UPSLAND FARM.

REPORT ON AN ARCHAEOLOGICAL GEOPHYSICAL SURVEY.

OSA REPORT No: OSA11EV12 (geophysics).

January 2012

OSA

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Report Summary.

PROJECT NO:	OSA11EV12 (Geophysics)
SITE NAME:	Upsland Farm, Kirklington, Bedale
COUNTY:	North Yorkshire
NATIONAL GRID REFERENCE:	SE 30423 79817
ON BEHALF OF:	Andrew Long Building Design Ltd Unit 2 Innovation Centre Conyngham Hall Bond End Knaresborough HG5 9AY
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Table of Contents.

List of Figures.

1.0 Abstract.

A geophysical survey was carried out by On-Site Archaeology *to investigate a piece of agricultural land to the north of the medieval moated site of Upsland Farm, a Scheduled Monument. The survey was carried out to support a future planning application to redevelop the site. The site lies close to the northern boundary of the Scheduled Monument.*

Several types of anomaly have been identified, of which most are likely to be of geological origin. Very little of definitively archaeological origin was revealed by the survey despite the existence of earthworks of potentially historical interest in the northeastern part of the site. Positive linear features identified in the northern part of the site may be of archaeological interest but may also be related to a relatively modern underground drainage as they are very close to both a culvert mouth for a stream and other anomalies interpreted as drainage features. It is thought possible that any archaeological features – if present - may have been masked by responses related to geological conditions and peaty soil.

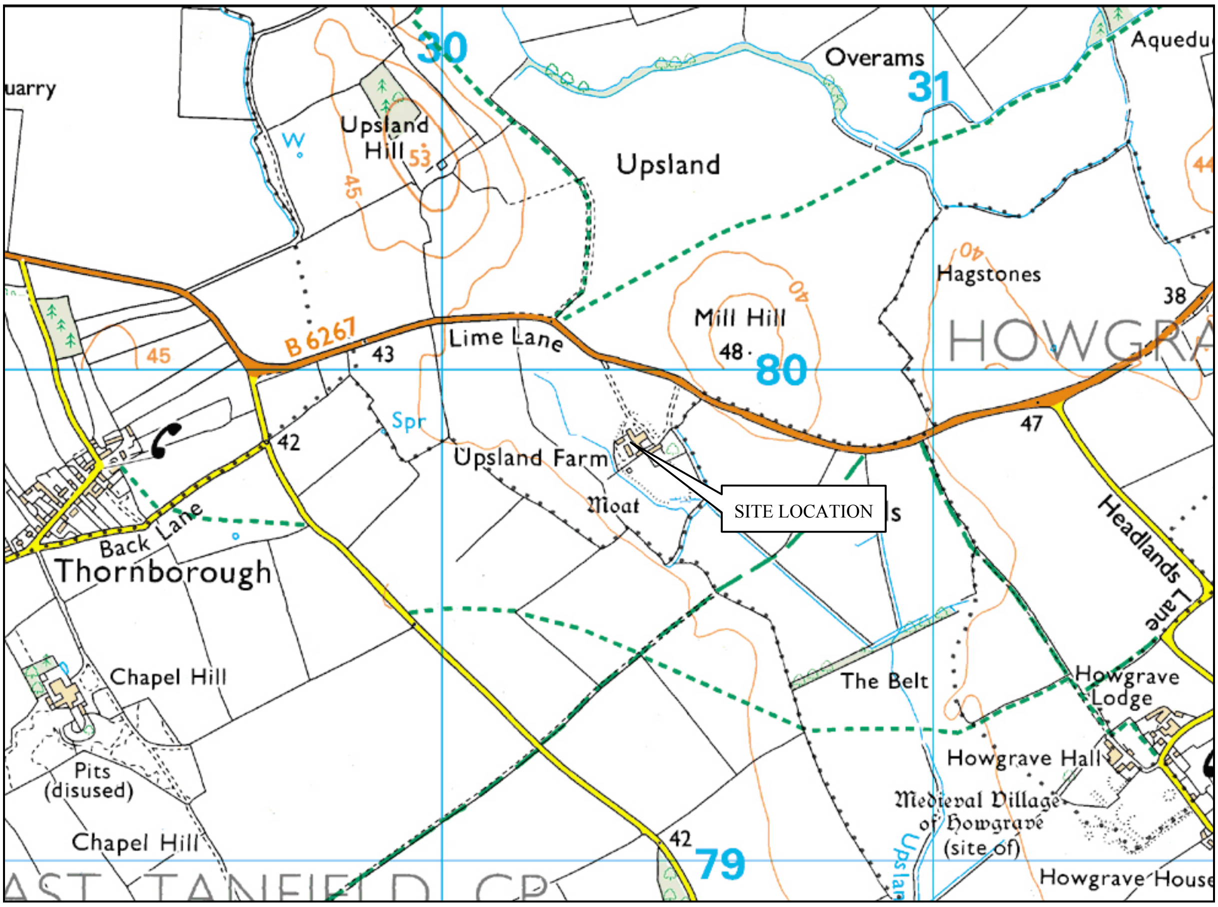

Figure 1. Site Location (NGR SE 30423 79817)

Reproduced from the 2000 Ordnance Survey 1:25 000 maps with the permission of The Controller of Her Majesty's Stationery Office.

2.0 Site Location, Geology, Topography and Land Use.

The site considered by this report, centred at NGR SE 30423 79817, lies off the 6267 Lime Lane, to the east of Thornborough and southwest of Kirklington (Figure 1). The land is presently flat agricultural land and lies at approximately 40m AOD.

The underlying geology is Roxby Formation calcareous mudstone (British Geological Survey http: //maps.bgs.ac.uk/), which is composed of mudstone and siltstone, reddish brown, with subordinate sandstone. sulphates (gypsum, anhydrite) common towards base. Superficial deposits include glacio-fluvial deposits of sand and gravel with peat deposits in places. The response of mudstone geology to magnetometer survey is classified as moderate (English Heritage 2008, 15).

