Magnetometry survey of a field to the NW of Tarradale House, Muir of Ord

Geophysical Survey

Interpretive Report

AOC Project Number: 70093

23rd December 2015

AOC Archaeology Group

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Magnetometry Survey of Tarradale Field, Geophysical Survey – Interpretive Report

On Behalf of:	**Dr Eric Grant** **Tarradale House** **Muir of Ord** **IV6 7RS**
National Grid Reference (NGR):	**NH 54734 49071**
AOC Project No:	**70093**
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This document has been prepared in accordance with AOC standard operating procedures.

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Abstract

A gradiometer survey was carried out on the northern section of a field to the northwest of Tarradale House on the 16th-17th December 2015 to investigate features identified on aerial photos and partially excavated in the 1990s. Several high positive anomalies were detected which could be interpreted as sub-surface archaeological deposits. An old road was easily detected and some very ephemeral traces of linear features also present that could relate to the features identified on aerial photos. Further work is recommended.

1 Introduction

1.1 Project Background

AOC Archaeology Group undertook a gradiometer survey at Tarradale, in a field located to the northwest of Tarradale House, Muir of Ord (NGR NH 54734 49071; Figure 1). This was at the request of Dr Eric Grant to investigate and assess possible archaeological features identified on aerial photographs and evaluated in 1991 by Professor Barri Jones.

1.2 Site Location and Description

The survey site was located in the northwest corner of the field and was composed of a flat topped hill with steeper slopes to the north and east. The site is located to the north of a probable Pictish barrow cemetery identified on aerial photos in the same field. Ground conditions were variable with a hard frost, a crop of winter turnips in the field and sheep penned in the northern section of the field with a temporary electric fence.

The site is located on an area of Raddery Sandstone Formation with superficial deposits of gravel, sands and silts forming raised beaches (BGS 2015).

1.3 Archaeological and Historical Background

The site lies within a significant prehistoric and historic landscape, currently being investigated by Eric Grant and a team from *North of Scotland Archaeological Society* (*NOSAS*). The Highland Council HER returns 16 records of archaeological sites in the immediate vicinity of the field that the geophysics cropmarks have been noted in:

Site 1 MHG8405 Motte, by Tarradale House NH 5530 4870
Possible site of an early medieval motte is recorded to the south of Tarradale House.

Site 2 MHG9117 Enclosure, by Tarradale House NH 5530 4870
A possible enclosure is recorded on aerial photos to the south-west of Tarradale House.

Site 3 MHG46391 Findspot, Brooch, Buckle, Coin NH 55 49
Findspots during a metal detecting survey around Tarradale, coins are 16th-17th C in date.

Site 4 MHG9097 Barrow Cemetery, Ring-ditch NH 5494 4895
A complex of cropmark ring ditches, at least three – five recorded on aerial photos. Additionally two possible square enclosures/barrows. Field NW of Tarradale House.

Site 5 MHG40177 Barrow Cemetery, Square Enclosure NH 5494 4895
A complex of cropmark ring ditches, at least three – five recorded on aerial photos. Additionally two possible square enclosures/barrows. Field NW of Tarradale House.

Site 6 MHG9098 Enclosure, Circular NH 5487 4888
A cropmark showing a circular enclosure approx. 30m in diameter immediately SE of the barrow cemetery enclosures. Field NW of Tarradale House.

Site 7 MHG9099 Enclosure, Rectilinear NH 5484 4891
Air photography has revealed cropmark evidence of parts of a rectilinear enclosure, c. 33 by 38m with a ditch of 1.5m width. Also a cropmark of a circular, possible bivallate enclosure that borders the pentagonal ‘castle’ site in the field NW of Tarradale House.

Site 8 MHG8443 Settlement, Bellevue Cottages NH 5470 4910
An undated unenclosed settlement recorded on aerials in the northern end of the field NW of Tarradale House.

Event EHG725 Excavation, Tarradale Cropmark NH 5470 4907 (centred)
Trial excavation on the cropmarks 1km east of Tarradale Mains, in the summer of 1991 by Dr Barri Jones. Established the presence of 'a defensive ditch and pits, a palisaded rampart with rearward hearth, internal perimeter road and internal timber building.' Excavations recorded these features; there was not a huge depth to topsoil or features, indicating truncation from original depth.

