UNDER WHITLE PALAEOENVIRONMENTAL INTERIM REPORT

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Summary

This report provides the interim results of palaeoenvironmental investigations for the 'Digging Deeper' project, based at Under Whitle farm in the Peak District. It includes work undertaken to identify and take samples from an area of wetland within the study area and geoarchaeological investigations of a lynchet.

The identification of potential palaeoenvironmental sampling sites within the study area included desk-based research and a walkover survey with trial auger work. This initial research identified a small area of wetland in the southern end of the study area as having the highest potential for further work, which will be referred to as 'Under Whitle Bog'. Detailed auger survey undertaken at Under Whitle Bog has established the nature of the stratigraphy of the site, which indicates that peat started accumulating at the site after colluvial action inhibited local drainage to form a small pool at the site of a spring. A core has been taken from the site for further palaeoenvironmental research. The results of initial radiocarbon dating analysis suggests that the core contains a sequence dating from the late-Bronze Age onwards. However, a second round of dating analysis will be undertaken to guide the selection of samples for pollen analysis, to insure that they are contemporary with archaeological remains identified by the Digging Deeper Project.

Geoarchaeological investigations of the lynchet involved careful examination of a test pit excavated over the feature (located in the northern end of the study area), taking an oriented (monolith) sample from the section of the test pit, and non-destructive geoarchaeological analysis. Observations in the field noted the presence of a possible palaeosol (old soil horizon) beneath the lynchet, a possible plough scar which cut through the palaeosol, and colluvial layers infilling the possible plough scar and laying on top of the palaeosol. The lack of any mixing of the deposits forming the lynchet appears to indicate it was formed by erosion of material from arable activities rather than being purposefully constructed. The non-destructive lab-based analysis included a detailed examination of the monolith's stratigraphy and magnetic susceptibility analysis. This analysis provided supporting evidence for the presence of a palaeosol beneath the lynchet, providing information to guide pollen analysis of the environment contemporary with the lynchet's formation.

Palaeoenvironmental investigations of the samples from Under Whitle are ongoing. It is hoped that this future work will provide additional information relating to changes in the environment of the neighbouring landscape that can be related to the archaeological remains being excavated by the project.

Table of Contents

List of Tables

List of Figures

1. Introduction

Background

This report was prepared as part of ongoing community-led archaeological research by the 'Digging Deeper: the Origins of Whitle' project. It provides the preliminary results of palaeoenvironmental investigations of key locations within the study area, which comprises land owned by Under Whitle farm (see Figure 1), near Pilsbury in the Derbyshire Peak District (centred on OS NGR SK 107640). Landscape survey previously undertaken by Rylatt (2005) identified several standing earthworks of mixed date within the study area, including a possible building platform, hollow ways, enclosures, and a field system with lynchets, ditches, banks and areas of ridge and furrow. A more recent LiDAR survey by the Environment Agency Geomatics Group (EAGG 2016) noted additional features associated with those identified by Rylatt, with more extensive areas of ridge and furrow than previously appreciated. Archaeological excavation of some of these features by the Digging Deeper Project identified activity at Whitle dating to at least the Anglo-Saxon period (Parker Heath pers. comm.). In addition to the archaeological features noted above, Rylatt (2005) identified areas with potential for preservation of palaeoenvironmental remains, which could be used to reconstruct past environments. These potential sampling areas are shown in Figure 1 and comprise the main focus of the investigative work presented here.

Topographic and geological setting

Under Whitle farm is located at the base of the south western slopes of a glacially formed, u-shaped valley. Closer to the north east side of the valley, the River Dove marks the northern edge of the study area. The topography immediately to the south of the Dove is steep-sided and lies next to a relatively level plateau overlooking the Dove, which is in turn overlooked by the aforementioned south western slopes of the valley. The study area lies at the boundary between limestone geology to the north east of the Dove and sandstone, mudstone and siltstone bedrock beneath the valley floor and its western slopes.

Scope of the palaeoenvironmental research

As noted above, the current report focuses mainly on the three areas of palaeoenvironmental research potential identified by Rylatt (2005). It also provides the results of the geoarchaeological assessment of a lynchet in the northern end of the study area marked on Figure 1. Tasks undertaken and to be completed for this work include:

- desk-based research
- fieldwork:
    - walkover survey
    - auger survey
    - palaeoenvironmental sampling
- lab-based assessment/analysis:
    - geoarchaeological assessment
    - radiocarbon dating (in progress)
    - pollen analysis (pending – to be undertaken once chronology has been established)

The methods used in these tasks are described below, followed by the preliminary results of this work.

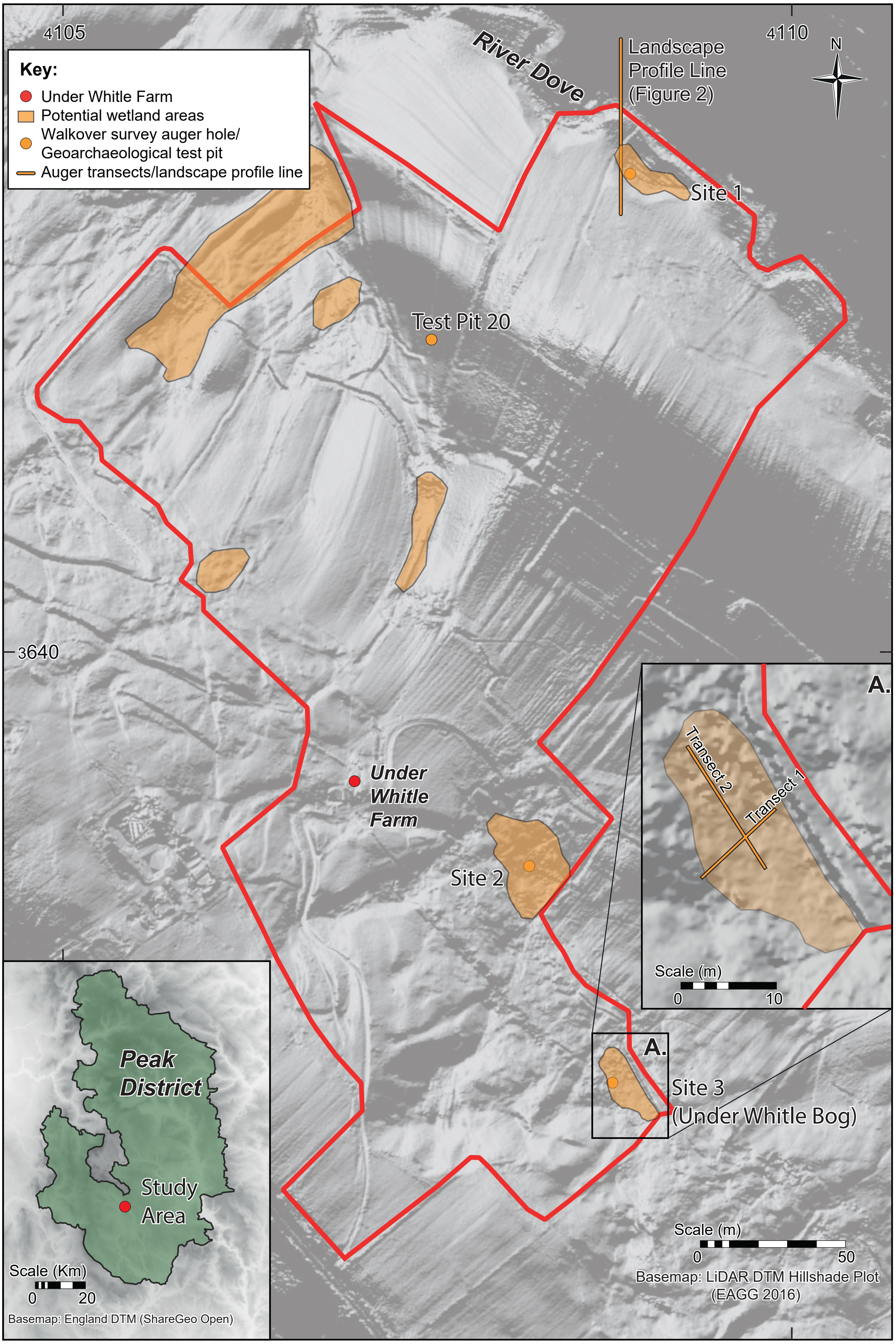


Figure 1. Map of the study area showing the locations of work areas

2. Methodology

Desk-based research

Prior to undertaking any fieldwork, a desk-based assessment of potential palaeoenvironmental sampling areas was undertaken, comprising a review of cartographic sources and previous research at Whitle, including:

- Ordnance Survey (OS) topographic maps
- British Geological Survey (BGS) geology maps
- Aerial photographs (Google Earth)
- LiDAR data (EAGG 2016)
- Rylatt's (2005) survey data

This process aimed to identify areas of waterlogged ground where conditions might be favourable for pollen preservation, for example peat deposits (cf. Moore et al. 1991: 14). The results of this work are provided in section 3.

