APPENDIX 8: SOIL MICROMORPHOLOGY REPORT FROM DUNASBROC *by Jo McKenzie*

8.1 Introduction

Analysis of micromorphological soil features is an established technique in archaeology which is not only able to identify anthropogenic features which may not be recognised through excavation, but can also allow these features to be set in context with the natural pedogenetic and disturbance-related processes to which an archaeological site is subject, both during and after its occupation. When coupled with more traditional spatial and stratigraphic archaeological analyses, soil micromorphology can therefore address key archaeological questions on, especially, the mechanics of site formation and the nature of the soils and sediments – and therefore the cultural environment – of the site in question (Davidson & Simpson 2001).

Dunasbroc is a steep-sided conical stack located at NGR: NB 4713 6215 off the north-west coast of Lewis, within a generally eroding coastal erosion cell of low rock platform and till cliffs (Barrowman, McHardy & MacLeod 2004, 28). Archaeological investigation upon the stack identified a range of vestigial structural features including a small plateau formed by natural bedrock and apparently artificially enhanced soil deposits. Excavation indicated that these deposits may have undergone significant heating; however, no directly anthropogenic indicators were recovered from this platform feature. The presence of pottery, stone tools, burnt bone and carbonised materials within other parts of the excavated area attest to a significant anthropogenic presence upon the stack, and offer a range of potential interpretations for the apparent heating activity seen at the platform. Micromorphological analysis of the platform deposits was therefore selected as the most appropriate means of investigating further the nature of this feature, and that of its potential past anthropogenic activity.

Three undisturbed sediment samples were collected in Kubiena tins (70 × 50 × 40mm) during excavation as follows (McHardy pers comm):

- Sample 1: the 'natural' subsoil adjacent to the platform feature
- Sample 2: the lower area of the platform feature (Context 005 Lower), apparently consisting of slightly reddened natural subsoil
- Sample 3: the near-surface platform deposit (Context 005 Upper), consisting of a highly reddened soil deposit with a more 'clayey' appearance than that seen in Context 005 Lower

The objective of this report is threefold:

- To confirm or disprove that the reddened soil matrix noted during excavation of the platform deposits indicates heating activity
- To assess the extent and nature of anthropogenic inclusions present in the sample set, and thus to comment on possible uses for the platform
- To use the natural subsoil sample provided in Sample 1 to assess the likely origin of the potentially human-influenced soils of Samples 2 and 3, and thus comment on the role of soil redeposition and enhancement in the creation of the platform feature

8.2 Methodology

Thin sections were prepared at the Thin Section Micromorphology Laboratory, University of Stirling. All water was removed from the samples by acetone exchange and confirmed by specific gravity measurement. The samples were then impregnated using polyester 'crystic resin type 17449' and the catalyst Q17447 (methyl ketone peroxide, 50% solution in phthalate). The mixture was thinned with acetone and a standard composition of 180ml resin, 1.8ml catalyst and 25ml acetone used for each Kubiena tin. No accelerator was used but the samples were impregnated under vacuum to ensure complete outgassing of the soil. The impregnated soils were cured for three to four weeks, culminating with four days in a 40°C oven. Resin impregnated soils were sliced, bonded to a glass slide and precision lapped to 30μm thickness, then cover-slipped to complete the manufacture of the thin section.

The manufactured thin sections were described using an Olympus BX-50 petrological microscope and by following the procedures of the *International Handbook for Thin Section Description* (Bullock et al 1985) and the most recent procedures of Stoops (2003). This allows systematic description of soil microstructure, basic mineral components, basic organic components, groundmass and pedofeatures. A range of magnifications (×10–×400) and light sources (plane polarised, crossed polars and oblique incident) were used to obtain detailed descriptions and these were recorded on a standard table (table 12). Interpretation of the observed features rests on the accumulated evidence of a number of workers, notably Courty et al (1989) and FitzPatrick (1993).

8.3 Results and discussion

8.3.1 Slide 1 – 'Natural'

This thin section, taken from apparently natural material adjacent to the platform feature, shows a predominantly mineral deposit with a mineralogy

typical of Lewisian gneiss. Quartz, feldspars and especially biotite predominate, allowing the deposit to be identified as 'biotite-gneiss' (MacDonald et al 2003, 216). This coarse mineral fraction is highly degraded, with quartz and especially biotite generally fragmented. A light brown fine material fraction is seen throughout the deposit, but especially in areas of significant mineral degradation. Although this is dominantly mineral, a small organic fraction is present, with a small amount of degraded plant material and very occasional phytoliths. Towards the base of the slide, some small traces of limpid clay infills are seen. These are a clear orange-red with no sign of the organic punctuations which would indicate anthropogenic disturbance, and are probably the result of illuviation. Diagnostic anthropogenic material, such as charcoal, is absent from the deposit, with only very occasional small rounded pieces of black amorphous organic material present. Although these may represent anthropogenic additions, their size and rarity do not indicate human activity as an influence upon this deposit, and the deposit is not heated.

