FULL ANALYSIS OF ENVIRONMENTAL REMAINS FROM LAND TO THE NORTH OF BRAYS ROAD, SHELDON HEATH, BIRMINGHAM

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With contributions by Alan Clapham

Summary

Full analysis of environmental remains from an archaeological evaluation at land to the north of Brays Road, Sheldon Heath Birmingham (NGR SP 1504 8516) was undertaken on behalf of CgMs Consulting and on behalf of their client as part of an agreed programme of mitigation works.

The sequence recovered from Sheldon Heath can be divided into two phases, separated by an unconformity, with an unknown period of time and period of erosion occurring prior to the deposition of the upper. The likely explanation is a change in the hydrology with the local watercourse migrating and eroding earlier deposits.

Six samples were submitted for Accelerator Mass Spectrometry (AMS) radiocarbon dating. Two samples failed due to insufficient carbon being present, these were replaced with substitute material whose potential for dating was higher. The three samples from the basal margins, 0.95m – 1.05m BGS (Beta-365217, Beta- 367147, SUERC-46779), all produced late Mesolithic dates (between 4347 – 3970 cal BC). The sole successful sample from further up the sequence (0.75m – 0.80m; SUERC-47007) was dated much earlier, 8631 – 8461 cal BC.

The basal deposit indicates a typical hydoseral succession whereby a wet, open landscape is transformed into drier woodland via the formation of a peat bog. The combination of the radiocarbon dating and the environmental remains indicates that this succession was occurring in the late Mesolithic, with wildwood and heathland extant in the wider landscape.

The upper deposit is very different to that of the underlying deposit, with both the plant macrofossils and pollen analysis indicating a more open, scrubby environment with a floodplain or alluvial character.

Report

1 Introduction

Full analysis of environmental remains from an archaeological evaluation at land to the north of Brays Road, Sheldon Heath Birmingham (NGR SP 1504 8516) was undertaken on behalf of CgMs Consulting and on behalf of their client as part of an agreed programme of mitigation works.

The initial archaeological evaluation was undertaken by Benchmark Archaeology with an environmental assessment by Worcestershire Archaeology. The results of the archaeological evaluation (Benchmark Archaeology 2013) will be briefly summarised below (Section 5.2) whilst the results of the environmental assessment will be assimilated into the present analysis and presented as a cohesive report.

2 Project parameters

The project conforms to relevant sections of the *Standard and guidance for archaeological excavation* (IfA 2008) and the *Manual of Service practice: fieldwork recording manual* (WA 2012).

In addition, the sampling, geoarchaeology and environmental analysis conform to relevant sections of *Environmental Archaeology: A guide to the theory and practice of methods, from sampling and recovery to post-excavation* (English Heritage 2010), *Geoarchaeology: Using earth sciences to understand the archaeological record* (English Heritage 2007) and *Environmental archaeology and archaeological evaluations* (AEA 1995).

The project also conforms to a project proposal (including detailed specification) which was produced by Worcestershire Archaeology (WA 2013) and approved by CgMs Consulting.

3 Aims

The Analysis was intended to have the following aims based upon the results of the assessment and discussions with Mike Hodder, the Birmingham City Council Archaeologist and Cathy Patrick of CgMs Consulting:

- Full analysis of the plant macrofossils from the lower part of the profile. All the spit samples from the bottom to half way up the profile should be processed in order to provide a detailed picture of the vegetation changes in the early prehistory of the area.

- Full analysis of at least one of the spit samples from between the middle and top of the profile in order to establish the continual change in vegetation change.

- Full analysis of the pollen from the lower part of the profile. A series of samples from regular intervals should be taken and analysed in order to produce a more complete picture of vegetation change in early prehistory.

- Full analysis of the pollen from between the middle and upper part of the profile should be carried out (but not at as close intervals for the lower part of the profile) in order to produce a more complete picture of vegetation change in the area.

- Additional radiocarbon dating will be undertaken (a minimum of two) to complement the full analysis and to provide accurate dating of the sequence and remains.

4 Methods

4.1 Personnel

The project was undertaken by Nicholas Daffern (BA Hons M.Sc.; Senior Environmental Archaeologist); who joined Worcestershire Archaeology in 2007 and has been practicing archaeology since 2004. The project manager responsible for the quality of the project was Derek

Hurst (BA Dip Post-Exc). Illustrations were prepared by Carolyn Hunt. Dr Alan Clapham (MSc, PhD) contributed the plant macrofossil analysis.

4.2 Methods

4.2.1 Sampling policy

The sampling, geoarchaeology and environmental analysis conform to relevant sections of *Environmental Archaeology: A guide to the theory and practice of methods, from sampling and recovery to post-excavation* (English Heritage 2010), *Geoarchaeology: Using earth sciences to understand the archaeological record* (English Heritage 2007) and *Environmental archaeology and archaeological evaluations* (AEA 1995) and standard Service practice (WA 2012). The sampling strategy was also in keeping with the methodology presented in the approved project proposal. (WA 2013).

The sampling of material for radiocarbon dating, artefact, plant macrofossil and pollen analysis was undertaken by the author during the archaeological recording and the geoarchaeological analysis.

4.2.2 Radiocarbon dating

Six samples were submitted to SUERC (Scottish Universities Environmental Research Centre) and Beta Analytic Inc for Accelerator Mass Spectrometry (AMS) radiocarbon dating.

No sources of contamination or non-contemporaneous carbon were evident during the fieldwork or during the subsequent assessment. All calibrated dates are identifiable by the prefix ‘Cal’, and, where calibrated date ranges are cited in the text, these are for 95% confidence.

Results are presented in Table 2. The full radiocarbon report is appended as Appendix 1. All calibrated date ranges cited in the text are those for 95% confidence.

4.2.3 Plant macrofossils

For each of the samples a sub-sample of 1 litre was processed by the wash-over technique as follows. The sub-sample was broken up in a bowl of water to separate the light organic remains from the mineral fraction and heavier residue. The water, with the light organic faction was decanted onto a 300μm sieve and the residue washed through a 1mm sieve. The remainder of the bulk sample was retained for further analysis.

The flots were scanned using a low power MEIJI stereo light microscope and plant remains identified using modern reference collections maintained by Worcestershire Archaeology, and a seed identification manual (Cappers *et al* 2006). Nomenclature for the plant remains follows Stace (2010).

The samples analysed from this site are presented in Table 1.

4.2.4 Wood identification

The cell structure of all the non-oak identification samples was examined in three planes under a high power microscope and identifications were carried out using reference texts (Hather 2000) and reference slides housed at the Worcestershire Archaeology office.

4.2.5 Pollen analysis

A total of thirteen sub-samples were taken from Monolith 1 for assessment and analysis, the exact depths of which are given within the results section below. The sub-samples were submitted to the laboratories of the Department of Geography & 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 2.

Where preservation allowed, pollen grains were counted to a total of 150 land pollen grains (TLP) for assessment purposes and 300 TLP for full analysis using a GS binocular polarising microscope at x400 magnification. Identification was aided by using the pollen reference slide collection maintained at the Worcestershire Archaeology office, and the pollen reference manual by Moore *et al* (1991). 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 at the Worcestershire Archaeology office and reference manuals, Kirk *et al* (2008) and Grant-Smith (2000). The pollen diagram was constructed using TILIA, TILIA.GRAPH, and TGView 2.0.2 software (Grimm 1990; 2004).

4.2.6 Discard policy

All unused sub-samples will be discarded 3 months after report submission.

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 Background

5.1 Topography and geology

The ground surface of the site is generally flat with the site lying at a height of *c*94 – 95m AOD (above ordinance datum).

The site is located on solid geology of the Mercia Mudstone Group deposited 206 - 248 million years ago during the Triassic period which is overlain by superficial deposits of Quaternary alluvium (British Geological Survey).

Due to the urban character of the site, the soils were unsurveyed by the Soil Survey of England and Wales (1983).

At the time of sampling in February 2013, the site was open, undeveloped grassland.

6 Report

6.1 Radiocarbon dating

6.1.1 Results

Six samples were submitted to SUERC for Accelerator Mass Spectrometry (AMS) radiocarbon dating. The results of which are contained in Table 2. The full radiocarbon report is appended as Appendix 1. All calibrated date ranges cited in the text are those for 95% confidence.

No sources of contamination or non-contemporaneous carbon were evident during the fieldwork or during the subsequent assessment. All calibrated dates are identifiable by the prefix ‘Cal’. Where calibrated date ranges are cited in the text, these are for 95% confidence.

Two samples failed due to insufficient carbon being present, these were replaced with substitute material whose potential for dating was higher.

The three samples from the basal margins, 0.95m – 1.05m BGS (Beta-365217, Beta- 367147, SUERC-46779), all produced late Mesolithic dates (between 4347 – 3970 cal BC). The sole successful sample from further up the sequence (0.75m – 0.80m; SUERC-47007) was dated much earlier, 8631 – 8461 cal BC.

6.1.2 Discussion

Despite the irregularities in the results, several hypotheses can be forwarded to explain the abnormality in the dating of the sequence.

The first is that later disturbance has disturbed and/or redeposited earlier material into a higher context therefore contaminating it with earlier Mesolithic material which unfortunately was selected for dating. This hypothesis is possible due to the later agricultural land use of the site (Richard Cherrington pers comm) with material being disturbed and turned over by ploughing and cultivation. Despite this, no obvious indications of this process were identified during the fieldwork or analysis and it would appear unlikely that agricultural processes would impact on the deposits so deeply without leaving an indication of the disturbance, particularly the lack of finer modern particulates such as coal which was entirely absent from the two lowest samples (Table 3).

The second hypothesis is that the material providing the late Mesolithic dates retrieved from the basal deposits (0.95 – 1.05m BGS) are intrusive, with the wood entering either through gravity fall into desiccation cracks created in the upper surface of sediment during hotter, drier summer months, a phenomenon that has been identified locally (Greig 2010; Daffern and Clapham 2012), or through intrusion by natural processes (tree fall pushing the branch downwards into the soft sediment) or by some human agency although the latter would appear unlikely.

