Land north of Brakes Farm
Sedgefield
County Durham

Geophysical Survey

July 2007

Report No. 1705

Northern Archaeological Associates

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Contents

Summary

A geophysical (magnetometer) survey covering 5 hectares was carried out on land to the north of Brakes Farm, near Sedgefield, in advance of proposed development. The most prominent and extensive anomalies are caused by the former practice of ridge and furrow ploughing. Several pit type anomalies have been identified immediately south of Brick Kiln Plantation (in Area C) that may locate a small cluster of clay extraction pits. Similar anomalies are also identified in the other two survey blocks. However, a geological cause for these anomalies cannot be discounted. No anomalies likely to be indicative of earlier archaeological activity have been identified.

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Archaeological Services WYAS

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1. Introduction and Archaeological Background

1.1 Archaeological Services WYAS was commissioned by Mary Fraser of Northern Archaeological Associates Ltd to carry out a geophysical (magnetic) survey on land approximately 1.5km west of Sedgefield, County Durham (see Fig. 1) in advance of a proposed development at Brakes Farm.

1.2 The three survey areas were located 300m north of the farm, (covering approximately 5 hectares) and were positioned to the west, north and east of Tile Shed Plantation and south of Brick Kiln Plantation (see Fig. 2). To the west, Area A was 1.8 hectares in size and orientated north-east/south-west parallel with the western boundary of Tile Shed Plantation. Area B was aligned north-west/south-east parallel and north-east of an access track covering an area of 1.4 hectares. The third area under investigation, Area C, was 1.8 hectares in size and bisected by a wire fence. A stream bounds the survey area to the north.

1.3 The fields were under permanent pasture at the time of the fieldwork (between June 25th and 27th 2007) and there were extensive earthworks of varying states of preservation indicative of ridge and furrow ploughing. Livestock were present in all the fields but no problems were encountered during the survey.

1.4 Topographically the land slopes steeply down to the north-west from 90m above Ordnance Datum (OD) to the north of Area B to about 80m in Area A which is relatively flat on the flood plain. The underlying solid geology comprises Magnesian Limestone overlain by glacio-fluvial drift. The soils are classified in the Arrow association being described as deep, permeable, coarse loams.

1.5 The only known evidence for archaeological remains within the boundary of Brakes Farm are the extensive remains of ridge and furrow earthworks and a few earthworks, north of the farm, that are thought to relate to clay extraction and brick and tile manufacture. This interpretation is given further credence by the place name evidence of the two nearby plantations.

1.6 A geophysical survey undertaken earlier in the year in fields to the south of Brakes Farm as part of the same development proposals (Webb 2007) identified anomalies interpreted as being due to changes in the drift geology/soils, topographical variation and ridge and furrow ploughing. To the east of the farm, an anomaly tentatively interpreted as a possible kiln was identified.

1.7 In the wider landscape Cades Road (Roman Road 80a) runs north alongside the east of the A177, about 1km to the east of the site. Iron Age/Roman settlement, possibly focused on the road, has been recorded from air photographs at Home Farm immediately to the south-east of Brakes Farm.

2. Methodology and Presentation

2.1 The general aim of the survey was to obtain information that would contribute further to an evaluation of the archaeological potential of the site by determining the presence or absence of buried archaeological remains in the defined survey areas.

2.2 More specific objectives were to:-

- provide information about the nature and possible interpretation of any magnetic anomalies identified by the survey;
- clarify the extent of any possible archaeological remains within the defined survey limits.

2.3 In order to achieve these aims and objectives it was proposed that detailed (recorded) magnetometer survey would be undertaken at three locations across the site, an area of approximately 5 hectares.

2.4 Detailed survey employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0.25m intervals, on traverses 1m apart. These readings are stored in the memory of the instrument and are later downloaded to computer for processing and interpretation. Further details are given in Appendix 1. Detailed survey allows the visualisation of weaker anomalies that may not have been readily identifiable by magnetic scanning.

