Land south of West Garth
Cayton
North Yorkshire

Geophysical Survey

January 2009

Report No. 1914

MAP Archaeological Consultancy Ltd.

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Cayton
North Yorkshire

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Summary

A geophysical (magnetometer) survey covering 6.5 hectares south of West Garth, Cayton, has not revealed any anomalies indicative of probable archaeological activity although linear and discrete anomalies at the western edge of the site do have some archaeological potential. Linear anomalies indicative of ridge and furrow ploughing are present across most parts of the site. Other anomalies are due to geology/soils and to modern activity.

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WYAS

Report Information

Client:	MAP Archaeological Consultancy Ltd Showfield Lane, Malton, North Yorkshire, YO17 6BT
Report Type:	Geophysical survey
Location:	West Garth, Cayton
County:	North Yorkshire
Grid Reference:	TA 057 829
Period(s) of activity represented:	Unknown
Report Number:	1914
Project Number:	3389
Site Code:	CTN09
Planning Application No.:	Pre-determination
Museum Accession No.:	-
Date of fieldwork:	January 2009
Date of report:	January 2009
Project Management:	Sam Harrison BSc MSc AIFA
Fieldwork:	Emma Watson BSc PGDip Ian Wilkins BSc MSc
Report:	Alistair Webb BA MIFA Illustrations: Sam Harrison BSc MSc AIFA
Photography:	n/a
Research:	n/a
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1 Introduction and archaeological background

Archaeological Services WYAS (ASWYAS) was commissioned by Paula Ware of MAP Archaeological Consultancy Ltd to undertake a geophysical (magnetometer) survey of land to the south of West Garth, Cayton (see Fig. 1) approximately 5km south of Scarborough.

Site location and topography

The geophysical survey area, centred at TA 057 829, covered approximately 6.5 hectares, and comprised four fields (see Fig. 2). West Garth delimits the site to the north with Station Road to the east. Residential properties and pasture fields border the site to the west and south. The geophysical survey was undertaken between January 21st and January 23rd 2009.

Topographically the site was flat at between 30m and 35m above Ordnance Datum. There was a slight north-east/south-west aligned ridge in Field 3 to the east of the site.

Soils, geology and land-use

The solid geology comprises Kimmeridge Clay overlain by stoney clay superficial deposits (BGS 1998). The soils are classified in the Burlingham 2 association being described as deep fine loams with slow permeable subsoils that are affected by seasonal waterlogging (Survey of England and Wales 1983). Field 4 at the southern edge of the site was sown with winter wheat whilst the rest of the site was under permanent pasture. A small area along the southern edge of Field 4 was under standing water and was not surveyed. Otherwise survey conditions were generally good and no problems were encountered during the survey.

2 Archaeological and Historical Background

No known archaeological remains are present on the survey area.

3 Aims and Objectives

The general aims of the geophysical survey were to obtain information that would contribute to an evaluation of the archaeological potential of the site. This information would then enable further evaluation and/or mitigation measures to be designed in advance of any proposed development of the site. These aims were to be achieved by undertaking detailed (recorded) magnetometer survey across the whole of the defined area. Specifically the survey sought to provide information about the nature and possible interpretation of magnetic anomalies identified during the survey and thereby determine the likely extent, presence or absence of any buried archaeological remains in the proposed development area.

4 Methodology

Magnetometer survey

A Bartington Grad601 magnetic gradiometer was used to take readings at 0.25m intervals on zig-zag (east-west) traverses 1m apart within 20m by 20m grids so that 1600 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. Detailed survey allows the visualisation of weaker anomalies that may not have been readily identifiable by less rigorous evaluation techniques such as magnetometer (magnetic) scanning.

Reporting

A general site location plan, incorporating the 1:50000 Ordnance Survey mapping, is shown in Figure 1. Figure 2 shows the processed greyscale magnetometer data superimposed on a digital map supplied by the client. The processed and 'raw' (unprocessed) magnetometer data from the survey, together with interpretation figures, are presented at a scale of 1:1000 in Figures 3 to 8.

The geophysical survey methodology, report and any recommendations comply with guidelines outlined by English Heritage (David *et al.* 2008) and by the IFA (Gaffney *et al.* 2002). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

Technical information on the equipment used, data processing and magnetic survey methodology is given in Appendix 1. Appendix 2 details the survey location information and Appendix 3 describes the composition and location of the survey archive.