Site 9 MHG9104 Ring-ditch NH 5459 4884
A cropmark of a ring-ditch is visible on aerial photographs 400m NNE of Bellevue Farmhouse. It measures about 10m in diameter.

Site 10 MHG8306 Road, Cropmark NH 5450 4900
A broad cropmark, c. 3m across continues the line of the old road from the adjacent field NW of Tarradale House.

Site 11 MHG9096/4644 Circular Enclosure, Pit NH 5422 4901
Aerial photographs show a large circular enclosure c. 20m in diameter with a narrow ditch, a large pit is also visible to the NW.

Site 12 MHG22671/44647 Circular Enclosure, Pit Circle NH 5420 4910
Cropmark of a circular ditched enclosure, c. 25m in diameter, a smaller rind of postholes adjoins to the west. 200m NW of Bellevue Cottages.

Site 13 MHG8431 Cropmarks, Balvattie NH 5440 4930
Occupation site recorded between Bellevue Cottages and Balvattie.

Site 14 MHG29984 Windhill, Round Barrow NH 5440 4930
The NGR for this site is placed some way from the burial recorded at Windhill so it is possible this is a duplicate.

Site 15 MHG8305 Road, Cropmark NH 5490 4860
A continuation of an old road is seen on aerial photographs.

The presence of so many cropmark sites, indicating likely prehistoric and early historic activity, is significant. This dataset implies that the area is culturally significant during these periods and merits further investigation. Recent work by Eric Grant and *NOSAS* has continued to highlight this with survey and small scale excavation work. The discovery of early prehistoric shell middens and several years of intensive fieldwalking finds substantiate that this region has been the site of intensive prehistoric and likely early historic activity.

Figure 1: Location of Tarradale field (*OS Open data 2015 ©)*

2 Methodology

2.1 Gradiometer Survey

The aims of the archaeological works were:

i) To survey an area to the northwest of the barrow cemetery to locate and assess the enclosure identified on aerial photos and excavated by Barri Jones

ii) To make recommendations for further survey and excavation work

The survey was undertaken using a Bartington Grad601-2 instrument (Gradiometer survey, Appendix 1). The parameters used were suitable for the prospective aims of the survey and in accordance with recommended professional good practice (David et al. 2008, 8). Data was collected zigzag with a sample reading of 0.25m and traverse interval of 1m within 30m by 30m grid squares. The grids were accurately laid out using survey-grade (cm accurate) GPS equipment (Trimble Geo-XR Rover 6000 series). These readings were downloaded with Grad 601 and processed using Geoplot v.3 software (Appendix 2/3).

All interpreted point, polyline and polygon layers were created in QGIS in SHP format.

The site location, including survey area and significant breaks of slope, were plotted using a Trimble Geo-XR Rover capable of centimetre accuracy.

3 Results

3.1 Overview

The fieldwork was carried out between 16th and 17th December. The conditions on site were cold but mainly dry. The combination of frozen ground, steep slopes and a winter turnip crop in the field made survey progress slow.

In general the survey revealed several high positive magnetic anomalies (Figures 2; 3) which are likely to represent (Figure 4) archaeological features (1 and 2), an old road and associated ditch (6 and 7). There was also evidence of modern plough scarring and earlier rig and furrow cultivation on the top of the hill (4). A very faint linear anomaly may be all that remains of a truncated ditch feature (it might also just be a natural anomaly caused by the steep break of slope on this side of the hill) (3). Metal was evident across the field (likely modern waste) through high positive and low negative dipoles (5), an area of mixed readings indicates disturbance of the natural soils (8) and a very faint positive linear anomaly runs across the rig and furrow orientation (9).

