# MONITORING AND MODELLING OF THE PALAEOLITHIC ARCHAEOLOGICAL RESOURCE AT CHARD JUNCTION QUARRY, HODGE DITCH PHASES II & III ASSESSMENT STAGE (5695)

## Final Report Stage III

**Prepared for**

**English Heritage**
**1 Waterhouse Square**
**138-142 Holborn**
**London, EC1N 2ST**

A Project administered by University of Southampton

Principal Investigator
Professor Tony Brown, University of Southampton

Project reference Number: 5695
Origination date:
Version: 1.0
UPD date: August 2012
Contact: Tony Brown, Project Manager
Submission Date: Wednesday 7th August 2013
Palaeoecology Laboratory University of Southampton
School of Geography
Highfields Campus
Southampton
SO17 1BJ

INVESTOR IN PEOPLE

UNIVERSITY OF Southampton
School of Geography

## Contents

# MONITORING AND MODELLING OF THE PALAEOLITHIC ARCHAEOLOGICAL RESOURCE AT CHARD JUNCTION QUARRY, HODGE DITCH PHASES II & III. ASSESSMENT STAGE 3 (PNUM5695)

This UPD for Stage 3 was submitted following the acceptance of the report of Stage 2 by English Heritage. The report is structured as per the original draft UPD contained in the Stage 2 report under Task 10. *To provide an updated Project Design for Stage 3.*

.

## Stage 3: Extension, Dissemination and Outreach

### 1 Palaeoenvironmental Extension:

Throughout the scanning and monitoring no organic sediments of recognisable land-surface was seen in any exposures in Hodge Ditch II. However, on the last visit to site on March 4th 2011 a red-purple disturbed and weathered horizon was noticed in Hodge Ditch III underlying gravels approximately 1.0 – 1.2 m below the junction with the upper diamicton unit (Stage 2 Report Figures 8.1 & 8.2). This organic horizon offers the potential to provide an additional and independent point of chronological correlation between Chard Junction, Broom and Kilmington effectively linking together over 20km the stratigraphy of the gravels throughout the middle and lower Axe Valley.

Hodge Ditch III is the small westerly extension of Hodge Ditch II with a continuation of the stratigraphy downstream and closer to the tributary junction that separates the Hodge Ditch sites from the old Chard Junction Quarries. The junction of the upper diamicton with the fluvial gravels had not been observed in Hodge Ditch II due to the infrequent (*ad hoc*) monitoring in the period between PRoSWEB work at Hodge Ditch I and the start of this project on Hodge Ditch II. The 'palaeosol' horizon was undulating and discontinuous with lens-like pockets of organic clay separated by iron-stained gravels. There were also small root channels with both sandy and organic-clay infillings. This suggests that the upper parts of the soil had been partially eroded leaving pockets of disturbed organic-rich clay. The form of these pockets is similar to the organic deposits found in small abandoned channels or tree-throw pits but the disturbance could equally be due to periglacial ground disturbance related to the deposition of the diamicton over the site.

The organic lens photographed in Figure 1.1 was removed and divided into an upper and lower sample each of 1cm in thickness. Initially two medium-sized samples (10g) were processed in order to test if pollen was present but after this assessment a larger (50g) sample was processed. The processing procedure used an in-house elutriation method (Scaife pers. comm.) followed by the standard chemical processing procedures involving both hydrofluoric acid digestion and acetolysis (Moore et al. 1991). The elutriation method involves the swirling of the sample in a dish to separate the denser mineral grains from organic matter including pollen. Exotic spores (Lycopodium) in tablet form were added to the samples in order to both aid pollen recovery (with low concentrations) and allow an assessment of pollen

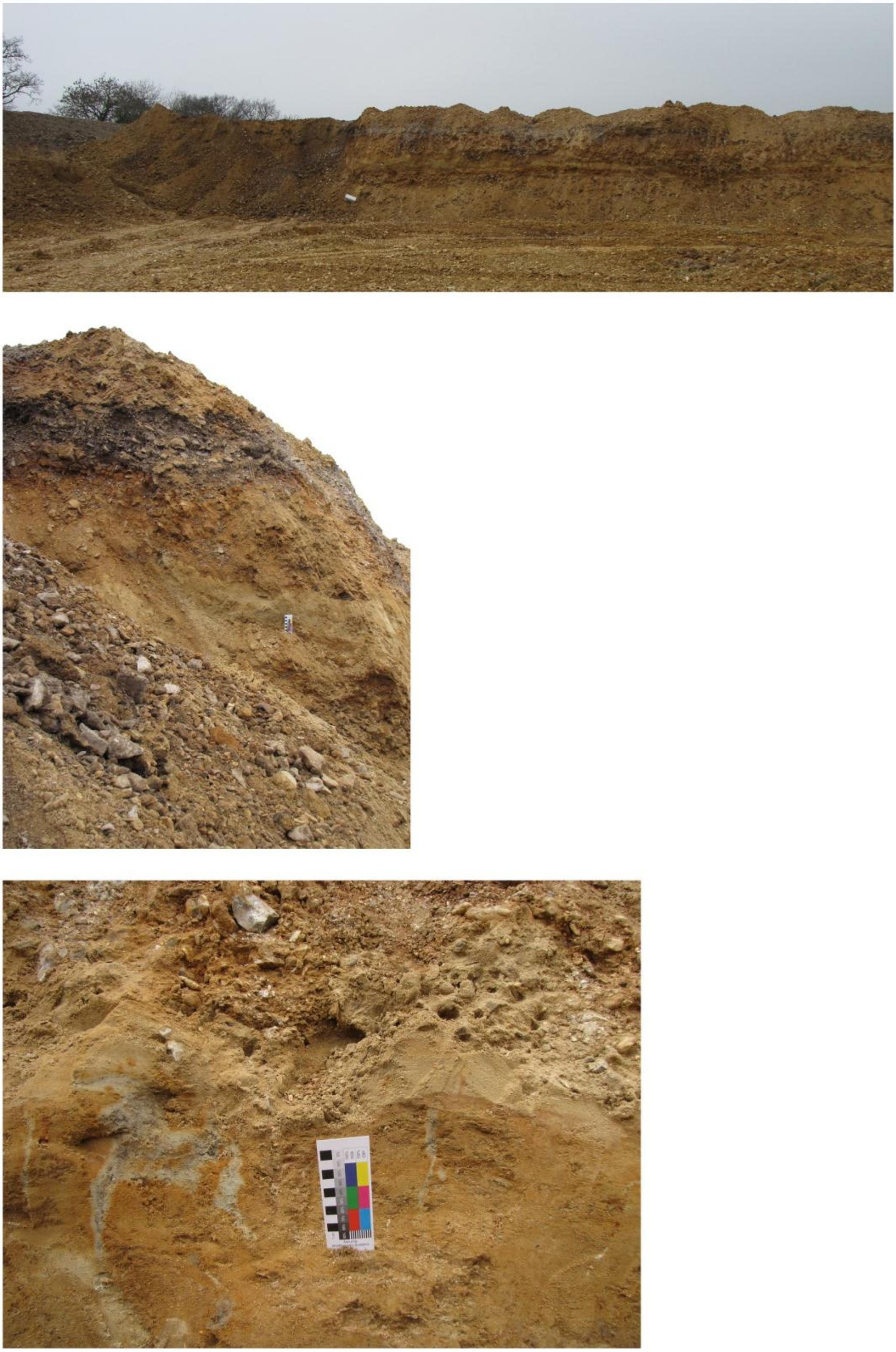


*Figure 1.1 The palaeosol as exposed in the west face of Hodge Ditch III on March 4th 2008. The organic lens shown in Figure 8.2 is ringed in red.*

concentration. The tablets were added at the initial stage of processing (addition of NaOH). In order to evaluate the same sample for plant macrofossils and insect remains the sample was sieved at 1mm and 0.5mm intervals and the retained fraction inspected under a low-power binocular microscope.

