A Fragmented Masterpiece

Recovering the Biography of the Hilton of Cadboll Pictish Cross-Slab

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Chapter 7

Artefact and environmental studies

7.1 Analysis of the fragments

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Methodology and logistics of the analysis

This section will describe how the carved fragments were analysed by the various agencies involved with this aspect of the project. The agents include several staff of RCAHMS, Historic Scotland and GUARD and consultants Isabel Henderson and Ian G Scott. Each had their own priorities which had to be accommodated within the project. One issue affecting the schedule of work was the hope that analysis of the fragments could inform the design of the replica cross-slab being sculpted by Barry Grove in Hilton. There was a fast approaching deadline for the fulfilment of the HLF funding and also a need to complete the sculpture while the stone was still in a suitable condition. Fortunately, Barry Grove had been involved with the excavation process on a daily basis and thus was familiar with the individual fragments. Initial developments in the reconstruction were relayed to him, but unfortunately the final design had to go ahead with only partial analysis to inform it.

The fragments retrieved during the Kirkdale excavations in 1998 were from a 1m square, which is equivalent to the four 0.5m squares 1015E 1025N, 1015E 1030N, 1020E 1025N and 1020E 1030N. These were collected as context (012), which is equivalent to the same context used by Kirkdale in 2001 and to GUARD's context (007). The fragments from 1998 were sent to AOC (for conservation) and then to Croft-an-Righ for storage where they were examined by Ian G Scott in 2000.

Ian G Scott's reconstruction methodology started with an initial rapid recording process. Each fragment was unwrapped and then laid on a small sandbag or high-density foam. A sketch was made, which consisted of the outline of the fragment and an indication of its modeling, with a scale. Photographs were taken vertically with the fragment lying near-horizontal, using a 35mm single-lens reflex (35–80 zoom-lens) Pentax camera. Four photographs were taken, changing the direction of the lighting each time, using a 100-watt halogen video floodlamp. For the purposes of immediate study, the drawings and photographs were photocopied to a common scale of 1:2. A speedy visualisation of the analytical problems was enabled by cutting out individual pieces from the drawing set at half-size and mounting them with adhesive strip on hardboard sheets. These photographs and drawings formed a 'visual index' which was supplemented with a catalogue-style listing comprising a record of each fragment and its context, and with some attempt at classification, for which a glossary was put together.

Kirkdale initially reported that there were 40 carved fragments from this first phase of the work. However, there are now over 400 fragments from the 1998 excavations on the database (although few have a carved surface).

In January 2001, Kirkdale devised an excavation strategy for recording what was expected to be a fairly small number of fragments from the chapel site. The excavation was to operate on a 0.5m grid, with each fragment being located within the appropriate grid square and numbered in a sequence that incorporated that location information. Although a 0.5m grid gives a maximum error of 0.7m, it was felt that recording the fragments at a finer resolution would not yield additional information and would impact on the time constraints of the excavation. Each 0.5m grid square was excavated individually and with the intention that the excavation would stop at the first archaeological layer below the deposit of fragments. It was felt that locating each of the fragments, using an EDM for example, would be time consuming and again would be unlikely to reveal significant information regarding what was then interpreted as a random scatter of fragments resulting from the re-dressing of the cross face of the monument.

The carved fragments retrieved during the Kirkdale excavations in 1998 and 2001 were thus recorded by grid square and given a location descriptor (eg

09901025), as well as an individual Kirkdale number, 1–n. This location descriptor relates to the site grid: the easting is the first three digits; the fourth digit is 0 or 5, which relates to the specific 0.5m; the next three digits are the northing; and the final number relates to the specific 0.5m.

Once GUARD became involved with the project, a relational database, designed in Access 97, was created. This contained the catalogue descriptions of each fragment, produced in consultation with Isabel Henderson and Ian G Scott. This database was constructed in order to record, present and analyse information on each of the excavated fragments.

During the GUARD excavation in 2001, the fragments were delivered to an off-site finds hut in Hilton at the end of each working day. They were immediately removed from their finds bags and placed in the open to dry thoroughly. As much dirt and organic material as possible was then gently removed with a soft brush. The fragments were kept with their grid square information at all times and clearly labelled to avoid mixing. Most of the fragments were in a good condition and only a small number were in a friable state. The fragments were then re-bagged using the same numbering system that was used in the field (see Chapter 3.3). Some basic data were entered into the database at this stage. Fragments from each grid square were counted, joins identified in the field were noted, and major decorative elements were identified.

The fragments retrieved by the Kirkdale excavations were removed from storage at Croft-an-Righ and delivered to the Portrait Gallery in Queen Street, Edinburgh, along with the fragments retrieved by GUARD during their excavation. Some of the setting stones, which had been left with the lower portion of the cross-slab in Hilton, were brought to Queen Street at a later date for inclusion in the catalogue. The fragments from the soil samples taken during the Kirkdale excavations in 1998 were delivered to the Museum in Chambers Street in Edinburgh in December 2005 to be added to the database.

Once the fragments were in Edinburgh, the reconstruction and cataloguing work commenced simultaneously. Initially Ian G Scott selected 783 of what appeared to be the most significant fragments from the assemblage based on size and the amount of decoration, especially key pattern and interlace. Of these, 752 have been individually accessioned and numbered by the Museum (X.IB 355.001 to X.IB 355.752). The remaining fragments have been accessioned but not individually numbered, the numbers being noted on the bags in which they are stored.

During this process, it was obvious that there were thick fragments which could not have come from the destroyed cross-face (face A) of the upper portion and therefore must either belong to another slab or to the missing mid-portion. These fragments, with large-scale spiral pattern or inhabited scroll, were identified as belonging to face C and they were arranged in a sandbox provided by the Museum. Gradually, more fragments were added to these clusters to form the partly reconstructed mid-portion of face C (see illus 4.5).

The remaining thick fragments were placed in a second sand box to attempt the reconstruction of the front, face A, of the mid-portion, since only one substantial piece had been identified as belonging to another cross (see relief cross illus 7.47). This reconstruction was based on the evidence of the lower portion because there were no clues from the refaced upper portion apart from the scars on its edges (faces B & D), which may have been relics of protruding cross-arms. A large fragment to the right (X.IB 355.5) fitted on to the lower portion and, with another group of fragments to the left (X.IB 355.1), probably established the content of the side panels leaving the cross itself unidentified except by its side bands. Above this, another group (X.IB 355.9) was placed (see illus 4.3).

The remaining fragments, which should represent what is left of the slice from the upper portion of the front of the slab, were arranged on trays of sand with some attempt at classification to allow judgements to be made. Initially, 'key pattern', 'interlace', 'bosses with spiral' and 'animal' were separated out. A very few fragments showed two of these classes of ornament, thus providing vital connections. Many that could not be so classified must constitute bands defining panels. But, being in short lengths, these were difficult to distinguish from, for example, the serpentine bodies.

Meanwhile, catalogue descriptions were written for the fragments and entered into the database. Initially, descriptions for 131 of the selected 752 fragments were produced by Isabel Henderson, and descriptions for the remaining 621 fragments were produced by Meggen Gondek during the period from March 2003 to August 2003. Douglas Morton took over from August 2003 to March 2005. Assistance with weighing the fragments was provided by Hilary Paterson. The fragments were weighed with an Ohaus CS200 Compact Scale with a maximum weighing capacity of 200g.

This database was later used to associate fragments with GUARD record photographs, and Ian G Scott's photographs and sketches. The database also tracked the progress of fragments through the post-processing work by recording information such as whether or not they should be drawn by Ian G Scott or photographed by Museum staff with the relevant reference numbers. As part of the processing of these fragments, information relating to their sculpted form was also recorded in the database. Most significantly, a thesaurus of 26 keywords was devised by Isabel Henderson and Ian G Scott and each fragment was described by the use of a subset of the thesaurus terms.

Cataloguing of the sculptural fragments in the database followed a procedure devised by Isabel Henderson:

1 Fragments were retrieved from the excavation grid-square bags and then weighed, measured, and individually re-bagged.
2 Records were created within the database for every fragment. Each record contained a wide range of information from basic weight and measurements to discursive fields on fracture type. Every fragment was assigned a GUARD number and those from the Hilton sculpture were also assigned NMS X.IB 355.1–n numbers. A total of 196 non-Hilton sculpted fragments were found, these were allocated a notional number in the catalogue for future reference.
3 Each fragment was examined individually and the data was entered into the database. If the fragment was of particular interest or was found to join another fragment, then it was set aside to have its NMS number painted on it to facilitate safe manual handling.
4 The Kirkdale fragments were treated in the same way as the GUARD fragments, except for the fact that the Kirkdale fragments had an additional Small Finds number and original bag number, which were added to the database.
5 All other fragments were securely bubble-wrapped and bagged before being boxed and stored, labelled according to an NMS number. Each box contains an inventory of contents to allow for easy location in the future.
6 The non-Hilton fragments were not entered into the database and were boxed separately.

While this work continued on the most significant fragments, the remaining fragments were classified and sorted in order to prioritise their accessioning and analysis. This work was undertaken by Amanda Brend under the guidance of geologist Allan Hall (Department of Archaeology, University of Glasgow). Sorting was undertaken by visual examination supported by binocular microscopy. The sorted samples were counted, re-bagged and labelled.

Summary of sorting criteria:

Class 1 Fragments with evidence that they belong to the sculpted surface.

1A Probable Hilton surface that has a sculpture pattern. Criteria: part of a shaped 'sandy' surface; reddened surface; remainder of fragment bounded by fracture surfaces; Hilton sandstone lithology or relatively fresh rock. Fragments lacking reddening were most problematic. This was the priority group, so even if there were some uncertainty, fragments would be put in this group.

1B Probable Hilton surface with an original flat surface. Criteria: as 1a but carved surface does not show any indication of belonging to a carved feature.

Class 2 Fragments probably from the Hilton stone.

2A Probable Hilton (unsculpted) fragments with features (sandstone fabric etc) that could help with their positioning in the reconstruction.

Criteria: lack of evidence of being part of the sculpted surface; pellets of brown limonitic iron; lamination due to variation in grain size of sediment; concentration of mica into a layer/slither or chisel marks.

2B Probably Hilton fragments (unsculpted), fragments lacking features.

Criteria: fresh angular chips of Hilton lithology.

Class 3 Fragments possibly from the Hilton stone.

3A Possible Hilton fragments with features (sandstone fabric etc.).

Criteria: Lithology similar to but not typical of Hilton or indication of shaped surface.

3B Possible Hilton fragments lacking features.
Criteria: as 3a but no indication of carving or of 'geological' feature.

Class 4 Fragments unlikely to be from Hilton stone.

4A Fragments with potential evidence of belonging to a sculpted stone.

Criteria: lithology and general appearance unlike Hilton stone; some of the surfaces are fracture surfaces or indicate that part of the fragment represents a carved/ shaped surface.

4B Fragments lacking features.

Criteria: spherical shape; rounded shape; intense weathering; not Hilton lithology; no indication of being carved in past.

The sorting was done without much appreciation of the nature of the context of origin and this was potentially a disadvantage. It was noted that, if the Hilton-type lithology (the fine grey micaceous sandstone) had been used for another carving on the site, and if this had also been fragmented, then it would not be possible to tell them apart. The assumption was made that all the fragments of Hilton-type lithology were from the same Hilton carved stone. A table of total numbers of fragments per classification was created but, as there were a small number of re-classifications during the cataloguing process, only the final table is presented in this volume.

Of the remaining fragments those with a class of 1A to 4A were entered into the database. This was undertaken by Meggen Gondek and by Douglas Morton from September 2003 until November 2004. The 4A and 4B fragments were initially not recorded in detail as they were not thought to belong to the Hilton of Cadboll cross-slab. However, they were visually examined again by Douglas Morton to ensure that no carved fragments had been missed. Any found to be carved were re-classified. A number of successful joins were made through examination of the fragments at each stage of cataloguing. Work with fragments from context 008, for example, provided a number of useful re-fits to the mid-portion of face C and, indeed, it is this area that is likely to form the most successful part of reconstruction. The majority of the other joins made have been between only two or three fragments, although there are a number of groups of two or more conjoined fragments. Well into the project, six fragments of flat relief-band were joined to form a 'T-shaped' border that may have separated decorative panels.

The initial remit was to catalogue all fragments that belonged to the Hilton sculpture. However, this was later extended to include any possible carved fragments not from the Hilton sculpture (4A). The class 4A fragments were also catalogued, but were provided only with a working number. In February 2005, it was decided to further assess the fragments from class 4B to eliminate the possibility of Hilton sculptural fragments remaining unchecked (see Chapter 7.5.4).

The keywords and descriptions for the first 3406 database entries were checked by Isabel Henderson. Her comments were entered into the database by Douglas Morton, who then continued editing the

Table 7.1
Total number of fragments per class

Class	**1998**	**Jan 2001**	**Aug 2002**	**Number of fragments**
1A	462	1653	1222	3337
1B	3	27	3	33
2A	72	183	148	403
2B	144	2460	666	3270
3A		271	60	331
3B		45	78	123
Total of Hilton fragments				7497
4A (not Hilton, on database)		187	6	193
4B (not Hilton, not on database)		*4*	*3541*	*3545*
No class		*14*	*3*	*17*
Final Total	681	4844	2186	11,252

remaining fragments, maintaining consistency with Isabel Henderson's standards. Before the catalogue was completed, a pilot study was undertaken to test whether a database-driven methodology was a useful tool in the reconstruction of the cross-slab and this is reported in Chapter 7.2.5.

The full database of all 7493 fragments can be consulted via the Arts and Humanities Data Service (http://ahds.ac.uk/).

7.2 The cross-slab and fragments

7.2.1 Petrology

SUZANNE MILLER

Introduction

Petrological provenancing is a well established technique in archaeology, with analysis of thin sections increasingly seen as an important extension to both interpretation of stone artefacts and to aid the assessment of supply, circulation and mobility of lithic raw material. In addition, analysis of petrological features of stone artefacts can not only help to identify whether fragments are likely to be from the same artefact, but can also allow these to be set in context of procurement and patronage.

The aim of this work is to identify the petrological characteristics of the sandstone of the Hilton of Cadboll cross-slab (X.IB 185) and to identify possible source/sources of raw material for this sculpture. In addition to these primary objectives, analysis was aimed at answering several context-specific questions especially significant to the site interpretation. These were as follows:

1 What is the nature of the red staining on the surface of the Hilton of Cadboll cross-slab? Is it natural iron deposit or an applied material such as paint?

2 What is the nature of the reddish (rusty) 'blebs' that feature in the greenish sandstone. Is this common? Can this feature be used to identify this particular stone?

3 It is proposed to reconstruct the original Hilton of Cadboll carved slab from the main pieces and all the fragments. How can 'geology' inform the reconstruction process?

4 What is the geology of the non-Hilton sculptured fragments:
   (a) X.IB 355.3 – could this be part of the Hilton stone?
   (b) The cross-incised architectural fragment (context 002, Kirkdale)

5 Is it possible to identify the sandstone fragments in soil layer 007? If so, is it possible to say whether these tiny fragments are the same geology as the cross-slab or the fragments? (This may help to determine whether or not layer 007 was formed when the defacement of the cross-slab was taking place.)

Methodology and petrology

All stone fragments have been examined using non-destructive petrological techniques in order to provide a macroscopic identification of the geological characteristics. This type of petrological analysis has provided a basic identification of rock type and has been used to distinguish between general rock types. All examination includes the following measurements;

colour (with reference to Munsell soil colour charts);

grain size (with reference to standard grain size measurements on the μm scale);

macroscopic mineralogy (ie mineralogical content that can be ascertained by examination with 10× magnification hand lens);

textural and structural characteristics such as parallel bedding/lamination, cross-bedding, jointing, other planar fabric, grain size variation;

clast/nodule distribution and composition;

weathering characteristics.

(Colour has been used only as a general guide to overall appearance since, in many cases, the sculptures have undergone varying degrees of weathering and/or cleaning, both activities that could significantly alter the colour of the surface of the specimen.)

Sampling of the upper portion of the Hilton of Cadboll cross-slab was undertaken using a 20mm micro-corer, producing a 17mm core sample. From the core, standard petrological thin sections were prepared, one cut parallel to the diameter of the core and one parallel to the core length. Thin sections, 30μm thick, were prepared at the National Museums Scotland (NMS) using the standard method. The micro-cores were sliced to provide 2mm-thick samples, using a diamond saw. These slices were bonded to a glass slide and precision lapped to 30μm, with cover slipping completing manufacture of the section. The thin sections were described using a Leica DMLP polarising microscope. Digital photomicrographs were taken using a Leica DC100 camera. Both plane polarised and polarised light sources were used for standard mineralogical and textural identification.

All the fragments examined are sandstones. They are classified according to their mineralogy, using the sandstone classification scheme of Folk where all rocks containing less than 15 per cent fine grained matrix are classified in terms of the three principal components;

quartz, feldspar (plus granite and gneiss clasts) and other rock fragments (Folk 1974). All outcrop specimens (potential source rocks) have been examined using petrological techniques in order to classify rock type. In addition to the macroscopic measurements taken for the artefact fragments, all examinations of outcrop specimens also include microscopic mineralogy.

Hilton of Cadboll cross-slab upper portion X.IB 189: geological characteristics

Macroscopic petrology

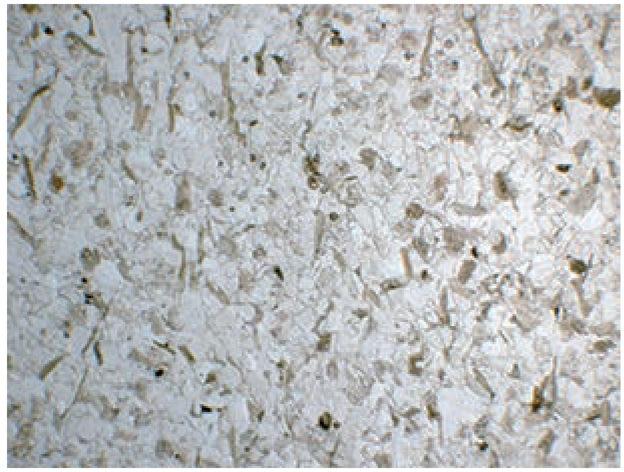
The stone of the Hilton of Cadboll cross-slab is fine-grained micaceous quartz sandstone. Both feldspar and opaque grains are also evident. The carved surfaces most probably correspond to original bedding planes, along which the stone would most naturally fracture. The sandstone is massive in the sense that there is no evident internal structure, for example lamination or cross bedding.

Two features are particularly characteristic. The first is the high mica content which gives a sheen to the main faces (both front and back). The alignment of the mica grains parallel to the main faces is consistent with these faces equating to original bedding planes since it is most likely that the micas would be bedding-parallel. The second distinctive feature is the presence of iron nodules. These are natural phenomena of diagenetic (post depositional) origin and probably resulted from subtle changes in pore-water chemistry during lithification and cementation of the sandstone. It is not possible to determine their exact mineralogical composition. (This would require additional mineralogical/chemical analysis.) However, they are almost certainly composed of iron oxide/oxyhyroxide mineral phases.

Thin section analysis

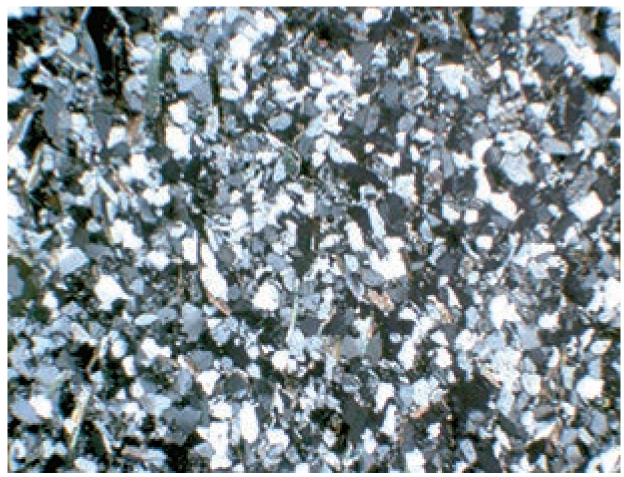
Slide X.IB 189(a)

The rock is arkosic sandstone with grains generally less than 250µm diameter (illus 7.1A & B). The principal mineralogical components are quartz, feldspar, biotite, muscovite, chlorite, calcite and opaque grains. The quartz and feldspar grains are anhedral and show sutured grain boundaries. They display undulose extinction (particularly obvious in the quartz grains) indicating a metamorphic protolith (ie pre-sedimentary source) for the sandstone. The quartz grains are generally monocrystalline but minor polycrystalline grains are present. The feldspars include plagioclase, microcline and orthoclase. All show some degree of alteration. The mica grains show a very distinct alignment, most probably bedding-parallel. Some biotite grains show alteration to chlorite. The matrix is principally composed of very fine grained clay with some calcite. Minor opaque grains (probably iron oxides/sulphides) are present. This sandstone is well sorted but the moderately high proportion of feldspar grains would indicate that it is mineralogically immature. This is consistent with the clay matrix.



a

Illustration 7.1
Thin section of the Hilton of Cadboll cross-slab upper portion: (a) ppl, 40× magnification, (b) cpl, 40× magnification



b

Slide X.IB 189(b)

No additional features were noted in the perpendicular section.

Fragment X.IB 355.3 Geological characteristics

This stone is fine-grained micaceous sandstone, containing quartz, feldspar, mica and opaque grains as well as small oxidised iron nodules 10–14mm in diameter. It is green-grey in colour with minor patchy surface discoloration. An area of the broken surface is pitted. This may be a late weathering feature. There is no obvious internal sedimentological structure although micas are aligned parallel to the bedding surface throughout.

Cross-incised fragment HC98 (002): geological characteristics

This fragment is fine-medium grained arkosic micaceous sandstone. It is yellow-brown in colour. No internal structure is apparent. This sandstone is petrologically unlike any of the other fragments examined.

Potential source material: outcrop geology

The Tarbat peninsula, apart from the hill of North Sutor, is composed of Devonian sandstones belonging to the Old Red Sandstone supergroup (ORS). The coastal strip westward towards Tain is composed of Upper Old Red Sandstones (UORS) from the Balnagowan group. The base of the UORS is conjectural but is thought to run on a line from Nigg Bay to Hill of Fearn and then north-east to Pitkerrie, Meikle Tarrel and on the coast at Wilkhaven. Sandstones exposed on the south-eastern side of the peninsula from a little south of Shandwick to Balintore, Hilton of Cadboll and Wilkhaven are composed of Middle Old Red Sandstones (MORS) of the Strath Rory group (Fortey *et al* 1998; Johnstone & Mykura 1989). The majority of these sedimentary rocks were deposited in fluvial (river) systems with thin but extensive lacustrine units representing deposition in the Orcadian lake around 380 to 390 million years ago. The rock types include extensive sandstones and limestones.

Quarries are generally limited to coastal areas or where the drift deposits are shallow as in the Lower Pitkerrie area. Today there are no working quarries, but around a dozen quarries are known to have been in existence since the 18th century. The *Statistical Account* for 1791 records 'There is a soft freestone at Pitkery, of an inferior quality, in the east of the parish, but little used; a pretty good freestone at Balintore, a good deal used for building; but at Catboll, in the rocky part of the coast there is a remarkable good freestone, little inferior to any in Scotland' (*Stat Acct*, 379–92). It is therefore clear that the geology around the Hilton site provides various potential sources for large sandstone slabs.

Source rock petrology

Various local outcrop specimens were sampled and their geological characteristics examined and recorded. Most outcrop specimens do not match the geological characteristics of the Hilton of Cadboll cross-slab. Specifically, many of the outcrop sandstones have a high iron oxide content which is present not only as discrete grains but also as iron oxide coatings on individual grains. This produces a pervasive red colouration to the rock. Many are texturally more mature than the X.IB 189 sandstone, showing more rounded grains and differences in degree of sorting. Some outcrops were discounted on the absence of iron nodules or on the basis of internal structure such as cross-bedding which is not evident in the Hilton of Cadboll cross-slab.

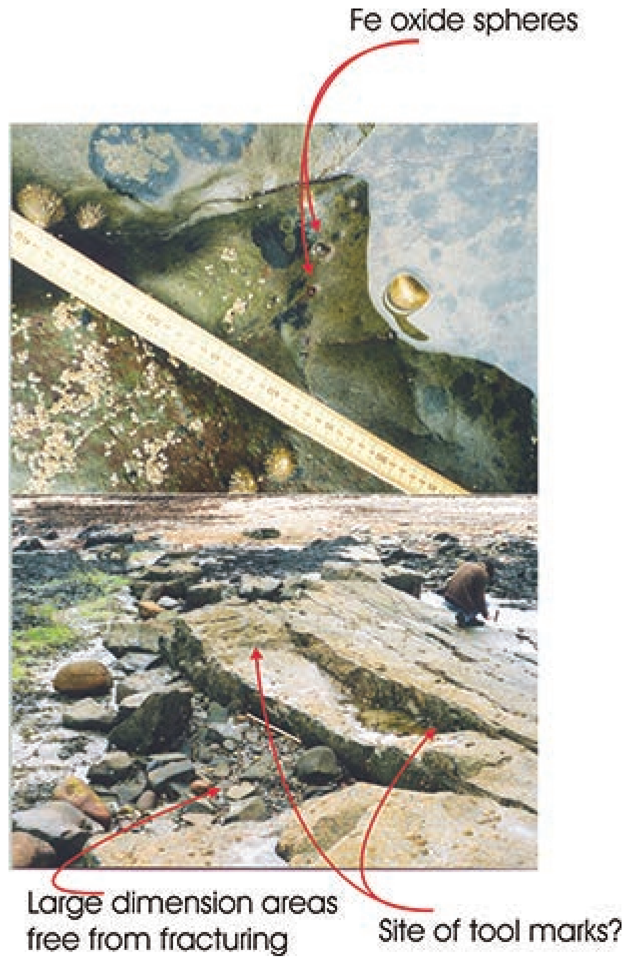
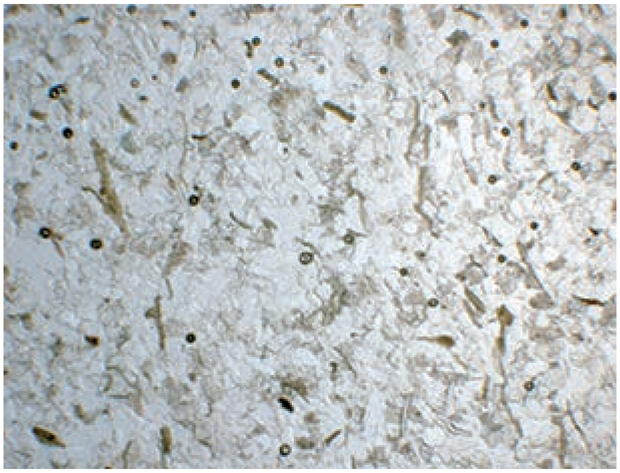


Illustration 7.2
Outcrop locality of suggested lithic source for the Hilton of Cadboll cross-slab: (a) general locality shot, (b) close-up showing iron nodules

Provenance of the Hilton of Cadboll cross-slab

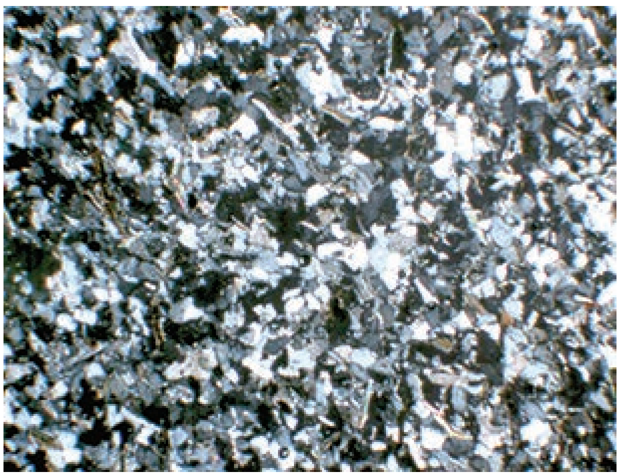
Having discounted various potential sources, one outcrop appears to have the same geological characteristics as the cross-slab. This sandstone is located to the north side of a sandy bay marked on the 1:25000 OS map as Jessie Port (NGR NH 879772). Medium to low tide is required for access. The first prominent feature on the north-east side of the bay is a light grey limestone (fish bed). This is followed by some siltstones and very fine sandstone units until a prominent sandstone bed containing large rip off clasts of silt and fish bed material is reached. There is a further metre (thickness) of silts and muds before two 0.7–1m thick sandstone beds, the lower of which contains iron oxide nodules (illus 7.2).

This unit is a micaceous arkosic andstone (illus 7.3a & b), with grains generally less than 250μm diameter and



a

Illustration 7.3
Thin section of the suggested source rock: (a) ppl, 40× magnification, (b) cpl, 40× magnification



b

defined by the presence of iron nodules. The principal mineralogical components are quartz, feldspar, biotite, muscovite, chlorite, calcite and opaque grains. The quartz and feldspar grains are anhedral and show sutured grain boundaries. They display undulose extinction (particularly obvious in the quartz grains) indicating a metamorphic protolith (ie pre-sedimentary source) for the sandstone. The quartz grains are generally monocrystalline but minor polycrystalline grains are present. The feldspars include plagioclase, microcline and orthoclase. All show some degree of alteration. The mica grains show a very distinct alignment, most probably bedding-parallel. Some biotite grains show alteration to chlorite. The matrix is principally composed of very fine grained clay with calcite. Minor opaque grains (probably iron oxides/sulphides) are present. This sandstone is well sorted but the moderately high proportion of feldspar grains would indicate that it is mineralogically immature. This is consistent with the clay matrix.

The petrology is remarkably similar to that of the cross-slab although some parts of the outcrop appear to contain slightly greater proportions of calcite. This minor discrepancy may be resolved by weathering of the cross-slab after quarrying, which resulted in dissolution of some calcite, or it may simply reflect bed by bed variations in relative proportions of the principal mineral components. The outcrop shows good potential for the extraction of large, coherent slabs, of a similar thickness to the cross-slab. In addition to the similarity of geological characteristics displayed by both this sandstone and that of the Hilton of Cadboll cross-slab, there are grooves on

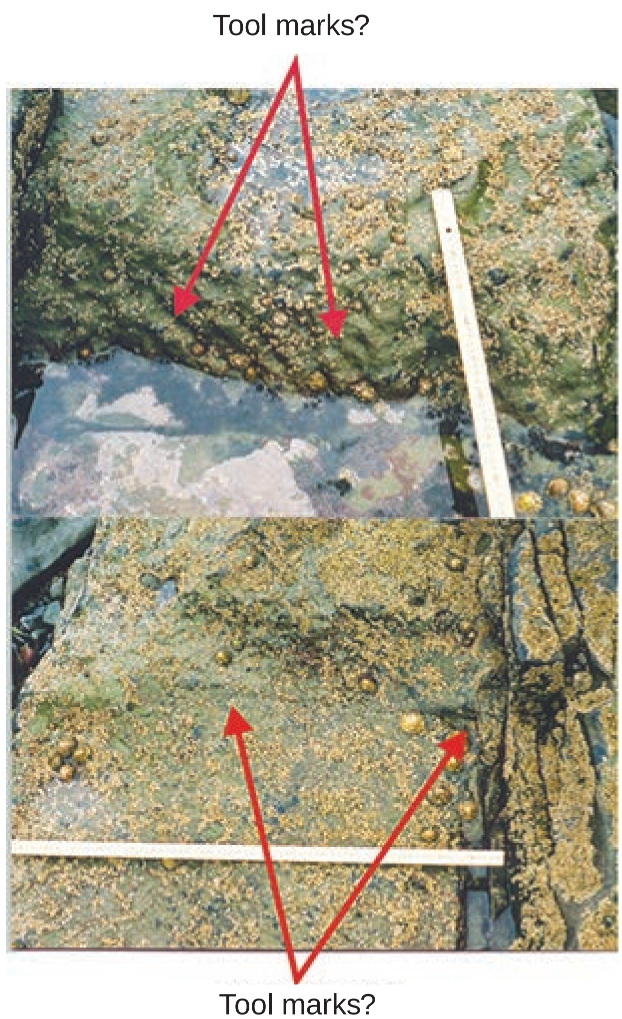


Illustration 7.4
Outcrop sandstone showing non-natural (?tool) marks

the outcrop (illus 7.4) that are difficult to explain as the result of a natural process. These grooves may be man-made toolmarks.

It is suggested here that this sandstone unit is a likely source for the raw material used for the Hilton of Cadboll cross-slab.

Conclusions

The descriptions and analysis of the Hilton of Cadboll cross-slab and outcrop thin section samples have provided an insight into the geological characteristics of the stones used for the carved monuments. The work has identified that a range of arkosic sandstones have been utilised for the monuments. It has also been possible to locate a potential source of raw material that, from a geological perspective, matches the characteristics of the cross-slab. Several general points can be made concerning the nature of the sandstones used at the Hilton site. Perhaps most notable is the overall similarity of the majority of the sandstones. This may indicate that various beds of the same outcrop or unit have been used as sources of raw material. This is consistent with generally similar petrology combined with subtle differences seen in individual fragments/monuments.

It is proposed that further work to constrain the potential source for the Hilton of Cadboll cross-slab should include magnetic susceptibility measurements. The cross-slab itself has already been measured as have numerous potential, but now discounted, source outcrops. This detailed analysis has also provided answers to some of more specific questions posed at the beginning of this report:

1 *What is the nature of the red staining on the surface? Is it natural iron deposit or an applied material such as paint?*

Natural red colouration is common in sandstones and is a particular characteristic of certain formations within the Old Red Sandstone. Indeed, it is one of the distinguishing features of certain units, for example the Upper Old Red Sandstone. It is generally the result of the oxidation of grains of ferrous iron minerals and/or coatings on grain surfaces and is pervasive throughout the rock rather than a surface feature. Many sandstones cropping out (and used for building) in Easter Ross are particularly iron-rich. The colour can vary from reddish yellow to dark brownish red. The exact nature of the iron minerals (ferrous and ferric oxyhydroxides) and presence of manganese can all influence the colour. In general, once formed, the red colour is generally fairly stable as ferric iron is insoluble in an oxidising environment. However, if the chemical environment changes, for example if the stone is buried and exposed to reducing conditions, iron may be leached from the rock.

A uniform reddish-brown colouration is a feature of the carved surface of the Hilton of Cadboll cross-slab, slightly more pronounced on the front of the slab than other faces. This staining may be caused by iron oxide, possibly the mineral haematite (Fe_2O_3). However, it is impossible to identify the actual composition of the pigmentation without further investigation such as XRD or FTIR analysis. The colour may have been applied although it is possible that this is a natural phenomenon as iron oxides are common constituents of the sandstones examined. The colour may have appeared gradually during weathering of minerals in the sandstone. Minerals which could produce the reddish colour on weathering include feldspars, detrital ferromagnesian silicates and iron-bearing clays. The uniformity of the colour could be due to the iron-source mineral being very fine-grained and distributed uniformly through the sandstone (eg fine iron-bearing clay minerals), or it could be due to iron being leached out of the sandstone during weathering and being re-deposited from a probably acidic, saline solution on oxidation and evaporation of the solution on the sandstone surface. Such a process could have been more marked in the earlier stages of weathering of the exposed carved sandstone.

The X.IB 189 thin sections do not show iron oxide coatings on grains. This is consistent with the suggestion that the stone used for the Hilton of Cadboll cross-slab is more likely to have been derived from Middle Old Red Sandstone outcrop and these rocks are generally more greenish-grey to brown in colour, lacking the iron oxide grain coatings that are common in other units. It is also consistent with a non-pervasive colour.

Further examination of the potential pigment surface is recommended in order to clarify its origin, especially since it does look superficially more like an applied pigment than a weathered product on the face and sides of the sample on display in the museum. Because the actual mineral material present is very slight and its nature would be essentially identical whether it was natural or applied, study of the surfaces requires detailed micro-analytical techniques such as scanning electron microscopy imaging to ascertain the physical nature of the coating.

2 *What is the nature of the reddish (rusty) 'blebs' that feature in the greenish sandstone. Is this common? Can this feature be used to identify this particular stone?*

The 'blebs', or nodules, are reddish brown and appear on the slab on display in the NMS as well as on some of the fragments examined. The reddish brown mineral is almost certainly an iron oxyhydroxide. The presence of ferric iron can produce a yellowish, brownish or reddish colour. The red colour is usually attributed to haematite Fe_2O_3 whereas the other colours are attributed to hydrated oxyhydroxides such as limonite (ochre) $FeOOH.nH_2O$. The exact mineralogical composition could be identified by further chemical/mineralogical analysis (eg XRF, XRD, SEM).

Iron-bearing minerals can result from oxidation of reduced ferrous iron minerals such as pyrite FeS_2 or siderite $FeCO_3$ on weathering of the rock. Although the original ferrous minerals may only be present in small amounts they can be concentrated in small areas especially as ferrous iron is soluble and can be easily leached by circulating pore fluids. Where there is a subtle change of chemistry in the rock, re-precipitation of iron-rich minerals may take place, with concentration of such minerals around suitable nuclei (eg grains of other iron minerals, organic matter or calcite/dolomite nodules). Repeated dissolution-precipitation cycles can enhance and 'grow' the nodules.

The iron may migrate through the body of the sandstone, along fractures, bedding planes or other planar structures and can produce reddish brown rings (Leisengang rings). In the fragments examined as part of this study, the sandstone is generally fairly massive and there are few early fracture or bedding surfaces. Iron staining seems to be restricted close to the original nodules in the case of the samples examined. On the slab on display in the NMS there are some quite large brown-ring features. They are present on both the old carved surface and the more recent gravestone (back) surface. The colour is similar to, but distinct from that of the reddish colour of the carved surface and is most probably a natural feature.

3 *It is proposed to reconstruct the original carved slab from the main pieces and all the fragments. How can 'geology' inform the reconstruction process?*

Sandstones very often exhibit a fabric that relates to its original depositional environment, for example sandstone deposited in a lacustrine or flood plain environment will most often be parallel bedded and may be massive or have fine internal laminations whilst sandstone deposited in a current may have well-developed cross-bedding. The bedding planes of sandstones provide an ideal, natural flat or flattish fracture surface which would be ideal for quarrying and carving. When a slab is broken into fragments, there is a good chance that the shapes of fragments and the orientation of fracture surfaces are influenced by this original depositional fabric. The carved surfaces of the cross-slab on display in the NMS are probably original bedding planes. There are indications on the carved front that weathering of the stone has resulted in peeling off of layered patches as would be expected if there were fine internal laminations parallel to the bedding plane and therefore parallel to the carved face. Both macroscopic and thin section examination of X.IB 189 show a very clear alignment of mica parallel to the presumed bedding plane (parallel to the carved faces). It would also be expected that any fragments would also display this orientation and could therefore be used as a point of reference to orientate the fragments relative to the main slab and to one another.

Fragments from different monuments of different sandstone could have a different internal fabric. For example X.IB 355.3, a large slab of flaggy fine-grained grey mica-rich sandstone, has orientation of micas parallel to the main face.

4 *What is the geology of the non-Hilton sculptured fragments?*

(a) X.IB 355.3 – could this be part of the Hilton stone?

Whilst fragment X.IB 355.3 is petrologically similar to other X.IB 355 stone fragments found at the excavation site, it does not appear to be petrologically identical to the sandstone of the Hilton of Cadboll cross-slab.

(b) The cross-incised architectural fragment (context 002, Kirkdale)

This fragment is petrologically different to other fragments examined. It is likely that the source of this sandstone differs from other fragments examined.

5 *Is it possible to identify the sandstone fragments in soil layer 007? If so, is it possible to say whether these tiny fragments are the same geology as the cross-slab or the fragments?*

The sandstone fragments identified from soil layer 7 show at least two sandstone varieties. Those in soil slide 1E (context 007) are arkosic, containing quartz, feldspar, mica and opaque grains. They contain less feldspar and much less mica than the Hilton of Cadboll sandstone. In particular, there is lack of aligned biotite. In addition, the quartz grains are slightly more mature, being more rounded than those in IB189.

The lithic fragment in soil slide 1F consists of polycrystalline quartz with feldspar, biotite, muscovite and opaque crystals. These fragments are not in any way similar to the sandstone of the Hilton of Cadboll cross-slab.

The sandstone fragment in soil slide 2B (context 042) is petrologically similar to X.IB 189 but appears to have a higher proportion of opaque grains and has a finer grain size. However, the sandstone fragments in soil slide 1D (context 019), which are also arkose, are petrologically identical to that of the Hilton of Cadboll cross-slab. They contain immature grains of quartz and feldspar and exhibit a clear alignment of biotite and muscovite. The grain size is also consistent with these fragments being part of the cross-slab.

7.2.2 Toolmarks: technical assessment of the lower portion, the upper portion and the fragments

PETER HILL

Introduction

This assessment was carried out in February 2003 at the request of GUARD, following on from assessments of other Pictish sculpture previously made for Historic Scotland (Hill 2001). The purpose was to examine the toolmarks in order to gain precise technical information about the methods used in working the stone, to establish the standards of workmanship and to see if any light could be shed on the way in which the stone was prepared. The assessment was made on an objective basis, without regard to any received opinion.

The cross-slab has been broken in the past, and there were three sites at which parts were examined. The lower portion slab was in a store in Hilton, Easter Ross, with some overhead natural light, supplemented by a flood lamp; the main part of the cross-slab is in the National Museums of Scotland in Edinburgh, under the normal museum lighting; and a large number of fragments were held in a gallery at Queen Street, Edinburgh, with some overhead natural light supplemented by a flood lamp. In all cases a hand torch was used as well. Photographs were taken with a hand-held 35mm camera with off-camera flash; the scales used were 250/500mm and 50/150mm.

Definitions

Measurements are given in the order length of face × depth × natural bed height.

'Straight' means that the surface is straight within 2mm in 300mm. 'Round' indicates a convex surface and 'hollow' a concave surface, with the average or typical deviation given in millimetres. 'Square' means an angle of 90° within 1mm in 300mm. 'Over-square' means an angle of greater than 90°, 'under-square' indicates an angle of less than 90°, with the deviation given in millimetres. 'Approximately square' is used when the nature of the faces prevents accurate measurement, but the balance of probability is that the faces are or are very nearly at right angles to each other. 'Range' is the maximum depth of the tool marks measured from the immediately adjacent surface. All measurements are approximate or average rather than absolute.

Illustration 7.5
General view of the front of the lower portion, showing the uncarved panels to left and right

Illustration 7.6
The left-hand panel, showing deep pecks on the right-hand side

Constant reference is made to the use of a punch. This is a simple bar of iron or steel, typically 150–200mm long and 10–25mm diameter, with one end drawn out to a point which may be fine or heavy according to the nature of the work; it is normally driven by a hammer. A punch will occasionally have, by design or as a result of wear, a short cutting edge of 1–2mm (Hill & David 1995).