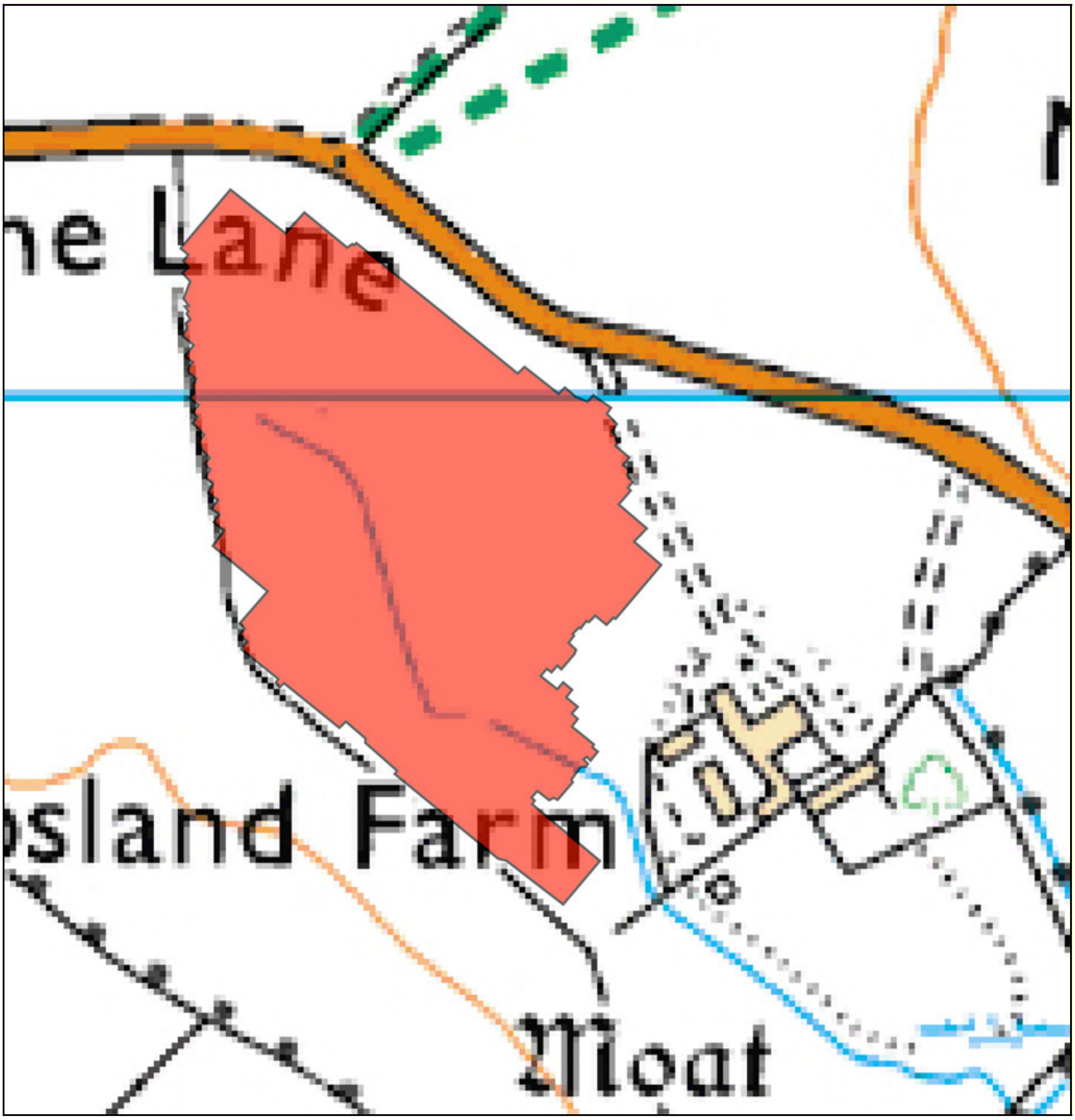

Figure 2. Location of survey (in red)

3.0 Archaeological Background.

The proposed development area lies within an area of high archaeological sensitivity and importance. Adjacent to the development site lies the scheduled monument of Moated Site at Upsland Farm.

The moated site of Upsland Farm is a Scheduled Monument (National Monument Number 28251). The Scheduled Monument comprises an elliptical moated site, the platform of which measures a maximum of two hundred metres in length. Within the northern part of the platform are a series of 19th Century farm building, which are not included within the Scheduling. Prior to the development the area of the platform comprised gardens to the east and south of the farm buildings with sheds, greenhouse, kitchen garden and wasteland to the west. The platform is currently approached by a causeway to the north leading from the B6297.

Documentary sources refer to Upsland from at least the 11th century. The two 'Manors' and three caracutes, which Archil and Torfin had held at Upsland (Opsala, Upsale, in the 11th Century and Uppeslunde by the 13th Century) were held in demesne in 1086 by Count Alan, whose successors retained the overlordship. In or before the 13th Century the mesne lordship of Upsland was divided between the lords of Tanfield and Middleham (VCH 1914).

The site is also located within an area of archaeological significance, including amongst other remains, the three Thornborough Henges and Cursus.

4.0 Methodology.

4.1 General.

The surveys and reporting were conducted in accordance with the current professional guidelines “Geophysical Survey in Archaeological Field Evaluation” (English Heritage 2008) and “Draft Standard and Guidance for Archaeological Geophysical Survey” (Institute for Archaeologists 2010).

Geophysical surveying enables the relatively rapid and non-invasive identification of potential archaeological features within landscapes and can involve a variety of complementary techniques such as magnetometry, electrical resistivity, ground-penetrating radar and electromagnetic survey. Some techniques are more suitable than others in particular situations, depending on a variety of site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

In this instance, based on existing knowledge of sites in the vicinity, it was considered likely that cut features, such as ditches and pits, may be present on the site, and that other types of feature such as trackways, and possibly fired features (such as kilns and hearths) might also be present (see above).

Magnetic survey is generally well suited to the detection of such features (including ditches, pits, etc) in a range of conditions, and provides the most rapid means of assessment of the extent of archaeological deposits over large areas. Its performance on mudstone geologies is considered moderate, and the successful detection of archaeological features in these conditions is usually possible, although local field conditions often play a significant factor in the results.

The most frequently used magnetic technique for archaeological survey in Britain is Gradiometry (using specially designed hand held Fluxgate Gradiometers), which detects and records minor variations in the vertical component of the local magnetic field of near surface soils and subsoils. These variations are often caused by changes in a soil’s magnetic susceptibility or permanent thermo-remnant magnetisation that in many cases can reflect archaeological activity and the form and extent of discrete features.

