ARCHAEOLOGICAL SERVICES WYAS

Land east of Westfield Way
Norton
North Yorkshire

Geophysical Survey

August 2008

Report No. 1859

MAP Archaeological Consultancy Ltd

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Norton
North Yorkshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey covering 1.1 hectares undertaken at land east of Westfield Way, Norton has not revealed any anomalies indicative of probable archaeological activity although a single area of magnetic variation has been identified as having possible archaeological potential. Two linear trends have also been identified. The smaller magnetic enhancements are thought to be due to pockets of magnetic sand and gravel.

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Report Information

Client:	MAP Archaeological Consultancy Ltd Showfield Lane, Malton, North Yorkshire, YO17 6BT
Report Type:	Geophysical survey
Location:	Wesfield Way, Norton, North Yorkshire
County:	North Yorkshire
Grid Reference:	SE 804 717
Period(s) of activity represented:	Unknown
Report Number:	1859
Project Number:	3333
Site Code:	WWN08
Planning Application No.:	Pre-determination
Museum Accession No.:	-
Date of fieldwork:	August 2008
Date of report:	August 2008
Project Management:	Sam Harrison BSc MSc AIFA
Fieldwork:	Alex Harrison BSc Emma Watson BSc
Report:	Sam Harrison BSc MSc AIFA
Illustrations:	Sam Harrison BSc MSc AIFA
Photography:	-
Research:	-
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1 Introduction and archaeological background

Archaeological Services WYAS (ASWYAS) was commissioned by Sophie Langford of MAP Archaeological Consultancy Ltd to undertake a geophysical (magnetometer) survey of land to the east of Westfield Way, Norton (see Fig. 1) approximately 0.5km north-east of Norton.

Site location and topography

The geophysical survey area, centred at SE 804 717, covered approximately 1.3 hectares, and comprised of a single field (see Fig. 2). Westfield Way delimits the site to the west with woodland bordering the land in all other directions. The River Derwent lies 0.5km to the north-west of the survey area. The geophysical survey was undertaken on August 20th 2008.

Topographically the site was flat, being approximately 20m above Ordnance Datum.

Soils, geology and land-use

The solid geology comprises Kimmeridge Clay and Ampthill Clay formations overlain by sand and gravel superficial (drift) deposits (BGS 2000). The soils are classified in the Landbeach association being described as permeable, calcareous, coarse loams that are affected by ground water (Survey of England and Wales 1983). At the time of survey the site was covered by mature barley.

2 Archaeological and Historical Background

The site lies approximately 1.2 kilometres east of the scheduled monument of Derventio Roman Fort in an area of high archaeological potential. The course of a Roman road passes less than 0.5km to the south of the site. Cropmarks viewed on internet mapping sites (Live Search Maps 2008) show visible trackways 0.8km to the south and east of the site.

Previous work in Norton and Malton has revealed remains of Roman activity, including buildings and human burials.

First edition Ordnance Survey mapping of 1854 shows no features within the survey area, although a brick and tile yard was situated immediately east of the site (see Fig.2). This area is now woodland and a pond.

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 this part of 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 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 together with the first edition Ordnance Survey mapping of 1854. 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, 4 and 5.

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

Magnetometer Survey

Ferrous material/magnetic disturbance

A low 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 caused by modern cultural debris that has been introduced into the topsoil. There are no obvious clusters and therefore these anomalies are not considered to be archaeologically significant.

The two areas of magnetic disturbance to the west and south-west of the survey block are due to the proximity of fencing and a gate.

Geological anomalies

Discrete anomalies (areas of magnetic enhancement) have been identified across the survey area. These low magnitude anomalies are not considered to be due to underlying archaeological features such as pits. The number and extent of these anomalies suggests that they are more probably due to pockets of magnetic sand or gravel.

Towards the northern end of the site a small cluster of discrete anomalies or area of magnetic variation is visible in the data. This variation may also be due to geological variation but an archaeological cause cannot be discounted.

Linear Trends

Two very weak linear trends have been identified in the survey running in a north-east/south-west direction approximately 75m apart. It is probable that these anomalies are due to former field boundaries or field drains of an unknown period.

6 Discussion

Geophysical survey on sands and gravels gives variable results. The contrast between sand and gravel geology and the fill of a feature becomes harder to distinguish in a magnetometer survey if the fill is of a similar material. The very weak signal strength of the two linear trends may be as a result of a lack of contrast in the ditch fills.

The two linear trend anomalies do not appear on the Ordnance Survey mapping of 1854 and may represent an earlier division of fields.

