Journal of Archaeological Science: Reports

Analysis of brown earth palaeosols and derived sediments associated with a Mesolithic pit and two Early Bronze Age burnt mounds on Exmoor, UK.

--Manuscript Draft--

Manuscript Number:	
Article Type:	Research Paper
Keywords:	Brown earth; Palaeosol; Exmoor; Prehistory; Mesolithic; Burnt Mound; Colluvium
Corresponding Author:	Chris Carey University of Brighton Brighton, United Kingdom
First Author:	Chris Carey
Order of Authors:	Chris Carey
	Richard Macphail
	Lee Bray
	Hayley White
	Rob Scaife
Abstract:	The deforestation of upland areas in southwest Britain during the mid-Holocene has become an archaeological narrative, derived from the analysis of pollen within the upland peat deposits. The transition of these environments from brown earth soils supporting temperate deciduous woodland, into the now familiar podzolic peat mire landscapes is seemingly associated with abandonment of the uplands in late prehistory. The prehistoric archaeological records of these landscapes are rich and significant questions remain unanswered about prehistoric societies and their role in the environmental transition of these upland systems. Despite these rich archaeological records and detailed palaeoecological studies, the geoarchaeological study of the pre-peat sediments has remained somewhat limited. This paper provides the analysis of a Mesolithic heated pit infilled with a brown earth soil, and the pre-monument deposit sequences at two Early Bronze Age burnt mounds. The analysis of these dated sequences provides an increased understanding of these environments prior to the transition of these areas into stagnogley podzols and identifies considerable human impacts, indicating human activities were important in stressing soils in these environments and contributing to their degradation.
Suggested Reviewers:	Tim Mighall Senior Lecturer, University of Aberdeen t.mighall@abdn.ac.uk Leading geoscientist
	karen Milek Senior Lecturer, Durham University karen.b.milek@durham.ac.uk leading geoarchaeologist
	Gianna Ayala Lecturer, The University of Sheffield g.ayala@sheffield.ac.uk Lecturer in landscape formation processes.
	Charly French professor, University of Cambridge caif2@cam.ac.uk Professor of Geoarchaeology
	Jane Siddell Honorary Lecturer, University College London j.sidell@ucl.ac.uk Honorary lecturer in geoarchaeology; Historic England specialist on geoarchaeology in

	commercial projects
Opposed Reviewers:	Matt Canti Geoarchaeologist, Historic England matthew.canti@HistoricEngland.org.uk Matthew Canti has a long running dispute with Dr Richard Macphail (co-author). We do not consider him a suitable referee for this paper as a consequnce

Abstract: The deforestation of upland areas in southwest Britain during the mid-Holocene has become an archaeological narrative, derived from the analysis of pollen within the upland peat deposits. The transition of these environments from brown earth soils supporting temperate deciduous woodland, into the now familiar podzolic peat mire landscapes is seemingly associated with abandonment of the uplands in late prehistory. The prehistoric archaeological records of these landscapes are rich and significant questions remain unanswered about prehistoric societies and their role in the environmental transition of these upland systems. Despite these rich archaeological records and detailed palaeoecological studies, the geoarchaeological study of the pre-peat sediments has remained somewhat limited. This paper provides the analysis of a Mesolithic heated pit infilled with a brown earth soil, and the pre-monument deposit sequences at two Early Bronze Age burnt mounds. The analysis of these dated sequences provides an increased understanding of these environments prior to the transition of these areas into stagnogley podzols and identifies considerable human impacts, indicating human activities were important in stressing soils in these environments and contributing to their degradation.

Analysis of brown earth palaeosols and derived sediments associated with a Mesolithic pit and two Early Bronze Age burnt mounds on Exmoor, UK.

Chris Carey[1*], Richard Macphail[2], Lee Bray[3], Hayley White[1] and Rob Scaife[4]

* author for correspondence

[1] School of Environment and Technology, University of Brighton, Lewes Road, Brighton. UK.

[2] Institute of Archaeology, UCL, Gordon Square, London. UK.

[3] Dartmoor National Park Authority, Parke, Bovey Tracey, Dartmoor. UK.

[4] Geography and Environment Science, University of Southampton, University Road, Southampton. UK.

Key words: Brown earth, Palaeosol, Exmoor, Prehistory, Mesolithic, Burnt Mound, Colluvium

Abstract: The deforestation of upland areas in southwest Britain during the mid-Holocene has become an archaeological narrative, derived from the analysis of pollen within the upland peat deposits. The transition of these environments from brown earth soils supporting temperate deciduous woodland, into the now familiar podzolic peat mire landscapes is seemingly associated with abandonment of the uplands in late prehistory. The prehistoric archaeological records of these landscapes are rich and significant questions remain unanswered about prehistoric societies and their role in the environmental transition of these upland systems. Despite these rich archaeological records and detailed palaeoecological studies, the geoarchaeological study of the pre-peat sediments has remained somewhat limited. This paper provides the analysis of a Mesolithic heated pit infilled with a brown earth soil, and the pre-monument deposit sequences at two Early Bronze Age burnt mounds. The analysis of these dated sequences provides an increased understanding of these environments prior to the transition of these areas into stagnogley podzols and identifies considerable human impacts, indicating human activities were important in stressing soils in these environments and contributing to their degradation.

1.0 Introduction

Exmoor is a national park in the southwest peninsula of Britain (Figure 1). It is an area of uplifted and semi-metamorphosed sedimentary bedrock (Edmonds et al. 1975), which contrasts to the other more famous granitic uplands of the region, principally Dartmoor and Bodmin Moor. The upland areas in southwest Britain are rich in prehistoric archaeological monuments such as cairns, barrows, stone settings and enclosures (Riley and Wilson-North 2001; Newman, 2016). On Dartmoor and Bodmin Moor there are also widespread prehistoric co-axial field systems, reaves (land divisions) and associated hut circles, presumed to date to the Middle Bronze Age, which have been most famously studied on Dartmoor (e.g. Fleming 2008; **Wainwright et al. 1980**).

The survival of such prehistoric landscapes and features on Dartmoor and Bodmin Moor has led to the emergence of a model of large-scale abandonment of the uplands in the Later Bronze Age/Iron Age, resulting in the fossilisation and preservation of these remarkable archaeological remains (Amesbury et al. 2008; Fleming 2008). This abandonment has been superficially linked to ecosystem transition in these environments, through the degradation of the early Holocene brown earth soils. Processes such as deforestation (Neolithic – Bronze Age) and subsequent landscape exploitation e.g. pastoral economies, and possible tilling/cultivation during the Bronze Age, potentially exacerbated the processes of soil degradation and the subsequent change into acid, waterlogged podzolic soils, associated with peat growth (Amesbury et al 2008; Roberts 2014, 228). Thus, an intimate link has been developed between the preservation of prehistoric archaeological landscapes, podzolisation and societal abandonment, although the evidence for a correlation between the palaeoclimatic data (Amesbury et al. 2008), palynological data (Dark 2006) and the archaeological evidence (Balaam et al. 1982; Fleming 2008) is questionable.

The geoarchaeological analysis of palaeosols associated with the pre-podzol peat environments of the uplands in southwest Britain has been limited. At Carn Brea, Cornwall, a palaeosol under the bank of a Neolithic enclosure (*c*. 3600BC) was an acid brown earth derived from loess and weathered granite, which had undergone podzolisation prior to burial, with leached iron and clay microfabrics in the upper Ah/Ea horizons, containing charcoal defining pre-enclosure human activity (Macphail 1989). At Chysauster, Cornwall, an early Holocene brown earth palaeosol, developed from late Devensian loess was preserved under a cairn. This soil had been affected by limited acidification prior to burial, and contained evidence of tilling, demonstrating soil degradation prior to podzolisation was occurring in the Early Bronze Age, with colluviation identified from the Bronze Age/Iron Age (Smith 1996; Macphail 1987). The seminal excavations at Shaugh Moor, Dartmoor, were supported by geoarchaeological analysis of the pre-reave sediments at Saddlesborough Reave, Dartmoor. The analysis of pre-reave soils demonstrated severe degradation prior to reave construction, with a peaty topsoil, Eag horizon and iron pan over a podzolic B horizon present (Balaam, et al. 1982). Far from being a reason to abandon the uplands, some land divisions were being constructed within an already partially podzolised locality.

Whilst these studies were ground breaking, they represent a small number of analyses of the large expanses of the uplands associated with rich archaeological records and podzol soils, causing peat accumulation. Recent research has identified a brown earth palaeosol, buried by colluvium beneath a Middle Bronze Age roundhouse at Holwell, Dartmoor (Hunnisett et al. forthcoming). On Exmoor, a mineral soil palaeosol was reported beneath peat, buried by the bank of Pinkery Canal by Crabtree Maltby (1975), although the palaeosol was undated. More recently, brown earth palaeosols have been analysed at Wintershead, Farley Water and Lanacombe. These palaeosols are preserved to varying degrees under the stagnogley podzols and suggest a laterally extensive pre-mire landscape has been preserved on Exmoor, although chronological resolution in the sequences analysed was low (Carey et al. in press). Significantly, colluvium was recognised above the brown earth palaeosols and beneath the current podzol at two locations, and although undated, this identified significant human impacts on these soils prior to podzolisation.

The relatively low number of geoarchaeological analyses of palaeosols across the southwest peninsula contrasts with the more numerous analyses of pollen sequences, from which the evidence for the environmental transition during the Holocene is recognised. Palaeoenvironmental research on Bodmin Moor indicates limited woodland clearance occurring in the early Neolithic and more widely during the Bronze Age (Gearey et al. 2000a; 2000b). Pollen analyses on Dartmoor have suggested the use of forest burning in the Mesolithic period, with significant woodland clearance originally postulated during the Neolithic - Early Bronze Age (Caseldine 1999; Caseldine and Hatton 1996), although more recent research suggests the process was diachronous and occurred significantly later in the Late Bronze Age and Iron Age (Fyfe and Woodbridge, 2012) in some areas. On Exmoor, Merryfield and Moore (1974) attributed peat growth at the Chains to prehistoric human activity based on evidence from two pollen sequences. On Codsend Moor, Exmoor, Francis and Slater (1992) date peat inception to no earlier than 470BC and suggest anthropogenic forest clearance for livestock grazing during the Mid-Late Bronze Age, followed by a Late Roman mixed pastoral and arable landscape. Straker and Crabtree (1995) also analysed a pollen sequence at the Chains and suggested peat inception at *c*. 3000BC, attributing this to a climatic driver, with no human impact identifiable before *c.* 1000BC. Fyfe (2012) identified a Middle Bronze Age palaeoecological transformation of the landscape at Setta Barrow and Five Barrows on Exmoor, which was noted as in contrast to the archaeological field evidence. Pollen analysis at Molland on the southern edge of Exmoor (Fyfe et al. 2003a), recorded a short duration woodland disturbance during the Early Neolithic, limited clearance from the Early Bronze Age, followed by intensive woodland clearance from the early Iron Age. Thus, the balance of evidence from Exmoor indicates that significant woodland clearance occurred from the Middle Bronze onwards, although this varies between locations.

The process and chronology of environmental change on Exmoor requires correlation to its archaeological record. The following summary is derived from Riley and Wilson North (2001, 18-54). Mesolithic activity (9000-400BC) is evident through flint scatters, with a late Mesolithic concentration around Porlock. There are no definite Neolithic (4000-2250BC) monuments, although there have been occasional finds of diagnostically Neolithic artefacts such as axes and discoidal knives and some of the lithic monuments, in the form of stone settings, rows and circles, potentially belong to this period. The Early Bronze Age (2250-1500BC) is well represented on Exmoor with 370 barrows recorded, while Middle Bronze Age (1500-1000BC) archaeology is less common, although the undated field systems at Codsend Moor, Hoar Moor and Chetsford Water are suspected to be of this date. Likewise, Exmoor has very low number of hut circles, although there are numerous undated hut platforms which might be the equivalent to the Middle Bronze Age stone settlements of Dartmoor and Bodmin Moor. In addition, Exmoor has a nearly fifty small hillslope enclosures, some of which are suspected to have a Bronze Age origin, e.g. Holworthy (Green, 2009), although these monuments are more conventionally dated to the Iron Age.

The prehistoric archaeological record of land divisions, houses and settlement on Exmoor is subtle compared to that of Dartmoor and Bodmin Moor, and consequently has attracted less archaeological investigation. This is also true of the geoarchaeological investigation of the soils and sediments of prehistoric Exmoor, creating a lacuna in the models of prehistoric landscape settlement, exploitation and human-environmental dynamics. This paper, then, details the analysis of brown earth palaeosols and derived sediments associated with dated prehistoric archaeological remains on Exmoor, providing a secure chronological framework for the analysis of the pre-monument environments. The sites analysed are a Mesolithic heated pit at Wintershead (EWH13), and two burnt mounds, one at Spooners (OA1210) and one at Farley Water (FW16) (Figure 1), both dating to the Early Bronze Age. All of the fieldwork reported here was carried out through the Exmoor Mires Program, funded by the Southwest Water Upstream Thinking Initiative, which is restoring the mire across Exmoor.

2.0 Materials and methods

2.1 Field sampling

As part of the Mire restoration program, site specific archaeological mitigation was undertaken, sometimes requiring excavation trenches to investigate potentially affected features. Geoarchaeological samples were collected from exposed sequences using square plastic drainpipe, cut in half longitudinally. The drainpipe was placed over the section, labelled, photographed and recorded on the section drawing, before sample removal. The sample was then wrapped in clingfilm and black plastic, before being placed in cold storage.