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.

5 Results and Discussion

Magnetometer Survey

Ferrous material/magnetic disturbance

A number of ferrous ('iron spike') anomalies have been located in the survey area. These anomalies are indicative of ferrous objects or other magnetic material in the topsoil/subsoil and, although archaeological artefacts may cause them, they are more often the result of modern cultural debris that has been introduced into the topsoil. Where there are no obvious clusters these anomalies are not considered to be archaeologically significant.

Large areas of magnetic disturbance are prominent in the data in the eastern half of Field 1 and along the northern and southern edges of Field 2. The extent and strength of the magnetic responses suggests systematic and deliberate tipping of strongly magnetic material.

At the southern end of Field 3 a strong, linear dipolar anomaly locates the route of a ferrous utility pipe.

Geological anomalies

Across the centre of Field 3, broadly aligned from south-west to north-east, the magnetic readings are extremely variable, with numerous discrete anomalies and larger areas of magnetic enhancement clearly visible in the data. Although these anomalies are not as strong or extensive of those present in the data set from a site south of Cayton Low Road, about 1km to the west (Harrison and Wilkins 2008), they are similarly interpreted as being due to the prevailing geology, probably to variation within the superficial deposits caused by pockets of stoney clay. The orientation and location of these geological anomalies also correlates with a slight ridge in the field.

Agricultural anomalies

Prominent in the data across much of the site are numerous parallel linear anomalies. To the east of the site in Field 3 they are aligned north-north-east/south-south-west extending the full length of the field until the responses are masked by that from the utility pipe. In Field 1 the anomalies are aligned north-north-west/south-south-east. All these anomalies are indicative of ridge and furrow ploughing, the characteristic striped appearance of the data being due to the magnetic contrast between the infilled furrows and former ridges. In Field 1 a linear anomaly at right angles to the ploughing is probably due to a former boundary or headland.

Possible archaeological anomalies

At the western edge of the site in Field 1 two linear anomalies have been identified that are slightly oblique to the alignment of the ridge and furrow ploughing. These anomalies could be indicative of archaeological features such as ditches although an agricultural orign cannot be discounted.

In addition several discrete anomalies adjacent to these linears are noted. The proximity could indicate that they are also archaeological in nature, possibly pits, although this interpretation is tentative and a natural geological origin is also possible.

No anomalies of probable archaeological origin have been identified.

6 Conclusions

The geophysical survey has demonstrated that ridge and furrow ploughing was carried out across most of the site. This perhaps may be agricultural activity associated with the deserted village at Osgodby which is situated approximately 1.5km to the north.

Although the survey has not identified any anomalies definitely indicative of archaeological activity linear and discrete anomalies at the western edge of the site do have some archaeological potential.

The remaining anomalies are attributable to geology/soils and modern activity.

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.