*Figure 1.2 Photographs of the disturbed palaeosol horizon at Hodge Ditch II as seen and sampled on March 4th 2008. Note its undulating form and lens-like pockets of organic-rich clay.See Figure 1.1 for its location on the Hodge Ditch III face.*

### 1.2 Full Palynological Analyses (Task 1)

As part of stage 2 an evaluation was undertaking by counting two small sub-sample slides (10x10mm) from each preparation. Pollen was found to be present in both sub-samples but at low concentrations. However, the pollen was in good condition and if concentrated by processing larger samples then could provide a single-level pollen spectra from the palaeosol. This was done using a 50g sample and the results are given in Table 1 and the samples was recorded as CHD3A.The same sample was also used for inspection under a low power binocular microscope (Nikon SMZ10) and was also analysed using an environmental scanning electron microscope (ESEM) with qualitative elemental analysis using electron dispersive spectroscopy (EDS).

| Type | CHD3A | %TLP | Gr ml$^{-1}$ | Comments (provenence) |
|---|---|---|---|---|
| **Trees** | | | | |
| *Betula* | 16 | 6.3 | 120 | Pioneer gap & floodplain tree (DI) |
| *Pinus* | 13 | 5.1 | 97 | Some in the greater region, perhaps in hill tops |
| *Picea* | 3 | 1.2 | 22 | Long-distance transport? |
| *Corylus* | 18 | 7.1 | 135 | Local understorey & gap tree |
| *Quercus* | 6 | 2.4 | 144 | Slope woodland |
| *Alnus* | 62 | 24.6 | 465 | Riparian corridor, local to site |
| *Fraxinus* | 28 | 11.1 | 210 | Slope woodland |
| *Taxus* | 1 | + | 7 | Slope of floodplain isolated trees |
| *Carpinus* | 5 | 1.9 | 37 | Slope woodland |
| Total Trees | *134* | *53.1* | *1005* | *Floodplain surrounded by woodland* |
| **Shrubs** | | | | |
| *Salix* | 6 | 2.4 | 45 | Floodplain |
| *Hedera* | 7 | 2.7 | 52 | On floodplain & slope trees |
| *Total shrubs* | 13 | 5.1 | 97 | (note *Corylus* incl. in tree group) |
| **Herbs** | | | | |
| Poaceae | 48 | 19.0 | 360 | Open parts of the floodplain |
| Cyperaceae | 20 | 7.9 | 150 | Floodplain & riparian zone |
| *Cannabis* t. | 1 | + | 7 | On floodplain, open areas (DI) |
| *Centaurea cyanus* | 2 | + | 14 | On floodplain, open areas |
| Chenopodiaceae | 4 | 1.5 | 30 | On floodplain or slopes, open areas (DI) |
| *Filipendula* | 1 | + | 7 | On floodplain, open areas |
| Lactuceae | 1 | + | 7 | On floodplain, open areas (DI) |
| *Plantago lanc.* | 5 | 1.9 | 37 | On floodplain or slopes, open areas (DI) |
| Rubiaceae | 2 | + | 14 | On floodplain or slopes, open areas (DI) |
| *Rumex acetosa* | 2 | + | 14 | On floodplain or slopes, open areas (DI) |
| *Sanguisorba* | 1 | + | 7 | On floodplain or slopes, open areas (DI) |
| *Thalictrum* | *1* | + | *7* | On floodplain or slopes, open areas |
| Total herbs | *87* | *34.1* | *652* | *High enough to indicate definite open areas (around site)* |
| **Spores** | | | | |
| *Polypodium* | 3 | 1 | 7 | Slope woodland |
| Unid. | *8* | *3.1* | *60* | Moderately high – mostly oxidation damage |
| Charcoal >50µ | *21* | - | *157* | Typical distribution for background (natural) fires |
| Charcoal >25-50µ | *84* | - | *630* | |
| Charcoal <25µ | *73* | - | *547* | |
| Exotics | *3333* | - | - | - |
| **Total land pollen** | **252** | **100** | **1890** | **Low concentration due to oxidation/reduction** |
| **Total pollen + spores** | **255** | **101** | **1891** | |

Table 1 Pollen count data from large sub-sample from the Hodge Ditch III palaeosol.

Even using the larger sample, triple sieving and double acetolysis the concentration was low and the full count achieved was only just over 250 pollen grains excluding spores. Despite the low concentration it is clear that the sample pollen is dominated by tree pollen and particularly *Alnus* and *Fraxinus*. The presence of A*lnus* and other thermophilious trees (*Quercus*, *Fraxinus* and *Corylus*) and shrubs (*Hedera*) confirms that this is from an interglacial rather than an interstadial deposit. Given this, the presence of *Carpinus* and *Taxus* and the absence of *Abies* and the sedimentary context below the upper diamicton, by far the most likely ascription is to MIS5e of the Ipswichian *sensu stricto* (c. 115-125 ka). However, the full count allows some further palaeoecological interpretation (see section 1.4).

### 1.3 Microscopy and ESEM/EDS Analysis

The low power microscopy revealed thin black rootlet channels penetrating the silty clay (Figure 1.3). No pedological structure was visible.

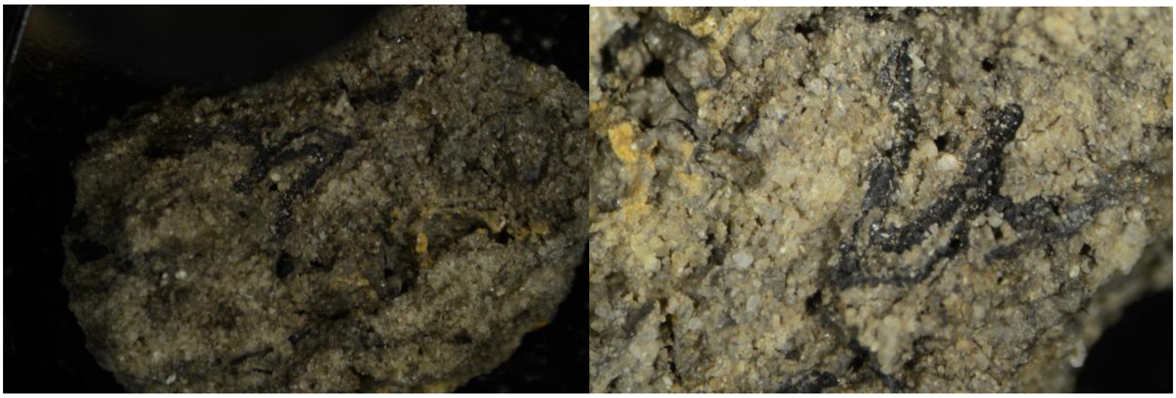
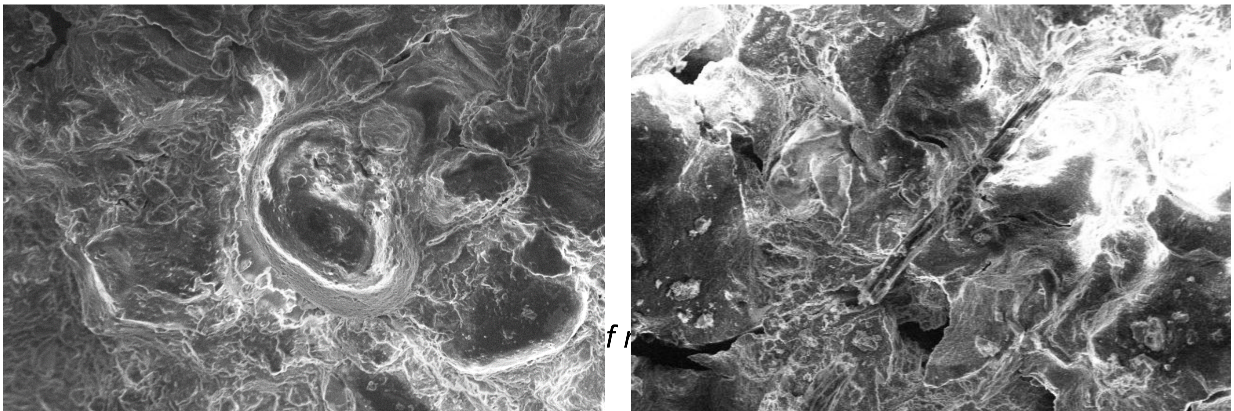


*Figure 1.3 Low power binocular image of the sediment face used for the ESEM work below. The face is 14x9m (Top image).*

The ESEM images show smooth skin fragments running within the massive silt texture of the sediment. In area where there is a cross-section it can be seen to resemble an organic structure (Figure 1.4). Plant tissues were observed (Figure 1.5) and in several cases a bracelet-like chain of cubic crystals were also seen (Figure 1.5). Comparison with other images of such crystal structures confirms them to be



