Rhum

Mesolithic and Later Sites at Kinloch, Excavations 1984–86

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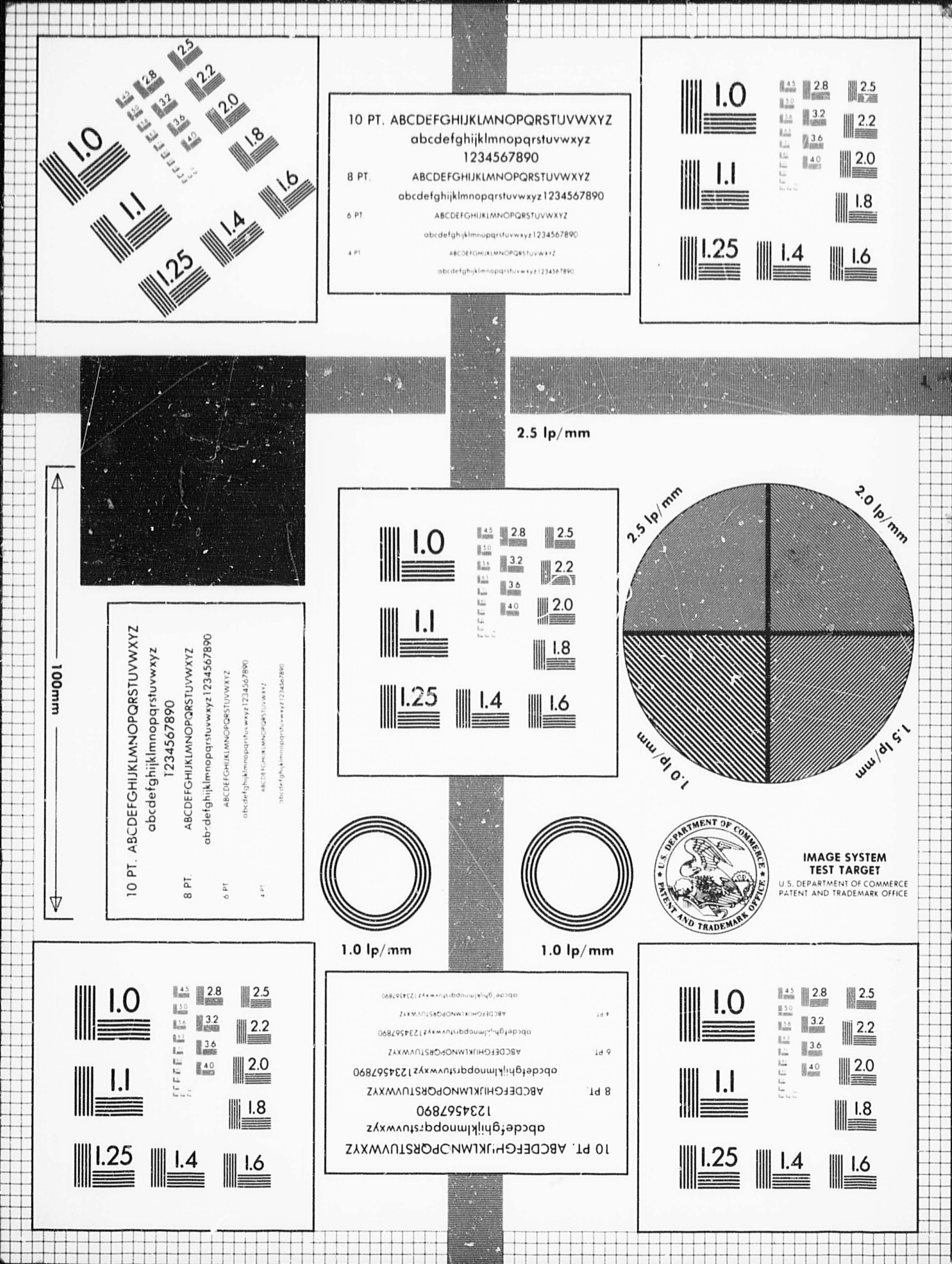
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KINLOCH, RHUM 1986: REPORT ON THE WOOD

R. McCullagh

Specimens were acquired from the routine sampling of each layer or as "special" samples from contexts particularly rich in waterlogged wood. The work was carried out to provide verified sources for C14 dates and to qualify some of the context descriptions. The samples were also examined for tool marks that could possibly be related to some aspect of the site's tool assemblage.

All of the samples came from the peat filled watercourse that ran across the three areas of the site. While it is possible that some of the peat may be quite modern, much of the wood came from the lower levels which produced the assemblage of neolithic pottery and other specimens were revealed overlying the surface of the gravels beneath the peat. It is possible that the roots of much later trees on the site had intruded into the peaty deposits and to test for this root wood was descriminated from limb or trunk wood in thin sections using the method of Schweingruber (1978). However, in none of the contexts examined was root wood shown to be present.

The unsieved material was examined to provide the range of species of the larger material. Because the sieved material represented a very large assemblage a 10% sub-sample was examined. Of the unsieved material 7 samples contained either no wood at all or merely bark, in the latter case identification to species level was not possible. One particular sample (BA 117/024) contained a considerable amount of very small flakes of bloodstone. Of the 11 remaining samples only 2 (BC 0020 and BA 0077) contained species other than alder.

BC 0022

10 specimens were examined which represents about 30% of the total. All were Alnus glutinosa and were fragments of roundwood. There was no evidence of tool damage; all the breaks in the bark appeared to result from damage in situ, though some of the ends appeared torn. Several specimens had what appeared to be patches of burning on the bark, the wood in these areas was more resistant to the sectioning knife but in thin section this was shown to result in a form of crystalline adhesion, the cell structure bore none of the characteristic alteration due to burning. One specimen bore a longitudinal split which appeared to have resulted from drying out at some stage. The diameters of the round wood ranged from 20-40mm, it was not possible to count the rings but the smooth nature of the bark suggested that the wood was derived from immature stems or branches. Most specimens had contorted patterns of growth.

BB 0023 115/034

The sample contained two specimens; one a fragment of alder roundwood and the other was a plant stem as yet unidentified. In cross section this was 7-8mm diameter with a hollow centre some

4mm in diameter, the outer surface was faceted with prominent vascular bundles at the junction of each pair of facets. The outer surface was stained to a dark brown but the interior cell structure was unstained. Compared with the wood specimen the cells bore little sign of fungal or bacterial damage. This may be cause for suspecting the stem to be intrusive.

BB 023 115/031

The sample contained two fragments of alder roundwood, one had been cut but the exposed wood beneath the bark was unstained and the damage must therefore be recent.

BC 0020

This context contained well preserved rods of alder and of Pomoideae (a sub-species of the Rosaceae grouped by their shared anatomy, it includes hawthorn (Crateagus monogyna), rowan (Sorbus aucuparia) and crab apple (Malus sylvestris) as well as other species not native to the west of Scotland (Schweingruber 1978, 124)) and single specimens of birch (Betula sp.) and of hazel (Corylus avellana). In addition it contained three, possibly worked fragments of larch (Larix decidua). They had been split from timber of about 100mm diameter in cross section and contained the later growth rings. The largest piece was tapered at one end, no clear cut marks survived but the tapering must presumably have been rendered with a sharp tool. Running down one side was a shallow groove with a slightly corrugated surface. The groove runs for 180mm but takes a sharp turn half way down.

Drilling is therefore discounted and the best explanation is that it is possibly part of the tunnel of a ship worm (Torredo sp. especially T. nivalis). The larch is not native to Scotland and damage by marine mollusca is very common on drift wood. This specimen was found in a near vertical position and may represent a fairly late insertion.

Of the remaining sectioned specimens two were identified as Pomoideae, one was birch and two were alder. All were round wood fragments but one specimen of Pomoideae bore an oblique cut mark that had completely severed the wood. The blow was delivered from an angle of about 30 degrees from the long axis of the wood. Such a steep angle is not usually replicated by a hafted stone blade but there are similar examples from the Sweet Track, Somerset Levels (Coles and Orme 1985, 43).

There was a considerable variation in the state of preservation of the specimens, some pieces had lost all the bark and some of the unsectioned material was no more than amorphous wood tissue. Microscopically the larch pieces were relatively free of the signs of cellular decay while much of the roundwood was difficult to thin section because of its poor state.

BB 0003 (Bottom)

Of 9 specimens from this sample four were thin sectioned and all were shown to be Alder. There was little morphological difference between the specimens, all were from rounwood of 30-40mm diameter with smooth bark except where the wood had bent. There was no sign of any worked surfaces.

BB 0023

This consisted of badly damaged roundwood, mostly torn surfaces and collapsed cell structures. All the sectioned specimens were alder and these matched the appearance of the unsectioned fraction.

BA 0077

This context was represented by a single large specimen and a very large volume of material recovered via the wet-sieve program. It contained both preserved wood and more charcoal than in any other context examined. The charcoal was derived from small diameter roundwood within the size range of twigs and small branches. The species present included alder, hazel and Pomoideae and also oak (Quercus sp.). The large specimen was a single piece of roundwood of alder. It had bent in several places and one end appeared to be cut. The damage was shown to be merely an area of collapsed cells beneath intact bark.

BB 0003

The sample contained numerous weathered fragments with one large piece of apparently squared timber. The sample was washed in water which removed most of the peat, the timber dissolved into a peaty slurry and a single piece of bark. Only two specimens could be identified and both were alder, in poor condition.

BB 0003

The sample contained a single fragment of alder roundwood in an advanced state of decay.

BB Fill of stake hole 025

Unidentifiable fragments of bark resembling the bark of previously identified wood but the cellular structure of bark is not diagnostic. Judging from the curvature of the bark the diameter of the original wood would have been about 30mm.

BC 0002 Tag No 540

Fragments of unidentifiable bark.

BC 0002 135/022

Stone.

BC 0002 133/021

Stone.

BA 117/024

The sample contained a single fragment of small twig of 5mm diameter, this was too fragile to section. Within the peat slurry there were numerous fine flakes of bloodstone.

BA 123/029

The sample contained fragments of bark which had come from wood of 30-50mm diameter, it was not identifiable to genus.

BB 023/031

The sample contained two large fragments of round wood of 40mm diameter. Both were alder and had been contorted in growth.

Bulk sieving programme

The following samples were derived from the bulk sieving programme: 122/019, 118/022, 123/029, 123/010, 119/016. None contained any identifiable botanical remains.

The retent from the sieving of the bulk samples produced samples; BA 0021, 0023, 0047, 0052, 0077, 0087, 0089, 0090, 0091, 0093, 0094, BB 0003, 0023, BC 0003, 0023. These were re-sieved through 4.0mm, 1.0mm and 0.5mm seives. With the exception of BA 0077 none of the samples contained any identifiable material. They all contained small fragments of charcoal, unhumified plant debris and minute peat fragments. There are 23 samples from BA0077 and of these about 50% of the volume were examined. The retent of the smaller sieves (1.0mm and 0.5mm mesh size) contained a markedly higher proportion of charcoal than the other samples, though none could be identified. The larger size component contained amorphous fragments of wood, twigs (ranging in diameter from 3mm to 12mm), other plant debris and fragments of peat. The wood was all identified as alder, but the charcoal represented a range of species; few specimens were large enough to examine in section but of those that were 50% were hazel, 21% was alder, 14% was oak, and 14% was Pomoideae. The latter probably representing mainly hawthorn or rowan. The identification of such small specimens is tentative as the cell structure of the smaller branches may deviate from that of the mature trunk wood (Jane 1970).

With the exception of some of the charcoal there is no evidence of wood of any maturity. The wood varied from well preserved specimens with only surface staining to pieces rendered to formless masses of soft wood fibres. No specimen was more than 25 cm long and although some fresh breaks were visible it seems that most of the wood had broken in antiquity or after its incorporation within the peat. The charcoal similarly varied between well presrved pieces of roundwood and amorphous lumps.

Only one specimen bore a definite cut mark (a piece of roundwood of possibly rowan or hawthorn-Pomoideae from 0020). Three specimens of larch from the same context were possibly worked but these are thought to be a later intrusion of driftwood. Several other possible cut facets were examined but all were caused by the collapse of the wood structure under the bark and presumably resulted from the compaction of the wood against some harder material.

Two other forms of damage were observed: firstly, the ends were frequently jagged and secondly, some specimens bore longitudinal splits that penetrated to near the centre of the roundwood. The latter may have resulted from the drying out of the wood at some stage in the decay process; it is not possible to diagnose the cause of the former. Most of the specimens examined in thin section bore numerous fungal spores and hyphae suggesting that at least some if not most of the decay process had been aerobic. The incorporation within the peat will have arrested this decay.

The assemblage examined can be seen as derived from the local woodland species. If it represents tha natural "windfall" debris from woodland it is surprising that no mature wood survived. It would seem fairly safe to assume that this woodland was maintained in an immature state or that there was selection of the mature wood for consumption elsewhere. If this is the case man must be seen as the major factor affecting the creation of this debris. It would seem likely that much of the wood and charcoal assemblage had decayed to an advanced state before incorporation within the peat.

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KINLOCH, RHUM: GEOMAGNETIC SURVEYS, MAY 1986

B. MAHER & D. WATSON

Site Conditions

Magnetic methods of remote sensing for the purposes of archaeological prospecting have been applied to a number of archaeological sites, with some success in detecting buried anthropogenic remains. The potential advantages of such techniques lie in the rapid location of artefacts and features, without wholesale site excavation, which is normally both time-consuming and expensive, and usually uncovers only a small fraction of the total area of human occupation. The most satisfactory method of magnetic surveying is to take readings at regular intervals, usually on a surveyed grid, so that any spatial patterns of variation in the data obtained can be revealed. Magnetic survey depends on measurable differences in the magnetic susceptibility of the soil and/or substrate across the investigated site. For example, topsoil and the fill of buried pits usually possess a higher susceptibility than the adjacent subsoil. Thus, magnetic detection of small, local modifications in the strength of the earth's field can, under favourable conditions, be related to the presence of man-induced site disturbance. Unfavourable conditions, such as the presence of natural magnetic variation, perhaps from geological heterogeneity, or post-occupation degradation of the site, will correspondingly reduce the discriminative power of the method in terms of its archaeological power. Finally, the preservation of any magnetic signal carried by specific sections of the site area, such as hearths or areas of fill, is obviously a pre-requisite for subsequent magnetic detection.

Optimal use of the magnetic survey as a prospecting technique on the Rhum excavations was negated in that the main area of interest had undergone extensive investigation in advance. Within the excavated trench BA only a surface susceptibility survey could be usefully carried out. Proton magnetometer and fluxgate gradiometer surveys were performed but only on the unexcavated area to the south of the main trench.

Methods

1. Surface susceptibility sensing

A search loop type M.S.2.D (Bartington Susceptibility Systems) was used to survey both the excavated trench and the adjacent unexcavated area. Readings were taken at 1m intervals.