2.2 Laboratory sub-sampling

Samples were cleaned, photographed and logged, before subsampling on a 1cm interval, removing *c*. 10g of sediment. The 1cm subsamples allow sediment variation both within and between contexts to be analysed. Spot samples for pollen analysis were collected from each context, with their location recorded. The remaining undisturbed sediment was retained for soil micromorphology. The 1cm subsamples were oven dried over 5 days at $40^{O}C$. When dry, each subsample was homogenized in a ceramic pestle and mortar, and fractionated using a 2mm sieve. The <2mm fraction was weighed and discarded, with the ≤2mm fraction retained for analysis.

2.3 Analysis of fine sediment fraction

The fine sediment fraction was analysed to determine sediment composition using a Malvern Mastersizer 2000 laser analyser, using a Mie scattering model (Malvern, 2005). Each subsample was disaggregated through adding 5ml of sodium hexametaphosphate (Calgon) to a heaped spatula of sediment (*c*. 1g), which was agitated on a platform rotary shaker at 175 rpm for a minimum of one hour. Each subsample was analysed using Basic Ultrasonic Method, making three measurements, with a mean value calculated. All data was exported from the Malvern Mastersizer using the Wentworth scale, a Phi classification of sediment sizes range (Table 1), and this nomenclature is used throughout.

2.4 Organic content

Loss on ignition was used to measure the organic content, which can be used for the identification of palaeosols (Canti 2015). Ceramic crucibles were over dried at $100^{O}C$ for 24 hours before weighing. A spatula of subsample was added to each crucible before drying for 24 hours at 100^{O}C. The samples were removed from the oven and placed in a desiccator before reweighing, and were then fired at 450^{O}C for four hours, before being placed in a desiccator and reweighed.

2.5 Magnetic susceptibility

Magnetic susceptibility was used to identify evidence of heating, as well as top soil inwashing, with both processes enhancing magnetic susceptibility values (Goldberg and Macphail, 2006, 350-352). Measurements of each subsample were taken using a Bartington MS2B magnetic susceptibility meter with the reading calibrated to the mass of the sample, using 10ml pots. Each sample followed a sequence of blank zero measurement, 5 second sample measurement, blank zero measurement.

2.6 Soil micromorphology

Thin sections were used to answer key questions, being placed over significant contexts to identify brown earth fabrics, inclusions and pedogenic features. Each thin section sample was impregnated with a clear polyester resin-acetone mixture; samples were then topped up with resin, ahead of curing and slabbing for 75x50 mm-size thin sections. Thin sections were further polished with 1,000 grit papers and analysed using a petrological microscope under plane polarized light (PPL), crossed polarized light (XPL), oblique incident light (OIL) and using fluorescent microscopy (blue light – BL), at magnifications ranging from x1 to x200/400. Thin sections were described, ascribed soil microfabric types (MFTs) and microfacies types (MFTs), and counted accordingly (Goldberg and Macphail, 2006; Stoops, 2003). Key soil micromorphology features are given in the text, with a table provided for each sample of the complete micromorphology descriptions. This data is semi-quantitative. For inclusions the ranges used are: very few 0-5%; few 5-15%; frequent 15-30%; common 30-50%; dominant 50-70% and very dominant >70%. For burrows and organo-mineral excrements the ranges used are: rare <2%; occasional 2-5%; many 5-10%; abundant 10-20%, and very abundant >20% (from Bullock et al. 1985).

2.7 Pollen

Standard techniques for pollen concentration of the sub-fossil pollen and spores were used on sub-samples of 1.5 ml. volume (Moore and Webb 1978; Moore et al. 1991). Minimum pollen counts of 400 grains per level were made at Spooners burnt mound and Wintershead. Taxonomy in general follows that of Moore and Webb (1978) modified according to Bennett et al. (1994) for pollen types and Stace (1991) for plant descriptions.

2.8 Presentation of data

With the analyses completed the data were entered into an Excel spreadsheet, before exporting to SPSS for the drawing of line graphs. Graphs drawn in SPSS were exported in Adobe Illustrator, and added to the sample logging sheet, with the context boundaries drawn over the graphs. Each context was then described and the data from the soil micromorphology and pollen analyses were integrated.

3.1 Results: Wintershead EWH13 <sample 6>

The site at Wintershead (EWH13) was recognised through the collection of an assemblage of worked prehistoric flints from erosion by a footpath adjacent to a spring line. A gradiometer survey was subsequently undertaken identifying numerous suspected archaeological anomalies (Figures 2 and 3), five of which were targeted by small evaluation trenches. Trench 1 produced 10 undiagnostic flint artefacts, while trench 2 yielded nine chert and flint flakes and a core fragment, all the recovered artefacts being unstratified. No artefacts were recovered from and no features identified in trenches 3 and 5.

However, trench 4 revealed three intercutting pits, found within context (420), an orange brown silt clay, with poorly sorted stone, the C horizon of the original brown earth soil. Context (420) was cut by pit [421], which in turn was cut by pits [408] and [409]. All of these pit features were visible from the cleaning of the surface of context (420). Pit [421] was c. 0.2m wide, 0.15m deep and was not fully excavated. It had been subject to heating and was filled by a single context of (422), a gritty red brown clay silt, with occasional stone and charcoal fragments. Cut [408] recut [409]. Only a small portion of [409] survived, which was filled by (410), a light brown clay silt.

Pit [408] had an asymmetrical bowl-shaped profile measuring *c*. 0.6m by 0.4m with a maximum depth of 0.3m. The pit had been subjected to heating and was filled by (411), of which 80% consisted of stone inclusions and fragments of baked clay, with the remainder composed of a dark brown silt clay with charcoal. A single burnt flint flake was recovered from (411). The charcoal was derived mature *Quercus* trunk wood with a minimum age of 20 years (Challinor, 2014). Two charcoal fragments submitted for radiocarbon dating returned dates of 6647-7003 cal BC (7896 +/- 29 BP) (SUERC-52976(GU33969)) and 6651-7002 cal BC (7902 +/- 26 BP) (SUERC 52977 (GU33970)) at 95.4% probability. Therefore, cut [421] and fill (422) predate this fill of (411) which dates to the end of the Early Mesolithic period. EWH13 sample <6> was taken from context (420) and the fill (422) of cut [421], consisting of a 15cm thick sediment sequence (Figures 4 and 5; Tables 2 and 3).

3.1.1 Context (420)

This is a brown orange clay silt with occasional rooting. Clay (17%), very fine silt (25%), and fine silt (32%) are high and show a slight rise, before a slight decrease. Medium silt (17%) is high and has a slight decrease before increasing. Coarse silt (6%) and very fine sand (2%) are low to moderate, and slightly decrease before increasing. Fine sand (0.4%), medium sand (0.24%) and coarse sand (0.1%) are low, and show a slight spike just after the cut [421]. The organic content (7%) is moderate with the magnetic susceptibility values high, especially at the base of the context, with a slight decrease evident through the context. No pollen analysis or soil micromorphology was undertaken on this context.

Context interpretation (420): this context is the original C horizon of the brown earth palaeosol at this site (**see Carey et al. in press**) that has been truncated through cut [421]. The magnetic susceptibility values are high, a product of heating from the overlying pit [421]/(422). The sediment fractions show some evidence of sorting at the base of the context.

3.1.2 Context (422) lower

This context was subdivided within the laboratory into (422) lower and (422) upper. Context (422) lower is an orange brown silty clay with charcoal. Clay (18%), very fine silt (22%) and fine silt (28%)

remain high and increase before decreasing at the junction with (422) upper. Medium silt (17%) is high and decreases before increasing at the junction with (422) upper. Coarse silt (9%) and very fine sand (4%) remain low and decrease before increasing at the junction with (422) upper. Fine sand (1%), medium sand (1%) and coarse sand (1%) are all low and have a spike at the base of the fill just above [421], before increasing towards the junction with (422) upper. Organic content (7%) remains moderate and magnetic susceptibility remains high, although a slight decrease is visible at the junction with (422) upper. Key soil micromorphology features include (Figure 5, A) dominant humic reddish brown silt and frequent brown silt soil, containing frequent small stones of bleached shale, and occasional burned (rubefied) quartzite (<7mm). There are abundant thin and very thin burrows associated with organo-mineral excrements. A pollen sample from 6cm proved to be very degraded, only containing *Polypodium* spores.

Context (422) lower interpretation: this is the lower fill of [421] containing strongly gleyed subsoil (Bg horizon), which is very stony. This is the remains of an interpreted heated (cooking?) pit base, with burnt quartzite rock. Although now an acidic soil, it had a brown earth origin, with the remains of organo-mineral excrements visible from soil fauna.

3.1.3 Context (422) upper

This is a brown light grey silty clay. Clay (17%), very fine silt (16%) and fine silt (18%) continue to decrease, but remain moderate to high overall. Medium silt (17%), coarse silt (15%) and very fine sand (9%) all increase, but remain moderate. Fine sand (4%), medium sand (3%) and coarse sand (2%) increase, although the data is spikey and they remain low overall. Organic content (9%) is high and magnetic susceptibility remains very high, with a spike at 2-3cm. Soil micromorphology records (Figure 5, A, B, C and D) a sharply mixed black peaty silt, frequent humic silt and more minerogenic silt loam soil, with few small shale stones, mainly in minerogenic soil. There is rare charcoal (<1mm), with example of burned quartzite (4.5mm). There are also abundant organo-mineral excrements.

Context (422) upper interpretation: this is a gleyed soil-diluted pit fill with small amounts of fine charcoal and burned mineral material indicative of being a cooking pit, or a pit containing hearth debris. Textural pedofeatures suggest rather wet conditions associated with infilling, with material derived from a brown earth mineral soil. The fill has subsequently been strongly affected by hydromorphic acid soil leaching and secondary ferruginisation linked to rooting.

3.1.4 EWH13 sample <6> Summary

This sample contains the C horizon of a brown earth soil (420) that has been truncated by cut [421]. This pit has two fills, with (422) lower containing burnt rock material. This pit has been probably deliberately backfilled with (422) upper, soil material from the surrounding brown earth, with some fine charcoal recorded in (422) upper. All of the contexts in this sequence are similar in terms of sediment composition and are either an *in-situ* brown earth palaeosol (420) that is heavily truncated or redeposited brown earth material into the pit (422). The process of backfilling and then subsequent weathering of the fill has caused some sorting of sediment fractions, with (422) upper, showing a reduction in clay and silt fractions with a corresponding increase in sand fractions, a result of compaction and waterlogging.

Pit [421] and context (422) were not directly dated, however, they predate cuts [409] and [408]. Cut [408] was filled by context (411) which produced the 7th millennium BC date. Therefore, pit [421] is interpreted as a Mesolithic heated/cooking pit, analogous to the well-preserved cooking pits from Prehistoric Vestfold, Norway (Viklund *et al*. 2013). The presence of a flint in the pit could be interpreted as structural deposition or a coincidental incorporation.

3.2 Results: Spooners Burnt Mound OA1210 sample <5>

Spooners burnt mound (OA1210) was identified by walkover survey, near the confluence of two streams and was subsequently defined through gradiometer survey (Figures 6 and 7). Evaluation excavation recorded and sampled the burnt mound deposits and underlying sediment sequence. The excavation identified a probable palaeosol consisting of context (104); a layer of light-yellow clay silt and context (110); a mid-brown clay. Overlying this was (103), a *c*. 0.35m thick deposit of charcoal rich, black clayey silt, containing *c*. 45% burnt shale and quartz. A radiocarbon date from charcoal in (103) dated to 2346 – 2138 cal BC (95.4%) ((SUERC-56652 (GU35968)). The overlying context (102) was *c*. 0.14m thick and composed of a root disturbed black clayey silt with frequent charcoal flecks and *c*. 20% burnt shale and quartz. This was overlain along the southern edge by (101), a 0.02-0.04m thick, mid grey silty clay deposit with rare burnt stones which might represent a trample zone caused by the dumping of burnt stones. The mound was sealed by a dark greyish black peat (100), 0.1-0.3m thick, with *c*. 5% burnt quartz and shale. OA1210 sample <5> was 14cm in length and collected from the west facing section of the trench, sampling contexts (104), (110) (103) (Figures 9 and 9; Tables 4, 5 and 6).

3.2.1 Context (104)

This is a light brown clayey silt. Clay (17%), very fine silt (15%) and fine silt (18) are high and increase before a slight decrease at the junction with (110). Medium silt (13%) and coarse silt (6%) are high at the base of the unit but decrease, before increasing at the junction with (110). Very fine sand (5%) is moderate and increases upward. Fine sand (2%), medium sand (3%) and coarse sand (4%) are low and decrease upward, indicating sorting. The organic content (2%) is low and increases slightly. Magnetic susceptibility is generally low throughout, although a slight rise is evident. Key features identified by soil micromorphology include minerogenic loamy silty sands. The pollen data demonstrated differential survival and poor preservation. However, *Alnus* (24 grains) and *Corylus avellana* type (68 grains) were present showing some woodland in the pollen catchment. Poaceae was low (8 grains) demonstrating limited evidence of grassland. There was also high levels of *Sphagnum* (150 spores) indicating some acidification and waterlogging.

Context (104) interpretation: this is a C/lower B horizon of a brown earth soil. The particle size data shows evidence of sorting at the base of the unit, whilst the organic contents are low, but consistent with a palaeosol formation. The clay to medium silt fractions all show a reduction at the top of this unit, indicating some translocation of these fractions down the profile. The limited pollen data identifies a mosaic, with waterlogged mire (*Sphagnum*), woodland and grassland around this locale. The presence of *Alnus* is significant and suggests some waterlogged/wet ground, possibly wooded corridors running along the edges of the spring lines on the high ground, which would be consistent with presence of *Corylus avellana* type.