The area of magnetic variation in the northern part of the site is the only geophysical anomaly that may be considered to be possibly archaeological in nature on this site.

7 Conclusions

The geophysical survey has not identified any anomalies indicative of archaeological activity. A small area of magnetic variation has been identified towards the north of the survey block. It is considered that this anomaly is geological in nature although an archaeological origin cannot be ruled out. Two linear trend anomalies have been identified in the survey but are of an unknown origin.

Given the geology of the site and the lack of anomalies identified in the survey, the site has an unknown archaeological potential.

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.

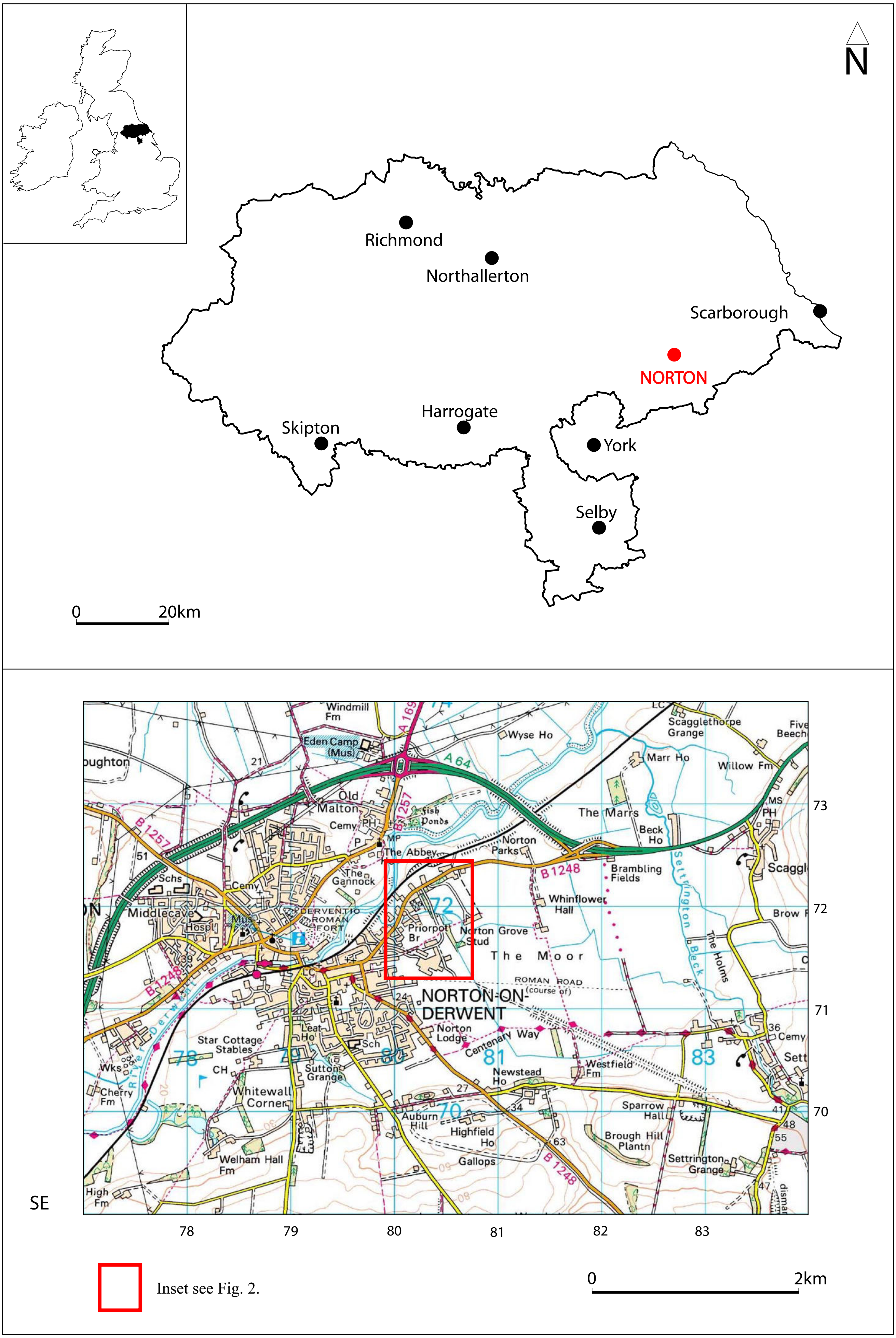

Fig. 1. Site location

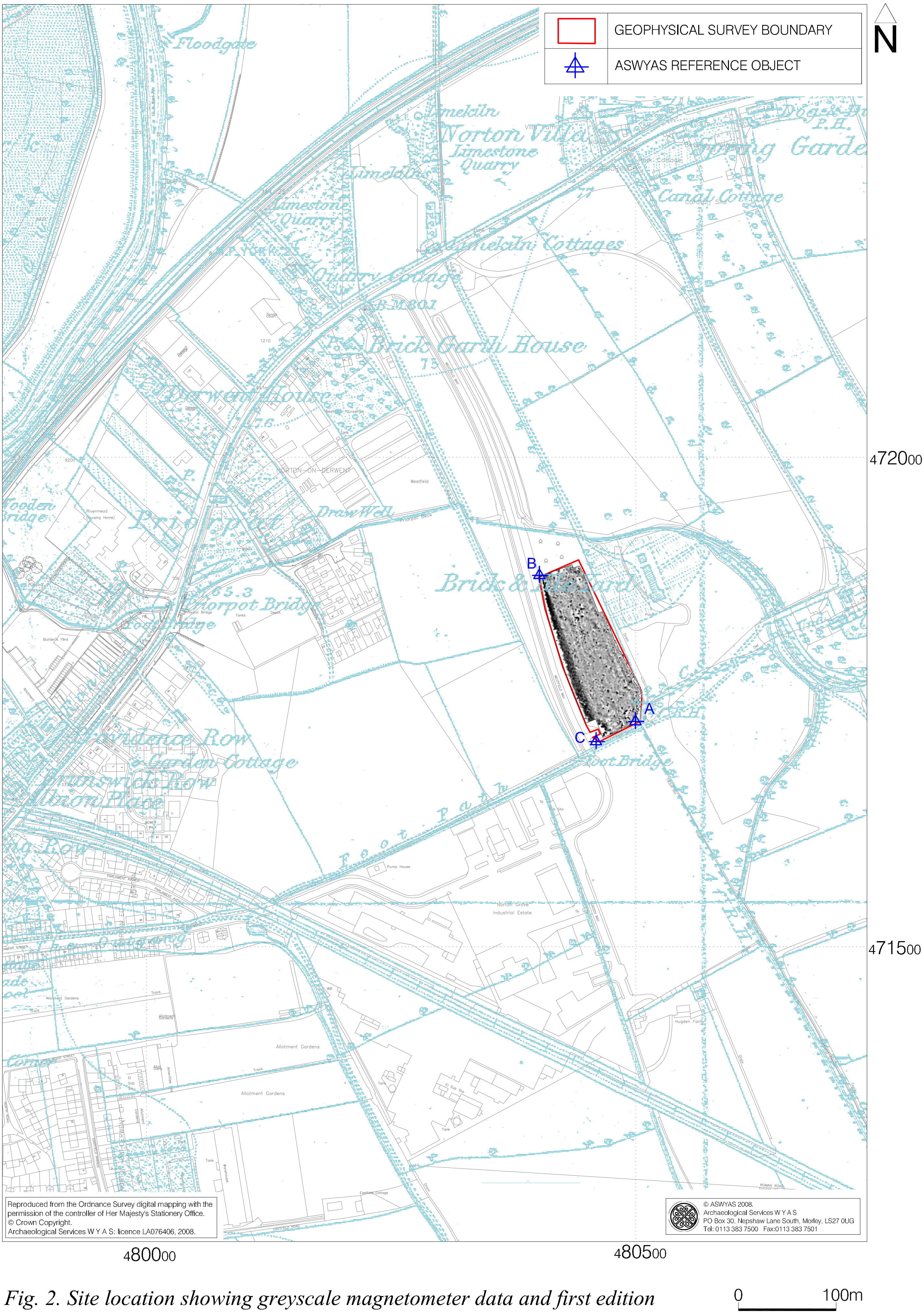

Fig. 2. Site location showing greyscale magnetometer data and first edition Ordnance Survey mapping of 1854 (1:5000 @ A4)

