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SUTTON HOO FIELD REPORTS

Volume 9 PALAEOECOLOGY
RF= means a report is held this Research Files

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6.2 Plant Remains Assessment of Charred plant remains from prehistoric features by A R Hall

1. **SUMMARY**

The volume is concerned with the environment of Sutton Hoo and the biology of anthropogenic assemblages. It contains scientific assessments and reports on soils, vegetation, taphonomy, animal and human remains and radiocarbon dates as given to or received from specialists, and back-up data for summaries that appear in the research report. Some interim assessments and reports are available only in hard copy in the Research Files (RF).

2. **STRATEGY**

2.1 **Aims and Objectives**

The research targets of the 1983 campaign were to enhance the soil and vegetation history and address the problems of what the land looked like before the mounds were built and what happened to them afterwards. It was decided to accept Dimbleby's results on soil pollen from the site and not to duplicate his investigation (FR 9/6.30). The vegetation sequence would be enhanced by a section cut off site, and by an examination of the present species population. The soil history would be studied by micromorphology, using the buried soil for the history before mound-building and the quarry -pit fills for soil use after the mounds had been built. The soil history would be also be studied in conjunction with archaeological studies of the processes of deposit formation, in order to try and understand when and how earth had been moved on the site.

2.2 **List of Studies commissioned and achieved**

Three specialist investigations were undertaken: an inventory of plant species present on the site in 1984 by Steve Rothera, which produced a *floral survey (FR9/6.1.5),* an analysis of soil pollen by Rob Scaife, from a trench cut off-site, which produced a *vegetational sequence (FR9/6.1.6)*; and the micromorphological study by Charles French (FR9/5.2) of samples taken off and on site which produced important evidence for the *formation of deposits and soils*.

Running alongside these specialist investigations was the *archaeological study of strata,* drawn from the soil descriptions and site geometry gathered by the recording procedures.

An allied investigation was that undertaken by the Leverhulme project (FR9/7), which set to out to understand the *taphonomy*, in particular the way that sand-bodies had formed and how chemical traces could be detected. The project showed that, (unless the acidity had been reduced by a large bulk of bone or contact with metal) organic material was transformed to humic sand within a decade, but that insoluble decay-products could be detected in the substrate. The acidity had probably also affected the formation of horizons within the buried soil. In 1983 the surface acidity was measured as pH 3.8-4.2.

2.3 **Consultancy documents on strategy**

2.3.1 *Preliminary Proposals for palaeoenvironmental studies*
by P Murphy 1983

<u>Sutton Hoo Context Survey: Preliminary Proposals for Paleoenvironmental Economic Studies</u>

It is clear that some preliminary groundwork is required before attempting to formulate any research programmes. Grant applications are unlikely to be successful without defining precisely the nature and scale of investigations proposed and the techniques used. This can only be done from a basis of knowledge gained by fieldwork in the area. Three main areas of study may be distinguished at this stage.

1. <u>Coastline Survey</u>

<u>Objectives</u> are (i) to locate sections providing stratigraphic evidence for phases of marine transgression and regression in the form of estuarine clays and freshwater peats in the South East Suffolk estuaries and (ii) to locate waterlogged archaeological sites, which elsewhere in this area will be uncommon. <u>Methods</u> will consist initially

of 'fieldwalking' with some limited hand augering at critical sites. (An example of what can be achieved in an estuarine area with limited manpower over a short period, in total about 4 man months, is provided by the attached interim reports of the Hullbridge Survey).

2. Valley Fen Survey

The objective is to locate deep valley-floor peats potentially suitable for pollen analysis. Methods will include field survey with hand augering supplemented by examination of bore logs held by such bodies as the County Highways Department, Geological Survey, etc.

3. Site Based Studies

Palaeoenvironmental/economic studies at archaeological sites must await completion of current fieldwalking. Objectives of this fieldwalking should include (i) location of earthworks of all periods (barrows, linear earthworks, mill-mounds, etc.) which are likely to seal fossil soils potentially suitable for palynological and soil studies and (ii) location of settlement sites which may yield economic information in the form of carbonised crop plant remains and animal bone. For the latter calcareous/neutral soil parent materials will be necessary. (An example of the type of regional study possible is provided by the attached paper on the Breckland).

This basic fieldwork is a necessary prerequisite for further palaeoenvironmental economic studies of the subregion. Other areas of study (eg colluvial deposits at the former Bolton's Pit, Ipswich, and similar sites) might at a later stage prove worthy of investigation.

Peter Murphy
23 November 1983

2.3.2 *Sutton Hoo Project: Archaeological Science applications* by N D Balaam 1987

2.4 **Revisions to Strategy**

2.4.1 *Environmental strategy 5 July 1987 [RFZ2.1(11)]*

2.4.2 *Environmental Archaeology Strategy 1988*

2.4.3 *Revised programme for H Atkinson, Aug 1988 [RFZ2.1(12)]*

2.4.4 *Programme for C French, Oct 1988 [RFZ2.1(13)]*

2.4.5 *Revised Environmental Strategy as at 10 July 1990* (MOHC)

Environmental Strategy as at 10 July 1990

Visit of C French and R Scaife

C French has completed work and delivered report. R Scaife has yet to start, but is awaiting C French's results.

Summary of C French's research

MOUND 2

Samples

30323	N311/0	1462	158	BS	under Horizon 4
30324	N311/0	1553	206	BS	under Horizon 5
32759	N311/8	1564	213	BS	under Horizon 6

Results

- All these contexts contain similar soil
- Identified as BS horizon of a podzol
- Contains pellety organic matter ingested by soil fauna
- Enriched with metallic oxides, Si, Al, Fe
- Reported as 16cm thick
- Hypothesised as truncated, ie between 15-50cm missing
- Cannot say if the soil was cultivated; no evidence from micromorphology

Comment

- Buried soil as measured beneath Mound 2 is actually c40cm thick.

- Cannot have been much higher in Neolithic /BA, otherwise incompatible with height of hearths and post sockets. These imply that top of buried soil as defined is equivalent to Neolithic/BA ground surface.

- Cannot have been much higher in period of cultivation manifested by lazy bed trenches. These may be Roman cultivation trenches (vineyard?).

- Therefore, the most likely periods of soil growth, podsolization and truncation are either Late BA (1000-0 BC) or post-Roman (400-600 AD).

- If the truncation was late BA, then IA earthworks would stand proud of buried soil surface.

- If the truncation was post-Roman, then it may have been done for construction of other mounds. But this does not explain why Mound 2, Mound 5 and Mound 6 buried soil platforms are at exactly the same level.

Implications

- Need height AOD of top and bottom of buried soil under Mound 2	AJC
- Need A4 plan showing location of the 3 columns.	LP
- Need height AOD of top and bottom of each column.	LP
- Need a micromorphological analysis of a context in F143 (primary Mound make-up). Best would be 1393 in N.	C French
- Need pollen analysis of the four contexts.	R Scaife

Mound 5

Samples

Upper	39229	- (?)	1584	224	Buried soil under Horizon 4
	39230	N369/15	1584	224	Buried soil under Horizon 4
Lower	39231	N369/15	1584	224	Buried soil under Horizon 4
			1774	391	Buried soil under Horizon 5
	39232	N369/15	1813	412	Buried soil under Horizon 5

Results

- Buried soil reported as 22.5cm thick
- Lower half identical to the whole of the profile under Mound 2
- Upper half is denser, with more organic matter and plant tissue fragments
- Charcoal fragments present

- Hypothesised as truncated
- No evidence for cultivation

Comment

- As Mound 2. However, the cultivation is criss/cross ploughing and accompanied by regularly spaced root marks ('cabbage patch')

Implications

- Buried soil is actually c 40cm thick	
- Need height AOD of top and bottom of buried soil under Mound 5	AJC
- Need A4 plan showing location of the column	LP
- Need height AOD of top and bottom of column	LP
- Need pollen analysis from all four samples	R Scaife

Mound 2 Burial Chamber

23364	N291/1	-	162	Natural from burial chamber floor

Results

- Natural confirmed. No organic matter.

Comment

- None

Implications

- None

Mound 2 Make-up

14446	N223/27	1309	138	Turf layer from Quad J

Results

- Dominated by amorphous organic matter
- Possibly derived from turf horizon of a podzol

Comment

- 1309/138 does not feature on the Mound 2 strat. diagram
- Therefore no clear to which Mound horizon this turf refers.
- However, good evidence that Mound was constructed from a podzol. Therefore further support for a post-Roman podzolisation.

Quarry Ditches

18982	1418	153	(Quad R)	Turf layer in ditch

Results

- Very dominant organic component. Not a turf, but deriving from the lower horizon of a podzol. (Or upper half of Mound 5 buried soil).

Implications

- Part of the Mound, constructed from middle of an original podzol.

Gully

40461 ? 216 Prehistoric gully under Mound 2

Results

- 1 xxxxxxx fill to quarry ditch, 18982.

Implications

- Open when soil already podsolised

- If this was Post Roman, could have been cut through just before construction of mound.

Summary of Research Questions Still to be Answered

Question	Result	Work Needed
1. Mound 2. What was soil profile at time of construction? Therefore, how was it constructed?	Truncated podsol, although not clear what caused the truncation. Is the missing podsol within the mound make-up?	Micromorph. on mound make-up samples from Mound 2. xxxx contexting would be 1393 from F143 and 1335 from F137
2. Mound 5,2. What was the vegetation at the time of construction?	Heath, apparently, but this is not compatible with the three types of cultivation traces observed	Pollen analysis from a) each horizon under Mound 2 and Mound 5 - 1564, 1553, 1462, 1584, 1774, 1813 b) Mound make-up 1393, 1335 c) Soil in Q showing the cabbage patch
3. How were the quarry pits filled and when?	[Wind-blown/waterxxxx sand/silt]	Micromorph. from quarry pit backfill. Pollen from some samples
4. What was the vegetation at the time of the early prehistoric settlement?		Pollen analysis from Neolithic boundary ditch (primary fill). (Int 48). Macrofossils from hearths and promising assemblages. Grain impression from pottery
5. What was the vegetation at the time of the later prehistoric settlement?		Pollen analysis from backfill of IA boundary ditch under Mound 6 (Int 44) and from Int 48, F56
6. Was the IA enclosure visible as an earthwork when the mounds were constructed?	[suggested by position of Mounds 5, 5, 17]	Micromorph. through enclosure ditch where it cuts buried soil under Mound 6

7. Can prehistoric and other features be assigned to period on the grounds of their botanic remains?		Bulk sieving for macrofossils from all pits and ditches excavated, including Anglo-Saxon graves and burial chambers
8. Can the sequence of vegetation and soil regime be determined more precisely?		Micromorph. and pollen analysis from captured sequence of erosion products in valley beneath the site
9. Can we relate crops to boundaries?		Pilot study of Mound 2 macrofossil samples either side of major boundaries Mound 6 bulk sieving inside and outside boundary for plant macrofossils

2.4.6 *Modified Environmental Strategy, 26 Sep 1990*

2.4.7 *Analytical Update, April 1991 [RF Z2.1(17)]*

2.4.8 *Programme of Scientific analyses as at Sep 1991 [RF Z2.1(17)]*

3. **METHODOLOGY and Data Acquired**

[see Research Report, Chapter 10]

4. **MODEL of SOIL and VEGETATION SEQUENCE**

[see Research Report, Chapter 10]

5. **SELECTED STUDIES: SOILS**

5.1 **General Surveys**

5.1.1 *Environmental* [reconnaissance] *work, C Royle April 1985.[RF Z2.2]*

5.1.2 *The Holocene Sequence of the Deben Estuary: a preliminary assessment of its potential for the study of the Sutton Hoo Ship Burials by T J Wilkinson and P Murphy*

5.1.3 *Environmental Work carried out near Sutton Hoo, summer 1985, by H Atkinson*

5.2 **Micromorphology** by C I French

5.2.1 Interim Report No 1: Mound 2 and Mound 5, 26 March 1990

THE MICROMORPHOLOGICAL ANALYSIS OF THE BURIED SOILS, MOUND MAKE-UP AND ANCILLARY FEATURES ASSOCIATED WITH MOUNDS 2 AND 5, SUTTON HOO, SUFFOLK : Interim Report 1

C. A. I. French

(25/3/1990)

1. Introduction

Twelve samples from six contexts associated with Mounds 2 and 5 were analyzed in thin section (after Bullock et al. 1985; Murphy 1986). The detailed micromorphological descriptions are found in Appendix 1 with the samples identified by site finds numbers, and the photomicrographic record in Appendix 2.

Two buried soil profiles were examined in detail. The buried soil beneath Mound 2 was sampled in three contiguous blocks (finds numbers 30323, 30324 and 32759 from top to bottom), as well as the underlying natural (subsoil) beneath the burial (finds number 26841). The buried soil beneath Mound 5 was sampled in four contiguous blocks (finds numbers 39229/30/31/32 from top to bottom).

In addition, the material infilling the Mound 2 burial chamber (finds number 23364), and a possible turf in the make-up of Mound 2 (finds number 14446) were sampled. Finally, the primary fill of the ring ditch around Mound 2 (finds number 18982) and the fill of a west-east prehistoric gully beneath Mound 2 (finds number 40461) were also sampled.

2. Discussion of Results

2.1 The buried soil beneath Mound 2

The buried soil beneath Mound 2 was c. 16 cm in thickness and exhibits similar micro-pedological characteristics throughout its surviving depth.

The soil is an apedal, homogeneous quartz sand, dominated by the medium and fine quartz sand grades. Although there is almost no fine (silt and clay) fraction present (<8%), it is characterised by very dominant polymorphic organic matter, which together with the silt/clay fractions is cemented by amorphous sesquioxides (iron oxides and hydroxides). Thus, the surviving buried soil is indicative of the lowermost illuvial horizon (or spodic horizon) of a spodosol (or podzol) and in particular is a Bs horizon (or enriched with metal oxides) (after de Coninck 1980; de Coninck and Righi 1983; Limbrey 1975).

In addition, the lowest sample of the buried soil (finds number 32759) contains one nodule of oriented clay and one soil fragment with random striated limpid and non- laminated dusty clay present in it. Both are probably eroded relics of the pre-podzol soil or an argillic brown earth which had developed in the area under former stable woodland conditions (Macphail 1987).

The underlying subsoil is dominated entirely by medium and fine quartz sand, and exhibits greater and lesser zones of cementation with amorphous sesquioxides, and contains no organic matter.

Polymorphic organic matter is one of two main types of amorphous organic material found in spodic horizons. It is rough-walled, with an irregular, patchy internal fabric (Bullock et al. 1985, 78-79). Although this Bs horizon is dominated by amorphous sesquioxidic impregnation, it is also characterised by polymorphic organic matter. Thus it is essentially a friable spodic horizon which contains silica (Si), aluminium (Al) and possibly iron (Fe) inside the polymorphic units.

Although there are different theories for the formation of a friable spodic horizon, it is probably due to two simultaneous processes. First, the illuviation of organo- metallic compounds (or organo-Al and organo-Al and Fe complexes), and second biological activity living on the remains of the many roots and on the illuviating complexes (de Coninck and Righi 1983).

The formation of these organo-metallic compounds is explained as follows. Soluble organic compounds are adsorbed at the surface of clay particles and amorphous metallic hydroxides; adsorption modifies the physical-chemical properties of the hydroxides, which acquire the characteristic pellety microstructure (de Coninck and Righi 1983).

Biological activity probably forms the pellety microstructure of friable B horizons in two ways. First, part of the plant remains ingested by the soil fauna forms faecal pellets, and pellets by the transformation of faecal pellets. Second, the other part of the plant remains is comminuted into small pieces and transformed into dark pellets. Thus, the pellety microstructure itself is the result of the action of fauna, but the aggregates contain a large amount of illuvial material associated with the fine mineral fraction and root remains (de Coninck and Righi

1983).

2.2 The buried soil beneath Mound 5

The buried soil beneath Mound 5 was c. 22.5 cm thick. The lower half of the profile is identical to the whole surviving profile beneath Mound 2, and is a friable Bs horizon of a spodosol. It is dominated by iron impregnation first, and amorphous organic matter second. The upper half of the profile (finds numbers 39229/30) is also similar, but it exhibits a slightly denser fabric, a greater polymorphic organic matter content and a few plant tissue fragments with their cell structure still evident. These characteristics suggest that the soil is grading up to a B(h)s or more humic illuvial horizon of a spodosol.

The classic sequence of soil degradation envisages the following order of soil deterioration : argillic brown earth - brown podzolic soil - podzol (Dimbleby 1962; Duchaufour 1977). On a free-draining parent subsoil, clay is moved or destroyed in an acidifying environment, prior to the eluviation of sesquioxides and organic matter down the profile. Under the impact of early clearance and agriculture, the climax soil (or argillic brown earth) became depleted of soil nutrients and progressive acidification occurred as a result of deforestation, burning and accelerated leaching. These factors are regarded as the major causes of podzolisation under heathland vegetation in the later Flandrian (Catt 1979; Dimbleby 1962).

There is little doubt that both the surviving soil profiles beneath Mounds 2 and 5 are severely eroded and/or truncated. As the Bh, Ea and humic horizons are absent, at least 50-70 cm of the original profile has not survived. It is most probable that the upper two-thirds of this spodosol has been removed and re-incorporated to form the barrow mounds themselves.

Thus, this spodosol (podzol) must have been well formed by the Saxon period. This soil could have formed at any time from the Neolithic period onwards (Macphail 1987; Dimbleby 1962) after its initial deforestation. Moreover, it would have been quite useless as arable land, and for which there is no surviving evidence.

Other examples of similar spodosols are found at Bawsey (Norfolk), West Heath (Sussex) and Keston Camp (Kent), to mention just a few. At Bawsey, a well preserved podzol exhibiting an Eah with abundant plant remains and polymorphic organic matter, a Bh and Bs horizon were found beneath a Bronze Age barrow. In addition, this soil had formerly been an argillic brown earth which had developed beneath woodland, prior to clearance, the development of heathland and concomitant acidification, and barrow construction (French in Wymer, forthcoming). At West Heath, pedological and palynological analyses of buried soils from a Bronze Age barrow cemetery suggests a mosaic of clear areas surrounded by woodland which had developed humo-ferric podzols (Drewett 1976; Macphail 1981; Scaife 1982). At Keston Camp, Iron Age ramparts buried a fully degraded podzol, in this case a complete and untruncated profile which had developed under woodland (Cornwall 1958; Dimbleby 1962).

2.3 The burial chamber within Mound 2

The material infilling the burial chamber is an inorganic quartz sand, with up to 50% of the quartz grains cemented with amorphous sesquioxides. This fabric is similar to the underlying natural sand subsoil (see 2.1 above). It must therefore be suggested that the burial chamber is infilled with redeposited subsoil material.

2.4 Turf within Mound 2

One of the many probable "turves" observed in section within the mound was sampled to confirm its field identification. This material is a porous loamy sand with frequent to common pellety organic matter, large flecks of charcoal and sub- angular plant fragments, and amorphous sesquioxide impregnation of plant tissues, most of the fine fraction and the polymorphic organic matter. Thus, this material is from the humic, probably turf horizon, of a spodosol. Nevertheless, it is poorly preserved and only moderately developed, which may be indicative of a modern organic horizon.

2.5 The primary fill of the ring ditch around Mound 2

The soil fabric and cemented pellety organic matter of this material is similar to the upper half of the buried soil beneath Mound 5 or B(h)s horizon material, and is less organic than the turf in Mound 2. Although this is not turf, it is probably redeposited or eroded material from the lower horizon of a spodosol. This reinforces the theory that the soil was already a well developed humo-ferric spodosol by the time the barrow and barrow ditch were constructed.

2.6 The prehistoric gully beneath Mound 2

This infilling material is similar to the fill of the ring ditch around Mound 2. Thus the dating of this gully should provide an approximate date by which time the development of heathland/spodosol had occurred in this area.

3. Conclusions

1) There were three phases of pedogenesis prior to the construction of the barrow mounds :
   - (i) the probable development of an argillic brown earth under stable woodland conditions in earlier Flandrian times;
   - (ii) deforestation, soil degradation, acidification and development of heathland during the prehistoric (probably pre-Bronze Age) period;
   - (iii) concomitant development of well-developed humo-ferric spodosol (podzol), very leached and iron impregnated, possibly up to 70-90 cm in thickness.

2) Associated with the construction of the Saxon burial mounds, there was a deep truncation of the soil profile, removing up to two-thirds or c. 50-70 cm of the profile.

3) The upper horizons of the spodosol were redeposited to form the make-up of the mounds, along with complete turves.

4) The ring ditch around Mound 2 contains eroded soil material from a spodosol, probably derived from the mound itself.

5) The burial chamber beneath Mound 2 is infilled with subsoil material.

6) The prehistoric gully beneath Mound 2 also contains eroded spodsolic material, which is further proof of the earlier prehistoric podzolisation of the soil in the area occupied by this site.

Acknowledgements

I would like to thank Dr.R.I.Macphail of the Institute of Archaeology, London; and the Mr.M.Smith and the soil micromorphology laboratory of the Department of Agriculture and Environmental Science, University of Newcastle-upon-Tyne.

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Appendix 1 : The detailed soil micromorphological descriptions.

Buried soil beneath Mound 2 :

Sample 30323 :

Same as for samples 30324 and 32759 below, except for :
Porosity : very few (<1%) channels, smooth to weakly serrated, walls accomodated, vertical, 1-1.5 mm wide, 1.5 cm in length; no metavughs present;
Amorphous : very rare (<1%) sub-rounded fragment of bone, 100-150 um.

Sample 30324

Same as sample 32759 below, except for :
Porosity : no metavughs present.

Sample 32759 :

Structure : apedal, homogeneous, bridged to pellicular grain; Porosity : c. 20% simple to complex packing voids, 50-200 um, much interconnected to irregular, between grains and aggregates/grains; c. 1% metavughs, 1-4 mm, sub-rounded, smooth to weakly serrated; Mineral Component : limit : 100 um; coarse/fine ratio : 80/20: coarse fraction : coarse (5%), medium (35%) and fine (40%) quartz, sub-rounded to sub- angular, 100-500 um, random, unoriented; fine fraction : 5% è very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented; <5% silt and <2% clay, very weakly speckled, very dark brown (PPL), orange (RL); c. 8% pellety organic matter; Organic Component : few (10%) very fine flecks of charred organic matter in fine fraction, <50 um; very few (<1%) large flecks of charcoal, 100-200 um; common (>40% of fine fraction) present as pellety amorphous organic matter, sub-rounded to irregular, 25-75 um, very dark brown (PPL), cemented with silt and amorphous sesquioxides; Groundmass : fine : undifferentiated to very weakly speckled; coarse : undifferentiated; related : chitonic to gefuric; Pedofeatures : Textural : very rare (<1%) non- laminated dusty clay coatings of grains, reddish orange (XPL); very rare (<1%) laminated dusty clay coatings of grains, weak to moderate birefringence, reddish orange (XPL); Fabric : one nodule in groundmass, sub-rounded, 50 um, composed of clay, amber (XPL), strongly birefringent; one sub-angular fragment in groundmass, 100x150 um, composed of very fine quartz, silt and limpid and non-laminated dusty clay, random striated, yellow (XPL); Amorphous : few (10%) sesquioxide nodules, sub-rounded, <150 um; whole fine fraction and amorphous organic matter impregnated with amorphous sesquioxides.

Sample 26841 :

Structure : apedal, homogeneous, single grain to very weakly pellicular grain; Porosity : c. 25-30% simple to complex packing voids, much interconnected; Mineral Component : limit : 100 um; coarse/fine ratio : 90/10; coarse fraction : medium (50%) and fine (40%) quartz, sub- rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 10% very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented; Organic Component : none; Groundmass : coarse : undifferentiated; fine : undifferentiated; related : monic; Pedofeatures : Amorphous : thin discontinuous coatings of amorphous sesquioxides in the upper half of the slide, yellowish orange (RL); in the lower half of the slide all quartz is cemented with amorphous sesquioxides, yellowish orange (RL).

The buried soil beneath Mound 5 :

Sample 39229 :

Same as sample 39230 below except for : Pedofeatures : Fabric : one nodule of non-laminated dusty clay within groundmass, sub-rounded, 100 um, striated fabric, light brown to reddish brown (XPL); Amorphous : very rare (<1%) nodule of very fine quartz and amorphous organic matter, sub-rounded, 2-3 mm.

Sample 39230 :

Structure : apedal, homogeneous, bridged to pellicular grain to intergrain micro-aggregate structure; Porosity :

c. 15% simple to complex packing voids, much interconnected; è very few (<5%) channels, elongate, smooth to weakly serrated, walls partially accomodated, 1-5 cm long, 0.5-1 mm wide, vertical and parallel; Mineral Component : limit : 100 um; coarse/fine ratio : 70/30; coarse fraction : medium (30%) and fine (40%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 8% very fine quartz, sub- rounded to sub-angular, 50-100 um, random, unoriented; <5% silt and <2% clay, c. 15% pellety organic matter; dark brown (PPL), orange (RL); Organic Component : common to dominant (>50% of fine fraction) amorphous organic matter, predominantly pellety aggregates, rounded to sub-rounded, 25- 75 um, rounded to sub-rounded, very dark brown (PPL); few (5-10%) ferruginised plant tissues with cell structure evident; Groundmass : coarse : undifferentiated; fine : undifferentiated to very weakly random speckled; related : chitonic, with locally a tendency to gefuric; Pedofeatures : Fabric : very few (<1%) individual quartz grains found in channels; Amorphous : very few (<2%) sub-rounded aggregates, <100 um, containing fragments of plant tiisue, silt and pellety amorphous organic matter; amorphous sesquioxide impregnation of whole fine fabric.

Sample 39231 :

Structure : apedal, homogeneous, bridged to pellicular grain to intergrain micro-aggregate; Porosity : c. 20% simple to complex packing voids, mainly 25-200 um and few 400-1000 um, smooth, simple elongate, much interconnected to irregular complex packing between grains and aggregates; 2% channels, elongate, smooth to weakly serrated, walls partially accomodated, 0.5-2 mm wide, 5-12 mm long, vertical and parallel; Mineral Components : limit : 100 um; coarse/fine ratio : 80/20; coarse fraction : medium (40%) and fine (40%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 5% very fine quartz, 50- 100 um, sub-rounded to sub-angular, random, unoriented; 5% silt and 2% clay; <8% pellety organic matter; dark brown (PPL), orange (RL); Organic Component : common (<40% of fine fraction) amorphous organic matter in the form of pellety aggregates, sub-rounded to rounded, 25-100 um, dark brown to very dark brown (PPL); few (<5%) ferruginised roots/stems with well preserved internal cell structure, 50- 150 um; few (<5%) plant tissue fragments with internal cell structure evident, 25-150 um; frequent (15%) very fine flecks of charcoal or charred organic matter within fine fraction, sub-rounded, <25 um; Groundmass : coarse : undifferentiated; fine : undifferentiated to very weakly random speckled; related : chitonic with locally a tendency to gefuric; Pedofeatures : Textural : very rare (<1%) non- laminated dusty coatings of grains, yellow to reddish yellow (XPL); Amorphous : whole fabric impregnated with amorphous sesquioxides; amorphous sesquioxide impregnation of roots/stems; very few (<5%) sesquioxide nodules, sub-rounded, <150 um; one nodule composed of pellety organic matter and silt, sub-rounded, 50-150 um, brown (PPL).

Sample 39232 :

Structure : apedal, homogeneous, bridged to pellicular grain to intergrain micro-aggregate; Porosity : c. 25% simple to complex packing voids, coarse micro to medium meso, 25-200 um, smooth, simple elongate, much interconnected to irregular complex packing between grains and micro- aggregates; Mineral Component : limit : 100 um; coarse/fine ratio : 80/20; coarse fraction : medium (60%) and fine (20%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 5% very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented; <5% silt, 2% clay; <8% pellety organic matter; very weakly speckled; dark brown to brown (PPL), orange (RL); Organic Component : common (<40% of fine fraction) pellety amorphous organic matter, rounded to sub-rounded, 25-200 um; few to frequent (15%) very fine charcoal fragments within fine fraction, <50 um; few (<5%) root/stem pseudomorphs, replaced by amorphous sesquioxides; very few (<1%) plant tissue fragments, <100 um, brown to very dark brown (PPL); Groundmass : fine : undifferentiated to very weakly, random speckled; coarse : undifferentiated; related : chitonic, with locally a tendency to gefuric; Pedofeatures : Textural : very rare (<1%) laminated dusty clay coatings of grains, moderate birefringence, yellow to reddish yellow (XPL); Amorphous : whole fabric impregnated with amorphous sesquioxides; very few (<5%) sesquioxide nodules, sub-rounded, <50 um; very few (<1%) nodule, composed of sesquioxide impregnated very fine quartz, sub-rounded, <100 um.

Sample 23364 : infill of the burial chamber beneath Mound 2

Structure : single grain; Porosity : c. 10-25% simple to complex packing voids, much interconnected; Mineral Component : limit : 100 um; coarse/fine ratio : 95/5; coarse fraction : medium (60%) and fine (35%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 5% very fine quartz, 50-100 um, sub-rounded to sub-angular, random, unoriented; Organic Component : none; Groundmass : fine : undifferentiated; coarse : undifferentiated; related : monic; Pedofeatures : Amorphous : c. 50% of fabric coated/cemented with amorphous sesquioxides.

Sample 14446 : turf within Mound 2

Structure : apedal, homogeneous, single grain to intergrain micro-aggregate; Porosity : c. 30% simple to complex packing voids, irregular, much interconnected; Mineral Component : limit : 100 um; coarse/fine ratio : 50/50; coarse fraction : medium (25%) and fine (25%) quartz, sub- rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 5% very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented; 10% silt and <5% clay; 30% pellety organic matter; very dark brown (PPL), very dark brown to black (RL); Organic Component : few (10%) plant tissue fragments, sub-angular, 100-150 um and 1-3 mm; dominant (>60% of fabric) amorphous organic matter occurring as pellety aggregates, sub-rounded to irregular with rough, irregular surfaces, 50-200 um, very dark brown (PPL); very few (<1%) large flecks of charcoal, sub-rounded to sub-angular, 2-5 mm; Groundmass : fine : undifferentiated; coarse : undifferentiated; related : enaulic; Pedofeatures : Amorphous : amorphous sesquioxide impregnation of plant tissue fragments and most of fine fraction and pellety organic aggregates.

Sample 18982 : primary fill of ditch around Mound 2

Structure : apedal, homogeneous, single grain to intergrain micro-aggregate; Porosity : c. 10-15% simple packing voids, some interconnected; c. 5% vughs, sub-rounded to irregular, smooth to weakly serrated, <150 um; Mineral Component : limit : 100 um; coarse/fine fraction : 80/20; coarse fraction : medium (30%) and fine (50%) quartz, sub- rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : <5% silt; 15% cemented pellety amorphous organic matter; dark brown (PPL), very dark brown (RL); Organic Component : very dominant (75% of fine fraction) pellety amorphous organic matter, 25-150 um; very few (<5%) fine flecks of charcoal, sub-rounded, <50 um; Groundmass : fine : undifferentiated; coarse : undifferentiated; related : gefuric to enaulic; Pedofeatures : Amorphous : whole fabric impregnated with amorphous sesquioxides.