3.2.2 Context (110)

This is a mid to light brown clayey silt. Clay (11%), very fine silt (15%), fine silt (18%), medium silt (14%) and coarse silt (12%) all significantly decrease, before increasing at the junction with (103). Contrastingly, very fine sand (9%), fine sand (5%), medium sand (8%) and coarse sand (8%) all increase upward, until the junction with (103) where they decrease. Both organic content (5%) and magnetic susceptibility shows a significant increase close to junction with context (103). Key soil micromorphology features (Figure 9, A, C and D) record a sequence of minerogenic loamy silty sands, which upwards become increasingly dominated by more humic and fine charcoal-rich loamy soils, showing evidence of compaction. There are few small tabular slate stones and gravel ($\leq$7mm). There is a rare trace of charcoal which becomes occasional upward. An example of rubefied iron stained stone is present in the upper part of (110). The pollen data again shows *Alnus* (31 grains) and *Corylus avellana* type (13 grains) are present, although in relatively low numbers. Herb pollen is low with Poaceae (45 grains) and *Plantego lanceolata* (6 grains) indicating some grassland. There is also virtually no *Sphagnum* (1 grain) present.

Context (110) interpretation: this is the B horizon and possibly A horizon of a brown earth soil that has been sealed by the burnt mound. A distinct A horizon was not visible in the thin section, although the increase in organic matter and magnetic susceptibility could represent an A horizon or alternatively represent the incorporation of some material from the overlying (103). Soil micromorphology shows burnt material incorporated into the top of this context, indicating chaotic mixing, probably through trampling under wet and muddy conditions, causing some slaking. This strongly suggests this was a locale of human activity prior to the creation of the burnt mound. The pollen demonstrates some woodland and grassland close by, although there is limited pollen survival.

3.2.3 Context (103)

This is a black dark brown matrix to clast supported, organic silt with abundant sub-angular rock fragments and charcoal. Clay (6%), very fine silt (8%) and fine silt (13%) all increase at the junction with (110) and then continue to decease, although these is some spikiness to the data. Medium silt (12%), coarse silt (12%) and very fine sand (12%) show the same trend, with a rise after the junction with (110) and then an overall decrease that is again spikey. Fine sand (11%), medium sand (13%) and coarse sand (11%) are higher in this context, although the data is again spikey. Organic content (13%) is high and rises. Magnetic susceptibility is very high and saw tooths in its values. Soil micromorphology records loamy silt sands with abundant fine to coarse wood charcoal and charred wood (≤6mm) and burnt rock fragments (Figure 9A and B).

No pollen analysis was undertaken on this context. However, Charred Plant Remains (CPR) analysis (Simmons, 2015) shows the wood charcoal assemblage is dominated by oak (95 fragments), with alder (3 fragments) also present. A high incidence of closely spaced annual growth rings indicates the use of slow grown oak. Fungal hyphae are present in the vessels of a small proportion of the wood charcoal fragments, indicating the use of a certain amount of dead or decaying wood. This data contrasts with the pollen data from context (110) that records some *Alnus* pollen, although *Quercus* is not recorded in the pollen spectra. A radiocarbon date from *Quercus* charcoal provided a date of 2346 – 2138 cal BC (95.4%) (SUERC-56652 (GU35968)), although an old wood effect should be considered possible. Brown et al. (2016) also recorded the use of *Alnus* in burnt mound deposits from Ireland, associated with the clearance/exploitation of wet woodland.

Context (103) interpretation: this context is the earliest in the burnt mound in the sequence excavated, containing burnt rock fragments and charcoal. The presence of slow grown oak indicates possible preferential wood selection, although *Quercus* is not noted in the pollen data from the preceding context, though this is probably due to differential preservation. The presence of *Alnus* is consistent with the pollen data. The radiocarbon date places this activity during the very Early Bronze Age.

3.2.4 OA1210 Sample <5> summary

This sequence contains a brown earth palaeosol (contexts (104) C/lower B horizon; context (110) B horizon and possibly A horizon) sealed beneath the burnt mound. The palaeosol shows considerable evidence of human activity prior to construction of the dumped deposits forming the burnt mound. The surface of the palaeosol has features consistent with compaction, slaking and trampling, all defining pressure on this brown earth soil prior to burial under the burnt mound. Whilst the soil had not acidified and transgressed into a stagnogley podzol, the soil here is clearly at least partially waterlogged, giving the slaked nature of (110). The Early Bronze Age date of the burnt mound is significant indicating human activity on the Exmoor uplands beyond the construction of cairns and barrows. Intriguingly, the very limited pollen data does suggest some grassland in the locale, with possibly some clearance already having occurred at this early date. However, woodland is clearly represented, with the presence of *Alnus* possibly indicating some fringes of wet wood along the edges of the spring lines. The presence of *Quercus* from the CPR analysis suggests woodland may have been present within a relatively short distance from this monument.

3.3 Results: Farley Water burnt mound FW16 sample <4>

Excavations at Farley Water (FW16) investigated a brown earth palaeosol (Carey et al. in press) associated with Mesolithic flint scatters (Gardiner, 2019). In addition, a small sample was retrieved from an eroded trackway, where burnt material was exposed overlying brown sediments (Figures 10 and 11). The trackway had seemingly truncated most of this burnt material. The exposed section was recorded by Exmoor National Park Authority in 2014, with FW16 <4> retrieving 18cm of sediment

(Figure 12; Table 7), sampling contexts (101) and (108). Context (101) is a light, orange-brown, gritty clay silt containing abundant, poorly-sorted stones. Above this was context (108), a dark grey-brown clay silt containing frequent small stones and charcoal fragments. This deposit did not appear to have been heated *in-situ*, with (110) probably being the same deposit. Above this was context (107) a grey-brown clay silt containing abundant, poorly-sorted stones, before a peaty topsoil (109).

To the northwest of the section is cut [102], which truncates (101) and is filled by (103) a brown clay silt containing very abundant, moderate to poorly sorted, stone inclusions and frequent charcoal. The rubified colour of the stone inclusions indicates heating. Context (103) is cut by [104], which is filled by (105) a firm, orange-brown clay silt containing frequent, poorly-sorted, rubified stones and rare charcoal fragments. Above this are deposited (106) a light orange- grey clay silt containing occasional stone and rare charcoal fragments and (107), covered by a peat (109).

There are three phases of the sequence; contexts (101) and (108/110) being pre-monument sediments, contexts (103), [104], (105), (106) and (107) representing the deposits of the burnt mound and (109) post burnt mound soil development. Charcoal from (103) was radiocarbon dated to 2577-2456 cal BC (95.4% probability; SUERC-52978 (GU33971)), giving a late Neolithic/Early Bronze Age date. No pollen or soil micromorphology was undertaken on this sample.

3.3.1 Context (101)

This is a light brown clay silt with abundant small stones. Clay (13%), very fine silt (20%) and fine silt (26%) are high and show a slight decrease before a slight increase at the junction with (108). The decrease is somewhat gradual and spikey. Medium silt (17%) is high and follows the same pattern with a slight decrease before increasing at the junction with (108). Coarse silt (11%) is high and very fine sand (7.4%) is moderate; both show an increase before decreasing towards the junction with (108). Fine sand (3%) and medium sand (15) are low and show a significant increase between 7-15cm, before decreasing at the junction with (108). Coarse sand (0.3%) is very low, although spikes are visible at 7cm and 12cm. Organic content (9%) is high and also shows an increase between 7-15cm. Magnetic susceptibility is generally quite high, with spikes evident at 15cm and 7-12cm.

Context (101) interpretation: the particle size data indicates this as colluvially derived sediment, probably overlying a brown earth palaeosol. The basal part of the context, from 15-18cm is possibly the brown earth palaeosol, with the particle size and organic contents being notably less spikey. The rest of the sediment in context (101) is colluvium (4-15cm), being clay to fine silt dominated, consistent with sediment eroded from a brown earth soil. The high organic content of the colluvium show it to be soil derived. There are multiple spikes in the magnetic susceptibility, particle size and magnetic susceptibility data indicating colluvial material, in addition to the description of the stone inclusions. Another sample, <FW2> from Farley Water (FW16), which was associated with Mesolithic flints, also identified colluvium above a brown earth palaeosol (Carey et al. in press).

3.3.2 Context (108)

This is a light to dark brown clayey silt with frequent small stones. Clay (13%), very fine silt (16%) and fine silt (19%) remain relatively high, but decrease substantially upward. Medium silt (15%) is high but also significantly decreases. Contrastingly, coarse silt and very fine sand (13%) are high and increase through the context. Fine sand (5%), medium sand (2%) and coarse sand (2%) whilst low, increase. The organic content (9%) is again high, although it decreases through the unit. Magnetic susceptibility values remain general constant, although a slight increase is visible at the top of the context.

Context (108) interpretation: on the present level of evidence, without the use of soil micromorphology, this unit is also interpreted as the top of the colluvial sediment that has been partially waterlogged and slaked, potentially through trampling. Charcoal was recorded in this context and as at Spooners burnt mound (OA1210) context (110), this indicates ground disturbance prior to the construction of the burnt mound. The reduction of the fine sediment fractions in this context would be consistent with waterlogging and slaking, causing the release of the fine sediment fractions.

3.3.3 FW16 Sample <4> summary

The brown earth palaeosol at this locale was not directly sampled, although the top of it is possibly represented at the base of the sample (15-18cm). However, colluvium was sampled with clear magnetic susceptibility and particle size spikes, and frequent inclusions of small stones. The sediment fractions of context (101) are consistent with erosion from a brown earth soil. There would also appear to be a phase of activity after deposition of the colluvium, when the top of the deposit became waterlogged and lost some of its fine sediment fractions. The date of the burnt mound above is early, and even allowing for an old wood effect, dates to the last quarter of the third millennium BC. This is highly significant, as this indicates substantial human impacts on the landscape during the very Early Bronze Age.

4.0 Discussion

Three samples have been analysed that are associated with archaeological features and brown earth soils on Exmoor, present before the evolution of the current stagnogley podzol. These analyses have significance for understanding human impacts on, and interaction with, the environment, within these upland landscapes, as well defining the archaeological potential of the pre-mire sediment sequences on Exmoor. EWH13 sample <6> from Wintershead contained a brown earth soil contemporary w the Mesolithic period. Not only was the pit filled with redeposited brown earth, but the pit features were was still partially encased within the palaeosol, towards the interface (C horizon) with the bedrock.

The presence of such archaeological features demonstrates a high potential for remains from early periods, such as the Mesolithic and Neolithic, to be preserved within these pre-peat sediment sequences. Equivalent features within other landscapes, e.g. the Wessex chalklands, have been largely destroyed through ploughing, leaving in many cases only flint scatters (e.g. Richards 1990). The upland areas in contrast, protected by the development of a later peat, have a higher potential to preserve such features. Mesolithic features have also been recognised at Farley Water (Gardiner 2019), Ven Combe and Hawkcombe Head (Gardiner 2011), demonstrating the potential of the pre-mire sediment palaeosols to contain significant archaeological resources. At Holwell, Dartmoor, two pre-reaves 'stake holes' containing charcoal have recently been dated to the Late Mesolithic (Bray, pers. comm). Blinkhorn and Little (2018) highlight the number of recorded Mesolithic pits within Britain, which has substantially increased over the last two decades primarily due to developer funded archaeology. They suggest they may mark places as special and/or provide a means for the 'correct' deposition of materials, e.g. flint. It is an intriguing possibility that the springhead at Wintershead was a Mesolithic 'place'. Unfortunately, the features in trench 4 were only partially excavated, and the true extent of the Mesolithic remains are unclear, although the gradiometer anomaly they are associated with is *c*. 5m on its longest axis, with the feature planned for *c*. 2m in the limits of trench 4. A potentially analogous pit measuring 1.3m diameter, filled with fire cracked rocks and containing *Crataegus sp.* (hawthorn) charcoal was excavated at Kingsdale Head, North Yorkshire, producing a radiocarbon date of 6840-6650 cal BC (80.7 per cent probability (SUERC-11499 GU14468)) (Melton et al. 2014).

The colluvial deposit underlying the burnt mound at Farley water is significant, given its very early date. This colluvium is interpreted as being derived from human induced landscape disturbance, most likely deforestation. Different palaeoenvironmental studies have indicated different dates of human impacts on the Exmoor landscape. Merryfield and Moore (1974) suggest that blanket peat initiation on Exmoor at the Chains could have been caused by human activity at 3000BC. Straker and Crabtree (1995) also at the Chains, give a date of definable human impact on the landscape post 1000BC. At Chapman Barrows, also on Exmoor, a period of Middle Bronze Age landscape reorganization is recognised (Fyfe, 2012). The evidence from Farley Water, however, shows that some locales are witnessing landscape impacts prior to the Middle Bronze Age and are possibly closer to the original Merryfield and Moore (1974) date.

Colluvium dating to before 755-680 cal BC was also recognized at Wintershead above a brown earth palaeosol (Carey et al in press). Similarly, Fyfe et al. (2003b) recognised increased alluviation at

Brightworthy on the river Barle floodplain, dating to between 2270-1940 cal BC, also caused by landscape disturbance. Whilst slightly later than the FW16 <4> colluvium, both sediments demonstrate significant landscape human disturbance on parts of the uplands during the Early Bronze Age. Brown et al. (2016) link together the environmental evidence from burnt mounds and woodland clearance. They analyse the exploitation of wet woods on Irish Bronze Age burnt mounds, particularly *Alnus*, and consider this an important mechanism for the clearance of wet woodland during the Early Bronze Age; it is possible that the data from Farley Water and Spooners indicate a similar phenomenon.

