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Marfield Quarry: A Palaeoenvironmental Assessment

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By

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Summary

This report presents the results of the extended auger survey and palaeoenvironmental assessment of the sediments recovered from Marfield Quarry, North Yorkshire. The auger survey confirmed the extent of the deposits within Swamp Field and revealed the irregular sub-surface topography of the feature they infill. The samples were recovered from a test pit in monolith tins and bulk samples which were assessed for the presence of pollen, beetles and plant macrofossil remains. The sediment archive was also recorded and was indicative of a still water environment with the lower deposits characterised by a well humified peat overlain by an organic silt. The plant macrofossils confirmed that these deposits were formed in standing/ slow moving water conditions with some areas of drier ground present. The beetle remains were poorly preserved although the identified species confirm the area may have been seasonally wet as is the case today. No evidence for human impacts upon the landscape were observed by any of the proxies examined. The lower deposits confirm an early Holocene date of 8630-8450 cal BC.

KEYWORDS: Marfield Quarry, North Yorks, peat, pollen, plants, beetles

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1. INTRODUCTION

An auger survey was carried out in advance of a proposed quarry extension at Marfield, North Yorkshire in October 2010 (Fig 1). The auger survey was carried out in an area of low-lying ground known as Swamp Field in association with two trial trenches excavated at the edges of this field. Based on the results of this, a further programme of coring was undertaken and a test pit was excavated, with samples recovered for palaeoenvironmental analyses. These samples were assessed for the presence of pollen, plant macrofossil and beetle remains. In conjunction with these assessments radiocarbon dating was carried out in order to provide a chronology for the sediment sequence. The excavation of the archaeological trenches in Swamp Field and other trenches on the adjacent areas revealed few dateable archaeological features within the quarry extension area (SLR 2010).

2. METHODS

2.1 Auger survey

A second phase of coring was undertaken in order to establish the extent of the palaeoenvironmental resource. As the deposits have been recorded in detail in the first phase of works the core logs have been simplified and the deposits have been characterised as follows:

Unit 1: Grey oxidised alluvial clay
Unit 2: Grey organic silt
Unit 3: Well humified silty peat
Unit 4: Yellow Silt sand
Unit 5: Blue grey clay

The core logs are presented in Appendix 1. The basal depths were used to calculate a surface in ArcGIS in order to illustrate the subsurface topography. Each of these datasets provided stratigraphic information with surface elevations recorded relative to Ordnance Datum. The three datasets were combined within MS Excel and imported into ArcGIS version 9.1. A tension spline interpolator was used to construct each surface to minimise the generation of interpolation artefacts (*cf.* Burrough 1986, Chapman 2006). The resulting raster Digital Elevation Models (DEMs) were generated at 2m cell resolution.

2.2 Samples

A total of 8 bulk samples were recovered from the test pit in Swamp Field (Fig 2). The upper alluvial deposit was not sampled due to lack of organic remains and the desiccated nature of the sediment, which is not conducive to good preservation of sub-fossil material. In conjunction with the bulk samples, four monolith tins were recovered (for pollen analysis) along with additional spot samples. For safety reasons the basal units were not sampled in section but were recovered from the auger chamber. Two bulk samples were sent for radiocarbon dating to Beta Analytic Inc., Miami, Florida. These were taken from the middle of the organic silt (2.14-2.19m) and from the base of the peat unit (3.70-3.75m) (see below). Each sample underwent acid/alkali/acid pre-treatment prior to dating. Several dateable fractions were recovered but only the organic fraction (plant matter) was chosen for dating as this was deemed the most reliable.

2.2 Pollen

A total of 16 sub-samples (16cm interval) were submitted for pollen assessment from the monoliths and spot samples. The samples were taken at 16cm intervals throughout the profile. Pollen preparation followed standard techniques including potassium hydroxide (KOH) digestion, hydrofluoric acid (HF) treatment and acetylation (Moore *et al.,* 1991). A minimum of 125 total land pollen grains were counted for each sample using a Nikon Eclipse 50i microscope. However, pollen concentrations were very low in six samples (1.82m, 1.98m, 2.14m, 2.94m, 3.10m and 3.26m depths) and pollen was absent from samples from 3.42m and 3.92m depths, for which assessment counts were not possible.

2.3 Plant Macrofossils and Beetles

The bulk samples were inspected and their lithologies recorded. Subsamples (1-2L) were processed for the recovery of plant and invertebrate macrofossils, broadly following the techniques of Kenward *et al*. (1980). Prior to processing, the subsamples were disaggregated in water for 24 hours and their volumes recorded in a waterlogged state (approximately, as all the subsamples formed a fine suspension). The residues were primarily of waterlogged plant material and were examined wet (separate washover and residue fractions were not obtained as the mineral component after processing was negligible). The residues were examined for macrofossils using a low power microscope (x7 to x45). To facilitate recording, the wet residues where separated into coarse and fine factions using a 4 mm sieve; the entirety of the coarse fraction was assessed for each sample and multiple subsamples from the fine fractions were assessed, until no new plant or invertebrate taxa were noted. Plant and invertebrate macrofossil remains were compared with modern reference material (where possible) and the use of published works (e.g. Cappers *et al*. 2006; Harde 1984; Lindroth 1974) and identified to the lowest taxon necessary to achieve the aims of the project. During recording, consideration was given to the suitability of the macrofossil remains for submission for radiocarbon dating by standard radiometric technique or accelerator mass spectrometry (AMS). Nomenclature for plant taxa follows Stace (1997) and insects follow Kloet and Hincks (1964-77).

3. RESULTS

Sediment summary

The sediment profile of the test pit consists of several distinct deposits, the lowest of which was a blue grey silt sand 0.12m thick (Fig 2, Unit 5). This was overlain by yellow silt sand 0.05m thick (Unit 4). These basal sands were overlain by a dry well humified peat unit 0.80m thick (Unit 3), which was sealed by a 1.40m thick deposit of organic silt (Unit 2). The basal sands and silts reflect deposition by relatively high energy fluvial processes with the humified peat (Unit 3) indicative of a transition to a waterlogged, semi-terrestrial environment. The overlying silt (Unit 2) reflects renewed deposition by fluvial processes, although the organic content of this unit suggests still or slowly moving water. The uppermost deposit (Unit1) indicates a final phase of alluviation which overlies the area.

The extended auger survey has shown the basal topography of the 'kettlehole' feature to be irregular (Figs 3 and 4). There seem to be two distinct subsurface depressions, one to the east and one to the north-west (Fig 4). The survey was constrained by two areas of high ground, where trenches 29 and 30 had confirmed the absence of any cut archaeological features. In addition, part of the south eastern area was flooded preventing auger survey, whilst the presence of an overhead power cable also restricted coring locations. Despite this sufficient information has been gathered to characterise the likely extent of the area which will be affected by the planned mineral extraction.

