8 Sedimentary Analysis of Soil Samples *by M Church*

8.1 Introduction

A series of routine soil tests were carried out for 49 sub-samples taken from the bulk samples removed during excavation. This section presents the results of those tests and discusses the implications for site formation processes and the preservation and taphonomy of ecofacts and artefacts, with particular reference to plant macrofossils.

8.2 Research basis

The samples were processed for doctoral research as part of a regional synthesis on the prehistoric use of plants in Lewis. This research is based on plant macrofossil assemblages recovered from over ten sites excavated by the University of Edinburgh, as part of the wider Calanais Archaeological Research Project (Harding 2000). A number of recurrent research questions were formulated for the sedimentary analysis from each of these sites, including the following:

Can basic sedimentary analysis help interpret differential preservation of ecofact and artefact types between sites?

Can basic sedimentary analysis give insights into generic site formation processes?

Can mineral magnetic analysis of ash components on the site allow taphonomic models for carbonized plant macrofossils to be proposed?

8.3 Methodology

8.3.1 On-site sampling

A sub-sample of approximately 0.25 litres was removed from the bulk samples prior to wet-sieving. Hence, the sampling strategy reflects that of the bulk samples taken on site in 1995. These were taken when the excavator deemed a context to be worthy of sampling, a strategy known as judgement sampling (Jones 1991). This strategy does not statistically represent the sampled population (ie the archaeological contexts across the site) so the results presented here will be biased in the favour of stratigraphically important contents and those perceived to be rich contexts. However, the 49 sub-samples can present a general picture of preservation systems and site formation processes.

8.3.2 Laboratory methodology

Each sub-sample was subjected to the following analyses: organic content, pH and mineral magnetic analysis. The methods employed for each test are described below.

1 Organic content (following Hodgson 1976)
Approximately 20 g of wet soil was dried at 40°C for 24 hours before being dry-sieved through a 2 mm gauge to remove stones and larger particles. The sieved material was then placed in a weighed crucible and placed in an oven at 100°C for 5 minutes to drive off any latent moisture within the soil. The crucible and soil were then weighed before being placed in a furnace for 4 hours at a temperature of 550°C, to incinerate the organic component. The crucible and material were then weighed and the percentage organic content (by weight) calculated.

2 pH (following Hodgson 1976)
The pH of the soil was measured using a Pye Unicam PW 9410 digital pH meter, calibrated to 7 pH and 4 pH buffer solutions. Approximately 20 g of wet soil was added to 50 ml of distilled water. The solution was left for 20 minutes and stirred periodically. Then the meter probe was immersed in the solution for 2 minutes and a reading taken. Only one reading was taken from each sample because of time constraints.

3 Magnetic susceptibility
The samples were dried at 40°C and dry sieved through a 2 mm gauge to remove stones and larger particles. Volumetric (κ) high and low frequency magnetic susceptibilities were measured with a Bartington MS2 meter and MS2 laboratory coil. Mass specific magnetic susceptibility (χlf) and percentage frequency dependent (κfd%) were then calculated (following Dearing 1994).

8.4 Results and discussion

Table 14 presents the results from the sedimentary analysis. These will be first analysed in terms of ecofact and artefact preservation, then generic site formation processes will be addressed with specific reference to carbonized plant macrofossil taphonomy.

8.4.1 Site preservation systems

When analysing artefacts and ecofacts within a site assemblage, consideration must be given to the overall preservation environment of the site. Some material, such as bone, requires specific conditions for its preservation. The soil pH for all the sub-samples ranged from 3.93 to 4.77, with a mean of 4.4.

