# Analysis of a brown earth palaeosol and derived sediments associated with a Mesolithic pit, a Late Neolithic - Early Bronze Age burnt mound and an Early Bronze Age burnt mound on Exmoor, UK.

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**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 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 burnt mounds dating to the Late Neolithic - Early Bronze Age. 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 that

anthropogenic activities were linked to important processes negatively impacting on soils in these upland areas 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 with the other more famous granitic uplands of the region, such as 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 and Smith 1980; Smith et al. 1981).

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 indicating 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, although the palaeosol was undated (Crabtree and Maltby 1975). 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. 2020). 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 in some areas (Fyfe and Woodbridge 2012). 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 landscape settlement, exploitation and human-environmental dynamics. This paper, then, details the analysis of a brown earth palaeosol and sediments derived from brown earth soils 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, B), one dating to the Late Neolithic - Bronze

Age and the other being 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 to investigate archaeological 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 useful for the identification of palaeosols (Canti 2015). Ceramic crucibles were oven 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 covered significant contexts in order 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, et al. 2018). Key soil micromorphology features are given in the text, with a table providing complete micromorphology descriptions for each sample. 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***

A very limited number of samples for pollen analysis were examined and as a consequence conclusions from the pollen data must therefore be regarded as somewhat generalised. Data presented relate largely to the on- and near-site environs. Exceptional, detailed, long term vegetation studies of Exmoor have been given by for example, Merryfield and Moore (1974); Crabtree Maltby (1975): Francis and Slater (1992); Straker and Crabtree (1995); Fyfe et al. (2003a); Fyfe (2012). It can, however, be noted that the character of pollen stratification, where it occurs in soils is broad, caused by a number of taphonomic processes (Dimbleby 1985). 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. Pollen taxonomy, in general follows that of Moore and Webb (1978) modified according to Bennett et al. (1994) for pollen types and based on Stace (1991).

***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 from erosion caused by a footpath, revealing an assemblage of worked prehistoric flints, adjacent to a spring line, in an area of moorland with no previously recorded archaeology. A gradiometer survey was subsequently undertaken identifying numerous suspected archaeological anomalies (Figures 2 and 3A), with the gradiometer survey and walk over survey recognising a probable small Bronze Age barrow. Five of the gradiometer anomalies 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 Trenches 3 and 5, and no features were identified.

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 (reported in Carey et al. 2020). 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 (422), a gritty red brown clay silt, with occasional stone and charcoal fragments. Pit [408] recut [409], of which only a small portion of [409] survived, which was filled by (410), a light brown clay silt (Figure 3, B).

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 from mature *Quercus* trunk wood with 35 out of 50 samples identified as heartwood through tysloses, with no ring curvature or roundwood fragments recorded, although preservation was generally poor (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 Cut [408] and fill (411) that dates to the end of the Early Mesolithic period. EWH13 sample <6> was taken from context (420) and the fill (422) of Pit [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 peak at the junction with 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. 2020) that has been truncated through Pit [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 Cut [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 (rubified) 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 Pit [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 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 heated (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 Pit [421]. This pit has two fills, with (422) lower containing burnt rock material and (422) upper consisting of probable backfilled material from the surrounding brown earth, with some fine charcoal inclusions. 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 soil (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 pits [409] and [408]. Pit [408] was filled by context (411) which produced the $7^{th}$ millennium BC date. A single burnt flint flake was recovered from (411), with the fuel selection being *Quercus* trunkwood. No artefacts were recovered from (422), although it was only partially excavated. Therefore, in absence of any other evidence, Pit [421] is interpreted as a Mesolithic heated pit, possibly used for cooking, analogous to the Iron Age well-preserved cooking pits from Vestfold, Norway (Viklund *et al*. 2013) or possibly the Mesolithic pit at Kingsdale Head, North Yorkshire (Melton et al. 2014).

### 3.2 Results: Spooners Burnt Mound OA1210 sample <5>

Spooners burnt mound (OA1210) was identified by walkover survey, near the confluence of two streams on an area of upland moorland, and was subsequently defined through gradiometer survey (Figures 6 and 7). No other archaeological features were identified in the immediate vicinity of the burnt mound by either the walkover survey or the gradiometer survey. The burnt mound deposits and underlying sediment sequence were recorded and sampled by evaluation excavation. 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, the earliest recorded context in the burnt mound sequence. A radiocarbon date from unidentified charcoal in (103) dated to 2346 – 2138 cal BC (95.4%) ((SUERC-56652 (GU35968)). The overlying context (102) was part of the burnt mound, *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 8 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. In this level, pollen preservation was generally poor with, therefore, the possibility of some differential preservation in favour of more robust taxa (e.g. spores *Dryopteris* type and *Polypodium Pteropsida*) and the under representation of less robust taxa such as Poaceae (grasses). However, *Alnus* (24 grains) and *Corylus avellana* type (68 grains) were present showing some woodland in the pollen catchment. Both taxa are, however, anemophilous and may be over represented in pollen assemblages (Andersen 1970; Janssen 1969; Scaife 1980; Binney et al. 2005) especially in floodplain carr woodland (Scaife 1980; Binney et al. 2005) and may also subject to long distant transport. Although the presence of alder pollen implies growth, the relatively low numbers recorded here does not necessarily attest to on or near site growth, unless in small numbers. Number of *Corylus* are more suggestive of growth in proximity to the sample site. The small numbers of Poaceae pollen perhaps indicate grassland although being a catholic group, the record may be referable to other plant communities such as wetland mire. There are high levels of *Sphagnum* spores (150) indicating some acidification and waterlogging and such mire communities.

*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 content is low but is 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*), around this locale and woodland and grassland locally and regionally. The presence of *Alnus* indicates wetland habitats, possibly running along stream courses or fringing the spring lines on the high ground. *Corylus* scrub may have been growing on the better drained soils of the interfluves. As noted, both taxa are anemophilous, high producers and as such may be over represented in pollen assemblages and may derive from long distance and regional sources.

#### ***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 rubified 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 *Plantago lanceolata* (6 grains) indicating some grassland, being a possible disturbance indicator. 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 one 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, with the associated reduction in the finer sediment fractions. 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 2016) 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, with dominance of weak ring curvatures, indicates the use of slow grown oak trunk wood. Fungal hyphae are present in the vessels in 11% of the wood charcoal fragments, indicating the use of a certain amount of dead or decaying wood or possibly wood storage (Moskal-del Hoyo, et al. 2010). 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 given the identification of trunk wood. Brown et al. (2016) also recorded the use of *Alnus* in burnt mound deposits from Ireland, associated with the clearance/exploitation of wet woodland, alongside Mighall et al. (2018) showing use of *Quercus* and *Alnus* branch wood as wood fuel in a burnt mound in Northern Ireland.

*Context (103) interpretation*: this context is the earliest in the burnt mound 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 probable anthropogenic impact on this brown earth soil prior to burial under the burnt mound. Whilst the soil had not acidified and transformed into a stagnogley podzol, the effect of a compacted slaked soil layer would have been to impede drainage possibly leading to localised waterlogging. 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, with Mighall et al. (2018) noting that burnt mounds were often positioned within partially open locales. However, woodland is well represented, with the presence of *Alnus* likely growing along rivers and spring lines and probably some hazel scrub. Clearly, a more detailed analysis of a longer organic sequence from an adjacent wetland peat sequence would allow some of the enigmas to be solved. Furthermore, the presence of *Quercus* from the CPR/anthracological analysis suggests woodland is likely to have been present within a relatively short distance from this monument. Comparable, but more detailed charcoal analysis of a burnt mound complex at Ballygawley, Northern Ireland (Mighall et al. 2018), demonstrated for the Neolithic - Copper Age *Alnus glutinosa* was the dominant fuel type, with lesser amounts of *Quercus*, *Prunus avium* and *Prunus padus*, with eleven fuel wood taxa identified for this period. In the Bronze Age *Alnus glutinosa* was again the dominant fuel source, although *Corylus avelenna type* was well represented, and lesser amounts of nine other wood species were recorded. The fuel source was identified as branch wood and was interpreted as being sourced locally. At Roughlan, Northern Ireland, Wheeler et al. (2016) recorded a similar picture, with *Alnus glutinosa*, *Corylus avellena* type and *Quercus* charcoal dominating the assemblage from 5 bunt mounds of Late Neolithic-Early Bronze Age date. Branch wood was again dominant, but trunk wood was also present. The data from Spooners indicates a more limited selection of species for fuel, with *Quercus* dominant and some *Alnus*, although this might represent local availability. Again contrastingly at Spooners, mature trunk wood was favoured over branch wood.

