Reports from the Environmental Archaeology Unit, York **95/18**, 12 pp.

Assessment of thin sections of soils and sediments from excavations at Thornbrough Farm, Catterick, North Yorkshire, sites CAS 452 (1990) and CAS 482 (1993)

by

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Summary

Micromorphological analysis was carried out on thin sections of undisturbed soil samples from two CAS excavations (including trenches across an Antonine fort, rampart and ditch), at Thornbrough Farm, Catterick, North Yorkshire. The soil samples had been collected and prepared by Dr M. McHugh, who carried out an assessment on the whole soils and sediments.

Thin section observation showed that the main issues of the origin and deposition of pre-fort and fort material, the local landscape at the time of deposition, the landuse, causes and time of waterlogging, and timescales of events, cannot satisfactorily be addressed through micromorphological analysis.

This is the case, in particular, because a very high variability was observed both in the thin sections and in the field and the information provided by micromorphology was only of local significance, restricted to the area of thin sections. Comparison of thin sections with the field data shows that micromorphology has no potential for extrapolation of results to the level of context or phase, or for providing significant additional information.

Keywords: Catterick; North Yorkshire; Roman; soil; sediment; micromorphology.

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10 March 1995

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Introduction

During 1990 and 1993, excavations were carried out at Thornbrough Farm, Catterick (SE 22375 99170) by the English Heritage Central Archaeological Service (CAS).

The site lies in the area of the Roman town *Cataractonium*. Wilson *et al.* (1993) indicate that the town was the successor to one or more Roman forts: the first fort was built after AD 80 and abandoned approximately in AD 120 and a second fort was built and continued in use until after AD 200.

The first excavation (site CAS 452) included two trenches across an Antonine fort and ditch, and the second (site CAS 482) included what was thought to be the *in situ* rampart of the fort. Full information is provided in Wilson (1990) and in Wilson *et al.* (1993)

A soil/sediment assessment was carried out by Dr Maureen McHugh (McHugh, 1993). The work includes a description of the sites and a field and sample assessment.
The present work describes the potential and significance of complementing such soil assessment with micromorphological analysis of thin sections from the same samples collected by Dr McHugh.

In the present work, assessments for the two sites are described separately, with the exception of the description of analytical methods for micromorphological analysis and comments concerning retention/disposal and the archive.

Analytical methods for micro-morphological analysis

Thin sections were analyzed with an optical microscope at various magnifications and described mainly using the terminology of Bullock *et al.* (1985), but some additional terms were also employed. The quantitative descriptions used are approximate and based on comparative figures from the same authors and from Hodgson (1976). Sorting is tentatively described using comparative figures of Pettijohn *et al.* (1973).

Site CAS 452 (Catterick 1990)

Site description, thin section location and selection for analysis.

During the 1990 excavation, two trenches were cut across an Antonine fort rampart and ditch running approximately N-S. The trenches included pre-Antonine to medieval archaeology.

The sampling strategy and the succession of phases are summarized in Table 1. Samples for thin section analysis were collected mainly from the lower layers below the Antonine paleo-groundsurface, in the western segment of the northernmost section of the excavation (excavation drawing No. 3005).

The samples belong to four of the fifteen phases identified and described during the excavation.

One representative section for each pre-fort occupation phase (Sections 6784, Context 269, for Phase 1a and 6779, Context 505 for Phase 0) and Section 6795 from the post-occupation Phase 15, were analyzed with a broad description including a wider range of variables and, on the basis of fewer selected characteristics, compared to the other thin sections available within the same phases.

Results

Phase 15

Thin section 6795, Context 273

Dark greyish-brown dotted fine material, undifferentiated b-fabric, very abundant (> 50% section area) coarse material from silt to pebbles, with angular and rounded unsorted grains, mainly quartz, but also feldspars and rock fragments

Phases		Thin Section No.	Context No.
15. Post-Roman to 19th C.		6795	273
7. Re-occupation after abandonment. 3rd C.		6791	272
1. Pre-fort and fort construction. AD 160-180	**1b**	6793	268
	1a	6784	269
		6785	507,506 (small fraction)
0. Basal material		6785 (lower part) 6779 6780 (upper part)	505
		6780 (lower part) 6781 (upper part)	508
		6781 (lower part) 6782 6783 (upper part)	509
		6783 (lower part)	514

Table 1. Thin section sampling strategy for site 452. The total number of thin sections is 10, including sections containing material from more than one context.

including quartzite, limestone and chert, in enaulic related distribution with the fine fraction. Biopores and textural pedofeatures are absent and the structure is apparently massive (no peds smaller than the thin section size). Occasional droppings, rare charcoal, charred plant remains, ceramic fragments, nodules of Fe and other opaque constituents.

