Wessex Archaeology

BritNed Interconnector
Isle of Grain

Archaeological Stage 3
Sample Assessment

Ref: 64493.01

October 2008

BRITNED INTERCONNECTOR
ISLE OF GRAIN

ARCHAEOLOGICAL STAGE 3 SAMPLE ASSESSMENT

Prepared by:

Wessex Archaeology
Portway House
Old Sarum Park
Salisbury
WILTSHIRE
SP4 6EB

Prepared for:

BritNed Developments Ltd.
c/o Metoc plc.
Exchange House
Station Road
Liphook
Hampshire
GU30 7DW

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Principal Author(s):	Jack Russell
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The project was managed for Wessex Archaeology by John Gribble. The sample assessments were carried out by Cathie Barnett, Nigel Cameron, Michael Grant, Jack Russell, Chris Stevens and Sarah Wyles.

This report was written by Jack Russell and figures were produced by Kitty Brandon.

John Gribble managed the project and edited the report and Steve Webster provided quality assurance.

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1. INTRODUCTION

1.1.1. Wessex Archaeology was commissioned by Metoc plc to undertake a Stage 3 archaeological assessment of samples taken from Borehole BH120 (**Figure 1**), recovered during a programme of geotechnical investigations on the site of the proposed Britned Interconnector, which will be located at the eastern extremity of the Isle of Grain in Kent. The geotechnical ground investigations were undertaken by Parsons Brinkerhoff in December 2006. Fugro Engineering Services Limited collected the cores.

1.1.2. This work forms part of a staged process of mitigation proposals including a geotechnical watching brief (Wessex Archaeology 2006) and subsequent Stage 1 and 2 archaeological assessment of geotechnical samples (Wessex Archaeology 2007).

1.1.3. The Stage 2 recording included an assessment of geotechnical data which provided a system of sedimentary units related to depth below ground level (Wessex Archaeology 2007). Levels reduced to Ordnance Datum and a more detailed geotechnical log for BH120 has since been received (Fugro 2006). Based on this a reinterpretation of the sedimentary units, with depths reduced to Ordnance Datum, is given in the table below and shown in **Figure 1**.

Sedimentary Unit	Description	Interpretation	mOD
Unit 1	Brick and concrete	Made ground	3.18 to 2.38
Unit 2	Sandy clay and gravel	Holocene alluvium and Made ground	2.38 to 1.18
Unit 3	Sandy silty clay	Holocene alluvium	1.18 to -26.77
Unit 4	Gracellt clay	Possibly Tertiary bedrock	-26.77 to -28.87

2. BACKGROUND

2.1.1. The terrestrial topography of the Isle of Grain is generally low-lying, with a maximum height of approximately 10m above sea level. The base geology of the area is London Clay laid down during the Eocene (*c*.55–34 million years Before Present (myBP)). In places this is overlain by Pleistocene sediments (1.8my to 11,550BP) including river gravels (IGS 1977). This may be an indication that the Isle of Grain once formed part of the River Medway, which now runs to the south of the island.

2.1.2. The London Clay and Pleistocene sediments are in turn overlain by alluvial deposits of clay, silt, sand and gravel with peat deposits. Borehole data examined by Metoc prior to the commencement of the geotechnical investigations suggested that the depth of alluvium varied across the site, from as little as 2.5m to 28 metres below Ordnance Datum (mbOD) (Wessex Archaeology 2006).

2.1.3. It is not the scope of this report to provide an archaeological background of the area although it is worth noting that the area is rich in archaeological remains from the Palaeolithic to Industrial periods (Williams 2007). In particular, the north Kent marshes, from which this site is reclaimed, are at present little understood. Findspots of Neolithic and Bronze Age date are common in the Medway region of the north Kent marshes, although no prehistoric settlement sites on former marshland or within the intertidal zone have as yet been recorded in this area (Fulford *et al.* 1997).

2.1.4. An archaeological watching brief during geotechnical investigations identified sediments of interest (Wessex Archaeology 2006). Subsequently a U4 core sample retrieved at a depth of 24.85 to 25.24mbOD from borehole BH120 was subjected to Stage 2 geoarchaeological recording (Wessex Archaeology 2007).

2.1.5. The stages of archaeological mitigation completed so far are outlined below:

Stage 1: Watching Brief

2.1.6. The archaeological watching brief included the assessment of the core logs generated by the geotechnical contractors. This assessment established the likely presence of horizons of archaeological interest and broadly characterised them, as a basis for deciding whether and what Stage 2 archaeological recording was required (Wessex Archaeology 2006).

Stage 2: Geoarchaeological Recording

2.1.7. The archaeological recording of the selected core section from BH120 entailed the longitudinal splitting of the core and the cleaning and recording of one half of the split core. The Stage 2 report reported the results of the archaeological recording and outlined the proposed Stage 3 work (Wessex Archaeology 2007).

3. METHOD

Stage 3: Sampling and Assessment

3.1.1. Samples for palaeoenvironmental assessment (radiocarbon dating, pollen, diatoms, foraminifera, ostracods, plant macrofossils and molluscs) have been taken from the core sample. Assessment comprising laboratory analysis of the samples to a level sufficient to enable the value of the palaeoenvironmental material surviving within the cores has been undertaken with recommendations made for any further Stage 4 work.

3.1.2. The method of subsampling and processing of each sample is given in **Appendices 1-7**. The depth of each assessed sample is also given in **Appendices 1-7** and shown in **Figure 1**. The samples were very productive with environmental remains present in all of the samples and often well-preserved.

4. RESULTS

4.1.1. This section summarises the results of the sample assessments. The full reports of the individual assessments, containing more detailed methodologies, discussions of results and recommendations, can be found in **Appendices 1-7**.

Radiocarbon Dating

4.1.2. The *Quercus* (Oak) acorn cup from 24.95m below Ordnance Datum (mbOD) submitted for radiocarbon dating returned a date of 8018±45BP NZA-29846, (7080-6770 cal.BC). This equates to the late Mesolithic archaeological period. This also represents a maximum age for the sedimentary unit (**Appendix 1**).

Pollen

4.1.3. Four samples were assessed for their pollen content (**Appendix 2, Figure 2**). The pollen assemblages were dominated by the woodland species *Quercus* (oak) and *Corylus* (hazel) with *Ulmus* (elm) and *Poaceae* (grasses) forming a significant component.

Waterlogged Plant Remains

4.1.4. The two plant macrofossil assemblages at 24.88 to 24.95 and 25.12 to 25.19 mbOD produced both waterlogged and charred plant remains. The charred plant remains consisted of *Quercus* (oak) wood. Waterlogged remains of woodland species including *Quercus* (oak), *Corylus* (hazel) and *Viburnum opulus* (guelder rose) were represented by acorns, nuts, seeds, buds and leaf fragments. *Musci* (moss) was recovered from the lower sample at 25.12 to 25.19mbOD.

4.1.5. Wetland species were recovered from both samples, the assemblages displaying slight differences. Within the lower sample at 25.12 to 25.19mbOD *Zanichella palustris* (horned pondweed) and *Chara* (stonewort) were recovered and not seen in the upper sample. The upper sample from 25.12 to 25.19mbOD contained *Carex* (sedge) and *Atriplex* cf. *littoralis* (grass-leaved orache). Both samples contained *Potomageton natans/perfoliatus* (pondweed), *Phragmites australis* (common reed) and *Ruppia maritima* (tasselweed), a known brackish water species (**Appendix 3**).