The survey confirmed that the deposits are consistent across the area with the deepest parts of the feature having a thin layer of inorganic blue clay (Unit 5) as the basal unit. The thin band of yellow sand (Unit 4) observed in the test pit was not recorded in any other cores and hence may be a localised deposit. The blue clay was then overlain by the well humified silty peat deposit (Unit 3) which was too dry and compacted to be recovered fully by the auger, as was the case in Core 13. The onset of the formation of this deposit has been dated to Cal BC 8360 to 8450 (BETA-28872 Cal BP 10,580 to 10,400). Overlying this was the organic silt which continued to be lain down well after the Bronze Age, Cal BC 1900-1690 (BETA-28871 Cal BP 3850 to 3640). This silt was also extremely compact and relatively dry.

This was then overlain by a thick deposit of inorganic oxidised alluvial clay (Unit 1). This alluvial clay tended to be thinner around the edges of Swamp Field where it directly overlay the gravels, which reflects the rise in subsurface topography. The GIS surface shows this higher ground as blue. This rise is expressed in the topography of the field in two distinct areas, one to the south west and one to the north east . The area investigated by Trench 30 also had visible ridge and furrow type features orientated north east to south west. These are probably drainage features which would encourage the water to run into the middle of the field which at the time of writing was under at least an inch of standing water.

The 'kettlehole' does not appear to extend much further east than the test pit with gravels being encountered between 0.40m and 1.79m below the current ground surface at this location. It is likely that the high ground bordering Swamp Field represents the maximum extent of the feature. The alluvial layer is unlikely to contain archaeological remains but the lower organic deposits (Units 2 and 3) have the potential to preserve organic archaeological remains.

Pollen Assessment

Eight out of the 18 pollen samples provided sufficient counts for palaeoenvironmental interpretation. However, pollen concentrations were low in samples from depths

1.82m, 1.98m, 2.14m, 2.94m, 3.10m and 3.26m to permit a reliable palaeoenvironmental assessment. The results of the pollen analyses are presented as a pollen diagram produced using the computer programme TILIA and TILIA*GRAPH (Grimm 1991) (Figure 5). All pollen percentages are of total land pollen (TLP) or TLP+aquatics or spores. Pollen nomenclature follows Moore *et al.* (1991) with the modifications proposed by Bennett *et al.* (1994).

The basal segment of the diagram (3.58m-3.74m, Unit 3) is dominated by tree and shrub pollen (c.50-85%). The sample taken from 3.74m largely consists of *Betula* (birch), Poaceae (wild grasses) and Cyperaceae (sedges). Other trees and shrubs are rare but include *Pinus sylvestris* (scots pine), *Quercus* (oak), *Corylus avellana*-type (hazel but may include sweetgale), Ericaceae (heaths) and a single grain of *Juniperus* (juniper). Other herbs are scarce and consist of occasional grains of *Filipendula* (meadowsweet), *Ranunculus*-type (buttercups), Lactuceae (dandelions) and *Artemisia* (mugwort). The implied environment would have been relatively open scrubby woodland. *Juniperus* attains maximum pollen frequencies at the start of the Holocene (Walker et al 1993) and few sites have a high occurrence of the shrub after c.9, 400 BP (Tipping, 1989). The presence at Marfield of *Juniperus* alongside the dominance of *Betula* would thus confirm that the basal radiocarbon date of 9300±40 BP (Beta-288272, Cal BC 8630 to 8450, Cal BP 10580 to 10400) in this sequence is reliable.

At 3.58m *Betula* has declined to values of <5% alongside a reduction in Poaceae (10%) and Cyperaceae (5%). *Corylus* has become the dominant species with values up to 40%. Other trees have also increased including *Pinus, Quercus* and *Ulmus* (elm) and herbs are scarce apart from a single grain of Lactuceae. *Sparganium* (bur-reed) is present, although at low values, indicating shallow water. Pteropsida (ferns) peaks at the base of the diagram with values up to 15% TLP+spores. The wider environment has become a mixed hazel woodland with some small grassy clearings.

Pollen is not preserved between 3.58m (Unit 3) and 2.78m (Unit 2). The middle segment of the diagram (2.78m-2.30m, Unit 2) is dominated by trees and shrubs and largely consists of *Corylus, Alnus* and *Quercus*. Other trees and shrubs are rare but include *Betula* (c.5%), *Ulmus* and *Tilia* (<5%) and occasional grains of *Fraxinus* (ash), *Hedera helix* (ivy), Ericaceae and *Ilex* (holly). Poaceae has increased slightly and reaches values between 5-15% and Cyperaceae maintains low but consistent values. *Plantago lanceolata* (ribwort plantain) is present up to 5%. Other herbs are scarce but the range of taxa has increased which include occasional grains of Chenopodiaceae (fat hen), *Caltha* (marsh marigold), *Plantago major* (greater plantain), *Ranunculus*-type (buttercups) and a single cereal-type pollen grain. Aquatics include *Sparganium* (c.5% TLP+aquatics), *Myriophyllium spicatum* (spiked water-milfoil) which peaks at 2.62m at 10% TLP+aquatics and *Myriophyllium verticillatum* (whorled water milfoil). Pteropsida has decreased to low but consistent values (c.5% TLP+spores).

The area around the sampling site would have been colonised by alder carr, along with tall herbs such as *Filipendula*, Caryophyllaceae and Apiaceae which thrive on damp soils. Shallow water is indicated by the record of aquatic taxa and some of the grasses which might be associated with wetter soils (*Phragmites*, common reed for example) rather than open areas in the wider landscape. *Corylus* would have dominated the fringing woodland with *Quercus* and stands of *Betula* and *Ulmus* on the better drained soils. Human activity in the general vicinity is suggested in this section of the pollen diagram by the presence of a single cereal grain and the anthropogenic indicator *Plantago lanceolata* (*sensu* Behre, 1981) (see below). Directly above the middle section (2.14-2.19m) a radiocarbon age of 3480±40 BP (Beta-288271, Cal BC 1900 to 1690, Cal BP 3850 to 3640) indicates this segment of the record dates to the early to middle Bronze Age. Pollen is again not preserved in the samples between 2.30m and 1.82m.The record re-commences at 1.82m where the uppermost two samples in the diagram are similar to the middle section of the diagram indicating little change to the local environment, with alder-hazel and oak woodland still prevailing.

Bulk samples

SEDIMENT UNIT 4 – 'YELLOW SILT/SAND'

Sample 3 3.74-3.78m
Moist, mid brown to mid grey-brown (with some lighter shades of brown and grey-brown in irregular patches), soft and sticky (working soft), slightly clay silt, with no obvious inclusions.

