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**Land west of Flaen Road  
Flamborough  
East Yorkshire**

**Geophysical Survey**

Report no. 2505

August 2013

Client: Bryan Brown Builders



# Land west of Flaen Road Flamborough East Yorkshire

## Geophysical Survey

### *Summary*

*A geophysical survey comprising both magnetometry and resistivity, covering 0.5 hectares of fallow land at Flaen Road, Flamborough, was carried out to inform a planning application for a proposed housing development. The magnetic data is dominated by very strong readings consistent with the presence of strongly magnetic material on the ground surface and in the topsoil, probably building materials left from adjoining housing developments. Against this background it is not possible to distinguish much weaker archaeological responses, if present. The resistance survey has identified areas of high and low resistance but with no pattern that might suggest an archaeological origin. Due to the magnetic contamination of the site the archaeological potential of the site is considered to be still unknown.*



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## Report Information

Client: Bryan Brown Builders  
Address: South Gable, South Landing Road, Flamborough, East  
Yorkshire, YO15 1AD  
Report Type: Geophysical Survey  
Location: Flamborough  
County: East Yorkshire  
Grid Reference: TA 2240 7035  
Period(s) of activity: n/a  
Report Number: 2505  
Project Number: 4104  
Site Code: FRF13  
OASIS ID: archaeol11-157082  
Planning Application No.:  
Museum Accession No.: n/a  
Date of fieldwork: July 2013  
Date of report: August 2013  
Project Management: David Harrison BA MifA  
Fieldwork: Chris Sykes  
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Photography: Chris Sykes  
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## Contents

Report information .....	ii
Contents.....	iii
List of Figures .....	iv
List of Plates .....	iv
<b>1 Introduction .....</b>	<b>1</b>
Site location, topography and land-use .....	1
Soils and Geology.....	1
<b>2 Archaeological and Historical Background.....</b>	<b>1</b>
<b>3 Aims, Methodology and Presentation .....</b>	<b>1</b>
<b>4 Results and Discussion.....</b>	<b>3</b>
<b>5 Conclusions.....</b>	<b>3</b>

Figures

Plates

### Appendices

Appendix 1: Magnetic survey: technical information

Appendix 2: Survey location information

Appendix 3: Geophysical archive

### Bibliography

### **List of Figures**

- 1 Site location (1:50000)
- 2 Site location showing processed greyscale earth resistance data (1:1000)
- 3 Processed greyscale magnetometer data (1:500)
- 4 XY trace plot of minimally processed magnetometer data (1:500)
- 5 Interpretation of magnetometer data (1:500)
- 6 Processed earth resistance data (1:500)
- 7 Minimally processed earth resistance data (1:500)
- 8 Interpretation of earth resistance data (1:500)

### **List of Plates**

Plate 1 General view of survey area, looking north-west

Plate 2 General view of survey area, looking south-west

## 1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by Bryan Brown of Bryan Brown Builders, to undertake a geophysical (magnetometer) survey of land off Bempton Road, Flamborough (see Fig. 1) to inform a planning application for a proposed housing development. The work was undertaken in accordance with guidance contained within the National Planning Policy Framework (2012) and in line with current best practice (Institute for Archaeologists 2010; David *et al.* 2008) and at the request of Humber Archaeology Partnership, in their capacity as Archaeological Advisors to the East Riding of Yorkshire Council. The survey was carried out on July 30th 2013.

### Site location, topography and land-use

The proposed development area (PDA) is located immediately west of Flaen Road and Flaen Close, off Bempton Lane, Flamborough (see Fig. 2). It comprises a single block of land approximately 0.5 hectares in extent on the western side of Flamborough, centred at TA 2240 7035, which is bordered by relatively recent housing developments to the east and south. Flamborough Castle, a scheduled monument, is situated immediately east of the site on the eastern side of Bempton Lane. Agricultural land extends to the north and west.

The survey area is flat at approximately 40m above Ordnance Datum and comprised an overgrown fallow field that had been mown to facilitate survey. It was obvious that the site had been tipped on in the recent past and a small bund of soil and assorted building debris was evident on the eastern site boundary (see Plate 1).

### Soils and geology

The underlying bedrock comprises Flamborough Chalk overlain by superficial deposits of till (British Geological Survey 2013). The soils in this area are classified in the Holderness association, being characterised as slowly permeable, seasonally waterlogged fine loams (Soil Survey of England and Wales 1983).

## 2 Archaeological and Historical Background

The site of the proposed development lies within 100m of Flamborough Castle, a scheduled ancient monument (see Fig. 2). A geophysical survey and subsequent trial trenching carried out in advance of the development to the immediate east of the current site (Webb 1993) identified a shallow circular feature of unknown date.

### **3 Aims, Methodology and Presentation**

The general objective of the geophysical survey was to provide information about the presence/absence, character, and extent of any archaeological remains identified within the specific area to be impacted by the proposed development and to help inform further strategies should they be required.