Sample 40461 : fill of prehistoric gully beneath Mound 2

Same as for sample 18982.

Appendix 2 : Catalogue of soil photomicrographs

Frame	Sample No.	Light	Frame size	Description
4	30323	PPL	4.5 mm	Bs, pellety organic matter
5	30323	XPL	4.5 mm	same as above
6	30323	RL	4.5 mm	same as above
7	30323	PPL	2.0 mm	same as above
8	30323	RL	2.0 mm	same as above
9	30324	PPL	2.0 mm	Bs, pellety organic matter
10	30324	RL	2.0 mm	same as above
11	32759	PPL	2.0 mm	plant tissue in Bs
12	32759	PPL	4.5 mm	Bs, pellety organic matter
13	32759	PPL	2.0 mm	same as above
14	32759	RL	2.0 mm	same as above
15	26841	PPL	4.5 mm	quartz grains
16	26841	PPL	4.5 mm	quartz grains with much sesquioxidic cementation
17	39229	PPL	4.5 mm	B(h)s, charcoal
18	39229	PPL	2.0 mm	B(h)s, charcoal, pellety organic matter
19	39229	PPL	2.0 mm	same as above
20	39231	PPL	4.5 mm	iron replaced plant tissue
21	39231	PPL	2.0 mm	Bs, pellety organic matter
22	39231	RL	2.0 mm	same as above
23	39230	PPL	4.5 mm	B(h)s, pellety organic matter
24	39230	RL	4.5 mm	same as above

Frame	Sample No.	Light	Frame Size	Description
25	39230	PPL	2.0 mm	B(h)s, pellety organic matter
26	39232	PPL	4.5 mm	Bs, pellety organic matter
27	39232	RL	4.5 mm	same as above
28	39232	PPL	2.0 mm	same as above

29	23364	RL	4.5 mm	cemented quartz
30	23364	PPL	4.5 mm	non-cemented quartz
31	14446	PPL	4.5 mm	organic/turf horizon
32	14446	PPL	2.0 mm	same as above
33	18982	PPL	4.5 mm	organic ditch fill
34	18982	PPL	2.0 mm	same as above
35	40461	PPL	2.0 mm	organic ditch fill
36	40461	PPL	2.0 mm	same as above

(XPL = crossed polarised light; PPL = plain polarised light; RL = reflected light)

5.2.2 *Revised Strategy, 24 July 1991*

5.2.3 *Response to queries on the truncation of soils under Mound 5, 6 Aug 1991.*

5.2.4 Interim Report No 2: Medieval bank and Mound 6 quarry pit.

THE MICROMORPHOLOGICAL ANALYSIS OF THE MEDIEVAL BANK (1814) AND THE MOUND 6 QUARRY PIT (3816), SUTTON HOO, SUFFOLK :

Interim Report 2

C. A. I. French

(26/8/1991)

1. **Introduction**

Two profiles were sampled for micromorphological analysis :

1) the medieval bank/lynchet 1814 (Int.48, 08420/15676); and

2) the turf and sub-turf disturbance through the quarry pit to the subsoil 3816 (Int.44, 12108/14300).
The thin sections were impregnated and cut (after Murphy 1986) with the assistance of the pedology laboratory, Department of Agriculture and Environmental Science, University of Newcastle-upon-Tyne, and described after Bullock et al. (1985). The detailed micromorphological descriptions are given in Appendix 1.

2. **Results and Interpretation**

2.1 The medieval bank/lynchet (1814)

A sequence of seven large thin section slides were taken through the 45 cm thickness of bank/lynchet.

A tripartite sequence is exhibited after examination in thin section :

(i) First, the upper c. 32.5 cm is characterised by a poorly sorted, porous sand, which is dominated by medium and fine quartz and c. 40-60% pellety organic matter (Bullock et al. 1985, 78-79; de Coninck and Righi 1983) dominates the fine fraction. The very poor sorting and open porosity suggest that this is redeposited soil, which has already been podzolised before redeposition in the form of a bank.

(ii)Second, the underlying horizon at c. 32.5-39 cm effectively forms a transition zone to the underlying (third) horizon. Although essentially similar to the overlying bank material, it is less dense and more compacted (in zones) than the overlying sand, and it contains greater amounts of pellety organic matter (c. 65% of the fine fraction). In addition, there is a more distinct, although still very minor, inorganic silt fraction present. The pellety organic matter is also impregnated with amorphous sesquioxides. Non-laminated dusty (or impure) clay coatings of the quartz grains are very rarely present.

These characteristics suggest that this is an in situ soil, although slightly dististurbed. This soil is probably the lower organic and sesquioxide-impregnated horizon of a podzol or the upper part of a Bs/h or spodic horizon.

(iii)Third, the underlying horizon at c. 39-45 cm represents the undisturbed in situ soil. It exhibits more well preserved soil characteristics than the other buried soils that have been examined beneath Mounds 2 and 5 (see French 1990).

Although it is also a sand to loamy sand dominated by medium and fine quartz, there is very little (comparatively) pellety organic matter present (<20% of the fine fraction), and there are comparatively high clay (c. 10%) and silt (c. 5%) contents present.

The clay content is particularly informative, and is indicative of three phases of former soil development in the following sequence. First, there are rare (c. 2%) limpid (or pure) clay coatings of the sand grains. These coatings rarely exhibit micro-laminations. This type of clay coating is indicative of former wooded conditions (Bullock and Murphy 1979; Macphail 1987). Second, there are rare to occasional (c. 3%) laminated dusty clay coatings of the sand grains which exhibit strong birefringence. These coatings are indicative of forest disturbance (Slager and van de Wetering 1977; Fisher 1982). Third, there are occasional (c. 5%) non-laminated dusty (or impure) clay coatings of sand grains with strong birefringence, which are indicative of further soil disturbance (Macphail 1987). These coatings may be associated with the truncation of the upper part of the original soil profile and the disturbance thus caused, as well as by the dumping of soil to create the bank/lynchet.

All of these characteristics indicate that this lowest horizon was an illuvial B or Bt horizon of a former brown forest soil (Avery 1980), which has subsequently become podzolised as a result of clearance and associated soil degradation.

The slightly better preservation of these important interpretative features is probably due to three features. First, this bank is situated slightly downslope; it is away from the disturbance caused by the construction of the barrows; and it has been buried by a later linear feature.

2.2 The Mound 6 quarry pit (3816)

A sequence of eight large thin section slides were taken through the c. 60 cm thickness of the Mound 6 quarry pit.

Throughout the quarry pit profile, the soil material is an homogeneous but poorly sorted sand dominated by approximately equal proportions of medium and fine quartz, with a very minor fine fraction (c. 30%). The fine fraction is dominated throughout by pellety organic matter, a characteristic feature of podzols (de Coninck and Righi 1983), from which this material is consequently derived. Of course, the concentration of pellety organic matter is greatest (c. 60% of the fine fraction) in the turf horizon (or the upper c. 10 cm), and decreases to about 30% (of the fine fraction) at the base of the quarry pit.

The silt and clay fractions are <10% combined in the upper 30 cm, and increases to about 15% in the lower 30 cm. There are rare to occasional textural pedofeatures evident throughout the quarry pit profile, although they are slightly greater in frequency in the lower half of the profile. There are two types of textural pedofeature present. First, and very rarely (<1%) in the upper 45 cm and occasionally in the lowest 15 cm, non-laminated limpid clay occurs either as coatings of grains and/or as small irregular to sub-rounded fragments within the groundmass. Both are indicative and surviving relics of the original brown forest soil profile which undoubtedly existed at Sutton Hoo prior to deforestation in prehistoric times (see French 1990 and section 2.1 above). Second, there are very rare (<1% in the upper 30 cm) to rare ((2% in the lower 30 cm) non-laminated dusty clay coatings of the grains. This type of coating is indicative of illuviation of fine material associated with soil disturbance (Macphail 1987).

There is every likelihood that there is a slightly greater amount of illuvial clay within the fine fraction in the base as opposed to the top of the quarry pit. This is because the exposed base of the surviving soil profile on the upper edge of the quarry pit was subject to initial erosion as a result of being cut through by the quarry pit. Upper horizons of the soil to either side would have also fallen in to the quarry pit at the same time, adding the organic component to the fill. The homogeneous but poorly sorted nature of the infill suggests a fairly rapid and immediate infilling process, a process which was undoubtedly aided by wind and water (rain splash impact and run-off) erosion of the exposed soil and subsoil to either side of the quarry pit.

Finally, the eroded and accumulated sandy soil in the quarry pit is derived from a soil profile which is already deforested, leached and podzolised by the period of the construction of Mound 6. This therefore confirms the nature of the pre-barrow soil profile that was postulated to exist beneath Mounds 2 and 5 by the Saxon period.

3. **Conclusions**

<u>The medieval bank/lynchet (1814)</u>

1) The basal <u>c.</u> 6 cm of this profile is believed to be the surviving but truncated remains of the original post-glacial soil profile. It was the Bt horizon of an argillic brown earth which had developed under wooded conditions by the time of the advent of man on site during the Neolithic period.

2) This same <u>in situ</u> soil horizon contains evidence in the form of laminated dusty clay coatings for the disturbance of the prehistoric woodland on site, probably associated with clearance activities by man during the Neolithic and Bronze age periods.

3) In addition, this illuvial or Bt horizon also contained non-laminated dusty clay coatings which are indicative of further soil disturbance and the truncation of the upper part of the original soil profile. This may be associated with one or more or any combination of clearance activities, tree-throw and the construction of the lynchet/bank much later in the medieval period.

4) The overlying <u>c.</u> 6.5 cm appears to be a transition zone between the relatively undisturbed relic soil profile and the overlying redeposited soil. It also exhibits characteristics of podzolisation, in particular, the organic and sesquioxide-impregnated lower B (or Bs/h) horizon of a podzol. Again this suggests that once deforestation had occurred on site in the earlier prehistoric period, that soil degradation and the process of podzolisation began and continued to occur.

5) The bank/lynchet material is characterised by redeposited sand with abundant pellety organic matter, which is characteristic of an already podzolised soil.

<u>The Mound 6 quarry pit (3816)</u>

6) The composition of the quarry pit is relatively uniform throughout and consists of very leached and podzolised sand, with the organic matter content decreasing with depth. This material has been derived from a podzol.

7) The rare to occasional textural pedofeatures in the base of the quarry pit suggest first the erosion of the lower horizons of the exposed <u>in situ</u> soil to either side, followed by the erosion of the upper more organic, adjacent soil horizons as a result of construction, exposure, wind and water erosion.

8) The soil profile has already degraded to a podzol by the time that the adjacent Mound 6 was constructed. A similar sequence has already been observed from the buried soils sealed beneath Mounds 2 and 5.

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5.2.5 Interim Report No 3: The Valley Section, INT 53

THE MICROMORPHOLOGICAL ANALYSIS OF THE VALLEY SECTION PROFILE (Intervention 53) : Interim Report 3

C. A .I. French

(June, 1992)

1. Introduction

Due to the intensively utilised and disturbed nature of the landscape immediately associated with the current excavations of the prehistoric and Saxon periods, it was decided to investigate the adjacent valley. It was judged probable that downslope, colluvial soil erosion may have buried the original soil profile, thereby leaving it relatively undisturbed. Accordingly, Intervention 53 was excavated by machine just above the base of the slope for the principal purposes of sampling for soil micromorphological and pollen analyses.

This sample trial trench excavation revealed a c. 1.3 m deep section which exhibited the following profile :

Depth (cm)	Context	Description
0 - 32	1000	ploughsoil - dark brown loamy sand
		(distinct boundary with)
32 - 80	1001	homogeneous, mid-brown loamy sand with few scattered gravel pebbles
		(merges over 2 cm with)
80 - 105	1002	homogeneous, reddish brown loamy sand with few scattered gravel pebbles
		(distinct, but irregular boundary with)
105-110	1003	clean, homogeneous yellow sand
		(distinct, but irregular boundary with)
110-123	1004	dark brown, loamy sand with scattered, common charcoal flecks
		(merges over 2 cm with)
123-130	1005	reddish brown loamy sand
		(merges over 2 cm with)
130 +	1006	dark reddish orange sand

The whole profile was sampled in a continuous column in 6 blocks. Of these, the major contexts were sub-sampled, except for the ploughsoil (1000) and the yellow sand (1003), as follows :

Context	Depth (cm)
1001	50 - 59.5
1001/1002	78.5 - 87.5
1002	95.8 - 105
1004	112 - 121
1004/1005	121 - 130

(The same profile was also sampled for pollen analysis.)

These samples were analysed in thin section (after Bullock et al., 1985; Murphy, 1986). The results are discussed below and summarised in Table 1. The detailed micromorphological descriptions are found in Appendix 1, and the photomicrographic record in Appendix 2.

2. Discussion of Results

The results are summarised in Table 1 below :

Depth (cm)	Context	Horizon	Description
0 - 32	1000	Ap	loamy sand ploughsoil
50 - 59.5	1001 (upper)	Ea(h)	podzolic fabric with pellety organic matter and colluvial clay formed in colluvium
78.5 - 87.5	1001 (lower) and 1002 (upper)	Ea(h)	essentially as above, with slightly finer fabric
95.8 - 103	1002 (middle)	Ea(h)	as above
103 - 105	1002 (lower)	Bs(/w)	poorly developed spodic horizon of podzol formed in colluvium with minor illuvial clay
105 - 110	1003	(C)	eroded, redeposited subsoil
112 - 118.5	1004 (upper)	Ah	lower A horizon of buried soil, contains high colluvial content, podzolised
118.5 - 121	1004 (lower)	Ea(h)	depleted horizon of podzol with relatively high organic matter content
121 - 128	1005 (upper)	Ea	depleted horizon of podzol

128 - 130	1005 (lower)	Bs(/t)	spodic horizon (Bs) of podzol developed in argillic horizon (Bt) of original brown earth
130 +	1006	C	in situ subsoil

2.1 Sample Contexts 1001, 1001/2 and 1002

All of these samples exhibit basically similar characteristics. They are characterised by an apedal, homogeneous, porous, loamy sand with about 50% of the fine fraction composed of polymorphic (or pellety) organic matter which is largely impregnated with amorphous sesquioxides. The relative minority component of silt and clay in the fine fraction and the relative abundance of pellety organic matter indicates that the upper two thirds of the whole profile (32-103 cm) is an Eah horizon of a podzol (de Coninck and Righi, 1983; Macphail, 1983).

There are very minor amounts of sub-rounded aggregates of non-laminated yellow clay, particularly in context 1001. This feature suggests that the profile received eroded remnants of another soil which had undergone considerable soil development prior to its erosion and incorporation in this Eah horizon.

The basal 2 cm of sample 1002 contains two additional characteristics. First, this zone contains a greater amount of sesquioxide impregnation of the whole fabric, including the pellety organic matter and textural clay pedofeatures. Second, there is a slightly greater concentration of clay pedofeatures - rare, non-laminated limpid clay and occasional non-laminated dusty clay coatings of the quartz grains and fine fraction groundmass.

The slight increase in illuvial clay deposition indicates that there has been a sufficient period of time for some soil formation, or incipient B(w) horizon formation (Limbrey, 1975). In addition, the subsequent and additional cementation with amorphous sesquioxides suggests that this B(w) horizon became a poorly developed spodic or B(s) horizon of a podzol (de Coninck and Righi, 1983; Macphail, 1983). Thus, all of this Eah and B(w) soil material has undergone some soil development or podzolisation since deposition.

In addition, colluvial aggradation of the profile continued. The homogeneous and relatively poor sorting, plus the depth of accumulation and presence of eroded clay aggregates suggests that there was a gradual accumulation of material as a result of long term colluviation, probably in the form of surface creep/overland flow and gully erosion (Morgan, 1979). These types of erosion are often visible today on the surface of the slope into which this trial trench was cut.

2.2 Sample Context 1003

Although this 5 cm thick context was not analysed in thin section, the distinct and clean yellow sand is undoubtedly the local subsoil. It can only have been derived from either slope erosion and/or deliberate re-deposition by man. As the latter is seems unlikely, severe soil and subsoil disturbance must be invoked.

This episode of subsoil erosion could have been caused by a variety of associated agencies. A most probable cause is deforestation of the upper part of the slope. Whether, this was a consequence of man's activities and/or storms and associated tree-throw, the almost immediate de-stabilisation of the soil and subsoil surface would have occurred, combined with rapid overland flow of the eroded material associated with episodes of heavy rainfall (Morgan, 1979).

The irregular nature of this re-deposited subsoil horizon also suggests that it suffered further erosion, probably gully erosion. This would be consistent with the unstable nature of the material immediately after its deposition and before colonisation and stabilisation by vegetation.

2.3 Sample Context 1004

This context exhibited three horizons.

The upper 2.2 cm (112-114.2 cm) was an apedal, relatively homogeneous, but poorly sorted sandy loam which contained no illuvial clay pedofeatures, but did exhibit rounded aggregates of limpid clay, charcoal fragments and a relatively high organic matter content, both in amorphous and polymorphic (pellety) forms. The colluvially derived limpid clay and organic matter is well mixed with the fabric, which suggests that there has been considerable soil faunal mixing.

It is suggested that this is the top of the former in situ soil, probably the lower Ah of a podzol. This soil has been buried by the subsequent erosion and colluvial deposition (ie. contexts 1003, 1002, 1001 and 1000). Prior to its burial, it had also been receiving minor amounts of colluvial material in the form of aggregates of limpid clay.

The middle 43 cm (114.2-118.5 cm) is essentially similar to the above horizon, although it contains less pellety organic matter but a slightly greater clay content. It represents the base of the lower Ah horizon. The clay content is in two forms, aggregates of eroded and re-deposited limpid clay as well as many limpid clay coatings throughout the groundmass. The former undoubtedly has a colluvial origin, that is rolled downslope and incorporated in the groundmass by soil mixing processes. The latter is illuvial clay resulting from the mass movement of soil associated with colluviation on this part of the slope (ie. a colluvial 'sludge').

The lower 2.5 cm (118.5-121 cm) exhibits completely different characteristics to the overlying Ah horizon. It is dominated by the sand fraction (80%), predominantly medium and fine quartz, with abundant sesquioxide impregnation, but it contains very little organic matter (5%) or fine fraction (<15%) and is more or less devoid of illuvial clay. This sandy, depleted horizon is the Ea horizon of a podzol. It is similar to the underlying context 1005 (upper 7 cm).

2.4 Sample Context 1005

This sample context exhibits three horizons. The upper 7 cm (121-128 cm) is similar to the overlying base of context 1004, and is the base of the Ea or depleted horizon of a podzol.

The lower 2 cm (128-130 cm) of this context exhibits characteristics of two different soil horizons. Although the texture is similar to context 1004 (above) and is dominated by the sand fraction (80%), there are occasional to many non-laminated limpid clay coatings within the groundmass and of the sand grains which exhibit moderate to strong birefringence. Although these coatings are not abundant, they have a relatively strong presence and orientation which suggests that they represent illuvial clay transported and deposited under former wooded conditions (Macphail, 1987). This suggests that this is the base of a former argillic earth (or Bt horizon) which is undoubtedly the base of the original in situ soil profile.

As a secondary process, these coatings have become impregnated with amorphous sesquioxides, as has the whole of the fine fraction. This indicates that the original soil profile had become podzolised and a poorly developed spodic (or Bs) horizon characteristic of a podzol had formed.

This Bs(t) horizon is developed on a sesquioxide impregnated sand (130+ cm), or the in situ subsoil.

3. Conclusions

The trial intervention towards the base of the slope immediately to the south of the high ground on which the site is situated has revealed the original soil profile. It has subsequently been buried by about 1.10 m of colluvial material.

Prior to burial, the original soil profile had developed into a brown earth with a relatively poorly developed argillic (or Bt) horizon. This profile must relate to pre-Bronze Age and pre-clearance phase of the area as originally set out by Dimbleby (1962). This phase probably occurred during the Atlantic/earlier Neolithic period of woodland cover which characterised the majority of southern England at this time (Keeley, 1982).

Subsequent to, and certainly as a partial consequence of, this brown earth became podzolised. This soil was characterised by a depleted Ea horizon and a spodic (enriched with metal oxides or Bs) horizon. The predominantly sandy matrix of this soil would have been very susceptible to the process of leaching once the protective vegetative cover had been removed.

This soil would have become increasingly unstable and susceptible to the processes of wind and water erosion.

Soil erosion had undoubtedly begun during the period of podzolisation. This is indicated by the presence of rounded aggregates of limpid clay well which were well mixed with the in situ soil in increasing abundance towards the top of the profile. The 'cleanness' of this clay suggests that this soil material originates from the initial disturbance of the original soil profile upslope, a process which is undoubtedly associated with the initial deforestation and accompanying soil disturbance, most probably in the earlier Bronze Age period. This material was transported downslope as colluvium. probably by a variety of processes such as rain splash and gully erosion.

The upper surface of the podzol has been truncated leaving only the base of the original A horizon in situ. This process and the presence of the horizon of clean yellow sand above indicate an erosive event of some magnitude and ferocity. As the sand is most probably an eroded subsoil moved and redeposited towards the base of the slope by overland flow, it must represent a deep disturbance of the deforested soil on the adjacent high ground. Without adequate dating evidence it is impossible to be categorical, but this could have occurred during the main period of mound building in the 7th century AD.

Subsequent to this dramatic erosive event, a further 105 cm of colluvial sand was deposited by colluvial processes. This soil material was probably already podzolised prior to transport and redeposition. Nonetheless, it underwent continuing podzolisation, forming a thick Ea(h) horizon and a thin, poorly developed spodic horizon (or Bs) developed on the redeposited subsoil horizon (context 1003). The dating of this is unsure, but has probably been a gradual process since the earlier medieval period.

This upper podzol has probably suffered further (and unquantifiable) erosion by a combination of factors such as rain splash, soil creep, overland flow and gully erosion.

Thus, there are four major phases of pedogenesis evident in this valley profile :

1) formation of an argillic brown earth under wooded conditions probably during the Neolithic period;

2) podzolisation of the original soil profile, a gradual process which was probably associated with clearance activities during the Bronze Age;

3) soil erosion, both slow and long term as well as fast, massive events, which was probably associated with the clearance of woodland as well as soil disturbance caused by tree-throw and human activities;

4) continuing soil erosion or colluviation, associated with podzolisation of the aggrading profile, the unstable nature of podzolic profile, poor vegetative cover and human activities, which continues up to the present day.

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5.2.7 *Final Report, 24 Sep 1992.*

THE MICROMORPHOLOGICAL ANALYSIS OF THE BURIED SOILS MOUND MAKE-UP AND ANCILLARY FEATURES AT SUTTON HOO, SUFFOLK

C A I FRENCH

1. **Introduction**

A total of 37 thin section slides were taken, prepared and analysed from a variety of contexts at Sutton Hoo. These include buried soils, both on- and off-site, mound make-up and various features, prehistoric pits, ditches and burial pits, and a medieval lynchet.

All of the samples were prepared using the methodology of Murphy (1986), and the thin sections were described using the terms and criteria of Bullock et al. (1985). The detailed soil micromorphological descriptions are found in Appendix 1, and the lists of soil photomicrographs in Appendix 2. The main results of the analyses are summarised in Tables 1 and 2.

The main contexts examined were as follows :

1) 12 samples from six contexts associated with Mounds 2 and 5 (Appendix 1.1);

2) the turf and sub-turf disturbance through the quarry pit to the subsoil 3816 (Int.44, 12108/14300) associated with Mound 6 (Appendix 1.2);

3) the Neolithic pit fills in Intervention 48 (Appendix 1.3);

4) the medieval bank/lynchet 1814 (Int.48, 08420/15676) (Appendix 1.4);

5) the section through the slope deposits of the adjacent valley (Intervention 53) (Appendix 1.5).

2. **Results**

2.1 Mounds 2 and 5 and associated features

Two buried soil profiles were examined in detail. The buried soil beneath Mound 2 was sampled in three contiguous blocks (finds numbers 30323, 30324 and 32759 from top to bottom), as well as the burial chamber (finds number 26841). The buried soil beneath Mound 5 was sampled in four contiguous blocks (finds numbers 39229/30/31/32 from top to bottom).

In addition, the material infilling the Mound 2 burial chamber (finds number 23364), and a possible turf in the make-up of Mound 2 (finds number 14446) were sampled. Finally,

the primary fill of the ring ditch around Mound 2 (finds number 18982) and the fill of a west-east prehistoric gully beneath Mound 2 (finds number 40461) were also sampled.

2.1.1 <u>The buried soil beneath Mound 2</u>

The buried soil beneath Mound 2 was <u>c.</u> 16 cm in thickness and exhibits similar micro-pedological characteristics throughout its surviving depth. The soil is an apedal, homogeneous quartz sand, dominated by the medium and fine quartz sand grades. Although there is almost no fine (silt and clay) fraction present (<8%), it is characterised by very dominant polymorphic organic matter, which together with the silt/clay fractions is cemented by amorphous sesquioxides (iron oxides and hydroxides). Thus, the surviving buried soil is indicative of the lowermost illuvial horizon (or spodic horizon) of a podzol, and in particular is a Bs horizon (or enriched with metal oxides) (after deConinck, 1980; de Coninck and Righi, 1983; Limbrey, 1975).

In addition, the lowest sample of the buried soil (finds number 32759) contains one nodule of oriented clay and one soil fragment with random striated limpid and non-laminated dusty clay present in it. Both are probably eroded relics of the pre-podzol soil or an argillic brown earth which had developed in the area under former stable woodland conditions (Macphail, 1987).

The underlying subsoil is dominated entirely by medium and fine quartz sand, and exhibits greater and lesser zones of cementation with amorphous sesquioxides, and contains no organic matter.

Polymorphic organic matter is one of two main types of amorphous organic material found in spodic horizons. It is rough-walled, with an irregular, patchy internal fabric (Bullock <u>et al.</u> 1985, 78-79). Although this Bs horizon is dominated by amorphous sesquioxidic impregnation, it is also characterised by polymorphic organic matter. Thus it is essentially a friable spodic horizon which contains silica (Si), aluminium (Al) and possibly iron (Fe) inside the polymorphic units.

Although there are different theories for the formation of a friable spodic horizon, it is probably due to two simultaneous processes. First, the illuviation of organo-metallic compounds (or organo-Al and organo-Al and Fe complexes), and second biological activity living on the remains of the many roots and on the illuviating complexes (de Coninck and Righi, 1983). The formation of these organo-metallic compounds is explained as follows. Soluble organic compounds are adsorbed at the surface of clay particles and amorphous metallic hydroxides; adsorption modifies the physical-chemical properties of the hydroxides, which acquire the characteristic pellety microstructure (de Coninck and Righi, 1983).

Biological activity probably forms the pellety microstructure of friable B horizons in two ways. First, part of the plant remains ingested by the soil fauna forms faecal pellets, and pellets by the transformation of faecal pellets. Second, the other part of the plant remains is comminuted into small pieces and transformed into dark pellets. Thus, the pellety microstructure itself is the result of the action of fauna, but the aggregates contain a large amount of illuvial material associated with the fine mineral fraction and root remains (de Coninck and Righi, 1983).

2.1.2 <u>The buried soil beneath Mound 5</u>

The buried soil beneath Mound 5 was c. 40 cm thick. The lower half of the profile is identical to the whole surviving profile beneath Mound 2, and is a friable Bs horizon of a podzol. It is dominated by iron impregnation first, and amorphous organic matter second. The upper half of the profile (finds numbers 39229/30) is also similar, but it exhibits a slightly denser fabric, a greater polymorphic organic matter content and a few plant tissue fragments with their cell structure still evident. These characteristics suggest that the soil is grading up to a Bh(s) or more humic illuvial horizon of a podzol.

The classic sequence of soil degradation envisages the following order of soil deterioration : argillic brown earth - brown podzolic soil - podzol (Dimbleby, 1962; Duchaufour, 1977). On a free-draining parent subsoil, clay is moved or destroyed in an acidifying environment, prior to the eluviation of sesquioxides and organic matter down the profile. Under the impact of early clearance and agriculture, the climax soil (or argillic brown earth) became depleted of soil nutrients and progressive acidification occurred as a result of deforestation, burning and accelerated leaching. These factors are regarded as the major causes of podzolisation under heathland vegetation in the later Flandrian (Catt, 1979; Dimbleby, 1962).

There is little doubt that both the surviving soil profiles beneath Mounds 2 and 5 are severely eroded and/or truncated. As the Bh, Ea and humic horizons are absent, at least 50-70 cm of the original profile has not survived. It is most probable that the upper two-thirds of this podzol has been removed and re-incorporated to form the barrow mounds themselves.

Thus, this podzol must have been well formed by the Saxon period. This soil could have formed at any time from the Neolithic period onwards (Macphail, 1987; Dimbleby, 1962) after its initial deforestation. Moreover, it would have been quite useless as arable land, and for which there is no surviving evidence.

Other examples of similar podzols are found at Bawsey (Norfolk), West Heath (Sussex) and Keston Camp (Kent), to mention just a few. At Bawsey, a well preserved podzol exhibiting an Eah with abundant plant remains and polymorphic organic matter, a Bh and Bs horizon were found beneath a Bronze Age barrow. In addition, this soil had formerly been an argillic brown earth which had developed beneath woodland, prior to clearance, the development of heathland and concomitant acidification, and barrow construction (French in Wymer, forthcoming). At West Heath, pedological and palynological analyses of buried soils from a Bronze Age barrow cemetery suggests a mosaic of clear areas surrounded by woodland which had developed humo-ferric podzols (Drewett, 1976; Macphail, 1981; Scaife, 1982). At Keston Camp, Iron Age ramparts buried a fully degraded podzol, in this case a complete and untruncated profile which had developed under woodland (Cornwall, 1958; Dimbleby, 1962).

2.1.3 The burial chamber within Mound 2

The material infilling the burial chamber is an inorganic quartz sand, with up to 50% of the quartz grains cemented with amorphous sesquioxides. This fabric is similar to the underlying natural sand subsoil (see 2.1.1 above). It must therefore be suggested that the burial chamber is infilled with redeposited subsoil material.

2.1.4 Turf within Mound 2

One of the many probable "turves" observed in section within the mound was sampled to confirm its field identification. This material is a porous loamy sand with frequent to common pellety organic matter, large flecks of charcoal and sub-angular plant fragments, and amorphous sesquioxide impregnation of plant tissues, most of the fine fraction and the polymorphic organic matter. Thus, this material is from the humic, probably turf horizon, of a podzol. Nevertheless, it is poorly preserved and only moderately developed, which may be indicative of a modern organic horizon.

2.1.5 The primary fill of the ring ditch around Mound 2

The soil fabric and cemented pellety organic matter of this material is similar to the upper half of the buried soil beneath Mound 5 or B(h)s horizon material, and is less organic than the turf in Mound 2. Although this is not turf, it is probably redeposited or eroded material from the lower horizon of a podzol. This reinforces the theory that the soil was already a well developed humo-ferric podzol by the time the barrow and barrow ditch were constructed.

