APPENDIX 1 – ASSESSMENT OF SOIL MICROMORPHOLOGY

1.1 Soil micromorphology

By Richard Macphail and John Crowther

Introduction

1.1.1 The multi-period site of White Horse Stone, Kent (Oxford Archaeological Unit) was visited and sampled by Dr Macphail and further samples were collected by Dr Martin Bates. Archaeology, samples, assessment strategy and archaeological (environmental/geoarchaeological) potential were discussed between Dr Macphail and the OAU (27-5-2000, 24-8-2000), and with Drs Martin Bates and John Crowther.

1.1.2 This work and the assessment were specifically designed to address a number of the Fieldwork Event Aims (see Section 2.2, aims 1-5).

1.1.3 Four soils of archaeological importance occur at White Horse Stone, namely:

1. The Allerød palaeosol (see Bates),
2. The Neolithic long house soil (posthole and drip gully fills),
3. The later prehistoric palaeosol, and
4. The Iron Age occupation soil (posthole and pit fills).

1.1.4 Soil studies will provide a necessary component to the landscape, environmental and cultural reconstruction of the White Horse Stone site. Precedents have been set at other chalk soil sites at the Channel Tunnel site of Hollywell Coombe, Folkestone, Kent (Preece 1992)(Allerød palaeosol), at Windmill Hill (Whittle *et al.* 1999) (Neolithic occupation on the chalk), and at Maiden Castle (Macphail, 1991)(Iron Age chalk soils and occupation). These and other sites (see below) provide analogues and databases. Archaeological chalk soils have also been undergoing experimental studies by Crowther and Macphail at the Overton Down Experimental Earthwork (Bell *et al.* 1996).

Samples and assessment results

The Allerød palaeosol

1.1.5 Monolith samples were examined at the OAU. The Allerød palaeosol is well preserved and appears to be similar to other soils of this location, type and age studied in the 1960s by Cornwall (e.g. Holborough, Kent; Cornwall reference soil thin-section collection; Macphail and Scaife 1987, Figure 2.4)(Kerney 1963), and more recently by Kemp on the Isle of Wight (e.g. soil micromorphology and earthworm granule studies; Preece *et al*. 1995). On the other hand, few Allerød palaeosols have been studied in sufficient soil micromorphological and chemical detail in order to reflect the full natural impact of the Allerød interstadial and the possible influence of Late Upper Palaeolithic humans upon it. An exception is the Allerød palaeosol formed on a limestone breccia, and associated with Late Palaeolithic occupation at King Arthur's Cave, Wye Valley, which was studied in detail through soil micromorphology and chemistry (Macphail, Crowther and Cruise 1998, unpublished report to Dr N Barton, Oxford Brookes University). This soil and three others contain burned bone and charcoal, inferring human activity.

The Neolithic longhouse soil (posthole and drip gully fill)

1.1.6 Soils were examined in monoliths, sub-sampled and assessed through soil micromorphology and by determinations of: loss-on-ignition (LOI) at 375˚C for 16 hours, which provides a measure of the organic matter content (Ball 1964); phosphate-P (total phosphate), separated into its inorganic (phosphate-P_i) and organic (phosphate-P_o) components, using the method described by Dick and Tabatabai (1977), but excluding the oxidation stage for phosphate-P_i; low frequency mass-specific magnetic susceptibility (χ), maximum potential susceptibility (χ_{max}) and percentage fractional conversion (χ_{conv}), following the procedures developed by Crowther and Barker, 1995); pH (1:2.5, water); and an estimate of carbonate content (Hodgson 1974). In the first instance, four thin-sections (M625a, M529a, M473a and M618) and four chemical samples (x625a, x529a, x473a and x618)(Table 15.2) were assessed, the first three being post hole fills and the fourth a drip gully fill.

1.1.7 Scanning of the thin-sections revealed that the drip gully fill (context 5156) is largely attributable to subsoil silting, with only limited background evidence of human activity, and this is reflected in the relatively low LOI (2.19%), phosphate-P concentration (0.642 mg g^{-1}) and magnetic susceptibility (χ, 37.5 x 10^{-8} SI kg^{-1}) and χ_{conv} (22.1%) (Table 15.4). By comparison, the results from the different posthole fills (Tables 15.3-4) show stronger signs of human activity. Soil micromorphological findings from the posthole fills can be summarised into:

a) Natural characteristics – dominant chalk gravel, the presence of earthworm worked soils and earthworm granules;
b) mixing – presence of topsoil and subsoil from mature rendzinas and calcareous brown earths (Andover 1 soil association)(Avery 1990; Jarvis *et al.*, 1984), including highly humic decalcified A1h horizon material, mixed with
c) anthropogenic soils - rich to very rich in fine to medium size charcoal and rare burned silt, with
d) anthropogenic components – wood charcoal, many charred mollusc fragments and rare burned bone.

1.1.8 Interestingly, the three posthole fills suggest different levels of human activity on the ground surface in the immediate vicinity of the postholes. Context 529, for example, contains the strongest anthropogenic signature, with charcoal-rich soils, burned soil, much burned mollusc shell and inclusions of burned bone (Table 15.3); and relatively high LOI (4.28%), χ (80.1 x 10^{-8} SI kg^{-1}) and χ_{conv} (29.2%) figures, and very high phosphate-P concentration (4.34 mg g^{-1}) (Table 15.4). The latter, which is mostly inorganic (84.1%), could be largely attributable to the presence of bone fragments, although more systematic soil micromorphological analysis will be required to fully interpret this fill. Sample 473a also shows strong signs of magnetic susceptibility enhancement, as might be associated with burning, and some degree of phosphate enrichment. Sample 625a, on the other hand, displays less evidence of human activity.

