank flooding of long-term pasture. It most probably developed hand-in-hand with the post-late 16th century AD construction of the embanked water catchment pond system as observed in Butler's Field (McOmish *et al.* 2005; Pollard *et al.* 2018a) and is reflecting topsoil erosion associated with wide-scale arable agriculture in the immediate catchment. This alluvial unit continues into the post-medieval period, defining a floodplain that had infilled and choked up with nearly 2500 years of anthropogenically induced alluvium. Unfortunately, the available geochronological data lacks the resolution to define changes in the rate of alluvial deposition across the floodplain in the Roman and later periods and it is currently not clear if there are periods of higher or lower alluvial deposition during the post-Roman to post-medieval timeframe.

NEOLITHIC STABILITY AND LATE BRONZE AGE/IRON AGE DISTURBANCE

The alluvial sediment record provides a clear model of landscape impacts and, to some extent land-use, throughout the Holocene (Tables 5 & S8). However, this model substantially contradicts previous studies that interpreted much larger impacts by prehistoric societies on these environments (eg, Evans *et al.* 1985; 1993). The new geochronological deposit model presented here stands in stark contrast to the magnificent scale of Neolithic and Bronze Age monuments that characterise this outstanding prehistoric landscape.

Early Holocene and Neolithic–Bronze Age landscape impacts through soil erosion and subsequent alluviation are detectable in the upper Kennet valley but only from channel bed deposits and limited soil erosion accumulating as alluvium within localised floodplain depressions. These deposits most probably represent low-level landscape impacts across the Neolithic–Early Bronze Age timeframes. The major alluviation in the valley did not start in earnest until the Late Bronze Age/Early Iron Age and provides palaeo-environmental context for this area. However, it is a dataset that also provides an explanation for understanding human activity in the periods of prehistory when alluviation was not present or slight as in the Neolithic and Early Bronze Age.

The palaeo-environmental context from the soil and sedimentary records in the upper Kennet valley is clear. The majority of the Avebury landscape was relatively stable and ostensibly open grassland on rendzina soils by the Neolithic period. There is no strong evidence for intensive or extensive landscape disturbance in the sediment record during the construction of long barrows, henges, avenues, and enclosures in the Neolithic, nor associated with the construction of barrows in the Early Bronze Age within the Avebury World Heritage landscape. Nonetheless, there were undoubtedly some intense impacts taking place in the middle and third quarter of the 3rd millennium BC in terms of monument construction which have not left substantial fingerprints in the floodplain alluvial record nor in valley bottom colluvial accumulations. This suggests that these events were spatially localised and relatively not disruptive of the wider landscape, over ill-defined and variable timeframes.

Put simply, large areas of woodland did not need to be cleared with associated soil disturbance in order to facilitate monument construction, although structures such as the West Kennet palisade enclosures would have required large areas of woodland to be felled (Whittle 1997, 154) and, likewise, extensive areas of turf and chalk substrate would have been required for the construction of sites such as Silbury Hill (Leary *et al.* 2013). Nonetheless, the areas affected by human activities are still relatively localised when considered on a catchment scale. Indeed, the insect assemblages in the Late Neolithic levels at Silbury Hill are dominated by open country species of herb-rich, light to medium grazed, well drained, unimproved grassland and, significantly, no specific fauna that could be linked to bare to disturbed ground and only 0.5% of the Coleoptera were associated with trees and woodland (Robinson 1997; 2011). In addition, the molluscan assemblages beneath the Early Neolithic long barrows in the Avebury landscape, such as West Kennet, and in the turf stack beneath Late Neolithic Silbury Hill ostensibly exhibited open grassland on thin rendzina soils succeeding a more shaded environment (Evans 1972, 263–7; Leary *et al.* 2013), with the only clear indication of woodland fauna being present observed in a much earlier subsoil hollow beneath the henge bank of Avebury in the Vatchers' excavations (Evans 1972, 268–73; Vatcher & Vatcher 1976). These palaeo-environmental aspects will be developed in the succeeding companion paper to this (French *et al.* in prep.).

