ARCHAEOLOGICAL SERVICES WYAS

Reighton Sands Golf Course
Reighton
North Yorkshire

Geophysical Survey

April 2010

Report No. 2055

CLIENT

Bourne Leisure Limited

Reighton Sands Golf Course
Reighton
North Yorkshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering approximately 12 hectares in eleven blocks, was carried out immediately south of Reighton Sands Holiday Park on an area of rough pasture where it is proposed to create a nine hole golf course. Anomalies due to geological variation, agricultural and modern activity have been identified. Three clusters of anomalies of unknown origin have also been located. No anomalies specifically correlating with the extent of a small mound of putative archaeological origin have been identified although there are anomalies within and immediately adjacent to the feature whose origin is uncertain. However, it is considered likely that the mound is most likely to be a natural topographic feature. On the basis of the geophysical survey the site is considered to have a low archaeological potential.

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Report Information

Client:	Bourne Leisure Limited
Address:	1, Park Lane, Hemel Hempstead, Hertfordshire, HP2 4YL
Report Type:	Geophysical survey
Location:	Reighton
County:	North Yorkshire
Grid Reference:	TA 140 755
Period(s) of activity: represented	None
Report Number:	2055
Project Number:	3497
Site Code:	RSG09
Planning Application No.:	Pre-determination (Outline)
Museum Accession No.:	n/a
Date of fieldwork:	November 2009
Date of report:	April 2010
Project Management:	Alistair Webb BA MIfA
Fieldwork:	Alex Harrison BSc Ian Wilkins BSc MSc
Report:	Alistair Webb
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Photography:	Ian Wilkins
Research:	n/a
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Authorisation for distribution: ---

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1 Introduction

Archaeological Services WYAS was commissioned by Mike Stephenson of Bourne Leisure Limited to carry out a programme of non-intrusive geophysical (magnetometer) survey in advance of the proposed development of land south of Reighton Sands Holiday Park for a nine hole golf course. The survey was undertaken in November 2009.

Site location, topography and land use

The site, centred at TA 140 755, is located about 7km to the south-east of Scarborough (see Fig. 1), immediately across a shallow valley south of Reighton Sands Holiday Park. Reighton village is located approximately 1km to the west. The site comprises four fields of rough pasture, interspersed with patches of gorse, and is split in two by Old Beck which runs across the site from east to west (see Fig. 2). The beck appears to be a natural water course which has been artificially deepened and re-cut to act as a drain. To the east is rough pasture with the field to the south-west under arable cultivation. On the northern side of the beck are several areas of dumped building material and debris. The site is situated at between 65m and 80m above Ordnance Datum.

Geology and soils

The solid geology comprises chalk and greensands overlain by chalky till. The soils are classified in the Burlingham 2 soil association comprising deep fine loams and sands.

2 Archaeological background

An archaeological desk-based assessment undertaken by Archaeological Services WYAS (Pollington 2007) revealed an historic hedge line and an earthwork mound which was interpreted as possibly being the remains of a Bronze Age barrow within the site boundary. Extensive evidence for prehistoric and medieval activity within 1km of the site lead to the conclusion that there was potential for unrecorded sub-surface archaeological remains within the site.

3 Aims, Methodology and Presentation

The general aim of the survey was to obtain information that would evaluate the archaeological potential of the site. This information would then enable further, informed, decisions to be taken prior to the finalisation of the development proposals.

Specifically the aims were to:-

- Record the nature and extent of any archaeological remains within the proposed areas of groundworks;

- to determine the nature of the earthwork mound.

To achieve these aims eleven individual blocks covering 11.75 hectares were surveyed. These blocks were positioned at locations where groundworks will be undertaken for the creation of ponds, greens and bunkers and also over the putative Bronze Age mound.

Magnetometer survey

Bartington Grad601 magnetic gradiometers were used during the survey taking readings at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m grids so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Geoplot 3 (Geoscan Research) software was used to process and present the data. Further details are given in Appendix 1.

Reporting

A general site location plan, incorporating the Ordnance Survey map is shown in Figure 1. A large scale (1:3000) site location plan with processed greyscale magnetometer data is shown in Figure 2. The data are presented in greyscale and X-Y trace plot formats with accompanying interpretation graphics in Figures 3 to 20 inclusive at a scale of 1:1000.

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 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).

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

Block 1 and Block 2 (see Figs 2, 3, 4 and 5)

Block 1 and Block 2 were located to cover the areas where it is proposed to site a green and a bunker respectively.

A discontinuous linear anomaly aligned broadly north/south and a small discrete anomaly immediately to the east are identified in Block 1. Without any supporting information it is difficult to make a confident interpretation. An archaeological cause cannot be excluded but it is considered more likely to be due to modern activity or perhaps to geological factors.

No anomalies other than ferrous responses (iron ‘spikes) have been identified in Block 2. These anomalies are due to ferrous material either on the ground surface or in the ploughsoil and are assumed to be modern in origin.

Block 3 and Block 4 (see Figs 2, 6, 7 and 8)

This is essentially one large block divided by the course of Old Beck, with Block 3 to the north of Old Beck and Block 4 to the south, and covers a proposed area of wetland, an artificial amphibian hibernaculae, five bunkers and a green. The earthwork mound was located to the north of the beck in Block 3.

The data in both blocks is characterised by the presence of numerous broad, irregular and predominantly low magnitude anomalies (areas of magnetic enhancement). These anomalies are interpreted as geological in origin and are thought to be due to the deposition of alluvium adjacent to the beck.

In contrast to the geological anomalies are three distinct groups of anomalies that are considered to have some archaeological potential. On the northern edge of Block 3 a series of linear anomalies, **A1**, can be seen. Some of these are aligned similarly to the weak parallel anomalies that are visible to the west of the block and which are interpreted as agricultural, being either due to ploughing or more likely to field drains. However, an archaeological origin cannot be dismissed.

The remaining two clusters are located to the south-eastern corner of Block 3, within 40m of the beck. On the eastern edge of the block a sub-circular cluster of anomalies, **A2**, are prominent in the data. Again an archaeological explanation cannot be excluded but a modern cause is considered more plausible.

Forty metres to the west is the final cluster of anomalies, **A3**. A degree of linearity to some of these anomalies is apparent which could suggest an anthropogenic cause, but whether due to an archaeological feature or much more recent activity is unclear.

To the western side of Block 3 a number of linear trend anomalies are interpreted as being probably due to field drains.

No anomalies specifically correlating with the extent of the mound have been identified although there are anomalies identified within the bounds of the feature and immediately beyond it.

Block 5 and Block 6 (see Figs 2, 9, 10 and 11)

These two small blocks cover the proposed locations of greens.

Anomalies due to geological and pedological variation predominate in Block 5 and to a lesser extent in Block 6. A vague linear trend anomaly of uncertain, probably agricultural, origin is also noted in Block 6.

Block 7 and Block 8 (see Figs 2, 12, 13 and 14)

These blocks cover the position of greens, water features and areas of tree planting.

Areas of modern ferrous disturbance and areas of magnetic enhancement due to geological variation are common in Block 7.

In Block 8 several linear trends of unknown, probably agricultural, origin have been identified together with several small discrete anomalies interpreted as geological.

Block 9 and Block 10 (see Figs 2, 15, 16 and 17)

Blocks 9 and 10 cover greens and an area of tree screening.

Geological anomalies, modern disturbance and vague linear trends of unknown origin have been noted in these blocks.

Block 11 (see Figs 2, 18, 19 and 20)

Block 11 covers a green and tree screen.

A large area of magnetic disturbance in this block suggests the deliberate spreading of strongly magnetic material such as building rubble or slag.

5 Discussion and Conclusions

Although numerous anomalies have been identified by the survey none are considered to be of probable archaeological origin. The greatest concentration of anomalies is immediately adjacent to the beck at the western end of the site in Blocks 3 and 4. Here, and elsewhere across the site, the anomalies are almost certainly indicative of underlying variation in the drift geology and soils. However, some anomalies which are not obviously geological have been noted in Block 3. It is considered most likely that these three clusters of anomalies will be due to relatively recent activity but an archaeological origin cannot be completely dismissed. Some of these anomalies fall within or immediately adjacent to the low mound. However, from the contour data shown on Figure 2 it seems as if the mound forms the southern end of a spur of land along the 70m contour line. For this reason it is concluded that this mound is probably a natural topographic feature.