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

Excavations at Farley Water (FW16) investigated a brown earth palaeosol (Carey et al. 2020) associated with Mesolithic flint scatters (Gardiner 2019). In close proximity to this excavation, burnt material had been previously identified adjacent to the head of a spring line. This had been truncated by a trackway, leaving an exposed section through these deposits, showing burnt material 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 sample FW16 <4> retrieving 18cm of sediment (Figure 12; Table 7), sampling contexts (101) and (108). The most likely explanation for this burnt material, given its proximity to the spring line, and abundance of shattered stone and charcoal visible in section, is a burnt mound. 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. Cuts [102] and [104] were not further investigated, other than being recorded in the eroded section; therefore their dimensions and function remain undefined. 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 [102], (103), [104], (105), (106) and (107) representing the deposits of the burnt mound and (109) post burnt mound soil development. Unidentified 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 (1%) 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 top of 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), which is 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 and particle size 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. 2020), *c*. 200m away from the FW16 <4> reported here.

***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 constant, although a slight increase is visible at the top of the context.

*Context (108) interpretation*: on the present level of evidence, and 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, with a brown earth palaeosol previously reported at Farley Water (Carey et al. 2020). 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 human impacts (colluvial soil erosion) in this landscape during the Late Neolithic - Early Bronze Age.

## 4.0 Discussion

Three sampled sites have been analysed that are associated with archaeological features, brown earth soils and sediments derived from 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, in these upland landscapes, as well demonstrating the archaeological potential of the pre-mire sediment sequences on Exmoor. EWH13 sample <6> from Wintershead contained a brown earth soil contemporary with 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-reave ‘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 have substantially increased over the last two decades primarily due to developer funded archaeology. They suggest pits 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 of pre Late Neolithic - Early Bronze Age. This colluvium is interpreted as being derived from human induced landscape disturbance, most likely some form of localised woodland disturbance, facilitating brown earth soil erosion. At Ballygawley and Roghan burnt mounds, Northern Ireland, analysis of pollen did not reveal definable human impacts on vegetation associated with the use of burnt mounds (Wheeler et al. (2016); Mighall et al. (2018)). It therefore seems probable that the colluvium under the burnt mound at Farley Water relates to wider human use of this landscape, rather than construction and use of the burnt mound *per se*. Different palaeoenvironmental studies have indicated different dates of human impacts on the Exmoor landscape, some of which have been directly linked to the process of podzolisation. 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 the colluvium at 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, although in the cases reported in our analyses pre-date the process of podzolisation.

Colluvium dating to before 755-680 cal BC was also recognized at Wintershead above a brown earth palaeosol (Carey et al. 2020). 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 appear to demonstrate a degree of human landscape disturbance within parts of the uplands during the Late Neolithic - 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. The poor survival of pollen in the palaeosol at Spooners burnt mound has limited its interpretative usefulness, and it would well be worth investigating longer, more detailed pollen sequences close to Spooners and Farley Water burnt mounds, to contextualise human impacts on woodland taxa around the dates of the burnt mound use. This is especially significant for Spooners burnt mound, where the CPR/ anthracological analysis revealed the use of trunk wood, which potentially indicates tree felling.

A significant aspect of both burnt mounds is the early date for these monuments. Even allowing for a possible old wood effect on both charcoal samples (the charcoal was unidentified in both cases), the Farley Water burnt mound dates to the Late Neolithic - Early Bronze Age and the Spooners burnt mound dates to the Early Bronze Age, adding a significant dimension to the archaeological record of Exmoor, which is dominated by cairns and barrows in this time period. 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 one 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 (O'Kelly 1954), brewing (Quinn and Moore 2007) and sweat lodges (Barfield and Hodder 1987). More recent scientifically driven investigations have developed these earlier ideas. Brown et al. (2016) suggest textile production and/or hide leather processing/working, based on palaeoecological and geochemical analyses. Mighall et al. (2018) provide evidence of coprophilous fungal spores associated with herbivores and burnt mounds, indicating a pastoral linkage for these monuments, whilst Wheeler et al. (2016) also suggests an association between burnt mounds and pastoral economies, again through coprophilous fungi. Brück (2019, 178-179) highlights how burnt mounds are located close to a water source, but often at distance from settlements, sometimes in liminal areas. The presence of the burnt mounds on Exmoor, in upland environments associated with spring lines, is therefore 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 and/or use of the southwest uplands during the Early Bronze Age. It is possible that the saw tooth distribution of the magnetic susceptibility, and to a lesser extent the larger sediment fractions, at Spooners burnt mound (103) reflects a similar periodic of deposition of burnt material, between phases of unburnt material.

The burnt mounds at Farley Water and Spooners were constructed within areas associated with prior human activity, evidenced through significant trampling and waterlogging that had occurred before the mound being constructed at Spooners and a similar interpretation is proposed at Farley Water. What this activity is and by how much it predated the construction of the burnt mound deposits is currently undefined. The trampling could indicate a societal gathering, which became fossilized with the construction of a burnt mound. At both Spooners and Farley Water pre-monument human activity had likely encouraged near-surface waterlogging, indicating that these two soil sites had been impacted, demonstrating a clear connection between human activity and soil degradation at these locations. 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 to what extent the human impact contributed to the later transition into podzolic soils in these locations.

These 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 and archaeological sites can certainly be added Mesolithic pits and burnt mounds. Such archaeological features have considerable potential to provide snapshot information on environmental conditions prior to the more abundant monuments of the Middle Bronze Age and Iron Age. By studying the palaeosols and fill sequences of the early Holocene through using a geoarchaeological approach, it may prove possible to reconcile the narratives produced from the more numerous pollen sequences, together with the visible field archaeology, and the settlement and postulated abandonment of the uplands during prehistory. Whilst the pollen survival in the samples analysed here was limited, the integration of soil micromorphology and sediment analyses provided a strong foundation for the analysis of localised human impacts within this landscape.

## 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 complement 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. At Farley Water burnt mound, colluvium derived from landscape disturbance is recognised in the late Neolithic - Early Bronze Age, as are slaked and trampled soils at Spooners burnt mound in the Early Bronze Age. Both attest to human impacts in these landscapes, albeit on a more localised scale. However, they demonstrate that pre-podzolisation, there are definable human impacts within these upland environments. Whilst the relationship to the soil degradation, in the analysis presented here, was not linked directly to podzolisation, there is a need to understand the scale and intensity the landscape impacts of past societies, and how these impacts contributed to the process of podzolisation. It is important to elucidate 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 through a geoarchaeological analysis of pre-podzol soils and sediments.


## 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.


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## 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).

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**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.

| Size (mm) | Wentworth scale |
|---|---|
| 0.0039 | Clay |
| 0.0078 | Very fine silt |
| 0.0156 | Fine silt |
| 0.031 | Medium silt |
| 0.063 | Coarse silt |
| 0.125 | Very fine sand |
| 0.25 | Fine sand |
| 0.5 | Medium sand |
| 1.0 | Coarse sand |
| 2.0 | Very coarse sand |

**Table 1:** The Wentworth scale used for the classification of the fine sediment ($\leq$2mm fraction).

| Context | | Clay | Very fine silt | Fine silt | Medium silt | Coarse silt | Very fine sand | Fine sand | Medium sand | Coarse sand | Organic Content | Magnetic susceptibility |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (420) | Mean | 17.34 | 24.66 | 31.97 | 16.90 | 5.98 | 2.41 | 0.40 | 0.24 | 0.09 | 7.14 | 0.000000738875 |
| | Minimum | 15.23 | 21.80 | 30.18 | 12.43 | 1.59 | 1.29 | 0.26 | 0 | 0 | 5.70 | 0.000000515500 |
| | Maximum | 20.06 | 30.17 | 34.19 | 20.32 | 8.23 | 3.47 | 0.78 | 0.97 | 0.37 | 8.95 | 0.000001149600 |
| | | | | | | | | | | | | |
| (422) lower | Mean | 17.60 | 22.28 | 27.17 | 16.97 | 9.09 | 4.06 | 1.21 | 0.93 | 0.63 | 6.72 | 0.000000471200 |
| | Minimum | 12.57 | 17.76 | 20.46 | 12.59 | 3.64 | 0.99 | 0.16 | 0 | 0 | 5.08 | 0.000000194900 |
| | Maximum | 23.20 | 27.89 | 34.85 | 20.53 | 13.43 | 7.04 | 2.54 | 1.93 | 1.66 | 10.25 | 0.000000710700 |
| | | | | | | | | | | | | |
| (422) upper | Mean | 16.88 | 16.23 | 18.12 | 16.46 | 15.01 | 8.52 | 3.84 | 2.85 | 1.81 | 8.60 | 0.000000502200 |
| | Minimum | 15.25 | 14.76 | 16.96 | 14.57 | 13.71 | 7.39 | 2.20 | 1.19 | 0.07 | 6.65 | 0.000000108500 |
| | Maximum | 18.81 | 17.75 | 19.85 | 17.48 | 16.04 | 9.19 | 4.85 | 4.13 | 3.37 | 9.64 | 0.000000885600 |

