ARCHAEOLOGICAL SERVICES WYAS

Blue Dolphin Holiday Park
Filey
North Yorkshire

Geophysical Survey

March 2010

Report No. 2038

CLIENT

Bourne Leisure Ltd

Blue Dolphin Holiday Park
Filey
North Yorkshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey covering approximately 3.5 hectares was carried out at two locations on the western side of the Blue Dolphin Holiday Park in advance of the proposed development of the site. The data is characterised by varying degrees of magnetic disturbance due to landscaping and service provision for the existing camping and caravan site. Against this magnetic background it is difficult to identify any potentially archaeological responses. A few anomalies which could have an underlying archaeological origin have been identified but given the prevailing site conditions it is considered much more likely that they reflect variation in the superficial deposits or are due to recent activity. Given the widespread nature of the magnetic disturbance it is difficult to assess the archaeological potential of the site.

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Report Information

Client:	Bourne Leisure Limited
Address:	1, Park Lane, Hemel Hempstead, Herfordshire, HP2 4YL
Report Type:	Geophysical survey
Location:	Filey
County:	North Yorkshire
Grid Reference:	TA 088 832
Period(s) of activity: represented	None
Report Number:	2038
Project Number:	3528
Site Code:	BDP10
Planning Application No.:	Pre-determination (Outline)
Museum Accession No.:	n/a
Date of fieldwork:	February 2010
Date of report:	March 2010
Project Management:	Alistair Webb BA MIfA
Fieldwork:	Alex Harrison BSc
	Ian Wilkins BSc MSc
Report:	Alistair Webb
Illustrations:	Sam Harrison
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Research:	n/a
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1 Introduction

Archaeological Services WYAS was commissioned by Mike Stephenson of the Bourne Leisure Limited to carry out a programme of non-intrusive geophysical (magnetometer) survey in advance of the proposed development and re-development of land at the Blue Dolphin Holiday Park. The survey covered two currently undeveloped areas, at the northern and southern ends of the site; the central part of the site was unsuitable for survey as it had previously been developed for the use of static caravans. The survey was undertaken in February 2010.

Site location, topography and land use

The site, centred at TA 088 832, is located about 4km to the south-east of Scarborough (see Fig. 1), at the western side of the Blue Dolphin Holiday Park. Stonepit Lane borders the site to the east with Gristhorpe Cliff immediately to the north. To the west is Crows Nest Caravan Park and to the south open fields extend towards the A165 (Filey to Scarborough) road.

The two survey blocks covered approximately 3.5 hectares. The northern block (Area 1) covered approximately 1.6 hectares and comprised rough grassland with two parallel earth banks, running broadly east/west, running through it and a large sub-rectangular mound (see Fig. 2) on the northern edge. Both banks were approximately 1m high; one bank marked the southern extent of Area 1 and was partially surveyed whilst the second bank roughly bisected the area and could be seen to continue eastwards on the opposite side of Stonepit Lane. These banks were probably constructed as wind breaks. The mound on the northern edge of the survey area was approximately 2m high and overgrown. Brick and concrete debris could be seen within the mound. Area 2 covered approximately 1.9 hectares and was grassed with a part-tarmac road along the northern edge and regularly spaced power and safety boxes for caravans/tents within the field. A small pond on the east side of the field slightly reduced the area available for survey.

The highest point of the site was the north-west corner of Area 1 (85m aOD) with the land sloping gradually down to the south and the lowest part of the site in the south-eastern corner of Area A at 60m aOD.

Geology and soils

The solid geology comprises of the Oxfordian - Lower Calcareous Grit Formation overlain by superficial deposits of stoney till. The soils are classified in the Burlington 2 association being characterised as deep fine loams with slowly permeable subsoils that are prone to seasonal waterlogging.

2 Archaeological background

An archaeological desk-based assessment undertaken by Archaeological Services WYAS (Pollington 2006) revealed only limited archaeological features and buildings in the wider search area and none within the site itself. However, two Bronze Age round barrows are located very close to the site (see Fig. 2). One of the barrows lies immediately adjacent to the proposed development site's northern boundary and was excavated by William Greenwell in 1887.

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.

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 (1:5000) 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 8 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

Area 1 (see Figs 3, 4 and 5)

Both the fully and partially surveyed embankments in Area 1 give strong magnetic responses typical of modern infill material. The readings from around the periphery of the mound are also very strong. A zone of disturbance along the northern edge of the area is due to the proximity of metal fencing and the presence of an overgrown track.

A few discrete anomalies (areas of magnetic enhancement) have also been identified. These anomalies could be due to underlying archaeological features but the absence of any other evidence to support an archaeological interpretation precludes this as a likely cause. It is considered far more likely that the anomalies are due to localised variation in the superficial till deposits.

