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LOW SCAMRIDGE FARM.

REPORT ON AN ARCHAEOLOGICAL GEOPHYSICAL SURVEY.

OSA REPORT No: OSA11EV17 (Geophysics).

May 2011.

OSA

ON SITE ARCHÆOLOGY LTD

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Report Summary.

PROJECT NO:	OSA11EV17 (Geophysics)
SITE NAME:	Low Scamridge Farm, Ebberston
COUNTY:	North Yorkshire
NATIONAL GRID REFERENCE:	SE 89580 85827
HET REF NUMBER:	3034 LH CNY10390
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1.0 Abstract.

A geophysical survey was carried out by On-Site Archaeology *in advance of the submission of a planning application for a pair of wind turbines and associated cable trench. As the archaeological implications of the proposals could not be adequately assessed on the basis of currently available information, in accordance with the recommendations of Planning Policy Statement 5 a scheme of archaeological evaluation by geophysical survey was carried out.*

Several types of feature have been identified, of which some are likely to be of geological origin. It should be possible to adjust the position of the turbine bases and cable trench to minimise the impact upon features of potential archaeological interest. All of the potential archaeological features may be avoided apart from one linear feature that will be crossed by the cable trench. However, it is not certain that this feature is of archaeological origin; it may be geological.

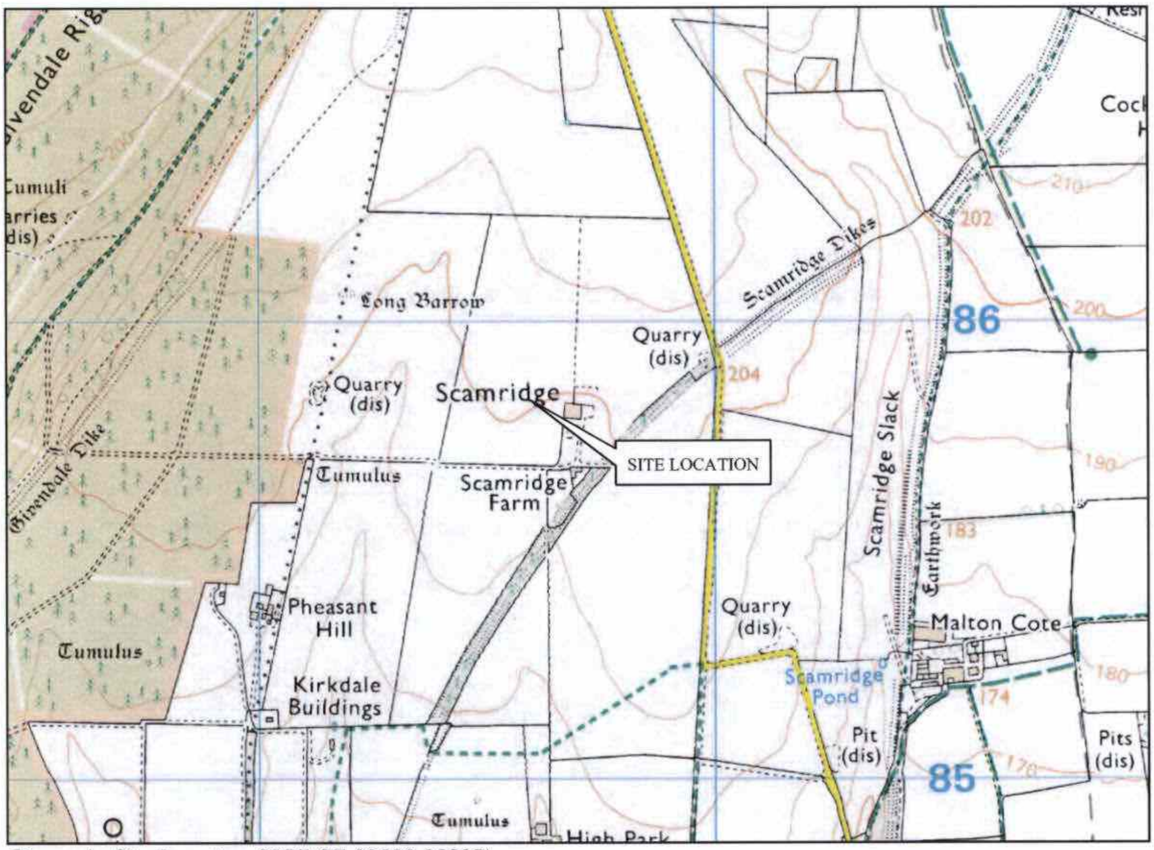

Figure 1. Site Location (NGR SE 89580 85827)

2.0 Site Location, Geology, Topography and Land Use.

The site considered by this report, centred at NGR SE 89580 85827, lies to the north of the village of Ebberston on sloping ground in agricultural fields (Figure 1). The proposed turbines will be sited in agricultural land.

The ground cover is wheat and the land lies at approximately 204m above Ordnance Datum (Figure 2).

The underlying geology is ooidal limestone of the Hambleton Oolitic Member (British Geological Survey http: //maps.bgs.ac.uk/). No overlying drift geology is recorded by the BGS. The Hanbleton Oolitic member is of Jurassic date and the response of the limestone of this age to magnetometer survey is good (English Heritage 2008).

