East Kent Access Road, Thanet, Kent: Soil Micromorphology and Chemistry

By

Dr Richard I Macphail

Institute of Archaeology, UCL, 31-34, Gordon Sq., London, WC1H 0PY, UK

Dr J. Crowther

Archaeological Services (UWLAS), University of Wales: Trinity Saint David, Lampeter, Ceredigion, UK SA48 7ED

(For *Oxford Archaeology South*, May 2012)

Summary

A small soil micromorphology, LOI and P study of 6 thin sections and bulk samples from 4 sites within the East Kent Access Project, was carried out. EDS microchemistry was also employed on one thin section. *Monolith 5108*: it can be tentatively suggested that the Neolithic Enclosure ditch records rapid layered sandy and clayey sand infilling in probably open conditions, with the studied thin section being representative of the monolith sample as a whole; rare charcoal probably relict of clearance, was noted. *Monolith 6157*: a two thin section and bulk soil study of Early Bronze Age barrow-buried soil on chalk seems to suggest a history of, 1) a first occupation perhaps associated with flint working (possibly fine flint debris and other fine anthropogenic inclusions), 2) later use of the area for pasture, which led earthworms to form a stone-free soil, 3) a second, immediately pre-barrow occupation related to use of the site and barrow(s) construction, and 4) post-burial formation of iron manganese nodules and earthworm burrowing through chalky soil associated with the barrow mound. *Monolith 6919*: a likely 'turf' stabilisation horizon was found in a Bronze Age barrow ditch fill on chalk, and this was corroborated by LOI data; background anthropogenic inclusions also occur. *Monolith 5325*: the two thin section (and EDS) and 3 bulk sample study of Roman dark earth on Thanet Beds found a plausible history of: 1) manured cultivation using probable midden waste associated with a Roman settlement, 2) abandonment/fallowing and biological homogenisation (grassland?), and 3) unknown subsequent (burial?) conditions which produced small amounts iron-manganese staining and inwash of dusty clay. The report is supported by 4 tables, 26 figures and a CD-Rom archive database.

Introduction

Six 0.50 m long monoliths from East Kent Access Road, Thanet, Kent (Phase 2) were received from Carl Champness (Oxford Archaeology South) for evaluation and soil study. These were Oxford Archaeology-selected monoliths from a Neolithic Henge enclosure ditch on Thanet Sands (5108), Bronze Age barrow ditch fills (6919) and Bronze Age buried soil (6157) on chalk, and a rural Roman dark earth formed in Thanet Sands (5325)(O-W Archaeology, 2012; Champness, pers. comm.). A soil micromorphology and chemistry study was undertaken (Goldberg and Macphail, 2006).

Methods

Evaluation and subsampling Given the priorities of the study (Champness, pers. comm.), the following sampling strategy was adopted (Table 1):

2 thin sections and 2 bulk samples from 6157,

2 thin sections and 3 bulk samples from 5325,

1 thin section and 1 bulk sample from 6169, and

1 thin section from 5108.

Chemistry Analysis was undertaken on the fine earth (i.e. < 2 mm) fraction of the samples. Phosphate-P_i was determined by colorimetry using 1N HCl as the extractant; and LOI (loss-on-ignition) by ignition at 375^{o}C for 16 hours (Ball, 1964) – previous studies having shown that there is no significant breakdown of carbonate at this temperature.

Soil micromorphology Subsampled monolith samples (Tables 2 and 4) were impregnated with a clear polyester resin-acetone mixture (Fig 18); samples were then topped up with resin, ahead of curing and slabbing for 75x50 mm-size thin section manufacture by Spectrum Petrographics, Vancouver, Washington, USA (Goldberg and Macphail, 2006; Murphy, 1986)(Figs 1, 6-7). Thin sections were further polished with 1,000 grit papers and analysed using a petrological microscope under plane polarised light (PPL), crossed polarised light (XPL), oblique incident light (OIL) and using fluorescent microscopy (blue light – BL), at magnifications ranging from x1 to x200/400. SEM/EDS (Energy Dispersive X-ray Spectrometry; (Weiner, 2010)) was carried out on M5325A (Table 3, Figs 25-26). Thin sections were described, ascribed soil microfabric types (MFTs) and microfacies types (MFTs)(see Tables 1 and 4), and counted according to established methods (Bullock *et al*., 1985; Courty, 2001; Courty *et al*., 1989; Macphail and Cruise, 2001; Stoops, 2003; Stoops *et al*., 2010).

Results

Chemistry

The analytical data are presented in Table 1, with key features relating to individual samples highlighted. Here a broad overview of the two soil properties is presented.

Loss-on-ignition (LOI) Although none of the samples is particularly organic rich, there is quite marked variability in the LOI data, with three of the samples having notably higher values (Table 1). Two of these are from the uppermost (topsoil) horizons from the Bronze Age buried brown earth/rendzina [sample x6157a: 2.38%] and Late Roman dark earth [x5325a: 2.39%]. In both cases, as would be anticipated, there is a clear reduction in organic matter content in the underlying horizon(s). However, the highest LOI (3.23%) was recorded in the sample [x6169] from the Bronze Age barrow ditch fill, which may indicate somewhat lower rates of organic decomposition within the ditch, perhaps as a result of more poorly drained conditions.

Inorganic phosphate (phosphate-P_i) Of the six samples, the three associated with the Late Roman dark earth stand out as having notably higher concentrations. The humic topsoil [x5325a] from this sequence is categorised in Table 1 as being 'enriched' in phosphate (phosphate-Pi: 2.05 mg g^{-1}), and the two underlying horizons as being 'slightly enriched'. This enrichment is likely to be anthropogenic in origin, possibly resulting from inputs of manure, cess, midden materials, etc. In contrast, neither the Bronze Age buried soil nor the barrow ditch fill show any clear signs of phosphate enrichment.