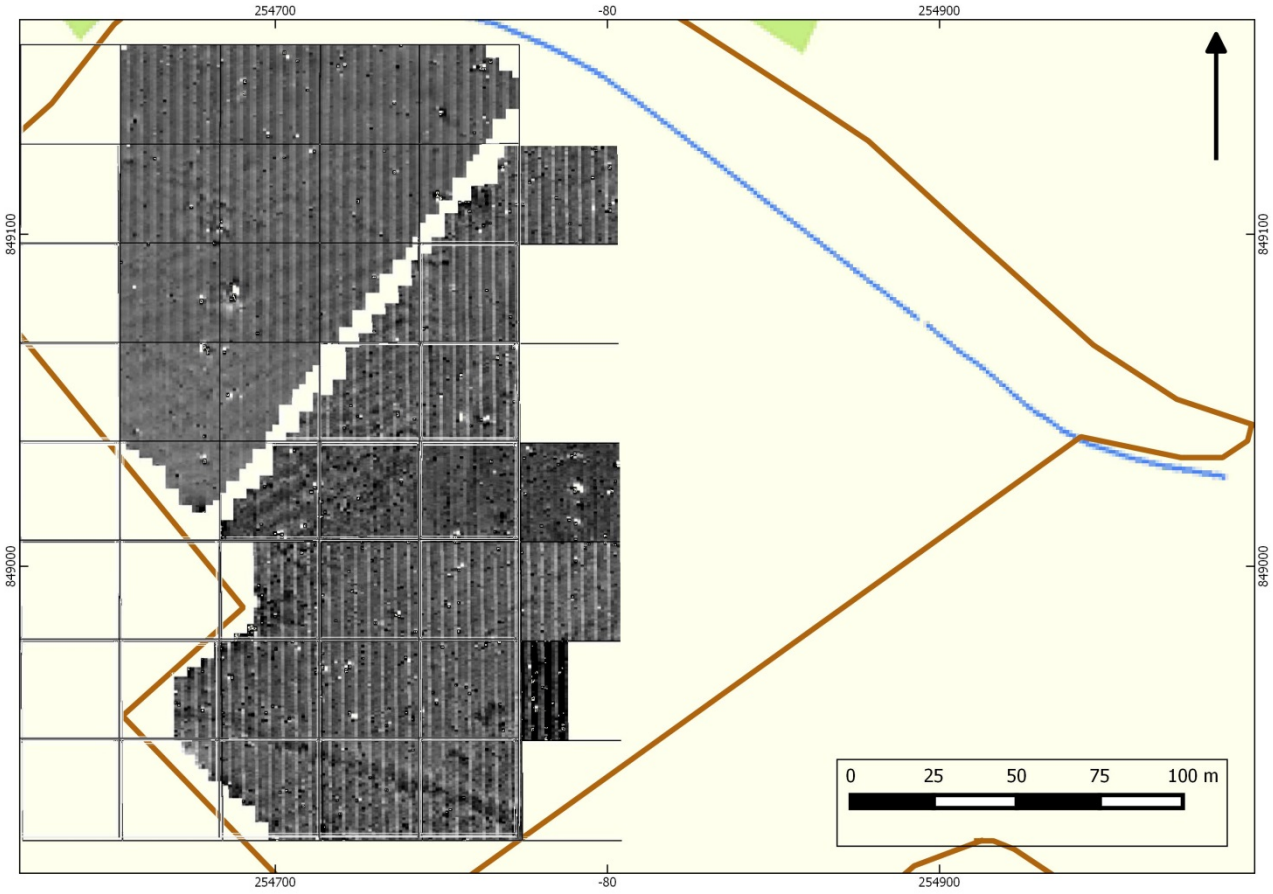

Figure 2: Plot of raw magnetometry data (black = high positive, white = low negative)

