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**Land east of Micklefield  
West Yorkshire**

**Geophysical Survey**

Report no. 2564

December 2013

Client: Prospect Archaeology Ltd



# Land east of Micklefield

## West Yorkshire

### Geophysical Survey

#### *Summary*

*A geophysical (magnetometer) survey covering approximately 7 hectares was carried out on agricultural land immediately east of Micklefield, to inform the determination of an outline planning application for the proposed development of the site. Anomalies indicative of ridge and furrow cultivation, more recent agricultural activity and variation within the superficial deposits have been identified. Two linear anomalies of uncertain origin are also noted and interpreted as of possible archaeological origin. However, on the basis of the survey, the archaeological potential of the site is assessed as low.*



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## Report Information

Client: Prospect Archaeology Ltd  
Address: Prospect House, Garden Lane, Sherburn-in-Elmet, Leeds,  
North Yorkshire, LS25 6AT  
Report Type: Geophysical Survey  
Location: Micklefield  
County: West Yorkshire  
Grid Reference: SE 4444 3304  
Period(s) of activity: post-medieval  
Report Number: 2564  
Project Number: 4162  
Site Code: MFL13  
OASIS ID: archaeol11- 168767  
Planning Application No.:  
Museum Accession No.: n/a  
Date of fieldwork: December 2013  
Date of report: December 2013  
Project Management: Alistair Webb BA MifA  
Fieldwork: Tom Fildes  
Alex Schmidt BA  
Dan Waterfall BSc  
Report: Alistair Webb  
Illustrations: Sam Harrison BSc MSc MifA  
Photography: Site Staff  
Research: n/a

Authorisation for  
distribution: -----



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## 1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Nansi Rosenberg of Prospect Archaeology Limited (the Client), to undertake a geophysical (magnetometer) survey of land to the east of Micklefield (see Fig. 1), prior to the determination of a planning application for the proposed development of the site. The work was undertaken in accordance with a Project Design (Harrison 2013) supplied to and approved by the Client, with guidance contained within the National Planning Policy Framework (2012) and in line with current best practice (David *et al* 2008). The survey was carried out on December 6th and December 9th 2013 in order to provide additional information on the archaeological potential of the site.

### Site location, topography and land-use

The Proposed Development Area (PDA) is situated to the east of Micklefield, centred at SE 4444 3304, and comprised an irregular shaped block of land covering approximately 11 hectares. The site is bound to the east by the A1(M) and by the Great North Road and the Garden Village of New Micklefield to the west and south-west (see Fig. 2). Manor Farm is located towards the centre of the PDA but the survey was limited to agricultural land to the north and south of the farm, an area of approximately 7 hectares. The two main survey areas (Field 1 and Field 4) were both fallow at the time of survey (see Plate 1 and Plate 3).

### Soils and geology

The underlying bedrock geology comprises Cadeby Formation Dolostone overlain by superficial deposits of Harrogate Till Formation (clay, sand and gravel) and Head (silt, sand, clay and gravel (British Geological Survey 2013). The soils are classified in the Aberford association, characterised as shallow, well-drained loams over limestone (Soil Survey of England and Wales 1983).

## 2 Archaeological Background

At the time of writing the archaeological potential of the site is unknown although it is understood that there are no known heritage assets within the PDA. There are, however, numerous cropmarks in the immediate vicinity of the site (see Fig. 2) indicative of fields, trackways and enclosures of likely Iron Age/Romano-British date.

### 3 Aims, Methodology and Presentation

The main aim of the geophysical survey was to provide sufficient information to enable an assessment to be made of the impact of development on potential sub-surface archaeological remains, and for further evaluation or mitigation proposals, if appropriate, to be recommended. To achieve this aim a magnetometer survey covering all of the PDA that was suitable for survey was carried out, an area of approximately 7 hectares.

The general 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.

#### Magnetometer survey

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). 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 (OS) mapping, is shown in Figure 1. Figure 2 is a large scale (1:5000) location plan displaying the processed magnetometer data in greyscale format. Figure 3 is an overall interpretation of the data at the same scale. Both of these figures also show cropmark detail. Large scale data plots of both the minimally processed (X–Y trace plot) and processed (greyscale) data and interpretative figures are presented at a scale of 1:1000 in Figures 4 to 12 inclusive.

Further technical information on the equipment used, data processing and survey methodologies is 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 2013). 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 to 12)

The anomalies identified by the survey fall into four different categories according to their interpreted origin. Each category is discussed below and cross-referenced to specific examples and locations within the site.

##### **Ferrous Anomalies**

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, as ferrous debris or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling. Throughout the PDA individual iron 'spike' anomalies are common but there is no obvious pattern or clustering to their distribution to suggest anything other than a random background scatter of ferrous debris in the soil.

Substantial areas of magnetic disturbance are identified around the periphery of the two survey areas. This is all assumed to be due to modern activity and of no archaeological significance. As stated above this is assumed to be reflect the tipping or accumulation of ferrous material from the adjacent residential properties and from Manor Farm.

##### **Agricultural Anomalies**

Throughout the site a series of parallel linear trend anomalies have been identified. In Field 1 the anomalies are aligned north-west/south-east and in Field 4 north-west/south-east and also north/south. In Field 4 the north/south trends are parallel with the eastern field edge and reflect recent ploughing parallel with the boundary created by the construction of the A1(M). The second series of trends are at right angles to the northern (19th century) field boundary and are due to the post-medieval agricultural practice of ridge and furrow cultivation. The anomalies are due to the magnetic contrast between the now soil-filled furrows and the former ridges.

Three other linear trend anomalies, **A**, **B** and **C**, either on the same alignment or at right angles to the ploughing anomalies, are also identified. These anomalies correlate with field boundaries shown on the first edition Ordnance Survey mapping and are caused by the remnant (below ground) soil-filled ditches.



## **Geological Anomalies**

Throughout the site numerous discrete and curvilinear anomalies characterised as areas of enhanced magnetic response. These anomalies are interpreted as of geological origin being caused by variations in the composition of the soils and superficial deposits, particularly pockets of magnetic gravels.

## **?Archaeological Anomalies**

Two other short linear trend anomalies, **D** and **E**, do not correspond with any boundaries recorded on the historic mapping but are on the same broad alignment as some of the cropmarks in the surrounding landscape (see Fig. 2). For this reason an archaeological origin is considered possible although a more recent (agricultural) origin is also considered plausible.

## **5 Conclusions**

The survey has identified numerous magnetic anomalies across all parts of the site. However, the overwhelming majority can be confidently interpreted as of no archaeological significance, being due to agricultural and modern activity and geological variation. Only two linear anomalies cannot be confidently interpreted as of no archaeological significance. Although these two anomalies are indicative of soil-filled ditches it is not possible to discriminate between a relatively recent (but unmapped) field boundary or a much older ditch feature of archaeological significance such as are identified across the wider landscape as cropmarks. However, on the basis of the survey the archaeological potential of the site is considered to be low.