Fieldwork

Walkover survey

Initial fieldwork for the project included a walkover survey, consisting of a rapid assessment of potential sampling areas identified during desk-based research. If initial observations suggested the potential for waterlogged sediments, an auger assessment was carried out to examine the nature of sub-surface deposits. Augering was undertaken using a 2cm wide window sampler (aka gouge auger) and the characteristics of deposits were recorded according to variations in depth, texture, colour and inclusions. The locations of augering sites were recorded using a handheld GPS (Garmin GPSMAP 64).

Auger survey

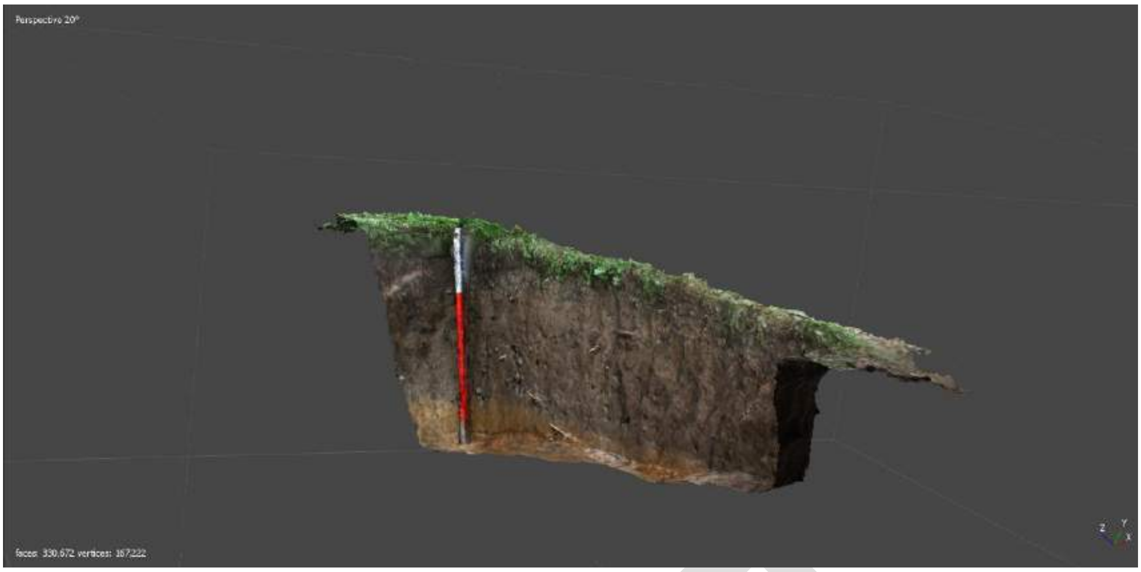
On identifying a site worth detailed investigation (site 3 – hereafter referred to as Under Whitle Bog - on Figure 1), an auger survey was undertaken to gain a more detailed understanding of its stratigraphy. This was carried out in the same manner as the walkover survey, examining the nature and depth of sub-surface deposits every 5-10m along two perpendicular transects across the site. The transects were laid out using hand tapes and their approximate locations were recorded using a handheld GPS. Variations in altitude of the bog surface were recorded using a level. The results of this survey were used to guide the selection of a sampling site location within the bog for further research as described below.

Palaeoenvironmental sampling

Palaeoenvironmental samples were collected from two locations within the study area. A core sample was retrieved from Under Whitle Bog whilst an oriented (monolith) sample was taken from Test Pit 20, which was excavated in order to investigate the formation processes of a lynchet in the northern portion of the study area (see Figure 1). The core sample was retrieved by hand using a Russian corer (see Photograph 1), taking sequential samples of 50cm depth with at least 10cm of overlap between each sample. The individual core segments were then extracted into plastic guttering and wrapped in cling film to avoid contamination.

Before retrieving the oriented sample from Test Pit 20, the stratigraphy exposed in section was carefully examined and its constituent features and deposits were noted. The test pit was then recorded using a series of photographs to enable the construction of a photogrammetric model of the trench using Agisoft Metashape (see Photograph 2). This model was subsequently used alongside digital survey data collected using a total station to produce a section drawing of the trench. An oriented sample from the trench was retrieved by pushing two sections of plastic guttering into the exposed section. Their locations were recorded within the trench before a trowel was used to cut the monolith away from the section. The oriented samples were then wrapped in cling film to avoid contamination. Both the core and monolith samples were subsequently placed in cold storage for preservation.

Photograph 1 Sampling using a Russian corer at Under Whitle Bog



Photograph 2 Screen shot of an extract of the photogrammetric 3D model of Test Pit 20

Laboratory-based assessment and analysis

Georarchaeological assessment

Both samples collected during fieldwork were subjected to a geoarchaeological assessment involving non-destructive techniques, allowing for the retention of material for future analysis as deemed appropriate. This included a description of the core undertaken in a controlled laboratory environment as well as magnetic susceptibility analysis.

The surface of each core and monolith segment was cleaned, photographed and the physical properties of the sediments recorded, making note of variations in texture (sand, silt and clay content), bedding, colour (using a Munsell chart) and inclusions. Full descriptions of the cores' stratigraphy are provided in Appendix B.

Magnetic susceptibility can provide information relating to deposit formation processes and sediment sources. This analysis was undertaken using a Bartington core logging sensor at 1cm intervals along each core and monolith segment.

Radiocarbon dating

Samples to assess the chronological range of the core retrieved from Under Whitle Bog by radiocarbon dating was undertaken at the Chrono Centre, Queen's University Belfast. The preliminary dating analysis was undertaken on three samples from organic-rich deposits within the core. The material for dating was taken from 0.5-1cm thick slices near the top, middle and bottom of the core. Attempts were made to obtain waterlogged plant remains from these levels, which would provide more secure dating material (cf. Walker *et al*. 2001, Bayliss *et al*. 2008), but were only found in sufficient quantity in the top sample (Simmons pers. comm.). Therefore, radiocarbon dating from the other two samples was undertaken on the humic acid content of the sediment from each level.

In addition to providing the chronology of the core, these allow an estimation of the variation in accumulation rates of deposits. These accumulation rates have been established by producing an age-depth model for the core through Bayesian analysis of the dates using "Bacon 4.0.5" (Blaauw & Christen 2011).

Pollen analysis

Pollen analysis will be undertaken on the samples from both the Under Whitle Bog and Test Pit 20. This work will aim to reconstruct the environmental setting of Under Whitle and to understand the development of the landscape surrounding the sampling sites. Sampling locations within each core/monolith will be guided by the results of radiocarbon dating and geoarchaeological analysis. For the monolith from Test Pit 20, samples will specifically target potential palaeosols contemporary with the creation of the lynchet, whilst the pollen samples from Under Whitle Bog will aim to target deposits contemporary with the medieval archaeological remains identified during excavation.

3. Results and discussion

Desk-based research

The review of geological data showed that no peat deposits had previously been recorded within the study area, but did note the presence of alluvium on the banks of the River Dove, which can include waterlogged sediments and bands of peat. However, waterlogged ground was noted at the south eastern end of the study area in the 2020 OS explorer series map. Rylatt's (2005) survey had previously identified both of these areas as having potential for palaeoenvironmental sampling and also noted a third site closer to the farm buildings in the centre of the study area (see sites 1, 2 and 3 in Figure 1). Additional potential wetland was also identified as part of the current study, based on visible differences in vegetation type and colour on aerial photographs and depressions in the LiDAR data that might imply waterlogged ground. All of the potential wetland areas were examined during a walkover survey of the study area as described below.

Fieldwork

Walkover Survey

After initial examination of the potential sampling sites identified through desk-based survey, the three sites previously identified by Rylatt (2005) appeared to be the best candidates for further examination. The investigation of the stratigraphy of these sites indicated that all three contained waterlogged sub-surface deposits over 1m in depth that would likely preserve palaeoenvironmental remains (see Table 1). A summary description of each of these sites is provided below:

- **Site 1** – Based on the examination of aerial photographs, this site appeared to be a palaeochannel comprising a former meander of the River Dove. On examination of the site's location in the field, the palaeochannel seemed to be located on the highest of a sequence of terraces overlooking the River Dove (see Figure 2). Augering within this meander identified deposits to at least 1.3m below the ground surface, beyond which deposits were too stiff to penetratewith the hand auger. The deposits identified within the auger consisted of two mid-brown clay loam layers separated by a light grey-brown clay with mid-brown mottles. This clay deposit was almost identical to the lowest deposit encountered in the auger hole and was probably formed through the same depositional processes (possibly representing a mixture of colluvial and fluvial activity). Likewise, the similarity of the lower clay loam deposit and the upper topsoil might indicate the presence of a palaeosol (old soil horizon) buried by later alluvial processes. The position of the channel on the upper terrace of this glacially formed valley suggests that it was probably active as long ago as the late glacial or very early Holocene. Although the waterlogged deposits in this area may well provide palaeoenvironmental remains that could be studied further, the likelihood that they will contain deposits contemporary with the medieval archaeological remains at Under Whitle is low.

