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HOMESTEAD MOAT
INCHNADAMPH, SUTHERLAND, HIGHLAND REGION
GEOPHYSICAL SURVEY REPORT

NAME: CIRCULAR ENCLOSURE, NR CHURCH, INCHADAMPH
LOCATION: INCHNADAMPH, SUTHERLAND, HIGHLAND REGION
NUMBER: 1524
DATE: OCTOBER 2005
CLIENT: -
AUTHER: D. HODGSON
ORGANISATION: HIGHLAND COUNCIL ARCHAEOLOGICAL UNIT
DATE OF REPORT: 04th NOVEMBER 2005

GEOPHYSICAL SURVEY REPORT

1 SUMMARY

In October 2005, the staff of the Highland Council Archaeology Unit and members of the public undertook earth resistance and gradiometer surveys in addition to a topographic survey over the suspected Homestead Moat at Inchnadamph, Sutherland (NGR NC 24879 21970). The survey was run as a voluntary event being part of the wider programme of activities on offer during Highland Archaeology Fortnight 2005. In addition to introducing volunteers to geophysical techniques and equipment, the aim of the surveys was to locate any internal structures or associated features and to expand on the existing information available about the site of the homestead and the area surrounding the nearby church and cemetery.

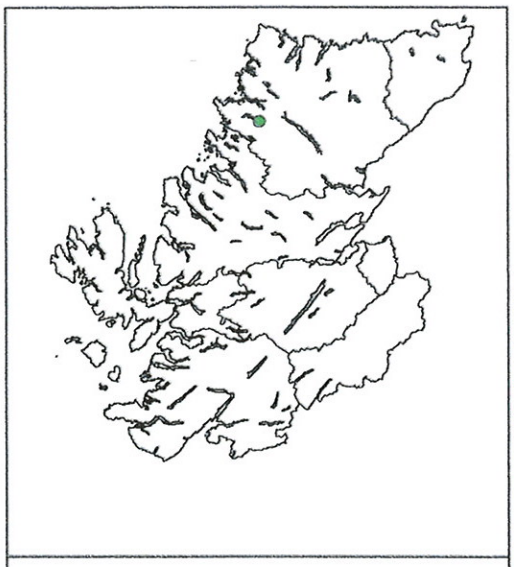
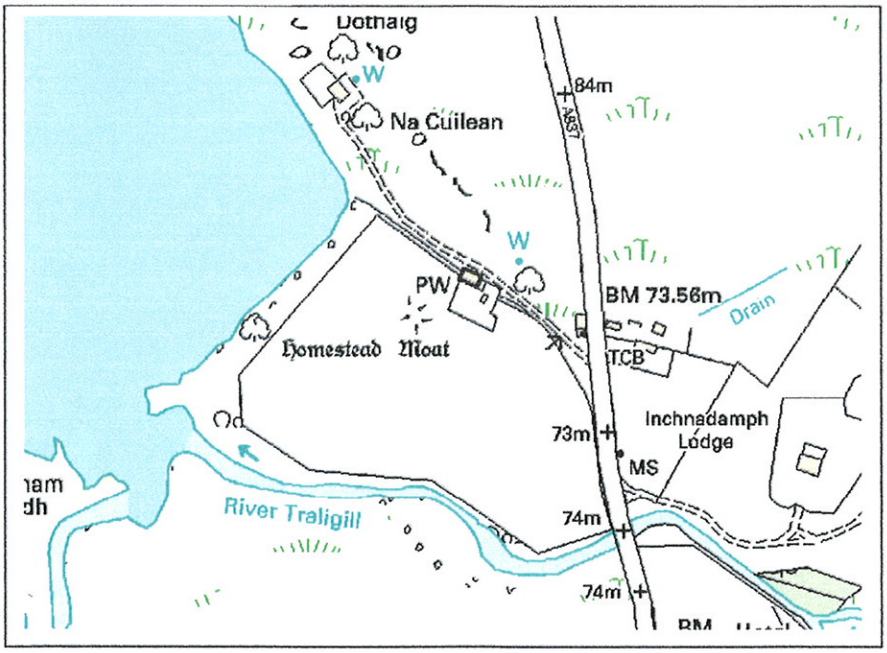


Figure 1 Site Location Plan
Inchnadamph Sutherland



2 INTRODUCTION

2.1 Contract Background

In October 2005, the Highland Council Archaeology Unit and a team of volunteers undertook geophysical surveys at the site of the suspected homestead moat at Inchnadamph, Sutherland as part of activities running during Highland Archaeology Fortnight. The site is centred NGR NC 24879 21970. The survey will contribute to ongoing research, investigating the wider historical and archaeological past of the area, currently being undertaken by Historic Assynt. The aim of the survey was to define any internal structures and associated features including possible boundaries belonging to the fifteenth century church.

The work involved earth resistance survey, gradiometer survey and topographic survey of areas 0.33, 0.37 and 0.68 hectares respectively. Each of these techniques uses different principles for the detection of sub-surface features. Earth resistance measures the resistance to the passage of a current and can therefore be interpreted as a measure of the moisture content, porosity and conductivity of the ground. A gradiometer responds to alterations in the geo-magnetic field caused by the presence of magnetic bodies buried beneath the surface. Each technique was chosen on the grounds that it would detect or provide different information about the anticipated features and history of the site (Gaffney & Gater 2003).

2.2 Location and Topography

The site lies 37km north east of Ullapool, at the junction between the valleys containing Loch Assynt, running north west to south east, and the river Loanan, running north to south. The site is bordered to the west by Loch Assynt and to the south by the river Traligill with the ground rising in to Gleann Dubh in the east and to the lower slopes of Glas Bheinn (2541m) to the north.

The area is low-lying pasture at a height of 65m OD with the site of the homestead lying no more than 2m above the surface of the loch. To the west of the site there has been some cultivation although there is no evidence to suggest that this ever extended into the survey area.

2.3 Geology and Soils

The homestead lies on a base geology of Dolomitic Limestone and Calcareous Mudstone of the Antsron formation although it is closely bordered to the north and east by Quartz-arenite, Feldspathic Arenite and Dolomitic sedimentary rocks. The drift deposit is made up of a recent terrace of fresh water alluvia laid down by the rivers Traligill and Loanan as they enter the loch. The coarse component being undifferentiated clay, silt and sand (BGS 1987).

2.4 Archaeological Context

Opinion is divided regarding the function and date of this site. It has been suggested that the site may be a Medieval or Pictish period moated homestead. The possibility has also been raised that the remains represent a possible Henge dating to the Neolithic period (NC22SW0006, HS9191).

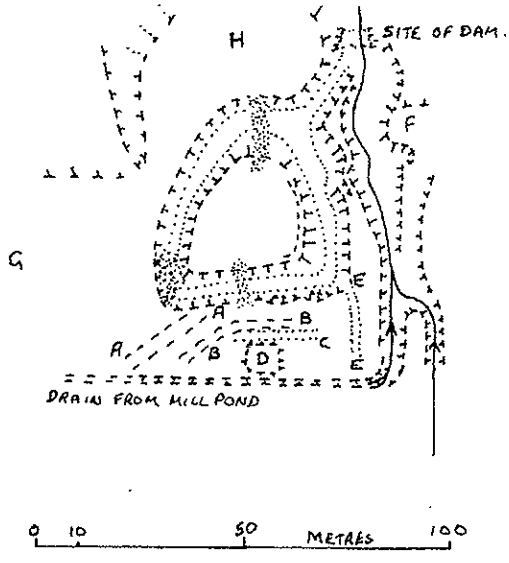
The earthwork consists of a central oval platform surrounded by a ditch, which in turn is bounded by a bank that survives to a height of c.0.7m. The feature measures approximately 65m north west to south east and 45m north east to south west. Both the bank and ditch are described as being approximately 5m wide. It is thought that a causeway and corresponding break in the eastern bank were the original entrance, although there are also breaks in the bank in the south east and north east. It is possible that the latter is an outflow for the moat and it remains the dampest area of the

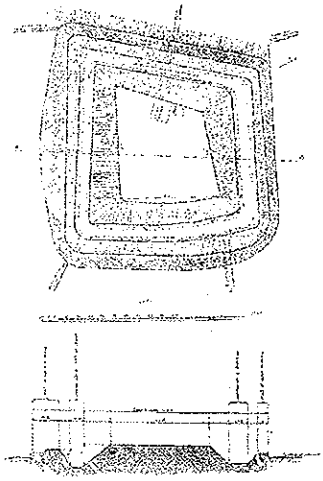
site. The multiple breaks have also been used to further the argument that the site is that of a Henge (RCAHMS 1911).

The Royal Commission on Ancient and Historical Monuments in Scotland have recorded 48 moated sites, of these there are 7 possible Homestead Moats within the Highland region (Canmore 18/11/05). These have a predominantly south eastern distribution, with four of the seven situated within the eastern coastal strip between Dornoch and Nairn. The number of sites is obviously too restrictive to allow any meaningful analysis however it should be noted that all of the sites are found on fertile low lying areas.

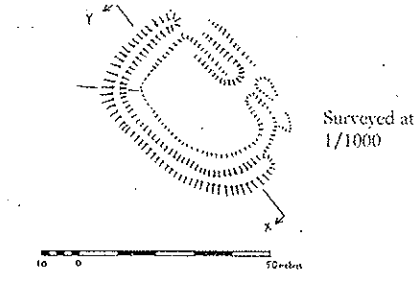
In form the sites appear to have several features in common. Each site has an external bank which is separated from a central mounded platform by a ditch. The ditches of these features are generally connected to water management systems which link to either rivers or ponds. The central platforms of the three sites that have been surveyed (David's Fort-Ross & Cromarty NH55SW0004, Poyntzfield Mill-Ross & Cromarty NH76SW0052 and Inchnadamph-Sutherland NC22SW0006) are described as being trapezoidal and measure 30m by 25m. (HCAU SMR)

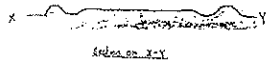
The site at Inchnadamph has raised some questions owing to its more oval appearance and the numerous breaks in the outer bank. It has been suggested that the feature may represent a rough Henge. This interpretation has been discounted by some scholars due to the irregular form which is far from circular.





David's Fort, Ross & Cromarty





Section X-Y
Vertical Scale 1/200

Inchnadamph, Sutherland

Site Plans of Recorded Homestead Moats in the Highland Region

A (Welsh 2004)
B and C (RCAHMS 1911)

Figure 2

Also of note on this site is the proximity of the site to the church (NC22SW0005, HS8309) the current building dates to the 18th century, however records show the origins of the building could reach back as far as 1436. Of the original church there remains the Macleod Vault, near the centre of the cemetery. The vault is a high arched burial chamber used by the Macleod's of Assynt. The shape of the cemetery wall is of particular interest, it is a very angular structure that incorporates the 18th century church in its north west corner. It is understood that the current church building was not built within the graveyard of the older church and it seems likely that an earlier boundary remains to be discovered (OPS 1955).

Religious activity on the site of the church has been further evidenced by the discovery in 1993 of pieces of a cross slab. The designs on the slab are thought to date to the eighth century and analysis of the stone indicates that it originated in Argyll. This would seem to suggest that the area was an important focus for local religious activity and moated site to the east should perhaps be seen in this context.

2.5 Previous Fieldwork

There has been no structured archaeological investigation of this site to date. It has been surveyed in recent times by the Ordnance Survey and field visits have been made regularly by Historic Scotland, the Royal Commission on Ancient and Historic Monuments in Scotland and by the Highland Council. Despite this little consensus can be agreed beyond the general form of the site.

