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Analysis of soil thin sections from Warren Field, Crathes, Aberdeenshire.

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INTRODUCTION

This report contains the results of the analysis of soil thin-sections from Warren Field, Crathes, Aberdeenshire. The site is situated within the Dee Valley and sits on glacio-fluvial sands that were deposited in well-sorted bands. Most of the samples were taken from a pit located within a Neolithic post-built structure (Pit 30). One sample was taken from a pit that forms part of a pit alignment (Pit 16).

Thin-section samples were taken with a view to elucidating the nature of the deposits and the processes by which they were formed. Issues of particular concern were the processes of infilling of the pits, the formation process of Context *e* in Pit 30 with regard to the possibility of its being a collapsed hurdle revetment, and the impact of post-depositional processes on pollen analysis from Pit 30.

In this report the thin-sections are described with particular attention to the most archaeologically relevant aspects of the samples. These descriptions are interpreted in terms of depositional and post-depositional processes in the Discussion section, followed by a consideration of the archaeological implications of that interpretation.

METHODS

A total of 6 samples was taken, five from Pit 30 and one from Pit 16. The samples are listed in Table 1. The samples from Pit 30 were taken in tandem with samples for pollen analysis. The thin-section samples were taken across deposit boundaries in order to allow the contacts between deposits to be examined and to allow ease of comparison between deposits.

Resin impregnation of the samples and thin section preparation was undertaken by the Department of Environmental Science, University of Stirling, and followed standard procedures (Murphy 1986). The thin sections were sub-divided into zones after an initial low magnification examination. The thin sections were recorded using a petrological microscope under a variety of magnifications and lighting techniques using the descriptive scheme and terminology recommended by Bullock *et al.* (1985), as supplemented and modified by Courty *et al.* (1989).

Sample Code	Zone Numbers	Context Numbers
1	1	30/11
1	2	30/12
2	1	30/12
2	2	30/2
3	1	30/6
3	2	Charcoal lens
3	3	30/2
4	1	30/13
4	2	30/6
5		30/6, 30/5
6	1	16/10
6	2	16/7

Table 1: Thin Section Samples and Corresponding Contexts

RESULTS

Descriptions of the thin sections are presented in Table 2. A number of summary observations can be made. All the deposits sampled exhibit little or no sediment sorting, with different size fractions arranged in a random and chaotic fashion. This indicates a relatively high energy, rapid process of infilling, as is discussed below. The sampled deposits in both pits are largely composed of two components: an unsorted to poorly sorted coarse mineral component of sand with small stones, composed of quartz, feldspars and fragments of metamorphic rock; and a fine organo-mineral component, composed of silt sized particles of quartz and feldspar, humified organic matter, with finely comminuted charcoal intermixed throughout the fine material. The fine material has formed as bacillo-cylindrical excrements, generally interpreted as being the product of enchytraeid worms (Bullock *et al.* 1985). Where coarse charred material occurred this was intimately associated with the organo-mineral fine material. The compositional difference from deposit to deposit was largely explicable in terms of the variation in the proportion in these two main components.

Pit 16

The contexts sampled in Pit 16 (Contexts 16/10 and 16/7) have undergone much reworking by enchytraeid activity. There are also possible traces of earthworm excrements in Zone 1 of Sample 6 (Context 16/10) and the channels that form the void space of Contexts 16/10 and 16/7 are indicative of biological activity in the form of root growth or earthworm burrowing. These contexts appear to be more heavily reworked than those sampled in Pit 30, and do resemble biologically active topsoils under the microscope. Despite the degree of reworking, the contexts are distinguishable both in the field and under the microscope.

Pit 30

As noted above, the deposits are mainly formed of two components. The only apparent exception is the apparent charcoal lens. Although the charcoal lens has a higher charcoal content than the other contexts it is still principally composed of the two components identified, with the association of charcoal with the fine fraction largely true. There is no indication that the charcoal formed *in situ,* with the coarse charcoal being intermixed with other material. I t has also eroded and rounded forms, indicative of having been moved with other sediment, and there is no other evidence of heating in the sample, e.g. reddening of the fine fraction, which might be expected if the charcoal had formed *in situ.*

Despite the ubiquity of enchytraeid excrement throughout the deposits in Pit 30, fragments of humified organic matter that have not been eaten by enchytraeids have been noted in Contexts 30/12, 30/2, 30/5, 30/6 and the charcoal lens. This indicates that enchytraeid activity was relatively short lived.

The Pit 30 deposits have generally undergone relatively little post-depositional modification: although there has been enchytraeid activity the reworking of sediment occurs over a very small scale. There is very limited evidence of movement of iron in solution throughout the deposits. The boundaries between deposits identified in the field are clear and defined under the microscope and relate to varying proportions of the two main components identified above, with one exception. This is the indistinct boundary between Contexts *d1* and *d2*. Contexts *d1* and *d2* have undergone significant rooting/earthworm burrowing. The boundary between them simply marks the variation in the degree of apparent porosity, with the upper 'deposit' being the more highly channelled material. Therefore the boundary reflects a difference in intensity of post-depositional activity, rather than a genuine stratigraphic boundary.