Diatoms

4.1.6. Four diatom samples all produced diatoms in generally high numbers with good preservation. All four samples contained marine and brackish water diatoms. The dominant brackish water taxa included *Nitzschia levidensis* (syn. *Tryblionella levidensis*), *Nitzschia navicularis, Nitzschia punctata* and *Campylodiscus echeneis.* Marine diatoms including *Paralia sulcata, Cocconeis scutellum* diatoms are common or abundant especially within the basal sample at 25.24mbOD (**Appendix 4**).

Molluscs

4.1.7. Two samples were assessed for their molluscan content. The assemblage from the upper sample, 24.88 to 24.95 mbOD, was dominated by marine and brackish water species, namely *Cerastoderma* spp. (cockle) and *Hydrobia* spp. Whereas, while the basal sample, from 25.12 to 25.19 mbOD contained a mixture of marine, brackish and fresh water shells, the brackish and fresh water species were dominant, with the shells of *Hydrobia* spp and *Theodoxus fluviatilis* and operculae of *Bithynia* spp. being the most significant elements of the sample. No terrestrial snails were present in either sample (**Appendix 5**).

Foraminifera

4.1.8. Six samples were assessed for their foraminiferal content (**Appendix 6**). The abundance of foraminifera was generally low. Preservation was poor and indicated that many of the specimens were reworked and transported.

4.1.9. The basal two samples at 25.17 and 25.25mbOD contained a few poorly preserved brackish taxa including variants (without an umbilical boss) of the genus *Ammonia* (*A. limnetes*, *A. aberdoveyensis* and *A. tepida)* usually found in estuarine conditions. These taxa were more abundant and better preserved in the middle two samples at 25.09 and 25.01mbOD.

4.1.10. The upper two samples at 24.93 and 24.85mbOD contained the same variants of *Ammonia*, although the assemblages were more diverse containing in addition some saltmarsh tolerant taxa *Jadammina macrescens* and *Trochammina inflata* and shallow marine outer estuarine taxa including *Planorbulina mediterraneansis* and species of *Elphidium*.

Ostracods

4.1.11. Six samples were assessed for ostracoda (**Appendix 7**). All of the samples contained very high numbers of generally well preserved specimens. The samples were dominated by adults and instars of the species *Cyprideis torosa*. Whole carapaces were also present indicative of a thanatocenosis. They were generally of the smooth form although occasional noded forms (1-2%) were noted with noding at up to five sites. *Loxoconcha elliptica* was also noted in all of the samples.

4.1.12. In addition, the basal two samples from 25.17 and 25.25mbOD contained significant numbers of adult taxa usually associated with freshwater environments, including *Darwinula stevensoni* and *Candona candida*. The upper two samples were notable for the occurrence of a few shallow marine specimens, including species of the genus *Semicytherura* (*S.cornutata* and *S. sella*) and *Hemicythere villosa*.

5. DISCUSSION

5.1.1. **Figure 1** shows the relative position of the sediments and the assessed samples. The pollen sequence as noted above is indicative of a *Quercus* (oak) and *Corylus* (hazel) woodland, with the pollen spectra unchanged throughout the sequence. This is the expected pollen spectrum for the radiocarbon date of 8018±45BP NZA-29846, (7080-6770 cal.BC). This date corresponds to the late Mesolithic archaeological period.

5.1.2. The plant macrofossils recovered confirm the presence of oak and hazel with significant amounts of oak charcoal suggesting the possibility of anthropogenic burning in the area. The possibility that the charcoal has formed as a result of natural processes such as lightning strikes is also noted. The on-site vegetation is shown to have an increasing marine influence up profile.

5.1.3. The molluscs, foraminifera and ostracods clearly point to an estuarine environment with a significant freshwater influence at the bottom and increasing salinity and connection to the sea noted in the upper samples. The ostracod fauna was particularly productive with the unnoded *Cyprideis torosa* being tolerant of widely fluctuating salinity and indicative of brackish creeks dominant throughout. The diatoms would point to a slight decrease in salinity up profile although are predominantly estuarine brackish forms. Comparison with sea level curves for southeast England and the North Sea (Devoy 1979, Long 1992, 1995 and Jelgersma 1979) would indicate that intertidal sediments at these depths are expected.

5.1.4. Overall the samples indicate a surrounding environment of a primeval Mesolithic forest within the Medway valley, with inhabitants possibly selecting oak for fuel in hearths. This forest is then inundated by sea level rise with brackish intertidal creeks developing in this location and increasing influence from the sea.

5.1.5. It is noted that archaeological material becomes more frequent in Kent after *c.*8000BP and it is postulated that this may be due to a real increase in population or loss of lower-lying land (and thus the coastal sites) due to sea level rise (Williams 2007). It is also at this time that uniquely British lithic industry (geometric microliths) appears, as is apparent at the largest concentration of Mesolithic flint tools in Kent further up the Medway valley at Addington (Williams 2007).

6. RECOMMENDATIONS

6.1.1. Stage 4 work including analysis (full counts) of the assessed samples is recommended for pollen, ostracods and diatoms. No further sampling of the core material will be required for Stage 4.

6.1.2. Stage 4 will produce an account of the successive environments within the coring area, a model of environmental change over time, and an outline of the archaeological implications of the analysis.

6.1.3. These analytical results should then be presented in a Stage 5 final report and worked up for publication in a relevant journal. This publication should take into account the geotechnical investigations on site and the subsequent dating and environmental analyses. Documentary research and comparison with available data in order to place the site into its local and national context should be undertaken as part of this process.

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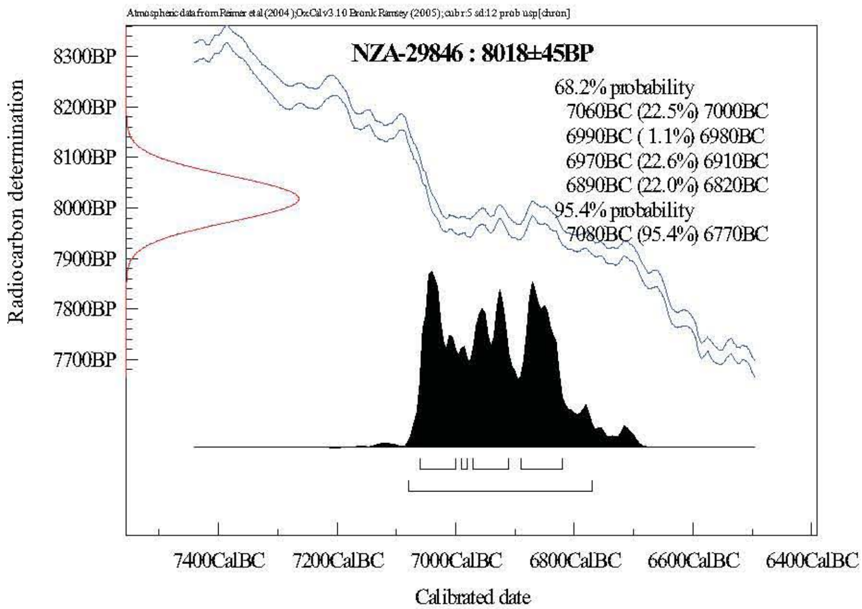
APPENDIX 1: RADIOCARBON DATING

Dr Chris Stevens

A single date was submitted from borehole 120 from a depth of 24.95 meters below Ordnance datum. The date was on a fragmented acorn cup recovered from a fine (low energy), humic estuarine, alluvium (not stasis but rare roots below, may be part stabilised) there is a slight possibility it may be reworked, and so may only provide a maximum age of unit. However, such remains are quite fragile and are unlikely to survive except where quickly incorporated into fine sediments.