Specifically, the objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the presence/absence and extent of any buried archaeological features; and
- to prepare a report summarising the results of the survey.

In order to achieve these aims detailed (recorded) magnetometer survey and earth resistance survey was carried out over the whole of the PDA, approximately 0.5 hectares.

#### **Magnetometer survey**

The geophysical survey site grid was established using survey grade GPS equipment with corrections obtained through the Trimble Virtual Reference Station (VRS) network. The site grid was tied into the Ordnance Survey National Grid so that the grid can be accurately re-located during any later stages of archaeological investigation.

Bartington Grad601 magnetic gradiometers were used during the survey, taking readings at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m grids, so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Geoplot 3 (Geoscan Research) software was used to process and present the data. Further details are given in Appendix 1.

#### **Reporting**

A general site location plan, incorporating the 1:50000 Ordnance Survey map, is shown in Figure 1. Figure 2 is a location plan displaying the processed resistance data at a scale of 1:1000. Detailed plots ('raw' and processed) and an interpretative figures of the data from both survey techniques are presented at a scale of 1:500 in Figures 3 to 8 inclusive.

Further technical information on the equipment used, data processing and survey methodologies are given in Appendix 1 and Appendix 2. Appendix 3 describes the composition and location of the site archive.

The survey methodology, report and any recommendations comply with the Project Design (Harrison 2013), and guidelines outlined by English Heritage (David *et al.* 2008) and by the

Institute for Archaeologists (IfA 2010). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

*The figures in this report have been produced following analysis of the data in 'raw' and processed formats and over a range of different display levels. All figures are presented to most suitably display and interpret the data from this site based on the experience and knowledge of Archaeological Services staff.*

## **4 Results and Discussion**

### **Magnetometer Survey (see Figs 3, 4 and 5)**

#### **Ferrous Anomalies - Modern**

Ferrous responses, either as individual 'spike' anomalies or more extensive areas of magnetic disturbance, are typically caused by modern ferrous (magnetic) debris, either on the ground surface or in the plough-soil, or are due to the proximity of magnetic material in field boundaries, buildings or other above ground features. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation. Ferrous debris or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling.

On this site the data set comprises almost exclusively of iron 'spike' anomalies, which coalesce into larger areas of magnetic disturbance, particularly around the periphery of the site. These responses are considered likely to be due to the dumping or spreading of building debris left over from the previous building developments to the east and south of the PDA. Against this magnetic background it is impossible to discern the much weaker responses from any sub-surface archaeological remains, if present.

#### **Resistance Survey (see Figs 6, 7 and 8)**

The resistance data shows areas of high and low resistance but with no obvious pattern or trends in the data to suggest that the results reflect anything other than the normal variation that might be expected in an area where the superficial deposits are variable as proven by the trial trenching in the adjoining plot (Webb 1993). There is also no obvious correlation between the areas of dumping (as identified by the magnetic survey) and the areas of high or low resistance.

## **5 Conclusions**

Neither the magnetometer nor the resistance surveys have identified any anomalies of archaeological potential. However, it is considered extremely unlikely that any potential



archaeological features or deposits could be identified on this site, if present, due to the high level of magnetic disturbance. Therefore, on the basis of the geophysical survey the archaeological potential of this site remains unknown.