2.1.6 The prehistoric gully beneath Mound 2

This infilling material is similar to the fill of the ring ditch around Mound 2. Thus the dating of this gully should provide an approximate date by which time the development of heathland/podzol had occurred in this area.

2.2 The Mound 6 quarry pit (3816)

A sequence of eight large thin section slides were taken through the c. 60 cm thickness of the Mound 6 quarry pit.

Throughout the quarry pit profile, the soil material is an homogeneous but poorly sorted sand dominated by approximately equal proportions of medium and fine quartz, with a very minor fine fraction (c. 30%). The fine fraction is dominated throughout by pellety organic matter, a characteristic feature of podzols (de Coninck and Righi, 1983), from which this material is consequently derived. Of course, the concentration of pellety organic matter is greatest (c. 60% of the fine fraction) in the turf horizon (or the upper c. 10 cm), and decreases to about 30% (of the fine fraction) at the base of the quarry pit.

The silt and clay fractions are <10% combined in the upper 30 cm, and increases to about 15% in the lower 30 cm. There are rare to occasional textural pedofeatures evident throughout the quarry pit profile, although they are slightly greater in frequency in the lower half of the profile. There are two types of textural pedofeature present. First, and very rarely (<1%) in the upper 45 cm and occasionally in the lowest 15 cm, non-laminated limpid clay occurs either as coatings of grains and/or as small irregular to sub-rounded fragments within the groundmass. Both are indicative and surviving relics of the original brown forest soil profile which undoubtedly existed at Sutton Hoo prior to deforestation in prehistoric times (see 2.1.1 and 2.1.2 above; Dimbleby, 1962). Second, there are very rare (<1% in the upper 30 cm) to rare ((2% in the lower 30 cm) non-laminated dusty clay coatings of the grains. This type of coating is indicative of illuviation of fine material associated with soil disturbance (Macphail, 1987).

There is every likelihood that there is a slightly greater amount of illuvial clay within the fine fraction in the base as opposed to the top of the quarry pit. This is because the exposed base of the surviving soil profile on the upper edge of the quarry pit was subject to initial erosion as a result of being cut through by the quarry pit. Upper horizons of the soil to either side would have also fallen in to the quarry pit at the same time, adding the organic component to the fill. The homogeneous but poorly sorted nature of the infill suggests a fairly rapid and immediate infilling process, a process which was undoubtedly aided by wind and water (rain splash impact and run-off) erosion of the exposed soil and subsoil to either side of the quarry pit.

Finally, the eroded and accumulated sandy soil in the quarry pit is derived from a soil profile which is already deforested, leached and podzolised by the period of the construction of Mound 6. This therefore confirms the nature of the pre-barrow soil profile that was postulated to exist beneath Mounds 2 and 5 by the Saxon period.

2.3 The Neolithic pit fill in Intervention 48

Two samples were taken from the fill of the Neolithic pit in Intervention 48 for analysis in thin section : 201/2672 and 200/2673. Both samples were essentially similar, except for one important aspect.

The fill of the pit is composed of an homogeneous loamy sand with about 60% of the fine fraction composed of polymorphic/pellety organic matter. This suggests that the fill is composed of the Ea(h) horizon material of a podzol.

There is also considerable impregnation of the whole groundmass with amorphous sesquioxides, particularly towards the base of the profile. This indicates that there was post-depositional, alternating wetting and drying of the matrix with groundwater.

There is one different and significant characteristic which occurs in sample 200/2673. Over about a 1 cm band in the middle of the sample, there are what appear to be alternating, rather irregular and indistinct, laminations composed of different size groups of quartz sand grains. A horizontal band composed of a mixture of medium/fine quartz sand, c. 500-750 um thick, overlies a thinner (c. 250-500 um thick) band composed of a mixture of coarse/medium quartz sand, which in turn overlies a thicker band of finer sand and so on. These apparent laminations of different size grades of quartz sand suggest that there has been some wind erosion contribution to the infilling of this Neolithic pit.

2.4 The medieval bank/lynchet (1814)

A contiguous sequence of seven large thin section slides were taken through the 45 cm thickness of bank/lynchet. This profile exhibited a tripartite sequence in thin section :

(i) First, the upper c. 32.5 cm is characterised by a poorly sorted, porous sand, which is dominated by medium and fine quartz and c. 40-60% pellety organic matter (Bullock et al. 1985, 78-79; de Coninck and Righi, 1983) dominates the fine fraction. The very poor sorting and open porosity suggest that this is redeposited soil, which has already been podzolised before redeposition in the form of a bank.

(ii) Second, the underlying horizon at c. 32.5-39 cm effectively forms a transition zone to the underlying (third) horizon. Although essentially similar to the overlying bank material, it is less dense and more compacted (in zones) than the overlying sand, and it contains greater amounts of pellety organic matter (c. 65% of the fine fraction). In addition, there is a more distinct, although still very minor, inorganic silt fraction present. The pellety organic matter is also impregnated with amorphous sesquioxides. Non-laminated dusty (or impure) clay coatings of the quartz grains are very rarely present.

These characteristics suggest that this is an in situ soil, although slightly dististurbed. This soil is probably the lower organic and sesquioxide-impregnated horizon of a podzol or the upper part of a Bs/h or spodic horizon.

(iii) Third, the underlying horizon at c. 39-45 cm represents the undisturbed in situ soil. It exhibits more well preserved soil characteristics than the other buried soils that have been examined beneath Mounds 2 and 5 (see 2.1.1 and 2.1.2 above).

Although it is also a sand to loamy sand dominated by medium and fine quartz, there is very little (comparatively) pellety organic matter present (<20% of the fine fraction), and there are comparatively high clay (c. 10%) and silt (c. 5%) contents present.

The clay content is particularly informative, and is cindicative of three phases of former soil development in the following sequence. First, there are rare (c. 2%) limpid (or pure) clay coatings of the sand grains. These coatings rarely exhibit micro-laminations. This type of clay coating is indicative of former wooded conditions (Bullock and Murphy, 1979; Macphail, 1987). Second, there are rare to occasional (c. 3%) laminated dusty clay coatings of the sand grains which exhibit strong birefringence. These coatings are indicative of forest disturbance (Slager and van de Wetering, 1977; Fisher, 1982). Third, there are occasional (c. 5%) non-laminated dusty (or impure) clay coatings of sand grains with strong birefringence, which are indicative of further soil disturbance (Macphail 1987). These coatings may be associated with the truncation of the upper part of the original soil profile and the disturbance thus caused, as well as by the dumping of soil to create the bank/lynchet.

All of these characteristics indicate that this lowest horizon was an illuvial B or Bt horizon of a former brown forest soil (Avery, 1980), which has subsequently become podzolised as a result of clearance and associated soil degradation.

The slightly better preservation of these important interpretative features is probably due to three features. First, this bank is situated slightly downslope; it is away from the disturbance caused by the construction of the barrows; and it has been buried by a later linear feature.

2.5 The valley profile (Intervention 53)

Due to the intensively utilised and disturbed nature of the landscape immediately associated with the current excavations of the prehistoric and Saxon periods, it was decided to investigate the adjacent valley. It was judged probable that downslope, colluvial soil erosion may have buried the original soil profile, thereby leaving it relatively undisturbed. Accordingly, Intervention 53 was excavated by machine just above the base of the slope for the principal purposes of sampling for soil micromorphological and pollen analyses.

This sample trial trench excavation revealed a c. 1.3 m deep section which exhibited the following profile :

Depth (cm)	Context	Description
0 - 32	1000	ploughsoil - dark brown loamy sand
	(distinct boundary with)	
32 - 80	1001	homogeneous, mid-brown loamy sand with few scattered gravel pebbles
	(merges over 2 cm with)	
80 - 105	1002	homogeneous, reddish brown loamy sand with few scattered gravel pebbles
	(distinct, but irregular boundary with)	
105-110	1003	clean, homogeneous yellow sand
	(distinct, but irregular boundary with)	
110-123	1004	dark brown, loamy sand with scattered, common charcoal flecks
	(merges over 2 cm with)	
123-130	1005	reddish brown loamy sand
	(merges over 2 cm with)	
130 +	1006	dark reddish orange sand

The whole profile was sampled in a continous column in 6 blocks. Of these, the major contexts were sub-sampled, except for the ploughsoil (1000) and the yellow sand (1003), as follows :

Context	Depth (cm)
1001	50 - 59.5
1001/1002	78.5 - 87.5
1002	95.8 - 105
1004	112 - 121
1004/1005	121 - 130

(The same profile was also sampled for pollen analysis.)

The results of the micromorphological analysis are summarised in Table 1 below :

Table 1 :

Depth (cm)	Context	Horizon	Description
0 - 32	1000	Ap	loamy sand ploughsoil
50 - 59.5	1001 (upper)	Ea(h)	podzolic fabric with pellety organic matter and colluvial clay formed in colluvium
78.5 - 87.5	1001 and 1002 (upper)	Ea(h) (lower)	essentially as above, with slightly finer fabric
95.8 - 103	1002 (middle)	Ea(h)	as above
103 - 105	1002 (lower)	Bs(/w)	poorly developed spodic horizon of podzol formed in colluvium with minor illuvial clay
105 - 110	1003	(C)	eroded, redeposited subsoil
112 - 118.5	1004 (upper)	Ah	lower A horizon of buried soil, contains high colluvial content, podzolised
118.5 - 121	1004 (lower)	Ea(h)	depleted horizon of podzol with relatively high organic matter content
121 - 128	1005 (upper)	Ea	depleted horizon of podzol
128 - 130	1005 (lower)	Bs(/t)	spodic horizon (Bs) of podzol developed in argillic horizon (Bt) of original brown earth
130 +	1006	C	in situ subsoil

2.5.1 Sample Contexts 1001, 1001/2 and 1002

All of these samples exhibit basically similar characteristics. They are characterised by an apedal, homogeneous, porous, loamy sand with about 50% of the fine fraction composed of polymorphic (or pellety) organic matter which is largely impregnated with amorphous sesquioxides. The relative minority component of silt and clay in the fine fraction and the relative abundance of pellety organic matter indicates that the upper two thirds of the whole profile (32-103 cm) is an Eah horizon of a podzol (de Coninck and Righi, 1983; Macphail, 1983).

There are very minor amounts of sub-rounded aggregates of non-laminated yellow clay, particularly in context 1001. This feature suggests that the profile received eroded remnants of another soil which had undergone considerable soil development prior to its erosion and incorporation in this Eah horizon.

The basal 2 cm of sample 1002 contains two additional characteristics. First, this zone contains a greater amount of sesquioxide impregnation of the whole fabric, including the pellety organic matter and textural clay pedofeatures. Second, there is a slightly greater concentration of clay pedofeatures - rare, non-laminated limpid clay and occasional non-laminated dusty clay coatings of the quartz grains and fine fraction groundmass.

The slight increase in illuvial clay deposition indicates that there has been a sufficient period of time for some soil formation, or incipient B(w) horizon formation (Limbrey, 1975). In addition, the subsequent and additional cementation with amorphous sesquioxides suggests that this B(w) horizon became a poorly developed spodic or B(s) horizon of a podzol (de Coninck and Righi, 1983; Macphail, 1983). Thus, all of this Eah and B(w) soil material has undergone some soil development or podzolisation since deposition.

In addition, colluvial aggradation of the profile continued. The homogeneous and relatively poor sorting, plus the depth of accumulation and presence of eroded clay aggregates suggests that there was a gradual accumulation of material as a result of long term colluviation, probably in the form of surface creep/overland flow and gully erosion (Morgan, 1979). These types of erosion are often visible today on the surface of the slope into which this trial trench was cut.

2.5.2 Sample Context 1003

Although this 5 cm thick context was not analysed in thin section, the distinct and clean yellow sand is undoubtedly the local subsoil. It can only have been derived from either slope erosion and/or deliberate re-deposition by man. As the latter is seems unlikely, severe soil and subsoil disturbance must be invoked.

This episode of subsoil erosion could have been caused by a variety of associated agencies. A most probable cause is deforestation of the upper part of the slope. Whether, this was a consequence of man's activities and/or storms and associated tree-throw, the almost immediate de-stabilisation of the soil and subsoil surface would have occurred, combined with rapid overland flow of the eroded material associated with episodes of heavy rainfall (Morgan, 1979).

The irregular nature of this re-deposited subsoil horizon also suggests that it suffered further erosion, probably gully erosion. This would be consistent with the unstable nature of the material immediately after its deposition and before colonisation and stabilisation by vegetation.

2.5.3 Sample Context 1004

This context exhibited three horizons.

The upper 2.2 cm (112-114.2 cm) was an apedal, relatively homogeneous, but poorly sorted sandy loam which contained no illuvial clay pedofeatures, but did exhibit rounded aggregates of limpid clay, charcoal fragments and a relatively high organic matter content, both in amorphous and polymorphic (pellety) forms. The colluvially derived limpid clay and organic matter is well mixed with the fabric, which suggests that there has been considerable soil faunal mixing.

It is suggested that this is the top of the former in situ soil, probably the lower Ah of a podzol. This soil has been buried by the subsequent erosion and colluvial deposition (ie. contexts 1003, 1002, 1001 and 1000). Prior to its burial, it had also been receiving minor amounts of colluvial material in the form of aggregates of limpid clay.

The middle 43 cm (114.2-118.5 cm) is essentially similar to the above horizon, although it contains less pellety organic matter but a slightly greater clay content. It represents the base of the lower Ah horizon. The clay content is in two forms, aggregates of eroded and re-deposited limpid clay as well as many limpid clay coatings throughout the groundmass. The former undoubtedly has a colluvial origin, that is rolled downslope and incorporated in the groundmass by soil mixing processes. The latter is illuvial clay resulting from the mass movement of soil associated with colluviation on this part of the slope (ie. a colluvial 'sludge').

The lower 2.5 cm (118.5-121 cm) exhibits completely different characteristics to the overlying Ah horizon. It is dominated by the sand fraction (80%), predominantly medium and fine quartz, with abundant sesquioxide impregnation, but it contains very little organic matter (5%) or fine fraction (<15%) and is more or less devoid of illuvial clay. This sandy, depleted horizon is the Ea horizon of a podzol. It is similar to the underlying context 1005 (upper 7 cm).

2.5.4 Sample Context 1005

This sample context exhibits three horizons. The upper 7 cm (121-128 cm) is similar to the overlying base of context 1004, and is the base of the Ea or depleted horizon of a podzol.

The lower 2 cm (128-130 cm) of this context exhibits characteristics of two different soil horizons. Although the texture is similar to context 1004 (above) and is dominated by the sand fraction (80%), there are occasional to many non-laminated limpid clay coatings within the groundmass and of the sand grains which exhibit moderate to strong birefringence. Although these coatings are not abundant, they have a relatively strong presence and orientation which suggests that they represent illuvial clay transported and deposited under former wooded conditions (Macphail, 1987). This suggests that this is the base of a former argillic earth (or Bt horizon) which is undoubtedly the base of the original in situ soil profile.

As a secondary process, these coatings have become impregnated with amorphous sesquioxides, as has the whole of the fine fraction. This indicates that the original soil profile had become podzolised and a poorly developed spodic (or Bs) horizon characteristic of a podzol had formed.

This Bs(t) horizon is developed on a sesquioxide impregnated sand (130+ cm), or the in situ subsoil.

3. Conclusions

The conclusions are set out below by their major context groups, but the nature of the surviving evidence for buried soils may be briefly summarised as follows in Table 2 :

Table 2 :

Context	Thickness of soil (cm)	Horizons Present
Mound 2	16	Bs of a podzol
Mound 5	40	Bh(s) and Bs of a podzol
Mound 6 quarry pit	-	podzolic matrix
1814 lynchet	6	Bs/h of a podzol; was a Bt of an argillic brown earth
Int.48 pit	-	eroded Ea(h) of a podzol
Int.53	20	Ah, Ea(h), Ea and Bs of a podzol; Bs was a Bt of an argillic brown earth

3.1 Mounds 2 and 5

There were three phases of pedogenesis prior to the construction of the barrow mounds :

(i) the probable development of an argillic brown earth under stable woodland conditions in earlier Flandrian times;

(ii) deforestation, and the resultant onset of soil degradation, acidification and development of heathland during the prehistoric (probably pre-Bronze Age) period;

(iii) concomitant development of well-developed humo-ferric podzol, very leached and iron impregnated, possibly up to 70-90 cm in thickness. Associated with the construction of the Saxon burial mounds, there was a deep truncation of the soil profile, removing up to two-thirds or about 50-70 cm of the profile.

The upper horizons of the podzol were redeposited to form the make-up of the mounds, along with complete turves. These turves were probably stripped from the area that the mounds were to occupy prior to construction.

The ring ditch around Mound 2 contains eroded soil material from a podzol, probably derived from the mound itself.

The burial chamber beneath Mound 2 is infilled with subsoil material.

The prehistoric gully beneath Mound 2 also contains eroded podzolic material, which is further proof of the earlier prehistoric podzolisation of the soil in the area occupied by this site.

3.2 The Mound 6 quarry pit (3816)

The composition of the quarry pit is relatively uniform throughout and consists of very leached and podzolised sand, with the organic matter content decreasing with depth. This material has been derived from a podzol.

The rare to occasional textural pedofeatures in the base of the quarry pit suggest first the erosion of the lower horizons of the exposed *in situ* soil to either side, followed by the erosion of the upper more organic, adjacent soil horizons as a result of construction, exposure, wind and water erosion.

The soil profile has already degraded to a podzol by the time that the adjacent Mound 6 was constructed. A similar sequence has already been observed from the buried soils sealed beneath Mounds 2 and 5.

3.3 Neolithic pit fill

The Neolithic pit was infilled with soil material which resembles that of the Ea(h) horizon of a podzol. The presence of this podzolic material need not necessarily imply that the soil infilling the pit was already podzolised prior to the period of infilling, this process is probably a post-depositional phenomenon.

Some of the soil material infilling the pit exhibits rather indistinct and discontinuous laminations of different size grades of quartz sand. This suggests the influence of wind erosion. This sandy soil and subsoil would have been extremely susceptible to wind erosion once de-vegetated and/or disturbed by man's activities. This is the only occurrence of this phenomenon observed in thin section from the site, but as the current programme of excavations has shown, wind erosion would have been a very common occurrence where the soil/subsoil was exposed.

The absence of more observable laminations within this Neolithic pit suggests that the pit infill had undergone some post-depositional mixing by soil faunal activity. This in turn suggests that this soil material was not yet podzolised when the pit was infilled, otherwise the soil fauna could not have survived the associated acidic soil conditions.

3.4 The medieval bank/lynchet (1814)

The basal *c.* 6 cm of this profile is believed to be the surviving but truncated remains of the original post-glacial soil profile. It was the Bt horizon of an argillic brown earth which had developed under wooded conditions by the time of the advent of man on site during the Neolithic period.

This same in situ soil horizon contains evidence in the form of laminated dusty clay coatings for the disturbance of the prehistoric woodland on site, probably associated with clearance activities by man during the Neolithic and Bronze age periods.

In addition, this illuvial or Bt horizon also contained non-laminated dusty clay coatings which are indicative of further soil disturbance and the truncation of the upper part of the original soil profile. This may be associated with one or more or any combination of clearance activities, tree-throw and the construction of the lynchet/bank much later in the medieval period.

The overlying c. 6.5 cm appears to be a transition zone between the relatively undisturbed relic soil profile and the overlying redeposited soil. It also exhibits characteristics of podzolisation, in particular, the organic and sesquioxide-impregnated lower B (or Bs/h) horizon of a podzol. Again this suggests that once deforestation had occurred on site in the earlier prehistoric period, that soil degradation and the process of podzolisation began and continued to occur.

The bank/lynchet material is characterised by redeposited sand with abundant pellety organic matter, which is characteristic of an already podzolised soil.

3.5 The valley profile

The trial intervention towards the base of the slope immediately to the south of the high ground on which the site is situated has revealed the original soil profile. It has subsequently been buried by about 1.10 m of colluvial material.

Prior to burial, the original soil profile had developed into a brown earth with a relatively poorly developed argillic (or Bt) horizon. This profile must relate to pre-Bronze Age and pre-clearance phase of the area as originally set out by Dimbleby (1962). This phase probably occurred during the Atlantic/earlier Neolithic period of woodland cover which characterised the majority of southern England at this time (Keeley, 1982).

Subsequent to, and certainly as a partial consequence of, this brown earth became podzolised. This soil was characterised by a depleted Ea horizon and a spodic (enriched with metal oxides or Bs) horizon. The predominantly sandy matrix of this soil would have been very susceptible to the process of leaching once the protective vegetative cover had been removed.

This soil would have become increasingly unstable and susceptible to the processes of wind and water erosion. Soil erosion had undoubtedly begun during the period of podzolisation. This is indicated by the presence of rounded aggregates of limpid clay well which were well mixed with the in situ soil in increasing abundance towards the top of the profile. The 'cleanness' of this clay suggests that this soil material originates from the initial disturbance of the original soil profile upslope, a process which is undoubtedly associated with the initial deforestation and accompanying soil disturbance, most probably in the earlier Bronze Age period. This material was transported downslope as colluvium. probably by a variety of processes such as rain splash and gully erosion.

The upper surface of the podzol has been truncated leaving only the base of the original A horizon in situ. This process and the presence of the horizon of clean yellow sand above indicate an erosive event of some magnitude and ferocity. As the sand is most probably an eroded subsoil moved and redeposited towards the base of the slope by overland flow, it must represent a deep disturbance of the deforested soil on the adjacent high ground. Without adequate dating evidence it is impossible to be categorical, but this could have occurred during the main period of mound building in the 7th century AD.

Subsequent to this dramatic erosive event, a further 105 cm of colluvial sand was deposited by colluvial processes. This soil material was probably already podzolised prior to transport and redeposition. Nonetheless, it underwent continuing podzolisation, forming a thick Ea(h) horizon and a thin, poorly developed spodic horizon (or Bs) developed on the redeposited
subsoil horizon (context 1003). The dating of this is unsure, but has probably been a gradual process since the earlier medieval period.

This upper podzol has probably suffered further (and unquantifiable) erosion by a combination of factors such as rain splash, soil creep, overland flow and gully erosion.

Thus, there are four major phases of pedogenesis evident in this valley profile :

1) the formation of an argillic brown earth under wooded conditions probably during the Neolithic period;

2) the podzolisation of the original soil profile, a gradual process which was probably associated with clearance activities during the Bronze Age;

3) soil erosion, both slow and long term as well as fast, massive events, which was probably associated with the clearance of woodland as well as soil disturbance caused by tree-throw and human activities;

4) continuing soil erosion or colluviation, associated with podzolisation of the aggrading profile, the unstable nature of podzolic profile, poor vegetative cover and human activities, which continues up to the present day.

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APPENDICES

Appendix 1.1 : The detailed soil micromorphological descriptions for Mounds 2 and 5.

Buried soil beneath Mound 2 :

Sample 30323 :

Same as for samples 30324 and 32759 below, except for :

Porosity : very few (<1%) channels, smooth to weakly serrated, walls accomodated, vertical, 1-1.5 mm wide, 1.5 cm in length; no metavughs present; Amorphous : very rare (<1%) sub-rounded fragment of bone, 100-150 um.

Sample 30324 :

Same as sample 32759 below, except for :

Porosity : no metavughs present.

Sample 32759 :

Structure : apedal, homogeneous, bridged to pellicular grain; Porosity : c. 20% simple to complex packing voids, 50-200 um, much interconnected to irregular, between grains and aggregates/grains; 1% metavughs, 1-4 mm, sub-rounded, smooth to weakly serrated; Mineral Component : limit : 100 um; coarse/fine ratio : 80/20: coarse fraction : coarse (5%), medium (35%) and fine (40%) quartz, sub-rounded to sub-angular, 100-500 um, random, unoriented; fine fraction : 5% very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented; <5% silt and <2% clay, very weakly speckled, very dark brown (PPL), orange (RL); c. 8% pellety organic matter; Organic Component : few (10%) very fine flecks of charred organic matter in fine fraction, <50 um; very few (<1%) large flecks of charcoal, 100-200 um; common (>40% of fine fraction) present as pellety amorphous organic matter, sub-rounded to irregular, 25-75 um, very dark brown (PPL), cemented with silt and amorphous sesquioxides; Groundmass: fine : undifferentiated to very weakly speckled; coarse : undifferentiated; related : chitonic to gefuric; Pedofeatures : Textural : very rare (<1%) non-laminated dusty clay coatings of grains, reddish orange (XPL); very rare (<1%) laminated dusty clay coatings of grains, weak to moderate birefringence, reddish orange (XPL); Fabric: one nodule in groundmass, sub-rounded, 50 um, composed of clay, amber (XPL), strongly birefringent; one sub-angular fragment in groundmass, 100x150 um, composed of very fine quartz, silt and limpid and non-laminated dusty clay, random striated, yellow (XPL); Amorphous : few (10%) sesquioxide nodules, sub-rounded, <150 um; whole fine fraction and amorphous organic matter impregnated with amorphous sesquioxides.

Sample 26841 :

Structure : apedal, homogeneous, single grain to very weakly pellicular grain; Porosity : c. 25-30% simple to complex packing voids, much interconnected; Mineral Component : limit : 100 um; coarse/fine ratio : 90/10; coarse fraction : medium (50%) and fine (40%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 10% very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented; Organic Component : none; Groundmass : coarse : undifferentiated; fine : undifferentiated; related : monic; Pedofeatures : Amorphous : thin discontinuous coatings of amorphous sesquioxides in the upper half of the slide, yellowish orange (RL); in the lower half of the slide all quartz is cemented with amorphous sesquioxides, yellowish orange (RL).

The buried soil beneath Mound 5 :

Sample 39229 :

Same as sample 39230 below except for :

Pedofeatures : Fabric : one nodule of non-laminated dusty clay within groundmass, sub-rounded, 100 um, striated fabric, light brown to reddish brown (XPL); Amorphous : very rare (<1%) nodule of very fine quartz and amorphous organic matter, sub-rounded, 2-3 mm.

Sample 39230 :

Structure : apedal, homogeneous, bridged to pellicular grain to intergrain micro-aggregate structure; Porosity : c. 15% simple to complex packing voids, much interconnected; very few (<5%) channels, elongate, smooth to weakly serrated, walls partially accomodated, 1-5 cm long, 0.5-1 mm wide, vertical and parallel; Mineral Component : limit : 100 um; coarse/fine ratio : 70/30; coarse fraction : medium (30%) and fine (40%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 8% very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented; <5% silt and <2% clay, c. 15% pellety organic matter; dark brown (PPL), orange (RL); Organic Component : common to dominant (>50% of fine fraction) amorphous organic matter, predominantly pellety aggregates, rounded to sub-rounded, 25-75 um, rounded to sub-rounded, very dark brown (PPL); few (5-10%) ferruginised plant tissues with cell structure evident; Groundmass : coarse : undifferentiated; fine : undifferentiated to very weakly random speckled; related : chitonic, with locally a tendency to gefuric; Pedofeatures : Fabric : very few (<1%) individual quartz grains found in channels; Amorphous : very few (<2%) sub-rounded aggregates, <100 um, containing fragments of plant tiisue, silt and pellety amorphous organic matter; amorphous sesquioxide impregnation of whole fine fabric.

Sample 39231 :

Structure : apedal, homogeneous, bridged to pellicular grain to intergrain micro-aggregate; Porosity : c. 20% simple to complex packing voids, mainly 25-200 um and few 400-1000 um, smooth, simple elongate, much interconnected to irregular complex packing between grains and aggregates; 2% channels, elongate, smooth to weakly serrated, walls partially accomodated, 0.5-2 mm wide, 5-12 mm long, vertical and parallel; Mineral Components : limit : 100 um; coarse/fine ratio : 80/20; coarse fraction : medium (40%) and fine (40%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 5% very fine quartz, 50-100 um, sub-rounded to sub-angular, random, unoriented; 5% silt and 2% clay; <8% pellety organic matter; dark brown (PPL), orange (RL); Organic Component : common (<40% of fine fraction) amorphous organic matter in the form of pellety aggregates, sub-rounded to rounded, 25-100 um, dark brown to very dark brown (PPL); few (<5%) ferruginised roots/stems with well preserved internal cell structure, 50-150 um; few (<5%) plant tissue fragments with internal cell structure evident, 25-150 um; frequent (15%) very fine flecks of charcoal or charred organic matter within fine fraction, sub-rounded, <25 um; Groundmass : coarse : undifferentiated; fine : undifferentiated to very weakly random speckled; related : chitonic with locally a tendency to gefuric; Pedofeatures : Textural : very rare (<1%) non-laminated dusty coatings of grains, yellow to reddish yellow (XPL); Amorphous : whole fabric impregnated with amorphous sesquioxides; amorphous sesquioxide impregnation of roots/stems; very few (<5%) sesquioxide nodules, sub-rounded, <150 um; one nodule composed of pellety organic matter and silt, sub-rounded, 50-150 um, brown (PPL).

Sample 39232 :

Structure : apedal, homogeneous, bridged to pellicular grain to intergrain micro-aggregate; Porosity : c. 25% simple to complex packing voids, coarse micro to medium meso, 25-200 um, smooth, simple elongate, much interconnected to irregular complex packing between grains and micro-aggregates; Mineral Component : limit : 100 um; coarse/fine ratio : 80/20; coarse fraction : medium (60%) and fine (20%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 5% very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented;

<5% silt, 2% clay; <8% pellety organic matter; very weakly speckled; dark brown to brown (PPL), orange (RL); Organic Component : common (<40% of fine fraction) pellety amorphous organic matter, rounded to sub-rounded, 25-200 um; few to frequent (15%) very fine charcoal fragments within fine fraction, <50 um; few (<5%) root/stem pseudomorphs, replaced by amorphous sesquioxides; very few (<1%) plant tissue fragments, <100 um, brown to very dark brown (PPL); Groundmass : fine : undifferentiated to very weakly, random speckled; coarse : undifferentiated; related : chitonic, with locally a tendency to gefuric; Pedofeatures : Textural : very rare (<1%) laminated dusty clay coatings of grains, moderate birefringence, yellow to reddish yellow (XPL); Amorphous : whole fabric impregnated with amorphous sesquioxides; very few (<5%) sesquioxide nodules, sub-rounded, <50 um; very few (<1%) nodule, composed of sesquioxide impregnated very fine quartz, sub-rounded, <100 um.

Sample 23364 : infill of the burial chamber beneath Mound 2

Structure : single grain; Porosity : c. 10-25% simple to complex packing voids, much interconnected; Mineral Component : limit : 100 um; coarse/fine ratio : 95/5; coarse fraction : medium (60%) and fine (35%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 5% very fine quartz, 50-100 um, sub-rounded to sub-angular, random, unoriented; Organic Component : none; Groundmass : fine : undifferentiated; coarse : undifferentiated; related : monic; Pedofeatures : Amorphous : c. 50% of fabric coated/cemented with amorphous sesquioxides.

