ARCHAEOLOGICAL SERVICES WYAS

Potgate Farm Quarry
Phase 2 Extension
North Stainley
North Yorkshire

Geophysical Survey

September 2010

Report No. 2108

CLIENT

MAP Archaeological Consultancy Ltd

Potgate Farm Quarry
Phase 2 Extension
North Stainley
North Yorkshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering approximately 5 hectares, was carried out immediately north of Potgate Farm Quarry, North Stainley, in advance of the proposed Phase 2 Extension of the existing limestone quarry. Intermittent linear anomalies that cross the site on a north-west/south-east alignment are interpreted as possible ditches flanking a trackway although a natural origin cannot be discounted given the prevailing geology. A second linear ditch type anomaly of possible archaeological potential has also been identified. However, on the basis of the geophysical survey the site is considered to have a relatively low archaeological potential.

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Report Information

Client:	MAP Archaeological Consultancy Limited
Address:	Showfield Lane, Malton, North Yorkshire, YO17 6BT
Report Type:	Geophysical survey
Location:	Potgate Farm, North Stainley
County:	North Yorkshire
Grid Reference:	SE 272 762
Period(s) of activity represented:	Late Iron Age/Romano-British?
Report Number:	2108
Project Number:	3626
Site Code:	PQR10
Planning Application No.:	pre-determination
Museum Accession No.:	n/a
Date of fieldwork:	August 2010
Date of report:	September 2010
Project Management:	Alistair Webb BA MIfA
Fieldwork:	Sam Harrison BSc MSc AIfA Adam Tinsley BA MA BA
Report:	Alistair Webb
Illustrations:	David Harrison BA MSc
Photography:	n/a
Research:	n/a
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1 Introduction

Archaeological Services WYAS was commissioned by Sophie Langford of MAP Archaeological Consultancy Limited on behalf of their client Lightwater Quarries Limited to undertake a geophysical (magnetometer) survey immediately north of Potgate Farm Quarry, North Stainley (see Fig. 1) in advance of the proposed Phase 2 Extension of the existing limestone quarry. The scheme of work was undertaken in accordance with the requirements of PPS5.

Site location, topography and land use

The site of the Phase 2 Extension, centred at SE 272 762, is located approximately 1.5km south-west of North Stainley and 4.5km north-west of Ripon. The survey area comprised a roughly rectangular parcel of land, approximately 5 hectares in area, bounded by the existing Potgate Farm quarry workings to the south-east, Musterfield Lane to the north-west, Musterfield Farm to the south-west and agricultural land to the west and east (see Fig. 2). A stand of maize and oil seed rape around the western boundary and a trackway around the northern edge of the site reduced the survey area by approximately 1.5 hectares to approximately 5 hectares in total.

The site was relatively flat at between approximately 88m above Ordnance Datum (aOD) towards the south-east corner (Fig. 2 - Ref. Obj. A) and 94 aOD in the north (Fig. 2 - Ref. Obj. C) and is currently under arable cultivation having been harvested immediately prior to survey.

Geology and soils

The solid geology comprises Lower Magnesian Limestone overlain by deep, fine loamy soils of the Nercwys soil association. These soils are derived from till from Palaeozoic and Mesozoic sandstones and shales.

2 Archaeological background

Research undertaken for a desk-based assessment of the proposed extension area and its immediate vicinity identified that the site is situated within a landscape of some archaeological significance with 32 sites recorded on the North Yorkshire Historic Environment Record (NYHER) within a 2km radius of the quarry. These sites range in date from the Neolithic through to the medieval and post-medieval periods and include the Castle Dikes Iron Age Hillfort, a scheduled ancient monument. However, there are no known archaeological sites within either the existing consent area or the proposed extension area. Nevertheless the assessment recommended '*that consideration is given to further evaluation of the site before there is a physical start on the development*'.

3 Aims, Methodology and Presentation

Further to the recommendations in the desk-based assessment it was determined, following consultation with the NYHER, that a geophysical survey of the Proposed Extension Area would be an appropriate first stage of evaluation.