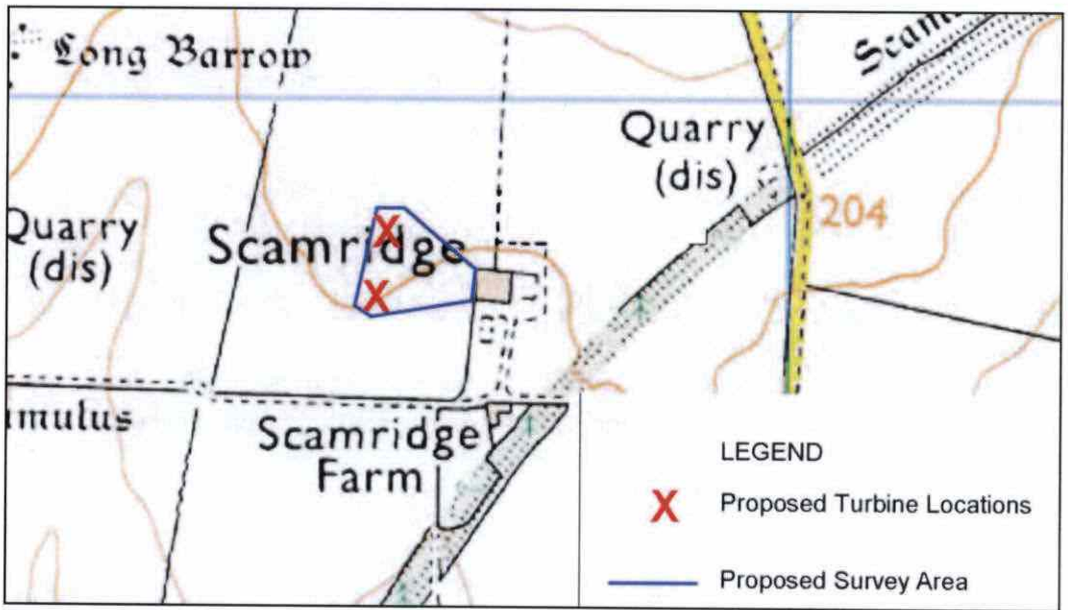

Figure 2. Location of survey

3.0 Archaeological Background.

The proposed development area lies within an area of high archaeological sensitivity and importance. Adjacent to the development site lies several designated heritage assets.

Scamridge Dikes: Prehistoric Linear Boundaries and Associated Features (Scheduled Monument number 35444) lies approximately 100m to the southeast of the proposed site and is a component part of a network of prehistoric ditch and bank landscape divisions found in the Tabular Hills area.

Round Barrow 600m West of Scamridge Farm (SM number 35164) is a round barrow dating to the early Bronze Age and lies to roughly 500m to the west of the development site.

Long Barrow 630m North West of Scamridge Farm (SM number 35440) is a Neolithic burial mound and lies approximately 500m to the west-northwest of the devlopment site.

Two Long Barrows 630m and 690m North East of Scamridge Farm are a pair of Neolithic burial mounds lying around 600m to the east of the site.

Round Barrow 200m North West of High Park Farm is a round barrow dating to the early Bronze Age and lies to roughly 700m to the south of the development site.

Round Barrow on Givendale Rigg, 1.5km South West of is a round barrow dating to the early Bronze Age and lies to roughly 1000m to the northwest of the development site. It is described in the schedule as "A large bracken clad Bronze Age round barrow located within an area of afforestation. It has a slightly elongated appearance resulting from a deep trench cut through the centre."

4.0 Methodology.

4.1 General.

The surveys and reporting were conducted in accordance with the current professional guidelines (English Heritage 2008 and 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 possible that archaeological features cut into the underlying geology - such as ditches and pits- may be present on the site. Other features such as track-ways, barrow monuments, and possibly fired (such as kilns and hearths) might also be present.

Given the sites topographical situation, geological composition (ooidal limestone), and the likely shallowness of potential targets, fluxgate gradiometry (a geomagnetic technique) was considered appropriate for the detection of most of the likely subsurface features mentioned above. The technique involves the use of a specific type of hand-held magnetometers called a gradiometer which detects and records minor variations in the vertical component of the local magnetic field at a given sample interval over the extent to of the survey area. These variations are often caused by changes in 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 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.

4.2 Fieldwork methodology.

The data collection for the survey was carried out using a continuous grid of 30m squares across the northern end of the field containing the proposed turbine site, dividing it into squares of 30m. In total, 12 grid squares comprising 10,800m^2 were surveyed. The survey was laid out in a T-shape to encompass the two potential turbine sites and the route of the cable trench linking the turbines to a meter housed in the farm outbuildings.

The survey grid was tied-in to known, mapped Ordnance Survey points using a Leica GPS900. The GPS900 is an RTK GPS unit providing survey quality location information accurate to around 10mm. The extent and position of the survey is shown on Figure 2.

The data collection was carried out using Bartington Grad 601-2 fluxgate gradiometer with automatic datalogging 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 is prepared and processed using a series of different tools to eliminate any data defects resulting from local conditions or collection problems. Once defects have been identified, images are prepared using greyscale and 'X/Y trace plots' of the survey data.

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 (Figures 3-8).

The following processing and image enhancement functions have been applied to Low Scamridge Farm dataset (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).

In this survey, due to the presence of metallic elements in the barns directly to the east of the survey area, it was necessary to clip the data to eliminate abnormally high and low responses, and subsequently to clarify the range of magnetic values that might be expected of archaeological and geological features. Data was clipped from its initial range of -100/+100nT (the full spectrum of possible readings under the instruments set sensitivity) to 20/+20nT.

For the production of the following graphic plots, the visible greyscale range of the data may be clipped for clarity of interpretation.

Despiking – 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 and should not be eliminated using despike and the setting should be applied appropriately. This is typically a result of the strength and shape of the magnetic anomaly.

Although metallic pollution in the topsoil was not a significant problem 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 traverse direction caused by variations in readings caused by the orientation of the sensors; also removes traverse striping caused by abnormally strong responses caused by ferrous pollution. NB the use of Zero Mean Traverse can sometimes 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.

Destagger – Limits the effects of differential pace of data collection in alternating traverses. Data defects of this sort most often occur where ground is sloping or uneven or difficult to traverse. Destagger was used to correct stagger errors in several grids to correct for pacing errors resulting from the crop cover.