A significant aspect of both burnt mounds is the early date for these monuments. Even allowing for an old wood effect, both were constructed in the very Early Bronze Age, adding a significant dimension to the archaeological record of Exmoor, which is dominated by cairns and barrows. Until recently, the number of burnt mounds known on Exmoor was limited to a single example reported in 2011 (Wilson-North and Carey, 2011), which is now supplemented by the Spooners and Farley Water sites. Contrastingly, burnt mounds are of the most common types of prehistoric monument across Britain, with approximately 1000 recorded in England and Wales (O'Neill, 2009), so their underrepresentation in the archaeological record of Exmoor (and more generally the southwest uplands, with none recorded on Dartmoor) is potentially an absence of identification.

The archaeological interpretation of burnt mounds within Bronze Age society is debated. Interpretations include cooking, leather working, wood working and sweat lodges (Gardner, 2019). However, their presence in upland environments associated with springlines is significant. Do they represent seasonal meeting places, relating to transhumance and seasonal occupation of the uplands or potentially to do they relate to more settled communities? Gardner (2019) interpreted seasonal use of burnt mounds from thin section analysis at Hoppenwood, Northumberland, though seasonal flood deposits interspersing burnt mound material. A summer/autumn seasonal use was postulated due to a lower water table. Macphail and Crowther (2013) also suggest seasonal activity occurred at a burnt mound in Stainton West, Carlisle, with alternating humic and humic poor silting, in the Early Bronze Age. Such an interpretation is an intriguing possibility for the occupation of the southwest uplands during the Early Bronze Age. It is possible that the saw tooth distribution of the magnetic susceptibility at Spooners burnt mound (103) reflects a similar periodic of deposition of burnt material, between phases of unburnt material.

The burnt mounds of Farley Water and Spooners were constructed within areas associated with prior human activity. What this activity represents is unclear, but significant trampling and waterlogging had occurred prior to the mound being constructed at Spooners and a similar interpretation is proposed at Farley Water. Trampling could be a product of livestock congregation or potentially a societal meeting, which became fossilized with the construction of a burnt mound. At both sites the pre-monument human activity had caused waterlogging and slaking, with associated loss of the fine sediment fractions, indicating both soils were under pressure. This demonstrates a clear connection between human activity at these locations and soil degradation. However, at both Spooners and Farley Water there was no evidence of podzolisation under the burnt mounds, indicating that although soils were being degraded, and in the case of Farley Water eroded (colluvium), it is unclear how much the human impact contributed to the transition into the podzolic soils in these locations.

The analyses demonstrate the nuanced interpretations that can be achieved through studying soils and sediments buried beneath early monuments or redeposited within features, in these dynamic upland landscapes. Given the number of barrows, hut circles and field divisions that are present across the uplands of the southwest, there is potential to investigate human impacts on these seemingly fragile ecosystems, prior to the process of soil podzolisation and the development of peat, within a more secure chronological framework. To these classes of monuments can certainly be added Mesolithic pits and burnt mounds. Both of these types of monument have considerable potential to provide snapshot information on environmental conditions prior to the more abundant monuments of the Middle Bronze Age and Iron Age. Through studying the palaeosols and fill sequences of the early Holocene it may prove possible to reconcile the narratives produced from the more numerous pollen sequences, the visible field archaeology and the settlement and postulated abandonment of the uplands during prehistory.

5.0 Conclusion

This paper has presented the analysis of three sediment sequences associated with brown earth palaeosols and prehistoric archaeology on Exmoor. These analyses compliment the recent identification of brown earth palaeosols on Exmoor, as well as earlier research into the pre-monument prehistoric soils and environments across the wider south western peninsula. This research highlights the potential to identify and interpret the past human environmental dynamics within these seemingly fragile upland landscapes. It is important to understand the extent to which human activities have contributed to the process of ecosystem change, through deforestation, farming and soil erosion, and the significance these activities had in causing later podzolisation. Key questions still remain on how past societies reacted to these changes. Indeed, linkages between palaeoenvironmental (pollen) data and wider climatic changes suggest little correlation between the Sub Atlantic downturn and land use (pollen data) in the uplands (Dark 2006). Given the definition of the Anthropocene in the academic literature and increasingly high profile news stories about environment change in the public domain, the relevance of understanding human impacts on environments, both past and present has never been stronger. The upland landscapes of southwest Britain have considerable potential to illuminate these debates.

6.0 Acknowledgements

The Exmoor Mires project is thanked for funding the analyses of these samples and supporting the excavations. Shirley Blaylock, Martin Gillard and Rob Wilson-North are thanked for their input and discussion. Magda Grove and Pete Lyons are thanks for their assistance in the laboratories. Charlie Hay is thanked for her support and constructive comments.

7.0 Bibliography

Amesbury, M. J., Charman, D. J., Fyfe, R. M., Landon, P. G. and West, S. 2008. Bronze Age upland settlement decline in southwest England: testing the climate change hypothesis. *Journal of Archaeological Science*, 35, pp 87-98.

Balaam, N. D., Smith, K. and Wainwright, G. J. 1982. The Shaugh Moor project: Fourth report – Environment, context and conclusion. *Proceedings of the Prehistoric Society*, 48, pp. 203-278.

Bennett, K.D., Whittington, G. and Edwards, K.J. 1994 Recent plant nomenclatural changes and pollen morphology in the British Isles. *Quaternary Newsletter,* 73, pp. 1-6.

Blinkhorn, E. and Little, A. 2018. Being ritual in Mesolithic Britain and Ireland: identifying ritual behaviour within an ephemeral material record. *Journal of World Prehistory*, 31, pp.403–420.

Bray, L. pers. Comm. *Recent excavations at Holwell, Dartmoor*.

Brown, A.G., Davis, S.R., Hatton, J., O'Brien, C., Reilly, F, Taylor, K., Emer Dennehy, K., O'Donnell, L., Bermingham, N., Mighall, T., Timpany, S., Tetlow, E., Wheeler, J., and Wynne, S. 2016. Environmental context and function of burnt-mounds: new studies of Irish Fulachtaí Fiadh. *Proceedings of the Prehistoric Society*, 82, pp. 259−290.

Bullock, P., Fedoroff, N., Jongerius, A., Stoops, G. and Tursina, T. 1985. *Handbook for Soil Thin Section Description*. Waine Research Publications: Wolverhampton.

Canti, M. 2015. *Geoarchaeology; Using earth sciences to understand the archaeological record* (3rd edition). Historic England: London.

Carey, C., White, H., Macphail, R., Bray, L., Scaife, R., Coyle McClung, L. and Macleod, A. In press. Identification and analysis of prehistoric brown earth paleosols under the raised mire of Exmoor, UK. *Geoarchaeology*.

Caseldine, C J. 1999. Archaeological and environmental change on prehistoric Dartmoor: current understanding and future directions, in, K J Edwards and J P Sadler (eds), *Holocene Environments of Prehistoric Britain, Quaternary Proceedings 7*, pp. 575–583. John Wiley and Sons: Chichester.

Caseldine, C J and Hatton, J M. 1996. Vegetation history of Dartmoor: Holocene development and the impact of human activity, in, D J Charman, R M Newnham, and D G Croot, (eds), *Quaternary of Devon and East Cornwall Field Guide*, pp. 48-61. Quaternary Research Association: Cambridge.

Challinor, D. 2014. *Wintershead Exmoor: the wood charcoal from a burnt pit*. Unpublished report for the Exmoor Mires Project. (SEM8138).

Crabtree, K. and Maltby, E. 1975. Soil and land use change on Exmoor. Significance of a buried soil profile. *Somerset Archaeology and Natural History Society*, 119, pp. 38-43.

Dark, P. 2006. Climatic deterioration and land-use change in the first millennium BC: perspectives from the British palynological record. *Journal of Archaeological Science*, 33, pp. 1381 – 1395.

Edmonds, E. A., Mckeown, M. C. and Williams, M. 1975. *British regional geology: south-west Britain*. HMSO: London.

Fleming, A. 2008. The Dartmoor Reaves. Investigating prehistoric land divisions (2nd edition). Oxbow Books: Oxford.

Francis, P. D. and Slater, D. S. 1992. Bibliography A record of vegetational and land use change from upland peat deposits on Exmoor. Part 3: Codsend Moor. *Somerset Archaeology and Natural History Society Proceedings*, 136, pp. 9-28.

Fyfe, R. M. and Woodbridge, J. 2012. Differences in time and space in vegetation patterning: analysis of pollen data from Dartmoor. *Landscape Ecology*, 27 (5), pp. 745-760.

Fyfe, R. M. 2012. Bronze Age landscape dynamics: spatially detailed pollen analysis from a ceremonial complex. *Journal of Archaeological Science*, 39, pp. 2764 – 2773.

Fyfe, R. M., Brown, A. G. and Rippon, S. J. 2003a. Mid- to late-Holocene vegetation history of Greater Exmoor, UK: estimating the spatial extent of human-induced vegetation change. *Vegetation History and Archaeobotany*, 12 (4), pp. 215-232.

Fyfe, R. M., Brown, A. G. and Coles, B. J. 2003b. Mesolithic to Bronze Age vegetation change and human activity in the Exe Valley, Devon, UK. *Proceedings of the Prehistoric Society, 69, pp. 161-181.*

Gardiner, P. 2019. *Farley Water Landscape Project Brendan Common, Exmoor. Research Design 2019*. Unpublished research design written for Exmoor National Park Authority.

Gardiner, P. 2011. South western hunter gatherer landscapes, in, S Pearce (ed), *Recent Archaeological Work in South-Western Britain. Papers in Honour of Henrietta Quinnell*. BAR 546, pp. 7-20. Archaeopress: Oxford.

Gardner, T. H. 2019. Assessing the contribution of integrated geoarchaeological approaches to understand the formation and function of burnt mounds: the example of Hoppenwood Bank, North Northumberland. *Archaeology Journal*, 176 (1), pp. 51-83.

Gearey, B. R., Charman, D. J. and Kent, M. 2000b. Palaeoecological Evidence for the Prehistoric Settlement of Bodmin Moor, Cornwall, southwest England. Part II: Land Use Changes from the Neolithic to the Present. *Journal of Archaeological Science*, 27, pp. 493-508.

Gearey, B. R., Charman, D. J. and Kent, M. 2000a. Palaeoecological Evidence for the Prehistoric Settlement of Bodmin Moor, Cornwall, Southwest England. Part I: The Status of Woodland and Early Human Impacts. *Journal of Archaeological Science*, 27, pp. 423-438.

Goldberg, P and Macphail, R. I. 2006. *Practical and theoretical geoarchaeology*. Blackwell: Oxford.

Green, T. 2009. Excavation of a Hillslope Enclosure at Holworthy Farm, Parracombe displaying Bronze Age and Iron Age Activity, *Proceedings of the Devon Archaeological Society*, 67, pp 39-98.

Hunnissett, K. L., Carey, C. J., Bray, L. S., Macphail, R. I. and Crabb. A. Forthcoming. Prehistoric soil degradation and landscape change on Dartmoor: what happened before the reaves and the roundhouses? *Journal of Archaeological Science.*

Macphail, R. I. and Crowther, J. 2013. *Stainton West (Parcel 27) CNDR, Cumbria: Soil micromorphology and microchemistry, chemistry, magnetic susceptibility and particle size analysis*. Unpublished report for Oxford Archaeology.

Macphail, R. I. 1989. *Soil report on Carn Brea Redruth, Cornwall; with some reference to similar sites in Brittany, France.* Ancient Monuments Laboratory Report 55/90. Unpublished report.

Macphail, R. I. 1987. *Soil report at on the cairn and field system, Chysauster, Penzance*. Ancient Monuments Laboratory Report 11/87. Unpublished report.

Melton, N. D., Russ, H. and Johnson, D. S. 2014. *Excavation of a Mesolithic site at Kingsdale Head (SD712 799) by the Ingleborough Archaeology Group 2009-2010*. Unpublished Report Ingleborough Archaeology Group.

Merryfield, D. L. and Moore, P. D. 1974. Prehistoric human activity and blanket peat initiation on Exmoor. *Nature*, 250, pp. 439-441.

Moore, P.D., Webb, J.A. and Collinson, M.E. 1991. *Pollen Analysis (*Second edition). Blackwell Scientific: Oxford.

Moore, P.D. and Webb, J.A. 1978. A*n Illustrated Guide to Pollen Analysis*. Hodder and Stoughton: London.

Newman, P. 2016. *The field archaeology of Dartmoor*. Historic England: Swindon.

Ó Néill, J. 2009. *Burnt mounds in Northern and Western Europe: A study in prehistoric technology and society*. VDM Verlag Dr. Müller, Saarbrücken, Germany.

Richards, J. 1990. The Stonehenge environs project. Archaeological Report no 16. English Heritage: Swindon.

Riley, H. and Wilson-North, R. 2001. *The field archaeology of Exmoor*. English Heritage: Swindon.

Roberts, N. 2014. *The Holocene an environmental history*. Wiley Blackwell: Chichester.

Simmons, E. 2016. *Lanacombe, Exmoor, Devon, wood charcoal analysis*. Unpublished report for Exmoor National Park Authority.

Smith, G. 1996. Archaeology and Environment of a Bronze Age Cairn and Prehistoric and Romano-British Field System at Chysauster, Gulval, near Penzance, Cornwall. *Proceedings of the Prehistoric Society*, 62, pp, 167-220.

Stace, C. 1991. *New flora of the British Isles*. Cambridge University Press: Cambridge.

Straker, V. and Crabtree, K. 1995. Palaeoenvironmental studies on Exmoor: past research and future potential, in, H Binding (ed), *The changing face of Exmoor*, pp. 43-51. Exmoor Books: Tiverton.

Stoops, G., Marcelino, V., and Mees, F. 2018. *Interpretation of Micromorphological Features of Soils and Regoliths* (2nd Edition). Elsevier: Amsterdam.