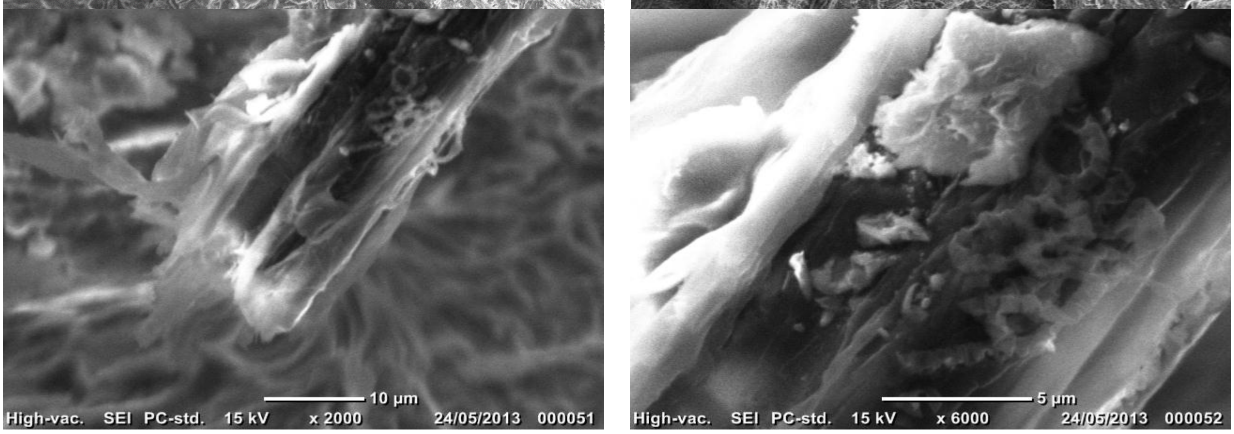



*Figure 1.5 Close-up ESEM image of plant tissue with magnetobacteria*

formed by magneto-bacteria (Stolz et al. 1990). Both the cross-section and the longitudinal organic structures are smooth walled and associated with he re-organisation of skeletal grains in the sediment. EDS analysis shows these structures to be composed primarily of carbon in contrast to the silicate groundmass (Figure 1.6). The chains of cubic crystals in which the crystals are 0.5-1 micron in size are of bacterial origin produced by magnetotactic bacteria that require molecular oxygen and produce magnetic minerals intracellularly in the form of a chain within a magnetosome (Stolz et al., 1990). Microbial activity under conditions of low and alternating redox potential is known to produce both spherules (Donner and Lynn 1989; Wiltshire et al. 1994; Ariztegui and Dobson 1996) and chains (Stolz et al., 1990). It has been proposed that this can produce a remnant magnetic alignment in palaeochannel sediments (Ellis and Brown 1998; Brown et al. 2010). These features cannot be of post-depositional origin as the sample was freeze-dried directly after collection.

Given the lack of soil structure, the quartz-dominated mineralogy, the carbonised rootlets and the evidence of reducing conditions from the magnetobacteria we conclude that this is the remains of a shallow pool or pond smeared-out probably by the deposition of the overlying sand and gravel and possibly the deposition of the superficial diamicton. It illustrates that there was a break in floodplain aggradation and the floodplain supported at least herbaceous vegetation growing in shallow pools.

### 1.4 Comparison & Discussion(Task 1)

As can be seen from Figure 1.6 this fits well with the upper cluster of OSL dates and so we believe that provides a firm upper chronology for the age/depth model.

No insect (coleoptera, diptera or chironomid) remains were found even after processing a large (100g) sample. The plant material consisted only of unidentified fine root or stem material probably of monocotyledonous origin, black humic matter and very small lignified fragments of stem or bark. Some small fragments of charcoal were present (under 2mm) and material, including a few whole leaves of bryophytes. Comparison with type material and reference to Smith (2004) showed them to be typical of *Sphagnum* sp.

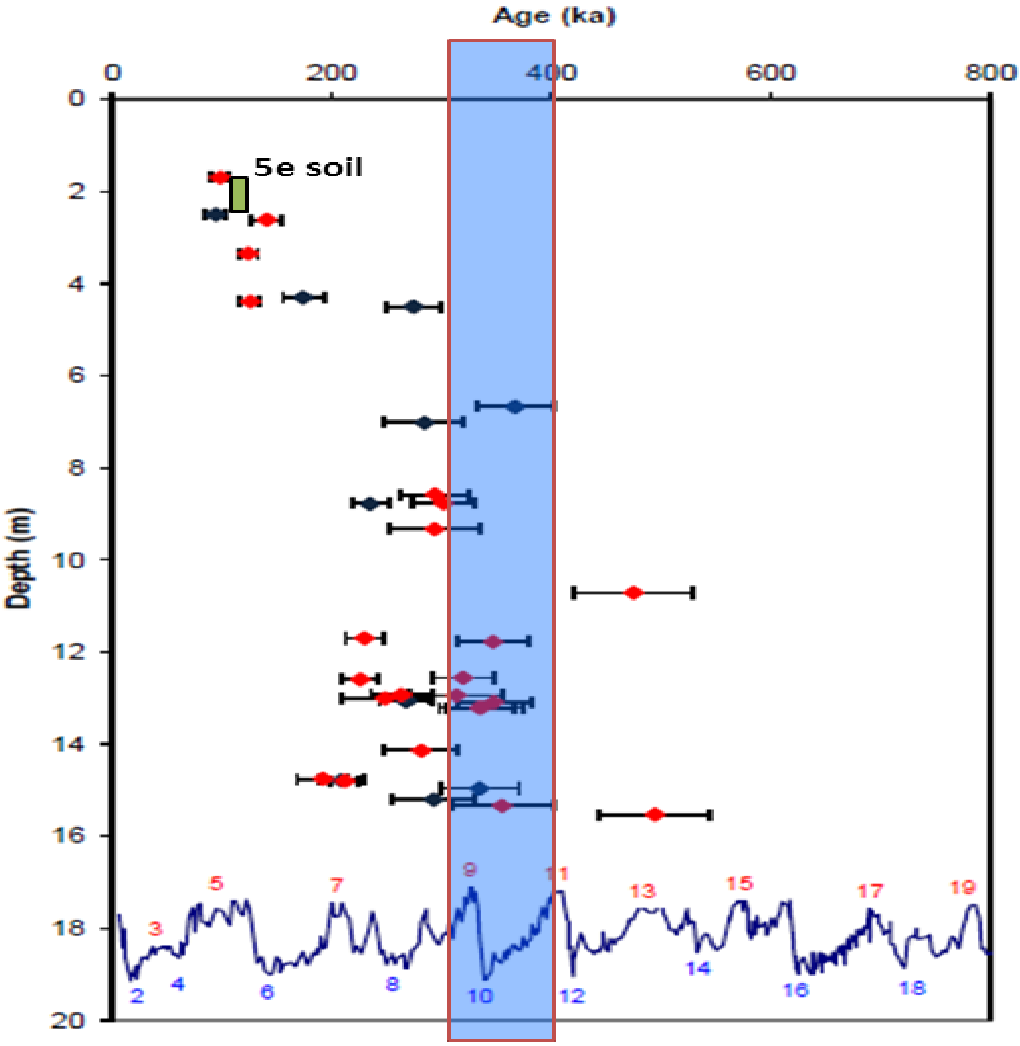



*Figure 1.6. The Chard Junction Stages I-III chronology with the pollen date added (5e soil).*

The sediments can now be compared with beds of finer sand and silt which are more common at both Broom and Kilmington and which have yielded pollen in the past (work at Broom by R. Scaife, and at Kilmington by James Scourse in the 1970s; Hosfield et al., 2011). The pollen spectrum from the Chard Hodge Ditch deposits is highly dissimilar to the pollen from Broom, which is dominated by *Betula*, and *Pinus* with high *Abies* (9.4%) and shrubs dominated by Ericales and open ground herbs. Although there is variation through the Broom silts, with higher *Corylus* and *Salix* in some levels the spectrum is still of a less thermophilous character. This agrees with Hosfield et al's (2011) ascription of the Broom silt levels to MIS11 (Hoxnian) or MIS9 (Purfleet) and it is probable that the spectrum was deposited during an interstadial between MIS7 and MIS11. The Chard (CHDA) spectrum is far more comparable with that derived from Lepe (Stone Point, borehole 16) to the east in the Solent system. This spectrum has a fully developed thermophilous phase dominated by mixed-oak woodland and is almost certainly of MIS5e as determined from both coleopteran and OSL dating (Briant, et al. 2009).

