ASSESSMENT OF THE ENVIRONMENTAL REMAINS FROM ABBEY BRIDGE, EVESHAM, WORCESTERSHIRE

Worcestershire Archaeology
Archive and Archaeology Service
The Hive, Sawmill Walk,
The Butts, Worcester
WR1 3PD

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Date:	18 September 2014
Author:	Suzi Richer
Contributors:	Andrew Mann
Illustrator:	Carolyn Hunt
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Contents

Environmental remains from Abbey Bridge, Evesham, Worcestershire

Suzi Richer

With a contribution by Andrew Mann

Summary

An assessment of environmental samples from a geoarchaeological borehole survey was undertaken on behalf of Worcestershire County Council (NGR SP033431; HER WSM58042).

Four samples were analysed for molluscan remains and pollen analysis was undertaken on eight samples. Pollen was present in good quantities in six of the eight samples. Both the molluscs and the pollen were in agreement that swampy conditions gave way to slow flowing, but well oxygenated water. In addition, the pollen evidence revealed a treeless, grassland environment, with patches of willow and juniper scrub low down in the profiles. Such an environment is not dissimilar from a modern alpine environment. Over time, pine, birch and hazel colonised the wider area, but were not likely to have grown at the site. The site is typical of the late glacial/early Holocene, showing a change from an open treeless landscape, to one where trees needing a warmer climate began to colonise the area.

Two samples submitted for radiocarbon dating produced dates from the terminal Upper Palaeolithic (10428-10015 cal BC) and the early Mesolithic 9356-9252 cal BC, consistent with the late glacial/early Holocene transition as interpreted from the environmental evidence.

The site of is regional importance, as sites dating to this period are extremely rare within the county and the West Midlands as a whole. The sequences from Abbey Bridge, therefore, have the potential to improve and refine our understanding of the vegetational history of the Avon valley and its surrounding area.

Report

1 Introduction and archaeological background

An analysis of environmental remains from two geoarchaeological boreholes (BH1 and BH2) from at Abbey Bridge, Evesham, Worcestershire (NGR SP033 431; HER WSM58042) was undertaken on behalf of Worcestershire County Council. The site is located next to the River Avon.

This assessment follows on from the recommendations made by Wilkinson (2013) following a geoarchaeological borehole survey at Abbey Bridge. The initial geoarchaeological project was carried our during engineering works conducted by Hotchief (UK) Construction Ltd to renew both Abbey Bridge itself and a causeway/viaduct leading to/from the town to the north end of the bridge. The purpose of the project was to mitigate any impact that the insertion of structural piles might have on strata with a high palaeoenvironmental potential, namely peats that had been recorded during previous borehole survey by Ian Farmer Associates (2010; Wilkinson 2013).

The underlying bedrock at the site is Blue Lias Formation and Charmouth Mudstone Formation. Both of these formations date from the Rhaetian stage of the Late Triassic (203 my BP) to the Pliensbachian stage of the early Jurassic (183 my BP). Wilkinson (2013) provides more local detail, in that the Charmouth Mudstone Formation outcrops 5.5–6.5m below ground level (BGL) at 16–17m OD at the northern end of the causeway. Pleistocene (2my–11.5ky BP) fluvial gravels from the Wasperton Sand and Gravel Member overlie the solid geology, which are in turn overlain by Holocene (11.5ky BP–present) alluvium.

The geoarchaeological work undertaken by Wilkinson (2013) suggests that the gravel of the Wasperton Sand and Gravel Member is present at 4.79m BGL (+17.00m OD) in BH1 and at 4.75m BGL (+16.79m OD) in BH2 (see Fig 1). In addition, the alluvial strata can be seen to sit above the gravels. In BH1 the alluvial strata is located between 4.22–4.69m BGL (+17.577–7.10m OD) and consists of mineral silts and clays and well-humified peats with overlying organic muds. In BH2 peat overlies mollusc shell-rich silts and fine sands at approximately the same position 4.18–4.75m BGL (+17.36 to +16.79m OD).

Wilkinson (2013) suggests that the difference reflects the fact that there was once a more complex Avon floodplain-channel interface than the one we are familiar with today, with abandoned channels or levees (elongated ridges running parallel to the river), and also damp, highly vegetated, depressions.

The remainder of both cores are primarily yellow/brown silt/clay that formed within a floodplain environment with very little potential for the survival of palaeoenvironmental remains. The exception to this is a grey silt/clay layer between 2.39–2.51m BGL (+19.40–19.28m OD) in BH1. This layer has been interpreted as a potential stable ground surface with possible metal-working debris, which was indicated by elevated magnetic susceptibility readings (Wilkinson 2013).

2 Project parameters

The environmental project conforms to relevant sections of the *Standard and guidance for archaeological field evaluation* (IfA 2012); *Environmental Archaeology: a guide to the theory and practice of methods, from sampling and recovery to post-excavation* (English Heritage 2010), and Environmental archaeology and archaeological evaluations (AEA 1995).

3 Aims

The aims of the assessment were to determine the state of preservation, type, and quantity of environmental remains recovered. This information will be used to assess the importance of the environmental remains.

More specifically the following aims have been identified:

- Obtain two AMS radiocarbon dates of the basal organic sediments to determine the periods over which they developed and whether there is contemporaneity with nearby archaeological sites.

- Palynological assessment (eight samples) of the basal organic sequence to determine how well palynomorphs are preserved and whether a palaeoenvironmental reconstruction from such a proxy is possible.

- Molluscan assessment (four samples) of key shell-rich beds to determine preservation and whether meaningful palaeoenvironmental reconstruction of aquatic environments, contemporary with nearby human activity, are possible.

4 Methods

4.1 Personnel

The project was undertaken by Suzi Richer (PhD, MSc, BSc); who joined Worcestershire Archaeology in 2014 and has been practicing archaeology since 2003. The project manager responsible for the quality of the project was Derek Hurst (BA (Hons), Dip post-exc). Andrew Mann (MSc, BSc) contributed the molluscan report. Illustrations were prepared by Carolyn Hunt.