Sample 14446 : turf within Mound 2

Structure : apedal, homogeneous, single grain to intergrain micro-aggregate; Porosity : c.30% simple to complex packing voids, irregular, much interconnected; Mineral Component : limit : 100 um; coarse/fine ratio : 50/50; coarse fraction : medium (25%) and fine (25%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 5% very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented; 10% silt and <5% clay; 30% pellety organic matter; very dark brown (PPL), very dark brown to black (RL); Organic Component : few (10%) plant tissue fragments, sub-angular, 100-150 um and 1-3 mm; dominant (>60% of fabric) amorphous organic matter occurring as pellety aggregates, sub-rounded to irregular with rough, irregular surfaces, 50-200 um, very dark brown (PPL); very few (<1%) large flecks of charcoal, sub-rounded to sub-angular, 2-5 mm; Groundmass : fine : undifferentiated; coarse : undifferentiated; related : enaulic; Pedofeatures : Amorphous : amorphous sesquioxide impregnation of plant tissue fragments and most of fine fraction and pellety organic aggregates.

Sample 18982 : primary fill of ditch around Mound 2

Structure : apedal, homogeneous, single grain to intergrain micro-aggregate; Porosity : c. 10-15% simple packing voids, some interconnected; c. 5% vughs, sub-rounded to irregular, smooth to weakly serrated, <150 um; Mineral Component : limit : 100 um; coarse/fine fraction : 80/20; coarse fraction : medium (30%) and fine (50%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : <5% silt; 15% cemented pellety amorphous organic matter; dark brown (PPL), very dark brown (RL); Organic Component : very dominant (75% of fine fraction) pellety amorphous organic matter, 25-150 um; very few (<5%) fine flecks of charcoal, sub-rounded, <50 um; Groundmass : fine : undifferentiated; coarse : undifferentiated; related : gefuric to enaulic; Pedofeatures : Amorphous : whole fabric impregnated with amorphous sesquioxides.

Sample 40461 : fill of prehistoric gully beneath Mound 2

Same as for sample 18982.

Appendix 1.2 : The detailed micromorphological descriptions for

the quarry pit of Mound 6 (3816).

Samples 1a and 1b (top) :

Structure : apedal, homogeneous, poorly sorted, pellicular to bridged grain; Porosity : <20% simple to complex packing voids, much interconnected to irregular between grains and aggregates/grains, c. 50-500 um; Organic Component : very abundant (>60% of fine fraction) pellety organic matter, cemented with silt and sesquioxides, sub-rounded, dark brown (PPL); very few (<5%) cell tissue/plant matter, often replaced by sesquioxides; much modern rooting, replaced by sesquioxides; Mineral Components : limit 100 um; coarse/fine ratio : 70/30; coarse fraction : 5% coarse, 30% medium and 35% fine quartz, sub-rounded to sub-angular, 100-400 um, random, unoriented; fine fraction : 5% very fine quartz, 50-100 um, sub-rounded to sub-angular; <18% pellety organic matter; <5% silt, <2% clay; dark brown to brown (XPL), brown (PPL), yellowish brown (RL); Groundmass : fine : undifferentiated to very weakly speckled; coarse : undifferentiated; related : gefuric to chitonic; Pedofeatures : Textural : very rare (<1%) non-laminated dusty clay coatings of grains, gold to golden red (XPL), moderate to strong birefringence; very rare (<1%) non-laminated limpid clay of grains, gold to yellow (XPL), moderate birefringence; Fabric : very rare (<1%) fragments of limpid clay, non-laminated, strong birefringence, reddish black (XPL), as irregular to sub-angular fragments in groundmass, <75 um; very rare (<1%) sub-rounded aggregates of silt, amber brown (XPL), <100 um; Amorphous : silt and pellety organic matter completely impregnated with amorphous sesquioxides; very rare (<1%) sesquioxide nodules, sub-angular, <100 um.

Samples 2a and 2b :

Similar to samples 1a and 1b above except for the following :

Organic Component : few (5-10%) plant tissue fragments with cell structure evident, replaced by sesquioxides; 50% of fine fraction composed of pellety organic matter; Mineral Components : coarse fraction similar to samples 1a and 1b; fine fraction : <5% very fine quartz, 50-100 um, sub-rounded to sub-angular; 15% pellety organic matter; 5% silt, <5% clay; Pedofeatures : Textural : rare (<2%) non-laminated limpid clay in voids, strong birefringence, parallel extinction, light gold (PPL), very dark brown to black (XPL); very rare (<1%) infills of void space and coatings of grains with successive layers of limpid clay, strong birefringence, parallel extinction, gold to orangey-gold (XPL); very rare (<1%) non-laminated limpid clay coatings of grains, moderate birefringence, yellow to gold (XPL).

Samples 3a and 3b :

Similar to above samples except for the following :

Organic Component : <35% pellety organic matter; Mineral Components : coarse fraction similar to above samples; fine fraction : 5% very fine quartz; <10% pellety organic matter; 8% silt and 7% clay; Pedofeatures : Textural : rare (2%) non-laminated dusty clay coatings of grains; occasional (5%) non-laminated limpid clay as coatings of grains.

Samples 4a and 4b :

Similar to above samples except for the following :

Organic Component : polymorphic organic matter is becoming less pellety and is <35% of the fine fraction; Mineral Components : coarse fraction : <1% coarse, 34% medium and 35% fine quartz, sub-rounded to sub-angular, 100-400 um; Pedofeatures : Textural : sequence observed of limpid clay first, overlain by non-laminated dusty clay second; former is not impregnated with amorphous sesquioxides, the latter is impregnated with amorphous sesquioxides.

Appendix 1.3 : **The micromorphological descriptions for the Neolithic pit fill samples in Intervention 48.**

Sample 201/2672:

Structure : apedal, homogeneous; relatively well sorted; pellicular to intergrain microaggregate; porosity : 30-35%; all interconnected complex packing voids; Organic Components : >12% (or 60% of the fine fraction) pellety organic matter, sub-rounded, <25 um; Mineral Components : limit 100 um; coarse/fine ratio : 80/20; coarse fraction : 50% medium and 30% fine quartz, 100-350 um, sub-rounded to sub-angular; fine fraction : <5% very fine quartz, 50-100 um; <2% silt and <1% clay; >12% pellety organic matter; dark reddish brown (CPL), dark brown (PPL), dark orange (RL); Groundmass : fine : very weakly porphyric; coarse : undifferentiated; related : chitonic to gefuric; Pedofeatures : Textural : very rare (<1%) non-laminated limpid clay, mainly of tgrains and minor amounts of groundmass, yellow to gold (CPL), moderate to strong birefringence; Amorphous : whole fine fraction impregnated with amorphous sesquioxides; very few (<2%) sesquioxide nodules, sub-rounded, <200 um; very few (<1%) aggregates of limpid clay, sub-rounded, orangey red (CPL), <100 um.

Sample 200/2673:

Essentially the same as sample 201/2672 above, except for :greater intensity of sesquioxide impregnation and pellety organic matter towards the base of the profile; discontinuous and indistinct laminations within groundmass composed of alternating medium/fine quartz, 500-750 um thick, and coarse/medium quartz, 250-500 um thick, over a 1 cm zone of the groundmass in the centre/right of the slide.

Appendix 1.4 : **The detailed micromorphological descriptions for the bank/lynchet (1814).**

Sample 1 (top) :

Structure : apedal, homogeneous, poorly sorted, pellicular to bridged grain to intergrain micro-aggregate; Porosity : 15-20% complex packing voids, much interconnected; Organic Component : 40-60% of fine fraction composed of pellety organic matter, <75 um, cemented with silt and sesquioxides, dark brown (PPL); very few (<2%) fragments of charcoal, <200 um; Mineral Components : limit 100 um; coarse/fine ratio : 75/25; coarse fraction : 5% coarse, 30% medium and 40% fine quartz, 100-400 um, sub-angular to sub-rounded, random, unoriented; fine fraction : 5% very fine quartz, sub-rounded to sub-angular, 50-100 um; 10-15% pellety organic matter; 3-7% silt; <3% clay; very weakly speckled; dark reddish brown (XPL), dark brown (PPL), medium brown (PPL); Groundmass : fine : undifferentiated; coarse : undifferentiated;
related : chitonic; Pedofeatures : Textural : very rare (<1%) non-laminated dusty clay coatings of grains, strong birefringence, reddish orange (XPL); very rare (<1%) non-laminated limpid clay coatings of grains, strong birefringence, yellow to gold (XPL); very rare (<1%) fragments of limpid clay within groundmass, non-laminated, moderate to strong birefringence, <75 um, gold to yellowish orange (XPL); Fabric : very rare (<1%) micro-contrasted silt and very fine quartz as discontinuous infills in void space, grey (XPL); Amorphous : fine fraction and pellety organic matter is generally impregnated with amorphous sesquioxides.

Samples 2a and 2b :

Similar to Sample 1 above except for the following addition :

Pedofeature : Fabric : very rare (<1%) sub-rounded aggregates of silt within groundmass, grey (XPL), <150 um.

Samples 3a and 3b :

Structure : apedal, homogeneous, poorly sorted, intergrain micro-aggregate to bridged/pellicular grain structure; Porosity : 10-15% complex packing voids; denser in zones than sample 4a below and more porous in other zones; Organic Component : 60% of fine fraction is composed of pellety organic matter, sub-rounded, <50 um, dark brown (PPL); Mineral Components : limit 100 um; coarse/fine ratio : 75/25; coarse fraction : 5% coarse, 25-30% medium and 40-45% fine quartz, sub-rounded to sub-angular, 100-400 um, random, unoriented; fine fraction : 5% very fine quartz, sub-rounded to sub-angular, 50-100 um; 15% pellety organic matter; >4% silt and <1% clay; dark brown (PPL), yellowish to medium brown (RL); Groundmass : as for samples 1 and 2; Pedofeatures : Textural : very rare (<1%) non-laminated dusty coatings in groundmass, moderate birefringence, yellowish orange (XPL); Amorphous : amorphous sesquioxide impregnation of pellety organic matter.

Sample 4a :

Similar to above samples except for :

Organic Component : *c.* 66% of fine fraction composed of pellety organic matter; Mineral Components : limit 100 um; coarse/fine fraction : 70/30; coarse fraction : 5% coarse, 25% medium and 40% fine quartz, 100-400 um, sub-rounded to sub-angular; fine fraction : 5% very fine quartz, 50-100 um, sub-rounded to sub-angular; 20% pellety organic matter; >4% silt, <1% clay; very weakly speckled; brown (PPL), yellowish to medium brown (RL); Groundmass : fine : very weakly random speckled; coarse : undifferentiated; related : gefuric to chitonic; Pedofeatures : Textural : very rare (<1%) non-laminated dusty clay coatings of grains, reddish orange, moderate birefringence.

Sample 4b (base) :

Structure : apedal, homogeneous, moderately well sorted; Porosity : <20% simple and complex packing voids; Organic Component : few (<5%) ferruginised plant tissue with cell structure evident; very few (<2%) flecks of charcoal, <50 um; <5% pellety organic matter in fine fraction; Mineral Components : limit 100 um; coarse/fine ratio : 70/30; coarse fraction : 5% coarse, 30% medium and 35% fine quartz, 100-400 um, sub-rounded to sub-angular; fine fraction : 5% very fine quartz, 50-100 um, sub-rounded to sub-angular; 5% pellety organic matter; 5% silt and 10% clay; very weakly speckled; orangey red (XPL), reddish brown (PPL) and orange (RL); Groundmass : fine : very weakly speckled to undifferentiated; coarse : undifferentiated; related : weakly chitonic to weakly gefuric; Pedofeatures : Textural : rare to occasional (3%) laminated dusty clay coatings of grains, strong birefringence, reddish orange to reddish yellow (XPL); occasional (5%) non-laminated dusty clay coatings of grains, strong birefringence, yellowish orange to reddish orange (XPL); rare (2%) limpid coatings of grains, non-laminated usually, rarely exhibit micro-laminations, moderate birefringence, reddish orange (XPL); Fabric : rare (<2%) irregular to sub-rounded aggregates of silt in void space, grey (XPL); very rare (<1%) sub-angular fragments of non-laminated limpid clay, strong birefringence, yellowish gold (XPL); Amorphous : all of fine fraction except limpid and non-laminated dusty coatings exhibit amorphous sesquioxide impregnation.

Appendix 1.5 : The detailed soil micromorphological descriptions for the valley profile (Intervention 53).

Context 1001/Upper (50-59.5 cm)

Structure : apedal, homogeneous; bridged to pellicular grain; Porosity : 25-30%; all interconnected complex packing voids between grains and small aggregates of fine fraction; Organic Component : very few (<2%) amorphous organic matter in fine fraction, <50 um; mainly polymorphic/pellety organic matter, composing 50% of non-quartz fine fraction, or 10% of the total groundmass, brown (PPL), <100 um, sub-rounded to irregular; Mineral Component : limit 100um; coarse/fine ratio : 70/30; coarse fraction : 20% coarse, 30% medium and 20% fine quartz, 100-500 um, rounded to sub-rounded to sub-angular; fine fraction : 10% very fine quartz; <5% silt, 5% clay, 10% pellety organic matter; very weakly speckled; reddish brown to orangey brown (CPL), yellowish brown to brown (PPL), orangey brown (RL); Groundmass : coarse : undifferentiated; fine : porphyric; related : weakly chitonic to gefuric; Pedofeatures : Textural : occasional to many (5%) non-laminated limpid clay of groundmass and grains, moderate birefringence, yellow to orange (CPL); Fabric : very rare (<1%) intrusive silty clay fabric, dense, striated to weakly reticulate striated, moderate birefringence, yellowish grey (CPL), very light brown (PPL); Amorphous : all pellety organic matter is impregnated with amorphous sesquioxides

Context 1001/1002 (78.5-87.5 cm)

Structure : apedal, homogeneous; weakly bridged grain; Porosity : 30-35%, all interconnecting complex packing voids between grains and to lesser extent small aggregates of fine fraction; Organic Component : few (5%) very fine flecks of fine charcoal, <25 um; 10% of groundmass is comprised of pellety organic matter; Mineral Component : limit 100 um; coarse/fine ratio : 80/20; coarse fraction : 15% coarse, 40% medium and 25% fine quartz, 100-400 um; fine fraction : 5% fine quartz, 50-100 um; 10% pellety organic matter; <2% silt, 3% clay; weak to moderate speckling; dark orangey-brown (CPL), yellowish brown to brown (PPL), orangey brown (RL); Groundmass : fine : weakly porphyric to undifferentiated; coarse : undifferentiated; related : weakly chitonic; Pedofeatures : Textural : very rare (<1%) non-laminated limpid clay of grains, yellow to orange (CPL), moderate to strong birefringence; rare (2%) non-laminated dusty clay coatings of grains, moderate birefringence, dark orangey-red to brown (CPL); Amorphous : very few (<1%) sub-rounded sequioxide nodules, 100-200 um; majority of pellety organic matter impregnated with amorphous sesquioxides.

Context 1002/1003 (95.8-103 cm)

Essentially the same as context 1002 above except for the following :

Organic Component : few (<5%) amorphous organic matter, <75 um; 18-20% pellety organic matter; Mineral Component : limit 100um; coarse/fine fraction : 70/30; coarse fraction : 5% coarse, 30% medium and 35% fine quartz, 100-400 um, sub-rounded to sub-angular; fine fraction : 5% very fine quartz, 50-100 um; <2% silt, 3-5% clay, increasing towards the base; 18-20% pellety organic matter, decreasing towards the base; Pedofeatures : Textural : in basal 2 cm : few (2%) non-laminated limpid clay of grains and groundmass, reddish orange (CPL), moderate birefringence; few to occasional (<5%) non-laminated dusty clay of grains and groundmass, reddish orange (CPL), moderate birefringence; Amorphous : in basal 2 cm the silt/clay fraction is strongly impregnated with amorphous sesquioxides.

Context 1004 (112-121 cm)

112-114 cm :

Structure : apedal, relatively homogeneous but poorly sorted; pellicular grain to intergrain micro-aggregate; Porosity : 20%; 10% complex packing voids; 5% voids, irregular, weakly serrated, 100-300 um; 5% channels, weakly serrated, walls partially accomodated, <100 um wide, <1 mm long; Organic Component : few (5%) fragments of charcoal with cell structure evident, <250 um; few (5%) very fine amorphous organic matter in groundmass, <75 um; 15% pellety organic matter (or about 30% of the fine fraction), sub-rounded, <75 um, light brown; Mineral Component : limit 100 um; coarse/fine ratio : 50/50; coarse fraction : 20% medium, 30% fine quartz, 100-250 um, sub-angular to sub-rounded; fine fraction : 20% very fine quartz, 50-100 um; <2% silt, 13% clay; 15% pellety organic matter; very weakly speckled or none; brown (CPL), yellowish brown (PPL), orangey brown (RL); Groundmass : fine : open porhyric; coarse : undifferentiated; related : open porphyric; Pedofeatures : Textural : many to abundant (10-13%) limpid clay within groundmass, light yellow (CPL); Fabric : few (5-10%) aggregates of limpid clay, sub-rounded to irregular, non-laminated, strong birefringence, <250 um, up to 5% of total groundmass, very light yellow (PPL), light yellow to black (CPL), light greyish brown (RL).

114-118.5 cm :

Structure : apedal, homogeneous, better sorted than above; pellicular to intergrain micro-aggregate; Porosity : 20%; 10% complex packing voids; 10% voids, irregular to sub-rounded, smooth to weakly serrated, 100-250 um; Organic Component : very few (<5%) very fine amorphous organic matter, <75 um; very few (<2%) charcoal fragments with cell structure evident; <10% pellety organic matter, less distinct and less common than above; Mineral Component : limit 100 um; coarse/fine ratio : 45/55; coarse fraction : 25% medium, 20% fine quartz, sub-rounded to sub-angular, 100-250 um; fine fraction : 15% very fine quartz, 50-100 um; 10% silt, 20% clay; <10% pellety organic matter; weakly speckled; reddish brown to brown (CPL), brown (PPL), orange (RL); Groundmass : fine : porphyric; coarse : undifferentiated; related : open porphyric; Pedofeatures : Textural : c. 10% of fine fraction is composed of non-laminated limpid clay throughout groundmass, yellow to gold to reddish gold (CPL), weak to moderate birefringence; Fabric : occasional to many (5-10%) aggregates of non-laminated limpid clay, sub-rounded to irregular, light yellow to light yellowish brown (PPL), very dark brown to grey brown (CPL); Amorphous : few (5-10%) sub-rounded nodules of sesquioxides, 100-200 um; most of fine fraction impregnated with amorphous sesquioxides.

118.5-121 cm :

Essentially the same as the base of context 1002, except for the following :

Structure : apedal, homogeneous; bridged grain; Porosity : 25%; all interconnecting complex packing voids between grains and to lesser extent small aggregates of fine fraction; Organic Component : few (5%) pellety organic matter, all impregnated with amorphous sesquioxides; very few (2%) amorphous organic matter, <50 um; Mineral Component : limit 100 um; coarse/fine ratio : 75/25; coarse fraction : 10% coarse, 35% medium and 30% fine quartz, 100-400 um, sub-rounded to sub-angular; fine fraction : 5% very fine quartz, 50-100 um; 10% silt, <5% clay; 5% pellety organic matter; reddish brown (CPL), dark reddish brown (PPL), orange (RL); Groundmass : fine : weakly porphyric; coarse : undifferentiated; related : chitonic to gefuric; Pedofeatures : Textural : very rare (<1%) micro-laminated limpid clay on grains, reddish gold (CPL); (remainder obscured by amorphous sesquioxides); Amorphous : whole fine fraction impregnated with amorphous sesquioxides; few (5%) sesquioxide nodules, sub-rounded, <250 um.

Context 1005

121-128 cm :

The same as sample context 1004 : 118.5-121 cm above, except for the following :

Pedofeatures : Fabric : very few (<2%) aggregates of limpid clay, irregular to sub-rounded; Amorphous : few zones of fine fraction exhibit greater and lesser amorphous zones of amorphous sesquioxide impregnation.

128-130cm :

Structure : apedal, homogeneous; pellicular to weakly intergrain micro-aggregate; Porosity : 25-30%; all interconnecting complex packing voids; Organic Component : very few (<2%) amorphous organic matter, < 75 um; <5% pellety organic matter; Mineral Components : limit 100 um; coarse/fine ratio : 75/25; coarse fraction : 10% coarse, 35% medium and 30% fine quartz, 100-400 um, sub-rounded to sub-angular; fine fraction : 5% very fine quartz, 50-100 um; 10% silt, 5% clay; <5% pellety organic matter; dark reddish brown (CPL), brown (PPL), orange (RL); Groundmass : fine : weakly porphyric; coarse : undifferentiated; related : gefuric to weakly chitonic; Pedofeatures : Textural : occasional to many (5%) non-laminated limpid clay of grains and groundmass, reddish orange to red (CPL), moderate to strong birefringence; Fabric : very rare (<1%) sub-rounded aggregates of limpid clay, reddish orange (CPL), <150 um; Amorphous : whole fine fraction is impregnated with amorphous sesquioxides.

Appendix 2 : The list of photomicrographs.

Film 1 : Mounds 2 and 5

Photo. No.	Description	Light	Frame Width(mm)

4	30323:	Bs,pellety organic matter	PPL	4.5
5	30323:	same as above	CPL	4.5
6	30323:	same as above	RL	4.5
7	30323:	same as above	PPL	2.0
8	30323:	same as above	RL	2.0
9	30324:	Bs,pellety organic matter	PPL	2.0
10	30324:	same as above	RL	2.0
11	32759:	plant tissue in Bs	PPL	2.0
12	32759:	Bs,pellety organic matter	PPL	4.5
13	32759:	same as above	PPL	2.0
14	32759:	same as above	RL	2.0
15	26841:	quartz grains	PPL	4.5
16	26841:	quartz grains with much sesquioxidic cementation	PPL	4.5
17	39229:	B(h)s, charcoal	PPL	4.5
18	39229:	B(h)s, charcoal, pellety organic matter	PPL	2.0
19	39229:	same as above	PPL	2.0
20	39231:	iron replaced plant tissue	PPL	4.5
21	39231:	Bs,pellety organic matter	PPL	2.0
22	39231:	same as above	RL	2.0
23	39230:	B(h)s, pellety organic matter	PPL	4.5
24	39230:	same as above	RL	4.5
25	39230:	same as above	PPL	2.0
26	39232:	Bs,pellety organic matter	PPL	4.5
27	39232:	same as above	RL	4.5
28	39232:	same as above	PPL	2.0
29	23364:	cemented quartz	RL	4.5
30	23364:	non-cemented quartz	PPL	4.5

31	14446:	organic/turf horizon	PPL	4.5
32	14446:	same as above	PPL	2.0
33	18982:	organic ditch fill	PPL	4.5
34	1898:	same as above	PPL	2.0
35	40461:	organic ditch fill	PPL	2.0
36	40461:	same as above	PPL	2.0

(CPL = crossed polarised light; PPL = plain polarised light; RL = reflected light)

Film 2 : The valley profile, Intervention 53.

Photo. No.	Description	Light	Frame Width(mm)
2	1001/upper : depleted sand	CPL	4.5
3	1001/upper : depleted sand	PPL	4.5
4	1001/upper : pellety organic matter	PPL	2.0
5	1001/2 : limpid clay aggregate	PPL	2.0
6	1002 : pellety organic matter	PPL	2.0
7	1002/3/upper : depleted sand	PPL	4.5
8	1002/3/base : illuvial clay	CPL	2.0
9	1002/3/base : illuvial clay	PPL	2.0
10	1004/upper : illuvial clay and charcoal	PPL	2.0
11	1004/upper : illuvial clay	PPL	2.0
12	1004/upper : illuvial clay	PPL	2.0
13	1004/upper : charcoal	PPL	2.0
14	1004/upper : organic matrix	PPL	2.0
15	1004/middle : pellety organic matter	PPL	2.0
16	1004/middle : colluvial clay	PPL	2.0
17	1004/base : sesquioxide impregnated matrix	PPL	4.5
18	1005/upper : as for 1004/base	PPL	4.5

19	1005/middle : as above	PPL	4.5
20	1005/lower : as above and clay aggregate	CPL	2.0
21	1005/lower : illuvial clay in Bs	CPL	2.0
22	1005/lower : as above	CPL	2.0
23	1005/lower : as above	PPL	2.0

(PPL = plane polarised light; CPL = crossed polarised light)

Film 3 : Neolithic pit 2672/3.

Photo. No.	Description	Frame Light	Width (mm)
24	200/2673 : depleted sand	CPL	4.5
25	200/2673 : depleted sand, minor pellety organic matter	PPL	4.5
26	200/2673 : illuvial clay on grain	CPL	1.0
27	201/2672 : depleted sand, minor pellety organic matter	PPL	4.5
28	201/2672 : depleted sand	CPL	4.5

(CPL = crossed polarised light; PPL = plane polarised light)

[Probable duplicate; taken out of final report August 2001]

Micromorphology Descriptions

TABLE The detailed soil micromorphological descriptions for Mounds 2 and 5.

Buried soil beneath Mound 2 :

Sample 30323 :

Same as for samples 30324 and 32759 below, except for :

Porosity : very few (<1%) channels, smooth to weakly serrated, walls accommodated, vertical, 1-1.5 mm wide, 1.5 cm in length; no metavughs present; Amorphous : very rare (<1%) sub-rounded fragment of bone, 100-150 um.

Sample 30324 :

Same as sample 32759 below, except for :

Porosity : no metavughs present.

Sample 32759 :

Structure : apedal, homogeneous, bridged to pellicular grain; Porosity : c. 20% simple to complex packing voids, 50-200 um, much interconnected to irregular, between grains and aggregates/grains; 1% metavughs, 1-4 mm, sub-rounded, smooth to weakly serrated; Mineral Component : limit : 100 um; coarse/fine ratio : 80/20: coarse fraction : coarse (5%), medium (35%) and fine (40%) quartz, sub-rounded to sub-angular, 100-500 um, random, unoriented; fine fraction : 5% very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented; <5% silt and <2% clay, very weakly speckled, very dark brown (PPL), orange (RL); c. 8% pellety organic matter; Organic Component : few (10%) very fine flecks of charred organic matter in fine fraction, <50 um; very few (<1%) large flecks of charcoal, 100-200 um; common (>40% of fine fraction) present as pellety amorphous organic matter, sub-rounded to irregular, 25-75 um, very dark brown (PPL), cemented with silt and amorphous sesquioxides; Groundmass: fine : undifferentiated to very weakly speckled; coarse : undifferentiated; related : chitonic to gefuric; Pedofeatures : Textural : very rare (<1%) non-laminated dusty clay coatings of grains, reddish orange (XPL); very rare (<1%) laminated dusty clay coatings of grains, weak to moderate birefringence, reddish orange (XPL); Fabric: one nodule in groundmass, sub-rounded, 50 um, composed of clay, amber (XPL), strongly birefringent; one sub-angular fragment in groundmass, 100x150 um, composed of very fine quartz, silt and limpid and non-laminated dusty clay, random striated, yellow (XPL); Amorphous : few (10%) sesquioxide nodules, sub-rounded, <150 um; whole fine fraction and amorphous organic matter impregnated with amorphous sesquioxides.

Sample 26841 :

Structure : apedal, homogeneous, single grain to very weakly pellicular grain; Porosity : c. 25-30% simple to complex packing voids, much interconnected; Mineral Component : limit : 100 um; coarse/fine ratio : 90/10; coarse fraction : medium (50%) and fine (40%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 10% very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented; Organic Component : none; Groundmass : coarse : undifferentiated; fine : undifferentiated; related : monic; Pedofeatures : Amorphous : thin discontinuous coatings of amorphous sesquioxides in the upper half of the slide, yellowish orange (RL); in the lower half of the slide all quartz is cemented with amorphous sesquioxides, yellowish orange (RL).

The buried soil beneath Mound 5 :

Sample 39229 :

Same as sample 39230 below except for :

Pedofeatures : Fabric : one nodule of non-laminated dusty clay within groundmass, sub-rounded, 100 um, striated fabric, light brown to reddish brown (XPL); Amorphous : very rare (<1%) nodule of very fine quartz and amorphous organic matter, sub-rounded, 2-3 mm.

Sample 39230 :

Structure : apedal, homogeneous, bridged to pellicular grain to intergrain micro-aggregate structure; Porosity : c. 15% simple to complex packing voids, much interconnected; very few (<5%) channels, elongate, smooth to weakly serrated, walls partially accommodated, 1-5 cm long, 0.5-1 mm wide, vertical and parallel; Mineral Component : limit : 100 um; coarse/fine ratio : 70/30; coarse fraction : medium (30%) and fine (40%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 8% very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented; <5% silt and <2% clay, c. 15% pellety organic matter; dark brown (PPL), orange (RL); Organic Component : common to dominant (>50% of fine fraction) amorphous organic matter, predominantly pellety aggregates, rounded to sub-rounded, 25-75 um, rounded to sub-rounded, very dark brown (PPL); few (5-10%) ferruginised plant tissues with cell structure evident; Groundmass : coarse : undifferentiated; fine : undifferentiated to very weakly random speckled; related : chitonic, with locally a tendency to gefuric; Pedofeatures : Fabric : very few (<1%) individual quartz grains found in channels; Amorphous : very few (<2%) sub-rounded aggregates, <100 um, containing fragments of plant tiisue, silt and pellety amorphous organic matter; amorphous sesquioxide impregnation of whole fine fabric.

Sample 39231 :

Structure : apedal, homogeneous, bridged to pellicular grain to intergrain micro-aggregate; Porosity : c. 20% simple to complex packing voids, mainly 25-200 um and few 400-1000 um, smooth, simple elongate, much interconnected to irregular complex packing between grains and aggregates; 2% channels, elongate, smooth to weakly serrated, walls partially accommodated, 0.5-2 mm wide, 5-12 mm long, vertical and parallel; Mineral Components : limit : 100 um; coarse/fine ratio : 80/20; coarse fraction : medium (40%) and fine (40%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 5% very fine quartz, 50-100 um, sub-rounded to sub-angular, random, unoriented; 5% silt and 2% clay; <8% pellety organic matter; dark brown (PPL), orange (RL); Organic Component : common (<40% of fine fraction) amorphous organic matter in the form of pellety aggregates, sub-rounded to rounded, 25-100 um, dark brown to very dark brown (PPL); few (<5%) ferruginised roots/stems with well preserved internal cell structure, 50-150 um; few (<5%) plant tissue fragments with internal cell structure evident, 25-150 um; frequent (15%) very fine flecks of charcoal or charred organic matter within fine fraction, sub-rounded, <25 um; Groundmass : coarse : undifferentiated; fine : undifferentiated to very weakly random speckled; related : chitonic with locally a tendency to gefuric; Pedofeatures : Textural : very rare (<1%) non-laminated dusty coatings of grains, yellow to reddish yellow (XPL); Amorphous : whole fabric impregnated with amorphous sesquioxides; amorphous sesquioxide impregnation of roots/stems; very few (<5%) sesquioxide nodules, sub-rounded, <150 um; one nodule composed of pellety organic matter and silt, sub-rounded, 50-150 um, brown (PPL).