*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.*

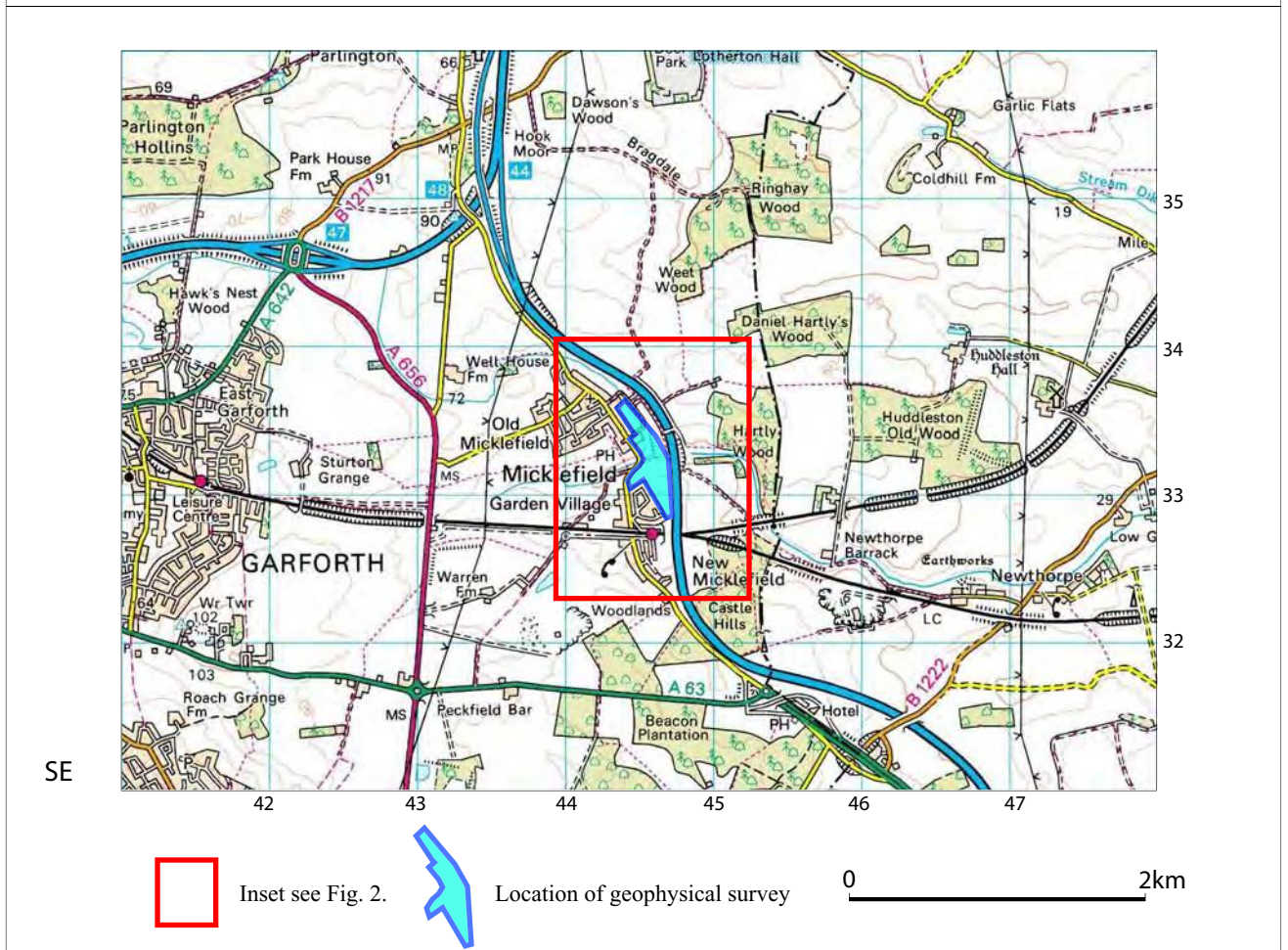
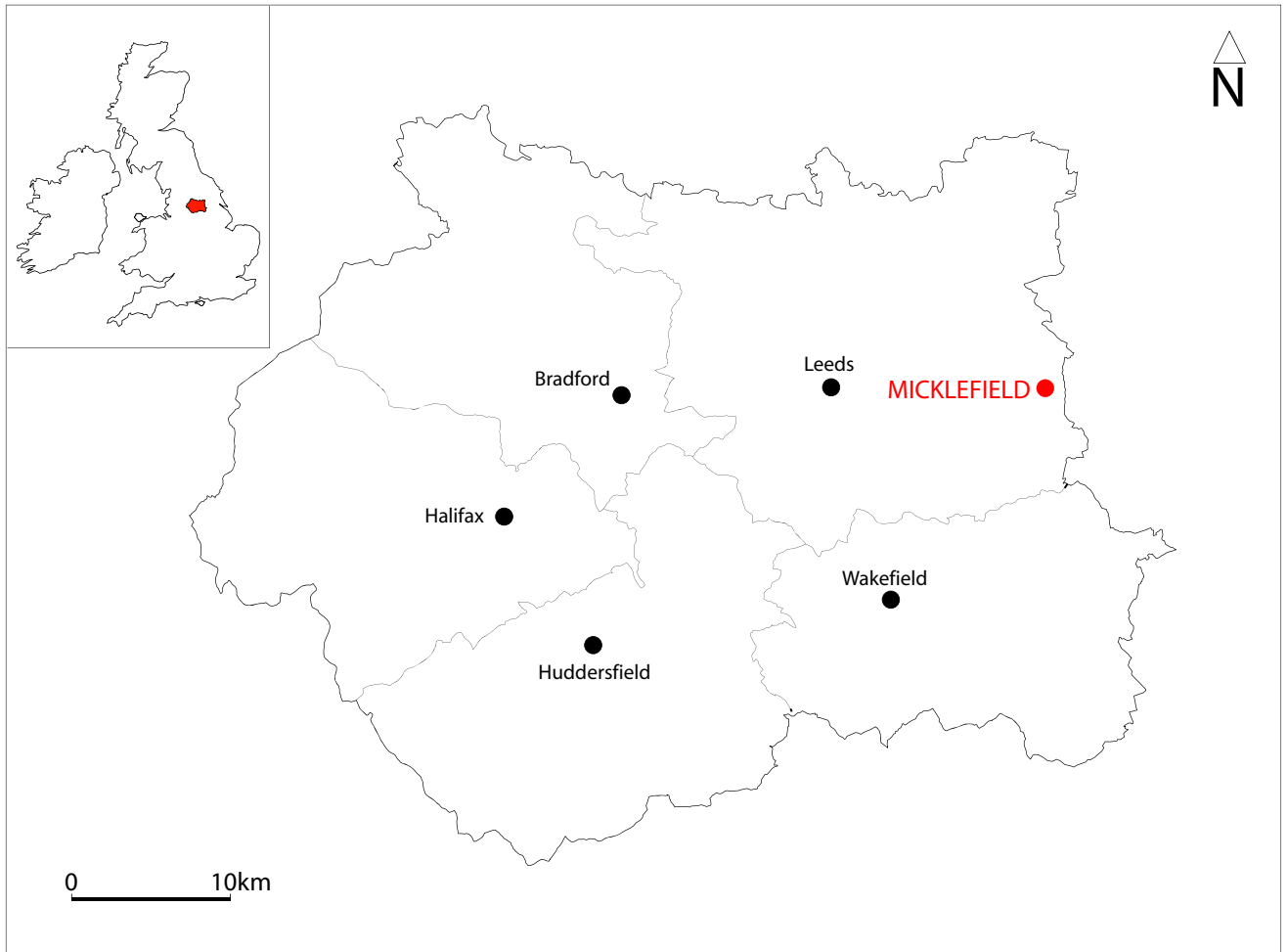
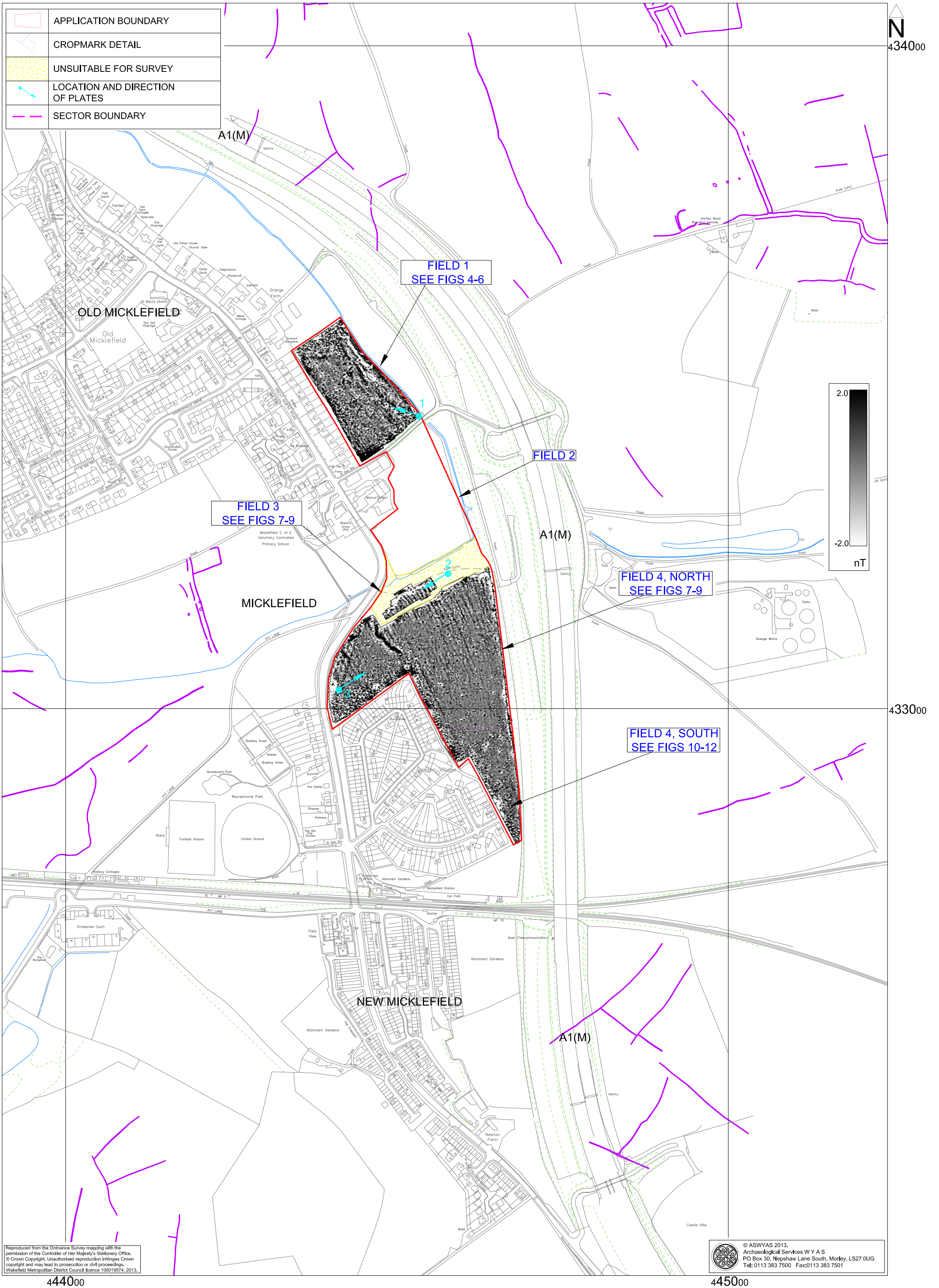