4.2 Methods

4.2.1 Sampling policy

The cores were extracted by ARCA, University of Winchester on 25–26 March 2013. BH1 was located at 403399.95, 243182.07, at an elevation of +21.79 OD and BH2 was located at 403380.71, 243173.60 at an elevation of +21.54m OD.

Samples were taken by the author from deposits that addressed the aims of the project and from levels where the deposits were considered to have high potential for the recovery of pollen, molluscs, and radiocarbon dating. Molluscan samples were taken at locations were mollusc remains were visible to the eye. All depths are discussed in relation to below ground surface (BGS).

A total of 14 samples were taken from the cores, eight for pollen analysis (each of 2cm³), four for molluscan analysis (5cm thick spits of <50 ml were removed from each core), and two for radiocarbon dating. The samples taken from the cores were from the following depths:

Depth BGS (m)	Depth AOD (m)	Sample number	Core	Sample type	Lithology (after Wilkinson 2013)
2.46	19.33	16	BH1	Pollen	Grey silt/clay
3.62–3.66	18.17–18.13	6	BH1	Molluscs	Grey silt/clay
3.90–3.94	17.89–17.85	7	BH1	Molluscs	Grey silt/clay with Mollusca
4.29	17.50	4	BH1	Pollen	Organic mud
4.69	17.10	15	BH1	Pollen	Peat
4.78	17.01	1	BH1	Pollen	Peat
4.78	17.01	5	BH1	C14	Peat

Table 1 Samples taken from BH1

Depth BGS (m)	Depth AOD (m)	Sample number	Core	Sample type	Lithology (after Wilkinson 2013)
3.69–3.74	17.85–17.80	14	BH2	Molluscs	Grey silt/clay with Mollusca
3.96	17.58	11	BH2	Pollen	Grey silt/clay
4.10	17.44	8	BH2	Pollen	Grey silt/clay
4.24	17.30	9	BH2	Pollen	Peat
4.24	17.30	12	BH2	C14	Peat
4.29–4.30	17.25–17.24	13	BH2	Molluscs	Bedded sands and silts
4.69	16.85	10	BH2	Pollen	Bedded sands and silts

Table 2 Samples taken from BH2

The highest sample in BH1 (sample 16) was from an organic layer that contained high magnetic susceptibility readings, which potentially indicates metal-working debris.

4.2.2 Processing and analysis

4.2.2.1 Pollen

Eight pollen samples were selected from the organic deposits in cores BH1 and BH2, exact depth are given above in Tables 1 and 2. The samples were submitted to the laboratories of the Department of Geography and Environment at the University of Aberdeen for chemical preparation following standard procedures as described by Barber (1976) and Moore *et al* (1991). The full methodology is described in Appendix 1.

Where preservation allowed, pollen grains were counted to a total of 150 land pollen grains (TLP) for assessment purposes using a GS binocular polarising microscope at x400 magnification.

Identification was aided by using the pollen reference slide collection maintained by the Service, and the pollen reference manuals by Moore *et al* (1991) and Beug (2004). Nomenclature for pollen follows Stace (2010) and Bennett (1994).

Fungal spores and parasite ova were noted with rapid identification being undertaken to genus level. Identifications were aided through reference material maintained by the Service and reference manuals by Kirk *et al* (2008) and Grant-Smith (2000).

4.2.2.2 Molluscs

Each of the samples was processed following the methods outlined by Evans (1972). Each sample was broken up in a bowl of warm water to separate the light organic remains from the mineral fraction and heavier residue. The water, with the light organic faction, including any floating shells, was decanted onto a stack of 2mm, 1m and 0.5 mm sieves. The remaining residue was then covered by warm water and a small quantity of hydrogen peroxide (30% solution) was added. After the reaction had ceased the residue was then poured through a stack of 2mm, 1mm and 0.5mm sieves.

The flots and residues were scanned using a low power MEIJI stereo light microscope and mollusc remains identified using modern reference collections maintained by the Service, and reference books including Evans (1972), Kerney (1999) and Kerney and Cameron (1996). Nomenclature for the plant remains follows the *Atlas of the land and freshwater molluscs of Britain and Ireland* (Kerney 1999).

4.2.3 Discard policy

Cores, scanned samples and sample residues will be discarded at 6 months following the submission of this report, unless there is a specific request to retain the material.

4.3 Statement of confidence in the methods and results

The methods adopted allow a high degree of confidence that the aims of the project have been achieved.

5 Report

5.1 Radiocarbon dating

5.1.1 Results

Two samples were submitted to SUERC for Accelerator Mass Spectrometry (AMS) radiocarbon dating. The results of which are contained in Table 3. The full radiocarbon report is appended as Appendix 2. All calibrated date ranges cited in the text are for 95% confidence.

Context, sample number and depth (m BGS)	Laboratory code	Material	13C/12C	Radiocarbon Age BP	OxCal calibrated age (95.4% probability or 2 sigma)
BH1 <5> 4.79m	SUERC-54192 (GU34454)	Humified peat: Humic acid	-31.5 ‰	10311±30	**10428-10015 cal BC** 10428-10386 cal BC 10356-10326 cal BC 10291-10015 cal BC
BH2 <12> 4.24m	SUERC-54193 (GU34455)	Humified peat: Humic acid	-29.5 ‰	9841 ±30	**9356-9252 cal BC** 9356-9354 cal BC 9343-9332 cal BC 9326-9252 cal BC

Table 3 Radiocarbon dating results

5.1.2 Discussion

SUERC-54192 (GU34454) and SUERC-54193 (GU34455)

The two radiocarbon dates from the cores indicate that the peat formed during the terminal Upper Palaeolithic and the Mesolithic.

The sample submitted from SUERC-54192, from BH1, came from the base of the peat overlying glacial gravels. The date returned, 10428–10015 cal BC, places the beginning of peat formation to the start of the Holocene, a time of rapid climatic warming. Archaeologically, this falls in the terminal Upper Palaeolithic.

A slightly later date was returned from the sample submitted from a BH2 (SUERC-54193), placing this layer to the early Mesolithic, 9356–9252 cal BC. This sample also came from a band of peat, thought to be of the same age as that in BH1, but in this core the peat was separated from the glacial gravels by a thick layer of sands and organic silts. A further date from the organic silts is needed to be able to fully understand the site formation processes that occurred in this transition period.