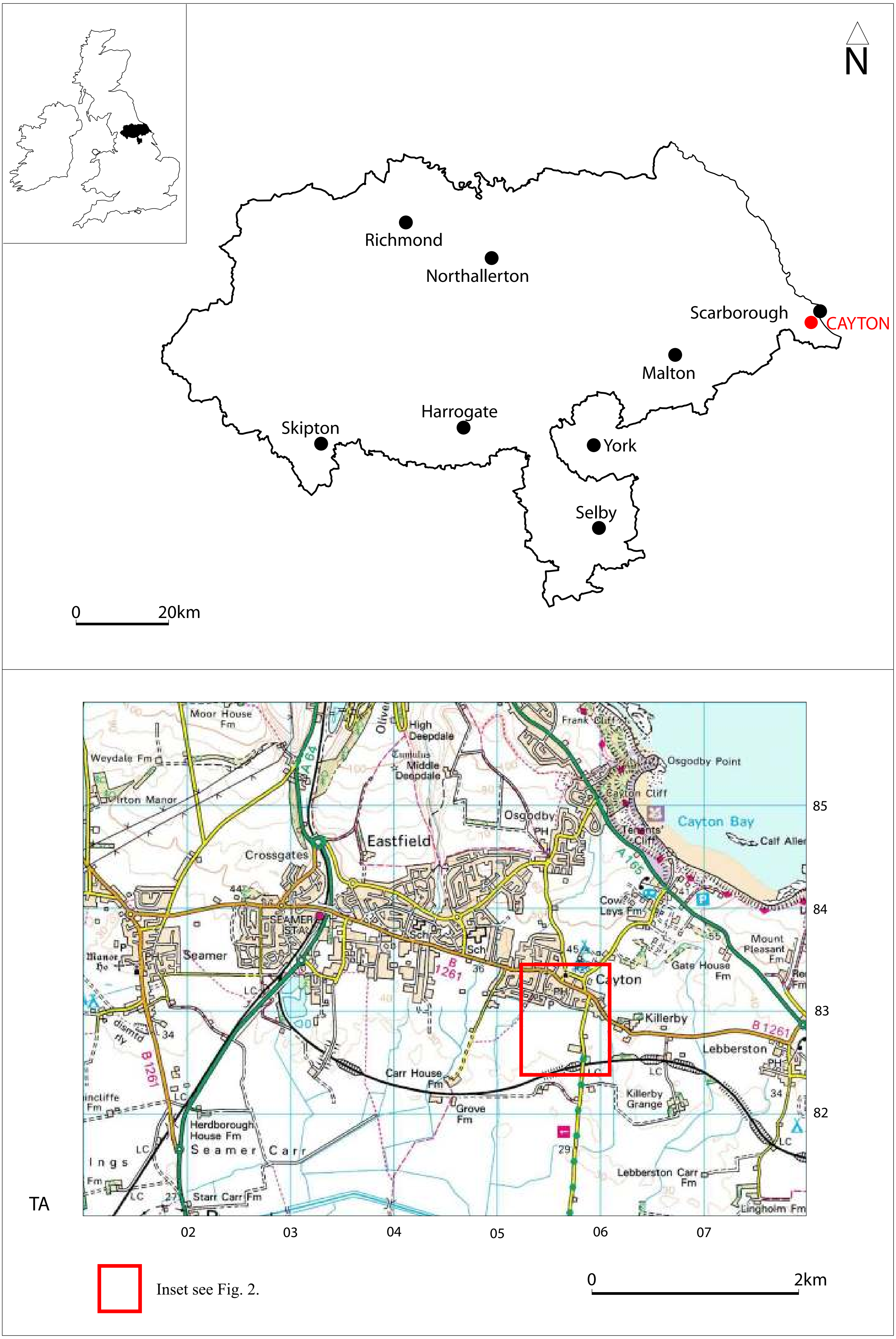

Fig. 1. Site location

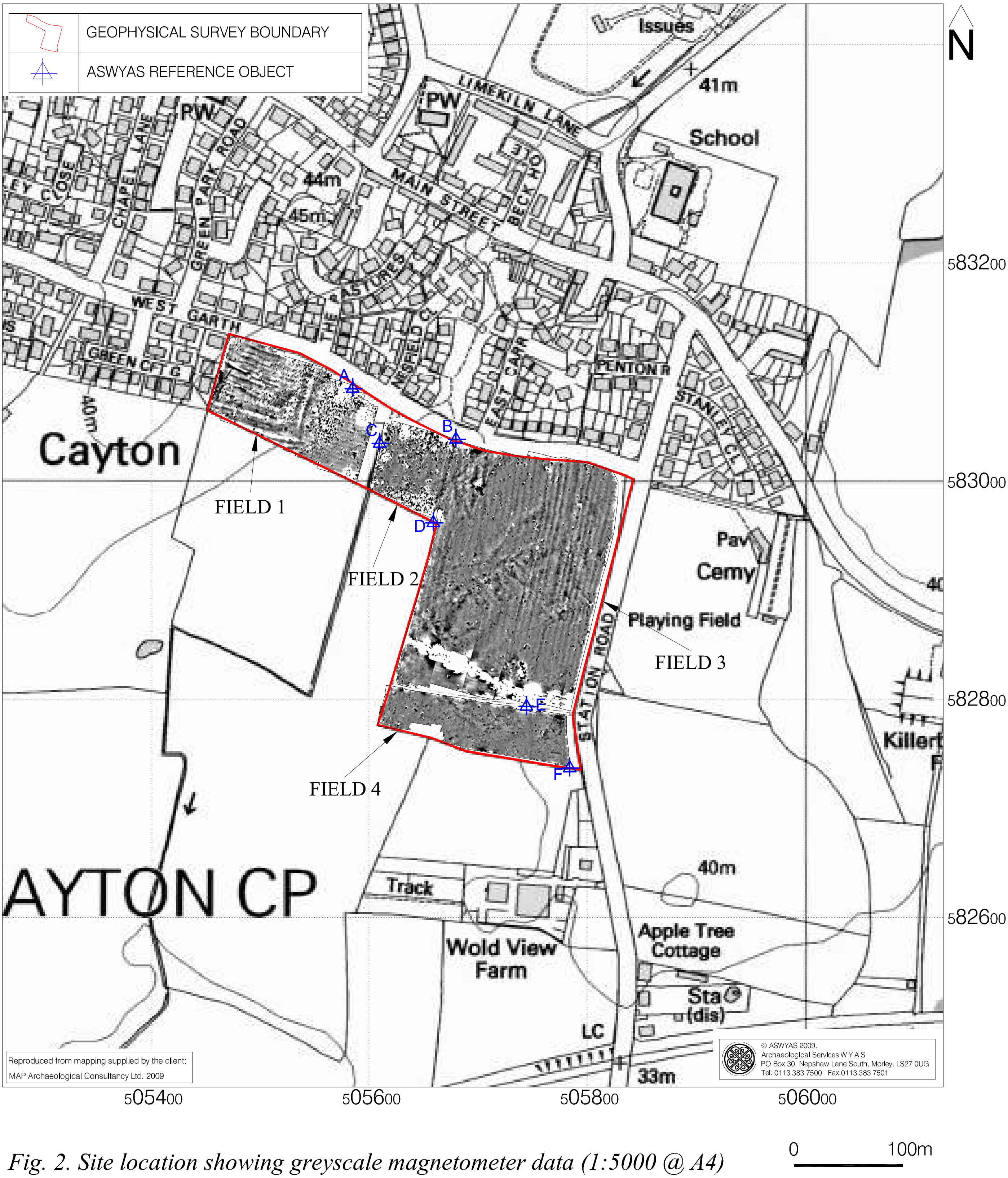

Fig. 2. Site location showing greyscale magnetometer data (1:5000 @ A4)

Fig. 3. Processed greyscale magnetometer data; Field 1 (1:1000 @ A4)

Fig. 4. XY trace plot of unprocessed magnetometer data; Field 1 (1:1000 @ A4)