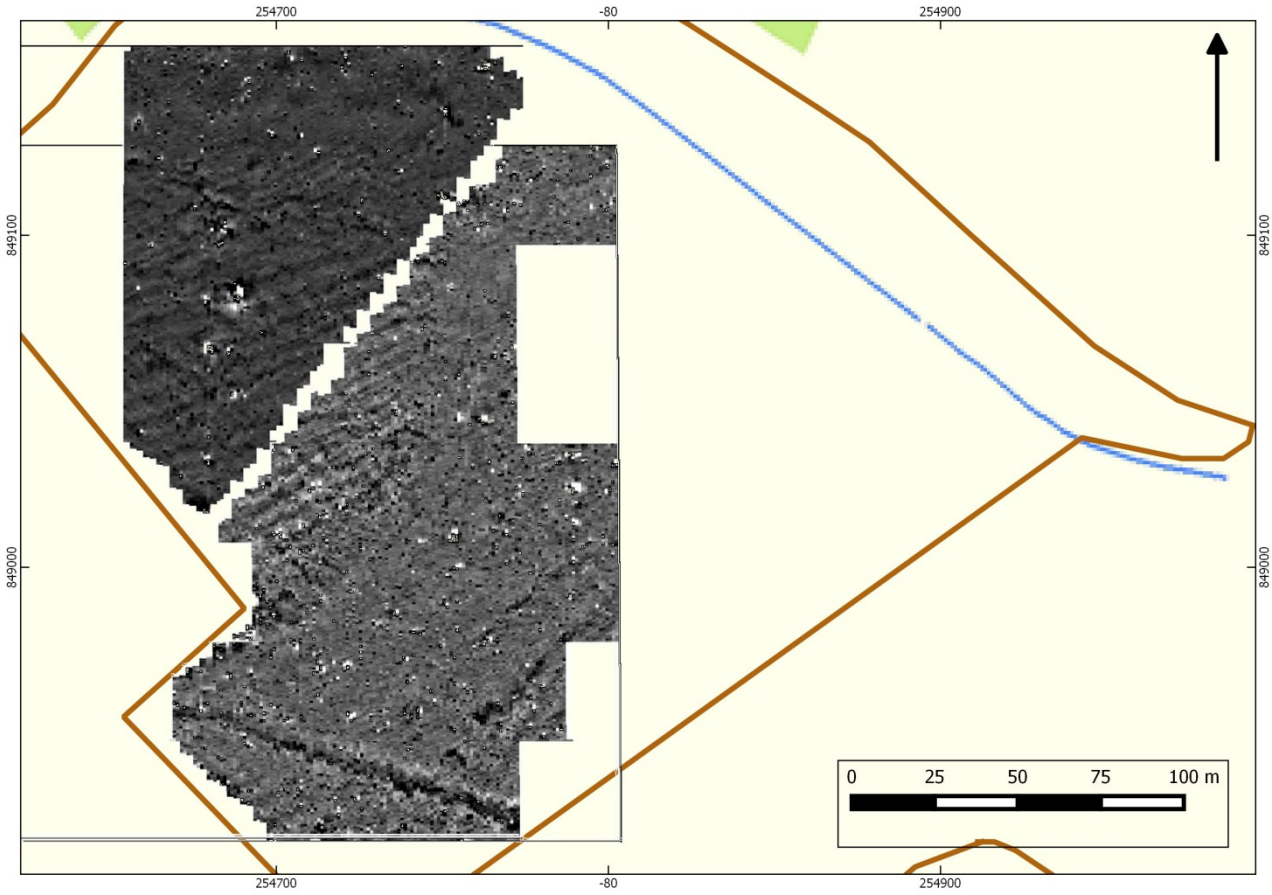

Figure 3: Plot of processed magnetometry data (black = high positive, white = low negative)