8.3.2 Slide 2: Context 005

This thin section, taken from the lower half of the platform feature, clearly separates into four distinct zones within the slide. These are recorded separately in table 11 and are described below.

Zone 2/a
Zone 2/a is seen only in the top centimetre of the slide, and could therefore represent a larger area within the platform stratigraphy than suggested in the sample. The coarse mineral fraction is dominated by generally rounded and weathered medium to fine sand-sized quartz grains with frequent small sandstone fragments and little biotite, in clear contrast to the natural material seen in Slide 1. The fine material fraction is denser and more organic than that seen in Slide 1 and shows frequent small organic punctuations, frequent small fragments of parenchymatic tissue and very occasional phytoliths. Although there is little direct evidence for potential anthropogenic activity, with only one small patch of disaggregated black amorphous organic material, the overall matrix of this deposit indicates a degree of material mixing which may represent disturbance, dumping or even construction activity. Towards the centre of the zone, a large discrete patch of almost exclusively fine material – clay to silt-sized mineral with some organic material – stands out within the fine sand matrix. This clayey lump could represent a fragment of construction material and may be related to the building of the platform. Additional small infills of fine, silt-sized material are seen filling void spaces throughout the zone. These are indicative of physical disturbance which again could relate to the construction of the platform.

The clearest evidence for anthropogenic influence within or near to Zone 2/a is, however, seen under oblique incident light, which reveals that the whole of this deposit has seen significant heating. Individual mineral grains, and the whole of the fine material fraction, are reddened to a degree consistent with heating at temperatures around 400°C (Simpson et al 2003, 1408). The absence of fuel residue material within both Zone 2/a and the lower zones in this slide suggests that burning activities above the deposit – presumably at the surface of the platform – are the cause of this.

However, the most significant feature of Zone 2/a is its lower boundary, and the contrast between this and the stratigraphy of the zones below it. Zones 2/b, 2/c, and 2/d show sloping, diffuse boundaries whose angles echo the lamination seen within each zone, and are reminiscent of the sloping, laminated, dominantly mineral matrix seen in natural deposit Slide 1. By contrast, Zone 2/a shows a clear, horizontal boundary which cuts across the parallel slopes of Zones 2/b and 2/d. It would seem that the lower boundary of Zone 2/a represents a truncation of these lower zones, and that deposit 2/a itself therefore represents a clear redeposition episode. As discussed below and in the Conclusion, thin section evidence points to this as the clearest point of primary construction activity within the platform stratigraphy.

Zone 2/b
Sealed by Zone 2/a, Zone 2/b extends from just inside the right-hand edge of Slide 2 to beyond its left-hand extent, sloping to this left to a maximum depth of 3.5cm. The coarse mineral fraction is much coarser than at Zone 2/a, and consists of coarse sand-sized quartz, feldspar and biotite arranged in repeated laminations which follow the slope of the deposit. These show frequent weathering. The fine fraction is mixed: largely mineral, but with some areas of denser, darker organomineral material which show some iron accumulation. There are some parenchyma and phytoliths. There is no direct evidence for anthropogenic activity, apart from possibly the two small, grey, crypto-crystalline features similar in appearance to those seen in Slide 3 (see Zone 3/b). Like Zone 2/a, the soil matrix shows heating, possibly to a slightly lesser extent than that seen above.

The mineralogy and material arrangement of Zone 2/b suggests that this deposit is, unlike the zone above, very similar to that seen in Slide 1 and represents degraded and probably disturbed biotite-gneiss bedrock.