**Table 2:** EWH13 <6> summary of mean, maximum and minimum values for the sediment data.

| EWH13 Sample <6>: thin section M6 | | | |
|---|---|---|---|
| **Context** | **Depth** | **Soil micromorphology description** | **Soil Micromorphology interpretation** |
| (422) lower | 0 – 3.5 cm | Dominant humic reddish brown silt and frequent brown silt soil, containing frequent small stones of bleached shale and (<12mm), and occasional burned (rubified) quartzite (<7mm), a trace of fine roots and many ferruginised roots. Abundant bleached rims and rock fragments, abundant iron pseudomorphs of roots and many void hypocoatings and fabric staining, abundant very thin burrows and occasional thin burrows, and abundant very thin mainly organic excrements, many very thin and thin organo-mineral excrements, with possible relict remains of total excremental microfabric (relict welded fabric). | Junction of pit fill with strongly gleyed subsoil (Bg horizon), which is very stony. Remains of this possible cooking pit base include burned quartzite rock. Although now an acidic soil, it probably had a brown earth origin (remains of broad organo-mineral excrements; during Mesolithic Period/Mesolithic pit use). General waterlogging led to bleached rocks, with later major iron staining and ferruginisation associated with rooting. |
| (422) upper | 3.5 – 7cm | Strongly heterogeneous with a sharply mixed black peaty silt and frequent humic silt and more minerogenic silt loam soil, with few small shale stones, mainly in minerogenic soil. Occasional fine roots and ferruginised medium roots, rare charcoal (<1mm) including likely charred root, with example of burned quartzite (4.5mm), occur. Pedofeatures include abundant bleached rims and rock fragments occasional iron pseudomorphs of roots and rare void hypocoatings and fabric staining, occasional thin burrows, with very coarse mixing/burrowing, occasional very thin mainly organic excrements and very thin and thin organo-mineral excrements. | Gleyed soil-diluted pit fill with only small amounts of fine charcoal and burned mineral material indicative of this being a possible cooking pit, or pit containing hearth debris. Textural pedofeatures suggest rather wet conditions associated with infilling. It is strongly affected by hydromorphic acid soil leaching, and secondary ferruginisation linked to rooting. |

**Table 3:** EWH13 <6> Soil micromorphology descriptions and interpretations.

| Context | | Clay | Very fine silt | Fine silt | Medium silt | Coarse silt | Very fine sand | Fine sand | Medium sand | Coarse sand | Very coarse sand | Organic content % | Magnetic susceptibility |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (104) | Mean | 17.18 | 23.10 | 25.52 | 13.39 | 6.12 | 4.95 | 2.39 | 2.55 | 4.11 | 0.68 | 2.25 | 0.0000001 |
| | Minimum | 12.37 | 15.77 | 17.90 | 12.75 | 2.38 | 2.36 | 0.60 | 0.98 | 2.75 | 0.58 | 1.79 | 0.000000082 |
| | Maximum | 19.77 | 27.41 | 30.23 | 13.77 | 13.17 | 9.86 | 5.31 | 5.62 | 5.78 | 0.82 | 2.56 | 0.0000001701 |
| | | | | | | | | | | | | | |
| (110) | Mean | 10.95 | 14.75 | 17.86 | 13.81 | 12.25 | 8.75 | 5.36 | 7.62 | 7.48 | 1.18 | 4.73 | 0.0000016630 |
| | Minimum | 6.34 | 8.87 | 12.01 | 10.19 | 10.98 | 5.56 | 1.17 | 0.79 | 1.06 | 0.00 | 3.54 | 0.0000003209 |
| | Maximum | 15.72 | 21.40 | 25.33 | 17.54 | 15.59 | 10.68 | 10.51 | 15.94 | 12.84 | 2.88 | 7.92 | 0.0000053484 |
| | | | | | | | | | | | | | |
| (103) | Mean | 5.47 | 8.01 | 12.65 | 12.05 | 12.09 | 11.99 | 10.58 | 12.57 | 11.19 | 3.404 | 12.60 | 0.0000055 |
| | Minimum | 3.72 | 5.62 | 9.65 | 10.26 | 9.89 | 10.21 | 7.23 | 8.33 | 6.82 | 0.93 | 7.66 | 0.0000014 |
| | Maximum | 7.68 | 9.92 | 15.35 | 15.93 | 15.06 | 14.24 | 13.35 | 16.83 | 16.05 | 8.75 | 20.76 | 0.0000124 |

**Table 4:** OA1210 <5> summary of mean, maximum and minimum values for the sediment data.

| **Site OA1210 Sample <5>: Thin section M5** | | | |
|---|---|---|---|
| **Context** | **Depth** | **Soil micromorphology description** | **Soil Micromorphology interpretation** |
| (104) | 12 – 11 cm | A sequence of minerogenic loamy silty sands. Rare thin burrows, and rare extremely thin organic (now ferruginised) excrements. | This is a C/lower B horizon of a brown earth soil. Rare evidence of burrows and excrements indicating pedogenic development. |
| (110) | 11 – 7 cm | A sequence of minerogenic loamy silty sands, which gradually 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 (≤7mm). There is a rare trace of charcoal which becomes occasional. This context contains some possible totally ferruginised thin amorphous organic matter and occasional channel iron hypocoatings that imply earlier rooting. An example of rubified iron stained granite is present in the upper part of (110). There are very abundant matrix intercalations and panning associated with formation of closed vughs and vesicle porosity pattern, and there are also rare areas of sorted dusty clay infills, many areas of weak iron impregnation and ferruginised organic traces and void hypocoatings (relict root channels), chaotic mixing and rare thin burrows, and rare extremely thin organic (now ferruginised) excrements. | An already disturbed soil, B horizon of original brown earth, with no A horizon material visible. Context (110) lower subsoil material shows chaotic mixing and textural pedofeatures of being deposited (or trampled) under very wet and muddy conditions, with muddy slaking. It could have developed from intensive human trampling. A burned stone had become included in (110), and much fine charcoal was also incorporated just below the (103) layer. Upwards, there has been physical mixing with fine charcoal. |
| (103) | 7 – 4.5 cm | Loamy silt sands with abundant fine to coarse wood charcoal and charred wood (≤6mm) and burnt rock fragments. An >35mm rock fragment is recorded (103). | A spread/dump(?) of burnt rock containing abundant charcoal. |

**Table 5:** OA1210 <5> Soil micromorphology descriptions and interpretations.

| **OA10 Sample <5>** | | |
|---|---|---|
| | **Count** | |
| **Trees & Shrubs** | **(104)** | **(110)** |
| *Alnus (alder)* | 24 | 31 |
| *Corylus avellana* type (hazel) | 68 | 13 |
| | | |
| **Herbs** | | |
| Poaceae | 8 | 45 |
| Ranunculus type | | 1 |
| *Plantago lanceolata* | | 6 |
| Lactucoideae | | 1 |
| | | |
| **Ferns** | | |
| *Dryopteris* type | 82 | 55 |
| *Pteridium aquilinum* | 8 | |
| Polypodium | 61 | 55 |
| *Sphagnum spp.* | 150 | 1 |
| Pre-Quaternary | 18 | 52 |

**Table 6:** OA1210 <5> pollen data from spot samples in contexts (104) and (110). Differential preservation is clearly evident in the data.

| Context | | Clay | Very fine silt | Fine silt | Medium silt | Coarse silt | Very fine sand | Fine sand | Medium sand | Coarse sand | Very coarse sand | Organic content | Magnetic susceptibility |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (101) | Mean | 14.80 | 20.17 | 25.54 | 16.52 | 11.23 | 7.42 | 2.53 | 0.86 | 0.67 | 0.26 | 9.34 | 0.0004854286 |
| | Minimum | 12.32 | 17.40 | 18.97 | 14.11 | 1.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.58 | -0.0000600000 |
| | Maximum | 19.93 | 25.81 | 38.47 | 19.29 | 15.46 | 11.90 | 5.17 | 1.97 | 3.25 | 1.77 | 12.84 | 0.0017030000 |
| (108) | Mean | 12.53 | 15.53 | 18.62 | 15.18 | 16.17 | 12.60 | 4.75 | 1.50 | 1.65 | 1.47 | 9.29 | 0.0003072000 |
| | Minimum | 9.42 | 9.51 | 10.61 | 12.52 | 8.41 | 3.99 | 0.85 | 0.14 | 0.00 | 0.00 | 6.79 | 0.0002310000 |
| | Maximum | 16.24 | 22.51 | 29.81 | 18.05 | 20.36 | 18.22 | 7.56 | 2.61 | 5.68 | 6.70 | 11.01 | 0.0005020000 |