It should be noted that this technique, whilst capable of identifying possible archaeological anomalies, is also responsive to changes in the magnetic gradient caused by geological composition or by ferrous material in the soil and above the surface. This means that service points, conduits, metal fences/ buildings, and modern ferrous objects in the topsoil all yield elevated magnetic responses, and where these features exist in the survey area, more subtle fluctuations resulting from archaeological features can sometimes be masked.

It is also important to note that like many geophysical methods, magnetic survey detects many types of archaeological feature, but does not provide information on dating or their relative phasing.

4.2 Fieldwork methodology.

The data collection for the survey was carried out in a field to the north of Upsland Farm over approximately five hectares divided into 30m grid units. In total, 42 grid squares comprising 37,800m^2 were surveyed once obstructions and unsuitable areas were excluded. The survey grids were tied-in to known Ordnance Survey points using a Leica GPS900. The GPS900 is an RTK GPS unit providing survey quality location information accurate to around 10mm.

Data collection was carried out using two Bartington Grad 601 fluxgate gradiometers with automatic data logging facilities. Samples were recorded using an interval of 0.25 x 1 m in accordance with current archaeological guidelines (English Heritage 2008), yielding 3600 measurements per 30m square. The instrument sensitivity was set to 0.03nT within a +/-100nT range ensuring the accurate recording of small variation in the local magnetic gradient.

4.3 Processing and data treatment.

Following initial field survey, data was prepared and processed using a series of software tools to eliminate any data defects resulting from local conditions or collection problems. Once defects have been identified, images are prepared using a greyscale representation of the relative strength of magnetic response in the survey areas. The greyscale plots provide a graphic‘ 2D image’ of subsurface magnetic conditions and form the basis of the interpretation diagram in Figures 8 and 9. (Additional ‘X/Y trace’ plots are also included where applicable, and in this case data has been presented in X/Y for comparison of processed results).

For processing, Geoscan *Geoplot 3.0* software was used for initial data processing and Golden Software’s *Surfer* used for the production of both raw and processed data plots.

The following processing and image enhancement functions have been applied to the data (see Appendix 1 for details):

Clip – Clips or limits data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic for the determination of potential archaeological anomalies (which generally produce lower responses than those for large ferrous features).

Despike – Used to locate and reduce the effects of random ferrous responses in the survey area largely resulting from iron objects near to the surface. NB Some features cannot be eliminated using despike and thus responses from some ferrous content are often present even after use of this processing procedure.

Although metallic pollution in the topsoil was not overly problematic in this survey, some despiking was necessary. The parameters used for the despike process to remove random responses from metal in the topsoil were: radius of X4x Y1 readings for local averaging with a threshold of 3.0. A ‘mean spike replacement method’ was applied using the despike filter in Geoplot 3.0 software.

Zero Mean Traverse – For removing striping effects in the data caused by the orientation of the instrument sensors; also removes traverse striping caused by abnormally strong responses caused by ferrous pollution. The use of Zero Mean Traverse can mask or remove natural linear anomalies that run parallel to the traverse direction, and thus it is only applied after reviewing the clipped date for any such responses. For settings see Appendix 2 below.

Interpolation – Increases the number of data points in a survey on one or both axes. In this instance survey data was collected using a 0.25 x 1m sampling interval, and for final graphic preparation clipped and processed data was interpolated on the Y-axis resulting in a smoothed greyscale plot. Geoplot's *sin x/x* interpolation method was used for this process.

5.0 Results.

The data is presented here using greyscale plots in its raw format with minimal processing to give an impression of the full range data statistics (Figures 3 and 4). Darker greys and blacks represent elevated magnetic readings, and lighter values lower readings, while middle grey indicates the 'survey average' response of the underlying geological conditions.

Magnetic values are measured here in nanoTesla (*nT)* and the Bartington is configured at a sensitivity of 0.3 *nT* and records data within a range of -100nT/ +100nT. Within this range most archaeological and geological features occupy relatively low magnitude with respect to the survey zero (typically between -20 and +20 nT).

Responses of very high magnitude in the top and bottom end of this usually result from isolated random or major ferrous objects, both of which were present in the survey area, and particularly at the edges of the filed where fences and gates are present. In sections of the field where the surface topography varies considerably and over areas of marshy ground hardcore and landfill has been imported. In some instances the presence of this material has resulted in areas of high magnetic 'noise' and or areas of high magnitude magnetic response.