DISCUSSION

Sediment Sources
The composition of the deposits in both Pit 30 and Pit 16 in terms of the mineralogy and size range (i.e. sand and gravels) of the coarse mineral fraction in all the slides is consistent with soils and sediments of local origin. The ubiquity of enchytraeid excrements and fine charcoal indicates that these deposits are not unmodified sub-soils, but material that had an input of organic material and charred material and underwent biological reworking. These features, combined with the nature of the coarse mineral fraction, are consistent with topsoils forming from the local sub-soils, although these are not topsoils that have formed *in situ* within the pit. The finely comminuted charcoal, intimately mixed with the organo-mineral fine fraction, indicates that soil formation probably occurred in the vicinity of human activity. Although the sediment sources are local, the evidence of soil formation prior to deposition means that the sediments in Pit 30 would have been brought into the structure rather than simply being the reworking of the sub-soil which the Neolithic post-built structure was built on.

Formation processes in Pit 16
As has been noted above Contexts 16/10 and 16/7 have undergone considerable reworking through biological activity, while still being recognisable as two distinct deposits. This indicates that after the deposition of each of these contexts there were periods of little of no sediment accumulation, and the contexts may have been ground surfaces for at least short periods. This means that the modern topsoil has accumulated and developed subsequently. The horizontal boundaries of Contexts 16/10 and 16/7 with the modern topsoil, contrasting with the inclined boundaries within the pit suggests that these deposits have been effectively truncated at the edges of the pit, either through biological or agricultural activity.

Formation processes in Pit 30
The unsorted nature of the coarse mineral fraction and the random distribution of topsoil fragments in the deposits of Pit 30 indicates a chaotic, relatively high energy process of infilling. The field section reveals a relatively complex pattern of digging and filling of the pit, with the pit being re-dug at least four times. This complexity is not reflected in the variety of deposit types. The section drawing shows that most of the cuts/deposit boundaries are much steeper than the natural angle of rest for the sub-soils through which the pit has been cut. The steep-sided shapes of the cuts suggest either that the pit must have been re-filled as soon as it was dug, or that the cut was supported. In respect of the first suggestion it should be noted that the fills are clearly distinguishable from the adjacent material through which their containing cuts have been made. It is argued that where a cut is rapidly filled the fill and the material through which it is cut will be difficult to distinguish, as the infill is usually compositionally identical to the cut material. The distinctiveness of the different fills therefore lends support to an interpretation in which the cuts have been supported and backfilling occurred later with a different, distinctive, fill after support was removed or became redundant. These two lines of evidence together indicate cultural rather natural processes of infilling.

Although evidence of enchytraeid activity is ubiquitous, the scale over which they operate is sufficiently small for it not to have a significant impact on the integrity of pollen assemblages when sampled at the scale used in Pit 30. The absence of large scale biological reworking of most of the deposits and the survival of small humic fragments, that would normally be incorporated into the organo-mineral fine fraction through invertebrate activity, indicates either the effect of the area being covered by a roof or that the infilling process was rapid. In either case conditions inimical to biological reworking were rapidly established within the deposits.

Archaeological implications
Pit 16
The effective truncation of the top of Pit 16, probably through the impact of ploughing and normal soil formation processes needs to be taken account of with regard to the possible loss of small banks or heaps of upcast. The scale of soil formation processes in Contexts 16/7 and 16/10 are insufficient to cause a problem with regard to analysis of environmental remains or small finds.

Pit 30

The process of cutting and filling the pit was a complex one, as has been noted above. This complexity is not, however, reflected in the composition of the sediments with which the pit has been filled. Although the various fills are clearly distinguishable in thin-section, none of them varies radically from the others in terms of composition. No exotic components were observed in thin section. Thus in terms of composition there is no evidence to indicate that the sediments of which the deposits are composed were regarded as particularly important in themselves. This is not to suggest that environmental and finds evidence may not point to the deposition of the fills themselves having a direct cultural significance. Allowing for this possibility, it would seem on the basis of the thin section and field observations that the cultural significance attached in some sense to the process of digging, re-cutting and filling the pit, either directly or in relation to some other element for which there is no direct evidence.

As discussed above, the form of the pit and its fills and the nature of the sediments through which it is cut precludes natural infilling: some sort of support must have existed. The support may have been some form of revetment to maintain an open pit, a suggestion initially based on the presence of the charred lens between 30/4 and 30/2, which was hypothesised by the excavator as the charred remains of a collapsed hurdle revetment. As discussed above, the composition of this deposit has disproved this hypothesis. In addition the tip angles of Contexts 30/2, 30/6 and the charred lens make it less likely that this was a revetted pit.