Standards

The working of the cross-slab is judged on the basis of what is readily achievable by a trained stone mason. This may seem a harsh judgement for a stone in which the interest relies to a considerable extent on the freehand low-relief carving, but there are many elements, from the initial preparation of the stone to the geometric designs, which lend themselves to such an approach. It also gives an objective standard by which other artefacts may be judged and compared. No comment is made on the artistic quality of the stone.

Assessment

1 The lower portion

The 1470mm-wide lower portion survives to a height of approximately 770mm, plus whatever is hidden by the temporary stand. Although somewhat weathered, it is in a generally very good state of preservation, with tool marks showing clearly over most of the stone. The lower part of the stone is broken away to a generally concave shape. There are several visible loose beds in the stone, which is face-bedded.

Face A

The left-hand side is generally more weathered than the right. The left-hand panel has a smooth, slightly undulating surface with hardly a toolmark showing, except on the right-hand side (illus 7.5). Here, over a length of 40–60mm, it is clearly worked in small pecks, range up to 3mm, resulting in the surface dipping by up to 5mm as it approaches the right-hand fillet or 'band' (illus 7.6); the rest of the surface is flush with the surrounding fillets. The lower part of the area, including part of the right-hand fillet, has been lost in the fracture.

The left-hand fillet is formed by the projection or lug on the left-hand side of the stone (see below, face D), and is thus only about 120mm high. The width of about 30mm is due in part to the form of the projection. The right-hand fillet runs down to the fracture. The horizontal fillet above this area has the start of a line pecked in from the left over a distance of about 75mm; it is very close to the top of the fillet (illus 7.6). The fillets are separated from the flat area by V-shaped pecked lines which are reasonably regular.

The right-hand panel is uneven, worked in pecks of up to 5mm; it has an unfinished look especially in the upper part (illus 7.7). The separation between the flat area and the fillets is less regularly marked than around the left-hand panel; the line to the right is deeper than the others, the upper one is very shallow, and the left-

Illustration 7.7
The right-hand panel, showing uneven working and variable lines around it

hand one is very variable in width and depth. The fillet to the right is rather heavily worked, range 4–5mm, and does not look well-finished, especially when compared to the equivalent against the left-hand panel. It is about 50mm wide, largely due to the form of the projection on the right-hand side of the stone (see below, face B). The bottom of the left-hand fillet has been lost in the break. At the bottom of the area there is a shallow, pecked line which appears to be delineating a lower fillet; towards the left, it appears to follow the line of the fracture in a parallel curve.

The horizontal fillets above the two panels have a more or less flat surface, whereas other fillets above that level are more rounded. This could be the result of weathering or they were perhaps worked to a rounder profile. Although it is impossible to be certain, the latter is slightly more likely. When measured across the stone, the lower edges of these two fillets appear to align very closely. The middle horizontal fillet on the left-hand side slopes down to left, but the equivalent on the right-hand side is horizontal and approximately square to the vertical fillets above and below it.

The fillets are uneven in width. The upper vertical one on the right-hand side is about 15mm wide. The broken remains of the upper fillet on the left-hand side were 30mm wide, whereas the equivalent on the right-hand side is 25mm; it is the latter Illustration which seems to be that aimed for. The horizontal fillet above the left-hand panel is dead straight, while that above the right-hand panel is at least 2mm round with large pecks in it. The latter has the appearance of less skilled, or at least less careful, work than that on the left-hand side. In general, the junction between the fillets and the background to the carving is somewhat uneven, with the sides of the fillets generally going down at an angle with a rounded junction to the background.

Most of the face is decorated with a key pattern filling a panel bordered by fillets. This is set out in a very regular manner; each part is different, but the differences are repeated exactly from side to side (rather than a mirror image). The face of this panel is 2mm round across its full width, and is set about 3mm below surrounding fillets. The surface was clearly prepared very carefully. The lines of alternate keys do not line up exactly, as they theoretically should, but they are very close.

In the same panel, elements of the key pattern are treated as double spirals raised to form bosses, five at the bottom, two in the middle, and three at the top. In the bottom and top rows the spirals run clockwise, and in the middle row anti-clockwise. The existence of these bosses implies the lowering of the surface over the whole of the face merely to accommodate them (and perhaps other projecting elements, now lost). The alternating direction of the spirals shows careful planning.

The backgrounds to the carved panels at either side are worked in fine pecks, range no more than 2mm, with the exception of the area immediately to the left of the right-hand panel. This is slightly more heavily worked, with pecks of up to 3mm deep (illus 7.8). In general this face has been set out very carefully, but one exception is the width of the undecorated panels. Between the vertical fillets above these areas, that above the left-hand panel is 240mm wide, while that above the right-hand panel is 215mm wide. The execution of the work does not always match its setting out. In particular, the grooves surrounding the right-hand panel are significantly less well worked than those around the left-hand panel. The latter has a much cleaner surface than the right-hand panel, although it is marred by the heavily pecked area on the right. It may be that the area was to be sunk down,

Illustration 7.8
Background to carving, right-hand side, showing heavier than usual working

or to be carved, but if any such plan was intended it was abandoned before completion.

Face C

The back preserves the lower horizontal section of a wide border of vine-scroll, and the first stages of the scrolls that ascend its vertical sides. Below the scroll is a roughly worked area, ending in an arched break as on the front (illus 7.9). The right- and left-hand edges above the projections return to the sides in a vertical chamfer. The carved detail stops above the level of the top of the projections, whereas on the front it continues well below the bottom of the projections. The horizontal vine-scroll has no fillet at the lower edge; the background rises to the general surface in a simple straight line. Below this line the surface has been worked with a heavy punch in long stokes, up to 5mm deep, at an angle of 60–70˚, running top left to bottom right. On the right-hand side, these marks continue almost to the bottom of the stone. The tool had a cutting edge about 2mm wide, perhaps as the result of wear on the point.

A pecked horizontal line crosses this area, running from the top of the projection at the right-hand side and ending 370mm from the left-hand chamfer, rising slightly towards the left-hand end. At the right-hand side it is 110mm below the base line of the vine-scroll, but only 90mm at the left-hand end. Above the line, the face is all worked with heavy punch marks, but beyond the left-hand end the surface is increasingly worked in pecks; some of these occur above the left-hand end of the line. Below the line, the left-hand two thirds of the face is worked with pecks, which are up to 4–5mm deep in places. It appears that the face was first worked in heavy strokes of the punch, and then cleaned up with small pecks below and to the left of the line. On the extreme right-hand side, there is another area of work in pecks, but this is not as neat except very close to the right-hand edge.

In the centre of the stone, some heavy punch marks occur below the line, but some of these appear to have been cut in a separate operation from those above the line. It may be than after the line was cut in, the surface below the line in this area was further reduced with long punch marks before the pecked work was begun.

On the right-hand side, the heavy strokes are crossed by two vertical lines which are aligned on the edges of the vertical fillet on the inner side of the right-hand vine-scroll. These lines are very roughly pecked and, although they appear to be marking out another fillet, the surface between the lines is very rough and rather too low and uneven. The lines stop some 50–60mm above the lower, broken, edge of the stone, while beginning just below them is another pecked line roughly parallel to and about 40mm from the edge of the stone. It is paralleled by the line at the base of the right-hand panel on the front of the stone, and may represent work following the fracture of the lower edge of the stone or it may be random, later work. It is understood that the stone may have been moved in antiquity, giving the opportunity for such work, but this is no more than speculation. However, the line on the back of the stone was not observed at the time of the survey; it shows on the photograph, but could be a trick of the light.

Illustration 7.10
False line on the horizontal fillet

Illustration 7.9
The back of the lower portion

The order of work may have been: heavy punch; the horizontal line; the pecked working of the surface. It is not clear whether the parallel vertical lines were cut before or after the horizontal line.

From side to side across the stone, measured midway between the lower edge and the carving, the surface rises by about 10mm. Across the heaviest punched work, it rises by 15mm.

The large curve at the bottom, now covered by the display stand, appears to be a fracture resulting from pressure or a sudden shock on the centre base of stone.

The background between the carved elements is slightly rounded and with no real attempt to achieve a flat surface; it dips down towards the carved elements.

The horizontal fillet above the vine-scroll is approximately straight with undulations of up to 2mm around the centre. The right-hand end shows an error where a line has been cut with a punch from the centre of the right-hand end for 165mm, curving down to the lower edge of the fillet (illus 7.10). This line, up to 5mm deep in places, is not especially neat. The carved tendril below the fillet has been cut in very neatly with a fine punch, giving it a flat upper edge, to separate it from the fillet. This punched line is very sharp in comparison to the rest of the stone; as it is a very narrow slot, about 2mm wide, it may have been filled with moss or lichen at an early date which would have protected it from weathering. The left-hand end of the fillet is lost, as is the left-hand vertical fillet above. About 70mm remains of the right-hand vertical fillet.

The external angle between the horizontal fillet and vertical fillet on the right is more than 270°. They would have met in a right angle if the lower edge of the horizontal fillet had not been cut back to make room for the tendril below. The distance from the base line below the vine-scroll to the lower edge of the fillet both at the left-hand end and just before the tendril intrudes is 215mm, but only 210mm at the right-hand end.

The left-hand end of the false line follows the outer curve of the tendril, which may indicate that the tendril was begun before the fillet was worked. However, there is no reason for it to have continued to rise towards the right and it may well be the result of inattention on the part of the carver.

The base line to the vine-scroll and the arris running up the chamfer on the right-hand side are approximately square to each other; that on the left, although now much damaged, was probably never square and the lines make an internal angle of about 100°.

Measured across the base of the vine-scroll, the stone is no more than 2mm round from side to side, suggesting that the stone had been trued up with great accuracy before carving began.

Above the vine-scroll, the surface is so damaged that little can be said. What remains was all worked in small

Illustration 7.11
Face D (left-hand edge as viewed from the front of the stone)

pecks. All the back of the stone was worked with a fine punch, apart from the area below the vine-scroll, where a heavier punch was used.

Face D

There is a more or less flat face against the front of the stone and a chamfer against the back. The 65mm-wide chamfer is about 3mm round, giving a distinctly rounded appearance as compared to the chamfer on Face B.

The right-hand 80–90mm of the face is straight and is worked neatly in 2–3mm pecks, but thereafter more coarsely, with pecks up to 5mm deep and the surface falls away to the left (back face) by 10–15mm (illus 7.11).

There is a projection or 'lug', which projects about 45mm, 400mm down from the broken top of the lower portion. It is deliberately curved in plan, with a convex curve on the side towards the front; the left-hand half of the projection has been subject to heavy damage leaving only the upper surface. The top of the projection at the junction with the side of the stone is level for the first 120mm from the front, after which it falls away. The top also slopes down towards the outer side, by up to 25mm at the left-hand side. The surface is more neatly worked against the front face of the lower portion, mirroring the face above. The face of the projection is worked in neat pecks on the right-hand, curved, side; the left-hand side is lost.

The face below the projection is worked neatly with 2–3mm pecks on the right, less well on the left, for the first 130mm down for the projection. Then it drops back 10mm or so in a short splay to a pecked surface of which only the upper 40mm is visible. Across this area is a 15mm-wide fillet which is smoothed as though by friction. It may be that when the stone was upright it was rocking against the collar-stone.

Face B

This end has a more or less flat face against the front of the stone with a chamfer against the back. The main part of the face is worked in small pecks, ranging up to 3mm, and is more or less straight from side to side, with undulations of 3mm hollow and 3mm round. In the centre of the face are two conjoined oval hollows, 5–6mm deep, with one or two punch marks running into them; they appear to be the result of the stone plucking out during working. The chamfer, about 70mm wide, is no more than 2mm round, and has a neater appearance than the rest of this face.

There is a projection, the top of which is about 450mm from the broken top of the stone; it projects about 30mm. On the top surface, the first 70mm from the front has been worked in to approximately a right angle in 2mm pecks, while to the right of this the junction is unfinished and left as a rough curve. The vertical face of the projection is also more neatly worked than the rest for 70–75mm from the face (illus 4.4). The rest of the face of the projection then rises in a step by about 10mm to an uneven surface, with notable holes up to 10mm deep. The projection is more or less flat across the end, as opposed to the rounded projection on face D.

Below the projection, the surface is worked in fine pecks and short 10mm furrows, no more than 2–3mm deep, with the front and bottom edges neatly delineated. It is neater at the right-hand edge, where there are clear signs of a loose vertical bed. From the right-hand side, the surface rises towards the left where it drops by 5mm at about 25mm from the front face.

The top of the lower portion

The broken top shows it to be a buff-coloured stone. There is at least one loose bed 100mm from the back face, and the nature of the break suggests that the stone is highly laminated. These laminations have broken at different points to produce a very jagged break. There are no marks to show how the slab was broken.

2 The upper portion

Only the back, face C, and the edges, faces D and B, of the Pictish work survive. These surfaces are all weathered which limits the information available. The assessment was made from ground level and was thus limited to a height of about 2m. Measurements high on the slab are very approximate.

Face C

The vertical fillets on the inner sides of the vine-scrolls are generally 25mm wide, but with some variation. The left-hand fillet immediately adjacent to the lower left-hand horse is 30mm wide, while directly opposite this point the right-hand fillet is only 20mm wide. These fillets are reasonably parallel through the lower panel, but at the base of the pictorial panel they begin leaning inwards; at the base of this panel they are 770mm apart and 740mm near the top of the panel when the damage makes them unmeasurable. Measuring over the fillets gives 820mm at the base of the pictorial panel and 800mm near the top. The horizontal fillet at the base of the pictorial panel dips down to the right a little; it is 410mm above the modern stand at the left-hand side and 400mm on the right-hand side. Measured from side to side of the stone, this fillet is no more than 2mm round overall, with occasional hollows of up to 2mm. One or two peck marks are visible, but the general lack of tool marks on the face of the fillets suggests that they were to some extent smoothed by abrasion rather than weathering. The abrasion will have been done with a slip of the same stone.

The incomplete panel of spirals at the bottom is straight from side to side, with occasional hollows of 1mm; this was clearly a well-prepared surface.

In the pictorial panel, the head of the lower right-hand horse, and the shield of its rider, have the appearance of having been abraded to a smooth surface. The same is true of the shield of the lower right-hand rider, and to some extent of his horse's head. The bodies of all the horses may also have been abraded. The background to the pictorial panel was worked entirely with a punch, in pecks and 10mm furrows. It does not seem to have been very carefully worked, and compares unfavourably in this respect with, for example, the relatively unambitious Meigle no 6 (Allen & Anderson 1903, 301–2; Hill 2001). The stem of the mirror symbol at the top left of the pictorial panel terminates in a small knob; at the seven o'clock position against this the background has not been fully worked. From nine o'clock to 11 o'clock on the mirror itself the descent to the background and fillet is in the form of an uneven splay. The background to the head and shoulders of the female rider is sunk some 4–5mm from the general background and on the left-hand side depicts the head of a fourth rider.

The upper panel was not easy to see in detail, but at the left-hand side of the left-hand roundel there was no attempt to separate it fully from the fillet. On the right-hand side of the left-hand roundel, just below three o'clock, the background dips quite noticeably and appears quite uneven. The key pattern with spiral elements in the centre of the crescent is not mirrored from side to side as is the key pattern on the front of lower portion.

Face D

The chamfer already noted on the edges of the lower portion continues on the upper portion. On face D, it is of unusual form in that it is sunk 2–4mm at the right-hand side. This feature is vestigial right at the bottom of the upper slab, but it becomes very clear about 500mm above the stand. It is almost certainly the result of weathering, but it is just possible that is was due to careless working. The chamfer is rounded, especially at the bottom of the stone, perhaps as a result of weathering. It returns to the back face in a fillet which is rounded, probably due to weathering. The rest of this edge is flat, and more or less square to the reworked front face; precise measurements were not taken. All of this edge is worked in pecks, range 3–4mm deep but occasionally deeper, neatly enough but not especially tidy or uniform.

At 490mm above the stand, there is a horizontal mark which is the result of pressure or friction. This was very probably caused by the triangular stand which formerly supported the stone in the museum in the National Museum of Antiquities of Scotland (Laing 1993, pl 13).

Beginning 1455mm above the stand is a projecting area 330mm high, over the full width of the edge (illus 4.3). It is highlighted by a slight sunken fillet immediately below, 70mm high, where surface drops 5mm then rises 10mm to the broad fillet. This projection is presumably the remains of a projection, similar to the ones on the lower portion, which was worked off at some unknown point in the history of the stone. In the middle of this area is a mortar repair roughly 70–80mm in diameter.

Face B

The chamfer on this edge is not sunk as on face D, but is approximately flat. The fillet on the return to face C is damaged and shows most clearly at the bottom of the stone, where it is about 20mm wide. The working of the stone is very similar to face D, mostly in 3–4mm pecks with some deeper ones; it is much weathered. Measuring the flat part of this edge, that is between the chamfer and the front face, from the reworked front face A, the first 50–90mm (variable) is worked slightly better than the rest which has rather deeper pecks of up to 6mm. This margin has a slight splay, which is also to be seen on face D. This more careful working against the front face also appears on the base portion (particularly on the projections) and is thus original rather than part of the 17th-century reworking of the stone.

At about 1480mm above the stand there is a slightly projecting area some 350mm high, as on face D; the projection, which runs the fill width of the slab, is about 10mm (illus 4.3). Again, it is probably the remains of a projecting projection. There is a mortar repair in this part, about 70mm wide and 50mm high.

Above this, the flat part has a slight twist in it (that is, it does not lie in a flat plane), which from some angles makes it appear that the stone tapers inwards from the top; this is an illusion.

When viewed from the front, the projections on both sides are clearly visible owing to the slight splay on the front margins of the edges.

Face A reworked

This face was not examined in any detail. There is no sign of any toolmarks other than from a punch; the face of the stone is slightly concave up to a maximum depth of 2mm.

3 The fragments

A large number of fragments were recovered during the excavations. Many derived from the reworking of the face, while others are believed to come from a missing section between the lower and upper portions. Comments are made only on those fragments which yielded useful information.

Most fragments are weathered. They show a lack of attention to the background, as noted in respect of face

C of the upper portion of the stone. All the working was done with a fine punch.

There are rectangular notches in one edge of a number of fragments, for example X.IB 355.181, X.IB 355.91 and X.IB 355.380 (see illus 7.12 for a typical example). These notches were probably caused by the tool which removed them from the face. There are two possible tools which may have been used, either an ordinary chisel or a small pick with a horizontal, adze-like blade at one end; such a pick would have had a head about 300mm long, with a shaft of about the same length. Whichever tool was used, the width of the blade was about 10mm. Cutting back a worked surface would not usually produce such well-defined notches in the fragments. The most likely explanation of these is that the surface came away readily owing to the highly laminated nature of the stone. This would allow an area of stone to break away in a piece leaving the impression of the tool on one edge; a more unified stone would call for a harder blow which would break up the edge around the tool. It is quite possible that at least some of the face was loose before it was reworked.

Illustration 7.12
Rectangular notch caused by tool used for reworking the face

Some fragments appear to have been rubbed very smooth. X.IB 355.271, X.IB 355.366 and X.IB 355.365, now all joined, show what appears to be a part of a tendril with some background. The background, tendril, and the junction between the two, have been carefully abraded leaving only faint traces of fine pecks. It is impossible to be certain, but the difference as compared to the other fragments and the main part of the slab suggest that these pieces may not belong to the Hilton of Cadboll stone.

On fragment X.IB 355.7, the background between what remains of the legs of the figure may also have been abraded. The significance of this is uncertain.

In a number of fragments, part of the pattern includes holes 6–10mm deep, such as on X.IB 355.155, X.IB 355.395, X.IB 355.396, X.IB 355.143, X.IB 355.34, X.IB 355.3, X.IB 355.29, X.IB 355.221 and X.IB 355.420. These may have been produced by repeated small blows on a punch, gradually deepening the holes, but there are indications that they were drilled. This need not have been even so simple a tool as a bow drill, but may simply have been caused by rotating by hand a punch which was forged with facets on the sides of the point. In fact, whatever the section of the shaft of a punch, it is normally brought to a point by forging on end to a tapered square section which naturally gives facets with sharp angles.

Among the carved fragments was a roughly worked stone (X.IB 355.3) measuring 420 by 200 by 35mm overall (illus 7.13). One end of one flat side of the natural slab has been sunk to depth of about 15mm over a length of 145mm. The return end, 25–30mm thick, is also worked; all the work was carried out with a punch. The return into the sinking is about 2mm hollow, neatly worked with a fine punch. The surface of the sinking is worked in pecks and furrows 10mm long, range 3mm. The work does not look as neat as the description implies, and the sinking is nowhere near flat and has a twist of over 5mm, varying between 3mm round and 3mm hollow. The return end was worked in fine pecks, range 2mm, and is partly broken away in the centre, but it was clearly up to 3mm hollow.

Summary and conclusions

The tools used

As with all Pictish sculpture examined by the writer, the evidence of toolmarks points to the exclusive use of the punch for both preparation of the stone and the final carving. The evidence previously observed was for the use of a relatively delicate tool for finishing. This was probably no more than 10mm in diameter, drawn out to

Illustration 7.13
The roughly worked slab

a fine point perhaps resembling that of a well-sharpened pencil. The surviving marks show that the tool was used almost exclusively at right angles to the surface, producing a small crater, or peck. The size of the peck mark is related to the weight of the hammer blow on the punch, and it can be a very delicate operation removing little stone. Occasionally, the mark is in the form of a short furrow which implies the removal of a larger flake of stone.

The survival of the little-weathered lower portion of the Hilton stone shows the use of a heavy punch, clearly used in the initial roughing-out of the stone. This is likely to have been around 20mm diameter, and was used at an angle to the surface to remove larger quantities of stone to a greater depth than with the fine punch. Used in this way, the tool will show either large peck marks or long furrows. It is the latter which show on the lower portion, and this suggests that perhaps something like 10–15mm was being taken off at once. Owing to the highly laminated nature of the stone, it may be that one bed of stone was being taken off.

The punch appears to have been the only tool used on those symbol stones and symbol-bearing cross-slabs stones examined by the writer. No non-symbol-bearing cross-slabs have been examined, nor any simple cross-marked stones. The punch is a very versatile tool, capable of modelling the finest detail in the carvings. It is a little surprising, however, that neither the claw tool nor the plain chisel was in use by the Pictish carvers. The former is excellent for reducing the level of a stone, or for roughing-out carvings, relatively rapidly and with less risk of the stone 'plucking', that is, stone lifting out from below the intended level. What is probably a pluck is visible on face B, mentioned above. The plain chisel would have been useful for finishing the fillets and the background to the carvings, giving a finer finish than the small peck marks which will have been visible over all the worked areas of the stone.

The lack of evidence for these two tools on cross-slabs sculptured in relief such as Hilton of Cadboll is the more surprising as the exclusive use of the punch continues the working methods used for producing symbol stones which use incision only. The production of the latter was a relatively simple matter of taking a natural, flattish slab and using the punch to follow around the outline of the intended design. Relief cross-slabs employ radically different principles. First, the preparation of the slab called for it to be worked on at least five sides to flat surfaces and right angles. In the writer's view, this represents a wholly different culture which must be derived from an external masonry tradition in which it would be normal for a range of tools to be known and used. Moreover, the new technique for the production of the stones seems to have been introduced quite abruptly, taking over with no transitional examples known to the writer. At the same time, the carvings changed from simple incision to varying heights of relief. This was another significant change, calling for a far greater degree of skill in execution. Using a punch to follow a sketched line to give an incised outline takes very little technical skill; removing stone to leave a three dimensional form is a very different matter.

Standards of workmanship

There are surprising variations in the way in which this stone has been worked. It is clear that the preparation of the slab was carried out with care and skill, for the front and back are worked to straight, flat surfaces, no mean feat on a stone nearly 1500mm wide. Although faces D and B are rather weathered, they seem to have been worked approximately square to the faces. All this implies the work of a skilled mason, with skills quite different from those producing symbol stones. The existence of the projecting spirals in the base panel of face A shows that the rest of the surface was worked off by an amount equal to the projection. This shows both careful advance planning of the work and the acceptance of many extra hours of preparation.

On face C, the back, of the upper portion, the fillets on the inner sides of the vine-scrolls are parallel either side of the lower panel, something which must be deliberate rather than accidental. But, either side of the pictorial panel, the fillets incline inwards by 20–30mm; this could be deliberate but is just as likely to be the result of carelessness. The fillet below the pictorial panel on the upper portion dips to the right by about 10mm. Some of the fillets on face A of the base meet at right angles, again an intentional feature, but others do not.

The key pattern on the base of face A is a remarkable piece of work, with differing patterns repeated from side to side to give matching patterns. Overall the surface of this area is virtually straight, and it is difficult to see how this could have been improved. Either side of this panel, the undecorated panels present problems. The left-hand panel seems to have been worked with some care, but the punch marks on the right-hand side suggest a change of plan, perhaps to form a regular sunk surface, which was abandoned. The right-hand panel has a significantly worse appearance and was perhaps never finished. The pecked lines dividing the panel from the surrounding fillets are very unevenly worked, with some much deeper and better defined than others. Again, this aspect is much worse than in the left-hand panel.

The projections at either side of these two areas are worked very differently. That on the left-hand, D, has a curved face as seen from the front, and is finished with neat pecks. The projection on face B is squarer, and much less well finished; indeed it looks unfinished. The differences on the two sides leads to a suspicion that perhaps more than one hand was at work, something not impossible given the size of the stone. The fact that the left-hand panel is wider than the right-hand panel by 25mm suggests a fault in the initial setting out of the design.

An interesting feature of the appearance of the stone, showing both on the lower portion and the upper portion, is that the front edges of the two sides of the stone are finished to a better standard than the back edges. This is particularly noticeable on the top of the right-hand projection, where only the first 70mm of the junction with the side is worked to anything like a right angle; the rest is left at the roughing-out stage.

The sides of the stone below the projections are noticeably less well-finished than above. This may be because they were always to be underground, but it could equally be that these projections were originally the same size as the upper projections and were worked off at some point in the history of the stone. The fact that the carving on the face comes down well below the lower edge of the projections suggests that the stone was originally longer. The carvings on the back finish above the projections, which may indicate a change of plan while the work was still in progress. In view of the highly laminated nature of the stone, it is possible that the stone broke during working or erection.

It is far easier to carve such a stone when it is in an upright position, in the same way as all inscriptions are set upright for letter cutting; the dust and chippings fall away rather than lying on the face, obscuring the work. A possible scenario might be that the stone was set up and work begun. An uneven foundation which put excessive pressure in the middle of the stone might have caused the failure which resulted in the arch-shaped fracture. The stone in its original form probably weighed close to three tonnes; if most of the weight was supported on an undressed stone in the centre a point load could have been exerted. Given the laminar nature of the stone it would not be surprising if it split.

At that point, the stone could have been taken down, the lower projections shortened to allow the stone to sit lower in the collar-stones, and the back worked to finish at a higher point, perhaps at the new ground level. Some support is given to this by the lines on the lower part of the back, which may represent part of the original design. It must be emphasised that this is no more than a speculative reconstruction which appears to fit the facts; there may well be other interpretations.

A number of errors are apparent on the stone. The most noticeable is the false line on the right-hand end of the lower fillet on the back of the lower portion. This could have been due to the carver following the line of the tendril below and simply not noticing until too late that he had crossed the fillet and was going far too high. Such inattention may be surprising, but it is quite possible, as the writer can testify, to hold an animated conversation while working stone; errors can and do occur in this way. The tendril on the right below this fillet comes very close to the fillet and is a little higher than the corresponding one on the left. The lower edge of the fillet has been cut away by a few millimetres in order to accommodate it. There is another false line on the fillet above the left-hand undecorated panel on the face of the lower portion for which there is no obvious reason, but again it could be due to lack of attention or a change of plan.

The key pattern in the crescent at the top of face A on the upper panel does not mirror from side to side as the key pattern on the lower portion does. It could be that fitting such a pattern into other than a rectangular outline makes regularity less easy, or it could be that this part of the design was drawn out by a less skilled designer (Allen & Anderson 1903, pt 2, 362).

The background to the pictorial panel is less good than might be expected, and in places was not quite finished cleanly, and the sinking behind the head of the upper rider gives the impression of an awkward afterthought.

The slightly sunk fillet below the upper projection on face D probably represents the initial sinking from the natural edge of the stone to mark the position of the projection.

Summary

A considerable number of errors of commission and omission have been pointed out, but this should certainly not be seen as condemnatory. The Hilton of Cadboll cross-slab is a remarkable piece of work by any standards, but any shortcomings must be recognised. They are significant, and cannot be dismissed as being of no importance to the carvers. It was clearly of importance that the stone should be prepared accurately, that lines of fillets should be straight, and that fillets should meet at right angles: these aspects were part of the design. Errors were made on the lowest fillets on front and back, and the lowest fillet on the upper portion has a visible sag to the right. These tend to show that the carver was not infallible, but they may also show some lack of competence on the part of the person concerned.

Against this may be set the very skilful drawing out and working of the key pattern panel on face A of the lower portion, which raises the possibility that at least two people worked on the stone. This panel shows much greater care and skill than the working of the background of the pictorial panel. The same might also apply to the key panel in the crescent, but this judgement is less certain. Mack (1997, 34) suggests that the stone may be an imperfectly understood copy of Aberlemno no 3. It is possible, although this is well into the realms of speculation, that the stone was begun, abandoned after the fracture at the base, and then taken over by less skilled carvers.

The critical and objective examination indicates that the undecorated right-hand panel and the projection on face B were probably never completed. This strengthens the suggestion that something happened to the stone before it was finished, and that the fracture at the base may have occurred very early in the life of the stone. The slightly low area below the upper projection on face D gives a useful indication of the way in which the working of the stone was approached.

7.2.3 Fragment distribution analysis

STUART JEFFREY

The objectives of this analysis exercise were twofold: firstly, to extract any archaeologically significant information from the pattern of fragment distribution within the site; and secondly, to facilitate the process of refitting fragments by predicting the relative positions of joining fragments based on the joins so far identified. The methodology best suited to this kind of analysis is derived from Geographical Information System (GIS) techniques. Despite the small scale of the area/distribution on which the analysis was carried out, the principals of GIS apply. ESRI ArcView GIS (3.2a plus Spatial Analyst) was used to plot the distribution of the fragments in relation to the original site grid. The additional information within the database relating to each fragment's properties (join dimensions, form, condition etc), in combination with their geospatial component, was then interrogated across the site to highlight any useful patterns within the data.

In looking at the distribution patterns, it should be noted that in order to create a model of the actual distribution pattern it was necessary to adjust the locational information associated with each fragment. Because the location of each fragment was only recorded to within a particular 0.5m square (referred to by its easting and northing) without adjustment, a distribution diagram would locate all the fragments on the spot where the particular easting and northing lines met. It would therefore not be possible to tell how many fragments were within that square. By adjusting the locational information, the fragments recovered from a particular grid square were randomly distributed spatially throughout that square, thus providing a visual impression of the distribution pattern.

This process required the randomisation of coordinates (generated from the fragment find number). Each fragment had a random number (representing a measurement between 0m and 0.5m) added to its X and Y coordinates. This means that, although the fragment falls in the correct grid square when plotted, its position within the grid square is in fact random. Since the object of the analysis was to look for patterns of distribution rather than to examine in detail the distribution of individual fragments, this approach was considered to be appropriate. The same randomisation process was carried out for fragments from the 1998 Kirkdale excavation, except for the fact that the fragments were randomised in a 1.0m square rather than a 0.5m square, because this was the only information that was available.

The software, Spatial Analyst, was used to perform density distribution plots of various subsets of the data (see illus 7.14–7.25; additional plots are in the archive). This is particularly useful when there are a large number of points in a fairly small area, as there is with the Hilton distribution. Plotting the points alone results in a very dense plot which still makes it difficult to tell where the largest number of fragments (or types of fragments) actually fall. Creating a raster image using colour contours which reveal the density of points (rather than the distribution) allows this information to be drawn out (see illus 7.15).

After some experimentation, a raster grid of around 700 x 700 (depending on the size of the distribution to be plotted) and a search radius of 0.2m was found to give the most information, although a colour ramp of several hundred increments is needed to provide good detail.

A total of 36 fragment distribution plots were produced, including fragmentation distribution of all fragments (illus 7.14) and a density plot of all fragments (illus 7.15). Each context that contained fragments produced a distribution plot (002, 007, 008, 011, 016, 037, 042 and 047, illus 7.16 and archive). There is a distribution plot of fragments by weight (illus 7.17), for all major keywords (illus 7.18–7.24 and archive) and for classes of fragments (illus 7.25 and archive).

The results of this technique are detailed in the sections below. The following points should, however, be noted. The randomisation process has resulted in apparent hard lines around the edges of high density grid squares, thus giving the impression that the fragments extended further than the context in which they were found. As the boundaries of excavated features do not end on lines within the 0.5m grid, the plots should be examined with reference to the site plan. A clear example of the impact of this is that around the setting of the lower portion, where the hard lines formed by the point plot of fragments are an artefact of the randomisation/plotting process. On the west side of the lower portion, the majority of the fragments actually fell in the pit (011) even though they are plotted outside the pit (but in the same grid square as it).

There are a number of fragments that, although they clearly belong to the monument, occur sparsely as outliers to the main distribution. These do not seem to represent significant patterning (apart from one small group; see below). The normal processes of bioturbation that will have been in progress for several hundred years, as well as the disturbance that would be expected in a graveyard in use, may well account for some of these outliers.

The current distribution and density plots do not take any account of the size of the fragments, and this has very serious implications when trying to compare different subsets in any other way apart from density, thus the distribution alone could give the impression that there were 100 fragments of type X at location Y and only five at location Z, where in fact the 100 fragments at Y may represent the same amount of the monument's surface as the 5 fragments at Z.

With regard to whether the resolution of the recording procedure was dense enough to allow for meaningful patterning to be extracted, or whether more could have

Illustration 7.14
Fragment distribution all contexts

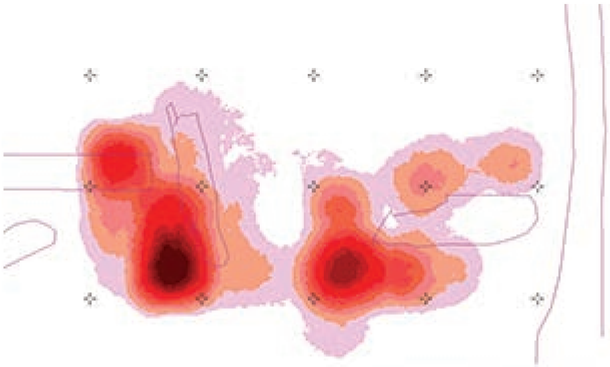


Illustration 7.15
Density plot of all fragments

been extracted on a 0.25m grid (or finer), I am confident that the significant features of patterning are apparent at the 0.5m resolution.

Observations on the distribution of fragments:

1 The fragments are distributed, almost entirely, in a sub-rectangular scatter roughly 4m east/west by 2m north/south. There are a number of outliers to the spread, but it can still be considered as fairly discrete (see illus 7.14). The density analysis of this relatively small area reveals further that there are two areas of particularly high density. One is centred adjacent to the lower portion on its south-west side and the other is a small area (*c* 0.5m x 0.5m) centred on E 101.25 N 102.25.

2 The general area of distribution seems to respect certain excavated features. The eastward distribution of the fragments appears bounded by the clay bank (context 005) and the westward distribution by the 'robber' pit. The southern extent of this distribution seems to have a coherent edge, but does not seem to respect any identified feature of the excavation. A real gap in the distribution occurs at grid square: E 100.5 N 102.5.

3 Groups of fragments (containing over five fragments) that were later shown to join do fall in patterns where they all lie in the either the same or adjacent grid squares. All these groups fall close to the lower portion and joined groups either fall on one side of it or the other. Fragments that join (over five fragments) do not fall on opposite sides of the lower portion. The simple patterning in groups of joined fragments should not be taken to be definitive as there has been no exhaustive examination of all fragments to detect all possible joins. There may be more complex patterns not yet revealed by the fragment analysis.

4 In a similar way to the joins, the clusters (with over 20 fragments) all fall close to the lower portion. Unlike the joins, the clusters have elements that fall on different sides of the cross base, and thus it is possible that clustering groups of fragments is not as reliable as joining.

5 The fragments with keyword 'spiral' have a distribution with a prominent concentration mid-way up the east side of the lower portion (see illus 7.23).

6 The fragments with keyword 'vine-scroll' have a very similar distribution to those with keyword 'spiral' (see illus 7.24).

7 Analysis of fragment distribution by weight revealed at least one significant disparity. Fragments weighing over 75g fall predominantly on the west side of the lower portion. This corresponds with the field observation that a number of larger fragments appeared in the upper layers of the pit.

8 The most significant feature of all distributions is the apparent gap in the grid square E 100.5 N 102.5. This square does contain fragments, but they are significantly fewer in number (especially classes 1A/1B) than the surrounding squares.

Interpretation

By analysing the spatial distribution of the fragments recovered during excavation, it has been possible to construct a hypothesis for the sequence of events affecting the Hilton of Cadboll cross-slab from its last known upright setting (where the lower portion was recovered *in situ*) to its removal from the chapel site. This analysis has utilised both the density of the fragments (where they were concentrated on the site) and the density and distribution of particular types of carved fragment. The sequence of events that may best match the distribution of the fragments as recovered during excavation is as follows.

A pit was dug at the base of the cross face of the monument to around 0.5m in depth. The intention of this may have been to dig out the cross. If this was the intention, it was never carried through. The presence inside this pit of a large number of fragments indicates instead that a large section of the cross face was removed as it stood upright. This caused the resulting fragments to fall into the pit creating by far the largest concentration of fragments on the site.

It is likely that the person carrying out this removal actually stood in the pit removing the carved surface up to about shoulder height. It may be significant that a number of large fragments shown by Ian G Scott to fit directly too, or to be closely associated with, the 'mid-portion' were not found in this pit. These larger fragments may well have remained intact and attached to the monument until a later episode in which it was toppled.

The monument then fell, causing a roughly horizontal break just above ground level, toppling towards the chapel. It is now thought likely that the stone blew down in high winds and it is therefore even possible that the stone, which had been stable for centuries, was destabilised and/or weakened by the pit and by the rough removal of some of its carved elements.

Once the monument was horizontal, with the partially defaced side skywards, the dressing/defacing continued. It is not possible to tell how much time elapsed between the two episodes of dressing when upright and dressing when horizontal. The second episode may have followed from the first immediately or after any number of years. Potentially, an earlier act of rough defacement was completed or enhanced by a finer redressing at a later date. The resulting fragment scatter from the episode of dressing when the cross was horizontal is heavily concentrated to the south of where the monument is likely to have fallen. Taken together with the less concentrated scatter of fragments to the north, it may be possible to discern a 'shadow' effect where the monument lay on the ground as the fragments were deposited around it. If we accept that there are two episodes of face removal then future work could potentially discern a clear difference between them and the tools used in each episode by analysis of the remaining toolmarks.

A gap exists in the scatter of fragments for around 1m to the chapel side of the lower portion. This would result from there being no need to dress off the carved surface of this section, it having previously been dressed off when the monument was upright. Although unlikely, there is also a possibility that the fragments from this area were used to back fill the pit and that no dressing took place at all when the monument was upright.

It is entirely possible, given the above proposed sequence of events, that the defacing/redressing of the monument and its subsequent fall were not conceived as part of the single act that ultimately resulted in its use as a funerary monument in the 17th century, but in fact represent a combination of deliberate action and natural process. A number of questions remain, the most thorny of which is: why was the pit dug in the first place? If it was to dig out or topple the monument, which proved too deep or difficult for the excavators to continue, why dress/deface the cross-side at all when it was upright? The case for the pit being filled by fragments as they fell directly from the face is strengthened by the existence of a number of joining fragments in the pit. Other sets of fragments that have seen been shown to join have been found in disparate locations around the monument, except for the concentration of such in the pit. It is even possible that some joined fragments were actually broken underfoot once they had fallen into the pit by the stone worker rather than by the action of their chisel. Finally, the concentration of heavier fragments (>75g) on the west of the lower portion suggests that it was large, prominent elements of sculpture that were removed when the stone was upright and that the continued working of the monument when it was horizontal was a more delicate affair.

With the exception of the pilot study carried out by Douglas Morton (see Chapter 7.2.4), there has been no attempt to integrate the spatial distribution and database descriptions of the fragments with the process of refitting. Fruitful lines of approach abound for future implementation, for example a query supplying every fragment over 75g from within contexts 007/011 and the spatial confines of the pit would be more likely to yield further joins than a simple qualitative visual approach to the entire body of fragments.

7.2.4 Fragmentation of the cross-slab

DOUGLAS MORTON

An examination of the various categories of fragments was undertaken in order to inform our understanding of the destruction of the Hilton of Cadboll sculpture. Examination was made of the fracture type and fragment condition data held in the Access database. Little recourse was made to the actual sculptural pattern or design as this work was undertaken in Glasgow. Instead, discussion focused on the other characteristics of the fragments such as condition, fracture style, and secondary toolmarks. 'Toolmarks' here refers to toolmarks caused by the re-dressing of the sculpture, not to those left by its initial creation.

Fragmentation of the mid-portion

A total of 253 fragments have been catalogued with the keyword 'mid-portion' in any of the three 'keyword' fields. Of these, 116 belong to face C; 22 are recorded as possibly being from face C; 87 are noted as probable mid-portion fragments; 21 are possibly from face A; and seven are from faces B or D.

Face C

Approximately 70 per cent of the mid-portion of face C has been reconstructed with three large clusters of bonded fragments, unbonded groups of other fragments and a number of floating fragments.