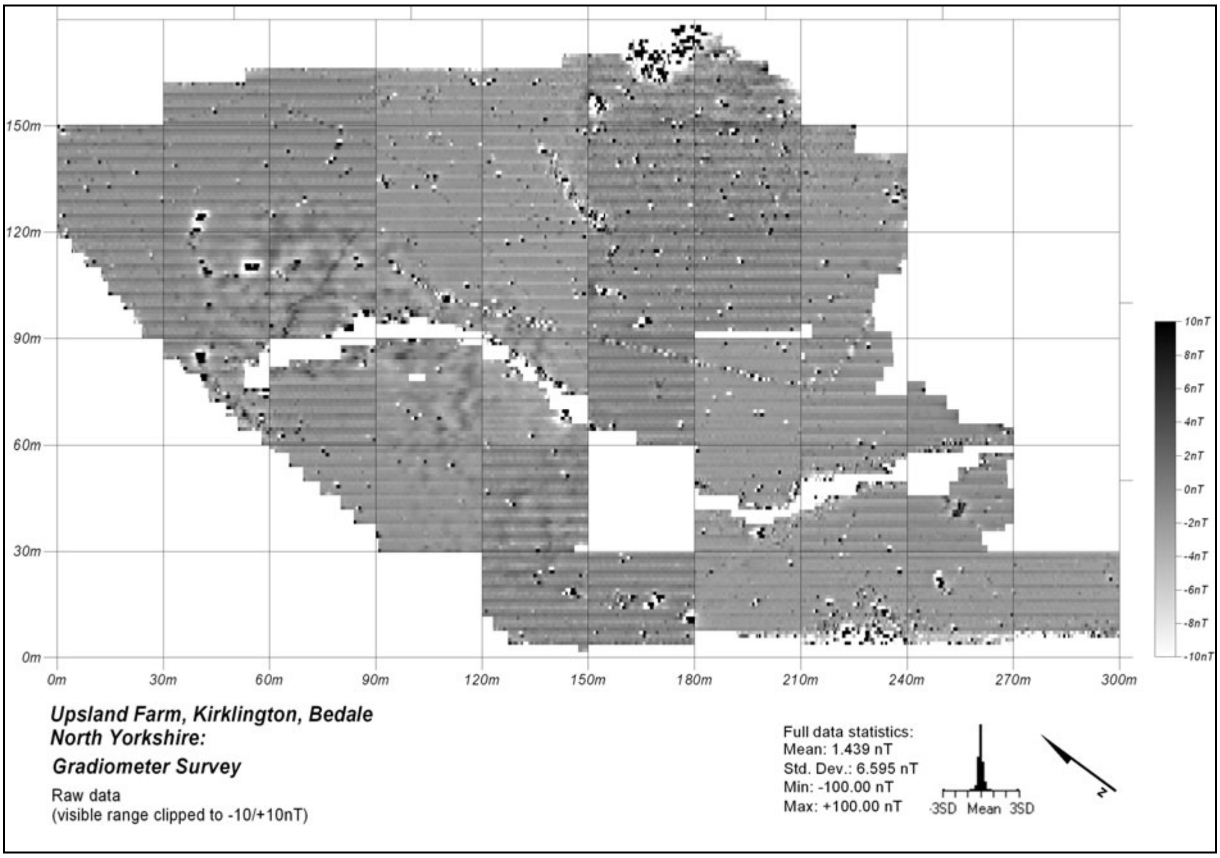

Figure 3: Greyscale plot of raw results (visible greyscale range -10/ +10 nT)

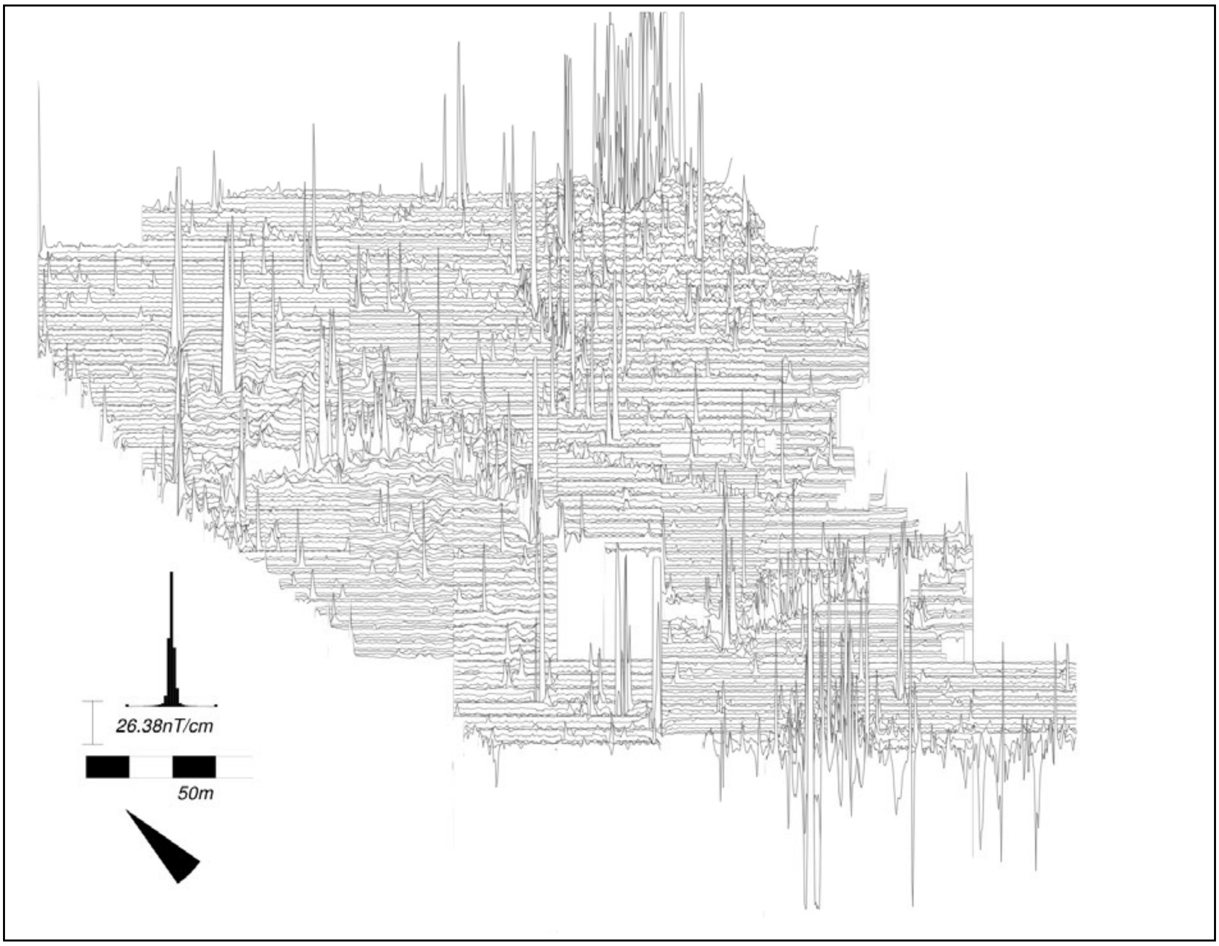

Figure 4: X/Y plot of raw results (Std. deviation -3/+3 nT

Processed Data

Processing of results was undertaken to eliminate data anomalies. As outlined above these include*, Clip, Despike, ZMT, and Interpolate*. The results are displayed in Figures 5, 6 and 7.

