10 Analysis of Thin Sections from Ash Deposits Within the Cairn *by S Carter*

10.1 Introduction

The north-west part of the cairn at Olcote contained layers of sediment identified in the field as burnt peat. Deposits of ash have been recorded elsewhere in association with cremation burials and have been interpreted as the product of the cremation pyre itself, together with fires forming part of other related rituals. The sediments at Olcote were sampled using two 250-mm monolith tins, with the intention of undertaking further analysis of the composition, origins and history of the deposits. Thin-sectioning was selected as an appropriate method of analysis.

10.2 Methodology

The first monolith tin had been severely distorted during sampling and, as a result, the sediment block within it had been disrupted. Therefore, it was discarded. The second monolith, sampled as a replacement for the damaged tin, was intact and was chosen for sub-sampling. The stratification of Monolith 2 was recorded before sub-sampling and four layers were apparent. The upper three layers, totalling 130 mm thick, were red-brown ashes with variable concentrations of carbonized inclusions. The lowest layer, a natural soil, occupied the remaining 10 mm of the monolith. Sub-samples were extracted in three overlapping Kubiena tins from the uppermost 190 mm of Monolith 2:

Sample 2.1 0–80 mm (ash)
Sample 2.2 45–125 mm (ash)
Sample 2.3 110–190 mm (ash and soil)

Eight 50-mm thin-sections were produced from the Kubiena tin blocks by the Department of Environmental Science, University of Stirling, using standard methods of acetone drying, resin impregnation and thin-sectioning (Murphy 1986). The thin sections were analysed using the methods and terminology recommended in the *Handbook for Soil Thin-Section Description* (Bullock *et al.* 1985).

10.3 Results

Following microscopic examination, it proved possible to divide the thin sections into six distinct horizontal bands of sediment, the upper five corresponding to the ash layers recorded in the field (Table 15).

Detailed descriptions of these layers are given in Table 16 although the characteristics of the sediments are summarized in Table 15. There is little evidence for post-depositional alteration. Modern roots are present in all layers but at low density and they have not radically altered either fabric or structure. They are the cause of the low-porosity channel structures in layers 1, 2 and 4 but this barely disrupted the original massive structure. Amorphous iron pedofeatures in layer 2 are post-depositional in origin and reflect gleying conditions in this sediment, probably due to partial waterlogging. Similar features in layer 6 (natural soil) probably developed prior to burial by the ash layers. It may be assumed that, overall, the present appearance of the sediments offers a good guide to their composition, fabric and structure at the time of deposition.

Only layers 1, 2 and 4 can be correctly described as ash layers; they consist entirely of the oxidized or reduced (carbonized) residues of burnt fuel (Courty *et al.* 1989, 105). Oxidized residues are characterized by very high reflectance in oblique incident light due to heating of iron oxides present in the fuel. No organic materials survived oxidation so the rare mineral components of the fuel have become concentrated, notably the biogenic silicas (phytoliths and diatoms). Combustion with limited oxygen led to the survival of organic residues in a reduced (carbonized) form; carbonized peat fragments are frequent in layers 1 and 4.

Layers 3 and 5 are similar, narrow bands of

Table 15 Summary of sediment bands

Layer	Depth (mm)	Description
1	21 (minimum)	Ash with frequent fragments of carbonized peat
2	55	Ash with very few carbonized fragments
3	12	Narrow band dominated by highly humified organic matter
4	38	Ash with frequent fragments of carbonized peat
5	5	Narrow band dominated by highly humified organic matter
6	50 (minimum)	Mineral subsoil with lenses of ash in upper 10 mm

Table 16 Summary descriptions of ash layers (the coarse: fine (c/f) limit for the following descriptions is 50 μm)