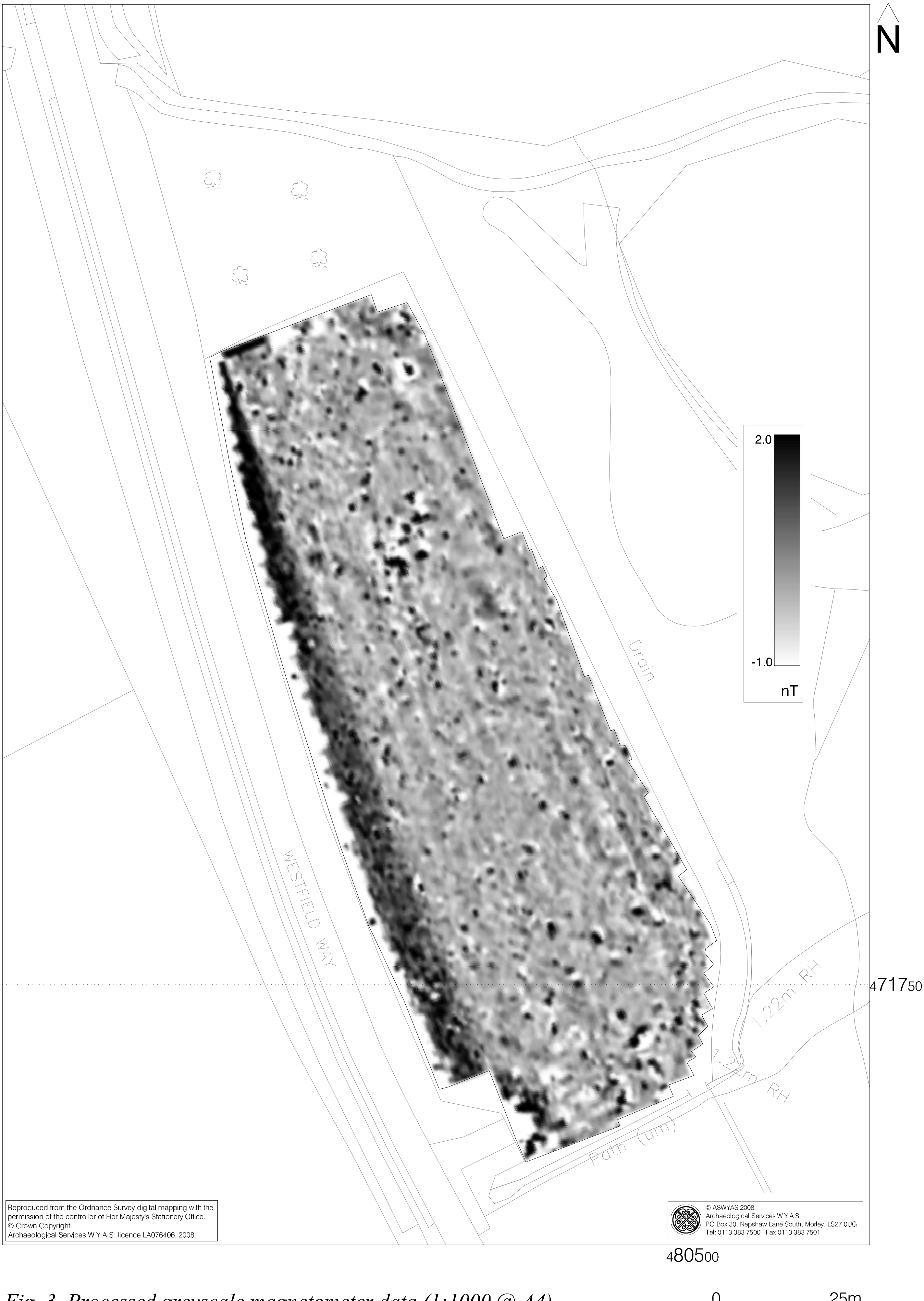

Fig. 3. Processed greyscale magnetometer data (1:1000 @ A4)

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

0 25m

TYPE OF ANOMALY		INTERPRETATION
•	DIPOLAR ISOLATED	FERROUS MATERIAL
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	MAGNETIC VARIATION	ARCHAEOLOGY ? / GEOLOGY
	LINEAR TREND	AGRICULTURAL / ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	GEOLOGY

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

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	480499.8	471730.0
B	480401.6	471879.3
C	480495.5	471709.6

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).

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http://maps.live.com/#JndoZXJlMT1tYWx0b24mYmI9NTQuNTkxMTYyNzk1MzA2JTdlMC4yMjUyMTk3MjY1NjI0OSU3ZTUzLjY3ODgxNTEzNDQwMjglN2UtMS44MTgyMzczMDQ2ODc1 (Last accessed 20/08/2008)

Ordnance Survey, 1854, *County Series 6 inch map sheet Yorkshire 124* (Surveyed 1854)

Soil Survey of England and Wales. 1983, 'Soils of Northern England. (Sheet 1) Scale 1:250,000 (map and legend)'