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 raw data is presented here in both *x/y*-trace (Figure 3) and greyscale plots (Figure 4) to give an impression of the full range data statistics. In greyscale representation, darker greys to black have been used to indicate magnetic values (measured in Nanotesla (*nT*)) in the higher ranges and lighter greys to indicate lower values. Most archaeological and geological responses are of relatively low magnitude with respect to the survey zero. Thus they occupy only a small portion of the total possible range of -100/ +100 nT detected by the gradiometer (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, and both types are present in the Low Scamridge Farm dataset. The former group is mainly represented by small iron objects present in the topsoil, and the latter by modern installations to the east of the survey area.

The raw data range then spans the full sensitivity range of the gradiometer (–100 to +100nT although the great majority of results occupy the -10/+10 nT range.

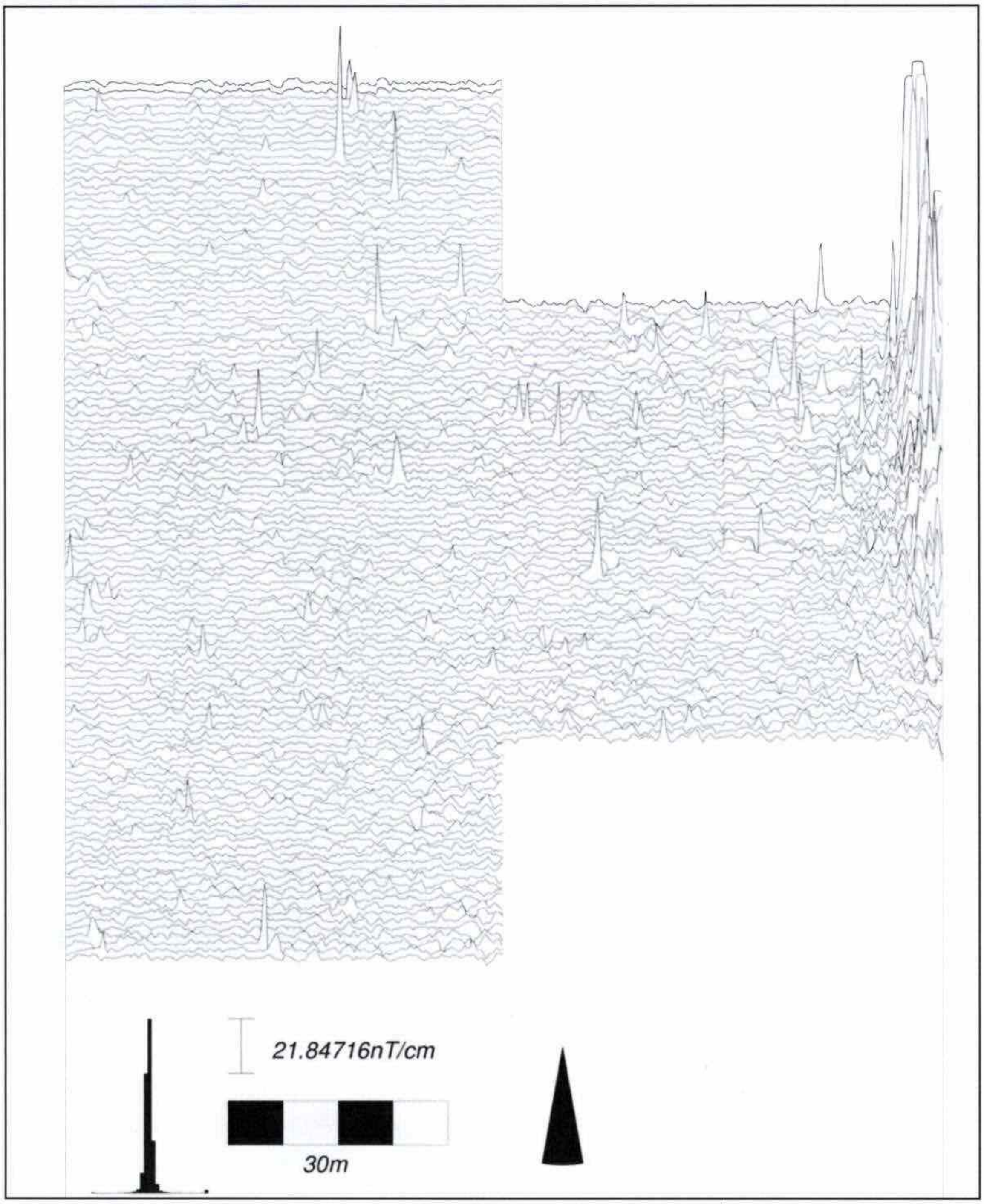

Figure 3. xy-*trace plot of raw results*

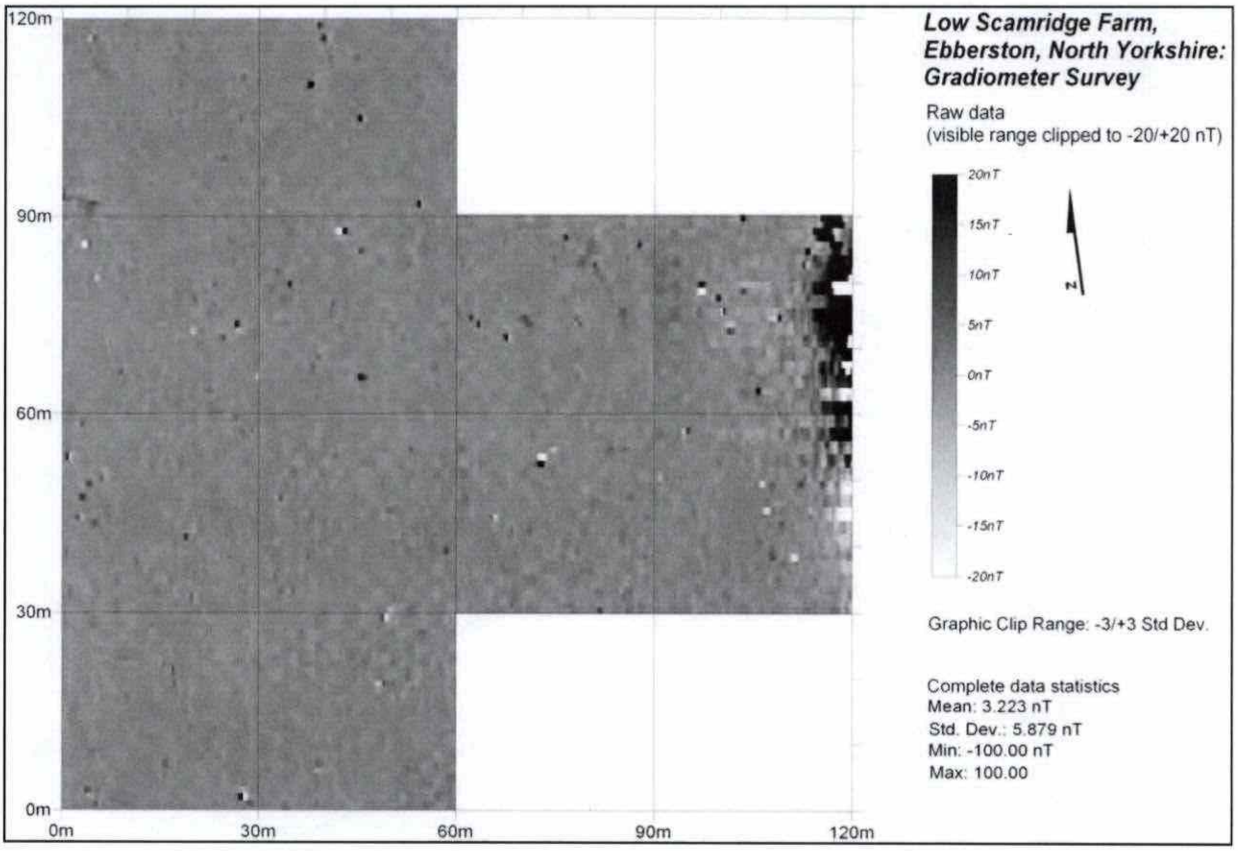

Figure 4. Greyscale plot of raw results (visible greyscale range -20/ +20 nT)

Processing of results was undertaken to eliminate data anomalies. As outlined above these include, *Data Clip, Despike, ZMT, Destagger, and Interpolate*. The results are displayed in Figures 5, 6 (data clipped to –20/ +20nT) and Figure 7.