2.5 A Bartington Grad601 magnetic gradiometer was used during the survey with readings being taken at 0.25m intervals on zig-zag traverses 1m apart within 20m by 20m grids. The readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation using Geoplot 3 software.

2.6 The survey methodology, report and any recommendations comply with guidelines outlined by English Heritage (David 1995) and by the IFA (Gaffney *et al* 2002). All figures reproduced from Ordnance Survey mapping are done so with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

2.7 A general site location plan, incorporating the 1:50000 Ordnance Survey mapping, is shown in Figure 1. Figure 2 shows the processed magnetometer data superimposed onto an Ordnance Survey map base at a scale of 1:5000. The processed (greyscale) and unprocessed (XY trace plot) data, together with accompanying interpretation diagrams, are presented in Figures 3 to 11 inclusive at a scale of 1:1000.

2.8 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 site 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.

3. Results and Discussion

3.1 Isolated dipolar anomalies ('iron spikes' - see Appendix 1) have been identified across all the surveyed areas. 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 often as a consequence of manuring. There is no obvious clustering to these responses to suggest that they are caused by anything other than random ferrous debris. The relatively low number of these 'spike' anomalies reflects the continued use of the land for pasture rather than arable agriculture as also evidenced by the survival of the ridge and furrow earthworks.

3.2 Magnetic disturbance along the division in Area C is due to the proximity of a metal fence and the strong dipolar linear trend anomaly aligned north/south is caused by a ferrous service pipe.

3.3 By far the most common anomalies are the curvilinear trend anomalies identified in all the survey blocks on varying alignments. These anomalies reflect the presence of the ridge and furrow earthworks. The relative strength of the anomalies is considered to primarily reflect the state of preservation of the earthwork - the striped magnetic effect being due to the magnetic contrast between the partially infilled furrows and ridges. However, the potential masking effect of alluvium may also be a contributory factor as there is a distinct relative weakness of these anomalies at the northern extent of each of the three survey blocks, *i.e* nearest the stream. There is also a shallow east/west aligned depression in Area A that separates the more widely spaced, 'weaker', anomalies to the north from the 'stronger', more closely spaced anomalies, to the south. In Areas B and C the changes in orientation of the ploughing are primarily thought to be due to topographical considerations.

3.4 Several discrete magnetic anomalies (small areas of enhanced magnetic response) have been identified across all parts of the site. A noticeable clustering to these anomalies is evident I n Area C. These anomalies are characteristically pit-like and may locate the position of small infilled clay extraction pits. This interpretation is given credence due to the brick and tile manufacturing that is known to have occurred in the vicinity and by the possible kiln identified in the previous survey (see Section 1.6).

4. Conclusions

4.1 The geophysical survey has confirmed the extent of ridge and furrow ploughing across this part of the site to the north of Brakes Farm. Discrete anomalies may be indicative of small clay extraction pits, although geological or pedological change cannot be discounted as a possible cause. No anomalies likely to be indicative of earlier archaeological activity have been identified.

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.

Bibliography

David, A., 1995. *Geophysical Survey in Archaeological Field Evaluation: Research and Professional Services Guidelines* No. 1. English Heritage