Conclusions from the Chemistry

The various contexts sampled display quite marked variability in both properties analysed. The sequences may be interpreted as follows:

- *Bronze Age buried calcareous brown earth/rendzina*: quite organic rich, particularly in A/B horizon, but no evidence of phosphate enrichment through anthropogenic activity;
- *Late Roman dark earth*: quite organic rich, especially in the humic topsoil, and good evidence of phosphate enrichment which is likely associated with anthropogenic activity; and
- *Bronze Age barrow ditch fills*: the single context analysed has a relatively high LOI, perhaps implying accumulation under poorly drained conditions, but has a low phosphate content.

Soil micromorphology Results and Discussion

Results are presented in Tables 2-4, illustrated in Figs 1-26, and supported by material on the accompanying CD-Rom. 22 characteristics were identified and counted from the 6 thin sections analysed.

5108 – Neolithic Enclosure on Thanet Beds (M5108)

Context 206007: This is a layered and laminated series of well sorted fine sandy and clayey-sandy fills, with numerous fine channels (Fig 1). The latter often include ferruginised traces of roots (Figs 2-3). The many burrows are often impregnated with iron and manganese (once weakly humic soil?). Trace amounts of wood charcoal occur (max 2.5mm)(Figs 4-5). Rare finely dusty clay void coatings and grain coatings are present alongside many impure clay infills of channels (of clayey sand layer origin), and these are weakly humic.

This example of the enclosure ditch fill records waterlain silting of the exposed Thanet Sand substrate/geology, and alternating weakly humic clayey sands. The latter may originate from the erosion of more clay rich subsoils developed in the Thanet Sands (Argillic brown earths; Frilsham soil series(?) within Hamble soil association; (Jarvis et al., 1983). Enclosure ditch infilling appears to have been a rapid semi-continuous process with both fine rooting and burrowing occurring. Iron was precipitated in these bio-channels within the ephemerally water-saturated fills. There is no evidence of coarse woody roots rooting in fill as it developed, possibly implying open conditions. The very small amounts of charcoal present are probable relict of clearance.

6157 Early Bronze Age barrow-buried soil on chalk (Figs 6-7)

Context 141094 (M6157B): This lower thin section shows a massive, poorly humic, generally decalcified fine sandy silt loam with underlying (relict) prismatic structure, to be present (Fig 7). Coarse chalk stones (max 40mm) occur alongside broad burrow-mixed calcareous fine soil. Here, rare biogenic calcite root traces and earthworm granules are present. Rare charcoal, an example of burned flint and two sand-size coprolitic fragments (autofluorescent under BL), occur (Figs 8-11). Examples of 0.5mm-size flint 'flakes' may also be of anthropic origin (Fig 8). Much of the soil has a total excremental homogenised microfabric, along with abundant thin and broad burrows (max 2.5mm), and occasional thin and very thin organo-mineral excrements. There are many fine iron-manganese nodular formations.

This sample represents the lower decalcified Ah horizon of a barrow-buried rendzina, in which only small amounts of chalk and chalky subsoil occur (Typical brown calcareous earth, Coombe I soil association; Jarvis et al., 1983). Some post-depositional burrowing may also be responsible for the mixing of chalky soil. Anthropogenic materials – charcoal, burned flint and coprolites (dog/human?, Macphail and Goldberg, 2010), and possibly small flint flakes – may have been concentrated at this depth by surface casting earthworms (see M6157A).

Context 141094 (M6157A): The upper buried soil is a massive, stone-free, fine sandy silt loam, characterised by channels (Fig 6). Upwards, humic soil occurs as small burrow fills and aggregates, likely associated with the relatively higher LOI (2.38%) here (Table 1). An example of strongly burned flint (1mm)(Figs 12-13) and rare to occasional fine charcoal (max 1.2mm) concentrations occur. Abundant thin and broad burrows, occasional thin and many to abundant (upwards) very thin organo-mineral excrements, and occasional broad and mammilated excrements, occur within the otherwise total excremental fabric. Abundant iron manganese nodule formations are associated with the relict humic soil present, which increases upwards (Figs 6, 14-15). An example of calcareous soil in a burrow includes fine charcoal concentrations.

This is the earthworm worked humic decalcified topsoil Ah horizon of a calcareous brown earth, with the burrowed-in remains of the Ah1 surface humus soil, also being present. There is the possibility that this is a soil formed under pasture (dung traces??), with earthworm working 'burying' earlier occupation debris, albeit sparse. The presence of calcareous soil in burrows here and below, which includes charcoal and coprolites, may possibly also indicate occupation 'spreads' at the site during barrow construction. This anthropogenic soil was worked down-profile before burial and sealing by the barrow.

Thus at the Early Bronze Age barrow site, and although the picture is obscure, it appears that:

1. a first occupation could be recorded, possibly associated with flint working (possibly fine flint debris)(see OW Archaeology, 2011),
2. later use of the area for pasture, which led earthworms to form a stone-free soil,
3. a second occupation related to ritual use of the site and barrow(s) construction, and

4. post-burial formation of iron manganese nodules and earthworm burrowing through chalky soil associated with the barrow mound (Crowther et al., 1996; Macphail, 1991).

6919 Bronze Age barrow ditch fill on chalk

290140 (M6919): This fill is a massive channelled calcareous fine sandy silt loam, which becomes much more humic upwards (3.23% LOI)(Table 1). Fill is also characterised by many landsnail shell (max 7mm), with occasional biogenic calcite – earthworm granules (Figs 17-18). Example of rounded flint-tempered pot, burned flint (8mm), a trace of fungal spores and fine charcoal, were encountered. The soil has a partial total excremental fabric, with very abundant thin to broad burrows, and very thin to broad organo-mineral excrements, some mammillated.

The thin section sampled across a likely 'turf' stabilisation horizon, where a bioworked and homogenised humic fine soil occurs over a relatively more minerogenic fill. Background anthropogenic inclusions occur, alongside evidence of earthworms and snail fauna. This humic soil probably reflects a local calcareous brown earth soil cover (Coombe I soil association; Jarvis *et al*., 1983), and findings from previous studies of turf barrows from the Monkton-Mount Pleasant areas of Thanet (Macphail unpublished reports to Canterbury Archaeological Trust).

