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SOIL MICROMORPHOLOGY

Method

Field sampling
Nine kubiena samples are analysed from deposits sampled from the Pictish, Norse and Medieval site at the church of St Colman at Portmahomack, Moray Firth. The summary results are given below and full descriptions in Appendix 1 and Table 1.

Thin section manufacture and description
The sample was prepared for thin section analysis by G. McLeod at the Department of Environmental Science, University of Stirling using the methods of Murphy (1986). Water was removed and replaced by acetone exchange and then impregnated under vacuum using polyester crystic resin and a catalyst. The blocks were cured for up to 4 weeks, sliced and bonded to glass and precision lapped to 30μm with a cover slip.

The four samples were assessed using a MEIJI ML9200 polarizing microscope following the principals of Bullock *et al* (1985), Fitzpatrick (1993) and Stoops (2003). A range of magnifications (40x-400x) and constant light sources (plane polarised light –PPL, cross-polars –XPL, circular polarised light and oblique incident light - OIL) were used in the analysis. The summary results are given below and full descriptions in Appendix 1 and Table 1.

Contexts of samples:

Sample 8030 = the soil sequence beneath F577 in S7 (Fig 1)

Samples 8033 and 8034 = the sequence encountered in Louis' sondage through the deposits under S13 (see Fig 2)

Samples 6899 and 6898 = accumulating P2 clay silts in D2 (Fig 3)

Samples 8031 and 8032 = sequence of sand, floor of S9 yard under primary burning (Fig 4)

Samples 4291 and 4292 = sand and floor of S9 yard again (sampled in baulk, no ills)

Objectives

The main objective of analysis was to characterise the nature of the sampled deposits. Various specific questions have also been posed of each sampled sequence.
Sample 8030, horizontal basal deposits [under the bridge in S7]:

- Did the sediment accumulate *in situ* or was it imported?

Samples 8033 and 8034, basal horizontal deposits [under the road S13]:

- Did the sediments accumulate naturally and *in situ*, or were they imported?
- What was the environment of accumulation?
- Was vegetation supported on the soils?

Samples 6899 and 6898, series of thin interbedded deposits capping pit [the clay silts in Module D2]:

- What was the mode and environment of sediment accumulation and/or deposition?
- What was the type and source of fuel(s) being utilised?

Samples 8031 and 8032, relatively substantial horizontal deposits [the floor of the yard of S9]:

- What was the mode and environment of sediment accumulation and/or deposition?

Samples 4291 and 4292 [the floor of the yard of S9]:

- What was the mode and environment of sediment accumulation and/or deposition?

Results

Summary descriptions

The natural, dominant in Samples 8034 and 8030, is a moderate to well sorted coarse sand dominated by rounded to sub-rounded quartz grains with between 5 to 10% feldspar grains. The microstructure is locally variable and includes: single grained structure (sand grains); pellicular structure (sand grains coated by fine material); and bridge grained structure (sand grains bridged by fine material). Fine material is limited in these samples to: coatings; fecal pellets produced by soil biota which occur between the sand grains; and in Sample 8034 thin laminations. The fine material includes: charred and burnt amorphous organic matter; dissolved and/or silt-sized charcoal fragments; very few large fragments of charcoal, some cellular the majority massive; and pseudomorphs of organic material in the form of goethite.

The remaining archaeological deposits are predominantly founded upon well to moderately sorted coarse quartz sand. The microstructures are complex, with all the very ash rich contexts containing very few to frequent small rounded intergrain microaggregates (fecal pellets), with a secondary component of either bridge grain structure, or pellicular structure, or granular and crumb structure, or vughy or spongy structure. However, some deposits and contexts also contain a significant silt content which is a constituent of fine ash that occurs in the form of clasts and/or laminations; the ash also contain significant amounts of biogenic silica. In all but one sample there are very few to frequent fragmentary phytoliths and in many of the contexts dominated by fine silty ash there are also very few diatoms. Charred and burnt amorphous organic material occurs in the majority of deposits but is less common in the fine silty ash deposits. Coarse sand-sized and larger charcoal fragments occur in small amounts in the majority of contexts. Silt-sized and amorphous charcoal is present in every deposit and common in a few. Other anthropic inclusions include fragments of bone, rounded fragments of pottery and the remnants of possible metal working and production, in the form shards of magnetite and two possible fragments of slag. Geothite pseudomorphs of organic material are also present in the majority of contexts.

Discussion

Sample 8030 [Fig 1]
This sample comprises a coarse, quartz dune sand with very little organic or fine organo-mineral. The organic content is dominated by amorphous charred organic matter that occurs between and forms thin coats on some mineral grains. Organic coatings to mineral grains often occur in peats (FitzPatrick 1993) and it seems probable that some of the sand is derived from peat ash. The presence of a very few fungal spores/pollen grains replaced by goethite is also indicative of peat as the original source deposit.