5.2 Mollusca remains, by Andrew Mann

5.2.1 Results

Samples 6, 7 and 14 all produced moderately rich mollusc assemblages although each was of low to intermediate species diversity (Table 4). Sample 13 produced the smallest mollusc assemblage and was also of low species diversity. All four assemblages were dominated by freshwater species with very few terrestrial molluscs being present.

Samples 6, 7 and 14 all contained relatively similar assemblages that were dominated by *Valvata cristata*, *Valavata piscinalis*, *Bithynia tentaculata* and *Lymnaea pergera*. These species are indicative of slow or still moving bodies of water that are well oxygenated and richly vegetated. Some species such as *Valvata piscinalis* and *Bithynia tentaculata* have a preference for muddy or

silty stream/river beds. *Lymnaea pergera* is almost ubiquitous within aquatic habitats and provides little further habitat information.

Other freshwater molluscs which were present in lesser numbers included *Planorbis planorbis*, *Gyraulus crista*, *Bathyomphalus contortus* and *Pisidium* sp. These can all inhabit a variety of aquatic locations and provide little further information regarding the fluvial conditions at this location.

The only terrestrial species present included *Carychium tridentatum*, *Cochlicopa lubrica* and *Vallonia pulchella*. These were present in very low numbers and are indicative of short and wet grassland environments.

Sample 13 is slightly different in composition to the other three samples as it is less diverse, but also contains new species. These include *Lymnaea truncatula*, *Lymnaea palustris*, and *Hippeutis complanatus*. These species are more typical of stagnant or very slow moving water, marshy grassland or swamp.

BOREHOLE	**Borehole 1**		**Borehole 2**	
SAMPLE	**6**	**7**	**13**	**14**
DEPTH	**3.62-3.66m**	**3.90-3.94m**	**4.29-4.33**	**3.69-3.74m**
SPECIES				
VALVATIDAE				
Valvata cristata	++		+	
Valvata piscinalis	++	++	+	++
BITHYNIIDAE				
Bithynia tentaculata	++	++	+	++
ELLOBIIDAE				
Carychium tridentatum	+	+		+
LYMNAEIDAE				
Lymnaea truncatula			+	
Lymnaea palustris			+	
Lymnaea pergera	++	++		++
PLANORBIDAE				
Planorbis planorbis			+	+
Bathyomphalus contortus	+	+		+
Gyraulus crista	+	++	+	+
Hippeutis complanatus			+	
COCHLICOPIDAE				
Cochlicopa lubrica		+		+
VALLONIIDAE				
Vallonia pulchella	+	+		+
SPHAERIIDAE				
Pisidium sp.	+	+		+

Table 4 Summary of the mollusc assemblages (+=occasional, ++=moderate, +++=abundant)

5.2.2 Summary

Given the dominance of the aquatic species within the mollusc assemblages the sampled sequences are likely to have been river channel deposits rather than over-bank alluvial material.

Samples recovered from the latter are expected to contain no more than 10% aquatic species (Davies 2008) but it is clear that samples 6, 7 and 14 are dominated by them. The assemblages are very similar in composition and suggest a slow flowing, well oxygenated river with a muddy base. These conditions are likely to have been constant during the time of siltation between 3.66–3.94m. The deeper sample (13) from 4.29–4.33m is more indicative of a marshy pool or an area of dense aquatic vegetation. This may suggest that this area, at this time had become isolated from the main channel or was nothing more than a well vegetated bank-side environment with emergent vegetation. A very similar assemblage was analysed by Shotton (1978) on river channel deposits at Bidford on Avon, around 10 miles upstream. Here approximately 2m of grey rivers silts were analysed and were thought to have accumulated between 3006-2600 BP (approximately 1056–56BC) (Shotton 1978). It is, therefore, likely that this stretch of the river has been slow, sluggish but well oxygenated and vegetated for much of its life.

5.3 Pollen assessment

The results of the pollen analysis are summarised in Tables 5 and 6 (Appendix 3).

5.3.1 BH1

Samples 1 (4.78m), 15 (4.69m), 4 (4.29m) and 16 (2.46m)

Four samples were assessed from BH1. The three lower samples (4.78m, 4.69m and 4.29m) all contained pollen that was well preserved and was present in moderate-good concentrations. Full assessment counts (150 land pollen grains) were achieved on all three samples (4.78m, 4.69m and 4.29m), but not on the uppermost sample (2.46m) due to extremely low concentrations. The latter sample will, therefore, not feature in the discussion, although it is worth noting that it contained high levels of micro-charcoal, which would be consistent with the interpretation of metal working noted from the magnetic susceptibility results for this level (cited in Wilkinson 2013).

An open landscape appears to have been present throughout most of the sequence, with tree pollen only coming to dominate the assemblage (42%) in the uppermost sample (4.29m). The tree pollen is composed almost entirely of pine (*Pinus sylvestris*) (38%), with small percentages of birch (*Betula* sp) (2.7%) and oak (*Quercus*) (1.3%). However, the presence of pine pollen does not necessarily mean that it was growing at the site, as it was likely to be just growing in the general area. The condition of the pine pollen grains was often degraded (washed out) and a lot of broken grains were present, suggesting that it had been exposed to oxygen and physically transported (Delcourt and Delcourt 1980). Pine is wind-pollinated and can travel very long distances, it is likely to have travelled to the site by a combination of wind and water, therefore accounting for both types of deterioration present. Although birch is present and a pioneer species, its presence in 10428–10015 cal BC is likely to be from an extra-local origin, as the cold conditions that were present across the southern half of Britain at that period, would have meant that pollen production was likely to have been supressed (Grant *et al* 2014).

Juniper (*Juniperus*), willow (*Salix*), guelder rose (*Viburnum opulus*) and sea buckthorn (*Hippophae rhamnoides*) were all present in the lowest sample (4.6%, 7.2%,1.3% and 0.7% respectively), suggesting that willow and juniper were almost certainly growing around the site. The first three species are also present in the upper part of the sequence, but only willow is present in the middle sample.