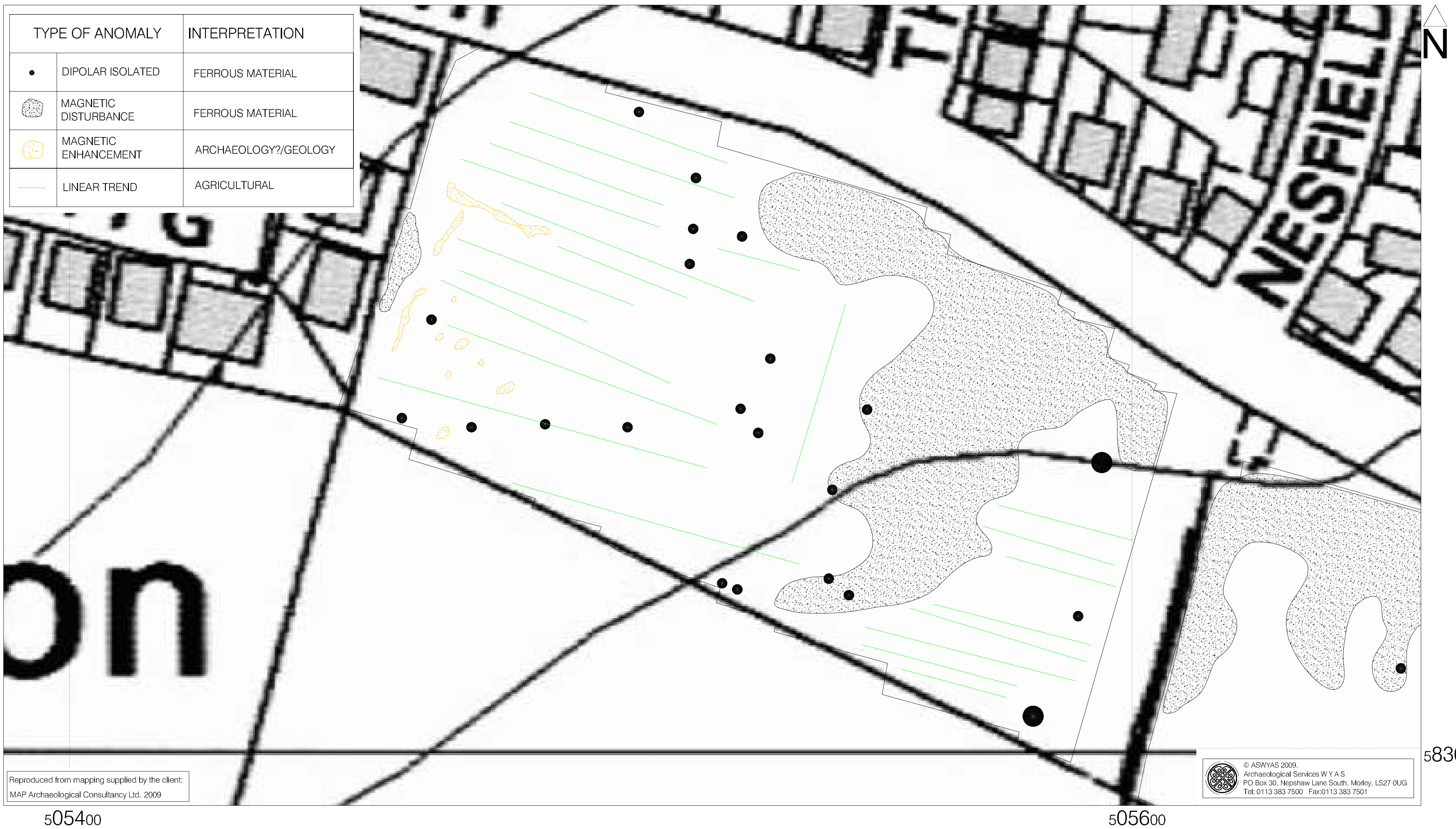

Fig. 5. Interpretation of magnetometer data; Field 1 (1:1000 @ A4)

Fig. 4. XY trace plot of unprocessed magnetometer data; Field 1 (1:1000 @ A4)