2.6 Aerial Photography

A series of aerial photographs have recently been commissioned of the possible homestead site at Inchnadamph, and of the church to the north east, by Members of Historic Assynt. From studying these it has become clear that the course of the river Traligill has wandered across much of the area around the head of the loch. The vegetation patterning is such that it is possible to discern earlier channels and possible pools. The site appears to have been constructed in between two of these channels and is in an area that still floods today.

The aerial photography shows the overall plan of the site to be much more regular than is suggested by inspection on the ground with what appears to be a sub-rectangular shape. In addition to the site being investigated, the aerial photographs provide evidence of more recent cultivation to the south of the site on the current banks of the river. There are also the remains of an angular wall to the east of the current churchyard, this does not appear on any of the early edition Ordnance Survey mapping and it is possible that it represents a medieval boundary to the church.

2.7 Scheduled Ancient Monument Number: The site is scheduled as a monument of national importance under the Ancient Monuments and Archaeological Areas Act 1979, Historic Scotland reference no 9191.

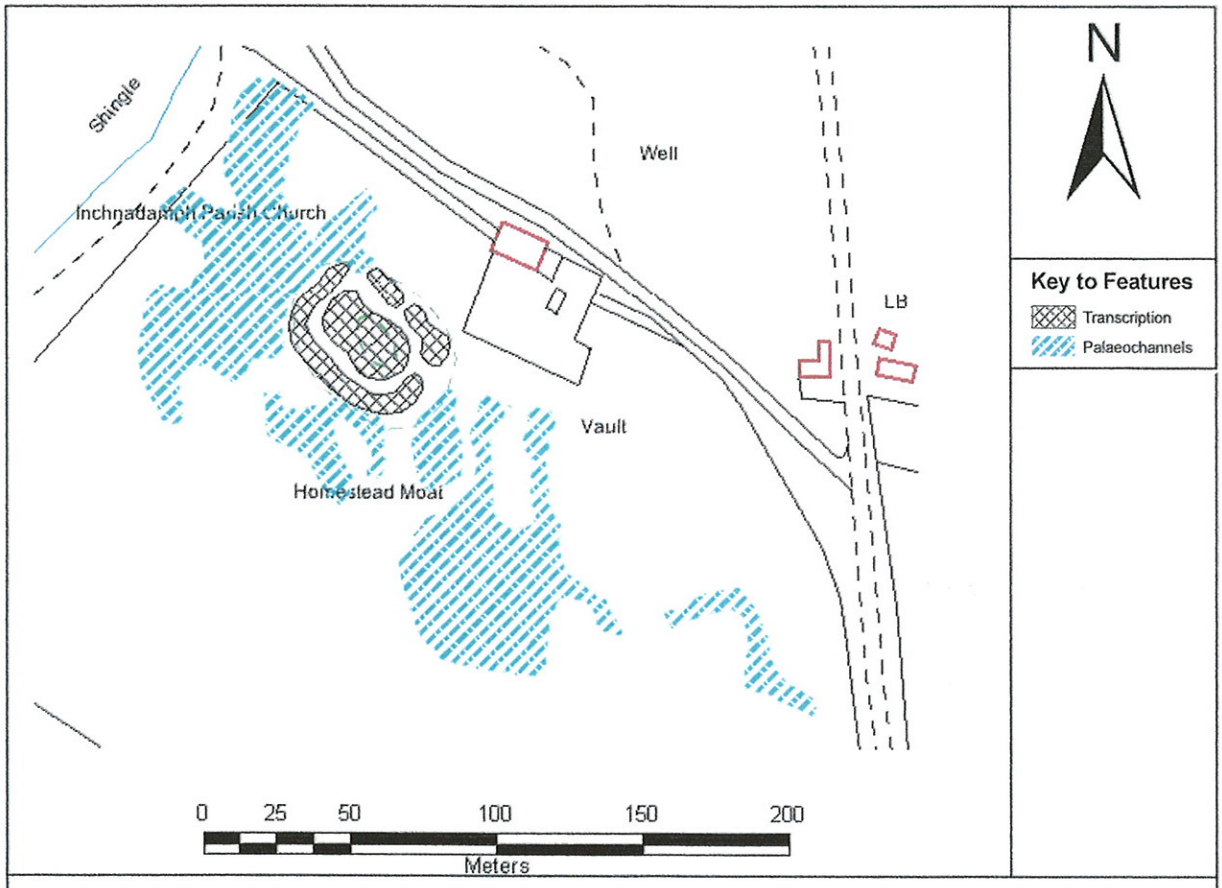


Figure 3 Features Transcribed from rectified Aerial Photographs copyright of Historic Assynt Inchnadamph Sutherland

3 METHOD

3.1 Survey Procedure

3.1.1 Earth Resistance Survey

In a resistance survey the measured values reflect the moisture content and thereby the conductance of an area of ground. Under normal conditions dense material such as clay or rock have little available space for moisture and will therefore prove more resistant to a current passed through them. Deposits filling archaeological pits and ditches on the other hand will be packed more loosely enabling them to hold more moisture and be less resistant.

The drainage properties of a soil and the weather conditions before a survey can influence the results obtained. As poorly drained soils maintain their moisture content; a survey on these soils preceded by a wet period can return results with generally low resistance and very little contrast between positive and negative anomalies. Similarly a survey on well drained soils can give high readings with little contrast and in extreme cases; wet periods followed by dry can lead to a complete reversal of the results (Gaffney and Gater 2003).

The resistance survey was conducted over an area of 0.36 hectares with the survey area being divided into grid squares 20m by 20m. (Figure 3) The survey used a twin probe array with a sample interval of 0.5m and a traverse interval 0.5m. The survey was conducted with zigzag traverses, the direction of the first traverse being east.

The resistance meter used was a Geoscan RM15 with a twin probe array and electrode separations of 0.5m. The readings were logged automatically, at each point, using the built in data logger, with the gain set to 0.1ohms. In addition two grids were recorded using a Geoscan RM4 Resistance Meter with readings recorded by hand. With this instrument a sample and traverse interval of 1m was used.

3.1.2 Pseudosection

In addition to the use of electrical resistance measurements in area surveys, as described above, it is also possible to use the vertical distribution of the grounds electrical properties to characterise the profile and approximate depth of features. The resistance value that is recorded by a meter is a function of the current that is introduced to the ground, the spacing between the probes and the properties of the ground through which the current is passed. By increasing the separation of the probes the depth of investigation is increased. This is because the current is travelling greater distances and the arc that its path describes is taking it deeper into the subsurface.

As the separation between electrodes is increased the resistance of the ground will decrease, as there is more volume for the current to spread out, hence a volume specific value is needed. Apparent resistivity is a function of the whole range of resistivity values in the ground assigned to a specific point, including variations within the soil and any features. The resistance value for each point is converted to apparent resistivity using a formula specific to the array type and the inter-probe spacing. The values generated are plotted at a depth, which broadly corresponds to half the inter-electrode separation, allowing features to be interpreted. For a twin probe array apparent resistivity equals the resistance value multiplied by pi by the electrode spacing, i.e. $\rho_A = R\pi a$.

The pseudosection was created using a Geoscan research RM4 resistance meter using a twin probe array and manual data logging. A 30m line was established from the central mound crossing both the ditch and bank with probe placements every 0.5m. The resistance meter frame was placed 15m from the line and the remote probes were moved systematically along the line to collect data, increasing the inter-probe separation by 0.5m after each reading.

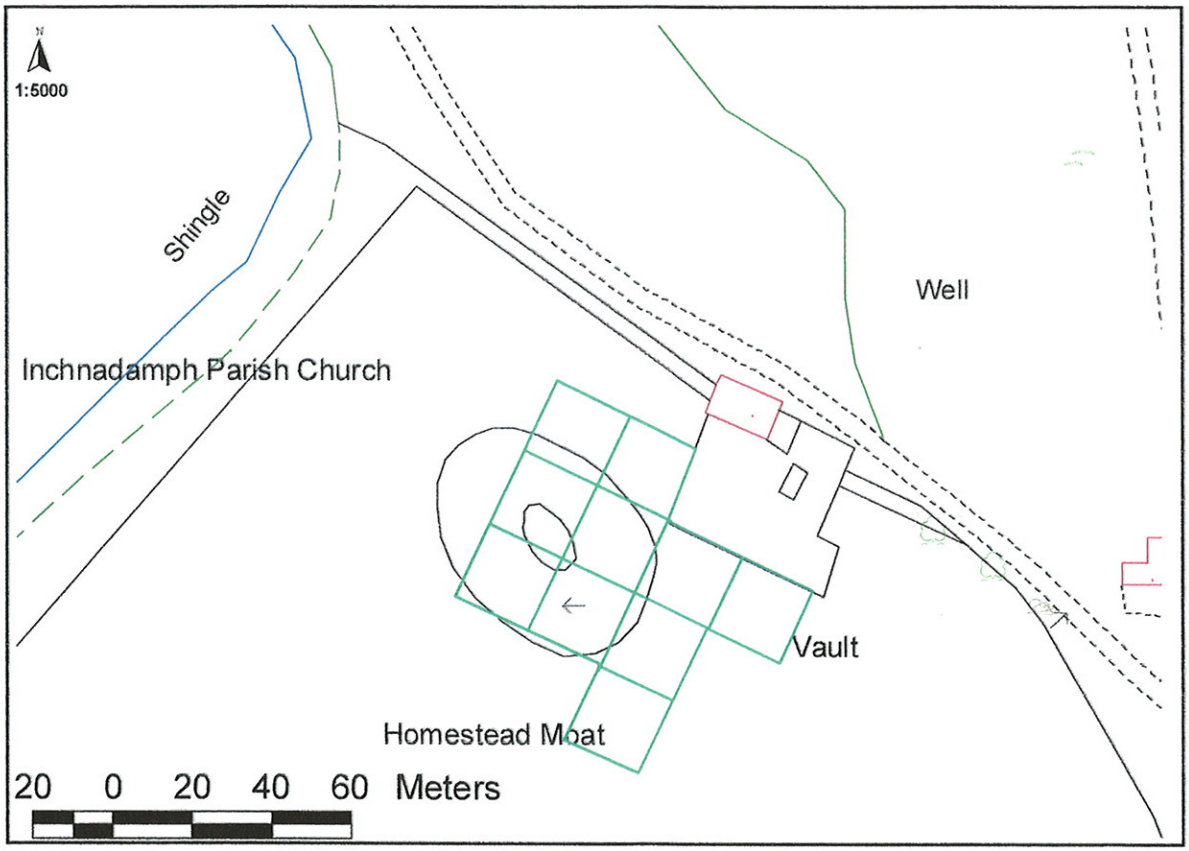
3.1.3 Gradiometer Survey

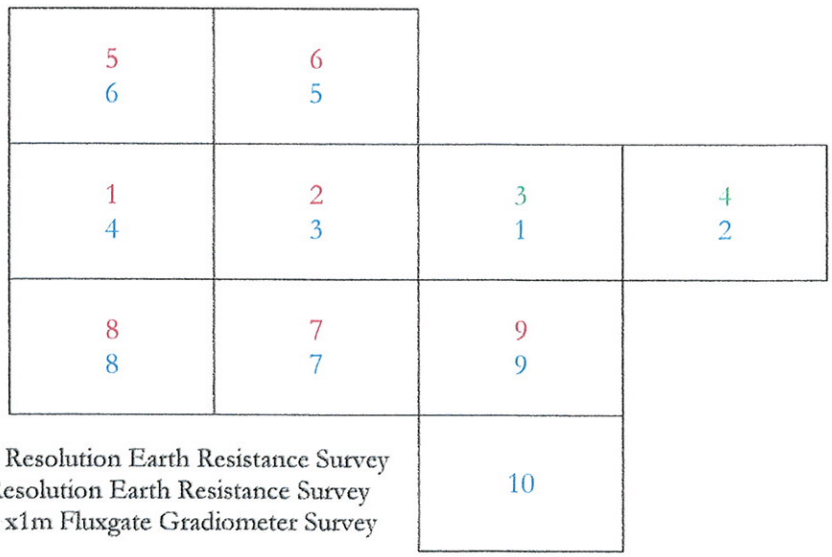
The gradiometer survey aims to detect the different magnetic responses of rocks, topsoil and anthropogenic materials. These differences lie in the orientation and strength of the magnetic field of a feature, meaning the values measured by the instruments near a feature will deviate from those expected from the geomagnetic field alone. The extent of these variations allow us to differentiate between features that have silted up, such as pits and ditches, as well as other features consisting of magnetic material like areas of burning or kiln fired material. Non-magnetic features can also be detected if the material surrounding them has a stronger magnetisation. (Gaffney and Gater 2003)

The survey results are presented as a contrast between positive and negative values. Topsoil is normally (although by no means always) more magnetic than the underlying subsoil. Therefore features silted or backfilled with topsoil will produce a positive anomaly. Weak or non-magnetic materials cutting into the topsoil generate negative responses. Areas of burning affect the magnetic component of a material in such a way that its magnetic field aligns with that of the earth to create strongly positive anomalies.

