

Post-burial clay and iron movement in archaeological soils and sediments

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Summary

Archaeological soils and sediments are a valuable palaeoenvironmental and archaeological resource. Burial of these deposits is generally thought to preserve the information they contain. However, burial also alters the physical, chemical, and biological properties of the soil leading to changes in its fabric. Perfect preservation of pre-burial soil properties, therefore, is rare. Features caused by the movement of clay and iron prior to burial can be important indicators of past environmental conditions and land management / cultivation practices. However, post-burial movement of clay and iron is also common. Care needs to be taken, therefore, over the interpretation of such features in archaeological soils and sediments. The movement of clay and iron may also have implications for the identification of depositional context boundaries in archaeological profiles. This case study presents evidence from Fordhouse, Barrow, Angus of the range of clay and iron features present and the different phases of their formation.

Keywords: Clay, Iron, Micromorphology, Post-burial change, Buried soil, Taphonomic processes, Site formation processes, Burial mound, Scotland.

Background

Processes of soil development and human activities associated with soils can produce characteristic features observable in soil thin sections. When buried beneath and within archaeological sites they become an important soil, environmental and cultural resource allowing the possibility of reconstructing site formation processes and past landscapes. However, following burial, perfect preservation of the former land surface is rare with the burial process altering the localised chemical, physical and biological conditions. In this way, the act of burial leads to changes within the fabric of the soil as a new equilibrium develops, to the detriment of the survival of pre-burial soil properties making interpretations of past environments difficult (Olson and Nettleton 1998).

Critical evidence of soil forming processes is provided by features observed in thin sections of undisturbed soils and include coatings of silt and clay around voids and on stones, which represent the deposition of clay that has washed down through the profile, and iron pans and nodules. However, such features can be formed by many different processes including natural soil formation, in response to anthropogenic disturbance such as clearance and cultivation, and through the actions of post-burial processes. In archaeological buried soils where both natural and anthropogenic processes may have operated this can lead to difficulties in differentiating phases and interpreting soil features. It is our contention, however, that difficulties of feature interpretation can be overcome by relating – or mapping - these features with fabric and microstratigraphy; in other words contextualisation of clay and iron features in the soil environment. The objective of this paper is to characterise the range of clay and iron-based features associated with Fordhouse Barrow and through integration

with fabric and micro-stratigraphy indicate which classes of pedofeature belong to pre-monument, construction and post-construction phases of site formation. The implications of clay and iron movement for field interpretation are also briefly explored.

Site

There is some dispute over the date of Fordhouse Barrow but it is thought to be a Late Neolithic / Early Bronze Age (3,000 – 900 BC) Ring Cairn in Angus, Scotland. The mound is approximately 20m in diameter and 2.5m high. Excavation of the site began in 1994 and revealed a burial mound (ring cairn) dating to the Early Bronze Age with peripheral insertions thought to date through to the Medieval period. Later excavation (1998) revealed a Neolithic passage grave beneath the mound.

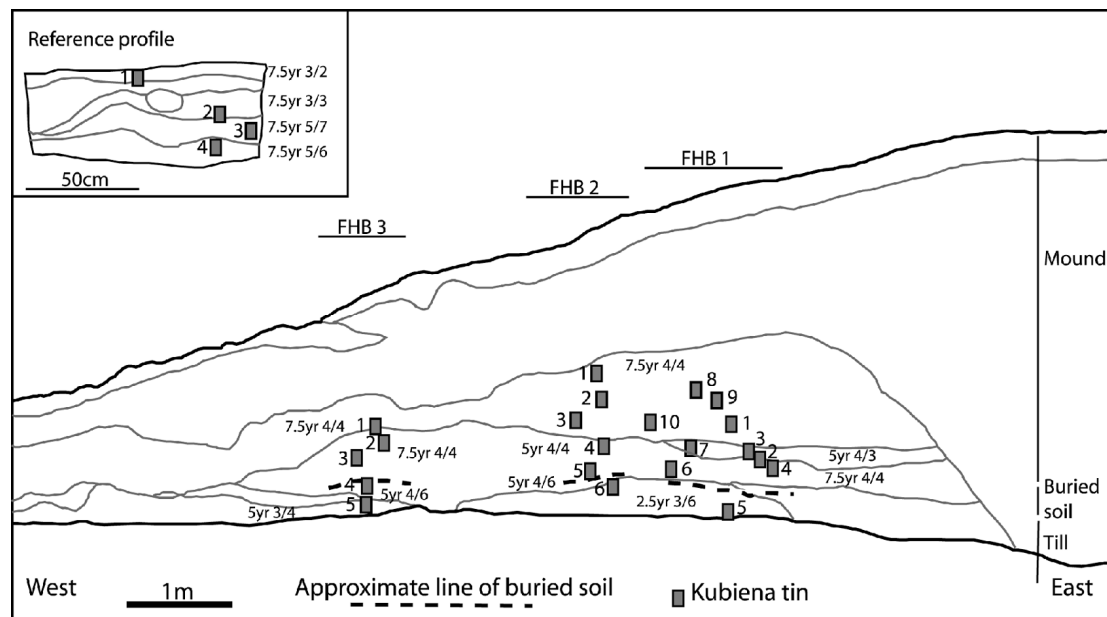


Figure 1: Section drawing of Fordhouse Barrow showing sampling locations

Previous examination of the mound had shown that it was constructed of local soil materials; top-soil materials have been used in the lower 0.5 – 1 m portion, with sub-soil sands and clays used more frequently towards at the top of the mound (Simpson, 1996). Sealed beneath the mound was an incipiently podzolised brown forest soil up to 30 cm thick containing a complex array of amorphous iron and textural pedofeatures.