Fig. 1. Site location





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Fig. 2. Survey location showing greyscale magnetometer data and cropmark detail (1:5000 @ A3)

0 50m



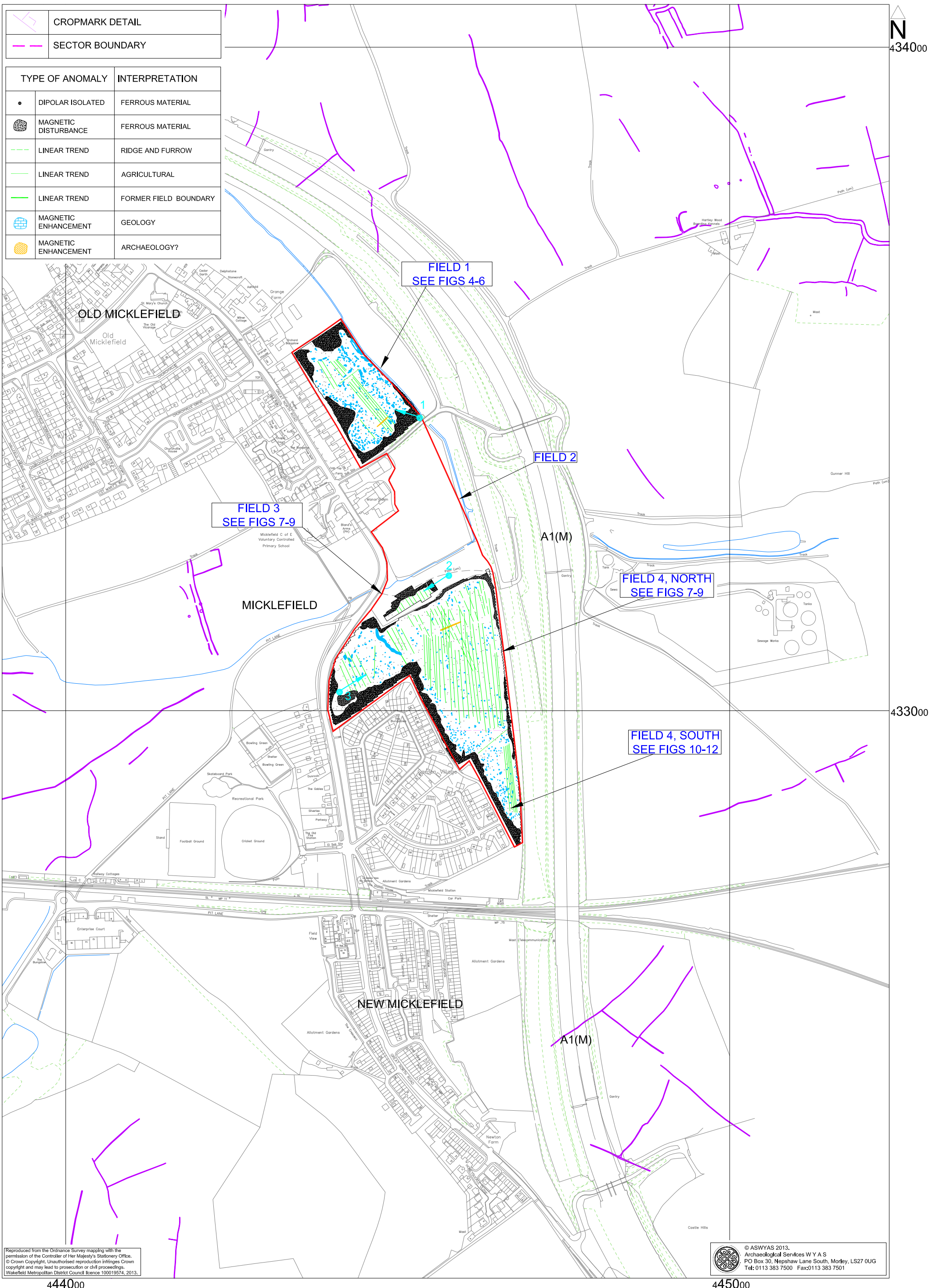


Fig. 3. Overall interpretation of magnetometer data and cropmark detail (1:5000 @ A3)

0 50m

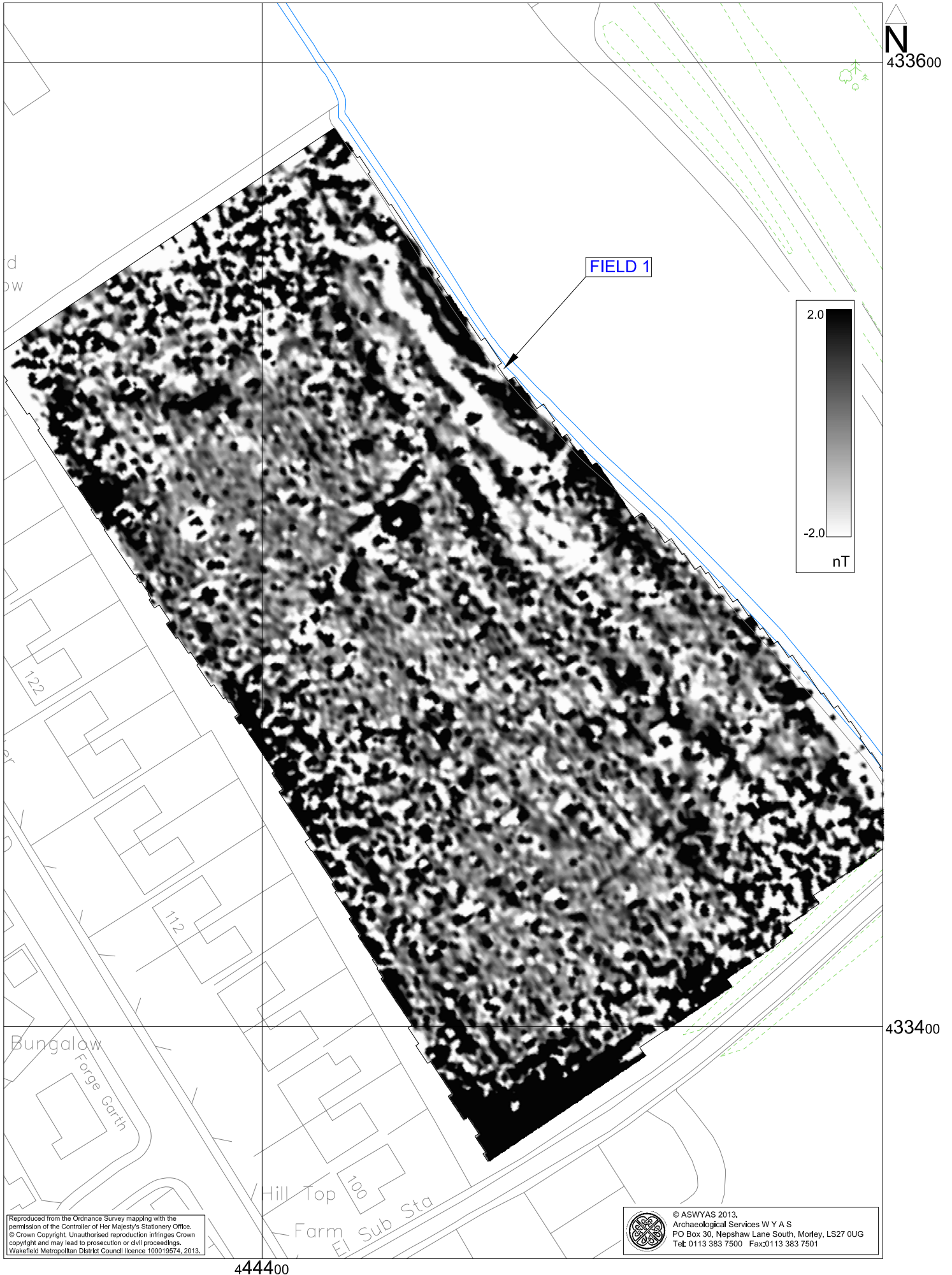
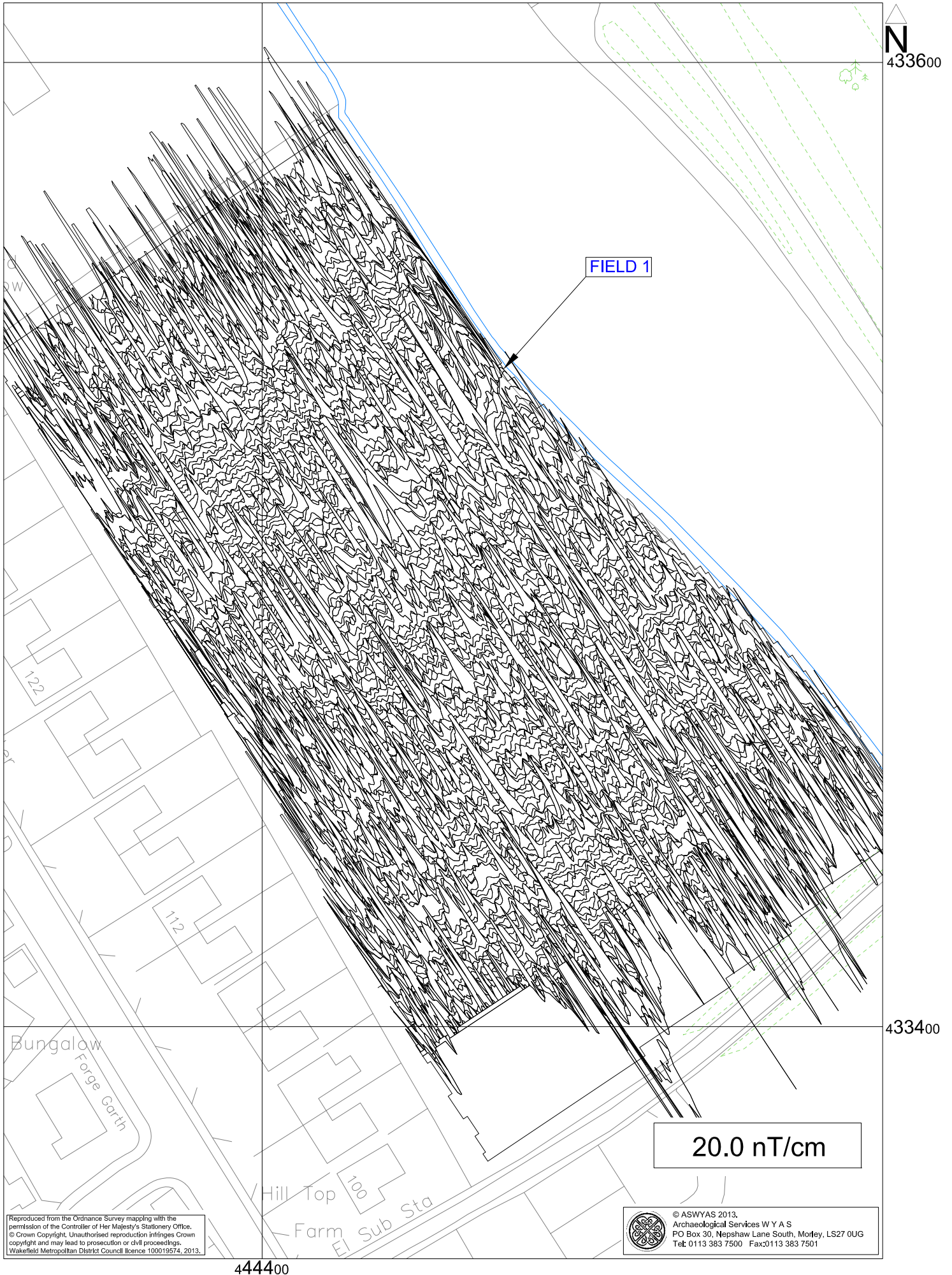