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

Acknowledgements

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Figures

Appendices

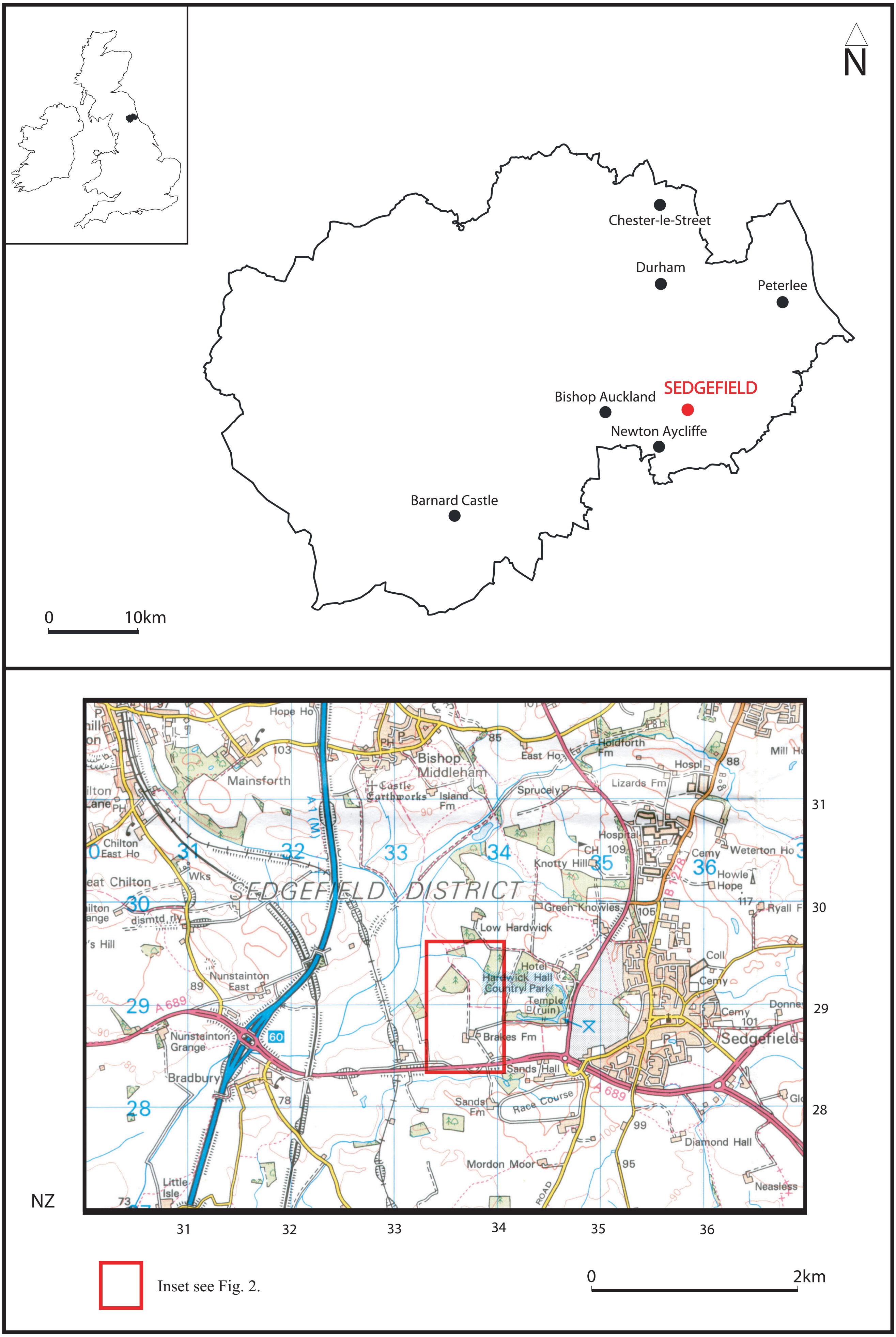

Fig. 1. Site location

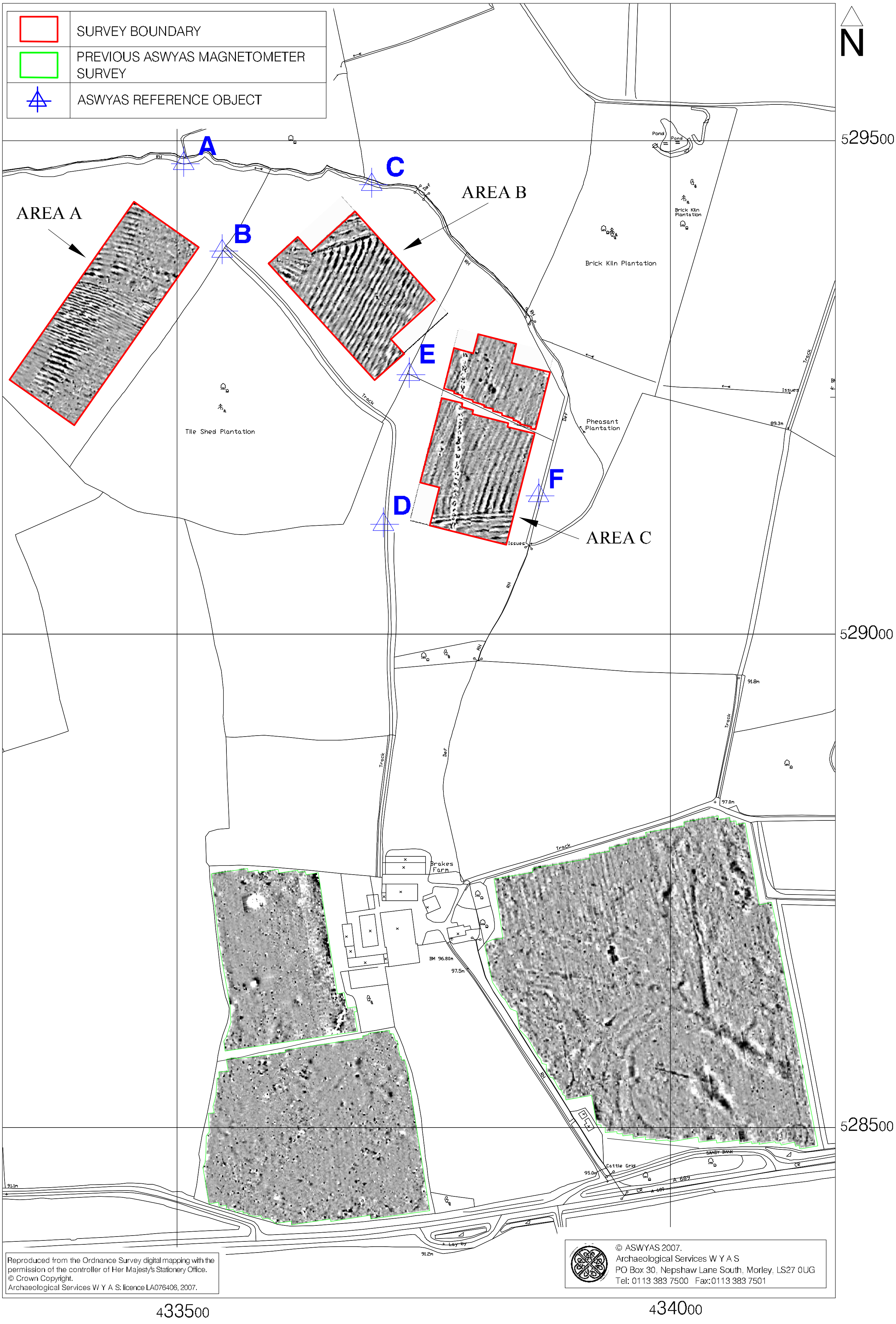

Fig. 2. Site location showing greyscale magnetometer data (1:5000 @ A4)