5325 – Roman dark earth on Thanet Beds

Context 133028 (M5325B): This lower sample records a massive, well sorted coarse silt-very fine sand, with a relict coarse prismatic structure. It is characterised by a moderately humic fine fabric, which becomes less humic down-profile (1.61% becoming 1.29% LOI, downwards; Table 1, Fig 19). The soil is partially bioworked by many fine channels and broad burrows. Occasional examples of broad organo-mineral excrements also occur. Anthropogenic inclusions include very fine charcoal and trace amounts of phytoliths, with a coarse example (40+mm) of fine sand tempered pot fragment, a 10 mm size burned flint, trace amounts of very fine coprolitic material (see M5325A), rare isotropic siliceous clasts, rare charcoal (max 2mm) and trace amounts of Fe-clay embedded silts. Trace amounts of finely dusty clay void coatings give way down-profile to occasional very dusty/matrix intercalations (Figs 19-20). Many fine to medium Fe-Mn nodules, and trace amounts of channel iron hypocoatings, were also noted. It is phosphate-enriched with 1.36 mg g^{-1} P (Table 1).

This slide samples the junction between, a) the humic topsoil formed by cultivation and abandonment/fallowing and b) the remains of the less altered lower Ap horizon. The latter retains relict textural pedofeature evidence of having been ploughed.

Context 133028 (M5325A): In the upper thin section sample the soil is a massive well sorted coarse silt-very fine sand, with relict coarse prismatic structures, characterised by a moderately humic fine fabric (2.39% LOI, Table 1, Fig 18) This contains much very fine charcoal and rare phytoliths. The soil displays abundant broad to very broad burrows, with a partial total excremental microfabric. An example of articulated phytoliths is present (Fig 21) alongside a <2mm size example of wetland sediment and rare fine size (max 5mm) coprolites and very fine coprolitic bone/amorphous coprolitic fragments (Figs 23-24). These are isotropic and autofluorescent under blue light (BL). Larger ones have Fe-staining and colourless to very pale yellow, with weak fibrous birefringence, colourless under OIL, with some whitish areas, suggesting that these are possibly dog coprolite remains)(Lawson, 2000)Macphail and Goldberg, 2010). This is consistent with overall phosphate enrichment (2.05 mg g^{-1} P). Occasional dusty, colourless and isotropic aggregates (fine to medium sand size) with melted silt (burned sandstone?)(Fig 22), rare rounded wood charcoal or flecks (max 1mm) and a rare trace of brown or colourless nodules embedding silt, also occur. Rare very thin very dusty clay void coatings (10-15µm) in some fine channels, and rare fine Fe-Mn nodules were recorded. EDS analyses found: coprolitic bone (34.5-36.1% Ca, 17.6-18.7% P; outer parts contain 1.54-1.71% F)(Figs 25-26); enigmatic isotropic clasts (siliceous with 28.6-38.8% Si; one with iron staining 3.18% Fe and 0.70% P); soil matrix (0.33% P) and dusty clay void coatings (0.38-0.51% P) are also phosphate enriched (Table 3).

The soil has a darkish colour because humus is mixed with fine charred and amorphous organic matter. It is relatively rich in anthropogenic inclusions, coprolitic material, charcoal, burned mineral material, phytoliths and pot. This appears to be settlement middening waste, rather than *in situ* occupation material. The concentration of inclusions and chemistry is thus more comparable to 'infield' manuring as recorded (by J. Crowther) in soils buried below the late 3rd C town walls at Canterbury (on brickearth) and at the early medieval (8th C) site of Büraburg, Nordhessen, Germany (Goldberg and Macphail, 2006, tables 9.1a-9.1b)(Greig, 2004; Henning and Macphail, 2004). Similarly, at the Roman towns of Scole (Norfolk) and Southwark, London edge of town 'dark earth' was a lightly manured sandy soil (Ashwin and Tester, Forthcoming). At the East Kent Access site, this manuring seems to be related to cultivation and the development of an Ap horizon (see Canterbury buried soil, above), and the 133028 subsoil is characterised by textural pedofeatures relict of ploughing (Goldberg and Macphail, 2006, 202-210; Lewis, 1998; Macphail *et al*., 1990). The ensuing biological homogenisation of this ploughsoil probably occurred when the ground was left to fallow or pasture; cf. the dark earth soil development of pasture soils at Deansway on the edge of Worcester, by late Saxon (burgh) times (Greig, 2004; Macphail, 2004)).

This dark earth soil therefore seems to have had a history of: 1) manured cultivation using probable midden waste associated with a Roman settlement (OW Archaeology 2012), 2) abandonment/fallowing and biological homogenisation (grassland?), and 3) unknown subsequent (burial?) conditions which produced small amounts iron-manganese staining and inwash of dusty clay.

Conclusions

A small soil micromorphology, LOI and P study of 6 thin sections and bulk samples from 4 sites within the East Kent Access Project, was carried out. EDS microchemistry was also employed on one thin section. *Monolith 5108*: it can be tentatively suggested that the Neolithic Enclosure ditch records rapid layered sandy and clayey sand infilling in probably open conditions, with the studied thin section being representative of the monolith sample as a whole; rare charcoal probably relict of clearance, was noted. *Monolith 6157*: a two thin section and bulk soil study of Early Bronze Age barrow-buried soil on chalk seems to suggest a history of, 1) a first occupation perhaps associated with flint working (possibly fine flint debris and other fine anthropogenic inclusions), 2) later use of the area for pasture, which led earthworms to form a stone-free soil, 3) a second, immediately pre-barrow occupation related to use of the site and barrow(s) construction, and 4) post-burial formation of iron manganese nodules and earthworm burrowing through chalky soil associated with the barrow mound. *Monolith 6919*: a likely 'turf' stabilisation horizon was found in a Bronze Age barrow ditch fill on chalk, and this was corroborated by LOI data; background anthropogenic inclusions also occur. *Monolith 5325*: the two thin section (and EDS) and 3 bulk sample study of Roman dark earth on Thanet Beds found a plausible history of: 1) manured cultivation using probable midden waste associated with a Roman settlement, 2) abandonment/fallowing and biological homogenisation (grassland?), and 3) unknown subsequent (burial?) conditions which produced small amounts iron-manganese staining and inwash of dusty clay.