Whilst this evidence provides a landscape context, perhaps this also helps to interpret the remarkable concentration of Neolithic and Bronze Age monuments in the Avebury landscape. It is known that earlier monuments, such as long barrows and cursus monuments, provide a focus for later aggrandisation and monumentalisation, but why are these early Neolithic monuments built within these specific landscapes to start with (cf. Pollard 2012)? Maybe it was the already largely open nature of this landscape, with increased visibility, extensive horizons, and skyscapes, that provided an area suitable for both settlement and the construction of monuments, and/or an ancestral or spiritual realm, which were different to other nearby off-chalk plateaux environments? Rather than monuments being constructed within woodland clearings, the more substantially open landscape provided a setting suitable for monument construction with areas of sarsen spreads easily visible. In other words, the monuments did not create the landscape but the landscape enabled the creation of the monuments. Certainly, several other major chalkland landscapes in southern England that have substantive monumentalisation, such as Stonehenge/Durrington Walls, Dorchester, and Cranborne Chase also revealed a similar, largely open, grassland aspect to their Neolithic and Bronze Age environments (Smith 1997; French *et al.* 2007; 2012). Moreover, these landscapes may be part of longer term, patchy open landscape trajectories and that may have had greater longevity than hitherto expected (cf. Svenning 2002; Whitehouse & Smith 2010; Robinson 2014).

Ideas of semi-sedentary lives in the early Neolithic and more mobile transhumant lives in the later Neolithic have been postulated (Bradley 1998; Thomas 1999; Leary & Kador 2016). It is also clear that there is a wider reduction of cereal growth in the middle and later Neolithic (Stevens & Fuller 2015). However, is there a signature of small scale horticulture on some of the valley sides in the Neolithic at Avebury? The answer is certainly not on a scale that has caused deposition of either deep or widespread colluvial or alluvial deposits in this landscape. As such, the alluvial archive record represents a landscape of wider sustained stability and only small scale localised disturbance despite a number of Neolithic lithic scatters and spreads seemingly being suggestive of an active and very much lived-in landscape. The nature of the alluvial record might not be such a juxtaposition to the monumental record as it first appears. Maybe the archaeological and geoarchaeological records tell the same story. It was a landscape that was certainly visited, used, and lived in, but may not have been cultivated in any great intensity during the 4th through to the mid-2nd millennium BC. But to maintain this landscape of ostensibly open grassland, it would have had to have been grazed and managed at a reasonable intensity. For example, dynamic ecosystem modelling of this aspect in the upper Allen valley by Samarasundera (2007, 199–205) has suggested that it could have required as few as 2.5 livestock (ie sheep and cattle) per hectare to keep the downland as grassland and free of woodland regeneration.

Perhaps, also, the extent and scale of settlement presence across the region during the Neolithic has been over-estimated by the LwM team, and especially during the latter part of that period. Consequently, this must feed into how to think about the nature of environmental impacts. This is an observation that comes out of the various lithic scatter excavations undertaken during the LwM project. Some, such as the Foot of Avebury Down (FAD) initially looked like they represented a very dense and sustained Neolithic presence but, following analysis of the lithic assemblage, it was clear that much of the flintwork was of probable Middle Bronze Age date (B. Chan, pers. comm.; Pollard *et al.* 2017). There are still Early, Middle, and Late Neolithic components that can be drawn out of this site but they are quite localised and do not constitute a dense and sustained presence. Likewise, on Folly Hill west of Silbury Hill, there is a ‘background’ of Early Neolithic lithic material but much is again of probable Middle Bronze Age date (Pollard *et al.* 2020a). In contrast, sites like the Middle Neolithic occupation on the West Kennet Avenue may be exceptional in terms of representing a more sustained presence (Gillings *et al.* 2015a; 2015b), potentially linked to gathering for the building of the earliest phase settings and earthwork at Avebury.

The one location in the region where settlement is well attested is at the causewayed enclosure on the summit and southern slopes of Windmill Hill (Whittle *et al.* 1999). This may be the principal settlement locale throughout the Neolithic. Although interpretation of the site as a settlement focus might run counter to current views of causewayed enclosures as gathering points for communities and sites of ceremony (through equation with its monumental status; Bradley 1998; Edmonds 1999; Whittle *et al.* 2011), the material signatures there conform closely to what we should expect of settlement activity at scale (ie large and varied numbers of tools and, from the enclosure, querns, hearth debris, etc.; Pollard 2021).

It is also worth expanding our focus outwards and considering how some of the environmental impacts of both monument building and dwelling might be more distributed, extending in part beyond the region. Accepting a degree of settlement mobility, perhaps especially in the Middle and Late Neolithic, it follows that communities were spending some of their time, seasonally or at greater intervals, outside the Avebury region. In the case of monuments, we have Whittle's observation that the straight-grown timbers used in the West Kennet palisades were most likely brought in, perhaps from Clay-with-Flints areas *c*. 4+ km to the east (Whittle 1997, 154). In this case, the environmental impact of monument construction may have taken place elsewhere. There is also the situation during the Late Neolithic, again with the West Kennet palisade enclosures, where isotope evidence shows a number of the animals consumed at the site were raised off the chalk, some at a great distance (Evans *et al*. 2019; Madgwick *et al*. 2019), and the material record (ie cores likely from East Anglia and granodiorite from the north-east) also supports the idea of people and animals coming into the region for monument building and ceremony. It may be that the total environmental impact was greater than that seen in the Avebury World Heritage landscape *per se*, being both more temporary and ephemeral (cf. Robinson 2014) and distributed across a range of locations on a wider inter-regional scale.