Fracture

There are two main types of fracture that characterise the fragments from the mid-portion of face C. The majority are large, thick pieces with edges that slope inward to a thin 'pared' back. These fragments all tend to slope in the same direction, with the angle pointing towards the

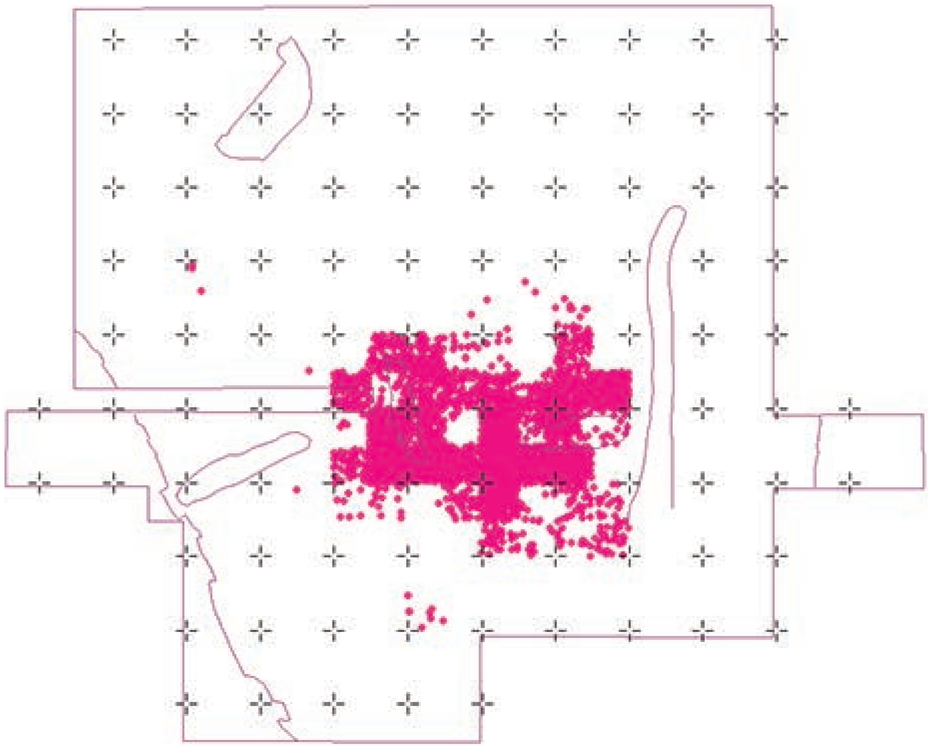


Illustration 7.16
Fragment distribution context (007)

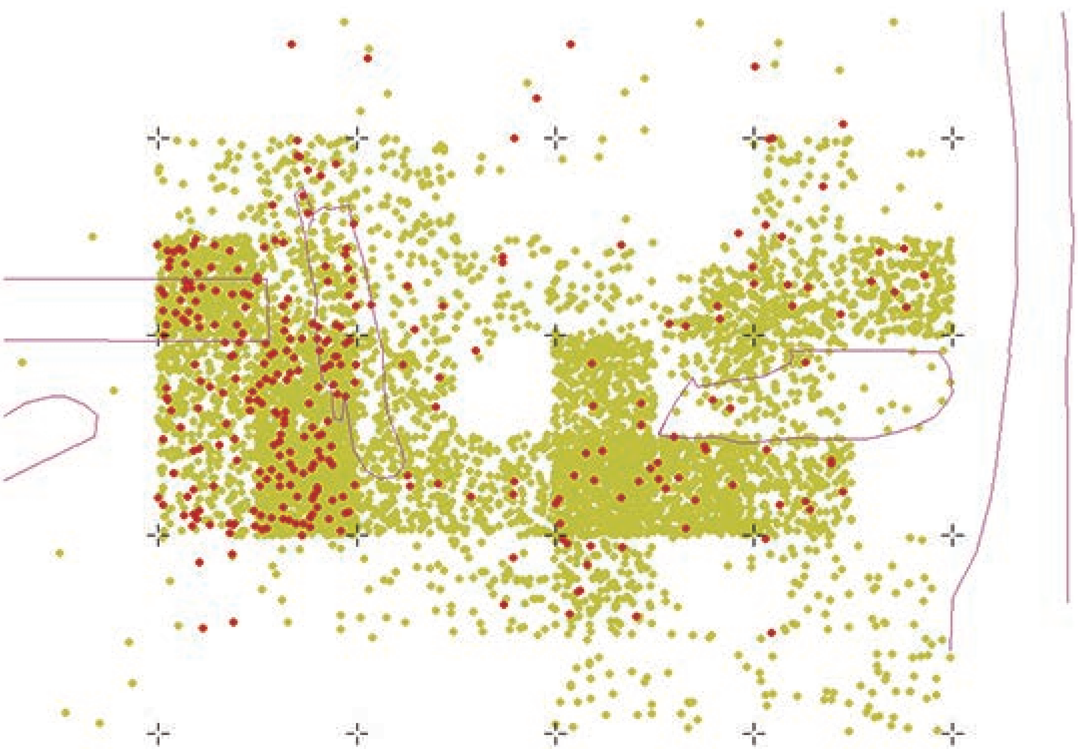


Illustration 7.17
Distribution of fragments by weight, red >75g and green <75g

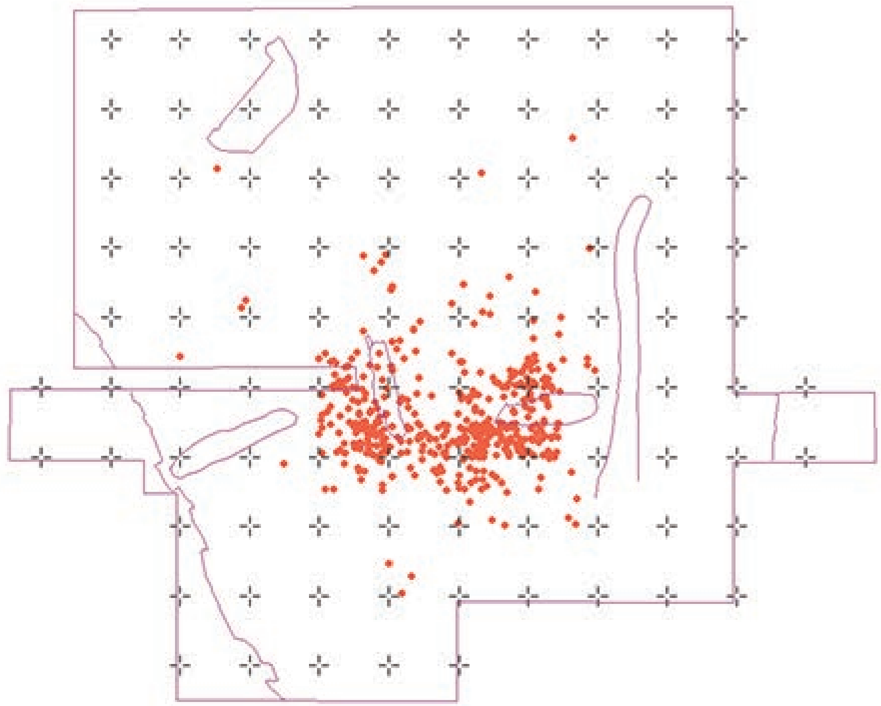


Illustration 7.18
Fragment distribution animal

Illustration 7.19
Fragment distribution human

Illustration 7.20
Fragment distribution interlace

Illustration 7.21
Fragment distribution key

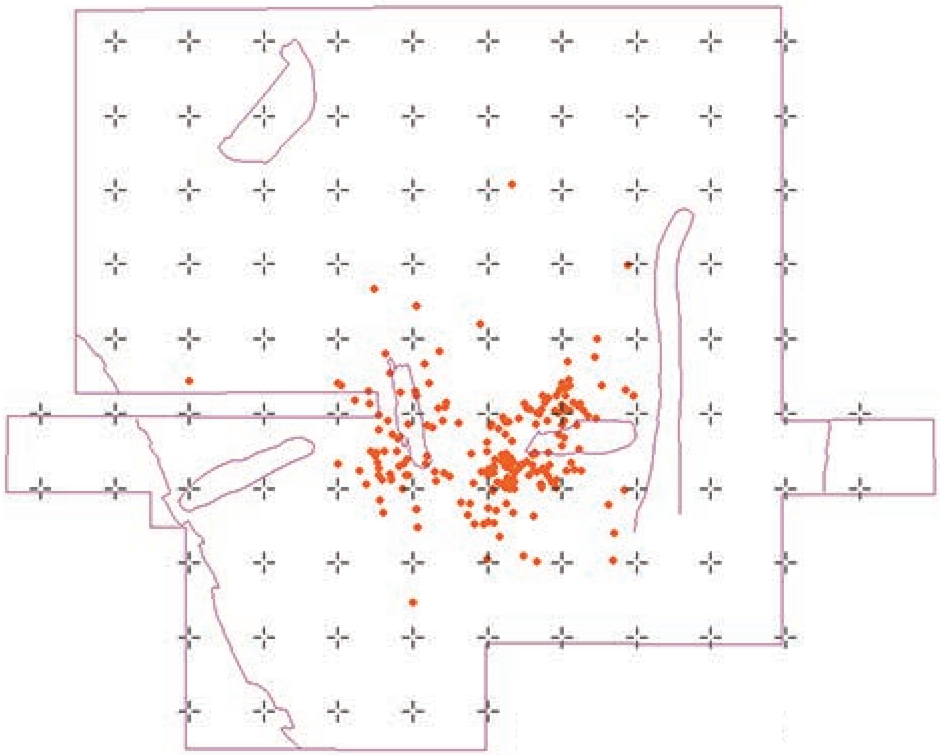


Illustration 7.22
Fragment distribution plant

Illustration 7.23
Fragment distribution spiral

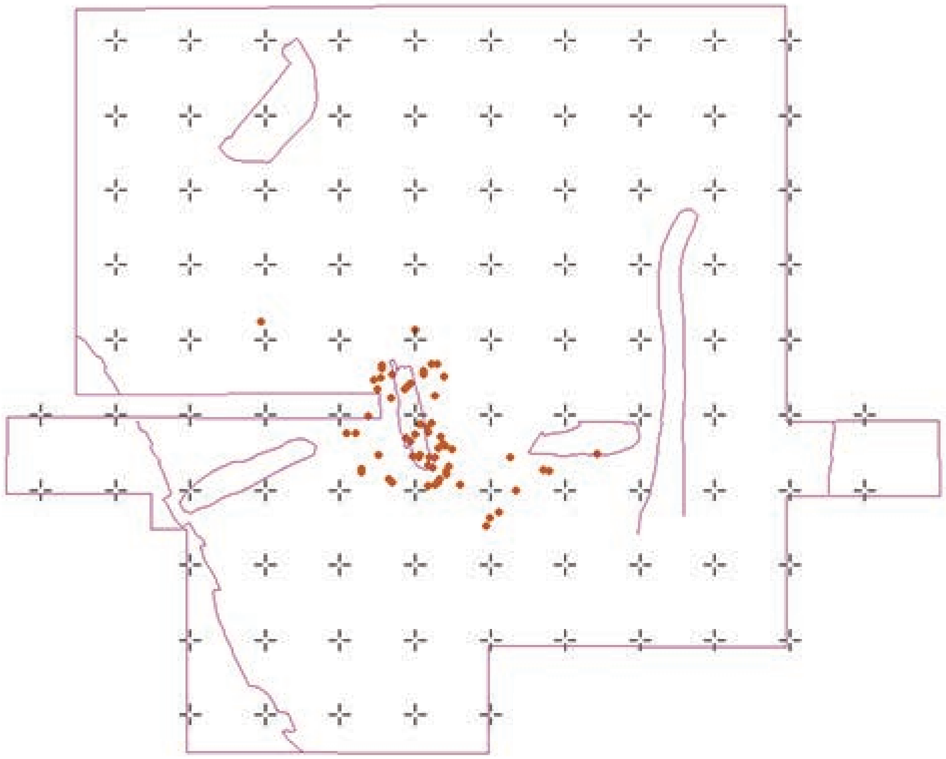


Illustration 7.24
Fragment distribution vine-scroll

Illustration 7.25
Fragment distribution class IA

base of the slab, perhaps indicating the method of break. The un-carved edges are often characterised by either a concave or bulbous appearance. The second type is entirely different and less well represented among the fragments. These are delicate fragments characterised by thin sections and slight convex backs. Whilst the larger thick fragments were found throughout the mid-portion of face C, the thin pieces were only found in an area that runs left-to-centre along the lower edge of the mid-portion.

Condition

The best-preserved fragments from this area are those of the thin-sectioned fracture style. These are in good condition, displaying a high level of surviving surface detail and a rusty-brown colour that is normally associated with fragments from face A. Where surface has survived on the larger fragments, it tends to be in a fair condition, with only minor damage and weathering to the surface detail. A small group of fragments from the lower right-hand side of the area have no remaining surface detail. A number of large mid-portion fragments survive with no remaining carved surface. These fragments are presumed to be internal pieces.

Discussion

That there are two very different types of fragment from the mid-portion of face C is of interest. The larger fragments all bear very similar characteristics and it is clear that their formation process is a relatively simple one. The similar patterns of wear, fracture style, and orientation all suggest that they form a coherent group caused by one destructive event, probably the breaking of the upper portion. The smaller, more delicate fragments have a more complicated history. The stark difference in their size and shape immediately hints at a different biography, but their find locations suggest this need not be the case. They were found during excavations lying flush against the lower portion, having separated from main surface at some point and fallen downward. It is this position (flush with the lower portion) that presumably created a safe environment for their survival, and hence has resulted in their good condition. It is possible that there were more of these thin fragments that were less fortunate, being crushed under the weight of other fragments and debris. The small group of fragments without surface on the lower right-hand side of the area may have originally held this type of carved surface, which is perhaps now lost. Another possibility is that this damaged 'bald' area is the result of a large hammer blow. The lamination of these thin-sectioned fragments away from the main body of the mid-portion is interesting. This may indicate an inherent weakness in the geology or possibly a weakness as the result of percussive damage.

Face A

With only 21 fragments attributed with any confidence to the mid-portion of face A, the reconstruction and understanding of this area is very much still work in progress. Consequently, understanding the fragmentation process of this area at this point is difficult. The fragments are in two main clusters with one other large fragment and a number of other possible floating fragments.

Fracture

The three main fragments/clusters are of a similar large size, but there the similarity ends. On the right hand side, X.IB 355.5 (the animal that completes the motif on the top right of the lower portion) has a concave fracture above the carved surface; the back surface is gently domed; inner edges are thinned and sharp. Fragment X.IB 355.9, the largest fragment from the centre of face A, is a thick piece that angles into the body of the slab and has a convex back with a lip. It is also part of a possible cluster of fragments that may stretch over half of the width of the mid-portion face A. These fragments differ in size but all share orientation and direction in which the back angles into the slab. Fragment X.IB 355.1 (the animal on the left side of the lower portion) forms the centrepiece of the third cluster of fragments. The fragments in this cluster are all of a fairly uniform thickness, with straight edges and slightly concave backs.

Condition

The two fragments that re-fit to the lower portion (X.IB 355.5 & .1) are both in a good state of preservation with excellent surface detail still visible. The carved surfaces are a distinctive rusty-brown colour. Fragments from the X.IB 355.9 cluster are in a lesser state of preservation with considerable damage to the relief and worn carved surfaces. The distinctive rusty-brown colour is absent on these fragments. Rusty-coloured veining can be seen running across the otherwise greyish-brown surface of X.IB 355.7.

Discussion

There is little about their fragmentary nature that draws the mid-portion A fragments together as a coherent group. Although their large size and similar state of preservation characterise some of the fragments, the fracture style often differs. One or two of the fragments re-fit to the lower portion, and it would only be through a testing of these joins that a full appreciation of their complexity could be achieved. The survival of a wide cluster of fragments stretching across half of the width of the mid-portion is interesting, perhaps indicating a horizontal trauma or weakness in the stone prior to a destructive event. That this cluster is in a lesser state of preservation than the other main groups is also of note, perhaps indicating differing biographies. It is possible that X.IB 355.1 is so well preserved on account of its deposition well away from the lower portion, where there was presumably a great deal of activity detrimental to the survival of the fragments. Similarly, the rusty veining on the X.IB 355.7 hints at staining caused by roots that may also have affected the state of preservation (see Chapter 7.2.1). This fragment was retrieved from just beneath the turf and so the staining could well be from the grass roots. Fragment X.IB 355.9 was presumably part of the cross itself and it is interesting to note the poorer state of preservation and the absence of red staining on this and its associated fragments.

Fragments from face A

The remaining 7216 carved fragments contained in the catalogue are all thought to come originally from face A. At the simplest level, the fragments are grouped within the catalogue according to categories described in Chapter 7.1. The fragments were catalogued in the same order as they appear in Table 7.1 from carved fragments with sculptural pattern (class 1A) to carved non-Hilton fragments (class 4A). The class 4B fragments were examined but were not catalogued in the database.

Class 1A

The 3287 fragments contained within class 1A form the largest coherent group of fragments. These fragments all bear evidence of belonging to the sculptural pattern on face A. For the purposes of the catalogue entries, the carved surface is termed the front, thus giving the fragment orientation across one axis while orientation across the others is often unknown.

Fracture

Given the size of the group, it is difficult to make generalisations about the class 1A fracture style. Nevertheless, over the course of the catalogue process two types of fracture were noted as being well represented: the typical conchoidal; and the flat-backed fracture. The typical conchoidal fracture is characterised by an 'oyster-shell' like appearance with thin edges on most sides, and a near-vertical break along one side, suggestive of an anthropomorphic origin. The flat-backed fracture is a fragment with an unusually flat back, probably the result of natural lamination of the stone.

Condition

The quality of the preservation of the 1A fragments differs greatly across the class, although some generalisations can be made. The carved surface is often in a good state of preservation, although the size of the surviving carved surface varies greatly. Carved areas are often a rusty-brown colour; damaged areas and the back of the fragment are greyish-brown.

Class 1B

This category was originally created as a grouping for fragments of flat-carved surface, of which there are 33. It became clear however, during the cataloguing of the 1A fragments, that it was often impossible to identify the orientation of the smaller fragments. In many cases, the smaller fragments, which appear to be flat surfaces, may in fact have been part of relief forms and thus may not be very useful as a separate class. Only fragments known to be part of an area of flat carved surface were catalogued as 1B.

Fracture

There exists a wide variety of fracture styles in this small group, although neither the typical conchoidal nor the flat-backed fracture are well represented.

Condition

The class 1B fragments are for the majority in good states of preservation. They display similar colouring to the 1A fragments discussed above.

Class 2A

Class 2A fragments have no surviving areas of carved surface yet are identified as being part of the Hilton sculpture by other diagnostic features such as toolmarks, fracture style, bleb stains or scars, surface colour, and geology. They are therefore internal fragments. There are 403 fragments of class 2A.

Fracture

The majority of these fragments are of the typical conchoidal fracture; a significantly smaller number are small chips.

Condition

All of the 2A fragments are recorded as surviving in poor states of preservation. Most of the fragments are a light brownish-grey colour.

Class 2B

Fracture

There is a wide variety of fracture styles for this large group of fragments, although the most common is the small chip. Class 2B fragments are found in the main as small thin flattish chips of stone, many with flat surfaces. Given that there are no carved surfaces on these fragments, orientation is often impossible. There are 3270 2B fragments.

Condition

Nearly all of these fragments are recorded as being in poor condition and of light greyish-brown colour.

Class 3A

Fracture

Irregular-shaped fragments. No coherent fracture styles. There are 331 3A fragments.

Condition

Poor condition. Greyish-brown.

Class 3B

Fracture

Irregular shaped fragments. No coherent fracture styles. There are 123 3B fragments.

Condition

Poor condition. Greyish-brown.

Secondary toolmarks

There are 278 positively identified, and 321 possibly identified, toolmarks recorded in the catalogue (Table 7.2) There were also two positively identified and four possibly identified toolmarks in the class 4 fragments.

The standard toolmark is a rectangular notch *c* 10mm wide (when measurable), which was identified as deriving from the tool used to redress the original carved surface. The presence of a small number of other rectangular notches *c* 5–7mm wide may indicate the use of a smaller tool for the removal of some fragments. Given that the orientation of the majority of fragments is not clear, it is not possible to locate the toolmark in terms of direction around the edge of each fragment.

Table 7.2
Number of toolmarks per class

	Toolmarks	Toolmarks possible
Class 1A	164	118
Class 1B	0	0
Class 2A	96	106
Class 2B	18	96
Class 3A	0	0
Class 3B	0	1

Discussion

That most toolmarks are found within the class 1A category of fragments is not surprising. These, after all, are the fragments with carved sculptural features, which would have presumably been the first to be removed from the surface of the cross-slab face. The remainder of the toolmarks are found among fragments of classes 2A and 2B, fragments which do not bear any carved surface. These must represent a second phase of fragment removal, presumably to begin levelling the surface. That there are not more toolmarked fragments must simply be because the toolmarks do not survive. The probability is that the process of relief removal would be as likely to split and destroy a fragment, as to remove it with a clean toolmark. Furthermore, the presence of a toolmark notch on a fragment would compromise its already fragile condition, and it is likely that many toolmarked fragments probably broke after the event.

Discussion: the fragmentation of the monument

While all of the fragments (1A to 3B) are probably tied together by the simple fact that they were created by the destruction of a piece of sculpture, a thorough examination of each grouping and sub-category of fragment has revealed many separate biographies. Perhaps the most striking aspect is the difference between the opposing sides of the mid-portion, and the difference again between those of the mid-portion and the remainder of the fragments. It is hoped that further reconstruction work on the mid-portion of face A will flesh out our understanding of its biography to a point where the mid-portion can be understood as a whole, and not as two opposing sides. The sorting of the other fragments into different classes according to visual characteristics was an essential part of the post-excavation work on a large body of material. Fortunately, it has also proved useful in understanding the destruction of face A as a whole. Through an examination of the different classes of fragment, the layers of destruction can be seen (illus 7.26). Perhaps most striking is the relationship between 1A/B and 2A/B fragments: 1A/B being the carved surface itself which had to be removed first; and 2A/B being the underlying relief, which was removed at a second stage as part of the re-preparation of the surface. That there is an almost equal amount of fragments in each category should not be seen as a coincidence, rather the result of the separation of two originally related layers of relief. Clearly the IA/B and 2A/B fragments represent two main phases of the removal of carved relief, while class 3A/B represents additional fragment removal before the carving of the 17th-century memorial.

Carved surface face A
1A/B
2A/B
3A/B
Dressed face of material

Illustration 7.26
Schematic section through the Hilton cross-slab face A with suggested layering of fragments

7.2.5 The application of database-driven methodologies to the reconstruction of the monument

DOUGLAS MORTON

Introduction

Upon nearing the completion date for work carried out on the Hilton of Cadboll project for the financial year ending April 2005, it was felt that there were certain analytical avenues that had not yet been addressed. One such avenue was the application of database-driven methodologies to the reconstruction of the monument. Reconstruction up until this point had concentrated solely on the 752 available for manual handling at Queen Street, without reference to the other possibly carved fragments. Furthermore, this methodology had not taken advantage of the unique locational information available for each fragment. Although it was recognised that there may have been a limited amount of bioturbation on the site, which could affect the potential validity of locational information, it was felt that the usefulness of this information should be explored as it was a part of the original remit of the excavations. This pilot study was developed as a response to these shortcomings, and as a means through which to assess the possibilities of future reconstruction methodologies. This work initially took place over 9.5 days during February and March 2005 and was then continued for 30 days between May and August.

Methods

It was initially hoped to test the applicability of the locational and database information in two ways: on fragments of a particular type and on fragments from a particular location. However, time constraints meant that only a portion of the former was possible. Fragments that have been ascribed the descriptive keyword BAND were selected for this study for the following reasons:

1 Apart from the numerous joins that had been made within the mid-portion of face C, a useful number of other joins had already been made between fragments of relief band.
2 Because of the chunky nature of these fragments, they are the most likely to fracture in such a way that allows for reconstruction to take place.
3 If successful, it was hoped that the reconstruction of these fragments would give an indication of the number of bordered panels on face A, and indeed of the size and shape of the contour of the cross itself.

Fragments were selected and located for analysis using the database KEYWORD SEARCH. A query was designed and performed on the database that would retrieve any fragment that contained the keyword BAND in any of the three potential keyword fields. Although it was recognised that this would return band fragments of different types/widths, it was hoped that the application of the pilot study to the widest sample held the potential

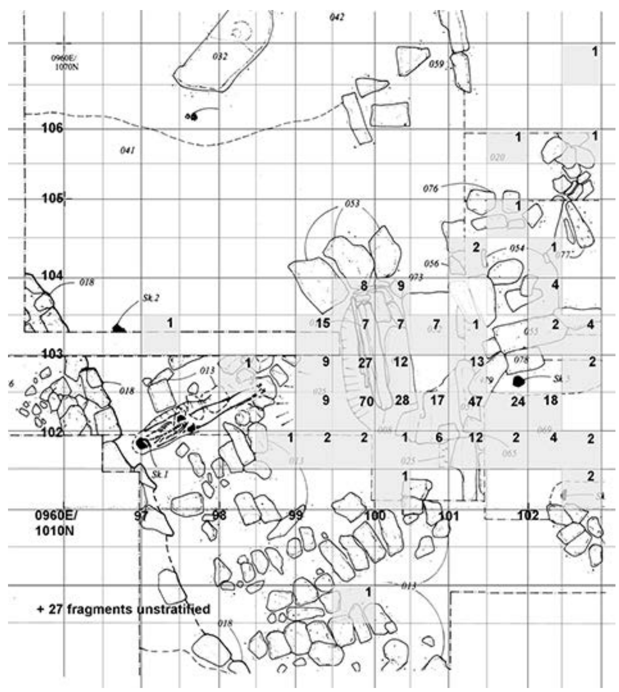


Illustration 7.27
The distribution and numbers of fragments of band in each grid square (the numbers in the top right corner of each shaded square)

Illustration 7.28
Joining band fragments

to yield the most results. A query of the database at that point (before completion of the fragment catalogue) produced a sample of 411 fragments. The totals of band per 0.5m grid square are illustrated on illus 7.27.

Fragments were then retrieved either from storage or from the sand trays at Queen Street. Only 255 out of 411 fragments had been marked with the museum accession number (X.IB 355.n) which presented problems for manual handling. Care was therefore taken during this work to maintain the association between the fragments and their bags, especially as ongoing reconstruction work was being carried out at the same time by Ian G Scott, art-historical analysis by Isabel Henderson and photographic recording by the NMS.

Fragments were then physically sorted into their appropriate grid squares. Due to restrictions on the available surface area within which to work it was not possible to lay the entire 411-fragment sample out in a full reconstruction of the original excavation location. Instead, each grid square had to be worked through one-by-one using a small working area available in the National Portrait Gallery in Queen Street.

Each fragment contained within a grid square was checked both for joins against other fragments from within the same grid-square, and against those from

Illustration 7.29
Joining band fragments

neighbouring grid-squares in all directions, including diagonal. Once all fragments from the selected grid square had been checked with all others in all directions, then that square was crossed off and its fragments were re-bagged according to grid-square and readied for return to their original locations. Fragments contained within isolated grid-squares with no neighbouring squares were briefly examined and then returned to their storage location. Unmarked fragments had to be removed from and placed on top of their small bags to avoid any confusion. Whilst examining the fragments and checking for joins, extreme care had to be exercised to ensure that fragments did not lose their original location. This became very difficult for grid squares that contained large numbers of fragments and slowed down the process greatly. However, all 384 fragments were checked for joins.

Results

The fragments which have been catalogued with the keyword BAND have different widths. There is wide band which is thought to form the outline of the cross, a thinner band about 25mm and 30mm wide and more rounded band which may form parts of plant or animal ornament. These fragments were in varying states of preservation and size, with those best preserved already available for study in the sand trays at Queen Street. Many fragments were unfortunately too incomplete to allow for any categorisation. As a result of this work, several short sections of relief band were assembled, some possibly forming part of the contour of the cross (see illus 7.28 & 7.29).

A total of 22 joins were made, but only three square comparisons produced more than one join. The most numerous joins were found within the 70 fragments from grid square 0995E 1020N which produced eight joins. Several ‘similarities’ were noted between fragments of band and these were noted on the database, but unless an actual join was made then they were not included here. The full results of the checking for joins in the above grid squares can be seen in the database and archive.

Discussion

It is clear that this wide and varied sample of band fragments is a result of the initial wide database search. Although it was initially felt that such a wide-ranging search would benefit the study, it may be that analysis of those fragments containing BAND as a keyword in Field 1 (278 fragments) would have been easier.

It was originally hoped that the pilot study would inform our understanding of the shape of the contour of the cross, which may well have been damaged beyond recognition. Within the portion of the sample studied, there were several joins and similarities between fragments of wide, flat relief band of a type normally associated with a margin or edge, which has contributed towards, but not clearly defined, the nature of the cross-face.

The relationship between fragments from neighbouring grid squares is far from clear. The majority of joins and similarities that were found appear to be between fragments from the same grid square rather than from neighbouring squares. This would imply that fragments have not been subjected to any significant post-deposition movement.

The results of the analysis suggest that there is no immediately recognisable pattern to be read from the location of fragments of a particular type. The individual grid squares contain many different types of fragments. This is something that is also borne out by the work of Stuart Jeffrey in Chapter 7.2.3.

While this work has not perhaps forwarded the reconstruction process very significantly, it has highlighted the problems with this type of endeavour. These problems include the lack of marking of the fragments, several people working on the fragments at the same time, the time-consuming nature of this matching process, and the freeform nature of the Pictish carving itself. Further work should perhaps concentrate on the keywords KEY (referring to key pattern) or INTERLACE, which contain some basic geometric shapes which presumably fill panels defined by the band.

Appendix

Summary of the joins found between fragments (full text in archive)

Similarities were also noted but are not included here.

The first phase of work produced the following:

10101015	10151015
12 fragments	2 fragments

One JOIN within grid square 10101015 between X.IB 355.2652 and X.IB 355.2661 to create a 30mm wide flat relief band of a type that could possibly form part of an edge/margin. The length of the relief band when joined is *c* 60mm.

One similarity within grid square 10101015 between X.IB 355.2652/X.IB 355.2661 and X.IB355.2657. X.IB355.2657 has lost nearly all its carved surface, though the scarring appears to be of similar band dimensions. The length of the scarred area is 28mm.

X.IB 355.2660, also from grid square 10101015, is also a wide flat relief band, though it appears slightly narrower at *c* 26mm.

10101020	10151020
47 fragments	24 fragments

One JOIN found within grid square 10101020 between X.IB 355.1569 and X.IB 355.1565 to form a section of very badly damaged relief band.

X.IB 355.371 (10101020) and X.IB 355.947 (10151020) are similar fragments of tubular curving band, probably part of plant stem.

X.IB 355.371 (101.01020) and X.IB 355.1042 (10151020) possibly JOIN to form a tubular curving band.

One JOIN found between X.IB 355.747 (10101020) and X.IB 355.604 (10151020) to form part of a *c* 30mm wide flat relief band *c* 102mm long. The band probably formed part of an edge-margin.

10101025	10151020
13 fragments	24 fragments

One JOIN found within grid square 101.0/102.5 between X.IB 355.735 and X.IB 355.783 to form a section of tubular band.

There are similarities between X.IB 355.733/X.IB 355.403, X.IB 355.785/X.IB 355.735, X.IB 355.734, X.IB 355.947, X.IB 355.57 and X.IB 355.1042.

10051015	10101020
6 fragments	47 fragments

One similarity within grid square 10051015 between X.IB 355.2201 and X.IB 355.2196. X.IB 355.2196 joins X.IB 355.5.

10051020	10101020
17 fragments	47 fragments

One JOIN between X.IB 355.571 (10051020) and X.IB 355.371 (10101020).

10051020	10101015
17 fragments	12 fragments

One JOIN found between X.IB 355.2604 (10051020) and X.IB 355.2660 (10101015) to form a section of wide flat relief band c50mm long.

Second phase of work produced the following:

10001020	10001015
28 fragments	2 fragments

One join between X.IB 355.141 (10001015) and X.IB 355.1291 (10001015) to form part of a flat relief band.

9901020	10001020
71 fragments	28 fragments

X.IB 355.309 (10001020) joins X.IB 355.3137 (9951020) to form part of a group of fragments that join to create a section of relief band from the contour of the cross.

10001035	10001030
9 fragments	7 fragments

X.IB 355.3226 (10001030) joins X.IB 355.962 (10001035) to form a section of straight relief band.

9901030
15 fragments

X.IB 355.139 joined to X.IB 355.514 within the grid square to form a section of band *c* 108mm in length. The top surface of the band is 20mm wide.

9951025
27 fragments

X.IB 355.3030 joins X.IB 355.3034; X.IB 355.3032 joins 3034.

10001020
28 fragments

X.IB 355.921 joins X.IB 355.922 within the grid square to form a section of tubular relief band, probably part of animal ornament.

X.IB 355.1298 joins X.IB 355.935 within the grid square to continue a relief band, probably part of animal ornament.

9951020
71 fragments

X.IB 355.724 joins X.IB 355.329 within the grid square to form part of a group of fragments that join to create a section of relief band from the contour of the cross.

X.IB 355.723 joins X.IB 355.725 within the grid square to form part of a group of eight fragments that join to create a T-shaped section of relief band which probably separated at least two panels.

X.IB 355.1122 joins X.IB 355.729 within the grid square to form part of a group of three fragments which join creating a straight section of relief band.

X.IB 355.1125 joins X.IB 355.729 within the grid square to form part of a group of three fragments which join creating a straight section of relief band.

X.IB 355.741 joins X.IB 355.3082 within the grid square to form part of a group of three fragments which join to create a section of relief band from an edge or margin.

X.IB 355.1216 joins X.IB 355.1221 to form a section of relief band *c* 52.2mm in length from an edge or margin, possibly part of the contour of the cross.

X.IB 355.3137 joins X.IB 355.329 to form part of a group of fragments that join to create a section of relief band from the contour of the cross.

X.IB 355.1125 joins X.IB 355.756 to form part of a group of three fragments which join creating a straight section of relief band.

7.2.6 The epigraphy of the inscription on the Hilton of Cadboll cross-slab

GEORGE THOMSON

Introduction

The face of the Hilton of Cadboll cross-slab, which was once carved with a cross and reworked as a 1676 memorial to Alexander Duff and his three wives, bears a rather unusual two-line epitaph in Old Scots (illus 6.1). The last word of the first line is superior to it, there is a dedication of two lines, and four sets of initials lie astride an heraldic shield, in a format common in the

Illustration 7.30
Hilton verso. Inscribed lettering on banner in shield (© Trustees of the National Museums of Scotland, photographed by Neil McLean)

17th century. The second quarter of the shield includes a banner on which is cut the letters TB/N (illus 7.30), but these may not be contemporary with the primary inscription.

This is a report on a study of the lettering on the verso that reads

VEIL
HE THAT LEIVES VEIL DOOES
SAYETH SOLOMON THE VYSE
HEIR LYES ALEXANDER DVF
AND HIS THREE WYVES 1676

and transcribes as

He that lives well does well
sayeth Solomon the wise.
Here lies Alexander Duff
and his three wives 1676.

There are what appear to be point separators between some of the words. The mark between HE and THAT is circular in form, the one between THAT and LEIVES diamond shaped, and between HIS and THREE there appears to be a colon (:). However, there is no logic or consistency to the use of these marks and it is probable that they are due to natural pitting of the sandstone (illus 7.31).

The letters on either side of the shield are:

A	DVF [1]	(for Alexander Duff)
K	S	
C	V	
H	V	

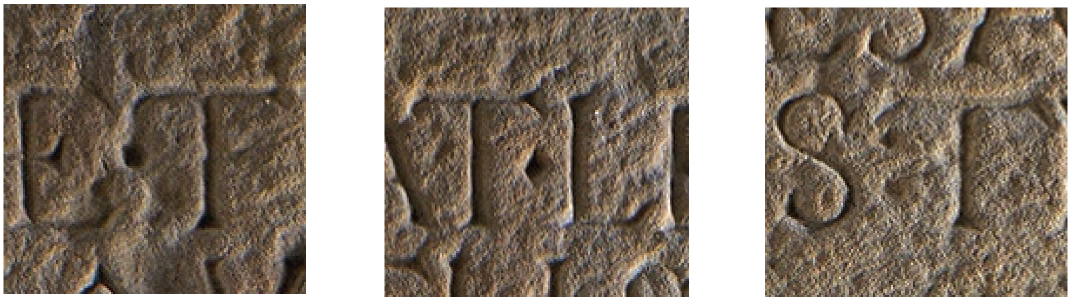


Illustration 7.31
Hilton verso. Marks between words resembling point separators (© Trustees of the National Museums of Scotland, photographed by Neil McLean)

The last three presumed to be Duff's wives: the first unknown, the latter two being Christian and Helen Urquhart.

Epigraphy

An analysis was made of the inscriptional lettering, based on a comparison with contemporary later 17th-century Scottish inscriptions, especially those in northern Scotland in the old burial grounds of Balnakeil (Sutherland), Dornoch Cathedral (Sutherland), Dunnet (Caithness), Elgin Cathedral (Moray), Inverness Old High Kirk (Inverness), Latheron (Caithness), Reay (Caithness) and Tongue (Sutherland).

The lettering style is incised roman of medium weight, with a clearly defined V-cut and distinct serifs. The inscription is entirely in capitals, the most common format of this period.[2] Letters are somewhat taller than broad, with wide D, H, W and X and narrow E, F, R and S. The letter cutting is rather poor (cf Campbell-Kease) and at times almost crude, *vide* K in the initial section (illus 7.32), with letters varying in proportion and, to a lesser extent, size. Even allowing for weathering, it is clear that serif formation is inconsistent. There is no evidence that the mason used horizontal guides and, as a consequence, the lines of lettering are not straight. Letter spacing is extremely variable.

The classical style of roman inscriptional capitals, resurrected during the Renaissance, is characterised by their distinctive proportions and variation in stroke width that, in turn, was derived from script written with a broad-edged pen (illus 7.33). The mason's awareness of this aspect of letterform is a good indicator of his skill and understanding. In more formal inscriptions we can see a distinctive thickening and thinning of the cut in the S and

Illustration 7.32
Hilton verso. Capital K from left side of shield (© Trustees of the National Museums of Scotland, photographed by Neil McLean)

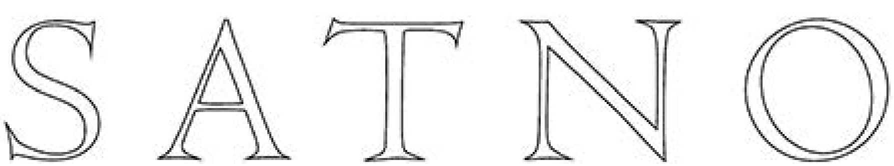


Illustration 7.33
Classical roman capitals showing the variation in stroke width

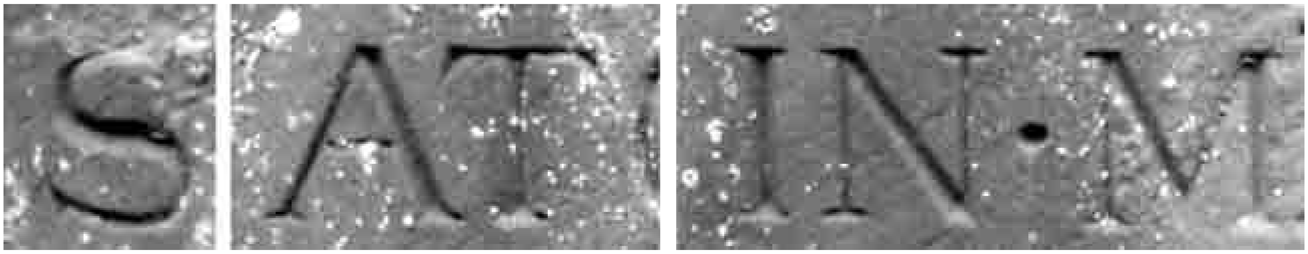


Illustration 7.34
Formal roman capitals from headstone inscription, Haddington 1697 (© George Thomson)

Illustration 7.35
Letters from Hilton inscription (© Trustees of the National Museums of Scotland, photographed by Neil McLean)

O and differential line widths in A, T and N (illus 7.34). In the Hilton inscription there is an attempt to vary line thickness in the E, N, W, O and possibly S (illus 7.35).

There is some inconsistency in the forms of some letters used. The more archaic straight leg form of R is used in the third line in HEIR and ALEXANDER, but the curved leg form is used in THREE in the fourth line (illus 7.36). The form of A used in the four-line inscription differs from the form with a horizontal bar above used beside the shield (illus 7.37). Differences of this sort are not uncommon at this time. However, the lettering on either side of the shield differs slightly in other ways from that of the main inscription. This could suggest that the mason who cut the shield and adjacent lettering was not the same individual who cut the epitaph and dedication. It is more likely, however, that the differences are due to the scale of the two sets of lettering as the form of the S, sloping backwards, is very similar in both sections.

The form of the very wide W, comprising two Vs, is typical of northern inscriptions at this time. The use of V for W in VEIL (well) and VYSE (wise) is very uncommon on Scottish graveslab inscriptions. The second occurrence may be explained by the superficial impression of a ligature WY with the V followed by Y but this does not account for repeated occurrence in the first line. The form of Y comprising two, rather than three lines (illus 7.38) is rather unusual and, in the north of Scotland, has been noted only at Reay.

The archaic form of the numeral 6, with the long upturned upper part (illus 7.39) was used later in the north of

Illustration 7.36
Hilton verso. Two forms of capital R used in the same inscription (© Trustees of the National Museums of Scotland, photographed by Neil McLean)

Scotland than elsewhere in the country and is the form utilised in this instance.

There are three ligatures. HE in the first line and THE in the second are two of the commonest of the 62 ligatures so far found in Scottish inscriptions.[3] However, the ligature VF (illus 7.40) has not been reported before.

The letters TB/N on the banner in the shield are different in both form and proportion from the rest of the lettering. This, together with the serif formation and use of full points after T and B confirms they were not cut by the same mason and are probably not contemporaneous with the main inscription.

Illustration 7.37
Hilton verso. Two forms of capital A from main inscription (left) and left side of shield (right) (© Trustees of the National Museums of Scotland, photographed by Neil McLean)

Conclusions

The lettering on the Hilton of Cadboll stone is typical of roman capital inscriptions of the late 17th century in the northern part of Scotland. Numerous inscriptions in the burial sites used for comparison and listed earlier in this report are of similar style and most have been cut by relatively unskilled masons. As such, the Hilton inscription could be classed as vernacular, rather than formal. This could suggest that the opportunities for masonry training were fewer than those in the more southerly urban areas such as Perth, Dundee, Edinburgh, Glasgow and Dumfries where many memorial inscriptions of the late 17th century exhibit great skill in their execution. More likely, it could suggest that, in the north, the individuals who cut even the larger memorials were part-time and had to be employed in other fields in order to make a living, as was the case in the rest of rural Scotland.

Notes

1 Campbell-Kease 2002; Campbell-Kease mistakenly reads these letters as DYF.
2 Thomson 2002.
3 Thomson, G unpublished MS.