The final and most likely hypothesis is that at some point in the sequence, the earlier, *Betula* wood was disturbed and transported from its original location to its final resting place in the sequence and was incorporated into the developing peat. This seems more probable given the active fluvial nature of the River Tame during the early Holocene (Tetlow *et al* 2008; Daffern and Clapham 2012) and this method would also leave little discernable evidence within the stratigraphic sequence given the 'natural' and discrete nature of the deposition.

6.2 Plant macrofossils, by Alan Clapham

The results of the full analysis of the 12 samples from Sheldon Heath, Birmingham are presented in Table 3. The majority of plant remains were preserved by waterlogging. A small number of the remains were preserved by charring and mineralization. Small fragments of charcoal were evident in many of the samples. The quality of preservation was such as to permit identification to species level wherever possible.

The profile examined in this study can be broken into two distinct contexts. The upper (302) can be divided into two layers. The upper 0.1m of this context consisted of a humified peat which was followed by 0.6m of a dark crumbly peat containing many wood fragments.

At 0.7m (BGS) there was an indistinct but noticeable boundary denoting a second context (303). Below this the peat has a higher clay content than that above the boundary and had reddish brown mottling. Woody roots were present. This context extended to 1.15m (BGS) where the natural substrate was encountered.

6.2.1 Context 303, sample 2

1.00 – 1.05cm BGS

This sample was dominated by waterlogged plant remains with small wood fragments present. Mineralization in the form of Iron pyrites was noted.

This sub-sample was one of the richest samples analysed in this study both in terms of diversity of taxa (38) and numbers of seeds. The majority of the taxa indicated a wetland or aquatic environment, although other habitats were present.

Open water is indicated by the presence of water crowfoot (*Ranunculus* subgenus *Batrachium*), mare's tail (*Hippuris vulgaris*), various-leaved pondweed (*Potamogeton* cf *gramineus*), small pondweed (*Potamogeton* cf *berchtoldii*), opposite-leaved pondweed (*Groenlandia densa*), branched bur-reed (*Sparganium erectum*) and floating club-rush (*Eleogiton fluitans*).

A water's edge environment is indicated by celery-leaved buttercup (*Ranunculus sceleratus*), marsh cinquefoil (*Comarum palustre*), great willowherb (*Epilobium hirsutum*), marsh yellow-cress

(*Rorippa palustris*), water-dock (*Rumex hydrolapathum*), gypsywort (*Lycopus europaeus*), water mint (*Mentha aquatica*), bogbean (*Menyanthes trifoliata*), welted thistle (*Carduus crispus*), common and marsh valerian (*Valeriana officinalis* and *V. dioica*), lesser water-plantain (*Baldellia ranunculoides*), water-plantain (*Alisma planatago-aquatica*), bulrushes (*Typha* sp), rushes (*Juncus* sp), common club-rush (*Schoenoplectus lacustris*), common spike-rush (*Eleocharis palustris*), lesser tussock-sedge (*Carex diandra*), and glaucous sedge (*Carex flacca*).

A drier environment was represented by the presence of buttercup (*Ranunculus acris*/*repens*/*bulbosus*), cinquefoil (*Potentilla* sp), birch (*Betula* sp), knotgrass (*Polygonum aviculare*), oak-leaved/red goosefoot (*Chenopodium glaucum*/*rubrum*), and thistle (*Cirsium* sp).

A more acidic heathland environment is represented by crowberry (*Empetrum nigrum*), sheep's sorrel (*Rumex acetosella*), dwarf birch (*Betula nana*), bog stitchwort (*Stellaria alsine*) and leaves of Sphagnum moss.

Other remains noted from this sub-sample included charcoal fragments, many insect remains, water flea eggs and egg cases (Cladocera) and stonewort (*Chara* sp) oogonia. The latter are indicators of open clear water.

Apart from the charcoal fragments, other charred remains included mare's-tail, common spike-rush and glaucous sedge a mineralised nutlet of lesser tussock-sedge was noted.

0.95 – 1.00m BGS

Large woody fragments along with waterlogged plant remains were recorded from this sub-sample.

Taxa representing similar environments were recorded from this level. But it was noticeable that some of the taxa, such as marsh cinquefoil, great willowherb, marsh willowherb (*Epilobium palustre*), gypsywort, common valerian, branched bur-reed, bulrush, common club-rush, lesser pond-sedge (*Carex acutiformis*) were either present in greater numbers than in the previous sample or recorded for the first time.

This increase with water's edge species and the corresponding decrease in more open water species suggests that there is an accumulation of organic matter raising the level of the surface. Open water is still present but possibly at a greater distance from the sample point. Other water's edge species recorded from this level include marsh-marigold (*Caltha palustris*), greater spearwort (*Ranunculus lingua*), marsh speedwell (*Veronica scutellata*), brooklime (*Veronica beccabunga*), and hemp-agrimony (*Eupatorium cannabinum*).

The bog plant crowberry is still present but in much lower numbers, although the number of Sphagnum moss leaves has increased, suggesting that a heath environment is still present.

Insect remains are still numerous and there is an increase in the number of water fleas eggs and egg cases as well as stonewort oogonia which again suggests that there is still some open water present.

0.90 – 0.95m BGS

This sub-sample also had small wood fragments present and again was dominated by waterlogged plant remains. There is a dramatic decrease in diversity with 22 taxa being recorded whilst in the previous 2 samples 38 and 32 taxa were noted.

The commonest habitat represented was again water's edge but it is noticeable that the species which dominated was common club-rush. The dominance of this species reduced the occurrence of other taxa representative of this environment suggesting that the tall common club-rush was shading out and out-competing the other water's edge species.

Stagnant water may be indicated by the presence of duckweed (*Lemna* sp), but other indicators of open water were absent. The presence of mudwort (*Limosella aquatica*) may suggest that there were some muddy openings within the vegetation.

Other remains such as insects also decrease but earthworm cocoons increase and the remains of caddis fly larval case fragments are recorded in high numbers for the first time. This does suggest that some open water was present but most likely as small isolated pools within the waterside vegetation.

0.85 – 0.90m BGS

Large wood fragments were recorded from this sub-sample but the most noticeable feature of this level is the dramatic decrease in plant taxa recorded. There is a drop from 22 plant taxa in the previous sub-sample to just 5 in this one.

The dominant environment was again waterside vegetation as represented solely by common club-rush. Other taxa such as buttercup, common nettle (*Urtica dioica*), birch and cow parsley (*Anthriscus sylvestris*) indicators of drier land were all present as single or low numbers of finds.

0.80 – 0.85m BGS

This sub-sample consisted of a very woody peat and small fragments of roundwood were present but they were too small to identify. The number of plant taxa was again down on the previous level and few plant remains were recorded.

Single finds of cinquefoil, common nettle, and hedge woundwort (*Stachys sylvestris*) were the only plant taxa recorded.

Insect remains were present in low numbers but charcoal fragments and soil fungal sclerotia (*Cenococcum geophilum*) and earthworm cocoons suggesting a drying out of the local environment.

0.75 – 0.80m BGS

Again this level consisted of many small wood and bark fragments. A large number of moss fragments were also noted.

There was an increase in the number of taxa were recorded from this sub-sample up to 12.

Environments represented included waterside/wetland (celery-leaved buttercup, marsh violet, ragged robin (*Silene flos-cuculi*) gypsywort, marsh lousewort (*Pedicularis palustris*), hemp-agrimony, fine-leaved water-dropwort (*Oenanthe aquatica*) and rushes), open land, tormentil (*Potentilla erecta*), birch, and redshank (*Potentilla maculosa*).

The resting bodies of Cenococcum geophilum increased dramatically in this sample suggesting that there was some periodic drying out but the presence of Sphagnum moss leaves suggests that there were some heath areas still in the area.

6.2.2 Context 302, sample 2

The six sub-samples from this context produced very little in the way of plant remains whether preserved by waterlogging or charring. The plant taxa that were recorded were present in low numbers and in most cases had the appearance of being of modern intrusions and include bramble (*Rubus* sect Glandulosus), common nettle, weld (*Reseda luteola*), redshank, fat hen (*Chenopodium album*), orache (*Atriplex* sp), prickly sow-thistle (*Sonchus asper*), elderberry (*Sambucus nigra*) and fool’s parsley (*Aethusa cynapium*). The majority of the species were indicative of disturbed or rough ground. There were indicators of other habitats such as wetlands and it is possible that these are reworked from lower levels.

The presence of coal fragments, hammerscale, glass fragments and ceramic building material fragments add to the argument that this context has been seriously disturbed in the past.

6.2.3 Discussion

Due to the massive disturbance evident in context 302 there is very little to discuss here. Context 303 on the other hand is very interesting for a variety of reasons.

Overall, this context demonstrates what can be described as a normal hydroseral succession whereby open water taxa are gradually replaced by waterside tall herb fen which is then replaced by a landscape dominated by trees. Although the evidence for trees is lacking in the form of seeds and fruits, the fact that the deposits contain many fragments of wood suggests that trees were present in the area.

In the lower portion there are several taxa which are of interest. Crowberry (*Empetrum nigrum*) is a plant of damp and dry extremely base-poor and nutrient poor peat. In the Birmingham area it is on the extreme southeast edge of its distribution in the UK (Trueman *et al* 2013). Modern records of this species in the Birmingham area include Sutton Park by Readett (1971).

Older records of crowberry are from two locations on Brownhills Common (Trueman *et al* 2013). It was mentioned as colonist of open-cast and bell pit workings near Brownhills by Rees and Skelding (1950), but has not been seen there since 1993 (Trueman *et al* 2013). As the remains of crowberry were found in the lower two deposits including the lower which has been dated to the late Mesolithic it is more likely that this species represents a past environment rather than a more recent one.

