ARCHAEOLOGICAL SERVICES WYAS

Land east of Rudston Road
Burton Agnes
East Yorkshire

Geophysical Survey

Report no. 2502

August 2013

Client: MAP Archaeological Practice Ltd

REGISTERED IA ORGANISATION

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Burton Agnes
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Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering 1.3 hectares of agricultural land at Burton Agnes was carried out to inform a planning application for the provision of car-parking facilities and access to Burton Agnes Hall, a Scheduled Ancient Monument. Anomalies caused by modern activity and by features shown on early mapping have been identified. In addition two anomalies of possible archaeological potential have been noted, one of which locates the continuation of a cropmark feature previously known to the immediate north of the site. A second cropmark feature, recorded within the site boundary, has not been identified. On the basis of the survey the archaeological potential of the site is considered to be low to moderate.

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Report Information

Client:	MAP Archaeological Practice Limited
Address:	The Croft, East Street, Swinton, Malton, YO17 6SH
Report Type:	Geophysical Survey
Location:	Burton Agnes
County:	East Yorkshire
Grid Reference:	TA 1010 6335
Period(s) of activity:	Post-medieval?
Report Number:	2502
Project Number:	4105
Site Code:	BAE13
OASIS ID:	archaeol11-156838
Planning Application No.:	DC/12/03739/STPLF
Museum Accession No.:	n/a
Date of fieldwork:	July 2013
Date of report:	August 2013
Project Management:	David Harrison BA MIfA
Fieldwork:	David Williams BA MIfA
Report:	Alistair Webb BA MIfA
Illustrations:	David Harrison
Photography:	David Williams
Research:	n/a

Authorisation for distribution: ---

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1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by Sophie Coy of MAP Archaeological Practice Ltd, to undertake a geophysical (magnetometer) survey of land to the east of Rudston Road, Burton Agnes, East Yorkshire to inform a planning application (Ref. No. DC/12/03739/STPLF) for the proposed creation of new car-parking facilities and improved vehicular access to Burton Agnes Hall. 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 29th 2013.

Site location, topography and land-use

The proposed development area (PDA) for the car-park is located on the northern periphery of the village of Burton Agnes, mid-way between Driffield and Bridlington, in the grounds of Burton Agnes Hall (see Fig. 1). The site is centred at TA 101 633 and is bound by Rudston Road to the west, by St Martins Church to the south, woodland to the east and by open arable farm land to the north (see Fig. 2). The survey area was flat at approximately 40m above Ordnance Datum and covered an area of approximately 1.3 hectares. The ground cover comprised an arable crop with a large areas of bare earth where it was apparent recent ground disturbance had taken place; a pile of soil in the centre of the site slightly reduced the overall survey area (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 Hunstanton association, being characterised as deep, well-drained, fine and coarse loams (Soil Survey of England and Wales 1983).

2 Archaeological and Historical Background

The site of the proposed development lies within the village of Burton Agnes, within the grounds of the early 17th century Burton Agnes Hall. The village itself lies on the southern edge of the Wolds. The northern part of the parish lies on a rolling stretch of the Wolds, whilst the southern part overlies the boulder clays and alluvium of the Holderness Plain. This is a landscape which has seen intensive human activity for much of the last 10,000 years; in the Middle Ages the Wold slopes were traditionally used for the arable open fields, whilst the more low-lying meadows, moor and carrs on the plain were used for grazing. Cropmarks of two possible trackways or old roads were mapped heading through the PDA from the north during the English Heritage National Mapping Project and these cropmarks are still visible on GoogleEarth images of the site. The date of these features is uncertain. The proposed car-park also lies directly to the north of St Martin's Church and of Burton Agnes Old Hall, a Scheduled Ancient Monument.