Samples 8034 and 8033 [Fig 2]
All three contexts within Sample 8034 comprise natural coarse dune sand which is peppered with thin, often irregular bands of ash. The majority of the ash laminations are less than 1 mm thick, but the boundary between (3584) and (3583) is marked by a thicker wavy band which is up to 5 mm thick (Plate 1). The ash is characterized by fragmented biogenic silica, mainly phytoliths but with very few diatoms, a few small woody charcoal fragments and charred contorted organic matter and a few mineral grains, mainly silt-sized but some coarse sand-sized. In places the burnt organic matter retains a linear preferred orientation. The ash is derived from either a grass rich damp turf, or more likely a thin peat that had developed upon a silt/sand rich substrate. The environment of deposition of the contexts was dynamic with overall net accumulation of dune sand interspersed by very frequent and short lived phases of ash accumulation, all occurring as the result of aeolian processes (wind). There is no micromorphological evidence of the *in situ* growth of vegetation on these dune sands. The diffuse nature of the boundary (Sample 8033) from (3583) into the overlying context (3560) indicates that there was no hiatus in sediment accumulation.

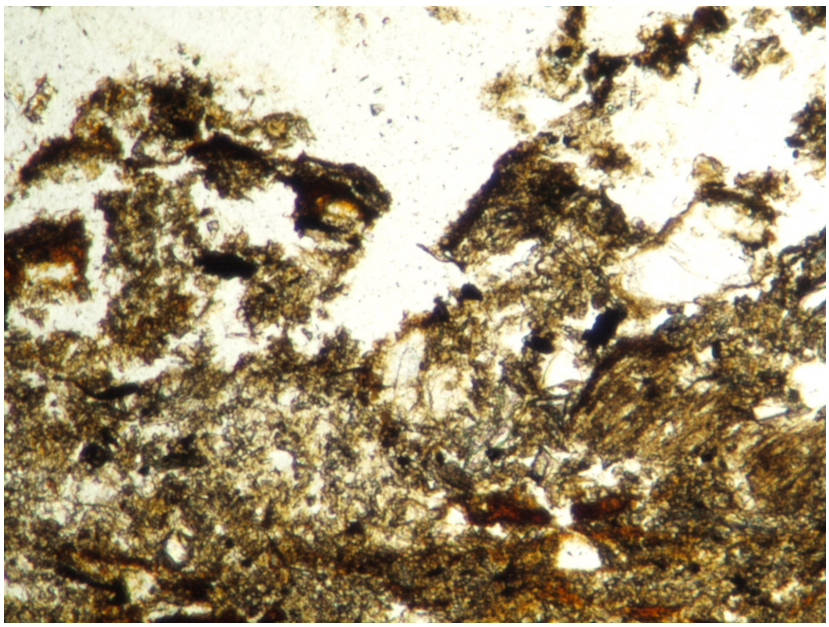

Plate 1. Sample 8034, lamination of peat ash (lower half of image) overlain by windblown sand (top of image), PPL, x 42.5.

(3560) contains significantly more and larger clasts of charcoal and charred, contorted organic material than the underlying (3583). The source of the fuel of the ash present in the upper portion of (3583) and (3560) is also peat, and clearly a fire in which combustion was incomplete. However, the relative scarcity of ash rich in biogenic silica may also to be a function of the carrying capacity of the wind, i.e. it was too strong to deposit the finer ash. There are two fragments of slag, one within (3583) (Plate 2) and one within (3560) hinting at the possibility that peat was being utilized to fuel a smelting furnace. The presence of very small fragments of bone, possible coprolite and a rounded clast of pottery suggests that the source of the ashy components of the deposits may have been a midden heap onto which domestic and industrial waste was being dumped.

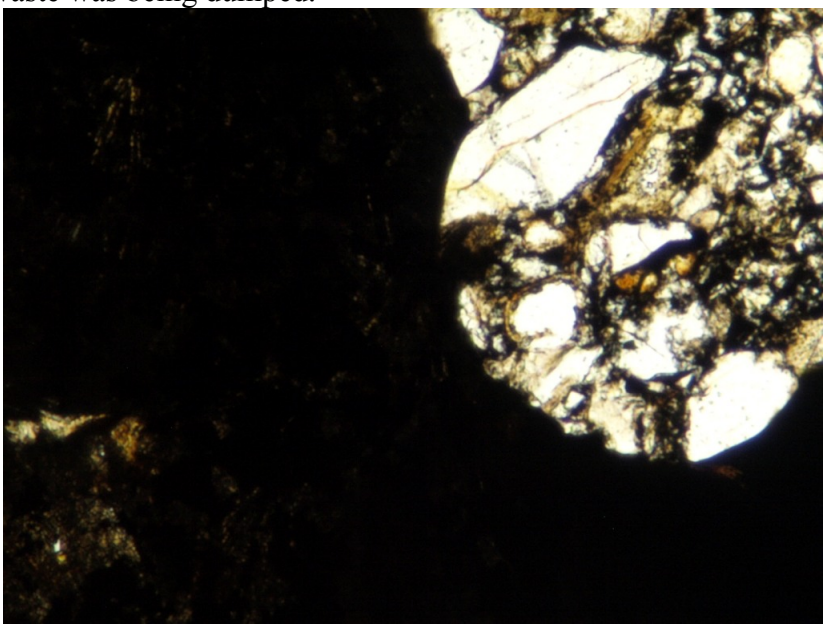

Plate 2. Sample 8033, fragment of slag (left side of image) with some mineral matter attached. PPL, x 42.5