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

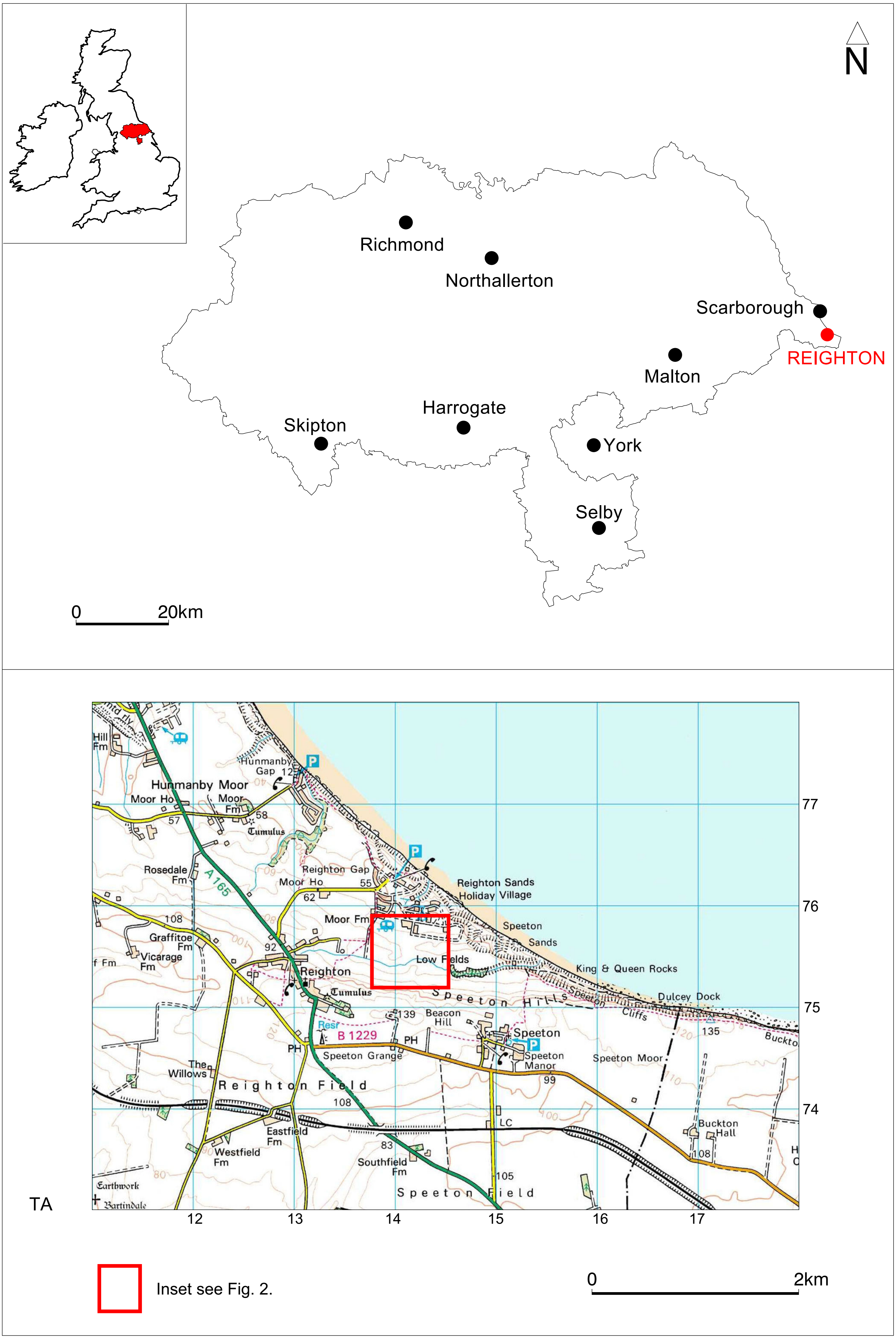

Fig. 1. Site location

Fig. 2. Site location showing greyscale magnetometer data (1:3000 @ A3)

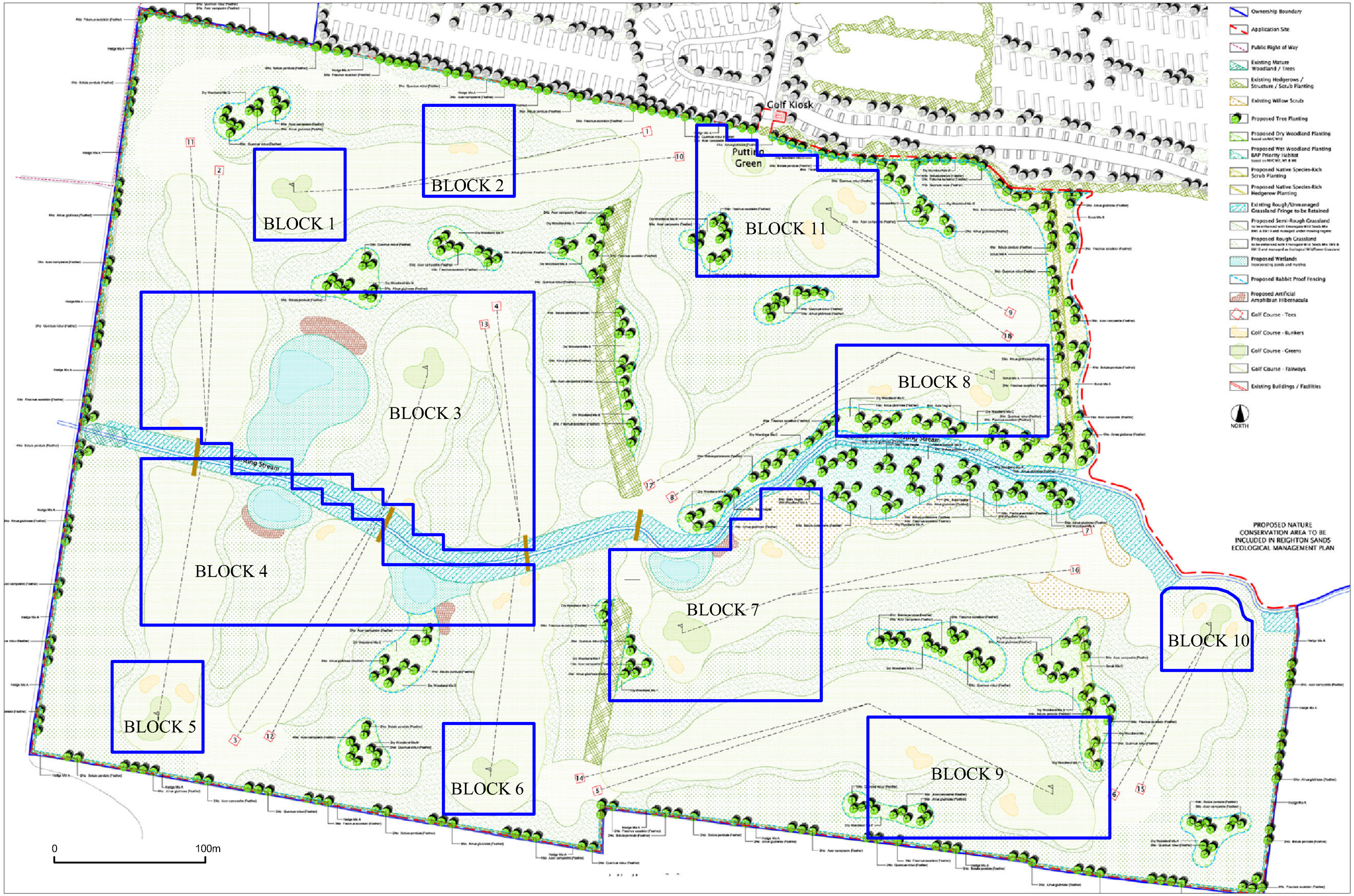

Fig. 2a. Geophysical survey areas (blue) focused on proposed groundworks, overlaying the approved plan for the golf course