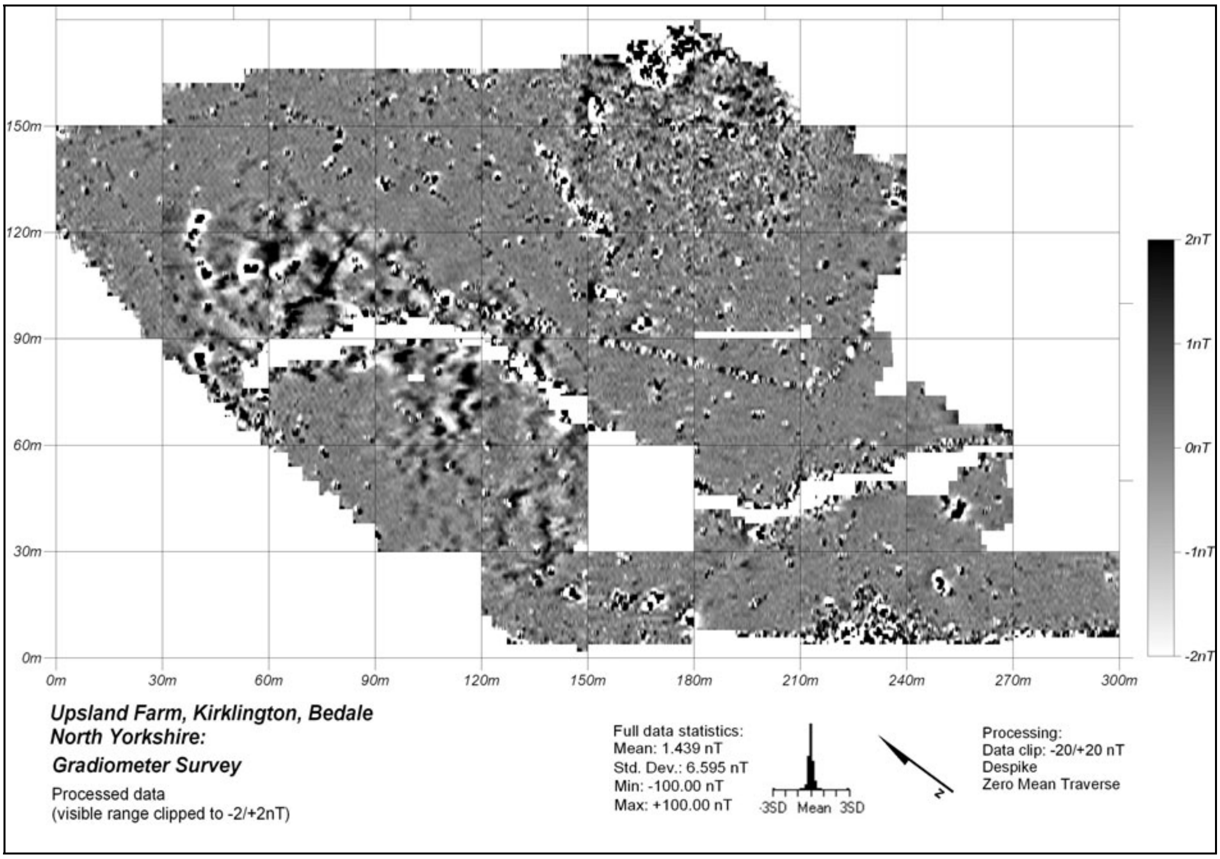

Figure 5:Greyscale plot of processed results (visible greyscale range -2/ +2 nT)

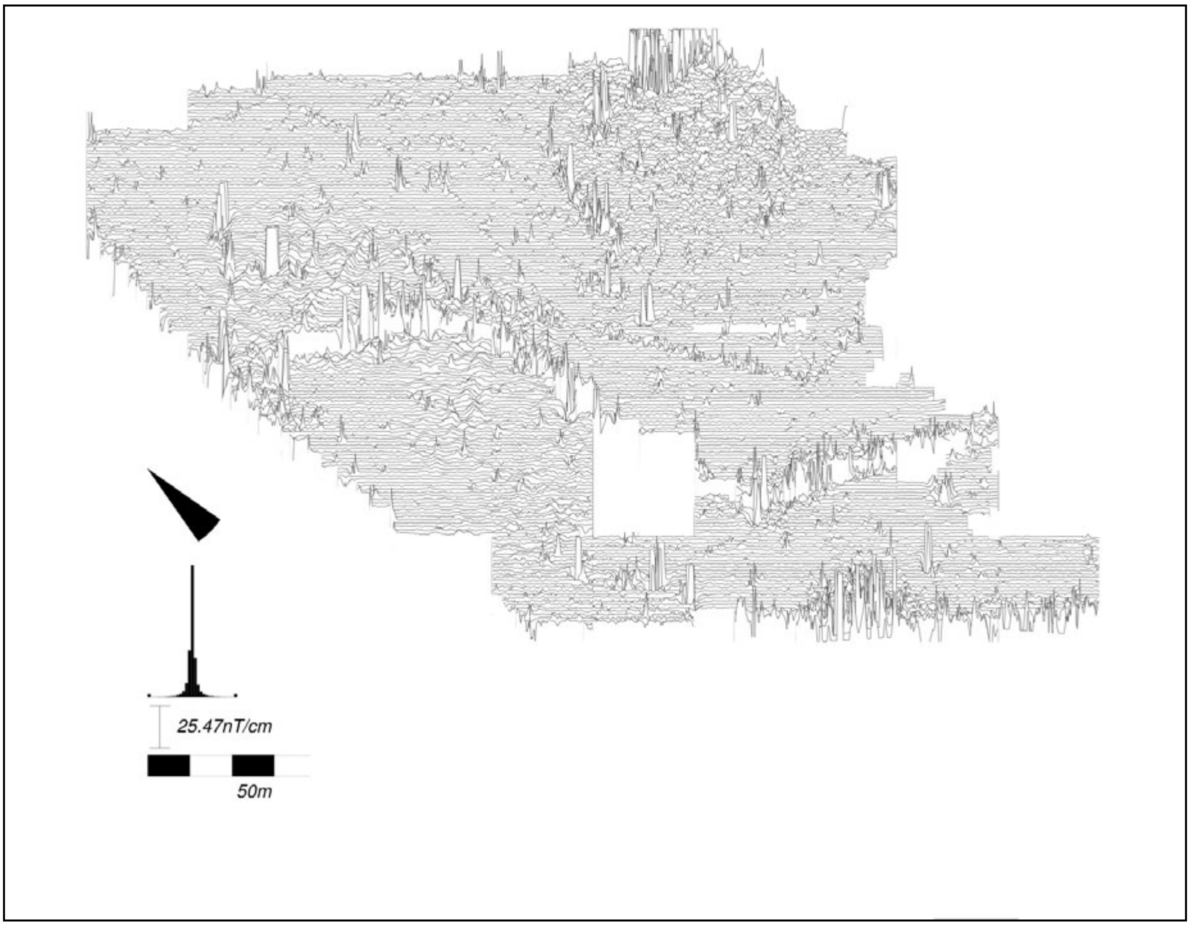

Figure 6:X/Y trace plot of processed results (visible greyscale range -2/ +2 nT)