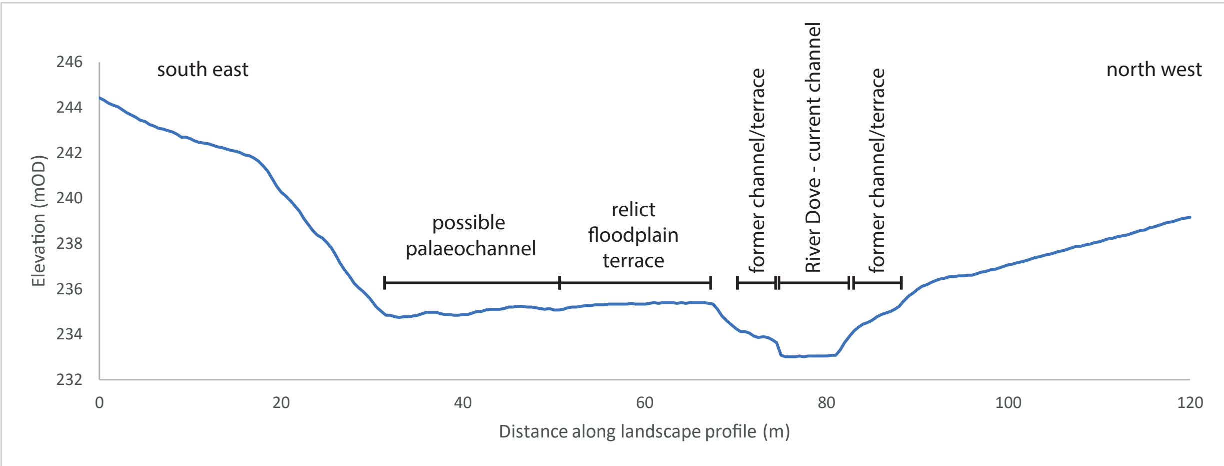


Figure 2 LiDAR Profile of the River Dove (location shown in Figure 1)

- **Site 2** – This wetland area is relatively small, measuring c.50x40m, and located near farm buildings central to the study area. During the site visit, the area underfoot appeared relatively wet, though there were no obvious drainage channels associated with the site. It is possible, however, that the neighbouring field system may have removed any evidence of natural drainage gullies in this area. An auger hole in the centre of this site indicated that its sub-surface deposits consist of an upper clay-loam topsoil overlying a series of clay deposits of varying colour. These deposits reached a depth of at least 1.24m, beyond which the deposits were too stiff for hand augering. It is believed this site represents either an area of impeded drainage or a small spring, where deposits have accumulated through colluvial activity. As with site 1, site 2 has the potential to contain waterlogged remains suitable for palaeoenvironmental analysis. However, organic fragments of plant remains remains were relatively rare within the deposits, which could lead to problems with radiocarbon dating owing to insufficient carbon 14 in the samples. Without radiocarbon dates it would not be possible provide a robust chronology for palaeoenvironmental analysis.

- **Site 3** (Under Whitle Bog) – This site is located at the very base of the western slope at the southern edge of the study area. The extent of this wetland area was not established during the walkover survey as trees growing across the site restricted access. This also hampered consideration of site formation processes without detailed study of the site's stratigraphy. However, targeted investigation with the auger established the presence of a peat deposit in the upper 0.33m of the site and a waterlogged mid-grey clay deposit to a depth of 1.67m below the surface, after which the auger hit a solid barrier, probably the underlying bedrock. Peat deposits of this kind are ideal for palaeoenvironmental reconstruction purposes, as they usually contain very well-preserved pollen together with organic remains suitable for radiocarbon dating. The peat deposit identified during augering was admittedly shallow in this case, but demonstrated the potential for peat accumulation at the site alongside waterlogged clay deposits of probable colluvial origins.

After considering the research potential of each of these three sites, it was decided that site 3 (Under Whitle Bog) was the best candidate for more detailed research. The presence of peat deposits at this site is of great importance for providing both palaeoenvironmental evidence and material suitable for dating, so a robust chronological framework can be established. The softer clay deposits below this peat, which may also preserve pollen and other palaeoenvironmental evidence, would also simplify further auger survey and sampling in comparison with the other two sites. Full details of the additional fieldwork undertaken at this site are provided below.

Under Whitle Bog auger survey and sampling

Detailed descriptions of the stratigraphy encountered during the auger survey of Under Whitle Bog are provided in Table 2 and displayed in graphical form in Figures 3 and 4. The density of woodland growing over the site hampered access to some sections of the bog, but the two transects across the bog provide an approximation of the site's extent and a good indication of the deposits accumulating there. The surface topography of the bog is gently inclined, facing north east, with a much shallower gradient than the neighbouring valley side to the south west. Maximum auger depths varied across the site and in some instances, it was not possible to identify the depth of underlying bedrock because of the stiff nature of deeper sediments. However, it was possible to gain a broad understanding of the base profile of the bog. The results from Transect 1 indicate that the underlying bedrock is inclined to the north east at a slightly greater gradient than the current bog surface. The mudstone bedrock appears slightly degraded at the south west end of the transect, where it was soft enough to be penetrated by the auger. Fragments of this mudstone bedrock were often found in the lower sediments of auger holes (see below). On Transect 2, the depth of the underlying bedrock is relatively consistent across the transect, usually varying between c.1.3 and 1.6m. Auger hole 2.2 was an exception – here there appeared to be a hollow in the bedrock at least 1.3m deeper than at neighbouring augering sites. The deposits infilling the site have been categorised into three separate phases of development. These are described in detail below:

- **Phase 1 – spring deposits –** In the very lowest levels of auger holes 1.3 and 2.4 a series of olive coloured sand and silt deposits were observed that were very different to others noted across the bog. Significantly, these deposits were also very different to the mudstone bedrock observed in auger holes 1.1 and 1.2, and do not derive from this bedrock as a parent material. The coarse texture of these deposits is typical of materials brought to the surface through fissures in more porous bedrock, associated with the action of gravity springs located at the base of hillslopes (cf. Waters 1992: 215). The presence of a spring, as indicated by these deposits, explains the waterlogged nature of the ground at this location.

- **Phase 2 – colluvium –** Immediately above the olive-coloured sediments and mudstone bedrock, the lowermost deposit in each auger hole consisted of a dark or very dark grey clay or silt, often with decayed mudstone fragments of varying size. The poorly sorted nature of these deposits is consistent with colluvial material eroded from the neighbouring slope. This deposit was much thicker at the north east end of Transect 1 in auger hole 1.6. Although its full extent could not be established because of its stiff nature, the colluvial material at auger hole 1.6 appears to form a natural bank at this north eastern end. This bank may have caused water to pool within the bog in the past, inhibiting the decomposition of organic matter and initiating peat formation within the bog (see below).