The gradiometer survey was conducted over an area of 0.40 hectares. The survey was conducted with a single gradiometer, the sample interval for was 0.5m with a traverse interval of 1m. The data were collected using parallel traverses.

A Geoscan Fluxgate Gradiometers FM36 was used on the site with manual triggers and built in data loggers. The log zero drift function was used and the gain was set at 0.1 nanoTesla.





1 – 0.5m Resolution Earth Resistance Survey
3 – 1m Resolution Earth Resistance Survey
1 – 0.5m x1m Fluxgate Gradiometer Survey

Figure 4

Grid Location Plan, Inchnadamph Sutherland

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3.2 Data Processing

The data from each survey were downloaded to and processed in Geoscan software Geoplot Version 3. Each survey was processed separately and with different methods and they will therefore be described in this way.

3.2.4 Resistance Data

These were initially edge matched in order to reduce the effect of different contrasts caused by changing weather conditions or the adjustment of the remote probes between the grids. This made it possible to see the data at a single set of clip parameters. Absolute values of 70 and 400 ohms were selected as a range that distributed the palette evenly across the data, and made the anomalies most distinct. The data were then despiked with a processing window of one reading in each direction, a standard deviation of 2.0 was used as the threshold and higher or lower readings were replaced with the mean value. By despiking the data, any false readings caused by contact resistance or short circuits were removed. Due to an error in grid Inchres8 where a faulty connection had caused a series of very high response it was necessary to lower the recorded values so that they might integrate better with the other data. In a similar way data from the first to traverses of grid Inchres1 had not been collected due to flooding in the grid, the dummy values visible in the raw data were adjusted to allow for a visually clearer plot for interpretation.

Data from grids Inchres3 and Inchres4 were collected at a 1m resolution in order to combine these with the data collected at a 0.5m resolution it was necessary to interpolate the data in both the X and Y direction. This allowed for the data to be combined in a single composite.

3.2.5 Pseudosection

The pseudosection data was collected manually and entered into MS Excel. The data points were doubled in order to provide an apparent depth of approximately half that of the electrode separation. This has been assigned arbitrarily and is based purely on what seems to produce the best visual results. The data were then copied and transformed into a calculated apparent resistivity using the formula specific to the twin probe array.

$\rho_A = R\pi a.$ Where ρ_A =Apparent Resistivity,
R= Measured Resistance
a=the electrode separation

The data were then exported to RES2DINV version 3.55 where a forward modeling subroutine was used with a non-linear least-squares optimisation technique. This inversion routine was used to calculate and assign resistivity values to a 'true' depth. This technique creates a set of rectangular blocks arranged to roughly correspond with the data points. The software then matches the observed apparent resistivity with a series of models of resistivity at varying depths and locations in order to produce an accurate plot of the resistivity section.

3.2.6 Gradiometer Data

Errors in the collection of the data from the FM36 made it necessary to first shift the data in traverses 2 to 20 by -2 readings in the X direction in grid Inchmag5. It was then necessary to add a constant to rows 17 to 20 in grid Inchmag1. This corrected a step in the recorded data, caused by a break in the collection of data which in turn prevented the Log Zero Drift function from correcting the gradient. The data were then edge matched in order to limit the effects of differing contrasts between grids, probably resulting from the diurnal variation. The data were then interpolated in the Y direction using the sin x/x function to equalise the data and smooth the transition between traverses

3.3 Data Presentation

The data are presented as a shade plot in greyscale with the values graded from light to dark. The results of the resistance survey can be interpreted with the dark areas representing high resistance readings and the light areas representing low resistance readings. The data are differentiated in the raw data plots by a range of absolute values between 70 and 400 ohms.

The gradiometer data are presented in the same manner with the dark areas representing positive anomalies and light areas representing negative anomalies. Intermediate values are graded from light to dark. The range in absolute values is from –45 to 100 nanoTesla.

3.4 Data Publication

Graphic plots of the data were saved as images and exported to Microsoft Word for publication. Interpretation diagrams and drawings were made with ArcView GIS Version 3.2 and were again exported to Microsoft Word for publication.

4 RESULTS

4.1 Description and Interpretation

When considering the interpretation of the data presented below it should be noted that the surveys were conducted in adverse conditions following a prolonged period of wet weather. Many parts of the site were waterlogged and the western bank was inaccessible due to flooding. The interior of the enclosure was however firm and does not appear to have been affected. In the area surrounding the enclosure the contrast between features and subsoil has been reduced it is however possible to see several broad anomalies.

4.1.1 Earth Resistance Survey

There are five interpretable anomalies visible in the resistance data. Three of the anomalies are caused by features resistant to the flow of the current, and two are caused by features permitting greater conductivity.

Anomaly 1 is the most obvious area of high resistance which equates to the raised central mound. It presents itself as a sub rectangular area measuring 30.5m from north west to south east and 20m transversely. The recorded values of resistance in ohms are between 375 and 440 which are the highest recorded on the site indicating that the area has been artificially enhanced. The distribution of values within the area appears to be unbalanced with a greater concentration of higher resistance at the south eastern end. Of particular note is an apparent rectangular area of high resistance measuring 10m by 5m aligned north west to south east. This anomaly does not present as a formal arrangement of walls and the possibility of an area of collapse is perhaps unlikely given the absence of any surface indicators, it is however distinctly possible that the anomaly represents a compacted floor surface potentially indicating occupation on the site. A comparison may be drawn here with the site of Tige Dige, Gairloch Ross and Cromarty. This site is described as being a 'Black House', built originally of turf with a roof of sticks and divots. (Dixon 1886). If that is the case at Inchnadamph the geophysical response would be limited.

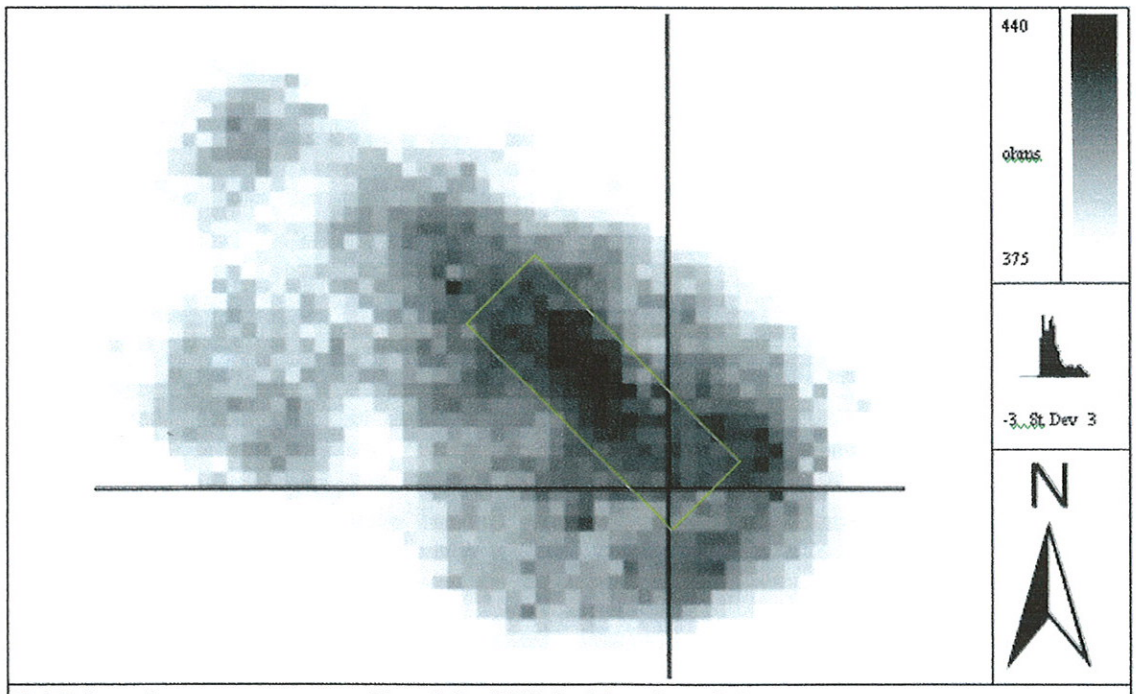

Figure 5. Detail Of Enclosed Area, Anomaly 1

Anomaly 2 appears as a broken curvilinear anomaly of high resistance, the anomaly encloses the central mound to the north east and west. The anomaly corresponds to the visible earth and stone bank that surrounds the whole site. The anomaly is between 3.5 and 5m wide and is broken in four places. The break in the north eastern bank appears to coincide with a slight rise in the ground linking the mound to the area outside of the enclosure and might therefore be interpreted as an entrance break and causeway about 2m wide. The breaks in the north corner and in the south eastern bank have been argued as being the result of recent erosion of the bank by flooding and as possible breaks associated with the water management system that supplied the moat. It can not be doubted that the site is subject to regular flooding which is undoubtedly having an effect on the surviving earth works. It would however also seem likely (given Anomaly 5) that the breaks link outflow and feeder channels to the ditch.

Anomaly 3 is a linear high resistance anomaly which is apparent for 6m running south west to north east and is 1.5m wide. It appears to form a link between the north eastern break in the bank (Anomaly 2) and the church yard. If the line of the anomaly is extended it passes close by the northern corner of the Macleod's vault. It is possible that this is a built up track way linking the two sites, it should however be noted that the line is offset from the centre of the break and rather links with the terminus of the bank on the southern side. An alternative assessment might be that it is in fact a natural deposit.