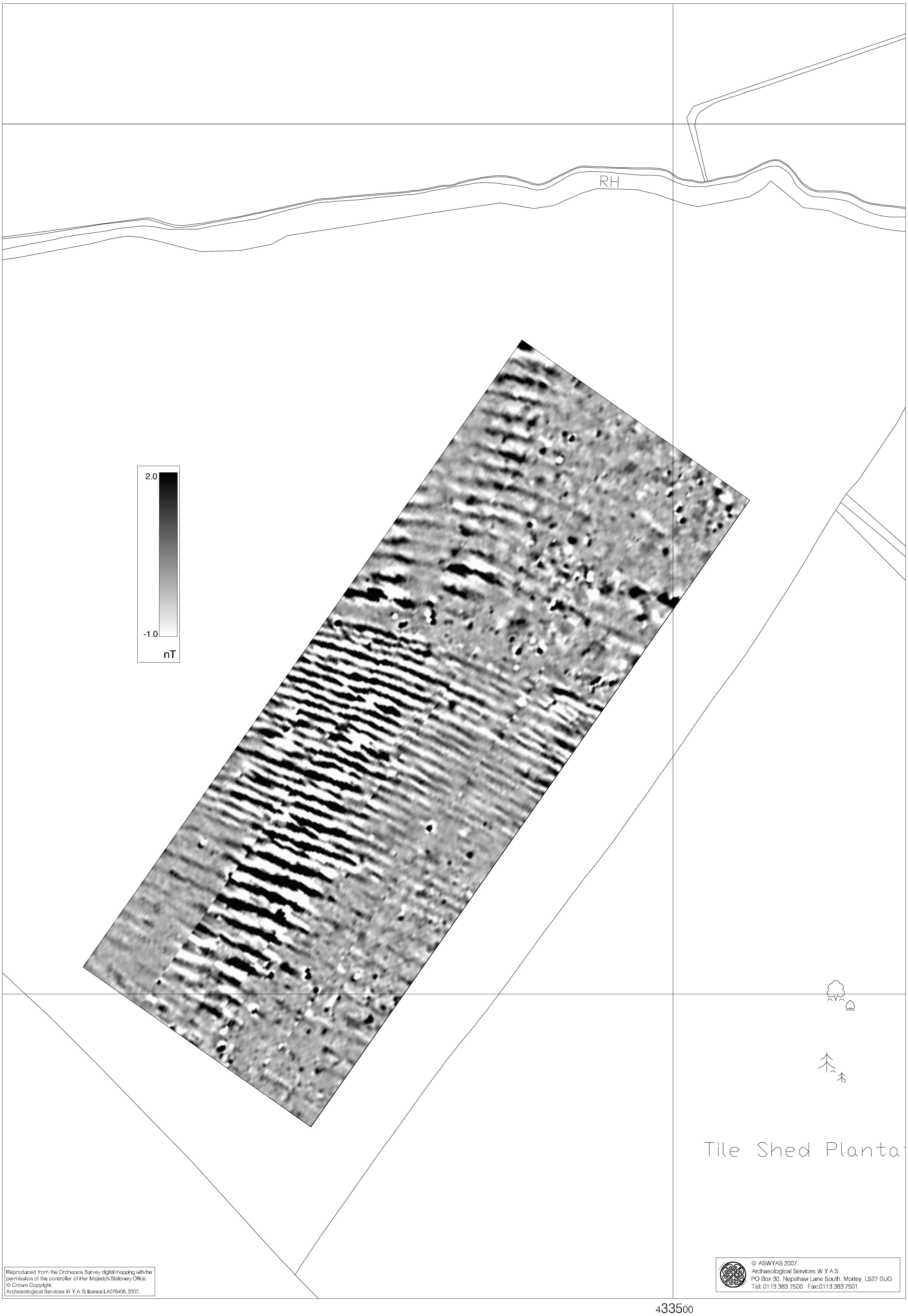

Fig. 3. Processed greyscale magnetometer data; Area A (1:1000 @ A3)