Accepting that the Chard palaeosol is MIS 5e it is possible to compare it with two other MIS 5e sites also from floodplains in SW England. As Figure 2 shows whilst the pollen type composition is similar to that from the waterhole deposits at Honiton

(*Betula*, *Pinus*, *Carpinus*, *Alnus*, *Picea*, *Quercus*, Poaceae, *Plantago*) the ratios are very different. The Honiton sample has a low percentage of trees (3.5%) and very high representation of Poaceae (36.5%) and Lactuceae/Compositae (38.5%). The author ascribes the spectrum to the creation of herb-rich meadows by large herbivores around the waterhole at the edge of the floodplain. He also suggests that the pollen may also be derived from dung from the Hippopotami which are well represented in the faunal remains at the site (Turner, 2011). Not far from Lepe is a site from under the present Avon floodplain at Ibsley which also revealed a spectrum that on compositional grounds was ascribed to MIS 5e (Barber and Brown, 1987). In this spectrum there was a large bias to species resistant to grazing which reach remarkably high values including *Ilex* (<36%), Rosaceae undiff. (<51%) and Umbelliferae unfiff. (<19). At the time the authors suggested that this was due to the

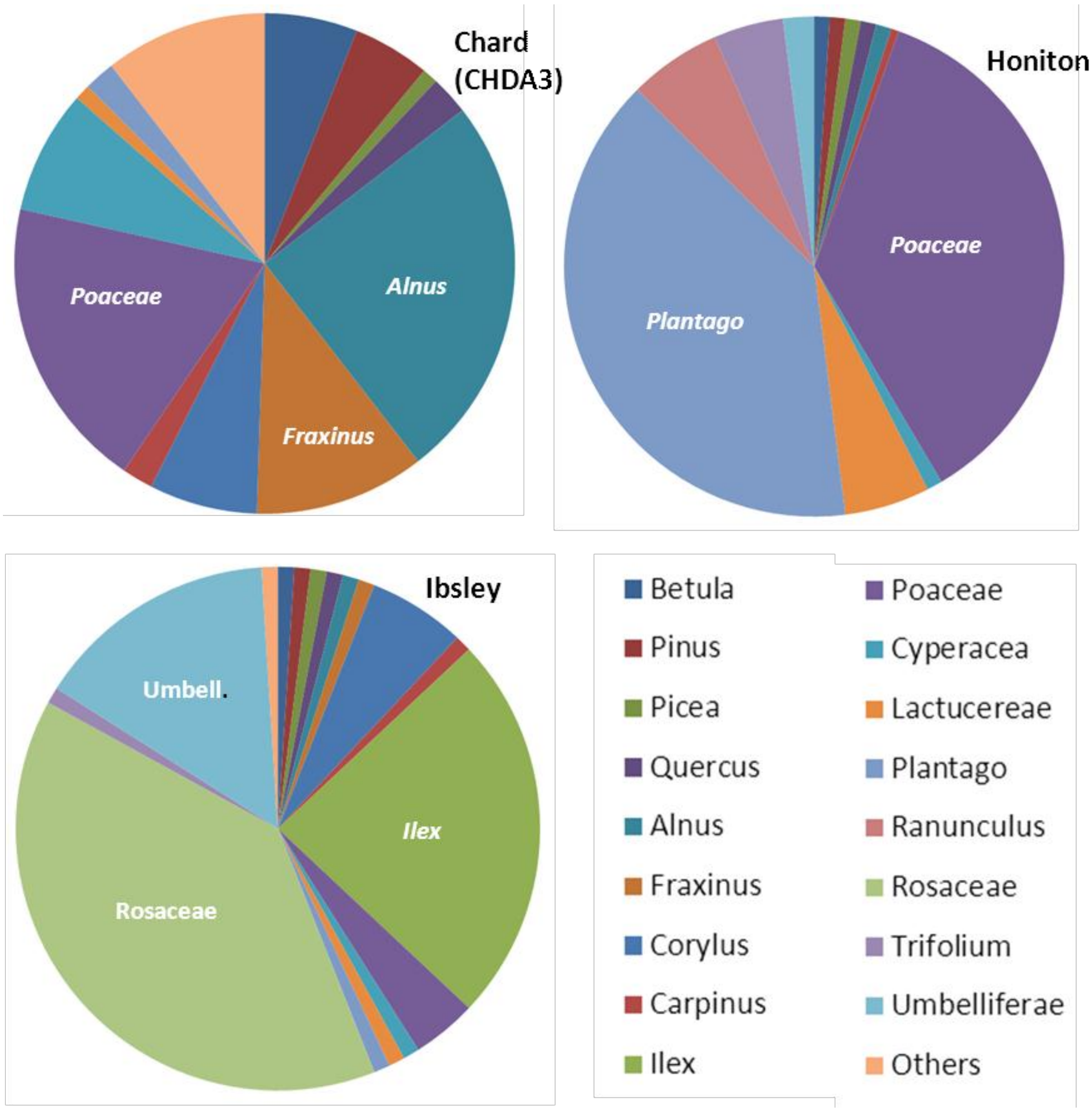



Figure 1.7. Comparison of MIS 5e pollen spectra from Chard (CHDA3), Honiton and Ibsley (see text for details).

grazing effect of large herbivores on the floodplain, an observation that has subsequently been made more recently from a number of other sites (Schreve, 2009).

### 1.5 Rockhead-Basal Gravel Sample

In 2012 a sample of basal silty gravel matrix had been collected for pollen analysis but using conventional extraction techniques no pollen was recovered. This sample was re-analysed using the methodology above and a 100g sample. Although no Pleistocene pollen was recovered a large number of distinctive spores were recovered along with Mesozoic conifer-type pollen. The inaperturate spores shown in Figure 1.8 are highly distinctive and could be identified as *Classopollis*, a circumpolles pollen with two unequal hemispheres and characteristic internal structure that gives an impression of closely spaced ‘ribs’ running around the equator. Photographs were sent to Dr Geoffrey Warrington (ex-BGS) who confirmed the identification and has proposed the closest match with *Classopollis torosus* (Reissinger) Balme 1957. *Classopollis* is commonly found in the Lower Jurassic in Britain including the Eype Clay, and Blue Lias (Wall, 1965).

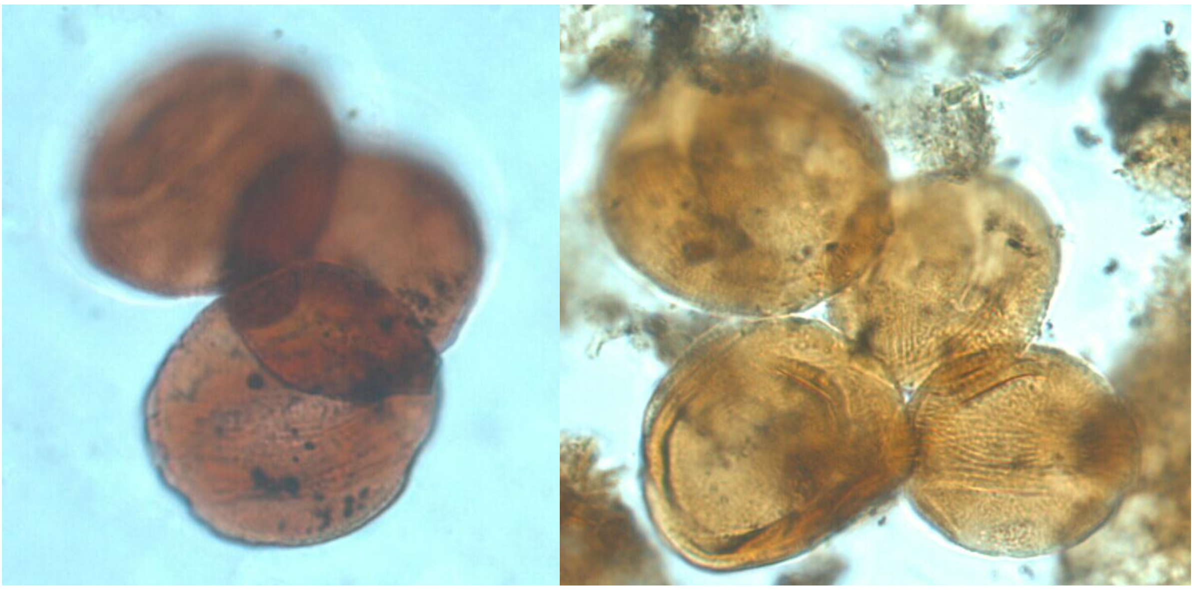


Figure 1.8. Miospores of *Classopollis* from sample CHHDIa at the bedrock-gravel interface.

The significance of this microfossil and its abundance is that it may be an indicator of intense weathering of the Eype Clay and underlying Charmouth Mudstone producing a concentration of resistant spores. The bedrock head was seen to be both brecciated and weathered and in places deformed. This is suggestive of deep periglacial weathering which caused not only the break-up of the Charmouth beds but also comminution of rock fragments and the liberation of silt and clay-sized particles. This observation is consistent with the dating evidence that suggests that the formation of the incised valley took place during a period of low relative sea level and under conditions of intense periglacial weathering probably during MIS12.

## 2 Dissemination (Task 2)

At this stage copies of the complete project archive are being placed with both local authorities and the ADS. This will include the following; Somerset County Council, Devon County Council and Dorset County Council.

1) Full digital archive. This is being supplied only to ADAS and the file format and metadata will follow the procedures used in Brown *et al.* (2010) for the archiving of the Star Carr scanning.

This is underway but has not been completed due to the generation of some additional data during Stage III, and will be completed by the end of August 2013.

2) Digital (pdf) reports from Stages 1,2 & 3 supplied to EH, ADAS, County Councils (Archaeology/Development Control) and Museums. To be completed by the end of August 2013 or after any revisions by English Heritage.