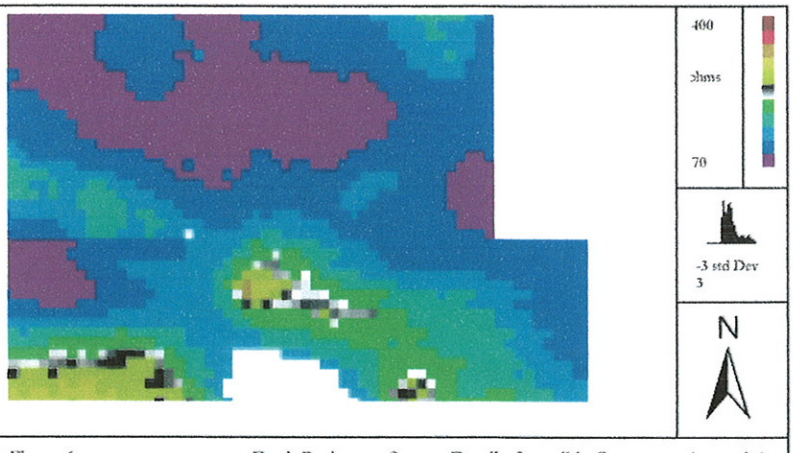

Figure 6 Earth Resistance Survey, Detail of possible Causeway, Anomaly3
October 2005 Inchnadamph Sutherland

Anomaly 4 is a curvilinear low resistance anomaly between 2.5 and 5m wide. It separates Anomalies 1 and 2 and can be seen as representing a silted ditch feature whose contents was in all likelihood used in the construction of the mound and bank. The ditch appears to be broken in two areas. To the north east a causeway has already been proposed in the discussion of Anomaly 3. To the south of the mound the response of the ditch is higher than else where in its circuit. It is possible that the ditch in this area was shallower perhaps as a result of the raising ground level around the feature. A further possibility is that in this area of the bank was constructed of more resistant material which, once it has eroded into the ditch has produced a similarly high resistance response.

Anomaly 5 is represented by a wide spread of low resistance values that are spread across the entire survey area. There are several linear stretches of these responses which are interpreted as palaeochannels, former courses of the river Traligill. Some of these can be seen on aerial photographs of the site and other that are less obvious might be seen as shallow channels excavated as feeder channels for the moat. Given this interpretation it is suggested that the enclosure was constructed on the edge of a natural rise within a water logged marshland.

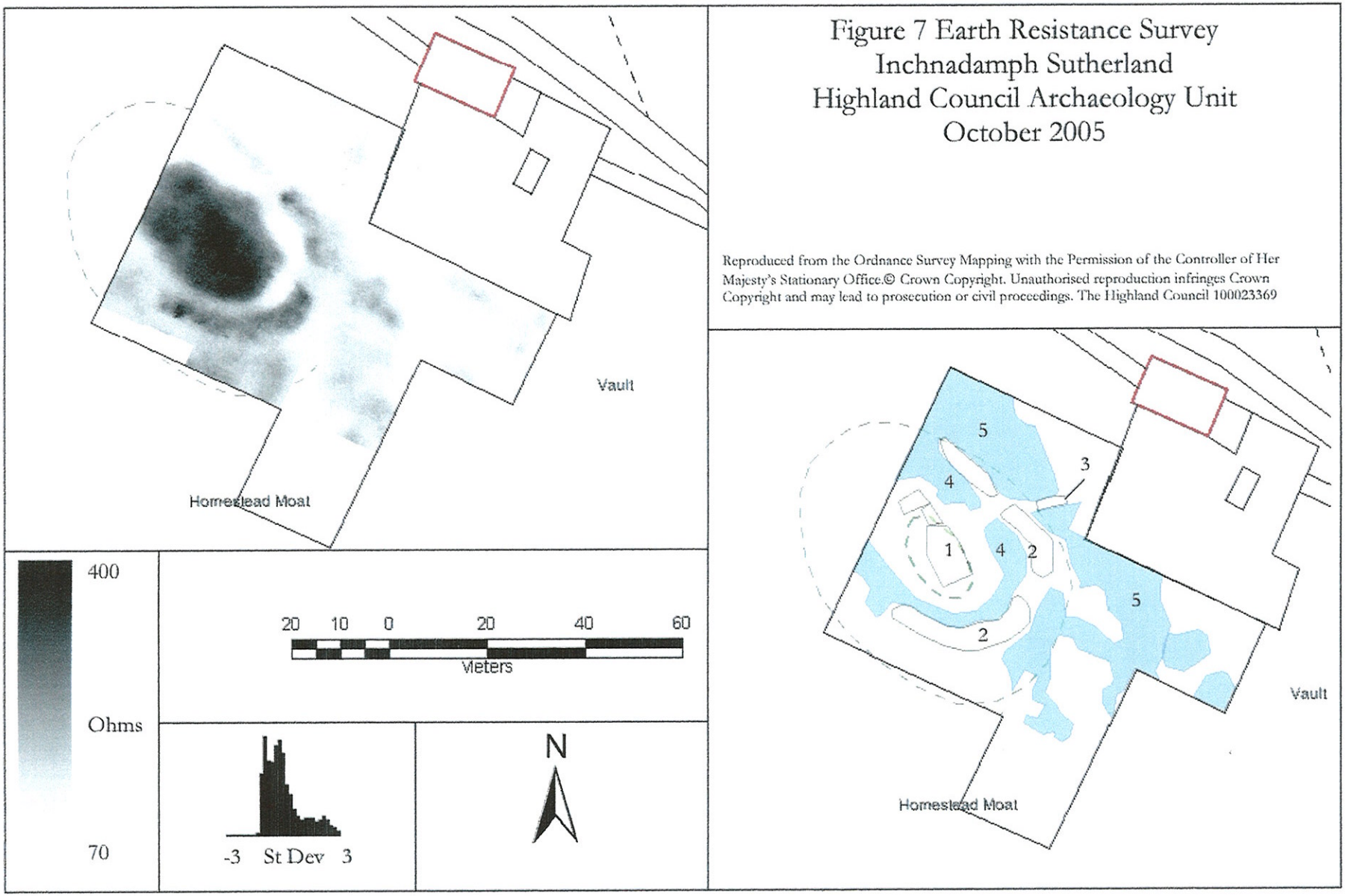

Figure 7 Earth Resistance Survey
Inchnadamph Sutherland
Highland Council Archaeology Unit
October 2005

4.1.2 Pseudosection

The data recorded during the vertical resistance survey showed the extent to which the ground surface of the survey area had been affected by water logging. The initial plots of measured and calculated apparent resistivity show a series of layers with increasing values. In the upper levels this equates to the water logging on the site (to approximately 1m) and in the lower levels it represents readings approximating the various states of a fragmenting base geology. In these plots there is little to indicate the presence of archaeological features and it might be assumed that they have been lost to water logging on the surface.

The data has not been corrected for the effects of topography and so it should be supposed that in places the observed water logging will be deeper. The extent of the waterlogging has implications for the interpretation of the area resistance survey, as the ground appears to be water logged to a depth below that which the meter can resolve. Given this the area survey was unlikely to detect anthropogenic features, such as post holes or ditches, out side the area of the enclosure.

Following the data inversion it is possible to see four anomalies in the data plot. The overall pattern that can be observed in the data is that of two wide channels approximately 13m wide by 4m deep and 12m by 3m respectively. In the first glance these might be mistaken for the ditch and bank of the homestead with a second channel to the east. The width of these features and their relative location to the ditch and bank observed in the area resistance survey argues against this however. It should be born in mind that during the area survey the effective depth of detection is between 0.25 and 0.75m. It seems likely that that the greater depth of detection that is offered through this method of surveying has served to highlight channels within the basal geology. These are in all likely hood representative of the palaeochannels that have been interpreted from both the geophysical data and the aerial photographic evidence.