As this species is restricted to peatlands and in this area to heathlands, it may suggest that in the Mesolithic, the heathlands in the Birmingham area were more extensive than they are now. It is thought that in the past, heathland in the Birmingham area would have covered a large area linking the heathlands of Channock Chase to those of Worcestershire and Warwickshire (Slater in Trueman *et al* 2013) and therefore covered this site.

The presence of heathlands is supported by the finds of sphagnum moss leaves and dwarf birch (*Betula nana*) in the lower level of (303) which would have grown in the same conditions. This heathland may well have been some distance from the sample source as the number of heathland species is low.

The lower samples are dominated by waterside species, such as common club-rush, and bulrushes. These are tall species and would have dominated the water's edge usually in large stands. Mixed with these tall herbs, plants such as the great and marsh willowherb could be found. and at the water side or the bank side of this tall herb fen, gypsywort would be found or in areas where there was a break in the tall vegetation along with other plants such as the marsh speedwell, brooklime, marsh cinquefoil, bogbean and water mint could also thrive.

Emerging from the water, mare's tail could be expected to be found along with water-plantain and further out the bed of the water body may have been blanketed by stonewort. Further out, away from the tall herb vegetation, more aquatic plants such as water crowfoot and pondweed could be growing.

The presence of pondweeds in these samples, can give and indication of water depth and often water chemistry and conditions.

Various-leaved pondweed (*Potamogeton* cf *gramineus*), occurs in a wide range of habitats including lakes, rivers, streams and ditches (Preston and Croft 1997). It is usually found in shallow waters in depths less than 1.5m. It is usually absent from the most acidic and oligotrophic sites. It is more tolerant of base-poor and nutrient poor water than most broad-leaved pondweeds (Preston and Croft 1997). It can also occur in meso-eutrophic and moderately base-rich sites.

Small pondweed *(Potamogeton* cf *berchtoldii*) is usually found in a wide range of still or slowly flowing waters (Preston and Croft 1997). It can be found in a variety of water chemistries ranging from base-rich to base-poor as well as a wide range of nutrient levels from mesotrophic to eutrophic waters.

Opposite-leaved pondweed (*Groenlandia densa*) grows in shallow, clear base-rich water in rivers, streams, ditches and ponds (Preston and Croft 1997).

The pondweeds suggest that the waters may well have been shallow and base-rich but possible not too rich in nutrients. This may seem contradictive to other plant taxa which have suggested the presence of base-poor peat deposits. It may be the case that close to the water's edge species of a greater range of tolerance of water conditions may have grown whilst further away from the influence of the water body more base-poor tolerant plants could have thrived and may have been washed into the sampling point during times of flooding.

Further up the profile it is evident that the tall herb vegetation becomes more dominant, especially common club-rush which at level 0.9-0.95m BGS appears to form a near pure stand forcing out the other species of the tall herb vegetation and those requiring a more open environment.

The lack of open water species further up the profile may suggest that either the water body had moved or that the presence of a stand of tall herbs has led to a build up of sediment.

6.3 Pollen analysis

The results of the pollen analysis are summarised in Figure 1 and Tables 4 and 5.

6.3.1 Pollen

Context 303 (0.71 – 1.09m BGS)

The basal levels of the sequence are characterised by herbaceous domination (75% TLP) with Poaceae undiff (grasses) (up to 45%TLP) being the most abundant with significant contributions (>5% TLP) being made by Apiaceae (carrot family), *Urtica dioica* (stinging nettle) and Cyperaceae undiff (sedges).

Tree and shrub species in the lower margins of the sequence are represented by *Betula* (birch), Pinus sylvestris (Scot's pine), Salix (willow), *Corylus avellana*-type (hazel) and *Juniperus communis* (common juniper).

Calluna vulgaris (heather) was the dominant heath species contributing 15% TLP in the basal sample although heath species decline as the sequence progresses contributing less than 5% TLP or being completely absent. Solitary identifications of *Empetrum nigrum* (crowberry) and *Vaccinium*-type (bilberry/ heath/ bog-rosemary) occurred at 1.09m and 0.75m respectively.

The remainder of this zone is characterised by an expansion in tree and shrub species with *Pinus sylvestris*, *Corylus avellana*-type and *Betula* being the main contributors. Tree and shrub species increase to 60% TLP at 0.75m before peaking at 92% TLP at 0.71m. Both *Betula* (*c*20% TLP at 0.90 – 0 .85) and *Corylus avellana*-type (29% TLP at 0.75m) peak and decline before the main peak in arboreal species at 0.71m.

Pinus sylvestris is the main contributor to this arboreal expansion and peak, increasing from less than 5% TLP and 10% TLP in the two basal sub-samples, increasing to a *c*40% TLP at 0.79m before peaking at 87% TLP at 0.71m.

This expansion *Pinus sylvestris* is mirrored by *Sphagnum* (Sphagnum peat moss) and *Tilletia sphagni* (see 6.3.2).

Herbaceous species gradually declines throughout the sequence in response to this expansion before rapidly decreasing at the top of the zone (40% TLP at 0.75m; 8% TLP at 0.71m). Poaceae undiff reflects this trend, reducing to 25% TLP at 0.75m before rapidly dropping to 5% TLP at 0.71m. Apiaceae and *Urtica dioica* also decline throughout the zone. Additional herbaceous species including *Solidago virgaurea*-type (daisies/goldenrods), *Filipendula* (meadowsweet), Caryophyllaceae (pink family), Amaranthaceae (goosefoot family) and *Plantago lanceolata* (ribwort plantain) were sporadically identified throughout the zone but their contributions were limited (<5% TLP).

Aquatics were more abundant in the basal margins of this zone becoming absent from the upper sub-samples of this zone. Species identified included *Nymphaea alba* (white water-lily), *Butomus umbellatus* (flowering-rush), *Potamogeton natans*-type (broad-leaved pondweed), *Sparganium erectum* (branched bur-reed) and *Typha latifolia* (bulrush).

Context 302 (0.27m – 0.70m)

The upper zone, represented by Context 302, is marked by a wholly different environment and assemblage from the previous, underlying zone/context.

At the base of this zone, tree and shrub species contribute a greater TLP sum than herbaceous species in two of the sub-samples (*c* 60% vs 40 TLP) yet *Pinus sylvestris* is almost completely absent, contributing less than 5% TLP. *Alnus glutinosa* (alder) (up to 44%), *Tilia cordata* (small-leaved lime) (up to 19% TLP) and *Corylus avellana*-type (5% TLP) are the main components of tree and shrub pollen with lesser contributions (<5% TLP) by *Ulmus* (elm), *Quercus* (oak), *Betula* and *Salix*.

Poaceae undiff (*c* 17% TLP) and Cyperaceae undiff (*c* 7% TLP) are the main contributors of herbaceous pollen at the base of this zone although lesser contributions were also made by *Urtica dioica*, *Cichorium intybus*-type (dandelion/ chicory), *Solidago virgaurea*-type and Apiaceae.

Grains of *Cerealia* indet (indeterminable cereal) and *Hordeum*-type (barley) were also identified in the lower sub-samples from this zone.

The upper sample of the zone was relatively equally divided between herbaceous (55% TLP) and tree and shrub (45% TLP) species. Poaceae undiff (22% TLP) was again the dominant contributor with *Cichorium intybus*-type (7% TLP) and Cyperaceae undiff (5% TLP) also making significant contributions. Lesser contributions (<5% TLP) were made by *Solidago virgaurea*-type, *Urtica dioica*, *Plantago lanceolata*, Apiaceae, Amaranthaceae, *Cirsium* (thistles) and *Trifolium*-type (clovers). Grains of *Cerealia* indet were again present.

Tree and shrub species were the same as in the lower sub-samples from this zone, *Alnus glutinosa* (22% TLP), *Tilia cordata* and *Corylus avellana*-type (both 7% TLP) were the main contributors. The identification of *Ilex aquifolium* (holly) and *Hedera helix* (ivy) were the sole variation from the previous sub-samples.

6.3.2 Parasite ova and fungal spores

Tilletia sphagni was the most abundantly identified fungal spores. It is a plant pathogen, more specifically a smut fungus, whose spores replace those of the mosses within the capsule (Dickson 1973, 63). Due to this parasitic nature, its frequency often parallels that of *Sphagnum* although according to Van Geel (1978) it infects *S. cuspidatum* more than any other *Sphagnum* species. *S. cuspidatum* is "the most aquatic of the British species of *Sphagnum*; a moss of pools and depressions in bogs, including old peat diggings. Also found in runnels and ditches on moorland. Normally found in very acidic habitats" (BBS Field Guides).

This relationship is clearly illustrated in the present sequences with percentages of *Sphagnum* and *Tilletia sphagni* mirroring each other, peaking in the 0.75m and 0.71m sub-samples before declining again.

Other fungal spores were sporadically present within the samples with *Ganoderma* sp being the most abundant. This is a genus of wood-decaying fungi which grow on both coniferous and hardwood tree species causing decay and loss of strength (Schwarze and Ferner, 2003).

Two other identifiable fungal spore species were *Cladosporium* sp and *Pithomyces* sp; both are often found in soil, plant litter and upon decaying leaves.

No parasite ova were identified during the analysis.

7 Synthesis

The sequence recovered from Sheldon Heath can be divided into two separate phases, the upper, Context 302 (0.27m – 0.70m BGS), and the lower, Context 303 (0.71m – 1.09m BGS).

The dating and cause of the break between the two contexts is uncertain but it is clear that the boundary is defined by an unconformity, with an unknown period of time and a period of erosion occurring prior to the deposition of Context 302. The most likely explanation for the unconformity is a change in the hydrology with the local watercourse(s), most likely proto versions of the Westley Brook, Hatchford Brook and the unnamed watercourse to the north of Brays Road, becoming more mobile, migrating and eroding earlier deposits. The drivers for such a change are presently unclear but they may be climatic (increased rainfall) and/or anthropogenic (woodland clearance) in origin.