**Table 7:** FW16 <4> summary of mean, maximum and minimum values for the sediment data.

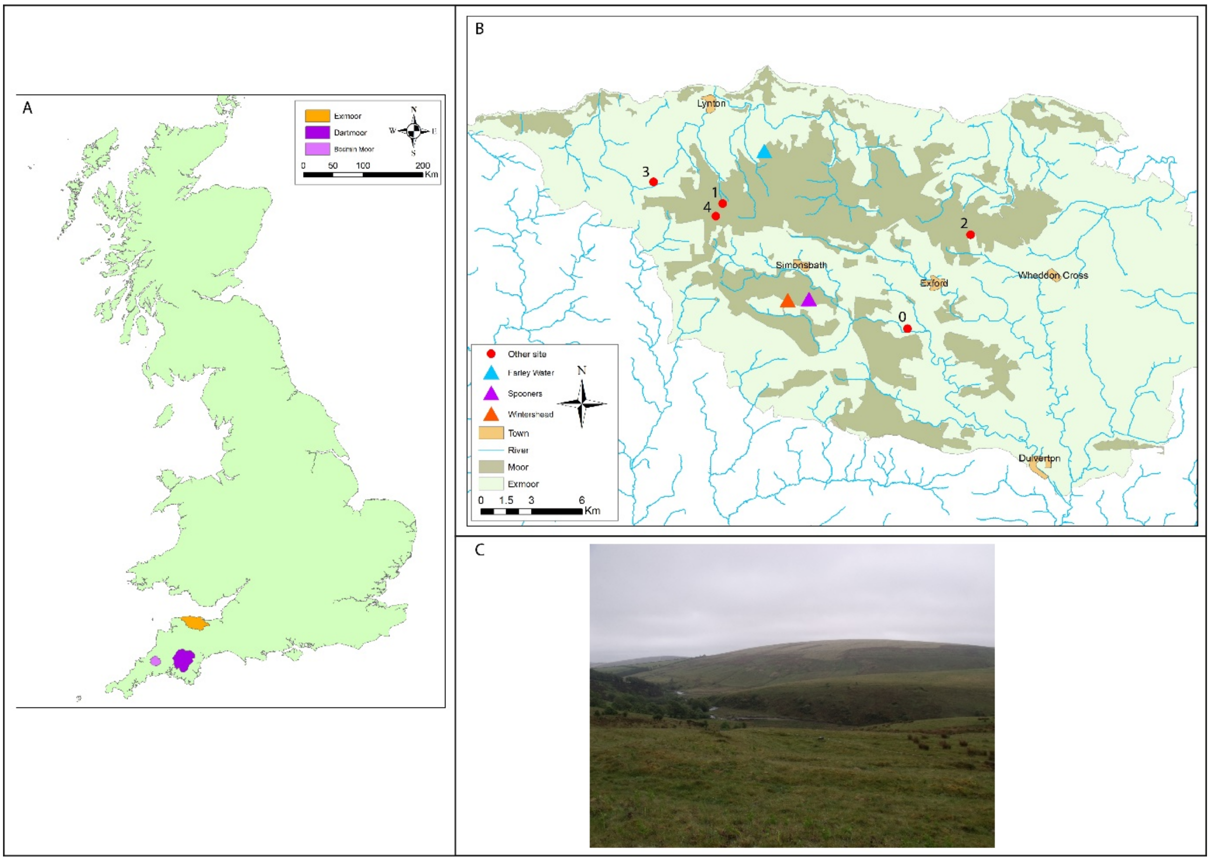


**Figure 1:** The location of Exmoor, at a national scale (A) and regional scale (B), with the sample sites and other key sites discussed in the text highlighted (0 = Brightworthy; 1 = The Chains; 2 = Codsend Moor; 3 = Holworthy hillslope enclosure; 4 = Pinkery Canal), and a classic Exmoor photograph 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).