Viklund, K., Linderholm, J., and Macphail, R. I., 2013. Integrated Palaeoenvironmental Study: Micro- and Macrofossil Analysis and Geoarchaeology (soil chemistry, magnetic susceptibility and micromorphology), in Gerpe, L.-E., ed., E18-prosjektet *Gulli-Langåker. Oppsummering og arkeometriske analyser*, Volume Bind 3: Bergen, Fagbokforlaget, p. 25-83.

Wilson-North, R. and Carey, C. 2011. A burnt mound on Brendon Common, Exmoor. *Proceedings of the Devon Archaeological Society*, 69, pp. 9-22.

Figure 1

Click here to access/download;Figure;Figure 1 location.jpg

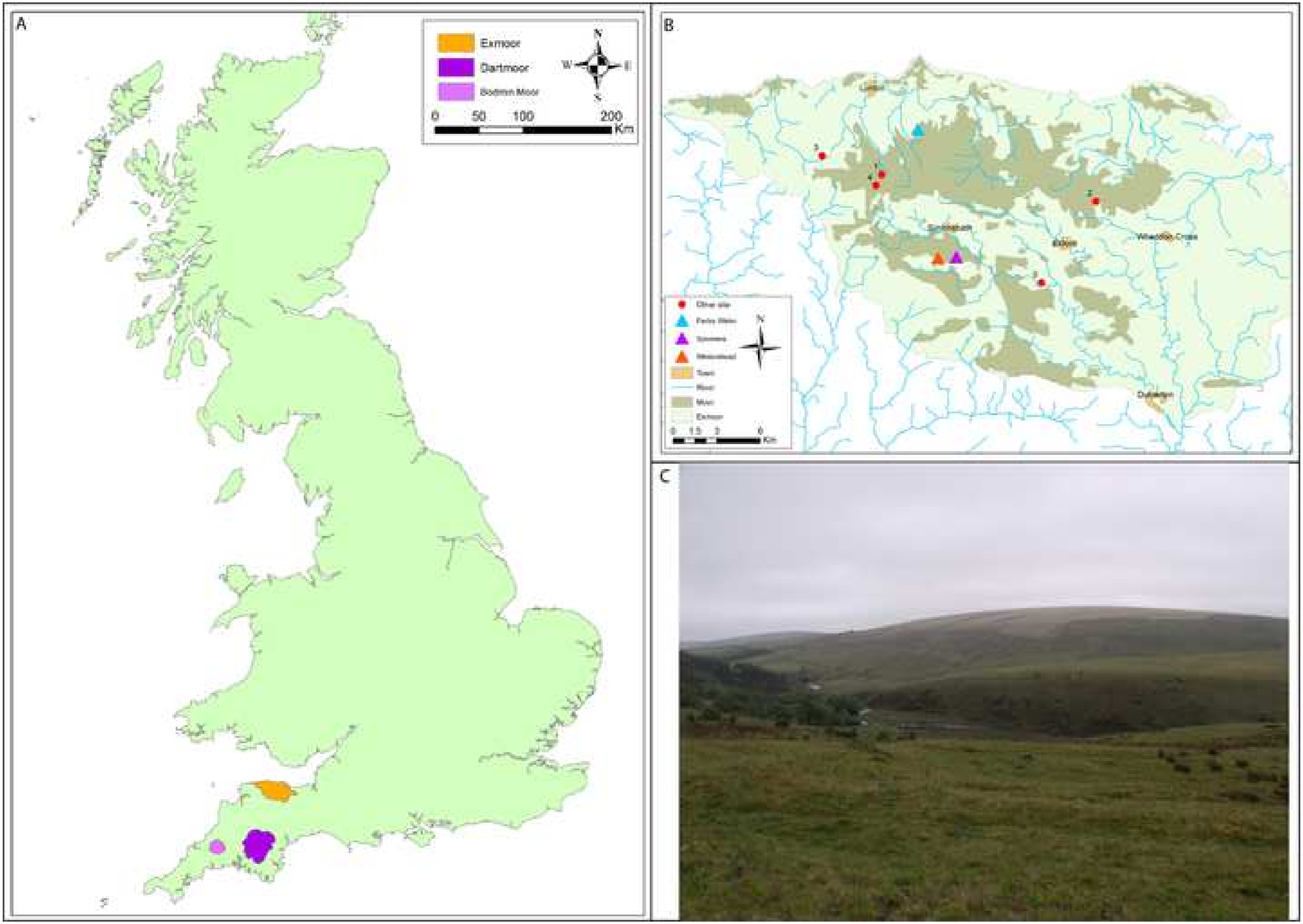


Figure 2

Click here to access/download;Figure;Figure 2 EWH location and grad final.jpg

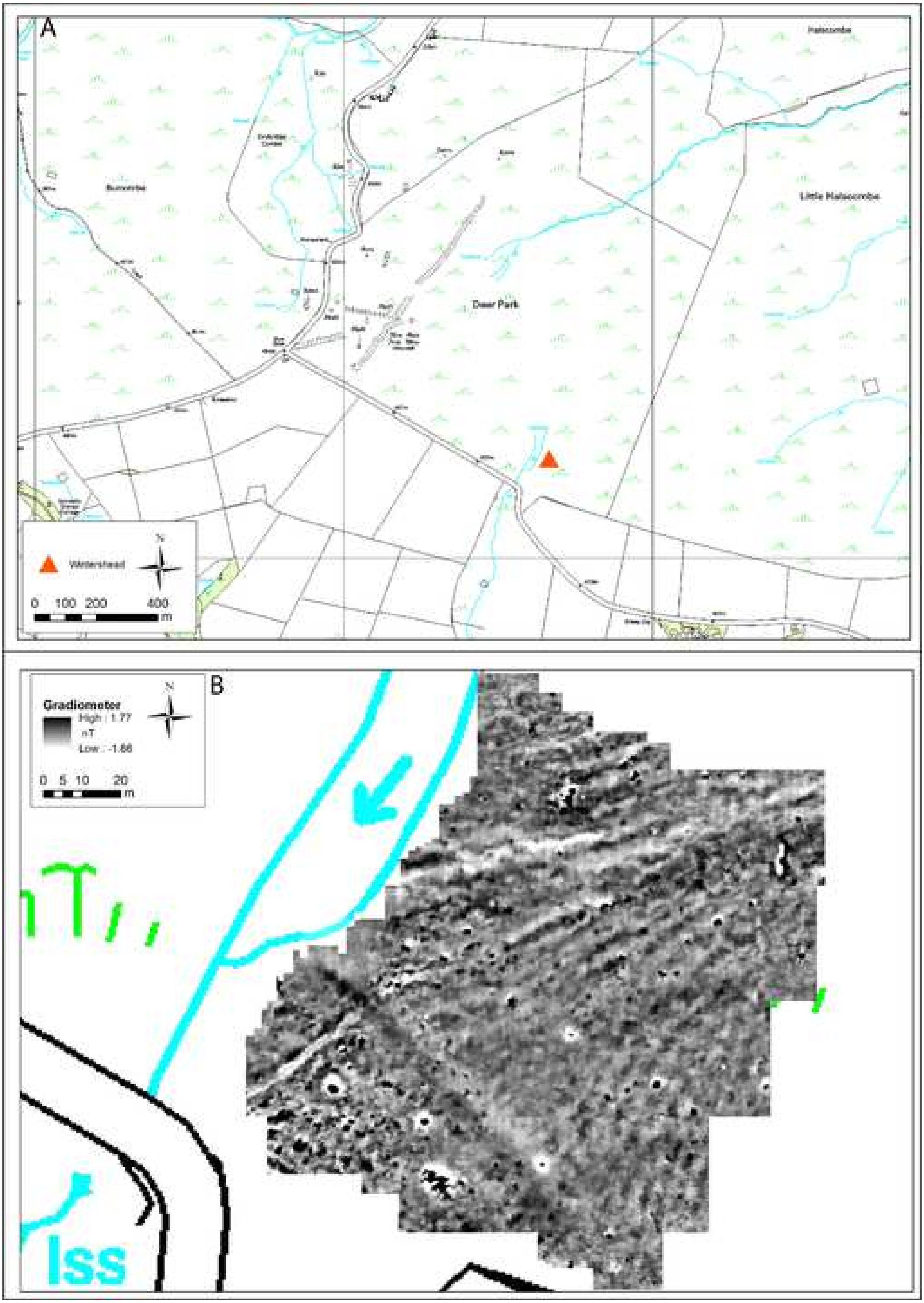


Figure 3

Click here to access/download;Figure;Figure 3 Grad inter and site detai.jpg

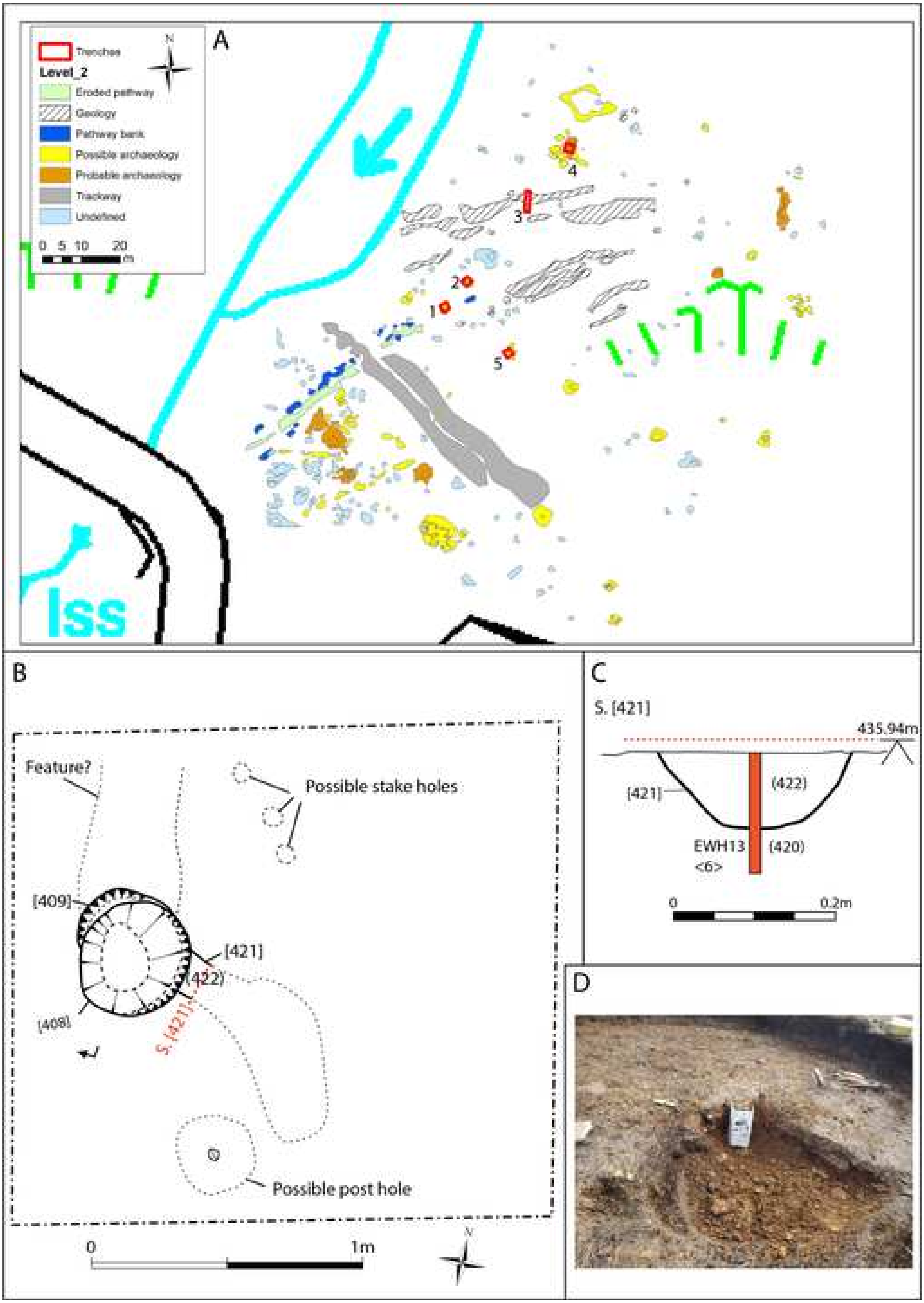


Figure 4

Click here to access/download;Figure;Figure 4 EWH13 Sample 6 all proxies.jpg

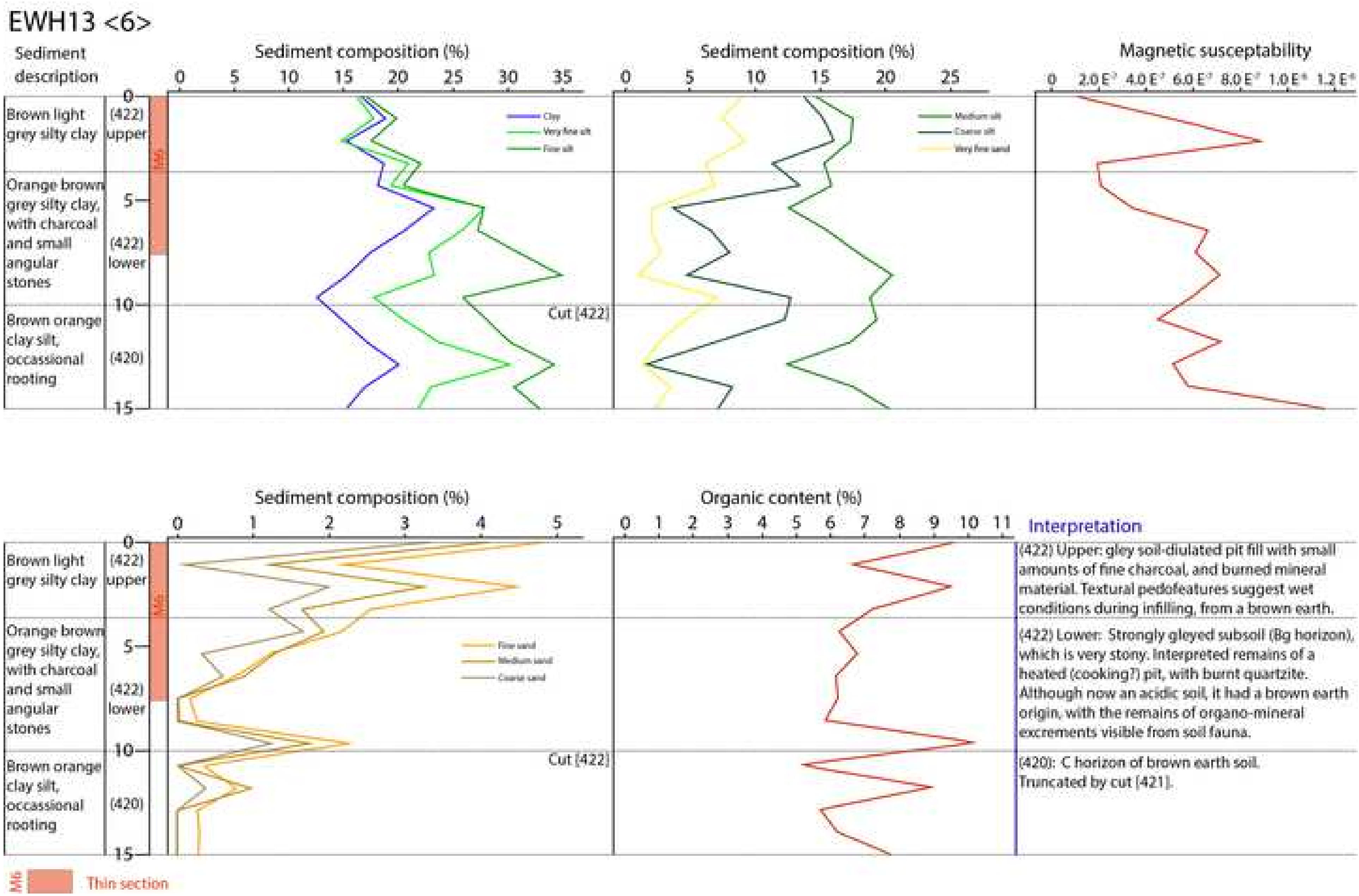
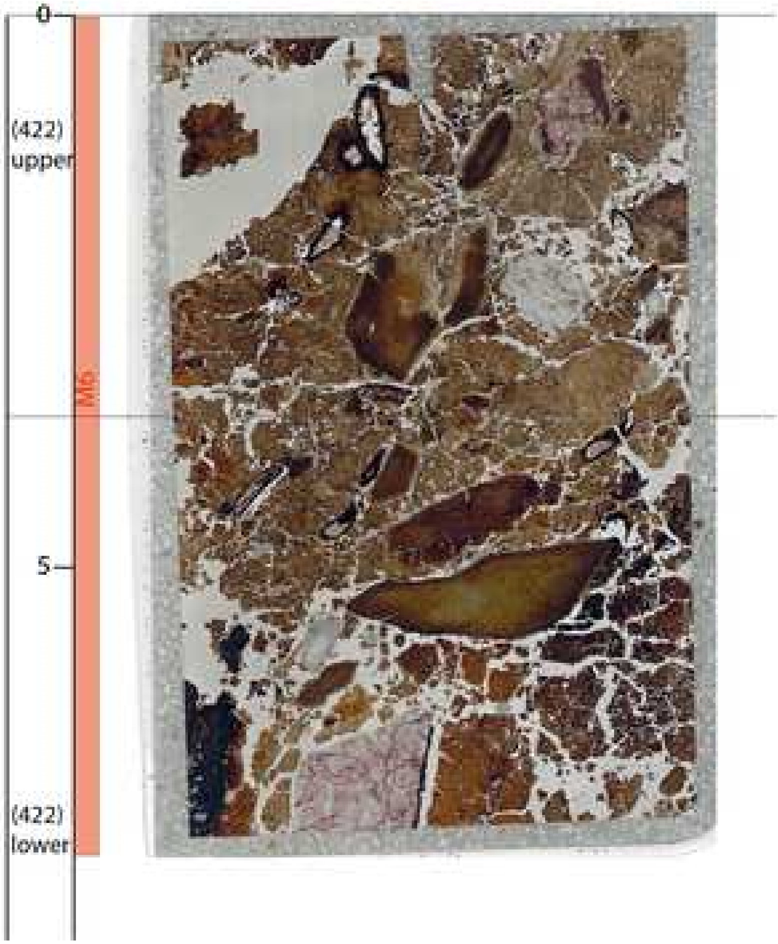


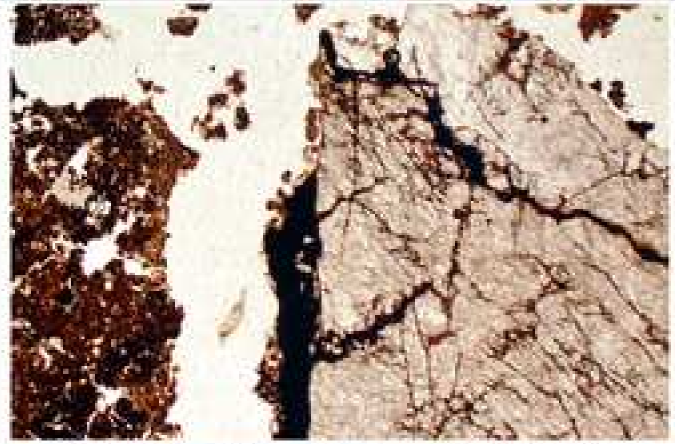
Figure 5