Samples 6899 and 6898 [Fig 3]

Sample 6899 comprises two units, Unit 1 is a coarse sand with abundant ash rich in charcoal and Unit 2 is a peat ash rich in silt with some sand. Unit 2 is contained within Unit 1, although there are clasts of Unit 1 like material within Unit 2. The fabric of Unit 1 has been disturbed by the post-depositional activities of soil biota. It is likely that lower portion of Unit 1 represents the accumulation of wind blown sand and locally eroded coarse components of peat ash into a shallow hollow within the confines of an active settlement. Further erosion of a near by midden is demonstrated by the presence of relatively large clasts of fine peat ash (Unit 2) and domestic waste, as indicated in the existence of rounded coprolite clasts (no bone is observed so this coprolite is possible human)(Plate 3), pottery fragments and burnt and unburnt bone. The sediment within Sample 6898 is similar but much richer in fine peat ash, with a relatively low sand content; it is essentially an ashy midden. The sediment has been subject to extensive post-depositional bioturbation which has largely destroyed the

original fabric. However some of the largely mixed ash clasts are clearly rounded indicating rolling across a surface propelled by the wind.

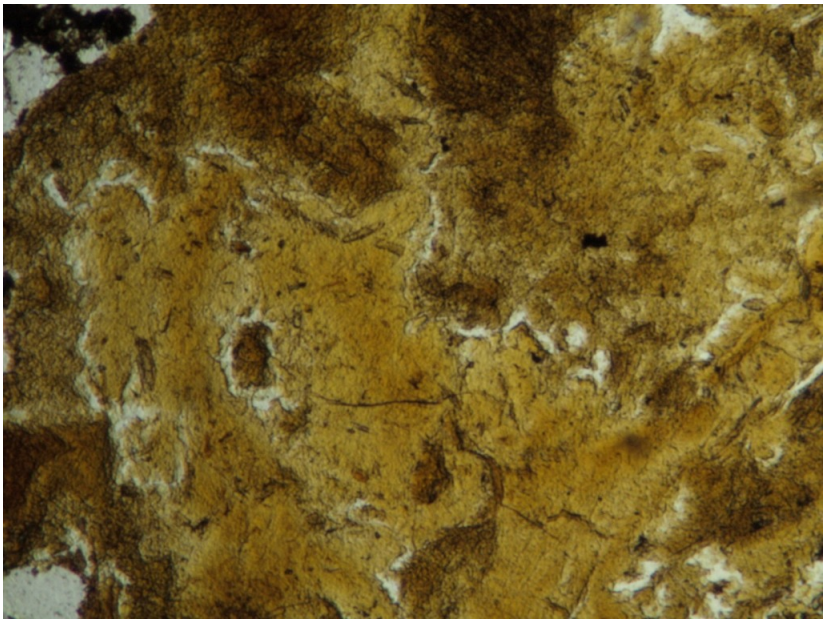

Plate 3. Sample 6899, possible human coprolite. PPL x 42.5

Samples 8032 and 8031 [Fig 4]
The lowermost context (2353) comprises a windblown sand with a small windblown ashy midden content. The sharp boundary into (2109) reflects a sudden increase in the amount of ash incorporated into the sediment. The ash in 8032 is dominated by clasts of charred amorphous organic material (partially combusted clasts of peat) while that in 8031 is dominated by fine, well combusted peat ash. As with many of the other deposits (2109) contains anthropic derived inclusions that indicate an ashy midden was being actively eroded and re-deposited as a band of dirty dune sand (Plate 4). Much of the bioturbation appears to be post-depositional in origin and reflects the high organic and nutrient rich nature of the midden material. The dark lens (3633) within (2109) comprises a mixture of fine, well combusted peat ash clasts and partially combusted peat ash clasts mixed with the occasional fragment of bone (burnt and not burnt).