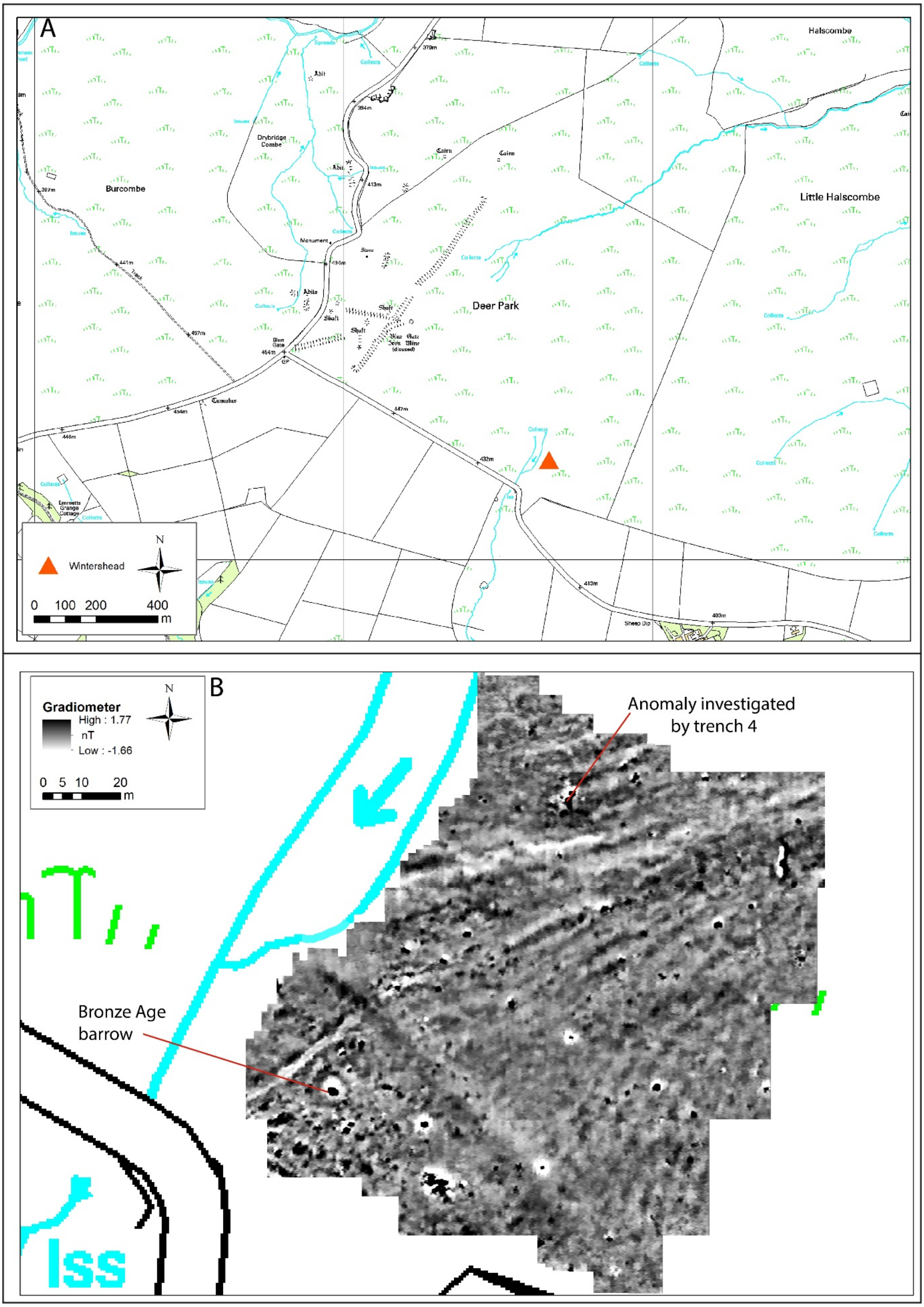


**Figure 2:** The location of site at EWH13 Wintershead (A) and the gradiometer survey (B).

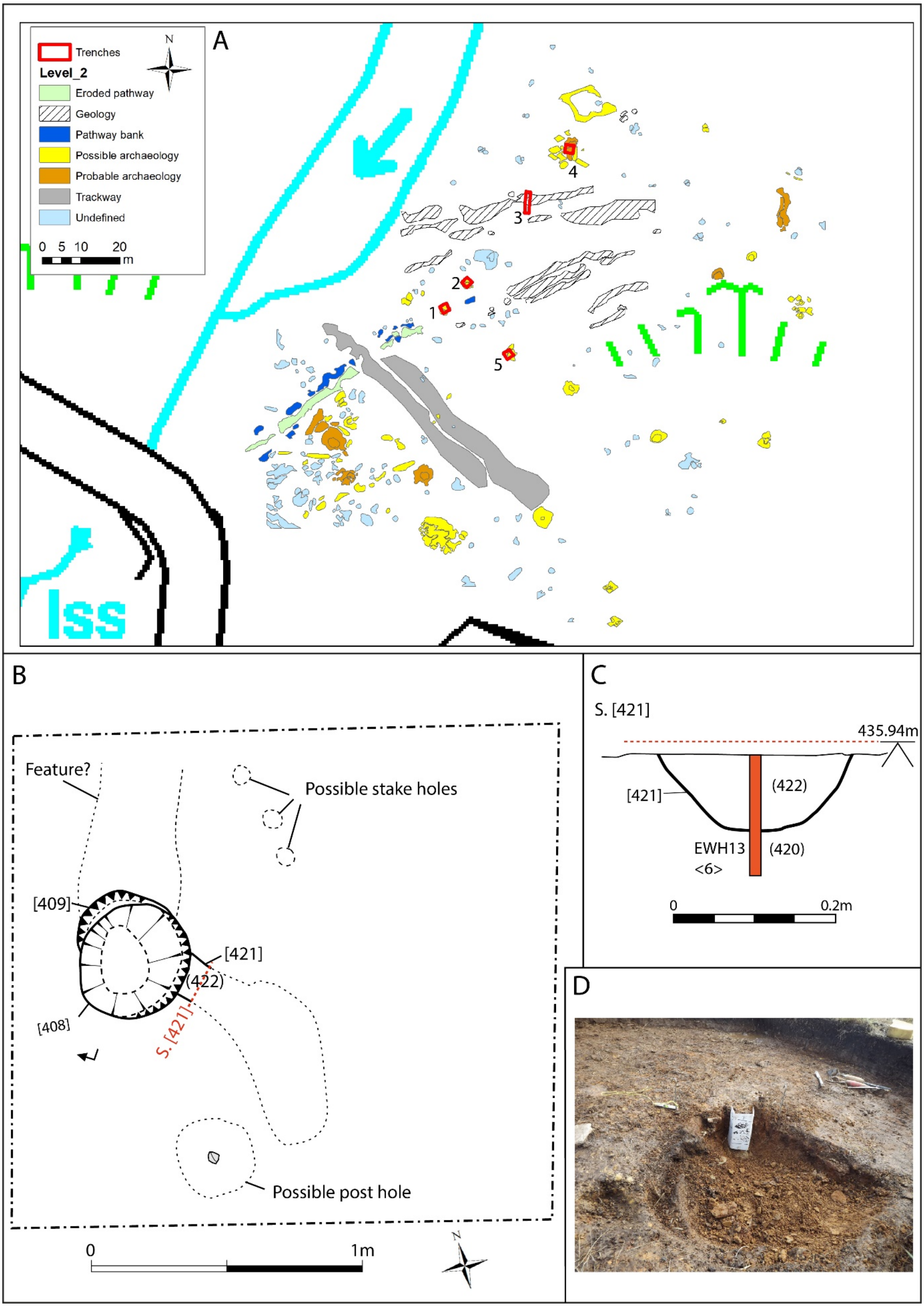


**Figure 3:** EWH13 interpretation of the gradiometer data and the location of the 5 trenches (A), the post excavation plan of trench 4 (B), The section feature [421] and sample EWH13 <6> and a working shot of sample EWh13 <6> during collection.