Analysis

Kubiena samples and related bulk samples were taken from 3 profiles through Fordhouse Barrow; further samples were taken from a neighbouring reference soil under woodland (Figure 1). Thin sections were manufactured according to the standard procedures at the University of Stirling Micromorphology Laboratory. Sections were analysed using a polarising microscope; descriptions follow Bullock et al (1985).

Measurements were also made of loss-on-ignition, pH, moisture content, bulk density, pyrophosphate and citrate dithionite extractable iron, and particle size distribution.

Results

Microfabric types were first characterised from the reference soil, and the mound and buried soil. These were broadly characterised as:

1. A and A/B type microfibrils originally from topsoil material consisting of organic and organo-mineral material with occasional sand sized quartz particles, and an inter-grain microaggregate and channel microstructure. In the reference soil biological activity is high in these upper horizons with both the mammillate and bacillo-cylindrical excrements typical of earthworms and enchytraeids respectively present. These are associated with the topsoil of the reference soil, the buried soil, and construction materials particularly in the lower third of the mound.
2. C horizon type micro-fabric derived from the local “natural” of mineral, glacial tills and sands. This consists of mica rich sandstones and metamorphic mica schists in a clay and silt fine matrix with common medium sand, containing silt cappings, silty orange clay void coatings and sandy fabric intercalations. These are found underlying the reference soil and buried soil and as construction material throughout the mound together with sands.

Based on colour and texture, three distinct clay and silt feature types were identified representing phases of clay movement and deposition. These are dusty brown clay coatings, type 1 silty orange clay coatings, and type 2 limpid to dusty orange clay coatings. The distribution of clay feature types was mapped alongside microfabric type (Table 1).

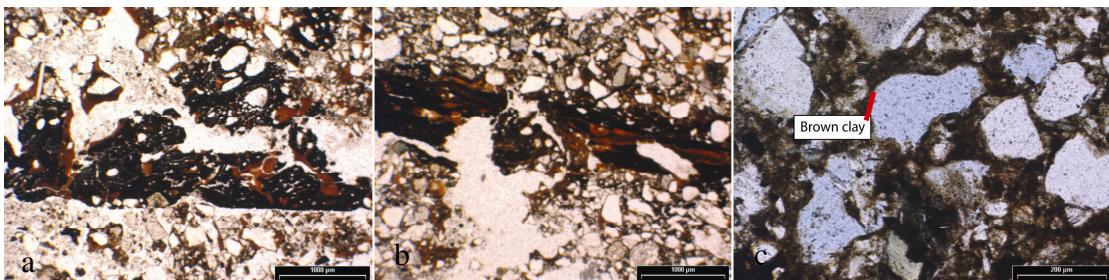


Figure 2: Clay and iron features from Fordhouse Barrow. a, type 2 orange clay coating charcoal; b, iron pan; c, brown clay coating.

Two iron feature types were identified associated with phases of iron movement: iron pans, iron depletion rims around stones. Discontinuous iron pans were found at the interface between the buried land surface and the mound. Further thin discontinuous iron pans were also identified within turf (A microfibrils) used within the base of the mound. No iron pans were present in the unburied reference soil. Iron depletion rims are pale zones around the outer edge of stones from which iron has been leached. Stones with iron depletion rims were found throughout the mound, buried soil and reference soil.

Table 1: Stratigraphic distribution of microfabric and clay pedofeature types.

Profile	Slide	Micro-fabric	Brown clay	Type 1 orange clay	Type 2 orange clay
Fordhouse Barrow - Central profile	1/8	C		t	**
	1/9	C		**	*
	1/10 top	C		*	*
	1/10 mid	A/B	t		**
	1/10 base	C		*	*
	1/1	A/B			*
	1/3 top	A	**		**
	1/3 mid	A/B	*		**
	1/3 base	A	t		*
	1/7	A/B	*		***
	1/2 top	A/B	t		*
	1/2 base	A/B	*		**
	1/6	A/B	*		*
	1/4	b A/B	*		**
	1/5 top	b A/B	*		***
	1/5 base	b C		**	t
Reference soil	1 top	A			
	2 top	A			
	2 base	A			
	3	Bg	*		
	6	Bg			
	4	C		*/**	

t less than 1% slide area, * 1-5% slide area, ** 5-15% slide area, *** 15-30% slide area; b Buried soil horizon, Bg Gleyed (wet mottled) soil horizon.