Overall, the plant macrofossil and pollen analysis of the basal deposit, Context 303, indicates a typical hydoseral succession whereby a wet, open landscape is transformed into drier woodland via the formation of a peat bog. The combination of the radiocarbon dating and the environmental remains indicates that this succession was occurring in the late Mesolithic, with wildwood and heathland extant in the wider landscape.

The character of Context 302 is very different to that of the underlying deposit, with both the plant macrofossils and pollen analysis indicating a more open, scrubby environment with a floodplain or alluvial character.

The preservation of both the plant macrofossils and pollen were poorer in the upper margins of the sequence indicating that they have been affected by disturbance and/or the effects of dewatering and shrinkage.

The relative absence of elm and the relatively high contribution of lime pollen may be indicative of a Neolithic or Bronze Age date, Lime is thought to have been a considerable, if not dominant, component of the wildwood of the Midland lowlands during the Neolithic, and the work of Brown (1982) at Ashmoor Common and Callow End (Worcestershire) and Greig (2007) at Wellington (Herefordshire) both support this prevalence of lime during that period. The figure of 19% TLP contribution of lime pollen from the Sheldon Heath sequence is similar to that identified at Ashmoor Common and Wilden Marsh (Brown 1982, 1988) and Worcester (BH8, Daffern 2013).

Strengthening the possibility that these deposits are late Neolithic/ Bronze Age in date is the tentative indication of the lime decline with TLP contribution decreasing upwards.

This anthropogenic decline is diachronous throughout Britain (Turner 1962) and is thought to have occurred due to clearance of woodland from fertile soils (the preferable habitat of limes) for agriculture. This is somewhat supported by the limited presence of unidentifiable cereals and grains of barley in the upper samples.

Despite its occurrence being variable throughout Britain, within the West Midlands it consistently occurs in the late-Neolithic or early-Bronze Age e.g. *c* 2000-2250 cal BC at Wellington, Herefordshire (Greig 2007) and Clifton, Worcestershire (Head and Daffern forthcoming), *c* 2300-2850 cal BC at Cookley, Worcestershire (Greig unpublished), *c* 2000 BC at Worcester (Daffern 2013) and, more locally, *c* 2130 cal BC at Perry Barr (Tetlow *et al* 2008).

Unfortunately, no suitable material for radiocarbon dating was available at this level and fears of contamination, as frequently noted during the plant macrofossil analysis, mean that the results of this dating must remain cautionary.

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.

Full analysis of environmental remains from an archaeological evaluation at land to the north of Brays Road, Sheldon Heath Birmingham (NGR SP 1504 8516) was undertaken on behalf of CgMs Consulting and on behalf of their client as part of an agreed programme of mitigation works.

The sequence recovered from Sheldon Heath can be divided into two phases, separated by an unconformity, with an unknown period of time and period of erosion occurring prior to the deposition of the upper. The likely explanation is a change in the hydrology with the local watercourse migrating and eroding earlier deposits.

Six samples were submitted for Accelerator Mass Spectrometry (AMS) radiocarbon dating. Two samples failed due to insufficient carbon being present, these were replaced with substitute material whose potential for dating was higher. The three samples from the basal margins, 0.95m – 1.05m BGS (Beta-365217, Beta- 367147, SUERC-46779), all produced late Mesolithic dates (between 4347 – 3970 cal BC). The sole successful sample from further up the sequence (0.75m – 0.80m; SUERC-47007) was dated much earlier, 8631 – 8461 cal BC.

The basal deposit indicates a typical hydoseral succession whereby a wet, open landscape is transformed into drier woodland via the formation of a peat bog. The combination of the radiocarbon dating and the environmental remains indicates that this succession was occurring in the late Mesolithic, with wildwood and heathland extant in the wider landscape.

The upper deposit is very different to that of the underlying deposit, with both the plant macrofossils and pollen analysis indicating a more open, scrubby environment with a floodplain or alluvial character.

9 Acknowledgements

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Tables

Context	Sample	Sub-sample (m BGS)	Volume processed (l)
302	2	0.20-0.25	1
302	2	0.30-0.35	1
302	2	0.35-0.40	1
302	2	0.40-0.45	1
302	2	0.45-0.50	1
302	2	0.50-0.55	1
303	2	0.75-0.80	1
303	2	0.80-0.85	1
303	2	0.85-0.90	1
303	2	0.90-0.95	1
303	2	0.95-1.00	1
303	2	1.00-1.05	1

Table 1 Samples processed and analysed from Sheldon Heath, Birmingham

Context, sample number and depth (m BGS)	Laboratory code	Material	13C/12C	Radiocarbon Age BP	OxCal calibrated age (95.4% probability or 2 sigma)
(302) <2> 0.20m – 0.25m	GU30541	Seeds: *Chenopodium album*	N/A	Failed: insufficient carbon	Failed: insufficient carbon
302 <2> 0.75m – 0.80m	SUERC-47007 (GU31016)	Waterlogged wood: *Betula* sp (10+ rings)	-28.6 ‰	9298 ± 28	8631 – 8461 cal BC
302 <2> 0.95m – 1.00m	Beta-365217	Waterlogged wood: *Alnus* sp	-27.7 ‰	5390 ± 30	4331 – 4229 cal BC AND 4194 – 4173 cal BC
302 <2> 1.00m – 1.05m	Beta-367147	Waterlogged wood: *Alnus* sp	-24.5 ‰	5250 ± 40	4230 – 4190 cal BC AND 4170 – 3970 cal BC
302 <2> 1.00m – 1.05m	Beta-365218	Seeds: *Empetrum nigrum*	N/A	Failed: insufficient carbon	Failed: insufficient carbon
(303) <2> 1.00m – 1.05m	SUERC-46779 (GU30542)	Waterlogged wood: *Alnus glutinosa* (4+ rings)	-27.2 ‰	5440 ± 34	4347 – 4241 cal BC

Table 2 Radiocarbon dating results

Habitat
A= cultivated ground
B= disturbed ground
C= woodlands, hedgerows, scrub etc
D = grasslands, meadows and heathland
E = aquatic/wet habitats
F = cultivar
G = bogs

Key to Table 3

		Context	302	302	302	302	302	302	303	303	303	303	303	303
Latin name	**Common name**	**Habitat**	**20-25cm**	**30-35cm**	**35-40cm**	**40-45cm**	**45-50cm**	**50-55cm**	**75-80cm**	**80-85cm**	**85-90cm**	**90-95cm**	**95-100cm**	**100-105cm**
Waterlogged														
Caltha palustris	marsh-marigold	E											1	
Ranunculus acris/repens/bulbosus	buttercup	CD							1		1		8	1
Ranunculus acris/repens/bulbosus fragment	buttercup	CD										1	4	
Ranunculus sceleratus	celery-leaved buttercup	E							18					26
Ranunculus sceleratus fragments	celery-leaved buttercup	E							18					8
Ranunculus lingua	greater spearwort	E											1	
Ranunculus lingua (fragment)	greater spearwort	E											12	
Ranunculus sbgen *Batrachium*	crowfoot	E											17	26
Ranunculus sbgen *Batrachium* (fragment)	crowfoot	E											216	35
Rubus sect Glandulosus	bramble	CD					1							
Rubus sect Glandulosus (fragment)	bramble	CD			2	1	1	1						
Potentilla erecta	tormentil	D							4					
Potentilla sp	cinquefoil	BCDE								1				1
Potentilla sp fragments	cinquefoil	BCDE												2
Comarum palustre	marsh cinquefoil	E										24	33	16
Comarum palustre fragments	water cinquefoil	E										15	237	21
Urtica dioica	common nettle	ABCD					1	1		1	2	1		
Betula sp (cone bract)	silver birch	C												1
Betula nana fruit	dwarf birch	G												1
Betula sp	silver birch	C							2		1	1	4	8
Viola palustris	marsh violet	E						3	6			1		
Viola palustris fragment	marsh violet	E							4					

		Context	302	302	302	302	302	302	303	303	303	303	303	303
Latin name	**Common name**	**Habitat**	**20-25cm**	**30-35cm**	**35-40cm**	**40-45cm**	**45-50cm**	**50-55cm**	**75-80cm**	**80-85cm**	**85-90cm**	**90-95cm**	**95-100cm**	**100-105cm**
Epilobium hirsutum	great willowherb	E										3	422	57
Epilobium hirsutum fragments	great willowherb	E											517	
Epilobium palustre	marsh willowherb	E										11	147	
Epilobium palustre fragments	march willowherb	E											44	
Reseda luteola	dyer's rocket, weld	ABDF	1											
Rorippa palustris	marsh yellow-cress	E											1	1
Persicaria maculosa	redshank	AB					4							
Persicaria maculosa (fragment)	redshank	AB					2		2					
Polygonum aviculare	knotgrass	AB												1
Rumex acetosella	sheep's sorrel	ABD												4
Rumex acetosella (fragment)	sheep's sorrel	ABD											1	2
Rumex hydrolapathum	water-dock	E										1	2	7
Rumex hydrolapathum (fruit fragment)	water-dock	E											1	1
Stellaria alsine	bog stitchwort	E												6
Stellaria alsine fragments	bog stitchwort	E												1
Silene flos-cuculi	ragged-robin	ABE							3					
Chenopodium glaucum/rubrum	oak-leaved/red goosefoot	AB												5
Chenopodium album	fat hen	AB		1	1		4							
Chenopodium album (fragment)	fat hen	AB	1											
Atriplex sp	orache	AB	1		1									
Atriplex sp (fragment)	orache	AB	4											
Empetrum nigrum	crowberry	G											1	7
Empetrum nigrum fragments	crowberry	G												3