Acknowledgements

The authors thank Carl Champness for samples and information. Kevin Reeves (UCL) kindly facilitated EDS studies.

References

Ashwin, T., and Tester, A., Forthcoming, *A Roman Settlement in the Waveney Valley: Excavations at Scole, 1993-4*: East Anglian Archaeology.

Ball, D. F., 1964, Loss-on-ignition as an estimate of organic matter and organic carbon in non-calcareous soils.: *Journal of Soil Science*, v. 15, p. 84-92.

Bullock, P., Fedoroff, N., Jongerius, A., Stoops, G., and Tursina, T., 1985, *Handbook for Soil Thin Section Description*, Wolverhampton, Waine Research Publications, 152 p.:

Courty, M. A., 2001, Microfacies analysis assisting archaeological stratigraphy, *in* P. Goldberg, Holliday, V. T., and Ferring, C. R., eds., *Earth Sciences and Archaeology*: New York, Kluwer, p. 205-239.

Courty, M. A., Goldberg, P., and Macphail, R. I., 1989, *Soils and Micromorphology in Archaeology* (1st Edition), Cambridge, Cambridge University Press, Cambridge Manuals in Archaeology, 344 p.:

Crowther, J., Macphail, R. I., and Cruise, G. M., 1996, Short-term burial change in a humic rendzina, Overton Down Experimental Earthwork, Wiltshire, England.: *Geoarchaeology*, v. 11(2), p. 95-117.

Goldberg, P., and Macphail, R. I., 2006, *Practical and Theoretical Geoarchaeology*, Oxford, Blackwell Publishing, 455 p.:

Greig, J., 2004, Buried soil pollen, *in* Dalwood, H., and Edwards, R., eds., *Excavations at Deansway, Worcester, 1988-89: Romano-British small town to late medieval city.*, Volume CBA Research Report No 139: York, Council for British Archaeology, p. 556-558.

Henning, J., and Macphail, R. I., 2004, Das karolingische Oppidum Büraburg: Archälogische und mikromorphologische. Stedien zur Funktion einer frümittelaterlichen Bergbefestigung in Nordhessen (The Carolingian times *oppidum* Büraburg: archaeological and soil investigations on the function of an early medieval hillfort in North Hesse), *in* Hänsel, B., ed., *Parerga Praehistorica. Jubiläumsschrift zur Prähistorischen Archäologie 15 Jahre UPA*, Volume Band 100: Bonn, Verlag Dr Rudolf habelt GmbH, p. 221-252.

Jarvis, M. G., Allen, R. H., Fordham, S. J., Hazleden, J., Moffat, A. J., and Sturdy, R. G., 1983, *Soils of England and Wales. Sheet 6. South East England*: Ordnance Survey, scale 1:250,000.

Lawson, A. J., 2000, *Potterne 1982-5: Animal Husbandry in Later Prehsitoric Wiltshire*, Salisbury, Wessex Archaeology.

Lewis, H., 1998, *The characterisation and interpretation of ancient tillage practices through soil micromorphology: a methodological study* [Doctoral Dissertation]: Cambridge.

Macphail, R. I., 1991, The archaeological soils and sediments, *in* Sharples, N. M., ed., *Maiden Castle: Excavations and field survey 1985-6*, Volume Archaeological Report no 19: London, English Heritage, p. 106-118.

-, 2004, Soil micromorphology, *in* Dalwood, H., and Edwards, R., eds., *Excavations at Deansway, Worcester, 1988-89: Romano-British small town to late medieval city.*, Volume CBA Research Report No 139: York, Council for British Archaeology, p. 558-567.

Macphail, R. I., Courty, M. A., and Gebhardt, A., 1990, Soil micromorphological evidence of early agriculture in north-west Europe: *World Archaeology*, v. 22, no. 1, p. 53-69.

Macphail, R. I., and Cruise, G. M., 2001, The soil micromorphologist as team player: a multianalytical approach to the study of European microstratigraphy, *in* Goldberg, P., Holliday, V., and Ferring, R., eds., *Earth Science and Archaeology*: New York, Kluwer Academic/Plenum Publishers, p. 241-267.

Macphail, R. I., and Goldberg, P., 2010, Archaeological materials, *in* Stoops, G., Marcelino, V., and Mees, F., eds., *Interpretation of Micromorphological Features of Soils and Regoliths*: Amsterdam, Elsevier, p. 589-622.

Murphy, C. P., 1986, *Thin Section Preparation of Soils and Sediments*, Berkhamsted, A B Academic Publishers.

O-W Archaeology 2011. *East Kent Access (Phase II), Thanet, Kent. Post-Excavation Assessment Volume 2*. Oxford-Wessex Archaeology.

Stoops, G., 2003, *Guidelines for Analysis and Description of Soil and Regolith Thin Sections*, Madison, Wisconsin, Soil Science Society of America, Inc., 184 p.:

Stoops, G., Marcelino, V., and Mees, F., 2010, *Interpretation of Micromorphological Features of Soils and Regoliths*.: Amsterdam, Elsevier, p. 720.

Weiner, S., 2010, *Microarchaeology. Beyond the Visible Archaeological Record*, Cambridge, Cambridge University Press, 396 p.:

Table 1: Sample details and analytical data

Sample	Context	Notes	LOI[a] (%)	Phosphate-P_i[b] (mg g^{-1})
x6157a	141094	Bronze Age buried calcareous brown earth/rendzina: A/B horizon	2.38*	0.838
x6157b	198083	As above: B/C horizon	1.47	0.483
x5325a	133028	Late Roman etc. rural dark earth on loamy Thanet beds, brickearth-like: humic topsoil	2.39*	2.05**
x5325b	133028	As above: moderately humic lower topsoil	1.61	1.36*
x5325c	133034	As above: subsoil	1.29	1.12*
x6169		Bronze Age barrow ditch fills, calcareous	3.23**	0.273

[a] **Loss-on-ignition:** Figures highlighted have notably higher values: * = 2.00–2.99%; ** ≥ 3.00%
[b] **Phosphate-P_i:** Figures highlighted show signs of phosphate-P_i enrichment: * = slightly enriched (1.00–1.99 mg g^{-1}), ** = enriched (2.00–2.99 mg g^{-1})