Analysis of material in the sediments from the core demonstrates that this part of the sequence relates to the inundation of oak-hazel forest and so provides an important indicator of sea-level at this date.

		Depth mbOD	Material	Result no.	C13 ‰	Result BP	Cal date BC (2 sigma, 94.5%)
BH120	Unit 3	-24.95m	Oak (*Quercus*) acorn cup	NZA-29846	-25.9	8018±45	7080-6770 BC



APPENDIX 2: POLLEN

Michael James Grant

Introduction

As part of archaeological mitigation in advance of construction works – an interconnecting cable at a power station, sediments were investigated from a "U4" sample from BH120. Pollen assessment (counts of 100-150 Total Land Pollen (TLP) was carried out on 4 samples.

Methods

4 samples were selected for assessment from the stratified sediment core samples as shown in **Figure 2**.

Samples were processed using standard procedure (Moore *et al.* 1991). 1cm^3 of sediment was sampled. A *Lycopodium* spike was added to allow the calculation of pollen concentration. All samples received the following treatment: 20mls of 7% HCl at 60°C for 30 minutes; 20 mls of 10% KOH (60°C for 2 minutes); 20mls of 60% HF (overnight); 15 mls of acetolysis mix (80°C for 4 minutes); stained in 0.2% aqueous solution of safranin and mounted on glass microscope slides in silicone oil.

Results

Counts of 100-150 Total Land Pollen (TLP – excluding *Alnus glutinosa*, Cyperaceae aquatics and spores) were made for each level and calculated as a percentage of the pollen sum (Spores and Aquatics calculated as percentage TLP + Group Sum). Identification was made using a Nikon Eclipse E400 at x400 magnification. Pollen nomenclature is based on Bennett (1994; Bennett *et al.*, 1994) and ordered according to Stace (1997). The pollen diagram was drawn using Tilia v 2.0.2 (Grimm, 1991).

Discussion

The pollen assessment results are shown in **Figure 2**. The pollen assemblage is dominated by *Quercus* (oak) and *Corylus* (hazel), with *Ulmus* (elm) and *Poaceae* (grasses) important components. The limited number of herb taxa identified implies a predominantly wooded environment. However, with Poaceae up to 20% and *Corylus* being dominant dense woodland is unlikely to have been extensive. The pollen assemblage is consistent with that generally associated with a sequence from the date indicated by the radiocarbon dating (NZA 29748, 8018±45 uncal. BP; 7070 – 6770 cal. yrs BP).

Recommendations

Pollen concentrations and grain preservation is very good. Increased pollen counts (up to 400 TLP) will enable a better understanding of the local environment as at present the limited abundance of herb taxa makes interpretation of the environment (beyond stating that it is wooded) difficult.

Increased pollen counts (400 TLP) will provide a better understanding of the local environment, as a larger diversity of pollen types is to be expected. As there is little variation in the percentages of the main taxa, it is likely that the sediment was either deposited over a short period, or there were few changes in the local vegetation during sediment deposition. In light of this additional sample locations are unlikely to provide any information on changes in the local environment.

Acknowledgements

Sediment description was undertaken by Jack Russell. Pollen samples were prepared by Karen Wicks, AFESS, University of Reading.

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FIGURE2: POLLEN DIAGRAM

APPENDIX 3: WATERLOGGED PLANT REMAINS

Dr Chris Stevens

Introduction

Two samples were taken from borehole BH120 at 24.88-24.95 and 25.12-25.19mbOD. The samples were processed for the recovery of environmental material, including charred and waterlogged plant remains and molluscs.

A radiocarbon determination on a waterlogged fragment of an acorn cup (*Quercus* sp.) from 24.95 mbOD, yielded a date of 7080-6770 cal. BC (NZA-29846, 8018±45 BP), indicating that the material is Late Mesolithic in date.

Methods

Two sub-samples of around 1 litre each were taken from the core. The samples were wet-sieved through a 250µm mesh. They were visually inspected under a x10 to x40 stereo-binocular microscope to determine if waterlogged plant remains occurred. Where waterlogged material was present, preliminary identifications of dominant taxa were conducted and are presented below. Taxonomy follows that of Stace (1997).

Results

Both of the samples produced waterlogged and charred plant remains. In terms of charred plant remains fragments of charcoal, probably mainly oak were quite common in the sample from 24.88-24.95mbOD, but relatively infrequent in the sample from 25.12-25.19mbOD.

The samples contained a mixture of woodland species and aquatics, with occasional wetland and saltmarsh species.

Woodland was represented mainly by remains of oak, particularly in the upper sample from 24.88-24.95mbOD. The remains consisted of acorns, and probable bud and leaf fragments. A single nut of hazel (*Corylus avellana*) was also recovered, along with seeds of guelder-rose (*Viburnum opulus*).

Relating to wetlands were seeds of tasselweed (*Ruppia maritima*), broad-leaved/perfoliate pondweed (*Potamogeton natans/perfoliatus* type), and stems of common reed (*Phragmites australis*). A single seed of possible divided sedge (*Carex* cf. *divisa*) was found in the upper most sample, while quite a high number of seeds of horned pondweed were recovered from the lower sample, along with several gametes of stonewort (*Chara* sp.) and a single seed of water-crowfoot (*Ranunculus* subg. Batrachium).

The only other identified seeds were a possible seed of grass-leaved orache (*Atriplex littoralis*) from the uppermost sample and a single seed of Polygonaceae, most probably water-pepper type (*Persicaria* sp.) and an unidentified grass seed resembling *Poa palustris* type.

There were also several seeds of two unidentified species. The first were small (*c.* 1mm) elongated seeds with an elongated reticulate cell pattern. The seeds were concave on one side and convex on the other. They tapered to a rounded tip at one end while the other was blunt. The longest edges of the seed were noted to be very obtuse almost square in profile, almost like a capsule fragment, but had clearly not been broken.

The second were possible seeds of bog myrtle (*Myrica gale*) from 25.12-25.19m although positive identification could not be confirmed.