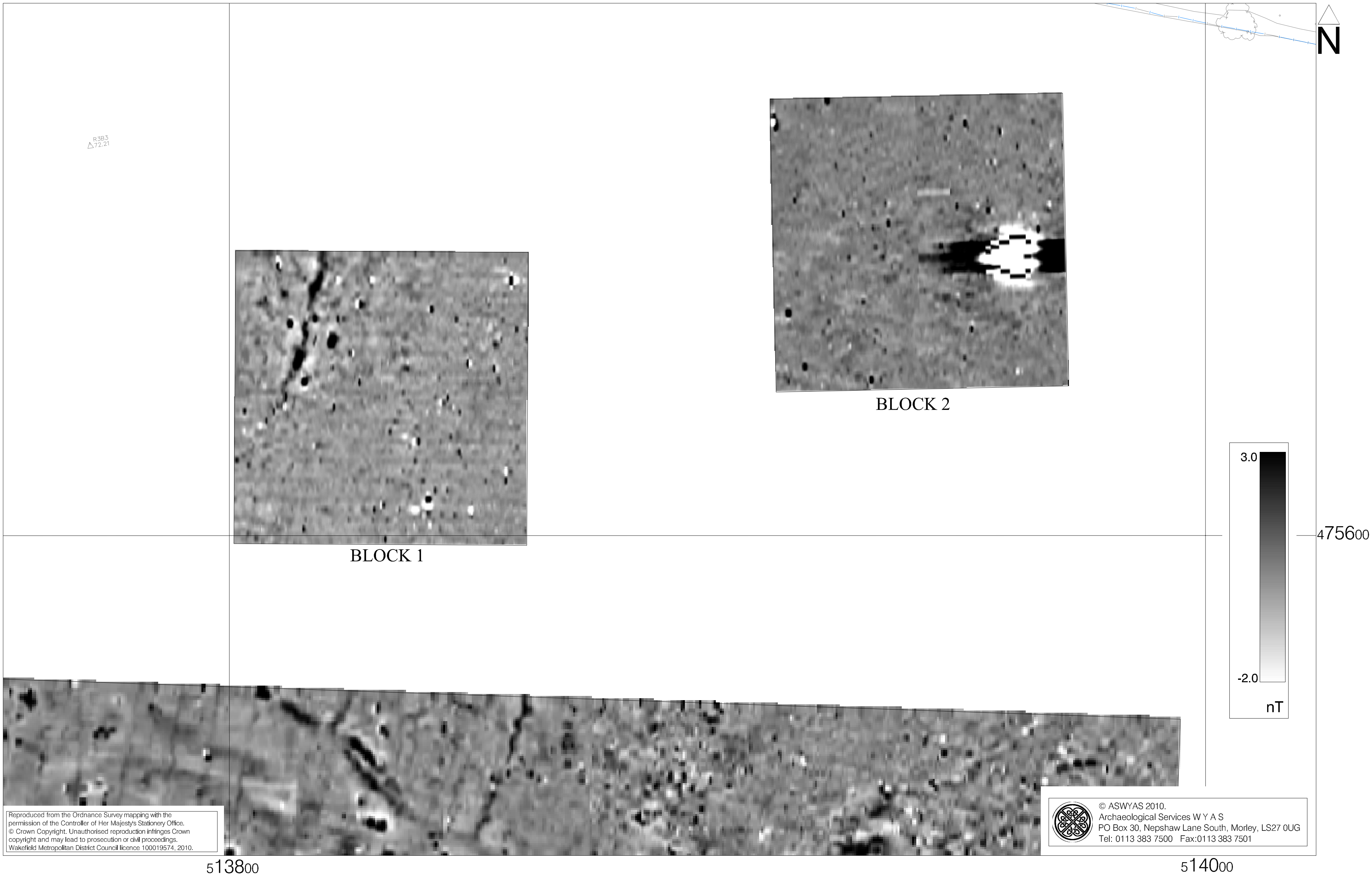

Fig. 3. Processed greyscale magnetometer data; Block 1 and Block 2 (1:1000 @ A3)

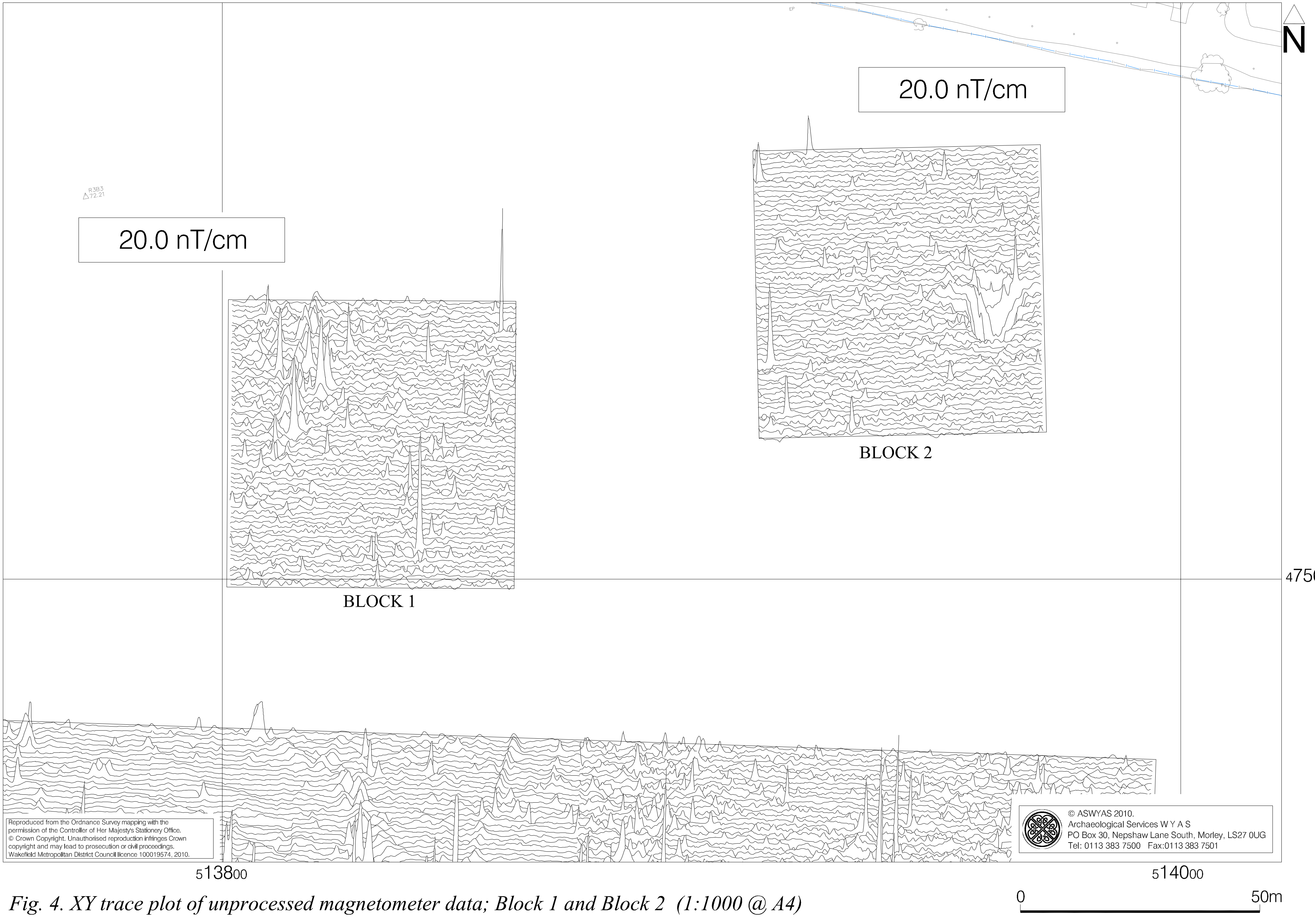

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Fig. 4. XY trace plot of unprocessed magnetometer data; Block 1 and Block 2 (1:1000 @ A4)