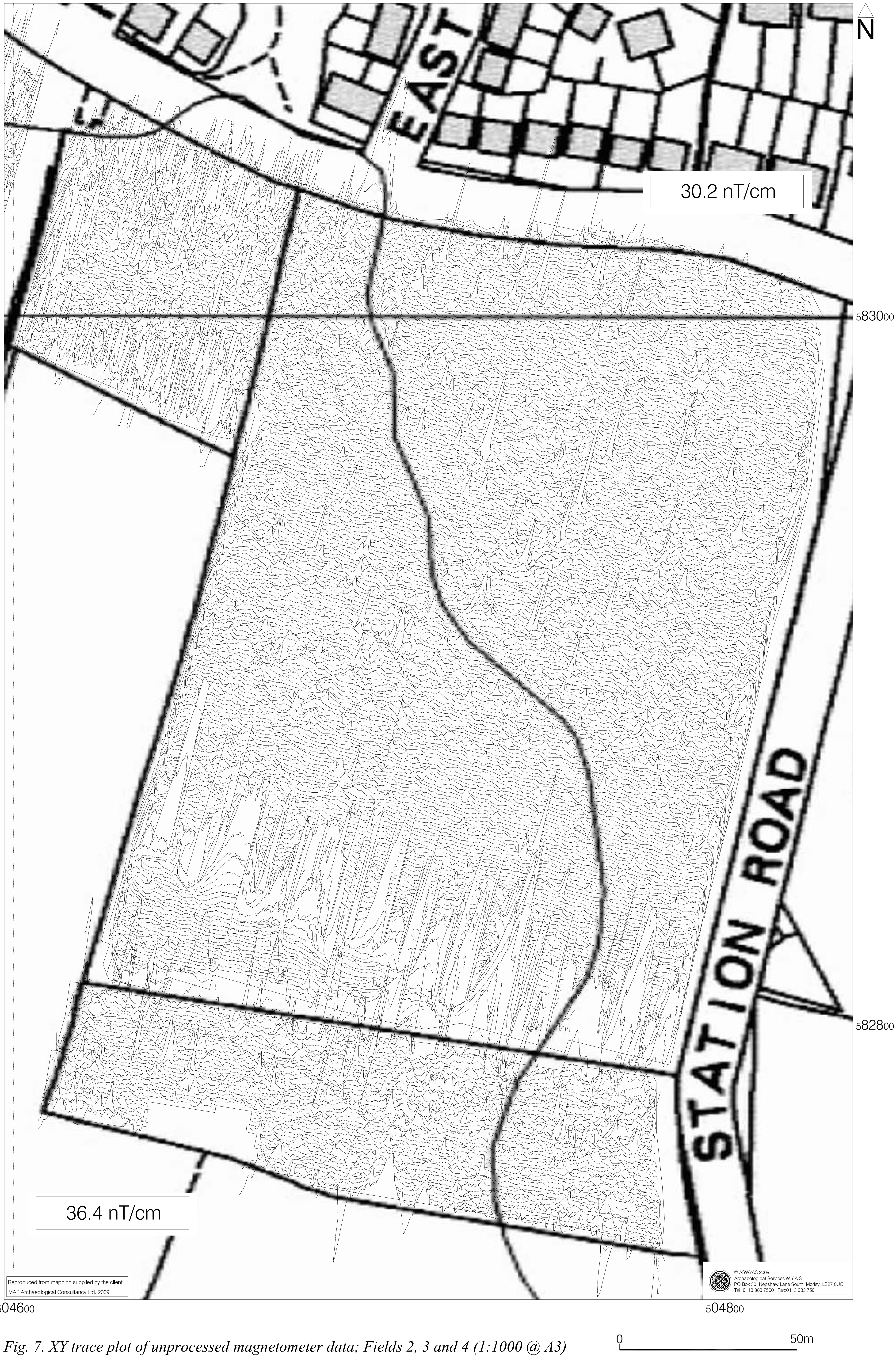

Fig. 7. XY trace plot of unprocessed magnetometer data; Fields 2, 3 and 4 (1:1000 @ A3)