The small wet residue (50 ml) primarily consisted of fine material (less than 4 mm), with only a few organic remains recovered in the coarse fraction, including a comminuted wood fragment and a fragment of 'bark-like' material. The fine fraction was dominated by fragmented vegetative remains, notably monocotyledonous stem fragments, Poaceae (wild grases) spikelet folks (excluding caryopses), woody herbaceous stem fragments and moss (*Musci*) stem fragments. The suite of wild plant species provisionally identified included semi-aquatic and aquatic species such as *Ranunculus* Subgenus *Batrachium* (crowfoots) and *Potamogeton* spp. (pondweeds), together with super-abundant oogonia of the 'plant-like' freshwater green algae Characeae (stonewort). There were also remains of the grass/meadowland species meadow/creeping/bulbous buttercup (*Ranunculus* Subgenus *Ranunculus*) and possible cf. *Agrimonia eupatoria* L. (agrimony) , whilst the presence of *Carex* spp.(sedges) and *Scirpus* sp.(club rushes) indicated damp/wet ground habitats. A single seed of *Empetrum nigrum* L. (crowberry) was also recorded which hinted at the presence of heathland.

Some invertebrate remains were recorded but these were largely restricted to larval fragments and scraps of adult beetle sclerites; there were occasional better preserved beetle remains but most of these were of heavily scleritised but undiagnostic body parts such as legs and mandibles. Some cladoceran (water flea, including *Daphnia*) ephippia (resting eggs) were also present; these are produced in response to environmental stress, such as over-crowding caused by a reduction in water volume or a decline in water quality caused by pollution, for example.

A single small stone was recorded in the coarse faction (over 4 mm) of the wet residue.

SEDIMENT UNIT 3 – 'HUMIFIED PEAT'

Sample 1 3.50-3.74m lower peat

Just moist, very dark grey to black (externally) to dark brown/grey-brown internally, brittle to crumbly, silt and amorphous organic sediment, with stones (over 60 mm) present and fine and coarse herbaceous detritus common.

The processed subsample reduced to a medium-sized wet residue (80 ml) containing well preserved organic remains. Comminuted wood fragments and some woody herbaceous stem/twig fragments were abundant in the coarse fraction and the fine fraction consisted of comminuted wood and vegetative fragments, with occasional buds and bud scales also recorded. The wild plants identified during the assessment included aquatic/wetland species such as crowfoot, possible cf. *Alisima* sp. (water-plantain), probable *Persicaria* cf. *lapthofolium* (L.) Gray) (pale persicaria), *Eleocharis* sp.(spike-rush) and sedges; stonewort oogonia were common. Weed species commonly associated with open ground were also identified, notably *Aethusa cynapium* L. (fool's parsley) and probable *Stellaria* cf. *media* (L.) Vill.) (common chickweed). Other taxa provisionally identified were Apiaceae (carrot family), Poaceae and *Rubus* sp(p) (bramble); the last typically associated with woodland, scrubland or hedgerow. In addition, a single fragment of *Corylus avellana* L. (hazel) nutshell was recovered from the coarse fraction, providing further evidence for the presence of wood/scrubland or hedgerow habitats.

Invertebrate remains were present in small numbers but largely restricted to indeterminate scraps of cuticle, with occasional fragments of beetle sclerite and possible fly puparia. There were also some cladoceran (including *Daphnia*) ephippia.

The mineral component of the residue consisted of a single rounded pebble.

Sample 2 2.90-3.00m main upper peat

Just moist, very dark brown/grey-brown (externally) to mid brown (internally), brittle to crumbly, silt and amorphous organic sediment, with 'seeds' present. The wet residue (~70 ml) from this sample from the upper part of the 'humified peat' was similar in composition to that from Sample 1. Coarse material in the form of degraded wood, small 'woody' stem/twig fragments and bark were common. The fine fraction consisted of comminuted vegetative material including wood, and small 'woody' herbaceous stem fragments. In addition, very occasional fragments of poorly preserved indeterminate charcoal were also noted in the fine fraction. The wild plant species identified from the 'seed' assemblage again included species of aquatic habitats (crowfoot, pondweed, and ?water-plantain) and wet ground (sedges), and stonewort oogonia were abundant. Evidence for scrubland/hedgerow habitat was also present in the form of hazelnut shell and seeds of *Sambucus nigra* L. (elder). Areas of disturbed ground were suggested by the presence of taxa such as *Urtica dioica* L. (stinging nettle), *Chenopodium* sp(p) (goosefoot), *Stellaria* sp?p. (stitchworts) and carrot family.

A little invertebrate cuticle was present which included larval fragments (some with encrusted sand grains) and indeterminate fragments of beetle sclerite (with an occasional slightly better preserved macrofossil, staphylinid elytra, for example). A few *Daphnia* ephippia were also noted.

Unusually for the sample group, Sample 2 did produce a small mineral residue fraction, which consisted of grey sand and small stones, suggesting an influx of water/sediment associated with this level of the deposit.

As previously noted for Sample 1, the remains recovered from Sample 2 were more characteristic of an organic silt than a well humified peat.

SEDIMENT UNIT 2 – 'ORGANIC SILT'

Sample 4 2.80-2.90m

Moist, mid to dark grey-brown (externally) to mid brown (internally), brittle to crumbly (working soft), slightly humic silt. There were no obvious inclusions.

Sample 4 was taken from just above the base of the organic silt overlying the 'humified peat' deposit and the wet residue (~80 ml) proved to be fairly similar in character to those from Samples 1 and 2, with occasional woody herbaceous/twig fragments and ?bark in the coarse fraction. The fine fraction was dominated by comminuted vegetative material, with some net-veined leaf fragments and occasional bud scales being noted. Traces of small fragments of hazelnut shell were also noted in the fine fraction, together with seeds of elder and bramble indicating the continued presence of wood/scrubland species. Aquatic taxa including pondweed, crowfoot and ?water-plantain were recorded as well as those of wet or damp ground (notably sedges and ?pale persicaria), together with abundant stonewort oogonia. Drier habitats were reflected by the presence of goosefoots, *Polygonum avicula* agg. (knotgrass), carrot family and grasses, in addition to the scrub/woodland species previously mentioned.

A small amount of invertebrate remains was recovered which was mostly larval fragments and scraps of beetle sclerite (occasional better preserved remains included a small pronotum which would probably be identifiable through further study but were mostly of undiagnostic body parts such as legs). Cladoceran (including *Daphnia*) ephippia were abundant and there were also a few mites (Acarina) present.

There was no mineral component to the residue from this sample.

Sample 5 2.50-2.60m

Moist, mid to dark grey-brown with a slight purplish cast (externally) to mid brown (internally), very slightly sandy, slightly humic silt. There were no obvious inclusions.

The wet residue (80 ml) gave only a tiny coarse fraction which consisted of a 'bark-like' fragment and two fragments of comminuted wood. The fine fraction primarily consisted of comminuted (filamentous) vegetative remains, with monocotyledonous stem fragments and some bud scales. The 'seed' assemblage was not diverse, being dominated by aquatic species of pondweed and crowfoot, with persicaria and possible agrimony also noted. Stonewort oogonia were common to abundant.