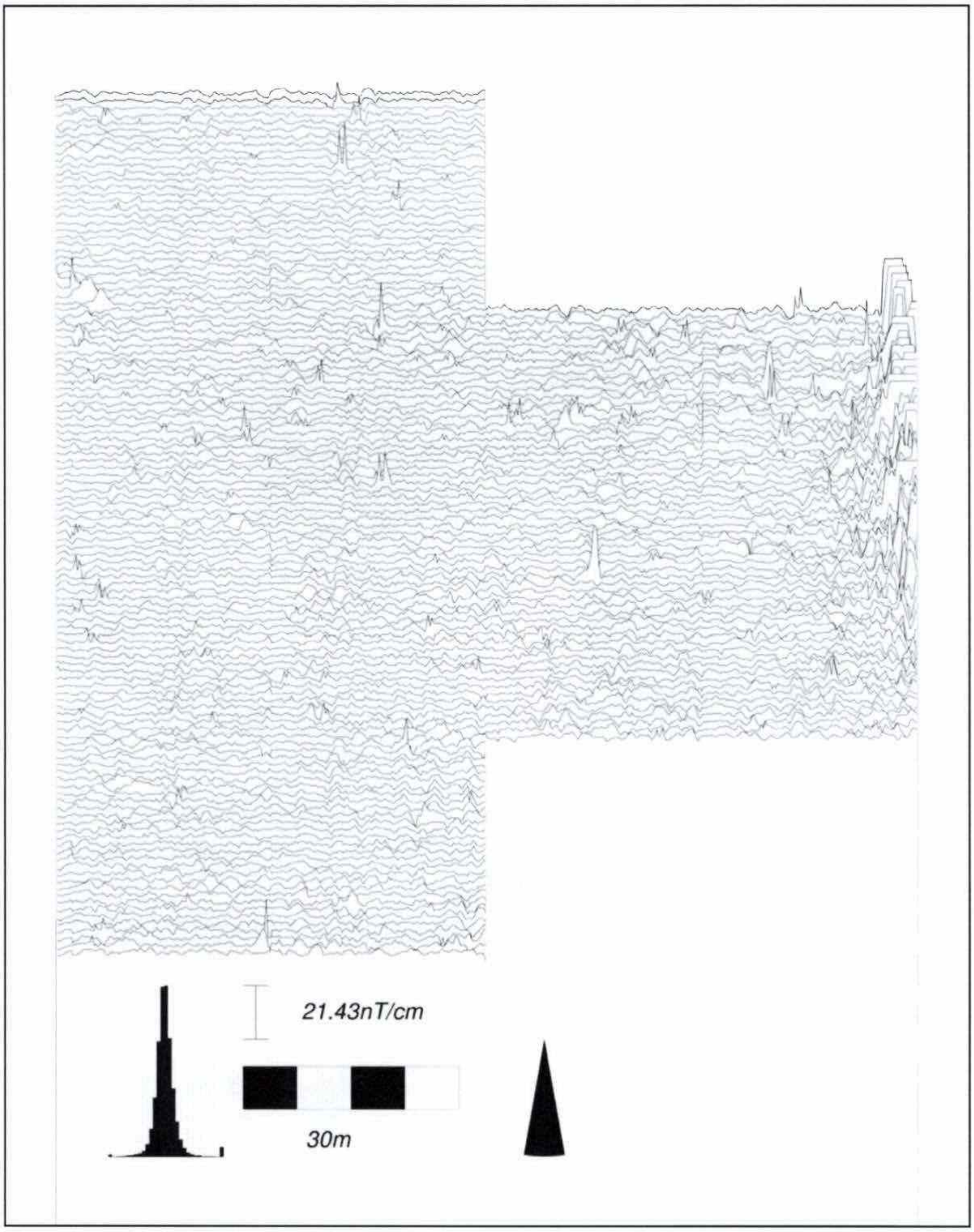

Figure 5. XY Trace plot clipped to –3/+3 nT

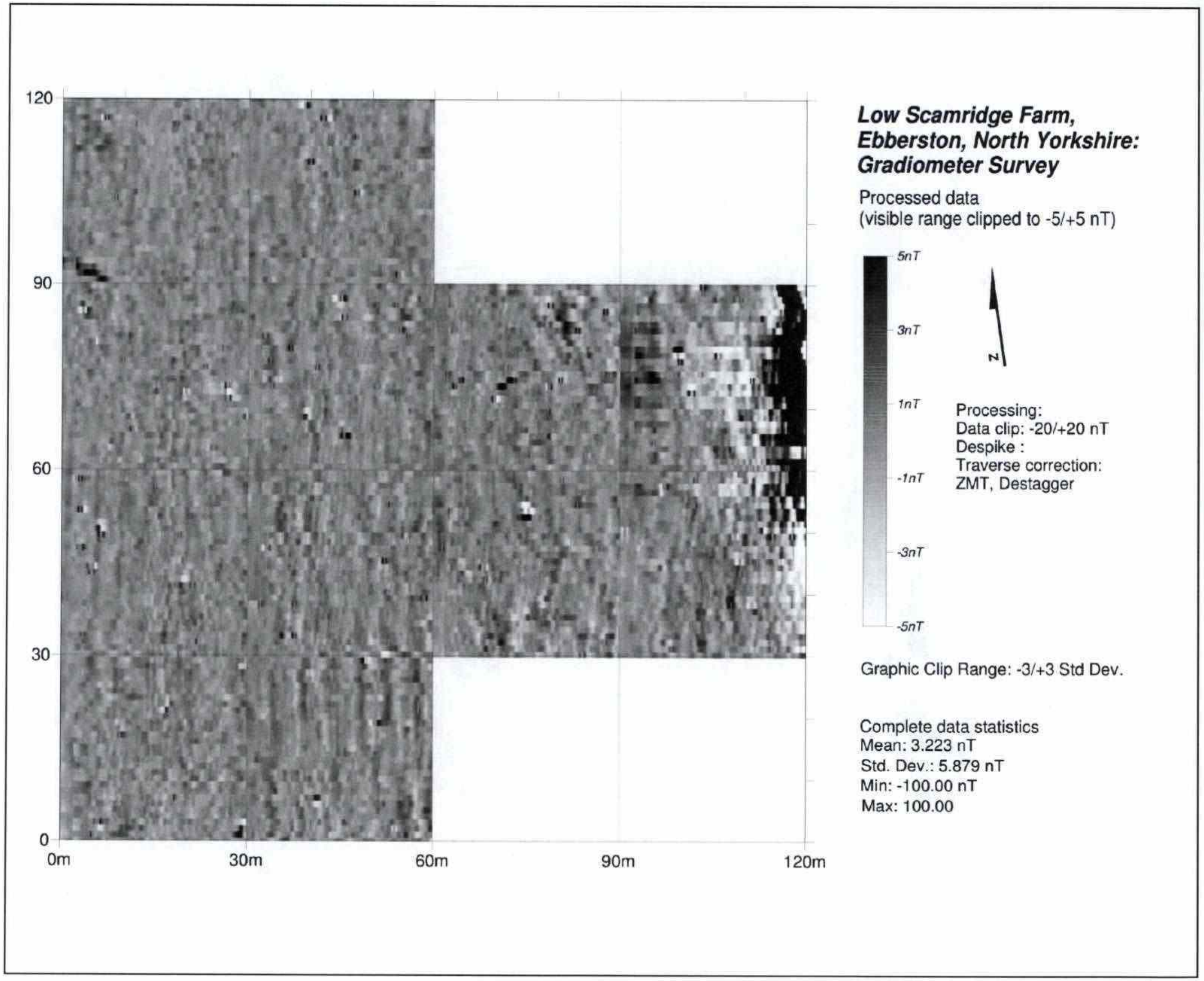

Figure 6. Greyscale plot: greyscale range clipped to –5/+5 nT