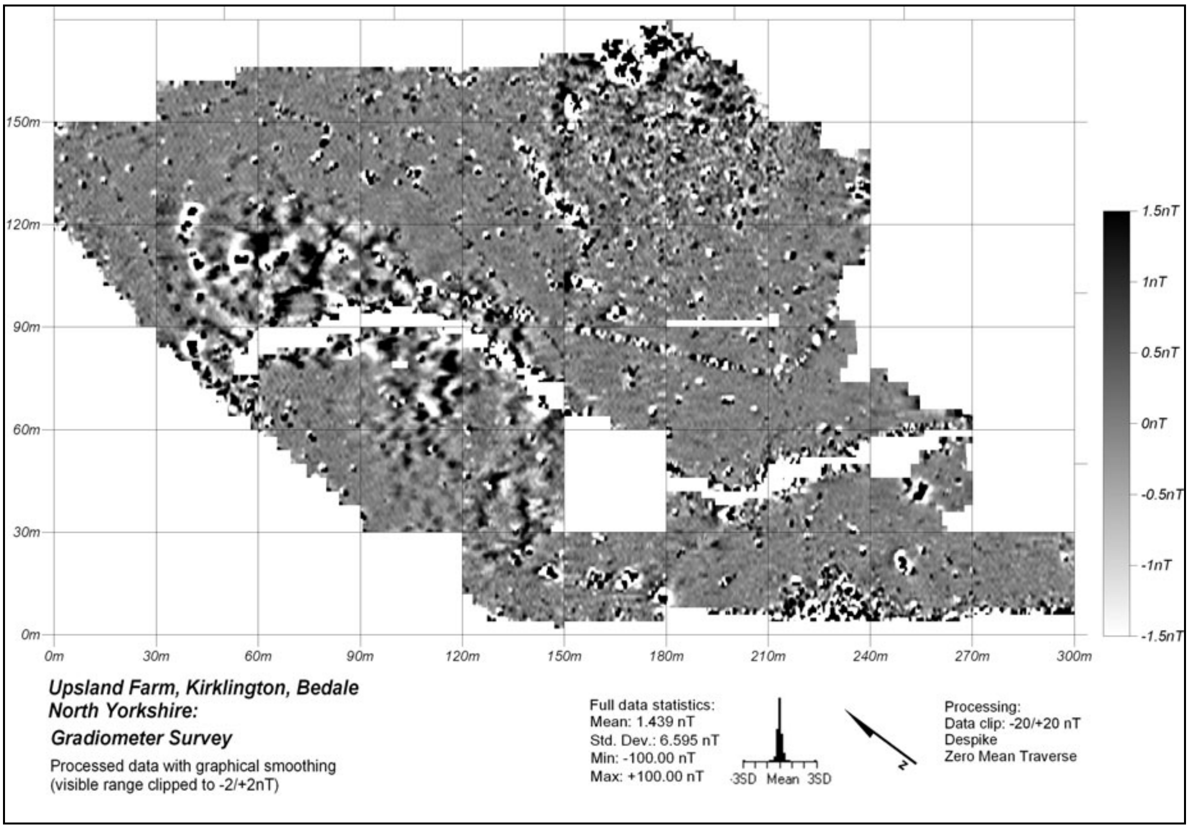

Figure 7: Greyscale plot of processed results. Data Interpolated and Low pass filtered for a smoother image (visible greyscale range -2/ +2 nT).

6.0 Interpretation.

Figures 8 and 9 illustrate interpretation of anomalies within the survey area. For discussion, see below.