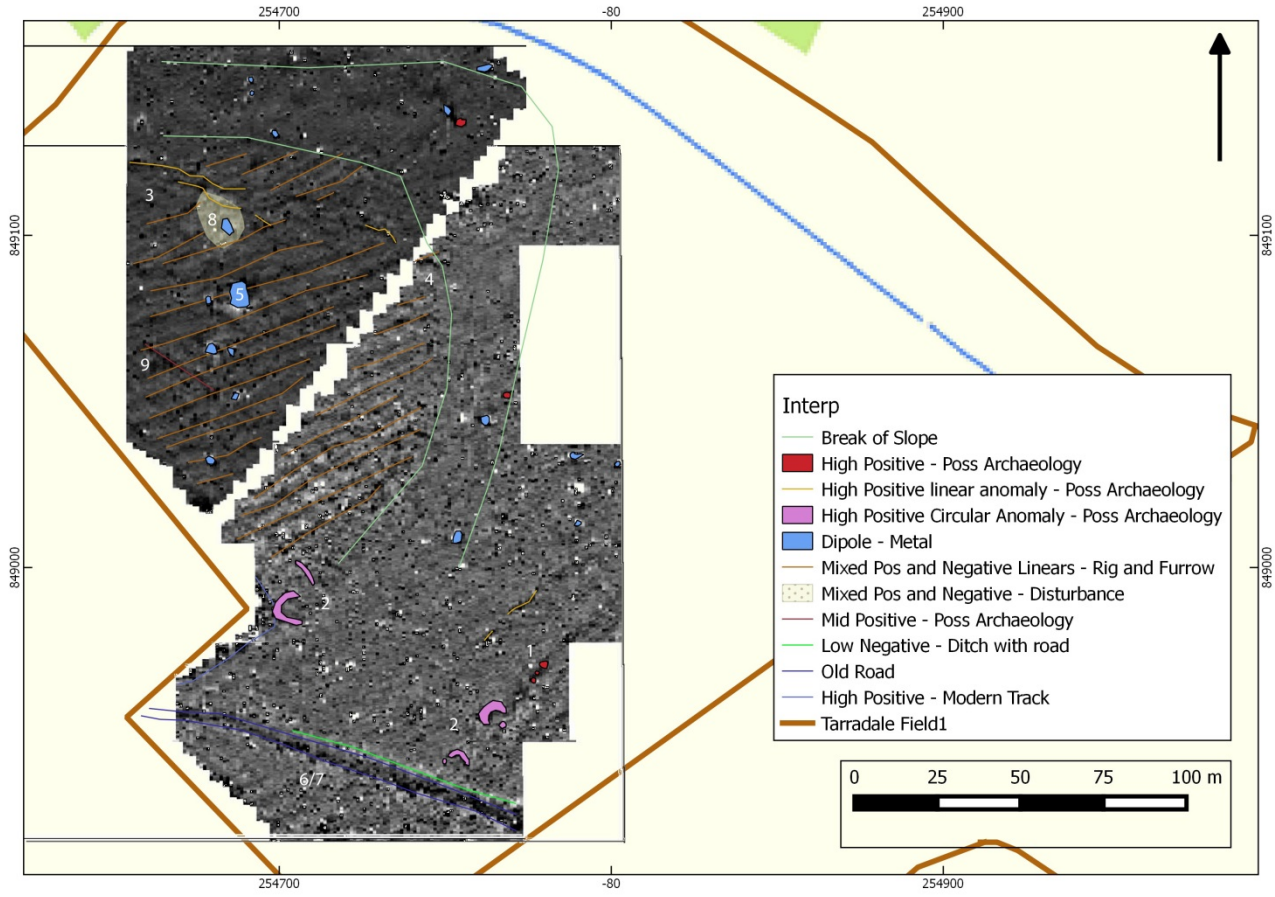

Figure 4: Plot of processed magnetometry data with interpretation

3.2 Anomaly 1 (Red areas)

Anomaly 1 refers to an alignment of three high positive circular anomalies in the southeast of the plot and one anomaly in the north of the plot. It is worth noting that the three in the southeast of the plot align with the route of the modern track through this field so could be related to modern activity. The anomaly to the north is next to a dipole likely caused by metal objects in the plough soil.

3.3 Anomaly 2 (Purple areas)

Anomaly 2 refers to a series of u-shaped high positive anomalies at the southern end of the plot. These features are approximately 5-7m across and could relate to archaeological features, possibly containing burnt or disturbed material. These features merit further investigation through excavation to confirm their character, extent and refine interpretation. It is worth contacting the tenant farmer to confirm that these areas have not been the site of cattle feeders before further work is undertaken. (The tread and wear pattern around circular feeders can often be mistaken for archaeological responses.)