Table 2: East Kent Access Road; soil micromorphology samples and counts

Monolith	Thin section	Rel depth	Bulk sample	Rel depth	Context	MFT	SMT	Voids	Gravel	Wetland sed frag?	Biog. Root traces	Org Root trace	Fe-root traces
6157	M6157A	0-15cm	x6157a	0-10.5cm	141094	B1	2a,2b,3b	35%				a*	
6157	M6157B		x6157b	18-23 cm	198083	B2	2a, 3a	25%	f		a		
5325	M5325A	0-15 cm	x5325a	0-11 cm	133028	A1	1a	35%		a-1			
	M5325B		x5325b	11-25 cm	133028	A1/A2	1a/1b	35%					
			x5325c	40-50 cm	133034								
6169	M6169A	0-18cm	x6169	3.5-10.5 cm	290140	B3	3c,3d	25%	f				
5108	M5108A	21.5-31.5 cm		21.5-31.5 cm	206007	D1	4a,4b	35%					aaa
Table 2, cont.													
Thin section	**Context**	**Earthworm granule**	**Cop. bone cop'.**	**Isotropic clasts**	**Fe-Silt nodules**	**Burned flint**	**Pot**	**Charcoal**	**Artic. phytoliths**	**Dusty clay coatings**	**Matrix intercal**	**Clayey inwash**	**Fe-Mn nodules**
M6157A	141094	a*				a-1		a(aa)					aaa
M6157B	198083	a	a*			a-1		a			a*		aa
M5325A	133028		a	aa	a*			a	a-1	a			a
M5325B	133028		a*	a	a*	a-1	a-1(aaa)	a		a*	a		aa
M6169A	290140	aa				a-1	a-1	a*					
M5108A	206007							a*		a		aaa	aaaa
Table 2, cont.													
Thin section	**Context**	**2ndary Fe**	**Broad burrows**	**Thin burrows**	**Broad O-M Excr**	**Thin O-M Excr**	**V. Thin O-M Excr.**						
M6157A	141094		aaaa	aaaa	aa(total)	aa	aaaa/aaa						
M6157B	198083		aaaa	aaaa	(total)	aa	aa						
M5325A	133028		aaaa		aa								
M5325B	133028		aaa		aa		a						
M6169A	290140		aaaa	aaa	aaa(total)	aaa	a						
M5108A	206007	aaa		aa									

* - very few 0-5%, f - few 5-15%, ff - frequent 15-30%, fff - common 30-50%, ffff - dominant 50-70%, fffff - very dominant >70%
a - rare <2% (a*1%; a-1, single occurrence), aa - occasional 2-5%, aaa - many 5-10%, aaaa - abundant 10-20%, aaaaa - very abundant >20%

Table 3: East Kent Access Road, SEM/EDS analysis of features and inclusions in M3235A

Feature	F	Na	Mg	Al	Si	P	P2O5	K	Ca	CaO	Ti	Mn	Fe	Fe0
Isotropic mineral inclusion 1		0.80	0.36	4.64	38.8			1.66	1.02				2.39	3.08
Ditto 2		0.86		5.21	36.6	0.70	1.60	2.34	1.59				3.18	4.09
Ditto 2 coating		0.42		8.66	28.6			11.9				5.19	0.64	0.83
Local soil matrix		0.39	0.46	4.08	39.1	0.33		1.13	0.76		0.32		2.86	3.68
Coprolitic bone – outer part	1.71	0.45		1.57	1.91	17.6	40.4		34.5	48.2			0.47	1.43
Ditto	1.54	0.57		0.80	0.40	18.7	42.8		35.6	49.8			2.10	2.70
Coprolitic bone – inner part				1.22	1.90	18.1	41.5		36.1	50.5			1.23	1.58
Dusty clay void coating			1.03	8.76	30.8	0.38		2.17	1.38	0.44			7.60	9.78
Ditto			1.72	10.3	28.3	0.51		2.09	1.56		0.32		8.33	10.7

Table 1: East Kent Access Road: Soil Micromorphology (Descriptions and preliminary interpretations)

Microfacies type (MFT)/Soil microfabric type (SMT)	Sample No.	Depth (relative depth) Soil Micromorphology (SM)	Preliminary Interpretation and Comments
MFT A1/SMT 1a	M5325A	0-75mm SM: heterogeneous; *Microstructure*: massive, prismatic(?), 35% voids, moderately accommodated curved planar voids, fissures, with fine open vughs and channels and chambers; *Coarse Mineral*: C:F Coarse:Fine limit at 10µm), 80:20, well sorted coarse silt-very fine sand-size quartz – subangular to subrounded, with flint, feldspar, mica and glauconite; egs of Fe-stained brickearth-like/Sands fragment; *Coarse Organic and Anthropogenic*: trace/eg of articulated phytoliths; <2mm size eg of wetland sediment (laminated silty clay with phytoliths and diatoms); rare fine (max 5mm) and very fine coprolitic bone fragments (larger ones with Fe-staining, colourless to very pale yellow, with weak fibrous birefringence, colourless under OIL, with some whitish areas, BL autofluorscent; possible dog coprolite remains); occasional dusty, colourless aggregates (fine to medium sand size) with melted silt? (?); rare rounded wood charcoal or flecks (max 1mm); rare trace of brown or colourless nodules embedding silt (?); *Fine Fabric*: SMT 1a: dotted and dusty darkish brown (PPL), very low interference colours to isotropic (close porphyric, speckled b-fabric, XPL), pale yellowish brown (OIL), moderately humic stained with very abundant very fine charred OM and charcoal – rare	133028 Massive well sorted coarse silt-very fine sand, with relict coarse prismatic structures, characterised by moderately humic fine fabric. This contains much very fine charcoal and rare phytoliths. Soil displays abundant broad to very broad burrows, with a partial total excremental microfabric. An example of articulated phytoliths is present alongside a <2mm size eg of wetland sediment and rare fine size (max 5mm) coprolites and very fine coprolitic bone/amorphous fragments. These are isotropic and autofluorescent under blue light (BL). Larger ones have Fe-staining and colourless to very pale yellow, with weak fibrous birefringence, colourless under OIL, with some whitish areas, suggesting likely dog coprolite remains). Occasional dusty, colourless and isotropic aggregates (fine to medium sand size) with melted silt (?), rare rounded wood charcoal or flecks (max 1mm) and rare trace of brown or colourless nodules embedding silt, occur. Rare very thin very dusty clay void coatings (10-15µm) in some fine

East Kent Access, Soil Micromorphology Figures 1-26

Fig. 1: Scan of M5108 (Context 206007); layered and laminated well sorted fine sands and clayey fine sands. The latter are slightly more iron-stained and the focus of fine rooting – root traces are also often ferruginised. Frame width is ~50mm.