An artefact of unidentifiable origin is represented by several small (< 1 mm) black, opaque, undifferentiated, discrete liquid-like features, containing voids resembling air bubbles, embedding fragments of the coarse fraction.

Phase 1

Thin section 6784, Context 269

Grey-yellow fine material dotted by microcontrasted particles including rare charcoal flakes, reddish/black Fe oxides and unidentified opaque particles; grey to yellow or masked interference colours.

Speckled b-fabric; abundant (> 40% section area) coarse grains, from silt to very coarse sand, angular and subordinately rounded, mainly quartz and alkali feldspars, in gefuric related distribution with the fine fraction.

Massive structure or aggregates larger than the thin section size. Rare < 200 :m to 3 mm diameter cavities, and rare elongated non-accommodated voids, up to approximately 300 :m thick. Some of the smallest cavities and elongated voids are lined by very thin clay coatings and rare hypocoatings, from limpid colourless to iron or opaque clay, and very thin (few :m) Fe coatings.
A large part of the section is occupied by a dark to black impregnation feature in an approximately 1 cm thick horizontal band, with sharp boundary with the surrounding fine fabric.

Comparison with Section 6785 (Contexts 506, 507)

Other materials representing this phase are included in the upper part of Section 6785, which describes Context 506. The material is similar to that of Section 6784, including the dark

impregnation feature, but with additional Fe impregnation. Context 507 below is only represented by a small fraction of the Section 6785. The material is very different from that of the other two contexts, and is characterized by abundant charred plant remains, charcoal fragments and intense impregnation by black/very dark material.

Phase 0

Thin section 6779, Context 505

Grey fine material, with differentiated but not speckled b-fabric. Partly or totally accommodated planes, 500-750 :m thick, defining a weak subangular medium blocky structure. Few (< 5%) elongated and equant non-accommodated voids, occasionally lined by fine (< 10 :m), and rarely larger, typic clay coatings, including limpid clay coatings and Fe coatings. Fabric reorganization, streaks, or hypo- and quasi- coatings are only occasionally around grain surfaces but absent around biological pores. Unsorted coarse grains, approximately 20% area, mainly quartz and feldspars, and subordinately fragments of quartz arenite, chert and siltstone, all mainly angular and subordinately rounded, in an open to closed porphyric, and subordinately enaulic related distribution with the fine fraction.

Vivianite occurs in microcrystalline masses, rounded aggregates and granular forms, often associated with goethite, and often on void walls, or in braces coating mineral grains, or within the fabric.

The upper part of the section is clouded by artefacts resulted from thin section manufacturing (carborundum grains). Mottles are few, faint and diffuse.

Fe and other opaque mineral nodules, unidentified microcontrasted particles, large (up to 2 mm) charcoal flakes, arthropod droppings, foraminifera and mollusc shells are present. Although most coarse particles, voids and nodules are in random distribution and orientation, some elongated voids and some mottles, have a parallel related distribution, and a referred distribution sub-parallel to the present-day ground surface (though the spatial pattern of the mottling is partly clouded by carborundum). Organic matter is very scarce (but more abundant in the smaller part of this context represented in thin section 6780, sampled below thin section 6779).

Comparison with thin sections from other contexts within Phase 0

In sections sampled within Phase 0 below Section 6779, Context 505 appears in continuity with Context 508 below, but the latter is more uniform and with a smaller coarse fraction. Thin Sections 6780/81 representing Context 508 are also very similar to Sections 6781/2/3 representing Context 509. In Section 6783, the material of Context 509 appears in continuity with that of Context 514 below. Mottles are absent or very rare in most sections of Phase 0, although in the lower part of the section representing the lowermost Context 514, they are more frequent. Fabrics show a variable, probably irregular, degree of organisation with depth. Root channels, biopores, and other soil features vary vertically, but irregularly, between all the sections of this phase. The nature and size of coarse fragments also varies between contexts. Subangular blocky peds are present but their size and degree of development also varies.