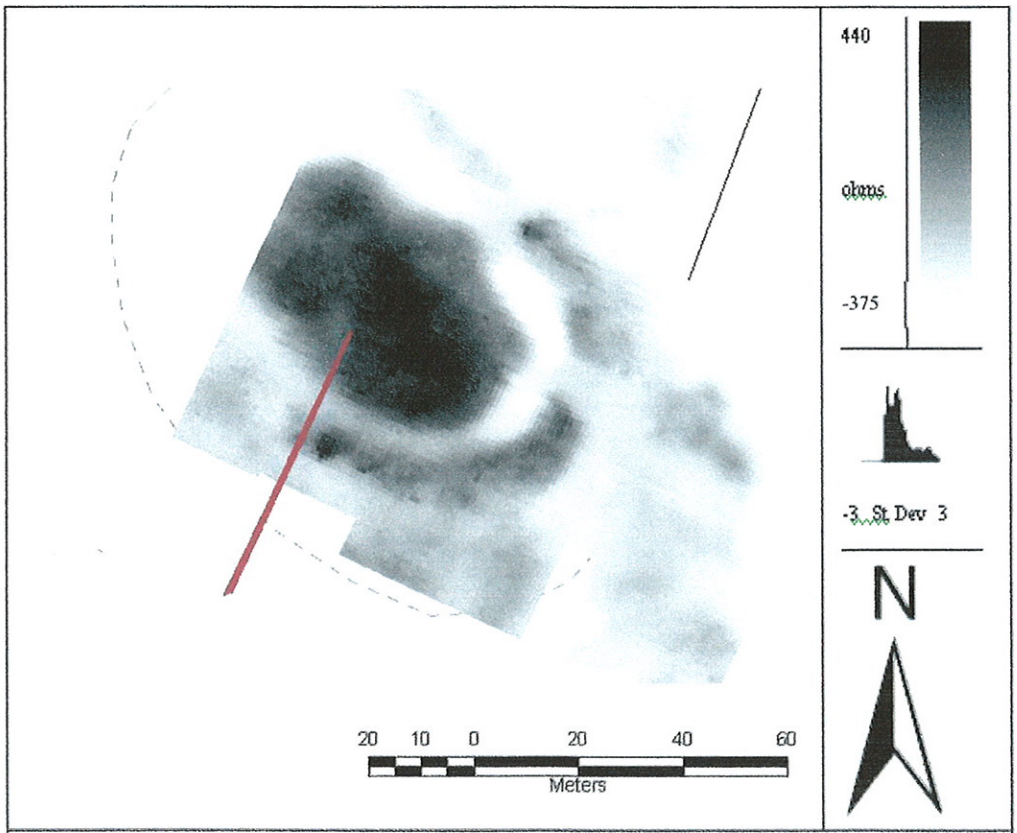

Figure 8 Earth Resistance Survey showing the line of the Pseudosection
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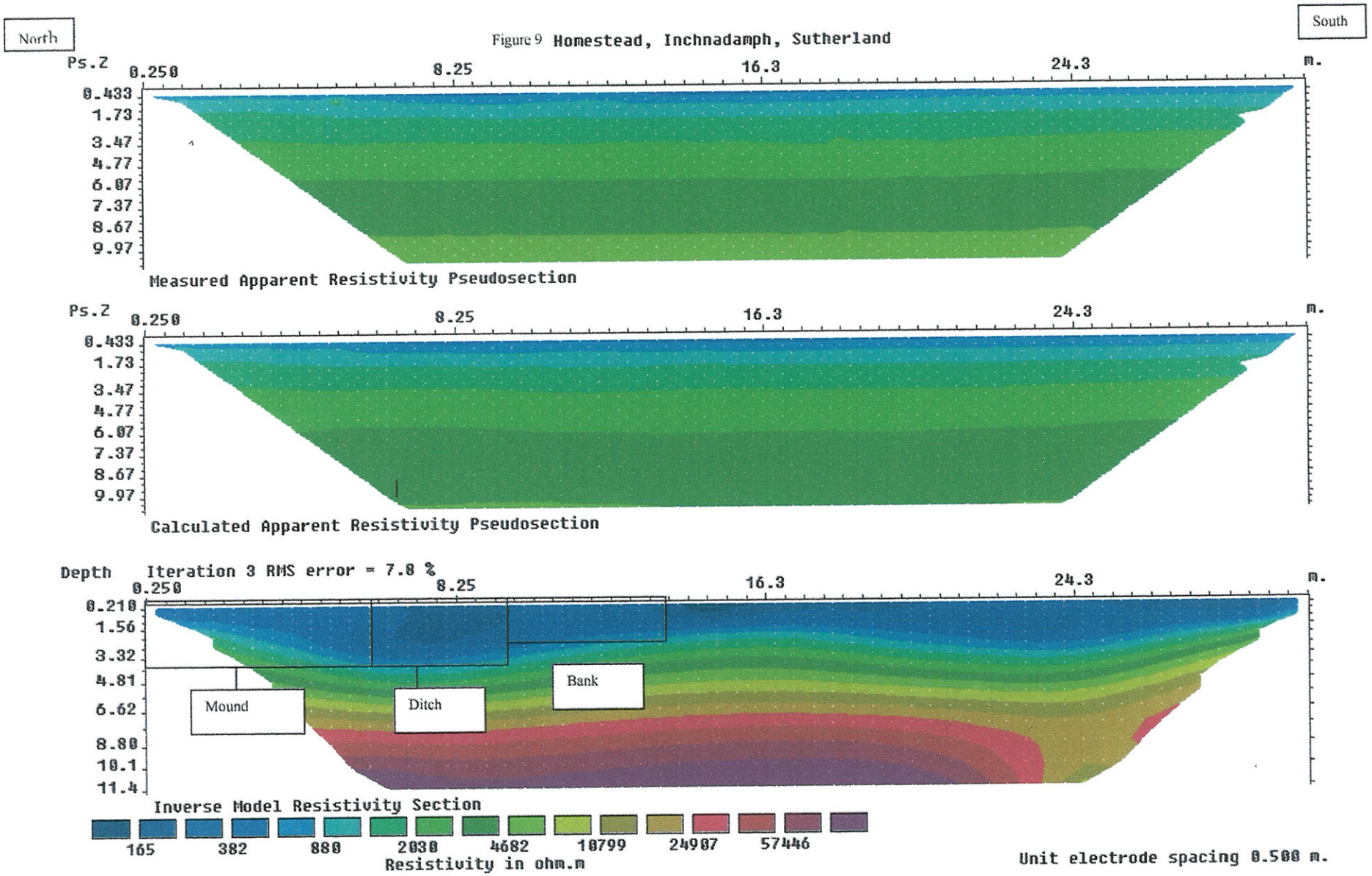
In terms of identifiable archaeological features in the pseudosection data, it is possible to make out the response of both the ditch and bank. The ditch presents as a wide, part U shaped, anomaly approximately 3m wide and in the region of 2m deep. The northern edge of the ditch does not appear as regular, this is probably the result silting or backfilling with material that has a higher resistivity. This data does not equate to an image of the ditch but is rather a distribution plot showing the spread of resistivity in the ground. It is not possible to define discrete layers within the ditch, but it is possible to say that a slightly higher resistivity response has disrupted the northern edge of the anomaly that is caused by the ditch.

The bank is not apparent as an anomaly but is rather defined by areas of lower resistivity on either side. It would appear to be 3.5m wide and is described on its southern side by an area of low resistivity to a depth of approximately 1m. This area of low resistivity might be seen as a slight channel outside the enclosure. There is little else that can be said about this feature. A topographic correction would generate some further detail; however the software to conduct this was not available to the survey team during the project.

This data has provided some useful information on the characteristics of the ditch, what is of more interest, are the questions that it raises about the location of the enclosure. As was noted from the Aerial Photographs the site is in an area that is flooded on a regular basis. This data raises the possibility that the enclosure was built on the banks of a channel or on higher ground within a system of channels that may once have isolated it. The situation within what would have essentially have been marshland or bog can has little to commend it and as such raises questions as to whether this isolation was enforced by pressure for land or, as is perhaps more likely given the possible links to an early religious site, whether it was deliberately sought out, possibly as some form of social or cultural statement.


North
South
Figure 9 Homestead, Inchnadamph, Sutherland
Ps.Z
0.250
8.25
16.3
24.3
m.
0.433
1.73
3.47
4.77
6.07
7.37
8.67
9.97
Measured Apparent Resistivity Pseudosection
Ps.Z
0.250
8.25
16.3
24.3
m.
0.433
1.73
3.47
4.77
6.07
7.37
8.67
9.97
Calculated Apparent Resistivity Pseudosection
Depth
Iteration 3 RMS error = 7.8 %
0.250
8.25
16.3
24.3
m.
0.218
1.56
3.32
4.81
6.62
8.80
10.1
11.4
Mound
Ditch
Bank
Inverse Model Resistivity Section
165
382
880
2030
4682
10799
24907
57446
Resistivity in ohm.m
Unit electrode spacing 0.500 m.

4.1.3 Gradiometer Survey

The results of the Gradiometer survey have proved surprisingly difficult to interpret. The alluvial drift deposits and waterlogged conditions during the survey are not ideal, despite this good signals have been detected from the bank and ditch. Other anomalies suffer from limited contrast due to the ground conditions and their interpretation should be seen as tentative.

Anomaly A is somewhat confusing, as is noted above the typical response generated by a ditch will be a positive peak. This is caused by the concentration of fermenting organic material and magnetically enhanced topsoil associated with human occupation. The response that should be expected from a bank would be the opposite, a negative peak caused by a concentration of banked subsoil that would generally have a lower magnetic susceptibility.

With the data recorded over the bank and ditch at Inchnadamph however there is a different pattern. Here the banks are showing as positive and the ditch as negative with a slight positive anomaly to the west. This signal might be caused in areas where the base geology is highly magnetic and where the topsoil has not seen enhancement caused by human activity. It has also been caused by erosion where soil slippage has contributed to an alteration in the response of features. When topsoil is eroded from a hill top it will cause a build up of material with relatively higher magnetic susceptibility lower down the slope, if a ditch is dug into this area and then filled by the continuing process of erosion, it will be fill by the less magnetic topsoil and generate a negative signal (Schleifer etal. 2003)

It seems unlikely that the cause of the reversed signals at Inchnadamph is connected to either of the processes described above. The base geology is Dolomitic Limestone and Calcareous Mudstone neither of which are noted for their high iron-oxide content. It is more likely that the signal should be attributed to either the water logging of the site at the time of the survey or the continuing process of inundation by the changing levels of the loch. More study combined with and analysis of the soil mineralogy would be required to comment more fully on the exact cause of these responses.

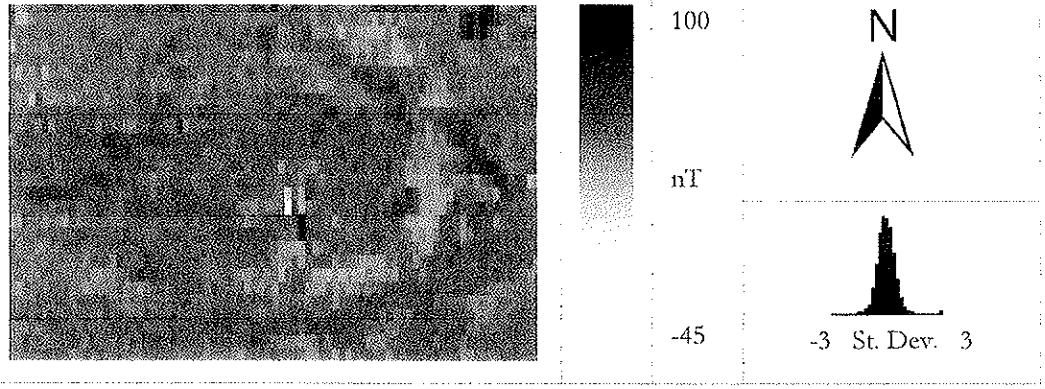


Figure 10 Fluxgate Gradiometer Survey
Inchnadamph, Sutherland October 2005
Anomaly A. Detail of the positive and negative anomalies generated by the ditch and bank

Anomaly B is a slight positive anomaly curving roughly east to west across the site from the break and causeway noted in the resistance survey. The anomaly measures 2m across and divides the mounded area in half. It is difficult to assess the true nature of this feature given the reversal of signals noted above. A positive signal should traditionally be seen as a ditch, in which case, this anomaly might be seen in the context of a drainage feature associated with a

track way connecting to the causeway or as a boundary ditch dividing the mound into activity areas.

Comparison with the resistance data shows no evidence of a ditch and the possibility of a route way should not be ruled out. The signal could be attributed to the spread of material enhanced during the occupation of the site and spread by the regular movement of either people or animals. It is noted that the signal is very feint and any interpretation is offered tentatively.

Anomaly C is again a very ephemeral anomaly. It shows as a band of weak positive and negative responses running north to south from the south eastern break in the bank. The anomaly measures approximately 6m across and corresponds with an area of low resistance which is interpreted as a possible palaeochannel. If this is the case the anomaly matches that which would be expected and as such seems to corroborate the interpretation.

It would appear then that the site is producing differing responses to similar features a palaeochannel and a ditch essentially being similar silted up features. For an explanation of this it would be necessary to look further into the mineralogy and pedological processes that are effecting each location.

Anomaly D is a further area of positive magnetic response which again coincides with an area of low resistance. It seems likely that this anomaly can also be seen as a silted feature associated with the shifting course of the river Traligill.

Anomaly E Is a broad positive signal which when viewed in the trace plot can be seen as a series of spikes increasing in magnitude to the northern boundary of the plot. On the ground this equates to the southern boundary of the church yard. It is believed that these anomalies are caused by local iron concentrations. Within the area of the churchyard there are several enclosures a number of which have wrought iron railings. It is thought that one of these is responsible for the anomaly that has been detected.

Anomaly F is similar to anomaly E in that it is thought to be an erroneous feature. In this case the anomaly is linear and is thought to be caused by a length of piping that has been removed from the church yard and deposited along the wall of the church yard.