Zone 2/c
Zone 2/c is a small lens of material present in the lower left-hand side of the slide and sealed by Zone 2/b. The coarse mineral fraction is finer, shows less biotite, and is paler and less iron-rich than Zone

2/b, however, the angle of slope of the deposit and its (less pronounced) internal lamination are more or less parallel with that seen in Zone 2/b, suggesting that, like 2/b, this is potentially a degraded gneiss bedrock deposit. Areas of fine organomineral material are larger and more frequent, and there are more degraded plant fragments than seen above, and occasional phytoliths. Anthropogenic material is absent, and, like the lower area of Zone 2/d (below), the soil matrix of Zone 2/c does not appear to have been heated. It would seem that the effect of heating from activities on the top of the platform extends only into the upper half of Slide 2.

Zone 2/d

This is the largest of the three lower zones in Slide 2, sealed at the top right-hand of the slide by Zone 2/a and sloping downward to fill the lower area of the slide. The coarse mineral fraction is dominated by very coarse sand-sized quartz grains and biotite accumulations which are strongly laminated and packed together to form a compact, largely single-grain structure very similar to the degraded bedrock of Slide 1. Although there is once again very little evidence for anthropogenic activity, with only very occasional small amorphous carbonised fragments, there is stronger evidence for some physical disturbance. Within areas of more degraded coarse mineral material, accumulations of fine organomineral material show some signs of faunal activity, with occasional spheroidal excrements. These are associated with some small organic coatings on single quartz grains. Several small and fractured limpid clay coatings and infills are seen within areas of degraded biotite. Towards the base of the zone, organomineral material becomes slightly more frequent, with small patches of dark brown colloidal material, and the deposit has a darker, more iron-rich appearance. Several large parenchyma fragments are seen near the top of the zone. In oblique incident light, the upper half of the zone is strongly heated, but this quickly lessens down-slide, and the base of Zone 2/d appears unheated. Like Zones 2/b and 2/c, Zone 2/d appears to be directly derived from the natural gneiss bedrock seen in Slide 1, showing disturbance and some mixing with finer organomineral material but little actual anthropogenic influence.

8.3.3 Slide 3: Context 005

Slide 3 is taken through the upper half of platform Context 005. Unlike Slide 2, in thin section this sample appears largely homogeneous with, however, a small discrete lens (Zone 3/a) at the top of the slide, and one towards the base (Zone 3/c).

Zone 3/a

This is a thin (max. 2mm depth) lens of light-brown, silty organomineral material which is seen at the very top of Slide 3. Zone 3/a shows frequent disaggregated cell residue material, fungal spores, and frequent parenchyma, some of which show some horizontal lamination. Much of the groundmass consists of small, spherical faunal excrements, indicating considerable biological reworking. Anthropogenic indicators are absent; however, oblique incident light shows this area, like the rest of Slide 3, to have been subject to considerable heating (see below).

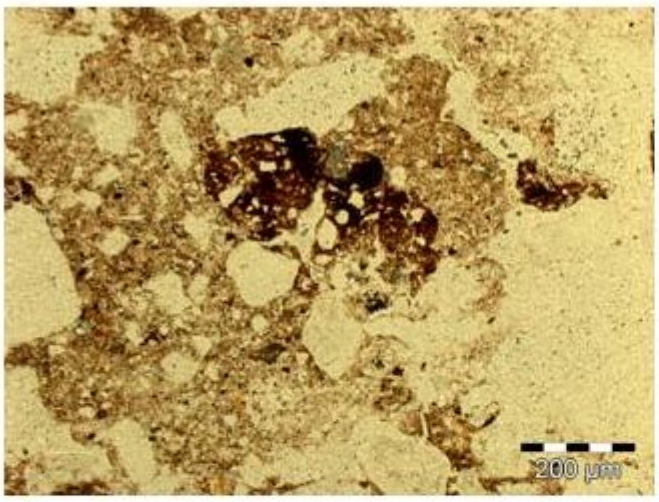
It is likely that this material, with its frequent plant residues, is related to the present-day surface, perhaps brought into the soil profile by worms or other soil fauna.