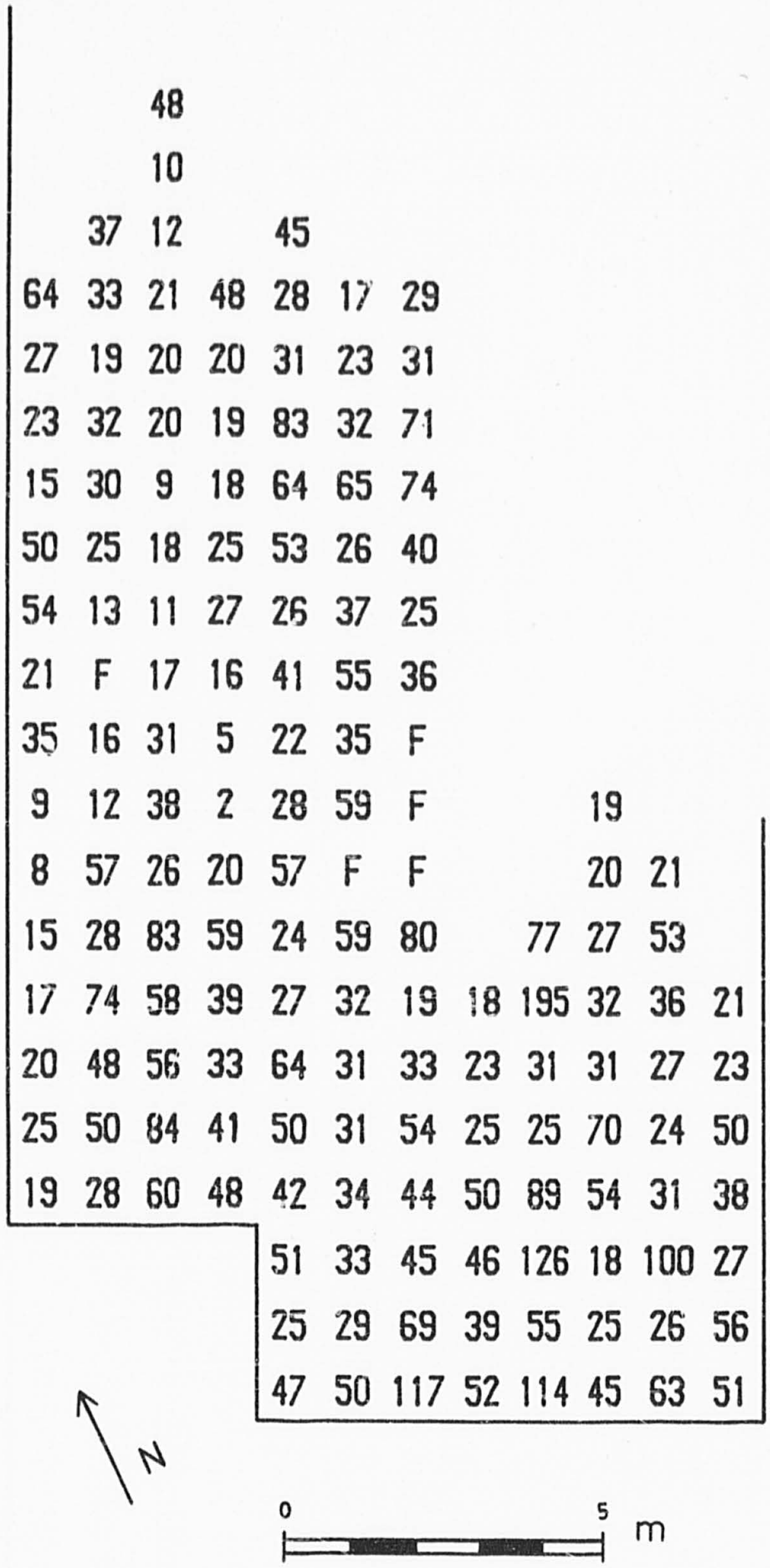
2. Fluxgate gradiometer survey

3. Proton magnetometer survey

Both instruments detect local perturbations in the earth's field (the fluxgate providing a continuous record of the change in field, the proton magnetometer an absolute reding of field strength). All readings were taken at 1m intervals.

Results

1. The surface susceptibility pattern for Trench BA (Ill 113)



ILL 113: Trench BA. Surface magnetic susceptibility survey.
F = Feature fill removed

displays distinct areas of high susceptibility, superimposed on fairly low 'background' readings averaging c.15 (these values are uncalibrated, the precise volume of material sensed at each measurement being unknown). Interpretations in terms of archaeological features is difficult owing to the depth variations from selective removal of topsoil across the trench area. Combination of this pattern of results with already known information regarding the trench area may, however, prove useful.

The pattern obtained for the unexcavated area also shows areas of high susceptibility values; field observations indicate that spatially isolated high values arise from the presence of stones at the surface (brought up from deep ploughing?), but that clusters of high points represent true subsurface features. In the upper (northerly) section of the surveyed area, thicker vegetation and the presence of a path are likely to be responsible for some of the apparent variations.

2. The results of the fluxgate gradiometer survey are unpromising. This instrument is prone to drift and requires careful orientation throughout the survey. However, two distinct areas are identified; one, to the southerly edge of the area, displaying higher values, the other, to the north/northeast of the surveyed area, clearly low values. The lack of correspondance with the susceptibility survey indicates the different depths to which each instrument is sensitive, the susceptibility sensor operative to c.20cm depth only.

3. Of the three types of survey, that by proton magnetometer is least beset by calibration and drift problems. Exact orientation is unnecessary since the total field is measured rather than any component. Preliminary contouring of the data indicates three seperate anomalies. Interpretation of the significance of these features should take due regard of the possible options, which include: a) the presence of a linear geological feature (such as a dyke); b) recent ground disturbance or possible infill of drainage channels; and c) pre-modern ground disturbance.

With specific reference to the Rhum site, a last note of caution should be added. While magnetic surveys of the type implemented and described here have proved very valuable at sites in more southerly regions of the UK, the nature of the conditions operative on Rhum has produced poorly drained, highly acidic topsoil and substrate at this site. Such conditions are somewhat prejudicial to preservation of those ferrimagnetic iron oxide grains present in the soil which would otherwise testify to the occurrence of burning and/or land cut and fill. Evaluation of the results presented here should be cautious in view of the limitations of the techniques under these circumstances.

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SOILS AND GEOMORPHOLOGY: Report on Visit to Kinloch Archaeological Excavation, Rhum 7-10th May 1984

Dr. DA Davidson

Physical Setting of Excavation Site

The site is located in a ploughed field on the north side of Kinloch Bay (NM 40359995). The field sloped at 4-5 degrees in a generally southerly direction with an altitudinal range from c.9-23m O.D. The underlying geology is Torridonian and is mapped by the Geological Survey as the Rudha Na Roinne Grit. No outcrops of rock are exposed within the excavation area, but outcrops occur in the pasture fields to the west whilst rock outcrops are frequent in the area of rough moorland to the immediate east. A sequence of narrow benches on the hillslopes above the excavation area result from the Torridonian structure.

The Soil Survey of Scotland has mapped the excavation area as a podzol (locality name Harris) developed on a raised beach; to the east of the field peat is dominant whilst the hillslopes behind are mapped as the Mulloch Mor complex of peat and rock. The annual average rainfall for the Kinloch area is 2400mm; since bedrock is never far from surface, the soils have to transmit considerable quantities of water by throughflow and seepage line mechanisms. The rough moorland area to the immediate east of the excavation is dominated by peat seepage lines between rock outcrops.

Description of Soils and Hillslope Deposits Outwith the Excavation

Pit 1. Soil pit 11m to north of dyke in area of rough moorland (table 54).

Interpretation: this is a peaty gley soil.

Discussion: The two peat layers differ in stone content and consistence. It is possible that the lower has been subject to some disturbance in the past in order to account for the stone content as well as the slightly higher mineral level; peat has subsequently developed on top of this layer following cessation of agricultural activities.

Pit 2. Soil pit in lazy bed 17m from east corner of dyke of excavated field (table 55).

The aim of digging this pit was to determine if a buried soil was preserved at the base of a lazy bed ridge. The selected area had very distinctive lazy beds (c.3.3m across and c.0.4m in max depth).

Interpretation: this is a fine example of a man-made soil with the upper layer (3-25cm) being formed by the ridge.

Discussion: It is probable that the original soil surface was at 25cm, but former disturbance of layer 25-37cm is suggested by the stone distribution. The material at 37-61cm is similar to the slope deposits exposed immediately below the cultivated horizon in the excavation field as well as to the material at 39-75cm+ in the first soil pit. The water-worked nature of the stones is very

0.00-0.03 m	Dry dead grass.
0.03-0.29 m	Black amerphous homogeneous peat.
0.29-0.39 m	Black peat; more compact than above, one fresh stone and some weathered sandstones.
0.39-0.75+ m	Very compact stony drift consisting of many angular/subangular stones (0.01-0.02m) with a very dark greyish brown (10YR3/2) matrix of gravel and sands. Moderate abundance of angular to sub-rounded stone over 0.20 m ; suggestion of a concentration of larger stones at top of layer.

Table 54 Soil profile in soil pit 1

0.00-0.03 m	Thin turf layer.
0.03-0.25 m	Dark brown (7.5YR3/2) sandy loam; many angular, subangular and subrounded stones (0.01-0.05m).
0.25-0.37 m	Very dark greyish brown (10YR3/2) sandy loam, many angular and subangular stones (0.01-0-0.05m), weathered sandstone.
0.37-0.61 m	Dark greyish brown (10YR4/2) layer dominated by stones (0.01-0.03m); matrix of silt loam.

Table 55 Soil profile in soil pit 2

evident.

Pit 3. Soil pit to immediate east of excavation field in mid slope position (table 56).

This pit was located within the rough moorland area distinguished in terms of its variability from peat hags, peat seepage lines to rocky outcrops. This particular pit was sited in the middle of a seepage depression line running down slope at 6 degrees.

Interpretation: this is a peaty gley showing signs of disturbance by human activity.

Discussion: The lower silty clay is at least 60cm thick and was deposited by hillwash processes prior to peat growth. The material probably originated from pockets of glacial till on the upper slopes. A dark grey till (silt loam) was observed under a sequence of sands, gravels and peat in the bank of Allt Slugan a'Choilich on the lip of Coire Dubh (NM 389979). It is likely that this type of glagial till also mantles the slopes of Mullach Mor and provides the sediment source for such deposits, as in the lower part of this soil pit. It is not possible to determine if the root fragments in this silty clay are in situ or derived from down-slope processes.

Soils and Hillslope Deposits as Exposed within Excavation Field

In essence three types of material (I-III) can be distinguished, typified by the sequence exposed in sample quadrat 080/856 (table 57).

0.00-0.08 m	Turf.
0.08-0.25 m	Black stone free peat.
0.25-0.45 m	Horizon dominated by weathered sandstone with a humus matrix.
0.45-1.05+ m	Very dark grey (7.5YR3/0) silty clay with occasional stone; stone content increasing towards brse; root fragments up to 0.01m in diameter; some lenses of coarse sands.

Table 56 Soil profile in soil pit 3

Layer I	0.00-0.24 m	Topsoil, sandy loam.
" II	0.24-0.58 m	Compact stone (0.01-0.05m) dominated layer with a very dark brown loamy sand as matrix, humus stained.
" III	0.58-1.16 m	Layer dominated by large round and subround stones (0.05-0.20m) with a matrix varying from medium sands to coarse sands and gravels.

Table 57 Soil profile from sample quadrat 080/856

A similar sequence is exposed in trench AC, although stratified sands and gravels are also evident in layer II.

Discussion: the origin of these deposits

Layer III

The waterworked nature of the larger stones in this layer is clear but the difficulty is in distinguishing the particular type of process responsible for such rounding. Marine or fluvioglacial processes or some combination are distinct possibilities. To aid interpretation, 50 stones from the top of layer III as exposed in trench AC were measured for maximum length (l), maximum width (w), maximum thickness (t), all at right angles, as well as maximum curvature (c as a radius) measured on the l-w plane. Hence the index of roundness was calculated (2000c/l) as well as the index of flatness (50[w+l]/t). For comparison, the same types of measures were made on the present day beach immediately below the excavation field. The results are presented in table 58.

A Student's t test was used to compare the differences in roundness, flatness and length between trench AC and the present day beach; all results proved to be statistically significant at the 5% level. In other words the tests established the differences in mean values of flatness, roundness and length between these two sampling positions.

An attempt was also made to determine if there was any difference

	$\overline{I}_r$	s_r	$\overline{I}_f$	s_f	$\overline{l}$	s_l
Layer III Trench AC	254.6	163.8	205.7	68.7	90.6	24.0
Present Beach	194.1	125.5	300.9	190.0	114.7	46.7

$\overline{I}_r$: mean value of index of roundness

$\overline{I}_f$: mean value of index of flatness

s_r : standard deviation of index of roundness

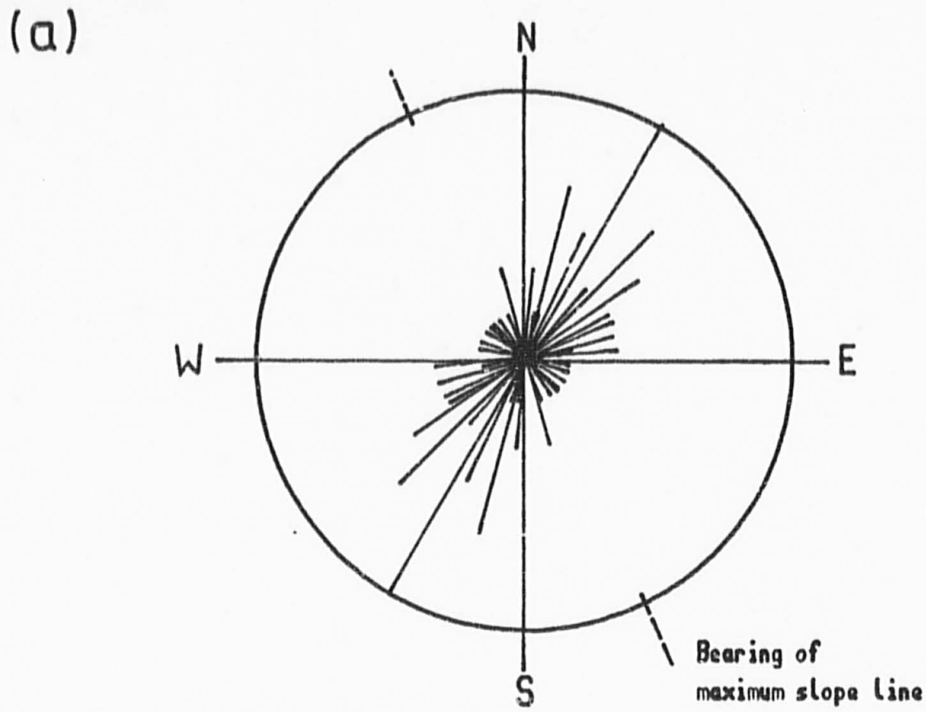
s_f : standard deviation of index of flatness

$\overline{l}$: mean value of maximum length measures

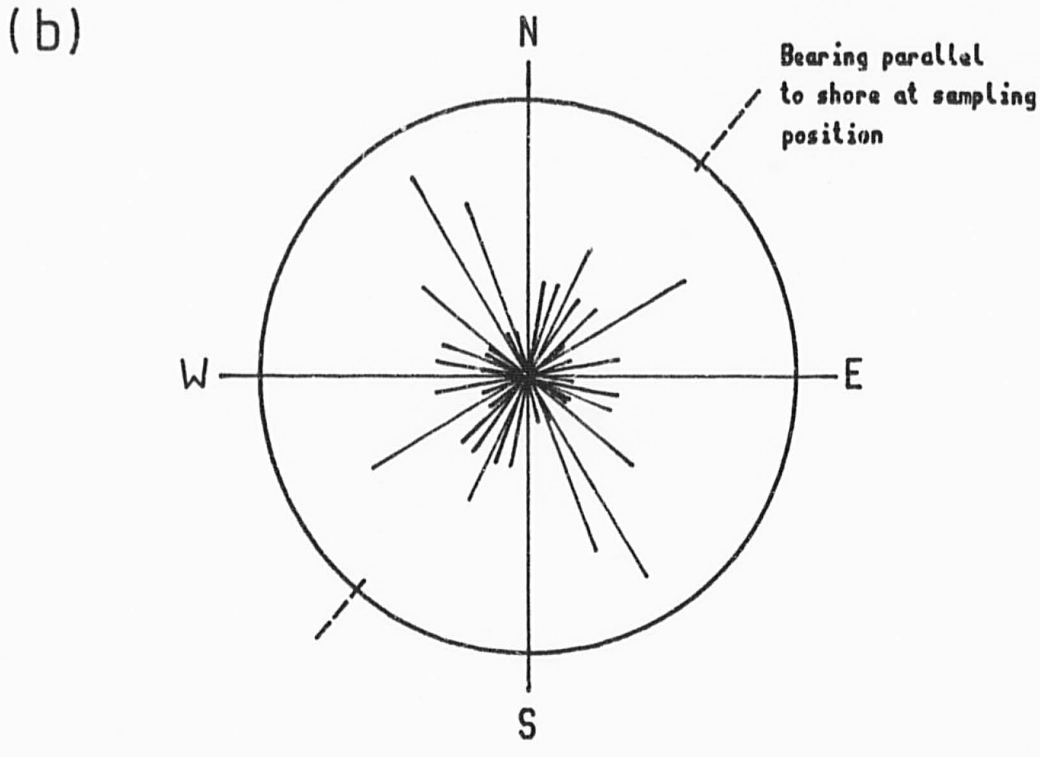
s_l : standard deviation of measures

Table 58 Roundness and flatness characteristics of stones from the matrix of the excavation site (trench AC) and from the present day beach at the head of Loch Scresort in the orientation of the long axis of the stones between trench AC and the present day beach. The results are plotted in Ill 114 using a circular graph; the bearing of the maximum slope at trench AC and the line of the shore at the beach sampling position are also indicated. The lack of any preferred orientation is evident at the present day beach with no relationship between orientation of stones and beach alignment. The stones in trench AC also do not display any very clear orientation pattern though a NNE-SSW emphasis is suggested. No relationship is evident between stone orientation and slope direction.