		Context	302	302	302	302	302	302	303	303	303	303	303	303
Latin name	**Common name**	**Habitat**	**20-25cm**	**30-35cm**	**35-40cm**	**40-45cm**	**45-50cm**	**50-55cm**	**75-80cm**	**80-85cm**	**85-90cm**	**90-95cm**	**95-100cm**	**100-105cm**
Veronica scutellata	marsh speedwell	E										11	12	
Veronica beccabunga	brooklime	E											3	
Hippuris vulgaris	mare's-tail	E										1	1	34
Limosella aquatica	mudwort	E										1		
Stachys sylvatica	hedge woundwort	CD								1				
Lycopus europaeus	gypsywort	E							5			272	1012	14
Lycopus europaeus fragments	gypsywort	E							7			158	506	
Mentha aquatica	water mint	E												1
Mentha aquatica fragments	water mint	E												5
Pedicularis palustris	marsh lousewort	DG							1					
Menyanthes trifoliata	bogbean	E											1	9
Menyanthes trifoliata (fragment)	bogbean	E											10	3
Carduus crispus	welted thistle	CE											5	3
Carduus crispus fragments	welted thistle	CE											4	1
Cirsium sp	thistle	ABDE												2
Eupatorium cannabinum (fragment)	hemp-agrimony	DE						2	2				1	
Sonchus asper	prickly sow-thistle	ABD					1							
Sambucus nigra (fragment)	elderberry	BC	2											
Valeriana officinalis	common valerian	DE										1	13	2
Valeriana officinalis fragments	common valerian	DE										4	55	
Valeriana dioica	marsh valerian	E												2
Valeriana dioica fragments	marsh valerian	E												1
Anthriscus cf *sylvestris*	cow parsley	CD									1			

		Context	302	302	302	302	302	302	303	303	303	303	303	303
Latin name	**Common name**	**Habitat**	**20-25cm**	**30-35cm**	**35-40cm**	**40-45cm**	**45-50cm**	**50-55cm**	**75-80cm**	**80-85cm**	**85-90cm**	**90-95cm**	**95-100cm**	**100-105cm**
Oenanthe aquatica	fine-leaved water-dropwort	E							1					
Aethusa cynapium	fool's parsley	AB	1											
Apium nodiflorum	fool's watercress	E										5		
Lemna sp	duckweed	E										2		
Baldellia ranunculoides	lesser water-plantain	E												2
Alisma plantago-aquatica (seed)	water-plantain	E												1
Alisma sp (seed)	water-plantain	E										1		
Potamogeton cf *gramineus*	various-leaved pondweed	E											3	19
Potamogeton cf *berchtoldii*	small pondweed	E												10
Potamogeton sp lids	pondweed	E											48	22
Potamogeton sp	pondweed	E											4	
Potamogeton sp (fragment)	pondweed	E												17
Groenlandia densa	opposite-leaved pondweed	E											2	7
Groenlandia densa fragments	opposite-leaved pondweed	E											28	
Sparganium erectum	branched bur-reed	E												12
Sparganium erectum (fragments)	branched bur-reed	E											95	1
Sparganium erectum (embryo)	branched bur-reed	E										3	94	4
Sparganium emersum	unbranched bur-reed	E											21	
Typha sp	bulrushes	E										826	2057	175
Juncus sp	rush	DE							2					2

		Context	302	302	302	302	302	302	303	303	303	303	303	303
Latin name	**Common name**	**Habitat**	**20-25cm**	**30-35cm**	**35-40cm**	**40-45cm**	**45-50cm**	**50-55cm**	**75-80cm**	**80-85cm**	**85-90cm**	**90-95cm**	**95-100cm**	**100-105cm**
Schoenoplectus lacustris	common club-rush	E									670	4060	198	132
Schoenoplectus lacustris (fragment)	common club-rush	E									685	2947	80	30
Schoenoplectus lacustris embryo	common club-rush	E									25	135		
Eleocharis palustris	common spike-rush	E										2	25	127
Eleocharis palustris fragments	common club-rush	E											10	20
Eleogiton fluitans	floating club-rush	E												197
Carex diandra	lesser tussock-sedge	E												34
Carex acutiformis	lesser pond-sedge	E										50	51	
Carex acutiformis fragments	lesser pond-sedge	E										136	10	
Carex flacca nutlets and utricles	glaucous sedge	DE												21
Carex flacca nutlets	glaucous sedge	DE												385
Carex flacca utricles	glaucous sedge	DE												7
Carex sp fragments	sedge	CDE											1	191
Carex sp (2-sided) nutlets	sedge	CDE											28	
Carex sp utricles	sedge	CDE										8	15	
Glyceria sp grain	sweet grasses	E										13	9	
Danthonia decumbens	heath-grass	D											1	
Poaceae sp indet grain	grass	AF	1						1				3	2
unidentified moss fragments									77	4		3	5	23
unidentified moss leaves												130		
unidentified leaf fragments														1
unidentified bud													1	13
Cenococcum geophilum sclerotia	fungus		3	1			10	25	781	27	17	14		

		Context	302	302	302	302	302	302	303	303	303	303	303	303
Latin name	**Common name**	**Habitat**	**20-25cm**	**30-35cm**	**35-40cm**	**40-45cm**	**45-50cm**	**50-55cm**	**75-80cm**	**80-85cm**	**85-90cm**	**90-95cm**	**95-100cm**	**100-105cm**
unidentifed charcoal fragments			4	17	10	1	149	55	7	28	1		59	18
unidentified insect remains										10+		10+	1000+	1000+
unidentified coal fragments			29	34	10	4	2	1						
unidentified slag			4	1	18		1							
unidentified earthworm coccoons			1	12	6	13		6	3	19	6	22	11	14
unidentified spherical hammerscale				2		1								
unidentified flake hammerscale						1								
unidentified Trichoptera (Caddis fly) larval case fragments	caddis fly								1			229		
Cladoceran ephippia	water flea egg pouches											2	124	35
Chara sp oogonia	stonewort	E											51	86
Sphagnum sp leaves	sphagnum moss	G		2				14	22				54	1
Charred														
Hippuris vulgaris	mare's-tail	E												1
Schoenoplectus lacustris	common club-rush	E											1	
Eleocharis palustris	common spike-rush	E												1
Carex flacca nutlets	glaucous sedge	DE												2
Poaceae sp indet culm node	grasses	AF	5											
Poaceae sp culm base	grasses	AF	1											
Poaceae sp indet stem frags	grasses	ABCD	6											
Mineralised														
Carex diandra	lesser tussock-sedge	E												1

Table 3 Plant remains from Sheldon Heath, Birmingham

			Context 302				
	Family	Common Name(s)	0.27m	0.39m	0.47m	0.55m	0.63m
Pinus sylvestris	Pinaceae	Scots pine	3		1	8	1
Juniperus communis	Cupressaceae	common juniper					
Ulmus	Ulmaceae	elm	1		2	4	
Quercus	Fagaceae	oak	5		6	6	
Betula	Betulaceae	birch	4		13	8	
Alnus glutinosa	Betulaceae	alder	77	1	136	88	
Corylus avellana -type	Betulaceae	hazel	22	1	7	17	
Salix	Salicaceae	willow	8		3	3	
Tilia cordata	Malvaceae	small-leaved lime	22	1	31	59	
Ilex aquifolium	Aquifoliaceae	holly	2				
Hedera helix	Araliacae	ivy	2				
Empetrum nigrum	Ericaceae	crowberry					
Calluna vulgaris	Ericaceae	heather			1	2	
Vaccinium -type	Ericaceae	bilberry/ heath/ bog-rosemary					
Caltha palustris -type	Ranunculaceae	marsh-marigold/ mousetail/ columbine			1		
Ranunculus acris -type	Ranunculaceae	meadow buttercup	2		1		
Chrysosplenium	Saxifragaceae	golden saxifrage	1				
Trifolium -type	Fabaceae	clovers	3				
Rosaceae	Rosaceae	rose family	1		1	2	
Filipendula	Rosaceae	meadowsweet					
Potentilla -type	Rosaceae	cinquefoils	2				
Urtica dioica	Urticaceae	stinging nettle	7			11	
cf Euphorbia	Euphorbiaceae	spurges					
Daphne laureola	Thymelaeaceae	spurge-laurel				1	
Persicaria bistorta -type	Polygonaceae	Common bistort			1		
Polygonum	Polygonaceae	knotgrass	1				
Rumex acetosella	Polygonaceae	sheep's sorrel				1	
Caryophyllaceae	Caryophyllaceae	pink family	3			1	
Amaranthaceae	Amaranthaceae	goosefoot family	4		5	2	
Primula veris -type	Primulaceae	cowslip/ primrose	1		1		
Rubiaceae	Rubiaceae	bedstraw family			1		
Cuscuta	Convolvulaceae	dodders					
Plantago major	Plantaginaceae	greater plantain	1				
Plantago lanceolata	Plantaginaceae	ribwort plantain	8		2		
Mentha -type	Lamiaceae	mints/ thymes/ gypsywort					
Pinguicula	Lentibulariaceae	butterworts					
Centaurea nigra	Asteraceae	common knapweed	1				
Cichorium intybus -type	Asteraceae	chicory/ dandelion	24		9	10	
Solidago virgaurea -type	Asteraceae	daisies/ goldenrods	10		6	1	
Cirsium -type	Asteraceae	thistles	5		1		
Adoxa moschatellina	Adoxaceae	moschatel					
Valeriana dioica	Valerianaceae	marsh valerian					
Apiaceae	Apiaceae	carrot family	6	1	4	4	
Iris	Iridaceae	Iris			1		
Cyperaceae undiff	Cyperaceae	sedge	17	1	20	24	
Poaceae undiff	Poaceae	grasses	72	1	50	56	
Cerealia indet	Poaceae	indeterminable cereal	6	1	6	7	
Hordeum- type	Poaceae	barley				1	
		TLP Grains counted	**321**	**7**	**310**	**316**	**1**
Nymphaea alba	Nymphaeaceae	white water-lily					
Callitriche	Callitrichaceae	water-starworts	1				
Lemnaceae	Lemnaceae	duckweeds				1	
Sagittaria sagittifolia	Alismataceae	arrowhead	1				
Butomus umbellatus	Butomaceae	flowering-rush					
Potamogeton natans -type	Potamogetonaceae	broad-leaved pondweed					
Sparganium erectum	Typhaceae	branched bur-reed					
Typha latifolia	Typhaceae	bulrush					
Ophioglossum	Ophioglossaceae	adder's-tongues	2				
Equisetum	Equisetaceae	horsetail family	4			2	
Pteridium aquilinum	Dennstaedtiaceae	bracken	12		3	6	
cf Athyrium filix-femina	Woodsiaceae	lady fern			2		
Polystichum	Dryopteridaceae	shield-ferns			4		
Polypodium	Polypodiaceae	polypody	4		18	36	
Pteropsida (mono) indet		ferns	23		32	38	
Sphagnum	Sphagnaceae	peat moss	8		4	2	
Tilletia sphagni	Tilletiaceae		3			1	