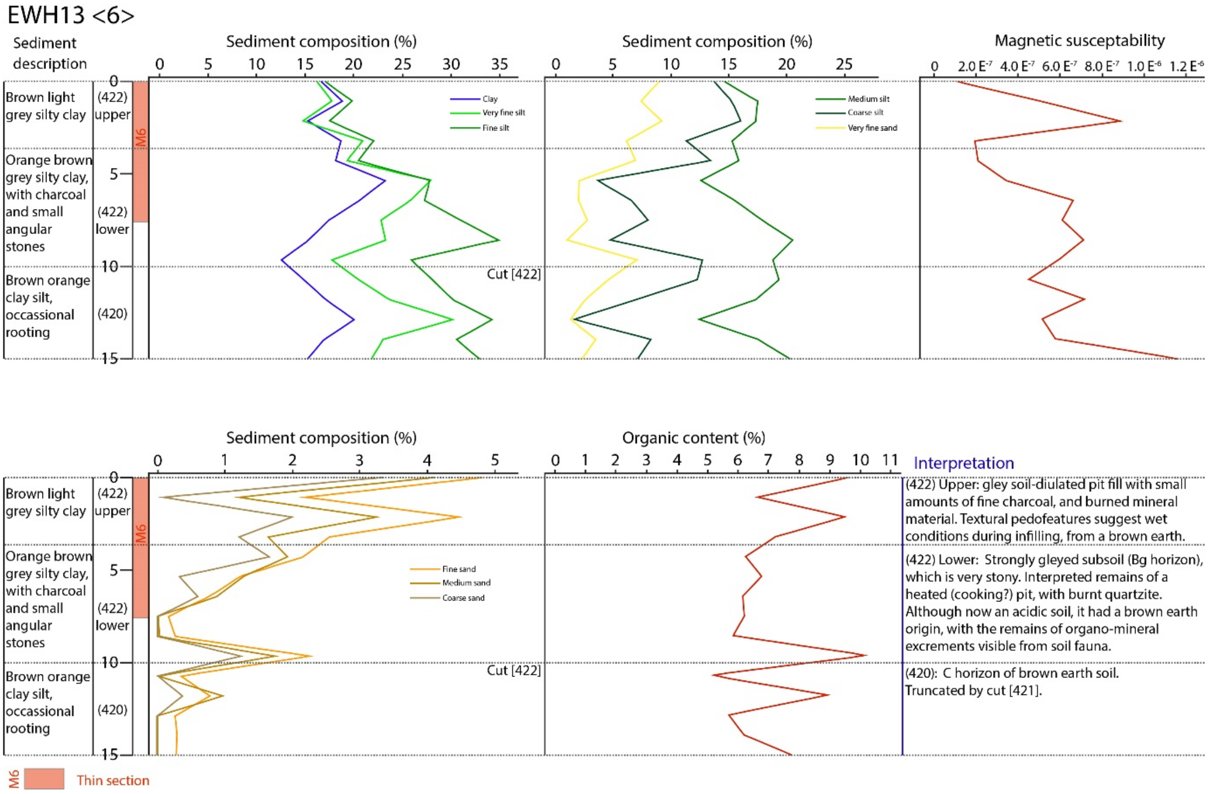


**Figure 4:** EWH13 <6> sediment analysis.

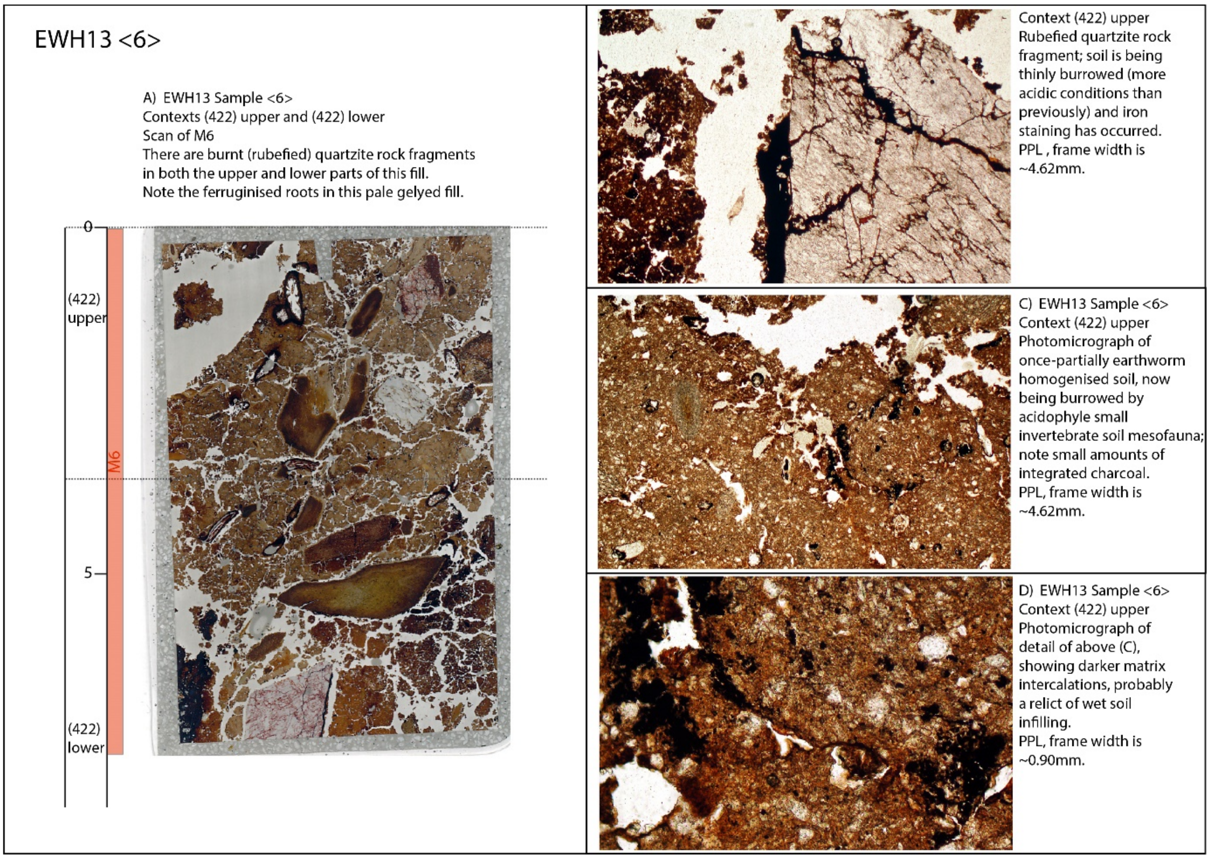


**Figure 5:** EWH13 <6> showing detail from the thin section over the Mesolithic heated pit fill.

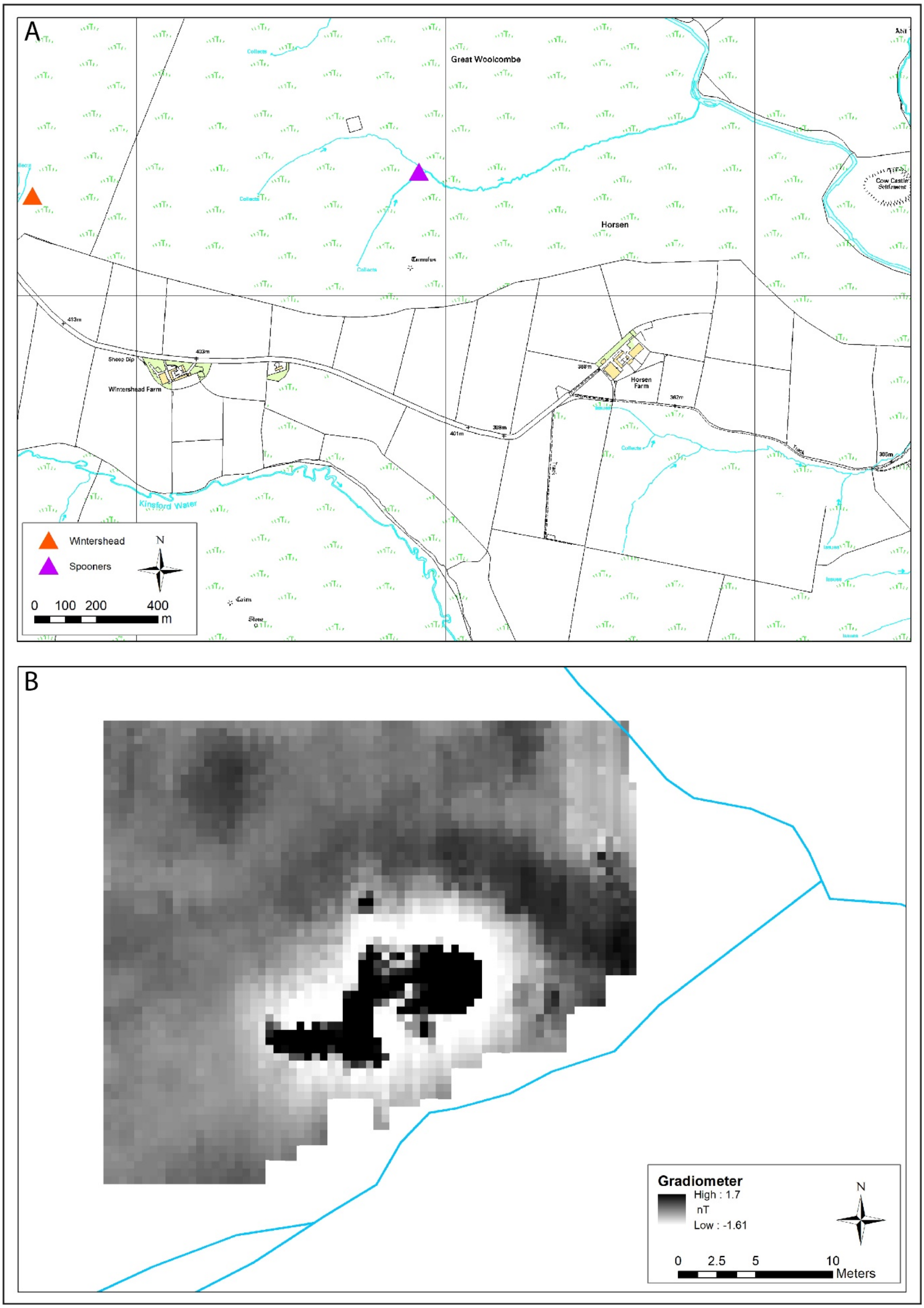


**Figure 6:** OA1210 showing site location (A) and the gradiometer survey (B).

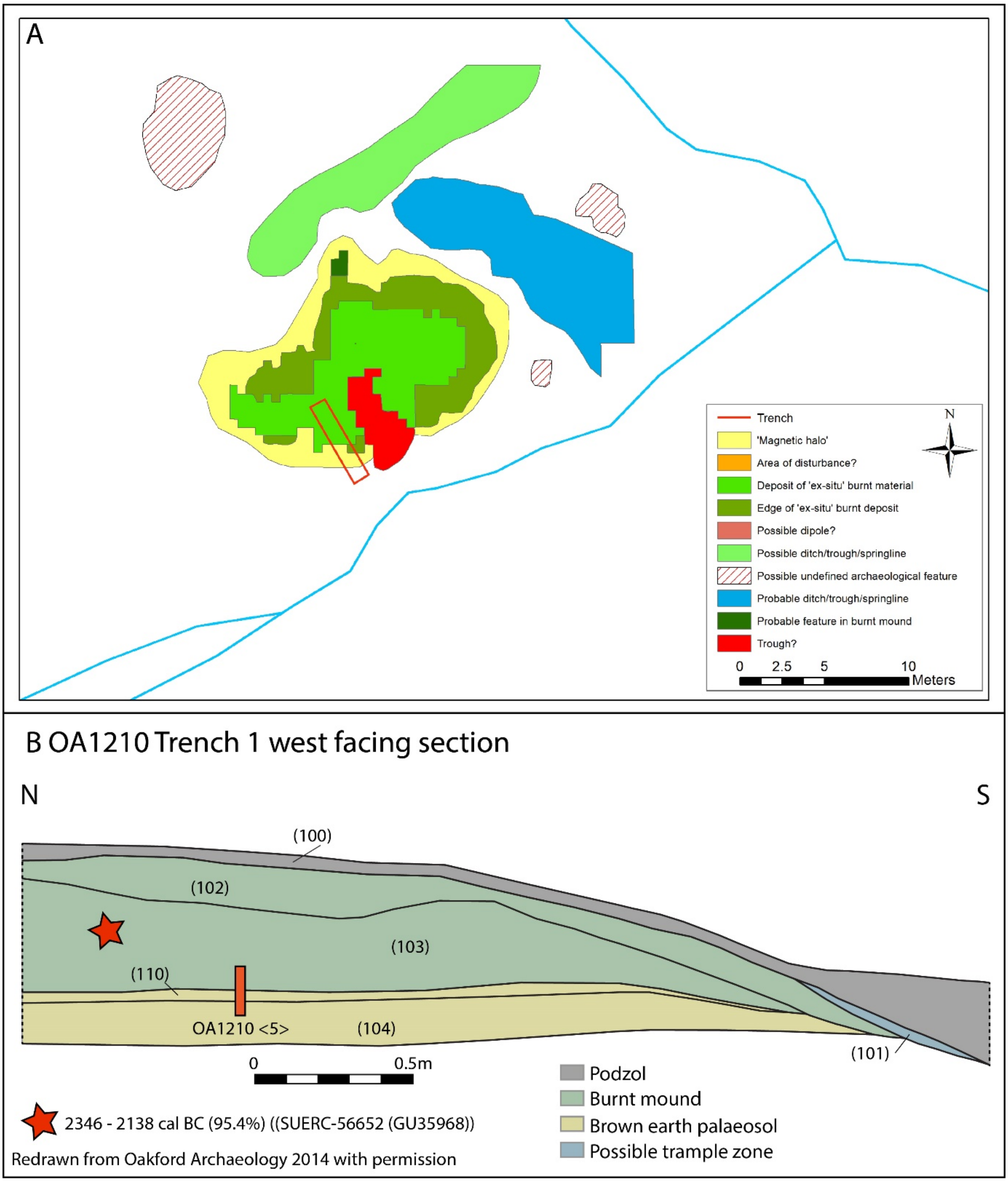