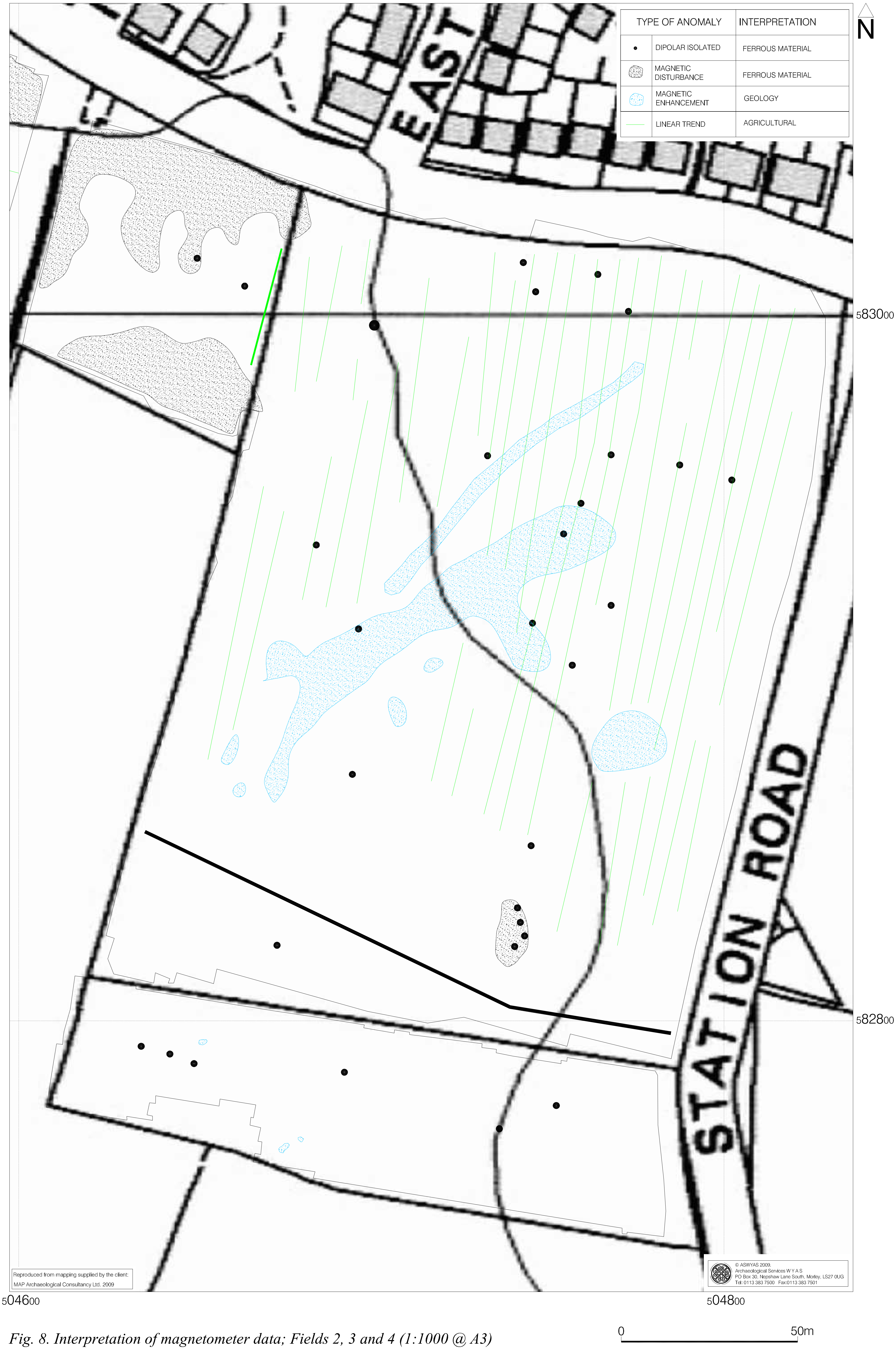

Fig. 8. Interpretation of magnetometer data; Fields 2, 3 and 4 (1:1000 @ A3)

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. Less magnetic material such as masonry or plastic service pipes that intrude into the topsoil may give a negative magnetic response relative to the background level.

The magnetic susceptibility of a soil can also be enhanced by the application of heat. This effect can lead to the detection of features such as hearths, kilns or areas of burning.

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. Such negative anomalies are often very faint and are commonly caused by modern, non-ferrous, features such as plastic water pipes. Infilled natural features may also appear as negative anomalies on some geological substrates.

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. An agricultural origin, either ploughing or land drains is 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. 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 20m by 20m 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 1600 readings were obtained for each 20m by 20m 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 Geodimeter 600s total station theodolite and tied in to the corners of buildings and other permanent landscape features and to temporary reference points (survey marker stakes) that were established and left in place following completion of the fieldwork for accurate geo-referencing. The locations of the temporary reference points are shown on Figure 2 and the Ordnance Survey grid co-ordinates tabulated below. The internal accuracy of the survey grid relative to these markers is better than 0.05m. The survey grids were then superimposed onto a map base provided by the client as a 'best fit' to produce the displayed block locations. Overall there was a good correlation between the local survey and the digital map base and it is estimated that the average 'best fit' error is better than ±1.5m. However, it should be noted that Ordnance Survey co-ordinates for 1:2500 map data have an error of ±1.9m at 95% confidence. This potential error must be considered if co-ordinates are measured off for relocation purposes.

Station	**Easting**	**Northing**
A	505585.5860	583084.3853
B	505680.3320	583037.9125
C	505610.2841	583034.1003
D	505659.4229	582961.2933
E	505744.9062	582792.9284
F	505784.6326	582736.5573

Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party or for the removal of any of the survey reference points.

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 2007) files.
- 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 relevant Sites and Monument Record Office).

Bibliography

British Geological Survey, 1998, Scarborough. England and Wales Sheet 54. Solid and Drift Geology. 1:50000 Provisional Series

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

Gaffney, C., Gater, J. and Ovenden, S. 2002. *The Use of Geophysical Techniques in Archaeological Evaluations*. IFA Technical Paper No. 6