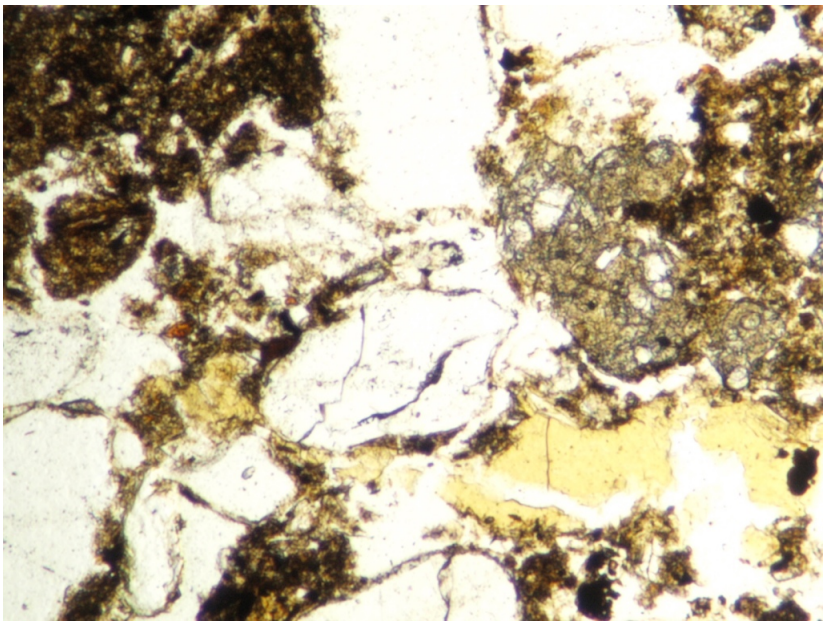

Plate 4. Sample 8031, fine peat ash, subject to high temperature combustion (grey brown material), with quartz sand grains (white material) and fragments of bone (yellow material). PPL, x 42.5.

Samples 4292 and 4291

The deposit sampled in 4292 is very similar to (3633) comprising a mixture of fine, well combusted peat ash and poorly combusted peat ash. This deposit contains the largest concentration of bone fragments of all the sampled contexts. The deposit has been extensively re-worked by soil biota. The basal portion of the deposit also contains more goethite pseudomorphs and goethite impregnations than any of the other sampled contexts, a probable consequence of the nature of this particular batch of peat. Sample 4291 comprises three irregular bands, the lower and upper band made up from a mixture of wind blown dune sand, well combusted and partially combusted peat ash and the central band is dominated by well combusted peat ash. In this central band there are very few clasts of sandstone cemented by iron (one oxidized and one metallic in Oil) which may have been the source rock of iron ore and used for the extraction of smelted iron. The central band appears to be a dump of mixed peat ash residue and midden material to which some sand has been incorporated probably by aeolian processes.

The fuel

The dominant fuel utilized was a silty, moderately humified peat. Some of the ash clasts are dominated by biogenic silica, mainly phytoliths derived from grasses (in the broadest sense) with a few diatoms, the latter clearly indicating that the organic matter accumulated under damp conditions. The degree of humification of the organic matter within the peat was poor to moderate, as woody charcoal derived from small shrubs is clearly visible within some of the ash deposits. The clasts rich in biogenic silica and yellow in colour when observed in OIL are remnants of peat that has been subject to relatively high temperatures (>600ºC) resulting in the combustion of nearly all of the organic matter (Simpson *et al* 2003). Within these clasts are occasional zones of

vesicular biogenic silica, where the temperature has attained such a high level as to melt the silica. In contrast the clasts dominated by charred and burnt organic matter have not been subject to such high temperatures and combustion is incomplete. One explanation of the micromophological evidence for contrasting burning temperatures of the peat is that the fuel was utilized for two purposes. Peat would have been burnt at a high temperature for 'industrial' use, such as the smelting of iron, whereas a lower temperature was necessary for domestic use.

In addition to the micromorphological evidence for high temperatures burning of peat, such as that required in a smelting furnace, other evidence for metal working includes a couple fragments of slag (Sample 8033), clasts of possible native ore (Samples 4292, 4291 and 8032) and shards of magnetite (Sample 8031).

The peat generally appears to have developed on a substrate rich in silt-sized quartz. However, in Sample 8031 a few clasts of silt ash contain muscovite indicating that at least some of the peat was removed directly from bedrock. The juxtaposition of clasts of peat ash derived from different temperature fires, along with the incorporation of bone fragments and rounded pottery fragments suggests that many of the contexts originated as either windblown detritus from midden heaps or were spread as thin dumps of midden material and to which wind blown sand was then naturally incorporated.

Summary conclusions

1. 8030 comprises a wind blown sand that appears to have accumulated *in situ* with the addition of some sand grains from peat ash.
2. 8034, the lower deposits are wind blown sands that appear to have accumulated *in situ* with the occasional influx of windblown ash from a near by midden; the ash content increases up the profile.
3. There is no evidence that vegetation was supported on the dune sands of 8034.
4. The remaining contexts comprise windblown sand mixed with peat ash. Generally the ash midden material appears to have been incorporated into naturally accumulating dune sand by aeolian processes.
5. Some deliberate spreading of ash midden may have occurred; windblown sand was then incorporated by natural aeolian processes.
6. The ash midden is derived from eroding midden heap(s), these middens are composed of the waste of domestic and 'industrial' activities.
7. The dominate fuel type utilized was a poor to moderately humified peat.
8. The peat ash occurs in two forms: a charcoal rich ash dark brown to black in colour derived from low temperature fires where combustion is often incomplete and a fine grey brown granular looking ash dominated by phytoliths and diatoms derived from high temperature fires where the majority of the organic matter has been burnt off.
9. The partially combusted ash is most probably derived from the domestic hearth. The fully combusted ash is likely to be derived from 'industrial' furnaces, probably associated with the smelting of ore.

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Appendix 1: Technical descriptions

SAMPLE 8034 [*Under the road S13*]

The sample includes (3587), (3584) and (3583).