	Mineral components			Organic components			
Layer	C/f ratio	Coarse material	Fine material	C/f ratio	Coarse material	Fine material	Features
1	Frequent: dominant	Common, poorly sorted angular sand grains and metamorphic rock fragments. Rare bone fragments up to 6 mm long	Mineral composition: Pale yellow to brown in PPL. Pale yellow to strongly reflective reddish-yellow in OIL. Dotted appearance with frequent phytoliths and few silt grains and diatoms	Very dominant: few	Frequent carbonized peat fragments up to 6 mm long. Few modern roots	Very few amorphous carbonized fragments	**Groundmass** Fabric of coarse material: random Fabric of fine material: undifferentiated b fabric Related distribution of c/f: porphyric **Microstructure** Channel structure created by modern roots. No true peds but common fragments of highly coalesced **Pedofeatures** *Textural* None *Depletion* None *Crystalline* None *Amorphous* None *Excrement* None *Fabric* None
2	Frequent: dominant	Common, poorly sorted angular sand grains and metamorphic rock fragments. Rare pottery fragments up to 15 mm long. Consists of silt and clay-sized grains with frequent fine fragments of carbonized organic matter	Mineral composition. Brown in PPL. Strongly reflective yellow to reddish-yellow in OIL. Dotted appearance with frequent phytoliths and silt grains and few diatoms	Unknown	Very few carbonized peat fragments. Few modern roots	Very few amorphous carbonized fragments	**Groundmass** Fabric of coarse material: random with some evidence of banding Fabric of fine material: undifferentiated b fabric Related distribution of c/f: porphyric **Microstructure** Channel structure created by modern roots. No true peds but common fragments of highly coalesced **Pedofeatures** *Textural* None *Depletion* None *Crystalline* None *Amorphous* Few impregnative ferruginous hypocoatings on channel walls *Excrement* None *Fabric* None
3	Common: common	Common, poorly sorted angular sand grains and metamorphic rock fragmentsRare pottery fragments as in layer 2	Organo-mineral composition. Dark brown in PPL. Non- reflective in OIL. Consists of amorphous organic matter with frequent silt grains heavily stained with organic matter	Very frequent: dominant	Few highly humified vascular and epidermal tissue fragments up to 5 mm longFew amorphous highly humified fragments up to 5 mm longFew amorphous carbonized fragments up to 2 mm long Few modern roots	Dominant dark brown amorphous organic matter	**Groundmass** Fabric of coarse material: random with some horizontal layering Fabric of fine material: undifferentiated b fabric Related distribution of c/f: porphyric **Microstructure** Spongy structure, high porosity with some recent root channels **Pedofeatures** *Textural* None *Depletion* None *Crystalline* None *Amorphous* None *Excrement* None *Fabric* None

Table 16 Summary descriptions of ash layers (the coarse: fine (c/f) limit for the following descriptions is 50 μm)