Invertebrate remains were numerous but identifiable remains were few. Larval fragments were common and included pieces of head capsules. Some beetle sclerites and sclerite fragments were also recorded; occasional remains such as undersides *may* be identifiable to further study but most of the more intact remains were of non-diagnostic body parts (e.g. mandibles). Cladoceran (including *Daphnia*) ephippia were abundant, mites were common and a few ant (Formicidae) heads were also present.

The mineral component of the residue consisted of a single small stone recorded in the coarse fraction.

Sample 6 2.30-2.40m

Moist, mid to dark grey to mid to dark grey-brown with a slight purplish cast (externally) to mid brown (internally), brittle and slightly sticky to crumbly (working soft), slightly humic silt. There were no obvious inclusions.

The wet residue was relatively large (~120 ml) and, again, dominated by the fine faction, with only a comminuted wood fragment and a small roundwood/twig fragment recovered in the coarse fraction. The fine fraction was characterised by fine, filamentous vegetative remains, with occasional leaf and monocotyledonous stem fragments, and moss 'stems'. The 'seed' assemblage was again dominated by aquatic species (pondweed, crowfoot and ?water-plantain) and those of wet or damp ground (sedges, spike-rush and perhaps persicaria), with abundant stonewort oogonia also noted. Drier terrestrial habitats were less well represented by remains of carrot family and possibly agrimony.

Invertebrate remains were super-abundant but predominantly of indeterminate larval fragments (subjectively, these were rather better preserved than in previous samples retaining more colour and a more rigid structure). Beetle fragments were common but largely as small indeterminate fragments; more intact remains were chiefly of undiagnostic body parts, such as legs, abdominal sclerites and mandibles, but there were also a few pronota and undersides which would probably be identifiable to further study and a ground beetle (Carabidae) head fragment. Mites and cladoceran ephippia (including *Daphnia*) were abundant and there were a few ?fly puparia fragments. Some statoblasts of the freshwater invertebrate *Cristatella mucedo* (sometimes known as a 'moss animal') were also noted. These animals (individuals are called zooids) form long gelatinous colonies which grow from early summer in slow-moving water and degenerate in the autumn; the 'seed-like' statoblasts are produced as the colonies degenerate and remain dormant over winter hatching in late spring to form new colonies.

There was no mineral component to the residue from this sample.

Sample 7 1.90-2.00m

Moist, mid to dark grey (externally) to mid brown (internally), brittle to crumbly (working soft), slightly humic silt, with stones (20 to 60 mm) present.

The wet residue was small (~40 ml), with no coarse fraction. The fine fraction consisted of fine, filamentous vegetative remains, with some moss 'stem' and 'leaf' fragments. The 'seed' assemblage displayed greater species diversity than in the previous sample, whilst still containing pondweed, crowfoot and spike-rush, as well as *Montia fontana* L. (blinks) which is also a species of damp/wet ground and super-abundant stonewort oogonia, species of disturbed or rough ground were present including goosefoot, (probable) common chickweed, *Rumex* (dock) and *Picris* (oxtongue). Grassland/meadow taxa were also represented by meadow/creeping/bulbous buttercup. In addition, a number of remains similar to the fruits (endocarps) of *Cornus* (dogwood) were also noted, but these would require further study to confirm or correct this identification.

The invertebrate assemblage was very similar to that from Sample 6. Remains were, again, super-abundant but predominantly of indeterminate larval fragments (in a similar state of preservation). Beetle fragments were common but largely as small indeterminate fragments; more intact remains were chiefly of undiagnostic body parts, such as legs, abdominal sclerites and mandibles, but there were also a few heads, elytra and undersides some at least of which would probably be identifiable to further study and a single elytron was identified as *Stenus* sp. Mites were common and cladoceran ephippia (including *Daphnia*) were super-abundant. Some statoblasts of *Cristatella mucedo* were also noted, together with some ant heads and a fragment of an adult fly (cf. Diptera sp.) eye.

The mineral component of the residue consisted of a single rounded pebble.

Sample 8 1.60-1.70m

Just moist, mid grey to mid grey-brown (externally) to mid brown (internally), brittle to crumbly (working soft), slightly humic silt. There were no obvious inclusions.

The final, uppermost, sample from the column sequence produced a medium-sized wet residue (~80 ml) which contained occasional small roundwood/twig and monocotyledonous stem fragments in the coarse faction. The fine fraction was primarily composed of fragmented vegetative remains, moss and monocotyledonous stem fragments. The 'seed' assemblage had very low species diversity with only pondweed, elder and possibly agrimony being identified; stonewort oogonia remained super-abundant, however.

Invertebrate remains were also super-abundant in the residue from this sample but, once again, mostly of indeterminate larval fragments, with some beetle sclerites including legs, mandibles, undersides and elytra – some of the two last would probably be identifiable to further study and the elytra included some of staphylinid species. Cladoceran (including *Daphnia*) ephippia were also super-abundant and there were a few ant heads but no mites or statoblasts were seen from this sample. There was no mineral component to the residue.

4. DISCUSSION

There has been very little systematic work carried out in the Swale-Ure washlands region although this is beginning to be addressed through the work of the Swale-Ure Washlands project and the Thornborough Project (Bridgland *et al.* forthcoming: www.thornborough.ncl.ac.uk). The early prehistory of the area is mainly represented by poorly collected flint scatters and chance finds. The proposed quarry extension at Marfield offers the opportunity to become part of the growing dialogue of investigations and has highlighted the potential of sediments preserved at the site to yield information of past landscape change.

The auger survey has mapped the likely extents of the deposits located within Swamp Field and has shown the feature to contain two discrete areas of deeper sediment. The samples recovered from the test pit, in the most eastern pool, revealed varying levels of macrofossil preservation. The pollen preservation was low throughout with indeterminable grains recorded at up to 10% (TLP+indeterminable) in all eight countable samples. Pollen concentration varied throughout the sequence with only half of the samples yielding sufficient palynmorphs for assessment. The results of the beetle analyses reveal fluctuating water levels throughout the period of deposition which may be in part responsible for this differential preservation of environmental proxies. The 'kettle' hole would have most likely have been kept wet by a combination of ground water and surface runoff which are strictly linked to climatic and vegetational variations. This would have led to periods of stagnation when more organic deposits would have formed.

The sample from the basal deposit, Unit 4, gave a small assemblage of plant macrofossil remains, which were very similar in character to those recovered from the samples from the other two sediment units (see below). Aquatic, damp/wet ground and grassland/meadow environments were indicated. There were also numerous oogonia (female cells) of the 'plant-like' green algae stonewort (Characeae) which suggested the water was still or slow-moving and of good quality (unpolluted). Some invertebrate remains were recorded but they were mostly indeterminate and of no interpretative value. However, cladoceran ephippia (water fleas) were present which, given the presence of the stonewort remains and the absence of any indications of human influence, suggested that the water level was subject to variation, perhaps seasonally.