3) Copies of published/submitted papers (see below) to EH, ADAS, County Councils (Archaeology/Development Control) and Museums. To be completed after proofs are available (see draft in Appendix A). We are also working on a high profile paper forb PLoS Online which will use the results of all the EH-funded work at Chard and also earlier work funded by EH under PRoSWEB (see Appendix A).

4) Selected images suitable for display including 3-D animation of scanning data, supplied to EH, ADAS, County Councils (Archaeology/Development Control) and Museums. To be completed by the end of August 2013.

5) A paper will be given in a session we are organising at the Institute of Field Archaeologists Annual Meeting at Glasgow in April 2014. We are also organising a session at the Theoretical Archaeology Group Meeting at Bournemouth in December 2013 on Scanning and Visualisation in Archaeology.

### 2.1 Outreach - Methodological Feedback to Industry (Task 3)

The stakeholders and industry workshop took place on 4th July 2013 at the Magdelen Centre near Forde Abbey. Invitations were sent out currently to all the potential interested parties as specified in the UPD. An additional element to the 4 talks in the morning was a demonstration of both the Scan Station 2000 that was used for most of the work undertaken as part of this project and also the new Leica C10 which has be used for the most recent terrestrial scanning. The day concluded with a discussion lead by John Humble, Senior National Minerals Advisor and Inspector of Ancient Monuments at English Heritage. In total there were 27 attendees out of 35 invited. The programme and details of the meeting is given in Appendix 2.

## 3 Status of Disused Quarries in the Axe Valley (Task 4)

In the UPD we agreed to undertake a review of the status of other disused quarries in the area to determine their archaeological potential, inform county archaeologists of that potential so as to inform National Planning Policy Framework (2012) considerations. There were a number of sites identified initially (at least 6), which were generally small, but which were excavated into or above the “100 ft” terrace which was known which have produced bifaces. No higher terraces have been mapped by BGS, however, the examination of higher quarries was also intended to check this absence. At least one of these sites was believed to be under direct threat and several others under potential threat.

| **Site name, NGR** | **Ownership** | **Geology** | **Alt. (m OD), NGR & County** | **Current state** |
|---|---|---|---|---|
| Kilmington, Nth & Sth quarries | Owned by Axminster Carpets Ltd., but managed by | 3-4m of Late Pleistocene gravels, large exposures | 40-44m SY275 979 Devon | Overgrown with birch but accessible & possible to clean off faces |
| Coaxdon Farm Quarry | Owned by Axminster Carpets Ltd., presently used for fishing | Hillside quarry into Pleistocene gravels and chert | 35-45m ST310 918 Devon | Overgrown with woodland but accessible but difficult to clean-off faces due to fishing lake position |
| Uplyme Quarry (Shapwick Grange) | Owned by Shapwick Grange Fm but currently under lease for quarrying for lime by | Quarry through Pleistocene gravels into chalk & then chert (geologically important site) | 105-135m SY3120 918 Devon | Being worked so variable but good exposures of terrace gravels |
| Axminster cemetery | Axminster Town Council | Terrace gravels | 55-60m SY304 991 Devon | Upper gravels visible in newly dug graves |
| Colston Fm | Private Colston Fm | Terrace gravels | 60-65m ST316 016 Devon | Terrace gravels cut into by covered yard, vegetated |
| Bagley Hill | Owned by Bagley Hill Fm – currently no access | Middle-Late Pleistocene gravels | 40-45m ST319 009 Devon | Now inaccessible due to farm buildings |
| Westford Mill-Batehams Fm | ECCQ - Bardon | Terrace gravels, main level | 65-70m ST319 043 Dorset | Higher Quarry disused & vegetated |
| Westford Mill Batemans Fm (Lower Quarry) | Private – Batehams Fm | Terrace gravels | 54-65m ST339 044 Dorset | Lower quarry now landscaped |
| Headstock Rd | Not known | Terrace gravels | 70-76m ST343 042 Dorset | Small disused high quarry |
| Winsham Bridge | Not known | Terrace gravels | 70-75m ST378 060 Somerset | Quarry on valley floor |
| Snowdon Caves & Quarries | Snowdon Hill Fm | Old quarry workings into chert, | 170-180m ST314 090 Somerset | Caves (old workings) open quarry partly infilled |
| Broom Quarries Pratt’s Old Pit, | Mostly infilled but some faces extant | Quarries in to the Middle-Late Pleistocene | 40-58m ST326 020- | Excavations in Railway Ballast Pit by Hosfield |

| | | | | |
|---|---|---|---|---|
| Pratt's New Pit, Railway Ballast Pit | | gravels, classic sites | 024<br>Devon | (2000-2006) remain accessible but Pratt's Old Pit is infilled, Pratts new Pit is overgrown with vegetation and degraded |
| Storridge Hill | Owned by Green Ln Fm | Edge of clay with flints into chalk & chert | 150-160m<br>ST318 043<br>Devon but partly in Somerset | Faces largely degraded & obscured by vegetation |
| Combehays, Witham Ball Pit & Jame's Close Pit | Linnington Estate | Edge of clay with flints into chert | 165-175m & 175-185m<br>ST306 071<br>Somerset | Faces largely degraded & obscured by vegetation |
| Bounds Ln Quarries | Edencote Fm | Edge of clay with flints into chert | 160-170m<br>ST316 075<br>Somerset | Faces largely degraded & obscured by vegetation |
| Seaton spit | Private houses | Thick coastal exposure preserved behind old warehouses on Seaton quay | 0-25m<br>SY254 899<br>Devon | At present clear of vegetation but likely to become vegetated. Note BGS borehole nearby. |

Table 2. Summary data on disused quarries and exposures in and around the Axe valley

Notes on these sites giving further information are presented below. Several other sites were visited (e.f. Tolcis Quarry) but found not to relate to the stratigraphy of the valley in such a way as to be of value for archaeological purposes.

### 3.1 Site Description (Principal Sites only)

#### Kilmington North Quarry

This site which was worked upon from 2003-2007 as part of the PRoSWEB Project (Basell et al., 2007) remains essentially unchanged. However, there has been widespread growth of young birch trees over the floor of the quarry and these now prevent access to the quarry faces. The quarry faces have also degraded. Although it is still owned by Axminster Carpets Ltd. it is managed as a local wildlife reserve. As part of this management a number of small shallow pits have been dug in the quarry floor. The site which has considerable Palaeolithic potential having produced 2 Acheulian bifaces and a number of flakes in the past (Hosfield et al., 2007) is essentially being preserved and it would be possible to open up a face for further research. The site is currently both owned and managed by Axminster Carpets Company.

*Figure 3.1. Kilmington North Quarry, March 2013.*

**Kilmington South Quarry**

This is leased by Bardon Aggregates and still contains a washing plant. No faces are available and there are large areas of dumped spoil throughout the quarry. This site has produced large sarsens in the past, a particular large example of which is located outside the village hall in Kilmington. The quarry would be very difficult to use for any further work and is essentially sterilised. The site is currently both owned and managed by Axminster Carpets Company but leased to Bardon Aggregates Ltd..

Figure 3.2. Kilmington South Quarry washing plant, March 2013.

**Axminster Cemetery**

The site slopes approximately 4-5m down the terrace surface E-W. Although no large exposure is present clay-rich cherty gravels is observable in newly dug graves. Although the site has low potential the fields to the north may well be developed and could give useful exposures or borehole data. The sloping form of the terrace is well illustrated at this site (Fig 3.3). The site is recorded in Campbell et al. (1998) with data from Green (unpub.).

*Fig. 3.3 Axminster cemetery showing the cross-valley sloping surface of the terrace and yellow clay-rich chert gravels.*

### Colston Fm

This is a site recorded in Campbell *et al.* (1998) from data provided by Green (unpub.). It is a covered yard that was cut into the upper part of the sloping gravel terrace (Fig. 3.4). Now vegetated it could be re-exposed. It appears to have been an exposure of approximately 3-4m of clay-rich gravels. The height of this site up to at least 65m OD and the continuity of this slope in fields to the north and south illustrates the continuous nature of the upper slope-derived diamicton unit.

*Fig. 3.4 View of the covered yard at Colston Fm which provided an exposure used in Campbell et al. (1998).*

**Coaxdon Farm Quarry**

This is a small quarry adjacent to the railway line that was dug into the hillside originally for railway ballast. The faces are steep and the quarry is floored by an artificial fishing lake. The quarry floor is water filled at the level of the floodplain water-table level (Fig. 3.5). The quarry was excavated down into grey Lias (shales, mudstones) but with gravel on a bench dipping to the railway line. Junction of lias with gravels c. 5m above water-level. There is a clear bench-like strath terrace upstream to Coaxdon Fm which is located in a tributary cutting through the terrace. The site is currently both owned and managed as a fishing lake by Axminster Carpets Company.