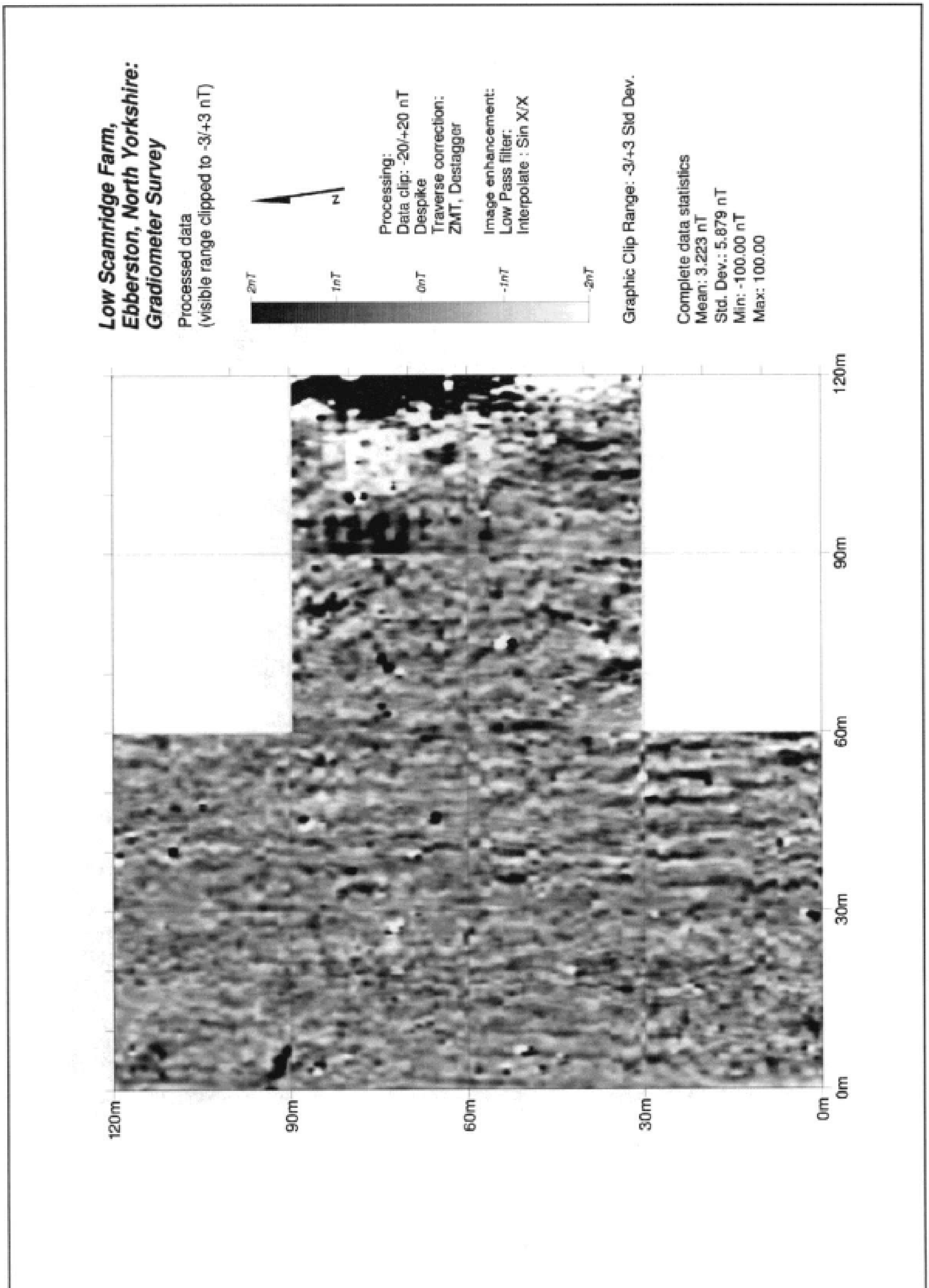

Figure 7. Greyscale plot processed and image enhanced for clarity

6.0 Interpretation.

Figures 8 and 9 illustrate interpretation