Area 2 (see Figs 6, 7 and 8)

The data from Area 2 is characterised by massive ferrous disturbance around the periphery of the survey area and by extensive individual and clusters of ferrous responses across the whole of the area. These anomalies are typically caused by ferrous (magnetic) material, either on the ground surface or in the topsoil, which causes rapid variations in the magnetic readings giving a characteristic, ‘spiky’, X-Y trace. Little importance is normally given 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, deliberate infilling or fly tipping. The extent of the disturbance suggests the deliberate and systematic spreading of magnetic material across the whole of the survey area.

5 Discussion and Conclusions

Despite both areas being apparently undeveloped the magnetic data suggests that in fact both areas have probably undergone varying degrees of landscaping and/or infilling. To the north in Area 1 the embankments are obviously relatively modern and are not of any archaeological significance. The ferrous responses suggest that they are comprised of building debris and are not merely earth bunds. The mound to the north is probably comprised of residual material from the construction of the embankments. Unfortunately this mound is immediately adjacent to the mapped location of the Bronze Age barrow making it virtually impossible to determine whether there might be any other archaeological features or deposits adjacent to the presumed location of the barrow.

Whilst there are no modern earthworks in Area 2 the data shows that there has been extensive spreading of magnetic material across the whole of the survey area, presumably to level up and consolidate the ground for the caravans. The strength and extent of the ferrous responses are such that it is considered unlikely that any anomalies due to underlying archaeological features would be identifiable against such a perturbed magnetic background.

In conclusion the strength and extent of the magnetic disturbance is such that the archaeological potential of the site cannot be evaluated on the basis of the geophysical survey results. There is no evidence to suggest that ground levels have been reduced so it is possible that archaeological features could still survive below the earthworks or a layer of magnetic material but that they cannot be detected due to the magnetic disturbance.

The results and subsequent interpretation of data from geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits.