CONCLUSIONS

The date of human induced alluviation in river valleys across southern England has been shown to vary greatly between localities (Brown *et al*. 2013; Macklin *et al*. 2014). This has been linked more broadly to the archaeological record of wider landscape disturbance within different settings. It is useful to consider the upper Kennet valley in this context, although it is a relatively small catchment in terms of some of the other river systems that have been studied but has truly massive scale Neolithic and Early Bronze Age monuments. However, although alluviation is definable from the Neolithic, it is unexpectedly small scale and localised. It is in the Late Bronze Age–Early Iron Age that alluviation accelerates. In the upper Kennet valley and several other areas of the chalk downlands of southern England, it appears that the scale of Neolithic monumentalisation was not necessarily related to extensive and/or intensive landscape impacts. Rivers such as the Kennet flowing through the Avebury monumental landscape record little Neolithic and Bronze Age anthropogenic alluviation. Similarly, in the upper Allen valley on Cranborne Chase colluviation and alluviation occurred much later, mainly from post-Roman times (French *et al*. 2007) and, in later prehistoric (Iron Age) times, in the Avon valley between Durrington Walls and Stonehenge (French *et al*. 2012). Moreover, in these chalk downland cases, soil erosion, colluviation, and alluviation were all relatively low level in intensity and extent. As such, it is perhaps time to re-appraise scenarios of post-glacial woodland development and Neolithic clearance, ceremonial, and agricultural impacts; themes which will be further developed in the succeeding paper (French *et al*. in prep.).

This record can be contrasted with many other river valleys in England. For example, in the River Lugg valley (Worcestershire), large Neolithic monuments are not common but alluviation is clearly visible from the Late Neolithic/Early Beaker period, such as at Wellington Quarry (Carey *et al*. 2017). On the River Frome in Herefordshire, large scale alluviation occurred from the Beaker period/Early Bronze Age (*c*. 2500 BC) onwards (Brown *et al*. 2009), although the landscape only contains a smattering of known small Neolithic monuments. On the confluence of the Trent–Soar in Nottinghamshire, alluviation starts from the later Neolithic/Early Bronze Age (Knight & Howard 2004). Conversely, other localities with extensive Neolithic and Early Bronze archaeological records appear to sometimes record earlier and greater volumes of anthropogenically induced alluviation, such as in the lower river valleys of the Cambridgeshire fen-edge (French 1990; 2003).

While different river catchments and reaches will have nuances in their colluvial and alluvial histories, it is possible that the seemingly low levels of alluvial sedimentation associated with several major monumentalised landscapes on the chalk downlands of southern England might also be an explanatory force for their construction and use through the Neolithic and Bronze Age. It is postulated here that landscapes such as the upper Kennet around Avebury are exceptional, just as those investigated in the Avon valley around Durrington Walls (French *et al*. 2012; Parker Pearson *et al*. 2020; 2022) and the upper Allen valley of Cranborne Chase (French *et al*. 2007). They were all relatively open and stable by the Neolithic, in a sense pre-adapted to the construction of big monuments of ceremony and death as well as everyday living. It was a landscape of a very different kind of everyday – with varying intensities of activity (as attested by monuments and lithic scatters), some of which involved the felling of hectares of mature forest for monument construction from elsewhere beyond the upper Kennet catchment and/or the 'skinning' of hectares of grassland for turf. Yet while these activities might have been locally intense and are interpreted as visible minor components within the alluvial sediment archives, it is human activity from the Middle–Late Bronze Age onwards that describes wider level landscape disturbance and alluviation across the upper Kennet valley.