Herbaceous pollen dominates the lower samples in the sequence (74.5–94.4%), before falling to 27.3% in the upper sample. At their maximum, Sedge (Cyperaceae), grass (Poaceae) and *Ceralia* indet. are all present in percentages between 13–29%. The group of *Cerealia*-type pollen also includes sweet grass (*Glyceria*; Dickson 1988), which is often found in sedge swamps, and on balance the *Cerealia*-type pollen is thought to have come from this plant, not from cultivated cereals.

Other herbaceous pollen present in low percentages include: meadow sweet (*Filipendula),* cinquefoil (*Potentilla*-type), bedstraw family (Rubiaceae), mugwort (*Artemisia*)*,* carrot family (Apiaceae), docks/sorrel (*Rumex*), goosefoot (Chenopodiaceae), meadow rue (*Thalictrum*),

buttercup (*Ranunculus acris*-type),thistle (*Cirsium*-type), saxifrage (Saxifragaceae), meadow saxifrages (*Saxifraga granulata*-type), valerian (Valeriana officinalis), and daisy (*Solidago vigaurea*-type).

Aquatics species were present in their highest numbers in the lowest sample (4.78m). Watermilfoil (*Myriophyllum alterniflorum*) dominated the aquatics in the lowest sample, but common bulrush (*Typha latifolia*) was also present in low quantities throughout the sequence. The presence of bulrush attests to the presence of shallow water and/or areas that were subject to flooding, while the watermilfoil shows that slow-moving water present. Fern (*Pteropsida*) spores were present towards the top of the sequence (4.29m)

5.3.2 BH2

Samples 10 (4.69m), 9 (4.24m), 8 (4.10m) and 11 (3.97m)

Four samples were assessed from BH2. The two lowermost samples (4.69m and 4.24m) both contained pollen that was well preserved and was present in good concentrations. Pollen within sample 8 (4.10m) showed poor to good preservation and was present in low-medium concentrations. Full assessment counts (150 land pollen grains) were achieved on the lower three samples (4.69m, 4.24m and 4.10m), but not on sample 11 (3.97m), due to extremely low concentrations, therefore sample 11 does not feature further in this discussion.

An open landscape prevailed throughout most of the sequence, with tree pollen only contributing 3.3-6.2% in the lowest samples. Tree pollen then increased to 59.7% by 4.1m. The pine pollen in sample 8 (4.10m) was quite degraded in comparison to the herbaceous pollen and it is suggested that it, along with the birch pollen, was growing in the wider area, but perhaps not at the site itself (see discussion of pine pollen in **5.3.1. BH1**). The only other tree pollen present in the samples was birch (*Betula* sp.) (2.6–5.2%).

Although shrubs were present in the lowest sample (2.6%), they were more abundant in the upper samples (16.4–17.2%). Juniper (*Juniperus communis*) dominated the shrubs and was present in reasonably high quantities (8.6–9.2%), suggesting that it was growing close by. The percentage of willow (*Salix* sp) (6.6–7.3%) at this time informs us that it was also growing in close proximity to the site.

Dwarf shrubs and herbs dominate the lower sequence, with percentages between 76.7–90.7%. This is primarily dominated by sedges (Cyperaceae) with 57.6% recorded at the bottom of the sequences. Grasses (Poaceae) (max. 21.2%) and *Cerealia*-type (max. 10.5%) are also present in reasonable percentages. *Cerealia*-type pollen is likely to have come from sweet grass (*Glyceria*), as discussed above in **5.3.1. BH1**.

Other herbaceous pollen present in low percentages includes: meadow sweet (*Filipendula),* bedstraw family (Rubiaceae), chicory/dandelion (*Cichorium intybus*-type), mugwort (*Artemisia*), carrot family (Apiaceae), bell flower (*Campanula*-type),thistle (*Cirsium*-type), sheep's bit scabious (*Jasione montana*-type), saxifrage (Saxifragaceae), legume (*Lotus*-type) and daisy (*Solidago vigaurea*-type). Meadow sweet (1.3–3.9%) is likely to be indicating wetland margins, and has been associated with a similar environment in late glacial deposits from Snowdonia (Rhind and Jones 2003).

Aquatics species are present in the highest numbers in the lowest sample (4.34m). Species in the sample included whorled water milfoil (*Myriophyllum verticillatum*), watermilfoil (*Myriophyllum alterniflorum*) and broad-leaved pondweed (*Potamogeton natans*-type). Both types of milfoil are indicative of slow-moving water. Fern (*Pteropsida*) spores were present towards the top of the sequence (4.10m) and two *Cercophera* spores were present in sample 9 (4.24m). *Cercophera* is a fungus that is present on herbivore dung and decaying organic matter (Aptroot and van Geel 2006), given the large quantities of organic matter seen on the slide of sample 9, this interpretation is favoured.

5.3.3 Summary

Both profiles show that an open environment existed at the site and it that was dominated by grasses and shrubs, such as willow and juniper, in the earliest part of the recorded sequence. Tree pollen, in the form of pine and birch both make an entrance at the top of each profile, but these are likely to represent the regional or extra-regional vegetation based on the condition of the grains. This pattern of vegetation is indicative of a landscape from the terminal upper Palaeolithic/early Mesolithic, whereby as the climate began to warm, larger trees species began to recolonize the country. In addition, the aquatic pollen from the lower part of each profile suggests that the site was initially situated close to, or within, an area of slow moving water with vegetation growing within it.

5.4 Discussion

5.4.1 Terminal Upper Palaeolithic

Peat formed directly over the Wasperton Sand and Gravel Member at 4.79m in BH1; the radiocarbon date from the base of the peat puts the peat formation at 10428–10015 cal BC, within the terminal Upper Palaeolithic (late Pleistocene). During this time slow-moving water covered the site, and the landscape was likely to be somewhat akin an alpine landscape today (i.e. open, meadow-like and with only occasional scrubby bushes such as willow along the water's edge and juniper on the drier slopes). The combination of the low velocity of the water and the abundance of plant material is likely to have enabled the peat to form.

In contrast to BH1, occasional faster flowing water appears to have covered the site of BH2 between the Wasperton Sand and Gravel Member and the peat formation. This is seen through the presence of the bedded sands and silts prior to peat formation. The molluscs from within this silty layer (4.29–4.33m) indicate that periods of stagnant or very slow moving water occurred causing a marshy grassland or swamp to occur. Equally, the presence of watermilfoil pollen from this time also suggests that slow-flowing water was present. Whether the silty layer is earlier than, or contemporary with, the initial peat formation in BH1 is not known at this time.