		Depth metres below OD	
Latin Name	**Common Name**	**24.88-24.95m**	**25.12-25.19m**
Chara sp. gametes	stonewort	-	5+
Musci	moss	-	+++
Ranunculus subg. Batrachium	water-crowfoot	-	1
Corylus avellana (nut)	hazelnut	1 whole	-
Quercus sp. (acorn)	oak acorn	2	-
Quercus sp. (buds)	oak possible buds	cf.5	3f
Quercus sp. (leaf fragments)	oak possible leaves	cf.++	cf.+
Quercus sp. (charcoal)	oak charcoal	++	1-2
Atriplex cf. *littoralis*	grass-leaved orache	2	-
Persicaria/Polygonum sp.	water-pepper/knotweed	-	1
Ruppia maritima	tasselweed	2	2
Viburnum opulus (seed/fruit)	guilder-rose	1	cf.1
Potamogeton natans/ perfoliatus	pondweed	cf.1	cf.1
Zannichellia palustris	horned pondweed	-	16
Carex cf. divisa	divided sedge	1	-
Poaceae indet. *c.*1-2mm	grass seed	-	1
Phragmites australis (culm node)	common reed	cf.1	cf.1
Indet seeds 1mm –reticulate cells		-	5+
Indet seeds 1mm – Myrica?		-	3
Other			
Insect remains		+ (1 ant head)	+

Table 1: Waterlogged plant macroscopic remains from BH120

Discussion

The presence of acorns and probable leaves and bud scales of oak, along with the hazelnut compare well with the dominance of these two species in the pollen record and show them to have been present in the immediate vicinity of the deposit. Guelder rose (*Viburnum opulus*) is often found in woodland on calcareous soils.

The seeds of wetland species are predominately those of floating or submerged aquatics. Of these tasselweed (*Ruppia maritima*) is only found in brackish waters and so the most prominent indicator of marine inundation and sea-level rise. However, horned pondweed (*Zannichellia palustris*) and the probable represented species of pondweed (*Potamogeton natans/perfoliatus*) while found in freshwater can also be found in brackish waters. The absence of *Zannichellia* from the upper levels may be significant in that it may indicate that salinity levels had risen to a point that this species was no longer present. Of the other species present in the sample, some are slightly more indicative of the brief establishment of probable small localised areas with open conditions. These include stems of probable common reed (*Phragmites australis*), a seed of possible divided sedge (*Carex divisa*) which is common in grassy places near the sea, a probable seed of grass-leaved orache (*Atriplex littoralis*) and an unidentified fragment of *Polygonum/Persicaria* seed.

While small in size, the assemblage is unusual in its mix of estuarine or maritime and woodland elements. The sequence is in this respect highly suggestive of a submerged forest horizon comprising oak and hazel.

The absence of alder is of some interest given the radiocarbon dating for this species at other sites in Southern England shortly prior to this date, e.g. Testwood, Hampshire (UB4258, 7881±36 BP; UB-4486, 7770±70 BP), this may be reflective of a general absence of alder from this part of Southern England at this date, or possibly just a localised absence.

The charcoal may come from natural forest fires, however, given the increasing wetness of the area and that the charcoal showed little indication of fluvial reworking, it may relate to human activity in the local vicinity. It should be noted that charred stumps of oak recovered from the Severn Estuary have dated to around *c.* 5700 cal. BC, have been associated to hunter-gather activity (Bell 2006).

While remains of oak were less frequent in the lower, earlier sample, it must be assumed that oak woodland was still dominant in the local vicinity of the core at this time, as seen also in the pollen report. The increase of finds in this part of the core probably relate more to increased rates of sedimentation and possibly even to the destruction of this woodland through marine inundation.

Potential

The sample has the potential to provide information regarding the nature of the local environment during the deposition of the deposits. There is also some potential to examine changes within this environment during sea-level rise and inundation.

The remains and potential to study waterlogged submerged forests often only exists for sites of generally more recent Neolithic or Bronze Age date, for example, a submerged forest of Neolithic date is known from Erith near Dartford (Paddenberg and Hession 2007).

Often such remains are also confined to more assessable sites where isostatic rebound has resulted in some up-lifting of the coast as in parts of Wales and North England. The recovery of such material from such depth then provides a unique opportunity to study the composition of primeval Mesolithic forest in southern England.

Recommendations

There is little further work to be carried out, although the presence of oak leaves and identification of some of the remaining taxa may be possible with reference material.

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APPENDIX 4: DIATOMS

Nigel Cameron
Environmental Change Research Centre,Department of Geography, University College London,Pearson Building, Gower Street, London WC1E 6BT

Introduction

Four samples for diatom evaluation were taken from Borehole BH120 at the Britned Interconnector site, Isle of Grain, Kent (Site Code 64493)

The aim of the diatom evaluation is to assess the potential to use diatom analysis of the BH120 samples for environmental reconstruction and to provide an outline of the environmental inferences that can be made from the diatom assemblages present. The diatom assessment takes into account the numbers of diatoms, their state of preservation and the species diversity of each sample. Where possible the type of diatom assemblage present is discussed with particular reference to diatom habitat and species salinity preferences.

Methods

Diatom preparation followed standard techniques: the oxidation of organic sediment, removal of carbonate and clay, concentration of diatom valves and washing with distilled water (Battarbee 1986). Two coverslips, each of a different concentration of the cleaned solution, were prepared from each sample and fixed in Naphrax, a diatom mounting medium of a suitable refractive index for diatom microscopy. Further details of sediment preparation methods can be found at: (http://www.geog.ucl.ac.uk/~jhope/lab/sedi.htm). A large area of the coverslips on each slide was scanned for diatoms at magnifications of x400 and x1000 under phase contrast illumination. Low sum, skeleton counts were made to estimate species relative abundances.

Diatom floras and taxonomic publications were consulted to assist with diatom identification; these include Hendey (1964), Werff & Huls (1957-1974), Hartley *et al.* (1996) and Krammer & Lange-Bertalot (1986-1991). Diatom species' salinity preferences are discussed using the classification data in Denys (1992), Vos & de Wolf (1988, 1993) and the halobian groups of Hustedt (1953, 1957: 199), these salinity groups are summarised as follows:

1. Polyhalobian: >30 g l^{-1}

2. Mesohalobian: 0.2-30 g l^{-1}

3. Oligohalobian - Halophilous: optimum in slightly brackish water

4. Oligohalobian - Indifferent: optimum in freshwater but tolerant of slightly brackish water

5. Halophobous: exclusively freshwater

6. Unknown: taxa of unknown salinity preference.

Results & Discussion

The results of the diatom evaluation are summarised in **Table 1**. Diatoms are present in all four samples from BH120. The results of the diatom species assessment are shown in **Table 2**.

Height (m OD)	Diatoms present	Diatom numbers	Quality of preservation	Diversity	Assemblage type	Potential for % count
-24.86	+	high	good to moderate	high	fw bk mar	very good
-24.98	+	high	good to moderate	high	fw bk mar	very good
-25.10	+	high	good to moderate	high	fw bk mar	very good
-25.24	+	moderate	moderate to poor	moderate	mainly bk	good

Table 1: Summary of diatom evaluation results for BH120
(mar – marine, bk – brackish, fw – freshwater)

The quality of diatom preservation is generally good or moderately good with only a slightly increased level of valve breakage in the basal sample. There is relatively little silica dissolution (see Flower 1993; Ryves *et al.* 2001) compared with many coastal sediment sequences. Species diversity is high or moderately high and all four samples have excellent potential for percentage diatom counting. Consistent with the lithological description of intertidal saltmarsh/mudflats and estuarine alluvium, all four samples contain both marine and brackish water diatoms. This indicates that the sedimentary environment was tidal. However, there is a significant component of freshwater diatoms in all but the basal sample (-25.24 m OD) which has fewer freshwater diatoms present. In particular the common freshwater epiphyte, *Cocconeis placentula* (here mainly *Cocconeis placentula* var. *euglypta*) is abundant in the top three samples. Other freshwater epiphytes that are present in these three samples include *Epithemia adnata* and *Synedra ulna*. These oligohalobous indifferent diatoms represent shallow, freshwater habitats.