*Figure 3.5 Coaxdon Quarry North face.*

**Uplyme Quarry (Shapwick Grange)**

Uplyme Quarry also known as Shapwick Grange Quarry, near Lyme Regis is a former chalk quarry enlarged to supply road grit and marl. It extends along the strike of a small NE-SW trending dry valley excavated into the Chalk. The BGS record it as being cut through the Middle and Lower Chalk into the underlying Upper Greensand and the site is known to geologists as exposing the contact between the Late Albian (Upper Greensand) and the Cenomanian (Middle Chalk) as described in Hamblin and Wood (1976) and Woods et al. (2009) (Figure 3.6). Due to recent re-opening of the quarry excellent sections have become available. These reveal the Lower Chalk limestones (Beer Head Limestones) contact with the complex conglomerate, chert and sandstone beds of the Eggerton Grit, and a normal fault cutting the valley from NW to SE. This fault is probably an extension of the Pinhay fault seen at the coast at Pinhay Bay.

*Figure 3.6. Uplyme Quarry, showing the Pleistocene gravels (vegetated), chalk with pipes and basal chert units. Note the person on a talus mound for scale.*

The Chalk at Shapwick is closest to its furthermost westward edge in the Blackdown Hills and is only c. 30m thick but varies with the topography up-valley. It is highly rubbly, fractured and penetrated by sub-vertical pipes. Below the Chalk c. 20m of horizontally inter-bedded fractured yellow-grey-purple cherts and silicified sandstones are exposed. In addition to the underlying geology and of particular relevance to the Quaternary of the Blackdown Hills are the overlying beds of gravel and clay with flints, and highly developed piping into the Chalk. Lying above the chalk is a discontinuous dark-red clay-with-flints unit capped by a yellow-brown gravel unit. In the smaller pipes only the red clay with flints occurs but in the larger pipes and those closest to the top of the chalk the gravel also occurs within the pipes. In places, especially down strike the piping is so highly developed that the rockhead of the chalk resembles pinnacle karst buried by the clay-with-flint and gravels. In some of the larger pipes the clay-with-flints is incorporated into the gravels and visa versa indicating severe post depositional disturbance.

The importance for Palaeolithic archaeology is two-fold. First above the chalk is a rare exposure of Pleistocene gravels on the chalk which would represent an upland valley environment. Secondly, the site is important in understanding the landscape evolution of the region and this has direct implications on the context of artefact deposition in the adjacent Axe valley, namely the de-periglaciation model of valley filling (Brown et al., in prep.). Further work in underway on this site as described in Brown et al. (2011).

**Bagley Hill**

This was a temporary exposure created whilst farm buildings were being erected in 2013 (Fig. 3.7). Only accessible for short time period only a photographic record and log could be made. However, the gravels that were exposed were the upper part of the Axe valley Formation and was 10m thick. It consisted in greater part of clast supported, unsorted, angular chert up c. 20cm in a matrix of dirty sand and clay. Discontinuous bedding could be seen. A small lens of green and yellow sand was present at the top of the exposure. However, this site awaits detailed description pending agreement for access by the owners.

*Figure 3.7. Bagley Hill exposure.*

**Westford Mill-Batehams Fm**

This was a quarry originally owener by ECCQ into the relatively flat terrace level at Chard Junction. The quarry today is highly overgrown and only small exposures would be practical (Fig. 3.8). A handaxe recorded as from Batemans Fm is likely to have been from this site, or from the lower quarry south of the public road.

*Fig. 3.8 Westford Mill (Batemans Fm) upper quarry.*

**Westford Mill Batemans Fm (Lower Quarry)**

This was a deep quarry excavated as late as the 1970s by ECCQ. A deep face still exists just to the south of the public road but it has now been rendered inaccessible by vegetation and landscaping of the lower part of the quarry (Fig. 3.9). The quarry extended down to the water-table (floodplain height) at this location at approximately 54m OD..

*Fig. 3.9 Westford Mill Batemans Fm (Lower Quarry). The house is Batemans Fm and the public road lies behind the trees.*

**Headstock Rd Quarry**

This is a small disused and completely overgrown small quarry (Fig. 3.10). It is of interest as it is clearly into chert-rich gravels but is high-up the valley side to over 75m OD. From the soils surrounding the quarry it is almost certainly cut into the upper clay-rich cherty diamicton.

*Fig. 3.10 Headstock Rd Quarry*

**Winsham Bridge**

This is the most upstream site visited and was recorded in Campbell et al. (1998) from data supplied by Green (unpub.). There appear to be old disused quarries extending down the lower valley slope onto the valley floor just upstream of the B3162 which were probably used as ballast for the nearby railway as was the case at Broom and Chard Junction. This site show that the Holocene floodplain is very limited at this location and gravels outcrop in the valley floor. The site is however, extremely overgrown with scrub woodland and is practically inaccessible (Fig. 3.11).

*Fig. 3.11 The overgrown state of quarries on the valley floor at Winsham Bridge.*

**Snowdon Caves & Quarries**

These are a series of quarries into the upper exposures of the chert at the prominent break of slope at around 175m OD. Above the chert there are poor and obscured exposures of clay with flints (Fig. 3.12). Intercalated within the cherts hare are conglomerates which include Palaeozoic rocks of non-local origin. These quarries sit at the edge of the urban area of Chard and supplied chert for building stone used extensively in the town. Unusually the adits still remain open although filled with refuse.

*Figure 3.12. Snowdon Caves near Chard, March 2013.*

Although of no importance in relation to Palaeolithic archaeology the site is important in relation to the industrial archaeology of Chard.

**Storridge Hill Quarries**

Quarries are just to the south of the edge of the clay-with flints. These old quarries appear to have been into chalk and the upper chert, probably the Whitecliff Chert. The chert is dipping 30$^{o}$ to the SW (Figure 3.13). Geologically the quarries are interesting as this is the last bed of chalk before it is entirely eroded off to the west. The disrupted from of the junction with large chert blocks within the chalk matrix suggests that this boundary was severely disrupted almost certainly by permafrost formation and thermokarst processes. The quarries are almost entirely overgrown and also inaccessible. There is no archaeological potential due to the geological nature of the bedrock here.

*Figure 3.13.Storridge Hill Quarries, March 2013.*

The sites will be cross-referenced with the Dorset RIGs list to assess whether any designation exists which can be used to safeguard any archaeological interest.

**Combehays, Witham Ball Pit & Jame's Close Pit**

These are a series of quarries into the upper exposures of the chert at the prominent break of slope at around 175m OD (Fig. 3.14). Above the chert there are poor and obscured exposures of clay with flints.

*Figure 3.14. Combehays Quarry, March 2013.*

These quarries provide a potentially valuable exposures in the clay with flints, although they have no direct Palaeolithic importance.

### Bounds Lane Quarries

Although not marked on the OS 1:25,000 map these are a series of quarries into the upper exposures of the chert at the prominent break of slope at around 175m OD (Fig. 3.15). Above the chert there are poor and obscured exposures of clay with flints. As with Snowdon Caves & Quarries they lie just beyond the urban area of Chard and supplied building stone to the town. As well as potential exposures into the chert they also provide limited exposures into the clay with flints.

*Figure 3.15. Bounds Lane Quarries, March 2013.*

The conclusions of this survey are that the only quarries that have any exposures of the Axe valley Formation (100 ft terrace) are Kilmington North, Kilmington South, Coaxdon, Broom Railway Ballast and Pratt's New Pit, Westford Mill Quarries, Headstock Rd. Chard Junction Quarries (old workings only) and Winsham Quarries. Of these Kilmington South and Coaxdon are probably of no futures use in relation to the Palaeolithic archaeology of the valley, but the remaining four are. In addition the temporary site at Bagley Hill Farm shows that any excavation into the terrace edge has the potential to expose a valuable section which has the potential to produce valuable Palaeolithic data.

The other quarries described here, have no direct Palaeolithic value but do have value in advancing our understanding of Pleistocene landform evolution in this area of South West England. This has indirect value for Palaeolithic archaeology as illustrated by Brown (2013). They are also an interesting record of the widespread nature of the chert quarrying industry which was principally for building stone.

**Seaton, Axe Mouth**

An additional exposure was also recorded at the mouth of the Axe at Seaton. The renovation of an old warehouse into accommodation had exposed a section of gravels at the eastern edge of the floodplain. Although access is difficult the section revealed 8-9m of poorly stratified medium to coarse gravels with a distinctly sloping surface caused by late Pleistocene down-cutting (Fig. 3.15). The total height which at the top of the slope is approximately 25m above mean sea level illustrated how these gravels were graded to a coast some kilometre out to sea, possibly even as much as 10km.This site is important as it shows contrary to Campbell et al. (1998) that te gravels extend down to sea level at the present Axe mouth.