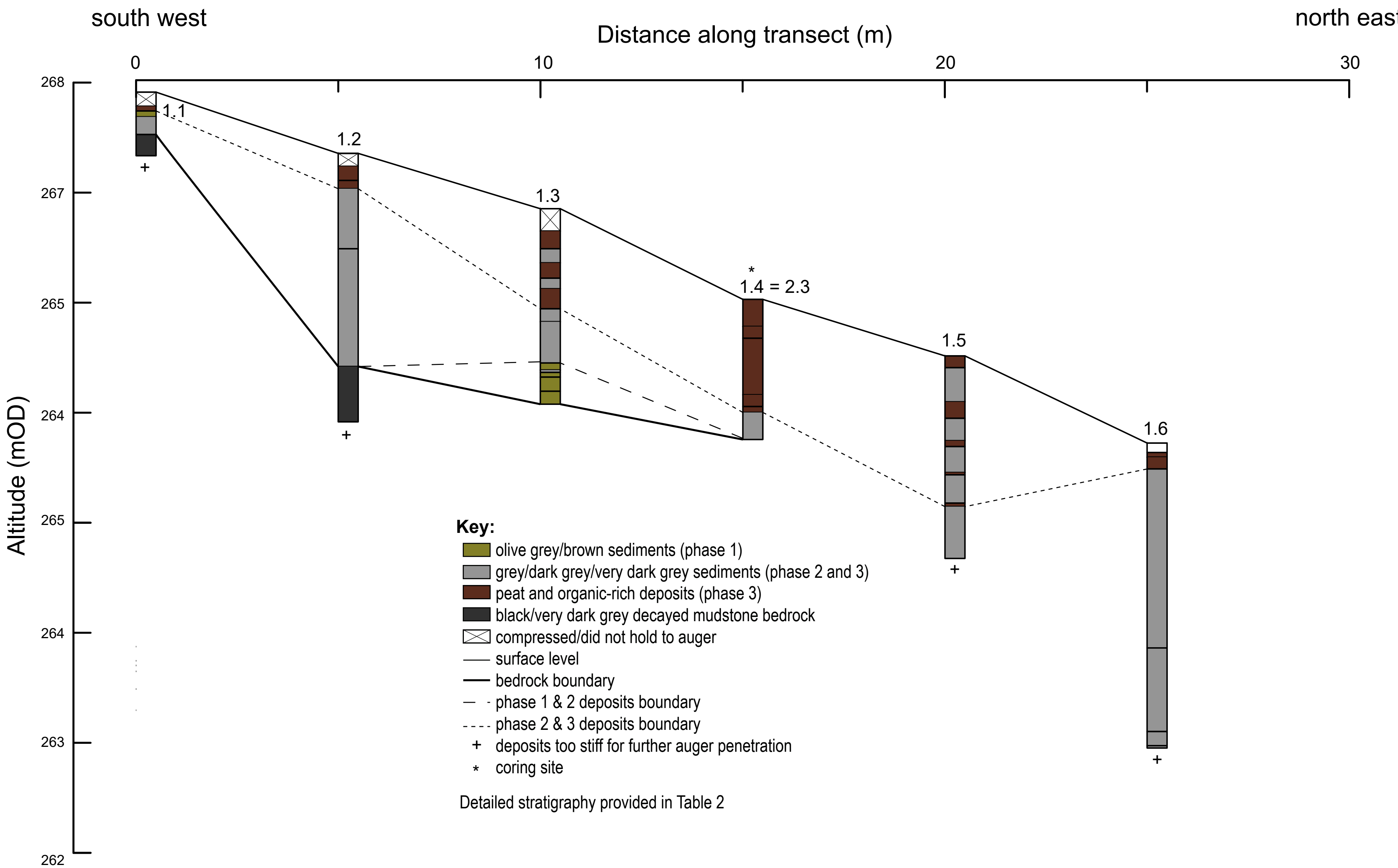


Figure 3. Under Whitle Bog - Transect 1 stratigraphy

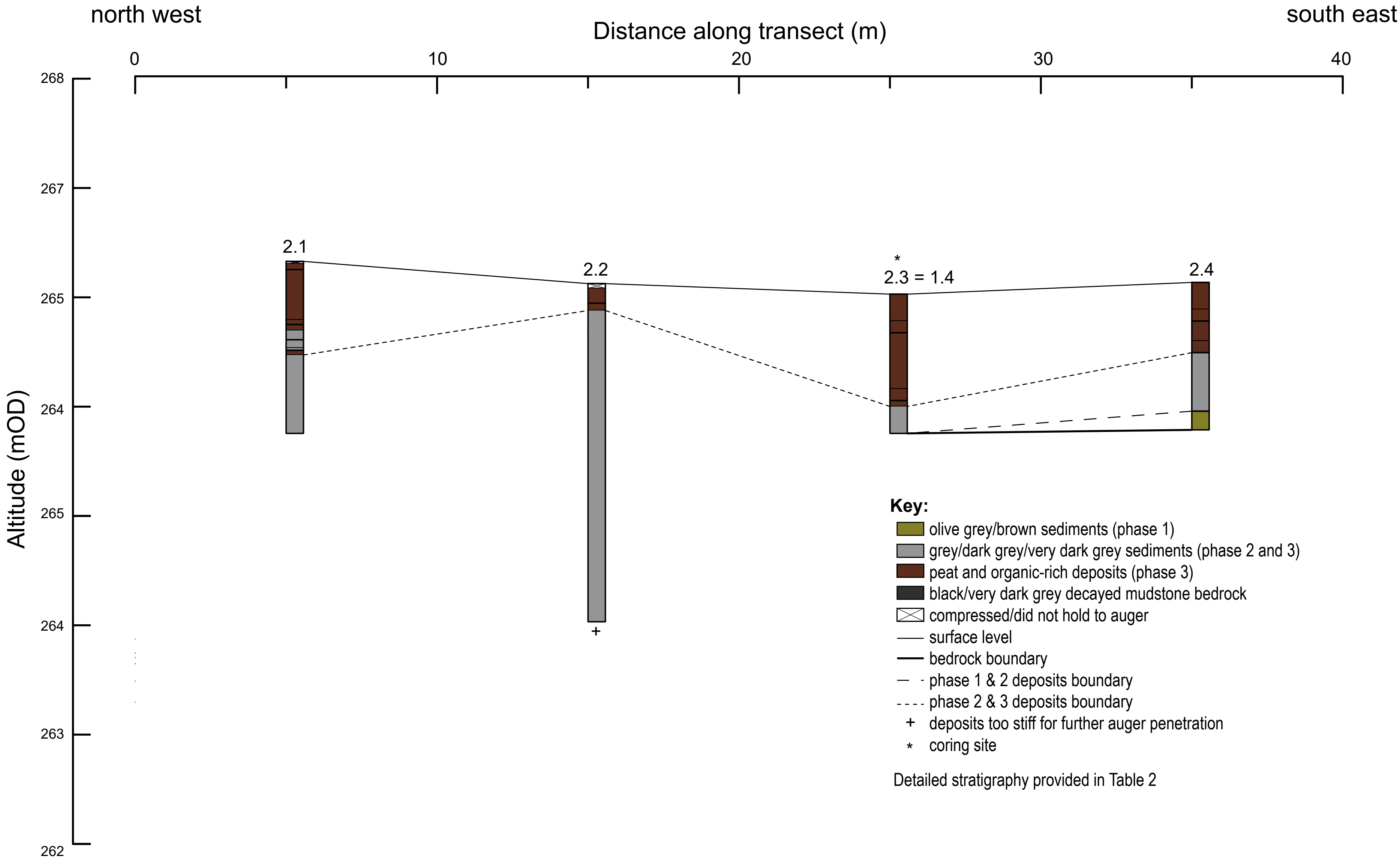


Figure 4. Under Whitle Bog - Transect 2 stratigraphy

- **Phase 3 – organic-rich sediments and colluvium –** The upper deposits within the bog consisted of a mixture of peat deposits, organic-rich silts and grey silt and clay deposits. The organic-rich silt and peat deposits suggest a degree of stability of the bog surface, which allowed the development of peat within a waterlogged environment. That said, the grey silt and clay deposit bear a degree of similarity to lower colluvial layers, suggesting continued erosion of material from the neighbouring valley slope. Given the lack of any waterlogged ground or peat deposits above the site on the valley side, it is likely that these peat deposits and organic-rich sediments developed in situ rather than being eroded and redeposited from elsewhere. The deposits towards the centre of the bog appear to have less grey silt/clay material, suggesting a lower influx of colluvial material and a greater degree of surface stability in that portion of the site.

A 95cm deep core from Under Whitle Bog was extracted from auger hole 1.4 at the centre of the bog. Although deeper areas of the bog might contain a longer time sequence of deposits, a core from this central area was selected because of the lower potential for accumulation of intrusive material eroded from outside of the bog, thereby providing material that is more secure for detailed analysis. The organic-rich nature of material at this site should also provide a greater quantity of organic remains suitable for radiocarbon dating.

Test Pit 20

After detailed examination of the exposed section of Test Pit 20, five different deposits and a possible cut mark were observed. Descriptions of these deposits are provided in Table 3 and displayed in Figure 5. The possible cut [055], was observed near the eastern corner of the test pit, cutting through deposits (054), (056) and (057). The lower two of these deposits – (056) and (057) – are a reddish yellow clay and a brown clay with mudstone fragments, that appear to represent the natural sub-soil and possibly degraded mudstone bedrock respectively. Deposit (054) is a greyish brown silty clay, interpreted in the field as a possible palaeosol – i.e. the original soil horizon existing prior to the construction or development of the lynchet. The possible cut is c.13cm deep, of uncertain width and infilled with deposit (053), a brown silt-loam which overlies deposit (054). Deposit (052) is very similar in colour to deposit (053), which it overlies. Without further investigation, the nature of feature [055] is uncertain, but it could plausibly represent the trough of a plough scar cutting into the original hillslope. If these initial interpretations are correct, this suggests that the original slope of the hill was similar to the lynchet's current profile at a c.8° angle. The lack of mixing of sub-soil with deposits (052) and (053) implies that they have naturally accumulated through colluviation, rather than being deliberately placed or used as construction materials for the lynchet. This implies that the lynchet formed as a result of erosion rather than being deliberately built in its current form. The start of this erosional process is likely to relate to the onset of arable activity up-slope from the lynchet, as suggested by the possible plough scar [55]. Additional analysis of the monolith taken through these deposits will investigate this possibility further.