	Mineral components			Organic components			
Layer	C/f ratio	Coarse material	Fine material	C/f ratio	Coarse material	Fine material	Features
4	Frequent: dominant	Common poorly sorted angular sand grains and metamorphic rock fragments Rare bone fragments up to 6 mm long	Mineral composition. Pale yellow to brown in PPL. Pale yellow to strongly reflective reddish yellow in OIL. Dotted appearance with frequent phytoliths and few silt grains and diatoms	Very dominant: few	Frequent carbonized peat fragments up to 6 mm longFew modern roots	Very few amorphous carbonized fragments	**Groundmass** Fabric of coarse material: random with some horizontal banding Fabric of fine material: undifferentiated b fabric Related distribution of c/f: porphyric **Microstructure** Channel structure created by modern roots. No true peds but common fragments of highly coalesced **Pedofeatures** *Textural* None *Depletion* None *Crystalline* None *Amorphous* None *Excrement* None *Fabric* None
5	Common: common	Common, poorly sorted angular sand grains and metamorphic rock fragments	Organo-mineral composition. Dark brown in PPL. Non- reflective in OIL. Consists of amorphous organic matter with frequent silt grains heavily stained with organic matter	Very frequent: domi nant	Few highly humified vascular and epidermal tissue fragments up to 5 mm longFew amorphous highly humified fragments up to 5 mm longFew amorphous carbonized fragments up to 2 mm longFew modern roots	Dominant dark brown amorphous organic matter	**Groundmass** Fabric of coarse material: random with some horizontal layering Fabric of fine material: undifferentiated b fabric Related distribution of c/f: porphyric **Microstructure** Spongy structure, high porosity with some recent root channels **Pedofeatures** *Textural* None *Depletion* None *Crystalline* None *Amorphous* None *Excrement* None *Fabric* None
6	Dominant: common	Common, poorly sorted angular sand grains and metamorphic rock fragments up to 10 mm	Mineral composition. Consists of poorly sorted silt and some clay. Variable abundance	N/A	None noted	None noted	**Groundmass** Fabric of coarse material: random Fabric of fine material: crystallitic b-fabric Related distribution of c/f: massive fragments are porphyric tending to gefuric/enaulic in areas with less fine fraction. **Microstructure** Large fragments with massive structure surrounded by matrix with intergrain microaggregate structure. **Pedofeatures** *Textural*Frequent silt coatings and infillings in fragments with massive structure, highly impregnate with iron (see amorphous) *Depletion* None *Crystalline* None *Amorphous* Frequent Fe impregnative nodules. Fragments with massive structure are variably impregnated with Fe. *Excrement* None *Fabric* None

sediment dominated by highly humified, but not burnt, organic residues. Ash (both oxidized and carbonized) residues are present as minor components of these layers. Layer 6, the natural soil beneath the cairn, contrasts strongly with the overlying deposits as it lacks any ash or unburnt organic components. It is purely a mineral sediment.

The presence of two exotic components in these sediments should be noted. Bone is present in layer 1 and pottery in layers 2 and 3.

10.4 Discussion

10.4.1 Composition and source of the ash layers

The composition of the three ash layers (1, 2 and 4) points to one type of fuel as the source of these deposits – peat. This general term covers a wide variety of organic sediments of terrestrial and aquatic origin and details of the composition may be used to define the nature of the fuel more precisely. Carbonized fragments preserve the original structure and composition of fuel. In these examples it ranges from plant tissue fragments to amorphous, laminated organic matter and amorphous, organo-mineral sediments. This mixture of residues is typical of peaty turves or shallow blanket peat which contain a significant proportion of mineral sediment and therefore create abundant ash when burnt. Total oxidation of peaty turves yields a mixture of amorphous mineral ash, abundant biogenic silica and mineral grains. This is the mixture recorded in layers 1, 2 and 4.

The only significant difference in composition between the three ash layers is the relative proportions of oxidized to carbonized residues. This simply reflects differences in the conditions of combustion of three essentially similar fuels. Layer 2 ash was created in a strongly oxidizing fire and therefore almost no carbonized residues were created. Total oxidation can normally be achieved simply by the limited tending of a fire and mixing of the ashes as they accumulate. Fuel generally survives in a carbonized condition either if it has fallen out of a fire before total combustion or if it is smothered by accumulating ash which cuts off the supply of oxygen. The variation in composition therefore tells us little about the nature of the fires that created the ashes.

The presence of a few small fragments of bone and pottery could reflect the nature of the source fires if it is assumed that they do not derive from a separate source. Given that there is no other evidence for another source, and the fact that bone will only have survived in a burnt condition, it is safe to assume that the bone and pottery was present in the fires. Given the proximity of an urned cremation in the cairn, it would be reasonable to assume that bone and pottery in the ash points to a source in cremation pyres. This interpretation cannot be supported by the thin-section evidence as the bone fragments are too small to identify as human (6 mm maximum length). Support for a cremation pyre source is also lacking in the overall nature of the ash which shows no signs of having been formed at high temperatures. Study of cremation pyres fueled with peaty turves at Linga Fold, Orkney (S Carter unpublished data) identified evidence of high temperatures. Biogenic silica (in particular from diatom frustules) was partially or totally melted and significant quantities of vitrified fuel ash occurred because of the general melting of silicates at temperatures in the range 500–1000°C. High temperatures were probably achieved in pyres through a combination of careful pyre construction, maintaining the supply of oxygen, a large volume of fuel and long firing time. Therefore, whilst it is an argument based on negative evidence, it may be proposed that there is no reason to believe that the ash layers derive from cremation pyres. A simple cooking fire, using peaty turves, could create ash of a type recorded at Olcote and bone or pottery could easily be incorporated into the ash in this context.