3.4 Anomaly 3 (Yellow lines)

Anomaly 3 refers to several slight positive linear anomalies on the top northern edge of the hill. The fragmented and ephemeral nature of these anomalies calls their interpretation into question. It is possible they relate to linear features that are heavily truncated or at some depth. They could potentially relate to the linear features that were identified on aerial photos and excavated by Jones in 1991. It is also entirely possible that they could be the result of erosion exposing contrasting superficial geology strata at the edge of the steep slope. The fact they run at odds to the ploughing and earlier rig and furrow cultivation and are set back from the very edge of the slope does imply they could merit further investigation through excavation to confirm their character, extent and refine interpretation.

3.5 Anomaly 4 (Brown lines)

Anomaly 4 refers to a series of alternating mid positive and mid negative linear anomalies. These extend across the flat top of the hill and do not extend onto steeper slopes. They are aligned roughly northeast-southwest and are not following the current ploughing regime. This is likely to be evidence of early rig and furrow cultivation, perhaps more evident on the flatter areas of the field where less erosion has taken place.

3.6 Anomaly 5 (Blue areas)

Anomaly 5 refers to a series of very high and very low anomalies next to each other. These dipoles are likely to represent modern metal objects in the plough soil.

3.7 Anomaly 6/7 (Blue/Green lines)

Anomalies 6 and 7 represent an old sunken road that runs through the field. This feature forms a routeway that runs from the shore of the Beauly Firth through the field and continues on to the northwest. A high positive linear anomaly (6) approximately 4-5m wide represents the main surface of the road or track. To the northern edge of this a low negative anomaly runs parallel (7), most likely representing a drainage ditch associated with the routeway. Some areas exhibit higher positive anomalies, it is possible these areas represent a stonier surfacing or metalling of the route. Excavation could confirm this and provide further information on character, extent and refine the interpretation

3.8 Anomaly 8 (White area)

Anomaly 8 refers to an area of mixed responses. This is normally indicative that the natural soils have been physically disturbed in some way. This could be the result of erosion, modern or historic human interference and even possibly archaeological excavation – the exact location of Barri Jones' excavation trench is unknown but thought to be in this section of the field.

3.9 Anomaly 9 (Red line)

Anomaly 9 refers to a faint linear anomaly on the top of the hill. This low to mid positive response could be related to structural activity on the top of the hill or perhaps drainage. Excavation could confirm this.

4 Discussion

The gradiometry survey has successfully identified some potential archaeological features that merit further investigation. Excavation would help to confirm the character and extent of these possible features and aid in refining interpretation. In addition geological responses and modern disturbance have been noted but the overall response of potential archaeological features has not been obscured by geological 'background noise'.

Other features may or may not be present in the field but have not been picked up by this particular technique. The level of magnetism of fills/deposits, depth of features and level of truncation all have implications for whether features will be detected by geophysical techniques.

Illustrations from the excavation in 1991 indicate the ephemeral nature of the original target features. The ditch and palisade identified on the aerial photos and later excavated consisted of features less than 0.5m depth under a shallow topsoil. The fill of the ditch is described by Jones as consisting of "a slumped infill of dirty sand... (1991)." This indicates that the fill may be very similar to the surrounding natural material and the cut hard to distinguish due the fragile and slumping nature of the loose sandy natural. Erosion may have caused further truncation of these features since excavation.

5 Conclusion

The identification of potential archaeological features at Tarradale through geophysical survey demonstrates that it would be worthwhile applying this technique elsewhere in the region to test other features identified on aerial photographs. Further investigation of the features identified in the Tarradale field through excavation would be invaluable in aiding understanding and interpretation of this particular site.

This potential work would have local and regional significance, enhancing the overall known heritage resource of the region. This area has a wide range of aerial photographs available for study, with many different cropmarks identified on them. The identification of archaeological sites of a variety of time periods has also already taken place, particularly through work in recent years led by Dr Eric Grant and *NOSAS*. Sites ranging from Mesolithic shell middens, prehistoric cairns, enclosures and barrow cemeteries have been located and identified. An invaluable research project would be created by the combination of a desk-based aerial photo analysis, larger scale geophysical prospecting and subsequent targeted excavation. Not only would this enhance the regional archaeological resource but it would also develop our understanding and application of geophysical techniques in the Highland region (an area long thought to have too strong an underlying geological response to be able to use geophyscial techniques to identify archaeology in a reliable manner). This project would also provide a rare opportunity to combine this research with in depth comparison of aerial photographic analysis and groundtruthing.