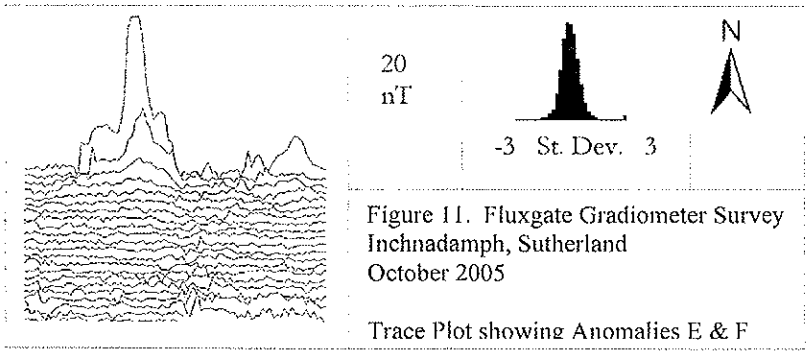


Figure 11. Fluxgate Gradiometer Survey
Inchnadamph, Sutherland
October 2005

Trace Plot showing Anomalies E & F

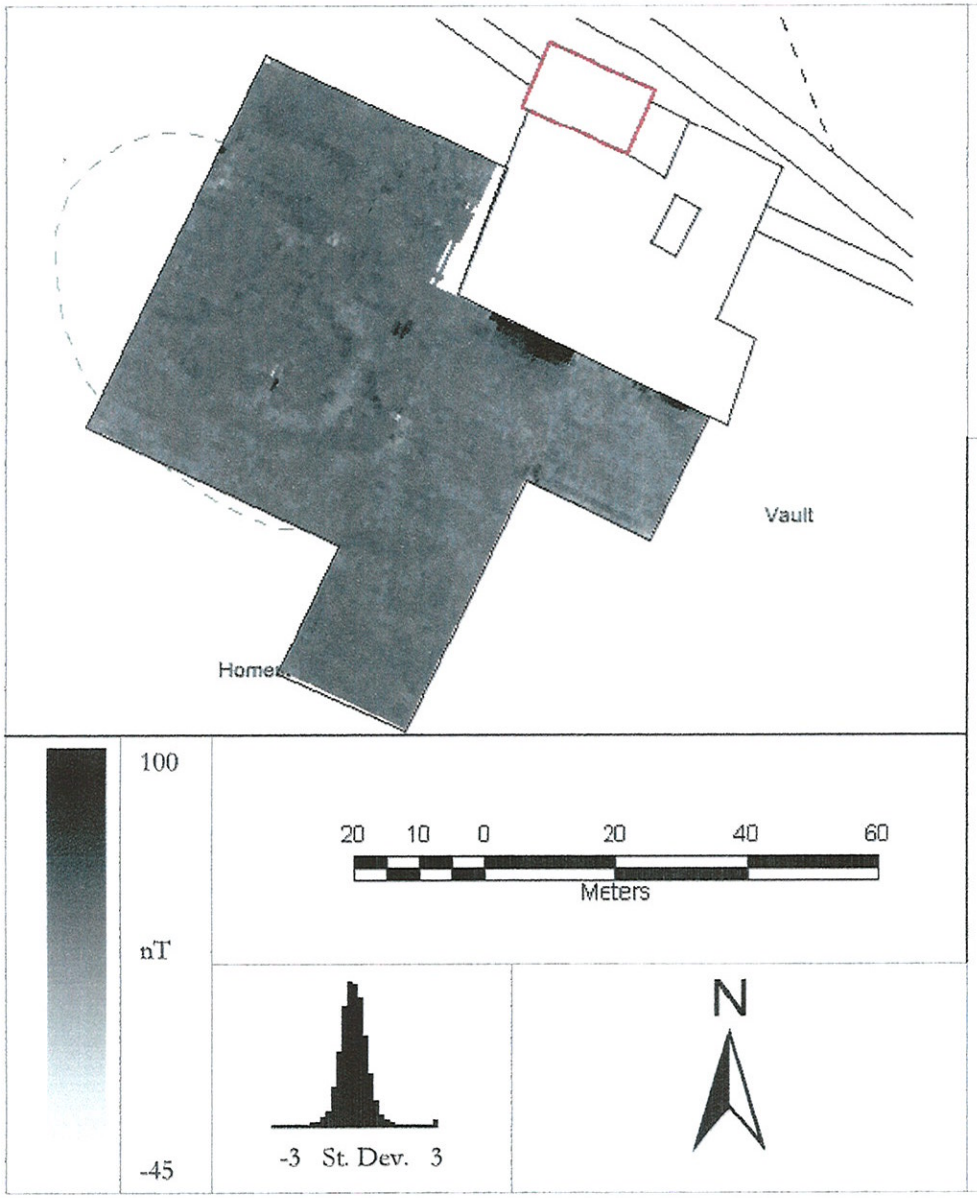
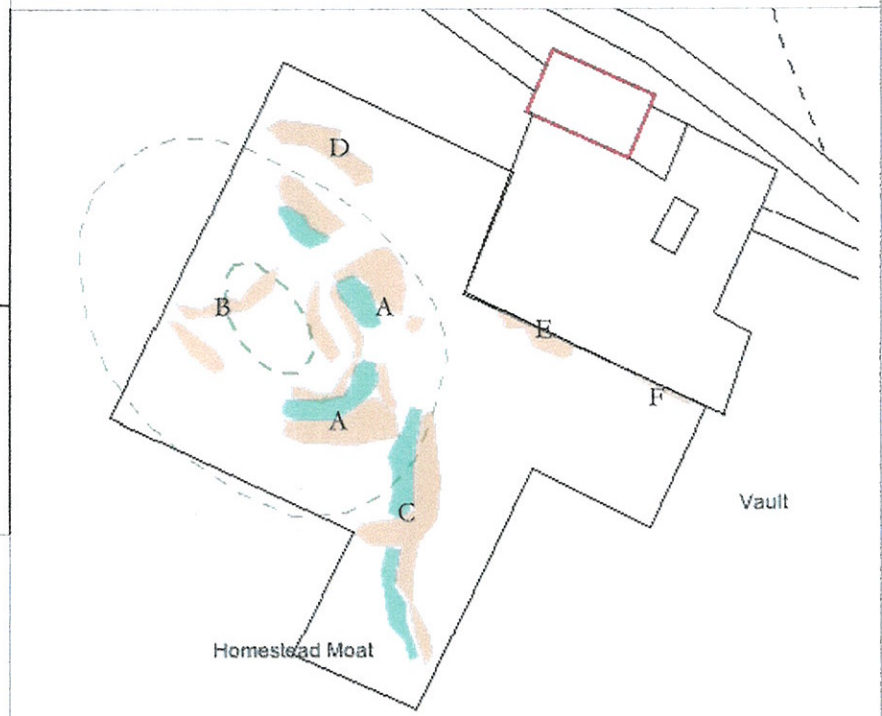


Figure 12 Fluxgate Gradiometer Survey
Inchnadamph Sutherland
Highland Council Archaeology Unit
October 2005



5 CONCLUSION

5.1 Assessment of aims

The survey was initiated as part of a wider project aimed at introducing volunteers, from the Highland Region, to non invasive techniques for investigating archaeological remains; and more specifically to geophysical methods of prospection. The archaeological objectives were to define any subsurface remains relating to the enclosure or to the early church. It was hoped that the survey would identify any internal features on the central mounded area, define the exact form of the surviving earthworks and identify any external features that may be associated with either the church or the enclosure.

5.2 Summary of Results

Despite what can only be described as adverse weather conditions the survey has achieved all of its initial objectives, however it should be noted that given the waterlogged conditions the presence of ephemeral features that were not detected during the survey cannot be ruled out. All of the data that has been presented here has been collected by volunteers new to the equipment and the standard of data should be commended.

In terms of the definition of features on the central mound of the enclosure it can be said that there is no obvious structural evidence within the data. The resistance data did however identify a rectangular area of high resistance at the south eastern end of the mound where it is highest. It is suggested here that this area represents a compacted surface and whilst not structural can be taken to indicate the former location of a building. Tigh Dige, Gairloch Ross and Cromarty is taken as a comparison, at this site a turf built structure with an associated garden and moated enclosure were identified in the nineteenth century and it does not seem unreasonable to suppose that a similar structure existed here (Dixon 1886).

The gradiometer survey identified two areas of positively enhanced magnetism; one running north east to south west parallel to the suggested structure and the other, at right angles, dividing the mound to the north. These anomalies are very ephemeral and a confidence in interpretation has to be low, it is however thought that these anomalies result from magnetically enhanced occupation debris being spread around the structure.

The bank and ditch are shown clearly on the resistance and topographic data with three obvious breaks in the bank. There has been some debate as to whether these breaks were designed or whether they resulted from subsequent erosion (OS 1962). The indication from the resistance data is that the breaks are a part of the original layout but have also been the subject of much erosion especially in the northern corner. It is believed that the northern and south eastern breaks were linked to a series of shallow channels that fed the moat and that the break in the north eastern section of bank linked to a causeway across the ditch and to the central mound allowing an entrance way approximately 2m wide. It is worth noting that an extension of the line created by the causeway would link the site directly to the northern end of the Macleod vault. Although there is no direct evidence of a link, the occurrence of a possible high status medieval dwelling so close to the focus early religious activity in the area should not be ignored.

The responses generated in the gradiometer data from the ditch and bank are of interest as they are at odds with those that might be expected. The reversal of response that has been observed indicates that the area is subject to some interesting pedological processes. These processes possibly involve the leeching of iron oxides from the soil matrix or else affect the

mineralogy of the oxides themselves. Without further analysis of the soil it is impossible to be more certain.

Further to the features associated with the enclosure both the gradiometer data and the resistance data confirm the presence of palaeochannels suggested by the aerial photography. The enclosure has been built on the edge of a series of channels that would have isolated it from the surrounding land.

5.3 Implications

The extents of the remains recorded during the survey appear to be neither extensive nor complex. It is however apparent that the site represents a rare survival. As was outlined in the introduction there are only seven moated sites within the Highland Region and of those only one that is directly comparable with the site at Inchnadamph. Based on what little comparative material that is available it seems likely that the structure dates to either the early medieval period. Little analytical study has been made of these features within the north of Scotland and little is understood about their perceived role within the social structures of their time. Given the waterlogged nature of the ground here it is likely that there will be a good level of preservation on the site which has seen little in the way of disturbance since it was abandoned. The site is however suffering from erosion caused by the regular inundation of lake waters and the continued survival of the earth works should not be seen as indefinite.

5.4 Recommendations

This study has defined the nature of the surviving earthworks on the site and gone some way to providing an understanding of the sub-surface features, the complex nature of the responses detected by the gradiometer survey show that there is much left to be done. In order to understand the magnetic survey data more fully it would be necessary to conduct an assessment of the magnetic mineralogy of the soil. It would also be of interest to assess the spread of magnetic susceptibility across the site and its potential for enhancement through a fractional conversion.

In order to further define the original ground surface upon which the enclosure was constructed and assess how it relates to the palaeochannels it would be of interest to carry out an auguring exercise. If this were combined with a limited excavation on the mound aimed at exposing the suspected surface a great deal of information could be retrieved that would allow for a more comprehensive understanding of this site as a type within northern Scotland and in the context of its surrounding landscape.

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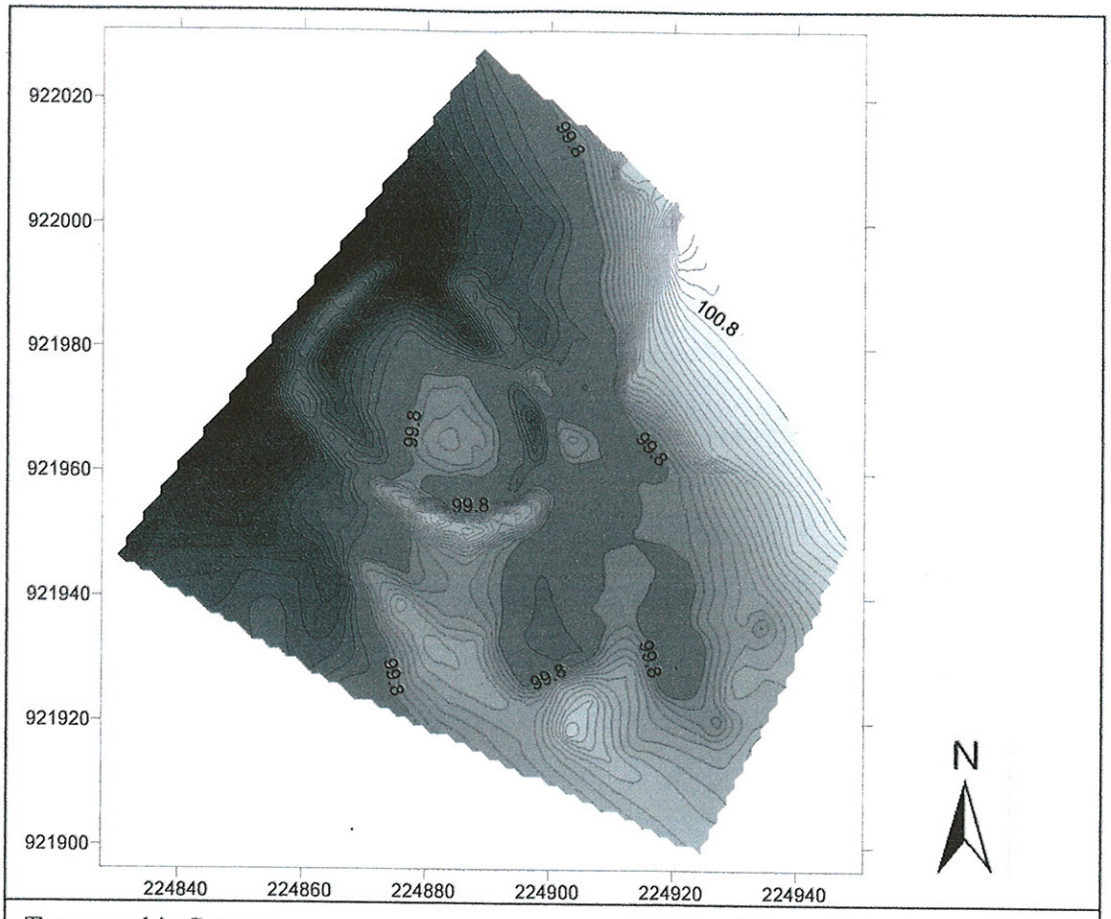
Many thanks are made to Janet Hooper and Historic Assynt who provided unrivalled local knowledge and logistical support through out the survey and who also made available their resources for analysis in this work. Thanks are also due to the volunteers without whom the data would never have been collected.