Illustration 7.38
Hilton verso. The capital letter Y formed of two strokes (© Trustees of the National Museums of Scotland, photographed by Neil McLean)

Illustration 7.39
Hilton verso. Archaic form of the numeral 6 (© Trustees of the National Museums of Scotland, photographed by Neil McLean)

Illustration 7.40
Hilton verso. Ligature VF (© Trustees of the National Museums of Scotland, photographed by Neil McLean)

7.3 Dating and soil

7.3.1 Soil thin section analysis and interpretation

JO McKENZIE

Introduction

Soil micromorphology is a well-established technique in archaeology, with analysis of thin sections increasingly seen as an important extension to both field description and the interpretation of site stratigraphy (Davidson & Simpson 2001, 169). Analysis of micromorphological soil features can not only identify elements relating to human activity which may not be identifiable during excavation, but can also allow these to be set in context with both 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.

At the Hilton of Cadboll site, soil thin section samples were taken from two main areas of interest: from deposits in three key phases, located to the east of the cross setting in the main section line A–B along the 'deep central trench' (see illus 3.4); and from deposits beneath the discarded collar stone (032) in the north-west of the excavated area. In addition to providing a contribution to the overall understanding of anthropogenic activity on the site and the local depositional environment, these specific sampling points were selected in order to address several key issues for site interpretation. Firstly, thin section samples were deliberately located alongside those taken for Optically Stimulated Luminescence (OSL) dating, in order to provide supporting information on the soil environment and to aid interpretation of dates obtained. Secondly, thin sections were located with the intention of providing information on specific questions of site formation which also have a bearing on the interpretation of the event sequence, and which may thus also influence interpretation of the OSL dating programme. These include, particularly, rates of soil accumulation within particular contexts and the identification of micro-layers within them, and the nature and definition of key context boundaries. These aims have successfully anticipated key issues which have arisen during both excavation and later interpretation, concerning especially the chronology of the cross setting and its subsequent disturbance, and the interpretation of the OSL dating sequence and its integration with other sources of evidence for site formation throughout the site.

In addition to these general objectives, thin section analysis was aimed at answering several context-specific questions especially significant to the interpretation of the site:

1. Does context (026) show evidence of bioturbation, and, if so, might this compromise the integrity of the radiocarbon dates?
2. Is there evidence that context (019) accumulated slowly, therefore providing a possible explanation for the range of dates provided both by the pottery and OSL sequences?
3. Is there evidence that context (016) derives from (019), and possibly also from (030)?
4. Does (007) represent a part of the cross-slab re-carving event at the point of the OSL sample?
5. What is the nature and extent of the disturbance seen in context (041), as seen in Slide 2A?

Methodology

Undisturbed samples were collected in Kubiena tins (70mm×50mm×40mm), by John Duncan (GUARD), and thin sections prepared from these at the School of Biological and Environmental Science, University of Stirling, following the procedure of Murphy (1986). All water was removed from the samples by acetone exchange and confirmed by specific gravity measurement. Impregnation was conducted using a polyester crystic resin. The blocks were cured for three to four weeks culminating with four days in a 40°C oven. Blocks were sliced, bonded to a glass slide and precision lapped to 30μm, with cover slipping completing manufacture of the 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. Additional mineralogical investigation was undertaken using the atlases of MacKenzie and Guilford (1980) and Adams *et al* (1984). 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 using a standard table (Table 7.3). Interpretation of the observed features rests on the accumulated evidence of a number of workers, notably Courty *et al* (1989), Fitzpatrick (1993) and Stoops (2003).

A detailed discussion and interpretation of significant soil features seen in each thin section sample is presented below chronologically by context, with reference to the phasing discussed in Chapter 3. Within this section, description of key soil characteristics is discussed with reference to the several key issues for site interpretation around which the thin section sampling programme was based. Finally, the conclusion gives a summary of these key points and their bearing on overall site interpretation.

Discussion

Profile 1: Phase 1 deposits

Context (023): Slide 1B

Context (023) is sampled in thin section over the bottom two-thirds of Slide 1B, and was described in the field as a yellow sand with brown and orange mottles. This is confirmed in thin section, with a groundmass typical of a medium to slightly coarse sand, largely made up of quartz grains (av 300–600 microns), notably few feldspars, some sandstone and siltstone fragments and small traces of other common minerals (see Table 7.3). This coarse quartz fraction is generally monocrystalline, sub-angular to angular and shows occasional traces of weathering. Occasional polycrystalline grains generally show sutured boundaries, characteristic of quartz from a metamorphic source (Adams *et al* 1984, 5). This coarse fraction is, however, not particularly well sorted, with several large (max 7000 microns) sandstone fragments present towards the top of the deposit, and smaller, slightly degraded fragments of the same seen at intervals down the sample. While individual mineral grains show some signs of heating, these appear to be intrusive, with the overall deposit showing no sign of heating.

The fine mineral and organo-mineral material seen in association with this coarse grain fraction also indicates a mixed deposit. This ranges in colour from light brown to orange and reddish-brown to occasionally light greyish brown, colour changes which indicate varying levels of organic content among the fine mineral fraction, and thus a variable origin for the material. The distribution of this material is patchy and sparse, with small concentrations of material randomly located throughout the deposit, creating localised areas of intergrain microaggregate microstructure. The majority of the sample, however, shows a general lack of this fine fraction, with only minimal amounts of fine material seen partially surrounding the quartz fraction to create a generally chitonic related distribution pattern.

Closer examination of this fine material shows that it is generally formed into discrete, small (av 10–20 microns) spheroidal to ellipsoidal and occasionally mammilate units, indicative of excremental material produced by soil fauna such as mites and/or worms. Some of these are degraded into coalesced masses while some areas are still extant, again indicating a mixed deposit. This excremental material indicates a degree of biological activity which would be typical of a soil at least partially derived from a midden incorporating anthropogenic material.

Anthropogenically-derived materials are themselves present in small quantities. Several fragments of identifiable wood charcoal are present at the base of the slide and one at the top, near the presumed boundary with context (026) above. These are fairly degraded, as are two small fragments of bone. Occasional pieces of lignified plant material of similar structure are also seen. Small (av 200 microns), generally rounded, sometimes cracked pieces of black amorphous organic material are present throughout the slide, but in the greatest concentration near the base and the top of the context, as is the case for the charcoal. These are likely to represent burnt organics but cannot be identified as to origin. Unburnt plant-derived material is also seen, with occasional cell residue and parenchymatic material identifiable, mainly within the redder areas of fine organomineral groundmass. Occasional limpid red to yellow-orange amorphous organic fragments are also seen in association with these areas, as are a very few phytoliths.

Iron movement is a feature of this context, with the larger sandstone and some metamorphic and siltstone grains showing either Fe concentration or slight Fe depletion at the rims. Particularly towards the middle of the sample, several infillings and coatings of bright reddish amorphous material within the fine fraction indicate Fe concentration. This is likely to be related to illuviation processes throughout the deposit. Such processes are also indicated by the small reddish-brown coatings and ‘compound’ coatings (ie those consisting of superimposed discrete layers) of clay and silty clay (illus 7.41,1) seen partially surrounding several grains towards the base of the slide, and also occasionally running over several adjacent grains to create a feature known as a ‘link capping’ (Bullock 1985, 99) (illus 7.41,2). Such accumulations of fine material, particularly those comprising more than one layer, can indicate a change in environment and the subsequent movement of fine material down-profile. Within this deposit, water movement is the most likely explanation for these pedofeatures. However, slight evidence of more physical disturbance processes is seen in the presence throughout the context of very small, dark brown, organic coatings on the surface of some of the coarse mineral grains. These small coatings are recorded, to a greater or lesser extent, in all thin section samples from Profile 1 (Table 7.3).

The overall appearance of this sample indicates a mixed deposit of sand, incorporating material from different sources plus a small amount of anthropogenic material. This is in keeping with the archaeological interpretation of this context as a wind-blown sand layer whose occasional anthropogenic inclusions indicate that it is likely to have partly accumulated during a period of Pictish activity in the near vicinity. While the poorly sorted nature of the material may be taken to indicate a 'dump', the slight zonation of all the features noted above (eg the concentration of anthropogenic inclusions at the base and top of the sample, the textural pedofeatures towards the base, the slight concentration of Fe-rich material to the middle) rather indicates a gradual build-up of probably windblown material, possibly over some considerable time-frame which allowed for the slight environmental changes indicated by the pedofeatures described above. A gradual build-up is also indicated by the degraded condition of much of the anthropogenic material and several of the larger sandstone fragments. These features tie in well with the wide date range given for this context by OSL.

There is an indistinct boundary with context (026) above, which is discussed further below.

Context (026): Slides 1B and 1C

Context (026) is described in the field as an orange sand with dark brown patches and decaying sandstone, and is interpreted as a second wind-blown sand deposit. Context (026) is seen in two thin section samples: the top third of Slide 1B, where the base of the context is seen to physically seal context (023) described above, and the bottom third of Slide 1C, where the top of the context is seen, physically sealed by context (019). These do not represent a vertical sequence, however, and it should be noted that the base sample (Slide 1B) is located physically beneath the cut of pit (012), while the top of context sample Slide 1C is taken approximately 0.45m to the east and to the east of the pit cut. Some variation between slides of the character of, especially, soil pedofeatures may therefore be attributable to this spatial variation.

Looking first at the base of (026) in Slide 1B, it can be seen that the mineralogy of this context is broadly similar to that seen below in context (023), a medium sand consisting mainly of quartz grains. The context, as seen in this slide, is also poorly sorted, with several large metamorphic and sandstone fragments seen. Overall, the similarity of the coarse mineral fraction with (023) is such that no clear boundary can be discerned between contexts: in particular, it is noted that while 'degraded sandstone fragments' are specified in the field description of context (026), in this slide, these are actually more prevalent throughout (023). This diffuse boundary may also indicate a slow rate of deposition for this material onto (023), and the presence of degraded sandstone throughout both layers may support the view that the degraded sandstone noted in (026) is not derived from the Hilton cross-slab itself (James 2006, 10).

Differences between these windblown contexts can, however, be identified within this slide. This (026) quartz fraction appears slightly more weathered than that seen in (023) (see illus 7.41,2), and slight differences in mineral composition can be seen (Table 7.3). Moving up the context into Slide 1C, the coarse mineral fraction becomes more well-sorted with a more uniform medium sand grain size similar to (019) above. As seen between (023) and (026), this results in the appearance of a diffuse boundary between (026) and (019) in Slide 1C (discussed below).

The fine mineral and organo-mineral fraction of (026), as seen in both the lower and upper parts of the context, is broadly similar in nature to that seen in (023), being patchily distributed and similarly excremental in nature. However, the (026) fine fraction is notably denser and seen in generally larger patches, resulting in a more generally intergrain microaggregate microstructure and a groundmass with a more mixed appearance. The presence of some large voids within (especially) the lower part of the context (Slide 1B), and the recording of animal burrowing in the vicinity (James 2006, 10) has raised the possibility that some of this mixed appearance may be the result of larger-scale animal disturbance. However, the upper part of this layer (Slide 1C) shows little sign of such disturbance, with, for example, no sign of cracking and/or distortion of the large patches of Fe-rich amorphous organic material seen throughout this part of the context (discussed below). It would therefore seem possible that the disturbance features within (026) at the base of the context may be related to the sample's position just beneath the activity related to the cutting of pit (012). Given both this and the excremental nature of the groundmass as a whole, the thin section evidence would indicate that variability in the radiocarbon dates obtained from this context may be either the result of a very gradual build-up of material, perhaps indicated by the more weathered nature of the coarse fraction, or, if disturbance-related, the result of the soil mesofauna action seen throughout the context (see illus 7.41,5).

In contrast to that seen in (023), the fine material fraction is generally more uniformly red to dark reddish brown in colour. This is possibly related to the outstanding feature of this context: the very high concentration of iron-rich mineral and iron-rich amorphous fine material seen throughout the context, mainly seen in close association with both burnt and unburnt plant-derived materials and most clearly visible towards the top of the context in Slide 1C. Here, several large patches of Fe-rich, mainly organic fine material are seen surrounding patches of quartz grains (illus 7.41,3) and/or single large sandstone pieces. Within these patches are located frequent cell residue, some fungal spores, and frequent yellow-orange patches of degraded amorphous organic material retaining a residual cell structure. These patches are also linked with burnt material, with several similar areas of individual heated quartz grains held within a matrix of this Fe-rich amorphous red organic material and black, presumably burnt, amorphous organic material. These formations appear to be intact portions of mixed, partially burnt plant material. The concentrated, discrete nature of these patches indicates that they are more likely to represent extant pieces of incorporated midden material, rather than iron-rich areas created through illuviation processes (illus 7.41,4). The survival of these features is also an indication that physical disturbance, for example by animals, has not unduly affected at least this part of the context. Were this the case, features such as these concentrations of plant material would be likely to be smaller and fragmented, and the iron-rich fine material infillings around them stretched and distorted.

As seen in (023), small amounts of other anthropogenically-derived materials are seen throughout the context, and reflect that noted in the field. One large (17×3mm) piece of slightly degraded, unburnt bone, plus several smaller bone fragments, are seen in Slide 1B (illus 7.41,5). Small fragments of charcoal are seen in both slides, and lignified tissue in Slide 1C. Black amorphous organic material pieces are notably larger in the base of (026) than the top of (023) (Slide 1B), and appear to increase up-context until the appearance of the larger burnt areas described above. Smaller, individual areas of red to orange limpid amorphous organic material are also seen, again, mainly in the upper portion of the context adjacent to the large, Fe-rich areas of plant remains (illus 7.41,6).

While iron movement is clearly a feature of this context, other significant pedofeatures indicative of illuviation activity or other disturbance, such as the distinctive compound coatings seen in (023) below, are absent, again suggesting that physical disturbance of this context, and also any material physically above, has been at a minimum. The only slight evidence for physical disturbance are the few small organic coatings seen. Some Fe depletion and accumulation within sandstones and (especially within Slide 1B) metamorphic grains is seen, as are some amorphous Fe-based nodules. Again, these are indicative of Fe movement, probably a result of illuviation. Overall, this context is mineralogically similar to (023) below, and can be described as a wind-blown sand with some considerable anthropogenic influence. Although there is little sign of zonation of materials which may indicate a build-up rate for this context (except perhaps the location of the Fe-impregnated plant residues described above within the upper part of the context), the generally more weathered appearance of the coarse mineral fraction may suggest a gradual accumulation rate for this context. As (026) shows little sign of physical disturbance, it may be that this gradual accumulation provides an explanation for the variable radiocarbon dates given for this context.

Profile 1: Phase 2 deposits

Context (019): Slides 1C and 1D

Context (019) is well represented in thin section, with the upper two-thirds of Slide 1C showing the base of the context (physically sealing wind-blown sand (026)) and the entirety of Slide 1D showing a section through the complete upper half of the context, just below its physical sealing by sandstone layer (030). As seen in (026), however, the samples are not in vertical section, with Slide 1D located approximately 0.3m to the east of Slide 1C.

Thin section analysis of these sampled portions of (019) clearly shows that this context is composed of a series of smaller layers or lenses of distinctly differing material. Given the varied sampling points taken from this context and the fact that not all of the context is sampled, it is possible that additional layers and/or a more complex microstratigraphy may have been present. As layering such as this is a strong indicator of a gradual accumulation process, it should be borne in mind that a complete event history may not have been sampled in thin section. Context (019) is therefore divided into three layers: a lowest Zone A, sampled in Slide 1C, illus 7.42,7) and also seen in the lowest portion of Slide 1D; a middle Zone B, seen in the middle section of Slide 1D (illus 7.42,8); and an upper Zone C, seen in the topmost section of Slide 1D (illus 7.42,9 & 7.42,10).

Context (019) was described in the field as one deposit: a brown sand with occasional charcoal inclusions. Mineralogically, each zone of (019) is fairly similar both to the other zones and to the wind-blown sand deposits (023) and (026), which Zone A of (019) seals at this point. Slight mineralogical differences are seen in the higher percentage of small fragments of minerals such as muscovite and hornblende seen in areas of (019). These are generally related to the slightly higher percentage of organomineral groundmass (within which they are largely incorporated) present in, particularly, Zone B of this context (see below). The boundary between context (019) and context (026) below is diffuse, which would tend to indicate a gradual build-up of material rather than the dumping activity implied by the activity of midden redeposition. A gradual build-up of material may also be indicated by the greater degree of weathering seen in the coarse mineral fraction seen in both (019) in Slide 1C and throughout (019) Zone C in Slide 1D. A small percentage of quartz and especially feldspar grains in both slides shows clear surface alteration, pitting, and occasionally Fe impregnation along fissures. However, this need not be the result of *in situ* grain degradation, but may have taken place prior to the formation of (019). As seen in (026), the deposit is only averagely sorted, with smaller quartz grains tending to be seen in the areas of denser organomineral groundmass characteristic of Zone B (discussed below) and occasional large fragments of sandstone and schistose quartz seen especially within Zone C. It is likely that these fragments may be derived from layer (030), which seals (019) just above the top of this sample point.

Clearer differences between each zone of (019) and the wind-blown sand layers are seen in the fine material fraction. This is generally light-to-mid- to dark brown and is largely excremental and, taking the context as a whole, is seen to be far more prevalent in (019) than either (023) or (026). It is in this fine organomineral fraction that the definite zonality seen within (019) is most clearly expressed. At the base of the context (Zone A in Slide 1C and also the base of 1D), this fine material is fairly patchy and sparsely distributed, creating a largely single-grain microstructure with a generally chitonic related distribution. However, from just above the base of Slide 1D (and thus approximately midway through the context), this fraction increases notably, creating the strongly intergrain microaggregate microstructure and enaulic related distribution which marks the boundary with Zone B. Zone B is also darker in colour, indicating a higher organic content, and notably, the majority of charcoal inclusions are also present in this area of the context. Just below the top of the slide, this fine material fraction lessens abruptly at approximately at the point at which the larger sandstone and schistose quartz fragments noted above begin to be seen (illus 7.42,9 & 7.42,10), and thus marks the boundary with Zone C.

Depending on the moisture content of the soil, such lensing may not have been visible during excavation, but certainly suggests a slow, perhaps even intermittent rate of deposition for the material in this context: the boundary between the lower Zone A, characterised by largely mineral material, and the more organomineral-rich central Zone B is the clearest boundary seen yet in the thin section sample set. This has a clear bearing upon the interpretation of both the OSL date and the pottery assemblage from this context, for it would appear that the wide date range given may be a valid reflection of the slow accumulation of this layer.

The range and concentration of anthropogenically-derived inclusions also partly reflects this lensing within the context. A few fragments of charcoal, lignified tissue and other burnt or partially-burnt black amorphous organic fragments are present in the lower part of the context (Zone A in Slide 1C), as are small amounts of cell residue and orange-to-red amorphous organic material within the excremental fine fraction. Occasional small areas of the organic fine fraction within this zone are dominantly limpid and reddish in colour, which may be related to the diffuse boundary between (019) and the iron-rich context (026) below. These are likely to represent degraded plant materials. However, greater concentrations of all these inclusions are seen in Slide 1D and most particularly in the wide, dark central Zone B described above. Notably higher in concentration are charcoal fragments and large black amorphous organic materials (illus 7.42,8). Parenchymatic tissue, absent from Slide 1C, is present in this zone. One small bone fragment is seen near the top of the context in Zone C. Heated stones, however, are not noticeably more prevalent in this lens than elsewhere in the context.

Unlike the wind-blown sand deposits, illuviation and disturbance pedofeatures are rare in this context. Occasional Fe accumulation and depletion is seen in some of the larger sandstone fragments, and there are occasional Fe-rich nodules. These are slightly more prevalent towards the top of the context. No clear large-grain coatings are seen, although there is a small presence of dark, fine organic coatings, similar to those seen elsewhere in the sample set. A general lack of these features may be taken to indicate minimal disturbance to the soil profile in this area, but it is possible that this lack of downward movement of fine material may also be related to the assumed lack of fine material in the sandstone layer (030) directly above. However, with no thin section sample of this material available, this is conjectural.

Context (019) is interpreted as an organic-rich layer derived from redeposited midden material from nearby settlement (James 2006, 16, 27–8). The deposit is dated by an OSL sample taken at the top of the context (adjacent to Slide 1D) to AD 1140 ± 70, notably earlier than the 13th- to 15th-century dates provided by the pottery assemblage. Given the clear lensing seen throughout the context in thin section, an extension to this interpretation is that this redeposition is perhaps likely to have taken place as a series of at least three distinct events, and therefore that context (019) is likely to have accumulated over a relatively long period of time, a fact that may explain the discrepancy between the dates provided from the pottery and OSL. However, without a complete thin section record from this deposit, further interpretation of the length or complexity of this sequence is not possible.

Profile 1: Phase 2 deposits

Context (016): Slide 1A

Context (016) was described in the field as a mid-brown sand, and as the primary fill of pit cut (012), seen in section on the east side of the cross-slab.

The mineralogy of (016) is relatively similar not only to context (019), but also to the other contexts so far examined in thin section: a medium sand deposit, dominated by quartz grains. As seen in other contexts, this quartz is generally subrounded and subangular, generally monocrystalline but with some compound and polycrystalline grains. As seen in especially the lower 'lens' of (019), this coarse fraction shows strong signs of weathering, with pitting and alteration visible on the surface of quartz and especially feldspars (illus 7.42,11).

A closer look at the mineral makeup of (016), however, shows less similarity with both (019) and the two wind-blown sand deposits. Feldspars and perhaps also biotite are notably more prevalent in this context. This is a very minor difference, and more notable is the lack of larger sandstone fragments, which are a feature of Zone C in (019) and especially (030) from which this deposit is also assumed to originate. By contrast, (016) lacks any larger rock fragments and is noticeably well sorted.

This high level of sortedness may be related to the low occurrence of fine mineral and organomineral material concentrations in the slide (as the opposite is noted for the less well sorted (019) above). There is very little fine material present in the deposit, especially within the lower half of Slide 1, which is almost entirely composed of a single-grain microstructure and monic related distribution. Moving up the slide, a fine mid-brown organomineral fine fraction gradually increases in concentration, with one large (7mm) discrete concentration of this material located at the very top of the slide. This material is similarly excremental in character to that seen in both (019) and other sampled contexts, indicating a degree of biological activity.

Anthropogenically-derived inclusions are similarly rare in this sample. Occasional black amorphous organic fragments, generally <200 microns, are seen throughout. One piece of lignified material is identified. Occasional, similarly small patches of limpid yellow-orange amorphous organic material are seen, occasionally in association with small pieces of cell residue, and mainly in the vicinity of the discrete area of organomineral material. Within this organomineral area, very occasional fragmentary diatoms can be identified. A very few slightly heated mineral grains can be seen. Textural pedofeatures are likewise largely absent from this sample, with some small amorphous Fe-impregnated nodules of material seen, and some very slight Fe depletion in individual, mainly siltstone, grains.

Two interpretations of the stratigraphic position of (016) have been suggested which have serious implications for the interpretation of the sequence of events regarding the chronology of activity around the cross-slab. While the field interpretation concluded that (016) was the second fill of the original setting an alternative explanation may be that (016) was the primary fill of a 'robber pit' which completely truncated the original cut for the cross-slab setting. An OSL date of AD 1120 ± 70 obtained for (016) may therefore either date the original setting of the cross-slab, or its later disturbance (see Chapter 3). The second of these interpretations concludes that the origin of (016) is slumped material from contexts (030) and especially (019) at the side of the pit, a view supported by the similarity in colour and composition of (016) and (019) in the field, and also possibly by the similarity in OSL date between these two deposits. Thin section interpretation of the nature of this deposit, and especially its similarity to Context (019), is therefore a key issue for this analysis. Context (016) is seen in thin section in Slide 1A, taken from the central area of this deposit.

While no microlaminations which may be indicative of gradual slumping processes were noted, the position of the sample point, towards the centre of the deposit, may mean that this effect may not be seen. The very well sorted nature of the deposit would appear to be more indicative of a gradual slumping of material within one size range, rather than a deliberate backfill event. However, given the similarity in size fraction of all the sand deposits through which cut (012) is taken, such a backfill may in fact appear very similar.

While differences in the mineralogy of contexts (016) and (019) may be fairly minimal, an overall view of these contexts sees noticeable differences in the distribution and concentration of the fine, especially organomineral fraction, plus the differences in occurrence of anthropogenic features such as charcoal, which would seem to indicate that context (016) is unlikely to be derived from either (019) or (030). However, the variability also noted between the individual 'lenses' in context (019) (see above) means that this is not necessarily the case. While there is a great variation in soil characteristics between the darker, more anthropogenically-influenced Zone B of context (019) and context (016), the differences between (016) and Zones A and C of (019) are in fact minimal. It should also be remembered that, despite its prominence within the deposit, Zone B within (019) appears to take up only approximately a fifth of its depth. It is therefore more than possible that the majority of (019) may be composed of a relatively organomineral-free microstructure that may indeed have contributed to slumping into the robber pit, and, indeed, the almost definitely structurally looser sand indicated in this lower area of the context would have been more likely than the more organic fraction to slump in this way. Despite this, if (016) is indeed derived from (019), it seems unusual that so little evidence for material from this distinctively dark Zone B area is seen in (016).

Thin section evidence for the relationship of these two contexts is therefore equivocal, with both similarities and differences seen between the contexts. It should therefore be remembered that, despite the detail of analysis provided, both contexts are represented here in thin section by only a fraction of their total content.

Context (007): Slide 1E

Context (007) was described in the field as a mid-brown sand containing carved stone chips. It is seen in the lower two-thirds of Slide 1E taken adjacent to the position of the OSL sample discussed above, and is sealed by context (002), sampled in the top third of the slide.

The contrast between these two deposits is immediately clear in this slide: the boundary seen between contexts (007) and (002) is the clearest yet seen within this sample set. Context (007) is dominated by several large (max 13×.25mm) sandstone fragments, the majority of which are positioned horizontally or vertically adjacent to one another to create a clear boundary at the top of the context (illus 7.42,12 & 7.43,13). At high (×10–×40) magnification, these large sandstone fragments are seen to be similar in composition, consisting of mainly quartz grains with muscovite and small veins of occasionally iron-rich metamorphic material (illus 7.43,14 & 7.43,15). They appear in a range of sizes, with some of the smaller pieces seeming slightly degraded and possibly fragmented from the larger pieces.

Aside from these large sandstone pieces, the overall mineralogy of context (007) is similar to that seen in previous deposits. Notable, however, is the high degree of weathering and poor sorting seen in (007), which results in a larger proportion of small quartz grains and some compound quartz fragments than that seen within the generally uniformly sized medium sands of earlier deposits. Again, this preponderance of smaller grain sizes appears to be connected to a higher concentration of fine mineral and organomineral groundmass. In context (007), a fine mid-to-dark and occasionally slightly reddish brown fine material fraction is distributed fairly evenly throughout the context, creating an intergrain microaggregate microstructure and enaulic related distribution. This is dominantly excremental. With the possible exception of the organic-rich lens of (019), this context has the highest organic fraction of any so far seen in this sample set.

Anthropogenic inclusions are similarly frequent. Several pieces of charcoal are present, including one very large (2500 microns) fragment (illus 7.43,16). There are frequent, generally small inclusions of black amorphous organic material, and one distinctive dark reddish-black amorphous organic fragment containing small mineral inclusions. This is characteristic of a possibly turf-derived and burnt material (illus 7.43,17); however, such a small inclusion of this kind does not indicate a surface at this point in the sequence. Smaller fragments of light yellow and orange amorphous organic matter are also present, as are fungal spores, lignified, parenchymatic and cell residue material, and occasional heated mineral grains. No bone is present. There is some indication of iron movement throughout the deposit, with occasional depletion in small siltstone fragments, and occasional iron-based nodules present.

Context (007) was interpreted in the field as a spread-like continuation of the debris relating to the re-carving of the Hilton cross-slab packed within the upper fill of pit cut (012). However, the precise nature and extent of this layer, both in terms of its actual relationship to the pattern of stone debris and its differentiation from the very similar context (002) above, has proven to be a key issue for the interpretation of site chronology at this point. Post-excavation spatial analysis indicates that very few cross-slab fragments were recovered beyond pit fill (011), and an OSL date taken from (007) is approximately a century earlier than that historically indicated for the re-carving of the slab (James 2006, 21). It is therefore suggested that, rather than representing a spread associated with the re-carving event, (007) may be unrelated to this disturbance and may instead relate more closely to post-medieval debris layer (002) above.

However, the presence of this density of sandstone fragments would seem to indicate that (007) as sampled at this point does indeed represent a spread-like continuation of the re-carving event recorded in (011). But other aspects of mineralogy, fine material characteristics and even anthropogenic inclusions, (007) show some significant similarities with (002), especially (002) as seen at the top of Slide 1E, and similarly significant differences with the generally fairly similar sandy deposits described previously. Firstly, although large sandstone fragments are absent from context (002) in Slide 1E, one similarly sized (although slightly different in internal structure – see above) sandstone fragment is seen at the base of (002) in Slide 1F (illus 7.43,18 & 7.43,19). The generally weathered and notably poorly sorted character of context (007) is also seen in context (002). Finally, the high concentration of both fine organomineral material and anthropogenic inclusions seen in both deposits give context (007) more in common with context (002) (described below) than with any of the previous deposits sampled.

While the distinctive sandstone fragments seen in context (007) would seem to connect the deposit to the re-carving event, other aspects of its micromorphology draw closer parallels with the later context (002). A closer look at the soil matrix material surrounding the 'stone chips' concentrated in pit fill (011) might further resolve this issue – is this material similar in composition to (007) as described here? What is its similarity to context (002)? A further possible contribution to the interpretation of these deposits would be to compare the mineralogy of the sandstone fragments seen in this context to those securely identified as coming from the Hilton cross-slab, either through comparative work with available thin sections of the upper portion of the cross-slab, or perhaps through the preparation of a thin section of one of these (007) fragments itself.

Profile 1: Phase 5 deposits

Context (002): Slides 1E and 1F

Context (002), described in the field as a brown sandy soil with stone chips and angular rubble (James 2006, 24), is essentially a topsoil deposit present across the whole excavation area to a depth of 0.15m. Context (002) is interesting in thin section for the comparative material it provides with which to assess the origin of spread (007) and the subsequent interpretation of the OSL date from this area, as discussed above. Context (002) is therefore seen in two thin section samples, with the base of the context seen sealing (007) in the top third of Slide 1E, and the entirety of Slide 1F showing a section through a slightly higher portion of the deposit, located immediately above the OSL date discussed above.

The mineralogy of contexts (007) and (002) is generally similar, as discussed above and recorded in Table 7.3. While the coarse mineral fraction is still dominated by quartz, (002) has a relatively lesser concentration of quartz fragments within the sample as a whole compared to earlier medium sand deposits, and a greater proportion of smaller grain sizes. The coarse fraction as a whole is generally poorly sorted, but absence of the range of large sandstone grains seen in (007) makes this less obvious a feature than noted for (007).

The single large sandstone fragment recorded in context (002) is seen at the base of Slide 1F, and is 18×9mm in size. This fragment appears to be of a slightly different origin than those seen in context (007), possibly supporting the interpretation that the sandstone inclusions in the latter are indeed derived from the Hilton cross-slab (again, a thin section example of a known fragment from the slab could perhaps clarify this). The fragment seen in (002) shows frequent hornblende and muscovite inclusions largely absent from the sandstones in context (007), and the quartz grains show a pronounced horizontal elongation, giving the fragment an appearance slightly similar to sheared quartz (Adams *et al* 1984, 5) (illus 7.43,18 & 7.44,19).

As seen in (007), a fairly high concentration of fine mineral and organomineral material is seen. This appears more mixed than in (007), with some discrete areas of light, mid- and dark brown material seen, particularly towards the top of Slide 1F, nearer to the modern turf layer (illus 7.44,20). This is dominantly excremental. Anthropogenic inclusions are similarly frequent, though not quite so much as seen in context (007). Charcoal and black amorphous organic material is present in small quantities, two of which show small mineral inclusions, possibly indicating a burnt fragment of turf-based material. Some small concentrations of reddish amorphous organic material are seen throughout and indicate degraded plant material. These are often in association with extant cell residue material (illus 7.44,21). Unsurprisingly, there are frequent parenchyma, particularly towards the top of the context, and some phytoliths in the fine material fraction in Slide 1E. A tiny bone fragment is noted at the interface with (007). An interesting feature of this context is a large, discrete patch of dense mid-brown organic and organomineral material containing phytoliths, fungal spores and cell residue, the density of which stands out among the generally open excremental soil fabric (illus 7.44,22). Much smaller fragments of similar material are seen throughout the top portion of the slide. This is most likely to be a fragment of turf-based material which, given its position at the top of Slide 1F, is most likely to be recent.

Adjacent to this turfy patch is the most distinctive feature of Slide 1F: a large, hollow nodular formation of amorphous organic material, varying between bright red to black in colour and showing some extant cell structure (illus 7.44,23). This is a plant pseudomorph: a plant fragment (here, most probably a root) which has become impregnated with iron to such an extent that the now almost entirely iron-based feature retains the structural appearance of the plant fragment itself. Throughout this top portion of the slide, there are also several iron-rich areas of amorphous organic infills and slightly iron impregnated compound grains, indicating a degree of illuviation at this level in the context.

Profile 2: Phase 1 deposits

Context (041): Slides 2A and 2B

Context (041) is a wind-blown sand deposit located to the north of the deep central trench, and is interpreted as an equivalent deposit to (026) in Profile 1 (see Chapter 3). Context (041) is sealed by a fairly similar sand deposit (042) (see below) which is in turn physically sealed by a large broken collar-stone of yellow sandstone (032), along the break of which the sampled section was located. Context (041) is sampled in both thin sections taken from Profile 2, with Slide 2A entirely located within (041), and Slide 2B providing a slightly overlapping sample point to the left of this, within which context (041) is seen in the lower part of the slide, and context (042) in the upper.

While context (041) is generally similar in character in both slides, the defining feature of Slide 2A, and thus context (041) as a whole, is the disturbance seen extending vertically throughout the right-hand side of Slide 2A, which can clearly be seen with the naked eye and is expressed as a darker colour to the groundmass (illus 7.44,24). There are two likely origins for the introduction of this material: firstly, animal disturbance by either burrowing animals or the activity of soil fauna such as mites or worms; and secondly, physical soil disturbance through human activity, perhaps associated with either the deposition or smashing *in situ* of the collar-stone (032). A third possibility, impossible to resolve completely using the limited area of the thin section sample, is that this change in material represents a different deposit cutting (041). Given that this disturbance was not noted during selection of the sampling position, this seems unlikely, and the undulating (although sharp and clear) boundary between the two materials further identifies this darker area as a disturbance feature. A separate assessment of the characteristics of this material alongside those of both (041) and (042) is undertaken to aid identification of these disturbance processes. The undisturbed and disturbed areas of context (041) are therefore recorded separately as: Zone A, undisturbed, recorded in both Slide 2A and 2B; and Zone B, disturbed, recorded in Slide 2A.

Both the undisturbed Zone A and (presumably) intrusive Zone B area of (041) show a broadly similar mineralogy, which differs only very slightly from that seen in the assumed equivalent context (026) in Profile 1 (Table 7.3). The deposit is dominated by quartz grains of medium sand size, which are slightly weathered and occasionally altered, and is generally well sorted. Degraded sandstone fragments are seen in the base of Slide 2B and also near to the boundary with (042) in this slide. A greater difference in the concentrations of minor minerals (eg hornblende) is noted between profiles, for example (026) and (041), than between Zone A (undisturbed) and Zone B (disturbed) areas of Slide 2A, possibly indicating that this intrusive Zone B material is of a very local origin.

A greater difference is obviously noted between the fine mineral and organomineral fractions of the disturbed and undisturbed areas of the slide. The undisturbed Zone A area of context (041) in Slide 2A is low in organics, showing a largely single grain microstructure and chitonic related distribution, with occasional small patches of dark brown, generally excremental, organomineral groundmass. A similarly minimal excremental fine mineral fraction is seen in context (041) in Slide 2B. This is, however, generally a lighter brown, and becomes more prevalent moving up the slide into a possibly diffuse boundary with the more organic context (042), although this boundary is actually very clearly marked by the immediate preponderance of large rock fragments to the base of (042). By contrast, the disturbed Zone B area of (041) shows a mid-to-dark brown and occasionally dense organomineral groundmass with an intergrain microaggregate microstructure.

Anthropogenic inclusions within the largely mineral undisturbed Zone A of (041) are limited, with no charcoal or bone identified. There are occasional small, angular and rounded black amorphous organic fragments, some parenchyma, phytoliths (not seen in the undisturbed Zone A), cell residue material (increasing in concentration towards the top of both slides), and some occasional small yellow-orange and limpid orange-red amorphous organic material, probably degraded plant fragments. The anthropogenic input to the undisturbed area of (041) therefore appears significantly less than that seen in equivalent context (026) (see above). However, this lack of directly anthropogenic material is also seen in the darker, more organic disturbed Zone B area of the context, save for a very few identifiable phytoliths.

The most distinctive feature noted in this sample is in fact seen in the disturbed Zone B area of (041). This is a series of three discrete, apparently intrusive patches of disaggregated sandstone, distinguished by their lighter brown to greyish-brown colour, composed of a distinctively smaller, rounder quartz fraction than that seen elsewhere in the groundmass, and incorporating some muscovite (notably more than seen elsewhere in the context) and some degraded plant-based fragments and cell residue (illus 7.45,25). These fragments are similar to the several degraded pieces of sandstone seen towards the base of Slide 2B and at the boundary with (042), and may indicate that the intrusive material represented in Zone B may have come from context (042).

Textural pedofeatures are absent from this deposit, save for some slight depletion seen in sandstone and siltstone grains in Slide 2B. This would appear to indicate little physical disturbance and/or illuviation processes throughout the (041)–(042) sequence, which is slightly surprising, given the destruction activity on the collar-stone (032) and the recorded disturbance in this context. A diffuse but clear boundary is seen with context (042) above.

Profile 2: Phase 2 deposits

Context (042): Slide 2B

Context (042) was described in the field as a mid-brown to orange sand with sandstone fragments which seals (041) and is sealed only by topsoil (002), giving a potentially long period of accumulation for this layer. However, in the sampled Profile 2 (Table 7.4), (042) is physically sealed by broken collar-stone (032). Context (042) is identified as possibly equivalent to (019) in Profile 1 (Table 7.3), having produced a similar OSL date for the 12th century, and is of interest here also as a likely source for the intrusive material seen in context (041) below.