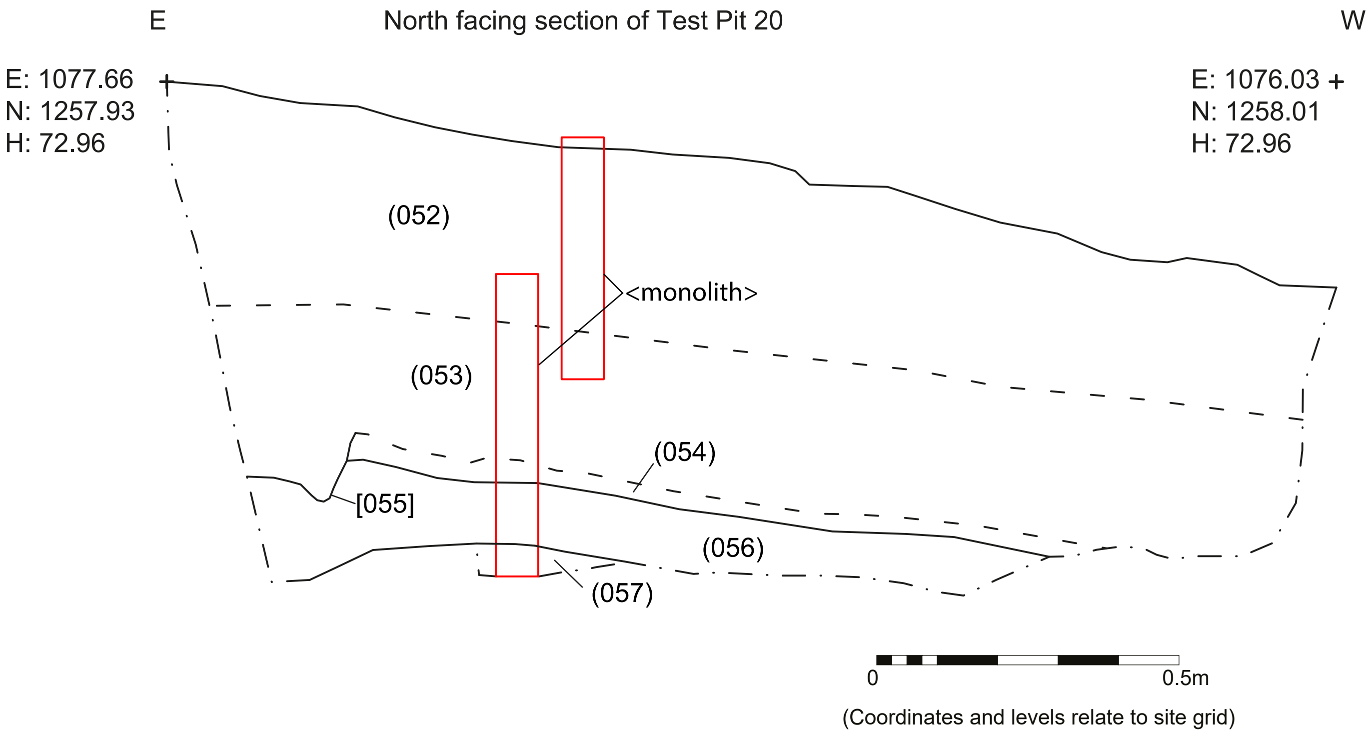


Figure 5. Section drawing and south facing photograph of Test Pit 20

Laboratory-based assessment and analysis

Geoarchaeological Analysis

Detailed examination of the samples under controlled conditions in the lab provided some additional data, which complemented what was observed in the field (see Tables 4 and 5). Although interpretations have not changed significantly as a result, the magnetic susceptibility analysis provided further information relating to the potential formation processes of the deposits identified (see Figure 6). These results are discussed separately for each sampling site below.

- *Under Whitle Bog core*

Unsurprisingly, the negative and very low magnetic susceptibility values obtained from the upper layers of the core are typical of values for peat and organic-rich sediments (cf. Gale & Hoare 2011: 208-209). The higher magnetic susceptibility values noted below a depth of 25cm could possibly relate to an increased proportion of colluvial material within the sediment (especially the spikes in the data), reflecting a greater intensity of erosion into the bog. However, it should be noted that the magnetic susceptibility readings are not particularly high and still fall into the expected range of values for peat (Gale & Hoare 2011: 208). The possibility that the deeper deposits contain colluvial material, while those in the upper layers are more secure, will, however, be taken into consideration when carrying out further analysis on this core.

- *Test Pit 20*

The magnetic susceptibility values obtained for the lower levels of the monolith provide an understanding of values expected for the parent sub-soil for deposits in this area, which fluctuate at around 0.7 SI. At a depth of 56cm, a spike in magnetic susceptibility values was observed corresponding with the top of the suspected palaeosol that was noted in the field. Although there are a number of factors that could cause an increase in magnetic susceptibility values (e.g. particle size, organic content, provenance of the sediment, or natural processes), these elevated values are consistent with the presence of a soil surface horizon, as pedogenic processes (i.e. soil formation) often cause an increase in magnetic susceptibility (cf. Gale & Hoare 2011: 213).

Other peaks in magnetic susceptibility values were observed throughout the monolith, but these do not correspond specifically with any other stratigraphic markers. Given the aforementioned range of influences on magnetic susceptibility, it is difficult to establish the cause of these raised values. The readings were certainly higher than that of the parent material for the deposits, suggesting that they have been enhanced in some way. One possible hypothesis is that the higher values represent episodes of reduced erosion that enabled pedogenesis to occur during of the formation of the lynchet. Another possibility is that the spikes in magnetic susceptibility represent the erosion and redeposition of magnetically enhanced topsoil during the gradual accumulation of material in this area.

These results provide a guide to the possible formation processes that may have influenced accumulation of deposits within the monolith. The magnetic susceptibility values in the lower sequence support the interpretation that a palaeosol has been preserved within the lynchet. This is highly significant in terms of further palaeoenvironmental research as it provides a horizon to target for pollen analysis. If well preserved, the pollen record from this layer could reflect conditions contemporary with the onset of local arable farming that led to the formation of the lynchet. If pollen is preserved in the overlying colluvial deposits, this may also provide a record of environmental changes whilst these deposits were accumulating. However, the value of undertaking any analysis of these deposits should be weighed against the ability to place the results within a chronological framework; if bulk samples taken from the profile provide material suitable for radiocarbon dating, then it may be worth undertaking detailed palynological research, but if dates cannot be obtained any pollen data would be of limited value.

Radiocarbon Dating Analysis

The results of the radiocarbon dating analysis on samples from the core from Under Whitle Bog are provided in Table 6 and are plotted against their depth within the core in Figure 7. These results suggest that the deposits within the core ranges from the late Bronze age (around the 11th century BC) onwards. Figure 7 shows a relatively constant rate of accumulation from the top of the core to a depth of 56cm (around the mid-thirteenth century), below which there appears to have a different accumulation rate. The change in accumulation rate appears to occur during the transition from lower sediments with decayed mudstone fragments to upper deposits without such inclusions. The current results may suggest that the upper deposits have a higher accumulation rate to the lower sediments with mudstone inclusions, or conversely that a hiatus (break in accumulation or truncation) may have occurred in between the two sediment types.

In order to obtain a better understanding of the accumulation rates of deposits within the core, a 2nd phase of radiocarbon dating analysis will be undertaken, targeting the change to sediments without mudstone inclusions at a depth of 72cm. Once this work has been undertaken, pollen analysis will target the sections of the core dating from the Anglo-Saxon to medieval period reflecting the date range of archaeological material excavated by the Digging Deeper project.