The general aim of the geophysical survey was to establish and clarify the nature of the archaeological resource within the proposed extension area.

Specifically the survey sought to provide information about the nature and possible interpretation of any anomalies identified during the survey and thereby determine the presence or absence and likely extent of any buried archaeological remains. The survey covered all of the proposed extension area that was suitable for survey, approximately 5 hectares.

The information from the geophysical survey will enable further evaluation and/or mitigation measures, if required, to be designed in advance of the proposed extraction.

The survey area was set-out with a Trimble 5800 VRS differential GPS to the national grid. Temporary reference objects (wooden survey marker stakes) which were established and left in place following completion of the fieldwork for accurate geo-referencing. The locations of the temporary reference objects are shown on Figure 2 and their Ordnance Survey co-ordinates tabulated in Appendix 2.

Magnetometer survey

Bartington Grad601 instruments were used to take 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 mapping is shown in Figure 1. Figure 2 is a more detailed site location showing the processed magnetometer data and the locations of the survey reference objects. The processed magnetometer greyscale data, the 'raw' XY trace plot data and interpretation figures are presented at a scale of 1:1000 in Figures 3, 4 and 5.

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 methodology and guidelines outlined by English Heritage (David *et al.* 2008) and by the IfA (Gaffney, Gater and Ovenden 2002). 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

Non-archaeological anomalies

Numerous isolated dipolar ('iron spike') anomalies have been identified throughout the survey area. These anomalies are typically caused by ferrous (magnetic) material, either on the ground surface or in the topsoil horizons, which causes rapid variations in the magnetic readings giving a characteristic 'spiky' XY trace. Little importance is normally attributed to such anomalies, unless there is supporting evidence for an archaeological interpretation, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring or tipping/infilling. There is no obvious clustering to these anomalies and they are consequently not considered to be archaeologically significant on this site.

Parallel linear trend anomalies can be seen along the north-eastern and south-western edges of the survey area. These are due to recent agricultural activity. Other parallel trend anomalies at the northern end of the survey area (parallel with Musterfield Lane) are due to recent ploughing.

In the southern half of the site several weak, broad areas of enhancement can just be discerned. These areas of enhancement are interpreted as being caused by a slight variations in the composition and depth of the topsoil/sub-soil.

Archaeological? anomalies

Running across the survey area on a north-west/south-east alignment are two parallel, intermittent, sinuous anomalies (**A** and **B**). In places the anomalies are very weak disappearing completely for about 30m near the northern end of the site and with **A** petering out towards the southern end of the site. The parallel nature of the two anomalies tends to point towards a probable archaeological origin - two ditches flanking a trackway. However, the slightly irregular, sinuous and discontinuous nature of the anomalies combined with the absence of any other intersecting linear anomalies that might indicate an associated field system, thus adding weight to an archaeological interpretation, leads to the possibility that the anomalies may be caused by infilled natural features, such as frost cracks or ice wedges, in the limestone bedrock.

In the south-west corner of the site a third linear anomaly, **C**, has been identified. Aligned east/west this anomaly also cannot be confidently interpreted. It could be due to an archaeological ditch, a recently removed field boundary or a field drain.

5 Conclusions

The geophysical survey has revealed three linear anomalies, **A**, **B** and **C**, of possible archaeological potential in the proposed extension area. If the parallel linear anomalies (**A** and **B**) are indicative of ditches either side of a trackway the apparent breaks in response suggest that the features could have been truncated by ploughing as infilled cut features generally give a strong, clear response on limestone geology. The absence of any other associated features, with the possible exception of the other linear anomaly to the south-west, may tip the balance in favour of a natural cause for these two anomalies. The other linear anomaly, **C**, is similarly difficult to confidently interpret. Its alignment is oblique to that of the possible trackway and also to the existing field boundaries possibly increasing the likelihood that it is of modern origin.

On the basis of the geophysical survey the site is considered to have a relatively low 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.