***The results and subsequent interpretation of data from geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits.***

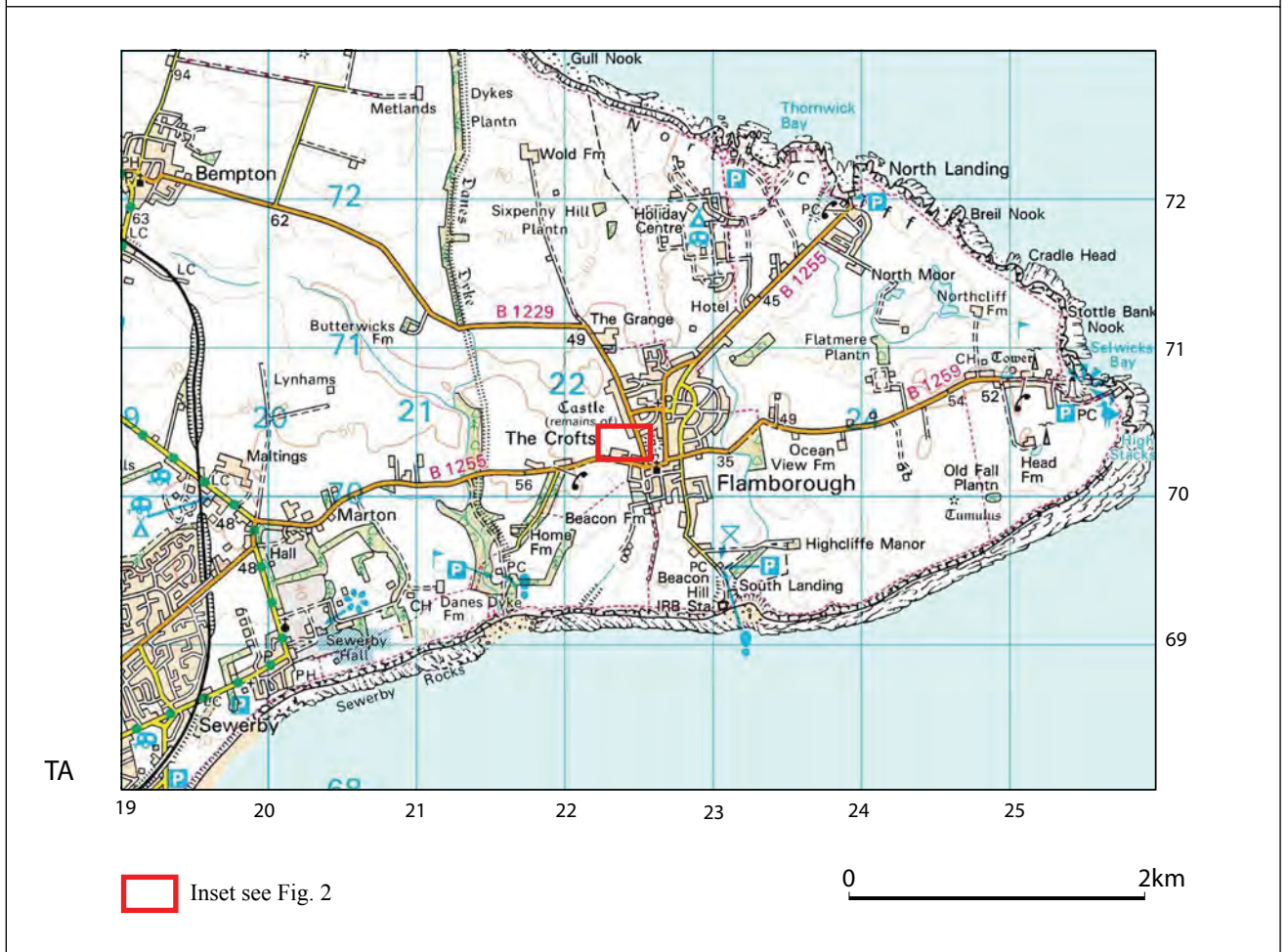
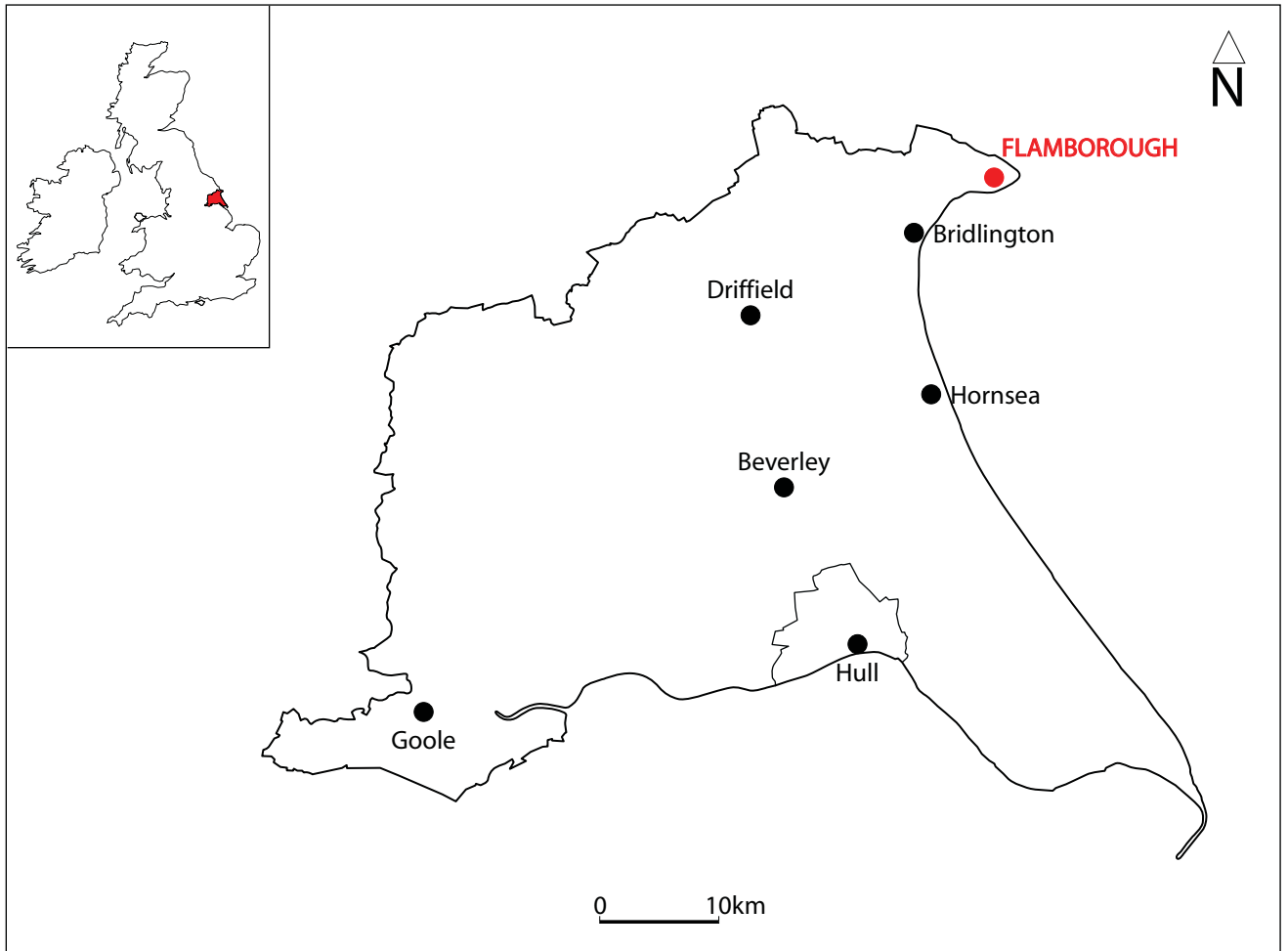
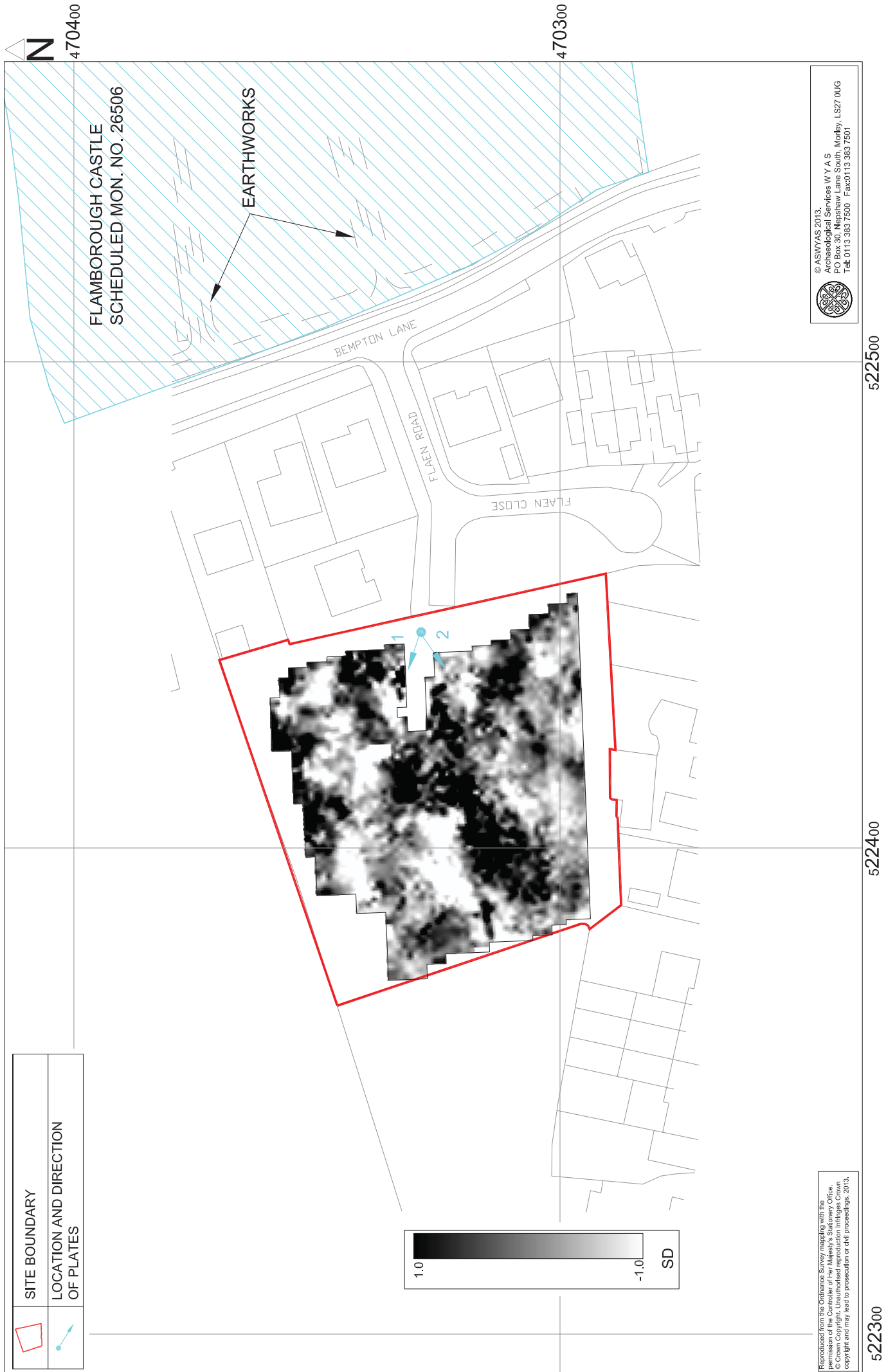