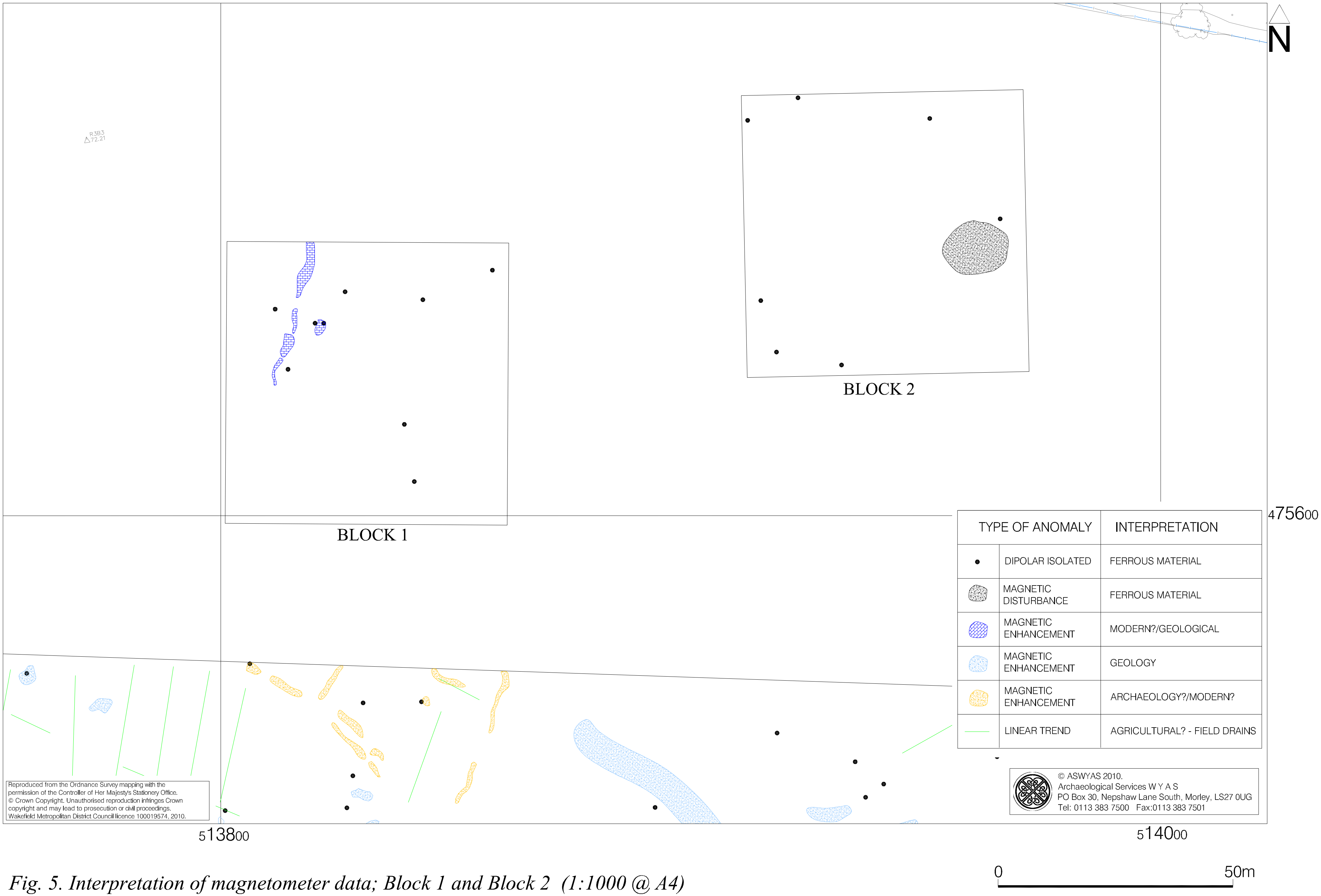

Fig. 5. Interpretation of magnetometer data; Block 1 and Block 2 (1:1000 @ A4)

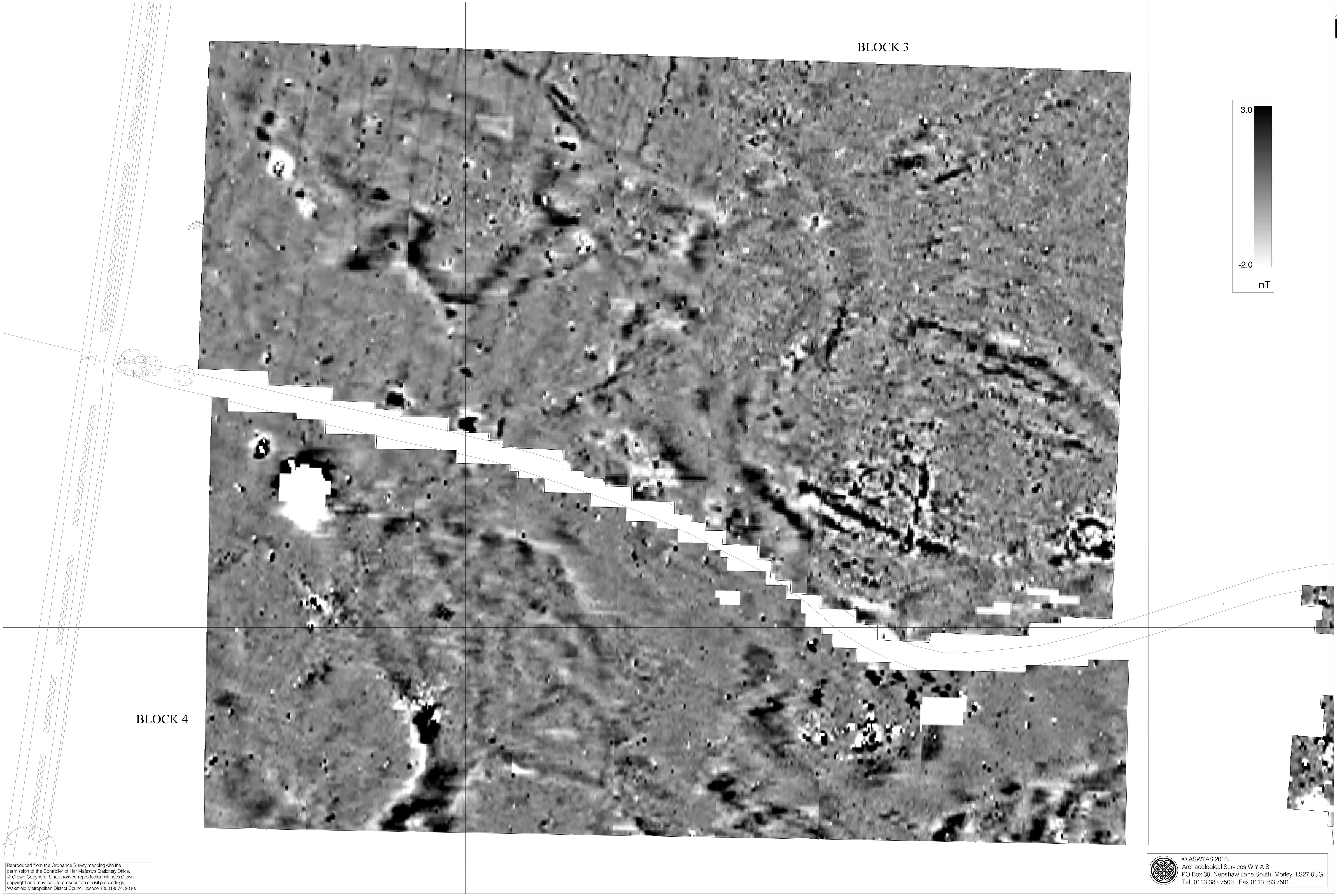

Fig. 6. Processed greyscale magnetometer data; Block 3 and Block 4 (1:1000 @ A3)