The dominant brackish water component of the assemblages is comprised mainly of benthic diatoms such as *Nitzschia levidensis* (syn. *Tryblionella levidensis*), *Nitzschia navicularis, Nitzschia punctata* and *Campylodiscus echeneis* but also includes open water plankton that originates from attached (shallow water habitats) such as *Melosira* cf. *moniliformis*. Brackish water epiphytes include *Synedra tabulata* (syn. *Synedra fasciculata*), *Achnanthes delicatula*, and *Rhopalodia gibberula*.

Marine diatoms are represented mainly by planktonic or tychoplanktonic species such as *Cymatosira belgica, Paralia sulcata, Podosira stelligera* and *Rhaphoneis* spp. However, the attached, marine-brackish species *Cocconeis scutellum* is common and the benthic marine diatom *Trachyneis aspera* is also present. Given the high numbers of benthic and epiphytic mesohalobous diatoms, the planktonic polyhalobous diatoms probably represent an allochthonous component of the diatom assemblage. Similarly, the presence of relatively high numbers of freshwater diatoms in the upper three samples may represent diatom transport beyond the freshwater species lifetime ranges or alternatively sediment mixing from a freshwater phase elsewhere in the sequence or within the level sampled. These diatoms would therefore represent phases of less saline conditions that have been time averaged with the brackish water phases.

As stated above, the basal sample at -25.24 m OD has lower numbers of oligohalobous indifferent diatoms. At this level mesohalobous (*Nitzschia navicularis, Campylodiscus echeneis, Nitzschia punctata, Synedra pulchella*), and polyhalobous (*Paralia sulcata, Cocconeis scutellum*) diatoms are common or abundant. The dominance of these species seems to reflect a more saline early phase with greater influence of tidal water.

More detailed, percentage diatom counting and refinement of the species composition and salinity groupings would be possible for these samples if required. However, the value of carrying out further diatom work would need to be justified in terms of the additional information that could be gained than that already provided by this assessment. Given that the diatom assemblages are mixtures from a diverse range of salinities, diatom percentage counting and analysis would be best used here combined with evidence from other geoarchaeological techniques. The diatom assemblages here cannot be used directly to comment upon the chronology of the sequence or the climate.

Conclusions

- Diatoms are present in high numbers are generally well preserved and form diverse assemblages in all four samples assessed from BH120.
- Mixtures of freshwater, brackish and marine diatoms are present in all four samples.
- The presence of high numbers of attached and benthic mesohalobous diatoms and (mainly allochthonous) polyhalobous diatoms shows that tidal conditions were prevalent.
- In the basal sample (-25.24 m OD) there is evidence for more saline conditions.
- The abundance of freshwater epiphytic diatoms in the upper three samples may represent a real freshwater phase or phases that have been integrated by sediment mixing or the diatoms may have been transported from freshwater environments elsewhere (allochthonous).
- The quality and diversity of these diatom assemblages means that there is very good potential for percentage diatom counting. However, carrying out full diatom analysis would need to be justified by the additional information that might be gained from that already indicated by the assessment.

Acknowledgements
Thanks to Jack Russell of Wessex Archaeology for the samples for diatom evaluation and for details of the site location, sediment and sample summary, and profile drawing.

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Sample Depth (m OD)/ Species and Salinity Group	**-24.86**	**-24.98**	**-25.10**	**-25.24**
Polyhalobous				
Cymatosira belgica	+	+	+	+
Dimeregramma minor			+	
Grammatophora sp.	+	+		
Paralia sulcata	+	++		++
Podosira stelligera	+	++	+	+
Rhaphoneis minutissima		+		
Rhaphoneis surirella				+
Trachyneis aspera	+		+	
Polyhalobous to Mesohalobous				
Cocconeis scutellum	++		++	++
Diploneis smithii	+		+	+
Navicula flanatica			+	
Synedra gaillonii			+	+
Mesohalobous				
Achnanthes brevipes			+	
Achnanthes delicatula	+	+++	+	
Amphora coffeaeformis		+	+	
Bacillaria paradoxa	+			
Campylodiscus echeneis	+	+	+	++
Cyclotella striata	+			
Diploneis didyma	+			
Melosira cf. *moniliformis*	+++	++		
Nitzschia acuminatum	+	++		
Nitzschia punctata	+	+	+	++
Nitzschia granulata	+			
Nitzschia navicularis	++	+	++	+++
Rhopalodia gibberula	+	++	+	
Synedra pulchella		+		
Synedra tabulata	+	+++	+	++
Mesohalobous to Halophilous				
Actinocyclus normanii	++	+		
Nitzschia levidensis	+++	+	+	
Oligohalobous Halophilous				
Navicula mutica	+			
Halophilous to Indifferent				
Epithemia sorex		+		+
Rhoicosphaenia curvata	+	++	+	
Oligohalobous Indifferent				

Sample Depth (m OD)/ Species and Salinity Group	**-24.86**	**-24.98**	**-25.10**	**-25.24**
Achnanthes lanceolata	+		+	
Aulacoseira sp.	+			+
Cocconeis disculus			+	
Cocconeis placentula	+++	+++	+++	+
Epithemia adnata	+	+	++	
Epithemia argus			+	
Epithemia sp.			+	+
Fragilaria pinnata				+
Gomphonema gracile			+	
Navicula tripunctata		+		
Opephora martyii		+	++	
Rhopalodia gibba		++	+	
Synedra ulna	+	+	+	
Unknown Salinity Group				
Amphora sp.	+		+	+
Cocconeis sp.		+	++	
Diploneis sp.				+
Gomphonema sp.	+			
Gyrosigma sp.		+		
Navicula sp.		+	+	+
Nitzschia sp.		+		

Table 2: Diatom species and salinity groups for BH120
(diatom assessment: + present, ++ common, +++ abundant)

APPENDIX 5: MOLLUSCS

Sarah F Wyles

Introduction

Two samples were taken from borehole BH120 at 24.88-24.95 and 25.12-25.19mbOD. The samples were processed for the recovery of environmental material, including charred and waterlogged plant remains and molluscs.

Methods

Two sub-samples of around 1 litre were taken from the core. The samples were wet-sieved through a 250µm mesh. They were assessed under a x10 to x40 stereo-binocular microscope to determine if molluscs occurred. Where shell was present, preliminary identifications were conducted. Nomenclature follows that of Kerney (1999) and Barrett and Yonge (1958).

Results

Shell remains were observed in both samples and are recorded in **Table 1**.

The shell assemblage from the upper sample, 24.88–24.95 mbOD, was dominated by marine and brackish water species, namely *Cerastoderma* spp. (cockle) and *Hydrobia* spp. Whereas, while the basal sample, from 25.12–25.19 mbOD contained a mixture of marine, brackish and fresh water shells, the brackish and fresh water species were dominant, with the shells of *Hydrobia* spp and *Theodoxus fluviatilis* and operculae of *Bithynia* spp being the most significant elements of the sample. No land snails were present in either sample.