Fig. 4. Processed greyscale magnetometer data; Field 1 (1:1000 @ A4)

0 25m





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

0 25m

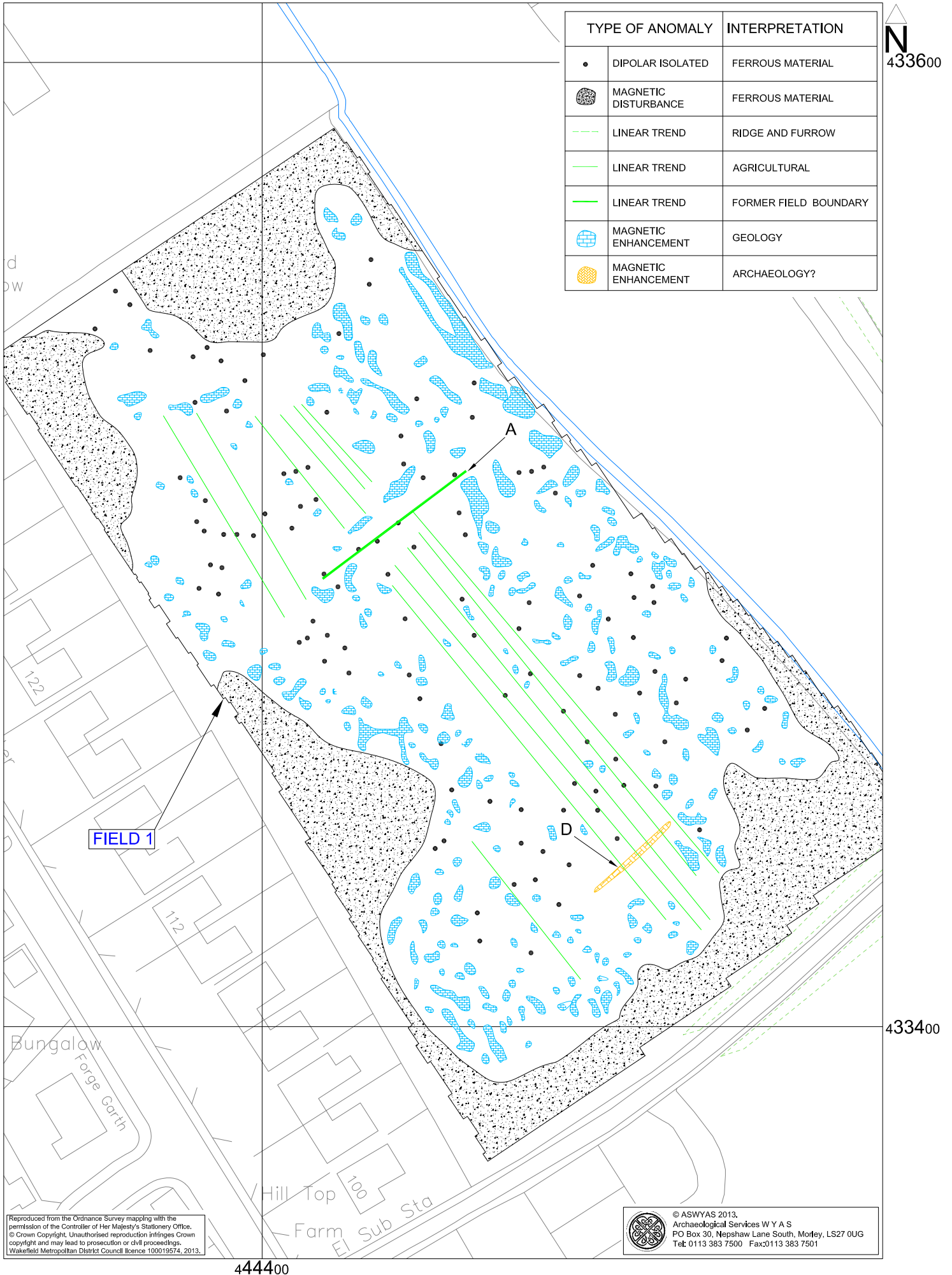


Fig. 6. Interpretation of magnetometer data; Field 1 (1:1000 @ A4)