1.1.9 Such natural chalk soils and soils affected by human activity, can be compared with unburied and buried experimental rendzinas of long term pastures of the Overton Down Experimental Earthwork (Crowther *et al.* 1996), buried Neolithic chalk soils at Easton Down and Windmill Hill (Macphail 1993; Whittle *et al.* 1999). The suite of natural rendzina/calcareous brown earth soils identified at White Horse Stone are consistent with types found at the above-cited sites. Of particular interest are the occupation soils at Windmill Hill, which are similar to those at White Horse Stone, contain charred organic matter and burned mollusc shell; but at White Horse Stone these soils have a very strong association with a longhouse structure. More work will be needed to deduce whether soils present in 529 relate to occupation floors, possibly associated with a hearth (*cf*. Pimperne House(s), Butser Ancient Farm) (Macphail and Cruise in press). The soil micromorphology and bulk analyses independently demonstrate that posthole fills differ in character, possibly reflecting the organisation and use of the long house, as recorded elsewhere in later prehistoric long houses by macrofossil studies of posthole fills (tripartite organisation; e.g., Viklund 1998). Bulk analysis, employing the different methods of organic matter measurements, phosphate analysis and magnetic susceptibility assays of further posthole fills, may well be able to advance our comprehension of the Neolithic long house. This would greatly contribute to any programme of spatial studies involving charred remains recovery. Soil micromorphology, as shown above, will aid any spatial reconstruction of the site through identifying sources of organic matter, burned materials, and phosphate (bone, organic matter/animal dung)(Macphail and Goldberg 1995).

The later prehistoric palaeosol

1.1.10 Examples of the prehistoric palaeosol were examined in the field and at the OAU. These composed excellent examples of probably colluvially over-thickened rendzinas (colluvial rendzinas; Avery 1990). It is very important to understand how such a mature soil cover formed, and under what conditions, because this soil likely developed after Neolithic/Bronze Age occupation, and was likely extant during the Iron Age (as assessed below). At Maiden Castle, Hampshire, a major humic soil horizon, just like the one at White Horse Stone, formed between significant Neolithic and Iron Age episodes, and essentially “downland” soils formed during this period, probably through grazing (Macphail 1991). It will be very useful therefore to carefully study the soil micromorphology, chemistry and magnetic susceptibility characteristics of the prehistoric palaeosol at White Horse Stone, building upon the Neolithic soil database. The work will also complement the land snail analysis of the soil. It will also be useful to choose one profile for detailed analysis and compare it with two others from the slope, in order to examine variations down the soil catena and possible variations in landuse likely to be contemporary with the Iron Age settlement.

The Iron Age occupation soil (posthole and pit fills)

1.1.11 Soil samples taken from Iron Age settlement deposits were carefully selected on site to answer specific questions posed by OAU in accordance with the Field Work Event Aims (see Section 2.2) and excavation findings, concerning the function of features, site formation processes and cultural activity. In order to complement macrofossil analysis of these features, it is suggested that five thin section samples (M142, M143a, M143b, M144 and M145) and seven bulk samples be analysed. Turf remains, ashed dung and cereal processing waste, any industrial debris, as found at Early Iron Age Maiden Castle and LBA/EIA Potterne, may well be recognised (Macphail 1991; Macphail 2000).

Updated research aims

1.1.12 Themes concerning the late Glacial/Holocene environment and settlement, landscape and society have the potential to be addressed.

Late Glacial/Holocene environment

- What is the character of the late glacial and early Holocene environment?

Settlement, landscape and society

- What is the character and extent of Neolithic activity within the longhouse? To what extent is it domestic in character?

- What is the character and extent of Iron Age occupation within the settlement? What activities are represented?
- What evidence is there for fields and what was their function?

Recommended further work

1.1.13 In connection with land snail studies, it is suggested that soil micromorphology and chemistry, grain size and mineral magnetic studies on bulk samples, should be carried out on two examples of the Allerød palaeosol.

1.1.14 It is suggested that a substantial amount of work could be carried out on the long house soils, as follows:

1.1.15 a) full soil micromorphological analysis of the posthole and gully fills, and to include a lower sample from post hole 529 (M529b), in order to fully characterise the different components contributing to the bulk analytical findings and to allow inferences concerning site formation processes of Neolithic long house floor deposits,

1.1.16 b) full bulk analysis of posthole fills examined in thin section, in order to understand changes with depth (another 4 samples),

1.1.17 c) bulk analysis of some 30 posthole fills selected from around 100 samples taken, in order to aid a spatial reconstruction of the long house and its organisation.

1.1.18 It is suggested that three profiles from the later prehistoric palaeosol are investigated, one in detail and two as comparisons from different slope-unit positions, including an example from near the settlement if possible.

1.1.19 Soil micromorphology will comprise standard description and counting (and digital recording of microfabrics and components; microprobe analysis where necessary, etc.), while bulk analyses will include LOI, phosphate analysis, magnetic susceptibility, pH, carbonate (as in the initial assessment) and organic carbon, with grain size and nitrogen analysis on selected samples (Bullock *et al*. 1985; Courty *et al*. 1989; Crowther and Barker 1995; Crowther *et al*. 1996). This will allow full characterisation of these ancient soils and the identification of past environmental and cultural conditions.

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