5.4.2 Early Mesolithic

By 9356–9252 cal BC peat had formed within the BH2 sequence. The pollen spectra still indicate an open landscape at this time, dominated by herbaceous species, willow and juniper. However, the first grains of hazel are noted, alluding to the beginnings of a warmer climate. Both sequences show an increase in pine and birch pollen and fern spores towards the top of the profile, suggesting that woodland was starting to form in the wider area, however this level is currently undated. Other pollen diagrams from the region, for instance Cross Mere, Shropshire (Beales 1980) and Shardlow Quarry, Derbyshire (Brayshay 1994; Howard and Knight 2004), depict increases in pine, birch and fern occurring around 8730 BP (approx. 7939–7607 cal BC) and 9130 ±70 BP (8540–8230 cal BC), respectively.

5.4.3 Mesolithic onwards

Mollusc samples from higher levels in both sequences indicate that the immediate environment did not change substantially, but a slow flowing and well oxygenated river with a muddy base existed; rather than the stagnant swampy conditions seen earlier on. This change is likely to be due to river incision caused by continuing low sea levels (Howard and Knight 2004), in particular:

> *In lowland river landscapes, particularly those of the Midlands and southern Britain, several studies indicate that the combination of low channel gradients and the predominance of fine-grained sediment and vegetated channel banks resulted in the development of stable, possibly multi-channelled (anastomised) river systems.* (Smith 1983, cited in Howard and Knight 2004)

The mollusc and pollen assemblages from Abbey Bridge certainly follows the same pattern, showing a highly vegetated swamp-like/marshy stream bank in the terminal Upper Palaeolithic, before becoming a slow-moving oxygenated river, typical of a multi-channelled river.

5.4.4 Comparison with other sites

Sites that cover the boundary between the terminal Upper Palaeolithic and the Mesolithic are extremely rare across the Midlands. In Worcestershire, the only dated sequence that covers this period is from Wilden Marsh (Brown 1988). Other sites from the wider area exist, for instance King's Pool, Stafford (Bartley and Morgan 1990), Cross Mere, Shropshire (Beales 1980) and Sheldon Heath, Birmingham (Daffern and Clapham 2013) and Shardlow Quarry, Derbyshire (Brayshay 1994).

Looking more specifically along the Avon, molluscan assemblages have been examined along the Avon, for instance at Bideford on Avon (Shotton 1978) and pollen work has also been undertaken previously at Abbey Park, Pershore (Greig 1995); on the Carrant Brook (a tributary to the Avon), Beckford (Greig and Colledge 1988); and at Birlingham (Greig 2000). The earliest radiocarbon date obtained from these sites is from Birlingham (Greig 2000), which produced a Neolithic date, however pollen preservation was poor from this level. Beckford dates from the early Bronze Age and shows an open, grassland, environment with limited trees growing in the area. The picture of an open landscape also emerges from the undated sequence from Pershore (Greig 1995) and from the later Bronze Age sequence from Birlingham (Greig 2000).

The Abbey Bridge profiles have shown that the open landscape that existed in the Bronze Age and beyond, also existed earlier in prehistory. However, a further C14 dates and pollen analysis would be needed on the cores to establish if woodland ever did colonise the floodplain during the later Mesolithic and Neolithic periods, or whether open grassland prevailed.

6 Significance

The pollen and macrofossil assessments presented here, in conjunction with the radiocarbon dates, demonstrate the usefulness of using two proxies in understanding the local environment of a site and its changing vegetation through time. The two sets of data contribute different levels of information and, therefore, produce a more complete picture of the site. The molluscs usually provide information on the immediate environment of the sample, primarily representing the vegetation within a few metres of the sample spot, whilst the pollen evidence produces information from a regional and extra-regional perspective, as well as providing local information.

During 11,000–10,000 BP it is thought that people once again abandoned Britain due to cold conditions, only returning when the climate dramatically improved *c.*10,300 BP, the onset of the Holocene (Myers 2007). The sequences from Abbey Bridge cover the onset of the Holocene, and the transition between the Palaeolithic and Mesolithic, a time when people were massively influenced by the changing natural environment around them. These deposits offer a significant resource in terms of understanding the landscape of the time, in an area where archaeological finds from these periods are scarce.

6.1 Research frameworks

The environmental material discussed here demonstrably fits in with the research framework for the West Midlands (Watt 2011). There are few sites within the West Midlands that have produced any environmental evidence for this date (Garwood 2011), and even fewer that cover both the terminal Upper Palaeolithic and the Mesolithic. This is, therefore, an important site as it adds to the limited dataset for the West Midlands and indeed currently provides the only dated pollen sequence for this period from the Avon, therefore improving our understanding of the past environments in the early prehistoric occupation of the area.

7 Recommendations

The following recommendations are made with regard to further work on the samples considered as part of this report.

7.1 Mollusca remains

Given the poor species diversity and the low numbers encountered in some of the samples it is not suggested to undertake full counts on these assemblages. As they are very similar in composition, undertaking full counts is unlikely to provide any further information regarding the changing fluvial conditions at this location. However, given the preservation encountered, should any further works disturb these deposits, mollusc analysis should be considered as part of the mitigation process, as other parts of the sequence may contain a more complete molluscan sequence.

7.2 Radiocarbon dating and pollen

Further work that is recommended for BH2 includes:

- Full counts (300 land pollen grains) should be made on the three pollen samples already assessed from BH2.
- Processing eight further pollen samples from BH2 is recommended, with full analysis counts (300 pollen grains) being undertaken on five of the newly processed samples. The processing of three extra samples is to take into account that not all samples will contain pollen, as has already been witnessed by sample 11 from 3.97m from BH2. Most of these samples should focus on the area between 4.00–4.24m, where the change in vegetation (grassland to becoming more wooded) occurred, although one further sample from between 4.70m and 4.24 should be sought to confirm the similarity in the vegetation pattern seen in samples 9 (4.24m) and 10 (4.69m)
- A pollen diagram, including a column for the lithology should be produced for BH2.
- Two further radiocarbon dates are also recommended for BH2. The first date should be from the base of the bedded sands and organic silts (*c*.4.70m), which is prior to the peat formation (4.18–4.27m) to see if this is contemporary with the peat formation in BH1. The second C14 date should be undertaken after the pollen analysis has been completed in the upper part of the organic sequence (expected to be between 4.10–4.00m) to establish if/when the thermophilious species recolonised the Avon valley.