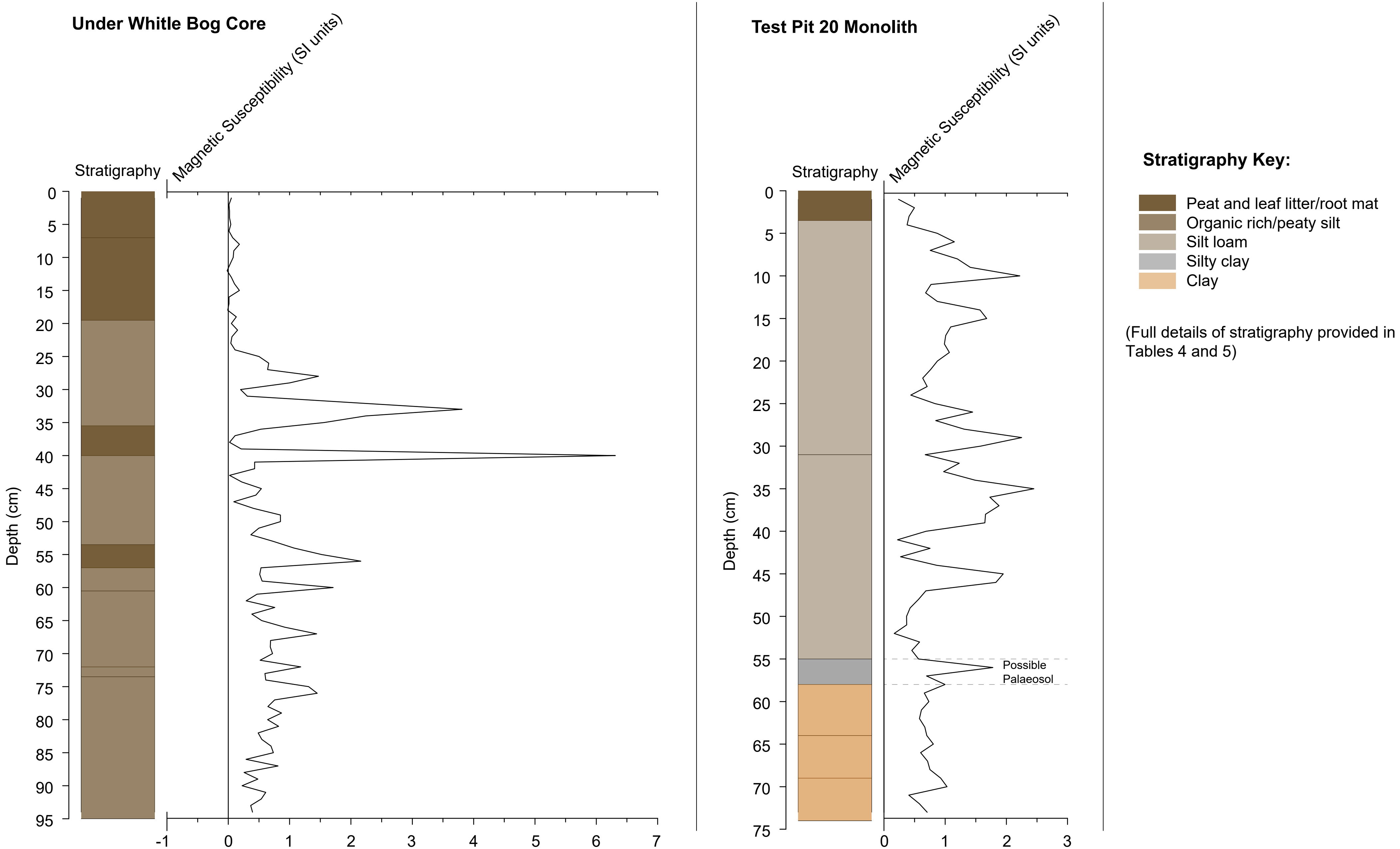
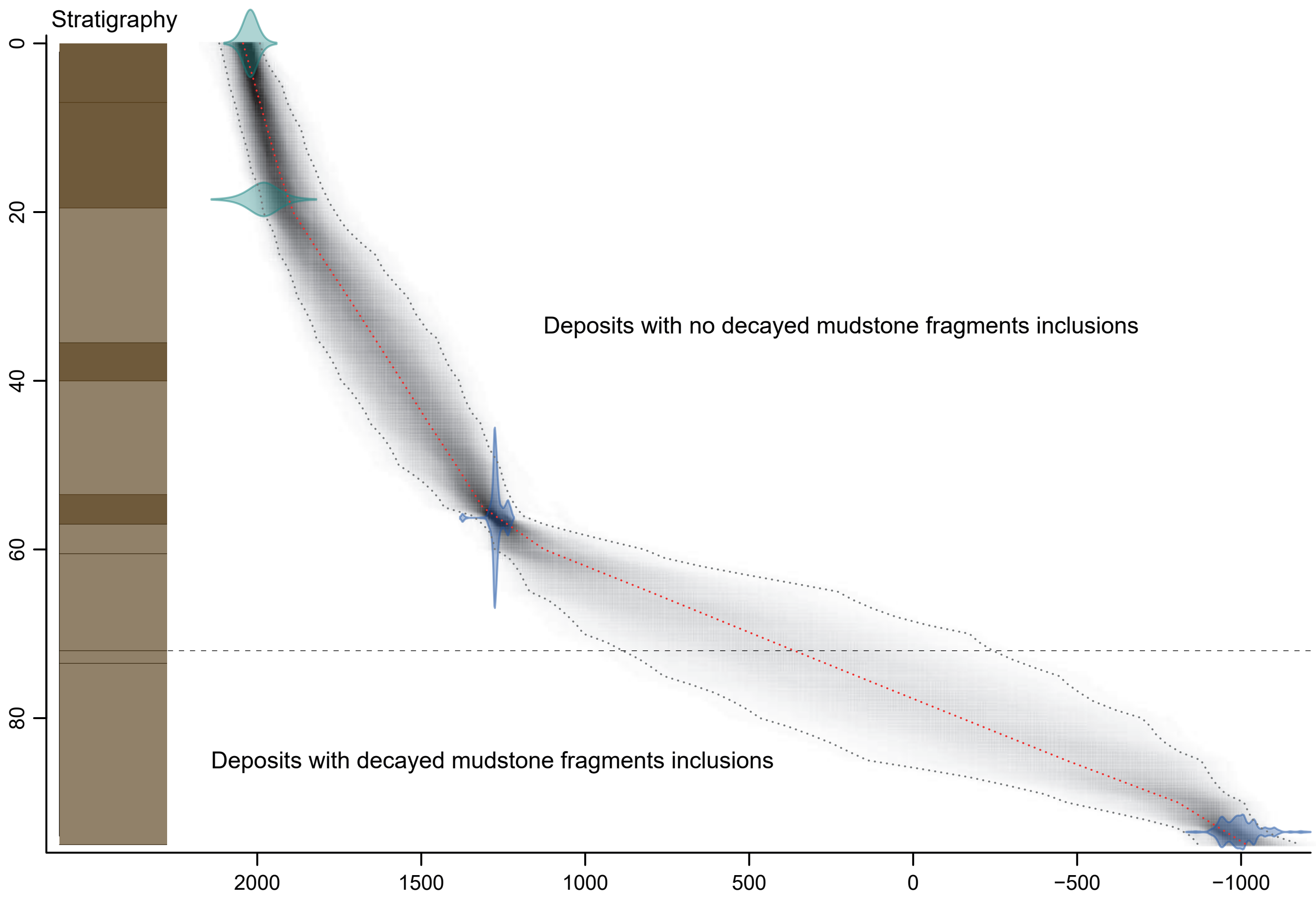


Figure 6. Magnetic susceptibility results from palaeoenvironmental samples



Stratigraphy Key: Peat and leaf litter/root mat; Organic rich/peaty silt

(Full details of stratigraphy provided in Table 4)

Figure 7. Bayesian age-depth model for the core from Under Whitle Bog

4. Preliminary Conclusions

After undertaking desk-based research and preliminary fieldwork in the study area, it was decided to focus on Under Whitle Bog for more detailed fieldwork and palaeoenvironmental sampling. This site had a greater depth of sediment than other potential wetland areas that were considered, together with evidence for peat formation within the bog. Detailed examination of the bog's stratigraphy through an auger survey has increased our understanding of the bog's formation processes. The stratigraphy of the site suggests that colluvial deposits have accumulated in this area over a gravity spring. When this colluvial material formed a natural bank on the north eastern portion of the area, it may have produced conditions suitable for peat formation alongside continuing colluvial activity. A 1m core has been collected from the site to provide material for detailed analysis. Radiocarbon dating has established that the core dates from the late-Bronze Age period onwards, but a 2nd round of dating will be undertaken to guide sampling for pollen analysis.