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SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit https://doi.org/10.1017/ppr.2024.6

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RÉSUMÉ

La géoarchéologie alluviale du bassin supérieur de la rivière Kennet dans le paysage d'Avebury : transformation monumentale d'un paysage stable, par Charles French, Chris Carey, Michael J. Allen, Philip Toms, Jamie Wood, Philippe De Smedt, Nicholas Crabb, Rob Scaife, Mark Gillings, et Joshua Pollard

Des recherches géoarchéologiques, menées dans le cadre du projet AHRC *Living with Monuments* (LwM), se sont penchées sur le bassin supérieur de la rivière Kennet qui traverse le paysage d'Avebury, classé au Patrimoine Mondial. Les résultats montrent qu'une très lente érosion des sols perturbés de la plaine alluviale a eu lieu au cours de l'Holocène ancien-moyen (*c.* 9500–1000 BC), avec les matériaux sédimentaires se déposant par colluvionnement dans un chenal reliant différents bassins d'eau plus profonds. A l'époque durant laquelle les monuments néolithiques furent construits (4ème–3ème millénaires), la rivière était large et peu profonde, avec de probables interstices et lacets. Entre *c.* 4000 et 1000 BC, des indices d'érosion anthropique participent de manière marginale à la sédimentation fluviale du paléo-chenal de la Kennet, mais ce phénomène reste localisé et de taille modeste. Ceci pointe fortement vers une absence de larges déforestations associées à l'agriculture néolithique et à la construction des monuments, malgré les besoins évidents en bois qu'a nécessité la construction de sites tels que les enceintes palissadées de West Kennet. Par conséquent, l'impact anthropique à l'intérieur des terres et sur les versants des vallées est resté relativement faible sur le temps long jusqu'aux âges du Bronze et du Fer, avec une prépondérance de pâturages par rapport aux terres arables. Le paysage néolithique ne consistait donc pas en des clairières regroupant les complexes monumentaux et représentant des lieux sacrés et ancestraux, mais plutôt en de vastes espaces ouverts, formant un paysage favorable avec des zones de dépôts erratiques de sarsen, sans doute facilement visibles. Lors de la période *c.* 3000–1000 BC, le niveau sédimentaire à l'intérieur du chenal s'est élevé progressivement avec le dépôt d'alluvions d'argiles limoneuses de plus en plus humides sur toute la vallée. Ceci, toutefois, ne représente qu'une modification de petite échelle du paysage. C'est à partir de l'âge du Bronze et du début de l'âge du Fer que les signaux anthropiques d'alluvions liées aux activités humaines deviennent dominants, et dépassent les signaux des sédiments fluviaux à travers la plaine alluviale, avec des dépôts colluviaux localisés aux marges de la plaine alluviale. Par la suite, les archives alluviales témoignent d'un impact humain de plus en plus important sur le paysage, comprenant la perturbation de sols riches en lœss dans le bassin versant. Le dépôt d'alluvions sur l'ensemble de la plaine alluviale continue tout au long des périodes romaine, médiévale et postmédiévale, en corrélation avec le développement d'un chenal unique à faible débit, et des sédiments alluviaux participant de manière moins en moins forte aux dynamiques de dépôt.

ZUSAMMENFASSUNG

Die alluviale Geoarchäologie des Oberlaufs des Flusses Kennet in der Landschaft von Avebury: eine monumentale Transformation einer stabilen Landschaft, von Charles French, Chris Carey, Michael J. Allen, Philip Toms, Jamie Wood, Philippe de Smedt, Nicholas Crabb, Rob Scaife, Mark Gillings, und Joshua Pollard

Im Rahmen des vom AHRC finanzierten Projekts *Living with Monuments (LwM)* wurden geoarchäologische Untersuchungen im oberen Flusssystem des Kennet in der Welterbelandschaft von Avebury durchgeführt. Die Ergebnisse zeigen, dass es im frühen bis mittleren Holozän (ca. 9500–1000 v. Chr.) nur eine sehr geringe Erosion von gestörten Böden in die Aue gab, wobei sich die Ablagerungen in der Aue auf eine natürlich entstandene Geschiebeablagerung beschränkten, die in einem flachen Kanal mit miteinander verbundenen tieferen Tümpeln verlandete. Zur Zeit der Errichtung der neolithischen Monumente im 4. bis frühen 3. Jahrtausend v. Chr. war der Fluss breit und seicht und wies vermutlich Bereiche verflochtener Ebenen auf. Zwischen ca. 4000 und 1000 v. Chr. bildete die vom Menschen verursachte Bodenerosion eine geringfügige Komponente der fluvialen Sedimentation im Paläokanal des Kennet, allerdings nur in geringem Umfang und lokal begrenzt. Dies deutet stark darauf hin, dass es kaum Belege für eine weit verbreitete Abholzung von Wäldern im Zusammenhang mit der neolithischen Landwirtschaft und dem Bau von Monumenten gibt, trotz des offensichtlich großen Holzbedarfs für neolithische Orte wie die Palisadenanlagen von West Kennet. Folglich wurden das Hinterland und die Talhänge in der *longue durée* bis in die späte Bronzezeit/frühe Eisenzeit nur relativ wenig durch den Menschen gestört, wobei Weideland gegenüber Ackerland vorherrschte. Anstelle der Errichtung großer neolithischer Monumentenkomplexe in Waldlichtungen, die Ahnen- und Sakralräume darstellen, bot die wesentlich offenere Landschaft ein geeignetes Umfeld mit Gebieten, in denen Sarsen potentiell gut sichtbar war. Während der Periode von 3000 bis 1000 v. Chr. wuchs die Sedimentfracht innerhalb des Kanals langsam an, wobei sich im Talboden zunehmend humose, schluffige Tone ablagerten. Dies stellt jedoch nur eine kleinräumige Störung der Landschaft dar. Ab der späten Bronzezeit / frühen Eisenzeit wird das anthropogene Signal der vom Menschen verursachten Aufschwemmungen dominant und überlagert das fluviale Sedimentsignal in der gesamten Aue, mit lokalen kolluvialen Ablagerungen an den Auenrändern. In der Folgezeit weist das alluviale Archiv umfangreichere menschliche Einflüsse in dieser Landschaft auf, einschließlich der Störung von lössreichen Böden im Einzugsgebiet. Die Ablagerung von Aufschwemmungen über die gesamte Aue setzt sich in den römischen, mittelalterlichen und nachmittelalterlichen Perioden fort und korreliert mit der Entwicklung eines einzigen Gerinnes mit geringem Durchfluss, wobei die Schwemmsedimente eine abnehmende Energie in der Ablagerungsumgebung aufzeigen.