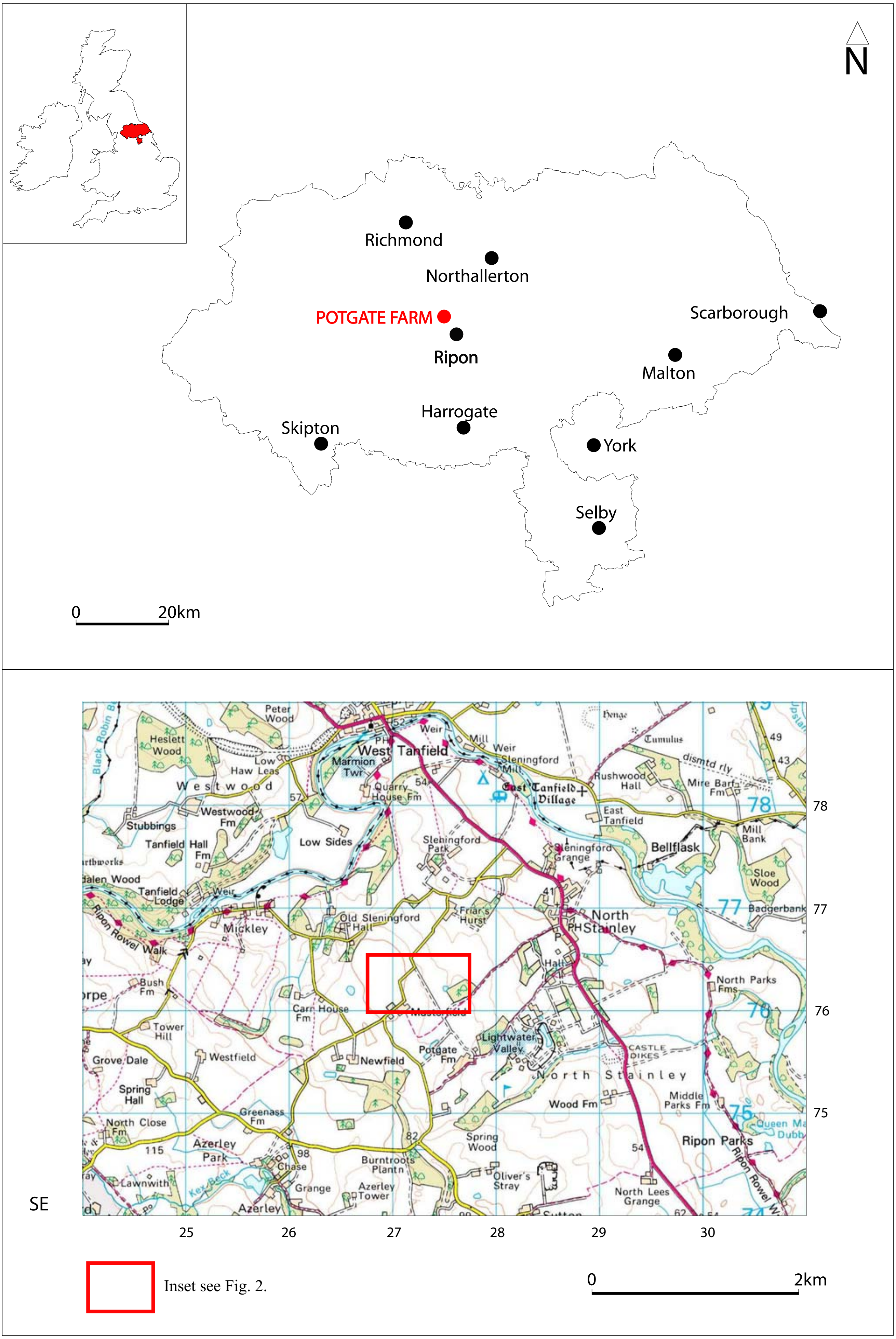

Fig. 1. Site location

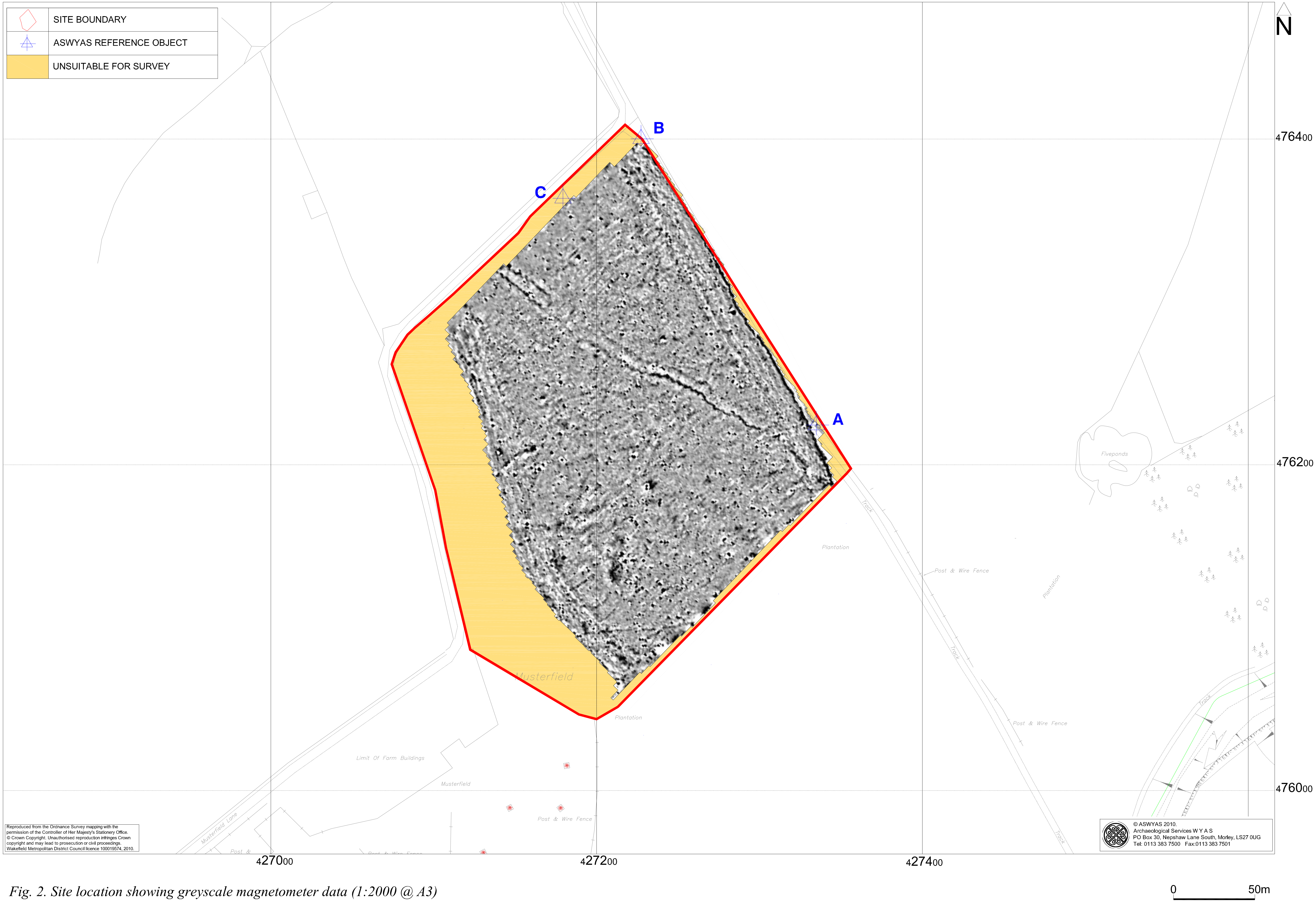

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Fig. 2. Site location showing greyscale magnetometer data (1:2000 @ A3)