Table 7.3
Profile 1

Context number	Thin section sample	Zone	Coarse mineral material (< 10µm): Quartz	Feldspar	Biotite	Muscovite	Garnet	Hornblende	Compound grains	Sandstone	Siltstone	Metamorphics	Phytoliths	Diatoms	Bone	Rubified mineral	Fine mineral material	Coarse organic material: Fungal spores	Lignified tissue	Parenchymatic tissue	Charcoal	Fine organic material: Cell residue	Amorphous (black)	Amorphous (brown)	Amorphous (yellow-orange)	Amorphous (inclusions)	Pedofeatures: Clay coatings	Clay infills	Silt coatings	Organic coatings	Amorphous crypto-crystalline	Depletion	Excremental (mamillate)	Excremental (spheroidal)	Microstructure	Coarse material arrangement	Groundmass b-fabric	Related distribution
023	1B		****	*	t	t	*	t	*	**	t	t	t		t	t	Light, red & dark brown heterogeneous organo-mineral. Dotted limpidity	t	*	t	*	t	*	*	t		t		t	*	*	*	*	**	Single grain to intergrain microaggregate	Random basic Quite poorly sorted	Weakly stipple-speckled	Monic to chitonic, occasional close porphyric
026	1B		****	*		t	*	t	*	*	t	*			**	t	Brown to reddish brown heterogeneous organo-mineral. Dotted limpidity	t	t		t	t	*	t	t					*	*	*	t	**	Bridged grain to intergrain microaggregate	Random basic Quite poorly sorted	Weakly stipple-speckled	Monic to chitonic, occasional close porphyric
	1C		****	*	t	t	*	t	*	*	t	t				t	Brown to reddish brown heterogeneous organo-mineral. Dotted limpidity	t	t	t	t	t	**	**	*	*				*	***	t	t	**	Single to bridged grain to intergrain microaggregate	Random basic Poorly sorted	Stipple-speckled	Monic to chitonic, occasional close porphyric to enaulic
019	1C	A	****	*	t	*	*	*	*	t	t					t	Light brown organo-mineral heterogeneous Dotted limpidity	t	t	t	t	t	*	t	t	t				*	t	t		*	Single to bridged grain to intergrain microaggregate	Random basic Sorted	Stipple-speckled	Monic to chitonic, occasional enaulic
	1D	A	****	*	t	t	*	*	*	*	*	t				t	Light brown organo-mineral heterogeneous Dotted limpidity	t	t	t	*	t	t	t	t					t	*	t		*	Single to bridged grain to intergrain microaggregate	Random basic Sorted	Stipple-speckled	Monic to chitonic, occasional enaulic
		B	****	*	t	*	*	*	*	*	t	t				t	Dark and reddish brown heterogeneous organo-mineral. Dotted limpidity	t	t	*	**	*	**	*	t	t				t	*	t	t	**	Intergrain microaggregate	Random basic Sorted	Stipple-speckled	Close to single-spaced porphyric
		C	****	*	t	t	*	*	*	**	*	t			t	t	Light brown organo-mineral heterogeneous Dotted limpidity	t		t		t	t	t	t					*	*	t	t	*	Single to bridged grain to intergrain microaggregate	Random basic Sorted	Stipple-speckled	Monic to chitonic, occasional enaulic
016	1A		****	*/**	t	t	*	*	*	t	*	t		t		t	Light brown organo-mineral heterogeneous Dotted limpidity	t	t			t	t							t	t	t	*	**	Single grain, small areas intergrain microaggregate	Random basic Well sorted	Weakly stipple-speckled	Monic to chitonic, occasional porphyric
007	1E		****	*	t	t	*	t	*	***	*	*			t	t	Light, mid and red brown heterogeneous organo-mineral. Dotted limpidity	t	*	t	**	t	*	t	*					t	t	t	t	**	Intergrain microaggregate	Random basic Poorly sorted	Stipple-speckled	Close enaulic, occasionally chitonic
002	1E		****	*	t	t	*	t	*	*	*	t	t		t	t	Light and mid brown heterogeneous organo-mineral. Dotted limpidity	t	*	t	*	t	t	t	t	t				t	*	t	t	**	Intergrain microaggregate	Random basic Poorly sorted	Weakly stipple-speckled	Close enaulic, occasional porphyric and chitonic
	1F		****	*		*	*	t	*	*	*	t		t		t	Light, mid and red brown heterogeneous organo-mineral. Dotted limpidity	****	t	*	*	*	t	t	t	t				t	**	t	t	***	Intergrain microaggregate	Random basic Poorly sorted	Weakly stipple-speckled	Close enaulic, occasional porphyric and chitonic

Frequency class refers to the appropriate area of section (Bullock et al., 1985): t Trace * Very few ** Few ***Frequent/Common **** Dominant/Very dominant
Frequency class for textural pedofeatures (Bullock et al., 1985): t Trace * Rare ** Occasional *** Many

Table 7.4
Profile 2

Context number	Thin section sample	Zone	Coarse mineral material (< 10μm): Quartz	Feldspar	Biotite	Muscovite	Garnet	Hornblende	Compound grains	Sandstone	Siltstone	Metamorphics	Phytoliths	Diatoms	Bone	Rubified mineral	Fine mineral material
041	2A	A	****	*	t	t	*	t	t	t	*	t				t	Occasional dark brown heterogeneous organo-mineral. Dotted limpidity
		B	****	*	t	*	*	t	t	*	*	t	t			t	Dense dark brown heterogeneous organo-mineral. Dotted limpidity
	2B		****	*	t	t	*	t	*	t	*		t			t	Mid to darkish brown heterogeneous organo-mineral. Dotted limpidity
042	2B		****	*	t	t	*	t	**	***	*	t				t	Yellow, light, mid and dark brown heterogeneous organo-mineral. Dotted limpidity

Context number	Thin section sample	Zone	Coarse organic material: Fungal spores	Lignified tissue	Parenchymatic tissue	Charcoal	Fine organic material: Cell residue	Amorphous (black)	Amorphous (brown)	Amorphous (yellow-orange)	Amorphous (inclusions)	Pedofeatures: Clay coatings	Clay infills	Silt coatings	Organic coatings	Amorphous crypto-crystalline	Depletion	Excremental (mamillate)	Excremental (spheroidal)	Microstructure	Coarse material arrangement	Groundmass b-fabric	Related distribution
041	2A	A	t		t		t	t	t	t					t				*	Single grain to bridged, occasional intergrain microaggregate	Random basic Moderately sorted	Weakly stipple-speckled	Monic to chitonic, occasional close porphyric
		B	t		*		t	*	*	*					*			t	***	Intergrain microaggregate	Random basic Moderately sorted	Stipple-speckled	Close porphyric to close enaulic
	2B		t		t		t	t	t						t		t		**	Single grain to bridged, very occasional intergrain microaggregate	Random basic Moderately sorted	Stipple-speckled	Monic to chitonic, occasional close porphyric
042	2B				*	*	*	t	*	*					t	*	t	t	**	Intergrain microaggregate	Random basic Poorly sorted	Stipple-speckled	Close enaulic to porphyric, occasional chitonic

Frequency class refers to the appropriate area of section (Bullock et al., 1985): t Trace * Very few ** Few ***Frequent/Common **** Dominant/Very dominant
Frequency class for textural pedofeatures (Bullock et al., 1985): t Trace * Rare ** Occasional *** Many

Table 7.5
Archaeological feature summary

	Profile 1								Profile 2		
	(023)	(026)	(019) A	(019) B	(019) C	(016)	(007)	(002)	(041) A	(041) B	(042)
Direct anthropogenic influence? (charcoal, bone, burnt organic material)	Some	Some	Some	Frequent	Rare	No	Frequent	Common	No	No	Some
Indirect anthropogenic influence? amorphous organic material, plant-derived materials)	Some	Common	Some	Frequent	Some	Some	Frequent	Frequent	Some	Some	Common
High temperature heating? (red and/or yellow groundmass colours in oblique incident light)	No	No	No	No	No	No	No	No	No	No	No
Within-context bioturbation? (excremental soil fabric, turbated groundmass)	Common	Common	Rare	Common	Some	Common	Common	Common	Some	Common	Common
Stratigraphic disturbance? (intrusive soil materials, turbated groundmass)	No	No	No	No	No	No	No	Some	Yes	Yes	Possibly
Likely rate of deposition? (mineral weathering, micro-lamination, sortedness)	Probably slow	Slow	Probably slow	Probably slow	Probably slow	Slow	Unclear	Unclear	Unclear	Unclear	Unclear
Evidence for water movement? (iron-rich or depleted areas or grains, clay to silt coatings)	Common	Frequent	Rare	Rare	Some	Rare	Rare	Common	Rare	Rare	Rare
Evidence for material movement down-profile? (silty and organic coatings and infillings)	Some	Some	Rare	Rare	No	No	Rare	Rare	Rare	Rare	Rare

The mineralogy of this context is broadly similar to other deposits seen on the site, including both (019) and (041) in this profile, being dominated by slightly weathered quartz grains. These are, however, not noticeably heavily weathered compared to other contexts, which may indicate a quicker period of deposition than that indicated by the sequence (042)–(002). Mineralogically, the outstanding feature of context (042) is the presence of two large, elongated sandstone fragments of almost siltstone fineness (100–150 microns), which overlap each other slightly to span the width of the slide, about midway down the sampled portion of the context (illus 7.45,27). Rock fragments of this size are not present in (019), and these fragments are the first of several features indicating that, although (019) and (042) may be contemporary deposits, they are unrelated in either mineral composition or anthropogenic character.

It is noted that one of the larger decorated cross-slab fragments recovered from the site came not from spread (007) but layer (042) (James 2006, 21). However, the internal structure of the sandstone fragments seen in this context differs from both those seen in context (007) (assumed to be part of the Hilton cross-slab), and context (002). The (042) fragments are both finer and slightly more degraded, and show cracks and fissures along both fragments. Such damage indicates that these fragments could in fact be chips from the broken collar-stone slab (032), which is assumed to have been broken *in situ*.

The fine mineral and organomineral fraction of (042) also varies greatly from that seen both in the various lenses of (019) and in (041) below. Context (042) shows a very mixed, dense organic and organomineral groundmass in a range of colours, indicating varying concentrations of organic residues and incorporating a variety of anthropogenically-derived materials. This mix of materials ranges from small patches of pale yellow to orange concentrations of partially degraded cell residue, to discrete areas of light to mid- to dark brown fine organo-mineral material, to paler grey, dominantly mineral patches largely composed of small, close-packed quartz grains and sometimes partially degraded sandstone fragments. These last are strongly similar in colour and composition to the disaggregated sandstone fragments seen in the disturbed Zone B area of context (041) below, indicating that the origin of this material is likely to be (042) above. This variety of fine fractions ranges from closely to loosely packed, creating a varied microstructure and giving a turbated, mixed appearance to the deposit. While most of this fine material is excremental, some large, closely-packed areas are not (illus 7.45,28).

Anthropogenic inclusions are present throughout context (042), though not in particularly high concentrations. Charcoal is seen towards the base of the context, with one noticeably large piece (2.5mm× 1.2mm). Adjacent to this are several smaller inclusions of black and dark red amorphous organic material, both of which are seen to gradually decrease up-context. Plant remains such as cell residue and parenchymatic tissue are frequent throughout the sample. Heated mineral grains are rare, and there are no textural pedofeatures noted, with the exception of some small Fe-rich nodules. During excavation, (042) produced fragments of industrial slag but, unfortunately, no trace of smelting residue or heating activity in general was identified in thin section.

Conclusions

The descriptions and analyses of the Hilton thin section samples discussed above and summarised in Tables 7.3–7.4 have provided an insight into both the varying degrees of anthropogenic activity seen in the deposits sampled and the local depositional environment of the two profiles. Key features among these which are of particular relevance to the archaeologist have been summarised in Table 7.5.

Several general points can be made concerning the nature of the deposits sampled in these two areas of the Hilton site. Perhaps most notable is the overall similarity of the majority of the sandy deposits which make up the majority of the sample set. In many cases, there are few diagnostically different soil features and/or fabrics seen, and this restricts micromorphological interpretation.

A second notable feature of the sample set is the generally limited amount of anthropogenic material seen in all deposits. With a few exceptions, direct evidence for anthropogenic activity, such as bone or charcoal, is at a minimum. Again, this offers few opportunities for detailed interpretation of the archaeological context of these deposits.

Thirdly, the generally excremental nature of the organo-mineral (as opposed to coarse mineral) fraction of the soil matrix indicates ongoing and extensive biological reworking of the fine material in these deposits (and possibly therefore organic anthropogenic features) by soil fauna such as worms and mites. This is likely to have affected the preservation of anthropogenic materials and possibly therefore the level of interpretation.

All of the above phenomena are likely to have, in some way, contributed to the generally diffuse nature of the context boundaries seen in thin section. There is, therefore, no suggestion from the thin section sample set that any of these boundaries have been misinterpreted on site. This detailed analysis has also provided answers to the set of more specific questions posed at the beginning of this report. Discussed in greater detail in the context-specific sections, this analysis will conclude with a summary of these findings.

1 Is there bioturbation seen in context (026), and does this compromise the integrity of the radiocarbon dates?

This seems unlikely. There is actually very little real sign of bioturbation and disturbance in (026), with the only possible sign of physical disturbance being the larger void space and patchier groundmass seen at the base of the context. This could well be more directly related to disturbance immediately above, connected with the cutting of pit (012). Within the deposit, signs of iron movement indicate a degree of illuviation, but a lack of other textural pedofeatures and the good preservation of the introduced iron-rich probable midden material fragments indicate that physical disturbance is not a key feature of this context. Variability in the radiocarbon dates may therefore either indicate that there has been a gradual deposition of the material, or, if disturbance-related, may be the result of the soil fauna activity seen throughout the context.

2 Is there evidence that context (019) accumulated slowly, therefore providing a possible explanation for the range of dates provided by both pottery and OSL?

Yes. Clear lenses can be identified within the context, to the extent that (019) has been recorded in thin section as four separate micro-layers. A lack of disturbance pedofeatures may also indicate that these layers gradually accumulated rather than being deliberately dumped.

3 Does context (016) derive from context (019) (and possibly also (030)?

Possibly. Due to the similarity of all the sand deposits sampled in Profile 1, it is not possible to identify the origin of context (016) within the sample set through mineral composition. Neither do anthropogenic inclusions indicate a relationship between the two contexts. This question is further complicated by the variability of the lensing recorded within (019) and, therefore, the relatively limited sample available from what may have been a more complex series of layers than that recorded in the field.

4 Does (007) really represent a part of the cross-slab re-carving event at the point of the OSL sample?

This would seem likely, given the concentration of sandstone fragments seen in this context in thin section. However, it is not possible to state conclusively whether these fragments come from the cross-slab itself. There are also general similarities between contexts (007) and (002) which indicate that these two later deposits may be more closely related than the sequence of sands sampled in the remainder of the profile, which implies that the (007) sandstone fragments are also later. However, the answer to this question ultimately depends on understanding the relationship between context (007) and context (011) (the pit fill representing the debris securely identified as being from the re-carving event). As context (011) was not sampled in thin section, this cannot be explored further. The presence of cross-slab fragments in a range of both earlier and later contexts (see Chapter 3) also indicates that the presence of cross-slab fragments in a deposit may not indicate a direct relationship with the re-carving event.

5 What is the nature of the disturbance seen in Profile 2: context (041) Zone B?

Micromorphological analysis strongly indicates that this intrusive material has at least partly travelled down-profile from (042) above. It is not possible to identify the cause of this disturbance as only a portion of the disturbed area is sampled. However, a general lack of evidence for down-profile movement and/or disturbance throughout the adjacent undisturbed areas of (041) suggests that this disturbance is localised and small-scale, with the sampled portions of contexts (041) and (042) in Slide 2B showing no sign of physical disturbance of this kind.

7.3.2 Luminescence dating of sediments

DAVID SANDERSON AND IONA MURRAY

Summary

This report presents details of the application of Optically Stimulated Luminescence (OSL) dating to the Hilton of Cadboll site. OSL dating operates by measuring the intensity of luminescence signals which are induced by long-term exposure of minerals such as quartz to ionising radiation in the environment. OSL signals are bleached by exposure to daylight and build up while the sample is enclosed in the archaeological monument. Providing the sample has been reset at time of deposition, the combination of OSL measurements of the radiation dose received and assessment of the environmental radioactivity of the sample and its context can be used to date depositional events.

Two series of samples were collected from the Hilton of Cadboll site during a visit in September 2001. Small profiling samples were used to evaluate mineralogy, luminescence sensitivities and to make preliminary stored dose measurements to identify the most appropriate luminescence approach. Larger dating samples collected in opaque tubes, and accompanied by in-situ measurements of the local gamma radiation fields of the site were used for dating measurements. Four dating samples were collected. One sample (context 042, SUTL 1447) was collected from a sand layer underneath the broken collar stone (032). The other three were from the vicinity of the lower portion of the Hilton of Cadboll cross-slab, which represented a secondary or later setting of the

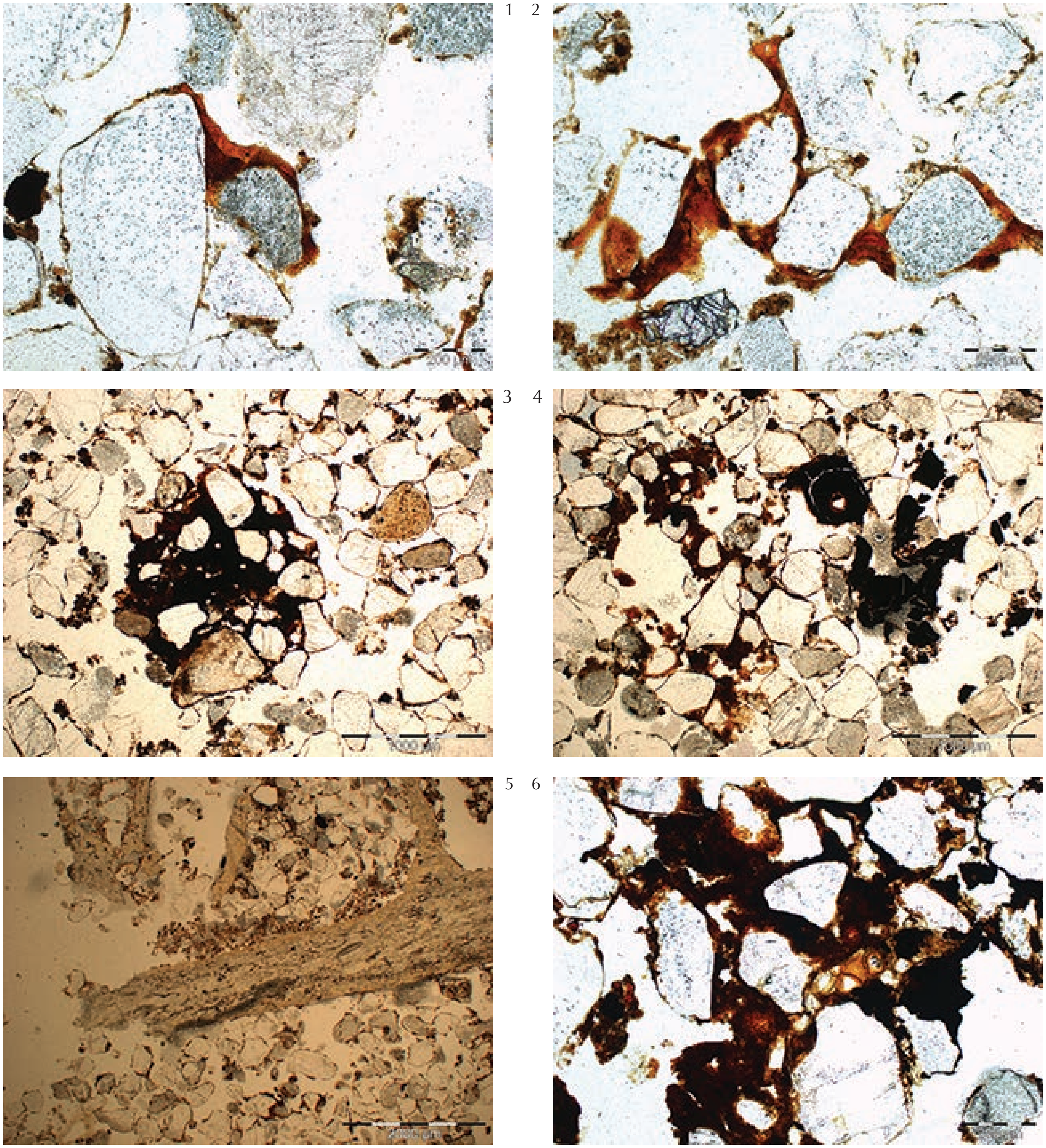


Illustration 7.41

(1) Context (023) in Slide 1B. Compound coating: superimposed layers of fine clay and silty clay upon quartz grain indicate down-profile movement of material, possibly through illuviation. (2) Context (023) in Slide 1B. Link capping: a continuous clay coating joins several slightly weathered quartz grains. (3) Context (026) in Slide 1C. Iron-rich fine clay infilling surrounding quartz grains. An indicator of illuviation processes. (4) Context (026) in Slide 1C. Black, red and reddish-brown iron-rich amorphous organic material, probably decayed plant material. Black areas indicate burning and thus a likely anthropogenic source. Note scored and weathered appearance of quartz grains. (5) Context (026) in Slide 1B. Fragment of degraded bone. Note light brown fine organo-mineral excrements surrounding top edge of fragment. (6) Context (026) in Slide 1C. Cell residue seen in matrix of iron-rich fine material. All plane polarised light.

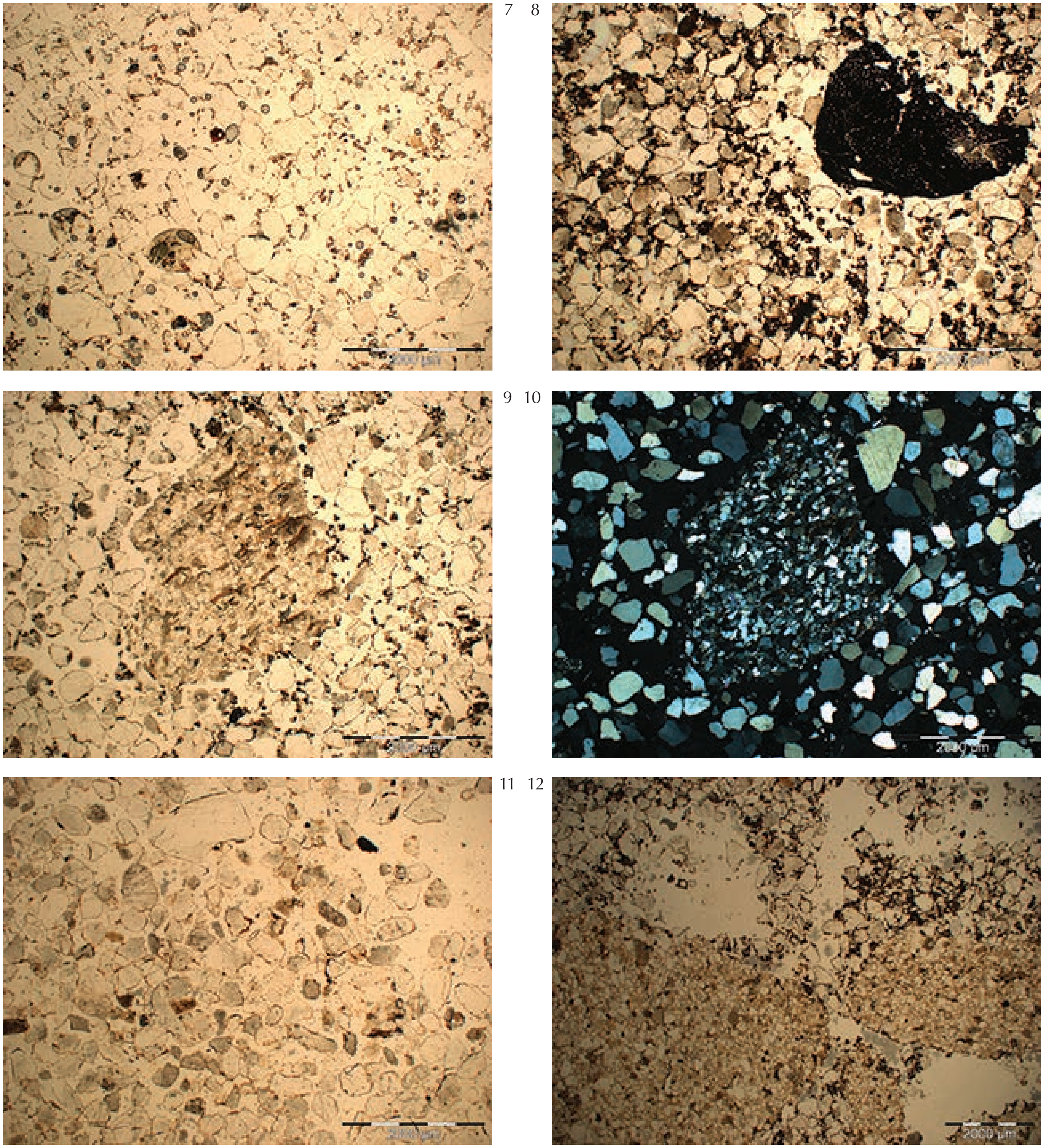


Illustration 7.42

(7) Context (019) in Slide 1C. General view of Zone A in Slide 1C. Note dominance of coarse mineral fraction. (8) Context (019) in Slide 1D. General view of Zone B in Slide 1D. Note dominance of fine organo-mineral fraction and higher concentration of anthropogenic material. (9) Context (019) in Slide 1D. General view of Zone C in Slide 1D, showing large fragment of sandstone. Note dominance of coarse mineral fraction, similar to that seen in Zone A. (10) Context (019) in Slide 1D. General view of Zone C in Slide 1D, showing large fragment of sandstone. Note dominance of coarse mineral fraction, similar to that seen in Zone A. Cross polarised light, ×2. (11) Context (016) in Slide 1A. General view showing frequent weathered grains. Note similarity to Zones A and C in context (019), but not to Zone B. (12) Boundary between Contexts (007) and (002) in Slide 1E. Note clear boundary indicated by layer of sandstone fragments seen marking the top of context (007). All plane polarised light except (10).

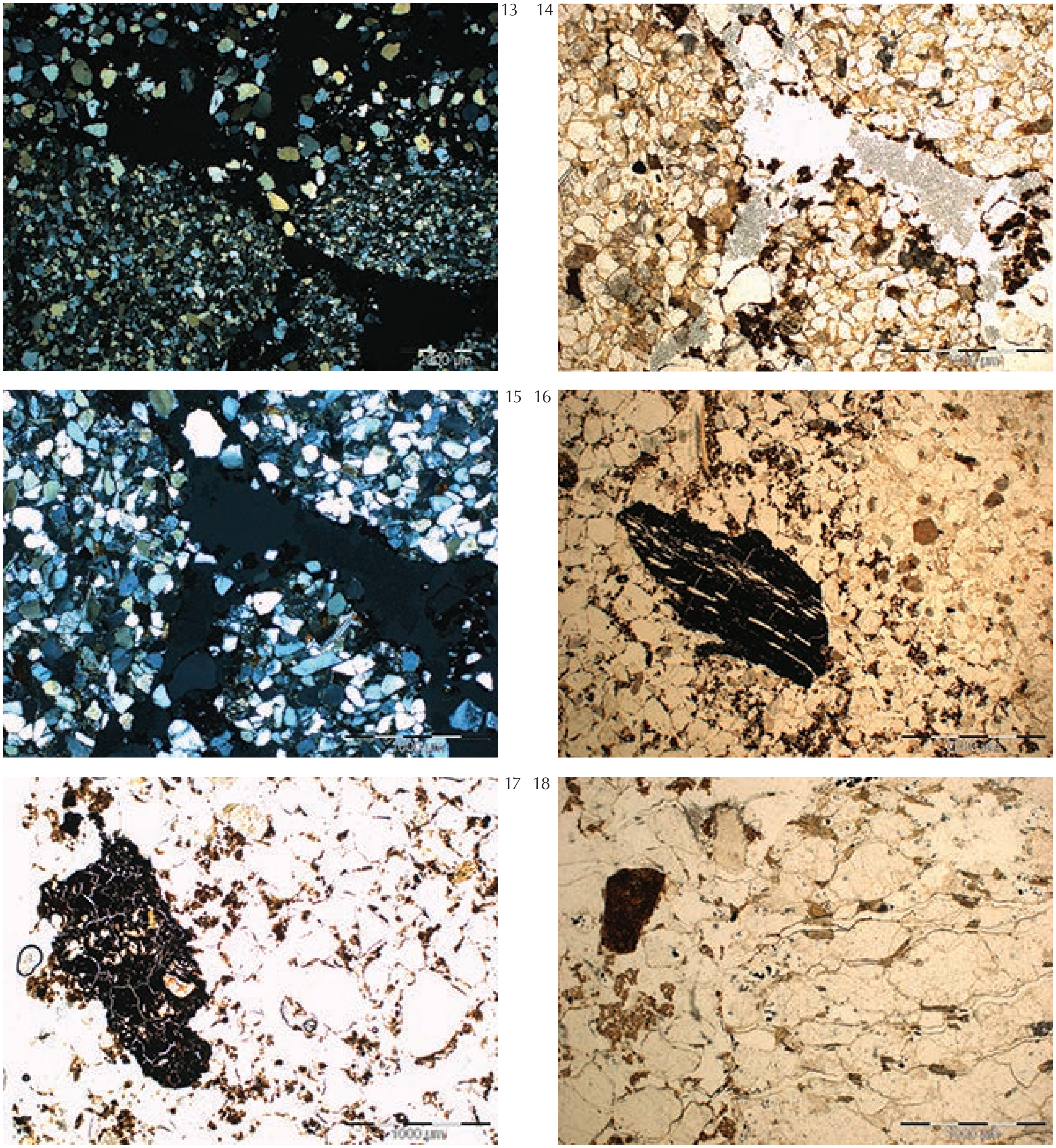


Illustration 7.43

(13) Boundary between contexts (007) and (002) in Slide 1E. Note clear boundary indicated by layer of sandstone fragments seen marking the top of context (007). Cross polarised light. (14) Context (007) in Slide 1E. Sandstone fragment consisting of mainly quartz grains with muscovite and small veins of occasionally Fe-rich metamorphic material. (15) Context (007) in Slide 1E. Sandstone fragment consisting of mainly quartz grains with muscovite and small veins of occasionally Fe-rich metamorphic material. Cross polarised light. (16) Context (007) in Slide 1E. Large charcoal fragment. Note extant cell residue to top of image. Plane polarised light. (17) Context (007) in Slide 1E. Large fragment of cracked reddish-black amorphous organic material containing small mineral inclusions. Possible turf-derived burnt fragment. Plane polarised light. (18) Context (002) in Slide 1F. Sandstone fragment consisting of quartz with frequent hornblende and muscovite inclusions. Quartz grains show a pronounced horizontal elongation, giving the fragment an appearance similar to sheared quartz. Note difference with sandstones seen in Context (007). Plane polarised light.

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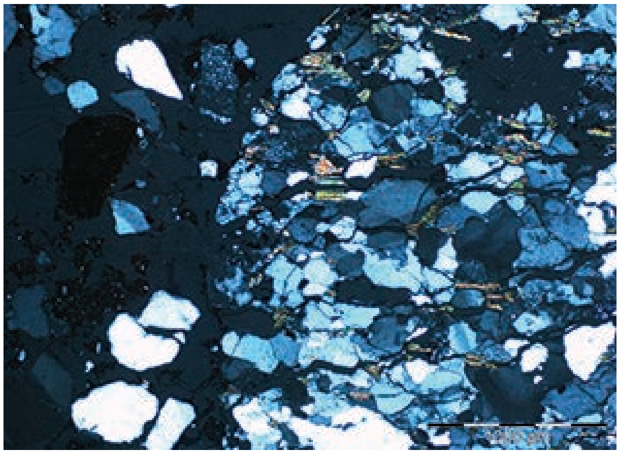
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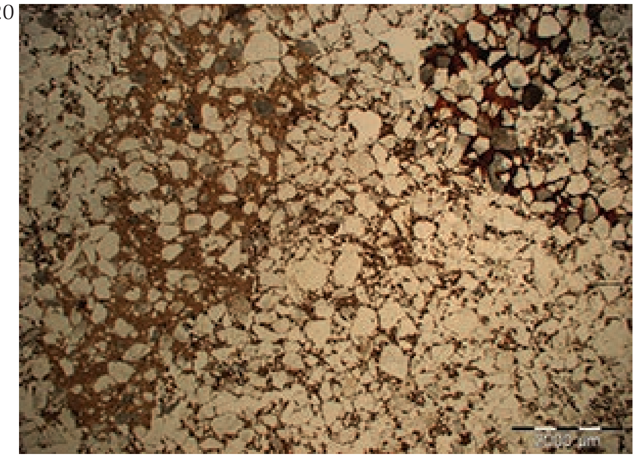
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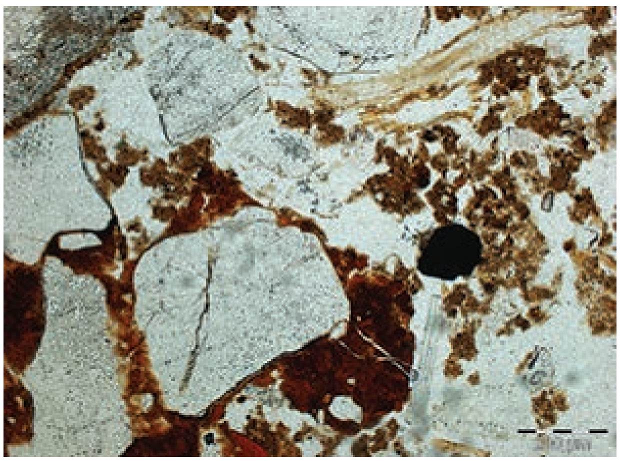
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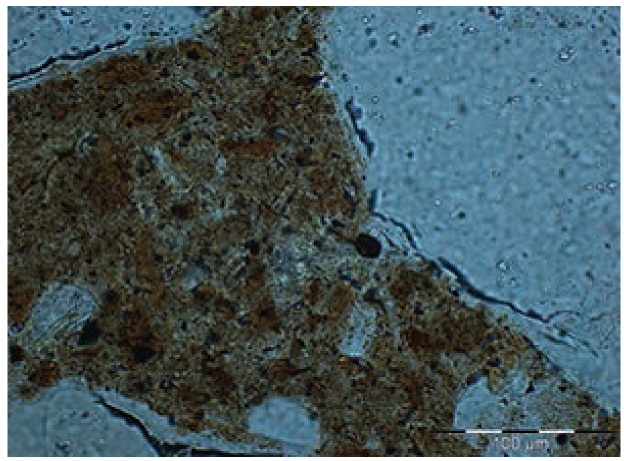
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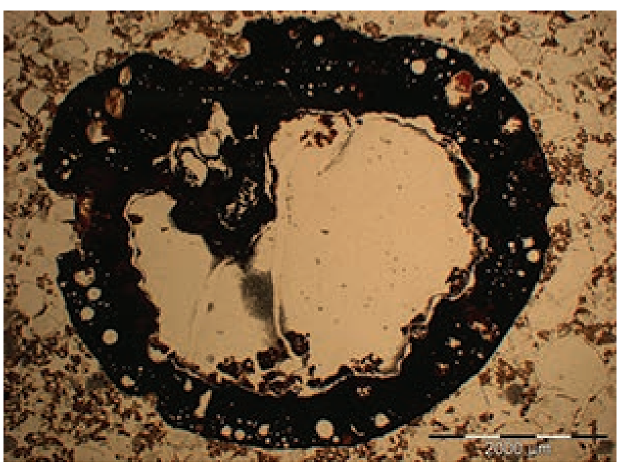
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Illustration 7.44

(19) Context (002) in Slide 1F. Sandstone fragment consisting of quartz with frequent hornblende and muscovite inclusions. Quartz grains show a pronounced horizontal elongation, giving the fragment an appearance similar to sheared quartz. Note difference with sandstones seen in Context (007). Cross polarised light. (20) Context (002) in Slide 1F. Groundmass variability near to the modern surface. To the left, dense mid-brown organic and organomineral material containing phytolith fragments: modern turf-based material. To the right: iron-impregnated groundmass. Plane polarised light. (21) Context (002) in Slide 1F. Reddish amorphous organic material in association with cell residue material. Degraded plant fragments. Plane polarised light. (22) Context (002) in Slide 1F. High magnification view of possibly modern turf-based material seen in Hilton-20. Note phytolith in centre of image. Plane polarised light. (23) Context (002) in Slide 1F. Plant pseudomorph: a root fragment impregnated with iron to such an extent that the now almost entirely iron-based feature retains the structural appearance of the root. Plane polarised light. (24) Context (041) in Slide 2A. Contrasting groundmass characteristics: undisturbed (Zone A, right) and disturbed (Zone B, left) areas of context (041). Plane polarised light.

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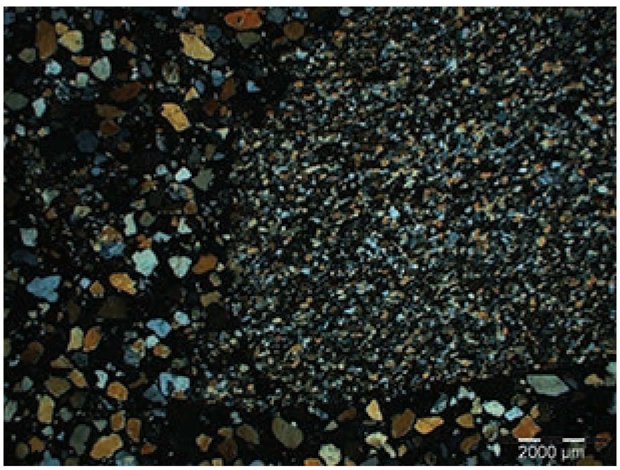

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Illustration 7.45

(25) Context (041) in Slide 2A, Zone B. Discrete patch of disaggregated sandstone within disturbed soil area, similar to that seen in (042) above, indicating that Zone B material may originate in context (042). Plane polarised light. (26) Context (042) in Slide 2B. Fine sandstone fragments mark the boundary between contexts (041) and (042). Plane polarised light. (27) Context (042) in Slide 2B. Fine sandstone fragments mark the boundary between contexts (041) and (042). Cross polarised light. (28) Context (042) in Slide 2B. Groundmass variation in context (042). Note small fragments of disaggregated sandstone, coarser in composition to the much larger fine sandstone fragments seen in 26 and 27 and similar to those fragments seen in the disturbed Zone B area of context (041). Plane polarised light.

stone prior to its destruction and 17th-century re-use as a memorial slab. The sample from context 016 (SUTL 1448) represents sand that infilled the pit originally cut when the stone was re-set in its final resting place; sample 019 (SUTL 1449) is from a sand layer located stratigraphically above the primary fill of the final stone setting. Sample (SUTL 1450) comes from a layer (007) which includes fragments of the broken slab surface.

The quartz single-aliquot regenerative OSL dating procedure was applied successfully to all four samples. Radiation dosimetry combined field gamma spectrometry, thick source beta counting and high resolution gamma spectrometry. In all four cases it was possible to use the OSL data to determine equivalent doses for the samples. All samples were initially measured with 16 aliquots. For samples 016 (1448) and 019 (1449) additional sets of 32 aliquots was also examined. The variance and dose distributions from replicated aliquots were used to assess the extent to which homogenous, well-bleached sands were encountered.

The results suggest emplacement of the broken collar stone (032) in the early 12th century, sample 042: AD 1100 ± 70 (SUTL 1447). The results from the sands associated with the lower portion also suggest emplacement in the 12th century, context 016: AD 1120 ± 70 (SUTL 1448) and context 019: AD 1140 ± 70 (SUTL

1449). The dose distribution from context 016 showed bimodality suggesting partial inheritance of an earlier OSL age representing mixture of 9th-century and 12th-century material. This is tentatively attributed to partial bleaching during the final emplacement activities, with the older material representing the depositional age of the older land surface into which the stone was inserted. The layer with carved fragments 007 gave an OSL date in the late 16th century, AD 1570 ± 25 (SUTL 1450), which corresponds approximately to the Scottish Reformation. The OSL date associated with defacement thus predates the inscribed date for re-use of the slab for memorial purposes in the 17th century.

The OSL analysis and results raised a number of hypotheses that have fed into other parts of the archaeological research at Cadboll. The original stratigraphic interpretation of the layers associated with the OSL dating samples was reviewed during post-excavation work, and several scenarios considered, taking account of the OSL evidence and other archaeological observations. The OSL results for the three samples associated with the repositioning of the collar stone and the final stone setting, all suggest a 12th-century resetting, which has been assimilated into the overall archaeological interpretation of the site. The implication from the date from context 007, that the defacement of the stone may have occurred significantly earlier than its re-use as a memorial slab also raised important hypotheses. The OSL work led directly to consideration of the historic context of the later reformation period in respect of possible defacement of the stone. The other corollary of the OSL date was the implication that debris from the initial defacement may have a separate spatial distribution on site, than the debris associated with re-dressing the slab in the 17th century for memorial use. Both of these aspects have been considered further in the archaeological work reported here. In these respects the OSL information not only provided a partial environmental context and chronology, but has also fed important ideas into the broader interpretation of the archaeological material recovered.

Introduction

This report presents sampling details and results of investigations of optically stimulated luminescence (OSL) from sediment samples recovered from the Hilton of Cadboll Chapel site, Ross and Cromarty, during excavations conducted by GUARD in 2001.

The context of the cross-slab setting is clearly rather complex, involving an active post-medieval burial site, in which there may have been one or more Pictish period stone settings, followed by medieval re-siting of the stone, and its re-use in the late 17th century. At start of excavation it was known that the site had a sandy substrate of presumed Aeolian origin. With this in mind provision was made for collecting samples for OSL investigation during the excavation. The aims of the OSL work were to attempt to characterise materials associated with the stone settings and their environmental context, to assess whether OSL could be used as a tool to date archaeologically significant horizons on the site.

Optically stimulated luminescence originates as a consequence of energy deposited within sedimentary minerals in response to naturally occurring ionising radiation in the sample and its environment. By stimulating the minerals in the laboratory using lasers or other suitable light sources, part of this stored energy is released, resulting in measurable luminescence which can be measured to quantify the radiation history of the sample. Luminescence signals can be erased either by heat or by exposure to daylight, leading to the two main classes of materials which can be dated using this approach. Heated materials such as ceramics or burned stones are effectively zeroed by a prior thermal event (eg firing of pottery, heating of a hearth), thus resetting the luminescence age information within the system. For sedimentary materials exposure to light during erosional and transport phases acts as the zeroing mechanism. Enclosure of the sediment after final deposition protects it from light and initiates the accumulation of luminescence signals that can be used for age estimation.

In both cases (heated materials and sediments) the luminescence age is determined by combining luminescence determinations of the radiation dose equivalent to the signals recovered from the samples (the equivalent dose), with measurements of the radiation dosimetry of the sample and its environment (the dose rate). The luminescence age is the quotient of equivalent dose over dose rate.

With sediment dating it is important to recognise that the luminescence age might represent an accumulated signal originating from many cycles of erosion, transport, bleaching and deposition. Only in the situation where undisturbed sediments are available and associated with effective zeroing at time of deposition can sediment dates be interpreted in terms of simple events. Whereas early sediment dating research was conducted using thermoluminescence readout methods (Aitken 1985; 1998) resulting in considerable ambiguity in initial conditions for many young holocene deposits, considerable progress has been made recently both through the use of photostimulation, or optical stimulation to target readily reset luminescence systems, and through development of highly sensitive automatic instrumentation (eg Bøtter-Jensen *et al* 2000), which can record weak luminescence signals from young sedimentary materials. The development of regenerative procedures for determining the stored dose within single aliquots or mineral grains (Murray & Wintle 2000, Sommerville *et al* 2001; 2003) has provided a means of investigating the distribution of doses within sediments. This approach has provided important information in diagnosing mixed sedimentary systems where heterogeneous material is encountered (Olley *et al* 1998, 1999; Lepper *et al* 2000; Duller *et al* 2000; Spencer *et al* 2003). Combined with exploitation of the differential sensitivities to bleaching of luminescence signals from quartz and feldspars (Sanderson *et al* 2001, 2003) this provides means of characterising the depositional circumstances of young sediments and assisting to interpret luminescence ages.

The challenges presented by a site such as Hilton of Cadboll should not be underestimated. At the outset there was no prior knowledge to indicate whether or not the available minerals had sufficient luminescence sensitivity to quantify signals associated with the last 1000 years or so. Nor could the availability of well-bleached, undisturbed, Aeolian sediments in useful archaeological contexts be assumed in advance of the excavation. Nevertheless in view of the interest in this site, a field visit was arranged to recover samples for OSL investigation, during the excavation.

This report outlines the samples collected, the measurements undertaken, and the conclusions that can be drawn from the results. It has been possible to utilise the quartz SAR method to estimate the depositional history of arguably the most significant features associated with the setting and destruction of the Hilton of Cadboll cross-slab.

Sampling

Sampling trip

During a site visit by Iona Murray on 8 September 2001 sediment samples were collected from deposits associated with the base of the symbol stone and the collar stone which may have been related to an earlier setting. The purposes of the visit were to examine possible sampling locations for OSL investigations, to collect suitable samples, and to make environmental gamma radiation measurements from sampling contexts to facilitate luminescence dating. Eight small samples were collected from two profiles for the purpose of general characterisation of the luminescence properties of available sediments. The profiles represented accessible areas in the vicinity of the stone lower portion (profile 1, Table 7.6), and underneath one of the collar stones (profile 2, Table 7.7). Sampling was performed in conjunction with sampling for micromorphological characterisation of the soils and sediments (Duncan 2003). It was not possible to obtain a deep suite of samples to define the complete environmental history of the site within the constraints of the excavation. Nevertheless the profiling samples do provide a means of assessing the local depositional environment of the main significant archaeological features being investigated. Four bulk samples were also collected in tubes for the purpose of luminescence dating measurements.

Profiling samples

Two sets of profiling samples were collected from stratigraphically significant deposits associated with the lower portion (context 008) (profile 1) and the collar stone (context 032) (profile 2). The samples were collected in 1-cm diameter plastic tubing, and protected from light exposure.

Table 7.6 summarises the sampling details for the five samples collected from the deposits revealed in section to the west of the stone lower portion at the time of the fieldtrip. As noted above it was not possible to obtain samples from depth within the sedimentary substrate, however the lowest sample in the sequence does come from a sand layer which was assumed, at time of excavation, to represent the substrate of the stone setting. It would have taken a far more extensive and invasive excavation to reveal the full archaeological and natural sequence of the site, and therefore it is doubtful that any of these samples were entirely free from anthropogenic influence. The depths recorded in Table 7.6 represent depths beneath the local surfaces exposed in the excavated section. The sampling positions were also recorded on archaeological section drawings, from which the absolute depths could be determined if required.