Fig. 1. Site location



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Fig. 2. Site location showing processed greyscale earth resistance data (1:1000 @ A4)



Fig. 3. Processed greyscale magnetometer data (1:500 @ A4)

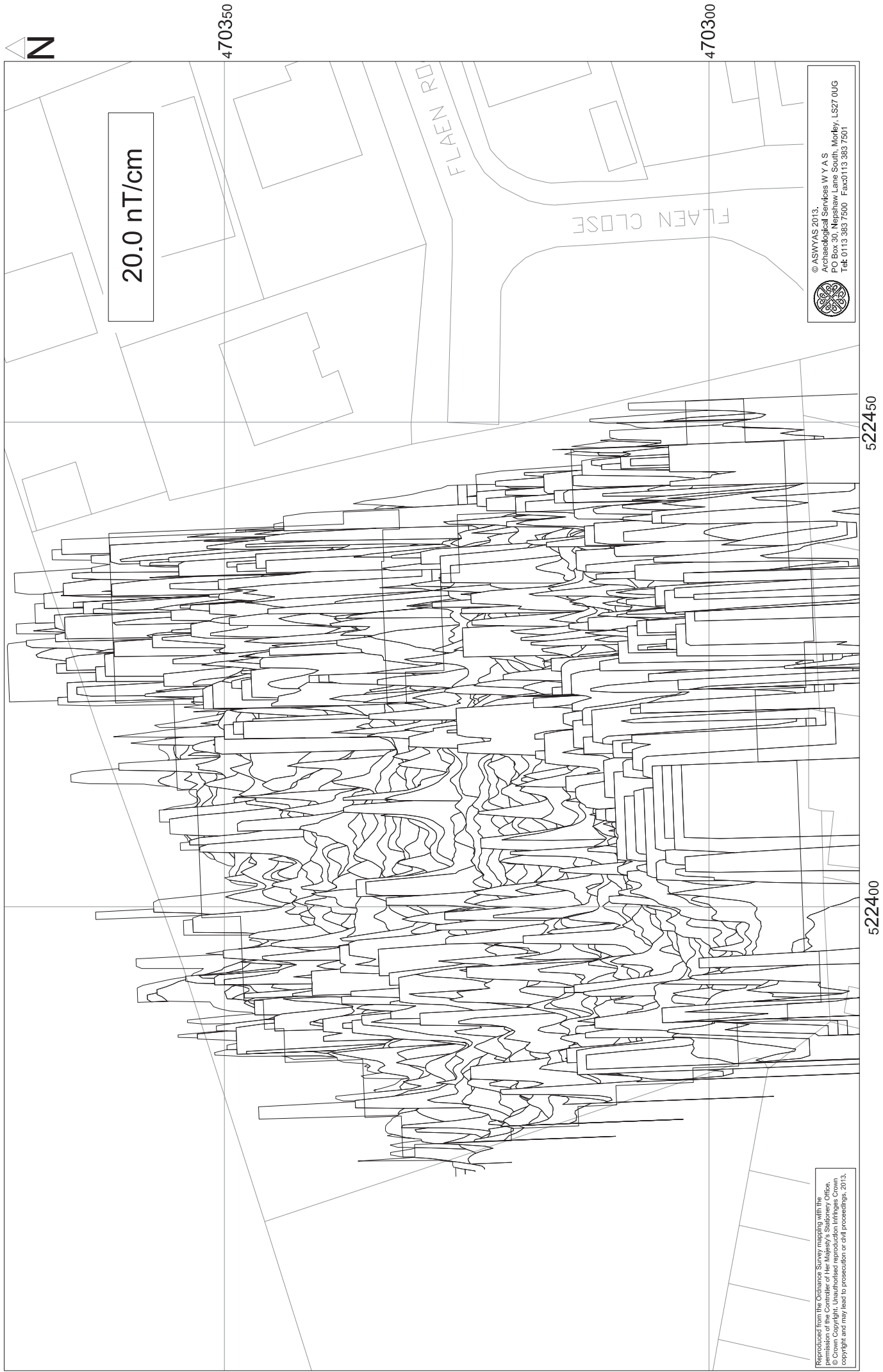


Fig. 4. XY trace plot of minimally processed magnetometer data (1:500 @ A4)