Discussion

Phase 15

In Section 6795, absence of *in situ* plant remains, root channels, fabric differentiation, weathering features or pedofeatures could be attributed to absence of any vegetation, cultivation or soil development, and the entire context considered as a recent, undeveloped material.

However, the significance and size of this thin section (the only one available for Context 273 and Phase 15) is very limited if compared with the variability of the whole system, as is shown by the fact that vegetation, ped development and traces of plant and animal activity were observed in the field by Dr McHugh (McHugh 1993), who described this material as a post-Roman soil, with a degree of structural development likely to reflect plant and animal activity of some considerable

duration or intensity, and prolonged accumulation/soil development, probably occurring around building remains.

Thus, spatial variation and the size of features such as horizon differentiation, peds, voids, vegetation, and their spatial changes, were probably much larger than the dimension of thin section ([1]) and, therefore, could be only be detected in the field.

([1]) 4 x 5.5 cm sample contained in a 7.5 x 5 cm section. Sample dimensions were aproximately the same for all sections analyzed.

Phase 1

Thin section 6784

In Section 6784, the fact that pedofeatures, root channels, and other biopores and biological features, are accompanied by a very low degree of fabric differentiation and weathering, scarce stress features and a very low degree of pedogenic features, might suggest a short duration of the period of land exposure and stability of the materials during which soil forming processes could occur in presence of vegetation and fauna.
However, since fabric variations and change in pore size and pedofeature distribution can occur even within small distances, the above interpretation can only be confirmed if the material of Context 269 and Phase 1 was uniform. But a very high variability has been reported by McHugh (1993) for this phase, and therefore Section 6784, the only one suitable for interpreting Phase 1 ([1]), is not representative.

For the same reasons, absence of mottling in this section cannot be interpreted in relation to waterlogging ([2]).

A timescale for the weathering event cannot be established because there is no information to establish whether the event occurred simultaneously with the material's deposition or soon after it, and whether it had continued until a later time or even to the present.

If soil development occurred in Context 269, Section 6784 is not sufficient to establish whether or not the pedogenic event was separated from the pedogenic events of Phase 0 below it by a gap or truncation of Phase 0 (see results section for Phase 0).

Presence of charcoal, apparent absence of sorting and layering of the coarse fraction are not correlatable with other information and are not sufficient to establish the depositional processes of this context.

([1]) Section 6793 includes a fragment of aggregate and is unlikely to be representative. Section 6785 includes only small fractions of samples from three differnt contexts (506,507,505).

([2]) Section 6784, for example, could even be smaller than the distance between mottles in the field.

Comparison with other contexts within Phase 1 {Section 6785 (Contexts 506, 507)}

Although Section 6785 contains fragments of Contexts 506 and 507 from Phase 1a, a minute area of Context 505 from Phase 0, and segments of the boundary between such three contexts, the very small size of such specimens limits the significance of analysis to the scale of the sections.
Since McHugh (1993) also mentions the obscure origin of Context 506, there is no other evidence for clarifying the origin of this context and of Context 507 within Phase 1.

Phase 0

Thin section 6779

The features described for Section 6779 (Context 505), suggest the occurrence of some soil forming processes, chemical and physical weathering in open air and oxidizing conditions. Charcoal and other charred plant material may have been

transported from above and there is not, within this section, any other indication of human influence. Parallel related orientation of elongated voids, often attributed to compaction, are more in agreement with the presence of a (topsoil?) granular structure, as also mentioned by McHugh (1993).

Although within Section 6779 there is no gley pattern indicating permanent waterlogging during soil formation, and the evidence for pseudo-gley and seasonal waterlogging is faint, the presence of vivianite/goethite associations, frequently on voids walls, or coating grains or within the fabric, confirms that (at an unknown time after deposition) some of this material has undergone significant changes in redox potential, pH and water saturation.

Other thin sections within Phase 0

From the observation of the parts of the context boundaries included in the sections analyzed it appears that all contexts underlying Context 505 are in continuity with each other. Groundmass and biological features, however, suggest different degrees of weathering and vegetation development (pedogenesis?) in each specimen of the thin sections within Phase 0.