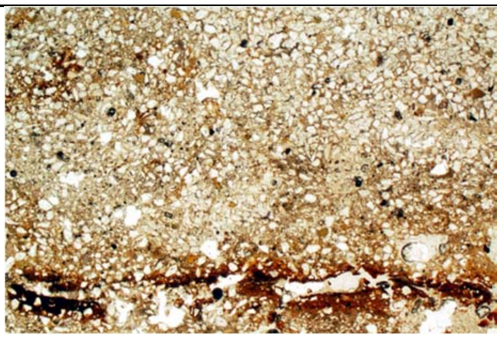

Fig. 2: Photomicrograph of M5108 (Context 206007); ferruginised root channel in clayey sands layer, below a sandy layer. Plane polarised light (PPL), frame width is ~4.62mm.

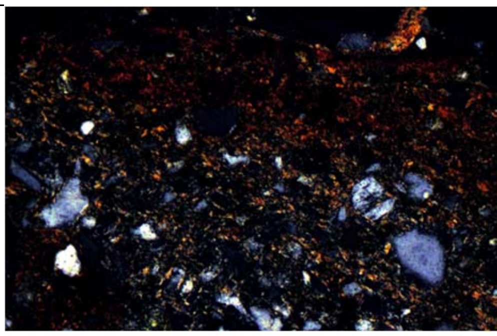

Fig. 3: Detail of Fig 2, under crossed polarised light (XPL); note iron staining of root channel (iron hypocoating). Frame width is ~0.90mm.

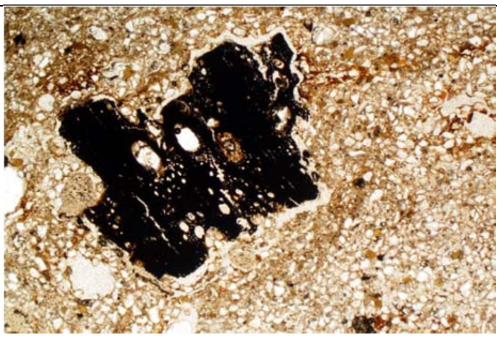

Fig. 4: Photomicrograph of M5108 (Context 206007), showing wood charcoal fragment in fine sands. PPL, frame width is ~4.62mm.

Fig. 5: As Fig 4, under oblique incident light (OIL); note pale iron-depleted sands in general (leached sands in sometimes water-saturated ditch?), with minor iron staining.

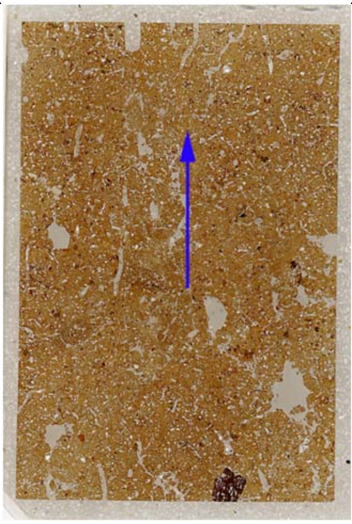

Fig. 6: Scan of M6157A (Context 141094), showing increasingly humic decalcified and stone-free soil, upwards (arrow); fine iron-manganese nodules associated with relict humic material are in evidence. Frame width is ~50mm.

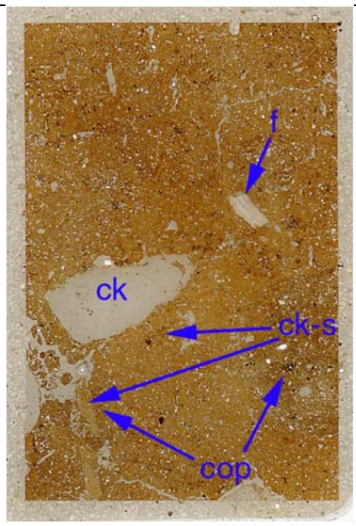

Fig. 7: Scan of M6157B (Context 141094); chalk (ck), flint (f) and two examples of sand-size coprolites (cop) are present, below a stone-free decalcified soil. Note pale burrow mixed chalky soil (ck-s). Frame width is ~50mm.

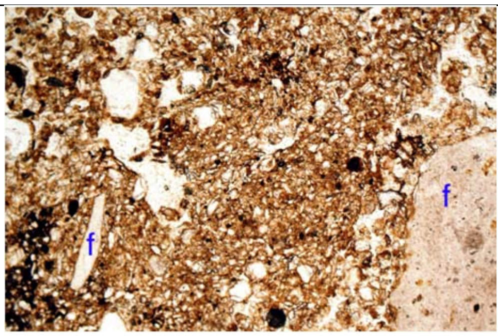

Fig. 8: Photomicrograph of M6157B (Context 141094); flint includes large calcined(burned?) fragments (f) and a scatter of fine 'flakes' (left). Note post-burial blackish Fe-Mn staining. PPL, frame width is ~4.62mm.