TYPE OF ANOMALY		INTERPRETATION
•	DIPOLAR ISOLATED	FERROUS MATERIAL
	MAGNETIC DISTURBANCE	FERROUS MATERIAL

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Fig. 5. Interpretation of magnetometer data (1:500 @ A4)

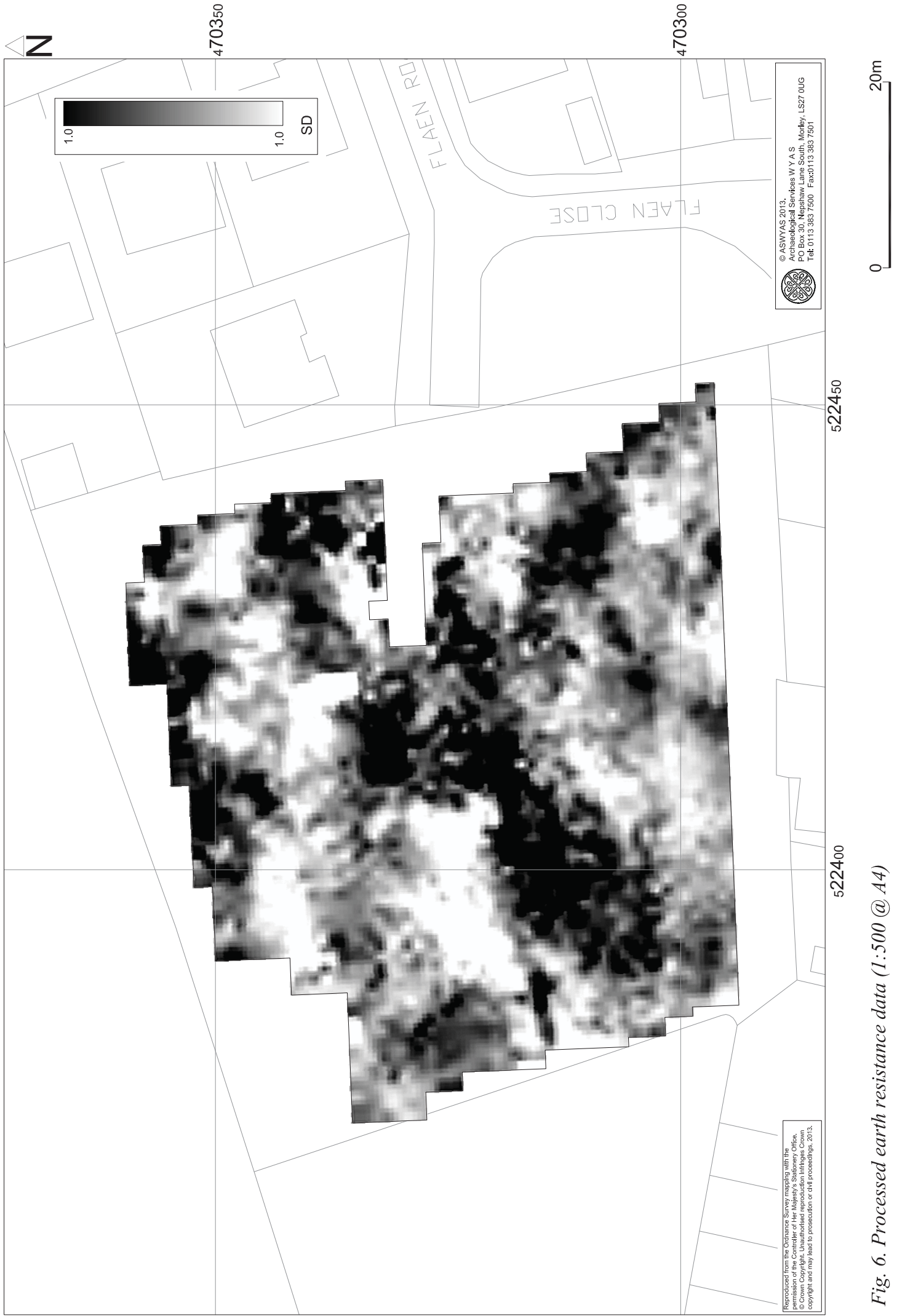
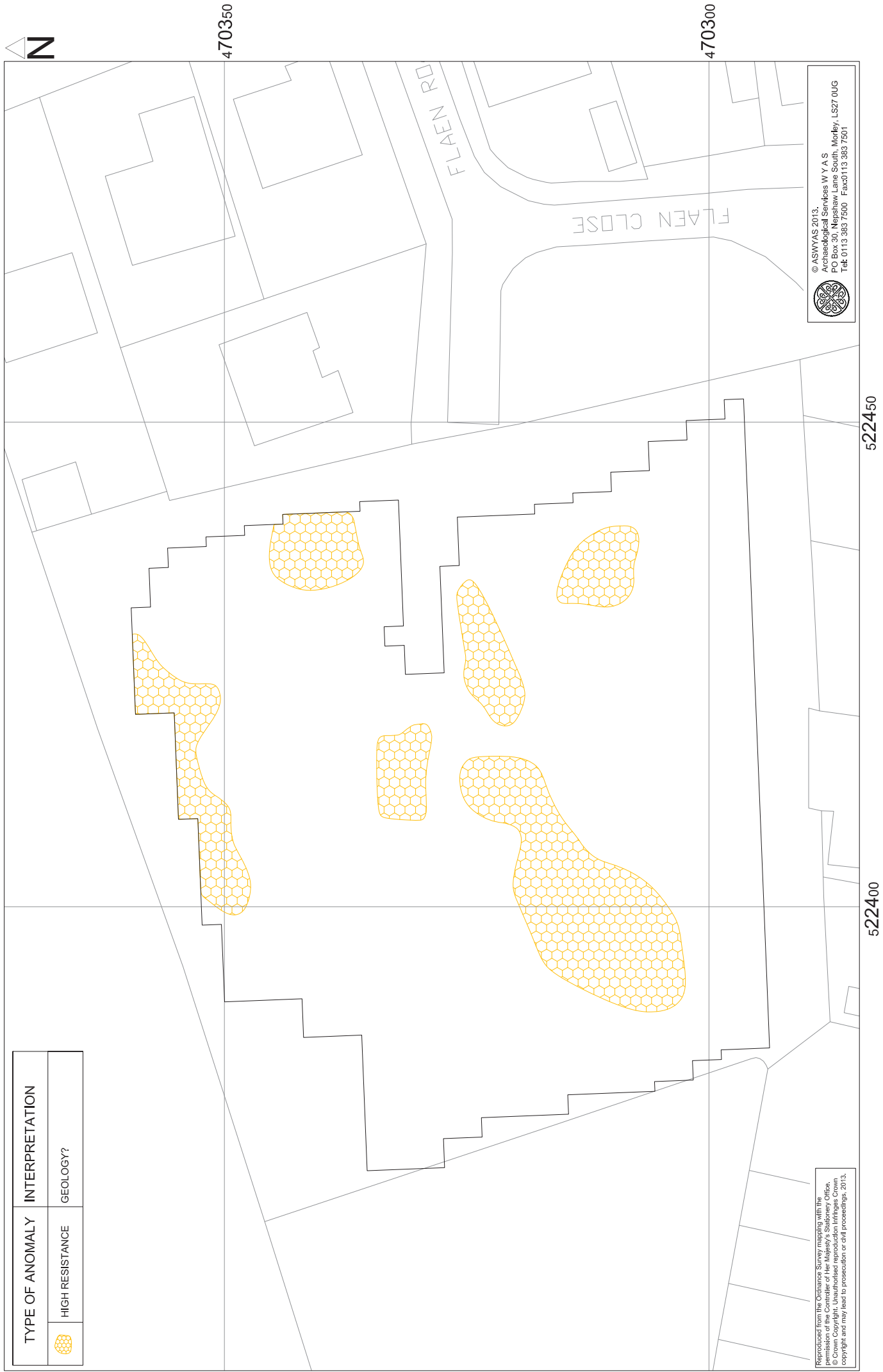