No further analysis is recommended for BH1, based on:

a) the vegetation profiles between BH1 and BH2 are extremely similar, and so there is little to be gained by examining both cores.

b) BH2 potentially contains more organic material, both below and above the peat, meaning it is most likely to yield the best information.

8 Publication summary

Worcestershire Archaeology has a professional obligation to publish the results of archaeological projects within a reasonable period of time. To this end, Worcestershire Archaeology intends to use this summary as the basis for publication through local or regional journals. The client is requested to consider the content of this section as being acceptable for such publication.

A assessment of environmental remains was undertaken on behalf of Worcestershire County Council from cores taken from close to Abbey Bridge, Evesham, Worcestershire (NGR ref SP033431; HER WSM58042).

Samples were assessed for both pollen and molluscan remains. Pollen was present in six out of the eight samples. Both the molluscs and the pollen were in agreement that swampy conditions gave way to slow flowing, but well oxygenated water. In addition, the pollen revealed a mainly treeless, grassland environment, with patches of willow and juniper scrub. Such an environment is not dissimilar from a modern alpine environment. Over time pine, birch and possible hazel colonised the wider area, but were not likely to have grown at the site.

Two samples submitted for radiocarbon dating produced dates from the terminal Upper Palaeolithic (10428-10015 cal BC) and the early Mesolithic 9356-9252 cal BC.

The site of is regional importance, as sites dating to this period are extremely rare within the county and the West Midlands as a whole, and, therefore, have the potential to improve and refine our understanding specifically of the vegetational history of the Avon valley and, more generally, of the wider Severn valley.

9 Acknowledgements

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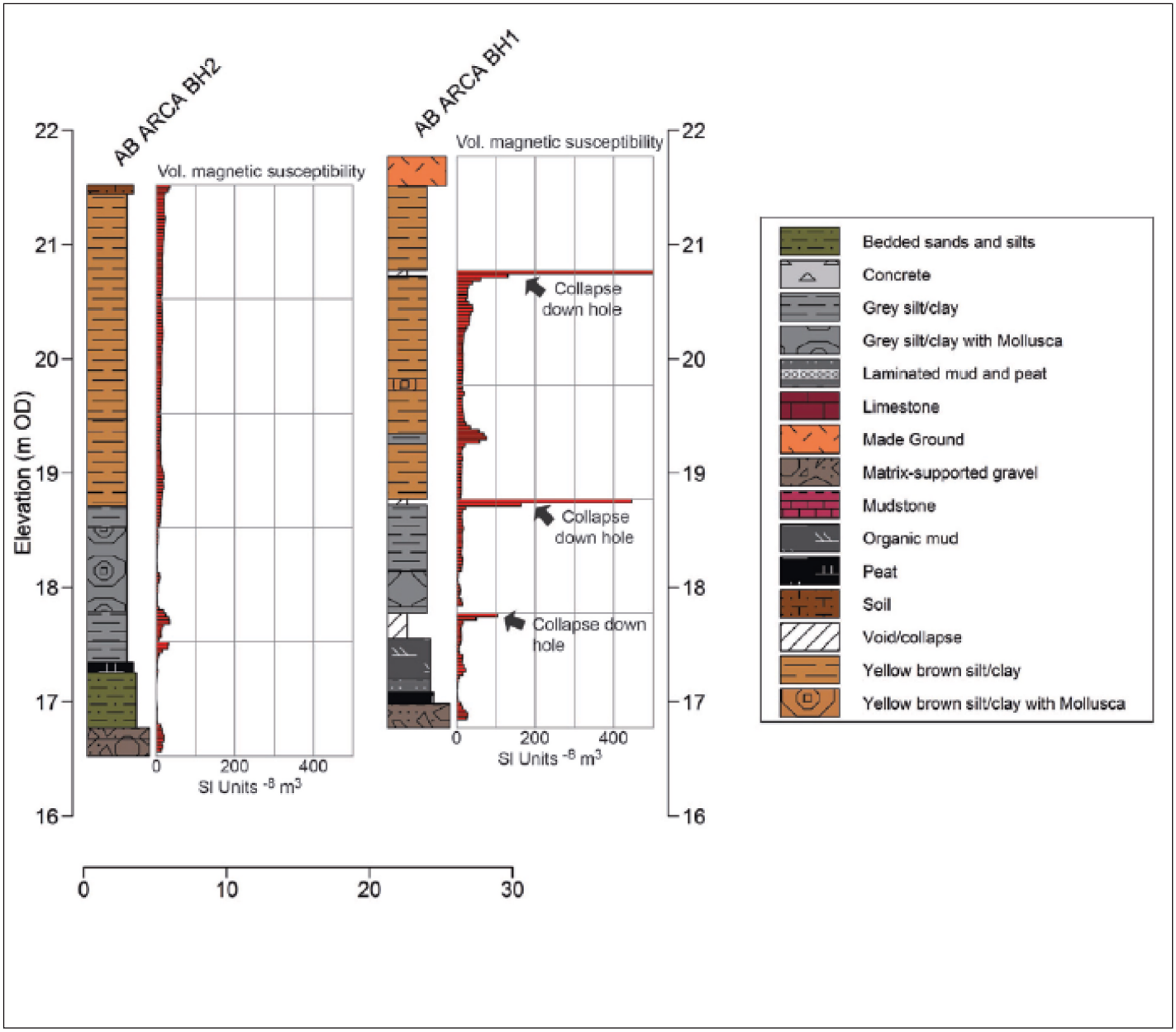
Figures



Litho-and magnetostratigraphy of Abbey Bridge, Evesham, boreholes 1 and 2 (after Wilkinson 2013)

Figure 1

Appendix 1 Pollen processing methodology (Tim Mighall, Department of Geography and Environment, University of Aberdeen)

ABSOLUTE POLLEN ANALYSIS: PREPARATION SCHEDULE

PRECAUTIONARY NOTES: All procedures, up to stage 25, should take place in the fume cupboard. Read precautionary notices on fume cupboard before starting. Ascertain whereabouts of First Aid equipment NOW. Please wear laboratory coat, gloves and goggles when dealing with all chemicals. Please organize fume cupboard carefully to maximize workspace. Use the containment trays provided. Always keep the fume cupboard door down as far as practically possible. Make sure the fume cupboard is switched on and functioning correctly.