The survey confirmed that the 30m or 100 ft terrace (above the modern floodplain) is almost continuous up the valley except where cut through by tributaries. It also confirmed that there is no higher morphological or depositional terrace above this level and this is again in contrast to rivers to the west and east. Although we cannot be certain why this is the case it is probably due to the small size of the catchment and possible capture of plateau headwaters by head-ward extension of the valley during the mid-Pleistocene.

*Figure 3.15 The gravel exposure on the east slope of the Axe valley at Seaton.*

## 4 Additional archaeological finds

During this phase of the project a fourth hand axe was discovered in the quarry on 23rd May 2013. It was found whilst Basell was examining piles of gravel excavated from below the watertable at the boundary of Hodge Ditch 2 and Hodge Ditch 3. Discussion with the excavator driver and the quarry manager established that the sub-water table gravels were the only possible source for the gravel and the artefact. This is important as it places the discovery at broadly the same depth as the previous biface finds during this project. The biface was considerably smaller that the previos finds being less that 10 cm in length (Appendix 3). It is a cordiform with some slight abrasion on the arretes. There is no significant difference between the two sides I terms of patination but it is strongly assymetrical. Like the others it is made on brown chert, probably from a small flake. No cortex is present except on the probably striking platform of the original flake. While smaller than those previously discovered by the autjors it is of a similar size to the twisted ovate previously discovered in 1954 by Wymer.

Additionally a possible flake discovered in 2012 has been confirmed and added to the artefact list and details have been supplied to the Dorset HER.

### 5. References

Ariztegui, D., and Dobson, J., 1996. Magnetic investigations of framboidal greigite formation; a record of anthropogenic environmental changes in eutrophic Lake St Moritz, Switzerland. *The Holocene* 6, 235–241.

Barber, K. E. and Brown, A. G. 1987. Late Pleistocene organic deposits beneath the floodplain of the river Avon at Ibsley, Hampshire. In Barber, K. E. (Ed.) *Wessex and the Isle of Wight. Field Guide.* Quaternary Research Association, London, 65-74.

Basell, L. S., Brown, A. G. and Toms, P. S. 2011. Chard Junction Quarry and the Axe Valley gravels. In Basell, L. S., Brown, A. G. and Toms, P. S. (Eds.) 2011. *The Quaternary of the Exe Valley and Adjoining Areas. Quaternary Association Fieldguide,* Quaternary Research Association, London, 93-102.

Basell, L. S., Brown, A. G. and Toms, P. S. (Eds.) 2011. *The Quaternary of the Exe Valley and Adjoining Areas*. Quaternary Association Fieldguide, Quaternary Research Association, London.

Bazylinski, D.A., Frankel, R.B., and Garratt-Reed, A.J., 1994. Electron microscope studies of magnetosomes in magnetotactic bacteria. *Microscopy Research and Technique* 27, 389–401.

Briant, R. M., Bates, M. R., Boreham, S., Cameron, N. G., Coope, G. R., Field, M. H., Keen, D. H., Simons, R. M. J., Schwenninger, J-L., Wenban-Smith, F. F. and Whittaker, J. E. 2009. Gravels and interglacial sediments at Stone Point Site of Special Scientific Interest, Lepe Countryv Park, Hampshire. In Briant, R. M., Bates, M. R., Hosfield, R. T. and Wenban-Smith, F. F. (Eds.) *The Quaternary of the Solent Basin and West Sussex Raised Beaches. Field Guide*. Quaternary Research Association, London, 171-188.

Brown, A. G. 2013. Gulls, dates and axes: recent Quaternary research in South-West England. *Geoscience in South-West England* 13, 1-11.

Brown, A. G., Ellis, C. and R. Roseff, R. 2010. Holocene sulphur-Rich palaeochannel sediments: Diagenetic conditions, magnetic properties and archaeological implications. *J. of Archaeological Science* 37, 21-29.

Brown, A. G., Powell, M. and Basell, L. S. 2011. Recent work at Shapwick Grange Quarry and the Blackdown Hills Plateau gravels. In Basell, L. S., Brown, A. G. and Toms, P. S. (Eds.) *The Quaternary of the Exe Valley and Adjoining Areas. Quaternary Association Fieldguide,* Quaternary Research Association, London, 128-132.

Brown, A. G., Bradley, C. R., Boomer, I. and Grapes, T. 2010. *Hydrological assessment of star Carr Catchment, Yorkshire.* Report PNUM 5822, by University of Southampton for English Heritage, 49p.

Campbell, S., Stephens, N., Green, C.P., and Shakesby, R.A. 1998. Broom gravel pits. In *Quaternary of South-West England*, Campbell S, Hunt CO, Scourse JD, Keen DH, Stephens N (eds). Geological Conservation Review series, Vol. 14 Chapman & Hall: London; 307–318.

Doner, H.E., and Lynn, W.C., 1989. Carbonate, halide, sulphate and sulphide minerals. In: Dixon, J.B., Weed, S.B. (Eds.), Minerals in the Soil Environment. *Soil Science Society of America*, Wisconsin USA, pp. 279–331.

Ellis, C. E. and Brown, A. G. 1998 Archaeomagnetic dating and palaeochannel sediments: data from the Medieval channel fills at Hemington, Leicestershire. *Journal of Archaeological Science* 25, 149-163.

Hamblin, R. J. O. and Wood, C. J. 1976. The Cretaceous (Albian - Cenomanian) stratigraphy of the Haldon Hills, south Devon, England. *Newsletters on Stratigraphy* 4, 135–149.

Hosfield, R. T., Brown, A. B., Basell, L. S., Hounsell, S., and Young, R. 2007. *The Palaeolithic Rivers of South-West England. (PNUM 3847).* Report for English Heritage, London.

Hosfield, R.T., Green, C. P., Toms, P. S., Scourse, J., Scaife, R. and Chambers, J. C. 2011. The Middle Pleistocene deposits and archaeology at Broom. In L. S. Basell, A. G. Brown and P. S. Toms (Eds.) *The Quaternary of the Exe Valley and Adjoining Areas: Field Guide*, Quaternary Research Association, London, 103-127.

Moore, P.D., Webb, J.A., and Collinson, M.E. 1991. *Pollen Analysis* (2nd ed) Blackwells, Oxford. *National Planning Policy Framework* 2012. HMSO

Schreve, D. C. 2009. A new record of Pleistocene hippopotamus from River Severn terrace deposits, Gloucester, UK—palaeoenvironmental setting and stratigraphical significance. *Proceedings of the Geologists' Association* 120, 58–64

Smith, A. J. E. 2004. *The Moss Flora of Britain and Ireland.* Second Edition. Cambridge University Press, Cambridge.

Stolz, J.F., Lovley, D.N., and Haggerty, S.E., 1990. Biogenic magnetite and the magnetisation of sediments. *Journal of Geophysical Research* 95, 4355–4361.

Turner, C. 2011. Honiton By-pass Hippopotamus site. In L. S. Basell, A. G. Brown and P. S. Toms (Eds.) *The Quaternary of the Exe Valley and Adjoining Areas: Field Guide*, Quaternary Research Association, London,133-138.

Wall, D. 1965. Microplankton, pollen, and spores from the Lower Jurassic in Britain. *Micropalaeontology* 11, 151-190.

Westaway, R. 2010. Cenozoic uplift of southwest England. *Journal of Quaternary Science* 25, 419–432.

Wiltshire, P. E. J., Edwards, K. E., and Bond, S. 1994. Microbial-derived metallic sulphide spherules, pollen and the waterlogging of archaeological sites. In: *AASP Contribution Series*, 29, pp. 207–221.

## APPENDIX 1

### A List of All Publications Available, Submitted and In Preparation from PNUM 5695 (in chronological order)

**Published**

Basell, L. S., Brown, A. G. and Toms, P. S. 2011. Chard Junction Quarry and the Axe Valley gravels. In Basell, L. S., Brown, A. G. and Toms, P. S. (Eds.) 2011. The Quaternary of the Exe Valley and Adjoining Areas. Quaternary Association Fieldguide, Quaternary Research Association, London, 93-102.

Brown, A. G. 2013. Gulls, dates and axes: recent Quaternary research in South-West England. *Geoscience in South-West England* 13, 1-11.