Microstructure and porosity:
Type: (3587) and (3584) complex microstructures, dominated by single grain structure and laminations of bridge grain structure. (3583) complex dominated by bridge grain structure with areas of single grain structure.
Voids: (3587) simple voids approximately 30%. (3584) simple packing voids 40%. (3583) simple packing voids 25%.
Boundary: (3587)/(3584) sharp and prominent boundary (in PPL) at x40; Unit (3584)/(3583) defined by irregular lamination of organic matter (2 – 3 mm thick).

Groundmass:
Sorting: (3587), (3584) (3583) well sorted coarse sands. All three contexts contain, near horizontal, short and thin microlaminations of organic matter and ash.
Pattern: Ash laminations contain fine silt in all three contexts
Coarse/fine related distribution: Gefuric.
Fines: (3587) c/f ratio 90:10; dark brown to grey in PPL, isotropic in XPL and yellow brown (organic matter) and cream (ash) in OIL. (3584) c/f ratio 95:5; dark brown to grey in PPL, isotropic in XPL and yellow brown (organic matter) and cream (ash) in OIL. (3583) c/f ratio 90:10; dark brown to grey in PPL, isotropic in XPL and yellow brown (organic matter) and cream (ash) in OIL.
Coarse material: All three contexts dominated by rounded to subrounded, undulating sphericity, quartz grains. Very few compound quartz grains. Very few feldspars in all units. Very few pyroxenes. Very few fragmentary phytoliths. In upper ash layer within (3583) phytoliths and diatoms associated with root charcoal.

Organics:
Charcoal: (3587) (3584) very few fine-sand sized fragments. (3853) very few large fragments of root charcoal – within lamination. Possible carbonized seed.
Plant: Very few sclerotia; a few are burnt – in (3584) very few occur as clusters in voids. Boundary, burnt organic matter, partially replaced by iron oxides. (3583) mixed lamination of burnt fungal spores (?) and root charcoal.
Amorphous: (3587)/(3584) charred amorphous, few, forms bridges between mineral grains.

Pedofeatures:
Pseudomorphs: (3587)/(3584) Very few fragmented clasts of organic matter where organic matter replaced by goethite.

SAMPLE 8033 *[Under the road, S13]*

The sample includes (3583) and (3560).

Microstructure and porosity:
Type: (3583) complex dominated by intergrain microaggregate with some bridge grain structure. (3560) complex, intergrain microaggregate dominates with pellicular grain structure.
Voids: (3583) and (3560) simple packing voids 30-40%
Boundary: diffuse and faint (in PPL) at x40 – barely discernable.

Groundmass:
Sorting: well sorted coarse sands.
Coarse/fine related distribution: Enaulic
Fines: (3583) c/f ratio 80:20 and (3560) c/f ratio 70:30. Both units dark brown/black to red brown in PPL, isotropic in XPL and brown (charred organic matter), black (charcoal) and reddish yellow (burnt peat) in OIL.

Coarse material: Both contexts dominated by rounded to subrounded, undulating sphericity, quartz grains. Very few compound quartz grains. In (3583) two rounded sand dominated 'clasts' roughly 15 mm x 15 mm with very few organic fines. Very few feldspars in all units. Very few pyroxenes. Very few fragmentary phytoliths in both units. (3583) very few clasts of nearly pure biogenic silica (phytoliths and diatoms)– clasts of peat ash.
Anthropic: (3583) fragment of slag. Rounded droplet of iron ore ? (3560) very few irregular clasts of burnt silt (dark brown in PPL, orange in OIL); associated with charcoal. One rounded fragment of clayey silt with fine sand, scorched on edges and attached to charred peat. Rounded clasts of iron ore (?) or slag, with vesicles; very few linear fragments, one in (3583) 7 mm long.

Organics:
Charcoal: (3583) few clasts of massive and fine cellular charcoal, up to 5 mm – 'woody' vegetation. Few fine sand-sized fragments and very few silt-sized. (3560) common fine cellular charcoal fragments up to 5 mm. Few fine sand-sized and silt-sized.
Amorphous: few charred organic matter in both units.
Bone: (3583) very few fragments of bone.
Anthropic: possible fragment of coprolite, rich in phosphate.

Pedofeatures:
Excrement: In both units the fine material has possibly been broken down by soil fauna.
Pseudmorphs: Very few of the charcoal in both units replaced by goethite (red/orange/yellow). (3583) very few fragmented clasts of organic matter where organic matter replaced by goethite.

SAMPLE 6899 *[clay silts in D2, C2294/2117]*

The sample comprises two sediment types, Unit 1 (charcoal rich ash) and Unit 2 (grass/peat ash) which occurs as sub-rounded clasts within Unit 1. Unit 2 contains large rounded clasts of Unit 1

Microstructure and porosity:
Type: Unit 1 complex dominated by intergrain microaggregate with some bridge grain structure. Unit 2 complex, intergrain microaggregate and vughy structure.
Voids: Unit 1 complex packing voids 10-15% and Unit 2 locally variable 10-25%.
Boundary: sharp and prominent (in PPL) at x40.