of anomalies within the survey area

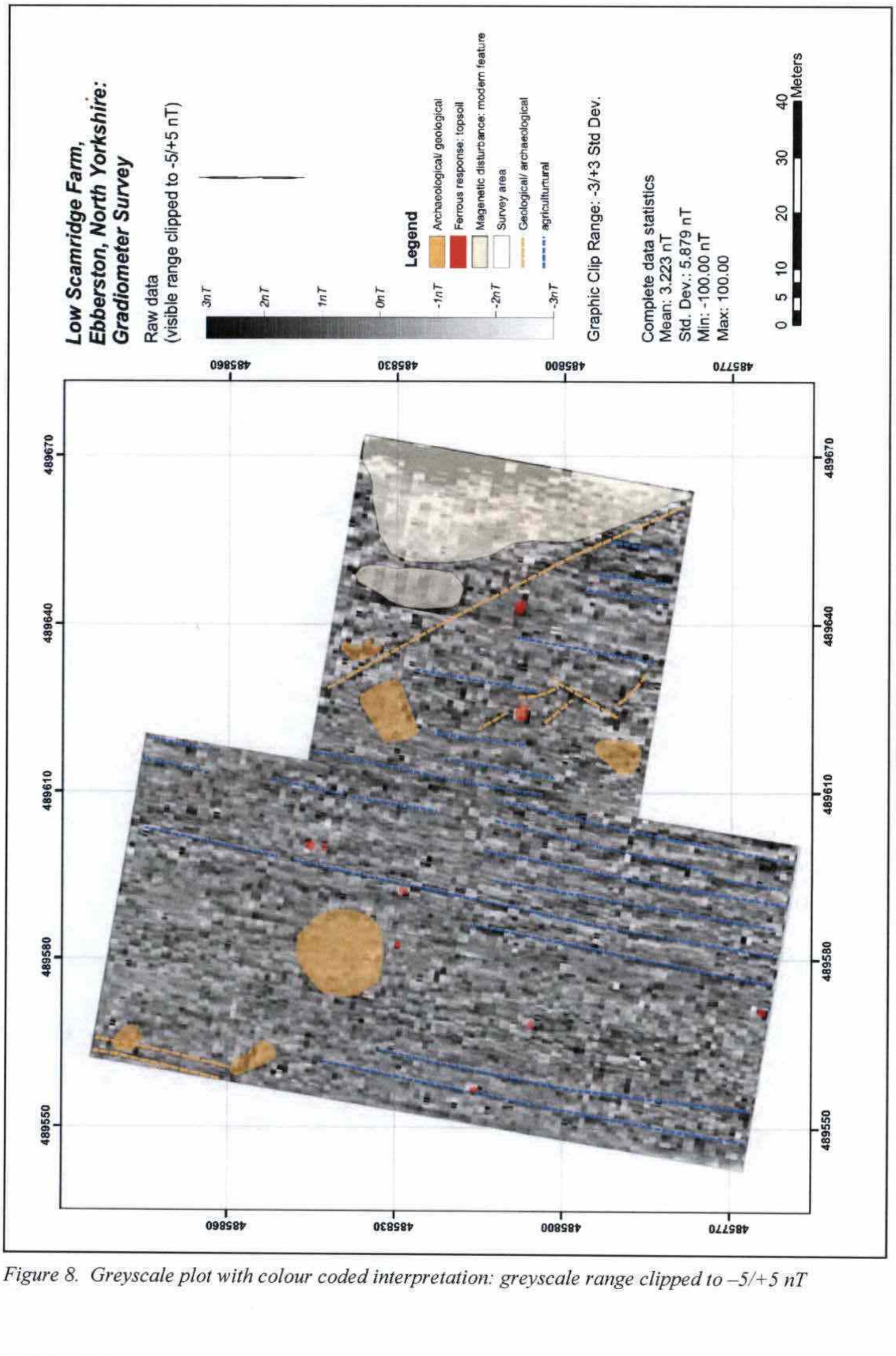

Figure 8. Greyscale plot with colour coded interpretation: greyscale range clipped to –5/+5 nT