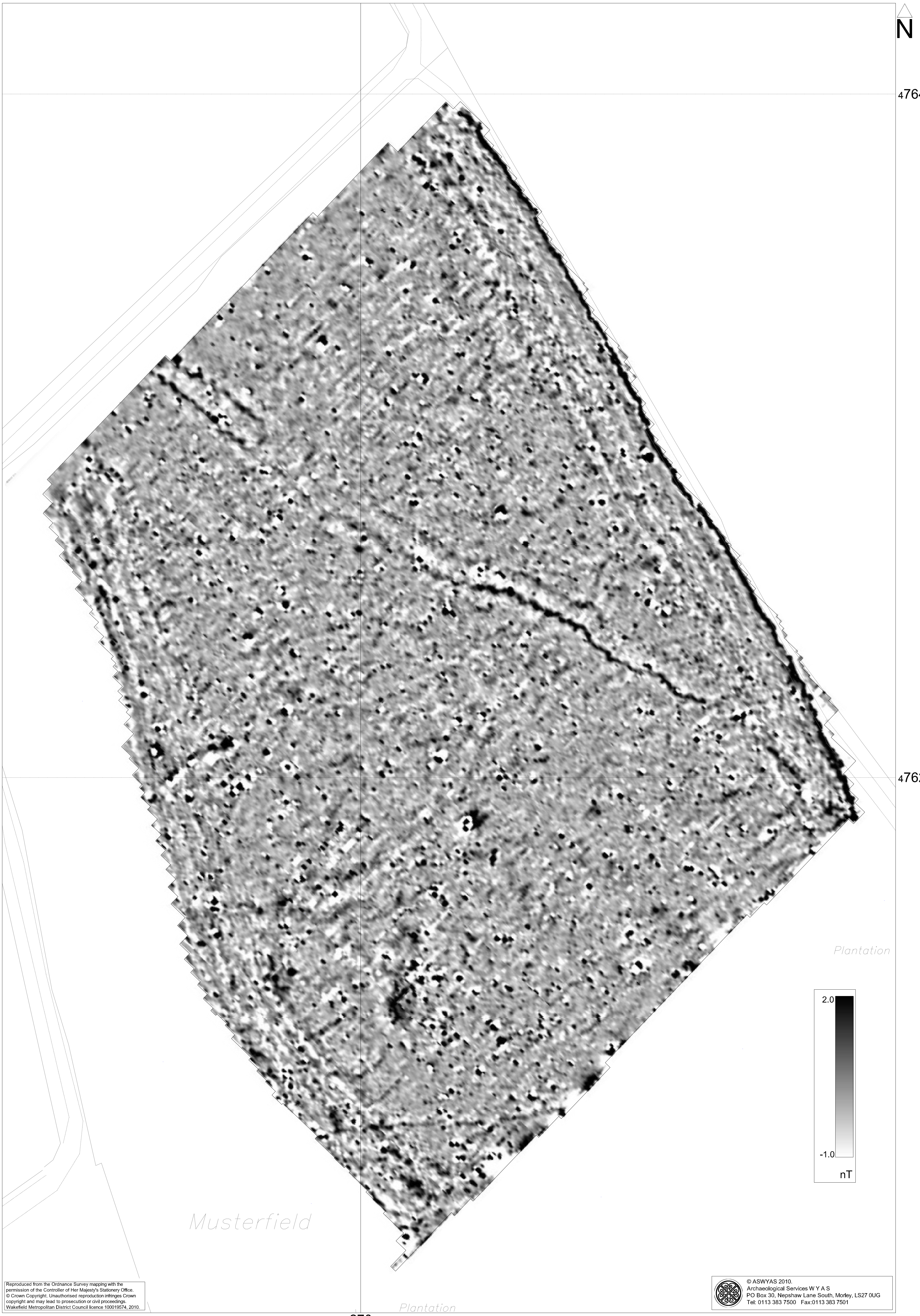

Fig. 3. Processed greyscale magnetometer data (1:1000 @ A3)

0 25m

Fig. 4. XY trace plot of unprocessed magnetometer data (1:1000 @ A3)