Groundmass:
Sorting: Unit 1 well sorted coarse sand, Unit 2 poorly sorted sandy (medium sand) silt (bimodal).
Patterns: Unit 1 random, Unit 2 occasionally weakly banded.
Coarse/fine related distribution: Unit 1 single spaced fine enaulic, Unit 2 double spaced fine enaulic.
Fines: Unit 1 c/f ratio 70:30 and Unit 2 c/f ratio 40:60. Unit 1 dark brown/black in PPL, isotropic in XPL and dark yellowish brown (charred organic matter) and black (charcoal) in OIL. Unit 2 in PPL greyish brown, isotropic in XPL and in Oil cream with few areas of bright reddish orange.
Coarse material: Both Units dominated by rounded to subrounded, smooth sphericity, quartz grains. Very few compound quartz grains. Unit 1 5% feldspar grains, Unit 2 1% feldspar grains. Unit 2 coarse sand sized basalt grain. Both Units very few composite grains of mainly quartz. Unit 1 very few grains of augite. Unit 1 very few fragmentary phytoliths. Unit 2 frequent fragmentary biogenic silica (phytoliths dominate, very few diatoms).
Anthropic: Fragment of fine pottery 3 mm.

Organics:
Charcoal: Unit 1 fines dominated by dissolved charcoal, common silt-sized fragments, very few larger fragments (up to 3 mm). Unit 2 very few silt-sized fragments, very few larger fragments (c. 1 mm).
Plant: Both units very few burnt sclerotia.
Amorphous: frequent charred in Unit 1.
Bone: Units 1 and 2 very few fragments of burnt bone.
Anthropic: Unit 1 very few sub-rounded fragments of coprolite, rich in phosphate (2 mm). Unit 2 very few fragments of coprolite.

Pedofeatures:

Excrement: Unit 1 frequent soil faunal fecal pellets, many fused or partially fused to form dense fines. Unit 2 ash reworked by soil fauna, fine sand-sized rounded fecal pellets. Much of silt fused pellets. Rounded fabric pedofeatures of ash, possible earthworm pellets.
Channels: Common channels/chambers, few partially infilled with fecal pellets.
Impregnations: Very few red geothite impregnative pedofeatures, moderately impregnated.

SAMPLE 6898 *[clay silts in D2, C2292]*
Microstructure and porosity:
Type: complex dominated by intergrain microaggregate with some granules and crumbs. Jutaxposed clasts of rounded ash.
Voids: Unit 1 complex packing voids, locally variable 10-25%.

Groundmass:
Sorting: Moderately sorted sandy (medium sand) silt (bimodal).
Patterns: Random.
Coarse/fine related distribution: Double spaced fine enaulic and double spaced porphyric.
Fines: c/f ratio locally variable 20:80. Greyish yellow brown with clasts of dark brown, isotropic in XPL and in Oil clasts of peat cream with few areas of bright reddish orange and clasts of charcoal rich ash brown.
Coarse material: dominated by rounded to subrounded, smooth sphericity, quartz grains. Very few compound quartz grains. 10% feldspar grains. Large quartzite rounded pebble 7 mm. Frequent fragmentary biogenic silica (phytoliths dominate, very few diatoms). Very few clasts of fused biogenic silica.

Organics:
Charcoal: Few charcoal fragments up to 3 mm; some small roundwood. Common silt-size charcoal fragments in brown ash, very few in grey ash. Very few sub-rounded, fragmented clasts of contorted charcoal.
Plant: Very few burnt sclerotia.
Amorphous: frequent charred in brown ash.
Bone: Very few fragments of burnt bone up to 3 mm.

Pedofeatures:
Excrement: Some of charcoal fragments reworked by soil biota, rounded fecal pellets. Frequent soil faunal fecal pellets, many fused or partially fused to form dense fines.
Channels: Common channels/chambers, few partially infilled with fecal pellets.
Impregnations: Very few red geothite impregnative pedofeatures, moderately impregnated.

SAMPLE 8030 *[Bridge in S7; under F577 support stone]*
Microstructure and porosity:
Type: pellicular grain structure.
Voids: Unit 1 simple packing voids, 25-30%.

Groundmass:
Sorting: Moderately sorted coarse sand.
Patterns: Random.
Coarse/fine related distribution: Monic to chitonic.
Fines: c/f ratio locally variable 95:05. Dark brown to black in PPL, isotropic in XPL and in dark brown to black in OIL.
Coarse material: dominated by rounded to subrounded, smooth sphericity, quartz grains. Very few compound quartz grains. 10% feldspar grains. Very few granite and microgranite pebbles. Very few grains of augite. Very few rounded grains of magnetite & pyrite.

Organics:
Charcoal: Very few sand-sized charcoal grains. One large fragment of silty peat charcoal, 5 mm.
Plant: Very few single cells. Very few roots.
Amorphous: Occurs as coatings to mineral grains, frequent amorphous charcoal/burnt organic matter.

Pedofeatures:
Channels: Very few channels/chambers.
Pseudomorphss: Very few rounded organic matter replaced by red goethite (possibly fungal spores/pollen grains)

SAMPLE 8032 *[Floor of yard of S9]*

The sample comprises two contexts (2353) and (2109).
Microstructure and porosity:
Type: (2353) complex, dominated pellicular grain structure, with some intergrain microaggregate a few granules (clasts of silty ash). (2109) complex, intergrain microaggregate and granular structure (clasts of ash). Possible clast of turf ash, thin band of biogenic silica underlain by silty ash
Voids: (2353) complex packing voids 20% and (2109) locally variable 10-20%.
Boundary: sharp and prominent (in PPL) at x40, wavy.