The exact source of the peaty turf burnt in these fires cannot be determined. Shallow, peaty soil horizons would have been widespread in the Bronze Age and provided an important source of fuel at a time when indigenous supplies of wood had effectively ceased in Lewis and the deep blanket peat of the modern landscape had yet to accumulate. Mineralogy of the sand grains and lithology of rock fragments in the oxidized ash do not help, as they represent a soil parent material present over most of the island. However, given the widespread occurrence of peaty soils, a local source for the fuel can be safely assumed.

10.4.2 Composition and source of the humified organic bands

Layers 3 and 5 are distinctive because they are dominated by highly humified organic residues that have not been burnt, so they are not fuel ash. The high degree of humification has left little structural information with which to identify the plants originally present. Recognizable remains include epidermal and vascular tissues which are commonly most resistant to decomposition. These derive from herbaceous (non-woody) plants but further identification is not possible. Without more precise identifications for the plants, a source for these layers cannot be proposed.

10.4.3 Formation of layers 1–5

Two distinct sources have been identified for sediment layers 1–5: fuel ash from fires burning peaty turves (1, 2 and 4) and unidentified herbaceous plants (3 and 5).

The three ash layers contain a mixture of oxidized and carbonized residues in varying proportions. Such mixtures can only be created once the ash has cooled because small carbonized fragments would be oxidized if mixed while the ash was still hot. Therefore, these layers represent either fires created *in situ* and mixed after cooling or dumps of cold ash from fires burnt elsewhere. The presence of uncarbonized organic matter in layers 3 and 5, interstratified with the ash, rules out burning *in situ* as this would have oxidized or carbonized the plant remains in those layers. Therefore, the ash layers can be confidently interpreted as dumps of cold ashes.

Surviving evidence for horizontal banding in the tissue fragments from layers 3 and 5 indicates that they were deposited in a fresh condition and decomposed *in situ*. Therefore, layers 3 and 5 were deposited as reasonably fresh herbaceous vegetation. The presence of some fragments of bone and pottery within these two layers probably resulted from infiltration of overlying sediment down into the loose mat of vegetation while still fresh. This suggests that the five layers accumulated over a relatively short period of time, a conclusion supported by the relative lack of evidence for surface soil-forming processes in any of the sediments.

The sediments were deposited onto the surface of a soil represented in thin-section by layer 6. The characteristics of layer 6 are those of a sub-surface soil horizon with a lack of organic matter, no evidence for biological activity or presence of textural pedofeatures. Therefore, it may be concluded that, at the time of sediment deposition, this soil had been truncated recently, removing its topsoil and exposing subsoil at the surface. The interleaving of lenses of ash and subsoil at the soil surface indicates that this surface itself was disturbed during deposition of the ash and plant layers.

10.5 Archaeological interpretations

The analysis of the thin-section evidence presented above offers some guidance to the archaeological interpretation of these deposits. The soil underlying the sediments had been truncated shortly before their deposition; this activity may have been part of the preparation of the site for the cist and cairn. The sediments can be divided into two types: cold fuel ash from fires burning peaty turves and unidentified herbaceous plants. The absence of positive evidence for the ashes originating in cremation pyres has been discussed above although they could have been derived from fires associated with other burial rituals. The role of the layers of plants in any burial activity is obscure but they have been repeatedly interleaved with ash and this suggests more than an accidental presence in the deposits.

next section