Click here to access/download;Figure;Figure 5 EWH13 sample 6 thin section details.jpg

EWH13 <6>

A) EWH13 Sample <6>
Contexts (422) upper and (422) lower
Scan of M6
There are burnt (rubefied) quartzite rock fragments in both the upper and lower parts of this fill.
Note the ferruginised roots in this pale gelyed fill.





Context (422) upper
Rubefied quartzite rock fragment; soil is being thinly burrowed (more acidic conditions than previously) and iron staining has occurred.
PPL , frame width is ~4.62mm.

C) EWH13 Sample <6>
Context (422) upper
Photomicrograph of once-partially earthworm homogenised soil, now being burrowed by acidophyle small invertebrate soil mesofauna; note small amounts of integrated charcoal.
PPL, frame width is ~4.62mm.

D) EWH13 Sample <6>
Context (422) upper
Photomicrograph of detail of above (C), showing darker matrix intercalations, probably a relict of wet soil infilling.
PPL, frame width is ~0.90mm.

Figure 6

Click here to access/download;Figure;Figure 6 OA1210 Location and grad.jpg

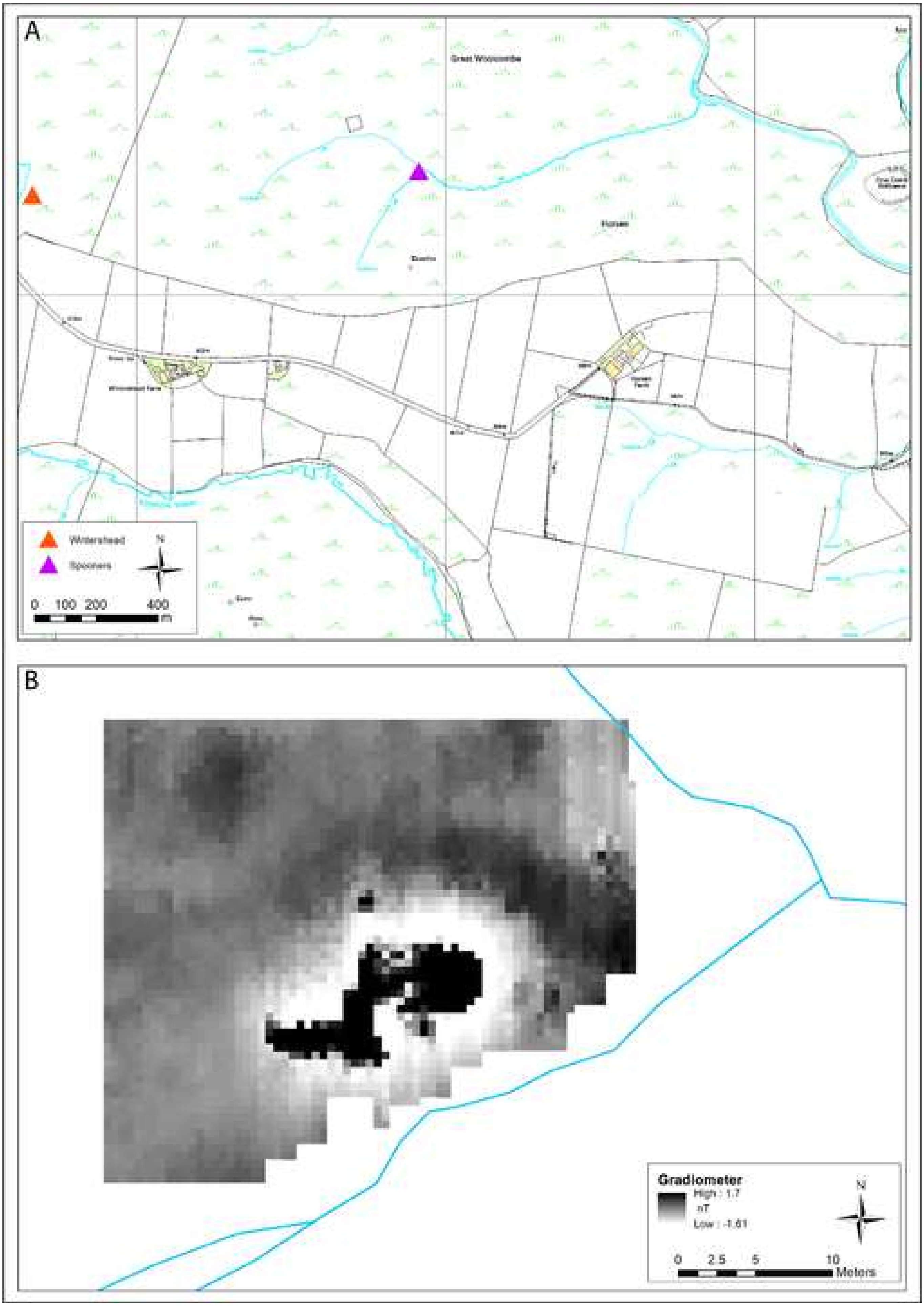
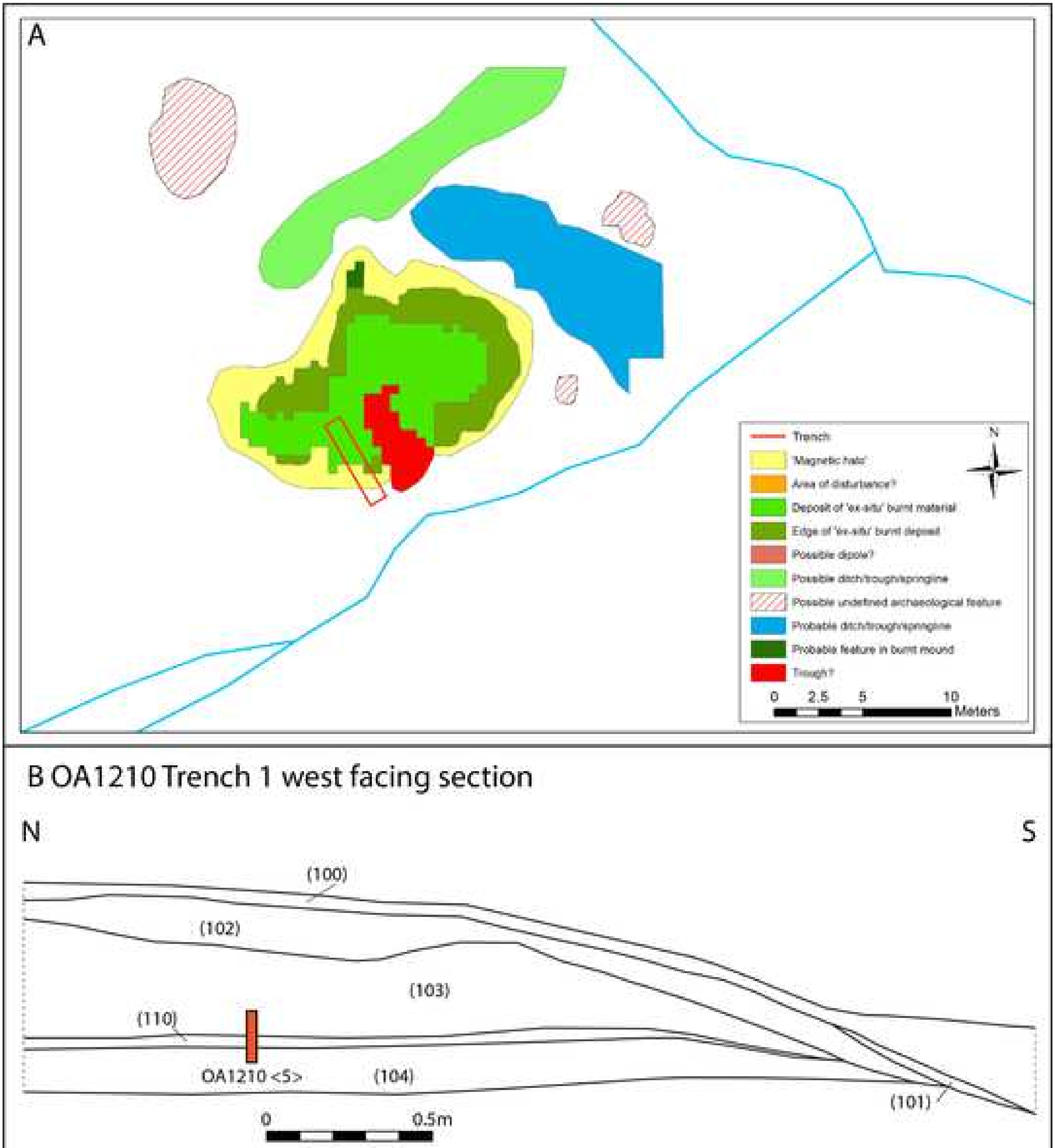