A more likely explanation is that the pit may have been the setting for a solid object, and that this propped the sides of the pit while it was in place. The object, or a series of objects, was set in and removed from the pit and the pit backfilled on at least four occasions, with the upper fill (Contexts 30/5 and 30/6) being the final fill after the object was removed for the last time.

CONCLUSION

In terms of the specific issues outlined in the introduction the following conclusions are drawn:

- The infilling of the upper part of Pit 16 was sufficiently gradual or episodic to allow soil formation to have occurred, meaning that Contexts 16/10 and 16/7 constitute old land surfaces.
- The infilling processes of Pit 30 are due to cultural activity, rather than natural processes such as the side of the pit collapsing, and represent part of a complex pattern of human behaviour.
- The stratigraphic boundaries recorded in the field and subject to thin section analysis have all been confirmed with the exception of the boundary between Contexts 30/6 and 30/5 which marks a variation in post-depositional soil formation processes.
- As such the pollen samples have been taken from boundaries/surfaces, as was intended, and biological reworking will not have been sufficient to render the results of pollen analysis spurious.

REFERENCES

Bullock, P, Federoff, N, Jongerius, A, Stoops, G & Tursina, T 1985 *Handbook for Soil Thin Section Description*. Wolverhampton, Waine Research Publications.

Courty, M A, Goldberg, P & Macphail, R 1989 *Soils and micromorphology in archaeology*. Cambridge: The University Press.

Table 2. Thin section descriptions from Warren Field, Crathes.

Sample No.	Zone No.	Context No.	Mineral Components	Organic components	Fabric	Microstructure	Pedofeatures
1	1		Common to dominant quartz. Common feldspars, frequent fragments of metamorphic rock, including granite. Coarse mineral fraction poorly sorted. Grains and fragments sub-rounded to rounded, rarely sub-angular. Many cracked quartz grains. Mineral suite generally has a 'battered', weathered appearance. Fine mineral silt sized, similar range of mineral types.	Coarse organic absent except single fungal spore. Fine material organo-mineral, with amorphous organic matter and comminuted charcoal.	Light brown fabric, enaulic, C/F limit 50 µm, C/F ratio 10:1	Intergrain aggregate, density of aggregates variable. Void space approx. 40%, packing voids.	Frequent bacillo-cylindrical excrements, highly fused. Possible rare reworked mamillated excrements. Rare reddened mineral grain.
1	2		Common to dominant quartz. Common feldspars, frequent fragments of metamorphic rock, including granite. Coarse mineral fraction moderately to poorly sorted. Grains and fragments sub-rounded to rounded, rarely sub-angular. Some cracked quartz grains. Slightly less weathered appearance to the mineral suite. Fine mineral silt sized, similar range of mineral types.	Frequent sand sized fragments of charcoal. Fine material organo-mineral with amorphous organic matter and comminuted charcoal.	Light buff brown fabric, enaulic to monic, C/F limit 50 µm, C/F ratio 20:1	Granular to intergrain microaggregate Porosity:	Occasional to common bacillo-cylindrical excrements, highly fused. Possible rare reworked mamillated excrements. Rare reddened mineral grain.
2	1		Common to dominant quartz. Common feldspars, frequent fragments of metamorphic rock, including granite. Coarse mineral fraction poorly sorted. Grains	Occasional fragments of amorphous	fabric, enaulic to monic, C/F limit 50 µm,	Intergrain microaggregate Porosity: 30%.	Common bacillo-cylindrical excrements, highly fused in places.

			and fragments sub-angular to rounded. Few cracked quartz grains. Fine mineral silt sized, similar range of mineral types.	organic matter (125 µm), battered sand sized fragments of charcoal. Occasional to common comminuted charcoal incorporated into organo-mineral fine fraction.	C/F ratio 15:1		Possible rare reworked mamillated excrements. Rare partially reddened mineral grain.
2	2		Dominant quartz, common feldspars, frequent fragments of metamorphic rock, including granite. Coarse mineral fraction poorly sorted. Grains and fragments sub-rounded to rounded. Some cracked quartz grains. Fine mineral silt sized, similar range of mineral types.	Frequent charcoal fragments (up to 8mm) and frequent fragments of humified material. Fine material more humic and contains more comminuted charcoal than Zone2.	Dark yellow brown fabric, enaulic, C/F limit 50 µm, C/F ratio 10:1	Intergrain microaggregate Porosity: 25%	Frequent bacillo-cylindrical excrements, highly fused/dense in places. Rare partially reddened mineral grain. Single large topsoil fragment.
3	1		Dominant quartz, occasional feldspars, frequent fragments of metamorphic rock. Coarse mineral fraction poorly sorted. Grains and fragments sub-angular to rounded. Fine mineral silt sized, similar range of mineral types, but feldspars frequent.	Occasional charcoal and lignified plant remains. Frequent	Dark yellow brown fabric, enaulic, C/F limit 50 µm, C/F ratio 3:1	Intergrain microaggregate Porosity: 20%	Frequent bacillo-cylindrical excrements, highly fused/dense in places. Rare partially reddened mineral grain.