Table 14 Routine soil test results

Context	Phase	Context type	Organic content (%)	pH	Magnetic susceptibility (HF)	Magnetic susceptibility (LF)	χlf ($\mu m^3 kg^{-1}$)	κfd (%)
123	1	Pit fill	7.70	4.32	39.5	42.5	0.70	7.06
124	1	Pit fill	15.93	4.37	36	37	0.55	2.70
126	1	Pit fill	14.31	4.30	11	11.5	0.14	4.35
196	1	Pit fill	6.81	4.42	32.5	33	0.45	1.52
197	1	Pit fill	9.11	4.51	57	60	0.78	5.00
198	1	Pit fill	5.87	4.40	58.5	60.5	0.90	3.31
199	1	Pit fill	6.40	4.60	48.5	51	0.74	4.90
200	1	Pit fill	10.93	4.44	129.5	139.5	1.79	7.17
201	1	Pit fill	4.85	4.55	81	84	0.86	3.57
202	1	Pit fill	5.27	4.51	73	78.5	0.99	7.01
203	1	Pit fill	6.97	4.56	30.5	33	0.46	7.58
204	1	Pit fill	6.31	4.65	58.5	63	0.83	7.14
205	1	Pit fill	12.34	4.61	22	23.5	0.35	6.38
206	1	Pit fill	7.86	4.52	22.5	23	0.26	2.17
207	1	Pit fill	4.24	4.61	37.5	40	0.47	6.25
208	1	Pit fill	5.70	4.33	31	31	0.43	0.00
165a	1	Pit fill	5.81	4.59	18	18	0.24	0.00
165b	1	Pit fill	4.37	4.66	23	23	0.27	0.00
176	2	Hollow fill	13.61	3.93	14	14.5	0.24	3.45
160	2	Hollow fill with OGS	5.57	4.77	86.5	91	1.30	4.95
161	2	Hollow fill with OGS	5.25	4.65	42	46	0.56	8.70
162	2	Hollow fill with OGS	5.83	4.73	50.5	52.5	0.67	3.81
163	2	Hollow fill with OGS	6.60	4.55	29.5	32	0.38	7.81
170	2	Hollow fill with OGS	19.01	4.42	16	17	0.28	5.88
128	2	OGS	5.88	4.36	8	8.5	0.13	5.88
154	3	OGS	6.94	4.75	53.5	56.5	0.74	5.31
172	2	Pit fill	8.97	4.12	14	15	0.22	6.67
121	3	Ash spread	14.48	4.01	528.5	570	8.35	7.28
134	3	Ash spread	8.89	4.20	1012	1090.5	19.68	7.20
137	3	Ash spread	11.25	4.51	462.5	498.5	8.85	7.22
177	3	Ash spread	8.50	4.31	215	229.5	3.29	6.32
180	3	Ash spread	10.22	4.30	169	182	2.72	7.14
181	3	Ash spread	7.69	4.36	248	266.5	4.14	6.94
135a	3	Ash spread	6.15	4.21	1366	1476	26.50	7.45
135b	3	Ash spread	8.54	4.30	364	393	5.59	7.38
122	3	Cist fill	18.20	4.18	238.5	257.5	4.36	7.38
125	3	Cist fill	14.86	4.02	40	42.5	0.81	5.88
129	3	Cist fill	16.89	4.22	148	160.5	2.91	7.79
164	3	Hollow fill	18.17	4.23	18.5	20	0.37	7.50
167	3	Pit fill	11.23	4.33	417	453	6.83	7.95
183	3	Pit fill	5.69	4.49	274.5	294	3.63	6.63
184	3	Pit fill	5.48	4.13	45	48	0.63	6.25
186	3	Pit fill	4.50	4.57	91	97.5	1.11	6.67
193	4	Pit fill	8.55	4.26	17	17	0.25	0.00
194	4	Pit fill	6.34	4.36	156.5	169	2.33	7.40
195	4	Pit fill	6.75	4.35	54.5	59.5	0.80	8.40
146	U	Hollow fill	6.96	4.54	9.5	10.5	0.13	9.52
147	U	Hollow fill	13.61	4.24	14	14	0.23	0.00
149	U	Hollow fill	8.39	4.33	6.5	6.5	0.11	0.00

The cist fills were very acidic, ranging from 4.02 to 4.22. This aggressively acidic soil environment means that no uncarbonized bone and shell survived on the site. The relatively low organic content of 4.37–19.01 (mean of 8.98), coupled with the comparatively well-drained nature of the site, meant that uncarbonized plant macrofossils and insect remains were not detected. The main classes of material recovered on the site were therefore lithics, pottery, carbonized plant macrofossils and burnt bone.

8.4.2 Site formation processes

The samples have been split into five blocks for analysis.