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 was carried out over the whole of the PDA, an area of 1.3 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 magnetic data at a scale of 1:2500. Figure 3 is a location plan showing the site boundary overlain on the first edition Ordnance Survey map of 1854, also at 1:2500. Detailed data plots ('raw' and processed) and an interpretative figure are presented at a scale of 1:1000 in Figures 4, 5 and 6.

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 (see Figs 4, 5 and 6)

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. Throughout the survey area iron 'spike' anomalies are common and there is no obvious pattern or clustering to their distribution to suggest anything other than a random background scatter of ferrous debris in the top-soil.

A large area of magnetic disturbance is located around the south-western periphery of the survey area. This disturbance corresponds with the former location of two small buildings shown on the first edition Ordnance Survey mapping (see Fig. 3).

A strong linear dipolar anomaly, **A**, aligned south-west/north-east locates a buried pipe.

Anomalies of significantly enhanced magnetic response - Modern

In the south-eastern corner of the site a cluster of anomalies of enhanced response, **B**, are also interpreted as of relatively modern origin. The first edition mapping shows outlines of buildings, presumably associated with the National School, and it is considered likely that these anomalies are caused by ground disturbance associated with the demolition and remediation of the ground in this area.

In the north-west corner of the site a second linear anomaly, **C**, aligned north-west/south-east, parallel with the western edge of the site is identified. The magnitude of the response is such that it is also considered likely to be of modern origin, possibly the line of a former track.

In the centre of the site, surrounding the small area that could not be surveyed due to the presence of a mound of soil (see Plate 1), two broadly parallel linear anomalies, **D** and **E**, have been noted. Both anomalies either respect or terminate at the pipe, **A**. Anomaly **D** also closely correlates with a linear feature on the first edition mapping. For these reasons both these anomalies are also interpreted as of likely modern origin although an archaeological cause should not be completely dismissed.

Geological anomalies

The magnetic background across the site generally is variable (see Fig. 5). This is a reflection of the variation within the superficial till deposits which overly the bedrock geology. The most prominent of these anomalies are shown on Figure 5.

Archaeological anomalies?

Two linear anomalies, **F** and **G**, have been interpreted as of possible archaeological origin.

To the west of the site anomaly **F** continues on the line of the westernmost of two cropmarks that have been previously identified to the immediate north of the site. Both these cropmarks have been interpreted as possible tracks. The anomaly is more indicative of an infilled ditch. Neither the cropmark nor the magnetic anomaly correlate with any of the paths or tracks shown on the first edition mapping (see Fig. 3). The second cropmark, that does continue across the PDA and is still visible on GoogleEarth images, does not present as a magnetic anomaly.

Anomaly **G**, to the east of the PDA, is aligned north-west/south-east and may correlate with a track shown on the first edition mapping. It is worth commenting that two other tracks shown on the early mapping do not present as magnetic anomalies.

5 Conclusions

The magnetic survey has identified numerous anomalies most of which are the result of modern activity and some of which possibly may reflect features, such as tracks, which are shown on the first edition mapping. In addition two other linear anomalies have been identified that cannot definitely be attributed to mapped features or modern activity and these have consequently been interpreted as of archaeological potential. The first anomaly matches the location and alignment of a cropmark identified immediately north of the site. The second anomaly to the east of the site does not, however, correspond with a second cropmark which crosses the site and which has not been detected.

On the basis of the geophysical survey, the archaeological potential of the site is thought to be low to moderate.

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.