On the basis of the assessment of the plant and invertebrate macrofossil evidence, Unit 3 appears to have formed in a rather dry (but still only semi-terrestrial) environment compared to Unit 2. This process of terrestrialisation began in the Mesolithic (8630-8450 Cal BC). Aquatic and wetland plant taxa were recorded and stonewort oogonia were common to abundant in both of the samples, with open ground plant taxa also present. The presence of woody herbaceous stem/twig fragments, buds and remains of species such as bramble, elder and hazel, suggested a woodland or scrub environment. The pollen record is only available for the base of Unit 3 (correlating with Sample 1). The pollen also reflects scrubby open woodland with a transition to mixed hazel woodland, however there is less evidence for aquatics/wetland species other than a few grains of bur-reed. It is likely that the wider landscape is better reflected in the pollen record rather than the environment on the sampling site itself, as indicated by the macrofossils which have a comparatively local source-area. The small quantities of invertebrate remains recovered were largely uninformative, although the presence of cladoceran ephippia suggested continued variation in water levels.

The apparent influx of mineral material in the upper part of Unit 3 (Sample 2) probably resulted from a flooding event, and the subsequent deposition of Unit 2 appears to be a continued accumulation of silts and fine organic debris, in rather wetter conditions. Coarse (woody) organic material and woodland/scrubland species were, in general, not encountered in the macrofossil samples from Unit 2. The pollen record however, illustrates a dominance of alder locally with fringing hazel/oak woodland. The series of five samples (Samples 4 to 8, lowermost first) from the organic silt deposit (Unit 2) were fairly homogeneous and depicted a gradual accumulation over an extended period of time, before the formation of the overlying alluvial clay (Unit 1) at the top of the depositional sequence. This accumulation continued into the Early Bronze Age (1900-1690 Cal BC) and it is during this period that there is a significant increase in monument building in the Swale-Ure washlands (Bridgland et al 2010:22). These monuments are mainly confined to the east of the River Ure and the population at this point would still have been fairly dispersed. The possibility for the wetland resource being exploited at this point again cannot be discounted as although farming was the main means of subsistence it would have been supplemented by occasional foraging and hunting. The increase in minerogenic sediment and increased wetness at Marfield may have been due to clearance occurring in the surrounding area. This would increase surface runoff and lead to destabilisation of the topsoil flushing more minerogenic sediment into the water system. This may also explain why there is little colluvial build-up noted on the higher ground (SLR 2010).

On the basis of the evidence from auger core 12 (which was the chosen location for the test pit), it was suggested that the organic silts which make up Unit 2 derived from fluvial sources. The macroscopic botanical evidence from the five samples consistently included aquatic species (notably pondweed and ?water-plantain) and species of wet or damp ground (i.e. spike-rush and sedges) consistent with waterlain deposits and waterside situations. The presence of alder in the pollen record confirms this local environment. However, the abundant stonewort oogonia, again, implied that the water was still or slow-moving; statoblasts of *Cristatella mucedo* from Sample 6 and Sample 7 lend further weight to this assertion and also provide some information regarding seasonality implying that these levels of the deposit formed in autumn. The general lack of mineral residue suggests that the area was not subject to sudden influxes of water from, say, natural drainage, but cladoceran ephippia implied continued fluctuations in overall water levels (the other invertebrate remains present were of little interpretative value). Importantly, there was also consistent evidence for drier terrestrial habitats from each of the macrofossil and pollen samples from Unit 2 – open/rough ground species such as buttercups, chickweed, goosefoot and fool's parsley along with woodland species such as oak, birch and hazel were recorded.

Overall, it appears that the site contained pools of standing/slow-moving clean water (subject to variations in size, perhaps seasonally), with wet ground (presumably at the water margins) and also drier terrestrial areas, particularly in the wider landscape throughout the time period represented by the series of samples. The extended auger survey has confirmed an irregular basal profile for this feature, with two distinct deep pools. The area seems to have become wetter and more open (i.e. with less substantial vegetation present) between the times represented by Unit 3 and Unit 2, perhaps triggered by a flood event at the transition point. There is evidence for a general shift in climate at this time with an increase in Bog Surface Wetness being recorded (Brown 2008:7).

No remains indicative of human activity in the immediate vicinity of the sample site were recovered from any of the plant macrofossil samples assessed, however there is evidence from the pollen record with the presence of ribwort plantain and a single cereal grain. This is likely to indicate that human activity in the wider area was occurring on the drier land away from the sampling site itself although the extent and nature of this activity is unclear. The presence of alluvial clay overlying the organic deposits point to a further increase in minerogenic sedimentation indicating more widespread clearance of the area, this is likely to have occurred in the Roman period or later as can be seen in other fluvial systems such as the Trent (Knight and Howard 2002). The earliest evidence of cultivation within the quarry area through site inspection and site investigation is that of ridge and furrow, generally assumed to be of the late 1st millennium AD or later.

Potential material for further radiocarbon dating has been recovered during processing, including waterlogged hazelnut shell fragments from Samples 1 and 2 (and, in lesser quantity, also from Sample 4). Other waterlogged plant remains present in all of the samples could also provide material for dating but the quantities available may be insufficient; unfortunately, the large ‘seeds’ (drupes) of pondweed recorded throughout cannot be recommended for this purpose because of the potential error from ‘reservoir effects’ incurred in dating such aquatic taxa.

The sequence of deposits assessed here has provided valuable information regarding the early Holocene development of the landscape at Marfield. Although little in the way of human activity has been identified, other than a single cereal grain and the anthropogenic indicator ribwort plantain, it does not discount the possibility of preserved archaeological remains within the sediments themselves. Sites such as Star Carr and Flag Fen have brought the issue of prehistoric wetland activity into sharp relief and theories of occupation in this period are being re-evaluated (Conneller *et al*. 2010: Pryor 2001). It is entirely possible that early human activity may not have had a marked impact on the local environment. Small wooden structures, like the platforms seen at Star Carr and the trackway on Hatfield moor, may have been constructed to facilitate the hunting of animals living in the wetland and may have involved very little woodland clearance or disturbance of the surrounding vegetation (Conneller et al 2010; Chapman and Gearey, forthcoming). It is also important to note that the Mesolithic is very poorly represented in the archaeological record, as structures at this time were often short-lived and only seasonally occupied. The deposits at Marfield have the potential to preserve prehistoric wooden remains. Although this may be regarded as unlikely, this should be considered when designing a mitigation strategy for the proposed scheme.

5. RECOMMENDATIONS FOR FURTHER ANALYSIS

Although plant and invertebrate remains preserved by waterlogging were recovered from all of the samples assessed, the quantities of identifiable macrofossils were small. Further study of the remains could produce quantitative or semi-quantitative species lists (and would almost certainly allow a small number of specific identifications of beetle remains) but would be of relatively little additional interpretative value for the site; such records may be of value as part of a wider synthetic study of the past environments of the area provided a sound chronology can be established for the deposits. No further study of the macrofossil remains from the assessed deposits is recommended in isolation, but processing of additional sediment may be appropriate in an attempt to recover additional material for radiocarbon dating of the sequence (if required).