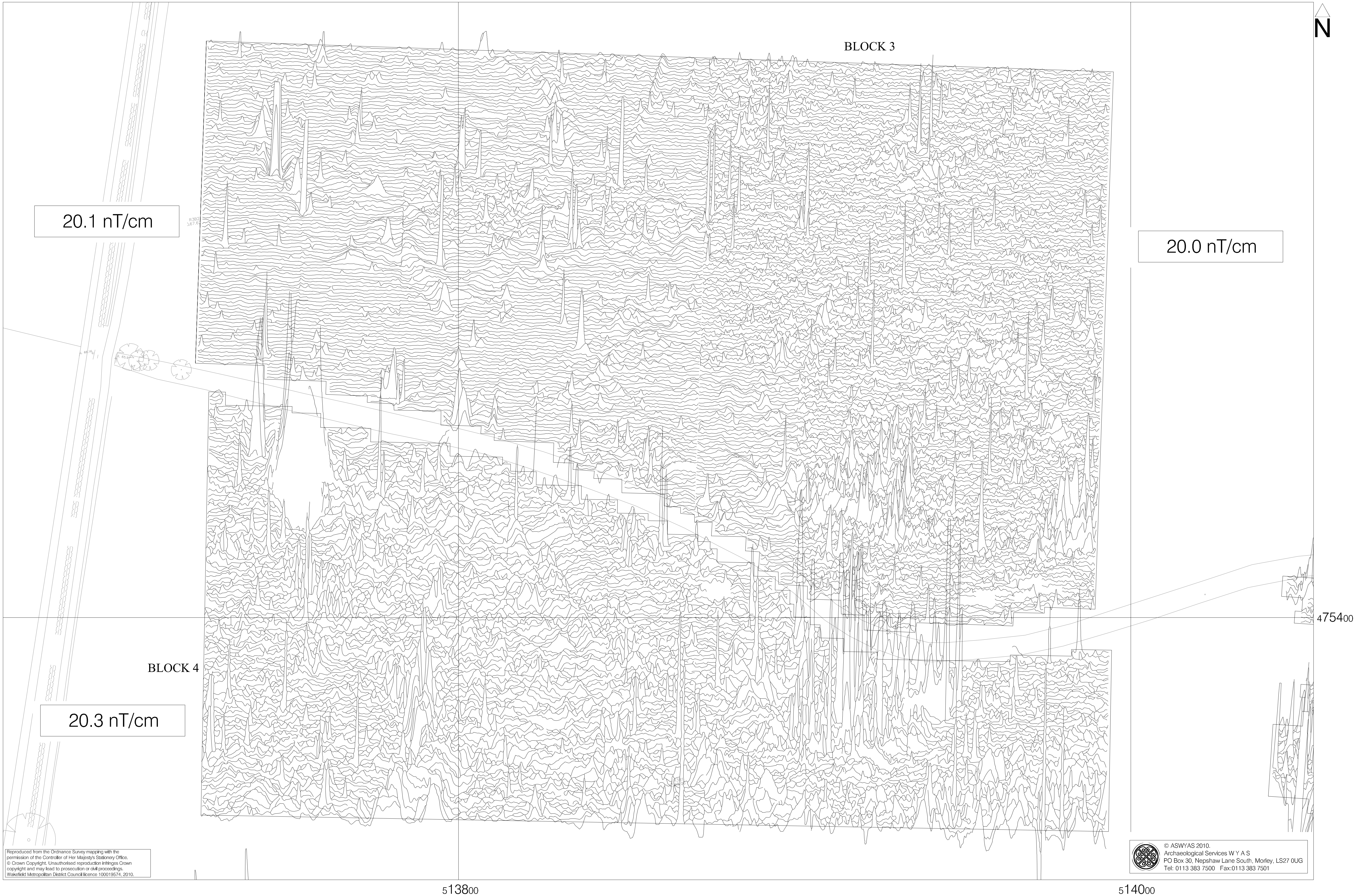

Fig. 7. XY trace plot of unprocessed magnetometer data; Block 3 and Block 4 (1:1000 @ A3)

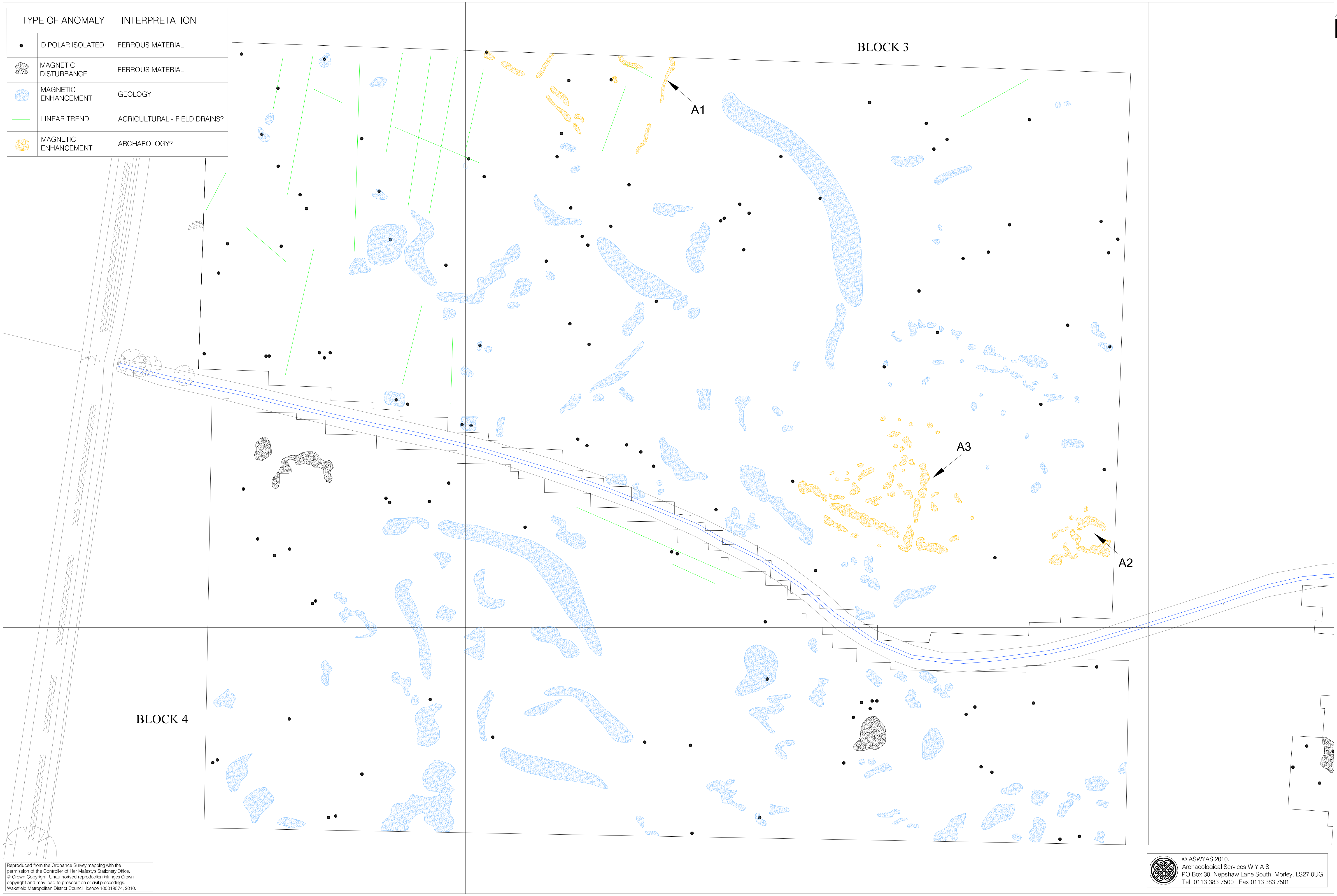

Fig. 8. Interpretation of magnetometer data; Block 3 and Block 4 (1:1000 @ A3)