	Depth metres below OD	**24.88-24.95m**	**25.12-25.19m**
Species	**Habitat Preference**		
Cerastoderma spp.	Marine	15	1
Hydrobia spp.	Brackish water	100+	25
Theodoxus fluviatilis (Linnaeus)	Fresh water	3	13
Bithynia operculum	Fresh water	-	25
Lymnaea spp.	Fresh water	-	1
Anisus leucostoma (Millet)	Fresh water	-	2
Gyraulus cf. *albus* (Müller)	Fresh water	-	1
Gyraulus spp.	Fresh water	+	-

Table 1: Mollusc remains from BH120

Discussion

The predominance of *Hydrobia* spp. within the upper sample is indicative of a brackish water environment such as estuaries and intertidal mudflats. Cockles favour soft sand, mud and muddy gravel on the middle and lower shore. Although *Theodoxus fluviatilis* is a fresh water species, it is also tolerant of brackish water.

The assemblage from the lower fill is more mixed. There is only a very small marine component and the percentage of brackish water species is much less than in the sample above. The presence of a number of *Bithynia* operculae but no apices is interesting. The ratio of shell apices to operculum is indicative of whether the assemblage accumulated *in situ*. The predominance of either apices or operculum indicates that there has been some element of movement within the assemblage.

The shell assemblages appear to show a brackish water environment with some fresh water input in the lower sample, with an increase in the salinity levels in the upper sample, indicated by a brackish water environment with a significant marine component.

There is no evidence in the assemblages for the presence of any woodland species.

Potential

The samples have the potential to provide information on the nature of the local water environment. This may augment or corroborate the information on the local environment gained from other environmental material such as the waterlogged plant remains and ostracods.

Recommendations

The identification of the hydrobias to species may provide more detailed information on the nature of the salinity levels.

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APPENDIX 6: FORAMIFERA

J. Russell

Introduction

Six sediment subsamples taken from core samples retrieved from a borehole (BH120) taken during construction work on the Isle of Grain, Kent have been assessed for the presence and environmental significance of foraminifera. The retrieved sediments are organic alluvial, silts and clays. Foraminifera were present in all of the samples.

Method

Sediment was wet sieved through a 63µm sieve. The sediment was then dried and sieved through 500µm, 250µm, 125µm sieves. Foraminifera were picked out under 10-60x magnification and transmitted and incident light, using a Meiji EMT microscope. Where possible fifty specimens per sample were picked out and kept in card slides. Identification and environmental interpretation follows Murray (1979) and Murray (1991).

Results

Abundance of foraminifera within the samples are summarised in **Table 1**. Abundance of foraminifera was low to medium and the preservation was in general moderate to poor.

The samples at 25.17m 25.25mbOD contained poorly-preserved and low abundances of foraminifera including species of the genus *Ammonia* (*A. limnetes*, *A. aberdoveyensis* and *A. tepida*). Some *Bythinia* operculae were also recovered.

Above these levels, at 25.09mbOD and 25.01mbOD, the same brackish tolerant taxa (*A. limnetes*, *A. aberdoveyensis* and *A. tepida*) were present although more numerous and in a better state of preservation. *Ammonia limnetes* was the most dominant of the three taxa.

More diverse assemblages were recovered above this at 24.93 and 24.85mbOD, including *A. limnetes*, *A. aberdoveyensis* and *A. tepida*, *Jadammina macrescens* and *Trochammina inflata*, *Planorbulina mediterraneansis* and species of *Elphidium*. All were however in low abundances and in a poor state of preservation.

Discussion

The abundance of foraminifera within the samples was generally low. The taphonomy of most of the specimens recovered suggests that they have been reworked, especially where they were occurring in small numbers. The specimens recovered are exclusively brackish water tolerant at 25.25, 25.17, 25.09 and 25.01mbOD and predominantly brackish water tolerant above this. At 24.93 and 24.85mbOD occasional saltmarsh tolerant (*Jadammina macrescens*, *Trochammina inflata*) and shallow marine and inner shelf specimens (*Planorbulina mediterraneansis*, *Elphidium cuvilleri*) are seen and are undoubtedly transported. The best assemblage for environmental inference is the sample at 25.09mbOD where a high abundance and well preserved assemblage of *Ammonia limnetes*, *Ammonia tepida* and *Ammonia aberdoveyensis* is strongly indicative of estuarine and brackish lagoons.

Further work

Attention should be paid to any dated sequences from these sediments as foraminifera can be used to infer sea levels (cf. Haslett *et al* .1997). Further samples are not suggested from these sediments (between 25.25 and 24.84mbOD). If further asamples are processed for ostracods then attention should be paid to the foraminiferal contents of these samples.

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Foraminfera/mbOD	**24.85**	**24.93**	**25.01**	**25.09**	**25.17**	**25.25**
Ammonia aberdoveyensis	x		x	x	x	x
Ammonia batavus						
Ammonia limnites	xx	x	xx	xx	x	x
Ammonia tepida	x	x	x	xx	x	x
Elphidium cuvilleri		x				
Elphidium sp.	x					
Jadammina macrescens	x	x				
Planorbulina mditerranensis	x					
Trochammina inflata	x	x				
Other						
Bithynia operculae						x
Hydrobids				x		
Gastropods	xx		xx			
Sponge spicules		x				
Charcoal		x				
Diatoms		x				
Sphagnum		x				
Potomageton		x				

Table 1: Abundance of foraminifera per sample
Abundance:
x – 1-9 specimens
xx – 9-50 specimens
xxx – greater than 50 specimens

APPENDIX 7: OSTRACODS

J. Russell

Introduction

Six sediment subsamples taken from core samples retrieved from a borehole (BH120) taken during construction work on the Isle of Grain, Kent have been assessed for the presence and environmental significance of ostracods. The retrieved sediments are organic alluvial silts and clays. Ostracods were present in all of the six samples.

Method

Sediment was initially wet sieved through a 63µm sieve. The sediment was then dried and sieved through 500µm, 250µm, 125µm sieves. Ostracods were picked out under 10-60x magnification and transmitted and incident light using a Vickers microscope. Where possible fifty specimens per sample were picked out and kept in card slides. Identification and environmental interpretation follows Athersuch *et al.* (1989) and Meisch (2000).

Results

Abundance of ostracods within the samples are summarised in **Table 1**. Abundance of ostracods was high and the preservation was in general very good.

All of the samples were dominated by adults and instars of the species *Cyprideis torosa*. Whole carapaces were also present indicative of a thanatocenosis. They were generally of the smooth form although occasional noded forms (1-2%) were noted with noding at up to 5 sites. *Loxoconcha elliptica* was also noted in all of the samples.

At 25.25mbOD a few freshwater indicator species were noted including *Darwinula stevnsoni* and *Candona candida*. Occasional species of the predominantly shallow marine genera *Semicytherura* and *Hemicythere* were also present. Occasional reworked fresheater specimens including *Candona candida* were also noted at 25.17mbOD and 25.09mbOD. Above this level at 25.01, 24.93 and 24.84mbOD brackish species are still dominant (*Cyprideis torosa* and *Loxoconcha elliptica*) however a few shallow marine specimens are recorded in cluding species of the genus *Semicytherura* (*S.cornutata* and *S. sella*) and *Hemicythere villosa*. The sample most abundant in most shallow marine taxa are seen in the uppermost sample 24.85mbOD.