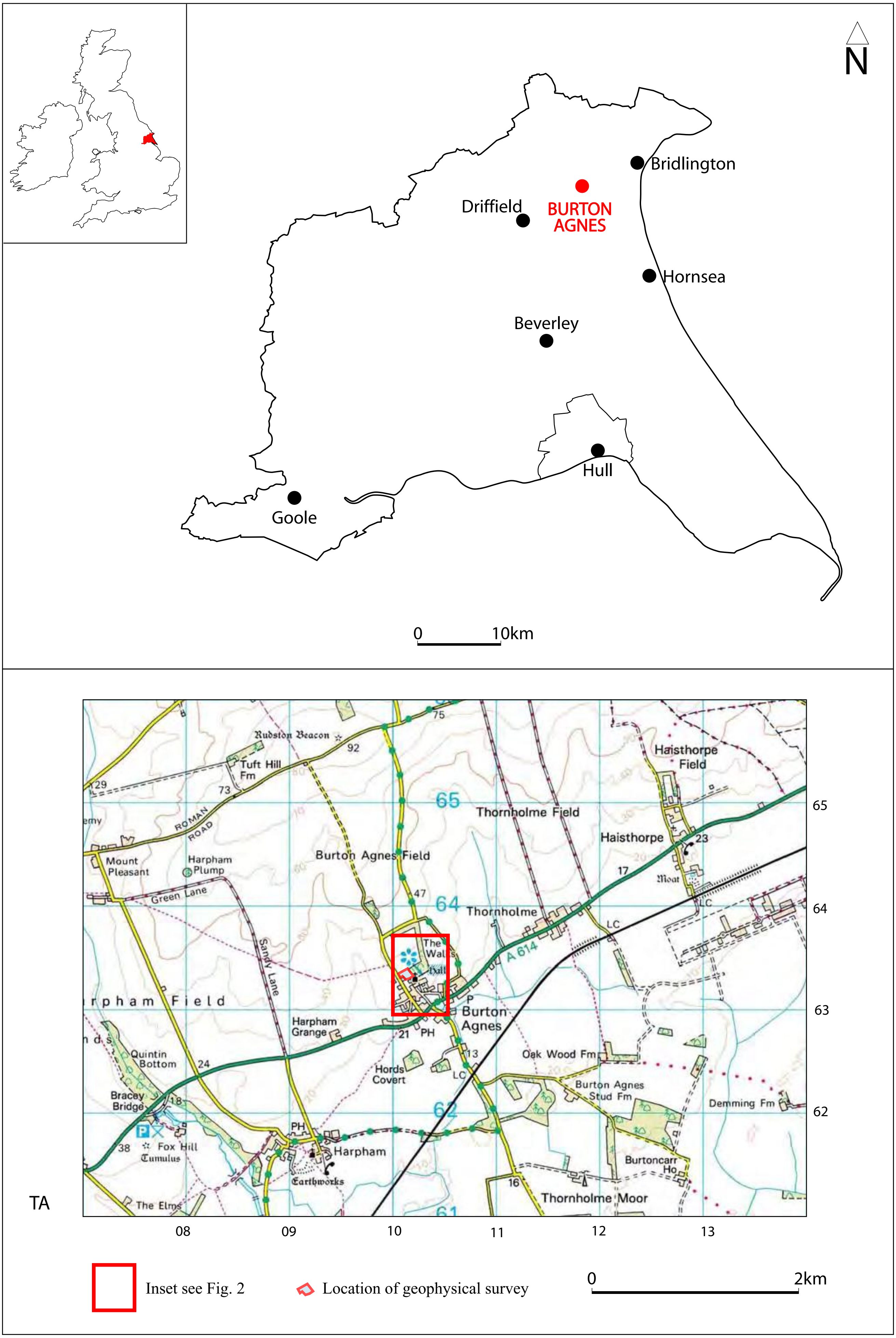

Fig. 1. Site location

Fig. 2. Site location showing greyscale magnetometer data (1:2500 @ A4)