Thus, either the materials of this phase have undergone a number of discrete pedogenic cycles or, rather, a single pedogenic cycle may have occurred, with a later truncation of the top soil and overimposition, in clear unconformity, of Phase 1a.

McHugh (1993), describes the contexts of this phase as:

Context 505: topsoil of surface-water gley or stagnogley from glacial drift;

Context 508: gleyed iron depleted eluvial horizon underlying the *in situ* top soil;

Context 509: undisturbed gley sub-soil of the *in situ* profile (Bg horizon);

Context 514: BC horizon of the *in situ* profile.

Thus, McHugh (1993) identified an **A-Eg-Bg-BC** *in situ* pre-Antonine soil profile developed in a single cycle, on the glacial drift, with seasonal waterlogging in the Bg horizon. The above interpretation, based on the spatial and causal relationships between horizons, could only be made through observations at the field scale.

Statement of potential

For Phase 15, micromorphology did not show significant potential for further analysis because it did not make it possible to establish the relation of individual features with the entire context enclosing them and with the contexts above and adjacent, and whether artefacts were *in situ,* whether disturbance was caused by human activity, or the timescale for the features observed.

The very high variability of Phase 1, compared with the size of Section 6784 and the very small size of the three specimens included in the section, do not make it possible to extend local evidence of soil weathering (particularly with regard to pore and pedofeature distribution, and to evidence for waterlogging) to the entire context or phase.

Thus, although some information can be obtained with micromorphological analysis, questions such as the origin, deposition and timescale of the fort material cannot satisfactorily be answered.

For Phase 0, further micromorphological analysis has not the potential to add any information to the interpretation of McHugh (1993) based on spatial and causal relationships observed at the field scale.

In summary, the main issue of site function and landuse prior to the construction of the fort, and therefore the origin, nature and history of development of the material underlying the Antonine

ground surface, cannot fully be addressed and answered by further micro-morphological analysis.

It is also unlikely that further analysis will allow interpretation of the black opaque impregnation feature present in contexts from most phases. However, since the feature seems to bear no relationship to the field stratigraphy and to the thin section groundmasses and pedofeatures, it is likely only to be recent.

Recommendations

No further micromorphological analysis is recommended.

As suggested by McHugh (1993), other characteristics such as charcoal, bone, pot and other anthropogenic debris are probably more likely to help clarify the site function, and radiocarbon dating of *in situ* charcoal, as established through the stratigraphy, could help to clarify the timescale of events.

Site CAS 482 (Catterick 1993)

Site description, sample location and selection for analysis

The sampling strategy in relation to phases and contexts is shown in Table 2. During the excavation, parts of the ramparts of the Antonine fort (Context 85) were revealed above a level of cobbles which marked the top of a soil-like material (Context 101); a ditch associated with the rampart (cut 87) was filled by Context 68; fill 68 was sealed by Context 52 (late 2nd century).

Micromorphological analysis was carried out on one thin section per phase represented: Sections 3 (Phase 2), 8 (Phase 1) and 2 (Phase 3).

Phase	Depth (cm)	Thin section	Context
3	10-18	1	52
3	20-28	2	68 (marginal part of ditch fill)
2	33-41	3	85 (rampart)
3	46-54	6	68 (central part of ditch fill)
1		8	101

Table 2. Thin section sampling strategy for site 482 (Catterick 1993). Phases sampled for thin sections included Phase 3 (fort abandonment after late 2nd century), Phase 2 (fort construction and occupation; 160-200 AD) and Phase 1 (pre fort - pre 160-180 AD).

Results

Thin section 8, Context 101, Phase 1

The material of Section 8 is very similar to that of Context 505 of the 1990 excavation, particularly in relation to the coarse fraction, the void pattern and the presence of vivianite. In Section 8, however, pedological characteristics are less well developed, the fine material is grey-brown dotted, and the b-fabric less differentiated — undifferentiated to slightly differentiated but not appreciably speckled. Vivianite, in coatings and nodules, is often associated with goethite and often lines root channels. These are normally 1 mm but may be up to 3 mm thick. No clear structure is visible, though peds could have been larger than the thin section size. The coarse fraction is poorly sorted, including silt to very coarse sand, with dominantly angular, and subordinately rounded coarse grains including quartz and occasional feldspars, quartzite and siltstone fragments. Rare charcoal flakes, haematite nodules, microcontrasted particles including opaque minerals and probably organic matter, and droppings up to > 2 mm diameter.