The Highland Council are gratefully thanked for funding this work in whole as part of their efforts in promoting archaeology to the public through events and activities organised for Highland Archaeology Fortnight.

Historic Scotland are owed thanks for kindly allowing the project Scheduled Monument Consent and Mr Vesty the Landowner is also thanked for granting us permission to access his land.

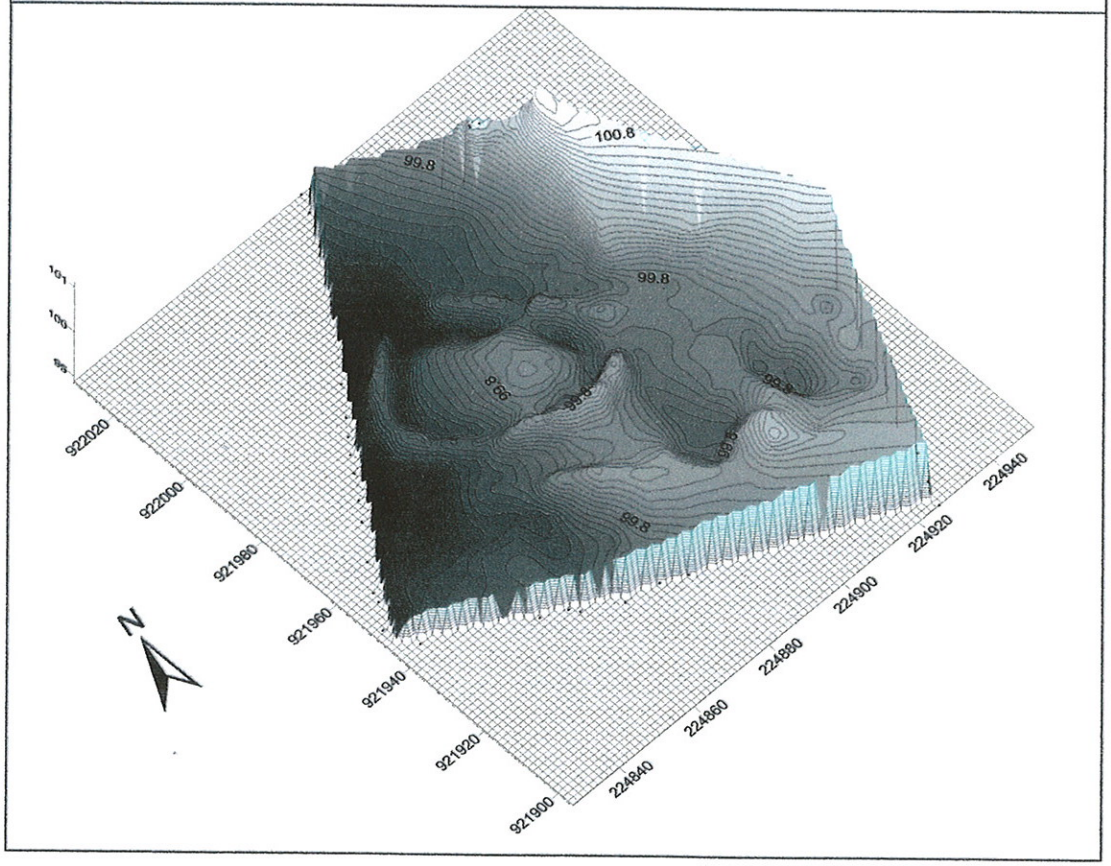
APPENDIX 1.

TOPOGRAPHIC DATA



Topographic Survey
Inchnadamph Sutherland

Highland Council Archaeology Unit
October 2005



APPENDIX 2.

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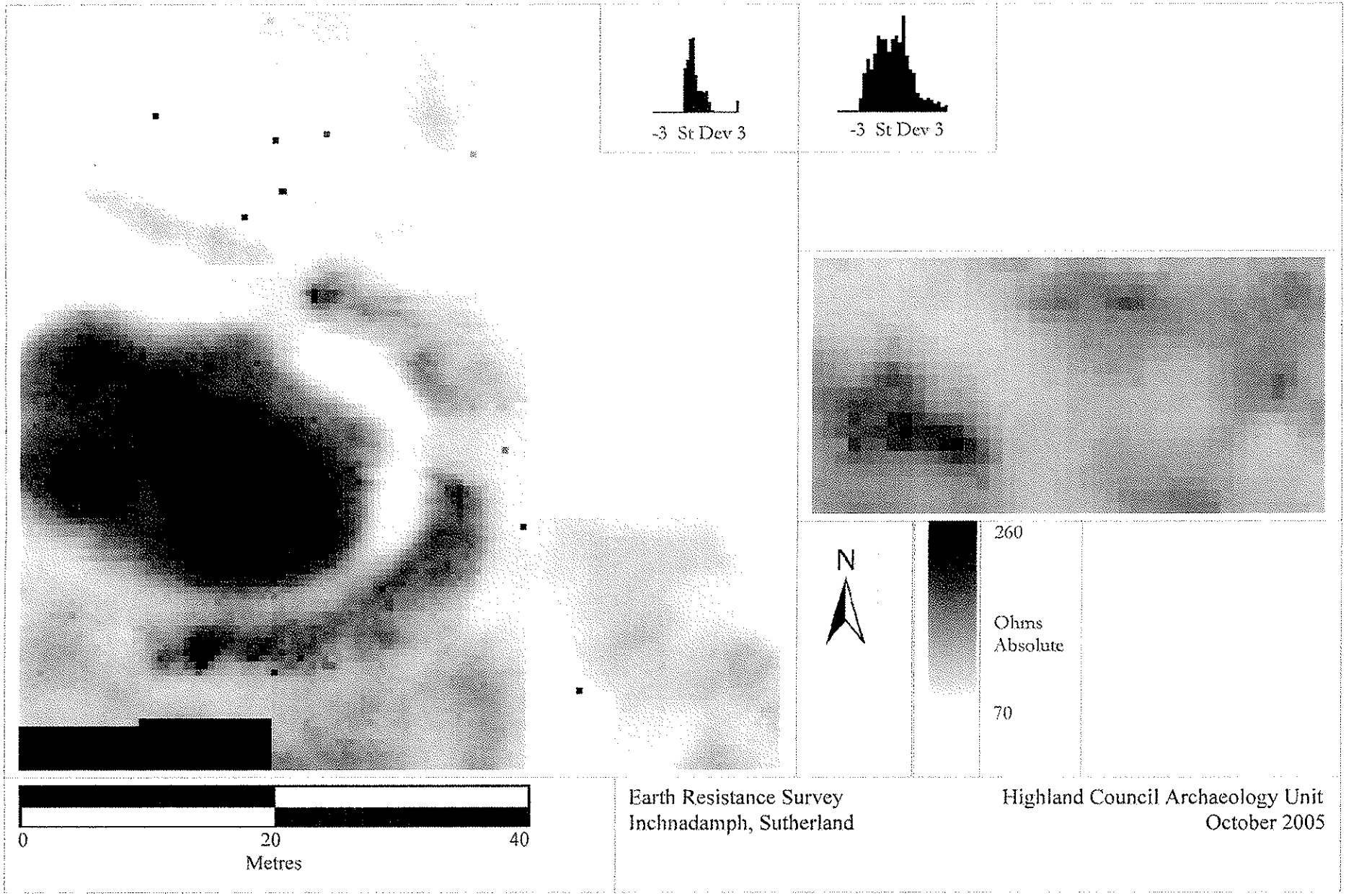
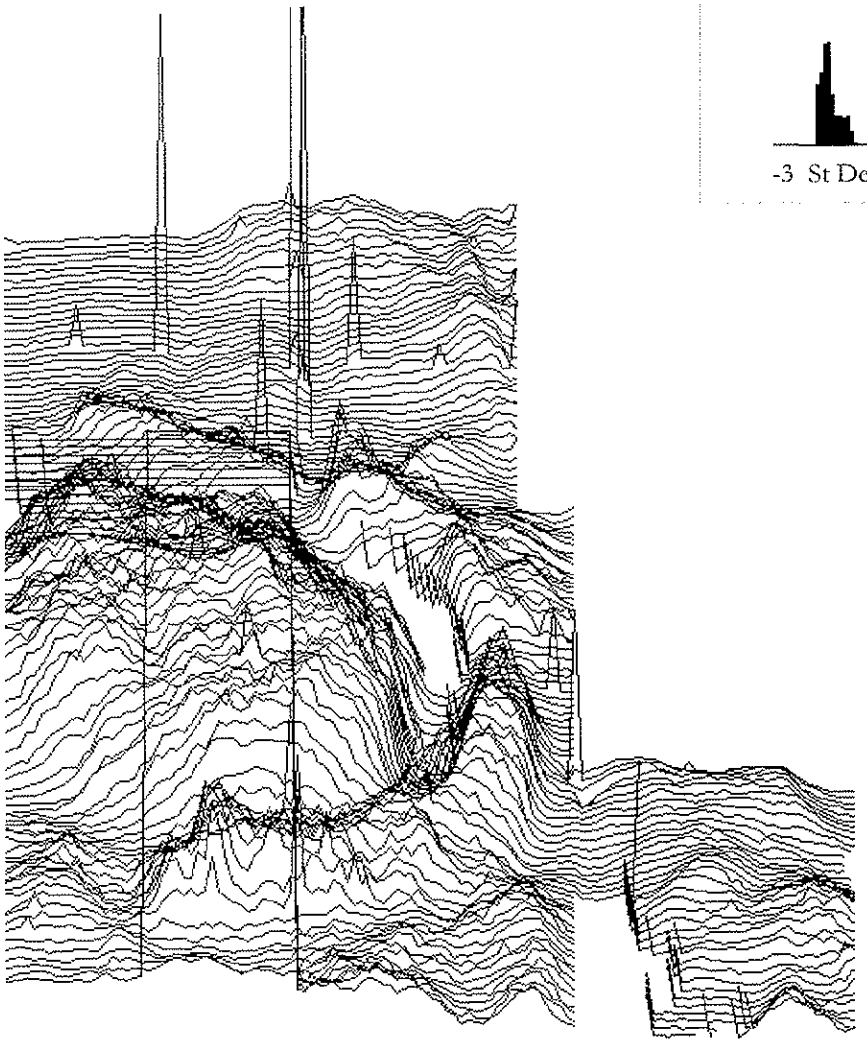


Earth Resistance Survey
Inchnadamph, Sutherland

Highland Council Archaeology Unit
October 2005



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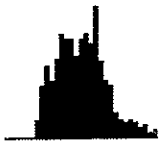