**Subm.**

Brown, A. G., Basell, L. S. and Toms, P. S.Subm. . A quasi-continuous Late Quaternary fluvio-periglacial sequence from the Axe valley, Southern England with implications for landscape evolution and Palaeolithic archaeology. *Quaternary Science Reviews*

Brown, A. G., Basell, L. S., Robinson, S., Toms, P. and Hosfield, R. T. In Prep. Palaeolithic Site Distribution at the Edge of the Palaeolithic World: A Nutritional Niche Reconstruction Approach. *PLoS Online*

Basell, L.S., Brown, A. G. and Neild, J. The use of terrestrial laser scanning for the monitoring and sedimentological investigations of an artefact-bearing fluvial sequence in Southern England. *Journal of Archaeological Science*

**APPENDIX 2**

**Programme and Participants to the Stakeholders Workshop 4th July 2013.**

# ARCHAEOLOGICAL MONITORING OF AGGREGATE QUARRIES WITH SPECIAL REFERENCE TO THE AXE VALLEY

A one day stakeholder meeting at the Magdalen Centre, Dorset.

Thursday 4th July 2013

Funded by English Heritage (PNUM5659)

ENGLISH HERITAGE

UNIVERSITY OF Southampton

Bournemouth University

UNIVERSITY OF GLOUCESTERSHIRE

**Programme**

| | |
|---|---|
| 10.30-11.00am | *Coffee/tea on arrival* |
| 11.00-11.40am | The geology & geomorphology of the Axe Valley with special reference to archaeology at Chard Junction quarry (Tony Brown) |
| 11.40-12.20am | Artefacts and antiquarians in the Axe Valley: searching for early humans at Broom (Rob Hosfield) |
| 12.20-1.00pm | Monitoring and terrestrial laser scanning at Chard Junction Quarry (Laura Basell) |
| 1.00-2.00pm | *Buffet Lunch (provided)* |
| 2.00-3.00pm | Demonstration of terrestrial laser scanning and Palaeolithic artefacts from Axe valley sites |
| 3.00-3.30 | OSL dating at Chard (Phil Toms TBC) |
| 3.30-4.00pm | *Tea/Coffee* |
| 4.00-5.00pm | Open Forum on Approaches to Monitoring Palaeolithic Archaeology in Working Aggregate Quarries (Chaired by John Humble). |
| 5.00pm | *Disperse* |

**Who's Who?**

Tony Brown: Professor of Physical Geography, University of Southampton

Laura Basell: Senior Lecturer in Palaeoanthropology, Bournemouth University

Phil Toms: Senior Lecturer in Physical Geography, University of Gloucestershire

Rob Hosfield: Senior Lecturer in Palaeolithic Archaeology, University of Reading

John Humble: Senior National Minerals Adviser & Inspector of Ancient Monuments at English Heritage

**How to respond**

There is **no cost** for this meeting but we would appreciate an e-mail informing us that you would like to attend. Please email acceptance, or decline to Laura on laura.basell@bournemouth.ac.uk as soon as possible.

If you need to contact us at any point please call Laura on:

01202 965672

07792 583742

**Dietary or Other Requirements**

If you have any other requirements relating to accessibility, or particular dietary requirements please let Laura know when you accept. It is possible to cater for a wide range of dietary requirements, but we do need to know in advance.

**Directions and Parking**

Directions to the Magdalen Centre if you are driving may be found at:

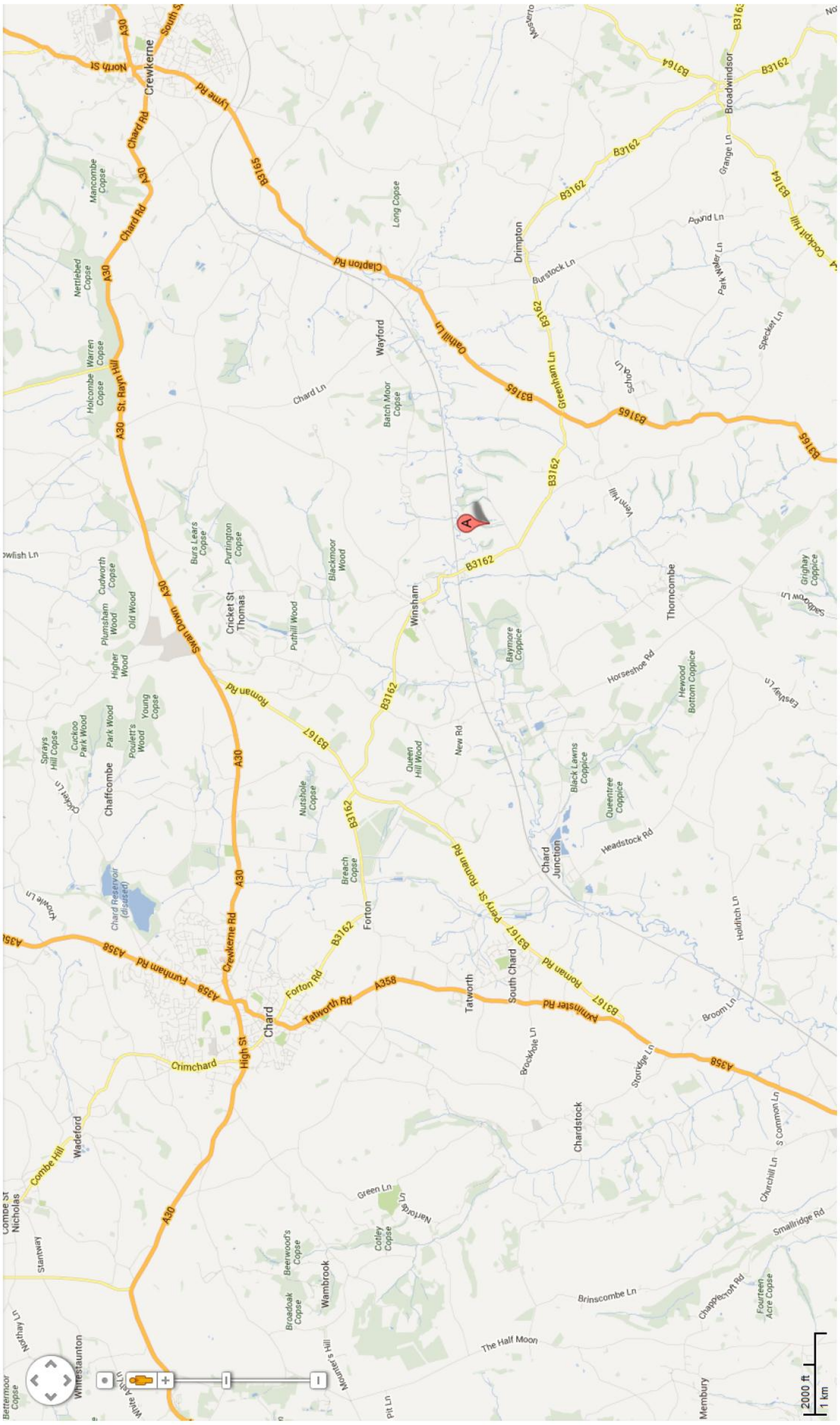
Venue Web Page: http://www.themagdalenproject.org.uk/contact.php

There is ample parking at the Magdalen Project, Magdalen Farm, Winsham, Chard, Somerset. TA20 4PA. Telephone: 01460 30144

A general location map is provided below where the venue is marked by the red marker “A”.

**Public Transport**

Unfortunately there is no easy access by public transport but special arrangements can be made through the organisers for a pick up at Axminster Railway Station. If you require a pick up please let us know well in advance.


Crewkerne
Chard
Winsham
Drimpton
Broadwindsor
Wayford
Thorncombe
Tatworth
South Chard
Chard Junction
Chardstock
Forton
Wambrook
Membury
Wadeford
Chaffcombe
Cricket St Thomas
A30
A358
B3162
B3165
B3167
B3164
2000 ft
1 km

Page **3** of **3**

**List of Attendees**

| | |
|---|---|
| Rachel Young | Maney Ltd. |
| Jo Bailey | Independent |
| Anthony Bailey | Independent |
| Hugh Prudden | Somerset RIGS Group |
| Genni Elliott | TVAS |
| Andrew Weale | TVAS |
| Steve Ford | TVAS |
| Stave Wallis | Dorset CC |
| Bill Horner | Devon CC |
| Jon Humble | EH |
| Jonathon Last | EH |
| Francis Griffith | CBA |
| Simon Wiltshire | Bardon Aggregates |
| Joanne Baker | Bardon Aggregates |
| Ella Egberts | Bournemouth University |
| Jonathon den Otten | Independent |
| Mervyn Newman | Natural England |
| Tony Pearson | Bardon Aggregates |
| Michael Lobb | University of Southampton |
| Kris Krewiec | Archaeology South East |
| Thierry Fonville | University of Southampton |
| Douglas Long | Chard Museum |
| Laura Basell | Bournemouth University |
| Tony Brown | Southampton University |
| Rob Hosfield | University of Reading |
| Phil Toms | University of Gloucestershire |

**APPENDIX 3**

**Photographs of Stage III Finds**