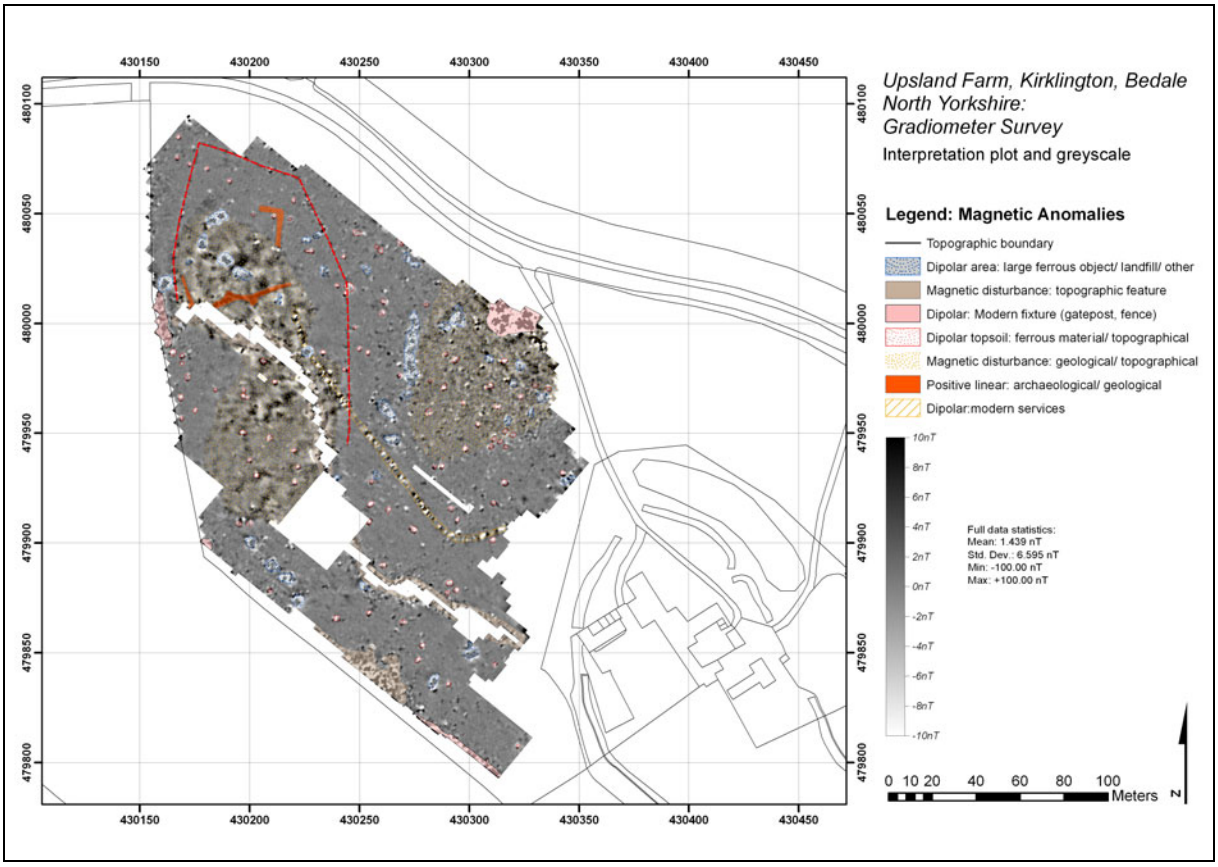

Figure 8: Greyscale plot with colour-coded interpretation: greyscale range clipped to –2/+2 nT

To clarify issues of terminology, in magnetic survey, responses are described by *Nan Tesla* values in relation to the survey '*zero*' or *mean.* Therefore, *positive* refers to elevated or enhanced magnetic values, *negative* refers to lower values, and *dipolar* refers to responses that consist of an elevated peak and a negative trough. Depending on their origin and structure, each of these can exist as linear features, localised features, or area features.

The combination of factors including: subsurface/ surface conditions, by the depth of the anomaly and material composition all affect the form of magnetic responses. The categories of response present in the Upsland Farm survey are relatively limited thanks to the generally 'quiet' magnetic character of the agricultural setting. Archaeological and geological features typically show up well in such conditions especially for features cut into the underlying geology (often are identifiable as areas of elevated magnetic response with respect to the background soil magnetism). Variations in magnetic enhancement can be detected and plotted with spatial accuracy dependant on the level of 'masking' by modern agricultural practice.

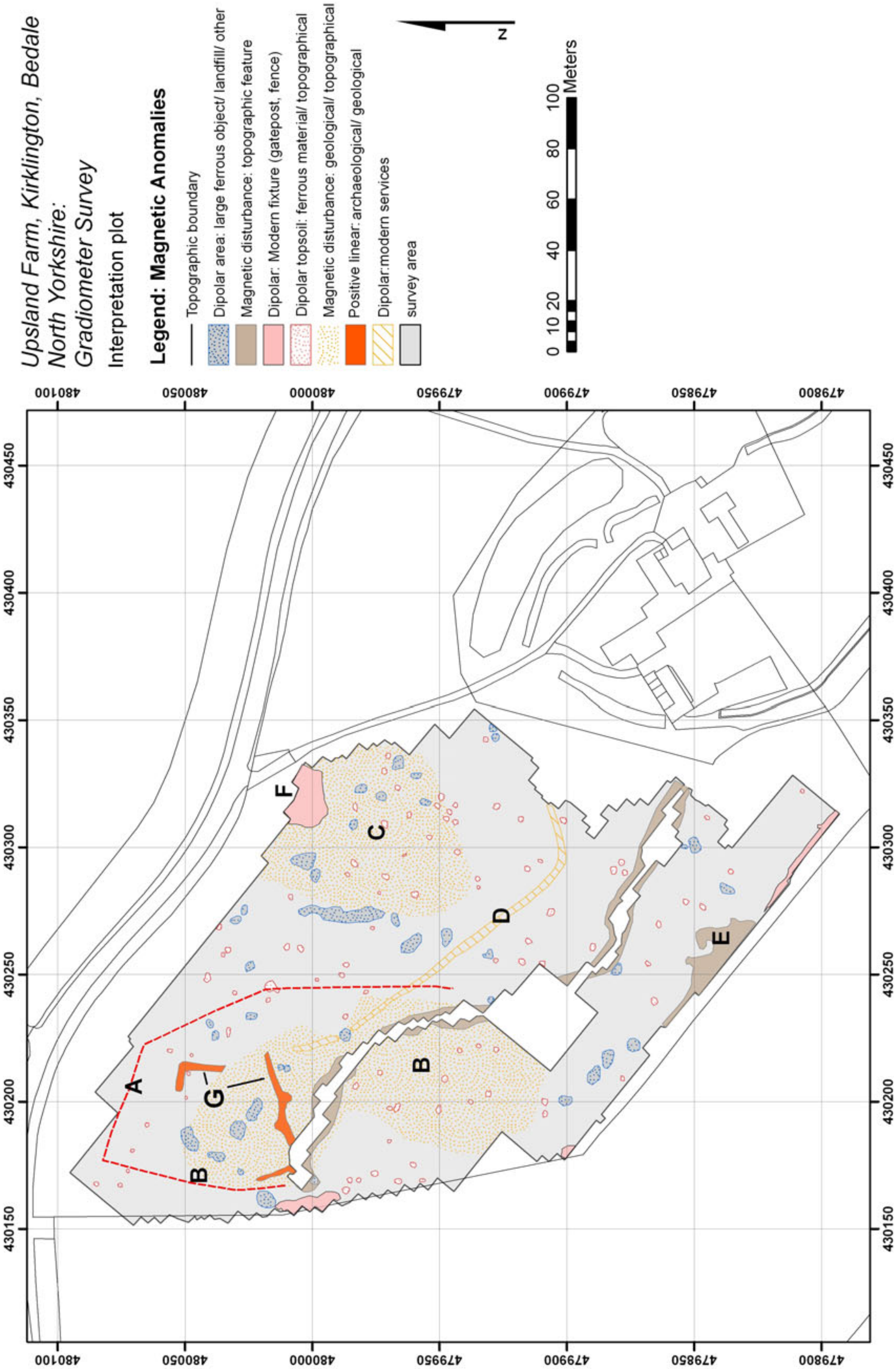

Figure 9: Interpretation with significant anomalies labelled.