0 25m

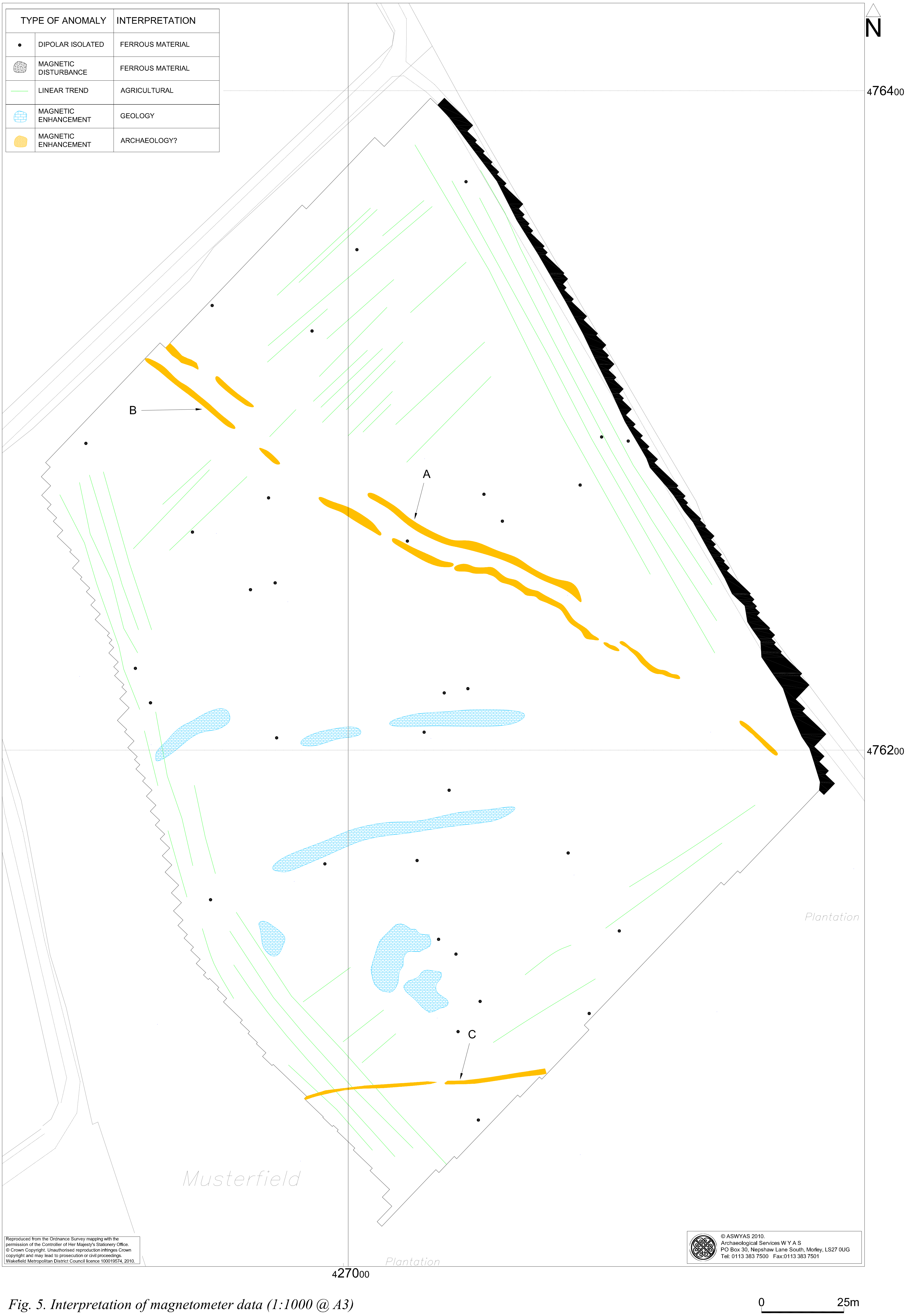

Fig. 5. Interpretation of magnetometer data (1:1000 @ A3)

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. 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 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 any 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. 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 temporary reference points left on site are shown on Figure 2 and the Ordnance Survey grid co-ordinates tabulated below. The internal accuracy of these markers 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.

Temporary reference objects were left on site (see Fig. 2). The Ordnance Survey reference points are listed below.

Station	**Easting**	**Northing**	**Elevation (aOD)**
A	427334.8560	476224.4500	87.601m
B	427227.2430	476400.1330	92.230m
C	427179.3200	476363.7100	94.395m

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

Bibliography

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