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

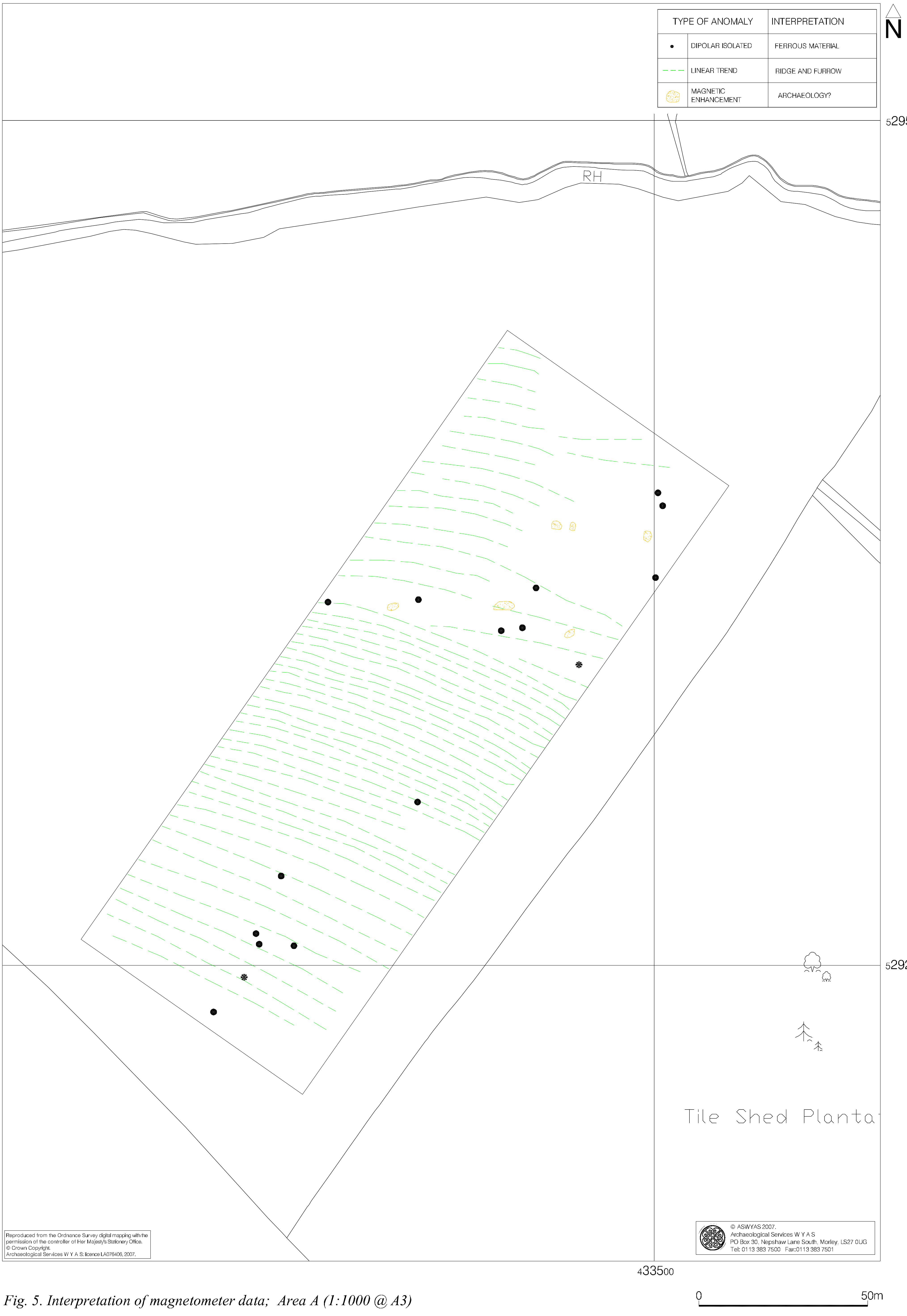

Fig. 5. Interpretation of magnetometer data; Area A (1:1000 @ A3)

Fig. 6. Processed greyscale magnetometer data; Area B (1:1000 @ A3)

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Fig. 7. XY trace plot of unprocessed magnetometer data; Area B (1:1000 @ A3)