0 50m

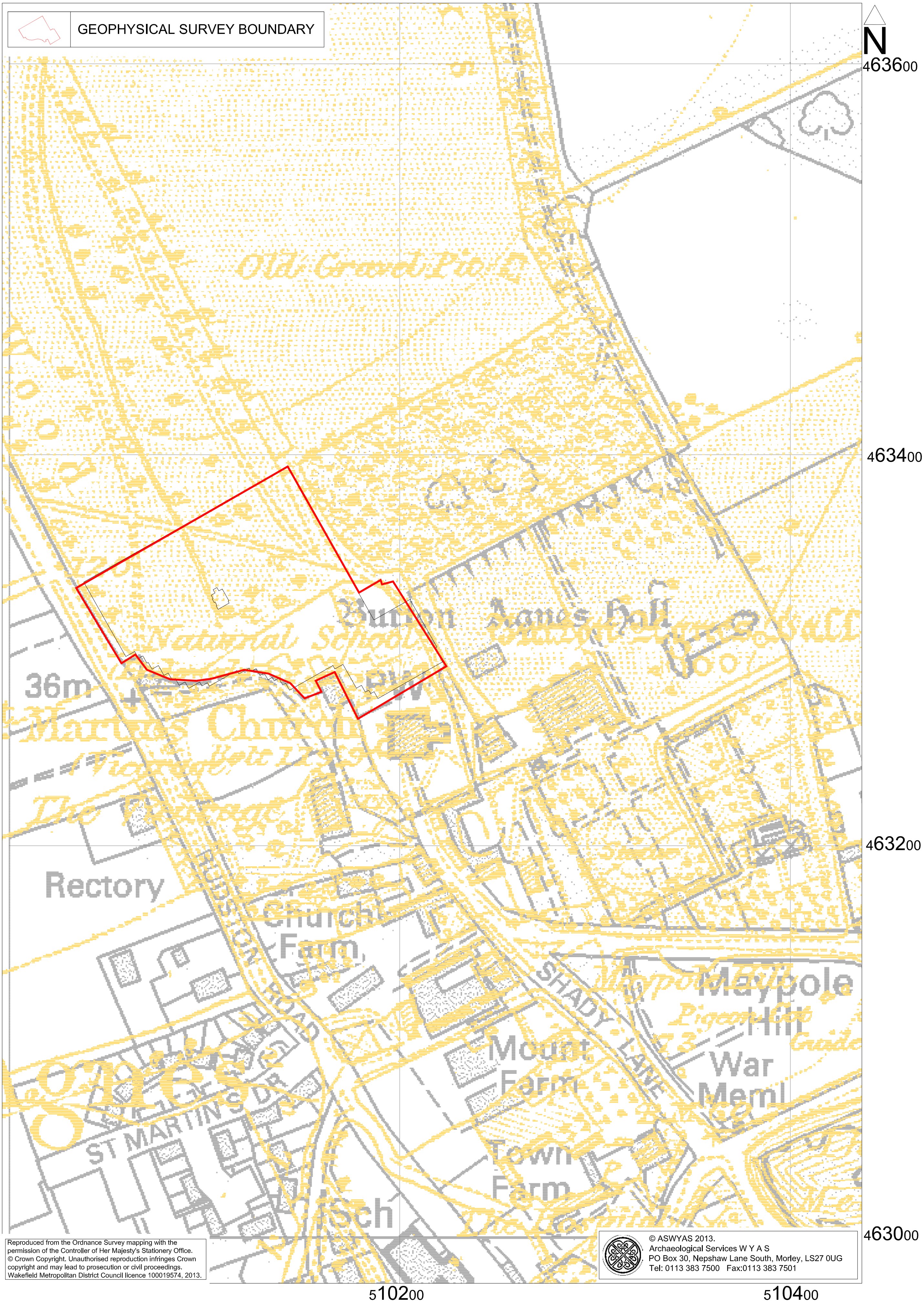

Fig. 3. Site location showing first edition Ordnance Survey Map (1:2500 @ A4)

0 50m

Fig. 4. Processed greyscale magnetometer data (1:1000 @ A4)

0 20m

Fig. 5. XY trace plot of minimally processed magnetometer data (1:1000 @ A4)