A) SOLUTION OF HUMIC COMPOUNDS

1) Switch on hotplate to heat water bath. Prepare 12 to 16 samples concurrently.

HCl. is an irritant and can cause burns. Wear gloves. Wash with water if spilt on your skin.

Using a clean spatula, place a known volume or weight of sediment (c. 2cm^3) and one spore tablet in each 50ml centrifuge tube. Add a few cm^3 of distilled water (enough to cover the pellet and tablets) and a few drops of 2M HCl. Wait until effervescence ceases, then half fill tubes with 10% KOH; place in a boiling water bath for 15 minutes. Stir to break up sediment with clean glass rod. Return HCl and KOH bottles to the chemical cabinet.

2) Centrifuge at 3,000 rpm for 5-6 minutes, ensuring first that tubes are filled to the same level. This applies throughout the schedule (Mark 7 on centrifuge).

3) Carefully decant, i.e. pour away liquid from tube, retaining residue. Do it in one smooth action.

4) Disturb pellet using vortex mixer; add distilled water, centrifuge and decant.

5) Using a little distilled water, wash residue through a fine (180 micron) sieve sitting in filter funnel over a beaker. NB Be especially careful in keeping sieves, beakers and all tubes in correct number order. Wash residue on sieve mesh into petri dish and label the lid. If beaker contains mineral material, stir contents, wait four seconds, then decant into clean beaker, leaving larger mineral particles behind. Repeat if necessary. Clean centrifuge tube and refill with contents of beaker.

6) Centrifuge the tubes and decant.

B) HYDROFLUORIC ACID DIGESTION

***(Only required** if mineral material clearly still present. Otherwise, go to stage 13)*

NB Hydrofluoric acid is extremely corrosive and toxic; it can cause serious harm on contact with eyes and skin. Rubber gloves and mask/ goggles MUST be worn up to and including stage 11. Please fill sink with H_20; have $CaCo_3$ gel tablets ready. Place pollen tube rack into tray filled with sodium bicarbonate.

7) Disturb pellet with vortex mixer. Add one cm^3 of 2M HCl.

8) With the fume cupboard sash lowered between face and sample tubes, very carefully one-third fill tubes with concentrated HF (40%). Place tubes in water bath and simmer for 20 minutes.

9) Remove tubes from water bath, centrifuge and decant down fume cupboard sink, flushing copiously with water.

10) Add 8cm^3 2H HCl to each tube. Place in water bath for 5 minutes. Do not boil HCl.

11) Remove tubes, centrifuge while still hot, and decant.

12) Disturb pellet, add distilled water, centrifuge and decant.

C) ACETYLATION

NB Acetic acid is highly corrosive and harmful on contact with skin. Wash with H_20 if spilt on skin.

13) Disturb pellet, add 10cm^3 glacial acetic acid, and centrifuge. Decant into fume cupboard sink with water running during and after.

14) Acetic Anhydride is anhydrous. Avoid contact with water. The acetylation mixture can cause severe burns if spilt on skin. Wash with water.

15) Make up 60cm^3 of acetylation mixture, just before it is required. Using a measuring cylinder; mix acetic anhydride and concentrated sulphuric acid in proportions 9:1 by volume. Measure out 54cm^3 acetic anhydride first, then add (dropwise) 6cm^3 concentrated H_2S0_4 carefully, stirring to prevent heat build—up. Stir again just before adding mixture to each tube.

Disturb pellet; then add 7cm^3 of the mixture to each sample.

16) Put in boiling water bath for 1-2 minutes. (Stirring is unnecessary—never leave glass rods in tubes as steam condenses on the rods and runs down into the mixture reacting violently). One minute is usually adequate; longer acetylation makes grains opaque. Switch off hot plate.

17) Centrifuge and decant all tubes into large (1,000ml) beaker of water in fume cupboard. Decant contents of beaker down fume cupboard sink.

18) Disturb pellet, add 10cm^3 glacial acetic acid, centrifuge and decant.

19) Disturb pellet, add distilled water and a few drops of 95% ethanol centrifuge and decant carefully.

D) DEHYDRATION, EXTRACTION AND MOUNTING IN SILICONE FLUID

20) Disturb pellet; add 10cm^3 95% ethanol, centrifuge and decant.

21) Disturb pellet; add 10cm^3 ethanol (Absolute alcohol), centrifuge and decant. Repeat.

22) Toluene is an irritant. Avoid fumes.

Disturb pellet; add about 8cm^3 toluene, centrifuge and decant carefully into 'WASTE TOLUENE' beaker in fume cupboard (leave beaker contents to evaporate overnight).

23) Disturb pellet; then using as little toluene as possible, pour into labelled specimen tube.

24) Add a few drops of silicone fluid - enough to cover sediment.

25) Leave in fume cupboard overnight, uncorked, with fan switched on. Write a note on the fume cupboard *'Leave fan on overnight - toluene evaporation',* and date it. Collect specimen tubes next morning and cork them. Turn off fan.

26) Using a cocktail stick, stir Contents and transfer one drop of material onto a clean glass slide and cover with a cover slip (22mm x 22mm). Label the slide.

27) Wash and clean everything you have used. Wipe down the fume cupboard worktop. Remove water bath from fume cupboard if not needed by the next user. Refill bottles and replace them in chemical cabinets.