Table 7.7 summarises the sampling details of the three samples collected from profile 2, in the vicinity of the broken collar stone. Depths again were related to a local datum, representing the exposed top of section at time of sampling, and marked on section drawings in the primary site record. Again the sampling depths were limited to the dimensions of the excavated sections at time of sampling, but they include at least the upper layers of sand layers assumed to represent substrates.

If the site were subject to further excavations in the future it would be relevant to consider extending sampling depths in order that a more complete record of the environmental history of the context could be assembled, and the working assumption that the basal sand layers were essentially unaltered natural sediments could be assessed.

OSL tube samples

OSL tube samples were collected from four locations. All samples were collected using 15–20cm lengths of 19mm diameter copper tubing and protected from light exposure, and sealed to retain moisture at time of sampling. Sampling was performed under a temporary cover, and the sections cleaned back immediately prior to insertion of the sampling tubes in order to avoid incorporation of sediments that had been exposed to daylight, or cross-

Table 7.6
Sampling details for Profile 1

Profile no	SUTL no	Depth in cm	Description of context	Stratigraphic significance
1–1	1497	60	(023) a sterile sandy layer	Upper part of sedimentary substrate for the stone setting
1–2	1498	50	(016) sandy layer	Primary fill of pit for Setting 2
1–3	1499	30	(019) a sand layer	Sand layer above 016. Field interpretation was as an upper fill to the stone setting (thus giving taq for the setting). It is cut by the robber pit
1–4	1500	18	(030) a layer of crushed sandstone	Cut by the pit associated with defacement of the stone; therefore predates this operation
1–5	1501	12	(007) sandy layer containing fragments	Associated with deposition of the carved fragments

contaminated as a result of excavation. Sample locations are summarised in Table 7.8.

Gamma ray spectra were recorded for the tube sampling sites and one of the profiling locations using a portable spectrometer (Rainbow 1-7010 with 1in x 1in NaI detector probe). Readings were taken over five or ten minute periods in 4π geometry and used to estimate local gamma ray dose rates using calibration factors established at SUERC. It was noted that higher dose rates were obtained from positions in close proximity to stone fragments, in keeping with experience elsewhere in many sand-rich deposits (Table 7.9). The use of a small gamma spectrometry probe of comparable dimensions to the OSL sampling tubes is advantageous in these circumstances.

Luminescence analysis

Sample preparation

The profiling samples were processed simply to recover minerals for luminescence characterisation. For the larger tube samples mineral separations were accompanied by dosimetric measurements to facilitate age estimation subject to satisfactory luminescence results. All sample handling and preparation was conducted under safelight conditions in the SUERC luminescence dating laboratories.

The profiling samples were wet sieved to extract 90–150μm and 150–250μm size fractions. These were treated with 1M HCl for 30 minutes and a subsample of the 90–150μm fraction extracted for polymineral analysis.

Table 7.7
Sampling details for Profile 2

Profile no	SUTL no	Depth in cm	Description of context	Stratigraphic significance
2–1	1502	15	(041) a sterile sandy layer – 15cm below collar stone 032	Wind-blown sand probably pre-dates the settings
2–2	1503	10	(041) Thin sandy layer – 10cm below collar stone	As above
2–3	1504	5	(042) a sand and gravel layer – 5cm below collar stone	Layer possibly equivalent to 019. Predates the re-positioning of the broken collar stone

Table 7.8
Sampling details for the four OSL tube samples

OSL no	SUTL no	Description of context	Stratigraphic significance
1	1447	Thin sandy layer (042) below broken collar stone (032)	Should give tpq for final placement of broken collar stone
2	1448	(016) sandy deposit, primary fill of stone setting	Should give taq for Setting 2
3	1449	(019) sandy deposit cut by 'robber' pit	Should give taq for Setting 2
4	1450	(007) layer of carved fragments	Associated with deposition of the carved fragments

The remaining material was given a 40-minute 40 per cent HF treatment, followed by 30 min 1M HCl to prepare a quartz concentrate. Both quartz and polymineral samples were washed repeatedly in deionised water, and then rinsed three times in acetone. Samples were dried in a 50°C oven for 1 hour prior to dispensing, and then dispensed onto 1cm diameter 0.25mm thick stainless steel discs sprayed with Electrolube silicone grease. Two discs of each sample were dispensed for polymineral analysis (all 90–150μm fraction). Two etched quartz discs per sample were also prepared from whichever of the sieved size fractions produced sufficient quartz. These samples were used for exploratory luminescence measurements as described below.

For tube samples mineral extraction in this case was aimed at recovery of quartz for analysis by the single aliquot regenerative (SAR) OSL method, and of measurement of does rates from the sample material to facilitate age estimation. The first step was to measure the initial, dry and saturated weights of each sample to determine actual and saturated water contents. Samples were then removed from the tubes, dried at 50°C and then split to remove 20g of material for does rate measurements. The remaining material was sieved to recover 90–150μm and 150–250μm size fractions. Both fractions were centrifuged in sodium polytungstate solution to remove heavy minerals with densities greater than 2800kg m^{-3}. The lighter fraction was split to retain material for future reference, and portions treated with HCl and HF acid in the same manner as described above to recover quartz concentrates for SAR analysis. 16 discs per sample were dispensed.

Measurements

Dose rate measurements

Dose rate measurements from the dating samples were undertaken by Thick Source Beta Counting (TSBC), and

Table 7.9
On-site gamma dosimetry readings

Reading	Context	Associated sample(s)	Counting time(s)	Dose rate (mGya-1)
HCAD-1	Sandy layer below broken collar stone	Profile 2	600	0.199 ± 0.01
HCAD-2	Sandy layer below broken collar stone	OSL1	600	0.284 ± 0.01
HCAD-3	(019)	OSL3, P1–3, P1–4	300	0.302 ± 0.02
HCAD-4	(007)	OSL4, P1–5	300	0.621 ± 0.03
HCAD-5	(023)	OSL2, P1–1, P1–2	300	0.226 ± 0.01

high resolution gamma spectrometry (HRGS) using the 20g dried subsamples referred to above.

Beta dose rates were measured using the SURRC TSBC system (Sanderson 1988). Sample count rates were determined with 10 replicate 1000s counts for each sample, bracketed by background measurements and sensitivity determinations using the SURRC Shap Granite secondary reference material. Dry infinite-matrix dose rates were calculated by scaling the net count rates of samples and reference material to the beta dose rate of the Shap Granite (6.25 ± 0.03 mGy a^{-1}). The estimated errors combine counting statistics, observed variance and the uncertainty on the reference value.

HRGS measurements were performed using a 50 per cent relative efficiency 'n' type hyperpure Ge detector (EG&G Ortec Gamma-X) operated in a low background lead shield with copper liner. Samples were sealed in 50mm diameter Sterilin petri dishes for a minimum of 2–3 weeks prior to measurement to allow radon equilibriation. Gamma ray spectra were recorded over the 30 keV to 3 MeV range from each sample, interleaved with background measurements and measurements from Shap Granite in the same geometry. Counting times of 85 ks per sample were used. The spectra were analysed to determine count rates from the major line emissions from ^{40}K (1457 keV), and from selected nuclides in the U decay series (^{234}Th, ^{226}Ra + ^{235}U, ^{214}Pb,^{214}Bi and ^{210}Pb) and the Th decay series (^{228}Ac, ^{212}Pb, ^{208}Tl) and their statistical counting uncertainties. Net rates and activity concentrations for each of these nuclides were determined relative to Shap Granite by weighted combination of the individual lines for each nuclide. The internal consistency of nuclide specific estimates for U and Th decay series nuclides was assessed relative to measurement precision, and weighted combinations used to estimate mean activity concentrations (in Bq kg^{-1}) and elemental concentrations (per cent K and ppm U, Th) for the parent activity. These data were used to determine dry infinite matrix dose rates for alpha, beta and gamma radiation. These were used in combination with measured water contents, field gamma dose rates and TSBC results, and with estimated internal alpha activity and modelled cosmic ray dose rates, used to determine the overall effective dose rates for age estimation.

Luminescence measurements

The aims of the initial measurements from profiling samples were to establish whether quartz and feldspars were present, to determine their luminescence sensitivities and to assess the extent of archaeological resetting relative to residual geological doses. At this stage polymineral silicates were used to assess the combined feldspar/quartz behaviour. Since luminescence sensitivities of feldspars are typically two or more orders of magnitude greater than quartz, the polymineral extracts can be used to evaluate the potential for separating feldspars for dating measurements. The quartz samples were used to assess the opportunities for applying the SAR method for dating these materials.

Polymineral discs were subjected to a multiple stimulation measurement procedure using a Riso DA15 Automatic luminescence reader. Samples were initially preheated at 220˚C for 30 secs, and then subjected to sequential infra-red stimulated luminescence (IRSL), post-IR blue OSL stimulation, and TL measurements. IRSL measurements were conducted for 60s at 50˚C, Blue OSL measurements for 30 s at 125˚C, in both cases 60 per cent of the available instrumental stimulating power being used. TL was measured from room temperature to 500˚C at a heating rate of 5˚Cs^{-1}. Following readout of the natural luminescence signals samples were irradiated with a 1 Gy ^{90}Sr beta dose and re-measured as before. Thereafter a 5Gy dose was applied, the measurement cycle repeated, and finally the 1Gy irradiation and readout sequence also repeated. The responses to the 1 Gy and 5 Gy doses were used to assess luminescence sensitivity, linearity of dose rate response and sensitivity changes for the material under IRSL, OSL and TL stimulation. The natural signals in conjunction with these readings were used to provide first estimates of the stored dose in each sample.

The quartz discs from profiling samples were subjected to a Single Aliquot Regenerative (SAR), in which measurements of OSL signal levels from individual discs are calibrated to provide stored-dose estimates using an interpolated dose-response curve constructed by regenerating OSL signals in the laboratory after each readout cycle (see diagram in archive). Sensitivity changes which may occur as a result of readout, irradiation and preheating (to remove unstable radiation induced signals) are monitored using a series of small test dose measurements which interleave the sequence of constructing the dose response curve. Stored doses are determined using normalised OSL signals, whereby each measurement is standardised to the test dose response determined immediately after its readout, thus compensating for observed changes in sensitivity during the laboratory measurement cycle. The ability of this procedure to correct for laboratory induced sensitivity changes is assessed using a recycling check whereby a low-dose irradiation near the start of the sequence is compared with a repeat measurement at the end of the sequence.

For the profiling measurements the natural signal was first read out, followed by a sequence of doses administered to reconstruct the regeneration line. The dose sequence was as follows; 0.5, 1, 1.5, 2, 2.5, 0.5, 0 Gy. The repeated 0.5Gy measurement was used to calculate recycling ratios in order to examine the effectiveness of sensitivity corrections. The zero Gy point at the end was used to monitor whether any residual OSL signals had accumulated over the measurement sequence. In addition, at the end of the run, a 1Gy dose was given, followed by an IRSL readout to check for possible contamination by IR sensitive minerals.

OSL tube samples were measured using the same procedure as quartz profiling samples, with the exception of preheat temperatures. Four different preheat temperatures were investigated (220, 240, 260 and 280°C), using sets of four discs for each datapoint. This enabled an assessment to be made of the dependence of equivalent dose (D_e) on preheat temperature. An additional 32 discs were later measured for samples SUTL 1448 and 1449 in order to further investigate the distribution of D_e within the samples.

Results

Profiling measurements

As noted above the main aims of the profiling measurements were to assess sensitivities and to make preliminary equivalent dose estimates from both polymineral samples and quartz to assess dating suitability and most appropriate approach for the tube samples. With observed field gamma dose-rates of 0.2 to 0.6 mGy a^{-1}, total dose rates of approximately 0.3 to 1 mGy a^{-1} are expected. Therefore samples of 500–1000 year age are expected to have equivalent doses of 0.15 to 1 Gy. These values are useful in making initial assessments of the profiling measurements.

Luminescence sensitivities of the polymineral samples were rather low, implying a feldspar deficient mineralogy for the sediments, and leading to highly scattered equivalent dose estimates from the multiple stimulation runs. The quartz separates were more promising with luminescence sensitivities of approximately 10^2–10^3 photon counts per Gy, accompanied by fast decaying OSL peaks characteristic of pure quartz and negligible IR response.

Table 7.10 shows the equivalent doses determined from the polymineral and quartz experiments. The poor feldspar sensitivities lead to extremely high fractional errors in equivalent dose, which do not seem to provide a promising basis for determining archaeological doses of the order of 0.1–1 Gy. While it may be possible to enhance feldspar sensitivity by specific feldspar separations, the results do not suggest that this would be a productive route for this site. By contrast the quartz equivalent doses for all sampling positions are broadly consistent with the expected age of the archaeological deposits. Moreover in profile 1 they are in stratigraphic order. In the second profile the upper sample is in close proximity to a stone slab which is likely to enhance the local dose rate in comparison with the lower samples.

Table 7.10
Equivalent dose estimates from profiling samples

Ref	Lab code SUTL	Depth in cm	Estimated Equivalent Dose De/Gy			
			Polymineral IRSL	OSL	TL	Quartz OSL
1–1	1497	60	2.2 ± 0.6	2.1 ± 0.1	21 ± 11	1.08 ± 0.14
1–2	1498	50	205 ± 150	43 ± 25	250 ± 10	0.99 ± 0.13
1–3	1499	30	5.5 ± 2.4	3 ± 1	34 ± 4	0.78 ± 0.08
1–4	1500	18	7.2 ± 0.2	3 ± 0.7	51 ± 35	0.83 ± 0.11
1–5	1501	12	37 ± 44	6.4 ± 0.8	51 ± 24	0.33 ± 0.04
2–1	1502	15	3.6 ± 1	4.3 ± 0.5	29 ± 22	1.08 ± 0.23
2–2	1503	10	8.3 ± 8.9	1.3 ± 0.2	25 ± 9	0.76 ± 0.12
2–3	1504	5	12 ± 0.3	7.3 ± 1.4	14 ± 1.5	1.22 ± 0.11

Table 7.11
Activity and equivalent concentrations of K, U and Th for samples SUTL1447-1450 as determined by HRGS

Sample	Activity Concentrations/Bqkg^{-1}			Equivalent Concentrations[1,2]		
(SUTL)	K	U	Th	K (%)	U (ppm)	Th (ppm)
1447	97.8 ± 22.1	5.3 ± 4.3	4.6 ± 2.2	0.32 ± 0.07	0.43 ± 0.35	1.13 ± 0.54
1448	213.3 ± 22.4	11.9 ± 4.3	6.8 ± 2.2	0.69 ± 0.07	0.97 ± 0.35	1.67 ± 0.55
1449	197.3 ± 22.3	9.2 ± 6.3	5.3 ± 2.2	0.64 ± 0.07	0.74 ± 0.51	1.31 ± 0.54
1450	232.7 ± 22.8	5.5 ± 4.4	8.4 ± 2.2	0.75 ± 0.07	0.45 ± 0.36	2.07 ± 0.54

[1] Conversion factors (based on OECD,1994) : ^{40}K : 309.26 Bq kg-1 %K^{-1} ; ^{238}U : 12.34787 Bq kg-1 ppmU^{-1} ; 232 Th : 4.057174 Bq kg-1 %$^{-1}$.
[2] Working values for Shap Granite :4.43+-0.03%K, 12.00+-0.06 ppm U, 28.5+-0.26 ppm Th. In Bq kg-1: K- 1370+-10 Bq kg-1, U-238 148.17+-7.4 Bq kg-1, 232-Th - 115.6+-1.05 Bq kg-1. Based on high resolution gamma spectrometry relative to CANMET and NBL standards by from Sanderson, 1986.

Taking this into account the results are broadly consistent with expectations. These preliminary results were used in formulating the decision to concentrate the tube sample preparation on quartz extraction for SAR analysis, with retention of sieved material as a contingency in case there was a need to attempt pure feldspar concentrations.

Dose rate measurements and calculations

Annual dose rates were estimated from the combination of on-site gamma spectrometry and laboratory measurements by TSBC and HRGS. Whereas field measurements were performed with the moisture content present at time of sampling, all laboratory measurements were conducted on dry samples. Water contents however were measured in the laboratory and used together with water attenuation corrections and microdosimetric grain size attenuation factors to calculate effective dose rates. Whereas the major sources of dose for dating could in principle have been estimated simply on the basis of field gamma spectrometry and TSBC, the addition of HRGS provides opportunities for independent verification of the inferred values, and also to evaluate the composition of the dosimetry in terms of relative contributions from U, Th and K, and sensitivity both to internal and external sources of radiation. The measured values from each technique, and their reconciliation and use to evaluate effective dose rates for 125–250μm quartz are summarised in tabular form below.

Table 7.11 presents HRGS results from each of the four dating samples both as activity concentrations (Bq kg^{-1}) and as equivalent concentrations, assuming, in the case of the U and Th series, full series equilibrium. The data were calibrated with respect to the SURRC secondary Shap Granite sample, and uncertainties have taken account of both analytical errors and the error in the reference values. Mean parent concentrations from all four samples were 0.55 ± 0.1 per cent K, 0.65 ± 0.13 ppm U, and 1.55 ± 0.21 ppm Th. These concentrations are lower than for many terrestrial soils, but are not atypical for either quartz rich or calcareous sands, which form the majority of the samples. The mean Th/U concentration ratio of all four samples is 2.4 ± 0.6, which is consistent with typical crustal values. The K concentration is broadly consistent typical proportions relative to U and Th.

Table 7.12 collates dose rates from laboratory and field gamma spectrometry plus thick source beta counting. The precision of dry infinite matrix dose rates by HRGS and TSBC is limited for the majority of these samples to some 10 per cent, mainly by the influence of background count rates on both forms of spectrometry and the relatively low radioelement concentrations. To improve on laboratory measurement precision for these low activity samples would require a combination of larger samples, longer counting times and reduced system background rates. The mean ratio of dry infinite-matrix beta dose rates determined by HRGS and TSBC is 1.25 ± 0.2, of debateable significance. Whereas the HRGS measurements were conducted with sealed samples which had been stored for radon accumulation, TSBC measurements were conducted in open geometry after drying the sample and would therefore not be expected to retain full equilibrium radon levels. It is thus possible that the differences between HRGS and TSBC measurements are partly due to the radon retention conditions of the

Table 7.12
Dose rates determined by HRGS, TSBC and field gamma measurements

Sample (SUTL)	Dry Infinite Matrix dose rates[1] by HRGS/mGya^{-1}			TSBC /mGya^{-1}	Field γ /mGya^{-1}
	Dα (dry)	Dβ (dry)	Dγ (dry)	Dβ (dry)	Dγ (wet)
1447	2.03 ± 1.05	0.36 ± 0.08	0.18 ± 0.05	0.49 ± 0.05	0.28 ± 0.01
1448	3.91 ± 1.06	0.76 ± 0.08	0.32 ± 0.05	0.51 ± 0.06	0.23 ± 0.01
1449	3.04 ± 1.48	0.68 ± 0.10	0.31 ± 0.07	0.44 ± 0.05	0.30 ± 0.02
1450	2.77 ± 0.75	0.75 ± 0.08	0.34 ± 0.05	0.63 ± 0.06	0.62 ± 0.03

[1] Based on dose rate conversion factors from Aitken 1983.

measurements. However it should also be noted that the U series contributions to beta dose rates for these samples are only some 10–15 per cent of the total beta dose rates. Taking account of all these considerations the beta dose rate estimates from both methods were combined.

Table 7.13 presents measured and assumed water content for all samples. Water content corrections have been applied to the average beta dose rate from HRGS and TSBC (Zimmerman 1971), and to the dry gamma dose rates determined by HRGS. Effective beta dose rates combine water content corrections with grain size attenuation corrections giving results which are broadly similar from sample to sample, with a mean value of 0.42 ± 0.04mGya^{-1}.

Calculated wet gamma dose rate values determined by HRGS are also tabulated. Comparison of these values with on-site gamma measurements indicates that samples SUTL1448 and 1449 are representative of their external gamma ray environment. Therefore the mean value of both sets of data has been used in final calculations.

Table 7.13
Annual dose rates for samples SUTL1447–1450

Sample	Water Content FW/ %	SW/ %	Assumed/ %	Effective β dose rate[1] /mGya^{-1}	Dγ (wet) by HRGS/ mGya^{-1}	Effective γ dose dose rate /mGya^{-1}	Total dose rate[2]/mGya^{-1}
1447	9	31	20 ± 10	0.31 ± 0.05	0.15 ± 0.04	0.28 ± 0.01	0.78 ± 0.06
1448	3	36	20 ± 10	0.46 ± 0.06	0.30 ± 0.05	0.26 ± 0.03	0.91 ± 0.07
1449	6	29	20 ± 10	0.41 ± 0.06	0.25 ± 0.06	0.28 ± 0.03	0.87 ± 0.07
1450	5	39	20 ± 10	0.50 ± 0.06	0.28 ± 0.05	0.62 ± 0.03	1.31 ± 0.07

[1] Effective beta dose rates combine water content corrections with inverse grain size attenuation factors obtained by weighting the 200 micron mean grain size attenuation factors of Mejdahl (1979) for K, U and Th sources by the relative contributions to beta dose rate from each source determined by HRGS.
[2] Obtained from the combination of effective beta and gamma dose rates and an additional 0.185 mGya^{-1} allowance for the dose rate due to cosmic radiation (Prescott & Hutton 1994).

Laboratory data from samples SUTL1447 and 1450 both imply 40–50 per cent lower gamma dose rates than those measured in the field. In both cases the higher field gamma dose rates are attributed to the presence of the *in-situ* collar stone and other rock fragments in the vicinity of the sampling position. In these circumstances the field measurement is the more appropriate value to carry forward, and this has been used in subsequent calculations.

Calculated total effective dose rates vary from 0.8–1.3 $mGya^{-1}$, values which are broadly consistent with those assumed during profiling assessment. The overall uncertainties in dose rate combining all data sets and corrections vary from ±5 per cent for sample 1450 to ±8 per cent for sample 1447. As stated above the relatively low activity levels of the samples, as well as consideration of the site stratigraphy and uncertainty in past water content determine these precision limits, which carry through to the individual age calculations below. The dosimetry of these samples is relatively well balanced between Uranium series activity and the more geochemically stable K and Th contributions. External gamma radiation represents between approximately 30 per cent and 50 per cent of the dose rate for these samples, which in view of the relatively complex stratigraphy again highlights the importance of utilising field measurements of gamma dose rates at time of sampling.

Single aliquot OSL results

Data from the single aliquot regenerative dose determinations were analysed both using the Risoe 'Analyst' programme, which constructed individual dose response curves and estimated doses for each disc, and using Excel spreadsheets and Jandel Sigmaplot software to examine composite data sets. Each individual

Table 7.14
Summary of SAR results from 16 disc runs

Sample	**1447**	**1448**	**1449**	**1450**
Mean Sensitivity/Counts Gy^{-1}	5600	4500	4060	7400
Sensitivity change/% per cycle	–5.20	–1.23	–0.199	–1.05
Recycling ratio	0.977 ± 0.026	0.987 ± 0.012	1.068 ± 0.046	1.006 ± 0.013
D_e at 220°C/Gy	0.694 ± 0.061	0.717 ± 0.177	1.157 ± 0.343	0.590 ± 0.092
D_e at 240°C/Gy	0.834 ± 0.058	1.276 ± 0.493	0.716 ± 0.261	0.532 ± 0.046
D_e at 260°C/Gy	0.703 ± 0.092	0.793 ± 0.159	0.811 ± 0.072	0.584 ± 0.036
D_e at 280°C/Gy	0.610 ± 0.037	0.914 ± 0.212	0.872 ± 0.069	0.578 ± 0.039
Combined D_e/Gy	0.711 ± 0.045	0.939 ± 0.148	0.871 ± 0.108	0.570 ± 0.035
De Precision/%	6.3	15.7	12.3	6.1
Effective Dose Rate/mGy a^{-1}	0.78 ± 0.06	0.91 ± 0.07	0.87 ± 0.07	1.31 ± 0.07
Age/ka	0.91 ± 0.09	1.03 ± 0.18	1.00 ± 0.15	0.435 ± 0.035
Date AD	1090 ± 90	970 ± 180	1000 ± 150	1570 ± 35
Weighted D_e/Gy	0.703 ± 0.012	0.765 ± 0.013	0.865 ± 0.016	0.565 ± 0.01
Age/ka	0.902 ± 0.071	0.842 ± 0.066	0.984 ± 0.081	0.432 ± 0.024
Date AD	1100 ± 70	1160 ± 70	1020 ± 80	1570 ± 25

measurement was scrutinised for OSL decay shape and signal consistency relative to the other measurements in the sets of 16 discs per sample originally examined. Checks for zero level were satisfactory in all cases (representing less than 1 per cent of the test dose response), as were the IR tests with the exception of one disc which also showed an anomalous OSL decay shape and intensity. A small number of outlying data points was also excluded from final analysis on the basis of consistency with the overall group. For all four samples there was clear evidence that the measured variance of regenerated dose response points (typically reproduced with ±2–3 per cent or better within groups of discs from the sample sample) was significantly smaller than the distribution of normalised natural OSL signals (which varied from ±4–5 per cent to >15 per cent depending on the sample). This was taken as an indication that the dose response curves from individual discs in each could be treated as random samples from the same underlying form. Moreover there was no evidence of significant differences in normalised OSL ratios (both in natural and regenerated dose points) between the subsets of discs pre-heated at temperatures from 220ºC to 280ºC. Accordingly composite dose response curves from all discs for each sample were constructed and used to estimate equivalent dose values for each of the individual discs, and their combined sets. Linear fitting was used in determining parameters for the dose response curves, and it was also noted that the coefficients determined from each sample were within statistical limits of each other.

Table 7.14 summarises the SAR characteristics and results, together with age determinations based both on unweighted and weighted combination of data from the individual discs. Clearly the choice of pre-heating temperature does not have a systematic effect on estimated dose. It is notable that the overall precision attained from unweighted analyses of samples 1447 (under the broken collar stone) and 1450 (from the rubble-filled layer) of approximately 6 per cent is better than from the sand samples 1448 and 1449, associated with the stone lower portion, at approximately 15 per cent. The use of weighted combinations tends to reduce uncertainty estimates, and for samples 1447, 1449 and 1450 makes little difference to the age estimates. However for sample 1448 the use of weighted combination appears to influence both the age estimate and the uncertainty.

Additional measurements were performed for samples 1448 and 1449, for which a a further 32 discs were investigated in an attempt to improve improve precision based on a larger data set, and to understand the distributional properties of the samples. The single aliquot dose distributions from the combined data sets (of 48 measurements per sample are shown in illus 7.46. The upper sand sample SUTL1449 shows a main singlemode dose distribution, with aslight suggestion of skew, and one outlying disc with a stored dose of approximately twice the modal value. The lower sand shows more evidence of mixed age behaviour. Five discs can be considered as outliers on the high dose side, one seems potentially low, and there is evidence of a bimodal distribution in the

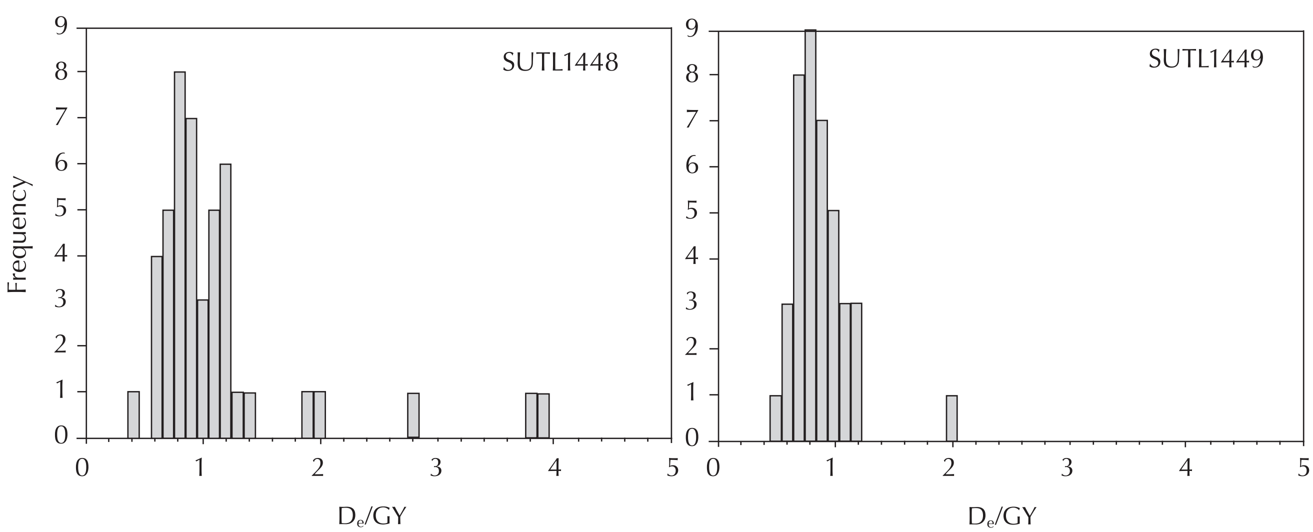

Illustration 7.46
Single aliquot dose distributions from SUTL 1448 and 1449

Table 7.15
Single aliquot results from SUTL1448 and SUTL1449 based on 48 replicate measurements

	SUTL1448 (context 042) De/Gy	Date/years AD	SUTL 1449 (context 019) De/Gy	Date/years AD
All discs unweighted	1.08 ± 0.11	820 ± 150	0.814 ± 0.04	1070 ± 85
All discs weighted	0.805 ± 0.01	1120 ± 70	0.753 ± 0.01	1140 ± 70
Unweighted without outliers	0.877 ± 0.04	1040 ± 80	0.79 ± 0.02	1095 ± 80
Weighted without outliers	0.804 ± 0.01	1120 ± 70	0.749 ± 0.01	1140 ± 70
Lower peak (1447)	0.8 ± 0.1	1120 ± 130		
Upper peak (1447)	1.1 ± 0.1	790 ± 140		

central area with components of approximately 0.8 and 1.1 Gy equivalent dose respectively. In both these cases the results suggest a degree of mixing of sands which have been zeroed at different times in the archaeological formation of the site. Given the sampling locations, and greater degree of mixing in the lower sample, these results could perhaps be viewed in terms of partial re-setting of sands re-deposited during the stone setting operation. In this interpretation the bimodal distribution would indicate both the inherited substrate age and the influence of the re-setting event.

Table 7.15 summarises equivalent doses and estimated ages from samples 1448 and 1449 based on the enlarged data set of 48 measurements. Taking all valid measurements the combined dose estimates from sample 1448 are still sensitive to whether weighted or unweighted combination is used; the former leading to a ninth-century age estimate, the latter to a 12th-century result. The differences for sample 1449 are not pronounced. When the outlying results (one observation for 1449; 6 for 1448) are removed the results are much more consistent, and not surprisingly the estimated dating errors are reduced. Table

Table 7.16
Final age estimates

SUTL no	Context	Stratigraphic significance	Luminescence age
1447	Thin sandy layer (042) below broken collar stone (032)	Should give tpq for final placement of broken collar stone	AD 1100 ± 70
1448	(016) sandy deposit, primary fill of pit for Setting 2	Should give taq for Setting 2	AD 1120 ± 70[1]
1449	(019) sandy deposit cut by pit for Setting 2	Should give taq for stone setting (and tpq for 'robber' pit	AD 1140 ± 70
1450	(007) layer of carved fragments	Associated with deposition of the carved fragments	AD 1570 ± 25

[1] As noted in Table 9.15 there is evidence of bimodality for this sample with apparent ages of AD 790 and 1120 for the two peaks in the dose distribution.

7.15 also shows the equivalent ages for the two modes of the central dose distribution of sample 1448, confirming that materials with both ninth- and 12th-century ages are present. If the data sets were separated into discs corresponding to each peak, the resulting distributional widths would be much closer to estimated measurement errors than for the mixed material.

For homogeneous samples the choice of whether to use weighted or unweighted combinations is largely unimportant. Where differences are evident arguably weighted combinations are preferable, and these are reproduced in Table 7.16 as the final age estimates for the four samples.

Discussion and conclusions

As noted in the introductory sections of the report, application of OSL dating methods to complex archaeological sites is potentially both challenging and rewarding. Careful selection of samples, which involves good planning of the work between excavator and the laboratory is a prerequisite. The suitability of available sample mineralogy, luminescence sensitivity and radiation dosimetry needs to be evaluated on the basis of laboratory results. It is also hard to prejudge whether or not sediments have incorporated mixed-age material, although the recent availability of single aliquot methods which can be used on many sub-samples to evaluate sample homogeneity has greatly helped in this respect.

In this project the use of small samples to evaluate mineralogy, luminescence sensitivity and potential suitability was useful in demonstrating the opportunity for applying quartz SAR methods to tube samples. The profiling results not only confirmed that quartz with an adequate luminescence sensitivity was available from all samples, but also yielded stored-dose estimates which were quantitatively consistent with the expected archaeological ages, and which were in stratigraphic order within each feature. Dose rates for these small samples were not explicitly determined, and therefore age estimates can only be made by assuming dose rates, either from co-located tube samples(where dose rates were measured) or by using mean values across this site (which are subject to variation). Therefore only broad chronological interpretation of the profiling data is possible. However it is apparent from the lowest sample taken in Profile 1, which comes from approximately 5cm into the sandy substrate into which the final lower portion setting was cut, that this surface corresponds to a stored dose (1.1 Gy) which is consistent with a late first millennium AD depositional age. This is also concordant with three radiocarbon dates from material within the layer ranging from AD 650–1160. Whether the surface is composed of natural aeolian material, or forms part of an earlier anthropogenic feature is not entirely clear from the excavation. It would be valuable in future work to explore the earlier environmental history and context of the site further. Profile 2 results also indicate the later first or early second millennium ad.

The results from OSL dating samples which are accompanied by full dosimetric measurements and detailed investigations of dose distributions, provide a more informative basis for evaluating the chronology of the main features associated with the stone setting. The use of up to 48 subsamples for the two sand samples was helpful in characterising the dose distributions, and dealing with the minor evidence of mixing in the upper sand (SUTL1449). The dose distribution in the lower sand (SUTL1448) shows demonstrable bimodality. The majority of discs correspond to a 12th-century age. A significant minority population however apparently registers an earlier event, equivalent to the late eighth/early ninth century AD. This would correspond both to the expected art-historical age of the Cadboll stone itself, and also according to the profiling results, to the age of the upperpart of the substrate into which the stone was finally set.

The sample from the layer thought to be assocaited with the defacement of the Cadboll stone is also interesting. The final luminescence age given by SUTL1450 (AD 1570 ± 25) is statistically earlier than the late 17th-century family inscription carved on the defaced stone. The luminescence age, however, corresponds remarkably to the Scottish Reformation, and it is possible that the initial destruction of the stone took place up to a century before its re-use as a memorial.

As noted in the summary the implications of the OSL results have had an important influence not only on defining some of the key chronological markers of the history of the stone and its setting, but also in raising hypotheses (for example the two-stage defacement followed by re-use, which had not hitherto been suspected) that could be assessed using the archaeological data set. The success of OSL in this project is most probably the consequence of a steadily accreting landsurface which has received prolonged input of aeolian material that has been well zeroed in the near-shore environment. The conditions under which OSL dating works well appear to be satisfied by this site, and the results obtained suggest that it could be a useful method to apply in a more comprehensive manner, both for dating and for use as a tracer of stratigraphic sequence if further excavations at the Cadboll site were to take place in the future. With hindsight it would have been extremely useful to have had a more comprehensive set of small samples to assist interpretation of the stratigraphy and to have sampled the stone setting in a more comprehenive manner,with particular attention to the material in Setting 1. Nonetheless the work conducted has made an interesting and potentially revealing contribution to understanding the site and the material recovered from these important excavations.

7.3.3 Radiocarbon dates

SCOTTISH UNIVERSITIES RESEARCH AND REACTOR CENTRE

Initially, six samples for radiocarbon dating were submitted to the Scottish Universities Research and Reactor Centre (East Kilbride) and were measured at the University of Arizona AMS Facility (Table 7.17). Three of these samples were of human bone from the cemetery and three from context 026 (Phase 1). Subsequently, three further bone samples were submitted for dating. Two were human bones from layer (026) and one was a horse jaw from the pit fill (context 011).

7.4 The ecofacts

7.4.1 Archaeobotany

JENNIFER MILLER AND SUSAN RAMSAY

Introduction

Soil samples for botanical analysis were derived from free-draining contexts in which uncarbonised ancient plant remains were unlikely to have been preserved. Consequently, all samples were processed using a Siraf flotation system with 500µ and 1mm sized sieves and the resultant flots and retents dried and sorted. Following this, laboratory examination and preliminary identification were undertaken using low power microscopy at variable magnifications of between ×4 and ×45. The anatomical characteristics of charcoal were observed at ×200 using the reflected light of a Zenith metallurgical microscope. Identification of seeds was initially by reference to the texts of Beijerinck (1947) and the extensive reference collection of Glasgow University. Charcoal was identified using the text and photographs in Schweingruber (1990). Vascular plant nomenclature follows Stace (1997), other than cereals, which follow Zohary and Hopf (2000).

Results

Context (026) (Phase 1)

Context (026) is a layer of wind-blown sand, which is sealed by (019) (Phase 2). It contained only a trace amount of poorly preserved charcoal, which could only be identified to cf birch. It was not abraded. It is difficult to use the botanical remains from this context to provide any further interpretation. Three radiocarbon dates have been returned from birch charcoal from this deposit.

Context (019) (Phase 2)

Context (019) was a more extensive layer that contained medieval pottery. Small fragments of charcoal identified as alder, birch and oak were recovered from this context along with a single grain of six-row barley (*Hordeum vulgare sl*). This assemblage is in keeping with domestic occupation debris brought on to the site rather than resulting from on-site habitation.

Context (030) (Phase 2)

Context (030) consisted of a layer of weathered sandstone fragments that contained sherds of medieval pottery of 13th- to 15th-century date and that sealed layer (019). It produced only very small quantities of charcoal of birch, heather type and oak but no other carbonised remains. Again, it would appear that this context represents trace evidence for domestic hearth waste, which has been brought onto the site accidentally.

Context (047) (Phase 2)

Context (047) was sand sealing the *in situ* collar-stone (052). medieval pottery (13th to 15th century) was recovered from this layer. It was suggested during excavation that this material might have contained re-deposited midden material used to hide an earlier setting for the cross-slab. The carbonised assemblage from (047) was entirely in keeping with this suggestion and was remarkably similar to contexts (036) and (038), both of which were also interpreted as dumped midden material. These three contexts were the only ones from the entire site to contain oats and hazel nutshell.

Context (006) (Phase 3)

Context (006) was a sandy loam with 'shelly mortar' and contains only very small quantities of carbonised remains. Charcoal of heather type (Ericales) and oak (*Quercus*) was present in trace amounts along with a single indeterminate cereal grain and carbonised seeds of plants associated with grassland habitats. This layer seals context (030) which contains medieval pottery of 13th- to 15th-century date and the botanical assemblage is completely in keeping with a date around this time. The assemblage as a whole has the appearance of re-deposited midden material either brought onto the site accidentally or as fill during improvements to the site.

Context (016) (Phase 2)

Context (016) was the primary fill of a pit (012) cut to the west of the lower portion and thought to represent a failed attempt to remove the cross-slab. This context contained charcoal of alder (*Alnus*), birch (*Betula*), heather type (Ericales) and willow (*Salix*), in addition to a single grain of cf barley (cf *Hordeum vulgare sl)*. The variety of charcoal types present in this context suggests that the material originated from hearth waste as a result of burning wood collected from the local area in addition to heather or possibly turves collected from nearby heathland. The quantities of carbonised material involved again suggest that there was not domestic occupation on site but that these carbonised remains were brought in from elsewhere.

Table 7.17
Radiocarbon dates

Lab code	^{14}C BP	Calibrated date 2σ		Delta ^{13}C	Material Context
AA-54981 GU-11010)	205 + 50	AD 1520–960	–20.2‰	Human bone: left Ulna	Skeleton 1
AA-54982 (GU-11011)	485 + 50	AD 1310–1620	–16.1‰	Human bone: left tibia	Skeleton 3
AA-54983 (GU-11012)	425 + 45	AD 1410–1630	–18.2‰	Human bone: left femur	Skeleton 4
AA-54984 (GU-11013)	1295 + 40	AD 650–860	–25.3‰	Charcoal: cf Betula	Context 026, orange sand with dark brown patches and decaying sandstone, seals layer 023 and dressed sandstones 031, sealed by layer 019.
AA-54985 (GU-11014)	1225 + 40 BP	AD 680–900	–25.2‰	Charcoal: cf Betula	Context 026 (see above)
AA-54986 (GU-11015)	985 + 35 BP	AD 980–1160	–25.6‰	Charcoal: Betula	Context 026 (see above)
SUERC-9141 (GU-13807)	1215 + 35	AD 680–900	–19.1‰	Human bone (cervical vertebrae)	Context 026 (see above)
SUERC-9142 (GU-13808)	1225 + 35	AD 680–890	–18.1‰	Human bone (first metatarsal)	Context 026 (see above)
SUERC-9143 (GU-13809)	170 + 35	AD 1650–960	–21.9‰	Horse bone (jaw)	Context 011, fill of pit

Context (021) (Phase 3)

Context (021), when excavated was thought to be the equivalent of (006) (Phase 3). The charcoal types present within it, however, are not identical, with only heather type being present in both. Context (021) has alder and birch as additional types and oak is not represented as it is in (006). Both (006) and (021) contain a single indeterminate cereal grain. Although these two contexts contain different charcoal assemblages, it is still possible to interpret both as containing general domestic occupation detritus, which has been brought onto the site.

Contexts (036) and (038) (Phase 4)

These deposits formed the core of an earth and stone bank thought to be of post-medieval date. The samples were extremely similar with respect to taxon composition, and are in keeping with re-deposited midden material. The presence of oats concurs with a medieval or later date for this feature. Both contexts contained hazel (*Corylus avellana*) nutshell, adding further weight to the theory of re-deposited midden.

Context (046) (Phase 4)

Context (046) was a pebbly sand near the chapel wall and contained 18th- or 19th-century pottery. The carbonised assemblage from (046) was scant, including only two tiny heather family twig fragments and several indeterminate stem fragments. Nothing further can be determined from these remains.

Discussion

The charcoal assemblage is in keeping with domestic occupation debris, probably from hearth waste. However, the small size and scarcity of fragments found, many of which were in poor condition, strongly suggests re-deposited material rather than material originating from *in situ* occupation. All of the tree and shrub types identified would have been available in the local environment, and there is no evidence for either the selection of specific types for use, or of the utilisation of driftwood or imported timber.