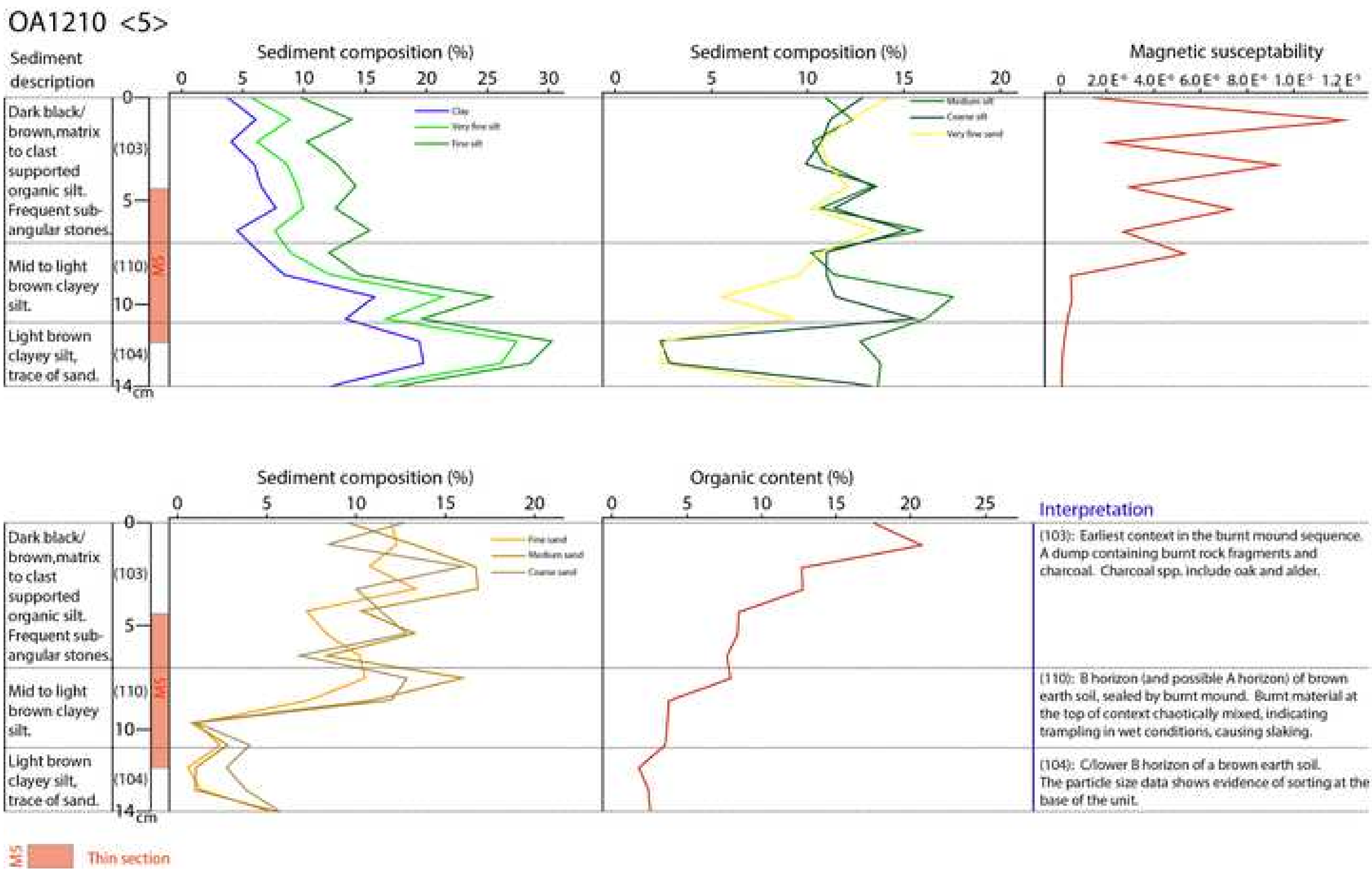
Figure 7

Click here to access/download;Figure;Figure 7 Spooners grad and section.jpg



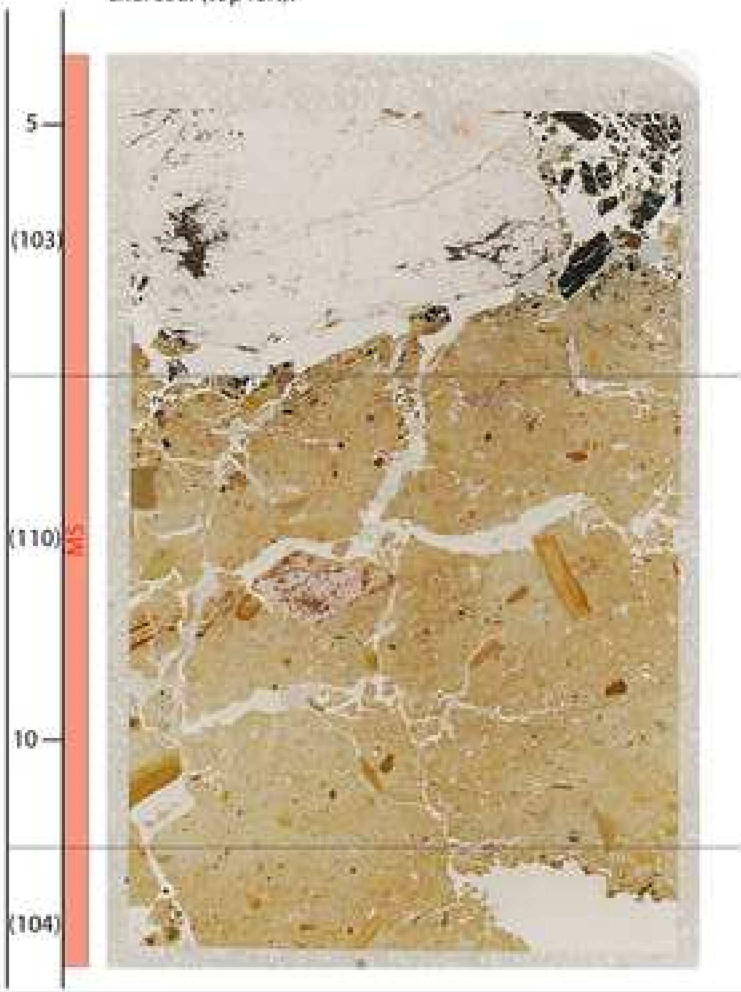
Redrawn from Oakford Archaeology 2014 with permission

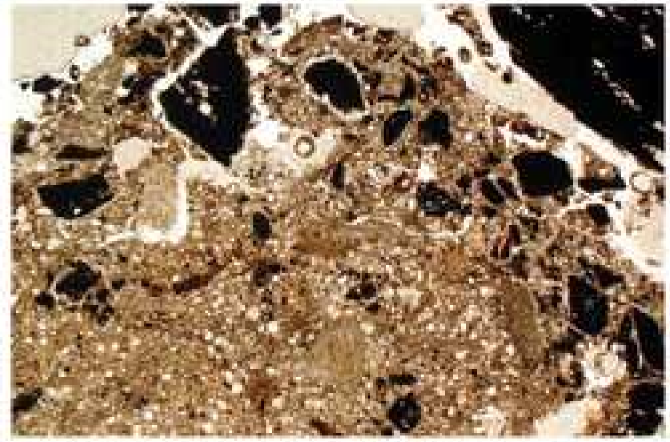
Figure 8


OA1210 <5>
Sediment description
Sediment composition (%)
Sediment composition (%)
Magnetic susceptibility
Dark black/ brown,matrix to clast supported organic silt. Frequent sub-angular stones.
(103)
Mid to light brown clayey silt.
(110)
Light brown clayey silt, trace of sand.
(104)
cm
SM
Sediment composition (%)
Organic content (%)
Interpretation
(103): Earliest context in the burnt mound sequence. A dump containing burnt rock fragments and charcoal. Charcoal spp. include oak and alder.
(110): B horizon (and possible A horizon) of brown earth soil, sealed by burnt mound. Burnt material at the top of context chaotically mixed, indicating trampling in wet conditions, causing slaking.
(104): C/lower B horizon of a brown earth soil. The particle size data shows evidence of sorting at the base of the unit.
Thin section

OA1210 Sample <5>

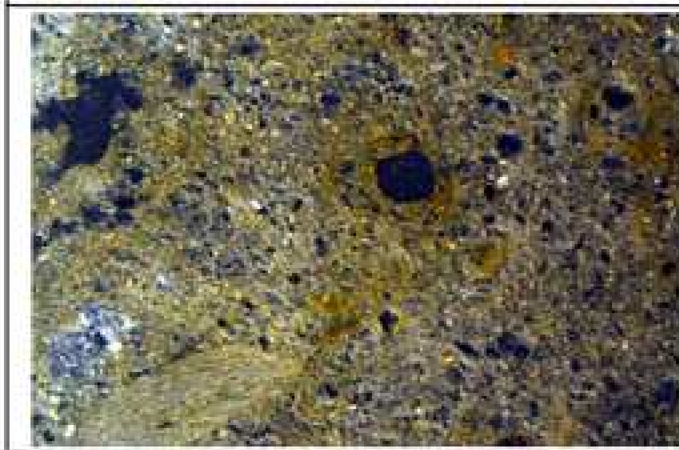
A) OA1210 Sample <SBM5>
Contexts (110) and (103)
Scan of M5
Context (110) is iron depleted and compact with matrix intercalations and closed vughs and vesicles (see C and D). There is a burnt stone (middle rubefied quartzite) and iron staining recording possible humic laminae (middle left). Context (110) is characterised by finely mixed in charcoal see B). Context (103) contains burnt rock (top right) and charcoal (top left).





B) OA1210 Sample <5>
Contexts (110) and (103)
Photomicrograph of M5 (103-110 junction). The interface shows a muddy mixed charcoal-rich soil.
PPL, frame width is ~4.62mm.

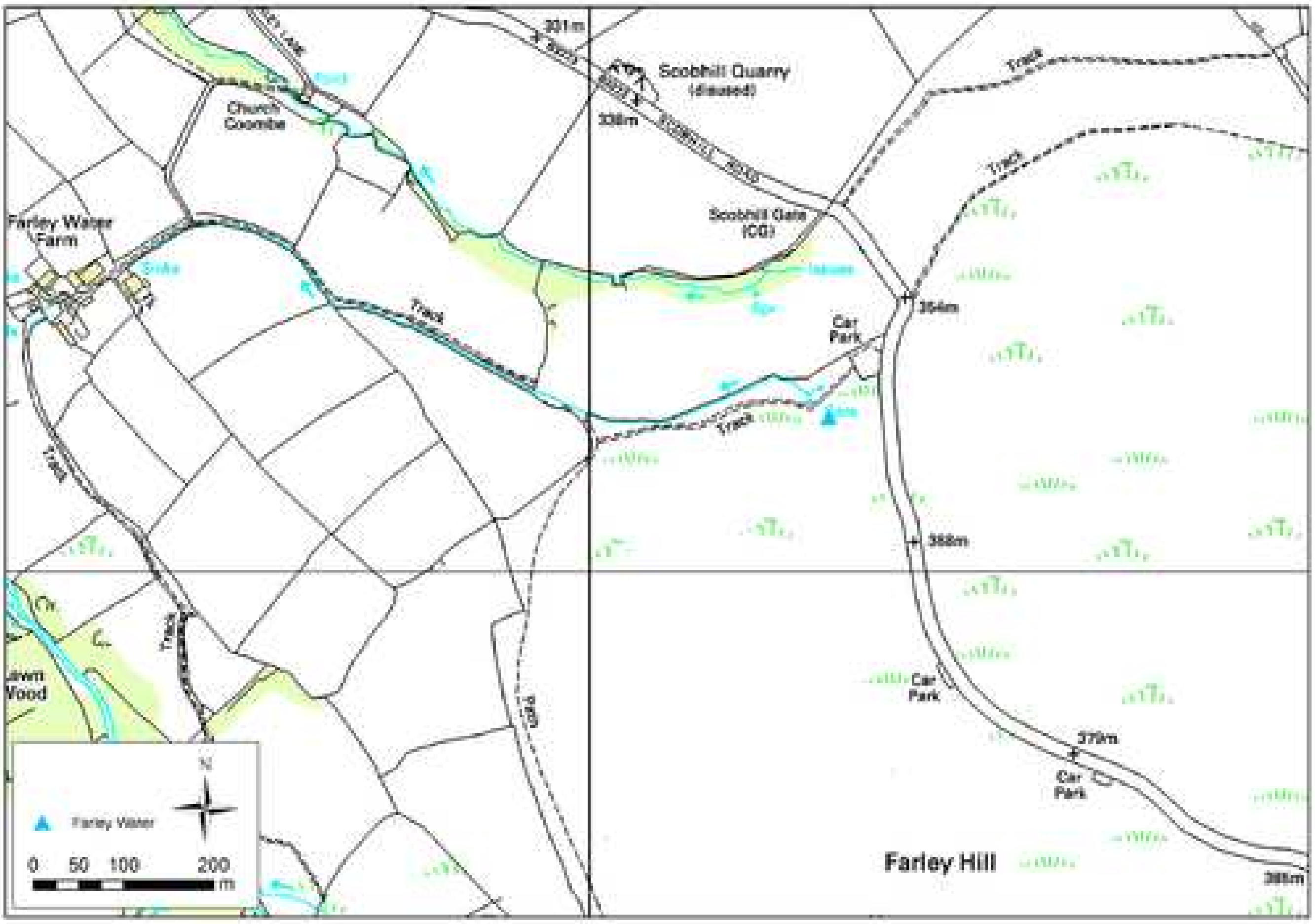
C) OA1210 Sample <5>
Context (110)
Photomicrograph showing vesicle (circular void), surrounding matrix infills and 'sorted' brown dusty clay, the result of muddy infilling/ disturbance.
PPL, frame width is 2.38mm.