0 25m





Fig. 7. Processed greyscale magnetometer data; Field 3 and Field 4, North (1:1000 @ A3)



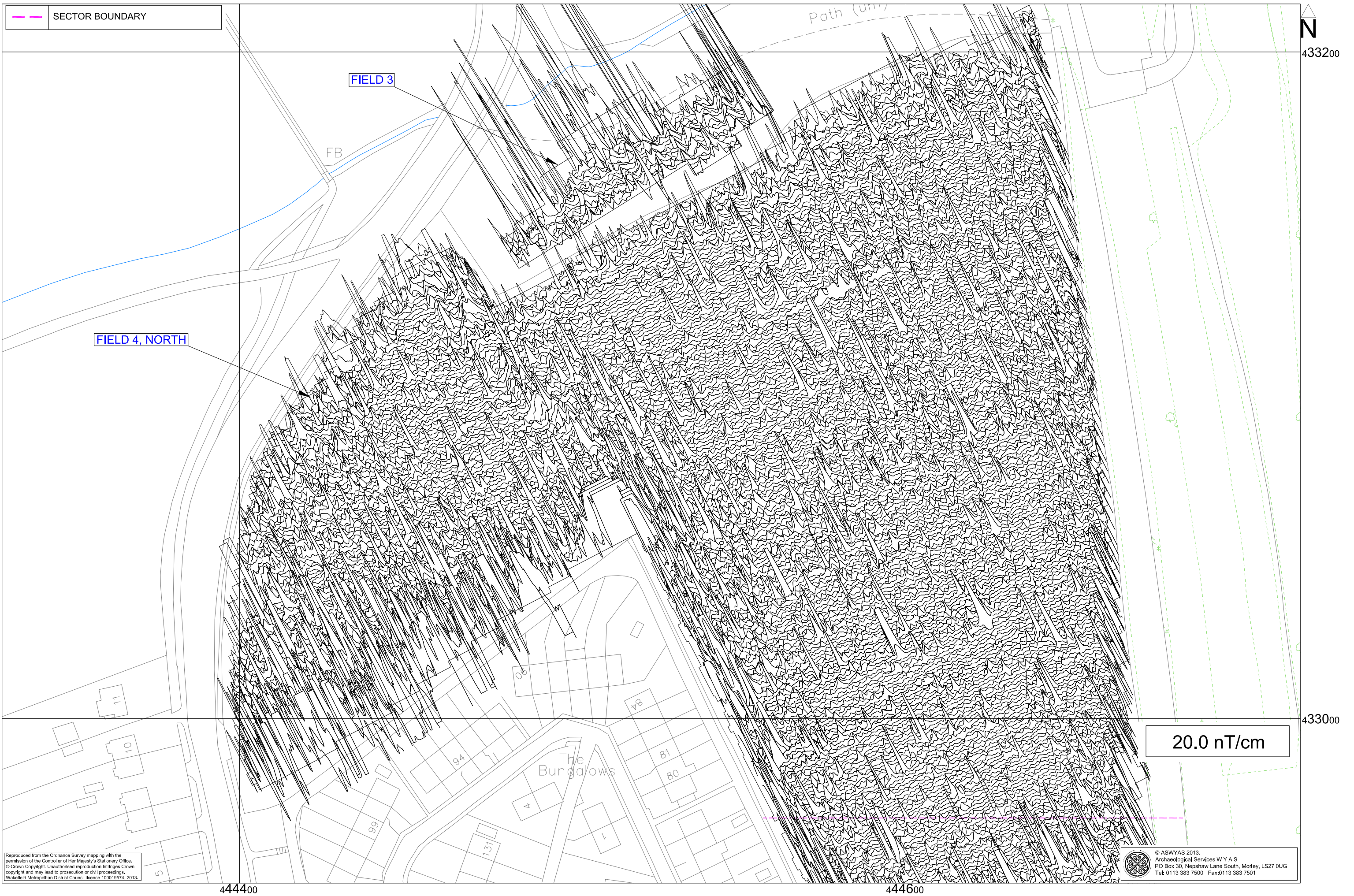


Fig. 8. XY trace plot of minimally processed magnetometer data; Field 3 and Field 4, North (1:1000 @ A3)