Thin section 3, Context 85 (rampart), Phase 2

Dark brown to brown fine material, dotted by microcontrasted particles including very fine charcoal flakes and organic matter; masked birefringence, undifferentiated b-fabric. Abundant (~ 30% area) angular and subordinately rounded coarse fraction including quartz, orthoquartzite, chert, pebbles of sandstone in random basic distribution and orientation, and enaulic related distribution with the fine fraction. Rare vivianite crystals. Occasional < 0.5 mm Fe nodules and other opaque nodules, charcoal flakes up to 1.5 mm thick. Weakly developed blocky structure. Large vughs, up to 2x6 mm diameter, interconnecting root channels up to 1.5 mm thick. Droppings up to 4 mm diameter. Rare (< 1% area) black liquid-like mass and drops, similar to those observed from site CAS 452.

Thin section No 2, Context 68, Phase 3

Light brown or yellowish brown fine material, less dotted than in the rampart sample, though still including microcontrasted particles of charcoal and other unidentified opaque material. Masked undifferentiated b-fabric.

The coarse fraction is abundant (>20 %) and, though still including quartz and orthoquartzite as the rampart Section 3, is less unsorted and less heterogeneous than in Section 3. All coarse fragments are in an enaulic related distribution with the fine material.

Massive structure, with subordinate very weak fine structure of unclear shape. Frequent interconnected vughs (up to 4 mm diameter) and channels (up to 1.5 mm diameter). In the upper part of the section, the related and referred orientation patterns of voids is parallel to the ground surface. Rare $CaCO_3$ precipitations and coatings, occasional thin Fe textural pedofeatures and thick typic clay coatings; vivianite/goethite hypo-coatings and nodules. Occasional mottles.

Occasional opaque nodules and rare larger charcoal flakes, average 1-1.5 mm are also present. Rare liquid-like black material, with circular voids, embedding the soil material as in Section 3 and material from site CAS 452.

Comparison of thin sections 2 and 6

Sections 2 and 6 are composed by the same material, but in Section 6 roots, voids and vughs are smaller and rarer, the structure is less developed and the fine fabric is less strongly differentiated and darker.

Discussion

Phase 1

The features of Section 8 suggest the two main hypotheses outlined below, but their significance is dependent on field relationships and on the representativeness of Section 8 for the whole of Context 101.

The first hypothesis is that a soil sub-surface horizon, suggested by the evidence for scarce humified organic matter in a predominantly mineral matrix, was first exposed to short, or low-intensity, surface weathering in the presence of little vegetation, and later truncated (hence the absence of A horizon or organic horizons) and buried.

Since in Section 8 there is no trace of *in situ* disturbance, physical modifications or burning, charcoal flakes could indicate the influence of overlying layers ([1]).

Another hypothesis could be that the material of Context 101 was formed from the same, or similar, material as Context 505 from site CAS 452, but soil forming processes or weathering were less intense or shorter in Context 101 (Section 8). This would be suggested by the similarity of Section 8 to the sections from Context 505 in site CAS 452, and (in Section 8) by the scarcity of biopores or evidence for vegetation and biological activity and lower degree of weathering.

The evidence available, however, is not sufficient for testing the two hypotheses, particularly because, as explained by McHugh (1993), at the time of sampling the profile including and below Context 101 could not be seen.

Thus, it was not possible to observe what was above and below the thin section sample, whether horizons such an A or B were present, what the nature was of the boundaries of the material, and what the vertical and lateral extent of the context/features was — particularly towards the east (site 452).

Thus, the representativeness of Section 8 for Context 101 is unclear and there is insufficient information for confirmation of the two above hypotheses, which are strictly dependent on field relationships.

([1]) In agreement with the stratigraphy, the burying agent could be correlatable to materials derived from the construction of the Antonine fort.

Rampart, Phase 2

Vegetation and animal activity are well represented within Section 3. However, the fact that channels, biopores, cracks and aggregates are *not* accompanied by fabric differentiation, weathering features or any pedofeatures related to voids, grains, or excrements, may either represent a local feature or a characteristic of the whole context ([1]).

Similarly, the unrelated and unreferred orientation and distribution of cracks and fissures in relation to biological and other features, cannot be attributed to physical disturbance which occurred after biological features had stopped developing, because the same pattern could, again, represent a local feature.