Zone 3/b

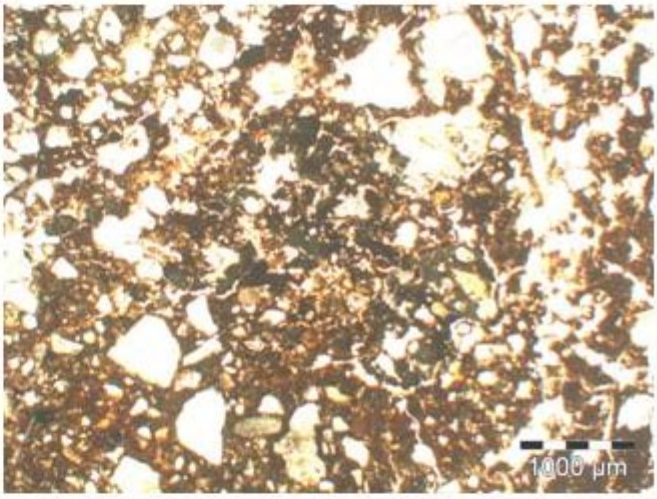
Zone 3/b is the most extensive single deposit in the sample sequence, taking up (with the exception of the two small lenses 3/a and 3/c) the whole of Slide 3. The coarse mineral fraction is composed mainly of fine to medium sand-sized and weathered quartz and feldspars, and frequent small sandstone fragments. Biotite is relatively rare, and thus there is a contrast between this deposit and both the natural material in Slide 1 and what has been interpreted as natural-derived material seen in the lower three deposits in Slide 2. The mineralogy of Zone 3/a is more similar to that seen in the topmost section of Slide 2, above that point at which the more natural material is truncated. Zone 3/b appears to represent deliberately introduced material which is not directly related to the surrounding natural, and has undergone considerable weathering.

The appearance of the fine fraction of the groundmass is also consistent with a dumped deposit. This is mixed and turbated, consisting of a mix of mineral and organomineral material ranging from light to dark brown to grey, with the lighter areas showing a slightly higher incidence of degraded plant fragments with occasional fungal spores. However, no phytoliths are recorded, although this could be related to the denser organomineral fraction present in this deposit. Textural pedofeatures consistent with physical movement and disturbance are also present, with fine silt material infilling several larger voids and some small clay infills present.

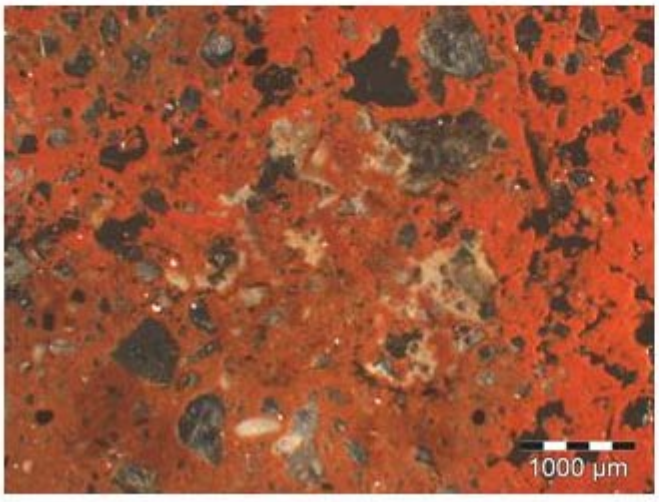
However, as in the more 'natural' deposits recorded in Slides 1 and 2, clear evidence for anthropogenic activity is still minimal. There are very occasional small amorphous fragments of carbonised material, and some small fragments of brown organic material that could be degraded peat (illus 69a). The most significant evidence for anthropogenic influence on the deposit is seen under oblique incident light, where the whole of the slide is seen to have been strongly heated. The strong red colouration seen here indicates a slightly higher heating temperature than that seen in Slide 2, probably above 400°C, but *not* above 800°C (at which point the deposit would take on a yellow-white colour; Simpson et al 2003, 1408). The absence of fuel residue deposits such as charcoal or burnt peat in this slide to complement



a



b



c

Illus 69a Zone 3 / b: brown amorphous material, possibly an unburnt peat fragment. Plane polarised light.
Illus 69b Zone 3 / b: grey crypto-crystalline features possibly representing fuel residue materials. Plane polarised light.
Illus 69c Zone 3 / b: as above, in oblique incident light. Bright yellow-white colour of possible fuel residue indicates high temperature heating. Note extensive reddening of surrounding soil matrix, indicative of comprehensive heating at c 400–500°C.

such evidence for intensive heating is unusual. Bone, burnt or otherwise, is also absent.

The most interesting feature of Zone 3/b is seen midway down the slide at the centre of the deposit. This is a patch of several small, rounded pieces of crypto-crystalline material which are pale grey in plane polarised light (illus 69b) and have a slight 'glow' in crossed polars. Under oblique incident light, these features are a bright yellow-white, and are clearly more highly heated than the surrounding soil matrix (illus 69c). These are similar in appearance to distinctive suites of features noted in urban and semi-rural anthropogenic soil contexts, where they appear closely related to fuel residues connected with industrial and domestic heating processes, such as clinker (McKenzie 2006). Their presence in this context is intriguing, and further investigation of, for example, their elemental composition, would be a worthwhile addition to further research into the nature of the platform deposits.