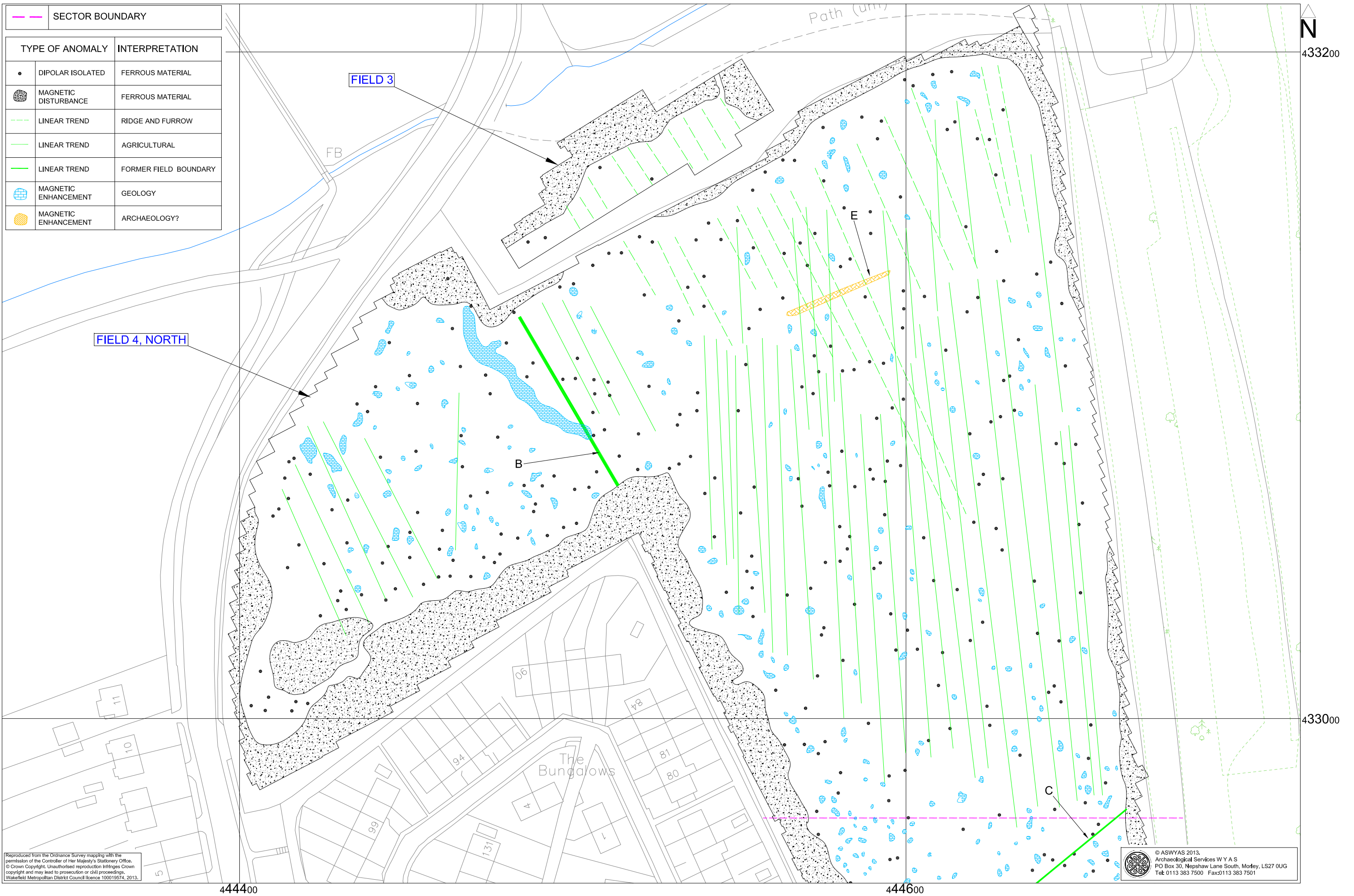


Fig. 9. Interpretation of magnetometer data; Field 3 and Field 4, North (1:1000 @ A3)

0 25m

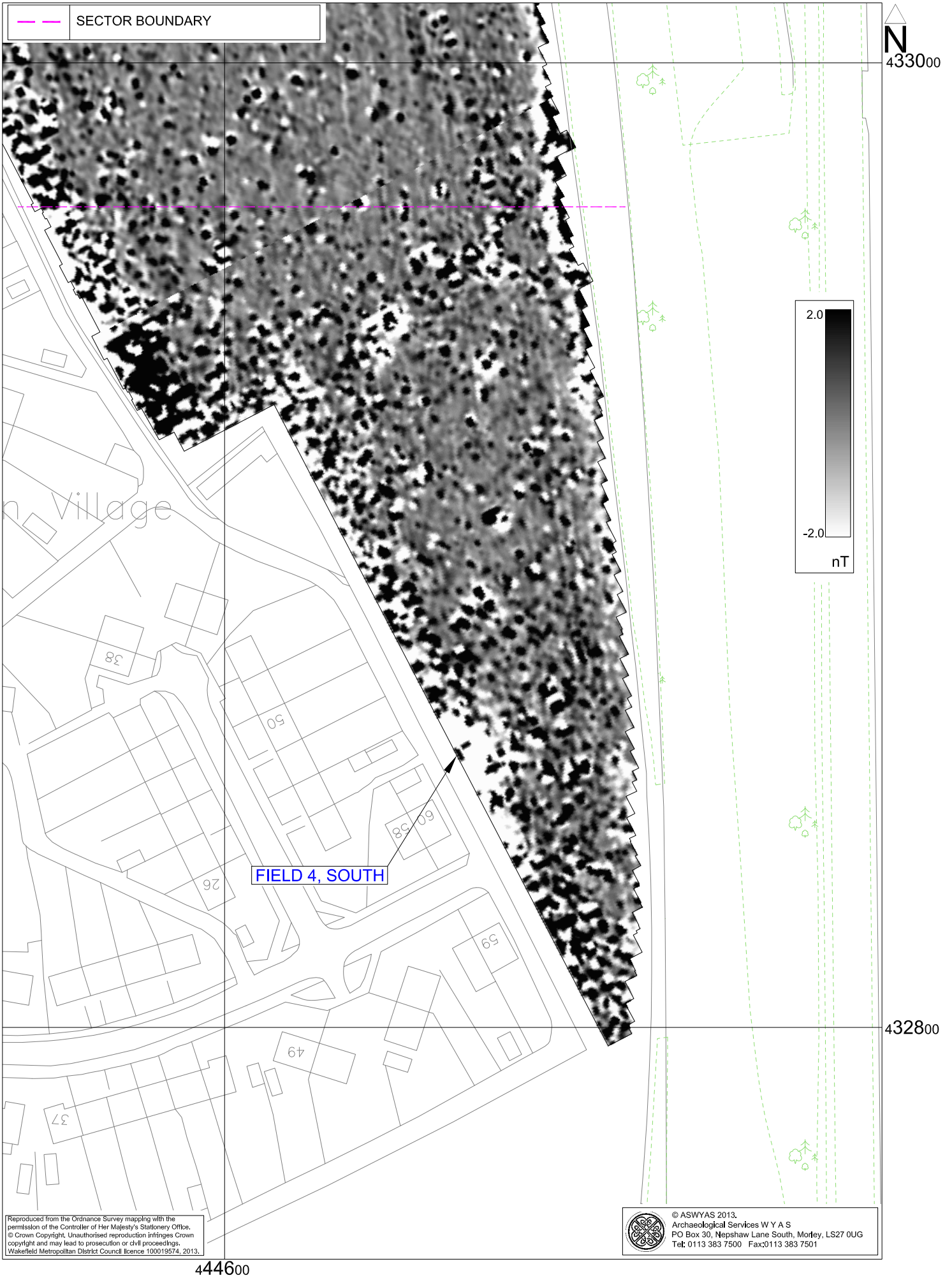


Fig. 10. Processed greyscale magnetometer data; Field 4, South (1:1000 @ A4)