Fig. 6. Processed earth resistance data (1:500 @ A4)



Fig. 7. Raw earth resistance data (1:500 @ A4)





TYPE OF ANOMALY		INTERPRETATION
	HIGH RESISTANCE	GEOLOGY?

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Fig. 8. Interpretation of earth resistance data (1:500 @ A4)



*Plate 1. General view of survey area, looking north-west*



*Plate 2. General view of survey area, looking south-west*

## **Appendix 1: Magnetic survey - technical information**

### **Magnetic Susceptibility and Soil Magnetism**

Iron makes up about 6% of the Earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haemetite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected. The magnetic susceptibility of a soil can also be enhanced by the application of heat and the fermentation and bacterial effects associated with rubbish decomposition. The area of enhancement is usually quite large, mainly due to the tendency of discard areas to extend beyond the limit of the occupation site itself, and spreading by the plough. An advantage of magnetic susceptibility over magnetometry is that a certain amount of occupational activity will cause the same proportional change in susceptibility, however weakly magnetic is the soil, and so does not depend on the magnetic contrast between the topsoil and deeper layers. Susceptibility survey is therefore able to detect areas of occupation even in the absence of cut features. On the other hand susceptibility survey is more vulnerable to the masking effects of layers of colluvium and alluvium as the technique, using the Bartington system, can generally only measure variation in the first 0.15m of ploughsoil.