Zone 3/c

This is a small, elliptical-shaped lens of fragmented clay/silt material extending for about two centimetres within the lower half of Slide 3. It is therefore contained within Zone 3/b and is essentially an inclusion within that deposit, albeit one large enough to merit separate recording. Although occasional (mainly quartz) individual mineral grains are present, this area mainly consists of fine silt and clay which appears to have been introduced as a discrete 'clod' of densely packed material. Several large cracks running through this zone only indicate some drying and shrinkage, which presumably occurred prior to deposition. There are no anthropogenic indicators present. It is possible that this lens represents a lump of construction material similar to that seen in Zone 2/a.

8.4 Conclusions

The three thin section samples from the Dunasbroc site provide an interesting and somewhat unexpected insight into both the construction of the platform feature and the possible circumstances of its use.

The first of the three questions posed in the Introduction – have the platform deposits been heated? – is clearly answered by the appearance of Slides 2 and 3 under oblique incident light. Their highly reddened appearance under this light source is consistent with heating at temperatures around 400°C (eg illus 69c). Furthermore, the nature of these colour changes – more intensely red at the top of the sequence and gradually lessening into Slide 2 – indicates that the source of this heating was at the platform surface.

This leads to the second question – what evidence can micromorphological investigation provide for human activity on the platform? With such strong evidence for significant heating at the top of the platform, frequent inclusions of fuel residue materials, such as charcoal or burnt peat alongside numerous more amorphous carbonised fragments, would be expected. However, these features are almost entirely absent from the sample set. In addition, *unburnt* inclusions indicative of human activity – such as the bone in evidence elsewhere on the site, or unburnt fuel and construction materials such as peat or turf – are also almost absent. This suggests that the platform area was not one in which 'everyday' activities were undertaken, and is likely to have been separate from any activity area at the Dunasbroc site. Furthermore, any residues of the burning activities that were undoubtedly undertaken on the platform appear to have been comprehensively removed quite quickly after the event, certainly before they could be incorporated into the material of Context 005 by, for example, faunal or weathering processes. Such removal could either have been deliberate or as a result of windblow on this exposed stack.

The only potential indicators for specific human activity on the platform are the small inclusions of possible fuel residue material seen in Zone 3/b. Although small and fragmentary, these strongly resemble a type of material inclusion noted in anthropogenic soils associated with fuel residues from highly heated contexts such as industrial furnaces. Previously seen only in urban-influenced, post-medieval contexts, the appearance of such features at a site of this type is interesting, and further characterisation of these features could provide an interesting addition to the site interpretation.

The final objective of this analysis was to investigate the nature of the soil material making up the platform structure, and the relationship of this to the 'natural' soil sample provided by Slide1. Here, some interesting observations can be made. Firstly, clear differences between the mineralogy and internal structure of the Lewisian gneiss deposit seen in Slide 1 and the platform deposits of Slides 2 and 3 indicate that the platform itself is indeed artificially constructed. However, it would appear that the extent of the platform sampled in Slides 2 and 3 represents two distinct phases of construction, within which different soil materials from different areas of the stack were used to build up the platform area. The boundary between these two phases is clearly marked in the upper area of lower Slide 2. Below this boundary, three broadly similar deposits of material which appear to be disturbed and probably redeposited natural are seen. They show the lowest incidence of anthropogenic inclusions and are similar in mineralogy to the natural material sampled at Slide 1. The uppermost of these sloping, laminated deposits is abruptly and horizontally truncated by a distinctly different dump of material whose mineralogy indicates that it is not redeposited natural material from the immediate vicinity. Similar dumped material is seen throughout upper Slide 3. In both slides, the mineralogy of this upper

material shows intensive weathering, dominated by small rounded quartz grains and with biotite largely absent. While still showing only minimal evidence for fuel residue material, in both slides, this dumped material contains large inclusions of dense, clayey material, possibly constructional. To interpret: it would appear that the lower part of the platform was constructed by redeposition of local soil and degraded gneiss bedrock. There is evidence that this may have been levelled before the introduction of finer, weathered, surface soil material, possibly from elsewhere on the stack, to further build up the platform. This upper element may have been strengthened, shaped or consolidated through the use of daub-like clay and silt material packed into and possibly around the platform structure.