Sample 39232 :

Structure : apedal, homogeneous, bridged to pellicular grain to intergrain micro-aggregate; Porosity : c. 25% simple to complex packing voids, coarse micro to medium meso, 25-200 um, smooth, simple elongate, much interconnected to irregular complex packing between grains and micro-aggregates; Mineral Component : limit : 100 um; coarse/fine ratio : 80/20; coarse fraction : medium (60%) and fine (20%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 5% very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented; <5% silt, 2% clay; <8% pellety organic matter; very weakly speckled; dark brown to brown (PPL), orange (RL); Organic Component : common (<40% of fine fraction) pellety amorphous organic matter, rounded to sub-rounded, 25-200 um; few to frequent (15%) very fine charcoal fragments within fine fraction, <50 um; few (<5%) root/stem pseudomorphs, replaced by amorphous sesquioxides; very few (<1%) plant tissue fragments, <100 um, brown to very dark brown (PPL); Groundmass : fine : undifferentiated to very weakly, random speckled; coarse : undifferentiated; related : chitonic, with locally a tendency to gefuric; Pedofeatures : Textural : very rare (<1%) laminated dusty clay coatings of grains, moderate birefringence, yellow to reddish yellow (XPL); Amorphous : whole fabric impregnated with amorphous sesquioxides; very few (<5%) sesquioxide nodules, sub-rounded, <50 um; very few (<1%) nodule, composed of sesquioxide impregnated very fine quartz, sub-rounded, <100 um.

Sample 23364 : infill of the burial chamber beneath Mound 2

Structure : single grain; Porosity : c. 10-25% simple to complex packing voids, much interconnected; Mineral Component : limit : 100 um; coarse/fine ratio : 95/5; coarse fraction : medium (60%) and fine (35%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 5% very fine quartz, 50-100 um, sub-rounded to sub-angular, random, unoriented; Organic Component : none; Groundmass : fine : undifferentiated; coarse : undifferentiated; related : monic; Pedofeatures : Amorphous : c. 50% of fabric coated/cemented with amorphous sesquioxides.

Sample 14446 : turf within Mound 2

Structure : apedal, homogeneous, single grain to intergrain micro-aggregate; Porosity : c.30% simple to complex packing voids, irregular, much interconnected; Mineral Component : limit : 100 um; coarse/fine ratio : 50/50; coarse fraction : medium (25%) and fine (25%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : 5% very fine quartz, sub-rounded to sub-angular, 50-100 um, random, unoriented; 10% silt and <5% clay; 30% pellety organic matter; very dark brown (PPL), very dark brown to black (RL); Organic Component : few (10%) plant tissue fragments, sub-angular, 100-150 um and 1-3 mm; dominant (>60% of fabric) amorphous organic matter occurring as pellety aggregates, sub-rounded to irregular with rough, irregular surfaces, 50-200 um, very dark brown (PPL); very few (<1%) large flecks of charcoal, sub-rounded to sub-angular, 2-5 mm; Groundmass : fine : undifferentiated; coarse : undifferentiated; related : enaulic; Pedofeatures : Amorphous : amorphous sesquioxide impregnation of plant tissue fragments and most of fine fraction and pellety organic aggregates.

Sample 18982 : primary fill of ditch around Mound 2

Structure : apedal, homogeneous, single grain to intergrain micro-aggregate; Porosity : c. 10-15% simple packing voids, some interconnected; c. 5% vughs, sub-rounded to irregular, smooth to weakly serrated, <150 um; Mineral Component : limit : 100 um; coarse/fine fraction : 80/20; coarse fraction : medium (30%) and fine (50%) quartz, sub-rounded to sub-angular, 100-300 um, random, unoriented; fine fraction : <5% silt; 15% cemented pellety amorphous organic matter; dark brown (PPL), very dark brown (RL); Organic Component : very dominant (75% of fine fraction) pellety amorphous organic matter, 25-150 um; very few (<5%) fine flecks of charcoal, sub-rounded, <50 um; Groundmass : fine : undifferentiated; coarse : undifferentiated; related : gefuric to enaulic; Pedofeatures : Amorphous : whole fabric impregnated with amorphous sesquioxides.

Sample 40461 : fill of prehistoric gully beneath Mound 2

Same as for sample 18982.

Appendix 1.2 : The detailed micromorphological descriptions for the quarry pit of Mound 6 (3816).

Samples 1a and 1b (top) :

Structure : apedal, homogeneous, poorly sorted, pellicular to bridged grain; Porosity : <20% simple to complex packing voids, much interconnected to irregular between grains and aggregates/grains, c. 50-500 um; Organic Component : very abundant (>60% of fine fraction) pellety organic matter, cemented with silt and sesquioxides, sub-rounded, dark brown (PPL); very few (<5%) cell tissue/plant matter, often replaced by sesquioxides; much modern rooting, replaced by sesquioxides; Mineral Components : limit 100 um; coarse/fine ratio : 70/30; coarse fraction : 5% coarse, 30% medium and 35% fine quartz, sub-rounded to sub-angular, 100-400 um, random, unoriented; fine fraction : 5% very fine quartz, 50-100 um, sub-rounded to sub-angular; <18% pellety organic matter; <5% silt, <2% clay; dark brown to brown (XPL), brown (PPL), yellowish brown (RL); Groundmass : fine : undifferentiated to very weakly speckled; coarse : undifferentiated; related : gefuric to chitonic; Pedofeatures : Textural : very rare (<1%) non-laminated dusty clay coatings of grains, gold to golden red (XPL), moderate to strong birefringence; very rare (<1%) non-laminated limpid clay of grains, gold to yellow (XPL), moderate birefringence; Fabric : very rare (<1%) fragments of limpid clay, non-laminated, strong birefringence, reddish black (XPL), as irregular to sub-angular fragments in groundmass, <75 um; very rare (<1%) sub-rounded aggregates of silt, amber brown (XPL), <100 um; Amorphous : silt and pellety organic matter completely impregnated with amorphous sesquioxides; very rare (<1%) sesquioxide nodules, sub-angular, <100 um.

Samples 2a and 2b :

Similar to samples 1a and 1b above except for the following :

Organic Component : few (5-10%) plant tissue fragments with cell structure evident, replaced by sesquioxides; 50% of fine fraction composed of pellety organic matter; Mineral Components : coarse fraction similar to samples 1a and 1b; fine fraction : <5% very fine quartz, 50-100 um, sub-rounded to sub-angular; 15% pellety organic matter; 5% silt, <5% clay; Pedofeatures : Textural : rare (<2%) non-laminated limpid clay in voids, strong birefringence, parallel extinction, light gold (PPL), very dark brown to black (XPL); very rare (<1%) infills of void space and coatings of grains with successive layers of limpid clay, strong birefringence, parallel extinction, gold to orangey-gold (XPL); very rare (<1%) non-laminated limpid clay coatings of grains, moderate birefringence, yellow to gold (XPL).

Samples 3a and 3b :

Similar to above samples except for the following :

Organic Component : <35% pellety organic matter; Mineral Components : coarse fraction similar to above samples; fine fraction : 5% very fine quartz; <10% pellety organic matter; 8% silt and 7% clay; Pedofeatures : Textural : rare (2%) non-laminated dusty clay coatings of grains; occasional (5%) non-laminated limpid clay as coatings of grains.

Samples 4a and 4b :

Similar to above samples except for the following :

Organic Component : polymorphic organic matter is becoming less pellety and is <35% of the fine fraction; Mineral Components : coarse fraction : <1% coarse, 34% medium and 35% fine quartz, sub-rounded to sub-angular, 100-400 um; Pedofeatures : Textural : sequence observed of limpid clay first, overlain by non-laminated dusty clay second; former is not impregnated with amorphous sesquioxides, the latter is impregnated with amorphous sesquioxides.

Appendix 1.3 : The micromorphological descriptions for the Neolithic pit fill samples in Intervention 48.

Sample 201/2672:

Structure : apedal, homogeneous; relatively well sorted; pellicular to intergrain microaggregate; porosity : 30-35%; all interconnected complex packing voids; Organic Components : >12% (or 60% of the fine fraction) pellety organic matter, sub-rounded, <25 um; Mineral Components : limit 100 um; coarse/fine ratio : 80/20; coarse fraction : 50% medium and 30% fine quartz, 100-350 um, sub-rounded to sub-angular; fine fraction : <5% very fine quartz, 50-100 um; <2% silt and <1% clay; >12% pellety organic matter; dark reddish brown (CPL), dark brown (PPL), dark orange (RL); Groundmass : fine : very weakly porphyric; coarse : undifferentiated; related : chitonic to gefuric; Pedofeatures : Textural : very rare (<1%) non-laminated limpid clay, mainly of grains and minor amounts of groundmass, yellow to gold (CPL), moderate to strong birefringence; Amorphous : whole fine fraction impregnated with amorphous sesquioxides; very few (<2%) sesquioxide nodules, sub-rounded, <200 um; very few (<1%) aggregates of limpid clay, sub-rounded, orangey red (CPL), <100 um.

Sample 200/2673:

Essentially the same as sample 201/2672 above, except for :greater intensity of sesquioxide impregnation and pellety organic matter towards the base of the profile; discontinuous and indistinct laminations within groundmass composed of alternating medium/fine quartz, 500-750 um thick, and coarse/medium quartz, 250-500 um thick, over a 1 cm zone of the groundmass in the centre/right of the slide.

Appendix 1.4 : The detailed micromorphological descriptions for the bank/lynchet (1814).

Sample 1 (top) :

Structure : apedal, homogeneous, poorly sorted, pellicular to bridged grain to intergrain micro-aggregate; Porosity : 15-20% complex packing voids, much interconnected; Organic Component : 40-60% of fine fraction composed of pellety organic matter, <75 um, cemented with silt and sesquioxides, dark brown (PPL); very few (<2%) fragments of charcoal, <200 um; Mineral Components : limit 100 um; coarse/fine ratio : 75/25; coarse fraction : 5% coarse, 30% medium and 40% fine quartz, 100-400 um, sub-angular to sub-rounded, random, unoriented; fine fraction : 5% very fine quartz, sub-rounded to sub-angular, 50-100 um; 10-15% pellety organic matter; 3-7% silt; <3% clay; very weakly speckled; dark reddish brown (XPL), dark brown (PPL), medium brown (PPL); Groundmass : fine : undifferentiated; coarse : undifferentiated;
related : chitonic; Pedofeatures : Textural : very rare (<1%) non-laminated dusty clay coatings of grains, strong birefringence, reddish orange (XPL); very rare (<1%) non-laminated limpid clay coatings of grains, strong birefringence, yellow to gold (XPL); very rare (<1%) fragments of limpid clay within groundmass, non-laminated, moderate to strong birefringence, <75 um, gold to yellowish orange (XPL); Fabric : very rare (<1%) micro-contrasted silt and very fine quartz as discontinuous infills in void space, grey (XPL); Amorphous : fine fraction and pellety organic matter is generally impregnated with amorphous sesquioxides.

Samples 2a and 2b :

Similar to Sample 1 above except for the following addition :

Pedofeature : Fabric : very rare (<1%) sub-rounded aggregates of silt within groundmass, grey (XPL), <150 um.

Samples 3a and 3b :

Structure : apedal, homogeneous, poorly sorted, intergrain micro-aggregate to bridged/pellicular grain structure; Porosity : 10-15% complex packing voids; denser in zones than sample 4a below and more porous in other zones; Organic Component : 60% of fine fraction is composed of pellety organic matter, sub-rounded, <50 um, dark brown (PPL); Mineral Components : limit 100 um; coarse/fine ratio : 75/25; coarse fraction : 5% coarse, 25-30% medium and 40-45% fine quartz, sub-rounded to sub-angular, 100-400 um, random, unoriented; fine fraction : 5% very fine quartz, sub-rounded to sub-angular, 50-100 um; 15% pellety organic matter; >4% silt and <1% clay; dark brown (PPL), yellowish to medium brown (RL); Groundmass : as for samples 1 and 2; Pedofeatures : Textural : very rare (<1%) non-laminated dusty coatings in groundmass, moderate birefringence, yellowish orange (XPL); Amorphous : amorphous sesquioxide impregnation of pellety organic matter.

Sample 4a :

Similar to above samples except for :

Organic Component : c. 66% of fine fraction composed of pellety organic matter; Mineral Components : limit 100 um; coarse/fine fraction : 70/30; coarse fraction : 5% coarse, 25% medium and 40% fine quartz, 100-400 um, sub-rounded to sub-angular; fine fraction : 5% very fine quartz, 50-100 um, sub-rounded to sub-angular; 20% pellety organic matter; >4% silt, <1% clay; very weakly speckled; brown (PPL), yellowish to medium brown (RL); Groundmass : fine : very weakly random speckled; coarse : undifferentiated; related : gefuric to chitonic; Pedofeatures : Textural : very rare (<1%) non-laminated dusty clay coatings of grains, reddish orange, moderate birefringence.

Sample 4b (base) :

Structure : apedal, homogeneous, moderately well sorted; Porosity : <20% simple and complex packing voids; Organic Component : few (<5%) ferruginised plant tissue with cell structure evident; very few (<2%) flecks of charcoal, <50 um; <5% pellety organic matter in fine fraction; Mineral Components : limit 100 um; coarse/fine ratio : 70/30; coarse fraction : 5% coarse, 30% medium and 35% fine quartz, 100-400 um, sub-rounded to sub-angular; fine fraction : 5% very fine quartz, 50-100 um, sub-rounded to sub-angular; 5% pellety organic matter; 5% silt and 10% clay; very weakly speckled; orangey red (XPL), reddish brown (PPL) and orange (RL); Groundmass : fine : very weakly speckled to undifferentiated; coarse : undifferentiated; related : weakly chitonic to weakly gefuric; Pedofeatures : Textural : rare to occasional (3%) laminated dusty clay coatings of grains, strong birefringence, reddish orange to reddish yellow (XPL); occasional (5%) non-laminated dusty clay coatings of grains, strong birefringence, yellowish orange to reddish orange (XPL); rare (2%) limpid coatings of grains, non-laminated usually, rarely exhibit micro-laminations, moderate birefringence, reddish orange (XPL); Fabric : rare (<2%) irregular to sub-rounded aggregates of silt in void space, grey (XPL); very rare (<1%) sub-angular fragments of non-laminated limpid clay, strong birefringence, yellowish gold (XPL); Amorphous : all of fine fraction except limpid and non-laminated dusty coatings exhibit amorphous sesquioxide impregnation.

Appendix 1.5 : **The detailed soil micromorphological descriptions for the valley profile (Intervention 53).**

Context 1001/Upper (50-59.5 cm)

Structure : apedal, homogeneous; bridged to pellicular grain; Porosity : 25-30%; all interconnected complex packing voids between grains and small aggregates of fine fraction; Organic Component : very few (<2%) amorphous organic matter in fine fraction, <50 um; mainly polymorphic/pellety organic matter, composing 50% of non-quartz fine fraction, or 10% of the total groundmass, brown (PPL), <100 um, sub-rounded to irregular; Mineral Component : limit 100um; coarse/fine ratio : 70/30; coarse fraction : 20% coarse, 30% medium and 20% fine quartz, 100-500 um, rounded to sub-rounded to sub-angular; fine fraction : 10% very fine quartz; <5% silt, 5% clay, 10% pellety organic matter; very weakly speckled; reddish brown to orangey brown (CPL), yellowish brown to brown (PPL), orangey brown (RL); Groundmass : coarse : undifferentiated; fine : porphyric; related : weakly chitonic to gefuric; Pedofeatures : Textural : occasional to many (5%) non-laminated limpid clay of groundmass and grains, moderate birefringence, yellow to orange (CPL); Fabric : very rare (<1%) intrusive silty clay fabric, dense, striated to weakly reticulate striated, moderate birefringence, yellowish grey (CPL), very light brown (PPL); Amorphous : all pellety organic matter is impregnated with amorphous sesquioxides

Context 1001/1002 (78.5-87.5 cm)

Structure : apedal, homogeneous; weakly bridged grain; Porosity : 30-35%, all interconnecting complex packing voids between grains and to lesser extent small aggregates of fine fraction; Organic Component : few (5%) very fine flecks of fine charcoal, <25 um; 10% of groundmass is comprised of pellety organic matter; Mineral Component : limit 100 um; coarse/fine ratio : 80/20; coarse fraction : 15% coarse, 40% medium and 25% fine quartz, 100-400 um; fine fraction : 5% fine quartz, 50-100 um; 10% pellety organic matter; <2% silt, 3% clay; weak to moderate speckling; dark orangey-brown (CPL), yellowish brown to brown (PPL), orangey brown (RL); Groundmass : fine : weakly porphyric to undifferentiated; coarse : undifferentiated; related : weakly chitonic; Pedofeatures : Textural : very rare (<1%) non-laminated limpid clay of grains, yellow to orange (CPL), moderate to strong birefringence; rare (2%) non-laminated dusty clay coatings of grains, moderate birefringence, dark orangey-red to brown (CPL); Amorphous : very few (<1%) sub-rounded sequioxide nodules, 100-200 um; majority of pellety organic matter impregnated with amorphous sesquioxides.

Context 1002/1003 (95.8-103 cm)

Essentially the same as context 1002 above except for the following :

Organic Component : few (<5%) amorphous organic matter, <75 um; 18-20% pellety organic matter; Mineral Component : limit 100um; coarse/fine fraction : 70/30; coarse fraction : 5% coarse, 30% medium and 35% fine quartz, 100-400 um, sub-rounded to sub-angular; fine fraction : 5% very fine quartz, 50-100 um; <2% silt, 3-5% clay, increasing towards the base; 18-20% pellety organic matter, decreasing towards the base; Pedofeatures : Textural : in basal 2 cm : few (2%) non-laminated limpid clay of grains and groundmass, reddish orange (CPL), moderate birefringence; few to occasional (<5%) non-laminated dusty clay of grains and groundmass, reddish orange (CPL), moderate birefringence; Amorphous : in basal 2 cm the silt/clay fraction is strongly impregnated with amorphous sesquioxides.

Context 1004 (112-121 cm)

112-114 cm :

Structure : apedal, relatively homogeneous but poorly sorted; pellicular grain to intergrain micro-aggregate; Porosity : 20%; 10% complex packing voids; 5% voids, irregular, weakly serrated, 100-300 um; 5% channels, weakly serrated, walls partially accommodated, <100 um wide, <1 mm long; Organic Component : few (5%) fragments of charcoal with cell structure evident, <250 um; few (5%) very fine amorphous organic matter in groundmass, <75 um; 15% pellety organic matter (or about 30% of the fine fraction), sub-rounded, <75 um, light brown; Mineral Component : limit 100 um; coarse/fine ratio : 50/50; coarse fraction : 20% medium, 30% fine quartz, 100-250 um, sub-angular to sub-rounded; fine fraction : 20% very fine quartz, 50-100 um; <2% silt, 13% clay; 15% pellety organic matter; very weakly speckled or none; brown (CPL), yellowish brown (PPL), orangey brown (RL); Groundmass : fine : open porhyric; coarse : undifferentiated; related : open porphyric; Pedofeatures : Textural : many to abundant (10-13%) limpid clay within groundmass, light yellow (CPL); Fabric : few (5-10%) aggregates of limpid clay, sub-rounded to irregular, non-laminated, strong birefringence, <250 um, up to 5% of total groundmass, very light yellow (PPL), light yellow to black (CPL), light greyish brown (RL).

114-118.5 cm :

Structure : apedal, homogeneous, better sorted than above; pellicular to intergrain micro-aggregate; Porosity : 20%; 10% complex packing voids; 10% voids, irregular to sub-rounded, smooth to weakly serrated, 100-250 um; Organic Component : very few (<5%) very fine amorphous organic matter, <75 um; very few (<2%) charcoal fragments with cell structure evident; <10% pellety organic matter, less distinct and less common than above; Mineral Component : limit 100 um; coarse/fine ratio : 45/55; coarse fraction : 25% medium, 20% fine quartz, sub-rounded to sub-angular, 100-250 um; fine fraction : 15% very fine quartz, 50-100 um; 10% silt, 20% clay; <10% pellety organic matter; weakly speckled; reddish brown to brown (CPL), brown (PPL), orange (RL); Groundmass : fine : porphyric; coarse : undifferentiated; related : open porphyric; Pedofeatures : Textural : c. 10% of fine fraction is composed of non-laminated limpid clay throughout groundmass, yellow to gold to reddish gold (CPL), weak to moderate birefringence; Fabric : occasional to many (5-10%) aggregates of non-laminated limpid clay, sub-rounded to irregular, light yellow to light yellowish brown (PPL), very dark brown to grey brown (CPL); Amorphous : few (5-10%) sub-rounded nodules of sesquioxides, 100-200 um; most of fine fraction impregnated with amorphous sesquioxides.

118.5-121 cm :

Essentially the same as the base of context 1002, except for the following :

Structure : apedal, homogeneous; bridged grain; Porosity : 25%; all interconnecting complex packing voids between grains and to lesser extent small aggregates of fine fraction; Organic Component : few (5%) pellety organic matter, all impregnated with amorphous sesquioxides; very few (2%) amorphous organic matter, <50 um; Mineral Component : limit 100 um; coarse/fine ratio : 75/25; coarse fraction : 10% coarse, 35% medium and 30% fine quartz, 100-400 um, sub-rounded to sub-angular; fine fraction : 5% very fine quartz, 50-100 um; 10% silt, <5% clay; 5% pellety organic matter; reddish brown (CPL), dark reddish brown (PPL), orange (RL); Groundmass : fine : weakly porphyric; coarse : undifferentiated; related : chitonic to gefuric; Pedofeatures : Textural : very rare (<1%) micro-laminated limpid clay on grains, reddish gold (CPL); (remainder obscured by amorphous sesquioxides); Amorphous : whole fine fraction impregnated with amorphous sesquioxides; few (5%) sesquioxide nodules, sub-rounded, <250 um.

Context 1005

121-128 cm :

The same as sample context 1004 : 118.5-121 cm above, except for the following :

Pedofeatures : Fabric : very few (<2%) aggregates of limpid clay, irregular to sub-rounded; Amorphous : few zones of fine fraction exhibit greater and lesser amorphous zones of amorphous sesquioxide impregnation.

128-130cm :

Structure : apedal, homogeneous; pellicular to weakly intergrain micro-aggregate; Porosity : 25-30%; all interconnecting complex packing voids; Organic Component : very few (<2%) amorphous organic matter, < 75 um; <5% pellety organic matter; Mineral Components : limit 100 um; coarse/fine ratio : 75/25; coarse fraction : 10% coarse, 35% medium and 30% fine quartz, 100-400 um, sub-rounded to sub-angular; fine fraction : 5% very fine quartz, 50-100 um; 10% silt, 5% clay; <5% pellety organic matter; dark reddish brown (CPL), brown (PPL), orange (RL); Groundmass : fine : weakly porphyric; coarse : undifferentiated; related : gefuric to weakly chitonic; Pedofeatures : Textural : occasional to many (5%) non-laminated limpid clay of grains and groundmass, reddish orange to red (CPL), moderate to strong birefringence; Fabric : very rare (<1%) sub-rounded aggregates of limpid clay, reddish orange (CPL), <150 um; Amorphous : whole fine fraction is impregnated with amorphous sesquioxides.

Appendix 2 : The list of photomicrographs.

Film 1 : Mounds 2 and 5

Photo. No.	Description		Light	Frame Width(mm)
4	30323:	Bs,pellety organic matter	PPL	4.5
5	30323:	same as above	CPL	4.5
6	30323:	same as above	RL	4.5
7	30323:	same as above	PPL	2.0
8	30323:	same as above	RL	2.0
9	30324:	Bs,pellety organic matter	PPL	2.0
10	30324:	same as above	RL	2.0
11	32759:	plant tissue in Bs	PPL	2.0
12	32759:	Bs,pellety organic matter	PPL	4.5
13	32759:	same as above	PPL	2.0
14	32759:	same as above	RL	2.0
15	26841:	quartz grains	PPL	4.5
16	26841:	quartz grains with much sesquioxidic cementation	PPL	4.5
17	39229:	B(h)s, charcoal	PPL	4.5
18	39229:	B(h)s, charcoal,	PPL	2.0

	pellety organic matter		
19	39229: same as above	PPL	2.0
20	39231: iron replaced plant tissue	PPL	4.5
21	39231: Bs,pellety organic matter	PPL	2.0
22	39231: same as above	RL	2.0
23	39230: B(h)s, pellety organic matter	PPL	4.5
24	39230: same as above	RL	4.5
25	39230: same as above	PPL	2.0
26	39232: Bs,pellety organic matter	PPL	4.5
27	39232: same as above	RL	4.5
28	39232: same as above	PPL	2.0
29	23364: cemented quartz	RL	4.5
30	23364: non-cemented quartz	PPL	4.5
31	14446: organic/turf horizon	PPL	4.5
32	14446: same as above	PPL	2.0
33	18982: organic ditch fill	PPL	4.5
34	1898: same as above	PPL	2.0
35	40461: organic ditch fill	PPL	2.0
36	40461: same as above	PPL	2.0

(CPL = crossed polarised light; PPL = plain polarised light; RL = reflected light)

Film 2 : The valley profile, Intervention 53.

Photo. No.	Description	Light	Frame Width(mm)
2	1001/upper : depleted sand	CPL	4.5
3	1001/upper : depleted sand	PPL	4.5
4	1001/upper : pellety organic matter	PPL	2.0
5	1001/2 : limpid clay aggregate	PPL	2.0

6	1002 : pellety organic matter	PPL	2.0
7	1002/3/upper : depleted sand	PPL	4.5
8	1002/3/base : illuvial clay	CPL	2.0
9	1002/3/base : illuvial clay	PPL	2.0
10	1004/upper : illuvial clay and charcoal	PPL	2.0
11	1004/upper : illuvial clay	PPL	2.0
12	1004/upper : illuvial clay	PPL	2.0
13	1004/upper : charcoal	PPL	2.0
14	1004/upper : organic matrix	PPL	2.0
15	1004/middle : pellety organic matter	PPL	2.0
16	1004/middle : colluvial clay	PPL	2.0
17	1004/base : sesquioxide impregnated matrix	PPL	4.5
18	1005/upper : as for 1004/base	PPL	4.5
19	1005/middle : as above	PPL	4.5
20	1005/lower : as above and clay aggregate	CPL	2.0
21	1005/lower : illuvial clay in Bs	CPL	2.0
22	1005/lower : as above	CPL	2.0
23	1005/lower : as above	PPL	2.0

(PPL = plane polarised light; CPL = crossed polarised light)

Film 3 : Neolithic pit 2672/3.

Photo. No.	Description	Light	Frame Width (mm)
24	200/2673 : depleted sand	CPL	4.5
25	200/2673 : depleted sand, minor pellety organic matter	PPL	4.5
26	200/2673 : illuvial clay on grain	CPL	1.0
27	201/2672 : depleted sand, minor pellety organic matter	PPL	4.5
28	201/2672 : depleted sand	CPL	4.5

(CPL = crossed polarised light; PPL = plane polarised light)

5.3 Soil deposition and movement determined on site [see Research Report Chapter 10]

6. **SELECTED STUDIES: VEGETATION**

6.1 **Pollen**

6.1.1 *Letter from G W Dimbleby, explaining preliminary sequence under Mound 1*

25.7.68

University of London
Institute of Archaeology
31-34 Gordon Square
London WC1

Department of Human Environment
Professor G W Dimbleby BSc, MA, DPhil (Oxon)

Dear Paul

Did I ever send you a copy of the pollen analysis diagram for the pre-barrow soil at Sutton Hoo? In case I didn't, here is a rough copy.

It seems clear that the top 6" is a well mixed topsoil with a very comprehensive agricultural spectrum, including remarkably high values for cereal pollen. Clearly a ploughed layer. Below this is an unploughed part of the profile, still agricultural in its pollen but with much less cereal and a fraction more woodland, though the countryside was completely open.

The presence of beech and hornbeam pollen throughout the whole profile shows that the whole is sub-atlantic.

The heathland species are scarcely represented and there can be no doubt that the landscape at the time of burial was open arable and not heathland.

I have had some further correspondence with Shotton about Osborne's report on the Wilsford Beetles. They seem anxious to get it published and are planning to make it a specialist report in the J. Animal Ecology. This, I think, is the best solution for the moment and will leave us free to draw on his data. Martin Speight had reservations about his interpretation of the beetle data. I have now taken the pollen a stage further and I hope to press on with the other biological material as I would like to clear the lot by Christmas.

All the best.

Yours

(Signed) Geoff

6.1.2 *Provisional Report on the Sutton Hoo Environment* by G W Dimbleby

SUTTON HOO

The Environment

The Modern Environment

At present the Scheduled Area in which the barrow lies is covered by acid grassland and patches of bracken. On similar land immediately to the south the bracken is completely dominant. It is difficult to establish from the published report (Phillips, 1940) what the vegetation was like in 1939, and this is a matter of some importance because Zeuner argued from the present condition to the past. Phillips (p.155) describes the area as "barren sandy heath covered with sparse turf and large expanses of bracken", but in Appendix IV (p.201) Zeuner says "the vegetation now forms a heath chiefly consisting of ling (Calluna), heath (Erica) and bracken". Much hinges on the term 'sparse turf', which would normally imply a grass cover, but might conceivably have been used for a short Calluna. Unfortunately none of the published photographs from 1939 show the surroundings.

In order to clear up any confusion samples of the old (1939) raw humus were taken from under the dump when it was excavated by Mr Paul Ashbee in 1967. Two samples were taken, Nos.40 and 41; No.41 lay to the west of No.40. The analyses are shown in Table 1. They are very similar to each other, with one difference: very high counts of Rumex-Acetosa type pollen were found in No.41. This type was also well represented in No.40. It presumably derives from Rumex acetosella (Sheep's Sorrel), a plant which can form dense circumscribed patches, for example on ground laid bare by fire or erosion. Apart from this species the two analyses agree closely in indicating that the site was open, dominated by grasses and bracken, and influenced strongly by oak, birch and pine, and to a lesser degree by other species, presumably from the adjacent plantations. Only 4 grains of Calluna were recorded in a total count of 526, leaving no doubt that heather (ling) was of negligible importance on the site, if indeed present at all.

Having asserted that Calluna heather was present in 1939, Zeuner argued - on the basis of the soils - that it was probably present in the Saxon period too (p.201), although, strangely, Phillips (p.156) was under the impression that Zeuner believed that forest was present then. Green (1963) rather illogically argues that since the soil could not have carried a "heavy vegetation" it must have been an open heath in Saxon times and suggests that analyses have proved this. As will be shown below, it now appears that none of these views was correct.