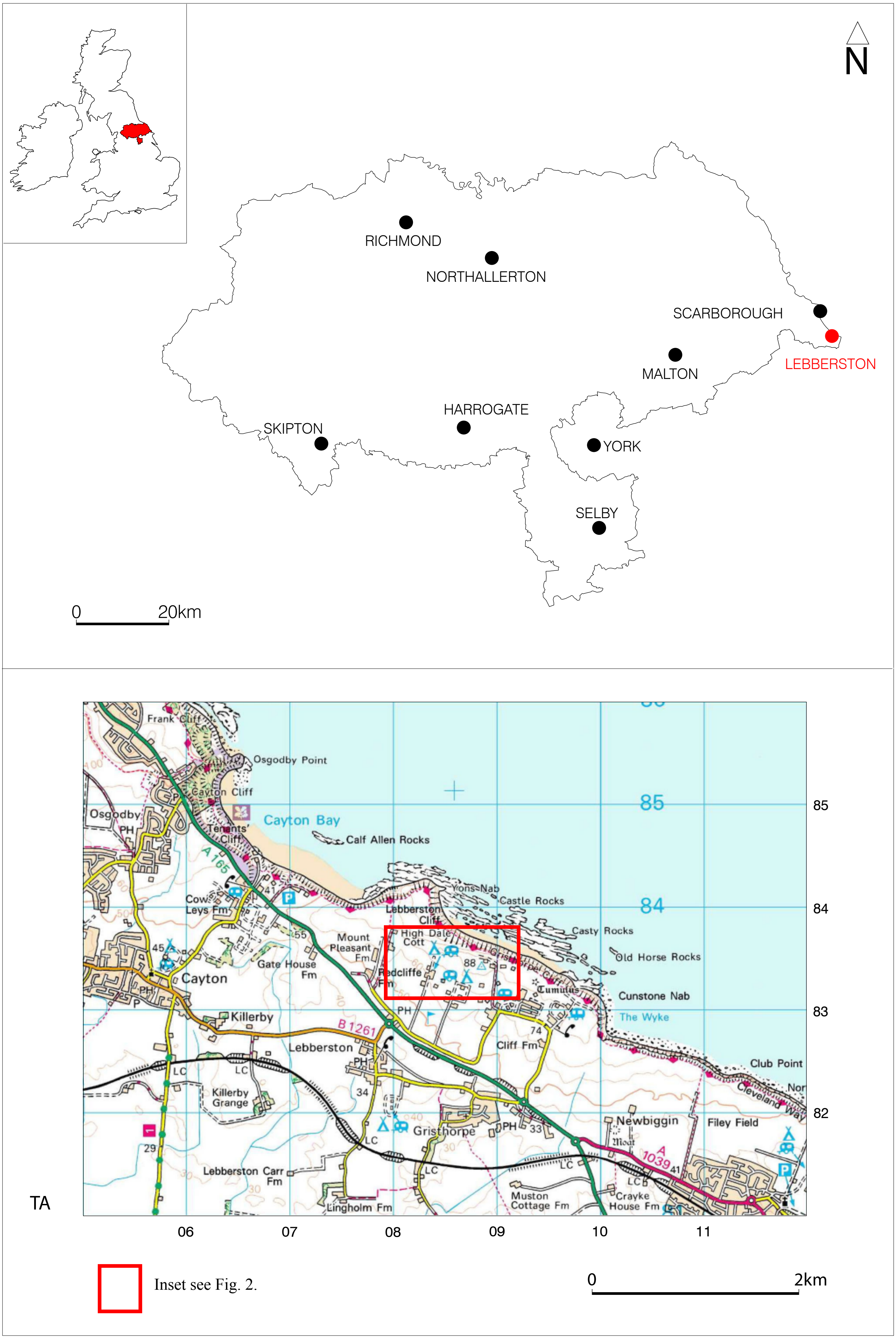

Fig. 1. Site location

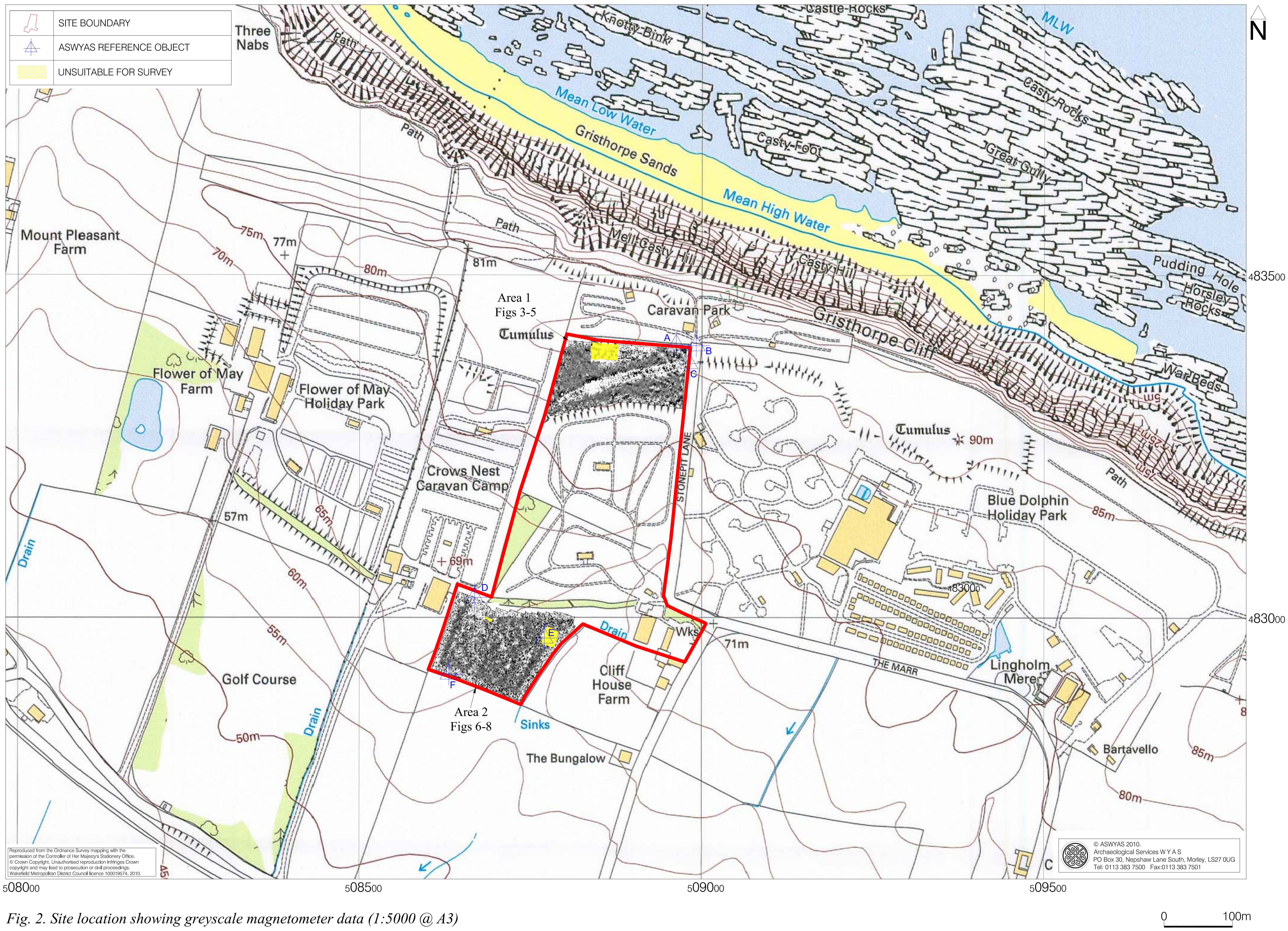

Fig. 2. Site location showing greyscale magnetometer data (1:5000 @ A3)