The aim of comparing these stone flatness, roundness, length and orientation measures between trench AC and the present day beach was to determine the degree of similarity. As can be seen from the results the stones on the present day beach are larger than in trench AC. Stones from the present day beach are flatter and less round than those in trench AC. The measures of roundness flatness and length are all marked by variability as expressed in the standard deviations, with variability in flatness for the beach being the most marked. These results indicate a difference in size and shape between the stones in the present day beach and those in trench AC, suggesting that the latter are not of simple marine origin. However, the limitations of sampling must be noted. Also Loch Scresort would have been much broader if at some stage the sea was at trench AC, hence the locality would have been exposed whereas, in contrast, the beach at the head of Loch



Scale: ⌞—⌟ = occurrence of one stone



Scale: ⌞—⌟ = occurrence of one stone

ILL 114 : Orientation of stones. (a) On the excavation site (Trench AC).
(b) On the present day beach below the excavation site

Scresort today is relatively well sheltered. Thus comparison between the present day beach and the stones in trench AC must be made with caution.

A fairly clear marine limit is evident c.60m to the north of the excavation field. This limit takes the form of a narrow discontinuous wave cut platform in the hillside; it extends eastwards along the lower slopes of Mulloch Mor and can be distinguished from the structural beaches on the basis of its consistency of elevation. The height of this shoreline was surveyed along grid line 050 and the result was 29.5m O.D. This elevation fits well with the figure of 30m given by Price (1983) for the maximum marine limit on Rhum. No date is available for this marine limit but it is presumed to relate to the transgression following the disappearance of Devensian ice. Eleven glaciers accumulated during the Loch Lomond Advance on Rhum, but only one reached sea level (Ballantyne and Waine-Hobson 1980). Thus the excavation field according to this interpretation was not over-run by this last glaciation but would have beeen subjected to intense periglacial conditions. A maximum marine transgression in postglacial times of 8m for Rhum is given by Price (1983) quoting research by Jardine (1982). No evidence exists at the head of Loch Scresort for such a limit, but an elevation of 8m means that the excavation field would have been above this transgression.

The excavation field was thus subject to a marine transgression in Late Glacial times but was not subject to later inundation by the sea. It is proposed that the original deposition of the large stones as in trench AC was by fluvioglacial processes, but the material was later reworked by the Late Glacial sea. During the final phase of Devensian ice on Rhum, deglaciation produced fluvioglacial deposits in the form of kames, kame terraces, eskers and possibly also outwash. It is precisely in such lower slope situations where fluvioglacial deposition takes place. No fluvioglacial landforms exist today and thus it can be postulated that marine processes subsequently reworked the fluvioglacial landforms. The matrix of sands and gravels is also of fluvioglacial origin.

Layer II

As already described this layer also indicates a water-worked origin. In trench AC the length of the longest axis was measured for 100 particles to give a mean value of 5.71mm and a standard deviation of 3.35mm. Thus the material is considerably finer than the underlying stones. It is proposed that much of the sands, gravel and small stones had a fluvioglacial origin, but much reworking and downslope movement has taken place, particularly during periglacial times. This could have been following the regression of the Late Glacial sea as well as during the Loch Lomond Advance.

Layer I

The topsoil is a cultivated horizon, the result of agricultural use over the centuries. The most extensive soil at the time of prehistoric occupation is likely to have been a peaty gley though a podzol may have occurred in the best drained situations, as in between seepage lines. The presence of a forest cover would also have improved drainage. Cultivation in recent historical times has resulted in the loss of the original peat layer and the production of a shallow stony mineral topsoil within which the bloodstone arifacts have been found.

Summary of Geomorphological and Pedological Evolution of Area in Vicinity of Excavation Site

POST GLACIAL	Historic time: cultivation and mixing of upper horizon (layer I); loss of peat layer; lazy bed formation. Flandrian transgression to 8m, occupation of site ? Development of a peaty gley-podzol soil suite.
LOCH LOMOND ADVANCE	Corrie glaciers on Rhum; intensive periglacial processes; extensive spreads of solifluction (layer II).
LATE GLACIAL TRANSGRESSION	Transgression to 30m O.D.; formation of shoreline; reworking, resorting fluvio-glacial deposits and landforms below 30m.

	(Layer III)
	Active periglacial processes.
DEVENSIAN GLACIATION	Fluvioglacial deposition: spreads of sands, gravels, water-worked stones as kames? eskers? kame terraces? Pockets of a dark grey glacial till.

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KINLOCH, RHUM: SOILS AND SEDIMENTS ENCOUNTERED DURING EXCAVATION

D JORDAN

This work reports on:

The geomorphology, parent materials and soils of the site and its immediate vicinity.

Aspects of the archaeological features and their fills.

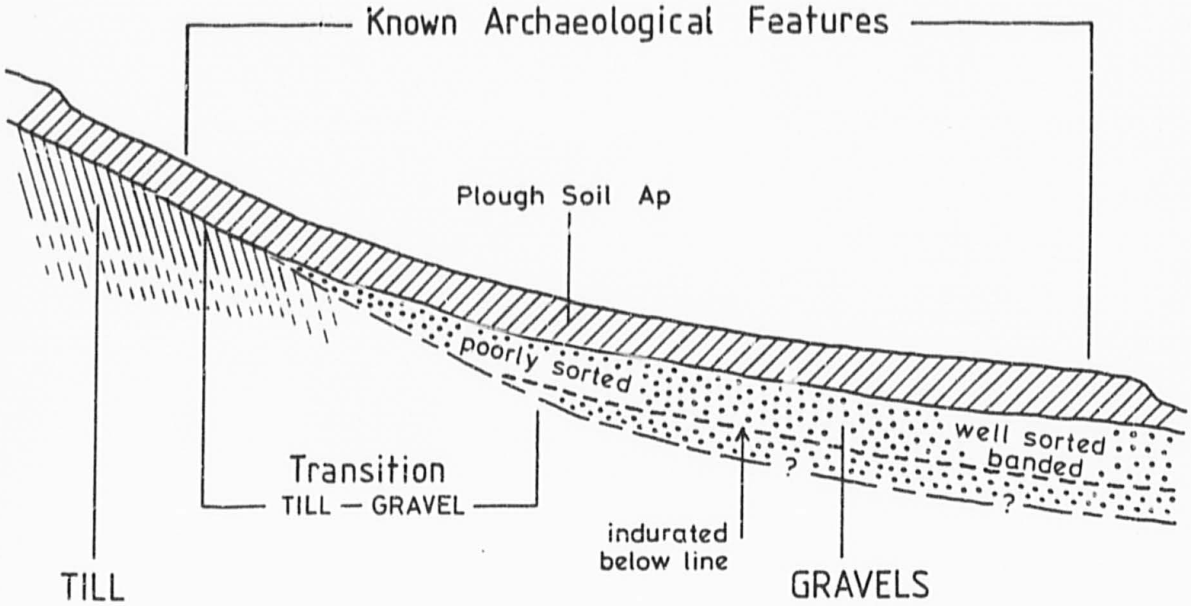
Erosion of soils and sediments in the vicinity of the site.

Parent Materials

The site overlies till and sorted sands and gravels. These rest on Torridonian sandstone which is exposed at several points in the immediate vicinity. The sorting has produced bands within which are found sands and gravels of similar sizes. This sorting is the result of water movement, probably waves on a raised beach.

The soil map of Rhum (Macaulay Institute 1958) indicates that the site partly lies on a raised beach and partly on till. These divide the field on which the site lies into two: till underlies the northern, uphill area of the site and field, occasionally broken by rock exposures. The southern part of the field is underlain by raised beach gravels which overlie the till (Ill 115).

The till deepens beneath the gravels and has been found in test pits 30m downslope of the contact at a depth of 1.8m. The contact passes through the site and across the field to the west, in



ILL 115 : Excavation site. Schematic section of underlying soils lobes. To the east it descends the slope and becomes complicated by rock exposures.

The till grades into gravels which have increasingly:

better drainage

better sorting

fewer cobbles

less fine matter

less-weathered stones

defined internal stratification

as the slope is descended.

Banding within the gravels lies sub-parallel to the slope of the field and stones tend to lie parallel to it. No imbrication was noted but traces of sorting and structure, probably periglacially derived, were observed in section. No evidence was found to suggest that the gravels have been laid down by pro-glacial streams. The consitent, sloping banding and lack of stream channel re-working or point bar type structures are consitent with this and support the suggestion that they are the result of raised beach sorting. The gravels could have originally been laid down by pro-glacial rivers and then have been resorted on a beach but they were seen to resemble the stones in the till which suggests that they had a very local origin.

Induration was encountered at a depth which increased from ca.40-

80cm downslope. Where fully developed, this hardening of the sands and gravels makes them impermeable, forcing water to flow over the top. Overlying this indurated horizon by 5-10cm was a band of gravels with silt cappings.

Near to the till contact the gravels become wetter and, as a result, more weathered. They drain poorly because they are closer to the impermeable till and because they contain more fine matter. They appear, as a result, to be more broken up than the better drained gravels and have a light blue, reduced tinge with diffuse, yellow mottles. This appearance was typical of a group of deposits , including archaeological stratigraphy, which was loosely and collectively named 'broken biscuit'.

The till derives from and contains a wide variety of rocks and sediments. Stones within it vary widely in shape. Most are angularly fractured while some have partly rounded surfaces suggesting that the till is partly derived from reworked outwash deposits.

Stones in the till surface tend to be oriented with the slope and this suggests some movement, possibly due to solifluction. There was no evidence of mass movement of the till down into the flush which diagonally crosses the site, nor of solifluction lobing or sorting.

The flush overlies the contact of till and gravels. Its limits have not been probed. Where it crosses the site its southern bank has been built up with material containing artefacts. It also contains isolated rafts of large stones the presence of which do not admit to any evident natural explanation.

The peat which fills it contained a few lenses of finer mineral matter but this was not well sorted and its stratigraphy did not suggest persistent stream flow.

Soils

The soil of the site is mapped as a podsol (locality name Harris) on the Rhum soil map (Macaulay Institute 1958).

That part of the site overlying till is formed on a non-calcareous gley similar to the peaty gleys of the 'Kinloch' locality name. The till soils are thin and have to transmit large amounts of water as a result.

The lower part of the site is found on a variety of soils including shallow gleys, gleyed podsols, podsols and iron-humus podsols. These soil variations are mainly due to minor changes in the ease and depth of drainage.

The majority of the site is found on an iron humus podsol with an occasionally gleyed C horizon.

Table 59 provides profile descriptions characteristic of the

(a) LOWER GRAVELS

Root Mat	0.02 m	Grasses
H	0.13 m	Greasy black well humified (Von Post grade 7) peat. Abundant grass roots. Massive, soft.
B1	0.12 m	Very coarse sandy clay loam with abundant stones, round to subangular. Abundant roots. 10YR3/1 very dark grey-brown.
B2s	0.65 m	Loamy coarse sand with dominant stones, round to subangular. 2.5YR3/2, dusky red. (Moister and less organic than B1)
C	+	Slightly indurated gravels and cobbles with silt cappings in situ.

(b) TILL

Ap	0.22 m	Mid to dark brown, moderately stony sandy clay loam. Slightly leached with common bleached sand grains. Abundant roots.
B/C	0.25 m	Firm dissagregated till with organic matter. Mid grey-brown, mottled yellow.
C	+	Soliflucted till ? Gleyed, mottled yellow.

Table 59 Kinloch: characteristic soil profiles. (a) Lower gravels. (b) Till

soils of the site the survival of banding and periglacial sorting features in the topmost layers of the gravels implies that the structures within the gravels are largely intact. This suggests that the apparently undisturbed relict archaeological features may actually be intact as well.

In the ploughsoil and in the archaeological features the organic matter component of the soil resembled the black, Mor type humus of acid soils. Soil analyses carried out by the Macaulay Institute on soils from a similar local site (unpublished) reflect this acidity with low exchangeable Ca and Mg as well as a low pH.

The Mor type humus found in the soils and archaeological features of the site is also found coating the stones of the upper gravels. It varies in the tenacity with which it sticks to stones across the site, probably due to changes in its nature and chemical environment.

Humus has infiltrated between the stones of the gravels, reducing in concentration with depth and is virtually indistinguishable in the field from the organic component of the pit fills. This organic matter seemingly acts to obscure boundaries of texture and colour by coating particles and reducing contrast. There seems no reason to suppose that it is not being moved around in the soil and several samples of it were found to be moderately easily dispersed in water. It may therefore contaminate feature fills. This implies that these fills contain fine matter which did not originate in them and thus that detailed analyses of the chemical and other properties of this fine matter must be treated with caution.

Rooting over the site was uneven and concentrated in the Ap and upper gravels, above 50cm. It had locally disturbed the gravels although it does not appear to have removed the gravel structure. Roots tended to penetrate into the till much less than into the gravels and appeared to concentrate in features.

The features and their fills

Features located in 1985 and 1986 were interpreted as scoops, pits and suchlike. They were filled with a mixture of fine organic mineral matter and stones of widely varying size and shape.

In section feature edges were unclear; careful cleaning showed that they had become obscured by the movement of fine organic matter into the gravels around. The stone textural and orientation boundaries seemed to be little disturbed suggesting that few stones had been moved from (or exchanged between) fill and surroundings.