### **Types of Magnetic Anomaly**

In the majority of instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

#### *Isolated dipolar anomalies (iron spikes)*

These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

#### *Areas of magnetic disturbance*

These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

#### *Linear trend*

This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

#### *Areas of magnetic enhancement/positive isolated anomalies*

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

#### *Linear and curvilinear anomalies*

Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

### **Methodology: Magnetic Susceptibility Survey**

There are two methods of measuring the magnetic susceptibility of a soil sample. The first involves the measurement of a given volume of soil, which will include any air and moisture that lies within the sample, and is termed volume specific susceptibility. This method results in a bulk value that is not necessarily fully representative of the constituent components of the sample. For field surveys a Bartington MS2 meter with MS2D field loop is used due to its speed and simplicity. The second technique overcomes this potential problem by taking into account both the volume and mass of a sample and is termed mass specific susceptibility. However, mass specific readings cannot be taken in the field where the bulk properties of a soil are usually unknown and so volume specific readings must be taken. Whilst these values are not fully representative they do allow general comparisons across a site and give a broad indication of susceptibility changes. This is usually enough to assess the susceptibility of a site and evaluate whether enhancement has occurred.

### **Methodology: Gradiometer Survey**

There are two main methods of using the fluxgate gradiometer for commercial evaluations. The first of these is referred to as *magnetic scanning* and requires the operator to visually identify anomalous responses on the instrument display panel whilst covering the site in widely spaced traverses, typically 10m apart. The instrument logger is not used and there is therefore no data collection. Once anomalous responses are identified they are marked in the field with bamboo canes and approximately located on a base plan. This method is usually employed as a means of selecting areas for detailed survey when only a percentage sample of the whole site is to be subject to detailed survey.

The disadvantages of magnetic scanning are that features that produce weak anomalies (less than 2nT) are unlikely to stand out from the magnetic background and so will be difficult to detect. The coarse sampling interval means that discrete features or linear features that are parallel or broadly oblique to the direction of traverse may not be detected. If linear features are suspected in a site then the traverse direction should be perpendicular (or as close as is possible within the physical constraints of the site) to the orientation of the suspected features. The possible drawbacks mentioned above mean that a 'negative' scanning result should be validated by sample detailed magnetic survey (see below).

The second method is referred to as *detailed survey* and employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0.25m intervals, on zig-zag traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation. Detailed survey allows the visualisation of weaker anomalies that may not have been detected by magnetic scanning.

During this survey a Bartington Grad601 magnetic gradiometer was used taking readings on the 0.1nT range, at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m square



grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

### **Data Processing and Presentation**

The detailed gradiometer data has been presented in this report in XY trace and greyscale formats. In the former format the data shown is 'raw' with no processing other than grid biasing having been done. The data in the greyscale images has been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

An XY plot presents the data logged on each traverse as a single line with each successive traverse incremented on the Y-axis to produce a 'stacked' plot. A hidden line algorithm has been employed to block out lines behind major 'spikes' and the data has been clipped. The main advantage of this display option is that the full range of data can be viewed, dependent on the clip, so that the 'shape' of individual anomalies can be discerned and potentially archaeological anomalies differentiated from 'iron spikes'. Geoplot 3 software was used to create the XY trace plots.

Geoplot 3 software was used to interpolate the data so that 3600 readings were obtained for each 30m by 30m grid. The same program was used to produce the greyscale images. All greyscale plots are displayed using a linear incremental scale.

## **Appendix 2: Survey location information**

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). The accuracy of this equipment is better than 0.01m. The locations of the survey grid and anomalies are available as a DXF file. The internal accuracy of these markers is better than 0.01m.

*Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.*

### **Appendix 3: Geophysical archive**

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2008) files; and
- a full copy of the report.

At present the archive is held by Archaeological Services WYAS although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). Brief details may also be forwarded for inclusion on the English Heritage Geophysical Survey Database after the contents of the report are deemed to be in the public domain (i.e. available for consultation in the East Yorkshire Historic Environment Record).



## **Bibliography**

- British Geological Survey, 2013. [www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html](http://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html) . (Viewed August 14th 2013)
- David, A., N. Linford, P. Linford and L. Martin. 2008. *Geophysical Survey in Archaeological Field Evaluation: Research and Professional Services Guidelines (2nd edition)* English Heritage
- Institute for Archaeologists, 2010. *Standard and Guidance for archaeological geophysical survey*. Institute for Archaeologists
- Soil Survey of England and Wales, 1983. *Soil Survey of England and Wales: Soils of Northern England*, Sheet 1
- Webb, A., 1993. *Land off Bempton Lane, Flamborough: Archaeological Evaluation*. Archaeological Services WYAS Unpublished Client Report No ASWYAS 161