Discussion

The array of microfabrics and pedofeatures within and beneath the monument reveal a complex developmental history which can be interpreted through comparison with the control profile and analysis of their stratigraphic relationships. This interpretation is summarised in table 2.

Orange type 1 clay coatings are associated with the clay rich Devensian tills and sands and hence can be attributed to periglacial freeze-thaw processes. Brown clay coatings are strongly associated with A and AB type microfabrics whether in the reference soil, the buried soil or the mound itself, suggesting they are inherited from local topsoil materials used in the mounds construction and hence are pre-burial in origin. Anthropogenic artefacts within the buried soil, including charcoal and heated stone, may suggest clearance of the site by fire, however there is little supporting evidence for cultivation activity prior to the building of the mound. Podzolisation and leaching of the buried and reference soils is suggested by the presence of iron depletion rims around sandstone clasts (Romans and Robertson 1975), but the ratio of pyrophosphate extractable: dithionite extractable iron is low in both the reference and mound suggesting podzolisation is incipient.

The distribution of brown clay coatings (Table 1) within the reference profile and buried soil profiles suggests partial truncation of the buried soil prior to the

construction of the mound. Perhaps the stripped turves were used along with soils from the surrounding area to construct the mound itself. Top-soil A and A/B type microfabrics are found towards the base of the mound, and pseudomorphs that appear to be of monocotyledon plant material are preserved within the iron pans. Sub-soil type microfabrics dominate the upper portion of the mound. Hence, construction of the mound represents an inversion of the local soil profile.

Table 2: Summary interpretation of pedofeatures and microfabrics.

Pedofeature and microfabric types	Process	Site formation phase and interpretation
Type 1 orange clay and silt cappings	Clay and silt movement	Pre-monument construction – probably caused by freeze-thaw affecting glacial tills in the late Devensian
Brown clay coatings	Clay and silt movement	Pre-monument construction - possibly initiated either by the clearance of vegetation from the site or cultivation exposing the soil surface to rain splash. No conclusive evidence for either process.
Depletion rims	Iron movement - podzolisation	Pre-monument construction - possibly following vegetation clearance of the site. Within the mound and reference soil depletion rims may have continued to form after mound construction.
A and A/B microfabrics in the mound	Turf stripping	Mound construction – Stripping of turf locally for use in the mound, particularly towards its base.
C microfabrics in the mound	Mound construction	Mound construction – these sub-soil type microfabrics are mostly found in the upper portion of the mound representing an inversion of the local soil profile as first top soil and then sub-soil is used in the construction process.
Iron pan	Localised iron movement	Post-construction - probably formed within a few decades of the mounds construction. Found in the buried turf line and turf materials used in mound construction.
Type 2 orange clay	Clay movement	Post-construction - post-dates the formation of the iron pans. Clay translocation may have been initiated by rainsplash at the unvegetated mound surface and could possibly have been exacerbated by later disturbance and insertions.

Type 2 orange clay coatings, orange/brown, and orange/red coatings postdate the construction of the monument. They occur only within the mound and buried soils and their distribution shows no association with microfabric type. Their absence in the stone sealed buried soil and their presence coating charcoal and iron pedofeatures within the mound adds further support to the hypothesis of post-burial formation. Clay appears to have been mobilised in the upper mound and was subsequently

redeposited as void coatings lower down the profile towards the base of the mound and in the buried soil.

Although the iron pans clearly predate the type 2 orange clay that coats them, they too are post-burial features having formed within the base of the mound following its construction. Experimental work in Denmark has suggested that pans may begin to form very soon after burial; after 1 month in Denmark (Breunig-Madsen and Holst 1998). The preservation of plant pseudomorphs within the basal iron pan at Fordhouse Barrow supports these findings of rapid pan formation.

Field effects of clay and iron movement

In the field the coatings created by clay movement can be hard to detect; often only visible as a metallic sheen on the inside surface of voids. However, the effects on overall field properties can be dramatic with a reduction in clay in upper horizons / contexts and an increase in clay lower down the profile. The effects may be most evident in sandy soils where the finer materials are most easily washed out and their loss has a significant impact on soil properties. This movement of fine materials can in some instances destroy evidence of depositional boundaries and superimpose its own post-depositional horizon boundaries. Deposited iron oxides have a distinct effect on soil colour which again can be superimposed over depositional boundaries. Although iron pans can form along depositional boundaries, such as along old land surfaces, they tend not to follow these boundaries faithfully and should not be used delineate depositional boundaries without carefully examining the deposits above and below to ensure that they are different materials. Both iron pans and clay enriched horizons can also impede water drainage sometimes resulting in gley mottle colours developing in the overlying material.

Conclusions

In total at least three different processes have been responsible for the formation of textural pedofeatures and two different processes for the development of iron pedofeatures in the mound and buried soil at Fordhouse Barrow. This supports the suggestion of previous researchers that many different processes can produce superficially similar soil features and highlights the potential complexity of interpreting site formation processes from archaeological buried soils both in the field and the laboratory.

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