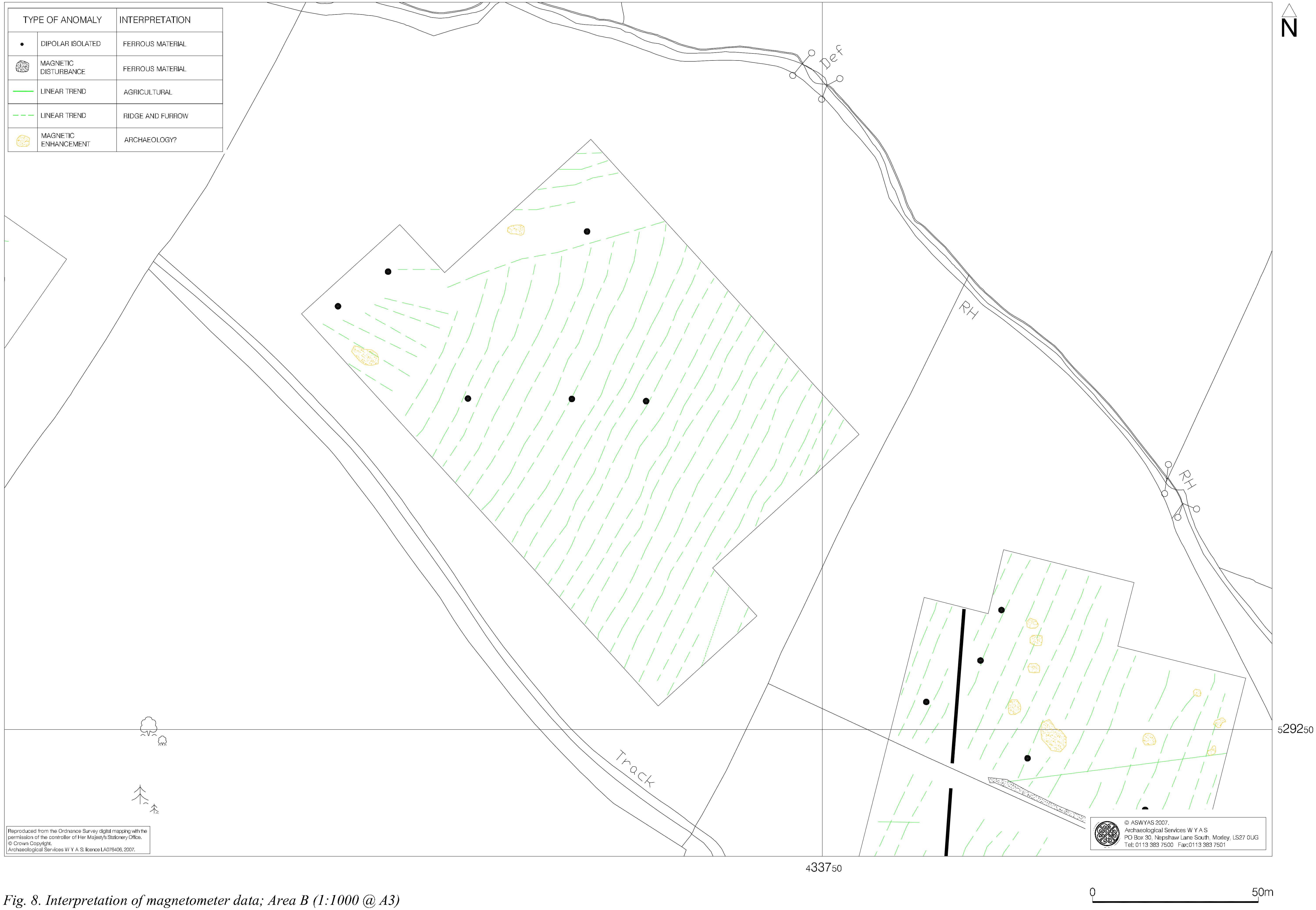

Fig. 8. Interpretation of magnetometer data; Area B (1:1000 @ A3)

Fig. 9. Processed greyscale magnetometer data; Area C (1:1000 @ A3)

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Fig. 10. XY trace plot of unprocessed magnetometer data; Area C (1:1000 @ A3)