Table 4 Pollen results from Context 302

			Context 303							
	Family	Common Name(s)	0.71m	0.75m	0.79m	0.83m	0.87m	0.91m	1.03m	1.09m
Pinus sylvestris	Pinaceae	Scots pine	265	73	118	109	74	73	33	3
Juniperus communis	Cupressaceae	common juniper					1		2	
Ulmus	Ulmaceae	elm	1			2				
Quercus	Fagaceae	oak			1					
Betula	Betulaceae	birch	1	11	4	20	64	69	32	23
Alnus glutinosa	Betulaceae	alder	5	13	5	2		1		
Corylus avellana-type	Betulaceae	hazel	7	95	36	43	30	30		1
Salix	Salicaceae	willow	1	3	4	6	5	7	10	5
Tilia cordata	Malvaceae	small-leaved lime								
Ilex aquifolium	Aquifoliaceae	holly								
Hedera helix	Araliacae	ivy								
Empetrum nigrum	Ericaceae	crowberry								1
Calluna vulgaris	Ericaceae	heather			8			3	15	50
Vaccinium-type	Ericaceae	bilberry/ heath/ bog-rosemary		1						
Caltha palustris-type	Ranunculaceae	marsh-marigold/ mousetail/ columbine								
Ranunculus acris-type	Ranunculaceae	meadow buttercup				2			1	1
Chrysosplenium	Saxifragaceae	golden saxifrage			1	2	1			
Trifolium-type	Fabaceae	clovers						1		1
Rosaceae	Rosaceae	rose family	1	1					2	2
Filipendula	Rosaceae	meadowsweet			1	1	7	4	9	4
Potentilla-type	Rosaceae	cinquefoils								2
Urtica dioica	Urticaceae	stinging nettle		4	16	14	22	12	18	38
cf Euphorbia	Euphorbiaceae	spurges				1				
Daphne laureola	Thymelaeaceae	spurge-laurel								
Persicaria bistorta-type	Polygonaceae	Common bistort								
Polygonum	Polygonaceae	knotgrass								
Rumex acetosella	Polygonaceae	sheep's sorrel								1
Caryophyllaceae	Caryophyllaceae	pink family		6		2	1		3	3
Amaranthaceae	Amaranthaceae	goosefoot family			5	1		3		1
Primula veris-type	Primulaceae	cowslip/ primrose				1	2			
Rubiaceae	Rubiaceae	bedstraw family							1	1
Cuscuta	Convolvulaceae	dodders								1
Plantago major	Plantaginaceae	greater plantain			2					1
Plantago lanceolata	Plantaginaceae	ribwort plantain			2	1				3
Mentha-type	Lamiaceae	mints/ thymes/ gypsywort								1
Pinguicula	Lentibulariaceae	butterworts								1
Centaurea nigra	Asteraceae	common knapweed								
Cichorium intybus-type	Asteraceae	chicory/ dandelion		2			2			2
Solidago virgaurea-type	Asteraceae	daisies/ goldenrods		4	10	8	10	9		2
Cirsium-type	Asteraceae	thistles						1	2	
Adoxa moschatellina	Adoxaceae	moschatel		1						
Valeriana dioica	Valerianaceae	marsh valerian								1
Apiaceae	Apiaceae	carrot family	1					1	12	66
Iris	Iridaceae	Iris								
Cyperaceae undiff	Cyperaceae	sedge	9	30	17	26	25	22	37	16
Poaceae undiff	Poaceae	grasses	14	83	87	83	84	86	142	103
Cerealia indet	Poaceae	indeterminable cereal								
Hordeum-type	Poaceae	barley								
		TLP Grains counted	**305**	**327**	**317**	**324**	**328**	**322**	**319**	**334**
Nymphaea alba	Nymphaeaceae	white water-lily							1	
Callitriche	Callitrichaceae	water-starworts								
Lemnaceae	Lemnaceae	duckweeds								
Sagittaria sagittifolia	Alismataceae	arrowhead								
Butomus umbellatus	Butomaceae	flowering-rush								2
Potamogeton natans-type	Potamogetonaceae	broad-leaved pondweed				1				
Sparganium erectum	Typhaceae	branched bur-reed						1	4	
Typha latifolia	Typhaceae	bulrush							1	
Ophioglossum	Ophioglossaceae	adder's-tongues								
Equisetum	Equisetaceae	horsetail family								
Pteridium aquilinum	Dennstaedtiaceae	bracken	5	3	1	1				4
cf Athyrium filix-femina	Woodsiaceae	lady fern								
Polystichum	Dryopteridaceae	shield-ferns	1							
Polypodium	Polypodiaceae	polypody	1		8	9	6	7		1
Pteropsida (mono) indet		ferns	27	31	35	75	50	47	35	3
Sphagnum	Sphagnaceae	peat moss	220	239	70	23	14	14	2	
Tilletia sphagni	Tilletiaceae		170	190	45	26	9	7		

Table 5 Pollen results from Context 303

Figures

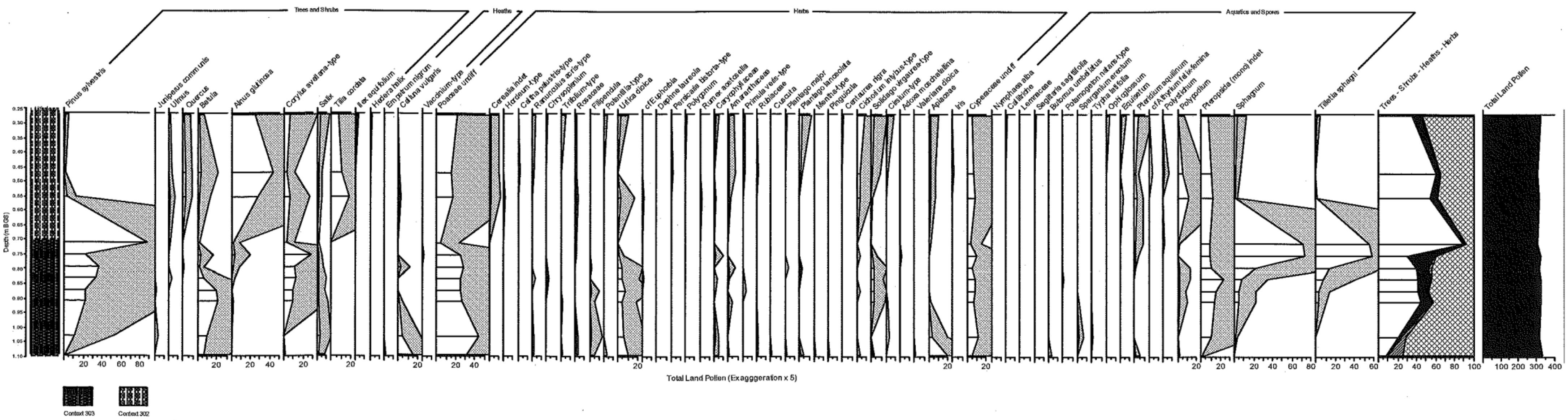


Figure 1 Pollen diagram - Sheldon Heath Monolith 1

Appendix 1 Radiocarbon dating

Scottish Universities Environmental Research Centre

Director: Professor R M Ellam

Rankine Avenue, Scottish Enterprise Technology Park,
East Kilbride, Glasgow G75 0QF, Scotland, UK
Tel: +44 (0)1355 223332 Fax: +44 (0)1355 229898 www.glasgow.ac.uk/suerc

RADIOCARBON DATING CERTIFICATE

26 June 2013

Laboratory Code	GU30541
Submitter	Nick Daffern Worcestershire Archaeology The Hive, Sawmill Walk The Butts, Worcester WR1 3PB
Site Reference	Sheldon Heath
Context Reference	302
Sample Reference	SHB13/2/302/0-5
Material	Waterlogged seeds : Chenopodium album
Result	Failed: insufficient carbon.

N.B. Any questions directed to the Radiocarbon Laboratory should quote the GU coding given above.

The contact details for the laboratory are email g.cook@suerc.gla.ac.uk or telephone 01355 270136 direct line.

Checked and signed off by :-

Date :-

Scottish Universities Environmental Research Centre
Director: Professor R M Ellam
Rankine Avenue, Scottish Enterprise Technology Park,
East Kilbride, Glasgow G75 0QF, Scotland, UK
Tel: +44 (0)1355 223332 Fax: +44 (0)1355 229898 www.glasgow.ac.uk/suerc

RADIOCARBON DATING CERTIFICATE

01 July 2013

Laboratory Code	SUERC-47007 (GU31016)
Submitter	Nick Daffern Worcestershire Archaeology The Hive, Sawmill Walk The Butts, Worcester WR1 3PB
Site Reference	Sheldon Heath
Context Reference	303
Sample Reference	SHB13/2/303/55-60
Material	Wood : Betulasp (10+ rings)
δ^{13}C relative to VPDB	-28.6 ‰
Radiocarbon Age BP	9298 ± 28

N.B. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error.