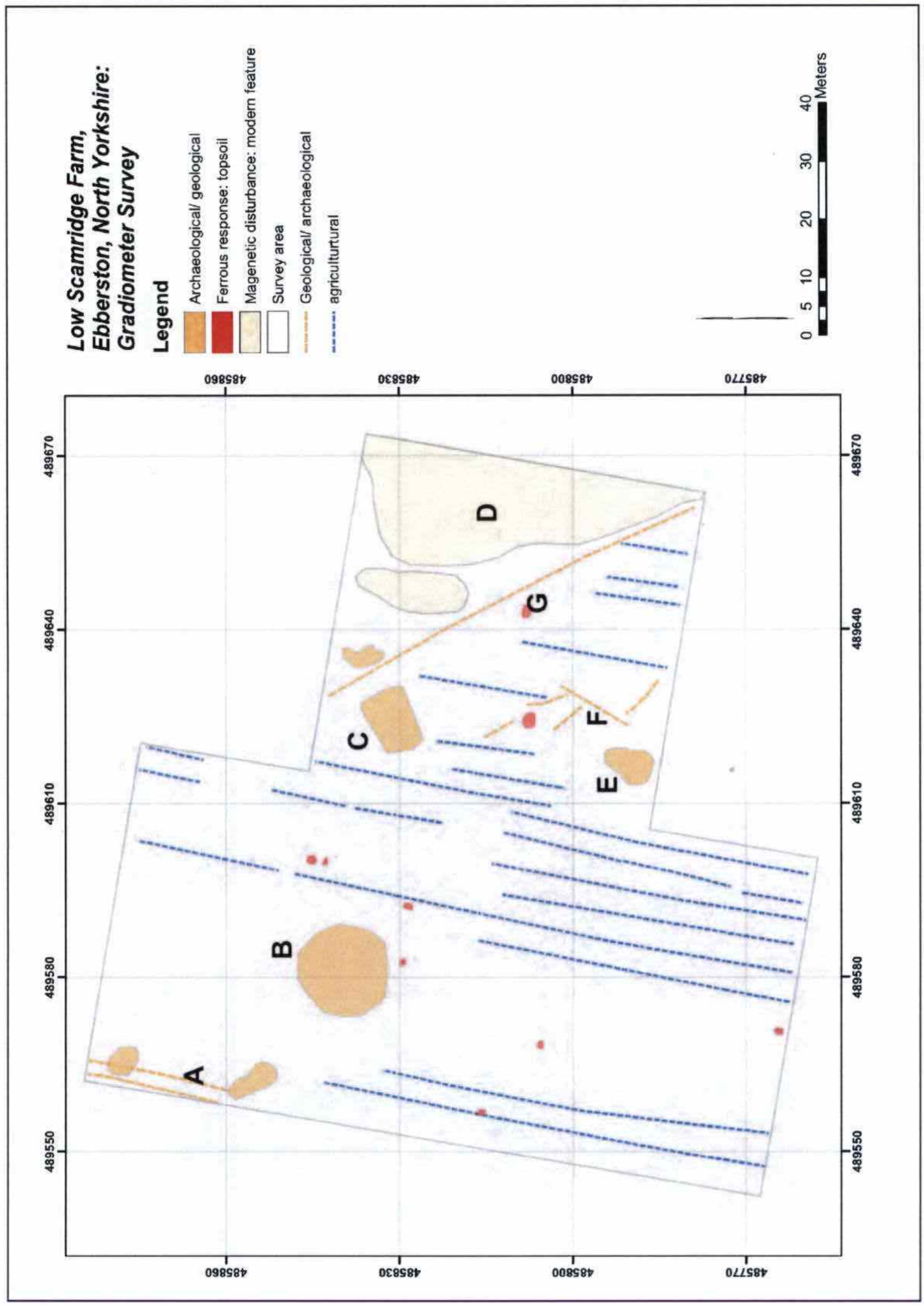

Figure 9. Interpretation

The categories of response present in the survey are relatively limited due to the generally 'quiet' magnetic character of the calcareous geology and the agricultural setting.

Archaeological and geological features typically show up well in such condition and often even subtle variations in magnetic enhancement can be detected and plotted with accuracy.

In the Low Scamridge Farm data there is little variation in local background soil magnetism. Variations that have been detected can be attributed predominantly to: isolated ferrous 'spikes' resulting from metallic objects in the plough-soil, to geological patterning, and to current and historical agricultural practices. However, several responses suggestive of either local geological anomalies or possible archaeological features are present also.

Figure 8 illustrates a suggested interpretive plan of results. Various categories of anomaly are outlined in the associated legend. To clarify issues of terminology, in magnetic survey, responses are described by their *nT* value 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 cause, each of these can exist as either linear features, localised features, or area features.

Each type of response results from a combination of the subsurface/ surface conditions, by the depth of the anomaly and by its material composition. In the current dataset the following general categories of magnetic anomaly were observed:

1. *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 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).

2. *Area of magnetic disturbance* - In eastern two squares of the survey, barns and machinery have caused a strong magnetic interference. The data had been clipped to counteract the masking effects of this, but the readings in this portion of the survey should not be considered in interpretation of geology or archaeology

3. *Positive and negative linear: modern and ridge and historic ploughing* – the entire survey area show evidence of recent / historic agricultural activity. The associated magnetic response is one of alternating positive and negative readings arrange in alignment with the direction of ploughing (in this case on a N/S axis).