A portion of the stones which the features contained were of shapes and sizes alien to the tills and gravels. These may be anthropogenic. A small amount of the organic fraction of a fill was examined under low power magnification, having been dispersed in 10% $NaOH(aq)$. It was observed to consist of a dark brown, amorphous, alkali-soluble mass containing small fragments of apparently intact organic matter and fine mineral matter.

Erosion

Organic and mineral coatings on particles in the B horizons of the gravel soils indicate that fine matter has been mobile in the soil.

The distribution of artefacts in the ploughsoil and observations on the lower slopes of the site suggested that remarkably little erosion of soil had occurred over the surface. This was unexpected, unexplained and implies that much more evidence of the original nature of the site may remain in the ploughsoil than was expected.

No plough erosion lyncheting was noted on the site itself, nor were there increased depths of A horizon or A horizon stonyness on the flatter areas downslope of the excavation where eroded soil might be expected to accumulate.

Archaeological features found at the flatter, lower end of the known site were not overlain by eroded material. Erosion was seen to be in progress on the ploughed area to the west of the site although all the eroded material was smaller than 2mm. The good drainage of the soils overlying the gravels is likely to have reduced erosion by reducing overland flow.

The lack of evidence of plough induced erosion on the site might suggest that past cultivation has been limited here and, perhaps, that a long standing field division separated the area of the site from the rest of the field.

The apparently good correlation between features and ploughsoil artefact concentrations strongly supports the conclusion that erosion of the coarse fraction of the ploughsoil has been limited.

A note on the soil chemistry

To accompany the chemical analyses carried out on the fills of the features a soil profile was analysed. A comparison may be made with the standard profiles analysed by the Macaulay Institute (Tables 60-63).

1. Peaty gley from Kinloch Glen. Locality name Kinloch.
2. Podzol from Guirdil raised beach. Locality name Harris.
3. Podzol from Kilmory raised beach. Locality name Harris.
4. Cultivated Podzol profile from Kinloch site.

The site podzol has a very different chemistry from the peaty gley and is considerably less clay rich. It is siltier than the two othe podzols recorded, reflecting the proximity of the till and the incomplete sorting. The higher silt content of the site Ap may be the result of mixing with till from upslope but this is not reflected in the clay content.

Loss on ignition and %carbon are much higher in the site profile than in the other podzols as, in general, are the exchangeable cation concentrations, %nitrogen and phosphate concentrations (total and readily soluble).

Altogether then, the site soil chemistry, while not favourable to agriculture, is much less unfavourable than those of other Rhum podzols. This is partly the result of recent liming and fertilising as is suggested by the Calcium and Readily Soluble Phosphate concentrations. This does not appear to be the whole story since the phosphate level is relatively high throughout the profile, perhaps reflecting the influence of the archaeology. On the other hand the site is near to a major centre of agriculture and may have been fertilised for a long time. There is no evidence that the soils of the site are inherently more fertile than other soils of the island.

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Horizon		H	A_{2g}	B_{2g}	B_{3g}
Depth (m)		0.05-0.15	0.02-0.13	0.20-0.30	0.51-0.61
% Loss on ignition		16.60	5.58	4.31	4.97
% Sand U.S.D.A		64.7	31.6	46.3	34.6
% Silt U.S.D.A		20.7	34.1	27.8	32.5
% Sand int.		76.9	47.7	58.8	49.9
% Silt int.		8.5	18.0	15.3	17.2
% Clay int.		2.1	31.5	23.7	20.4
Exchangeable Cations me/100g	Ca	2.32	3.03	4.24	10.75
	Mg	1.66	2.58	2.98	6.35
	Na	0.37	0.29	0.28	0.27
	K	0.57	0.03	0.03	0.14
	H	10.02	1.40	nil.	nil.
% Saturation		32.1	80.9	100.0	100.0
pH		5.32	5.66	5.74	5.21
% Carbon		8.47	1.07		
% Nitrogen		0.604	0.074		
Total P_2O_5 mg/100g		226.0	57.0	45.0	49.0
Read. sol. P_2O_5 mg/100g		1.6	0.8	2.5	1.1

REMARKS

Low exch. Ca in H. High exch. Ca and Mg in B_2G.
Low total P_2O_5 in mineral horizons.
Low soluble P_2O_5 throughout.

Table 60 Kinloch Glen: soil analysis

Horizon		A	B	B	C
Depth (m)		0.02-0.08	0.15-0.25	0.30-0.38	0.61-0.72
% Loss on ignition		12.60	3.79	3.75	2.41
% Sand U.S.D.A		61.6	90.6	92.9	93.6
% Silt U.S.D.A		8.1	3.3	2.0	2.6
% Sand int.		89.6	91.2	93.6	94.4
% Silt int.		4.2	2.7	1.4	1.8
% Clay int.		4.0	2.3	1.2	1.4
Exchangeable Cations me/100g	Ca	nil.	nil.	nil.	nil.
	Mg	0.43	0.10	0.09	0.06
	Na	0.16	0.09	0.09	0.11
	K	0.16	0.05	0.05	0.01
	H	16.2	3.31	1.80	2.00
% Saturation		4.4	6.8	10.4	8.3
pH		5.05	5.30	5.52	5.20
% Carbon		6.01	1.53		
% Nitrogen		0.355	0.116		
Total P_2O_5 mg/100g		125.0	115.0	134.0	156.0
Read. sol. P_2O_5 mg/100g		0.5	0.2	0.3	0.4

REMARKS

Exch. Ca very low throughout.
Exch. Mg low in B and C.
Soluble P_2O_5 very low throughout.

Table 61 Guirdil raised beach : soil analysis

Horizon		A_1	B_2	C
Depth (m)		0.02-0.13	0.18-0.25	0.36-0.46
% Loss on ignition		7.15	2.09	1.03
% Sand U.S.D.A		88.4	95.1	96.2
% Silt U.S.D.A		6.6	1.8	2.2
% Sand int.		92.7	95.5	97.2
% Silt int.		2.3	1.4	1.8
% Clay int.		1.4	1.0	nil.
Exchangeable Cations me/100g	Ca	0.87	0.08	0.08
	Mg	1.05	0.17	0.17
	Na	0.23	0.07	0.09
	K	0.17	0.01	0.01
	H	6.6	1.9	0.96
% Saturation		26.4	14.8	26.7
pH		5.60	5.86	6.00
% Carbon		4.49	0.76	
% Nitrogen		0.384	0.060	
Total P_2O_5 mg/100g		138.0	64.0	32.0
Read. sol. P_2O_5 mg/100g		0.9	1.0	1.8

REMARKS

Low exch. Ca in A_1.
Very low exch. Ca and low exch. Mg in B_2 and C.
Very low soluble P_2O_5 in A_1.
Low total and soluble P_2O_5 in B_2 and C.

Table 62 Kilmory raised beach: soil analysis

Horizon		Ap	B	C
% Loss on ignition		24.51	14.41	17.84
% Sand int.		79	83	87
% Silt int.		20	15	13
% Clay int.		1	2	<1
Exchangeable Cations me/100g	Ca	14.31	6.19	3.57
	Mg	2.13	1.77	0.64
	Na	0.46	0.23	0.21
	K	0.26	0.08	0.17
	H	19.97	14.88	21.68
% Base saturation		46.2	35.7	17.5
pH	H_2O	5.25	5.28	5.41
	$CaCl_2$	4.78	4.62	4.68
% Carbon		11.49	5.36	6.91
% Nitrogen		0.68	0.26	0.43
Total P_2O_5 mg/100g		506	204	514
Read. sol. P_2O_5 mg/100g		42	14	16

Table 63 Kinloch excavation site: soil analysis

KINLOCH, RHUM: A REPORT ON THE THIN SECTIONS

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Kubiena can samples were taken intact from the interior and edges of depressions interpreted as archaeological features. Thin sections were prepared from these in the normal way (Fitzpatrick 1980) and examined under low and high power magnification (x30 to x400). Examination and description followed the procedure of Fitzpatrick (op cit).

It was very difficult to resolve the components of the feature fills during excavation in the field. One of the great strengths of microscopic study thin sections of such fills is the clarity with which their component parts can be observed in most cases. Such observation can be taken considerably further than simple visual description since other techniques can be applied to the section such as optical mineralogy and X-ray spectroscopy under electron microprobe. This allows a study which relates the properties of components of archaeological features to their spatial arrangement. This present study was limited to microscopic examination of the sections.

One of the three thin sections was taken from the centre of the fill of BA023, one from across the bottom of the cut of BA023 and one from the centre of BA021 at the surface revealed by the removal of the ploughsoil.

Section 1, taken from the centre of BA023 is dominated by a very dark matrix in which fragments of carbonised ?hazelnut shell abound. Between these fragments, small fragments of other, intact plant materials are also found. Small stones are common and carry thin coatings of the dark matrix. Larger stones, of diameter greater than 2cm or so were also occasionally found in the feature. They were avoided to make it easier to recover intact samples. The dark matrix consisted of particles too small to be resolved in thin section. Earlier analyses had shown that a high proportion of such materials on this site consisted of alkali soluble decayed organic matter. Worm pores were common, although small in diameter. No trace of soil structure was found. Nor were there any divisions of the sectioned fill except into its individual components. Modern roots were occasionally found.

Section 2, taken across the lower boundary of the fill of BA023 showed a gradual change from a matrix with few stones to a matrix dominated by stones. This change marked the boundary of the feature which was seen on excavation to be less stony inside than out. The proportion of organic matter in the fine matrix was seen to be greater within the feature than outside it with a transition over 2cm as seen in thin section. The matrix of the feature showed no structure and contained few cracks or pores. The stones within the feature contrasted with those outside by being coated with dark organic matter which explains why the dark organic matrix of the feature so dominated its appearance. The stone content of the feature seems to have had comparatively little effect on the appearance of the features in excavation because the stones are largely masked by their dark organic coating. Abundant worm and mite faecal matter suggest that the fill of the feature is being actively reworked although few worms were found during excavation. Two small flakes of bloodstone were found in the fill. Very few coatings were found which might indicate the movement of fine matter through voids. Neither fine organic matter nor clay were seen to have formed layered coatings on pore surfaces although occasional, weakly oriented, clay domains were seen. Thus the movement of fine matter in suspension does not appear to have brought about the diffusion of the contents of the feature. Fragments of organic matter within the feature (as defined by colour and therefore by organic matter concentration) were found to be of a wide variety of particle sizes whereas those outside the colour change boundary were found to be predominantly of diameters greater than 200 microns. This could indicate that the visible boundary of the feature is partly the result of the removal of finer organic fragments and that the observed boundary is not that which was originally formed.

Section 3 was taken from the centre of BA021. Organic matter dominated the matrix of the feature less than in BA023 (section 1) and fragments of organic matter larger than 500 microns in diameter were very rare. Nevertheless the feature matrix was seen to be very organic and fragments of intact cellular organic matter were commonly found within it. The matrix contained approximately 30% stones by volume, much more than that of BA023, and it had a weak granular structure. Fine pores were found within the matrix and worm faeces were commonly encountered. Much of the organic matrix was too fine to be resolved. Within the dark organic matrix were areas of finer, more mineral rich matter. This was isotropic and might be the result of mixing. Stones carried a thin , unoriented coating of the dark organic matrix of the feature, again making them appear very dark. Oriented clay domains were occasionally observed as were rare clay and silt plugs.

What conclusions can be drawn from these sections? The volume sampled by this approach is very small when compared with the total volume of the possible archaeological features. Only one class of feature was examined, the 'pit'. The features of BA021 and BA023 differ in the make up of their matrices. BA023 contains more coarse organic matter and has less evident structure and mixing than BA021. The unresolvable fine organic matter in both features could not be differentiated from similar matter outside the features. The slightly smaller evidence of mixing of fine matter in BA023 when compared with BA021 suggests that this fine matter is more likely to have originated within the feature than is the case for the fine matter within BA021 but this is only a relative consideration. Rare, oriented and sorted fine coatings, domains and plugs suggest that fine organic matter has been mobile within the archaeological features. This would suggest that such fine matter found within the features may not originate within them and that the analysis of fine matter may not be a reliable guide to the original contents of the features. Uncertainty remains as to whether the colour change seen to indicate the edges of features is not the result of the sorting of fine organic matter from the features. as in the case of BA023. The clear change in stone abundance at the edge of the feature seems to indicate that the edge is as it was when first formed since later disturbance is unlikely to have brought about such a change.

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KINLOCH, RHUM: A REPORT ON THE STATISTICS OF STONES FROM CONTEXTS

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Introduction and Objectives

The features discovered during excavation were filled with material in which the sizes and shapes of the stones appeared to differ from the neighbouring ploughsoil and naturally occurring sediments. It was thought that information on the nature of these stones might help in understanding the manner in which the features were filled and the material that was used for filling. This might, in turn, suggest reasons why the features were formed and whether there were any associations between them.

Methodology

On site it was found that there was a close correspondence between the distribution of artefacts in the topsoil and features below. There was no significant accumulation of material at the base of breaks of slope and relict periglacial structures were preserved in the soil profile. Hence it was concluded that particles with a diameter greater than 2mm had not suffered significant movement in the soil since the site was occupied. Thus analyses were confined to stone sizes larger than this.

The following variables were measured in each sample:

* Particle size distribution in classes of 3-4mm; 4-8mm; 8-16mm and >16mm (all stones).
* Roundness of stones 8-16mm (100 stones)

* Shape of stones 8-16mm (100 stones)

* Mass of stones 8-16mm (100 stones)

* Roundness of stones >16mm (all stones, two scales)

* For the majority (28 out of 42) of the samples 50 stones were measured along their three principal axes so that their shape could be calculated.

The number of samples that could be analysed was limited. Samples were chosen in order to provide examples of several feature types, parent materials and ploughsoils. Nineteen of the forty-two samples were duplicates.

Once collected, each sample was wet-sieved at 3mm and the retentate dried. This was then shaken through sieves of 4mm, 8mm and 16mm mesh to constant weight and each of the four resulting fractions was weighed. The fraction of 8-16mm was then quartered and quartered again and eight of the resulting sub-samples were chosen at random and examined in random order. Stones were taken from the first sub-sample and their roundness estimated on a standard scale. Each stone was then assigned to a shape class and weighed. When all the stones of the first sub-sample had been examined, the second sub-sample was used until 100 stones had been examined. This elaborate procedure was instigated because it was found that there was a bias towards larger stones being selected if they were taken from the sample directly. One replicate of 50 stones was carried out and it was found that 10 stones were assigned to different shape classes and 14 to different shape classes on re-estimation. Thus reproducibility was low.

All the stones over 16mm in diameter were classified according to two classificatins of roundness (Gardiner & Dackombe 1983; Fitzpatrick 1980). One replicate of 50 stones was carried out and it was found that 10 of these 50 were assigned to different classes on the first index and 4 on the second. Thus again reproducibility was quite low.

Results

Each sample is briefly discussed below. Few generalisations can be made except for one which stands out. With only one exception (fill 0089), the natural parent materials are more rounded than the fills of the features. Thus it may be concluded that the material with which the features are filled is partly artificially angular. It can also be concluded that the pits are similar, at least in angularity of contained stones, although some contain many more angular stones than others. The variability in sphericity is considerable, even within fills, but some fills have consistently high or low spreads of stone sizes. Although similarly variable, mean maximum lengths show that some features contain consistently larger stones than do others. These features also tend to have considerable spread of stone sizes, suggesting that the high values of mean maximum length may be due to a proportion of large stones within fills which otherwise have normal stone sizes.