Groundmass:
Sorting: (2353) well sorted coarse sand, (2109) moderately to well sorted coarse sand.
Patterns: random.
Coarse/fine related distribution: (2353) single spaced fine enaulic, (2109) single spaced fine enaulic.
Fines: (2353) c/f ratio locally variable 80:20 and (2109) c/f ratio – two 60:40 and where sand dominated 90:10. (2353) dark brown/black in PPL, isotropic in XPL and dark yellowish brown (charred organic matter) OIL. (2109) in PPL dark brown/black, isotropic in XPL and dark yellowish brown to yellowish brown in OIL.
Coarse material: Both Units dominated by rounded to subrounded, smooth sphericity, quartz grains. Very few compound quartz grains. (2353) 10 % and (2109) 5% feldspar grains. (2109) schist/gneiss pebble. Both contexts very few composite grains of mainly quartz and very few grains of augite. Very few rounded iron rich sand nodules. (2353) very few fragmentary biogenic silica (phytoliths and diatoms). (2109) few fragmentary biogenic silica (phytoliths dominate, very few diatoms). Much of biogenic silica within charred amorphous organic matter, few sub-rounded clasts of near pure biogenic silica; very few fused clasts.

Organics:
Charcoal: (2353) fines dominated by dissolved charcoal, common silt-sized fragments, very few larger fragments (up to 3 mm). (2109) fines dominated by dissolved charcoal, common silt-sized fragments, very few larger fragments, some cellular (c. 1 mm).
Plant: Both contexts very few burnt sclerotia. (2109) very few roots.
Amorphous: frequent charred in both contexts
Bone: (2353) <1% burnt bone, (2109) very few fragments of burnt bone.

Pedofeatures:
Excrement: (2353) few soil faunal fecal pellets, fused or partially fused to form dense fines, especially in granules. (2109) frequent , fine sand-sized rounded fecal pellets, few fused pellets.
Channels: (2353) very few channels/chambers, occasional infilled by coarse sand. (2109) very few channels, more common toward top of slide; some partially infilled.
Pseudomorphs: (2109) Very few red geothite pseudomorphs of organic matter.

SAMPLE 8031 *[Floor of yard of S9]*

The sample comprises two contexts (2109) and (3633), with the latter forming a lens within (2109).
Microstructure and porosity:
Type: (2109) complex, intergrain microaggregate and granular structure (clasts of silty and sandy ash). (3633) complex, granular structure with intergrain microaggregate.
Voids: (2109) complex packing voids 20% and (3633) locally variable 10% where sand and 20% where ash.
Boundary: diffuse and faint (in PPL) at x40, very irregular.

Groundmass:

Sorting: (2109) and (3633) moderately sorted coarse sand.
Patterns: random.
Coarse/fine related distribution: (2109) double spaced fine enaulic and (3633) single spaced fine enaulic.
Fines: (2109) c/f ratio 60:40 and (3633) 70:30. (2109) in PPL dark brown/black, isotropic in XPL and orange yellow in OIL. (3633) clasts of black, clasts of cream and clasts of yellowish brown in PPL, isotropic in XPL and in OIL yellow brown with fleck of black (charcoal rich ash), yellow clasts (grass/peat ash) and reddish orange (peat ash).
Coarse material: Both Units dominated by rounded to subrounded, smooth sphericity, quartz grains. Very few compound quartz grains. Both contexts very few composite grains of mainly quartz and very few grains of augite and muscovite. (2109) elongate thin shard of magnetite. Clast of silty ash in upper portion of (2109) contains few muscovite in addition to quartz etc. (2109) few biogenic silica. Both contexts very few clasts of muscovite rich ash phytoliths and diatoms (more diatoms than generally observed in other ashes). Much of biogenic silica within charred amorphous organic matter. In both contexts very few sub-rounded clasts of near pure biogenic silica and very few fused, vesicular clasts of biogenic silica. (3633) few fragmentary biogenic silica (phytoliths dominate, very few diatoms). Clasts of peat ash (*2) with very few calcite crystals (reddish orange in OIL). (3633) very few clasts of ash where original fabric visible.

Organics:
Charcoal: (2109) very few larger fragments, some cellular. Few silt-sized fragments. (3633) few larger fragments of charcoal, some cellular (largest 5 mm), some roundwood; one clast of contorted organics. Peat clasts very few silt-sized charcoal fragment, common in brown ash.
Plant: Both contexts very few burnt sclerotia, very few sclerotia (not burnt) (2109).
Amorphous: frequent charred in both contexts
Bone: (2109) very few fragments of burnt bone (2 mm). (3633) very few burnt and unburnt bone fragments (2 mm).