Soils

In Appendix IV to the 1940 report, Zeuner describes (but does not illustrate) the soil beneath the barrow. This appears to be a massive podzol, with an A_1 40cms deep and a bleached A_2 of 50-60cms. During the 1966 excavations the buried soil was exposed for
a considerable distance. Samples from a typical section were taken for pollen analysis and other analyses. It has to be said that by no stretch of the imagination could this soil be described as a podzol. It is clearly seen in the photograph (colour) to be a

brown soil. In order to make sure that the colour was not masking leached sand, some samples were tested against the Munsell Colour Chart before and after ignition. The results are as follows:

Depth from O.L.S	Before Ignition	After Ignition
1-2 ins.	5 YR 4/3	2.5 YR 4/6
2-3 ins.	5 YR 4/3	2.5 YR 4/6
9-10 ins.	5 YR 4/3	2.5 YR 3/6

Reference to the chart will show that these samples turned a rich haematite colour on ignition and were clearly rich in iron.

As will be seen below, the pollen analyses give further grounds for not regarding this soil as podzol.

The soil profile may be described as follows:

Barrow mound: Light brown sand with a few stones (no structure visible, but section inadequate).

Thin layer (½in.) of yellow sand overlying O.L.S (cf. Phillips, p.156; Zeuner, pp.201-2).

0-9 in. Brown sand with dark streaks of humus and flecks of charcoal. Fragments of oak charcoal were identified. Slightly stony, merging into

9-18 in. paler brown sand, also slightly stony throughout, merging into yellow-brown subsoil sand, with scattered stones, and stratified at lower levels.

Zeuner believes these sands are of fluvioglacial origin, a view which would accord with the known Pleistocene geology of the region, though Cornwall (see below) suggests that the sand grains have been shaped by the sea and wind.

Though the profile described above would be acceptable as an undisturbed acid brown earth, Phillips records one fact that might cast some doubt on this interpretation. In cutting the sections, several Early Bronze Age hearths were found, lying about a foot below the old ground surface. Unless we assume that each of these was in its own depression, they might indicate some general aggradation of material since the Early Bronze Age.

Phillips and Zeuner also seem to have misunderstood each other over the structure of the mound itself. Phillips believed that the mound was made up of turves stripped from the surface of the heath (sic); the faint outlines of turves could apparently be made out. Zeuner, however, describes the mound as of "homogenous dark-brown sand" which he believes could have been scraped up from all over the neighbourhood. In either case it is implied that the mound is made of topsoil, however collected, and this in turn would mean that the soils for an unknown distance round about would be truncated. No further investigations have been made on the mound itself (suitable sections were not available and could not be cut) but some corroborative evidence comes from the soil profile under the 1939 dump.

This profile appeared as follows (1967):

Thin (< 1cm) compressed layer of raw humus

0- ca. 17 cms. mottled brown/fawn sand, with leached pockets extending from the surface to 6 cms.

17-20/30 cms band of slightly darker staining (B) varying from 3-15 cms in thickness, yellow-orange sand

(It is regretted that between 1966 and 1967 depth-recording became metric).

There are two points to note about this profile as compared with that under the barrow:

(a) there is distinct evidence of incipient podzolization in this profile. Colour change after ignition was carried out on a sample from 2-4cm deep. Before ignition 10 YR 4/3: after ignition 2.5 YR 5/4. This material is therefore less iron-rich than the A horizon samples from the buried soil.

(b) unstained subsoil sand likes at about 10-12 ins as against 18 ins in the buried soil. This might indicate that this soil has been truncated, though it must equally be remembered that the buried soil may have been added to between Bronze Age and Saxon times.

Pollen analyses (see below) also provide some slight additional evidence of truncation, as perhaps to pH measurements. The top of the buried soil under the dump measured 4.05, perhaps indicating a marginally higher base status. However, figures from such situations may be misleading because of the possible effect of having been buried under mounds of topsoil for differing lengths of time. Zeuner quoted a value of 4.5 for the present "weathering sections", but as he did not cite his method comparison is not possible.

Pollen Analyses

The pollen analyses have been concentrated on the soil buried beneath the barrow. Later, analyses (not yet completed) were also made from the soil beneath the 1939 dump.

Samples were taken at 1 in intervals through the whole profile of the buried soil. Pollen occurred in countable quantity in the top 14 samples.

From these results several salient facts are immediately obvious. First of all, the land was not under heathland, forest, or a specially made clearing in a forest. It was under cereal agriculture. Furthermore, the proportion of non-tree to tree pollen (NAP/AP) (1033 for the top 5 ins) means that the surroundings were completely treeless. The analyses from the 1939 raw humus buried beneath the dump give a value of 301. It is clear, therefore, that the slopes on the west, which now carry the 1881 plantation, were treeless in Saxon times.

Before returning to the question of the plant cover in a little more detail, certain features of the profile ought to be explained first. Two lines have been drawn across the diagram, one at 5 in and the other at 11 in. They mark distinct breaks in the pollen sequence. That at 11 in is characterised by a sudden increase (reading downwards) in the amount and proportion of oak (Quercus) pollen, and also by a lesser increase in hazel (Corylus). At the same time the Liguliflorae and ribwort plantain (Plantago lanceolata) - weeds of farming - decrease. The NAP/AP ratio at this point is 255, indicating an open site in a wooded neighbourhood. The pollen distribution here strongly suggests a buried soil surface, and at this depth it is tempting to equate this with the inferred Early Bronze Age surface mentioned above. However, though the landscape that this analysis indicates would accord with what might be expected in the Early Bronze Age, the floristic details are less convincing. At that time one would expect to see the pollen of lime (Tilia) consistently represented, whereas it is not recorded in any of the counts at this level.

Nevertheless, there is some indication here that at least 11 ins of mineral soil have accumulated on this site prior to the construction of the barrow. It is not obvious how this could have come about. In such a sandy area it is to be expected that the sand might readily blow, but this is not likely to be the sole explanation as there were stones scattered through the soil profile.

Is the mineral soil overlying the buried surface at 11 ins itself homogenous? There is clearly a break in the pollen sequence at about 5 ins. Below this level the pollen shows a distinct distribution pattern, most clearly seen in the grass (Gramineae) curve. The quantities decrease with depth. Therefore this part of the soil is not mixed - either by soil animals or by tillage. The top 5 ins of the profile, on the contrary, show a much less regular distribution of pollen, and the most likely explanation is that this zone has been ploughed. There still remains the question whether the 5-6 ins sample represents the top of a second buried soil surface which was in turn covered, but it may be equally valid to assume that the whole 11 ins depth represents a single soil, the top 5 ins of which have been ploughed. On balance the first suggestion seems the more likely since there is some discrepancy between minor species present below 5 ins, but absent or reduced in quantity above it. If the sample 5-6 ins is indeed a buried surface it is interesting to note that it gives a NAP/AP ratio of 1238, indicating if anything even more treeless conditions than at the time the barrow was built.

To return to the period when the barrow was built, as indicated by the pollen in the top 5 ins of the soil, we see the characteristic high grass percentages and the abundance of weeds associated with arable farming. Most definitive, however, are the high values of cereal pollen (these are unusually high; cereal pollen is generally very much under-represented). These high values continue into the top of the layer beneath, but then fade out, suggesting that in this layer we have some indication of a change of land use. In the lower levels ribwort plantain is abundant, but nearer the surface it becomes less abundant, whilst Liguliflorae and sorrel (Rumex) increase. This looks like a change from pastoral to arable farming.

It is important to ascribe any date to these inferred changes. Pollen of beech (Fagus) and hornbeam (Carpinus) is present throughout the top 11 ins of soil, and this merely indicates that the pollen record here belongs to some part of the Subatlantic period - that is, the last 2500 years.

It may seem a drastic change to suggest that this 'barren, sandy heath' could have been used for agriculture in Saxon times. At no point in the pollen sequence, however, does heather exceed 3.0% and bracken 3.6% of the total count. Therefore neither could have played anything but a minor role in the local ecology, and the likelihood is that this pollen was wind-carried from more distant sites. It is easy to assume that present infertility is a guide to past fertility, but it has to be remembered that the passage of some 1400 years has probably led to decreased fertility, through burning and grazing. Even so, cereal agriculture is being practised today on fields adjacent to this site, and whilst modern fertilisers are no doubt used, comparable effects could have been achieved in Saxon times by the use of manures. It is also pertinent that Philips refers (p.150) to the ploughing of the slopes to the west of the site, and points out that the ploughing extended on to the plateau and resulted in damage to the western end of the ship-barrow. Presumably this ploughing was for agriculture. The present practice of ploughing for forestry is a recent innovation and in any case would not be necessary on this type of land. On these various grounds, therefore, the interpretation of the pollen analyses in terms of cereal agriculture does not appear to be too improbable. Certainly this interpretation is not at variance with the recognition of the soil as a brown earth. Had it been the podzol that Zeuner thought it to be there would have been great difficulty in reconciling the soil and pollen evidence.

One small point remains concerning the barrow itself. If this were in fact a ploughed surface, it would not have produced a turf which could be cut and stacked to build up a mound. This is not to deny that such turves existed, though Zeuner apparently did not see them, but to suggest that they did not come from the immediate environs. In fact, both Phillips and Zeuner might be right - the mound could have been made up both of turves and topsoil scraped up from the surrounding fields. This must imply, however, that agriculture was consciously abandoned in the vicinity of the site.

Finally, preliminary pollen analyses have been made on a profile of the soil beneath the 1939 dump. Compared with the buried soil, the pollen content was rather poor. It showed a mixture of agricultural pollen and grass-heath pollen. It is premature to make any interpretation, but at first sight the pollen pattern would seem to confirm the interpretation of the soil as being truncated.

Sand Analyses

Two samples were collected from under the keel for an investigation of dark stains or flecks. They were as follows:

No. 173, Rib 8 Below keel. Blue-black stain below keel. Is this humus manganese or magnetite?

No.255, Rib 7 Flecks of black in stratified sand alongside rib and under keel: are they precipitated iron or manganese?

Dr Cornwall reports:

No. 173 This is a mainly coarse to medium silica sand, nearly all grains coated with a limonite crust which often showed a high polish. There were a few concretions of finer iron-cemented grains and a small amount of clay.

The iron deposit dissolved readily in cold concentrated hydrochloric acid, so is apparently hydrated. There were few actual concretions; it was mostly limonite-coated quartzes. Manganese and charcoal were absent and the colour with sodium hydroxide indicated very little humus.

The acid insolubles were mainly clean quartzes, many matt-surfaced and very well-rounded, indicating wind action, but there were also many which were highly polished, indicating water action. As few of these were at all angular they had probably been worked upon by the sea. This seems to be a ferruginous beach sand, in part wind-rounded.

The iron may have been deposited in a podzol B-horizon (but one would expect much humus here also) but deposition also takes place on a beach (cf. Cromer coast) where percolating land-water springs occur in the cliffs or beach and is today staining flints, etc.

No.255 This is mainly of the fine sand grade. Some grains float on first wetting, indicating the presence of humus. The colour with sodium hydroxide shows large quantities of humus. There is less iron than in No.173 and it needs boiling acid to extract it. Manganese is absent. The humus-coating resists acid treatment, leaving the sand grey after iron extraction. Boiling sodium hydroxide removes this humus coating. A few particles (?carbonised) withstand both treatments. The residue is a clean quartz sand.

Summary

1. The ship-barrow was built on an acid brown earth soil which was being used for cereal agriculture up to the

time of construction.

2. The landscape was considerably more treeless than today.

3. The barrow was built of topsoil and the nearby soil (under the 1939 dump) showed evidence of truncation.

4. The soil under the 1939 dump showed incipient podzolization. The vegetation at that time was a heath of grass and bracken.

<u>References</u>

PHILLIPS, C W (1940) The excavation of the Sutton Hoo Ship Burial. Antiq. J., XX, 149-202

GREEN, C (1963) Sutton Hoo. London

<u>Investigations Remaining to be Done</u>

1. Extend pollen series for buried soil

2. Complete pollen analysis of 1939 soil.

3. Pollen analysis of Longworth's pit

4. Pollen analysis of beeswax

5. Investigation of possible remnants of wood structure in samples from hull and keel

6. Preparation of ignition profiles of soils beneath barrow and 1939 dump

<u>TABLE 1</u>

	Counts		%		APF	
	40	41	40	41	40	41
Alnus	3	3	1.3	1.0	1,752	1,752
Betula	8	18	3.6	6.0	4,672	10,512
Carpinus	-	+	-	+	-	+
Fagus	-	1	-	0.3	-	584
Picea	1	2	0.4	0.7	584	1,168
Pinus	6	14	2.7	4.6	3,504	8,176
Quercus	24	26	10.7	8.6	14,016	15,184
Tilia	-	+	-	+	-	+
Ulmus	2	5	0.9	1.7	1,168	2,920
Corylus	1	3	0.4	1.0	504	1,752
Calluna	3	1	1.3	0.3	1,752	584
Gramineae	85	80	37.9	26.5	49,640	46,720
Cereal	+	4	+	1.3	+	2,336
Caryophyllaceae	+	1	+	0.3	+	584
Chenopodiaceae	2	-	0.9	-	1,168	-
Compositae						
Artemesia	1	-	0.4	-	584	-
Ligulaflorae	2	2	0.9	0.7	1,168	1,168
Tubuliflorae	+	1	+	0.3	+	584
Cruciferae	1	1	0.4	0.3	584	584
Cyperaceae	1	1	0.4	0.3	584	584
Helianthemum	1	-	0.4	-	584	-
Labiatae	-	1	-	0.3	-	584
Papilionaceae	2	1	0.9	0.3	1,168	584
Plantago coronopus	-	3	-	1.0	-	1,752
Plantago lanceolata	6	5	2.7	1.7	3,504	2,920
Ranunculaceae	2	+	0.9	+	1,168	+
Rosaceae	1	-	0.4	-	584	-
Rumex-Acetosa type	19	95	8.5	31.5	11,096	55,480
Rumex-ex-Rumex type	2	2	0.9	0.7	1,168	1,168
Umbelliferae	1	1	0.4	0.3	584	584
Varia	7	6	3.1	2.0	4,088	3,504
Dryopteris type	2	-	0.9	-	1,168	-
Pteridium	42	25	18.8	8.3	24,528	14,600
TOTAL	224	302				
NAP/AP			307	297		

6.1.3 *Reply by R L S Bruce-Mitford to the provisional report*

Letter from R L S Bruce-Mitford, British Museum, London WC1
to:
Professor G W Dimbleby
Institute of Archaeology
31-34 Gordon Square
London WC1

2 April 1970

Dear Dimbleby

Very many thanks indeed for your provisional report which is of the greatest interest, and thank you for producing it so quickly for our meeting. I am having it Xeroxed and copies sent to Ashbee and Longworth.

We can have the pollen diagram re-drawn here professionally, and sent to you for checking. Certainly you may have any colour plates you like. Would it be otiose to have micro-photographs of the pollen grains themselves, with identifications and comments. We are having micro-photos of cross-sections of animal hairs for identification as between beaver, otter and grey seal. The publication is a fairly grandiose one, and you could make something of a demonstration of it if you wished. I would of course like to include the beeswax and Longworth pit results and the final result of the surface below the 1939 dump.

The beeswax is something of a novelty and provides you with matter which can be dated to the year of the burial (probably 626 AD!). Isn't that of interest?

I take it that the agriculture referred to under the mounds could 'be of the Iron Age' or Bronze Age. Or are you suggesting that it continued through Romano-British times.

We have some fine 1939 panoramas which show the surroundings. I will bring them round to you some time.

Would it be infra dig or feasible in any case to give English equivalents of the Latin names, or of those that can be easily rendered into familiar names? The essential picture comes out, but the detailed picture escapes me.

A matter of considerable interest to me is the presence of clay in the soil. You remember the 'Clay Pan' for 'ritual purposes' (Ant. J. XX, Plate XVIIa). Ashbee is now thinking that this was a natural formation, a sort of stratified clay sediment that developed at a certain point below the bowl-shaped sinkage caused by the collapse of the large burial chamber.

Phillips refers to lumps of clay (p.155 'rolled nodules of whitish clay of various sizes also occur') and in the re-excavating in 1966/7 we find a raft of it slumped over the port gunwale of the boat at the stern, as hard as concrete. We had to use a pick on it.

It was thought that the clay of the clay pan was exotic (brought up from the river area). Could it be a natural formation, consequent upon human actions? (eg the creation of a dump? Its depth can be seen from Ant. J. XX, Fig. 4.

The special interest of the picture of agriculture 'right up to the period when the barrow was built' is to me that it would seem to imply a Saxon settlement in the vicinity. There is an enormous bulk of Bronze Age-Neolithic pottery, but no Anglo-Saxon pottery worth mentioning and very little RB. There are however Iron Age given fragments from the vicinity.

Altogether your results seem more important. From other evidence I think I can say that the agricultural usage goes back into medieval times. The field bank which ran across the western truncated end of the mound goes back to the 16th century certainly; and the Parish Land Survey of Sutton (1629) shows fields south and east of the mounds, distinguishable from rough heather land. In one place the field bank is described as 'sheep walk' (1848).

Once again, I am extremely grateful and look forward to the full story. Could the outstanding results conveniently be in by say June 1st? Lastly is there anything to be said about the banded natural sand, and its efficiency as a drainage soil? The dark sand layers seemed to me more impervious than the bright yellow sand. I am interested in the factors bringing about the disappearance of wood and organic substances generally speeds of disintefration (sic) of the boat and of bone, and the behaviour of phosphate from bone. Phillips found the area of the bottom of the boat wet, even after dry months. (p. 155).

Yours sincerely

PS. Have you any expenses which you would like us to meet in connection with the work? I will see what can be done.

6.1.4 Final Report on the Sutton Hoo Environment by G W Dimbleby

<u>Sutton Hoo</u>

<u>The Environment</u>

The setting of the barrow group on a sandy plateau overlooking the estuary of the River Deben has already been described (Phillips p 150). The geological nature of this plateau, which stands about 100 ft above the present high water mark, is important because it has a considerable bearing on the ecology and particularly the soils of the site.

This plateau is a thick deposit of sand with small amount of gravel interspersed. Zeuner believed that this was a fluvioglacial deposit, a view which would accord with the known Pleistocene geology of the region. Microscopic examination of the sands by Dr I W Cornwall, however, revealed that they consisted largely of polished grains, indicating water action, together with a proportion that were matt-surfaced and rounded, suggesting wind action. He concludes that the material was originally a beach sand in part wind-rounded. Such material may, of course, have been re-worked by fluvioglacial action, and, in view of the present height above sea-level, cannot well be beach-sand <u>in situ</u>.

Dr Cornwall also found that the grains were coated with limonite (hydrated ferric oxide) which often showed a high polish. It is not possible to say at what stage this iron deposit was formed, but it does become mobile as a soil develops and it also tends to move in association with water moving through the soil mass. This may lead to its re-deposition, for instance along lines of current bedding, and it was this cementing of the bedded sand by deposited iron that made it possible for the excavators so easily to distinguish between disturbed and undisturbed sand.

This sandy deposit has little clay in it, though rolled nodules of whitish clay were described by the excavators. The fact that the clay occurs in such a discrete form and is not distributed through the soil mass has two important implications. Firstly it means that objects are not going to become coated with clay by the normal process of eluviation by percolating water. Where clay masses do occur, as over the burial chamber, some other explanation will have to be sought. The second influence is on the ecology of the site. A soil which is poor in clay may tend to dry out in the upper layers, and it will also tend to be poorly endowed with reserves of nutrients such as calcium and magnesium which would normally be adsorbed on the colloidal fraction of the soil. Clay and organic matter are the main sources of soil colloids. Under forest conditions it is to be expected that the base status of the soil would only become depleted slowly, but if the forest was cleared, and particularly if fire were used, the soil might rapidly become strongly acid. In this situation, therefore, we have the possibility that the ecological state could have changed dramatically as the result of human activity. For this reason it would be unwise to assume, as Green does, that because we have 'an open heath' today (or in 1939) conditions were similar in Saxon times.

The Modern Environment

At present the Scheduled Area in which the barrow lies is covered by acid grassland and patches of bracken with a dense cover of sheep's fescue beneath. On similar land to the south the bracken is vigorous and completely dominant. Photographs taken in 1939 , however, show that on the Scheduled Area itself bracken was dominant then, except for a strip of short-grazed turf along the top of the scarp on the western edge of the area. It seems likely that rabbit-grazing produced this effect; rabbits had been burrowing into the ship mound for centuries, according to B J W Brown.

An important point to note is that heather or ling (Calluna) does not feature as a component of the vegetation today (it did not appear in a list made in 1970), and according to the photographs it did not in 1939 either. It is odd, therefore, that in his Appendix IV to Phillips's paper Zeuner stated that "the vegetation now forms a heath chiefly consisting of ling (Calluna), heath (Erica) and bracken". This point will be returned to because of its significance in relation to the soil profiles.

Soil Profiles

Three soil profiles were examined and sampled for pollen analysis. One was the profile of the soil buried beneath the barrow at a point on the north side of the ship excavation, and the other two were outside the mound. Of these, one was nearby - in fact under the 1939 dump - and the other (Dr Longworth's pit) further away to the NE. From these three sections it was hoped to get a picture of conditions at the time of burial and, from the modern profiles, some indication of where the material of the mound had come from.

i) The Soil Under the Barrow

The old land surface is clearly demarcated by a thin layer of yellow or orange sand which was spread, whether accidentally or deliberately, "in a broad oval layer some 30 feet wide over the grave and its surrounding natural surface" (Green, p 28). This layer is clearly seen in section, separating the material of the base of the mound from the topsoil of the buried profile beneath.

The buried soil is clearly iron-rich throughout, as is shown by the ignited profile (the right-hand of the two). There is a suggestion of iron accumulation at about 25cms but in no sense could this soil be described as a podzol; it is an acid brown earth.

The section may be described as follows:

Base of barrow mound	Light brown sand with a few stones. No structure visible.
Thin layer (1cm)	of yellow-orange sand covering old land surface.

0-22cm Brown sand (5YR 4/3) with dark streaks of humus and flecks of charcoal (oak charcoal was identified). pH at surface 3.85 (glass electrode). Slightly stony, merging into

22-45cm paler brown sand (7.5YR 4/2), also slightly stony throughout, merging into

45cm downwards	yellow-brown subsoil sand (7.5 YR 5/4), with scattered stones, horizontally bedded in lower levels.

Though this profile would be acceptable on its face value as an undisturbed acid brown earth, Phillips records one fact that might cast some doubt on this interpretation. In cutting the sections, several Early

Bronze Age hearths were found, lying about a foot below the old ground surface (p 155). Unless we assume that each of these was in its own depression (the 1939 excavators expressed no opinion on this), their occurrence might indicate aggradation of material on the site since the Early Bronze Age.

Pollen Analysis

Samples were taken contiguously at 2.5cm intervals to cover the profile from a point 45cm below the surface to about 6cm above it. It is these samples which were used to construct the profile

Pollen was abundant and well-preserved in the upper part of the buried soil, but the frequency decreased with depth and counts were not possible below 40cm from the buried surface. Complete analyses are given in Table 1.

On the diagram the pollen profile has been divided into three zones, X, Y, Z. In Zone X the pollen frequencies, as shown by the left-hand half of each double histogram, show a more or less even distribution with depth, suggesting that this is a mixed soil. In Zone Y, on the other hand, the distribution does change with depth; the grass (Gramineae) curve shows this particularly clearly. In this zone, therefore, there cannot have been physical mixing of the soil. Zone Z is typical of a buried soil marked at the buried surface by relatively high values of certain pollen types, in this case oak (Quercus) and grasses, and then a progressive falling away with depth (Dimbleby, 1961b). The analyses of the modern soils show the characteristic high frequence at a soil surface and illustrate the grounds for interpreting Zone Z as a buried soil.

Taking the three zones in chronological order, the analyses give some indication of the ecological changes which have taken place on the site. The pollen analyses of Zone Z show a greater proportion of three and shrub pollen than any other analyses on the whole site. The ratio of non-tree to tree pollen (NAP/AP) in the surface of the buried soil in 255, which indicates open conditions in a wooded neighbourhood. The assemblage suggests pastoral farming in cleared forest, a landscape which would not be inconsistent with the inferred land use pattern of the Early Bronze Age. It is therefore tempting to equate this level with those buried hearths that Phillips recorded. Detailed floristic evidence, however, is not entirely supporting. Whilst it is true that pollen of beech (Fagus) and hornbeam (Carpinus), which are sub-atlantic immigrants, is not found in this zone though it occurs in Zones X and Y, the virtual absence of lime (Tilia) and elm (Ulmus), and the small representation of alder (Alnus) seem to deny a date in the first half of the sub-boreal.

If Zone Z is indeed a buried soil, then the material above it had accumulated on the site before the barrow was built. How this came about is still not clear. Wind action cannot be the sole explanation because scattered stones occur through this accumulated material. Any sort of hillwash is ruled out by the flat topography. Soil working by man seems the only possible explanation (see Discussion).

Whatever the cause, this material is rich in pollen and, assuming that the bulk of it has been derived from land use on the site, it presents a clear picture of the changes which have gone on. The dominant pollen type in the whole of this deposit is grass (Gramineae), which makes up about 45% of the total pollen and spore count throughout, as it did, incidentally, in Zone Z too. Associated species may be used to suggest different forms of land use within this overall pattern. If Zone Y is indeed an undisturbed profile (or part of one), then it is possible to interpret the changes in it as changes with time, on the principle that in a soil where no faunal mixing is taking place, the deepest-lying pollen will be the oldest (Dimbleby, 1961a). On this basis, the high values of ribwort plantain (Plantago lanceolata) associated with the grasses in the lower part of Zone Y would indicate pasture. As one goes up the profile, however, the ribwort plantain curve falls away and others, notably Rumex (presumably sheep's sorrel) come in, suggesting a change-over to arable farming. The increased occurrence of cereal pollen at the top of Zone Y would support this conclusion.

The question must now be raised whether Zone Y is a complete profile in itself, with a buried surface at 12.5cm, or whether the overlying Zone X was derived from a longer profile by the mixing of the top part of the soil. In the absence of earthworms, which would seem to be precluded by the soil acidity (pH now 3.85), the most obvious agency for soil mixing in this way would be ploughing. As already indicated, the upper part of Zone Y gives a pollen spectrum strongly indicative of arable farming; it seems virtually certain that this took place on the site, because the cereal values reached were unusually high, and as cereals are largely self-pollinated, it is unlikely the pollen would be wind-carried to this extent. If cereal-growing were being practised here, however, the ground would certainly have been ploughed, so we are forced to assume that Zone X is the plough soil and that the pollen of arable species has washed down from it into the upper layers of Zone Y. The two zones are not distinct, but represent the ploughed and unploughed parts of one profile.

It is instructive to compare the NAP/AP ratio for this plough soil, which works out at 1033%, with the ratio for the surfaces of the modern soils. The raw humus of the 1939 surface under the dump gave 301% and the surface of Longworth's pit 467%. At the time of the cereal agriculture, therefore, there was much less influence of tree pollen that there is now. It is reasonable to assume that the adjacent scarp, which now carries a nineteenth century plantation, was treeless then. Nevertheless, in the tree pollen which did occur, beech and hornbeam were represented throughout zone X and into the upper part of zone Y. This would suggest that this agricultural phase fell within the Sub-atlantic period, that is, in the last 2500 years.

A final point to make in relation to this particular profile is that the pollen does not show any concentration at the surface immediately below the thin layer of yellow sand. Neither is there any 'turf-line' of old humus visible in the section. The significance of this will be brought out in the Discussion.

ii) The Soil Under the 1939 Dump

The surface of the soil buried beneath the dump was clearly recognisable as a thin turf-line, the old humus layer of the 1939 soil. The soil may be described as follows:

Thin (<1 cm) compressed layer of raw humus, pH 4.05

0- ca. 17 cm	Mottled brown-fawn sand (7.5YR 5/4), with leached pockets extending to 6 cm from surface
17-20/30 cm	Band of slightly darker (but still 7.5YR 5/4) staining (B) varying from 3-15 cm in thickness, merging into
20/30 cm downwards	yellow-orange sand (7.5YR 5/8)

The irregular nature of this profile is due to the changes taking place in it. The very early stages of podsolization are showing themselves in the leached (not bleached) pockets in the A horizon and the development of an incipient B horizon in which both iron and humus are accumulating. The evidence of podsolization scarcely shows, underlining the fact that the soil is still properly described as an acid brown earth even though degradation is beginning.

Pollen Analysis

Pollen analyses of the soil beneath the dump were carried out for two purposes: to corroborate the photographic evidence of the vegetation in 1939, and to see whether there is any evidence that the soil has been truncated.

To establish what the vegetation was like in 1939 two samples of the buried raw humus were taken from different points under the dump (samples 40 and 41). Sample 40 was the top sample of a profile exposed for deep sampling. In both samples grass pollen is abundant. There is a strong influence of tree pollen, especially oak, and bracken is well-represented, though not dominant. Bearing in mind that this site is near the edge of the grassy clearing adjacent to the plantation on the scarp this picture confirms the photographic evidence. There is, however, one big difference between the two analyses. In Sample 41 the amount of grass pollen is actually exceeded by the Rumex acetosa-type pollen, doubtless produced by sheep's sorrel (Rumex acetosella). This small plant is characteristic of acid soils and is often very abundant on trackways, or fallow arable land, or on ground exposed by erosion. It is the dominant plant colonising the ground where the turf has been removed in the course of the archaeological investigations on this site. It also occurs in patches amongst the short turf of sheep's fescue, and even, though in small quantities, in the taller bracken community. Its abundance in Sample 41 is therefore to be seen as the influence of a local abundance of sheep's sorrel at the point of sampling. It does not represent any significant difference in the vegetation cover as a whole.

The pollen sequence down the profile is given in Table II. It is a simple sequence covering the top 18cm of the soil; below this level the pollen is too sparse to count. The lowest part of the sequence shown bracken spores exceeding grass pollen in quantity, with Liguliflorae equally abundant. Liguliflorae pollen is something of a mystery in such analyses since it is not certain which species produce it. With both the Liguliflorae and bracken, the larger percentages in the lower levels are not merely due to differential decomposition because their frequencies are also higher here than they are in the layers above. As one traces the profile upwards, the Liguliflorae fall away and the grasses increase relative to bracken. There are phases of abundance of the two plantains and more recently of sheep's sorrel, perhaps due to changes in grazing pressure affecting the composition of the sward. Broadly, the change is of progressive decline of the abundance of bracken.

The time scale of this sequence is difficult to ascertain. A spruce grain was recorded at 8-10cm; spruce is present in the scarp wood today, but no weight can be placed on the occurrence of a single grain. The percentages of alder and hazel are consistently lower than those of the buried soil which is presumed to be of Anglo-Saxon date, and this may suggest that the pollen record in this profile extends only over a few centuries.