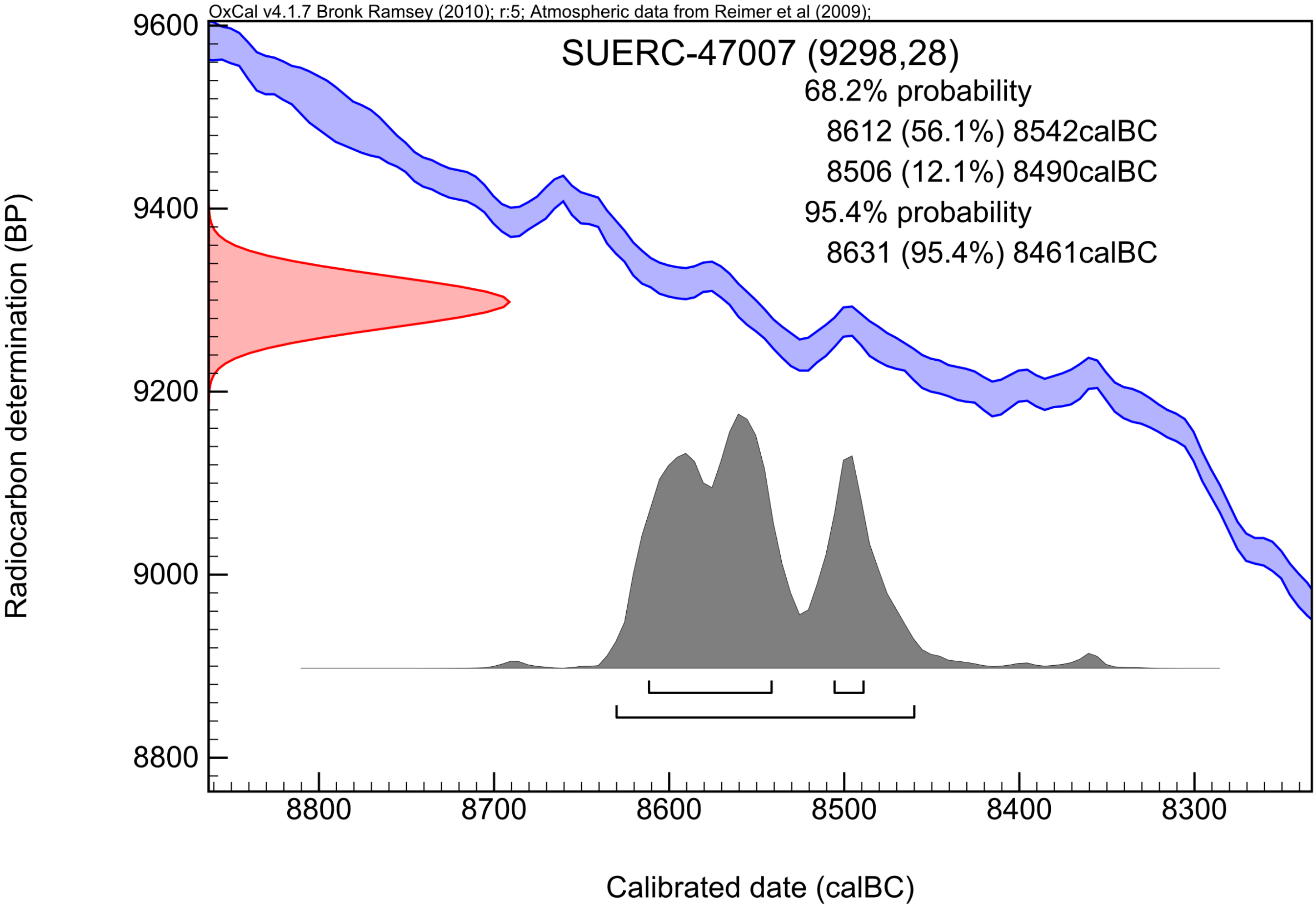
The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal4).

Samples with a SUERC coding are measured at the Scottish Universities Environmental Research Centre AMS Facility and should be quoted as such in any reports within the scientific literature. Any questions directed to the Radiocarbon Laboratory should also quote the GU coding given in parentheses after the SUERC code. The contact details for the laboratory are email g.cook@suerc.gla.ac.uk or telephone 01355 270136 direct line.

Conventional age and calibration age ranges calculated by :- Date :-

Checked and signed off by :- Date :-

Calibration Plot



Scottish Universities Environmental Research Centre

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RADIOCARBON DATING CERTIFICATE

26 June 2013

Laboratory Code	SUERC-46779 (GU30542)
Submitter	Nick Daffern Worcestershire Archaeology The Hive, Sawmill Walk The Butts, Worcester WR1 3PB
Site Reference	Sheldon Heath
Context Reference	303
Sample Reference	SHB13/2/303/80-85
Material	Waterlogged wood : Alnus glutinosa (4+ rings)
$\delta^{13}C$ relative to VPDB	-27.2 ‰
Radiocarbon Age BP	5440 ± 34

N.B. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error.

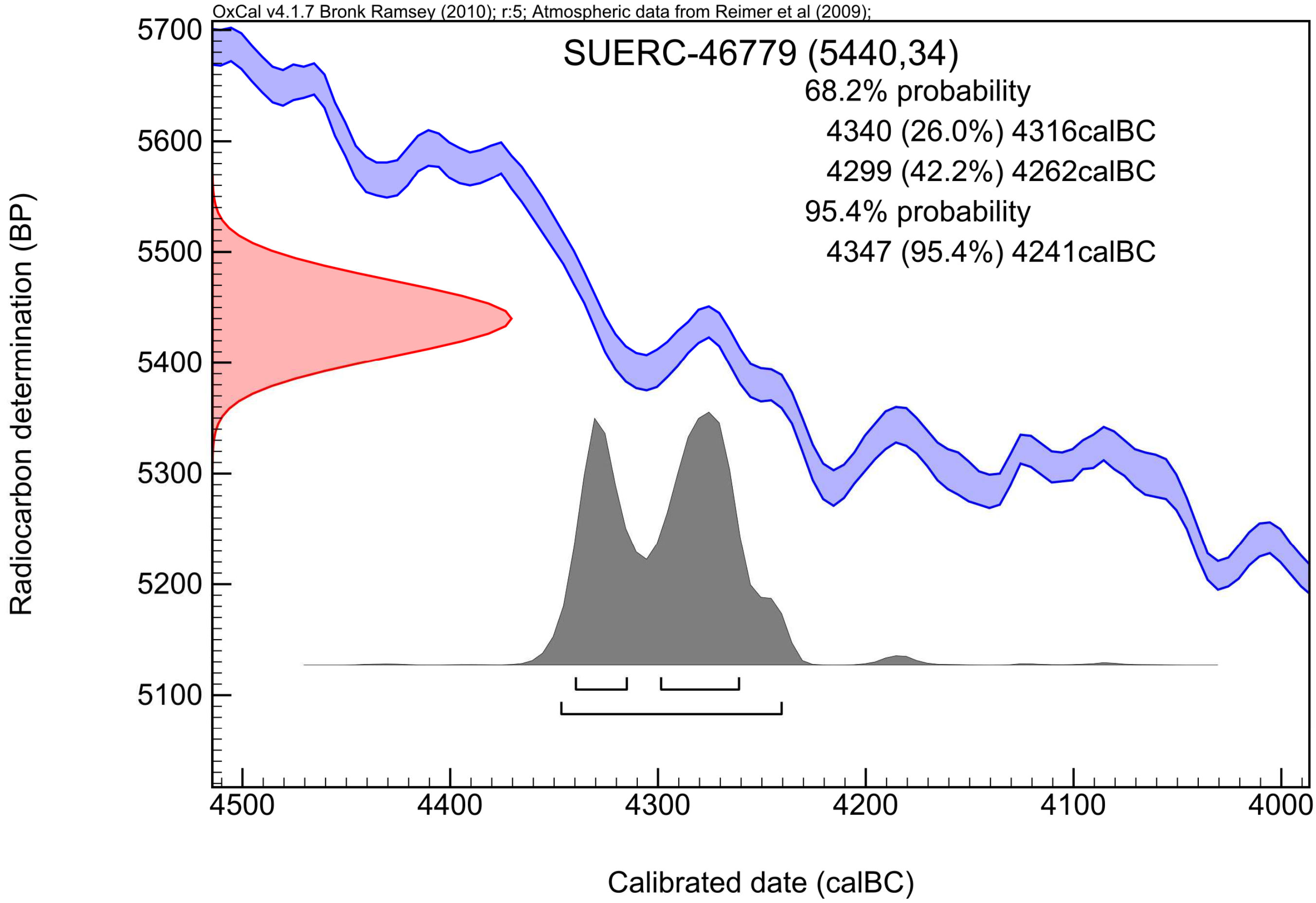
The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal4).

Samples with a SUERC coding are measured at the Scottish Universities Environmental Research Centre AMS Facility and should be quoted as such in any reports within the scientific literature. Any questions directed to the Radiocarbon Laboratory should also quote the GU coding given in parentheses after the SUERC code. The contact details for the laboratory are email g.cook@suerc.gla.ac.uk or telephone 01355 270136 direct line.