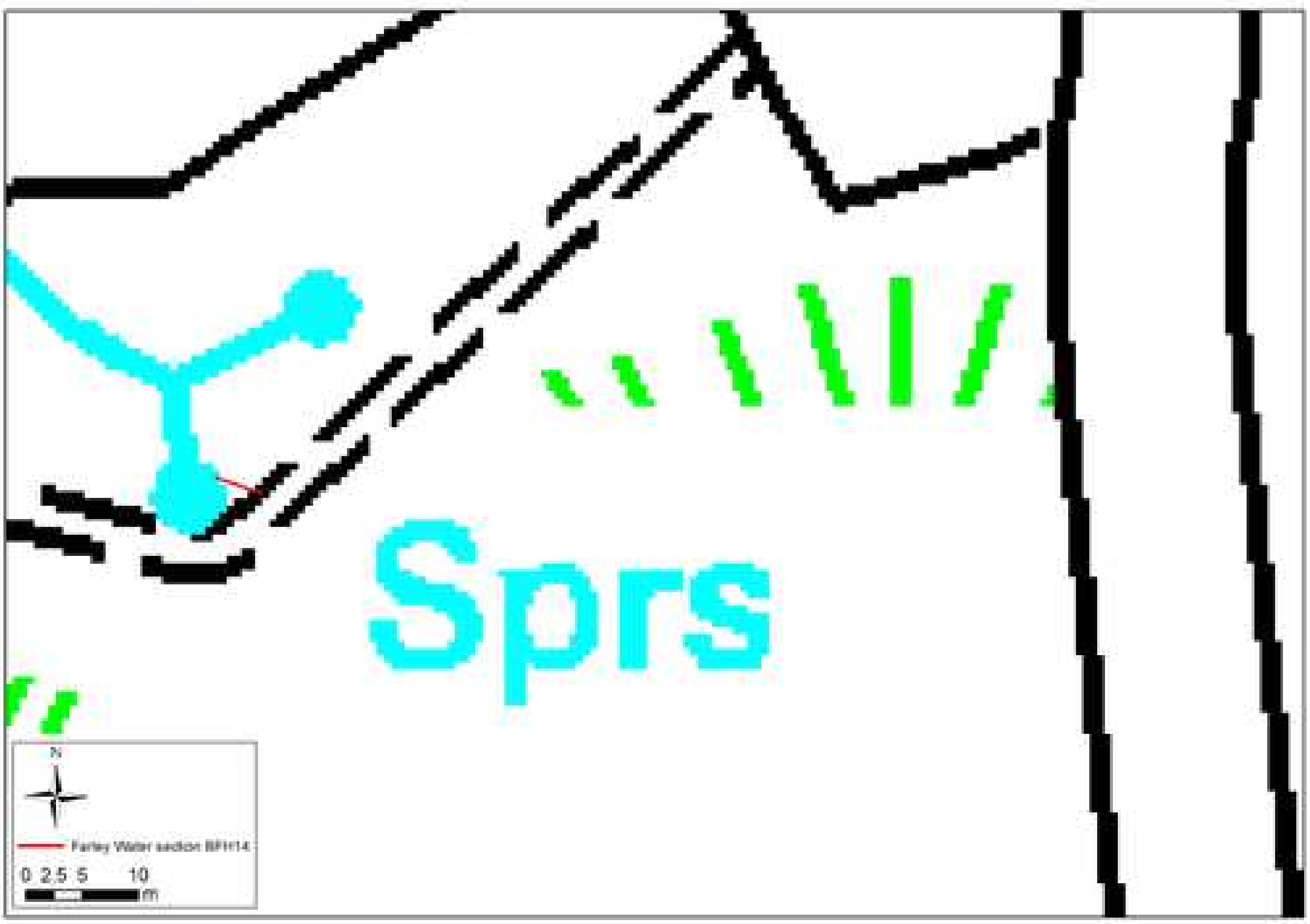


D) OA1210 Sample <5>
Context (110)
As above (C) under OIL, showing a small amount of iron staining of textural pedofeatures.
OIL, frame width is ~2.38mm.

Figure 10

Click here to access/download;Figure;Figure 10 FW16 location.jpg





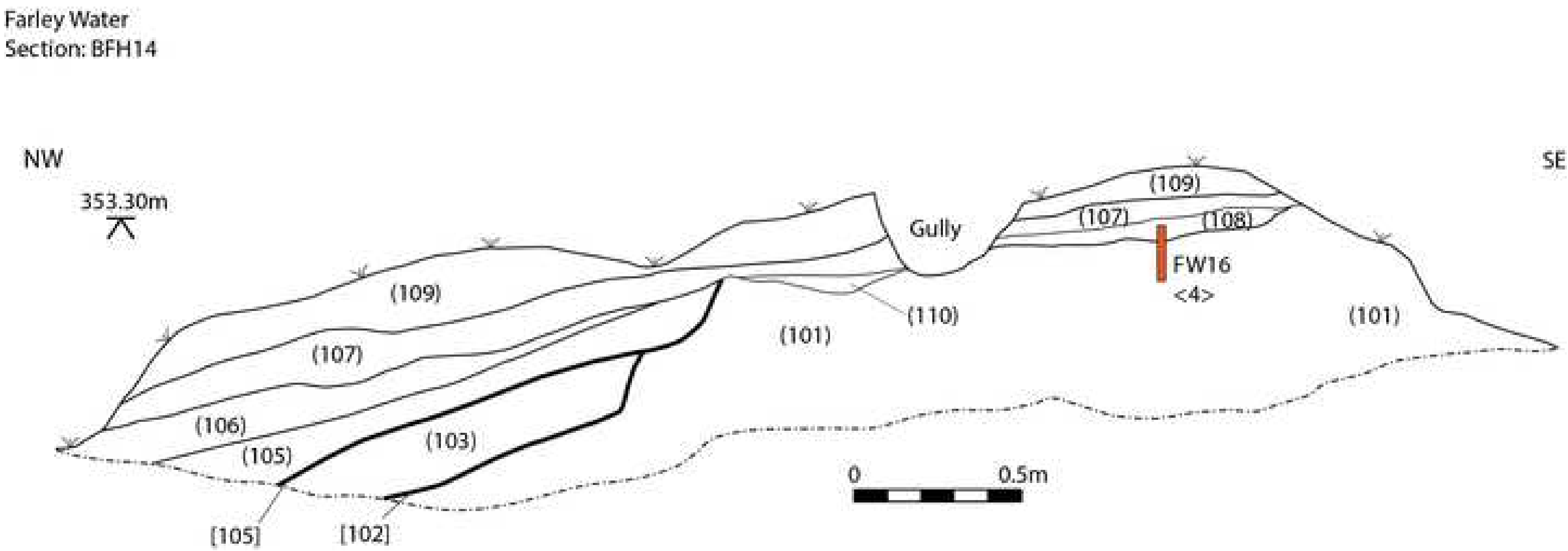

Farley Water
Section: BFH14
NW
SE
353.30m
(109)
(107)
(106)
(105)
(103)
(101)
(110)
Gully
(109)
(107)
(108)
FW16
<4>
(101)
[105]
[102]
0
0.5m

Figure 12 Click here to access/download;Figure;Figure 12 FW16 Sample FW4 all proxies.jpg

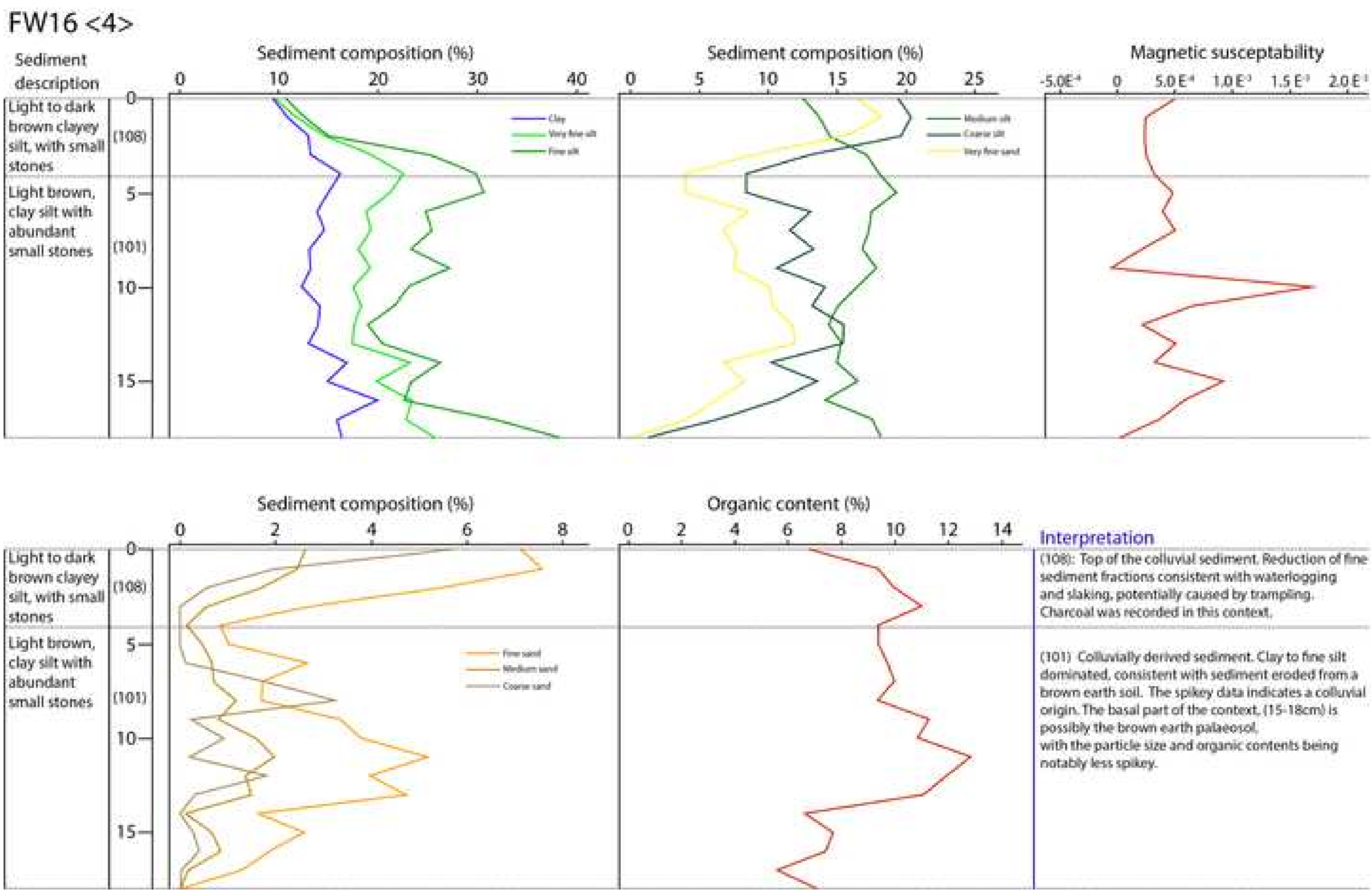


Figure captions

Figure 1: The location of Exmoor, at a national scale (A) and regional scale (B), with the sample sites and other key sites discussed in the text highlighted (0 = Brightworthy; 1 = The Chains; 2 = Codsend Moor; 3 = Holworthy hillslope enclosure; 4 = Pinkery Canal), and a classic Exmoor photograph showing the raised mire on the high ground, with improved pasture downslope and some woodland in the steeply incised river valleys, Cheriton Ridge, Exmoor (C).

Figure 2: The location of site at EWH13 Wintershead (A) and the gradiometer survey (B).

Figure 3: EWH13 interpretation of the gradiometer data and the location of the 5 trenches (A), the post excavation plan of trench 4 (B), The section feature [421] and sample EWH13 <6> and a working shot of sample EWh13 <6> during collection.

Figure 4: EWH13 <6> sediment analysis.

Figure 5: EWH13 <6> showing detail from the thin section over the Mesolithic heated pit fill.

Figure 6: OA1210 showing site location (A) and the gradiometer survey (B).

Figure 7: OA1210 interpretation of the gradiometer data (A) and section OA1210 trench 1 section, showing the location of OA1210 <5> (B).

Figure 8: OA1210 <5> sediment analysis.

Figure 9: OA1210 <5> showing detail from the thin section brown earth palaeosol and the overlying burnt mound deposit.

Figure 10: FW16 site location (A) and the location of section BF14.

Figure 11: FW16 section BFH14 and the location of FW16 <4>.

Figure 12: FW16 <4> sediment analysis.

Table

Click here to access/download
Table
Carey - JASR Exmoor table.docx