Cereal grains found were generally in very poor condition, and were often not identifiable to type. However, oats, hulled barley and a single, very small wheat grain were recorded. The oats and barley would certainly have been grown locally, although this cannot be said with certainty for the wheat grain. However, it is possible that this may have been grown in sheltered areas, given the coastal location of the site. The three finds of oats are all from contexts associated with medieval or post-medieval activity, which concurs with regular occurrences in the archaeological record for this cereal in Scotland for this period (Dickson & Dickson 2000). These three contexts of re-deposited midden material (036, 038, 047) also contained the only evidence for hazel nutshell from the site, and this similarity of composition hints at a possible single event for the incorporation of this domestic waste, or a common initial origin. This suggests that the site landscaping, involving the building of an enclosure wall and earthen bank, may be broadly contemporary with the sealing of the collar-stone.

7.4.2 Faunal remains

CATHERINE SMITH

Bones were retrieved from both hand-excavated contexts (Table 7.18) and from sieved samples (Table 7.19). A more detailed description by context is held in the archive. Larger animal species present in the hand-excavated material were cattle, sheep/goat, pig, horse, roe deer, dog, canid/dog, and cat. Human bones were also recovered. Smaller species were field vole (*Microtus agrestis*), bird (probably snipe), fish and amphibian (frog or toad). Present in the sieved samples were field vole, shrew (*Sorex* sp), fish, amphibian, Passerine bird species (eg sparrow), probable cattle, sheep/goat and human. Most abundant in the retents were the bones of small fish and amphibians, for fish bones were present in all but one of the nine samples and amphibian bones were present in three out of nine samples.

Discussion

The cattle, sheep/goat, pig and roe deer bones are probably all from animals whose meat was eaten by people who lived in the vicinity, as are the fish remains. The horse remains from the fill of the robber pit in Phase 4 (context 011; find nos 153, 161 and 253) are probably all from the same very elderly individual and represent the burial of a natural casualty.

The domestic animal bones are all from fairly small, unimproved types, typical of the period prior to the 19th century, and may well be post-medieval or medieval in date on the basis of size and butchery evidence. The recovery of a baculum or os penis from a canid of dog size is interesting, since this was the only surviving dog bone in context (043), Phase 3. However, a piece of dog skull (petrous) was recovered from context (037) (in Phase 5, but in the vicinity of 043) and, thus, these two bones may have come from the same individual. If the bones are not associated, it is possible that the baculum was kept as a talisman, a practice known from the Roman period.

Small mammal remains from voles (*Microtus agrestis*) indicate an open grassy environment around the site, while the bones of frogs or toads are an indicator of a localised supply of fresh water. There is also a possibility that the vole, shrew and amphibian bones originated from owl pellets.

Table 7.18
Faunal remains from hand-excavated contexts

Key: IM = Indeterminate mammal; LU = Large ungulate; SU = Small ungulate

Phase	Context	SF no	Species	Bone
1	023	48	Fish	Vertebra
1	023	48	Fish	Mandible
1	023	?	Cattle	L astragalus
2	016	46	IM	
2	019	106	Fish	Vertebra
2	019	218	?Horse	Tooth
2	019	218	IM	
2	019	218	LU	Vertebra
2	019	218	LU	Rib
2	019	246	Cattle	Mandible
2	019	–	Cattle	Tooth
2	034	78	Sheep/goat	Metatarsal
2	047	228	IM	
2	047	228	Sheep/goat	Tooth
2	047	263	cf Cattle	Mandible

Table 7.18 (cont)
Faunal remains from hand-excavated contexts

Phase	Context	SF no	Species	Bone
3	006	–	cf Sheep	cf humerus
3	020	213	IM	
3	021	54	Bird cf Snipe	Tibio-tarsus
3	043	170	LU	
3	043	194	Canid cf dog	Os penis
3	043	194	IM	
3	043	194	SU	Vertebra
3	061	241	Sheep/goat	L mandible
3	067	242	Cattle	R mandible
3	067	242	LU	
3/4	006/007	27	IM	
3/4	006/007	30	Fish	Vertebra
3/4	006/007	30	IM	
3/4	006/007	112	Fish	
4	005	236	IM	
4	005	236	LU	Rib
4	007	11	IM	
4	007	12	Horse	L calcaneum
4	007	18	IM	
4	007	23	IM	
4	007	80	cf Sheep	Tibia
4	007	123	Cattle	R femur
4	007	123	IM	
4	007	126	Sheep/goat	Tooth
4	007	216	IM	
4	011	108	LU	
4	011	113	Human	3rd Phalange
4	011	113	Pig	Tooth
4	011	147	LU	Rib
4	011	147	LU	Rib
4	011	153	Horse	L&R mandibles
4	011	153	Horse	Tooth
4	011	153	Horse	Tooth
4	011	161	Horse	L mandible
4	011	161	Horse	Tooth
4	011	161	Horse	Tooth
4	011	253	Horse	Splint
4	011	253	IM	
4	011	253	Sheep/goat	Tooth
4	015	35	Sheep/goat	L tibia
4	015	41	?Bird	
4	015	52	cf Cat	Humerus
4	015	159	IM	
4	015	211	Horse	Tooth
4	015	255	Horse	Metapodial
4	015	255	IM	
4	025	101	Fish	Vertebra
4	025	101	Fish	Rib
4	025	?	Fish	
4	027	62	?Fish	
4	027	62	Amphibian	Innominate
4	027	62	Amphibian	Humerus
4	027	62	Field vole	Skull
4	027	62	Field vole	L&R maxilla
4	027	62	Field vole	R mandible
4	027	62	Field vole	Mandible
4	027	62	Field vole	L&R maxilla
4	036	134	Cattle	L radius

Table 7.18 (cont)
Faunal remains from hand-excavated context

Phase	Context	SF no	Species	Bone
4	036	137	Sheep/goat	Tooth
4	036	138	Cattle	Tooth
4	036	202	Cat	R radius
4	036	202	Fish	Vertebra
4	036	202	Fish	
4	036	202	IM	
4	036	202	Sheep/goat	Tooth
4	037	40	Pig	1st phalange
4	037	42	cf Cattle	Mandible
4	037	55	Canid cf dog	Skull
4	037	187	IM	
4	038	129	IM	?rib
4	038	129	Sheep/goat	R metatarsal
4	038	129	Sheep/goat	Tooth
4	038	136	Cattle	1st phalange
4	038	136	Cattle	3rd Phalange
4	038	136	Fish	Vertebra
4	038	136	IM	
4	038	136	SU	Vertebra
4	038	206	Fish	Vertebra
4	038	206	Fish	Cleithrum
4	038	206	Fish	
4	038	206	Fish	Vertebra
4	038	206	Horse	Metatarsal
4	038	206	IM	
4	038	206	Sheep/goat	?metatarsal
4	038	206	Sheep/goat	Carpal
4	046	247	Pig	Fibula
4	049	192	IM	
4	049	240	Cattle	Skull
5	002	9	Dog	Tooth
5	002	36	IM	
5	002	85	IM	
5	002	86	Roe deer	Tooth
5	002	91	IM	
5	002	92	IM	
5	002	118	IM	Rib
5	002	118	IM	
5	002	119	cf Sheep	L scapula
5	002	119	Fish	Skull
5	002	120	IM	
5	002	120	Horse	Tooth

Table 7.19
Species present in the nine sieved samples that contained bone

Species	No of samples
Field Vole (*Microtus agrestis*)	1
Vole sp	1
Rodent, eg Vole	1
Shrew (*Sorex* sp)	1
Small Mammal	1
Bird cf Passerine sp	1
?Bird	1
Amphibian	3
Fish	8
cf Cattle	1
Sheep/goat	2
Large Ungulate	1
Indeterminate Mammal	6
?Human	2

Table 7.20
Human remains: age at death

Skeleton/context number	Age at death
1	25 to 35 years
3	12 to 15 years
4	2 to 4 years
007	0 to 3 months
025	Adult
065a	0 to 2 months
065b	0 to 2 months

7.4.3 Human remains

JULIE ROBERTS

Introduction

This report presents the results of osteological analysis of the seven articulated skeletons uncovered. With the exception of skeleton (025) (Phase 4), which was represented only by a fragmented cranial vault and left femur, the state of preservation of the remains was good. There was some mixing of the remains, and associated animal bone, coffin nails and wood were also present in some contexts (see Burial Record below).

Age at death

The age at death of all the individuals was determined using standard methods outlined by Buikstra and Ubelaker (1994). Five of the seven individuals were immature, therefore age could be established with relative accuracy using dental development and stages of epiphyseal fusion. The estimation of age in older adults is notoriously problematic as age related changes occur at different rates in different individuals, depending on such factors as lifestyle and physical activity, and genetic predisposition. Although Skeleton 1 had reached dental and skeletal maturity, the individual was sufficiently well preserved to allow the use of multiple ageing methods, including the appearance of the auricular surface of the ilium, the pubic symphysis, and the sternal end of the fourth rib. Dental attrition and cranial suture closure were also considered, although these can be highly variable and are therefore less reliable as a means of determining age. The poor state of preservation of the remaining adult, context (025), meant that an age range could not be ascribed with confidence, although cranial suture closure indicated an age of greater than 25 years. Table 7.20 summarises the age at death of all the individuals.

Seventy-one percent of the individuals analysed were immature and, of these, 60 per cent had died before they were three months old. The two individuals (context 065, Phase 4), aged zero to two months were apparently buried within the same grave, and it is possible that they were twins that did not survive for more than a few weeks after birth.

The demographic profile of the group cannot be considered as a whole, due to the small sample size and uncertainty regarding the relationship between the burials. It can be said, however, that a high death rate in the zero-to-three months age group is typical of a pre-modern population, where vaccination and antibiotics were not available to treat the infections that can be fatal in individuals of this age (Roberts & Manchester 1997). A much larger proportion of the cemetery would have to be excavated in order to determine whether this sample was representative of the local community as a whole.

Worthy of note is the discrepancy that was evident in the ages indicated by dental development and those suggested by long bone length (Bass 1995), in Skeletons 3 and 4 (Phase 3). The ages indicated by long bone length, particularly in the case of Skeleton 3, were younger than those indicated by dental development. After birth, factors such as nutrition and disease can affect bone growth, whereas they have comparatively little effect on dental development. The fact that these individuals were small for their age is probably an indication that they were under nourished or unwell. The pathological conditions observed in both skeletons support this interpretation (see below).

Sex

Standards for determining sex of the two adults were in accordance with those outlined by Buikstra and Ubelaker (1994) and Krogman and Iscan (1986). As yet, there are no acceptable standards for the determination of sex macroscopically in immature individual.

Skeleton 1 (Phase 4) was undoubtedly male. The sexually dimorphic features of the cranium, including the glabella, supra-orbital ridges and mastoid processes, were particularly pronounced. There was little surviving of the skeleton in context (025) (Phase 4), however, the zygoma was typically male and the femur was large and robust. A probable male sex was therefore assigned.

Stature

A living stature of 173.53 ± 2.99cm (5' 7") was calculated for skeleton 1 (Trotter 1970). This compares well with the average height observed at a number of other medieval Scottish sites (Roberts 1999). The femur belonging to the skeleton in context (025) was incomplete, therefore it was not possible to calculate stature. The surviving part of the element was, however, large and robust, suggesting a well built individual

Pathological conditions

A number of pathological conditions were identified on the skeletal remains, including traumatic injury, iron deficiency anaemia, periostitis and dental disease.

Iron deficiency anaemia

Evidence of iron deficiency anaemia, characterised by *cribra orbitalia* was observed in three of the skeletons. All of these were immature. In two cases, skeletons 3 and 4, the condition was severe (classification after Stuart Macadam 1992). There are many causes of iron deficiency anaemia, amongst the most common being lack of absorbable iron in the diet and a high pathogen load within the body (Grauer 1993). Both skeletons 3 and 4 were small for their age, and skeleton 3 also suffered from dental enamel hypoplasia, a recognised 'stress indicator' (see Dental disease). These combined disorders suggest that the infants were malnourished either because of a poor diet, chronic illness, or both.

Traumatic injury

Skeleton 1 had a healed fracture of the distal shaft of the right ulna, and a soft tissue injury that had affected the bone in a corresponding location on the right radius. The fracture had healed well and was in good alignment, but there was still a moderate amount of callous around the fracture site, indicating that healing was not totally complete. The injury may have been sustained as a result of warding off a blow, although it was located nearer to the distal end of the bone than a typical parry fracture, or it may simply have been the result of an accident. Complications arising from the fracture would have been unlikely.

Periostitis

Evidence of periostitis, inflammation of the periosteum and soft tissues around the bone, was observed on the left femur of the skeleton in context (025). The type of bone growth present indicated that the causative infection was not severe, and that it was no longer active at the time of death. This condition is frequently observed in archaeological skeletons and can relate to a number of disorders, including specific infection or direct trauma to the soft tissues.

Dental disease

Skeleton 1 had suffered from caries, a dental abscess, and had lost one tooth prior to death. A moderate-sized carious lesion was present on the mesial surface of the tooth crown of the right maxillary first molar. This disease occurs when oral bacteria metabolise any fermentable carbohydrates (eg sugars) present on a tooth, which then becomes de-mineralised. This is usually the result of poor oral hygiene, but research has shown there is also a greater prevalence in populations whose diet was primarily carbohydrate based or where sugar consumption was high (Larsen 1984).

Dental abscesses occur when the pulp inside a tooth dies and toxic products are formed which diffuse out of the apex of the tooth and into the periodontal ligament. This results in localised resorption of the bone and the formation of a draining sinus, often around the apex of the root. In skeleton 1, a very large, externally draining, periapical abscess was associated with the left mandibular central and lateral incisors. In addition, the right mandibular third molar had been lost prior to death, and the tooth socket had been almost completely resorbed. The most common cause of ante-mortem tooth loss is periodontal disease, inflammation of the soft tissues and bone around a tooth.

Calculus, the mineralised form of plaque, was present on the lingual surfaces of the mandibular anterior teeth, and the buccal surfaces of the maxillary molars. It was moderate in severity (Brothwell 1981). This condition is frequently observed on the teeth of archaeological skeletons, and again, it is generally caused by poor oral hygiene.

A reference was made above (in association with iron deficiency anaemia) to dental enamel hypoplasia. This disorder is characterised by defects, linear grooves and pits, which appear in the enamel of a tooth representing a cessation in its growth and development. Febrile infections, malnutrition and metabolic disorders have been cited as possible causes (Aufderheide & Rodriguez-Martin 1998; Goodman *et al* 1984). The condition was evident in a moderately severe form in the 2–4 year old, skeleton 4. Slight calculus was also present on the buccal surfaces of the right maxillary teeth, and the individual was prognathic (had a marked overbite).

Discussion

A total number of seven articulated skeletons were examined. Of these, two were adult and five were immature individuals (three aged less than three months at death). The two youngest individuals, aged zero-to-two months, had been buried within the same grave. This raises the possibility that they were twins. Overall, the health of the children did not appear to be good. Three suffered from iron deficiency anaemia, one of these also had dental enamel hypoplasia, and two were short in height for their age. All of the above factors suggest malnourishment and a failure to thrive. Whether this was representative of the health and nutritional status of the majority of the immature individuals from this population, cannot be determined without examining a larger proportion of burials from the cemetery.

Burial Record

Skeleton 1 *(Phase 4)*

Preservation	Good. >90 per cent complete. Minimal surface erosion
Age at Death	25–35 years
Sex	Male
Stature	173.53 ± 2.99cm/5' 7"
Pathology	Healed fracture distal shaft of right ulna, enthesopathy distal shaft right radius, dental abscess, caries, ante-mortem tooth loss, calculus
Comments	Double atlas facets and calcaneal facets (right and left), Occipital bun with ossicles at lambda and both lambdoid sutures.

Skeleton 3 *(Phase 3)*

Preservation	Very good. 90 per cent complete. Minimal surface erosion and fragmentation
Age at Death	12–15 years (probably at younger end of range)
Sex	NA
Pathology	Cribra orbitalia
Comments	Lay directly beneath Skeleton 4 (below). Long bone age considerably younger than age based on dental development.

Skeleton 4 *(Phase 3)*

Preservation	Very good. 85 per cent complete. Minimal surface erosion but cranium fragmented
Age at Death	2–4 years (probably younger end of the range)
Sex	NA
Pathology	Cribra orbitalia, dental enamel hypoplasia, slight calculus
Comments	Marked prognathism. Long bone length gave a slightly younger age than age based on dental development.

Context (007) *(Phase 4)*

Preservation	Fair. 50 per cent complete. Moderate surface erosion
Age at Death	0–6 months (probably 0–3)
Sex	NA
Pathology	None observed
Comments	Associated small coffin nails and fragments of wood. Green staining on right humerus

Context (025) *(Phase 4)*

Preservation	Very poor. Fragmented cranial vault, zygoma, and left femur only.
Age at Death	Adult. Probably 25+ years
Sex	? Male
Stature	Unknown
Pathology	Periostitis
Comments	Right and left parietal foramen, left hypotrochanteric femur. Remains mixed in with animal bone

Context (65a) *(Phase 4)*

Preservation	Fair. Cannot estimate completeness as co-mingled with 65b. Slight surface erosion and some fragmentation
Age at Death	0–2 months
Sex	NA
Pathology	Cribra orbitalia
Comments	Remains mixed with infant of same age (65b). Possibly twins.

Context (65b)	*(Phase 4)*
Preservation	As above
Age at Death	0–2 months
Sex	NA
Pathology	None observed
Comments	See above

Table 7.21
Disarticulated human bone

Phase	Context	SF no	Species	Description
1	026	223	Human	Vertebra
1	026	225	Human	Tarsal
1	026	225	Human	Metatarsal
2	019	106	Human	Tooth
2	019	106	Human	1st phalange
2	019	106	Human	1st phalange
2	019	106	Human	2nd phalange
2	019	246	Human	Pelvis
2	019	246	Human	Femur
2	019	246	Human	Tibia
2	019	246	Human	Tarsals
2	019	246	Human	?humerus
2	034	71	Human	?femur
3	043	194	Human	Vertebra
3	043	194	Human	Metapodials
3	043	194	Human	1st phalange
3	067	242	Human	Radius
3	068	232	?Human	Skull
3	068	232	?Human	Rib
4	007	156	?Human	Innominate
4	007	156	?Human	Tibia
4	007	156	?Human	
4	007	216	Human	Skull
4	011	147	?Human	Rib
4	037	187	?Human	Skull?
4	038	136	Human	Skull
4	046	247	?human	Vertebra
4	046	247	Human	Vertebra
4	049	219	Human	Tarsal
4	060	212	?Human	?fibula/ulna
5	002	58	Human	Tooth
5	002	118	IM/?human	Rib

The adult male, skeleton 1, was in a good state of health, although he had some dental disease and a healed fracture of his right forearm. His height was within the normal range for a medieval male, and his bones showed no evidence of nutritional disease. The poor state of preservation of the skeleton in context (025) precluded an assessment of his health status.

[See Burial Record]

The human bone identified by Catherine Smith from among the mammal bone consisted mainly of disarticulated fragments from the hands and feet, although a few vertebrae, ribs and long bone fragments were also recovered (Table 7.21). Human remains, or bones thought very likely to be of human rather than animal origin, came from Phase 1 (context 026), Phase 2 (contexts 019 & 034) Phase 3 (context 006, 043, 068), Phase 4 (contexts, 007, 011, 049, 046, 060, 036, 037, 038), and Phase 5 (context 002), including two out of a total of nine sieved samples.

7.5 The finds

7.5.1 The fragment of a medieval relief cross

ISABEL HENDERSON

Finds Number: 10001030.001 (Kirkdale 2001)

Stone type ?

Context 007

The fragment consists of the top left quadrant of a relief ringed cross (illus 7.47). It has a flat finished surface on the back. The cross is carved on a piece of stone with a rounded end and a well-formed shoulder *c* 70mm deep. The ring is 30mm wide and meets what appears to be the top arm of the cross-head, which when complete would have been *c* 50mm wide. The length of the surviving arm is 90mm. The ring meets the arm about half way along its length. The arm is superimposed on the ring and passes over it. There are surface traces at the top of the shoulder which suggest that the top arm may have projected beyond the top edge of the shaped stone. The arm has a small rounded arm-pit the appearance of which, in spite of loss of surface, can be seen. The left arm of the cross has also lost its surface but can be seen to meet the ring. A stub on the left edge may be the remnant of its projection beyond the left edge of the stone. The uncarved surface of the front face of the shoulder appears to meet the ring at this point. Both the rounded shoulder and the background surface of the cross are dressed more roughly than the surviving surfaces of the cross-head. The outer arc of the ring is

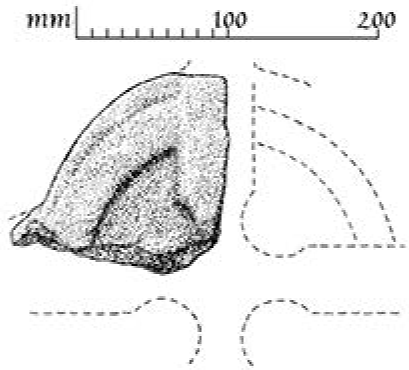

Illustration 7.47
Medieval relief cross (scale 1:5; drawn by Ian G Scott)

formed by a pecked incised line while the inner arc is more fully defined.

The fragment is part of a substantial cross-marked stone carved on one side only, but its form is not altogether typical, particularly if the cross arms projected from the edge of the stone. The most familiar feature of the cross design is the thistle shape at the angles of the arms. This shape is formed by near circular armpits and the location of the ring towards the upper ends of the arms. Such small rounded arm-pits constrict the size of the area where the arms cross. A group of cross-marked stones at Portmahomack are of this type (X.IB 347, 356, 357 and 360), but none of these, or any of the other cross-marked stones at Portmahomack, has rings.[1] The collection at Rosemarkie has a number of relief ringed crosses. One of these, X.IB 128, a boulder stone with a relief carved equal-armed cross, provides a closer, but not exact, local analogy for the relief cross from the Hilton site.[2] An unpublished fragment of a deeply incised ringed cross, with a single quadrant surviving, found in a grave in Rosemarkie Churchyard in 2004, has the same thistle-shape at the angle of the arm and, like the Hilton fragment, lacks the more usual contouring of the cross. The Rosemarkie fragment preserves what appears to be an original straight edge and presumably is part of a regularly shaped slab. The format of the Hilton relief cross is unclear. If its arms projected, one would expect it to have been free-standing. There are no local analogies for this format other than the small cruciform stones at Portmahomack. An unpublished cruciform stone with very small arm projections was found a few years ago at the west end of Nigg Old Parish Church, but it is merely shaped with no relief carving expressing a cross. In spite of the lack of close analogies, the competent carving technique and the thistle shape at the angles support a medieval date.

Notes

1 Sculpture found during the excavations at Portmahomack, Tarbat, is displayed at the Tarbat Discovery Centre but has National Museums of Scotland accession numbers. For a published example of this type of unringed cross-shape see Carver 2005, fig 2.7, TR 21 (= X.IB 347).
2 Henderson & Henderson 2004, fig 312.

7.5.2 An unshaped stone with an incised linear cross

ISABEL HENDERSON

SF 226 (GUARD 2001)

Stone type ?

Context 061

The stone has a maximum height of 250mm, a maximum width of 320mm, and a maximum thickness of 70mm (illus 7.48). The cross is lightly incised on an approximately central position of a flat, comparatively smooth, area. This flat area is probably part of a bedding plane, as is the naturally flat back. The rest of the face with the cross is rough and broken at the right and lower edges. The left edge slopes at an angle of 45° to the cross-shaft but has a straight edge. The top left corner appears to have been roughly shaped for the purposes of some primary or secondary use for the stone. The transverse arms of the cross span 45mm. They are set comparatively high on a line, 60mm long, representing the shaft and the upper arm. Two similar cross-marked unshaped stones are found at Portmahomack, Tarbat. Both have simple linear crosses set deliberately at the broader ends of unshaped stones with a vertical format.[1]

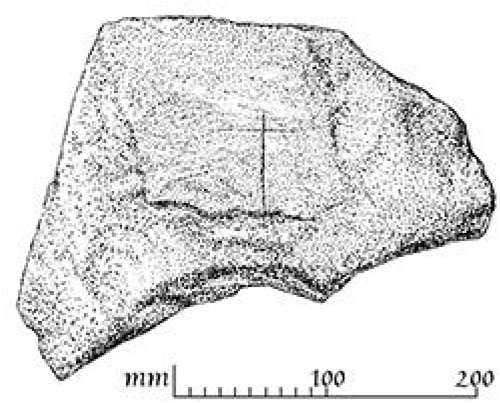

Illustration 7.48
An unshaped stone with an incised linear cross (scale 1:5; drawn by Ian G Scott)

The Hilton stone has a more horizontal format, but the position for the cross has been equally carefully chosen. Such crosses could be of any date but the scratch-like incision of the cross, and its careful placing combined with the selection of a suitable unshaped stone, is typical of such simple cross-marked stones, whether in incision or relief, in the west Highlands and islands, and at ecclesiastical sites throughout Scotland north of the Forth/Clyde line.[2] Both of the Hilton cross-marked stones are appropriate finds for a medieval ecclesiastical site, but they do not provide an adequate monumental context for the production of the Hilton of Cadboll cross-slab, and they have lost their locational context within the cemetery at the site.

Notes

1 X.IB 350 =TR24 and X.IB 351 = TR25 Tarbat Discovery Programme 1997, Appendix 2.
2 Fisher 2001; Henderson & Henderson 2004, Map 5, 158.

7.5.3 The architectural fragment

RICHARD FAWCETT

An architectural fragment was retrieved by Kirkdale from context 002 (illus 7.49). This is either a broken fragment of either a window mullion or a vaulting rib, probably the former. The five leading faces have been carefully dressed with diagonal tooling, albeit with vertical tooling at the upper edge to finish it off more neatly. It also has a dressed upper (or lower?) face, which has been quite deeply stugged, presumably to provide keying for mortar. This upper face also has what appears to be a mason's mark in the form of an incised X with unequal arms. The fragment was evidently originally the upper (or lower?) part of a larger stone, since the lower face is irregularly broken. Several of the arrises are weathered, but one has been quite badly chipped. At the back of the stone there are short dressed faces on each side, with a wider broken face between, from which it is likely there was originally a rectangular tongue-like projection. The rebates on each side of this tongue are likely to have been the seating for internal glazing frames or armatures. Alternatively, they could have been the seating for the webbing of stone vaulting, though there is no sign of curvature to the stone and this makes it less likely that it was a rib. A stone vault might be rather unexpected in this context.

If it was a window mullion, it is possible that it dates from as early as the 13th century, since rebates for glazing frames were being increasingly superseded in major traceried windows by glazing chases cut into the flanks of the mullions by the later 13th century. However, mullions with rebates for glazing frames continued to be used throughout the later Middle Ages in smaller scale churches and in domestic contexts, and thus it could date from the earlier 13th century onwards, though possibly with slightly greater likelihood in the earlier part of that period.

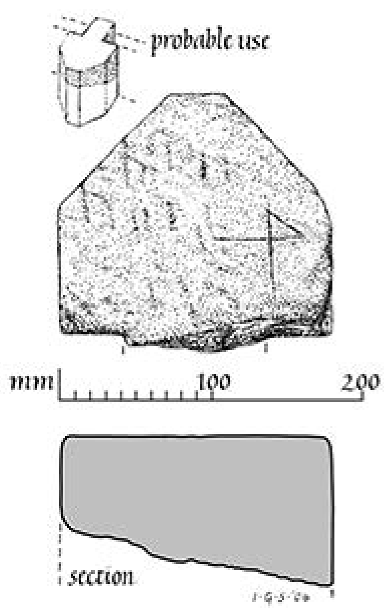

Illustration 7.49
Architectural fragment with mason's mark (scale 1:5; drawn by Ian G Scott))

7.5.4 Selected carved fragments that are not from the cross-slab

DOUGLAS MORTON

Fragments from the Hilton of Cadboll excavations (both Kirkdale and GUARD) were initially sorted during post-excavation by Allan J Hall and Amanda Brend in March 2003. Fragments were sorted into four different 'classes' according to their basic geology and sculpted characteristics. A total of 196 fragments had some evidence of sculpture but were thought not to be from the Hilton of Caboll cross-slab (class 4A) and 3545 fragments lacked any features (class 4b, see Chapter 7.1).

1 Fragments with sculpture but not from the Hilton cross-slab (class 4A)

With the exception of X.IB 355.239 and X.IB 355.238, the class 4A fragments are bagged and contained within two labelled boxes (Boxes 14 & 23) for NMS storage.

The following general observations were made from an examination of the database entries.

Condition: In general, fragments in the 4A category were in a fair condition with limited damage to any possible carved surfaces or relief features, and only slight surface wear. These fragments were found to be a range of brown-based colours with a significant number being a striking pinkish-brown.

Fracture: Fracture styles varied, with fragments often being of a large and thick size. It was noted that many fragments had, on at least one surface, broken across the grain of the stone. The resultant surface was often smooth, flat, and easily confused with a flat carved surface.

Description: Fragments from the 4A category are, with the exception of mid-portion fragments, the largest fragments contained within the catalogue with an average length and thickness of 57mm and 18mm respectively. The majority are catalogued with very simple entries often only stating that the fragment bears a 'possible relief form' or 'possible carved surface'. It is unfortunate that for the majority of 4A fragments there are no conclusive diagnostic features. This ambiguity is borne out in Table 7.22, which shows the keywords used during the catalogue process to describe the 198 class 4A fragments. The majority utilise only the FRAG keyword in Field 1 and the SURFACE keyword in Field 2. This indicates that the majority of the 4A fragments are simple and fairly ambiguous fragments that bear flat areas or surface features that may have originally been carved surfaces. In many cases, it is not clear whether the recognised feature is actually a carved form or a natural product of the geology. Although the majority of class 4A fragments are somewhat ambiguous, there is a small number for which there is an increased degree of certainty regarding their carved features.

X.IB 355.238 (09851025.102, context 002, Phase 5)

A brownish-grey coloured fragment with a rusty-coloured possible worked surface. The fragment is thick with a flat back. It has a pecked, possibly worked, surface on a narrow edge of the fragment. The surface is rounded and shows a levelling off at one edge before the break. The other feature occurs on a long face of the fragment. This is part of a circular bowl-shaped hollow, with grooves which look as if the stone has been worn away. This circular depression could be from domestic use (such as a socket or door post?) and need not be related to the pecked surface perpendicular to it. It was also considered whether this was a lamp fragment, but there are no signs of burning.

Table 7.22
Keyword usage in class 4A

Keyword	Keyword Use Field 1	Field 2	Field 3
Band	1	2	2
Frag	188	1	0
Stone	2	0	0
Strip	0	2	1
Surface	5	93	0

X.IB 355.239 (10151055.101, context 020, Phase 3)

A brownish-grey fragment with vertical edges on four edges and a flat back as if smashed. The fragment bears a thick rounded possible band of relief that narrows from 30mm to 25mm at its base. The section of the relief also changes from a gentle D-shape to a more triangular or peaked shape. This was identified by R Fawcett as 'possibly sculptural' and not a piece of architecture.

Discussion

The majority of the fragments in Table 7.23 are from layers 002 and 007. Fragment 3234 was originally thought to belong to context 008, but is probably just a fragment of a blocking stone. Fragment 3239 is of interest as it is the only 4A fragment to have a possible toolmark. Unfortunately, the damage to the fragment prevents any measurement of the mark being made. There is little to draw the class 4A fragments together into any coherent group, however a significant number appeared to have a reddish colour and were large in size. There was no indication that any of these joined to form another carved stone. It is probable that many of the fragments may be natural stones.

Fragments without sculpture and not from the Hilton cross-slab (class 4b)

The 3545 class 4b fragments were examined visually to check for any carved surfaces or other features which may have been missed during the initial inspection. Three fragments were re-classified as belonging to the Hilton of Cadboll cross-slab (one was a bleb, one was a class 1a and one was class 4A) and the remainder were thought to consist of natural stones.

Table 7.23
Other stone fragments with features

Working no	Location no	Context no	Significant feature
3229	10051015.112	007	an amorphous relief form
3234	10001030.009	008 (G)	part of a flat relief band
3239	99999999.005	007	possible toolmark
3241	09951020.324	007?	two flat possibly carved areas
3251	09951035.163	002?	a portion of a relief band
3284	10001035.045	002?	a relief band or strip with brown staining
3292	10051030.135	047?	a wide relief band
3697	10101020.489	007?	a low-relief strip
6527	09951035.226	002?	a wide relief form

7.5.5 Ironworking

MARIA KOSTOGLOU

Introduction

This report presents the analytical results of iron objects and industrial waste found during the investigation of the setting and the context of the Hilton of Cadboll cross-slab. After the first macroscopic evaluation of the material, it was decided that a detailed archaeometallurgical analysis could contribute to the following areas:

1 Identification. This includes both identification of evidence for metalworking on the site based on the distribution and context of iron found there, and identification of the finds. Not all iron finds are easily identifiable due to the extensive corrosion that can deform the original features. A detailed recording and measuring of the macroscopic characteristics provides the first typological classification (distinguishing fragments of artefacts from industrial waste). All measurements are approximate due to the extent of corrosion.

2 Structural and compositional analysis of finds, which can add an extra dimension to conventional typological studies, providing information on manufacturing techniques, provenance and so on.

3 Evaluation of the role of ironworking and iron material in the site.

Methodology

The iron appears to be very corroded, fragmented and badly preserved. During the first part of this work, all material was studied macroscopically and all the external characteristics of the finds (such as size, weight, form, magnetic properties) were observed and recorded in detail. As noticed in the catalogue at the end of this report, most of these characteristics are given in their approximate form: small, medium, large. All the measurements taken are also approximate since iron corrosion is a very active process and the size of the finds will change in the immediate future until they will become fragments of corrosion, as indeed has happened already with most of the material from Hilton of Cadboll.

A number of the best-preserved finds were then chosen for further study (Table 7.24). The stage of corrosion of the nails also made their analytical study problematic. No metallic core seems to be preserved in them as this is indicated by the absence of any magnetic indication. Most of them were very fragmented already and they could not be handled without further damage. The archive includes a detailed description, a black and white photograph and a line drawing of a scale 1:1 of the best-preserved finds.

During the second stage of this work, a representative amount of finds (nails) and all industrial waste (a total of only three fragments) were prepared for metallographic

Table 7.24
Iron finds

Phase	Context no	SF no	No of frags	Description	Measurements
1	023	45	4	Two iron nails, one nail head and one fragment of bone	Very fragmented
1	023	47	4	Fragments of iron nails with disk-shaped heads	Various 0.01–0.03m Diameter = 0.01m
1	026	43	2	Non-metallic fragments	
1	026	53	5	Non-metallic material – bone?	
2	019	234	1	Small fragment of wood preserved in iron corrosion	<0.02m
2	019	247	2	Iron nails with wood preserved in the corrosion	<0.02m
2	030	160	3	Small iron nails with wood preserved in the corrosion layers	< 0.03m
2	034	84	4	Fragments of very corroded iron nails	Various 0.02–0.06m
2	034	84	3	Fragments of very corroded iron nails	Various 0.03–0.08m
2	042	166	1	Medium size fragment of porous, magnetic slag	0.02 × 0.05m
2	047	262	1	Iron nail	0.04m
3	006	16	1	Iron nail, very corroded	0.01m
3	021	36	1	Small fragment of light, magnetic, porous slag	0.02 × 0.02m
3	021	37	4	Non-metallic fragments of material preserved in iron corrosion (bone?)	<0.01m
3	043	143	1	Iron nail	0.05m
4	005	?	3	Iron nails	0.04–0.06m
4	005	141	1	Iron nail	0.05m
4	005	237	1	Iron nail	0.03m
4	007	17	3	Non-metallic fragments of material preserved in iron corrosion (bone?)	<0.01m
4	007	26	Many small	Fragments of iron corrosion	<0.01m
4	007	49	1	Wood fragment preserved in iron corrosion	<0.015m
4	007	121	3	Two iron nails and one small fragment of wood	Nails <0.05m Wood <0.02m
4	007	139	1	Iron nail	0.05m
4	007	158	1	Small iron nail in L-shape with soil trapped in the corrosion layers	0.02m

Table 7.24 (cont)
Iron finds

Phase	Context no	SF no	No of frags	Description	Measurements
4	007	169	Many	Small fragments of iron corrosion with wood	<0.03m
4	007	249	1	Disk-shaped head of iron nail, very corroded	Diameter = 0.01m
4	007	251	1	Fragment of iron nail	0.04m
4	011	254	1	Non-metallic material – bone?	
4	015	39	3	Small iron nails	0.03–0.05m
4	015	104	1	Iron nail	0.05m
4	015	179	1	Iron nail	0.04m
4	015	190	1	Complete iron nail with disk-shaped head	Length = 0.04m Diameter = 0.01m.
4	025	99	6	Small fragments of very corroded iron nails with wood preserved	Various 0.01–0.03m
4	033	171	1	Iron nail with disc-shaped head and square cross-section profile	Length = 0.04m Diameter = 0.01m
4	033	173	1	Iron nail	0.07m
4	036	204	1	Iron nail	head 23 mm; length 17 mm
4	033	173	1	Iron nail	0.01m
4	037	189	1	Fragment of iron nail	0.06m
4	037	239	1	Iron nail	0.04m
4	037	243	1	Fragment of iron nail	0.02m
4	037	244	1	Fragment of iron nail	0.04m
4	038	132	1	Small fragment of light, magnetic, porous slag	0.02 × 0.2m
4	046	175	2	Iron nails	0.04m and 0.05m
4	046	176	3	Iron nails	0.02–0.06m
4	049	238	1	Iron nail with disk-shaped head	Length = 0.05m Diameter = 0.01m
5	001	107	2	Two very corroded iron nails with sand and soil around	0.02m and 0.05m
5	002	3	1	Very small, fragment of iron nail with wood preserved in the corrosion layers	Length = 0.02m
5	002	8	1	Iron nail	0.03m
5	002	11	Many	Small iron corrosion fragments	<0.01m

Table 7.24 (*cont*)
Iron finds

Phase	Context no	SF no	No of frags	Description	Measurements
5	002	19	1	Disk-shaped head of iron nail, very corroded	Diameter ?0.01m
5	002	33	1	Iron nail	0.06m
5	002	34	3	Two fragments of iron nails and one disc-shaped iron nail head	Nails = 0.01-0.03m Diameter = 0.01m
5	002	57	2	One iron nail and one disc-shaped iron head	Nail = 0.02m Diameter = 0.02m
5	002	61	1	Iron nail with disc-shaped head	Length = o.04m Diameter = 0.01m
5	002	68	2	Iron nails	<0.04m
5	002	72	5	Iron nails	0.05-0.06m
5	002	81	1	Iron nail with disc-shaped head and soil/sand preserved in the corrosion	Length = 0.05m Diameter = 0.01m
5	002	87	1	Iron nail with disc-shaped head	Length = 0.07m Diameter = 0.01m
5	002	93	3	Fragments of iron nails	0.032-0.06m
5	002	93	3	Iron nails	0.02–0.06m
5	002	96	1	Iron nail with disc-shaped head	Length = 0.05m Diameter = 0.01m.
5	002	116	1	Big iron nail with disc-shaped head	Length = 0.07m Diameter = 0.02m
5	002	117	1	Fragment of wood preserved in iron corrosion	<0.02m
5	002	214	2	Iron nails with partly preserved disc-shaped head	0.03m and 0.05m
5	002	235	4	Four identical iron nails	0.05m each
–	U/s	88	1	Iron nail	0.03m
–	U/s	233	1	Iron nail	0.04m

study, providing information on the manufacturing techniques of the nails and the chemical composition of the slag. The metallographic study took place in the Materials Centre in UMIST using standard metallographic microscope. All the samples were sectioned, mounted, grinded and polished by the standard metallographic techniques. The samples from the nails were etched with Nital solution. The analysis of the chemical composition took place in a Philips, SEM 525M with EDAX microanalyser. The results are quantified and presented in their normalised form and in oxides Wt per cent.

Analytical results

Artefacts

The majority of iron finds consists of nails of various sizes and profiles (see Table 7.24). Two nails were randomly selected for sectioning (SF 237, SF 87). Nail SF 237 comes from the foundation of a post-medieval clay-bonded wall (context 005, Phase 4). Under the metallographic microscope, it shows a high carbon steel structure, with islands of pearlite surrounded by cementite and no slag inclusions. Areas of deformed ferrite (widmanstatten structure) are located around the edges of the sample (representing the surface of the nail) and indicate that slow cooling took place after the carburisation of the nail. Nail SF 235 is the product of a smith highly skilled in the hot working of wrought iron. Nail SF 87 comes from beneath the turf and topsoil (002, Phase 5) and is made from wrought iron (big ferrite grains under the microscope) with a lot of slag inclusions. The iron used in the production of this nail is poor quality, which is more consistent with what is known about iron nails in antiquity.

Industrial waste

All three samples of industrial waste (slag) were very corroded, highly porous and lightly magnetic (context 042, SF 166; context 021, SF 36; context 038, SF 132).

The heterogeneous nature of the material caused problems during both the preparation and the analysis of the samples. Under the microscope, all three samples revealed the three most common phases in slag, namely wustite, fayalite and interstitial glass (see glossary in archive report). In all three samples, the amounts of iron oxide lost in the slag are moderate to low (50–67 per cent in area analysis). The silicate phase (fayalite) is rich in manganese oxide, alumina, magnesia, and lime (see SEM photographs) and the matrix shows high phosphorous content and in one case (SFN132) sulphur, indicating the smelting of ores of organic origin such as bog ores that are located in the area (MacGregor 1996).

Sample SF 36 contained dendrites of manganese rich (4.96 per cent) wustite (white), needles of fayalite rich in manganese (12.60 per cent) and magnesium oxides (2.96 per cent), and interstitial glass (dark grey) rich in alumina (11.68 per cent), soda (2.15 per cent), potash (4.13 per cent), lime (5.91 per cent) manganese oxide (5.97 per cent) and small amounts of phosphorous (0.94 per cent) and sulphur (2.32 per cent) oxides.

Based on their macroscopic characteristics (small, amorphous fragments), metallography and chemical composition all three samples are most likely the by-products of smelting operations. The correlations of aluminium, manganese, magnesium and calcium, along with the high phosphorous in the glassy matrix point to the smelting of bog ores. Bog ores, such as limonite, are easily smelt despite the low iron content (they belong to the so-called self-fluxing ores). Unfortunately, these samples are not in their primary location and cannot be co-related to any of the features excavated in the site. Therefore, at this stage, the *in situ* smelting of iron ores seems most unlikely.