The pollen record, although fragmentary does shed valuable light on the early to mid-Holocene environment in this region. However, due to the low concentrations and poor preservation of the palynmorphs no further work from the assessed deposit is recommended. It is however recommended that during the removal of these deposits samples are recovered for comparison as the sediments may have differential preservation over a large area. The auger survey has defined the ‘kettle’ hole feature as being confined to the area of the Swamp field with the possibility for deposits in the small area to the south west of this field, bounded by sharply terraced ground. The removal of the deposits should be controlled and monitored for the presence of preserved wooden remains by an appropriately qualified wetland archaeologist.

6. ARCHIVE

The samples are currently held in the BAE lab and will be stored for a maximum of one year.

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Figures

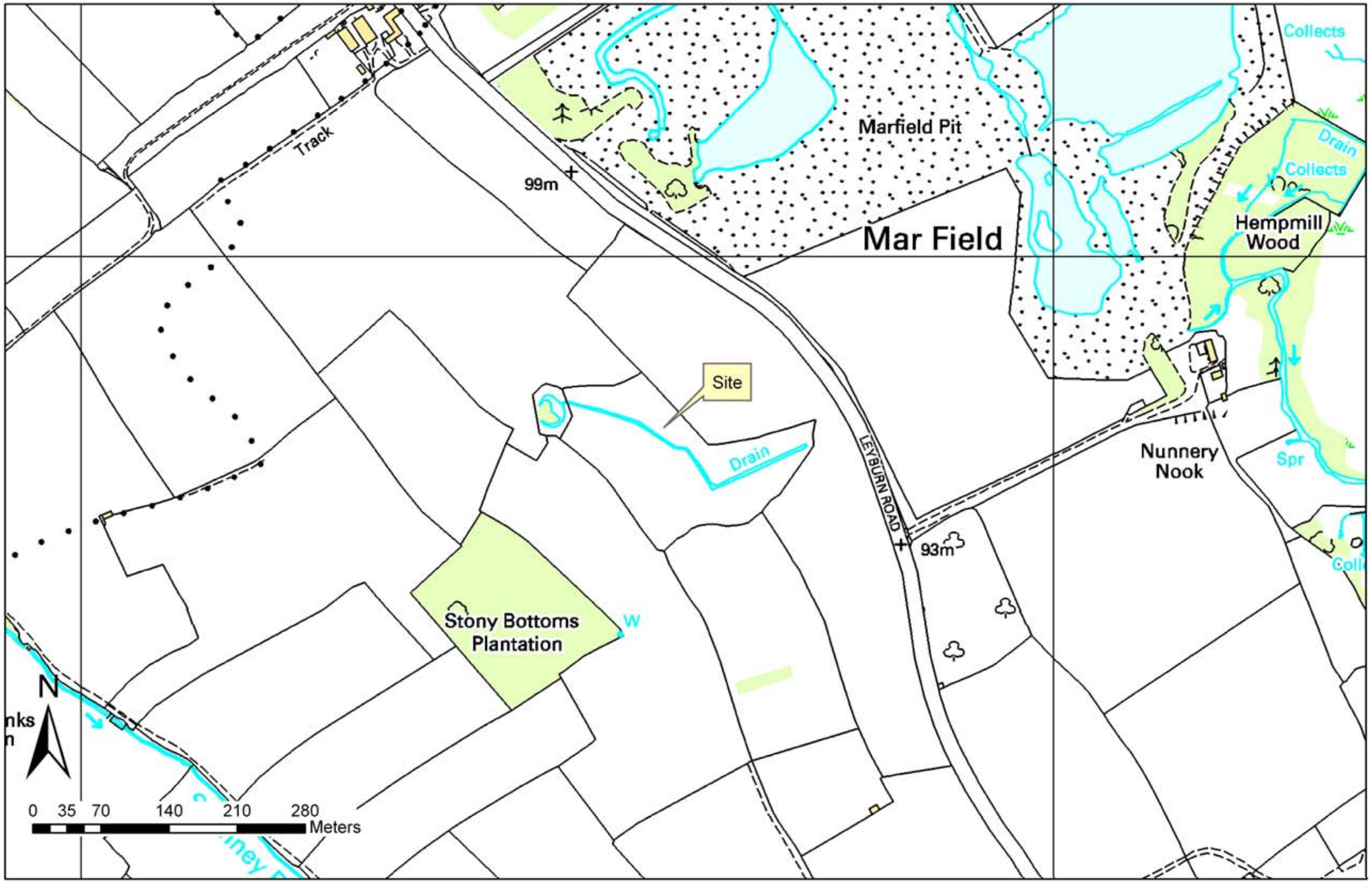

Figure 1: Site location

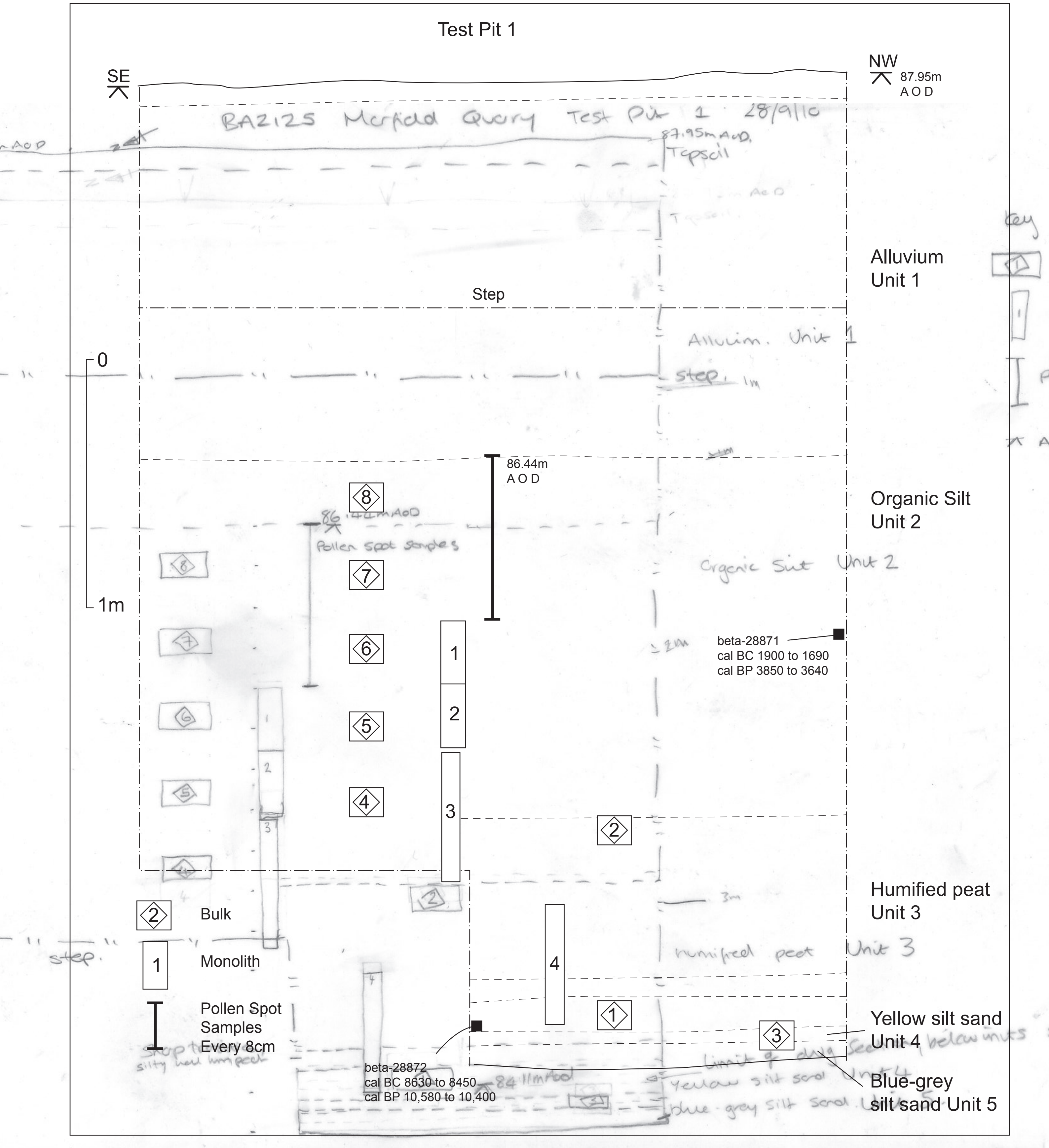
Test Pit 1
SE
NW
87.95m A O D
Alluvium Unit 1
Step
0
1m
86.44m A O D
Organic Silt Unit 2
beta-28871
cal BC 1900 to 1690
cal BP 3850 to 3640
Humified peat Unit 3
Bulk
Monolith
Pollen Spot Samples Every 8cm
Yellow silt sand Unit 4
Blue-grey silt sand Unit 5
beta-28872
cal BC 8630 to 8450
cal BP 10,580 to 10,400
BAZ125 Morfield Quarry Test Pit 1 28/9/10