RESUMEN

La geoarqueología alluvial de la parte alta del río Kennet en el paisaje de Avebury: una transformación monumental de un paisaje estable, por Charles French, Chris Carey, Michael J. Allen, Philip Toms, Jamie Wood, Philippe de Smedt, Nicholas Crabb, Rob Scaife, Mark Gillings, y Joshua Pollard

La investigación geoarqueológica como parte del proyecto *Living with Monuments* (LwM) financiado por la AHRC se ha centrado en la parte alta del sistema fluvial del río Kennet en el paisaje de Avebury declarado Patrimonio Mundial. Los resultados demuestran que en el Holoceno inicial-medio (*c.* 9500–1000 BC) hubo una baja erosión de suelos perturbados en la llanura fluvial, con depósitos de llanura aluvial limitados a un depósito fluvial de carga de fondo formado naturalmente mediante la acumulación en un canal poco profundo de pozas más profundas interconectadas. En el momento de la construcción de los monumentos neolíticos en el IV-inicios del III milenio BC, el río era ancho y poco profundo con áreas de llanura entrelazadas. Entre el *c.* 4000 y el 1000 BC la evidencia de erosión antrópica se convirtió en un componente menor de la sedimentación fluvial en el

paleocanal de Kennet pero fue a pequeña escala y localizada. Esto sugiere encarecidamente que hay poca evidencia de una remoción generalizada de bosques asociada con la agricultura neolítica y la construcción de los monumentos, a pesar de los evidentes requerimientos de grandes cantidades de madera en los emplazamientos neolíticos como los cercados de empalizadas del West Kennet. Consecuentemente, se produjo una perturbación antrópica relativamente leve del hinterland y las laderas del valle desde este momento hasta el final de la Edad del Bronce/inicios de la Edad del Hierro, con un predominio del pastoreo sobre las tierras de cultivo. En lugar de que los grandes complejos monumentales neolíticos fueran construidos en los claros de bosque, representando espacios ancestrales y sagrados, el paisaje sustancialmente más abierto proporcionó un paisaje idóneo con áreas de dispersión de sarsén fácilmente visibles. Durante el período 3000–1000 BC, la carga sedimentaria dentro del canal lentamente se incrementó con los depósitos aluviales de arcillas limosas cada vez más húmicas en toda la llanura del valle. Sin embargo, esto solo representa una alteración a pequeña escala del paisaje. Es a partir del final de la Edad del Bronce e inicios de la Edad del Hierro cuando la evidencia antrópica llega a ser dominante y supera la señal fluvial en toda la llanura aluvial, con depósitos coluviales localizados en las márgenes de la llanura aluvial. Consecuentemente, la información aluvial describe un impacto humano más extensivo a lo largo de paisaje, incluyendo la alteración de los ricos suelos de loess en la captación de la cuenca hidrográfica. La deposición alluvial en toda la llanura aluvial continúa a lo largo de los periodos romanos, medievales y postmedievales, correlacionando con el desarrollo de un canal único de flujo bajo, con sedimentos aluviales que describen una disminución de la energía en el entorno deposicional.