The characteristics of thin Section 3 are neither sufficient to indicate whether the context represents a part of an original organic or A soil horizon, or whether the material was, rather, a dumped sediment with very recent soil and vegetation development. Likewise, features cannot be interpreted in terms of the pre-rampart or *in situ* environment and local landuse.

Although the material of this thin section is apparently poorly sorted and grains are mainly angular, there is no indicator of the depositional mechanisms and it is not possible to establish the source of the material on the basis of micromorphology.

([2]) In the latter case, biological activity is likely to be only recent.

Thin section 2, Context 68

The better evidence for weathering and biological activity in the material of this thin section, in comparison with that from the rampart, may either represent a local variation or indicate a stronger (longer or more intense) soil formation and development of the fill in comparison with the rampart.

In fact, McHugh (1993) describes the material of Context 68 as extremely variable in composition, colour, structure, texture and, on the basis of observations on the looseness of the fill material, its incoherence and structure weakness, concludes that the degree of soil development of the fill was, rather, much lower than in the underlying *in situ* rampart remains.

Since the material was so variable, the field interpretation is clearly more reliable than that from the observation of Section 2, and encompasses information on spatial relationships and variability.

The referred and related orientation of voids parallel to the ground surface in the upper part of the section could be the result of local structure variations or, since some disturbance was also observed in the field, indicate a degree of compaction.

Mottles are here related to periodic waterlogging; this is also in agreement with the presence of vivianite/goethite hypocoatings and nodules. It is not known, however, when this occurred.

Comparison of thin sections 2 and 6

Comparison of Sections 2 and 6 (i.e. between samples from marginal and central part of the ditch fill, respectively) shows that the thin sections are composed of similar material, but in Section 6 the evidence for weathering or soil development is lower.

This could be explained with a range of hypotheses, from describing the material of Section 6 (central) as deposited more recently (possibly with gradual aggradation on the ditch slope) to the hypothesis that local changes in the degree of weathering have occurred on a ditch filled at once. It is unlikely that further thin section analysis can help to establish the process.

Statement of potential

For the basal materials below the cobbles, in Phase 1, micromorphology can only provide a basis for a number of hypotheses on the nature and development of the materials but further analysis has not the potential to confirm such hypotheses or to provide reliable interpretations or other significant information.

Since for the rampart thin section characteristics cannot unequivocally be attributed to soil evolution, development of vegetation and subsequent disturbance, but could rather be attributed to local variations at the scale of the specimen, the potential of further micromorphological analysis for interpreting the history of the material is very restricted.

Similarly, further analysis of the rampart section would not have significant potential for the interpretation of the pre-rampart environment and landuse, and micromorphology alone cannot provide information on the depositional mechanisms.

Since McHugh (1993) had indicated an extremely variable composition, colour, structure and texture for the rampart ditch fill, here the thin section representativeness is, again, restricted because biological and weathering patterns are more likely to represent local features than being reliable indicators of the origin and evolution of the fill or of the dynamics of ditch filling.

It is also unlikely that micromorphological analysis can help to establish the kind and time of waterlogging.

In conclusion, the high phase/context variability is not accompanied by information on the causes of the variability pattern and on whether the latter is random and results from natural causes. This, together with the low representativeness of the sections and the lack of other information parallel to micromorphology, all reduce the potential of further analysis to the production of currently untestable hypotheses only.

It also seems unlikely that further analysis would allow interpretation of the black opaque liquid-like feature present in many sections. Since the feature is in samples from both sites, and its orientation and distribution patterns are unreferred and unrelated to all other micromorphological features and to the field stratigraphy, it is likely, again, to be only a recent feature.

Recommendations

No further micromorphological analysis or related work is recommended.

Sites CAS 452 and CAS 482

Retention/disposal

Thin sections from sites CAS 452 and CAS 482 will be retained at the EAU, York.

Archive

All papers and electronic records are retained at EAU, York.

Acknowledgments

Thanks to Maureen McHugh for travelling and discussing the sites with me, and for providing data and thin sections; to Clare de Rouffignac for providing useful material for both sites; Allan Hall for his constructive comments and plant recognition for the thin sections; Annie Milles and Brian Irving for recognition of Foraminifera and a mollusc shell.

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