4. *Magnetic enhancement: geological/ archaeological?* - Features of a slightly elevated response with respect to the background mean. These are mostly of a non-distinct form, some are suggestive of linear features. They can represent either natural or archaeological features, but in this instance it is difficult to determine which. They are treated individually below where applicable.

Specific anomalies of note are labelled alphabetically in Figure 9. They are as follows:

A- Two areas of slightly elevated values indicative of cut features in the subsoil. These are linked by two parallel linear features that seem also to represent cut features, but may also be attributed to modern agricultural activity.

B- A large anomaly of apparent curvilinear form whose north and east edges are more clearly articulated than south and west. Responses for this anomaly are in the range of +3 nT representing a subtle magnetic enhancement with respect to that of background soils. The curvilinear character of these responses suggests either localised geological patterning or disturbance due to past human activity.

C- Similar type response to B, but less clearly defined and more ambiguous in extent.

D- Area of magnetic interference from barns.

E- Similar to C and B, but very unclear in from. Likely of geological origin.

F- A series of faint linear responses that of slightly elevated nT values. As in the case of E, they are not well articulated and are likely of geological origin.

G- A linear anomaly running obliquely to the modern ploughing direction.

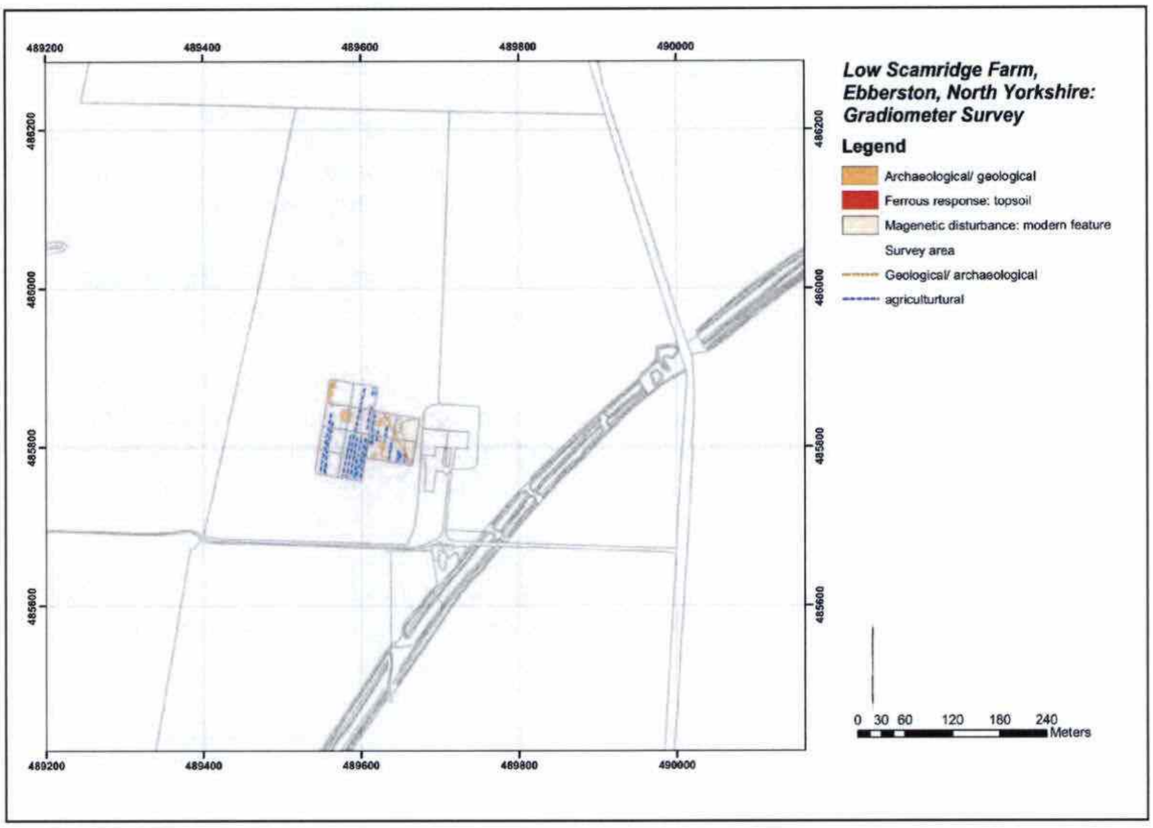

Figure 10. Survey area

7.0 Discussion and Conclusions.

The evaluation has revealed responses mostly geological or modern nature, but some possible archaeological responses are present also.

None of the results would indicate the clear and obvious presence of extensive archaeology over the site, although the presence of barrow sites and other features of landscape or historic importance should be considered in the treatment of the results as outlined above. Of particular note here is the presence of anomaly B, which is in close proximity to the northern proposed turbine and which may indicate archaeological deposits.

It is recommended that the position of the turbine is adjusted in order to avoid any impact on anomaly B and anomaly A. The cable run should be similarly routed in such a way as to avoid anomaly B and also to avoid anomalies C, E and F by passing through the centre of the eastern arm of the surveyed area. It would appear that the cable trench will be unable to avoid an impact on the linear anomaly G. However, the nature of G is unclear and it may not be a feature of archaeological nature.

8.0 Appendix 1: Methodology.

Survey area	Low Scamridge Farm, NEbberston, North Yorks	
Crop types	Wheat	
Geology	Limestone and calcarious grit/ sandstone	
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 0.5m 1m 30x30m 1x0.25m Zig-Zag May 2011
Processing	Using Geoplot 3.0 software: Clip, Despike, Zero Mean Grid, Zero Mean Traverse, Interpolation	
Coordinate system	GB Ordnance Survey	
Staff	Ben Gourley, James Stanley	

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: 3.223 nT

Std. Dev.: 5.879 nT

Min: -100.00

Max: +100

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

English Heritage 2008 *Geophysical Survey in Archaeological Field Evaluation.* English Heritage 2008.

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