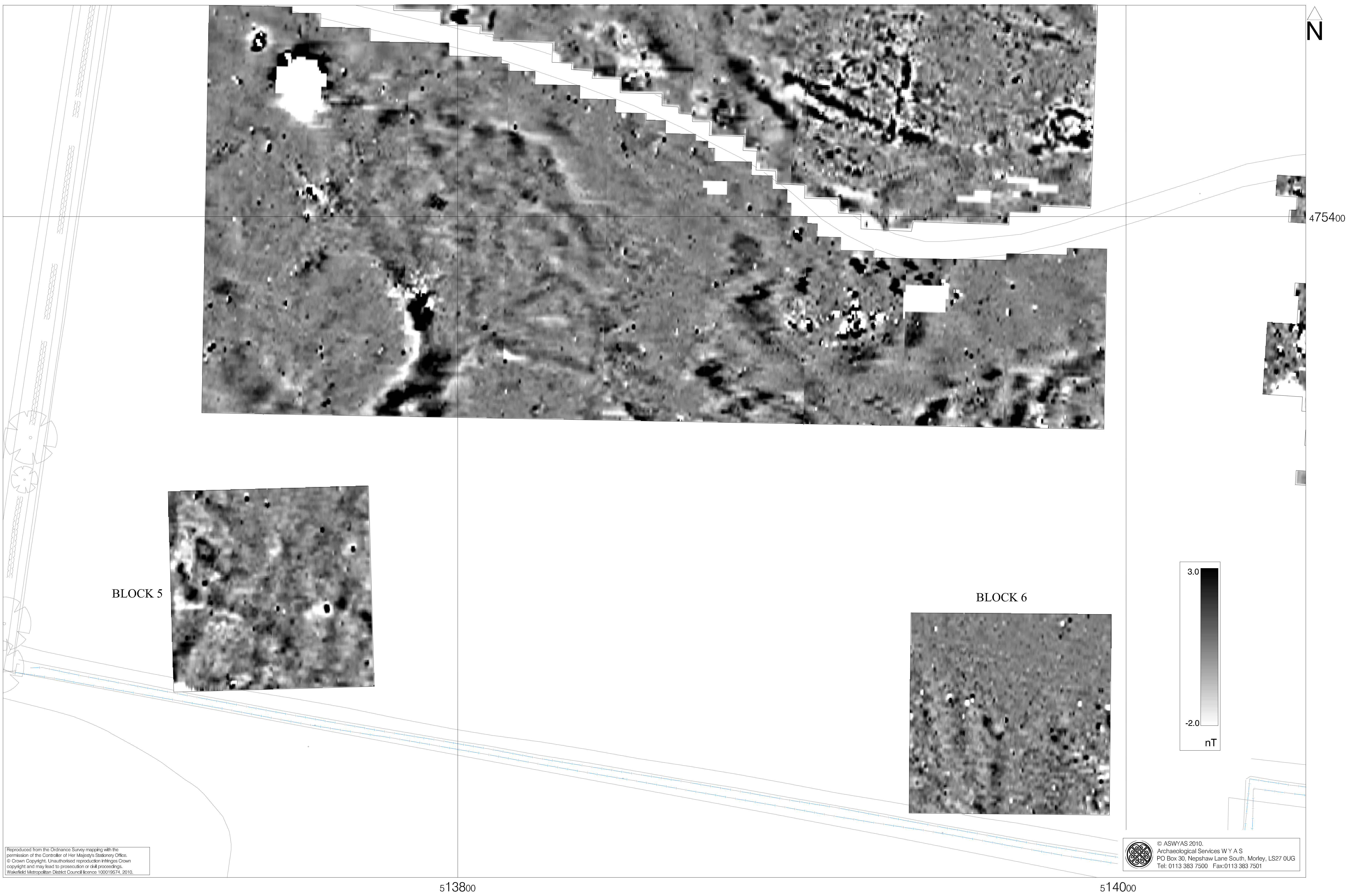

Fig. 9. Processed greyscale magnetometer data; Block 5 and Block 6 (1:1000 @ A3)

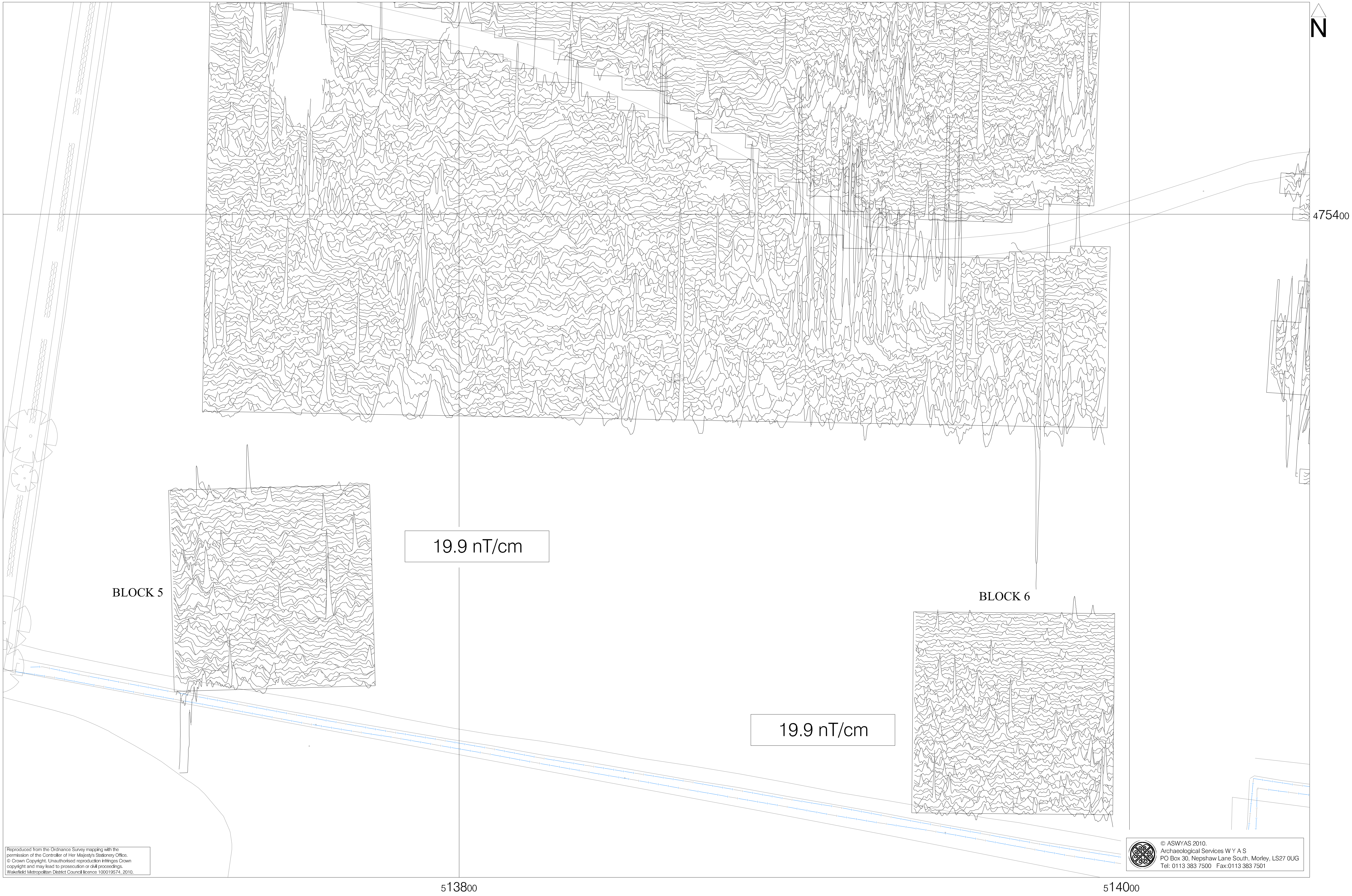

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Fig. 10. XY trace plot of unprocessed magnetometer data; Block 5 and Block 6 (1:1000 @ A3)