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Appendix 1: Information on Gradiometer survey

Gradiometer survey

Gradiometer surveys measure small changes in the earth's magnetic field. Archaeological materials and activity can be detected by identifying changes to the magnetic values caused by the presence of weakly magnetised iron oxides in the soil (Aspinall et al., 2008, 23; Sharma, 1997, 105). Human inhabitation often causes alterations to the magnetic properties of the ground Aspinall et al, 2008, 21). There are two physical transformations that produce a significant contrast between the magnetic properties of archaeological features and the surrounding soil: the enhancement of magnetic susceptibility and thermoremnant magnetisation (Aspinallet al., 2008, 21; Heron and Gaffney 1987, 72).Ditches and pits can be easily detected through gradiometer survey as the top soil is generally suggested to have a greater magnetisation than the subsoil caused by human habitation. Also areas of burning or materials which have been subjected to heat commonly have high magnetic signatures, examples include: hearths, kilns, fired clay and mudbricks (Clark1996,65; Lowe and Fogel 2010,24). It should be noted that negative anomalies can also be useful for characterising archaeological features. If the buried remains are composed of a material with a lower magnetisation compared with the surrounding soil, the surrounding soil will consequently have a greater magnetisation resulting in the feature displaying a negative signature. For example stone materials of a structural nature that are composed of sedimentary rocks are considered non-magnetic and so will appear a negative features within the data set. Ferrous objects-i.e. iron and its alloys-are strongly magnetic and are typically detected as high-value peaks in gradiometer survey data, though it is not usually possible to determine whether these relate to archaeological or modern objects. Although gradiometer surveys have been successfully carried out in all areas of the United Kingdom, the effectiveness of the technique is lessened in areas with complex geology, particularly where igneous and metamorphic bedrock is present. All magnetic geophysical surveys must therefore take the effects of background geological and geomorphological conditions into account.

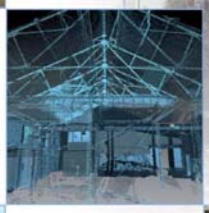
Appendix 2: Details of geophysics processing

Process	**Extent**
Shade plot: Raw Palette Scale	Grey99: Min: -10 Max: 10
Palette Scale	Grey99: Min: -2 Max: 2
Zero Mean Traverse	All LMS = on
Destagger	All grids, X direction shift 1 Line Pattern 34-78 Dual-DS
Both areas processed to same spec. as above	

Appendix 3: Geophysics Processing Terms

Process	Effect
Clip	Replaces data values outside a specified range, in order to display important data with relative values stretched across the display range.
De-spike	Removes exceptionally high values represented in the data that can obscure the visibility of archaeological features. In resistivity survey, these can be caused by poor contact of the mobile probes with the ground; in gradiometer survey, these can be caused by highly magnetic items such as buried ferrous objects.
De-stagger	Counteracts the striping effect caused by misalignment of data when collected on a zig-zag traverse pattern.
Edge Match	Counteracts edge effects in grid composites by subtracting the difference between mean values in the two lines either side of the grid edge.
High pass filter	Removes low-frequency, large scale detail in order to remove background trends in the data, such as variations in geology.
Interpolate	Increases the resolution of a survey by interpolating new values between surveyed data points
Low Pass filter	Uses a Gaussian filter to remove high-frequency, small scale detail, typically for smoothing or generalising data.
Periodic Filter	Used to either remove or reduce amplitudes of constant and reoccurring features that distort other potential patterns. An example of which is plough lines.
Wallis filter	Applies a locally adaptive contrast enhancement filter.
Zero Mean Grid	Resets the mean value of each grid to zero, in order to counteract edge discontinuities in composite assemblies.
Zero Mean Traverse	Resets the mean value of each traverse to zero, in order to address the effect of striping in the data and counteract edge effects.



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