Conventional age and calibration age ranges calculated by :- Date :-

Checked and signed off by :- Date :-

Calibration Plot



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beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Dr. Nick Daffern | Report Date: 12/11/2013

Worcestershire Archive and Archaeology Service | Material Received: 11/19/2013

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 365217	5430 +/- 30 BP	-27.7 o/oo	5390 +/- 30 BP

SAMPLE : SHB13/303/75-80
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (wood): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 4331 to 4229 (Cal BP 6281 to 6179) AND Cal BC 4194 to 4173 (Cal BP 6144 to 6123)

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-27.7:lab. mult=1)

Laboratory number: **Beta-365217**

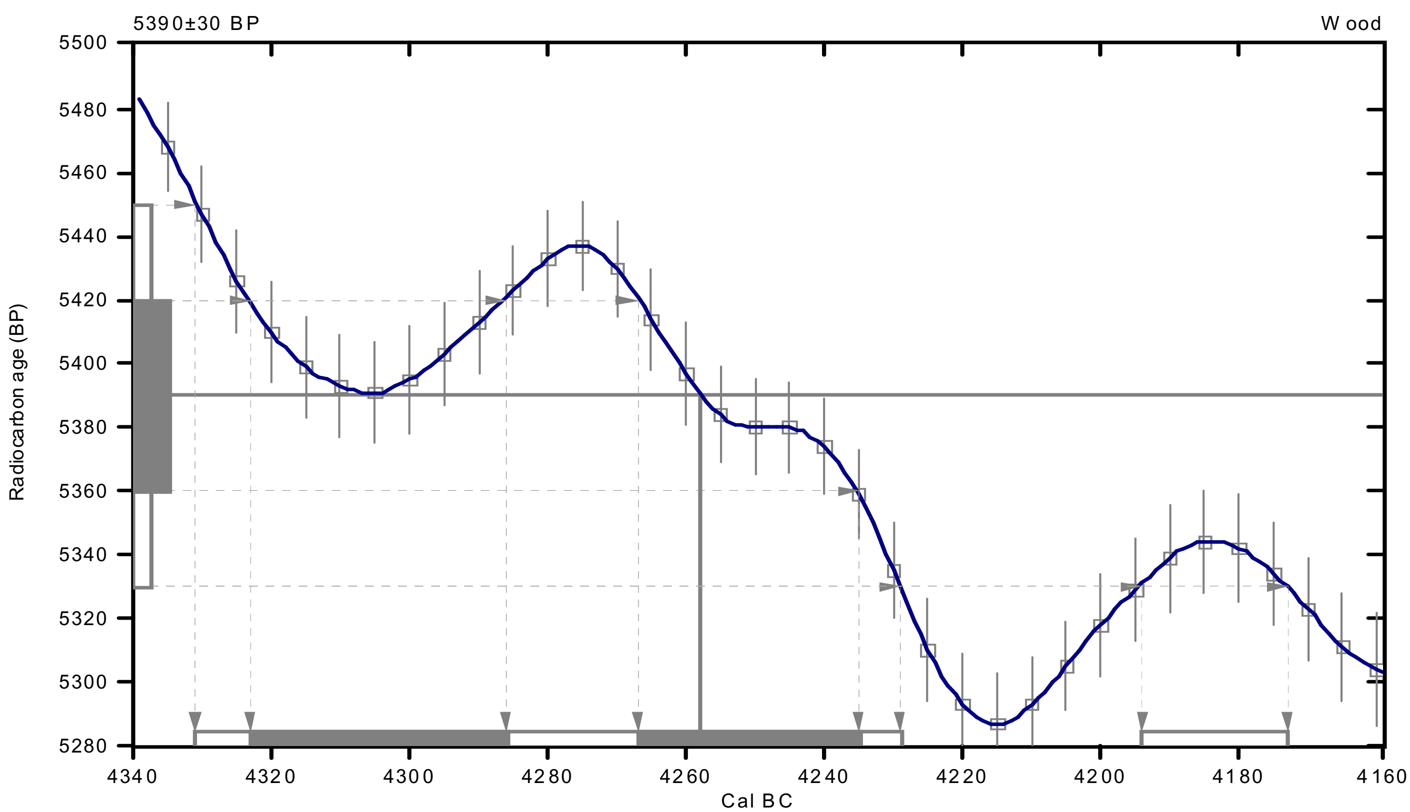
Conventional radiocarbon age: **5390±30 BP**

2 Sigma calibrated results: (95% probability) **Cal BC 4331 to 4229 (Cal BP 6281 to 6179) and Cal BC 4194 to 4173 (Cal BP 6144 to 6123)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 4258 (Cal BP 6208)

1 Sigma calibrated results: (68% probability) Cal BC 4323 to 4286 (Cal BP 6273 to 6236) and Cal BC 4267 to 4235 (Cal BP 6217 to 6185)



References:

Database used

INTCAL09

References to INTCAL09 database

Heaton,et.al.,2009, Radiocarbon 51(4):1151-1164, Reimer,et.al, 2009, Radiocarbon 51(4):1111-1150, Stuiver,et.al,1993, Radiocarbon 35(1):1-244, Oeschger,et.al.,1975,Tellus 27:168-192

Mathematics used for calibration scenario

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2):317-322

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REPORT OF RADIOCARBON DATING ANALYSES

Dr. Nick Daffern — Report Date: 12/30/2013

Worcestershire Archive and Archaeology Service — Material Received: 12/10/2013

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 367147	5240 +/- 40 BP	-24.5 o/oo	5250 +/- 40 BP

SAMPLE : SHB13/2/303/80-85
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (wood): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 4230 to 4190 (Cal BP 6180 to 6140) AND Cal BC 4170 to 3970 (Cal BP 6120 to 5920)

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number: **Beta-367147**

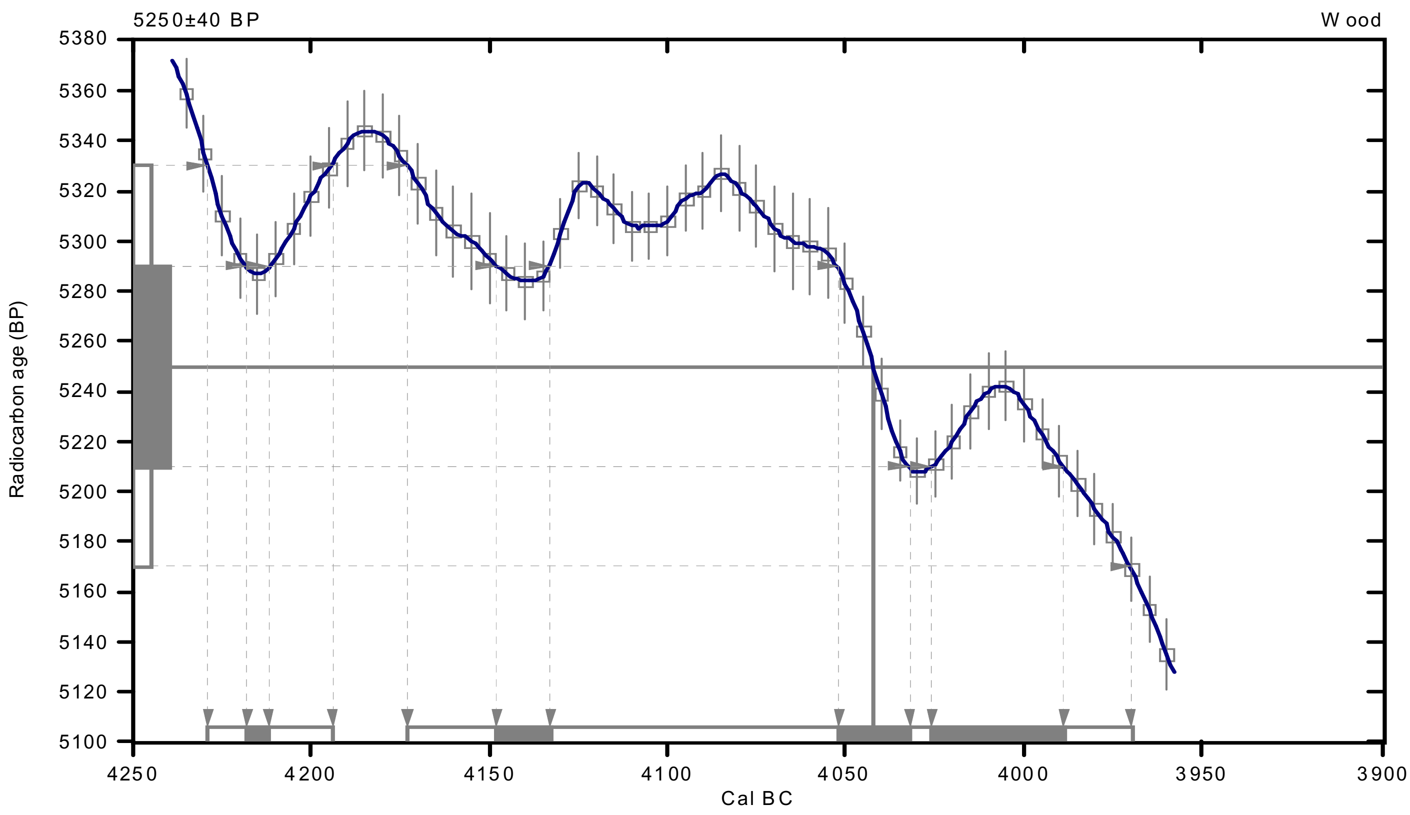
Conventional radiocarbon age: **5250±40 BP**

2 Sigma calibrated results: **Cal BC 4230 to 4190 (Cal BP 6180 to 6140) and**
(95% probability) **Cal BC 4170 to 3970 (Cal BP 6120 to 5920)**

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal BC 4040 (Cal BP 5990)

1 Sigma calibrated results: Cal BC 4220 to 4210 (Cal BP 6170 to 6160) and
(68% probability) Cal BC 4150 to 4130 (Cal BP 6100 to 6080) and
Cal BC 4050 to 4030 (Cal BP 6000 to 5980) and
Cal BC 4030 to 3990 (Cal BP 5980 to 5940)



References:
Database used
INTCAL09
References to INTCAL09 database
Heaton,et.al.,2009, Radiocarbon 51(4):1151-1164, Reimer,et.al, 2009, Radiocarbon 51(4):1111-1150, Stuiver,et.al,1993, Radiocarbon 35(1):1-244, Oeschger,et.al.,1975,Tellus 27:168-192
Mathematics used for calibration scenario
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Appendix 2 - 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.