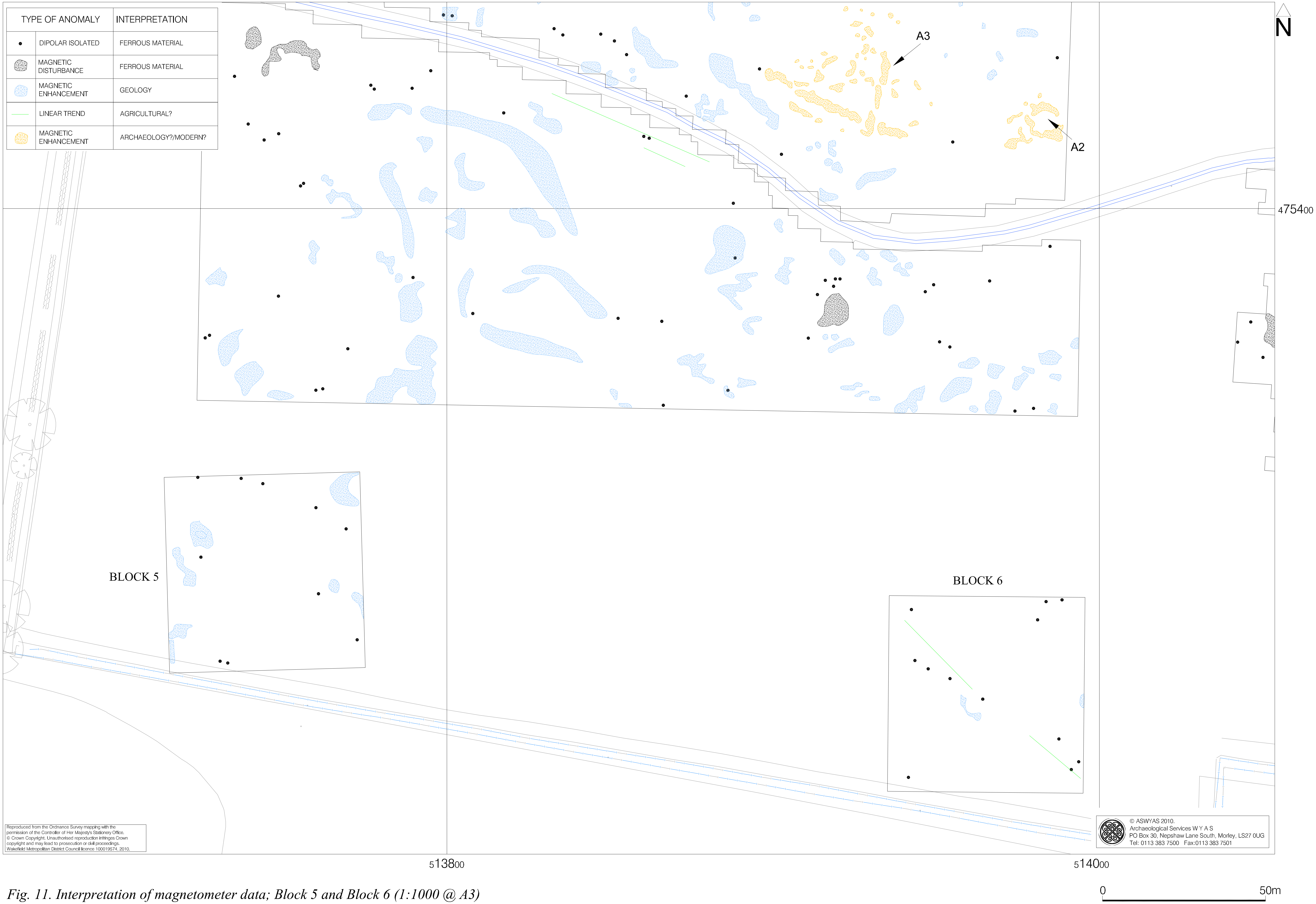

Fig. 11. Interpretation of magnetometer data; Block 5 and Block 6 (1:1000 @ A3)

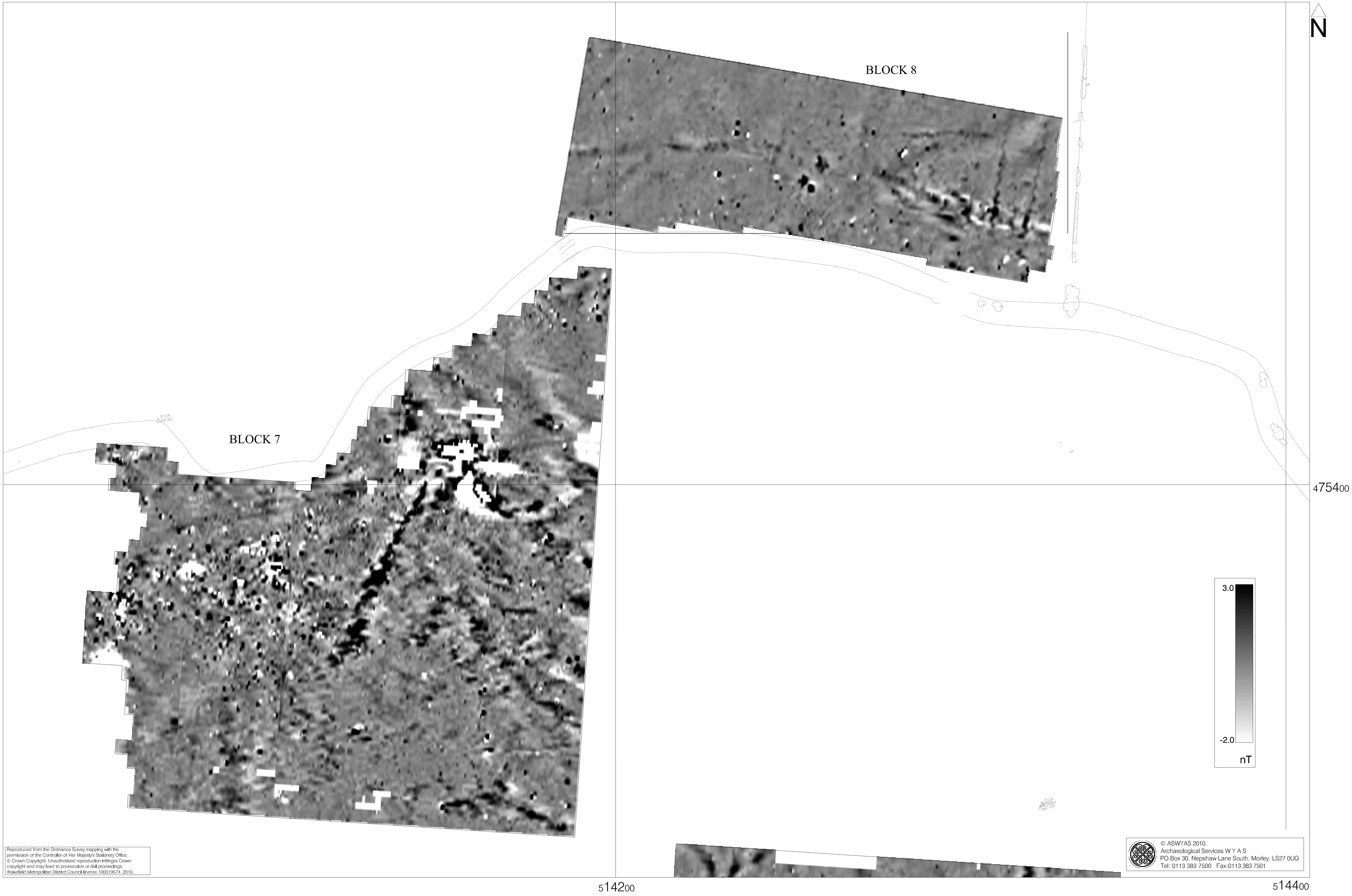

Fig. 12. Processed greyscale magnetometer data; Block 7 and Block 8 (1:1000 @ A3)

Fig. 13. XY trace plot of unprocessed magnetometer data; Block 7 and Block 8 (1:1000 @ A3)

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Fig. 14. Interpretation of magnetometer data; Block 7 and Block 8 (1:1000 @ A3)