0 25m



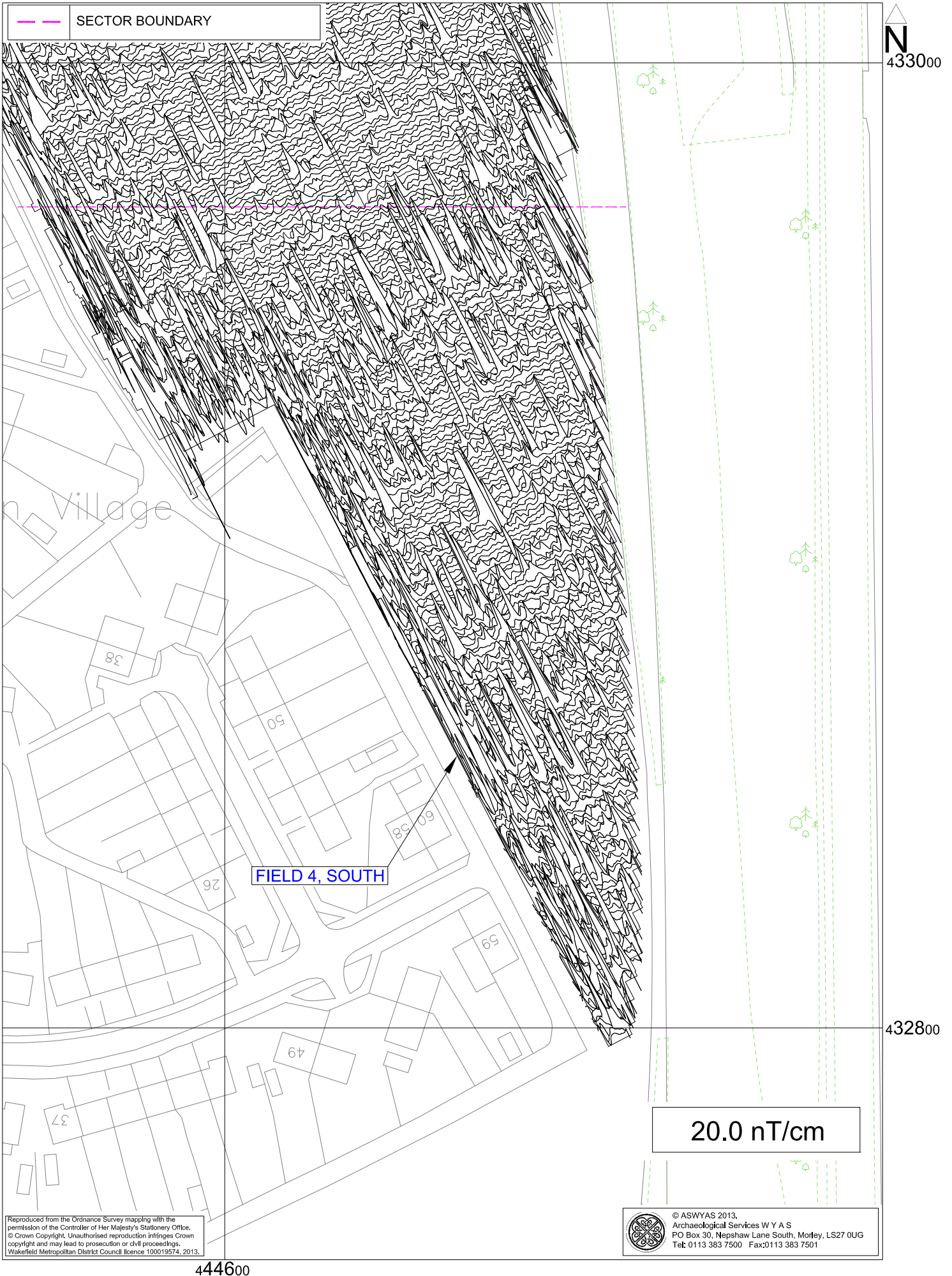


Fig. 11. XY trace plot of minimally processed magnetometer data; Field 4, South (1:1000 @ A4)

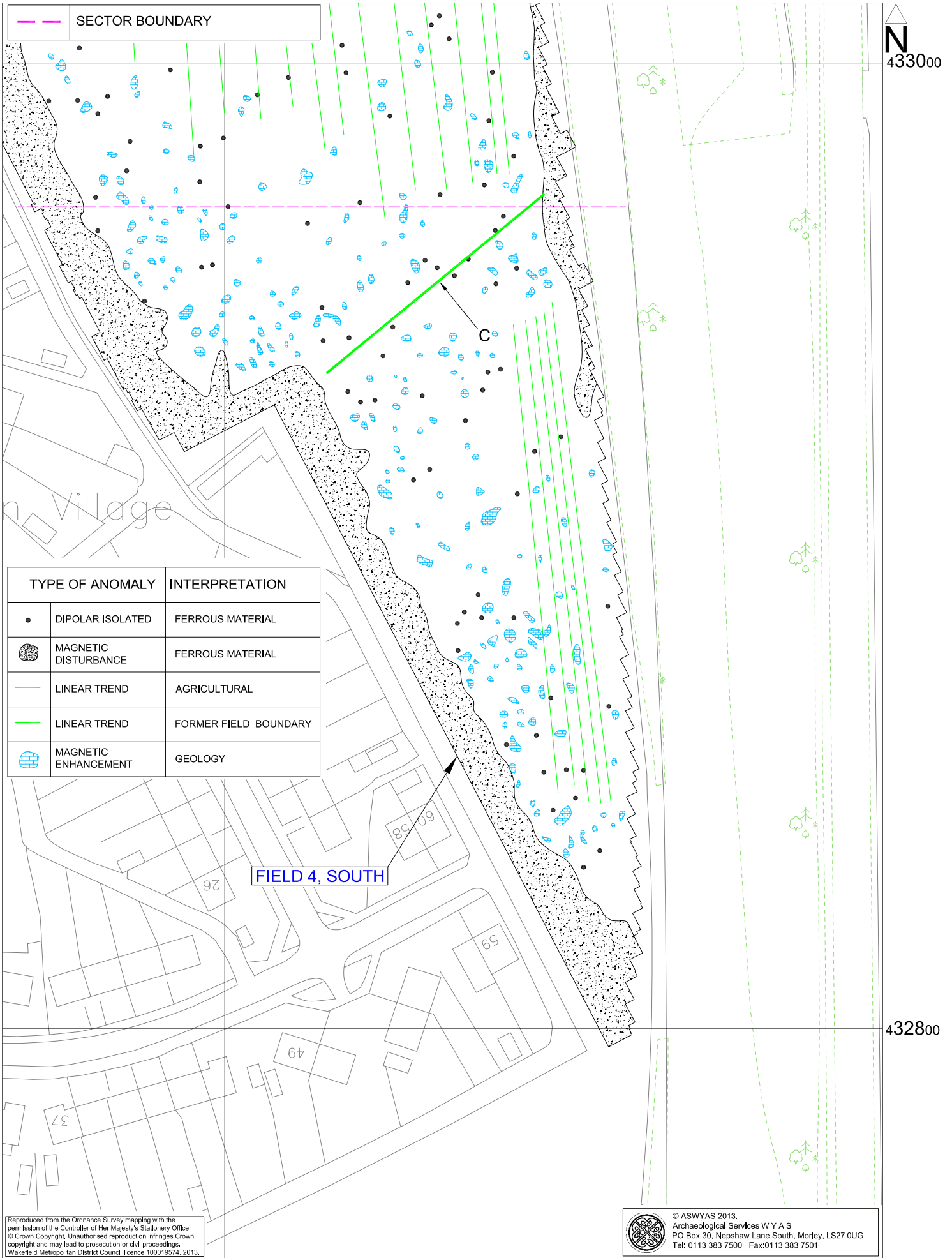


Fig. 12. Interpretation of magnetometer data; Field 4, South (1:1000 @ A4)

0 25m



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



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



*Plate 3. General view of Field 4, looking north-east*



## **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 survey grids were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if co-ordinates are measured off hard copies of the mapping rather than using the digital co-ordinates.

*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 West 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 December 19th 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

Harrison, D. 2013. *Land east of Micklefield, West Yorkshire, West Yorkshire; Geophysical Survey Project Design* Unpublished ASWYAS Document

Institute for Archaeologists, 2013. *Standard and Guidance for archaeological geophysical survey*. IfA

Soil Survey of England and Wales, 1983. *Soil Survey of England and Wales: Soils of Northern England*, Sheet 1