Pit fills from Phase 1: The pH and organic contents of the fills fall within the range of the overall site variation. In general, the χlf and κfd% values are relatively low, with some pits showing slight magnetic enhancement, presumably from the re-deposition and mixing of ash with soils and the other materials resulting from human activity. The low levels of κfd% are evidence of the paucity of superparamagnetic grains, which are generally indicative of the input of ash into soil.

Phase 2 relic soil: A coherent layer was identified immediately below the cairn, with evidence of cultivation marks within that layer. Carter (Section 10) has suggested, through soil micromorphology, that the layer is the remnant of a relic soil, perhaps stripped during the construction of the cairn. The routine soil results from the relic soil and various pits and hollows filled with this material supports the presence of a horizon soil, with relatively low organic content (5.25–6.6) and a slightly less acidic pH (4.36–4.77) than the rest of the site. The χlf is low and the κfd% values range from 3.81 to 8.7, the latter values being difficult to interpret in the context of low χlf values (Dearing 1994). The more organic sample from 170 may represent a fragment of the A horizon or degraded turf from the relic soil.

Phase 3 ash spreads: A number of the samples relate to the dumping of burnt, peaty turf within the body of the cairn (Section 10). All of these samples display significant magnetic enhancement, with high χlf and κfd% values, confirming the ashy and burnt nature of much of the material. The organic content and pH vary throughout the site, the higher organic values presumably incorporating carbonized material incinerated at 550°C.

Pits and cist within the body of the cairn: Some of these features were filled with material with an ashy component, presumably from the ash spreads, whilst others contained little magnetic enhancement and therefore a lack of ash within their soil matrices. The three samples from the cist fill had a relatively high organic component that may suggest a slightly different type of material, such as decomposed organics, comprising a significant proportion of the matrix. Again, two of the three cist fills had evidence of magnetic enhancement stemming from the input of ashy material. This suggests that the ash spreads were incorporated into the body of the cairn immediately after the cist was constructed or that the cist was not lidded when the ash was deposited.

Phase 4 and unphased negative features: Only one of these features, a stone-lined pit (194), displayed magnetic enhancement with the input of some ashy material. The organic content and pH vary over the site.

8.4.3 Carbonized plant macrofossil taphonomy

The presence of ashy material, and therefore the possibility of input of carbonized plant macrofossils, can be gauged through mineral magnetic enhancement of the soil (cf Batt & Dockrill 1998; Peters *et al.* 2000). Table 14 displays the χlf (μm^3 kg^{-1}) and macrofossil concentration (quantifiable components/litre) for many of the bulk samples that contained plant macrofossils (see Section 9.3.2). The phase and sample type is indicated on the *x* axis and the values of both parameters on the *y* axis. This shows that the main magnetic enhancement of the Phase 3 ash spreads (denoted 3AS) correlated with the greatest concentration of carbonized plant macrofossils. Limited magnetic enhancement was seen in most of the other samples, with a concomitant decrease in macrofossil concentration. Negative features, such as the cist fills (3CF), with higher χlf, relate to the incorporation of this ashy material into their soil matrix. The pits from Phase 1 (1PF), Phase 2 relic soil (OGS) and unphased hollow fills (UHF) had little or no magnetic enhancement and so therefore had very low concentrations of plant macrofossils, derived through limited re-deposition or bioturbation.

8.5 Conclusions

A number of key points can be extracted from this analysis:

- The acidic nature and relatively low organic and moisture content of the site has precluded the preservation of bone, shell, uncarbonized plant macrofossils and insect remains. Therefore, the main classes of material recovered on the site were lithics, pottery, carbonized plant macrofossils and burnt bone.
- The routine soil tests confirmed the presence of an altered relic soil beneath the cairn, with much of the soil representing the B horizon and a possible fragment of the A horizon (170).
- The correlation between the enhanced magnetic signal and the high concentration of carbonized plant macrofossils in the ash spreads confirms the taphonomy of the archaeobotanical assemblage from the burning and dumping of ash from peaty

turves and other incorporated plant material into the main body of the cairn.

- Two of the three fills within the cists displayed magnetic enhancement from the input of ashy material from the ash spreads. Therefore, the ash spreads were incorporated into the body of the cairn immediately after the cist was constructed or the cist was not lidded when the deposit was made. The excavation demonstrated that the ash layer was probably cut to insert the cist. It is likely that the ash was re-deposited in the cist during this process.

next section