SAMPLE NO.	ORIGIN	SPHERICITY		MAXIMUM LENGTH	
		MEAN	S.D.	MEAN	S.D.
1	Ap, Test pit 3	62.4	8.27	48.9	11.3
2	Till, 0.30-0.60m	64.0	8.60	54.5	29.5
3	Ap, South Extension	62.4	7.83	55.1	23.8
4	Gravel Natural	64.2	12.42	45.3	10.8
5	Gravel Natural T.P. 3	60.5	11.84	68.5	27.9
6	BA0021	59.4	9.96	53.8	14.6
7	"	56.7	9.40	56.6	22.4
8	"	52.7	10.20	55.2	17.4
9	BA0023	54.8	11.73	63.7	28.7
10	BA0047	49.2	10.36	56.7	20.9
11	"	51.1	9.02	57.0	24.2
12	"	51.7	9.97	50.1	13.8
13	BA0052	56.2	8.62	49.1	8.6
14	"	55.3	9.44	53.4	17.2
15	BA0087	56.1	8.12	46.0	10.0
16	"	59.9	11.83	44.6	8.8
17	BA0089	64.2	9.18	41.5	9.4
18	"	60.9	8.37	45.8	8.9
19	BA0090	57.4	12.78	59.7	25.8
20	"	54.4	9.74	57.8	21.6
21	"	53.5	12.62	62.4	25.8
22	BA0091	54.6	13.43	52.1	15.7
23	"	51.7	15.77	58.2	19.0
24	BA0093	55.2	10.58	54.7	22.0
25	"	53.2	10.87	56.5	20.2
26	BA0094	52.8	11.37	60.0	20.8
27	"	54.2	10.36	58.3	30.0
28	"	59.2	12.28	54.2	17.8

Table 64 Comparison of stones from the archaeological features and the excavation site matrix, sphericity and maximum length

The samples are discussed mainly in the light of the data for sphericity and maximum length (table 64) since these are most readily interpreted.

1. *The Ap horizon of soil test pit no.3.*

This is one of five samples of ploughsoil. Mean sphericity is very high and relatively invariant while mean maximum length is low and also relatively invariant. Thus sample 1 is comparatively well rounded and sorted. These are interesting and perhaps surprising attributes for a ploughsoil. It is not consistently similar or dissimilar to any particular class of samples or fills except that its high degree of rounding is similar to the other parent material samples.

2. *Till.*

The stones in this sample are comparatively well rounded, of approximately mean size and very poorly sorted.

3. *Ploughsoil.*

The stones in this sample are comparatively well rounded, of approximately mean size and moderately poorly sorted.

4. *Gravel parent material.*

The stones in this sample are comparatively well rounded although variable. They tend to be very small and very well sorted.

5. *Gravel parent material.*

This is moderately and moderately variably well rounded. Its stones are comparatively large and poorly sorted. It differs from sample 4 in these respects.

6, 7, 8. *BA021.*

These are quite similar to each other and near the mean for sphericity, size and their variabilities. Their properties are quite different from those of the parent material samples.

9. *BA023*

This is near the mean for sphericity and its variability. Its stones are very large and poorly sorted, however.

10, 11, 12. *BA047*

These are quite similar to each other, 10 and11 more so. They are all very angular and not very variably so. They are close to the mean for mean maximum length and variability. This feature appears to be particularly rich in the exotic, angular stones.

13, 14. *BA052*

While quite different from the parent materials, these samples are only a little below the mean for sphericity and for mean maximum length. Sample 13 is less variable and sample 14 slightly less variable than the mean for both criteria.

15, 16. *BA087*

While these samples differ in sphericity, they contain stones of similar sizes and sorted to a similar degree. The sphericity of stones in sample 15 is close to mean while the associated standard deviation is low. Stones in sample 16 are moderately spherical but more variable than the mean. Stone sizes in both samples are low and vary very little ie. the samples are well sorted.

17, 18. *BA089*

These samples differ from the other feature fills in having comparatively spherical stones. These stones are also small and well sorted. The samples are similar to each other.

19, 20, 21. *BA90*

Samples 19 and 21 are moderately similar to each other, but 20 is slightly different. The stones in sample 19 are moderately spherical, while those in samples 20 and 21 are slightly more angular than the mean. The sphericity of 19 and 21 is very variable while that for 20 is much less so. Stones in all three samples are large and poorly sorted.

22, 23. *BA91*

These samples differ slightly from each other. Both contain stones which are less spherical than the mean, sample 23 very much so. Both have very variable sphericities. While the stones in sample 22 are smaller than the mean and moderately well sorted, those in sample 23 are larger and moderately poorly sorted.

24, 25. *BA093*

These samples are very similar to each other. Both are slightly less spherical than the mean and contain stones which are slightly larger than the mean. The variability of both is slightly greater than the mean, for both criteria.

26, 27, 28. *BA094*

These samples differ from each other, 28 more so than 27 and 26. While 26 and 27 are less spherical than the mean and contain larger stones, 28 is more spherical and contains larger stones. This follows the trend established in other samples which shows that angular stones which are exotic to the parent material are also larger than the mean.

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KINLOCH, RHUM: TOTAL PHOSPHATE ANALYSIS OF SOILS

S LEE

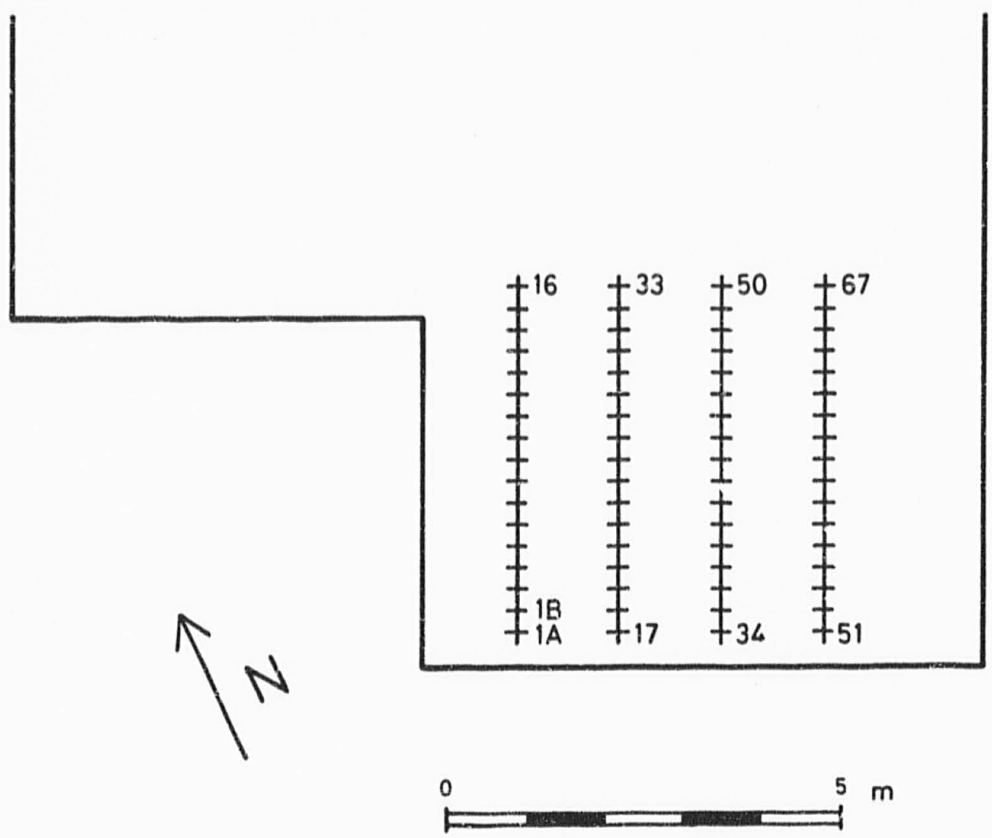
Introduction (Ill 116)

Total phosphate determinations were carried out on 68 samples taken from a grid survey of part of the site in trench BA thought to have underlain a possible structure. The aim of this part of the analysis was to determine whether the distribution of phosphates correlated with the distribution of archaeological features. If this was found to be the case then it was hoped that phosphate levels could be used to clarify the status of the archaeological features.

The phosphate grid samples were taken from four lanes each one metre apart and within the lanes at 25cm intervals from a depth of 3cm below the ploughsoil. The area covered by the grid was 3m x 4m.

Also analysed were 26 background samples and further samples from around a feature AD222. These samples had previously been investigated using a different methodology (Hirons and Edwards, mf) and the aim of analysing them again was to check for comparability with the previous work.

The background samples were also used as a measure of the natural phosphate variability.



ILL 116 : Trench BA. Location of samples for total phosphate analysis of soils

Samples were also taken from a number of features in trench BA but outside the area covered by the grid. Samples were taken from the fills of features and also from 20cm under the visible edge of the feature. This work aimed to cast light on the behaviour of phosphate deposits with respect to their mobility.

Method

Samples were air dried and then sieved through a 2mm mesh. The samples were then placed in an oven at 50 degrees Celsius and dried to constant weight (24 hours was found to be sufficient for this).

Circa 0.2gm of soil was then taken and ignited at 550 degrees C for one hour. The soil was boiled in 25ml 1N HCl for thirty minutes to extract the phosphate (Anderson 1976). The cooled extract was filtered and made up to 25ml in a volumetric flask. 10ml of this extract was put in a 50ml volumetric flask and to this was added about 25ml of water. Then 10ml of the molybdovanadate solution was added and the mixture made up to volume. This was left for at least 10 minutes but less than an hour and the absorbance read on a Corning EE 197 Spectra Colorimeter. A calibration curve was prepared for each batch of readings although the curve itself was found to be consistent. THe curve was made by substituting aliquots of a 50ppm P stock solution for the extract in the assay mix. The calibration curve was found to be linear between 1 and 10ppm with a slight loss of linearity between 10 and 20 ppm.

The solutions were read against a phosphate free blank and also measured was an extraction blank (25ml HCl boiled for 30 minutes and a 10ml aliquot taken for assay). This blank was always found to contain no phosphate.

This method was used by Hamond (1985) and the assay is best described by Jackson (1958).

1 in 4 samples were replicated, the majority of these cross batch to enable an estimate of overall laboratory precision.

All glassware was thoroughly washed in phosphate free detergent solution, rinsed and left standing in 10% nitric acid for 24 hours before being rinsed three times in tap water and three times in distilled water.

Throughout the procedure steps were taken to avoid contamination of the samples from external sources of phosphate, thus following the advice: 'Dust, saliva, perspiration and tobacco ashes carry appreciable amounts of phosphorus and should therefore be excluded'! (Jackson 1958).

Results

The overall precision indicating the level of laboratory error was calculated using the method of Vermeulen (1953) and was found to be 102ppmP. Laboratory error was therefore around 5%.

1985 Samples (table 65)

The results of the re-analysis of the 1985 samples were found to be linearly related to the original values. Although this gave cause for concern, time was not available to investigate its origin. The cross batch duplicates suggested that the analysis was internally consistent and the results of this work are still of value.

1986 Samples (table 66)

Only a limited number of the samples taken from the pits excavated in 1986 were analysed due to a lack of available time. Nothing conclusive can be said about these results , however some interesting patterns have emerged and are worth considering.

The phosphate levels found in the fills of features BA23 and BA47 are not markedly higher than those found in the natural soils of the site. However, the control samples taken from 20cm below the visible edge of the feature do have enhanced phosphate levels. This may indicate movement of phosphate from the feature into the underlying natural soil where it is apparently bound.

Alternatively the samples from the fills of BA107 and BA108 do exhibit considerably enhanced phosphate levels. The control samples from these features were not analysed.

The Grid (table 67)

SAMPLE NO.	PPM	PPMREP	PPM BY HIRONS
P1	820	940	528
P2	1130	1220	700
P3	1290	1040	550
P4	1040	1120	600
P5	1390		720
P6	1650		710
P7	1090	1110	584
P8	1260		710
P9	1690		885
P10	2490	2600	1370
P20	520		390
P21	830		216
P22	580		344
P23	900		360
P24	1430		436
P25	340		136
P26	1300		660
P27	900		207
P28	890		280
P29	850		345
P30	1170		456
P31	1120		392
P32	810		510
P33	750		337
P34	860		300
P35	630		266
P36	1060		410

Table 65 Total phosphate analysis: replication of 1985 samples

FEATURE & SAMPLE	PPM P	DESCRIPTION
BB018G	990	BB018 consisted of two layers a black peaty layer overlaid a grey silt clay. The control sample was from the sandstone gravels 0.50m c. N of BB018.
BB018 NATURAL	320	
BB019	1150	
BA021B	2170	
BA023D	1850	Base of fill BA023
BA023 CONTROL C	3580	0.20m below bottom of visible edge.
BA047B	1130	Middle of top layer.
BA047D	1320	Middle of lower layer.
BA047 CONTROL C	4180	0.20m below visible base of feature.
BA107B	3740	0.40m below top of BA107.
BA107M	5800	0.25m "
BA107T	3550	0.15m "
BA108BS	2840	
BA101/1	3770	
BA102/2	4100	
BA103/3	4100	
BA104/4	2180	

Table 66 Total phosphate analysis : 1986 features, sample results

SAMPLE NO.	PPM	PO4
1A	2070	2130
1B	2210	2190
2	2940	2890
3	2350	
4	3020	3030
5	2850	
6	2160	
7	2460	
8	2900	2880
9	2420	2450
10	1630	1630
11	1330	
12	1630	
13	1840	
14	1830	
15	3540	
16	2740	2940
17	1840	
18	1960	
19	1060	1220
20	1910	
21	3650	
22	1930	
23	2550	
24	2530	
25	3720	
26	2560	2540
27	3210	
28	7840	8250
29	2550	
30	1680	1980
31	2850	
32	2180	
33	2680	2800

SAMPLE NO.	PPM	PO4
34	1950	
35	2690	
36	2660	
37	2610	
38	2890	
39	4300	
40	2830	3090
41	2720	
42	2030	2000
43	1980	
44	3160	
45	1180	
46	1580	1560
47	1440	
48	2070	
49	2380	
50	1900	2130
51	4730	
52	2380	2430
53	4850	
54	2930	
55	2790	
56	2720	
57	2290	
58	1640	1630
59	1880	
60	1380	
61	1700	
62	1100	
63	860	830
64	1750	
65	2720	2660
66	4780	4800
67	3520	

Table 67 Total phosphate analysis: 1986 grid samples in trench BA, sample results

Comparing the set of samples from the grid and the samples from the natural soils (P20 to P36) using the Whitney Mann U test (Ebdon 1978) it can be shown that the two sets of samples are likely to be from different populations at the 0.001 significance level.

The Whitney Mann U test was also used against all those samples taken from within 17cm of suspected features and the rest of the samples from the grid. The null hypothesis could be rejected at the 0.05 significance level. This would be expected if we consider the features to be areas of concentrated human activity within the settlement as a whole.

The south east corner of the grid area was thought possibly to have overlain part of an early structure. A Whitney Mann U test was carried out on the twelve samples from this area and the rest of the grid samples. The Null hypothesis could be rejected at the 0.05 significance level suggesting that the samples from around this area do come from a separate population to those from the rest of the grid. This may support the possibility that this area was associated with a structure.

Conclusion

Analysis of the phosphate content of soils on and around the site was carried out. The results demonstrated that the soils within the area of the site exhibited enhanced phosphate levels compared to the phosphate content of the natural soils around the site.