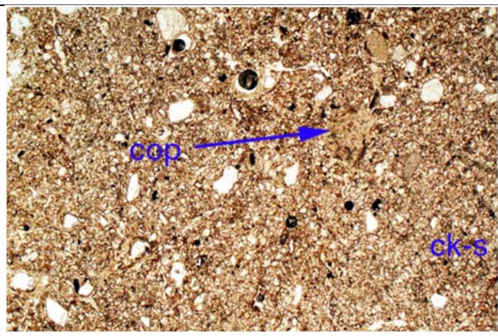

Fig. 9: Photomicrograph of M6157B (Context 141094); moderately humic decalcified soil and burrow-mixed chalk soil (ck-s)(see Fig 7). A coprolite fragment is also present (cop, see Fig 11). PPL, frame width is ~4.62mm.

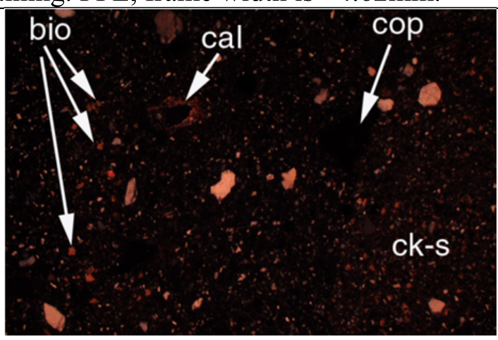

Fig. 10: As Fig 9, under XPL; note secondary calcite void hypocoating (cal) and biogenic calcite crystals (bio) mixed into the generally decalcified soil.

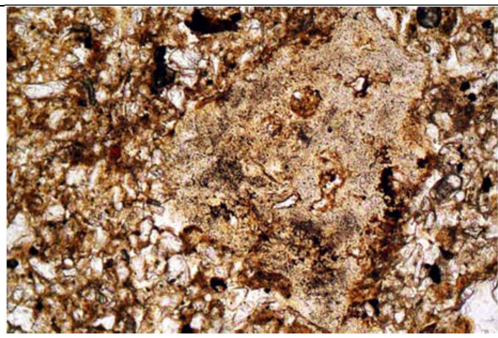

Fig. 11: detail undifferentiated (dog/human) in Fig 9. This is isotropic but autofluorescent under blue light implying a calcium phosphate apatite mineralogy. PPL, frame width is ~0.90mm.

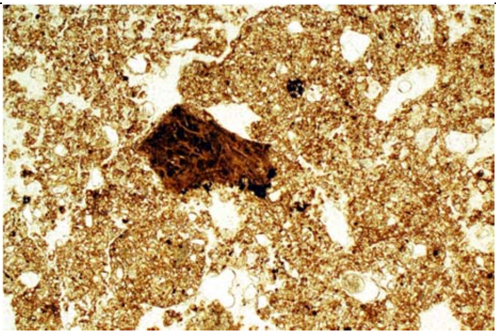

Fig. 12: Photomicrograph of M6157A (Context 141094)(see Fig 6); strongly burned flint in bioworked humic topsoil. PPL, frame width is ~4.62mm.

Fig. 13: As Fig 12, under OIL.

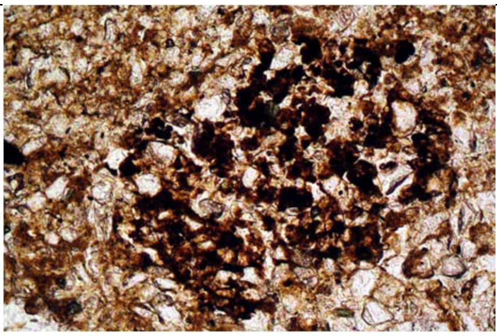

Fig. 14: Photomicrograph of M6157A (Context 141094)(see Fig 6); detail of humic soil burrow fill composed of humified pellets of amorphous organic matter. PPL, frame width is ~0.90mm.

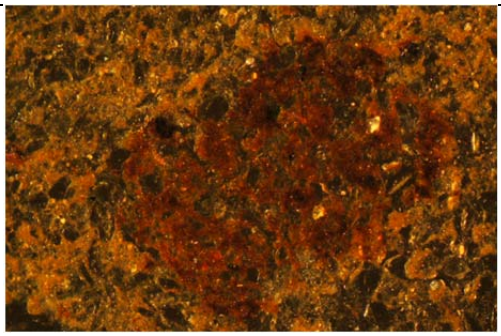

Fig. 15: As Fig 14, under OIL, showing iron stained nature of humified organic matter – possibly a dung residue.

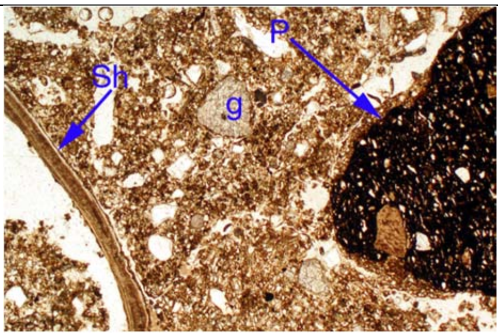

Fig. 16: Photomicrograph of M6169 (Context 290140); bioworked humic ditchfill soil, containing landsnail shells (S), earthworm granules (g), and an example of flint tempered pot (P). PPL, frame width is ~4.62mm.

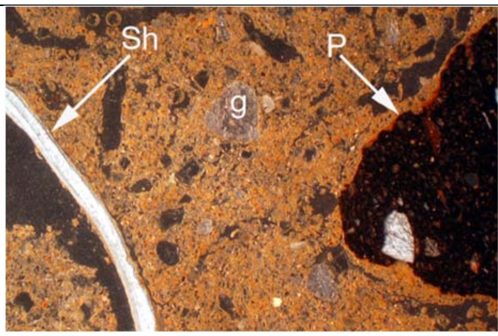

Fig. 17: As Fig 16, under OIL. Note burned flint in pot.

Fig. 18: Scan of resin embedded block M5325A&B, showing humic Roman dark earth topsoil formed in brown earth, with anomalous irregular boundary between the upper more humic (2.39% LOI) topsoil and less humic subsoils (1.61% and 1.29% LOI, respectively). Note large pot fragment, also present in thin section M5325B. Height is ~18cm.