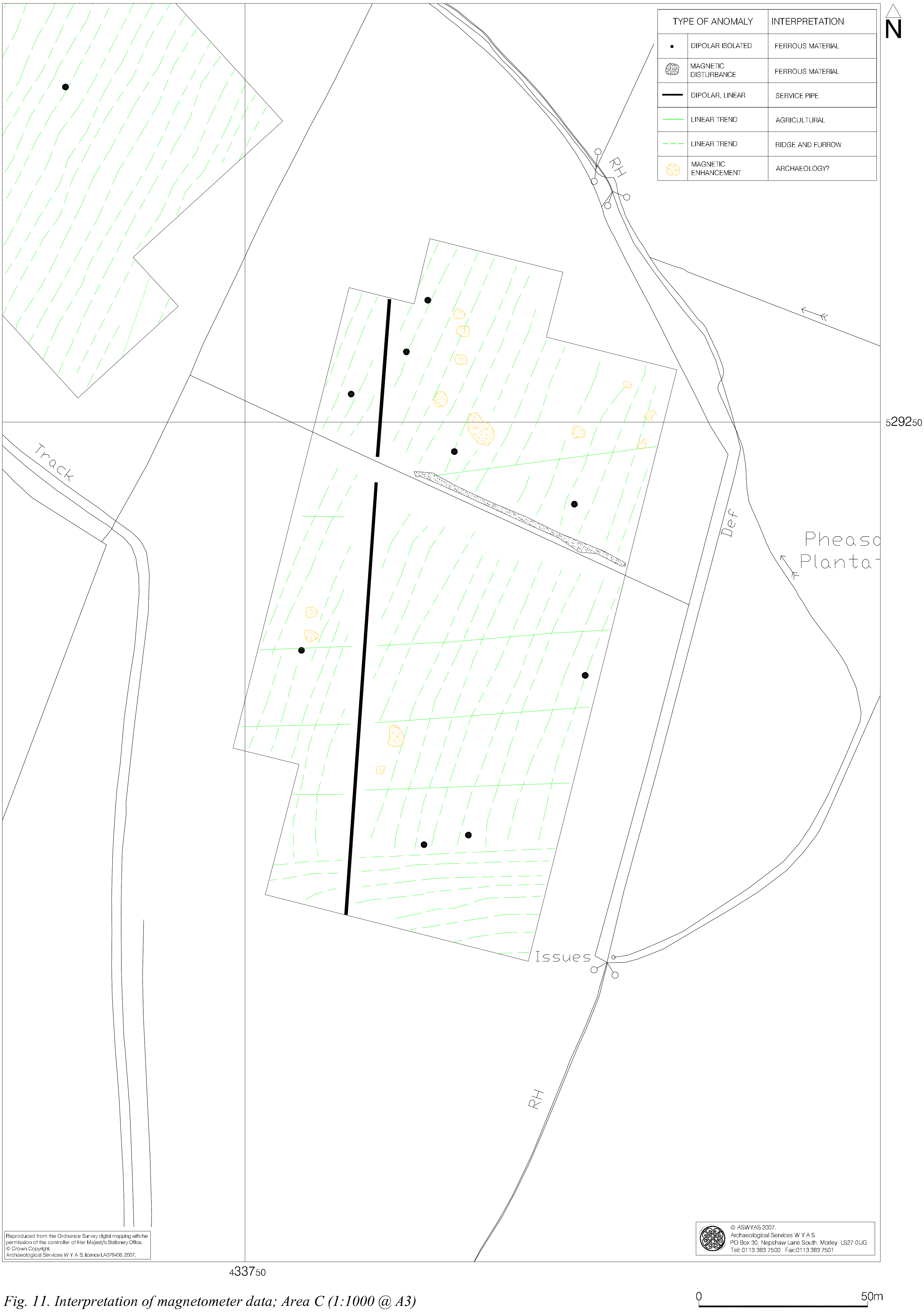

Fig. 11. Interpretation of magnetometer data; Area C (1:1000 @ A3)

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	433506.9342	529476.5540
B	433545.8892	529387.9211
C	433697.4123	529455.3304
D	433709.1167	529111.1611
E	433735.5453	529263.0340
F	433866.5558	529140.1162

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 (Word 2000), and graphics files (Adobe Illustrator 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 will 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).