Fig.2

Figure 3: Core locations

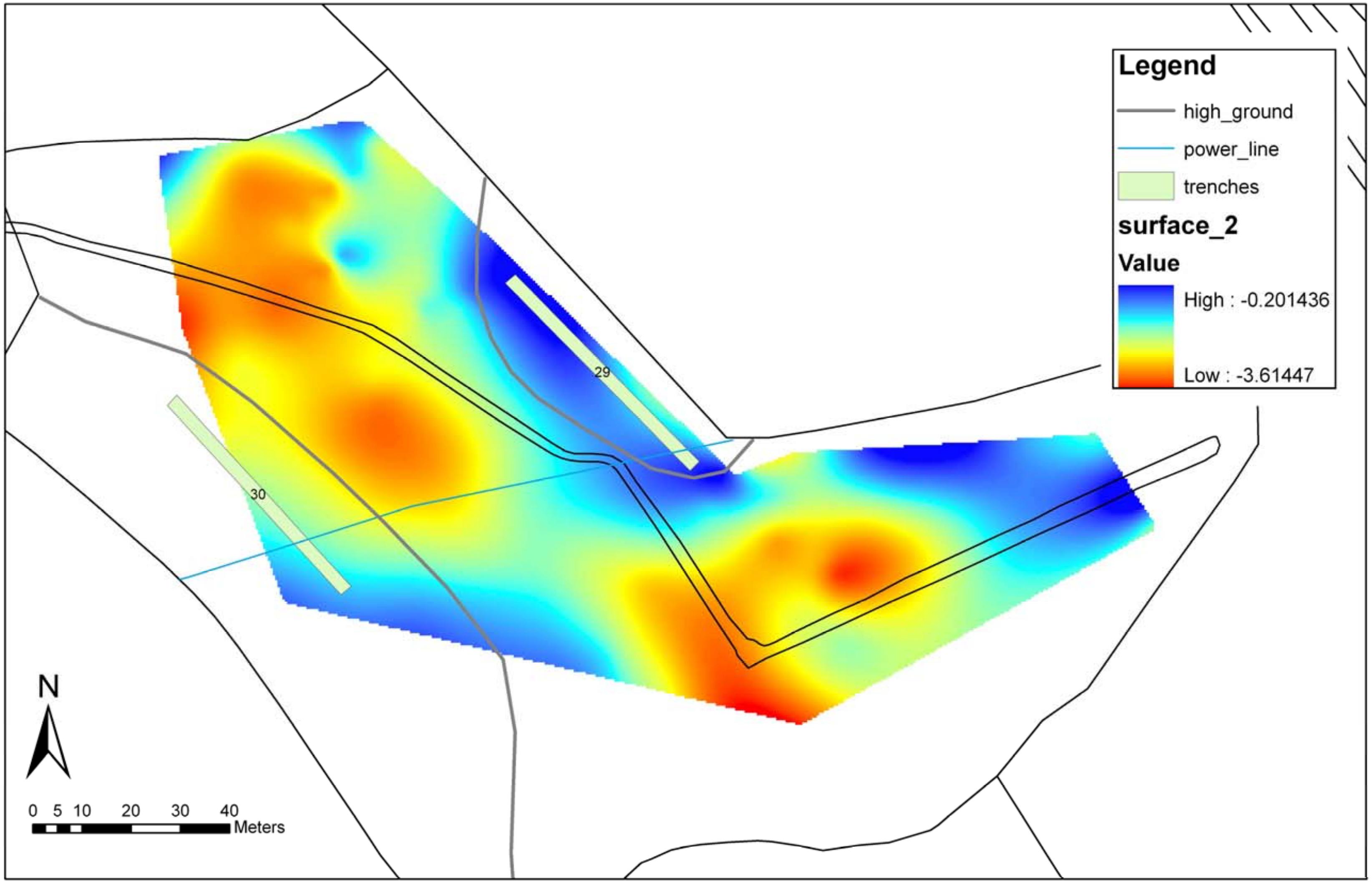

Figure 4: Basal topography of Swamp Field

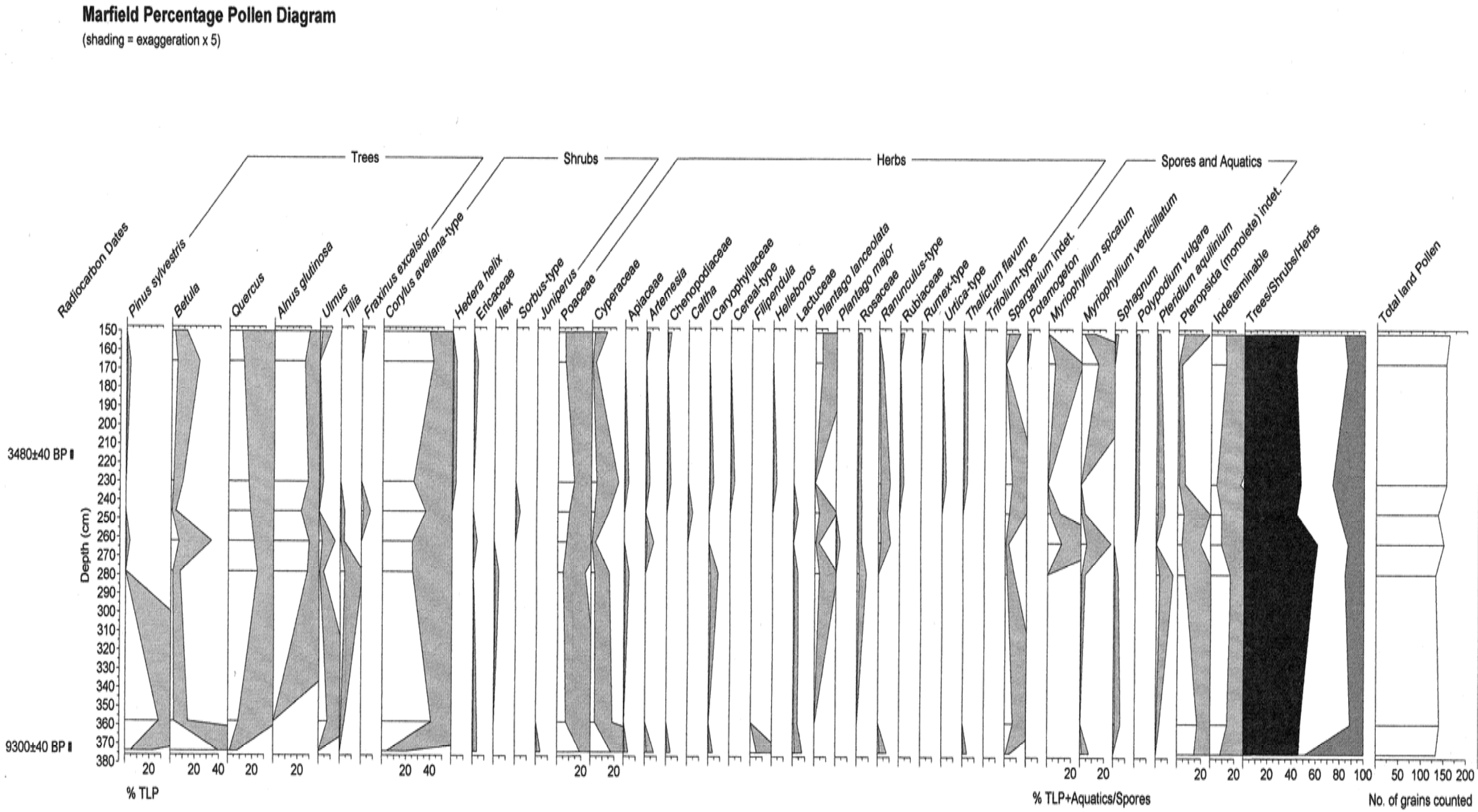

Figure 5: Pollen diagram

Radiocarbon Table

Beta sample number	Material	13C/12C	Radiocarbon Age	Calibrated Age
BETA-288271 BA2125-2.14-2.19m	peat	-28.1o/oo	Cal BP 3850 to 3640	Cal BC 1900 to 1690
BETA-288272 BA2125-3.70-3.75m	peat	-27.0o/oo	Cal BP 10580 to 10400	Cal BC 8630 to 8450

BA2140
Marfield Core Logs

TRANSECT 4
Core 1

0-1.30m	Unit 1

Core 2

0-2.10m	Unit 1

Core 3

0-1.51m	Unit 1

Core 4

0-1.60m	Unit 1

Core 5

0-1.62m	Unit 1
1.62-2.50m	Unit 2
2.50-2.55m	Organic band
2.55-2.80m	Unit 2 (higher clay component than previously)

Core 6

0-1.27m	Unit 1
1.27-2.37m	Unit 2
2.37-2.83m	Basal clay with gravel at base (Unit 5)

Core 7

0-1.40m	Unit 1
1.40-1.70m	Unit 2
1.70-2.91m	Alternating silt and clay
2.91m	Hit clay base, too stiff to continue

Core 8

0-1.30m	Unit 1
1.30-2.77m	Unit 2
2.77m	Blue clay at base (Unit 5) – end of core

Core 9

0-1.40m	Unit 1
1.40-2.90m	Unit 2 – Very dense clay at base and unable to continue

Core 10

0-1.36m	Unit 1
1.36-3.00m	Unit 2 – Very dense clay at base and unable to continue

Core 11

0-1.43m	Unit 1
1.43-2.96m	Unit 2