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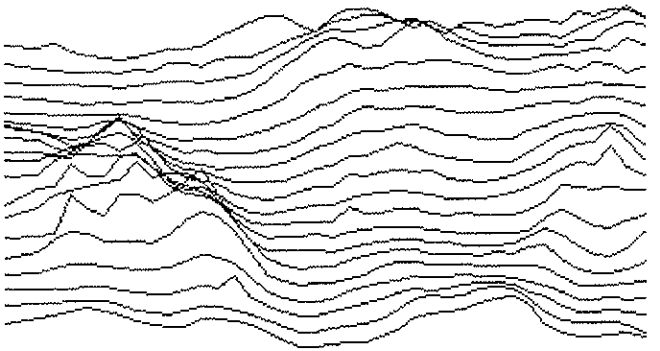
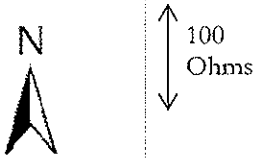
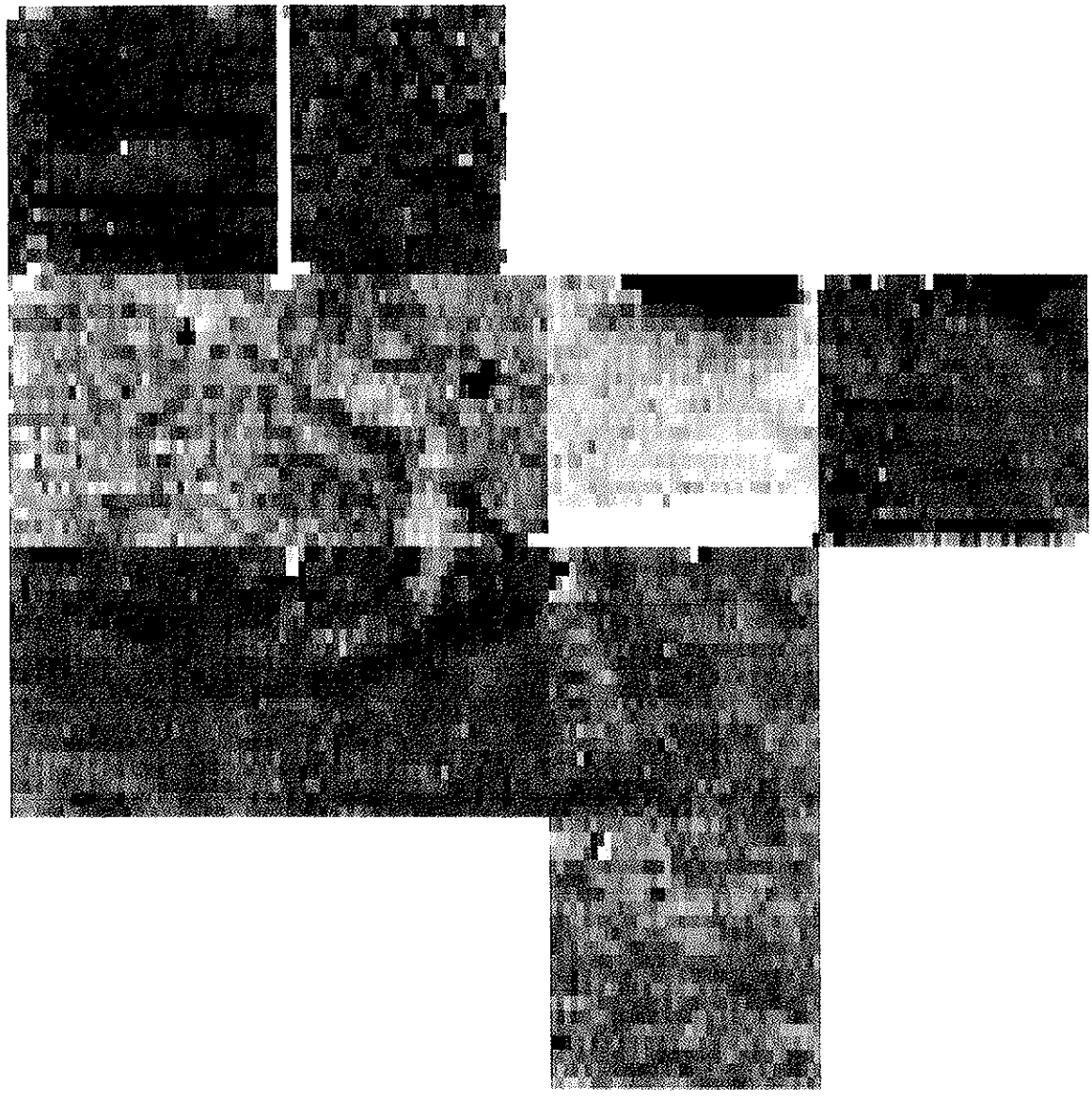




Earth Resistance Survey
Inchnadamph, Sutherland

Highland Council Archaeology Unit
October 2005



0 20 40
Meters

N

Fluxgate Gradiometer Survey
Inchnadamph, Sutherland

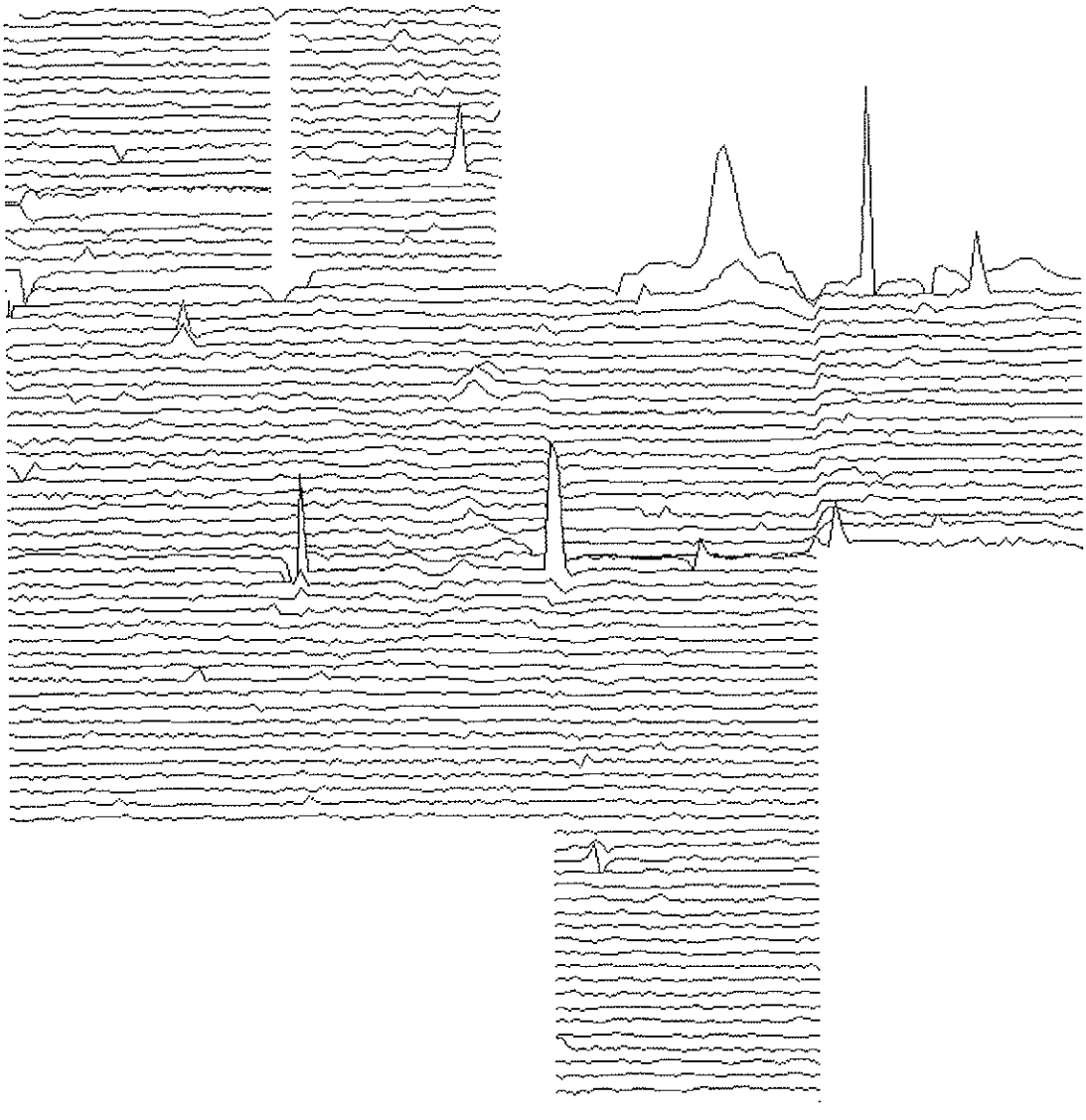
Highland Council Archaeology Unit
October 2005

100

nanoTesla
Absolute

-45

-3 St Dev 3



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Fluxgate Gradiometer Survey
Inchnadamph, Sutherland

Highland Council Archaeology Unit
October 2005

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Absolute

-3 St Dev 3

APPENDIX 3.

META DATA

META DATA

SURVEY NAME:	Inchnadamph, Sutherland
SURVEY INDEX:	
SURVEY PURPOSE:	To locate internal and External sub surface features associated with either the enclosure or the church
BIBLIOGRAPHIC REFERENCES:	
SURVEY KEYWORDS:	Moat/Homestead/Medieval/Earth Resistance/Gradiometer
SPACIAL COVERAGE:	NGR NC248 219 – NC249 220
ADMINISTRATIVE AREA:	Assynt, Sutherland, Highland Region.
COUNTRY:	Scotland
SOLID GEOLOGY:	Dolomitic Limestone & Calcareous Mudstone
DRIFT GEOLOGY:	Clay, Silt, Sand and Gravel, Alluvial Deposits
DURATION:	01/10/2005 – 04/10/2005
WEATHER:	Gales and Heavy Rain
SOIL CONDITION:	Waterlogged
LAND USE:	Rough Grazing
MONUMENT TYPE:	Homestead Moat
MONUMENT PERIOD:	Medieval
SAM Number:	HS9191
SURVEYOR:	Highland Council Archaeology Unit
CLIENT:	
PRIMARY ARCHIVE:	Highland Council Sites and Monuments Record
RELATED ARCHIVE:	
COPYRIGHT:	HIGHLAND COUNCIL

META DATA

METHODS OF SURVEY:	Resistance Survey	
INSTRUMENT TYPE:	RM15 / RM4	
ARRAY TYPE:	Twin Probe Array	
PROBE SEPARATION:	0.5m	
UNITS:	Ohms	
AREA SURVEYED:	0.37 Hectares	
GRID SIZE:	20m By 20m	
DIRECTION OF FIRST TRAVERSE:	East	
SAMPLE INTERVAL:	0.5m (RM15)	1m (RM4)
TRAVERSE INTERVAL:	0.5m	1m

METHODS OF SURVEY:	Gradiometer Survey
INSTRUMENT TYPE:	FM 36
UNITS:	nT
AREA SURVEYED:	0.4 Hectares
GRID SIZE:	20m By 20m
DIRECTION OF FIRST TRAVERSE:	East
SAMPLE INTERVAL:	0.25m
TRAVERSE INTERVAL:	1m
DRIFT LOGGED:	Yes
SUMMARY:	All survey methods located the remains of a bank and ditch between 3.5 and 5m wide. A high resistance anomaly located at the south eastern end of the central area is interpreted as a possible compacted surface with the Gradiometer data showing possible occupation debris scattered to the north and east. The breaks in the banks to the north and south east are thought to belong to a water management system with that on the north east linking to a causeway leading from the enclosure towards the old church. The Enclosure is surrounded by a system of Palaeochannels.