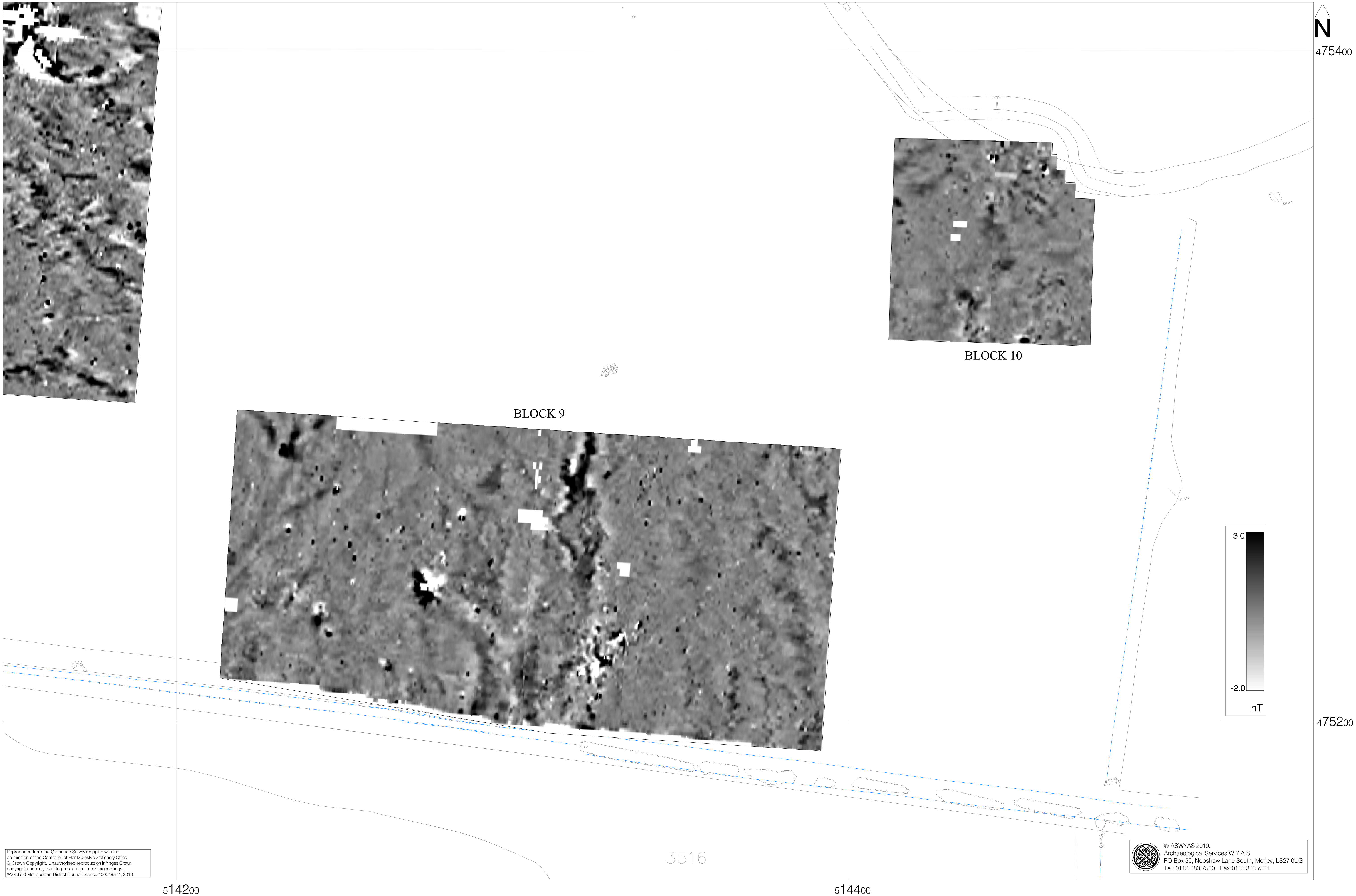

Fig. 15. Processed greyscale magnetometer data; Block 9 and Block 10 (1:1000 @ A3)

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Fig. 16. XY trace plot of unprocessed magnetometer data; Block 9 and Block 10 (1:1000 @ A3)

Fig. 17. Interpretation of magnetometer data; Block 9 and Block 10 (1:1000 @ A3)

Fig. 18. Processed greyscale magnetometer data; Block 11 (1:1000 @ A3)

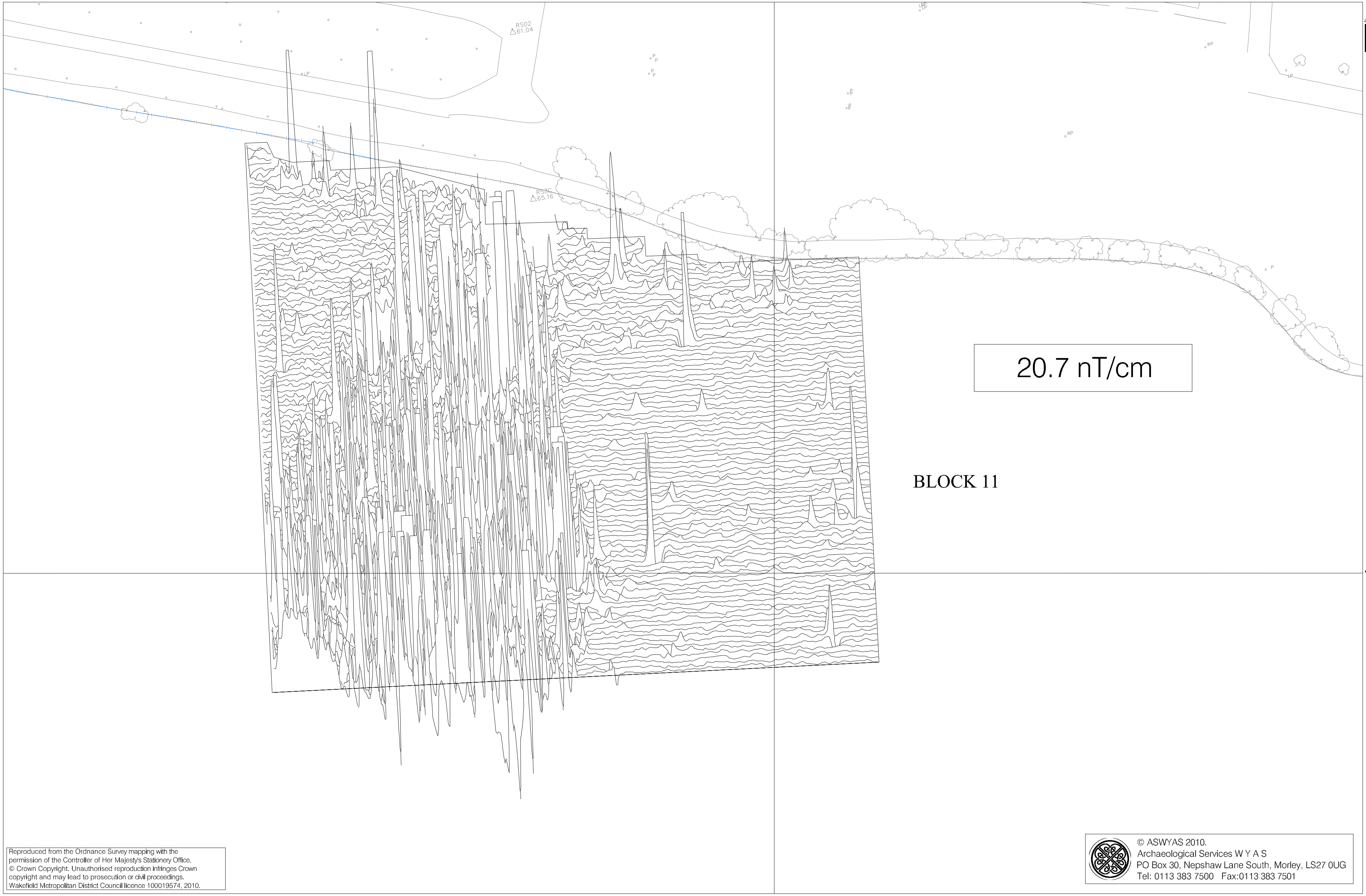

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Fig. 19. XY trace plot of unprocessed magnetometer data; Block 11 (1:1000 @ A4)

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Fig. 20. Interpretation of magnetometer data; Block 11 (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. 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 approximately located on a base plan. This method is usually employed as a means of selecting areas for detailed survey when only a percentage sample of the whole site is to be subject to detailed survey.

The disadvantages of magnetic scanning are that features that produce weak anomalies (less than 2nT) are unlikely to stand out from the magnetic background and so will be difficult to detect. The coarse sampling interval means that discrete features or linear features that are parallel or broadly oblique to the direction of traverse may not be detected. If linear features are suspected in a site then the traverse direction should be perpendicular (or as close as is possible within the physical constraints of the site) to the orientation of the suspected features. The possible drawbacks mentioned above mean that a 'negative' scanning result should be validated by sample detailed magnetic survey (see below).

The second method is referred to as ***detailed survey*** and employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0.25m intervals, on zig-zag traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation. Detailed survey allows the visualisation of weaker anomalies that may not have been detected by magnetic scanning.

During this survey a Bartington Grad601 magnetic gradiometer was used taking readings on the 0.1nT range, at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m square grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

Data Processing and Presentation

The detailed gradiometer data has been presented in this report in XY trace and greyscale formats. In the former format the data shown is 'raw' with no processing other than grid biasing having been done. The data in the greyscale images has been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

An XY plot presents the data logged on each traverse as a single line with each successive traverse incremented on the Y-axis to produce a 'stacked' plot. A hidden line algorithm has been employed to block out lines behind major 'spikes' and the data has been clipped. The main advantage of this display option is that the full range of data can be viewed, dependent on the clip, so that the 'shape' of individual anomalies can be discerned and potentially archaeological anomalies differentiated from 'iron spikes'. Geoplot 3 software was used to create the XY trace plots.

Geoplot 3 software was used to interpolate the data so that 3600 readings were obtained for each 30m by 30m grid. The same program was used to produce the greyscale images. All greyscale plots are displayed using a linear incremental scale.

Appendix 2: Survey location information

The site grid was laid out using a 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	513719.8839	475641.0882
B	513696.6047	475485.9164
C	513674.7055	475336.8791
D	513691.3997	475260.4256
E	514064.7596	475410.8470
F	514327.7501	475303.5985
G	514337.4131	475494.1239
H	514190.0534	475477.0889
I	514027.9101	475549.6714

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

Appendix 3: Geophysical archive

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2008) files.
- 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).

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