In the survey data there is some noise in background soil magnetism introduced by geological conditions but this is limited. Large variations in the local magnetic field can be attributed firstly to isolated ferrous ‘spikes’ (metallic objects in the plough-soil), but also to modern features such as gates and fences, and to imported hardcore. Less exaggerated magnetic responses are caused mostly by localised geological formation, surface disturbances and peaty soils. A proportion of these responses may indicate archaeological deposits but these are very limited in extent, and may also be attributed to local topographic or geological conditions. It should be noted that the survey area shows evidence of historic land use in the form of shallow earth works particularly in the northeast of the field. For a variety of reasons relating to local topographic conditions, these do have a significant impact on the survey data

Figures 8 and 9 show an interpretation of anomaly types with various categories of anomaly outlined in the associated legend. Categories are as follows with specific anomalies labelled where relevant:

1. *Land drain*– A distinct linear response which rings the western area of magnetic disturbance is probably caused by a ceramic land drain marked **A** on Figure 9.

2. *Area of magnetic disturbance: Geological/ Topographical* – On the west side of the survey area high water table boggy ground around the surface stream which runs across the site has resulted in an area of magnetic disturbance (**B** on Figure 9). This is characterised by low magnitude positive and negative responses with no distinct form. This appears as a slightly mottled area in the greyscale plots. In the NE corner of the field undulating surface topography has resulted in a similar set of responses and that can only be defined broadly in extent. It reflects the effects of the geology over this area of slightly elevated ground (**C** on Figure 9).

3. *Dipolar modern services* – A second linear response running alongside and to the east of the stream is suggestive of a buried drainpipe or conduit (**D** on Figure 9).

4. *Magnetic disturbance: topographic feature* – Topographic disturbance caused by a creek that winds from the NW of the site to toward the farm buildings presented readings of a slightly elevated range. Similarly, and area of disturbed ground (where a horse is kept: **E** on Figure 9) along the SW boundary of the survey presents a significant area of magnetic disturbance.

5. *Dipolar: Modern fixture (gatepost, fence)* – Several sections along the fence line show signs of pollution of the magnetic readings from ferrous content, but the most significant of these is in the NE corner where an electricity pylon is situated. The large area of very high magnitude readings can be attributed to this feature (**F** on Figure 9).

6. *Positive linear: archaeological/ geological*– Marked **G** on Figure 9, three linear features of slightly elevated magnetic character indicate cuts into the near surface natural geology. The proximity of these features to the outlet of the stream (which issues from a ceramic pipe) suggests that they are more than likely directly related to this feature, but the possibility that they are archaeological cannot be ruled out. They are heavily masked by the presence of major dipole reposes to the west.

7. *Dipolar area: large ferrous object/ landfill/ other* – Across the survey area several high magnitude dipolar responses are evident. These are mostly localised in extent

but in some case they cover considerable ground. Most of these appear to be caused by the importation of material to reclaim boggy sections of the land and don't appear to be of archaeological significance. However, some of the more localised dipolar responses of this type may be caused by soil conditions mostly of a geological or topographical character.

8. *Dipolar responses associated with ferrous material in topsoil*- A range of isolated dipolar responses across the survey area indicate the likely presence of ferrous objects near the surface in the topsoil. The dipolar form of the response is caused by the structure and the alignment of the local magnetic polarity of the feature.

   The despike process eliminated many of the isolated responses of this type, but the interpretive plot shows where the stronger of such responses have been retained (typical range -25/+25 *nT* or lower).

7.0 Discussion and Conclusions.

The survey has revealed no significant evidence of extensive archaeological deposits. Most of the data reflects modern features or geological and topographical variation over the site. It is possible that a limited number of features may reflect archaeological responses but these are localised and are in most cases probably related to relatively modern water management in the form of a culvert and several drainage pipes.

It should be noted that the northeastern part of the survey area shows evidence of low level earthworks, which may be of historical interest, but these do not show up well in the geophysics due to masking from other features and variable geological conditions.

Because it is thought possible that any archaeological features – if present - may have been masked by responses related to geological conditions and peaty soil, it is recommended that further investigation of this site should be in the form of trial excavation to target the possible archaeological features, the slight earthworks and other seemingly blank areas identified by the geophysical survey.

8.0 Appendix 1: Methodology.

Survey area	Upsland Farm, Kirklington, Bedale, North Yorkshire	
Crop types	Pasture	
Geology	Mudstone	
Instrumentation	Bartington Grad 601-2 Leica GPS900	
Software	Geoplot 3.00, ArcGIS 9.3, AutoCAD 2004, ArcGIS 9.3 Surfer	
Survey	Resolution: Sample Interval: Traverse interval: Grid Size: Cell size: Traverse method Survey Date	0.03nT/m used in 100nT range 0.25m 1m 30x30m 1x0.25m Zig-Zag Jan 2012
Processing	Using Geoplot 3.0 software: Clip, Despike, Zero Mean Grid, Zero Mean Traverse, Interpolation	
Coordinate system	GB Ordnance Survey	
Staff	Ben Gourley	

9.0 Appendix 2: Processing Methodology.

All processing and image preparation was done using Geoplot 3.00 software

Data Statistics: min/ max/mean and std. dev:

Mean: 1.439 nT

Std. Dev.: 6.595nT

Min: -100.00

Max: 100.00

Processing procedures:

Despike: Search radius X=4 Y=1, Threshold: 3, Replacement method: Mean

Zero mean traverse: using Threshold Standard Deviation= 0.25

Zero mean traverse: using Geoplot Presets Grid=All, LMS=On. Pos.Threshold = +5, Neg.Threshold = -5.

Interpolate Using Geoplot Sin X/X on y-axis.

10.0 Appendix 3: Equipment used.

Bartington Grad 601- 2 dual fluxgate gradiometer. Data is stored in a non-volatile memory.

Full technical specification is available via http://www.bartington.com/templates/asset-relay.cfm?frmAssetFileID=102

Geoscan Geoplot 3.0 software http://www.geoscan-research.co.uk/page9.html

Leica GPS900 RTK dual frequency GPS. The GPS900 is a dual-frequency, geodetic, real-time RTK receiver with a potential accuracy of Kinematic (phase) Horizontal: 10mm + 1ppm and moving mode after initialisation Vertical: 20mm + 1ppm.

Full technical data and specification for the GPS900 may be obtained from http://www.leica-geosystems.com/en/downloads-downloads-search_74590.htm?search=true&product=GPS900.

11.0 Appendix 4: Bibliography.

British Geological Survey *OpenGeoscience* http://maps.bgs.ac.uk/geologyviewer_google/googleviewer.html

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