2.96-3.03m	Unit 3
3.03m	Start of blue basal clay (Unit 5)

Core 12

0-1.40m	Unit 1
1.40-3.30m	Unit 2
3.30-3.40m	Unit 3

<u>TRANSECT 5</u>

Core 13

0-1.40m	Unit 1
1.40-2.50m	Unit 2 – unable to recover past this depth

Core 14

0-1.43m	Unit 1
1.43-3.08m	Unit 2
3.08-3.18m	Unit 3
3.18m	Start of Unit 5 Basal Clay

Core 15

0-1.24m	Unit 1
1.24-3.00m	Unit 2
3.00m	Start of unit 3 – too dry to recover

Core 16

0-1.36m	Unit 1
1.36-2.80m	Unit 2

Core 17

0-1.24m	Unit 1
1.24-1.36m	Unit 2

Core 18

0-1.17m	Unit 1
1.17-1.48m	Unit 2

<u>TRANSECT 6</u>

Core 19

0-1.00m	Unit 1

Core 20

0-1.56m	Unit 1

Core 21

0-1.82m	Unit 1

Core 22

0-1.97m	Unit 1

Core 23

0-1.30m	Unit 1

Core 24

0-1.50m	Unit 1
1.50-3.00m	Unit 2

Core 25

0-0.93m	Unit 1 – onto saturated sand

TRANSECT 7

Core 26

0-0.10m	Topsoil
0.10-0.40m	Sub-soil

Core 27

0-1.79m	Unit 1

Core 28

0-1.60m	Unit 1

TRANSECT 8

Core 29

0-0.10m	Topsoil
0.10-0.40m	Sub-soil

Core 30

0-1.00m	Unit 1

TRANSECT 9

Core 31

0-1.68m	Unit 1

Core 32

0-1.76m	Unit 1
1.76-2.85m	Unit 2
2.85-2.92m	Unit 3

TRANSECT 10

Core 33

0-1.80m	Unit 1
1.80-3.40m	Unit 2
3.40-3.50m	Unit 3

Core 34

0-0.70m	Unit 1

Core 35

0-1.40m	Unit 1
1.40-2.90m	Unit 2

Core 36

0-1.00m	Unit 1