Pedofeatures:
Excrement: (2109) frequent , fine sand-sized rounded fecal pellets, few fused pellets.
Channels: (3633) few channels/chambers, many partially infilled by coarse sand and fecal pellets. (2109) very few channels, more common toward top of slide; some partially infilled.
Pseudomorphs: (3633) Very few red geothite pseudomorphs of organic matter.

SAMPLE 4292 *[Floor of yard of S9]*

Microstructure and porosity:
Type: complex, intergrain microaggregate and granular structure (clasts of silt rich and sand rich ash).
Voids: complex packing voids locally variable, top of slide 5% (silty peat ash) and base of slide 25% (sand and granules of sandy ash).

Groundmass:
Sorting: poorly sorted sand (base of slide) and poorly sorted silt with sand (top of slide).
Patterns: random.
Coarse/fine related distribution: double spaced fine enaulic.
Fines: base of slide c/f ratio 60:40 and top of slide 15:85. PPL dark reddish and dark yellowish brown, isotropic in XPL and peat ash orange to yellow in OIL and other ash yellowish brown.
Coarse material: dominated by rounded to subrounded, smooth sphericity, quartz grains. Very few compound quartz grains. Common biogenic silica (phtoliths and diatoms) especially where ash is mainly derived from peat. Very few pebble-sized clasts of rock with magnetite. Few rounded clasts of magnetite (edges hematite). Juxtaposition of ash clasts, vesicular silica, nearly pure biogenic silica, mixed clasts of burnt amorphous organic matter, biogenic silica and silt grains.

Organics:
Charcoal: very few larger fragments, some cellular. Very few silt-sized fragments in peat ash, other ash slightly higher content. Very few rounded clasts of vesicular charcoal.
Plant: very few burnt sclerotia.
Amorphous: frequent, burnt

Bone: few fragments of burnt bone (largest 9 mm).

Pedofeatures:
Excrement: frequent , fine sand-sized rounded fecal pellets, few fused pellets.
Channels: few channels/chambers, many partially infilled by coarse sand and fecal pellets.
Pseudomorphs: Rounded spheroids (silt-sized) of goethite? associated with biogenic silica and bone fragments (pseudomorphs or fungal spores?). Coarse sand-sized fragments of geothite, replaced organic matter.

SAMPLE 4291 *[Floor of yard of S9]*

The sample comprises three irregular bands, the lower and upper a mixed peat/wood ash and the central band a fine peat ash (Unit 2). The lower and upper bands are essentially the same material and are described as Unit 1.

Microstructure and porosity:
Type: Unit 1 complex, intergrain microaggregate and granular structure (clasts of silt rich and sand rich ash). Unit 2 complex, granular structure (fused fecal pellets within granules), spongy structure (dominated by peat ash).
Voids: Unit 1complex packing voids locally variable 15 -25% and Unit 2 complex packing voids 10-25%.
Boundary: in places sharp and prominent (x40) PPL.

Groundmass:
Sorting: Unit 1 moderately sorted coarse sand, Unit 2 and poorly sorted silt with sand.
Patterns: random.
Coarse/fine related distribution: Unit 1 double spaced fine enaulic. Unit 2 concave gefuric but with zones of enaulic.
Fines: Unit 1 c/f ratio 70:30 and Unit 2 15:85. Unit 1 PPL dark reddish and dark yellowish brown, isotropic in XPL and peat ash dark orange/yellow in OIL. Unit 2 in PPL clasts of greyish brown and very few clasts of brown, isotropic in XPL and clasts of bright orange, very few clasts of yellow and clasts of brown in OIL.
Coarse material: dominated by rounded to subrounded, smooth sphericity, quartz grains. Very few compound quartz grains. Very few feldspar grains. In Unit 1 clast of sandstone where grains welded together by iron, internal clay coatings of a few voids, possible clast of ore? Unit 1 few biogenic silica. Very few coarse sand-sized rounded fragments of iron (magnetite). Very few fine sand-sized fragments of pyrite (?) Unit 2 common biogenic silica (phytoliths and diatoms). Juxtaposition of pure biogenic silica ash clasts and vesicular silica clasts. Unit 1 fragment of shell.

Organics:
Charcoal: Unit 1 very few larger fragments, some cellular, some with sand or silt; one iron oxide in pores. Very few silt-sized fragments and sand-sized fragments. Unit 2 few larger fragments, much cellular (up to 9 mm), fragmented by compaction and bioturbation. Few sand-sized and silt-sized fragments.
Amorphous: frequent, burnt. Unit 2 some peat ash clasts retain original linear fabric. Clast of red organic matter with some sand, burnt peat where much of organic matter replaced by geothite.
Bone: Unit 1 very few fragments of burnt bone, possible fish bone? Unit 2 very few fragments of burnt bone.

Pedofeatures:
Excrement: Unit 1 frequent , fine sand-sized rounded fecal pellets, few fused pellets. Unit 1 few fecal pellets.
Channels: Unit 2 very few channels/chambers, some partially infilled silt ash, others by fecal pellets.
Pseudomorphs: Unit 2 very few coarse sand-sized fragments of iron oxide, replaced organic matter. Very few clasts of burnt peat where organics replaced by goethite.
Impregnations: Unit 2 very few clasts of silica ash stained by geothite.