Appendix 2 Radiocarbon dating

Appendix 3

			BH1			
	Family	Common Name(s)	2.46m	4.29m	4.70m	4.78m
Pinus sylvestris	Pinaceae	Scots pine		57	3	9
Quercus	Fagaceae	oak		2		
Betula	Betulaceae	birch		4	2	8
Empetrum nigrum	Ericaceae	crowberry		2		
Calluna vulgaris	Ericaceae	heather				
Vaccinium-type	Ericaceae	bilberry/ heath/ bog-rosemary		5	2	2
Corylus avellana-type	Betulaceae	hazel		23		
Salix	Salicaceae	willow		2		11
Viburnum opulus	Caprifoliaceae	guelder rose		4		2
Juniperus	Cupressaceae	juniper		10	2	7
Caltha palustris-type	Ranunculaceae	marsh-marigold/ mousetail/ columbine		4		
Hippophae rhamnoides	Elaeagnaceae	sea buckthorn				1
Saxifragaceae	Saxifragaceae	saxifrage			2	
Saxifraga granulata-type	Saxifragaceae	meadow saxifrage			2	8
Filipendula	Rosaceae	meadowsweet		2	6	3
Potentilla-type	Rosaceae	cinquefoil			3	
Rumex acetosa	Polygonaceae	common sorrel				2
Rumex acetosella	Polygonaceae	sheep's sorrel				2
Rubiaceae	Rubiaceae	bedstraw family			3	
Ranunculus acris-type	Ranunculaceae	meadow buttercup			2	
Thalictrum	Ranunculaceae	meadow rue			2	
Plantago lanceolata	Plantaginaceae	ribwort plantain				1
Solidago virgaurea-type	Asteraceae	daisies/ goldenrods			1	1
Cirsium-type	Asteraceae	thistles				1
Artemisia-type	Asteraceae	mugwort			1	
Apiaceae	Apiaceae	carrot family		2	1	1
Chenopodiaceae	Chenopodiaceae	goosefoot			1	
Cyperaceae undiff	Cyperaceae	sedge		23	102	44
Poaceae undiff	Poaceae	grasses	3	10	26	21
Cerealia indet	Poaceae	indeterminable cereal			0	29
		TLP Grains counted	**3**	**87**	**161**	**136**
Myriophyllum verticillatum	Haloragaceae	whorled water milfoil			5	
Myriophyllum alterniflorum	Haloragaceae	watermilfoil				28
Myriophyllum spicatum	Haloragaceae	Eurasian watermilfoil			3	
Sparganium undiff.	Typhaceae	bulrush				2
Typha latifolia	Typhaceae	lesser bulrush		4	6	9
Pteridium aquilinum	Pteridium	common bracken		1		
Pteropsida (mono) indet		ferns		10		1
Sphagnum	Sphagnaceae	peat moss				
Sordaria-type	Sordariaceae				2	1

Table 5 Results of pollen assessment for BH1

			BH2			
	Family	Common Name(s)	3.97m	4.10m	4.24m	4.69m
Pinus sylvestris	Pinaceae	Scots pine	17	86.5	1.5	1
Quercus	Fagaceae	oak				
Betula	Betulaceae	birch		4	8	4
Calluna vulgaris	Ericaceae	heather				5
Vaccinium-type	Ericaceae	bilberry/ heath/ bog-rosemary		4	1	
Corylus avellana-type	Betulaceae	hazel	4	2	1	
Salix	Salicaceae	willow	1	11	10	2
Juniperus	Cupressaceae	juniper	1	13	14	2
Saxifragaceae	Saxifragaceae	saxifrage				1
Lotus-type	Fabaceae	legume		1		
Filipendula	Rosaceae	meadowsweet		2	6	4
Rumex acetosella	Polygonaceae	sheep's sorrel				1
Anagallis-type	Primulaceae	pimpernel			1	
Rubiaceae	Rubiaceae	bedstraw family		4	3	4
Plantago lanceolata	Plantaginaceae	ribwort plantain				1
Cichorium intybus-type	Asteraceae	chicory/ dandelion			2	
Solidago virgaurea-type	Asteraceae	daisies/ goldenrods		1		1
Cirsium-type	Asteraceae	thistles			1	
Artemisia-type	Asteraceae	mugwort		2	1	
Apiaceae	Apiaceae	carrot family	1		1	2
Campanula-type	Campanulaceae	bell flower			1	1
Jasione montana-type	Campanulaceae	sheep's bit scabious			1	
Cyperaceae undiff	Cyperaceae	sedge	1	13	67	87
Poaceae undiff	Poaceae	grasses		8	17	32
Cerealia indet	Poaceae	indeterminable cereal			16	3
		TLP Grains counted	**25**	**151.5**	**152.5**	**151**
Myriophyllum verticillatum	Haloragaceae	whorled water milfoil				6
Myriophyllum alterniflorum	Haloragaceae	watermilfoil				1
Myriophyllum spicatum	Haloragaceae	Eurasian watermillfoil				
Potamogeton natans-type	Potamogetonaceae	broad-leaved pondweed	1			3
Sparganium undiff.	Typhaceae	bulrush				
Typha latifolia	Typhaceae	lesser bulrush			1	
Polypodium	Polypodiaceae	polypody	2			
Pteridium aquilinum	Pteridium	common bracken				
Pteropsida (mono) indet		ferns		16		1
Sphagnum	Sphagnaceae	peat moss		1		
Cercophora-type	Sordariaceae				2	

Table 6 Results of pollen assessment for BH1

Appendix 4 Technical information

The archive

The archive consists of:

8 Pollen score sheet AS35

2 Radiocarbon reports

Copy of this report (bound hard copy)

The project archive is intended to be placed at:

Worcestershire County Museum
Museums Worcestershire
Hartlebury Castle
Hartlebury
Near Kidderminster
Worcestershire DY11 7XZ
Tel Hartlebury (01299) 250416

Summary of data for Worcestershire HER

Methods of retrieval	**Yes/No**
Hand retrieval	
Bulk sample	
Spot sample	
Auger	
Monolith	Yes
Observed	

Type	**Preservation**	**Date (note 1)**	**Specialist report? Y/N (note 2)**	**Key assemblage? Y/N (note 3)**
Plant remains – pollen	Variable, some excellent some poor.	Upper Palaeolithic and Mesolithic	Y	Y
Shell – mollusc	Excellent.	Upper Palaeolithic and Mesolithic	Y	Y