Finally, the minor amounts of chlorine detected in the slag might be explained by the close proximity to the sea or by the fact that some of the soil used in the site was brought up from there (ie SF132 is from context 038 which was rich in shells).

Discussion and conclusions

The iron finds consist almost totally of iron nails of small or medium size with square cross section and disk-shaped heads. With regards to their typological distribution and frequency it is apparent that most of the nails were found in contexts (002) (Phase 5) and (007) (Phase 3) in the immediate vicinity of the chapel wall. Nails were also found in all phases of the site apart from Phase 2 and Phase 5. Nail typology: mainly small (0.01–0.04m) or medium size (0.04–0.07m) nails. The size and their form (with the disc-shaped head) along with the wood preserved in the corrosion of many of them (Table 7.24) suggest that they were used to hold wooden constructions. The presence of wood preserved around nails in Phases 5, 4 and 3, as well as the presence of human bones with indications of iron corrosion, suggests that several of the nails were coffin nails.

The slag fragments are most likely in a secondary deposition. There is no indication for any kind of activity related to iron smithing or smelting and no evidence for any kind of metallurgy related workshop. However, the analysis of the slag samples indicates the smelting of bog ores.

7.5.6 The pottery

DEREK W HALL

This excavation produced 146 sherds of pottery of medieval and early modern date. All the sherds have been examined by eye and, where possible, assigned a recognised fabric name (Table 7.25). No petrological analysis has been undertaken.

Local redware (illus 7.50,1–5)

The assemblage is dominated by this fabric which accounts for 106 of the 146 sherds. It is commonly an oxidised red-brown colour although there are variants present which are grey in colour. Three of the sherds from contexts (007), (040) and (051) are slipped white on their external surface, a technique which is common on other Scottish redwares. The most common vessel

Table 7.25
Pottery catalogue by context, fabric and vessel type

Phase	Context	Redware	Yorks type	TGE	Org temp	Tile	Jug	Cooking pot	Spot date
2	016	1					1		13–15
2	019	3	1				4		13–14
2	020	1					1		13–15
2	030	3					3		13–15
2	034	3					3		13–15
2	047	26					24		13–15
2/4	007 or 030	1						1	13–15
3	006	8				1	6	2	13–15
3	017	2					2		13–15
3	021	2					2		13–15
3	048	1					1		13–15
3	051	1					1		13–15
3	063	2					2		13–15
3/4	006/007	1					1		13–15
4	007	15	1				13	1	13–14
4	015			1			N/A		18–19
4	033			2			N/A		18–19
4	036	2					2		13–15
4	037			2			N/A		18–19
4	038	4	10				13	1	13–14
4	040	3					3		13–15
4	046			7			N/A		18–19
4	049	1					1		13–15
5	001	1					1		13–15
5	002	25	1	13	1		19	7	18–19
	Totals	106	13	25	1	1	103	12	

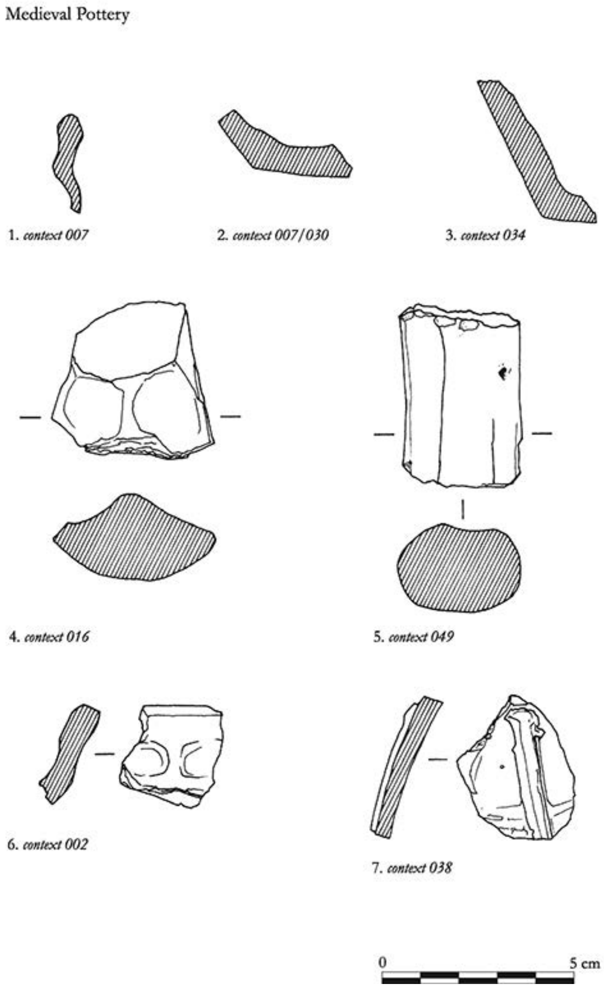

Illustration 7.50
The medieval pottery
Redware: (1) Slightly everted rimsherd from jug. Context 007. (2) Basal angle from cooking pot? Context 007/030. (3) Basal angle from jug. Context 034. (4) Rod handle from jug, with spot of yellow-brown glaze. Context 016. (5) Rod handle fragment, glazed green-brown. Context 049. (6) Organic Tempered Ware: 6 rimsherd from unidentified vessel. Context 002. Yorkshire Type Ware: (7) bodysherd from jug, glazed lustrous green, with fragment of applied strip decoration. Context 038.

form is the splash-glazed jug, although there are eleven sherds present which are smoke-blackened and may be from cooking vessels. It would appear to belong to an identified Scottish medieval redware tradition and is liable to be of local manufacture (Hall 1998a, 170–8). Similar fabrics have been recovered from excavations at Tarbat (Hall 1998b), Inverness (MacAskill 1982) and Dornoch (Hall forthcoming). This material is dated between the 13th and 15th centuries.

Yorkshire type ware (illus 7.50,7)

There are thirteen sherds in this fabric type which may all be from the same vessel. These sherds are all from a jug, glazed lustrous green with a raised strip decoration on its surface. They may be from a vessel in Scarborough ware as the published fabric description is the closest visual match (McCarthy & Brooks 1988, 230). This fabric is the most popular imported pottery in the Scottish east coast burghs in the 13th and 14th centuries.

Organic tempered ware (illus 7.50,6)

There is a single rimsherd present in this fabric from context 002. This fabric is commonly identified as belonging to a northern Scottish tradition and is notoriously difficult to date when evidence for vessel form is lacking. Tea services in this fabric type were still manufactured in the Hebrides until the 19th century (Cheape 1994, 109–27).

Tin glazed earthenware

There are 25 sherds in this fabric type which would appear to be from plates or dishes. This industrially produced pottery dates to the 18th and 19th centuries.

Discussion

The medieval element of this small assemblage would seem to date to between the 13th and 15th centuries based on its domination by a possible local redware. The presence of sherds of Yorkshire type ware migh allow for this date bracket to be tightened to the 13th or 14th century, but caution is required as all the sherds may be from only one vessel. There is nothing of an identifiable early medieval or Pictish date. When combined with the evidence from Tarbat, Dornoch and limited excavations in Inverness (MacAskill 1982), this small group from Hilton of Cadboll provides further evidence for a local redware pottery industry, presumably using the Carse clays of either the Dornoch or Moray Firths.

7.5.7 Non-sculptured finds

ADRIAN COX

This section describes the non-sculptured finds of copper alloy, iron and stone from the excavation, discussed by material category and within this by artefact type (Table 7.26). Measurements are expressed to the nearest 1mm except where they are less than this, when they are expressed to the nearest 0.1mm.

Copper alloy objects *(illus 7.51)*

Six copper alloy artefacts were recovered. No 1 is a mount, fabricated from three components. Its decorative

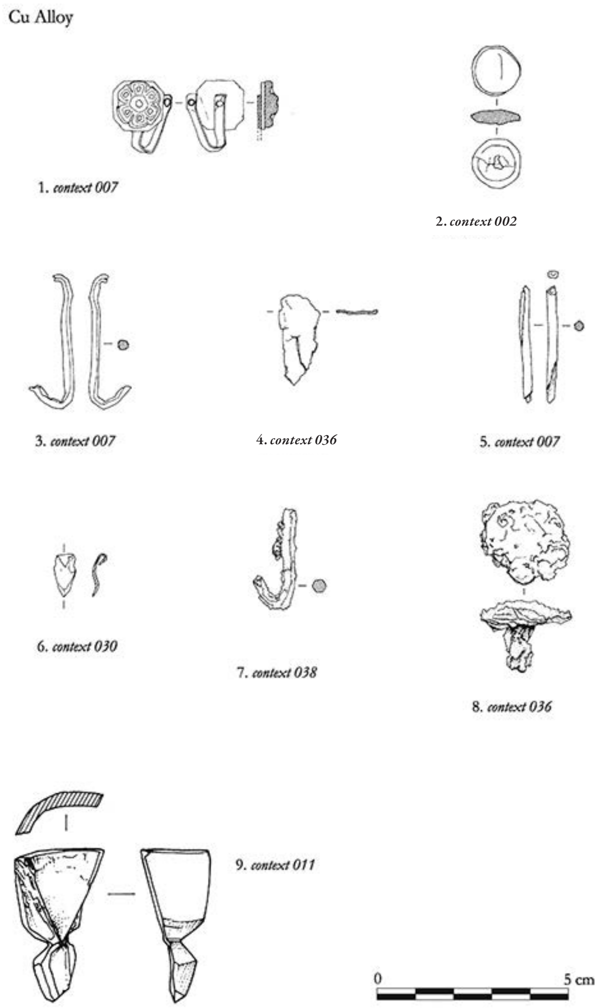

Illustration 7.51
Copper alloy, iron and bone artefacts

face is formed by a convex, sexfoil sheet, which is secured to a slightly broader octagonal plate by means of a rivet. A loop is secured to the reverse of the plate. Mounts such as this one were used as ornamentation in a variety of settings. From the medieval period onwards, small sexfoil mounts were used to decorate girdles and other straps, although they also occurred on other types of clothing and on bags and purses. A variety of mounts is also known from book covers, furnishings and horse harness equipment. Contemporary depictions in manuscripts and paintings indicate that medieval and post-medieval mounts on clothing were rarely used singly. Their overall decorative effect appears to have depended to some extent upon repetitive patterns. It seems most likely that no 1 (Phase 4) represents a strap or clothing fitting, although another decorative use is possible. Its form and composite construction suggests a probable 15th- to 17th-century date.

No 2 (Phase 5) is a small, circular stud, probably of 18th- or 19th-century date. It is decorated by a single circular groove. Evidence survives of an internal iron component that once terminated in a projecting pin or eye. Corrosion of this component has caused it to expand and damage the lower surface.

Part of a loop (no 3), possibly used as a belt or horse harness fitting, came from Phase 4. The loop has been fabricated from tightly-rolled sheet and the surviving fragment incorporates a straight section with angled ends. The method of manufacture indicates a probable 17th-century or earlier date.

No 4, from Phase 4, is a curved sheet fragment with a linear perforation. This is probably part of a repair patch. Patches such as this were frequently used, in conjunction with rivets made from folded sheets, to repair areas of damage on copper alloy vessels. Splits in wooden objects could also have been repaired in a similar manner. This form of repair patch has a long currency. Examples are known from the Viking period (eg Curle 1938, 102) and from medieval contexts (eg Cox 1996, 768; Caldwell 1996, 636), and their use appears to continue well into the post-medieval period.

A shaft fragment from a pin or needle (no 5) was also found in Phase 4. In common with no 3, it was made from tightly-rolled sheet. It is more likely to represent a needle fragment than a pin, and, like no 3, is of 17th-century or earlier date. Needles manufactured in this way have been recovered from other Scottish medieval sites, for example St John's Tower, Ayr (Cox forthcoming). No 6 (Phase 3) is a small sheet fragment, curled at one end. It appears to represent a fragment of a broken object rather than an offcut.

1 Mount

Context 007; SF 13; Phase 4

Length 21mm; max width 17mm; thickness 4mm

Mount incorporating a decorative, convex, sexfoil sheet, secured to an octagonal plate by means of a circular cross-sectioned central rivet. The rivet also secures a narrow strip to the rear of the plate. The strip (now distorted) forms a loop above the mount and includes another circular rivet hole near its terminal.

2 Stud

Context 002; SF 95; Phase 5

Diameter 12mm; thickness 2mm

Circular stud with a plain, slightly convex upper surface and a flat or slightly convex lower surface with a single

Table 7.26
Non-sculptured finds (illustrated)

Phase	Context	Catalogue no	Description
2	030	6	leaf-shaped sheet fragment
2	034	10	pot lid
3	043	12	stone hone
4	007	1	copper alloy mount
4	007	3	copper alloy wire loop fragment
4	007	5	needle shaft
4	011	9	bone toggle or winder
4	011	11	stone disc
4	015	14	roof slate
4	036	4	curved sheet fragment
4	038	7	iron fish hook
5	002	2	copper alloy stud
5	002	13	quern stone

circular groove near the edge. Iron corrosion products are apparent near the centre of the lower surface.

3 Loop fragment

Context 007; SF 250; Phase 4

Length 35mm; width 2mm; thickness 2mm

Fragment of wire of circular to oval cross-section, made from a rolled sheet; broken at both ends.

4 Perforated sheet fragment

Context 036; SF 135; Phase 4

Length 24mm; max width 11mm; thickness 0.3mm

Slightly curving sheet fragment with one surviving straight edge. The remaining edges are broken and irregular. A linear perforation, 7mm in length, lies *c* 4mm from the surviving edge, to which it is roughly parallel.

5 Pin or needle shaft

Context 007; SF 15; Phase 4

Length 30mm; width 2mm; thickness 2mm

Shaft fragment from a pin or a needle of approximately oval cross-section, made from a tightly rolled sheet and broken roughly at both ends.

6 Sheet fragment

Context 030; SF 7; Phase 2

Length 11mm; width 5mm; thickness 0.4mm

Approximately leaf-shaped sheet fragment or offcut, curled over at one end. Weight 0.2g

Iron objects

Two iron objects, a fish hook (no 7) and a nail (no 8), were recovered. Medieval and post-medieval iron fish hooks were made from drawn wire and usually had either a splayed end or, less commonly, a terminal ring or eye, for attachment of a line. Both barbed and unbarbed examples are known. In the case of no 7, the means of line attachment is missing, as is the tip. Both nos 7 and 8 were recovered from Phase 4 deposits and are likely to be of later post-medieval rather than recent date.

7 Fish hook

Context 038; SF 209; Phase 4

Length 25mm; width 4mm; thickness 3mm

Fish hook made from oval to circular cross-sectioned wire, tapering towards the missing tip and angled sharply.

8 Nail (see also Chapter 7.5.5)

Context 036; SF 204; Phase 4

Max width of head 23mm; length 17mm

Nail fragment consisting of a roughly oval head and a remnant of the shaft, possibly of rectangular cross-section.

Bone object (illus 7.51)

No 9, derived from a mammalian long bone shaft, originally had a roughly oval cross-section and was encircled by a broad, V-shaped groove. This may have enabled it to function as a toggle to fasten clothing or a bag, or as a reel for thread. Approximately one quarter of the original object survives. Species identification is by C Smith.

9 Toggle or winder?

Context 011; SF 146; Phase 4

Length 39mm; max width 26mm; max thickness 9mm

Fragment derived from a mammalian long bone shaft (probably that of a large ungulate such as cattle or horse), sawn across both ends. A broad groove with a V-shaped profile encircles the object. The internal surface of the marrow cavity is present.

Stone objects *(illus 7.52)*

A roughly circular disc, derived from micaceous stone (no 10) came from Phase 2. Discs of similar size and form have been interpreted as pot-lids (eg Curle 1938, 107) and are known from both Viking and medieval contexts. The deliberately tapered profile of some excavated examples lends support to this interpretation, and it seems a strong possibility in this case. Other functions, as gaming pieces and plugs for other types of containers, have also been suggested for similar discs. A fragment of what was originally a larger disc (no 11) came from Phase 6 and is broken across the point at which a perforation had been started.

No 12, from Phase 3, is a hone of D-shaped cross-section, broken into two pieces. The stone has good honing properties, containing hard, angular minerals set within a softer matrix. The smooth undulations of the object's sides appear to represent wear resulting from its use in the sharpening of blades. There is no evidence of sharpening of fine points. Although the sides are worn in this way, the flat base and the ends of the object do not appear to have been similarly used. Although smaller hones were portable enough to be worn about the person, this example would probably have been used in a workshop.

During the medieval period, most querns consisted of upper and lower circular stones, the upper of which was rotated by hand. It is likely that not all examples were fully-rotating; some may have been intended to oscillate back and forth. Some examples were provided with raised collars or rims, to give them added strength. The primary use of rotary querns was to grind bread flour. Querns survived in use in the Highlands until recent times, despite opposition from the feudal authorities who wished to ensure that grain was ground in the official mills and dues paid accordingly. Querns continued to be used in the 19th century, especially in areas where water mills were few and where barley meal remained popular. No 13 is associated with a late phase of activity at this site and may well be of 18th- or 19th-century date, although it is considerably worn and may be earlier. It has broken across a turning slot which allowed rotation or oscillation of the stone by means of a rod.

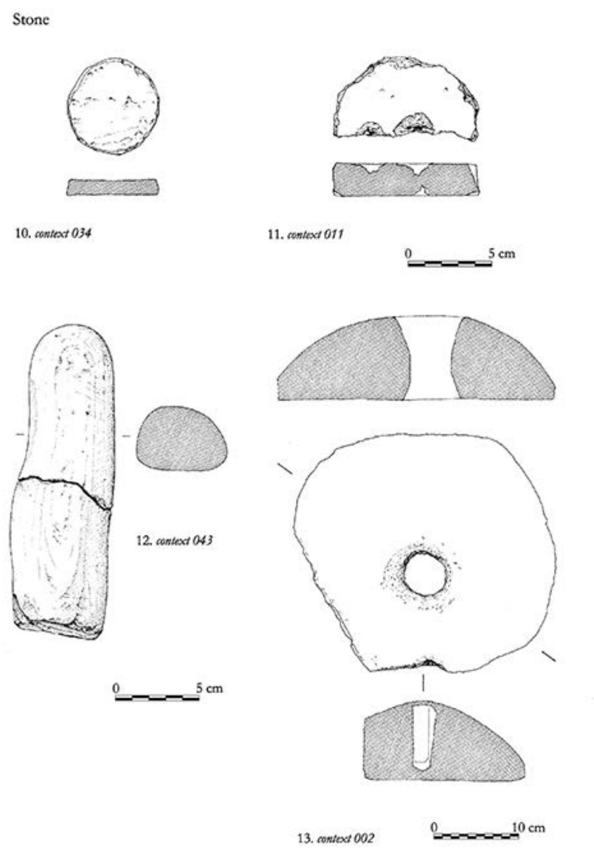

Illustration 7.52
Stone objects

10 Disc

Context 034; 95.5/103.5; SF 76; Phase 2

Diameter 54mm; max thickness 9mm

Circular disc derived from micaceous stone.

11 Disc fragment

Context 011; SF 248, Phase 4

Original diameter *c* 84mm; thickness 11mm

Fragment representing approximately half of a disc. The object has broken across the point at which a slightly off-centre perforation has been started.

12 Hone

Context 043; SF 256: Phase 3

Length (conjoined) 186mm; max width 58mm; max thickness 37mm

Hone of D-shaped cross-section in two conjoining fragments.

13 Quern

Context 002; SF 114; Phase 5

Original diameter *c* 330mm; max thickness 94mm

Upper stone from a rotary quern, possibly derived from mica schist. The outer edge of the stone is heavily worn and partially broken. The upper surface has a gentle convex profile, flattening towards the apex, around the central, circular aperture, the diameter of which is greatest at the upper surface (*c* 80mm) and then tapers to *c* 46mm. The stone has broken across what appears to be a vertical, circular cross-sectioned turning slot near its edge. This slot penetrated most of the stone, stopping *c* 15mm short of the flat base.

Stone building material

No 14 is a fragment from near the apex of a rather thin roof slate, broken across a perforation to accommodate an iron nail. Given its dimensions, it may have been used on the roof of an insubstantial structure.

14 Roof slate fragment

Context 015; 104.5/105.0; SF 181; Phase 4

Length 44mm; max width 84mm; thickness 5mm

Roof slate fragment derived from micaceous stone, broken across a perforation (max width *c* 14mm) that has been drilled from one side only. Traces of iron corrosion survive around the edge of the perforation. Two small, additional fragments accompany this find.

7.5.8 Lithics

ELAND STUART

This is a small assemblage of only 10 pieces (none illustrated). There are five pieces of flint, four of quartzite and one of chalcedony that is probably agate (no 3) (Table 7.27).

Flint

Three flints are pale grey in colour (nos 6, 9 & 10), one is a darker grey (no 3) and one is a deep red (no 8). Nos 9, 7 and 10 have a slight surface polish that could be scouring from blown sand or from prolonged contact with the sand. No 9 is probably natural. It has been rolled around but bears no clear sign that it was struck. Some small scars run down one face but are likely to be the result of natural abrasion. No 6 is a platform rejuvenation flake. It was struck across a previous work axis leaving truncated scars. The plunging terminal was brought short when the fracture line met a pair of diametrically opposed incipient cones. No 7 is a blade from a core with at least two platforms. The proximal end is snapped off this blade and might have happened when it was struck. No 8 is slightly ambiguous but might be a chunk from a small core. No 10 is an irregular flake trimmed from a core with at least two platforms.

Quartzite

The anthropogenesis of three quartz pieces (nos 1, 2 & 4) is ambiguous. The fourth (no 5) is natural. The most likely struck piece is no 1 which is a large irregular flake, with a possible point of percussion visible. One edge is long and curved with possible signs of edge damage.

Chalcedony (no 3)

This piece is most probably a natural fragment of agate.

Conclusions

All the pieces have a unique complexion, except two grey flints that may be of the same parent piece (nos 7 & 10). All the flints (except for no 9) were struck by the human hand. No piece bears any clear sign of either its age or function, but the anthropogenic pieces are consistent with prehistoric lithics assemblages. Only no 2 is from Phase 1 (context 23) while all the other anthropogenic lithics are from post-medieval Phases (6, 7 & 8) and so are most probably residual prehistoric material.

7.5.9 Glass

ROBIN MURDOCH

It is beyond reasonable doubt that all of the clear white glass from this small assemblage is modern (Table 7.28). There is no sign of degradation from burial in the soil nor is seed (small trapped gas bubbles) present in any of these shards. In addition, the surfaces are extremely smooth with no apparent manufacturing irregularities. The wine bottle shards are potash glass and exhibit typical weathering crusts for the period from Scottish contexts. This suggests that the pH of the local soil would almost certainly have resulted in at least some dulling or slight iridescence even in the more durable soda glass if any of similar antiquity were present. There is no discrepancy with the chronology as most of the glass shards were found in Phases 4 and 5. A single glass shard was found in the upper part of context (011) which belongs in Phase 4. As this layer is dated to the 17th century, it is therefore thought to be intrusive.

7.6 Summary of newspaper articles concerning the fate of the Hilton of Cadboll cross-slab in 1921

SIÂN JONES

Highland News, 29/01/1921, 'Another Attraction Gone', states that another attraction, 'although perhaps a minor one', the Hilton stone, is to be lost. This is on same page as other discussions about Invergordon's losses such as the Dockyard and damage to its scenic beauty.

The Scotsman, 03/02/1921, 'The Hilton Stone' 'An Ancient Moray Firth Monument' 'Possible loss to Scotland', brief recent history and description of HoC. Highlights the author's opinion of the importance of the preservation of such monuments in their original location. Also mention

Table 7.27
Catalogue of lithics

Phase	Context	Cat no	SF no	Material	No of pieces	Type	Notes
1	023	2	231	Quartz/quartzite	1	Flake	This primary flake of quartz is ambiguous and may be natural. One edge is concave and perhaps usable, although there is no clear sign that it was in fact used
2	047	5	230	Quartzite	1		Micaceous. Natural
4	007	3	B	Chalcedonyagate?	2	Chunk	This flawed and fragmented piece with a hint of mica is probably natural
4	007	7	127	Flint	1	Blade	From core with 2+platforms, the proximal end is snapped off this blade and might have happened when it was struck
4	007	9	C	Flint	1	Chunk	A rolled piece with no clear sign that it was struck. Some small scars run down one face but piece is a likely natural chunk
4	015	6	103	Flint	1	Flake	This piece is a platform rejuvenation flake. It was struck across a previous work axis leaving truncated scars. The plunging terminal was brought short when the fracture line met a pair of diametrically opposed incipient cones
4	036	10	203	Flint	1	Flake	This large irregular flake may be anthropogenic, with a possible point of percussion visible. One edge is long and curved with possible signs of edge damage
5	001	1	A	Quartz/quartzite	1	Flake	This large irregular flake may be anthropogenic, with a possible point of percussion visible. One edge is long and curved with possible signs of edge damage
5	001	4	148	Quartzite	1	Chunk	Probably natural
5	002	8	32	Flint	1	Chunk	Chunk that might be from small core

of the Scottish Ancient Monuments Board under whose care the stone should have been placed.

Glasgow Herald, 03/02/1921, 'Famous Sculptured Stone' 'Threatened Removal to London', brief des-cription of HoC and its history including local mythology. Also mention of the nearby Tarbat stone.

The Inverness Courier, 04/02/1921, 'A Famous Stone', report on moves to prevent the removal of the upper portion to England. Also states the Scottish Ancient Monuments Board should have been consulted as the stone is a National monument.

The Inverness Courier, 04/02/1921, 'The Stone Described', description of HoC, its carvings and its history/legend.

Glasgow Herald, 04/02/1921, 'Hilton of Cadboll Stone' 'Demand for Restoration', article discussing the indignation felt in Scottish antiquarian circles at the donation of

Table 7.28
Glass shards

Phase	Context	SF no	Description
4	011	–	Shard of probable bottle glass in clear white firebright metal, slight mould mark. Modern, late 20th century
4	013	196	Shard of bottle glass in clear white firebright metal. Modern, late 20th century
4	015	102	Four shards of a wine bottle, pale green metal with moderate to heavy weathering. The diameter over the base ring has been relatively small and the curve through it fairly gentle, all characteristics indicate likely date of around 1670–90. Three thin body shards probably from the same bottle
4	036	6	Very small shard probable bottle glass in clear white firebright metal. Modern late 20th century
5	001	266	Four shards in clear white firebright meal, no tinge, no patination (denaturing). Mid-20th century
5	002	88	Small shard probably from a wine bottle in dull mid-green with moderate to heavy weathering. Late 17th/early 18th century
5	002	97	Small shard probable wine bottle in dull mid-green with mainly secondary surfaces ie moderate to heavy weathering crust has become detached. Late 17th/early 18th century
5	002	98	Four shards in clear white firebright metal, one with embossed lettering. Late 20th century

the upper portion to London. Also mentions the Royal Commission on Ancient Monuments, the Society of Antiquaries and the Ancient Monuments Act 1913.

Glasgow Herald, 04/02/1921, 'Ancient Sculptured Stones', letter discussing the neglect of the carved stones in Scotland and the effects of weathering on those left uncovered in their locations.

Highland News, 05/02/1921, 'The Obelisk of Hilton', legend concerning Hilton, Nigg and Shandwick cross-slabs. Barbarous treatment/defacement of HoC. Description of remaining scene.

The Scotsman, 05/02/1921, 'Hilton of Cadboll Stone', letter of disbelief at behaviour of British Museum in accepting stone contrary to the spirit of the Ancient Monuments Act.

Glasgow Herald, 05/02/1921, 'The Hilton of Cadboll Stone', progress report on protest against removal of stone. Meeting of the Council of the Society of Antiquaries is to be held. Also mentions Mr Munro, Secretary for Scotland. Annoucement expected concerning the Scheduling of the HoC by the Ancient Monuments Board.

Glasgow Herald, 05/02/1921, 'Famous Sculptured Stones', letter demanding return of stone which would be of benefit to art students and craftsmen in Edinburgh and Glasgow. Claims that London has ignored the Ancient Monuments Act. Uses case of Wallace sword as a comparable example of artefact returned to Scotland.

The Inverness Courier, 08/02/1921, 'Hilton of Cadboll Stone' 'Demand for Restoration', report that the upper portion has been moved. Mentions the Ancient Monuments Board for Scotland, the Ancient Monument Act of 1913.

The Scotsman, 08/02/1921, 'Hilton of Cadboll Stone', letter demanding steps be taken to ensure return of the upper portion. Disapproval of the British Museum's actions. Argues that all items of Scottish antiquaries should be cared for in Scotland not England.

Glasgow Herald, 08/02/1921, 'Hilton of Cadboll Stone: A Correction', letter detailing recent history of the upper portion.

Glasgow Herald, 09/02/1921, 'Famous Sculptured Stones', agrees with safe custody of stone but argues that this need not be in London.

The Scotsman, 09/02/1921, 'Removal of Cadboll Stone' 'Scottish Antiquaries Protest', reports that on the protest by the Society of Antiquaries of Scotland and the letters sent to the Secretary for Scotland and the Secretary of HM Office of Works. Also mentions the Ancient Monuments Act of 1913.

The Scotsman, 09/02/1921, 'Loss to Scotland', reports on loss to Scotland of historical monument. Brief history of HoC. Criticism of decision for stone to be sent to London and the lack of consultation with the 'Ancient Monuments Department'. Refers to examples of goods returned to Dublin from British Museum and hopes that the same action will be taken.

The Scotsman, 10/02/1921, 'Ancient Scottish Stones Removed', update on the situation. Claims that further fragments of stone sent to London. Communication underway between the Ancient Monuments Branch of HM Office of Works and the Trustees of the British Museum.

Glasgow Herald, 10/02/1921, 'Scottish Sculptured Stones' 'Other Removals to British Museum', claims that a stone from Tarbet Easter Ross has also been sent to London. A description of this stone and a brief history is provided. It is expected that this will also be demanded back.

Glasgow Herald, 10/02/1921, 'Hilton of Cadboll Stone', argues that the Lia' Dail (Stone of Destiny) is a comparable case which was never returned to Scotland. Expresses the injustice of both this and the removal of Cadboll Stone.

Glasgow Herald, 10/02/1921, 'Hilton of Cadboll Stone', letter from Ludovic M'L Mann identifying what he claims are inaccuracies in another correspondent's details and criticising the apathy of the Scottish public in caring for their national monuments.

The Ross-Shire Journal, 11/02/1921, 'Captain Macleod of Cadboll', description of Captain Macleod, his property and position and criticism by Scottish antiquaries ('backed by Scottish sentiment') of his handing over of the Cadboll stone to the British Museum. Also indicates that Macleod may aid in steps to 'secure its restoration to Scottish soil'.

The Scotsman, 11/02/1921, 'Cadboll Stone' 'Protest by Glasgow Archaeologists', resolution made at the meeting expressing disapproval of removal of the stone surprise at the British Museum (in not following the spirit of the Ancient Monuments Act) and supporting placement of stone in Edinburgh.

The Scotsman, 11/02/1921, 'British Museum', Director of British Museum, Sir Frederick Kenyon, expresses surprise at Scotland's protest as they own many such stones and London has no examples on show of early Scottish Art.

The Scotsman, 11/02/1921, 'The Cadboll Stone' in 'Letters to the Editor', describes comparable case of the Lia' Dail (Stone of Destiny) which was never returned to Scotland. Expresses the injustice of both this and the removal of Cadboll Stone. Same letter was in the *Glasgow Herald* 10/02/1921.

The Scotsman, 11/02/1921, 'The Cadboll Stone' in 'Letters to the Editor', lists a number of journals where HoC has been previously mentioned dating from 1776–1856. Provides a history of the monument.

The Scotsman, 11/02/1921, 'The Cadboll Stone' in 'Letters to the Editor', expresses sympathy for removal of the upper portion to British Museum due to previous neglect by The Council of Antiquaries of Scotland and the Antiquarian Museum of Scotland

Highland News, 12/02/1921, 'Removal of Hilton Stone' 'Protest by Society of Antiquaries', reports that the Council of the Society of Antiquaries of Scotland has resolved to protest about the movement of the upper portion to London and steps would be taken with BM Trustees to ensure its speedy return.

Highland News, 12/02/1921, 'The Hilton of Cadboll Stone', objection that another paper has claimed first intimation of removal of the Cadboll stone when in actual fact it had previously been mentioned in *Highland News* 19/01/1921.

Highland News, 12/02/1921, 'Local questions', three questions are posed: will stone be returned to Easter Ross?; or Edinburgh?; and who was responsible for its placement in London?

Glasgow Herald, 12/02/1921, 'The Hilton of Cadboll Stone', disputing some of points made by Ludovic M'L Mann concerning history of stone in the *Glasgow Herald* (10/02/1921).

Glasgow Herald, 12/02/1921, 'The Cadboll Stone', points out that the Cadboll Stone is not a scheduled monument so HM Office of Public Works can only use 'moral persuasion' in its meeting with the British Museum Trustees due to take place the next day.

Glasgow Herald, 12/02/1921, 'Scottish Relics', criticism of general apathy of Scottish Nation in its history of handing over artefacts and relics to London. Also mentions Ancient Monument Act.

The Scotsman, 14/02/1921, 'Meeting of British Museum Trustees', report on proceedings of a meeting of the British Museum Trustees. States that they are anxious to acquire stone but will defer decision at present until Secretary for Scotland has conferred with the donor.

The Scotsman, 14/02/1921, 'Hilton of Cadboll Stone', letter disputing the British Museum's claim that it has no comparable examples of early Scottish art.

The Scotsman, 14/02/1921, 'The Removal of the Cadboll Stone' 'Protest by the Scottish Ecclesiological Society', meeting of the Scottish Ecclesiological Society discussing letter from the Society of Antiquaries as well as a letter from Rev Arch B Scott of Helmsdale. The Society agree to support the protest and will write to the Secretary for Scotland and the Board of Works.

The Inverness Courier, 15/02/1921, 'Hilton of Cadbol Stone' 'Ecclesiological Society's Protest', two letters encouraging the Ecclesiological Society to protest against the removal of the stone to London. Report that a meeting of the Society resolved to support the protest in writting to the Secretary for Scotland as well as raising a question in the House of Lords.

Perthshire Courier?, 15/02/1921, 'The Cadboll Stone' in 'Links with the Past' – 'Protest by Perthshire Society', The Perthshire Society will join in the protest against the removal of the Cadboll Stone and send letters to HM Office of Works and the Trustees of the British Museum.

Glasgow Herald, 17/02/1921, 'The Cadboll Stone' 'Viscount Esher and the Facts', defensive letter highlighting that British Museum is entitled to accept the gift of the stone (being an unscheduled monument) and criticism at the tone used in the letters of protest from Scottish Society.

Glasgow Herald, 17/02/1921, 'William Gillies (pres) Peter Bennett (secretary) Royal Philosophical Society', letter protesting at removal of Cadboll Stone to London.

Glasgow Herald, 17/02/1921, 'Gaelic Society', article detailing a letter sent to the Gaelic Society in response to previous correspondence arguing for the return of the Cadboll Stone to Scotland.

The Ross-Shire Journal, 18/02/1921, 'Removal of the Hilton Stone', reporting on the removal of the ancient monument (Hilton stone) from Invergordon Castle to the British Museum and claiming that a further package of nine fragments and a cross-slab found in the Churchyard of Tarbet had been sent.

The Inverness Courier, 18/02/1921, 'The Cadboll Stone' 'Viscount Esher Defends the British Museum', letter highlighting that British Museum is entitled to accept the gift of the stone (being an unscheduled monument) and criticising the tone used in the letters of protest from Scottish Society of Antiquaries and the Glasgow Archaeological Society. Same letter was published in the *Glasgow Herald* 17/02/1921.

The Inverness Courier, 18/02/1921, 'The Cadboll Stone', reprint of letter protesting removal of stone to London.

The Inverness Courier, 18/02/1921, 'Injured Dignity' and 'The Ethics of the Case', answering Esher's letter (*Glasgow Herald* 17/02/1921) commenting negatively on the attitude of British Museum Trustees. Claims that were it not for the War the Hilton stone would be scheduled under 'Ancient Monuments Act'.

The Scotsman, 18/02/1921, 'Cadboll Stone', response to Esher's letter from John Stirling Maxwell Chairman of the Scottish Ancient Monuments Board. Expresses regret and explanation for the stone not being previously scheduled and intentions to rectify this.

The Scotsman, 18/02/1921, 'Cadboll Stone', a description of Cadboll Stone and the Tarbet fragment disputing details previously printed by paper. Sympathy expressed for Captain Macleod.

Highland News, 19/02/1921, 'The Cadboll Stone', criticising incorrect details printed in a contemporary newspaper. Also description of some of Cadboll Stone's recent history, ie its previous location in Invergordon.

The Scotsman, 21/02/1921, 'The Cadboll Stone', sympathy with all parties concerned (British Museum and doner) and general appreciation of the Cadboll Stone

The Scotsman, 22/02/1921, 'Restoration of Stone to Scotland', an update reporting that the situation looks promising regarding the Cadboll Stone's return. Mentions other fragments which were thought to have been sent to London. Also mentions Ancient Monuments Board.

The Scotsman, 24/02/1921, 'Hawick Archaeological Society and the Cadboll Stone', reports that Hawick Archaeological Society received a reply from the Secretary for Scotland stating that their opinion that the stone should be returned had been listened to. Also cites the Ancient Monument Act in support.

The Ross-Shire Journal, 25/02/1921, 'Restoration of the Cadboll Stone', reporting the restoration of the stone and fragments to Scotland. Discusses national sentiment and what the author sees as Ross-shire's original neglect of the stone.

Highland News, 26/02/1921, 'The Hilton Obelisk' 'Why it was removed', describes the recent history of the Stone (ie its placement at Invergordon). Comments that the stone had suffered great neglect and was only valued once removed to the British Museum. Also expresses an interest in the Scheduling of such monuments.

The Times, 01/03/1921, 'Historic Scottish Stone' 'Protests at Removal to British Museum', mentions protest from the Society of Antiquaries in Scotland and the Secretary for Scotland. States that the Cadboll Stone is not a unique example of Scottish artwork. Includes brief history and folklore surrounding stone.

The Scotsman, 04/03/1921, 'The Cadboll Stone' 'Secretary for Scotland to Confer with Captain Macleod', update of situation that Trustees of British Museum have agreed to postpone their decision

The Times, 08/03/1921, 'Scotland's Right to Protest' in 'Cadboll Stone', a defence of Captain Macleod highlighting his approval for the stone to be returned to Scotland and seeking the understanding of the Trustees on the matter.

The Scotsman, 08/03/1921, 'The Cadboll Stone' 'Saint Andrews Society's Protest', reprint of letter supporting the Scottish Ecclesiological Society and Glasgow Archaeological Society in their protest at the removal of the Stone. Argues that all national monuments should stay in Scotland.

The Scotsman, 09/03/1921, 'Cadboll Stone' 'Duke of Atholl on Scotland's Right to Possession', reprint of letter originally appearing in the Times 09/03/1921.

The Scotsman, 10/03/1921, 'Captain Macleod', reports that the Secretary for Scotland has spoken with Captain Macleod who is happy for the stone to be returned and has now contacted the British Museum.

The Ross-Shire Journal, 11/03/1921, 'The Cadboll Stone', reports that a request has been made in the House of Commons that the Stone remain in Scotland as had it not been for the War it would probably have been scheduled under the Ancient Monuments Protection Act.

The Inverness Courier, 11/03/1921, 'The Cadboll Stone', a report indicating that matter should be resolved as Captain Macleod has informed the British Museum of his desire for stone to remain in Scotland. The author is critical of the British Museum Trustees.

Highland News, 12/03/1921, 'Easter Ross Obelisks' 'More Cadboll Stone Memorial Protests', a letter from the St Andrew Society of Glasgow supporting the protest against removal of the Cadboll Stone. States that monuments are 'national possessions' and individuals should not be responsible for their fate but rather the decision should be in the hands of a Scottish institution such as National Museum of Antiquities.

The Scotsman, 15/03/1921, 'Return of the Stone', reports that the Trustees of the British Museum have agreed to return the Stone to Scotland

The Scotsman, 16/03/1921, 'Cadboll Stone', reports that the Cadboll Stone is to be returned to Scotland and thanks relevant parties.

The Scotsman, 16/03/1921, 'The Cadboll Stone' 'To be Retransferred to Scotland', report from the House of Commons where the Secretary for Scotland confirmed that the Cadboll Stone would be returned to Scotland.

The Inverness Courier, 18/03/1921, 'The Cadboll Stone' and 'Its Destination', uses the successful return of the Stone to demonstrate the National importance of such monuments. Also mentions the opinion of the Inverness Field Club and the Ancient Monument Board for Scotland when considering the stone's final destination.

Highland News, 19/03/1921, 'The Cadboll Stone' 'To be Returned to Scotland', reports that the Trustees of British Museum have agreed to return stone although they are disappointed at Scotland's refusal to offer an example of such artwork to the Museum. States that the Duke of Atholl's intervention had much influence on result.

Highland News, 19/03/1921, 'The Cadboll Stone' 'Statement in Parliament', a report that the British Museum had decided to release Captain Macleod from his promise by declining offer of the Cadboll Stone.

Highland News, 02/04/1921, 'Hilton of Cadboll Stone and the Public', the claimed despondancy of the local population in relation to the Hilton Stone is attributed to lack of decent amenities in the village.

The Ross-Shire Journal, 08/04/1921, 'Notes and Comments', announcement by Lady Fowler that Captain Macleod of Cadboll is prepared to facilitate return of the Cadboll Stone to Ross-shire. He will also hand over to a public collection the tombstone fragment and the 'Armada Chest'. Lady Fowler suggests the establishment of a local country museum in Ross-shire to house them.

The Ross-Shire Journal, 08/04/1921, 'Ross-shire Historic Relics' 'Alice Lady Fowler's Proposal' in 'Letters', discussion of the inscribed fragment from Tarbet, which was examined by Rev Browne, former President the Society of Antiquaries, Rev Dr Joass of Golspie and Rev A Scott. Brief discussion of 'Armada Chest'. The author is hoping to raise money to secure objects for a local public collection.

The Ross-Shire Journal, 22/04/1921, 'Stone to be preserved in Scotland', Captain Macleod has offered to hand stone over to the 'Society for preservation' in the Museum of Antiquaries. Although this is deemed preferable to London, the author argues that the Stone should be returned to Ross-shire, its 'native and natural home'.

The Ross-Shire Journal, 20/05/1921, 'Captain Macleod's cease of ownership of land and property in Ross-shire', sale of furniture and lands of Captain Macleod, who now only owns about 50 acres near Invergordon. No reference to the Cadboll Stone.