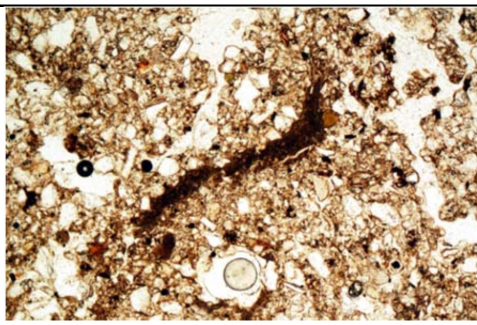

Fig. 19: Photomicrograph of M5325B (Context 133028); weakly humic dark earth subsoil, with marked dark silty clay intercalatory pan, probably relict of a plough soil history on the site. PPL, frame width is ~2.38mm.

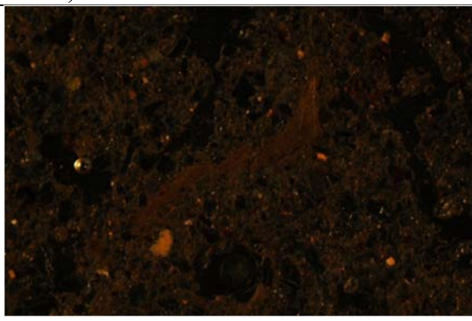

Fig. 20: As Fig 19, under OIL.

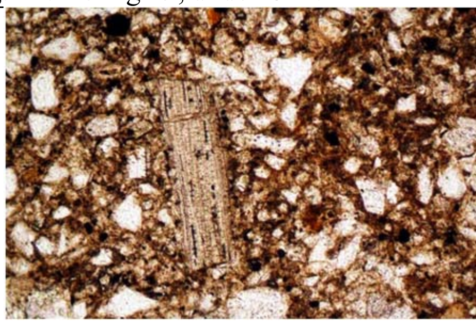

Fig. 21: Photomicrograph of M5325A (Context 133028); upper humic dark earth contains fine amorphous and charred organic matter, and phytoliths, including this example of articulated phytoliths or possible cereal origin. PPL, frame width is 0.90mm.

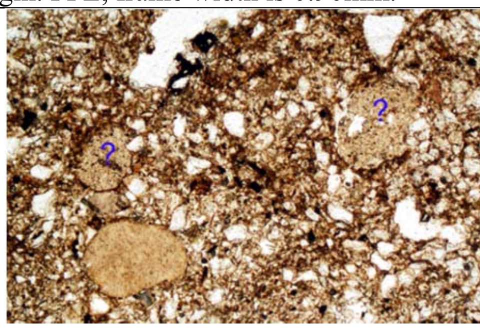

Fig. 22: As Fig 21; enigmatic isotropic clasts (?); EDS found these to be siliceous, sometimes with P (Table 3); strongly burned sandstone rock fragments? PPL, frame width is ~2.38mm.

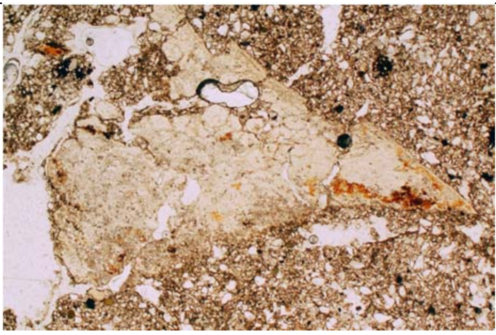

Fig. 23: As Fig 21; coprolitic bone fragment as evidence of middening/manuring. PPL, frame wdith is ~4.62mm.

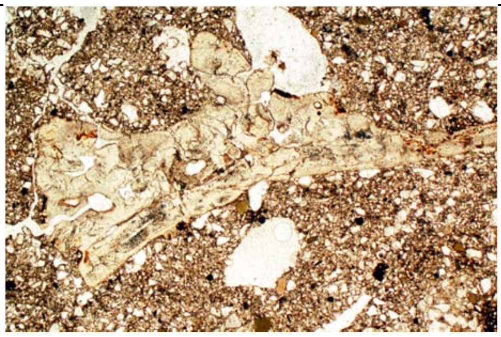

Fig. 24: As Fig 23, another example of coprolitic bone. This one was studied employing EDS (see Figs 25-26). PPL, frame wdith is ~4.62mm.

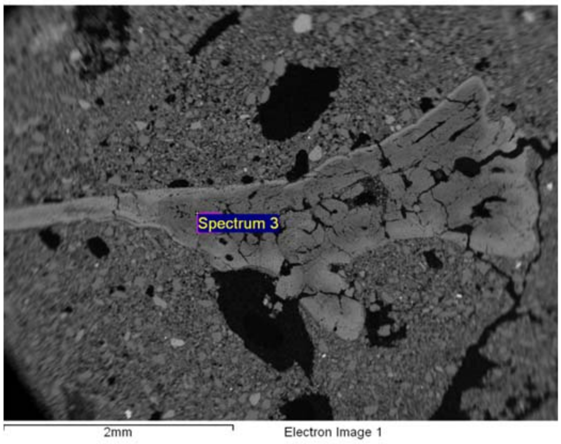

Fig. 25: As Fig 24, EDS BSE image of coprolitic bone; Ca-P chemistry with pale outer parts including 1.54-1.71% F. Scale=2mm.

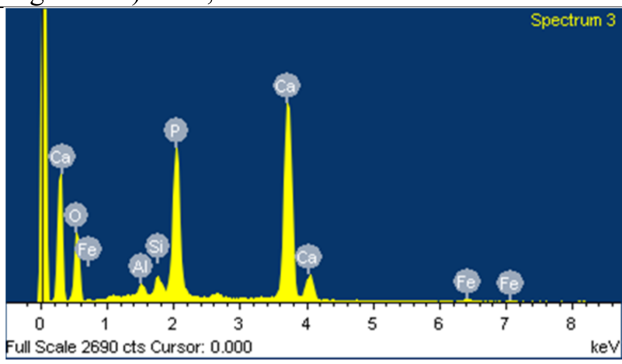

Fig. 26: As Fig 25, EDS Spectrum. Coprolitic bone is dominated by Ca (34.5-36.1%; 48.2-50.5% CaO) and P (17.6-18.7%; 40.2-42.8% P_2O_5)(Table 3).