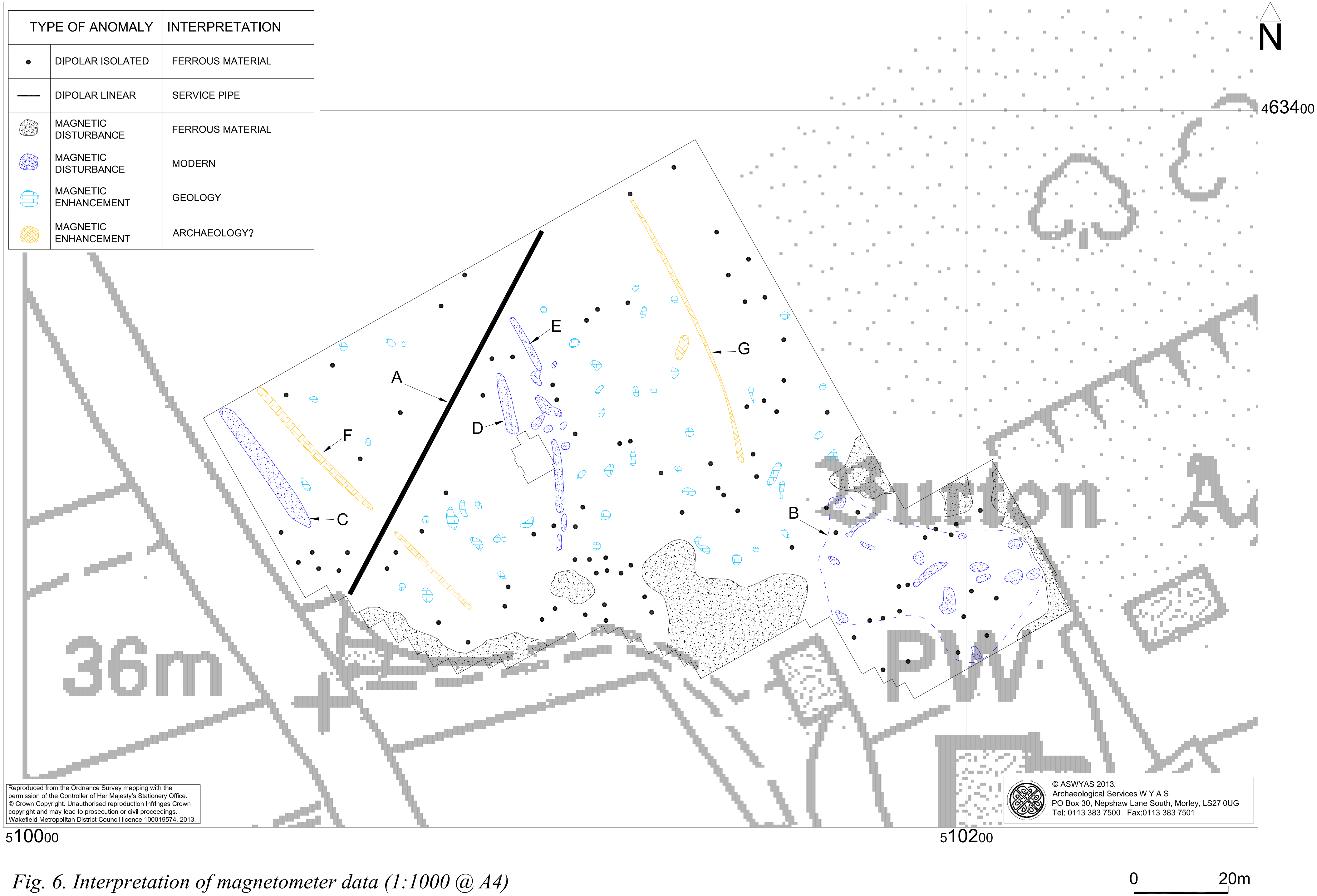

Fig. 6. Interpretation of magnetometer data (1:1000 @ A4)

Plate 1. General view of survey area, looking south-east

Plate 2. General view of survey area, looking south

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 it 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 then 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.

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).

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