Discussion

The abundance of ostracods within the samples was generally very high and preservation very good. The dominance of the ostracod *Cyprideis torosa* throughout the sequence is an overwhelming indication of a brackish tidal creeks with fluctuating salinity. That is that the environment is in receipt of both marine and freshwater incursions. There is some suggestion that the noded forms occur in lower salinities. *Loxoconcha elliptica,* present in all of the samples is also indicative of brackish conditions.

The freshwater input indicated by transported taxa is seen to be greater in the basal sample (including *Darwinula stevensoni*) and bno existebnt in the upper three samples. A marine connection is noted throughout with the greatest number of transported marine taxa noted in the uppermost sample at 24.85mbOD. This is an indication of and increasing marine connection up profile. The increase in numbers of *Loxoconcha elliptica* over 25.09 to 25.01mbOD boundary also probably marks the transition between predominantly brackish creeks (with a considerable freshwater input) at 25.25, 25.17 and 25.09mbOD to a more open estuarine environment above this at 25.01, 24.93 and 24.85mbOD

Further work

As abundance of ostracods is very high, preservation very good and a changing environment noted up profile concomitant with a sea level rise it is suggested that full counts of these highly abundant samples are completed for analysis.

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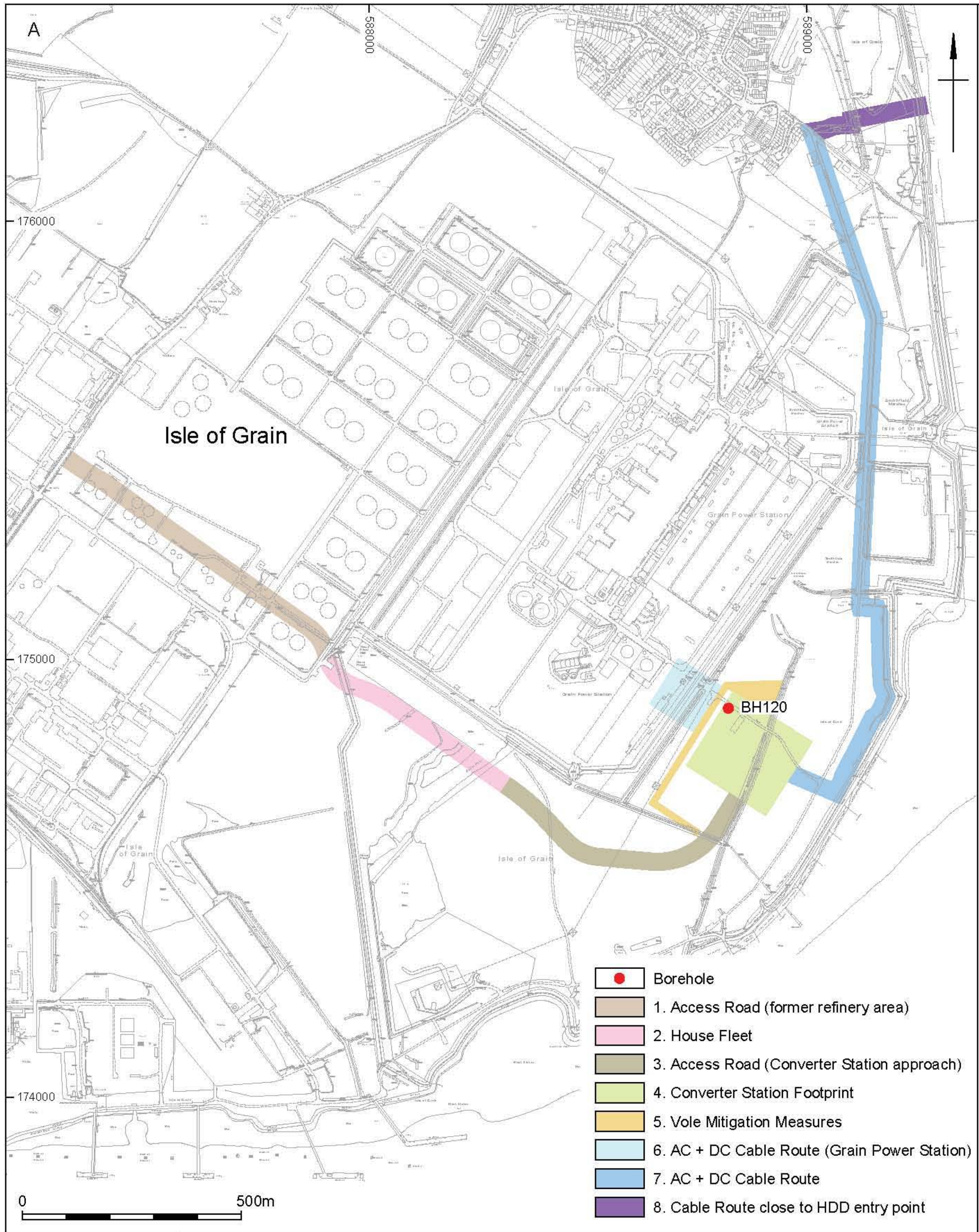
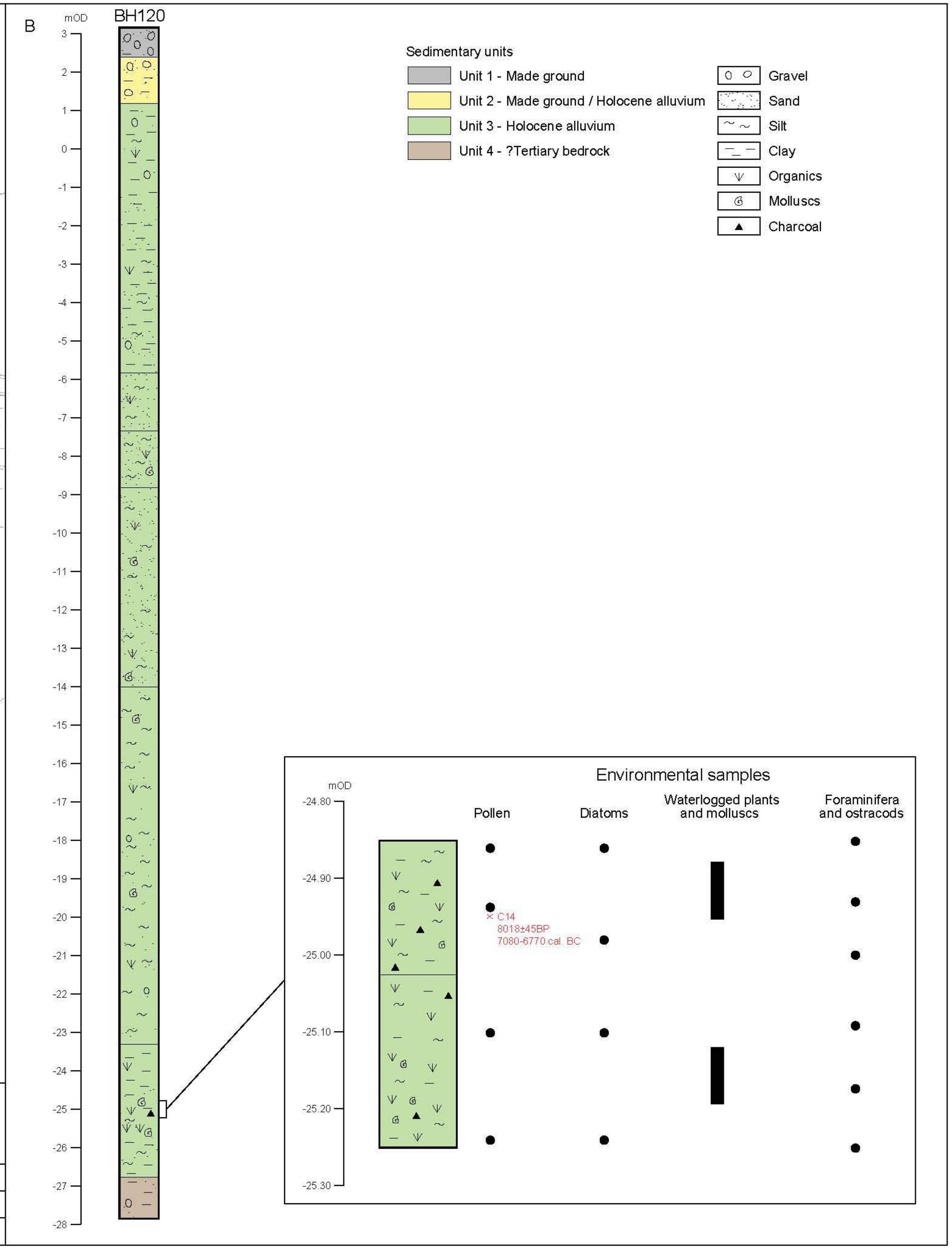
Ostracods/mbOD	24.85	24.93	25.01	25.09	25.17	25.25
Candona sp.					x	x
Candona candida						x
Cyprideis torosa	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
Darwinula stevensoni						x
Hemicythere sp.		x		x	x	x
Hemicythere villosa	xx					
Leptocythere pellucida						
Loxoconcha elliptica	xx	xx	xx	x	x	x
Semicytherura cornutata		x				
Semicytherura sella	x	x				
Semicytherura sp.	x		x	x	x	