Further to this the soils from the site taken from within 17cm of suspected features exhibited enhanced phosphate content (when treated as a population) compared to the other soil samples taken from within the site. However, soil phosphate levels alone were not capable of diagnosing between soils from individual features and the other soils of the occupation area. Preliminary work suggested that some features retained high phosphate content whereas other features had lost phosphate to the underlying natural.

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Report on Geomorphological Investigations Carried Out in Support of the Excavation at Kinloch, Rhum.

DG SUTHERLAND

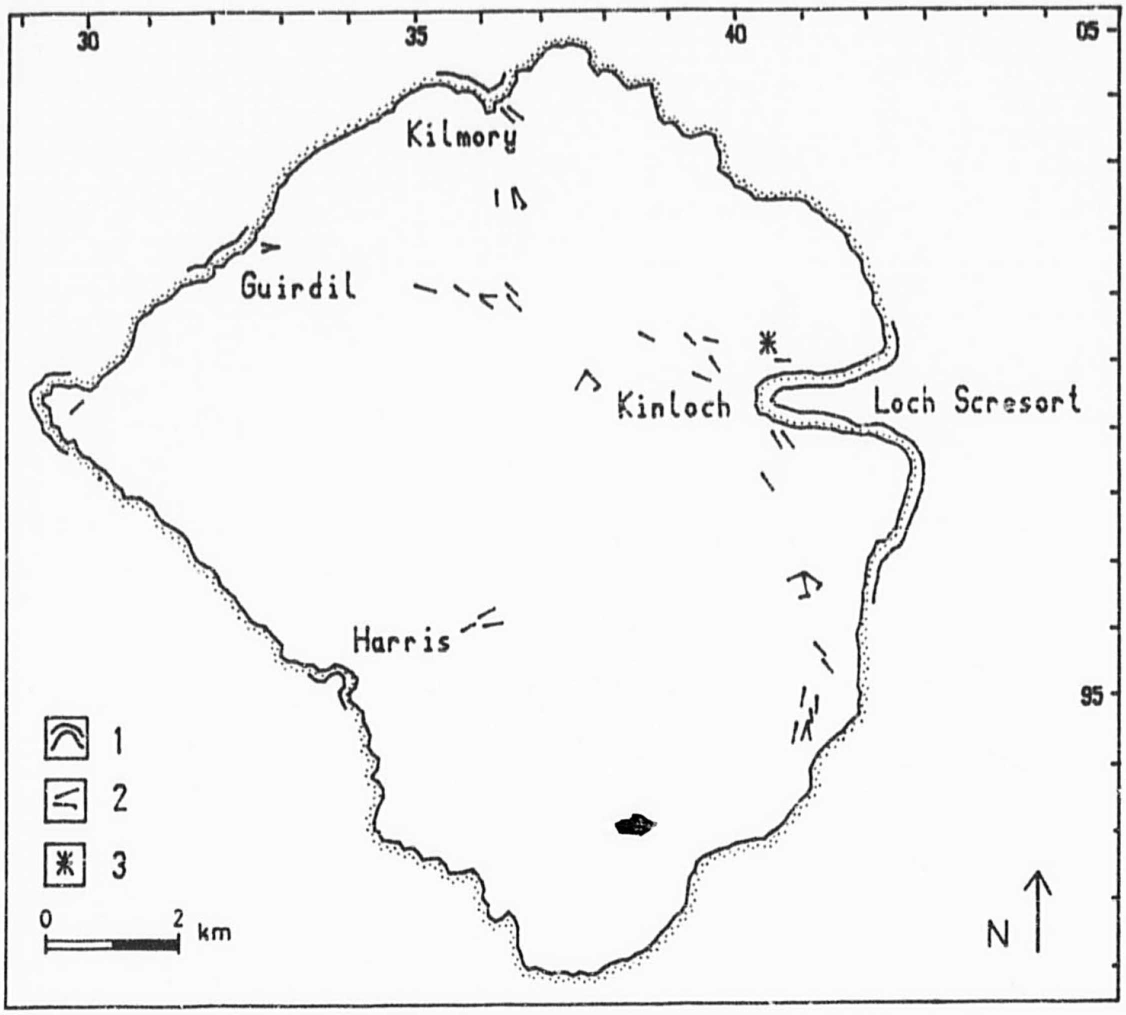
Introduction and Objectives

During 1984, archaeological excavations were carried out at Kinloch, Rhum which established Mesolithic occupation of that area from as early as c.8500 BP. The site is situated between c.11 and 15m above local O.D., but its relationship to Flandrian sea levels was unknown. Sea level during the period of occupation of the site and subsequently is of importance (a) as a factor in the local environment and (b) as a potential factor in disturbance of the site by marine transgression after its abandoment.

The principal objective of the work reported here was therefore to study the history of sea-level change around the coast of Rhum and to relate this to the Kinloch site. A second objective was to study the sediment forming the undersoil of the site in order to understand its genesis. In addition, factors relating to the natural transport of bloodstone from Bloodstone Hill and its incorporation in the beach at Guirdil were also examined.

Work Carried Out

Following examination of the whole of Rhum on aerial photographs at a scale of c. 1:27,000 and a review of the relevant literature, a 10-day programme of field work from 6th to 16th



1. Stretches of coastline mapped at 1:10,000
2. Striations mapped during this study; older striations tail marked. The striations indicate dominant ice-flow from east-west, Lastglaciation.
3. Archaeological Site

ILL 117 : Geomorphological work on Rhum 1985

April 1985 was carried out. Those stretches of coastline and lower portions of adjacent valleys that seemed likely to preserve evidence of former sea-level changes were mapped at a scale of 1:10,000 (Ill 117). During this mapping, in addition to landforms and sediments resulting from sea-level changes, features relating to glaciation or post-glacial processes were also recorded. The mapping was supplemented by shallow hand bores to a maximum depth of 3m to investigate the sediments at the head of Loch Scresort (10 bores) and in the lower part of the Kilmory Glen (8 bores) together with a number of other bores through peat around Kinloch.

Subsequent to mapping, all clear raised shoreline features around Loch Scresort, at Harris and at Guirdil were accurately levelled on closed traverses using a Koshiba semi-automatic level.

Sedimentological investigations were also carried out both in the field and subsequently in the laboratory on samples from the substrate of the archaeological site.

Sea Level Change

Introduction:

Certain aspects of the raised shorelines around the coasts of Rhum have been described in the literature (Harker 1908, McCann and Richards 1969, Peacock 1976). These accounts have concentrated mainly on the rock-cut shorelines and Lateglacial depositional features and have only mentioned briefly marine landforms and sediments that were presumed to date from the

Flandrian (i.e. c.10,000 BP to the present). More general reviews of raised shorelines around Scotland (e.g. Sissons 1976) have provided maps that indicate the altitude attained by the sea at the peak of the Main Postglacial Transgression (i.e. c.6500-7000 BP). On Rhum, this figure has been put at c.8-9m O.D. It is important to note, however, that figures derived from such national diagrams are broadly related to Newlyn Datum, a mean-tide datum, whilst Rhum local datum, according to the 2nd Edition 1:10,560 maps, is a low-tide datum. (No resurvey of bench marks was carried out during production of the 1:10,000 maps on Rhum: the bench mark altitudes given on these maps are the 6-inch 2nd Edition values converted to metres). Admiralty Tide Tables indicate the tidal range in this area of the Inner Hebrides to be c.4m. Hence, on the altitude reached by the Main Postglacial Transgression on Rhum when related to local datum should be increased by c.2m to 10-11m local O.D.

Local Shore-Forming Factors:

In addition to the datum problem, the development and altitude of any particular shoreline feature is a function of local factors such as sediment supply, exposure, offshore profile and coastal profile (as well as regional factors such as isostasy and eustasy which alter the altitude of operation of marine processes over long time periods).

On Rhum, sediment supply to the coast today, as apparently during the whole of the Flandrian, is very low. This is indicated by the poor development of Flandrian shorelines, the paucity of river terraces graded to these and the considerable thickness of peat and fine-grained sediment accumulated in the lower reaches of Kilmory Glen. The low total sediment supply to the coasts of Rhum seems attributable to the lack of extensive (easily-eroded) glacial deposits. The numerous short streams that drain the island also result in such sediment as is transported being dispersed around the coast rather than concentrated in particular areas. Much of the material in Flandrian raised shorelines, as in the present beaches, therefore appears to be of very local derivation or reworked from earlier periods of sediment supply (i.e. the Lateglacial period, c.13,000-10,000 BP).

Exposure varies very greatly around the coast of Rhum. The bays at Harris and Guirdil on the south and west coasts have maximum fetches of well in excess of 150km, whilst Kilmory on the north coast has a maximum fetch of c.75km. The head of Loch Scresort near the archaeological site is the most sheltered stretch of coast on the island with a maximum fetch of 25km to the east-south-east, itself a direction of relatively low frequency of strong winds. Exposure is the principal control on the altitude to which waves are liable to move sediment along a particular shoreline and hence local variation due to this factor must be anticipated around the Rhum coast.

The coastal profile of Rhum is typically very steep with cliffs, rising in places to over 300m, around all but a few stretches of coast. These cliffs are fronted by various rock platform remnants that pre-date the Flandrian indicating the cliffs to be fossil (McCann and Richards 1969) and hence, despite their impressive appearance, supplying very little sediment to the coast. The steep nature of the coastal profile, even in many embayments, precludes extensive development of depositional marine landforms.

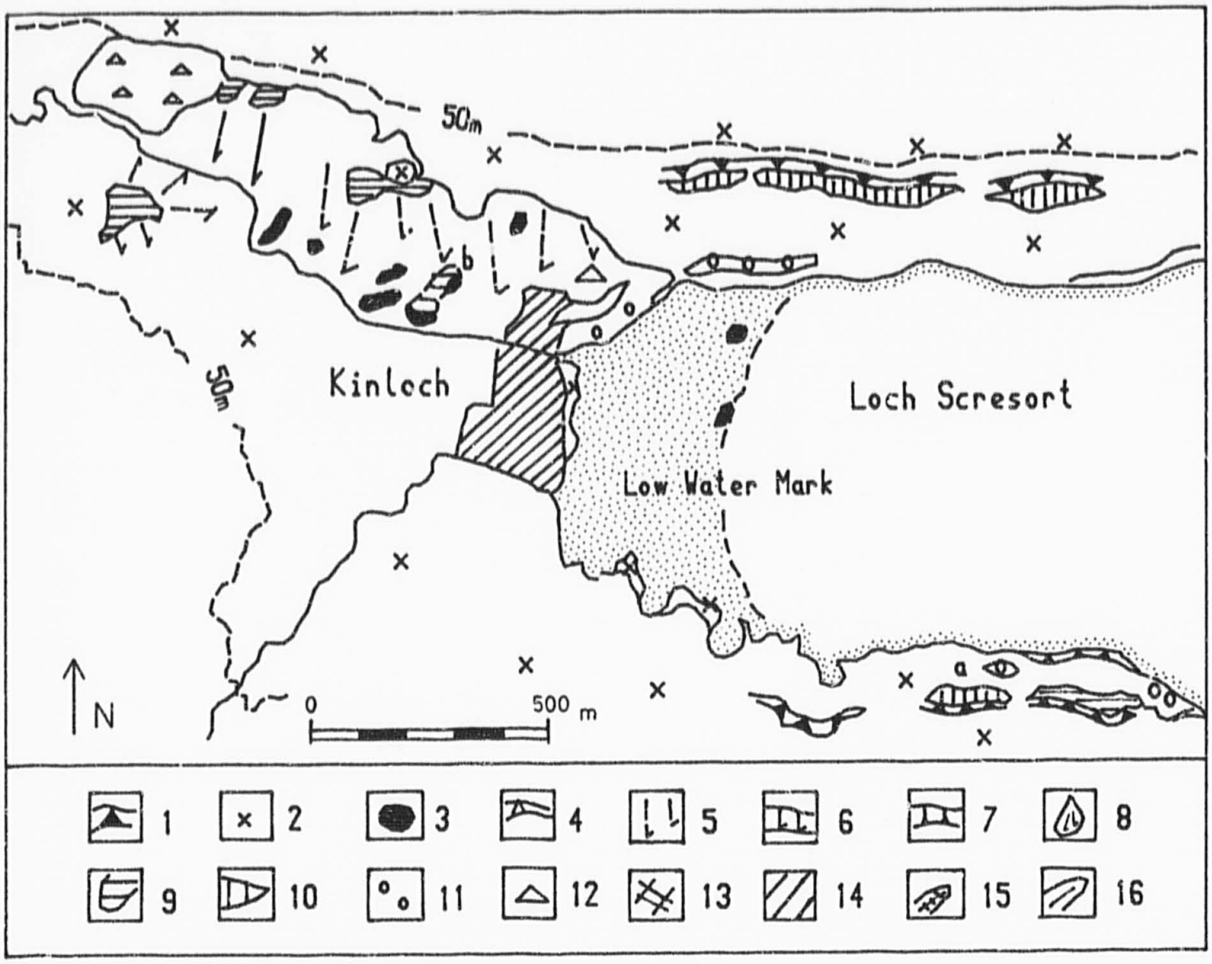
The offshore profile is also generally steep around Rhum, the only exception being in Loch Scresort. A shallow offshore profile results in the reduction of wave energy prior to its reaching the shore. Hence on Rhum this factor operates in sympathy with fetch in emphasising the sheltered nature of Loch Scresort, particularly its head around Kinloch, and the exposed nature of Harris and Guirdil.

In summary, the local factors affecting the development and altitude of shoreline features are not conducive to widespread formation of depositional land forms. There is also likely to be considerable local variation, from bay to bay, in the altitude at which given processes are effective. Loch Scresort has by far the most sheltered coastline on the island. As is discussed later, at the maximum of the Main Postglacial Transgression the lower part of Kilmory Glen would have been an even more protected brackish/marine embayment. Insofar as Mesolithic settlement was influenced by the sheltered nature of Loch Scresort, then in the middle Flandrian the lower portion of Kilmory Glen may also have offered an attractive environment.

Field Evidence of Former Sea Levels:

A geomorphological map of the area around Loch Scresort is shown in (Ill 118).The highest marine features, formed at the time of deglaciation, are found within Glen Kinloch where depositional terraces, fronting a large drift mound, have an altitude of c.35m local O.D. During the fall in sea level subsequent to the formation of these features a further depositional terrace was formed in the mouth of Glen Kinloch at an altitude of c.24m local O.D. A major rock-cut platform and degraded cliffline occurs along the north of Loch Scresort and on the south side of the loch by its mouth. This was surveyed near the head of the loch where it has an altitude of c.32m O.D. The age of this and similar rock platforms which are found widely around the coast of Rhum is unknown: they may be older than the last regional glaciation.

The remaining evidence relating to sea-level change around Loch Scresort is considered to be of Flandrian age and to have been formed at the maximum of, or following, the Main Postglacial Transgression. No evidence has been found in the area around Loch Scresort to establish the transgressional nature of these marine landforms and sediments. However, evidence for such a transgression probably exists in Kilmory Glen where a line of eight boreholes proved a widespread minerogenic layer with peat above and below at an altitude of around 10m. This site deserves further detailed investigation. Furthermore, the Main Postglacial



1. Sharp break of slope in bedrock. 2. General bedrock exposure.
3. Limited bedrock exposure. 4. Sharp break of slope in drift. 5. Moderate drift slope.
6. Steep drift slope. 7. Talus. 8. Alluvial fan. 9. Terrace in drift.
10. Rock platform. 11. Beach gravel spreads. 12. Large accumulation of glacial sediments.
13. Infilled peaty basin. 14. Man-made ground. 15. End moraine. 16. Shingle ridge.