Sampling for geoarchaeological analysis has also been undertaken on Test Pit 20, which aimed to establish the formation processes of a lynchet in the north of the study area. The examination of the deposits present within this test pit suggest that the lynchet formed as a result of erosion, probably stimulated by the onset of arable activity further up the slope. Preliminary geoarchaeological analysis of samples from this area supports the presence of a palaeosol surviving beneath the standing earthwork of the lynchet, which will be targeted for pollen research alongside the core from Under Whitle Bog.

5. Acknowledgements

The author is very grateful to Dr Ian Parker Heath for facilitating fieldwork and for discussions about the archaeology of the study area, to Mrs Elspeth Walker for her kind hospitality whilst undertaking fieldwork for the project, to all the volunteers on the Digging Deeper project for their assistance during fieldwork, and to Dr Emily Forster for providing a technical review and proofreading this report.

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Appendix A - Field records

Table 1 Walkover survey - auger records

Auger site/ stratigraphic unit	Top depth (m)	Base depth (m)	Unit thickness (m)	Description
1.1	0.00	0.10	0.10	Brown clay loam – top soil.
1.2	0.10	0.12	0.02	Light grey-brown clay with mid-brown mottles
1.3	0.12	0.24	0.12	Brown clay loam – possible palaeosol
1.4	0.24	1.30	1.06	Light grey-brown clay with mid-brown mottles getting darker with depth. Rejection below[1]
2.1	0.00	0.06	0.06	Mid to dark brown clay loam – top soil
2.2	0.06	0.13	0.07	Mid grey clay with rare sandstone gravel fragments (<8mm)
2.3	0.00	0.58	0.58	Mottled orange and light grey-brown clay with rare organic fragments
2.4	0.58	1.24	0.66	Mid-dark grey sandy clay with rare organic fragments, becoming a darker shade of grey with depth. Hit stone at base
3.1	0.00	0.33	0.33	Dark brown peat
3.2	0.33	1.67	1.34	Mid grey clay with rare mudstone gravel fragments (<5mm). Hit stone at base
1. Auger could not penetrate any deeper due to the stiff nature of deposits.				

Table 2 Under Whitle Bog – auger survey records

Transect/ auger hole/ stratigraphic unit	Distance along transect (m)	Top depth (m)	Base depth (m)	Unit thickness (m)	Top altitude (mOD)	Base altitude (mOD)	Description	Phase
1.1.1	0	0.00	0.13	0.13	267.91	267.78	Did not hold/compressed	n/a
1.1.2	0	0.13	0.17	0.04	267.78	267.74	Very dark greyish brown (2.5Y 3/2) silty peat	3
1.1.3	0	0.17	0.22	0.05	267.74	267.69	Light olive brown (2.5Y 5/3) slightly sandy silty clay	2/3
1.1.4	0	0.22	0.38	0.16	267.69	267.53	Dark grey (5Y 4/1) slightly sandy silty clay with a few small organic fragments	2
1.1.5	0	0.38	0.57	0.19	267.53	267.34	Very dark grey (5Y 3/1) platy decayed mudstone. Rejection below	0
1.2.1	5	0.00	0.12	0.12	267.36	267.24	Did not hold/compressed	n/a
1.2.2	5	0.12	0.25	0.13	267.24	267.11	Dark grey-brown (10YR 3/2) peat	3
1.2.3	5	0.25	0.32	0.07	267.11	267.04	Very dark grey (5Y 3/1) peaty silt	3
1.2.4	5	0.32	0.87	0.55	267.04	266.49	Dark grey (5Y 4/1) clay silt with some organic fragments and rare decayed mudstone fragments	2
1.2.5	5	0.00	1.07	1.07	266.49	265.42	Very dark grey (5Y 3/1) clay silt with many small decayed mudstone fragments	2
1.2.6	5	1.07	1.58	0.51	265.42	264.91	Black (5Y 2.5/1) platy decayed mudstone. Rejection below	0
1.3.1	10	0.00	0.20	0.20	266.85	266.65	Did not hold/compressed	n/a
1.3.2	10	0.20	0.36	0.16	266.65	266.49	Very dark greyish brown (10YR 3/2) peat	3
1.3.3	10	0.36	0.49	0.13	266.49	266.36	Dark grey (5Y 4/1) silt with many organic fragments and rare small decayed mudstone fragments	3
1.3.4	10	0.49	0.63	0.14	266.36	266.22	Dark brown (7.5 YR 3/2) peat	3
1.3.5	10	0.63	0.73	0.10	266.22	266.12	Very dark grey (5Y 3/1) silty clay with some small decayed mudstone fragments	3
1.3.6	10	0.73	0.91	0.18	266.12	265.94	Very dark brown (10YR 2/2) peat with rare small decayed mudstone fragments	3
1.3.7	10	0.91	1.03	0.12	265.94	265.82	Very dark grey (5Y 3/1) silt with some organic fragments and a few small decayed mudstone fragments	2

Transect/ auger hole/ stratigraphic unit	Distance along transect (m)	Top depth (m)	Base depth (m)	Unit thickness (m)	Top altitude (mOD)	Base altitude (mOD)	Description	Phase
1.3.8	10	1.03	1.40	0.37	265.82	265.45	Dark grey (5Y 4/1) silty clay with rare organic fragments	2
1.3.9	10	1.40	1.46	0.06	265.45	265.39	Olive (5Y 4/3) sand	1
1.3.10	10	1.46	1.48	0.02	265.39	265.37	Dark grey (5Y 4/1) silty clay with rare organic fragments	1
1.3.11	10	1.48	1.53	0.05	265.37	265.32	Olive (5Y 4/3) sand	1
1.3.12	10	1.53	1.66	0.13	265.32	265.19	Olive (5Y 5/3) silty clay with rare organic fragments	1
1.3.13	10	1.66	1.77	0.11	265.19	265.08	Olive (5Y 4/3) sandy silt. Hit stone	1
1.4.1	15	0.00	0.25	0.25	266.03	265.78	Very dark brown (7.5 YR 2.5/2) peat	3
1.4.2	15	0.25	0.35	0.10	265.78	265.68	Very dark grey (5Y 3/1) organic-rich silt	3
1.4.3	15	0.35	0.87	0.52	265.68	265.16	Very dark grey (2.5Y 3/1) silty peat	3
1.4.4	15	0.87	0.98	0.11	265.16	265.05	Very dark grey (2.5Y 3/1) peaty silt with rare decayed mudstone fragments	3
1.4.5	15	0.98	1.03	0.05	265.05	265.00	Black (2.5Y 2.5/1) organic-rich silt	3
1.4.6	15	1.03	1.27	0.24	265.00	264.76	Very dark grey (5Y 3/1) clay silt with rare organic fragments and some small decayed mudstone fragments. Hit stone	2
1.5.1	20	0.00	0.11	0.11	265.52	265.41	Very dark brown (7.5 YR 2.5/3) peat	3
1.5.2	20	0.11	0.42	0.31	265.41	265.10	Laminated – grey silt (2.5Y 5/1) with black (2.5/N) silt and frequent organic fragments	3
1.5.3	20	0.42	0.57	0.15	265.10	264.95	Very dark greyish brown (2.5Y 3/2) silty peat	3
1.5.4	20	0.57	0.78	0.21	264.95	264.74	Dark grey (5Y 4/1) silt	3
1.5.5	20	0.78	0.83	0.05	264.74	264.69	Very dark grey (5Y 3/1) peaty silt	3
1.5.6	20	0.83	1.06	0.23	264.69	264.46	Dark grey (5Y 4/1) silt with many organic fragments and rare small decayed mudstone fragments	3
1.5.7	20	1.06	1.09	0.03	264.46	264.43	Very dark grey (2.5Y 3/1) peaty silt	3
1.5.8	20	1.09	1.34	0.25	264.43	264.18	Dark grey (5Y 4/1) silt with many organic fragments and rare small decayed mudstone fragments	3
1.5.9	20	1.34	1.38	0.04	264.18	264.14	Very dark grey (2.5Y 3/1) peaty silt	3
1.5.10	20	1.38	1.85	0.47	264.14	263.67	Dark grey (5Y 4/1) silt with many organic fragments and many	2