Table 1: Abundance of ostracods per sample in BH120.

Abundance:
x – 1-9 specimens
xx – 9-50 specimens
xxx – greater than 50 specimens
xxxx – greater than 100 specimens





Drawing Projection OSGB National Grid.

Basemap supplied by client.

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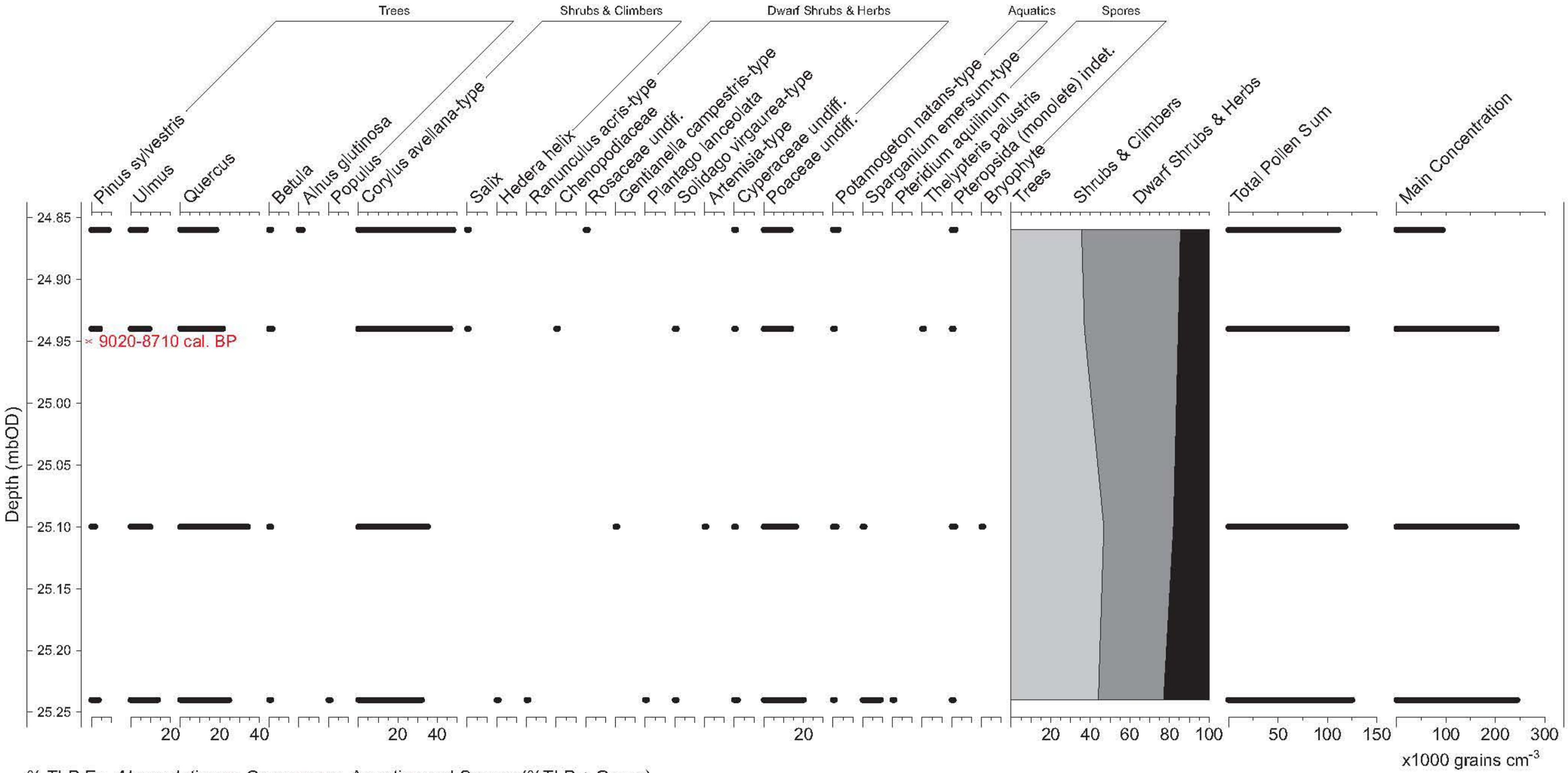
Site location, borehole sediments and assessed samples

Figure 1

9020 - 8710 cal. BP



% TLP Ex. *Alnus glutinosa*, Cyperaceae, Aquatics and Spores (%TLP + Group)

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Pollen diagram

Figure 2

WESSEX ARCHAEOLOGY LIMITED.
Registered Head Office: Portway House, Old Sarum Park, Salisbury, Wiltshire SP4 6EB.
Tel: 01722 326867 Fax: 01722 337562 info@wessexarch.co.uk www.wessexarch.co.uk
London Office: Unit 113, The Chandlery, 50 Westminster Bridge Road, London SE1 7QY.
Tel: 020 7953 7494 Fax: 020 7953 7499 london-info@wessexarch.co.uk www.wessexarch.co.uk

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