The distribution of pollen and spores in this profile shows the characteristic pattern of pollen downwash, with high frequencies at the very surface, but progressively lower frequencies with increasing depth. There is nothing to suggest that any of the pollen in the profile has not come from the 1939 surface. There is no buried surface, and no elements which might suggest that the sand contained any older pollen. In other words, this pollen profile appears to have developed in a pollen-free sand deposit. This would accord with the suggestion that at some time during or since the Anglo-Saxon period the soil was truncated down to the pollen-free subsoil. Assuming that the profile was originally commensurate with the adjacent soil buried beneath the barrow, this would imply the removal of at least 40cm depth of soil. It is not possible by this type of investigation to be any more precise, but if the soil were truncated to make the mound, the result would probably be like what we see in this soil section.

If some truncation has taken place, this would of course affect the development of the soil profile itself. The amount of horizon differentiation seen today would be the result of not more than 1400 years' development in undifferentiated sand. It should not be compared in sequence, therefore, with the soil beneath the barrow.

b) Longworth's Pit

Dr Longworth cut out a soil section some distance to the north and east of the one last described. The point was further away from the scarp wood, and in an area where the bracken was dominant, though grass, particularly sheep's fescue, formed a continuous ground cover. The soil profile showed some indication of the development of a humus B horizon and was sufficiently different from the soil beneath the barrow to warrant further investigation.

The profile was as follows:

0-5cm Grass root mat in sand. pH 3.95

5-22cm	Light brown (10 YR 4/3) sand, with scattered stones
22-37cm	Darker sand (7.5 YR 4/2). Moister. Rhizomes of bracken, especially at base
37-50cm	Brown-stained sand (7.5 YR 5/6) and occasional stones
50-55cm	Stone layer
55cm downwards	Ochre-coloured subsoil sand (7.5 YR 6/6) and occasional stones

The ignition profile of this soil shows no detectable movement of iron through the profile. Such horizon differentiation as there is, therefore, only involved the humic fraction. The question arises as to whether the darker humic horizon at 22-37cm is in fact a B horizon or whether it could be a buried soil surface. Pollen analysis was used to investigate this point.

<u>Pollen Analysis</u>

Apart from the topmost sample the soil was much less rich in pollen than the soil beneath the mound. Nevertheless, countable amounts were found down to 37-50cm, and the analysis is shown in Table III.

Once again there is clear evidence of a buried surface, at 30cm. The frequencies of many species are significantly greater here than in the overlying sample. Above this level the pollen profile is very similar to that of the 1939 soil, though the bracken is throughout more strongly represented. There is a similar trend in which the grasses increase relative to bracken, but this is reversed in the topmost sample where bracken is clearly dominant - reflecting the present vegetation. The Liguliflorae curve, too, is similar to its counterpart in the 1939 soil. This profile, like the 1939 one, appears to have developed in a pollen-free sand.

From 30cm downwards the pollen spectra are quite different. Bracken is insignificant but grasses and especially ribwort plantain reach increased proportions. Cereal pollen is no longer present and the woody species are poorly represented. With no really diagnostic types of pollen present in this analysis it is difficult to make trustworthy comparisons, but there is some similarity between this pattern and the lower part of zone Y of the soil beneath the mound. The Liguliflorae are more strongly represented and the NAP/AP ratio is even higher -

2164% - but otherwise the similarity is close, again suggesting a pastoral phase. In Longworth's pit the pollen runs out below this level; there is no parallel with zone Z of the soil beneath the mound.

The analyses cast some light on the nature of the soil profile at this point. In the first place, the upper part of the profile shows the development of a pollen sequence in what was a pollen-free material. As was suggested for the 1939 soil, this may be a truncated profile, but in this case there is a buried soil - perhaps itself truncated - beneath this layer of sand. The upper part of the profile is therefore developed in parent material which is transported and not <u>in situ</u>.

The buried soil at 30cm comes within the darker horizon described above, but it does not coincide with the surface of this horizon. The probability therefore is that the darker horizon is a later formation; it is not unusual for accumulation (B) horizons to form at our around buried surfaces in soils with such complex origins. Such a
deposition of humic matter may well be associated with the dominance of bracken. The absence of such a horizon in the 1939 soil would be consonant with the relative dominance of grass over bracken at this point.

<u>Discussion</u>

In any consideration of environmental changes on this site one factor must be borne in mind from the start: the soil material is physically unstable. This is not to say that good sections cannot be cut; they can, and where cemented by iron or humus they are particularly firm. Nevertheless, in the upper eluvial horizons of the soils the sand is loose when exposed by the removal of the surface turf and during excavations sand-blows were sometimes a nuisance. Such would also be the case then the land was under arable crops, particularly in the spring when the soil was rapidly drying and the crop had not yet covered the ground.

Stones are present in the material overlying the buried surfaces in Longworth's pit and in the soil under the barrow, which might suggest that these surfaces were not covered by blowing sand. However, frost action might have brought stones up into a layer of blown sand when the surface was unconsolidated, as for instance during cultivation. The possibility must also be considered that soil has been redistributed on this site by human activity, as for instance by the levelling of down-cutting trackways. The site had clearly been a centre of activity for a long period and it cannot be assumed that all the physical changes in the soil were 'natural'. Certainly the construction of the mounds would involve massive soil movement. There is no evidence that ploughing was the cause of the movement of the soil over what are now buried surfaces. The two modern soils have not been ploughed, and the ploughing in the soil beneath the mound took place at the top of a soil which was originally under pasture and whose pollen stratification (zone Y) showed that it had not been mixed.

It has been shown by these investigations that the soil immediately beneath the mound was an agricultural soil in which a change of land use from pasture to arable farming could be demonstrated. This phase of arable cultivation was the last episode which was detectable before the mound was built, and on these grounds it would be
asserted that the mound was constructed on Anglo-Saxon ploughing. This conclusion causes some difficulty archaeologically for two reasons:

a. there is no other evidence of Anglo-Saxon ploughing, eg pottery sherds; or a nearby settlement site.

b. The site itself is thought to have been a cemetery for perhaps 100 years before the ship mound was built, and one would not expect a cemetery to be ploughed.

These objections force us to look at the evidence for contemporary ploughing rather critically. Let us suppose, for the sake of argument, that the ploughing was earlier than Anglo-Saxon and that subsequently the site had passed out of cultivation. Inevitably it would have become covered with vegetation of some sort, probably a grass sward. This would have resulted in the development of a 'turf-line'. Such a turf-line would probably have been detectable visually in section, but at no time, either in the pre-war or the post-war excavations, has any trace of such a turf-line been reported. Even if the line were too ill-defined to be recognisable, it should certainly have shown up in the pollen analyses. The surface samples of the two modern soils show clearly how the pollen frequency builds up at a surface, but there is no trace of any such concentration at the surface of the buried soil.

If the archaeological evidence demands that there shall have been a phase of abandonment after the ploughing, then it will have to be concluded that the buried soil itself has been deliberately truncated, removing all trace of that period from the pollen record. This is a purely negative argument; there is nothing in the environmental evidence which might support it.

We are driven, therefore, to re-examine the archaeological objections. Suffice it here to pose the following questions:

i. Pottery fragments on fields are characteristic of manuring with household refuse; could other forms of organic matter have been used (eg animal dung, seaweed?)

ii. Can we say with certainty that no Anglo-Saxon settlement existed within farming distance of this site?

iii. Is there any possibility that the ship barrow was built outside the area of the earlier cemetery?

Whether or not it can be established with certainty that the ploughing was Anglo-Saxon, there can be no doubt that the site was cultivated and cereals were grown in the Sub-atlantic period. This conclusion is so much at variance with the conclusions reached by F E Zeuner in his Appendix IV to Phillips's report that the grounds on which he based his conclusions must be examined carefully. Zeuner did not carry out any pollen analyses. His deductions about the vegetation were based on his assessment of the buried soil. He described a heath podzol which, he says, continued right underneath the barrow. According to his account, the present vegetation "now forms a heath consisting of ling (Calluna), heath (Erica) and bracken" and as the soil beneath the barrow was similar, he concluded that it is "probable that the heath dates back to the Saxon period".

These basic observations have to be questioned. The 1939 photographs (Pls.) show a vegetation not very different from today, and in a vegetation list made in 1970 neither heather (=ling, Calluna) nor heath (Erica) was recorded. Moreover, in the pollen analyses of the two samples of 1939 raw humus only 4 grains of heather and none of the heath were recorded in a total count of 526. There can be no question, therefore, that Zeuner's description of the vegetation as ericaceous heathland was not correct.

Nor, unfortunately, is the situation much more satisfactory as regards the soils. None of the exposed soils shows any significant degree of bleaching in the A horizon; there is no soil on the site which could conceivably be described as a heath podzol. The only explanation which can be offered of this misinterpretation is that Zeuner was misled by the appearance of the soil beneath the barrow when it is dry.

The zones X and Z appear to have a higher colloid content than zone Y and remain moist as the section dries out. Zone Y, however, dries rapidly, becoming light fawn in colour. Consequently the dry profile has a stratification of dark, light and dark horizons which superficially resemble a podzol. As soon as the dry face is trimmed back, however, the colour is seen to be almost uniform.

There is considerable discrepancy between the dimensions of the soil and those given by Zeuner. However, this soil does vary somewhat in the depth of the various zones from place to place.

It must be considered that the evidence which Zeuner collected was seriously open to question and that there are no valid grounds to support his belief that the site was under ericaceous heathland in Saxon times. On the other hand, it may seem very improbable that the "barren, sandy heath" (Phillips, p.155) could have been used for agriculture. It is easy to assume that the present infertility is an inherent feature of such a site, but it has to be remembered that the passage of some 1400 years will have led to decreased fertility on such base-poor soil of low clay content, aggravated by burning and grazing. It is not unusual for heather-dominated heathland, even with a podzolised soil, to have had an early history of agriculture. Until recent reclamation there was such an area within a mile of the present site. The site itself, however, apparently never reached this condition; nowhere in the whole series of pollen analyses does the heather percentage exceed 5%, whereas it normally reaches 60-90% when heather is dominant. This may be due to differences in inherent soil fertility or in land use - particularly the use of fire - in the past. Saxon agriculture may have been practised because of locally better soil conditions; or, having been practised, it may have increased the resistance of the soil to subsequent processes of deterioration. Either explanation would account for the present conditions of soil and vegetation. It is pertinent that Phillips refers (p.150) to the ploughing of the slopes to the west of the site before the plantation was established in 1881, and he points out that the ploughing extended on to the plateau and resulted in damage to the western end of the ship-barrow. Presumably this ploughing was for agriculture. On these grounds, therefore, the interpretation of the pollen analyses in terms of cereal agriculture does not seem too improbable. Once the soil is recognised as a brown earth and not a podzol many of the difficulties of such an interpretation disappear.

A last point of interest in this environmental assessment arises from the make-up of the mound itself. Phillips believes that the mound had been composed of turves "stripped from the surface of the heath"; in many places, he says, the faint outline of the turves could be seen, and suggests that by "a chemical test"

Zeuner confirmed this diagnosis. In Appendix IV, however, Zuener does not mention such a test, but he describes the mound as consisting "entirely of a homogeneous dark-brown sand which, in every respect, resembled the material of the A_1 horizon under the barrow and in the neighbourhood", and suggests that it was collected by "superficial scratchings from all over the neighbourhood".

This conclusion does not match very well with Zeuner's own interpretation of the soil as a heath podzol, for a podzol of this nature has a well-defined turf structure, not a loose sandy surface. One would have expected, therefore, that it the soil had been a podzol the mound would have a pronounced turf structure when seen in section. On the contrary, the description of the make-up of the mound as dark-brown sand sounds much more like the top-soil of an acid-brown earth, and it should be borne in mind that a ploughed soil would not produce turves but would in fact produce a homogeneous soil such as Zeuner described.

Nevertheless, a poorly-defined turf structure was apparently detectable according to both Phillips and Ashbee, and future analysis of samples of these may resolve the problem. It is possible that both scraped-up topsoil and cut turves may have been incorporated in the mound, coming from different types of soil surface in the neighbourhood.

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6.1.5 *Preliminary* [and Final] *Report on the* [Present] *Vegetation of Sutton Hoo by S L Rothera 1984.*

Introduction and background

The archaeological site at Sutton Hoo lies towards the south-western extremity of a crescent of mainly coastal heaths known as the Sandlings. These stretch from south of Woodbridge up almost to Lowestoft. Within the designated site at Sutton Hoo the present vegetation is species-poor grass heath infested by bracken. Grass heath describes a floristically variable, yet characteristic, vegetation composed of the `heath grasses' interspersed with a few perennial herbs and several annual or ephemeral flowering plant species. It occurs on the same sandy well drained, often acid and nutrient poor lowland soils as `true' i.e. *Calluna* (heather) heath, by which it may be invaded and which it replaces on heavily grazed sites (Tansley 1949).

Grass heath, indeed, owes its very existence to grazing, principally by sheep, but also by goats, cattle and latterly rabbits. In the absence of grazing, the land would revert relatively quickly to scrub of gorse, bramble, elder, birch and even oak in certain places. Most lowland heaths, including the Sandlings, were managed as grazing land from at least medieval times onwards. Sheep would be pastured on the heath in summer, fed on green crops in autumn and sustained on root crops in winter. This practice continued on the Sandlings as recently as the 1930s (Armstrong 1971). Heaths were occasionally ploughed at times of high grain prices, from the Napoleonic wars on, but this was seldom profitable for long on such dry infertile soils. The importance of heaths as sheep pasture was declining before 1930. The process accelerated this century with much heathland being `improved' and afforested or cleared for arable purposes. Rabbit warrens were established in the Sandlings from 1400 onwards as a profitable use for the light sandy soils. Feral rabbits became a prevalent phenomenon only from the 18th century (Sheail 1978).

The Sandling heaths have a parallel in the Breckland (the area of sandy soil bordering the Fens in western

Suffolk and Norfolk). Similarly sandy soils developed in a region of low rainfall and with a history of shifting cultivation, sheep pasture and rabbits means that the Breckland has a similar flora. Differences in the nature and development of the sands, and the earlier cultivation of the Breckland, however, mean many floristic differences. The Breckland has many more specific endemics.

Precise details of the land-use history of Sutton Hoo can be partially traced, no doubt, from historical documents. The present vegetation at the site is a result of this management history, the nature of the soil, and year to year variations induced by climatic fluctuations. The site may have been partially ploughed as recently as 1914-18 (Dimbleby in Bruce-Mitford 1974) and then presumably returned to heath pasture. Many heaths periodically suffer from fires. Sutton Hoo may not be an exception.

At what date the grass heath became invaded by bracken is unknown. Photographs from 1938/9 (Bruce-Mitford 1974) show it to cover all but the western edge of the site, into which it might still be invading at that time, or being restricted by rabbit grazing-damage as suggested by Dimbleby (*loc. cit.*). The spread of bracken has occurred widely on lowland heaths generally and in Breckland. Factors such as climatic change, reduced grazing pressure, incidence of fire, and altered land management have been considered important.

Excavations of Mound 1-4 in 1938/9 will have had a large impact on the vegetation, particularly where turf was removed, or soil dumped. The more recent phase of digging (1965-70) has likewise had an impact, which is still visible in the vegetation in 1984. The intervening period saw the site used for military training during World War II. Some soil and vegetation disturbance is visible in a 1946 aerial photo (fig. 48 in Bruce-Mitford 1974), but apart from the subsequent anti-glider ditches it shows less disturbance than that of the surrounding heathland.

In 1965, the site was shaved of bracken and the sward beneath cut closely. This may have been repeated subsequently. The vegetation of the site appears a different shade to the heath to the south in aerial photos of c1970, in part probably due to raking off of bracken litter with the chippings. Also visible are the tracks of vehicles used to clear an area east of Mound 2, thought to have been contemporary agricultural midden-heaps. Other signs of human occupation (paths etc.) and the positions of archaeologists' huts also show clearly in aerial photographs. Most recently (summer 1983) the site has again been stripped of bracken, shrub vegetation cut to ground level and the grass mown.

The present survey of the vegetation was undertaken with two main aims. Firstly, to record a complete list of species present and a description of the vegetation of the site, as at June 1984. Secondly, to examine whether features of the present species composition or distribution at the site could be related to features of archaeological interest. In particular, any clues in the vegetation to past disturbance events would be valuable.

Method of survey and proposed analysis of data

The site was divided into 50 x 30m areas based on the main site survey, each square given a letter code, and a number of quadrats (0.5m side) randomly located within each square. For each quadrat the species present within it were recorded, and a Domin cover-abundance value estimated for each of them (excepting the first 20 examined). One hundred and ninety quadrats were located, including three placed deliberately on Longworth's pit (Int 11) west of Mound 5. Additionally, the site was closely examined for species that fell outside of the quadrats.

The data was suitable for analysis using computerised multivariate methods of classification and ordination. Multivariate techniques aim to discover structure in a data set, and to provide an objective easily understood and communicated summary of complex community information. Ordination seeks to represent samples and species relationships accurately in low dimensional space, grouping similar samples (e.g. quadrats) or species together. The axes of an ordination may offer interpretation in terms of environmental/historical factors which give rise to the perceived gradients of community composition. Classification groups similar entities (again e.g. quadrats) together often in a hierarchical fashion which allows assessment of their closeness of relationship (Gauch 1982). Both approaches were to be attempted on suitably manipulated Sutton Hoo data, using the DECORANA (reciprocal averaging and de-trended correspondence analysis ordinations) and TWINSPAN (hierarchical classification by two way indicator species analysis) programs (Hill 1979a and b). It was hoped by these methods to identify communities or assemblages of species which, with a knowledge of some of the recent history of the site and the ecology of the species, can be interpreted ecologically and archaeologically.

Results and discussion of main vegetation features.

The survey was conducted between the 5th and 12th June 1984. The raw data of species cover-abundance for each quadrat were deposited in the Sutton Hoo archive (FR 9/616). The vegetation is developed on an acid brown earth (surface pH 3.8-4.2) soil of markedly sandy composition, thought to be fluvio-glacially re-worked beach sand (Dimbleby, *loc. cit.*). A total of 68 species and varieties were identified on the site (see TABLE 10.1). Of these 20 were graminoids (grasses, sedge, rush), 35 dicotyledonous flowering herbs, 1 fern *bracken), 3 tree or shrub species, 6 mosses and 3 lichens. None of the vascular species are rare in the sense of appearing in the *Society for the Promotion of Nature Conservation Red Data Book I* (Perring and Farrell 1977).

The vegetation as a whole resembles something between an acid facie of Grassland C and a species-rich version of Grassland D, as classified for Breckland grass heaths by Watt (1940). Watt himself declines to extend comparisons to other lowland grass heaths, and the description is simply used here as a guideline.

The developmental stage of the vegetation reflected the relatively dry winter and cold spring conditions. The earliest plants of common and brown bent, *Agrostis tenuis* and *Agrostis canina*, were beginning to exert their panicles from the culm by 12th June. Sheep's fescue, *Festuca ovina*, was releasing copious pollen, and heath bedstraw, *Galium saxatile*, was in bloom. The bracken croziers had reached a maximum height of 15-30cm, but without unfolding of the laminae. Bracken, *Pteridium aquilinum*, is ubiquitous over large areas of the south and east of the site, occurring in 46% of the sampled quadrats. Its relative absence from the western edge reflects past and present rabbit grazing, and excavations that have removed (or fatally buried beneath soil) the underground rhizomes by which it spreads.

Apart from bracken the vegetation consists predominantly of perennial grasses. Sheep's fescue, *Festuca ovina* predominates among these, being found in 97% of the sampled quadrats; common bent, *Agrostis tenuis* occurs in 68%, Yorkshire fog, *Holcus lanatus* in 35%; and brown bent, *Agrostis canina* ssp *montana*, in 30%. Small gaps in the turf allow annual species to gain access. The commonest of these at Sutton Hoo were sheep's sorrel, *Rumex acetosella*, in 53% of quadrats, and the early hair-grass *Aira praecox* in 20% of quadrats. Other characteristic heath annuals include the widely scattered early forget-me-not, *Myosotis ramosissima*, and wall speedwell *Veronica arvensis*; shepherd's cress, *Teesdalia nudicaulis* found on and adjacent to British Museum spoil heaps; least birch foot trefoil, *Ornithopus perspusillus*, restricted to Longworth's pit (Int 11); common vetch, *Vicia angustifolia* found widely (13% of quadrats) in dense sward; and the squirrel-tail (*Vulpia bromoides*) and rat's tail (*V. myuros*) fescues, both of which were restricted to an area south of the more westerly midden heap mark (e.g. quadrats L15 and L16). Typical heath perennials on site include the white-flowered heath bedstraw, *Galium saxatile*, present in 18% of quadrats; field woodrush, *Luzula campestris*; and yellow flowered lady's bedstraw, *Galium verum*.

The two commonest mosses at Sutton Hoo are *Pseudoscleropodium purum* (in 51% of quadrats) and *Hypnum cupressiforme* (in 27%). Both occur beneath, and intermingled with, the sward over much of the site. They have the greatest cover abundance however, on or around the rebuilt Mound 1, the area most recently affected by excavation. This matter will be returned to.

In addition to heathland species a number of arable `weed' species and those common to waste ground are found on site. These include thale cress, *Arabidopsis thaliana*; barren brome, *Bromus sterilis*; white bryony, *Brionia dioica*, (unpalatable to rabbits); sticky mouse-ear chickweed, *Cerastium glomeratum*; creeping thistle, *Cirsium arvense*; pepperwort, *Lepidium compestre*; *Montia perfoliata*; curled dock, *Urtica dioica*; and large field speedwell, *Veronica persica*. An agricultural pasture element is represented by cocksfoot, *Dactylis glomerata*; perennial rye grass, *Lolium perenne*; annual meadow grass, *Poa annua*; cat's ear, *Hypochaeris radicata*; and sweet vernal grass, *Anthoxanthum odoratum*.

The typical arable and wasteland species occur firstly, along the eastern and southern edges of the site (e.g. quadrats J14, J16, C12) and secondly, associated with the recent midden heaps north of Mound 2 (eg.quadrats L13, P7, Q1, Q3, Q4). The southern and eastern edge vegetation appears to be slightly nutrient enriched from the surrounding arable land, judged both by the luxuriance of growth compared with the *F. ovina* heath, and in the species composition itself. Similarly, the areas of putative cleared midden heaps support luxuriant growths of nettles, barren brome, rye grass, *Montia perfoliata*, and creeping thistle consistent with this interpretation of origin. Nettles indicate a high phosphate status, and grow abundantly on the more easterly midden patch. Where nettles grow elsewhere on site, they are relatively depauperate and their distribution possibly reflects not local concentrations of phosphates so much as gaps colonised by an unpalatable species.

It must be stressed that this survey presents a `snapshot' of the vegetation at one particular time. Vegetation is dynamic. Even with consistent management practice the individuals living, degenerating, invading, or spreading from a particular patch of ground change with time, as may the species composition of their relative abundance to one another (e.g. see Davy and Jefferies 1981). This depends on a multiplicity of interacting environmental and biotic (inherent in the plant species themselves) factors, and makes detailed interpretation of patches of vegetation quite difficult. However, by comparing Sutton Hoo with grass heath studied elsewhere, e.g. Breckland by E. Pickworth Farrow and A.S. Watt, several general and specific observations can be made.

Despite this dynamic nature, a moderately stable hierarchy of species can exist little affected by temporal fluctuations (Grubb, Kelly & Mitchley 1982). As noted, bracken dominates a sward composed chiefly of *Festuca ovina* at Sutton Hoo. Occasional, temporary clearance of the bracken and its litter is not a consistent management practice. It is, therefore, little surprise to find that after the last clearance and mowing the surface mapped features of the vegetation in November 1983 differ from the situation found in June 1984. In particular, the stoloniferous grass Yorkshire fog, *Holcus lanatus*, increased its area, possibly as a direct result of the removal of the bracken. This species predominates in the dark green colour coded areas of the surface feature mapping. Where *Holcus* has a high cover abundance (Domin of 7 or more), common bent and sheep's fescue are very reduced, whilst smooth meadow grass, *Poa pratensis*, increases. The ecological, much less the archaeological, significance of this is not clear. Ordination may shed some light on this, and allow an assessment of the homogeneity of the surface feature mapping colour codes.

Bracken has dominated the community structure over much of the site. Extensive studies of the species invading grass heath in Suffolk Breckland show it possesses pioneer, building, mature and degenerate phases (Watt 1947). A patchwork of these phases develops in the hinterland behind a vigorous advancing front, the bracken becoming a victim of its own success by being unable to grow well through its own accumulating, slowly-decomposing, litter (Watt 1976). Rhizome depth varies with the phase of growth. Pioneer and degenerate phase shoots are more susceptible to winter frost and spring or summer drought (Watt 1964). Grass heath re-invades the degenerate phase of bracken.

The most recently heavily brackened area is between Mounds 3, 4 and 9; only sheep's fescue (*Festecua ovina*) had survived beneath its shade. The finely-fragmented, deep, bracken litter tilth appears inimical to the establishment of seedlings of either annuals or other grasses, for the time being. The possibility exists of the bracken fronds being toxic to other plants in the vicinity (Gliessman 1976). Many heath species have survived in the past in the areas the bracken has vacated. Some winter/spring annuals such as early hair-grass, *Aira praecox*; shepherd's cress, *Teesdalia nudicaulis*; early forget-me-not, *Myosotis ramosissima* and spring vetch, *Vicia lathyroides*, may complete their life cycles, producing seed, before the bracken canopy effectively extinguishes the light. These early flowering annuals are adapted to avoid the harsh, dry conditions of summer on the heath, and possibly thereby pre-adapted to tolerate the presence of some bracken.

Discussion of specific vegetation features

The characteristic midden-heap assemblage of species (north of Mound 2) has been detailed already. The next most striking feature is the close cropped, bracken free, sward on and around Mound 1. Sharp discontinuities in the vegetation on the north and east of mound 1 reveal where the 1965-70 excavations back-filled the sandy soil into excavated areas between which were left strips of the sward developed after the 1938/9 digging. These latter strips are darker green and composed almost exclusively of perennial grasses *Festuca ovina* and *Agrostis tenuis* etc. The paler green patches in between support a more diverse flora developed on an initial shifting sand substrate deprived of its thin humus layer and associated nutrients. The flora here possesses the perennial grasses (including the less common brown bent, *Agrostis canina*) but at a lower cover abundance. In between grow sheep's sorrel, early hair-grass and heath bedstraw in abundance. Most characteristic are the occurrence of the *Polytrichum* mosses, *P. juniperinum* and *P. piliferum* and the lichens *Cladonia impexa* and *C. pyxidata.* This assemblage parallels somewhat that developed on eroded sand blow-outs in Breckland (Watt 1938). Sutton Hoo soil is, however, probably more stable, less acid or nutrient poor than that described by Watt.

The area north of Mound 1 (in area G) has a similar flora to that just described. From this, it is inferred that the surface humus layer was similarly removed and bare sand left for colonisation. Such events remain visible in the vegetation for so long because the dry, nutrient poor, soil permits only slow growth. The occurrence of this type of plant assemblage elsewhere on site probably implies disturbance and removal of the surface vegetation in recent times e.g. within the last 20 years. This could be due to many causes, including digging by contemporary `treasure' hunters or the burrowings of rabbits. A similar association of species is found on the summit and flanks of mound 2 in an area clearly recently affected by rabbits. Mound summits may, however, be more exposed than the surrounding heath, and not develop the thick perennial grass sward that dominates the area east of the line of main mounds.

Longworth's pit (Int 11) appears unvegetated in aerial photographs of 1970. It was presumably back-filled contemporaneously with Mound 1. The vegetation is similarly more open than the mature perennial grass sward. Species diversity is high and includes *Polytrichum juniperinum* as on mound 1. Least birdsfoot trefoil, *Ornithopus perpusillus* occurs here and nowhere else on the site. The occurrence of sand sedge, *Carex arenaria*,here is also interesting. It is common on sand dunes but occurs at few inland sites, yet is found extensively in Breckland and occasionally on Sandling heaths. The species is spreading in the north-west corner of the site (south of Mound 12) only.

Relatively bare rectangles north-east of Mound 3 mark the sites of the huts removed in 1983. The ground remains largely uncolonised on the larger except for a few vigorous dark green plants of common bent, *Agrostis tenuis* (quadrat E2). These are thriving on reduced competition and the increased nutrients previously input by nesting kestrels. The other relatively bare patch possesses many bramble stems (*Rubus fruiticosus agg.*)

It is possible that bramble requires disturbance in vegetation to establish, but this is uncertain. The species occurs on the south-west of Mound 3 and also on Mound 7. Disturbance by rabbits at both sites is possible. Brambles once established may not be particularly palatable to rabbits. Mounds make ideal rabbit warrens, and such structures were sometimes especially created for the purpose (Sheail 1984; see also Chapter 12, p000).

The anti-glider ditches thrown up some 45 years ago are not differentiated vegetationally from the surrounding mature sward despite their microtopographic difference. Bracken, however, prefers a deep soil, so it is probably not an optical illusion that the highest frond densities often occur on the flanks of mounds and the banks of the anti-glider ditches.

It is difficult to discern the effects of military disturbance on vegetation today, and positively draw the correlation. However, Crompton and Sheail (1975) could still tentatively make a connection between species distribution (in 1971) and war time military activity in grass heath at Lakenheath Warren, Suffolk. Ribbon-like frost hollows, for example, formed in the tracks of army vehicles and excluded the frost-sensitive bracken.

It is similarly difficult, if not impossible, to age a `hole' by its vegetation. Robber pits dug in antiquity are unlikely to possess a specific or characteristic flora today. It may, however, be possible to suggest that an abundance of annual herbs and grasses on a feature means recent (<15 years) rather than ancient disturbance. Conversely, a dense sward of perennial grasses likely indicates a longer period (e.g. 40 years +) since the last disturbance, if any.

Currently rabbits are the greatest natural cause of disturbance in the vegetation, after a period from the middle 1950s to the 1970s when myxomatosis virtually eradicated all rabbits on Sandling heaths (Chadwick 1982). Their burrows and scrapes provide openings for annual species once local grazing ceases. Their `latrines' create local nutrient inputs, and the grasses in particular respond, growing greener and more lushly than the adjacent sward.

Moles too provide open sites in the sward. The activity in June 1984 was most marked in the south of the site (areas A. B, C, F and Y). Ants similarly scatter sand and may partially smother perennials thereby opening niches for annuals. Their activities are most noticeable on areas where the percentage of bare ground is already quite high, such as the area north of Mound 1.

Small rodent holes and tracks are found in the deeper sward east of the main line of mounds. Their influence, by feeding on roots, seeds, and other plant parts, on the composition of the grass heath is not known; some impact may however be assumed.

Management implications

Removal of bracken from the site is probably desirable both for aesthetic and archaeological reasons. A soft grass sward studded with flowering species is visually appealing and makes access to, and appreciation of, site features easier. Bracken rhizomes may penetrate 25-30cm or more below the surface and cause problems where immediately sub-surface archaeological features are of interest. These rhizomes will make clearance difficult as they contain great reserves from which the fronds can re-generate many times after defoliation. Hand pulling and scything is time and labour consuming; whilst the application of the bracken-control chemical asulam (at 4.48 kg/acre) is more effective, it is not without its side-effects on other species in the sward beneath (Cadbury 1976).