**Figure 7:** OA1210 interpretation of the gradiometer data (A) and section OA1210 trench 1 section, showing the location of OA1210 <5> (B).

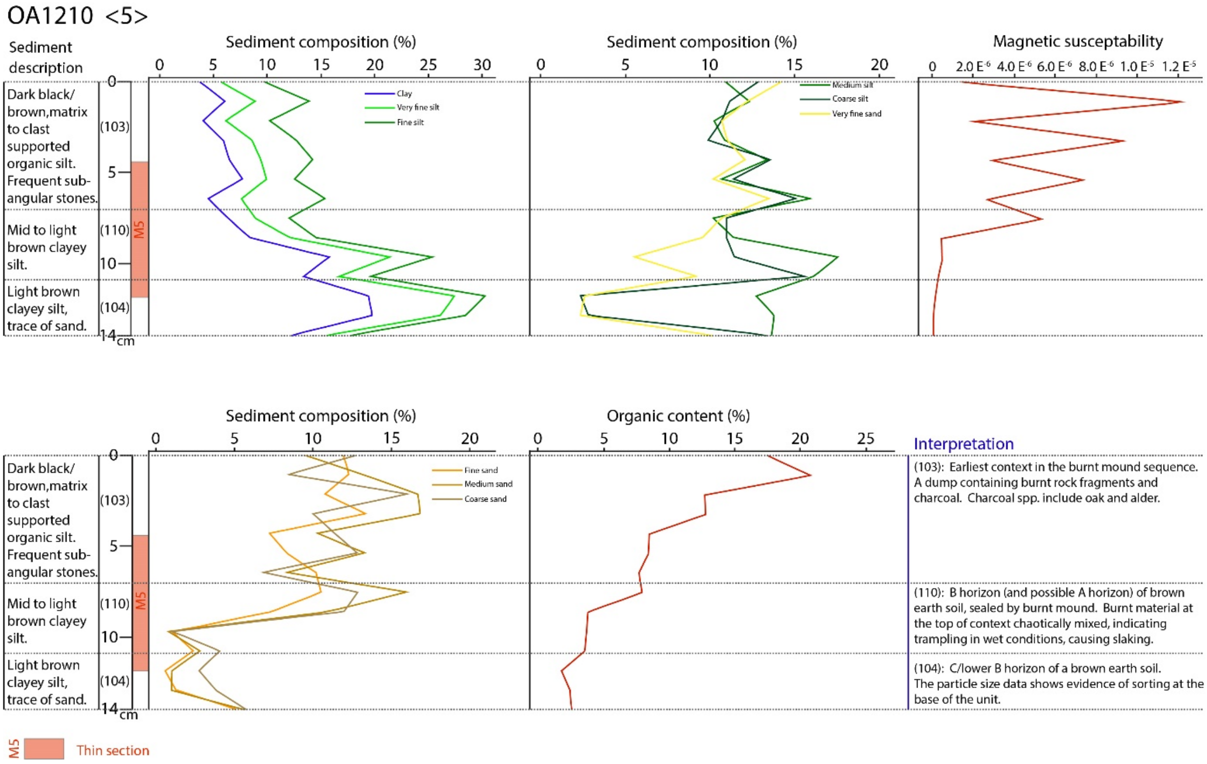


**Figure 8:** OA1210 <5> sediment analysis.

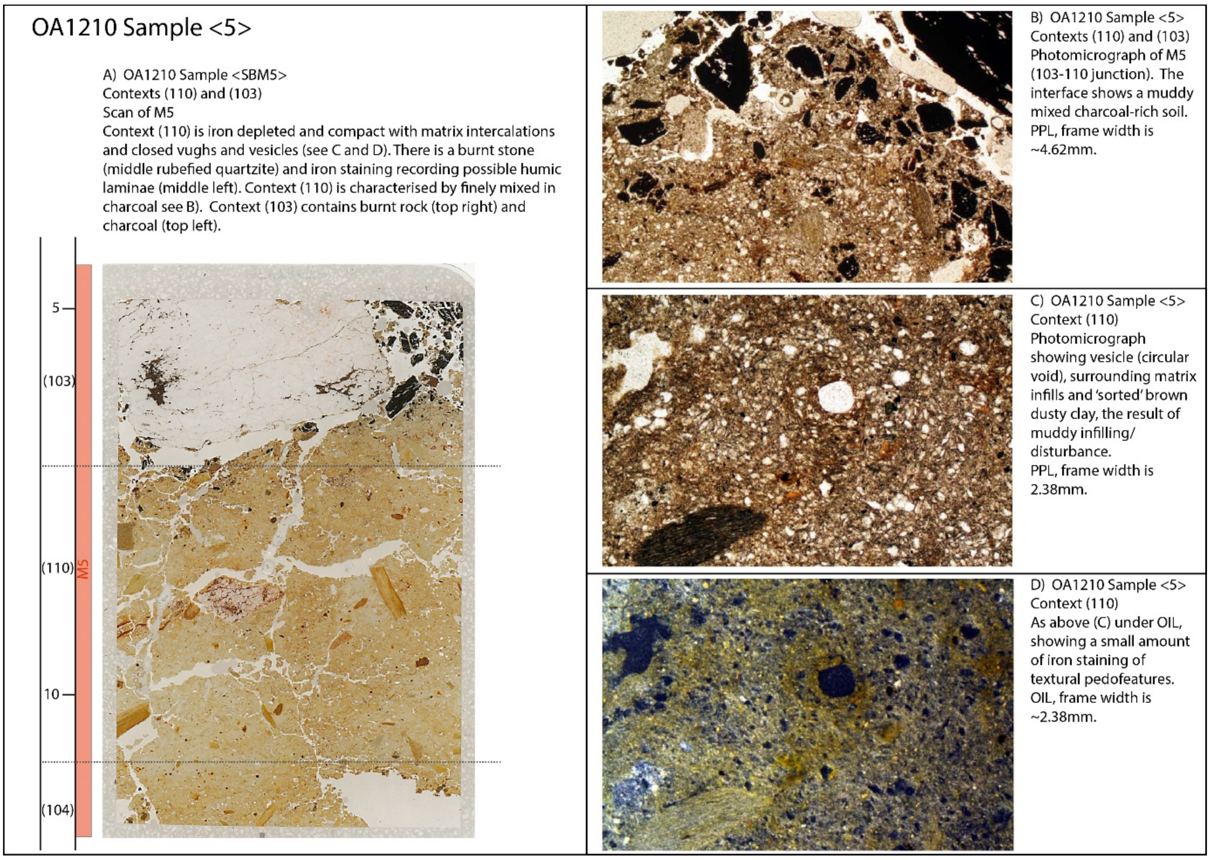


**Figure 9:** OA1210 <5> showing detail from the thin section brown earth palaeosol and the overlying burnt mound deposit.