ILL 118 : Geomorphological map of the head of Loch Scresort and the lower part of Kinloch Glen

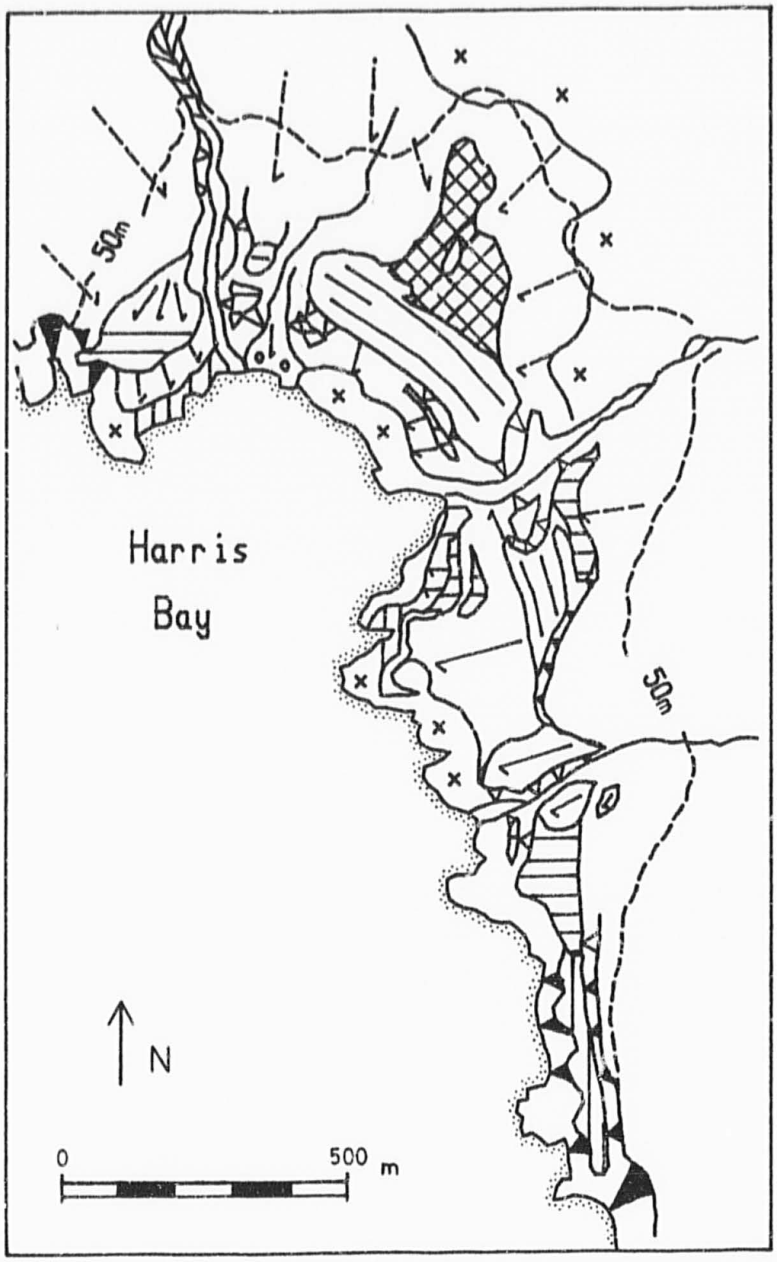
Transgression has been established at a sufficiently large number of localities around the Scottish coast to make it certain as an element in the sea-level history of Rhum. The sea-level changes established elsewhere in Scotland indicate an early Flandrian regression minimum at between 8000 and 8500 BP. followed by the Main Postglacial Transgression which culminated in the formation of the Main Postglacial Shoreline at around 6500-7000 BP.

Ten boreholes were drilled in the intertidal sediment at the head of Loch Scresort in a search for any early Flandrian peats that may have formed during the early Flandrian regression and been presesved because of the low energy environment and low sediment budget at the loch head. No peat was found, however, just a c.50cm surface layer of medium to coarse shelly sand overlying grey shelly silty fine sand in most bores. This lower deposit is thought to be the finer-grained offshore sediments deposited during the higher middle Flandrian sea levels. The drilling programme had to be curtailed because of tidal changes that restricted access to the lower part of the intertidal zone.

Around the margins of Loch Scresort, Flandrian beach gravels, where present, occur mainly as thin spreads resting on bedrock. On the south side of the Loch, however, a narrow depositional terrace exists at (a) in Ill 118.This has an altitude of 11.4m local O.D. and although this altitude may be influenced by the underlying rock structural bench, this provides a maximum altitude for the Main Postglacial Shoreline by Loch Scresort.

In the lower part of Kinloch Glen to the north of the river (b) in Ill 118 , a peat-covered terrace was investigated. The sub-peat surface consists of grey sands and silts with a thin surface layer of gravel at an altitude of 9.9m local O.D. The base of the peat is characterised by abundant Phragmites macrofossils and, although no microfossil evidence is presently available on this section, it is thought that the minerogenic/peat transition is a seral contact from marine to freshwater conditions (but see Chapters 11 & 12 in text). A sample was removed for radiocarbon dating from the basal 2cm of the peat and it is anticipated that this sample should closely date the retreat of the sea from the maximum achieved at the peak of the Main Postglacial Transgression.

The evidence of former sea-level change at Harris and Guirdil is broadly similar to that for Loch Scresort. A geomorphological map of the coast around Harris is shown (Ill 119).The highest former marine features are the notable series of raised shingle ridges around the head of Harris Bay at an altitude of c.30m. Sea level fell following the formation of these ridges and beaches have been preserved at c.21m and c.17m, the former appearing as a more significant feature in the area of Harris Lodge for it coincides approximately with the level of a pre-existing rock platform that can be traced along much of the south/west coast of Rhum. All these raised shorelines predate the Flandrian.



ILL 119 : Geomorphological map of Harris Bay

The generally steep coastal slope around Harris Bay below the level of the high rock platform has restricted the development of Flandrian marine deposits. These are typically in the form of steep banks of gravel and only one such feature was surveyed, in the south/east of the bay. This had an altitude of c.8m, which, given the degree of exposure of the bay and the information from elsewhere on Rhum as to Flandrian sea levels, implies formation in the latter part of the Flandrian.

At Guirdil (Ill 122), there are only two depositional features that can be related directly to sea level. The higher, at an altitude of c.27.5m, relates to the period of deglaciation when a small valley glacier occupied Guirdil Glen. The lower feature is the raised beach on which the bothy stands. It represents the highest Flandrian shoreline and occurs at c.9.5m. Given the variation in coastal conditions and the likely effect of isostatic tilting, this figure for the uppermost sea level during the Flandrian is in agreement with the figures derived for Loch Scresort. More detailed discussion of the Guirdil area is included later.

Conclusions

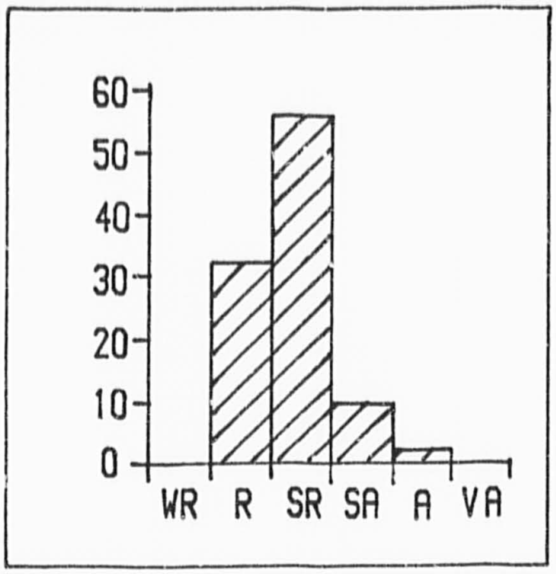
In conclusion, the available evidence suggests that the maximum altitude achieved by the sea during the middle Flandrian may be placed at approximately 10-11m local O.D. around Loch Scresort. This event was very probably preceeded by a period of lower sea level and, by comparison with other areas in Scotland the time of lowest sea level approximately coincided with the earliest period of occupation of the Kinloch site. The local sea level at this time is, however, undetermined. In eastern Scotland where the Main Postglacial Shoreline (allowing for differences in datum) is at approximately the same altitude as around Loch Scresort, the early Flandrian regression appears to have approached or dropped below present sea level. At the time of earliest occupation of the Kinloch site, therefore, sea level could have been close to or perhaps below present sea level.

The subsequent rise of sea level during Main Postglacial Transgression did not reach such an altitude that would have disrupted the area excavated. That the occupation site has been traced to a lowest altitude that broadly coincides with the uppermost Flandrian sea level may suggest, however, that lower portions of the site have been destroyed during the transgression.

At the time of the Main Postglacial Shoreline the lower reaches of Kilmory Glen were occupied by the sea or by a brackish inlet. This may have provided an attractive sheltered environment for mesolithic man.

Sediment Analysis from the Substrate of the Kinloch Site

A particular problem related to the archaeological excavation was the nature of the sediment on which the Mesolithic settlement had been established. As can be seen (Ill 118), there is only a



WR: well rounded R: rounded
SR: sub-rounded SA: sub-angular
A: angular VA: very angular

ILL 120: Trench AJ. Clast roundness

0.00-0.25 m	Topsoil. Grey-black organic rich sand with pebbles scattered throughout.
0.25-0.55 m	Organic rich medium-fine sand with more abundant pebbles and cobbles than above. Abundant rootlets and iron staining. Very compact.
0.55-0.75 m	Very compact clast-supported cobbles with coarse sand and small gravel matrix. Iron staining and rootlet penetration.
0.75-0.80 m	Very compact reddish-brown clast supported cobbles with medium sand matrix. Reduced iron staining.
0.80-1.10 m	Very compact reddish-brown clast supported cobbles and small boulders. Matrix small gravel to medium-coarse sand. Some iron staining. Some clasts weak and partly rotted.
1.10 m	Base of pit.

Table 68 Trench AJ: stratigraphy

limited area of sediment-covered ground around the head of Loch Scresort. The largest such area is on the north side of the head of the loch where the excavations were located. A short distance to the east of the site the sediment thins out against a Torridonian bedrock rise whilst to the west bedrock outcrops in a number of areas suggesting that the sediment itself is relatively thin. A small fossil possibly marine-cut cliff occurs immediately south of the site. This has a maximum relief of c.3m, implying that in this area the body of sediment has at least this thickness. In order to investigate this sediment more closely and to confirm the base of the site, a trench (AJ) was dug towards the lower end of the site. It had a surface altitude of 11.8m local O.D. The stratigraphy is shown in table 68.

The sediment analysis described below was carried out on the lowermost 30cm of the pit as this would be the least disturbed by surface activity (the archaeological material occurred in the topmost c.55cm) and soil-forming processes.

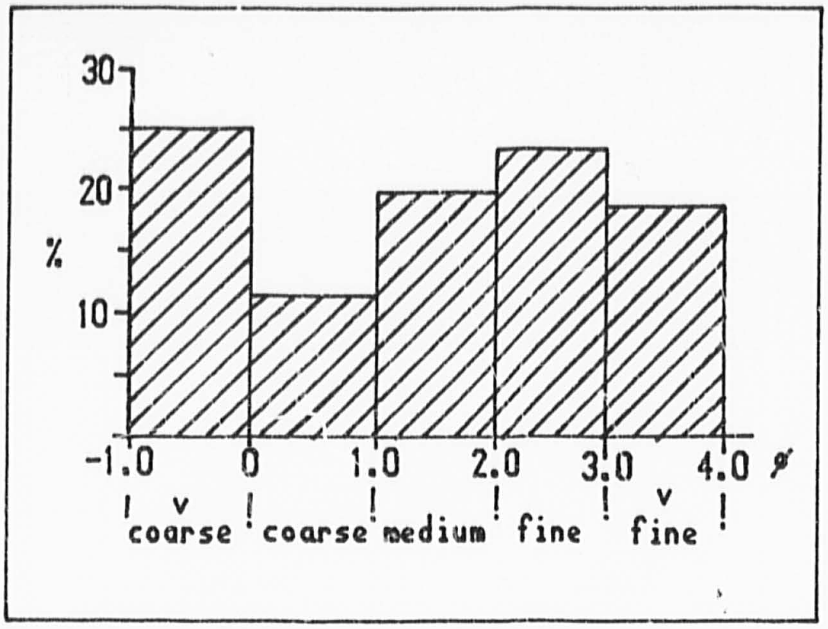
Clast form. Fifty clasts, the long axes of which were greater than 4cm, were measured for the long (a), intermediate (b) and short (c) axes. The mean [a+b]/2c ratio was 2.04 and the mean c/a ratio was 0.46.

Roundness. The roundness of the same 50 clasts was assessed on a six-point scale extending from well-round to very angular. The results are shown in Ill 120 from which it can be seen that the modal class is sub-round with rounded clasts being the most frequent.

Lithology. The lithology of the same 50 clasts was also classified. The dominant lithology was Torridon Sandstone (44%). Of particular interest were Schistose and Mesozoic sedimentary lithologies (12.5%) that do not crop out on Rhum. The remainder of the clasts were various igneous lithologies. These are likely to have been derived from Rhum although some, particularly basalts and dolerites, could have come from outwith the island.

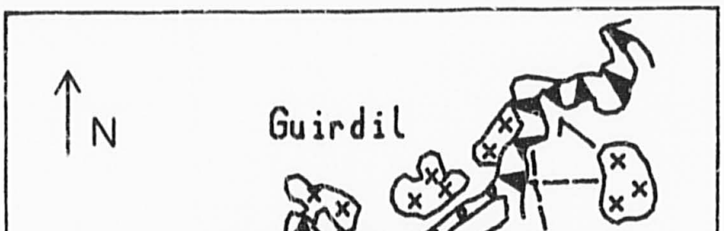
Matrix particle size distribution. A matrix sample was removed and dry sieved in the laboratory at 0.5 intervals between -1.0 (2mm) and 4.0 (0.063mmm). The graphic mean diameter of the matrix was 1.93 (0.262mm) but it was poorly sorted (~ = 1.45 ; 0.366mm). The silt and clay (i.e. <4.0) percentage was c.10.5% and the sand fraction had two modes: a larger one of very coarse sand (-1.0 to 0 ; c.25% of the sand fraction) and a smaller one of fine sand (2.0 to 3.0 ; c.23.5% of the sand fraction) (Ill 121).

Interpretation The observations in the field and the sediment analysis indicate that the deposit is unstratified poorly-sorted clast-supported sediment. The matrix is primarily a coarse sand, particularly when consideration is given to the likelihood of downwashing in the soil profile of fine sand, silt and clay. This may be the explanation of the secondary mode in the fine sand fraction. The lithology of the clasts, with the significant



Sand-size fraction of matrix of sediment from excavated site substrate.

ILL 121: Trench AJ. Matrix particle size distribution



ILL 122: Geomorphological map of Guirdil

component of foreign erratics, is suggestive of glacial action playing some role in the origin of the sediment, though no striations were noted on any of the clasts. The poorly sorted nature of the sediment would also support a glacial origin but the roundness analysis implies that, compared to most tills, which mainly have a modal class of subangular material, this sediment has been subjected to rounding, presumably by fluvial or marine processes. The average clast form is not dissimilar to that found in tills although the c/a ration is relatively low implying selection of or modification to flatter clasts such as occurs on beaches or as a result of frost shattering. Considering all the available information it is concluded that the sediment underlying the archaeological site is a stone-rich glacial till that has been partly modified, probably by marine processes, producing increased roundness and flatness in the clasts.