				comminuted charcoal and humified matter incorporated into organo-mineral fine fraction.			
3	2		Dominant quartz, occasional feldspars, frequent fragments of metamorphic rock. Coarse mineral fraction poorly sorted. Grains and fragments sub-angular to rounded. Fine mineral silt sized, similar range of mineral types.	Frequent charcoal and lignified plant remains. Frequent to abundant comminuted charcoal and humified matter incorporated into organo-mineral fine fraction.	fabric, gefuric, C/F limit 50 µm, C/F ratio 4:1	Intergrain microaggregate Porosity: 25-30%, including possible biological channels	Frequent bacillo-cylindrical excrements. Rare partially reddened mineral grain.
3	3		Abundant quartz and feldspars, frequent fragments of metamorphic rock, including granite. Coarse mineral fraction poorly sorted. Grains and fragments sub-angular to rounded. Significant chemical weathering of feldspars. Fine mineral silt sized, similar range of mineral types.	Occasional sand sized battered charcoal. Occasional but ubiquitous comminuted charcoal incorporated into organo-mineral fine	Pale buff fabric, monic to enaulic, C/F limit 50 µm, C/F ratio 10:1	Granular to intergrain microaggregate Porosity: 40%	Occasional to common bacillo-cylindrical excrements. Rare to very rare partially reddened mineral grain.

				fraction.			
4	1	30/13	Abundant quartz and feldspars, frequent fragments of metamorphic rock. Coarse mineral fraction poorly sorted. Grains and fragments sub-rounded to rounded. Some cracked quartz grains. Fine mineral silt sized, similar range of mineral types.	Occasional comminuted charcoal incorporated into organo-mineral fine fraction.	Pale brown fabric, enaulic, C/F limit 50µm, C/F ratio 10:1	Intergrain microaggregate Porosity: 40%	Occasional bacillo-cylindrical excrements.
4	2		Abundant quartz and feldspars, frequent fragments of metamorphic rock. Coarse mineral fraction poorly sorted. Grains and fragments sub-rounded to rounded. Some cracked quartz grains. Fine mineral silt sized, similar range of mineral types.	Frequent charcoal fragments. Abundant comminuted charcoal incorporated into organo-mineral fine fraction.	Dark yellow brown fabric, chito-gefuric, C/F limit 50µm, C/F ratio 3:1	Dense intergrain microaggregate Porosity25-35%	Frequent to abundant bacillo-cylindrical excrements. Rare to partially reddened mineral grain.
5			Abundant quartz and feldspars, frequent fragments of metamorphic rock. Coarse mineral fraction unsorted. Grains and fragments sub-angular to rounded. Fine mineral silt sized, similar range of mineral types.	Occasional to common charcoal fragments, of battered appearance. Abundant comminuted charcoal incorporated into organo-mineral fine fraction.	Pale buff brown fabric, C/F limit 50µm, C/F ratio 3:1	Intergrain microaggregate to channelled granular. Porosity varies across slide: 60% at top, reducing to 30% at base.	Occasional to common bacillo-cylindrical excrements. Rare partially reddened mineral grain. Very rare iron impregnated plant tissue pseudomorphs.
6	1		Abundant quartz and feldspars, frequent fragments of metamorphic rock. Coarse mineral fraction poorly to	Rare charcoal fragments.	Pale yellow brown fabric,	Intergrain microaggregate	Common to frequent bacillo-cylindrical

			moderately sorted. Grains and fragments sub-angular to rounded. Fine mineral silt sized, similar range of mineral types.	Common comminuted charcoal incorporated into organo-mineral fine fraction.	C/F limit 50µm, C/F ratio 6:1	to pellicular granular. Porosity 30-40%, mainly channels.	excrements. Single possible reworked mamillated excrement. Occasional to rare partially reddened mineral grain.
6	2		Dominant quartz, abundant feldspars, frequent fragments of metamorphic rock. Coarse mineral fraction poorly to moderately sorted. Grains and fragments sub-angular to rounded. Fine mineral silt sized, similar range of mineral types.	Rare charcoal fragments. Abundant comminuted charcoal incorporated into organo-mineral fine fraction.	Yellow brown fabric, C/F limit 50µm, C/F ratio 4:1	Intergrain microaggregate Porosity 40%, mainly channels.	Common to frequent bacillo-cylindrical excrements. Rare to very rare partially reddened mineral grain.