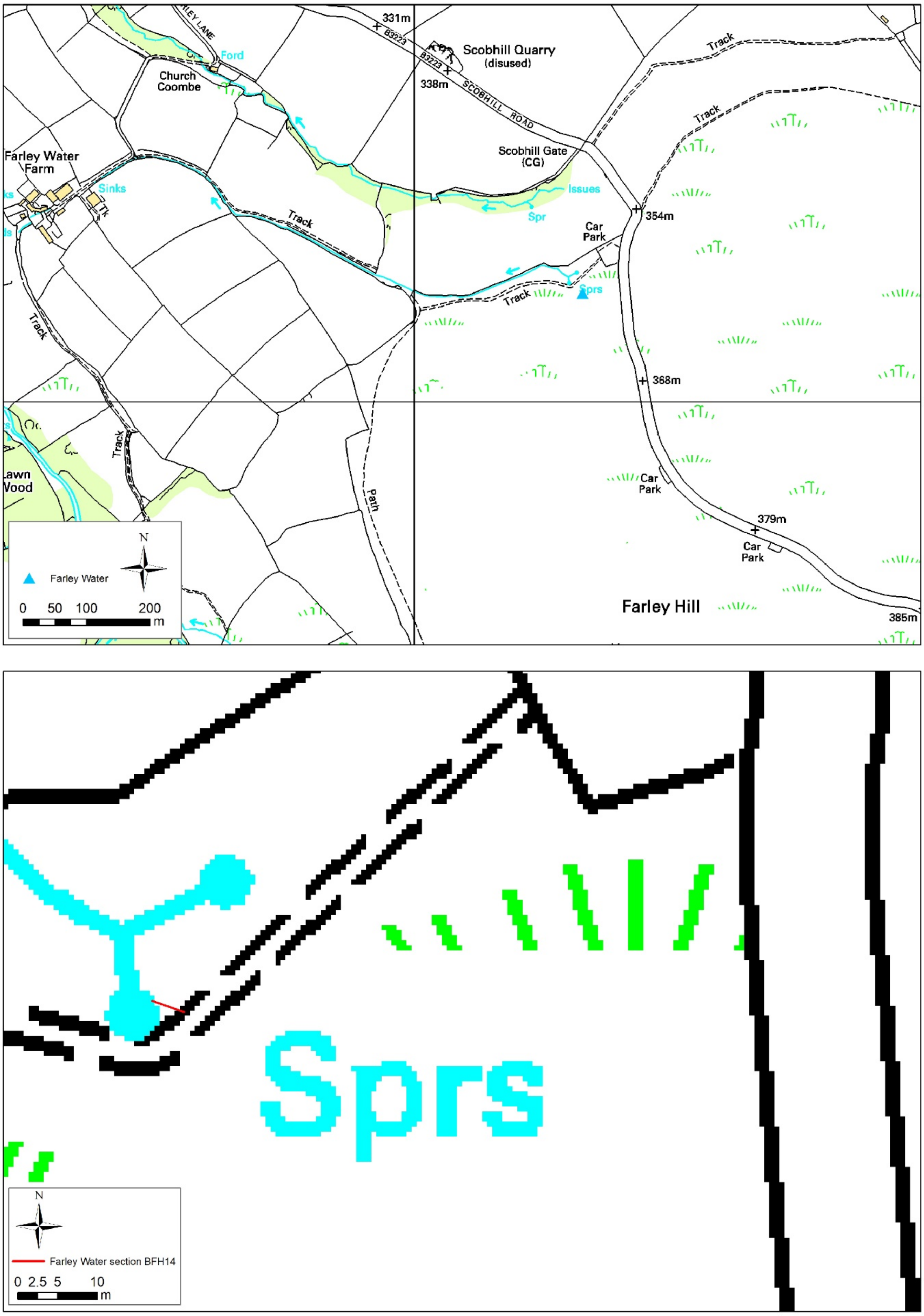


**Figure 10:** FW16 site location (A) and the location of section BF14.

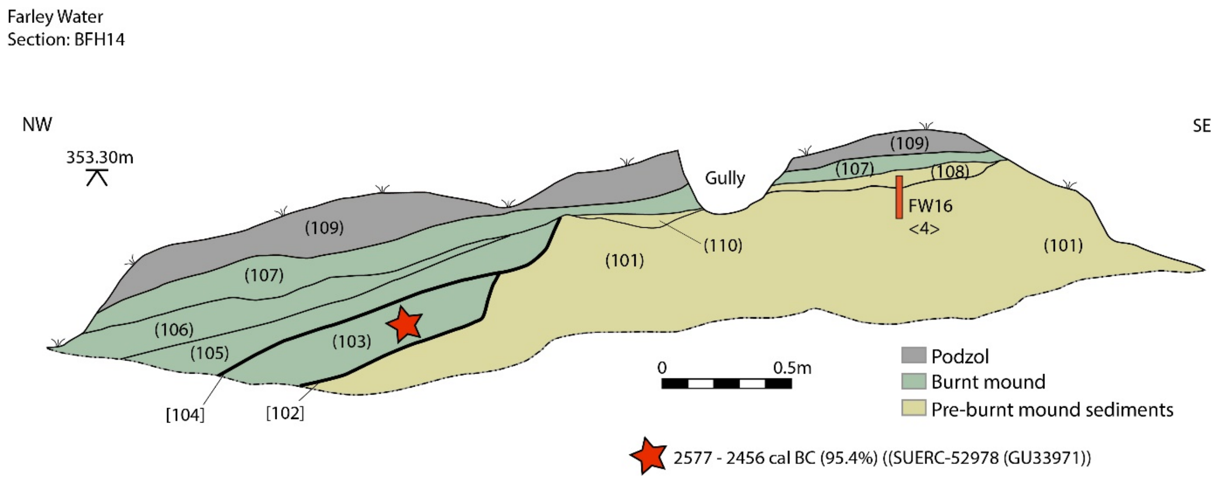


**Figure 11:** FW16 section BFH14 and the location of FW16 <4>.

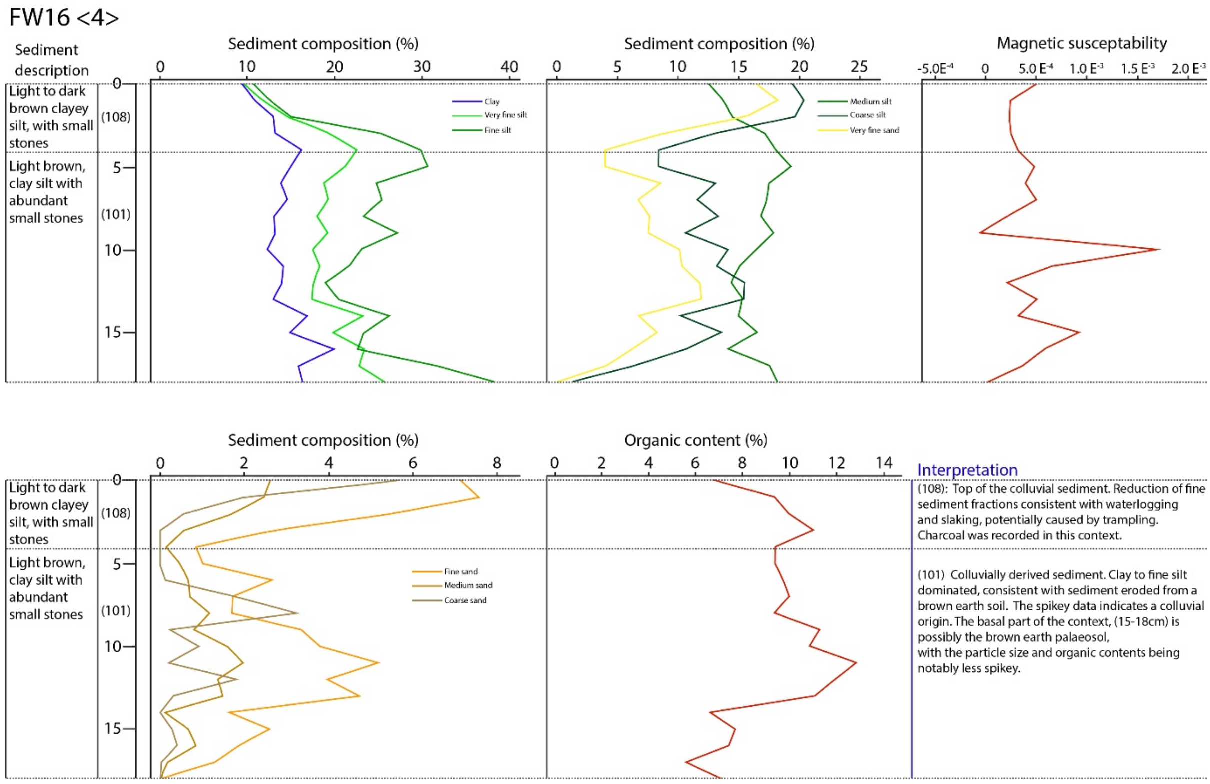


**Figure 12:** FW16 <4> sediment analysis.