Once bracken is suppressed the perennial grass species will probably take advantage and dominate even more the grass heath. A deepening litter layer would form beneath them making colonisation by other herbs difficult. To maintain floristic diversity it would be necessary to mow the site regularly, and rake off the clippings to reduce local litter accumulation. Mowing must be performed at times of year compatible with the phenology of the species one wished to retain. Mowing is obviously unselective as to species cropped unlike grazing which would differently affect species composition, possibly in unpredictable ways. I know of no comparison of the effects of mowing and grazing on lowland acid heath; general principles, however, are outlined in Duffey *et al* (1974).

To retain the winter annuals a high cut in early spring, followed by lower cuts could be achieved before the end of September, the time of gemination of those species in gaps. Natural gaps will continue to be created by rabbits, moles etc. This management regime will certainly have the effect of eventually excluding taller non-vegetatively reproducing perennials such as white campion, *Silene alba*, which is less abundant on the site than in neighbouring unmown grassland. Later flowering annuals, unable to set seed before the first low cut, would also suffer e.g. squirrel tail and rat's tail fescues *Vulpia bromoides* and *V. myuros*. Mowing the eastern side of the site as a mosaic of differently timed cuts would help solve this; but may well be impracticable for the archaeologist to bother with. Whatever management approach is adopted, a full record of how the site was treated would help greatly in understanding the vegetation of the future.

Because the sward is slow growing, persistent trampling of an area can be detrimental (Gimingham 1981), and paths cut quite quickly where human pressure is greatest.

Whatever management the site receives will also have implications for the fauna, on which a botanist is unable to comment.

Concluding remarks

Archaeological digging at Sutton Hoo has been a major source of vegetation disturbance in the past. Far from destroying the habitat this has, with time, helped to maintain the species diversity across the site by laying bare soil for re-colonisation. Not all the species on site are found in such areas, but some species occur nowhere else, having been excluded from thicker swards. The interests of archaeology and the species diversity of this habitat are, therefore, compatible. Lowland heaths have been under immense pressure this century, and the Sandling heaths have disappeared rapidly (Chadwick 1982). The preservation of one further example of this type, however tiny, is, therefore, to be welcomed.

List of species found growing at Sutton Hoo 5th-12th June 1984. This includes species not found in the randomly placed quadrats, but present elsewhere on the site.

Species	English or Common Name
Agrostis canina subs. montana	Brown bent
Agrostis tenuis	Common bent
Aira praecox	Early hair-grass
Anthoxanthum odoratum	Sweet vernal-grass
Anthriscus caucalis	Bur chervil
Aphanes arvensis	Parsley piert
Arabidopsis thaliana	Thale cress
Arenaria leptoclados	Thyme-leaved sandwort
Arrhenartherum elatius	False oat-grass
Bromus mollis	Soft brome
Bromus sterilis	Barren brome
Bryonia dioica	White (or red) bryony
Carex arenaria	Sand sedge
Cerastium glomeratum	Sticky mouse-ear chickweed
Cirsium arvense	Creeping thistle
Dactylis glomerata	Cocksfoot
Festuca ovina	Sheep's fescue
Festuca rubra	Red or creeping fescue
Festuca rubra var. pruinosa	--
Galium saxatile	Heath bedstraw
Galium verum	Lady's bedstraw
Geranium molle	Dove's-foot cranesbill
Geranium pyrenaicum	Mountain cranesbill
Hieracium pilosella	Mouse-ear hawkweed
Holcus lanatus	Yorkshire fog
Hypochaeris radicata	Cat's ear
Lactuca serriola	Prickly lettuce
Lepidium campestre	Pepperwort
Lolium perenne	Perennial rye-grass
Luzula camapestris	Field woodrush
Montia perfoliata	--
Myosotis ramosissima	Early forget-me-not

Ornithopus perpusillus	Least birdsfoot trefoil
Phleum pratense	Timothy grass or cat's tail
Plantago lanceolata	Ribwort
Poa annua	Annual meadow-grass
Poa pratensis	Smooth meadow-grass
Pteridium aquilinum	Bracken
Quercus sp. (seedling)	Oak
Rubus fruiticosus agg.	Bramble
Rumex acetosella agg.	Sheep's sorrel
Rumex crispus	Curled dock
Sambucus nigra	Elder
Senecio jacobaea	Ragwort
Silene alba	White campion
Stellaria graminea	Lesser stitchwort
Teesdalia nudicaulis	Shepherd's cress
Thlaspi arvense	Field penny-cress
Trifolium dubium	Lesser yellow trefoil
Trifolium striatum	Soft trefoil
Trisetum flavenscens	Yellow oat-grass
Ulex sp. (seedling)	Gorse
Urtica dioica	Stinging Nettle
Veronica arvensis	Wall speedwell
Veronica persica	Large field speedwell
Vicia sativa ssp. nigra (V. augustifolia)	Common vetch
Vicia lathyroides	Spring vetch
Vulpia bromoides	Squirrel-tail fescue
Vulpia myuros	Rat's tail fescue

Mosses
Dicranium scoparium
Hypnum cupressiforme
Polytrichum juniperinum
Polytrichum piliferum
Pseudoscleropodium purum
Rhytidiadelphus squarrosus

Lichens
Cladonia impexa (C. portentosa)
Cladonia sylvatica (C. arbuscula)
Cladonia pyxidata

6.1.6 *Pollen Analysis by R Scaife*

6.1.6.1 Briefing document August 1988

POLLEN ANALYSIS (R. Scaife)

1. Burial mounds and buried soil beneath

1.1 Mound 2: make-up, quarry pits and buried soil
(16 columns taken by Helen Atkinson. Report awaited)

Station 20 14446 (41/42/1309). Identified as turf from a podsol in mound make-up. 1 sample from C French. To be analysed.

1.2 Mound 5: buried soil
(8 columns taken by Helen Atkinson. Report awaited)

1.3 Mound 6

	3917 (44/1083,1172) Buried	Sample with	Decision
in	soil, upper	C French	July
	------------------ Buried	to be taken	
	soil, lower	July 1991	

1.4 Mound 7

	---------- column through	to be taken	
	buried soil	July 1991	

2. Prehistoric Features

	Station 19		
	43433 (41/117/1217) neo-	pollen in primary	2 samples
	lithic boundary ditch	and secondary	to be
taken			
	43431 (41/117/2047,2048)	fills	July 1991
	neolithic boundary ditch		
	----------Int 48, IA	pollen in primary	1 sample
	boundary ditch	fill	to be
taken			
			July 1991
	2895 (48/29/1049,1055)	pollen in primary	1 sample
	neolithic pit	fill	decision
in			
			July

3. Medieval Features

	1813/ /1300-1306	pollen,	1 sample
	lynchet	cultivands	to be
			analysed

4. Soil Erosion Sequence in Valley

	-------- (53/1000-1006)		30

samples			
	Section		to be analysed
5.	Graves		
	----- (to be chosen)	Evaluate	1 sample to be analysed

Summary of Commissioned Work

14446	1 sample	to be done	(c.£300)
3917		to be decided July	(c.£300)
----	Mound 6 lower buried soil	to be decided July	(c.£900)
----	Mound 7 buried soil	to be decided July	(c.£900)
43431, 43433	Neolithic boundary ditch	to be done	(c.£600)
----	IA boundary ditch	to be taken July	(c.£300)
2895	Neolithic pit	to be done	(c.£300)
1813	Medieval lynchet	to be done	(c.£600)
	Valley section	to be done	(c.£1,000)
	Grave	to be done	(c.£100)
			c.£6,400

6.1.6.2 Final Report on the findings from the Valley Section, INT 53, Oct 1992 (R. Scaife).

6.2 Plant Remains *Assessment of Charred plant remains from prehistoric features* by A R Hall
Reports from the Environmental Archaeology Unit, York **94/40**
Assessment of charred plant remains from prehistoric features
from Interventions 41, 48 and 55 at Sutton Hoo, Suffolk

by Allan Hall

Summary

Charred plant remains from wet-sieved samples from deposits exposed during three periods of excavation (Interventions 41, 48 and 55), and isolated finds of charred plant material from two of these (Interventions 41 and 55) have been assessed for their archaeobotanical potential.

Most of the sieved samples produced at least a little charcoal, though the amount was usually very small and the individual fragments rarely larger than 10 mm. Charred hazelnut shell was frequently recorded, again usually in rather small amounts, but the charred cotyledons of oak (from acorns) were quite frequent, especially in some post-hole fills from one area of Intervention 41, and were often complete or present as large fragments. Charred cereal grains were almost absent and no cereal chaff was observed.

A small amount of further work is recommended to identify a subsample of the charcoal and to place the nutshell and acorn remains in the context of other prehistoric sites.

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19 April 2005

Assessment of charred plant remains from prehistoric features from Interventions 41, 48 and 55 at Sutton Hoo, Suffolk

Introduction

Charred plant remains from wet-sieved samples from deposits exposed during the execution of Interventions 41, 48 and 55, and isolated finds of charred plant material from Interventions 41 and 55 were submitted for assessment of their archaeobotanical potential. All the material was from prehistoric (Neolithic-early Bronze Age or Iron Age) features, mainly post-hole fills and pit fills.

The wet-sieved material consisted of the 'flots' from sieving 1 bucketful of sediment (approx. 10 l) in each case. Sieving had been carried out on site using a 1 mm mesh; residues had not been retained.

Methods

All the material submitted was examined under a binocular microscope and brief notes made about the charred remains and any modern contaminants present. The maximum size of charred material in each category (charcoal, nutshell, acorn cotyledon) was also noted, to the nearest 5 mm. Quantification was as follows: for the flots, a three-point scale was adopted in which 1 indicates that less than an estimated 10 cm^3 of the component was present, 2 indicates 10-50 cm^3, and 3 indicates >50 cm^3. For the 'spot' finds, there were only ever single specimens or a very few fragments and these have therefore always been scored as '1'.

Results

The results of the assessment are shown in the appendix. In all, 139 flots or spot finds were examined. Table 1 gives scores for the amount (by volume) of four common components of the flots, together with an indication of the size of the largest specimen or fragment for charcoal, charred hazelnut shell and charred acorn cotyledons.

The sieved samples showed considerable variation in their content of ancient plant remains, but most gave at least a little charcoal, usually as rather small fragments.
For Intervention 41, charcoal was most abundant (scores of 2 or 3) in a hearth deposit, a post-hole fill and four scoop fills from the area of Mound 2, and three post-hole fills from the area of Mound 5. A single pit fill from Intervention 48 and six pit fills from Intervention 55 also gave moderate or large quantities of charcoal. Perhaps not surprisingly, there was strong correlation between the amount of charcoal and its maximum size.

Nineteen samples contained at least traces of charred hazelnut shell and eleven of the spot finds were of this taxon. The only two moderately high concentrations were from two post-hole or pit fills (F223, F333) from the Mound 2 area of Intervention 41.

Charred acorn seed-leaves (cotyledons) were recorded from eight flots and 19 of the spot finds comprised this material; it is also probable that some of the material recorded as charcoal may have included cotyledon fragments. All the moderate or high concentrations were from post-hole fills in the centre of the area of Mound 5 (features F466, F543, F544 and F545).

Other charred plant remains were very scarce; there were only two barley grains, one ?oat, 1 ?wheat and a further unidentified grain which may have been a cereal. A single sloe (*Prunus spinosa*) was also recorded. It is possible that the paucity of cereal remains reflects methodology since charred grain often remains with the residue rather than the flot or washover during wet-sieving. Ideally, unless the residues for these samples were screened on site for charred material and found to be barren, they should have been retained for examination with the flots.

A few modern contaminants, inevitable in material sieved on-site, were observed and there was a variable content of roots and rootlets, most of which are presumably of recent origin.

Discussion

The remains recovered offer some modest insight into the use of wild resources by the prehistoric inhabitants of this area and also point to the probability that cereals were only exploited in a limited way (assuming that at least some of the deposits formed in the vicinity of domestic occupation). The comment above concerning the possibility that cereals remained in the wet-sieved residues means, however, that a definitive statement cannot be made.

An interesting taphonomic aspect of the results is the contrast between the preservation of the *shell* of hazelnut and the *seeds* of acorns. The absence of acorn ‘shells’ may well be a function of their rather flimsy nature (compared with the much more substantial, woody, shells of hazelnut); the absence of hazel kernels might reflect a difference in the way the two kinds of seeds were used. Acorns would require some kind of treatment by roasting or leaching to make them less unpalatable, whilst hazelnuts (once shelled) could be consumed without any form of preparation.

Statement of potential and recommendations for further work

The larger charcoal assemblages will provide some information about the types of wood used, though it is doubtful whether a distinction can be made between structural timber and brushwood used for fuel, for example. Certainly some or all of the 16 samples with moderate or large amounts of charcoal could be re-examined to establish for the species present (during this assessment, oak or ?oak was noted from several samples but no attempt was made to identify the charcoal systematically).

Very little more work seems appropriate for the charred hazelnut and acorn remains, though some attempt should be made to put them into their archaeobotanical and archaeological contexts by undertaking a literature search for comparanda. Individual nutshell or cotyledon fragments would also provide ideal material for dating by radiocarbon assay (using AMS), if this was thought appropriate.

3

Retention/disposal

All material should be retained pending a decision about further work.

Archive

Paper and electronic archives relating to the work described in this report are currently lodged in the Environmental Archaeology Unit, University of York.

Acknowledgements

I am grateful to Dr Madeleine Hummler for providing archaeological information about the material discussed here and for comprehensive documentation concerning the samples. My colleague Dr Annie Milles kindly read a draft of this report. The generosity of English Heritage in permitting me to carry out this work is also gratefully acknowledged.

Appendix

The full catalogue of samples examined is shown below, ordered by intervention and feature number.

Remains recorded are presented in Table 1 in order of feature number.

I. Intervention 41 (1986), excavations of Mounds 2 and 5

A. Flots from wet-sieved samples

(i) from the far NW corner of Int. 41, not associated with Mounds 2 or 5

Feature	Context	Sample/Find no.
F68 (gully in F)		
	1145	26753
F70 (PH in F)		
	1149	26751
	1148	26752

(ii) Area of Mound 2

F195 (Ploughmarks in R/S)		
	1574	29952
F216 (IA ?gully through Mound 2)		
	1576	40481
		41008
F218 (hearth, N platform of Mound 2)		
	1951	41630
F220 (hearth, centre of ‘roundhouse’)		
	1640	33590
F222 (PH of Beaker ‘roundhouse’ porch)		
	1582	33596
	1626	33595
F223 (PH/pit S of Beaker pit)		
	1583	37754
F235 (pit, N platform of Mound 2)		
	1602	41007
F238 (PH, N platform of Mound 2)		
	1605	41347
F258 (Slot in O, E of Beaker pit)		
	1627	33594
F226 (PH to E of Beaker pit)		
	1593	33296
	1746	33297
F264 (PH of Beaker ‘roundhouse’)		
	1639	33593
F265 (PH of Beaker ‘roundhouse’)		
	1634	33589
	1750	33591
F267 (PH of Beaker ‘roundhouse’)		
	1748	33592
F270 (cremation? in YO, centre of Beaker ‘roundhouse’)		
	1641	37752
	1767	37751
F289 (PH, W platform of Mound 2)		
	1934	41348
F294 (scoop/pit, W platform of Mound 2)		
	1822	40258
F311 (Pit in N, S of Beaker pit)		
	1682	34420
F313 (Pit in N, Beaker pit)		
	1684	37753
	1788	37749
F330 (Pit in N, Beaker pit)		
	1701	37750
	1783	37646
	1795	37647
F333 (PH in S, S of Beaker pit)		
	1800	37644
F342 (PH/pit in S, next to Beaker pit)		
	1713	37645
F356 (PH of BA fence)		
	1727	41610

F383 (PH in H, BA fence)
1760 34416

F502 (scoop in quarry ditch SW of Mound 2)
1929 41346

F506 (scoop in quarry ditch NE of Mound 2)
1933 41409

F511 (PH of BA fence)
1950 41631

(iii) Area of Mound 5

F117 (ditch system)
1217 43523

F122 (IA gully)
1238 41809
1960 41808

F466 (PH in R, centre of Mound 5)

1882 42625

F532 (scoop in H)
1999 42015

F543 (PH in R, centre of Mound 5, cuts pit F468)
2014 42630

F544 (PH in R, centre of Mound 5, ?cuts Beaker ?pit F468)
2012 42626

F545 (PH in R, centre of Mound 5, cuts pit F468)
2016 42629

F551 (PH, centre of Mound 5, cuts pit F468)
1915 43092

F552 (PH, centre of Mound 5, cuts pit F473)
2030 43094

F561 (gully of ditch system)
2045 43469

F562 (gully of ditch system)
1222 43438

38493

F571 (gully of ditch system)
2048 43524

F583 (gully of ditch system)
2070 43525

<u>(iv) Buried soils in areas of Mounds 2 and 5</u>

Mound 2

(a) oval roundhouse

F158 (Horizon 4)
32167
32168

F206 (Horizon 5)
32221
32222

F213 (Horizon 6)
32303
32304

(b) Western feature complex

F158 (Horizon 4)
32138
32139

F206 (Horizon 5)
32189
32190

F213 (Horizon 6)
32275
32276

Mound 5

F224 (Horizon 2/4)
37985
37986
37987
37988

F412 (Horizon 6)
38491
38492

38494

F391 (Horizon 5)
38821
38822
38823
38824

B. Spot finds from prehistoric features

F137 (Mound 2, Horizon 2)
41153

F223
34421
34422
34423
35063
35064

F226
34379

F391 (Mound 5, Horizon 5)
36165
36181
36184
36188
36211
36219
36239
36242
39453
39461

F460 42889
F468 42634
42865
F473 43106

F521 42623
F571 (ditch system) 43488

II. Intervention 48 (immediately W of Mound 5)

A. Flot samples

F29 (Beaker? pit in central part of area), context 1049
3232
3234
3235
3236
3237
3238
3239
3240
3241
3242
3243
3244
3245
3246

F90 (Beaker? pit) 1 4 1 1
4314
1413 4313

III. Intervention 55 (southernmost area examined 1983-92)

A. Individual finds from Beaker pit complex

F6
1015 630
682

F63
1351
1352
F67
1585
F71
1124 1786

F72
1126 1362
F85
1133 1790

B. Flot samples from Beaker pit complex

F7 1017 2075
1102 2076

F16 1036 2077

F41 1067 2078

	1104	2079
F62	1022	2080
	1112	2081
F63	1105	2082
F67	1110	2083
F70	1119	2084
F71	1123	2085
F72	1125	2086
F78	1120	2087
F82	1121	2088
F83	1142	2089
	1132	2090
F85	1133	2091
F86	1134	2092

Table 1. Results of examination of flot samples and individual finds. Key: Int.—Intervention no.; Ftr.—Feature no.; Con.—Context no.; CA—charcoal abundance; CT—charcoal type (gr=granular, fl=flaky); CS—charcoal max. size; HA—hazelnut abundance; HS—hazelnut max. size; AA—acorn abundance; AS—acorn max. size; R—rootlet abundance.

Int.	Ftr.	Con.	Sample		CA	CT	CS	HA	HS	AA	AS	R	Other items
41	F117	1217	43523	F	1	gr	10	-	-	-	-	2	-
41	F122	1238	41809	F	1	gr/fl	15	-	-	-	-	1	-
41	F122	1960	41808	F	1	fl	5	-	-	-	-	-	-
41	F137	-	41153	S	-	-	-	-	-	1	20	-	-
41	F158	-	32138	F	1	gr/fl	5	-	-	-	-	-	-
41	F158	-	32139	F	1	gr	10	-	-	-	-	-	1 Hordeum sp.
41	F158	-	32167	F	1	gr	10	-	-	-	-	-	-
41	F158	-	32168	F	1	gr	10	-	-	-	-	-	-
41	F195	1574	29952	F	1	gr	5	-	-	-	-	-	-
41	F206	-	32189	F	1	gr	10	-	-	-	-	2	mod. conifer needles; ?sml mammal tooth fgt
41	F206	-	32190	F	1	gr/fl	10	-	-	-	-	2	-
41	F206	-	32221	F	1	gr	10	-	-	-	-	-	-

9

41	F206	-	32222	F	1	gr	10	-	-	-	-	-	-
41	F213	-	32275	F	1	gr	10	-	-	-	-	-	-
41	F213	-	32303	F	1	gr	10	-	-	-	-	-	-
41	F213	-	32304	F	1	gr/fl	10	-	-	-	-	-	-
41	F213	-	32276	F	3	gr/fl	20	-	-	-	-	-	modern birch fr
41	F216	1576	40481	F	1	gr	10	-	-	-	-	1	-
41	F218	1951	41630	F	2	gr/fl	10	1	10	-	-	-	1 Prunus spinosa
41	F220	1640	33590	F	1	gr	5	-	-	-	-	-	-
41	F222	1582	33596	F	1	gr	10	-	-	-	-	-	-
41	F222	1626	33595	F	1	gr	10	-	-	-	-	-	-
41	F223	-	34421	S	-	-	-	1	10	-	-	-	-
41	F223	-	34422	S	-	-	-	1	10	-	-	-	-
41	F223	-	34423	S	-	-	-	1	15	-	-	-	-
41	F223	-	35063	S	-	-	-	1	10	-	-	-	-
41	F223	-	35064	S	-	-	-	1	10	-	-	-	-
41	F223	1583	37754	F	1	gr	5	2	20	-	-	-	-
41	F224	-	37985	F	1	gr	10	-	-	-	-	-	?mod. elder seed fgts; 2 mod. ?clover seeds
41	F224	-	37986	F	1	gr	10	-	-	-	-	-	-
41	F224	-	37987	F	1	gr	10	-	-	-	-	-	-
41	F224	-	37988	F	1	gr	10	-	-	-	-	-	-
41	F226	-	34379	S	-	-	-	1	10	-	-	-	-
41	F226	1593	33296	F	1	gr	10	-	-	-	-	-	-
41	F226	1746	33297	F	1	gr	5	-	-	-	-	-	-
41	F235	1602	41007	F	1	gr	5	1	5	1	15	-	-
41	F238	1605	41347	F	1	gr	10	-	-	-	-	-	-
41	F258	1627	33594	F	1	gr	10	-	-	-	-	-	-
41	F264	1639	33593	F	1	gr	5	-	-	-	-	-	1 Hordeum sp.
41	F265	1634	33589	F	1	gr	5	-	-	-	-	-	-
41	F265	1750	33591	F	1	gr	10	-	-	-	-	-	-
41	F267	1748	33592	F	1	gr	15	-	-	-	-	-	modern insect fragments
Int.	Ftr.	Con.	Sample		CA	CT	CS	HA	HS	AA	AS	R	Other items
41	F270	1641	37752	F	1	fl	5	-	-	-	-	-	-
41	F270	1767	37751	F	-	-	-	-	-	-	-	1	-
41	F289	1934	41348	F	2	gr/fl	15	-	-	-	-	-	-
41	F294	1822	40258	F	2	gr/fl	25	-	-	-	-	-	-
41	F311	1682	34420	F	1	gr	5	-	-	-	-	-	

	?1 charred cereal grain											
41	F313	1684	37753	F	1	gr	5	1	10	-	-	1
	-											
41	F313	1788	37749	F	1	gr	5	1	10	-	-	-
	-											
41	F330	1701	37750	F	1	gr	5	1	10	-	-	-
	-											
41	F330	1783	37646	F	1	gr	5	1	15	-	-	-
	-											
41	F330	1795	37647	F	1	gr	5	1	20	-	-	-
	-											
41	F333	1800	37644	F	1	gr	10	2	15	-	-	-
	-											
41	F342	1713	37645	F	1	gr	5	1	10	-	-	-
	-											
41	F356	1727	41610	F	1	gr	10	1	5	-	-	-
	1 ?Avena; 1 ?Triticum and ?other ch fgts											
41	F383	1760	34416	F	1	gr	5	-	-	-	-	1
	-											
41	F391	-	36165	S	-	-	-	-	-	1	20	-
	-											
41	F391	-	36181	S	-	-	-	-	-	1	15	-
	-											
41	F391	-	36184	S	-	-	-	-	-	1	20	-
	-											
41	F391	-	36188	S	-	-	-	-	-	1	20	-
	-											
41	F391	-	36211	S	-	-	-	-	-	1	20	-
	-											
41	F391	-	36219	S	-	-	-	-	-	1	15	-
	-											
41	F391	-	36239	S	-	-	-	-	-	1	15	-
	-											
41	F391	-	36242	S	-	-	-	-	-	1	10	-
	-											
41	F391	-	38821	F	1	gr	10	-	-	-	-	-
	-											
41	F391	-	38822	F	1	gr	15	-	-	-	-	-
	-											
41	F391	-	38823	F	1	gr	15	-	-	-	-	-
	-											
41	F391	-	38824	F	1	gr	10	-	-	-	-	-
	modern insect fgts											
41	F391	-	39453	S	-	-	-	-	-	1	20	-
	-											
41	F391	-	39461	S	-	-	-	-	-	1	10	-
	-											
41	F412	-	38491	F	1	gr	5	-	-	1	10	-
	-											
41	F412	-	38492	F	1	gr	10	-	-	1	10	-
	-											
41	F412	-	38493	F	1	gr	10	-	-	-	-	3
	-											
41	F412	-	38494	F	1	gr	5	1	5	-	-	-
	-											
41	F460	-	42889	S	-	-	-	-	-	1	15	-
	-											
41	F466	1882	42625	F	-	-	-	-	-	2	25	1
	-											
41	F468	-	42634	S	-	-	-	-	-	1	20	-
	-											
41	F468	-	42865	S	-	-	-	-	-	1	15	-
	-											
41	F473	-	43106	S	-	-	-	-	-	1	20	-
	-											
41	F502	1929	41346	F	2	gr	25	-	-	-	-	-
	modern birch frs and insect fgts											
41	F506	1933	41409	F	3	gr	30	-	-	-	-	-
	-											
41	F511	1950	41631	F	1	fl	10	-	-	-	-	-
	-											
41	F521	-	42623	S	-	-	-	-	-	1	20	-
	-											

41	F532	1999	42015	F	2	gr	25	-	-	-	-	2	-
41	F543	2014	42630	F	-	-	-	-	-	3	25	1	-
41	F544	2012	42626	F	2	gr	25	-	-	2	20	2	-
41	F545	2016	42629	F	2	gr	25	-	-	2	20	2	-
41	F551	1915	43092	F	3	fl	30	-	-	-	-	2	-
41	F552	2030	43094	F	1	gr/fl	15	-	-	1	20	-	-
41	F561	2045	43469	F	1	gr	5	-	-	-	-	-	-
Int.	Ftr.	Con.	Sample		CA	CT	CS	HA	HS	AA	AS	R	Other items
41	F562	1222	43438	F	1	gr	10	-	-	-	-	-	-
41	F571	-	43488	S	-	-	-	-	-	1	20	-	-
41	F571	2048	43524	F	1	gr	10	-	-	-	-	-	modern grass spikelet fgts
41	F583	2070	43525	F	1	gr	5	-	-	-	-	-	-
41	F68	1145	26753	F	1	gr	10	-	-	-	-	-	-
41	F70	1148	26752	F	1	fl	15	-	-	-	-	-	mod earthworm egg caps
41	F70	1149	26751	F	1	fl	15	-	-	-	-	-	-
48	F29	-	3232	F	1	gr	10	-	-	-	-	-	-
48	F29	-	3234	F	1	gr	5	-	-	-	-	2	-
48	F29	-	3235	F	1	gr	5	-	-	-	-	2	-
48	F29	-	3236	F	1	gr	5	-	-	-	-	2	-
48	F29	-	3237	F	1	gr	5	-	-	-	-	-	-
48	F29	-	3238	F	1	gr	5	-	-	-	-	2	-
48	F29	-	3239	F	1	gr	5	-	-	-	-	2	-
48	F29	-	3240	F	1	gr	15	-	-	-	-	2	-
48	F29	-	3241	F	1	gr	5	-	-	-	-	2	-
48	F29	-	3242	F	1	gr	5	-	-	-	-	2	-
48	F29	-	3243	F	1	gr	10	-	-	-	-	-	-
48	F29	-	3244	F	1	gr	10	-	-	-	-	3	-
48	F29	-	3245	F	1	gr	10	-	-	-	-	3	-
48	F29	-	3246	F	1	gr	10	-	-	-	-	3	-
48	F90	1411	4314	F	2	gr	25	-	-	-	-	-	modern moss shoots
48	F90	1413	4313	F	1	gr	5	-	-	-	-	1	modern moss shoots
55	F16	1036	2077	F	1	gr	10	-	-	-	-	2	-
55	F41	1067	2078	F	1	gr	5	1	10	-	-	-	-
55	F41	1104	2079	F	1	gr	10	1	10	-	-	2	-
55	F6	1015	630	S	-	-	-	-	-	1	25	-	-

55	F6	1015	682	S	-	-	-	-	-	1	10	-	-
55	F62	1022	2080	F	1	gr	5	-	-	-	-	3	-
55	F62	1112	2081	F	2	gr	15	-	-	-	-	2	-
55	F63	-	1351	S	-	-	-	1	15	-	-	-	-
55	F63	-	1352	S	-	-	-	1	10	-	-	-	-
55	F63	1105	2082	F	2	gr	10	1	10	-	-	2	-
55	F67	-	1585	S	-	-	-	1	15	-	-	-	-
55	F67	1110	2083	F	2	gr	20	1	15	-	-	2	-
55	F7	1017	2075	F	2	gr	10	-	-	-	-	3	-
55	F7	1102	2076	-	1	gr	10	-	-	-	-	2	-
55	F70	1119	2084	F	1	gr	10	1	10	-	-	3	-
55	F71	1123	2085	F	1	gr	10	1	10	-	-	2	modern moss shoots
55	F71	1124	1786	S	-	-	-	1	10	-	-	-	-
55	F72	1125	2086	F	2	gr	10	-	-	-	-	2	-
55	F72	1126	1362	S	-	-	-	-	-	-	-	-	bark fragment approx. 20 x 10 mm
55	F78	1120	2087	F	2	gr	10	-	-	-	-	3	-
55	F82	1121	2088	F	1	gr	15	-	-	-	-	3	-
55	F83	1132	2090	F	1	gr	10	1	10	-	-	2	-
55	F83	1142	2089	F	1	gr	10	-	-	-	-	3	-

Int.	Ftr.	Con.	Sample		CA	CT	CS	HA	HS	AA	AS	R	Other items
55	F85	1133	1790	S	-	-	-	1	10	-	-	-	-
55	F85	1133	2091	F	1	gr	10	-	-	-	-	3	tree root bark? 2
55	F86	1134	2092	F	1	gr	15	1	10	-	-	3	-

7. **SELECTED STUDIES: Taphonomy**

7.1 The Leverhulme Project. Interim Report Jun 1986 by P Bethell et al

7.2 Interim Report March 1987 [RF Z8.5(4)]

7.3 Interim Report March 1988

7.4 Experimental work: Int 54