The altitude of the sample pit is slightly above the level to which it may be inferred that the uppermost Flandrian sea reached. It is therefore thought unlikely that marine modification occurred during the Flandrian. It is more probable that such modification took place during the Late glacial marine regression from the marine limit (at c.35m local O.D.) at the head of Loch Scresort.

Bloodstone Hill/Guirdil

A detailed geomorphological map of Guirdil/Bloodstone Hill is shown (Ill 122). The following account focusses on the environmental changes in this area as they relate to the liberation of bloodstone and its incorporation in the local sediments, particularly the Guirdil beaches.

During ice-sheet deglaciation, a glacier occupied the greater part of Glen Guirdil, its terminus being marked by one large and two small moraines on the eastern side of the glen. This ice marginal position is related by a terrace on the west side of the glen to a sea level of about 27m. The glacial deposits are composed dominantly of Torridonian material with subsidiary fine-grained igneous rocks and a few granophre clasts derived from the head of the valley. As most of the material carried by the glacier would have been transported down valley, it is unlikely that any significant concentration of bloodstone would be found in these glacial deposits and, by extension, in the raised shoreline deposits derived from them.

The eastern flanks of Bloodstone Hill are masked in their middle portion by an extensive, vegetated talus. As this Talus derives much of its material from the area of outcrop of the bloodstone, its development is fundamental in the transport of bloodstone to the local beaches. The talus must have started to form on deglaciation but at this time there is unlikely to have been significant transfer of bloodstone to the beaches because (i) the talus had to build up, thus trapping freshly eroded bloodstone, and (ii) sea level would have been falling rapidly at this time and the Guirdil Burn would have been eroding into and mainly transporting the glacial deposits in the bottom of the glen.

Both the rate of production of the talus and the fall of sea level arc likely to have diminished during the Lateglacial Interstadial but during the subsequent Loch Lomond Stadial (c. 11,000-10,000 BP) there was a marked environmental change towards more severe climatic conditions. Small glaciers built up again in the corries of Rhum and periglacial processes were very active (Ballantine and Wain-Hobson, 1980). This is likely to have been the period of most rapid frost-riving of the free faces on Bloodstone Hill and the talus probably achieved its present dimensions during this period.

The talus is developed on a bedrock slope that is stepped in sympathy with the structure of the underlying Torridonian Sandstone. A larger bedrock step towards the base of the talus produced an area of rock outcrop and below this a series of large alluvial fans/debris cones. These are likely to have been principally constructed during the Loch Lomond Stadial: one of them is clearly inactive today as the gully cuts through it and hence sediment by-passes it, whilst there are also relict gullies on the face of the talus.

The gullies have derived debris from the talus, the bedrock faces above and from the underlying bedrock into which the larger gullies are incised. They have delivered poorly sorted sediments, via the alluvial fans, to the Guirdil Burn. During the

Loch Lomond Stadial, it is likely, on the basis of analogy with other areas of Scotland, that this was a period of stillstand of sea level or even slight transgression. This would have the effect of trapping the sediment from the Guirdil Burn in Guirdil Bay and also diminishing the amount of downcutting in the glacial deposits in Guirdil Glen. Given therefore, (i) the likely increase in activity on the slopes of Bloodstone Hill, (ii) the likely reduction in supply of material from the glacial deposits, and (iii) sea-level changes that favoured increased retention of sediment in Guirdil Bay, it seems probable that the Loch Lomond Stadial was the time when there first occurred a significant component of bloodstone in the Guirdil beaches. The exact altitude of the sea at that time is unknown: by extrapolation from elsewhere on the west coast of Scotland it may be presumed to have been slightly below present sea level.

The start of the Flandrian is likely to have been characterised by falling sea levels (reaching a low at around 8500 BP) and, with climatic amelioration and vegetation development, increasing slope stability. At this period there is likely to have been a marked decline in the addition of new bloodstone to the talus on Bloodstone Hill but continued gully activity (some gullies being active in present conditions) and possible erosion of the lower parts of the alluvial fans due to a lower base level are likely to have ensured a continuing, albeit reduced, supply of bloodstone to the beaches.

After c.8500 BP the Main Postglacial Transgression occurred subsequent to which the sequence of raised shingle deposits in Guirdil Bay were deposited. Slope activity during the middle and late Flandrian is unlikely to have been greater than that of today and hence supply of sediment to the beaches rather low. It is thought that much of the material in the raised and present beaches has been reworked from that supplied during the Loch Lomond Stadial and early Flandrian.

Reworking of the beach sediments may be of some relevance to the quality of bloodstone available for collection from the beach. The bloodstone has a variable content of vesicles and it may be presumed that those pieces of bloodstone with a high proportion of vesicles would be mechanically weaker and hence more readily destroyed in the high-energy beach environment. If this is correct, then the bloodstone on the beach would not only be the most readily located source of bloodstone but would also be of a naturally selected higher quality than that occurring on the talus.

In summary, on the basis of the landforms in the Guirdil/Bloodstone Hill area and knowledge of the likely environmental and sea-level changes since deglaciation, it is suggested that the period of most abundant 'production' of bloodstone fragments was during the Loch Lomond Stadial. Further, the time of greatest transport of bloodstone to the beaches was likely to have been during the Stadial and the very early

Flandrian. During most of the Flandrian fresh release of bloodstone fragments from the bedrock is likely to have been rather low and the main part of the bloodstone in the present and raised beaches formed after c.6500-7000 BP is thought to have been reworked earlier material. This reworking probably has had the effect of destroying (i.e. reducing to small size) bloodstone fragments that had a high content of vesicles and leaving behind more coherent and mechanically sounder bloodstone. Finally, this reconstruction is rather qualitative but a detailed study could quantify the processses operating.

Conclusions

The conclusions to the work carried out may be summarised as follows.

1. At the time of earliest occupation of the Kinloch site, sea level is likely to have been at or slightly below its present level. The sea, however, would have been close enough to the site to have been a relevent factor in its choice as an occupation area.

2. The subsequent rise of sea level during the Main Postglacial Transgression did not attain such an altitude that the area of the excavation was directly affected. However, the coincidence in altitude between the lowermost part of the site and the uppermost level reached by the Flandrian sea suggests that lower portions of the site may have been reworked or destroyed during the transgression.

3. At the time of the Main Postglacial Shoreline, the lower part of Kilmory Glen would have been a marine or brackish embayment that might have provided an attractive environment for Mesolithic occupation.

4. The site at Kinloch is underlain by sediment interpreted as a stoney till the upper part of which has been reworked, probably during the Lateglacial fall in sea level, at which time, at least briefly, the area of the site would have been subject to littoral processes.

5. The most probable time for natural release of bloodstone from Bloodstone Hill and incorporation into the Guirdil beaches is during the Loch Lomond Stadial and the early Flandrian. Most of the bloodstone found in the Flandrian raised beaches and the present beach at Guirdil probably reached the coast during the above period. Subsequent reworking in the high energy beach environment has probably lead to destruction of bloodstone with a high content of vesicles and a consequent increase in the proportion of better quality bloodstone in the beaches.

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Pumice on Rhum: Geochemical analyses and interpretation

A Dugmore

Introduction

In 1972 Richard Binns drew attention to the presence of drifted pumice horizons in Holocene strandlines in the British Isles, Norway and Svalbard, and noted several related occurences upon archaeological sites. Recent work in the Hebrides by archaeologists from the SDD/HBM and the University of Sheffield has located a number of midden sites in which pieces of pumice are frequent. These sites lie in the machair of North and South Uist, facing the open Atlantic. Similar pumice has also been recovered during SDD/HBM excavations at Kebister on the Shetland Islands. The realisation that these occurences could be used to define important isochronous marker horizons within Scottish later prehistory has led to the detailed study of this material (Dugmore *et al*, in prep). The analysis of pumice recovered from the excavations on Rhum should be considered in this wider context.

The analyses

Samples of three pieces of pumaceous material were analysed to determine both major and trace element abundances. The material was prepared by the author and X-Ray flourescence analyses were performed at the Grant Institute of Geology, University o Edinburgh. In their original state all of the samples floated in fresh water.

Sample A was sub-rounded in shape, brown, and weighed 13.7g. Given the reference number AG128 5594 it was recovered from a Neolithic context.

Sample B was angular and irregular in shape, light grey in colour and superficially weathered; it weighed 9.6g and given the reference number BA00052 it was recovered from a Mesolithic context.

Sample C was similar in appearance to sample B, but despite its rough, irregular surface the piece was approximately spherical and it weighed 8.2g. The piece was one of three recovered from a Mesolithic context and described as AD00162.

The results of the XRF analyses are given in tables 69 and 70.

Conclusions

A comparison of the Rhum data with published sources leads to the following conclusions:

1. Sample A is volcanic and probably Icelandic in origin (cf. Binns 1972, Mangerud et al 1984); comparison with data from post-Mesolithic excavations in the Outer Hebrides and Shetland combined with Icelandic source data suggests that all this Scottish material is from a single volcanic source in Iceland. It is possible that this pumice was produced during a single

ELEMENT	SAMPLES A	B	C
SiO_2	64.76	79.32	83.00
Al_2O_3	14.21	8.63	5.77
FeO	6.19	2.50	3.04
MgO	1.23	0.67	0.96
CaO	3.18	0.72	0.33
Na_2O	4.82	1.70	0.05
K_2O	2.58	3.01	2.62
TiO_2	1.23	0.64	0.44
MnO	0.19	0.02	0.02
P_2O_5	0.33	0.08	0.10
TOTAL	98.71%	97.28%	96.31%

Table 69 Pumice samples : major element abundances determined by XRF

eruption c. 2700 14C years bp (Dugmore *et al* in prep).

2. Samples B and C are most unlikely to be volcanic in origin; perhaps they are grains of a heat altered sandstone (table 71). The likely origin of this material may be determined from thin section analysis.

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ELEMENT	SAMPLES A	B	C
V	19.3	103.3	117.4
Ba	575.6	511.1	419.9
Sc	9.3	7.7	6.3
La	82.0	24.2	21.1
Nd	85.1	21.6	19.2
Ce	185.0	54.1	47.7
Cr	5.4	97.0	79.1
Ni	5.5	11.0	50.6
Cu	0.2	-2.2	4.1
Zn	161.5	73.0	28.1
Pb	8.2	8.4	8.8
Th	9.8	8.7	6.6
Rb	56.3	79.4	59.9
Sr	313.8	168.4	95.6
Y	74.8	12.9	11.7
Zr	782.2	510.8	331.1
Nb	93.1	10.4	9.2

Table 70 Pumice samples : trace element abundance determined by XRF (ppm)

SAMPLE B

CIPW NORM (WT%)

QUARTZ	56.64	CORUNDUM	1.50	ORTHOCLASE	18.29
ALBITE	14.77	ANORTHITE	3.18	HYPERSTHENE	3.15
MAGNETITE	1.04	ILMENITE	1.25	APATITE	0.19

SAMPLE C

CIPW NORM (WT%)

QUARTZ	72.67	CORUNDUM	2.60	ORTHOCLASE	16.09
ALBITE	0.41	ANORTHITE	1.04	HYPERSTHENE	4.81
MAGNETITE	1.27	ILMENITE	0.86	APATITE	0.25

Table 71 Pumice samples : composition of samples B and C

RADIOCARBON DETERMINATIONS: PROCEDURAL RESUMÉ

GT COOK & EM SCOTT

PRETREATMENT

Pretreatment procedures were generally standard. During the chemical removal of potential contaminants from the carbonised hazel-nut shell a double alkali treatment (2% w/v potassium hydroxide, <KOH>) was employed following an initial hot 1 molar hydrochloric acid (1M HCl) treatment. After the second KOH pretreatment a final hot 1M HCl treatment was carried out. Subsequently, the carbonised shell was filtered, washed with distilled water and dried at 80°C. Wood samples were finely chopped (to approximately matchstick sized pieces) and subject to successive boilings in 2M KOH. Finally, cellulose was produced by extraction with a sodium chlorite/hydrochloric acid solution. Again the samples were filtered, washed with distilled water and dried at 80°C. For peat samples the second (and subsequent) humic acid fractions were regarded as being the most reliable. Following extraction of the acid soluble fulvic acid fraction with hot 1M HCl the residual material was extracted with cold 1% KOH to remove the first humic acid fraction (alkali soluble). The residual material from this extraction was then heated with a further aliquot of 1% KOH. The humic acid containing solution was then filtered, washed and dried ready for sample combustion.

SAMPLE SYNTHESIS

Liquid scintillation counting of benzene is the technique employed for measurement of the residual C-14 activity at Glasgow. Combustion of samples to carbon dioxide (CO_2) was achieved using a combustion bomb filled to 2 bar pressure with CO_2 free oxygen. As a second stage lithium carbide was produced by the reaction of the CO_2 with molten lithium. On cooling, acetylene was generated by the addition of distilled water to the lithium carbide. Finally, high purity benzene was synthesised by cyclotrimerisation of the acetylene at 100-120 °C using a chromium based catalyst. Isotopic fractionation corrections were applied via mass spectrometric measurement of the C-12/C-13 ratio on combustion derived CO_2. Background (C-14 free) samples were derived from the synthesis of benzene from calcium carbide and anthracite, as well as from commercially purchased scintillation grade benzene. Wet oxidation by acidified potassium permanganate solution was used for the preparation of CO_2 from the NBS Oxalic Acid Standard. Subsequent synthesis to benzene was as previously described.

BENZENE VIALLING

The counting geometry consists of 4.5g benzene (accurately weighed to four decimal places) and 0.95g of scintillant solution (12g/1 butyl-PBD + 6g/1 bis-MSB in toluene). Samples of less than 4.5g were made up to constant weight using scintillation gradient benzene. Borosilicate sealable ampoules were used in preference to screw cap vials as they do not suffer from the disadvantage of weight loss due to evaporation that is encountered with screw cap vials. Prior to counting, the upper half of all ampoules were masked to a standard height with matt black paint to help reduce photomultiplier cross-talk and thereby reduce background count rates.

QUENCHING

A series of approximately 40 ampoules containing C-14 spiked benzene and varying amounts of acetone as a quenching agent were vialled and sealed as per the sample benzenes in order to produce a plot of counting efficienct as a function of impurity level. The External Standard ratio was used as a measure of the quenching.

COUNTING

All scintillation counters were heavily discriminated against tritium (<1%) resulting in C-14 counting efficiencies of aprroximately 70%. Quasi-simultaneous batch counting was employed with each sample undergoing two consecutive 40 minute counts, each with a short count of the external standard to produce the quenching indicator. Normally, each batch consists of four C-14 free benzenes (backgrounds), four NBS Oxalic Acid Standards, approximately twelve samples and two C-14 spiked standards to measure constancy of efficiency. Each sample was counted for a minimum of 2000 minutes.

AGE CALCULATIONS

At the end of each five cycle period the sample count rates were converted to radiocarbon dates according to the standard treatment of Stuiver and Polach (1979). There is unfortunately no similarly rigorous approach to error analysis. In this laboratory the errors on (a) background, (b) modern standard and (c) the sample count rates, together with errors on (d) quenching, (e) fractionation and (f) replicate analysis all contributed to the final error in the age.

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