Transect/ auger hole/ stratigraphic unit	Distance along transect (m)	Top depth (m)	Base depth (m)	Unit thickness (m)	Top altitude (mOD)	Base altitude (mOD)	Description	Phase
							small decayed mudstone fragments . Rejection below	
1.6.1	25	0.00	0.08	0.08	264.72	264.64	Did not hold/compressed	n/a
1.6.2	25	0.08	0.13	0.05	264.64	264.59	Very dark brown (2.5Y 4/1) peat	3
1.6.3	25	0.13	0.23	0.10	264.59	264.49	Dark grey (Gley 1 5/10Y) organic-rich silt	3
1.6.4	25	0.23	1.86	1.63	264.49	262.86	Dark grey (5Y 4/1) clay silt with rare small decayed mudstone fragments	2
1.6.5	25	1.86	2.62	0.76	262.86	262.10	Greenish grey (Gley 1 5/10Y) clay silt with many organic fragments and some small decayed mudstone fragments	2
1.6.6	25	2.62	2.75	0.13	262.10	261.97	Dark grey (Gley 1 4/N) clay with many small decayed mudstone fragments	2
1.6.7	25	2.75	2.77	0.02	261.97	261.95	Dark grey (Gley 1 3/N) clay silt with many small decayed mudstone fragments. Rejection below	2
2.1.1	5	0.00	0.02	0.02	266.33	266.31	Did not hold/compressed	n/a
2.1.2	5	0.02	0.08	0.06	266.31	266.25	Very dark brown (10YR 2/2) peat	3
2.1.3	5	0.08	0.54	0.46	266.25	265.79	Grey (5Y 4/1) clay silt with some organic fragments and few small decayed mudstone fragments	3
2.1.4	5	0.54	0.58	0.04	265.79	265.75	Black (10YR 2/1) peat	3
2.1.5	5	0.58	0.63	0.05	265.75	265.70	Dark olive grey (5Y 3/2) peaty silt	3
2.1.6	5	0.63	0.72	0.09	265.70	265.61	Dark grey (5Y 4/2) clay silt	3
2.1.7	5	0.72	0.79	0.07	265.61	265.54	Grey (Gley 1 5/N) silty clay with many small decayed mudstone fragments	3
2.1.8	5	0.79	0.82	0.03	265.54	265.51	Dark grey (Gley 1 4/N) clay silt with some small decayed mudstone fragments	3
2.1.9	5	0.82	0.86	0.04	265.51	265.47	Very dark grey (Gley 1 3/N) organic-rich silt with some small decayed mudstone fragments	3
2.1.10	5	0.86	1.58	0.72	265.47	264.75	Dark grey (Gley 1 4/N) clay silt with many small decayed mudstone fragments. Hit stone	2
2.2.1	15	0.00	0.05	0.05	266.13	266.08	Did not hold/compressed	n/a

Transect/ auger hole/ stratigraphic unit	Distance along transect (m)	Top depth (m)	Base depth (m)	Unit thickness (m)	Top altitude (mOD)	Base altitude (mOD)	Description	Phase
2.2.2	15	0.05	0.21	0.16	266.08	265.92	Dark brown (10YR 2/2) peat	3
2.2.3	15	0.21	0.27	0.06	265.92	265.86	Very dark grey-brown (10YR 3/2) peaty silt	3
2.2.4	15	0.27	2.89	2.62	265.86	263.24	Dark grey (5Y 4/1) clay silt with many small decayed mudstone fragments and rare organic fragments. Mudstone fragments increase in size and frequency with depth. Rejection below	2
2.3.1	25	0.00	0.25	0.25	266.03	265.78	Very dark brown (7.5 YR 2.5/2) peat	2
2.3.2	25	0.25	0.35	0.10	265.78	265.68	Very dark grey (5Y 3/1) organic-rich silt	2
2.3.3	25	0.35	0.87	0.52	265.68	265.16	Very dark grey (2.5Y 3/1) silty peat	2
2.3.4	25	0.87	0.98	0.11	265.16	265.05	Very dark grey (2.5Y 3/1) peaty silt with rare decayed mudstone fragments	2
2.3.5	25	0.98	1.03	0.05	265.05	265.00	Black (2.5Y 2.5/1) organic-rich silt	2
2.3.6	25	1.03	1.27	0.24	265.00	264.76	Very dark grey (5Y 3/1) clay silt with rare organic fragments and some small decayed mudstone fragments. Hit stone	3
2.4.1	35	0.00	0.25	0.25	266.14	265.89	Dark brown to black (10YR 2/2 - 10YR 2/1) peat	3
2.4.2	35	0.25	0.36	0.11	265.89	265.78	Dark brown (10YR 2/2) silty peat	3
2.4.3	35	0.36	0.54	0.18	265.78	265.60	Very dark grey (Gley 1 3/N) organic-rich silt	3
2.4.4	35	0.54	0.65	0.11	265.60	265.49	Very dark grey (10YR 3/1) silty peat	3
2.4.5	35	0.65	1.18	0.53	265.49	264.96	Dark grey (Gley 1 4/N) clay silt	2
2.4.6	35	1.18	1.35	0.17	264.96	264.79	Olive (5Y 4/3) sandy silt. Hit stone	1

Table 3 Test Pit 20 Context descriptions

Context	Top depth (m)[1]	Base depth (m)[1]	Unit thickness (m)	Description
(052)	0.00	0.37	0.37	Layer – dark greyish brown silt loam with many mudstone fragments. Overlies (2). Interpretation: Probable colluvial layer
(053)	0.37	0.58	0.21	Layer – brown silt loam with many mudstone fragments. Underlies (1), overlies (3), fills [4]. Interpretation: Probable colluvial layer
[054]	0.58	0.63	0.05	Layer – greyish brown clay. Overlies (5), cut by [4]. Interpretation: Possible palaeosol
(055)	0.58	0.70	0.12	Cut – only visible on side of trench. Steep-sided with a pointed base, becoming near flat to the east. Cuts (3), (5) and (6). Filled by (4). Interpretation: Possible plough scar
(056)	0.63	0.78	0.15	Orange clay. Overlies (6), cut by [4]. Interpretation: Natural sub-soil
(057)	0.78	0.83	0.05	Reddish brown clay with many decayed mudstone fragments. Overlain by (5), cut by [4]. Interpretation: Natural sub-soil

1. Refers to depth below surface at the south eastern corner of the trench

Appendix B – Laboratory records

Table 4 Under Whitle Bog core stratigraphy

Unit	Top depth (m)	Base depth (m)	Unit thickness (m)	Description
1	0.00	0.07	0.07	Very dark grey (10YR 3/1) leaf litter
2	0.07	0.20	0.13	Very dark brown (10YR 2/2) peat
3	0.20	0.30	0.16	Dark grey (10YR 4/1) organic-rich silt
4	0.355	0.4	0.045	Very dark grey (10YR 3/1) peat
5	0.40	0.54	0.14	Dark grey (10YR 4/1) organic-rich silt
6	0.54	0.57	0.03	Very dark grey (10YR 3/1) silty peat
7	0.57	0.61	0.04	Dark grey (10YR 4/1) organic-rich silt
8	0.61	0.72	0.12	Very dark grey (10YR 3/1) peaty silt
9	0.72	0.74	0.02	Grey (10YR 5/1) organic-rich silt with rare small (<2mm) decayed mudstone fragments
10	0.74	0.95	0.22	Very dark grey (10YR 3/1) organic-rich silt with some small (<5mm) decayed mudstone fragments

Table 5 Test Pit 20 monolith stratigraphy

Unit	Top depth (m)	Base depth (m)	Unit thickness (m)	Description
1	0.00	0.04	0.04	Dark greyish brown (10YR 4/2) root mat
2	0.04	0.31	0.27	Dark greyish brown (10YR 4/2) silt loam with many angular mudstone fragments (<15mm)
3	0.31	0.55	0.24	Brown (10YR 4/3) silt loam with many angular mudstone fragments (<15mm) frequent roots above c.0.42m
4	0.55	0.58	0.03	Greyish brown (10YR 5/2) silty clay with mottles of (7.5YR 3/2) dark brown clay
5	0.58	0.64	0.06	Grey (10YR 6/1) clay with mottles of (10YR 6/8) brownish yellow clay
6	0.64	0.69	0.05	Reddish yellow (7.5YR 6/8) clay with mottles of (10YR 6/1) grey clay
7	0.69	0.74	0.05	Brown (5YR 5/4) clay with many small (<3mm) decayed mudstone fragments – possible layer of decayed oxidised mudstone bedrock

Table 6 Radiocarbon dating analysis results

Lab ID	Depth (m)	Material	Radiocarbon age (BP)	Calibrated date (IntCal20)[1]
UBA-47483	0.18-0.19	3x Carex spp. seeds	MODERN[2]	MODERN[2]
UBA-47484	0.56-0.565	peat - humic content	745 ± 21	Cal. AD 1230-1290
UBA-47485	0.93-0.94	sediment - humic content	2839 ± 24	1105-917 Cal. BC

1. Calibrated using Bacon 4.0.5 (Blaauw & Christen 2011).
2. ‘Modern’ dates relate to radiocarbon dating results suggesting readings after c.1940 when the atmosphere was artificially contaminated with ^{14}C isotopes (ORAU 2016) and are difficult to accurately calibrate