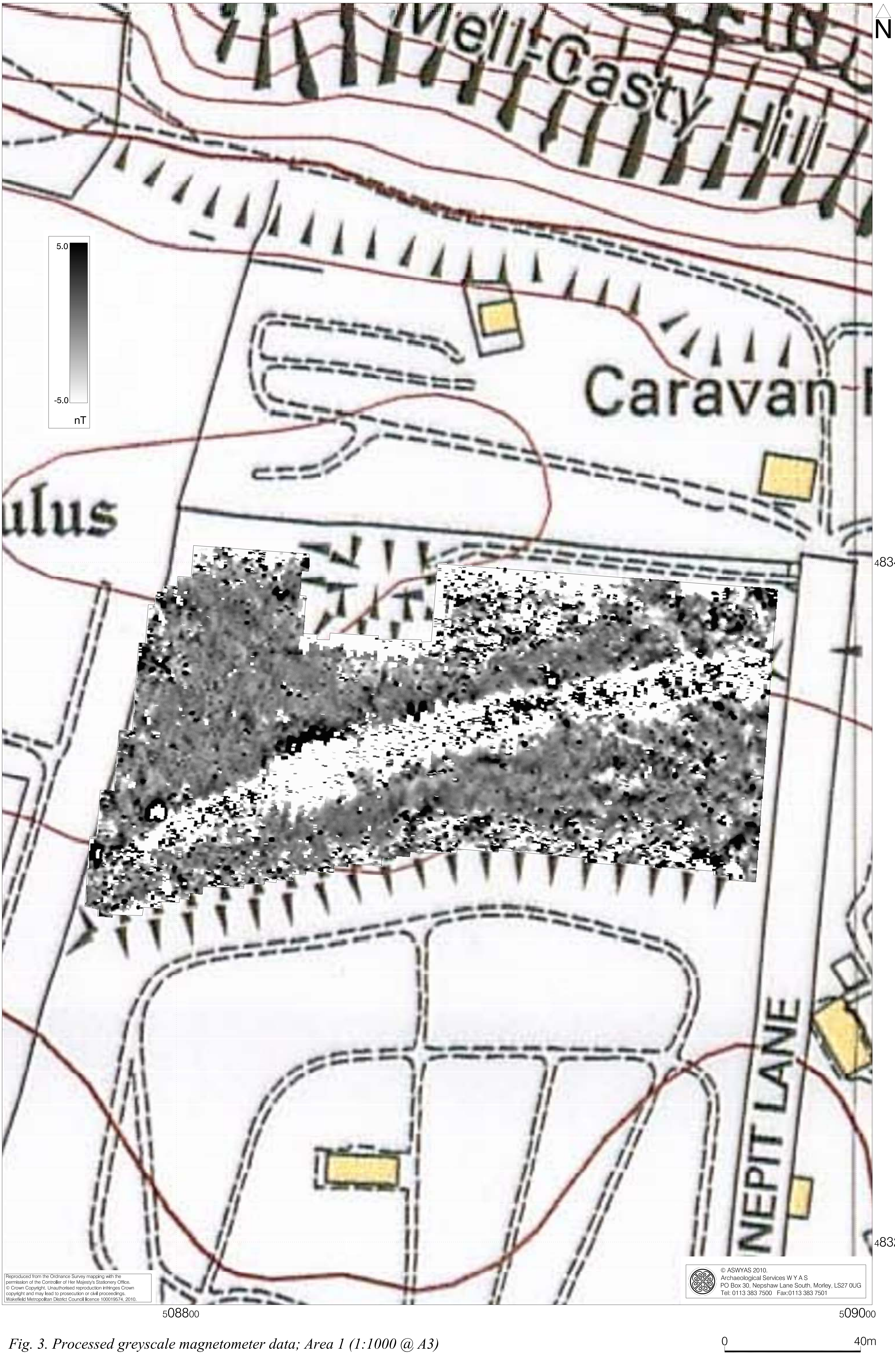

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Fig. 3. Processed greyscale magnetometer data; Area 1 (1:1000 @ A3)

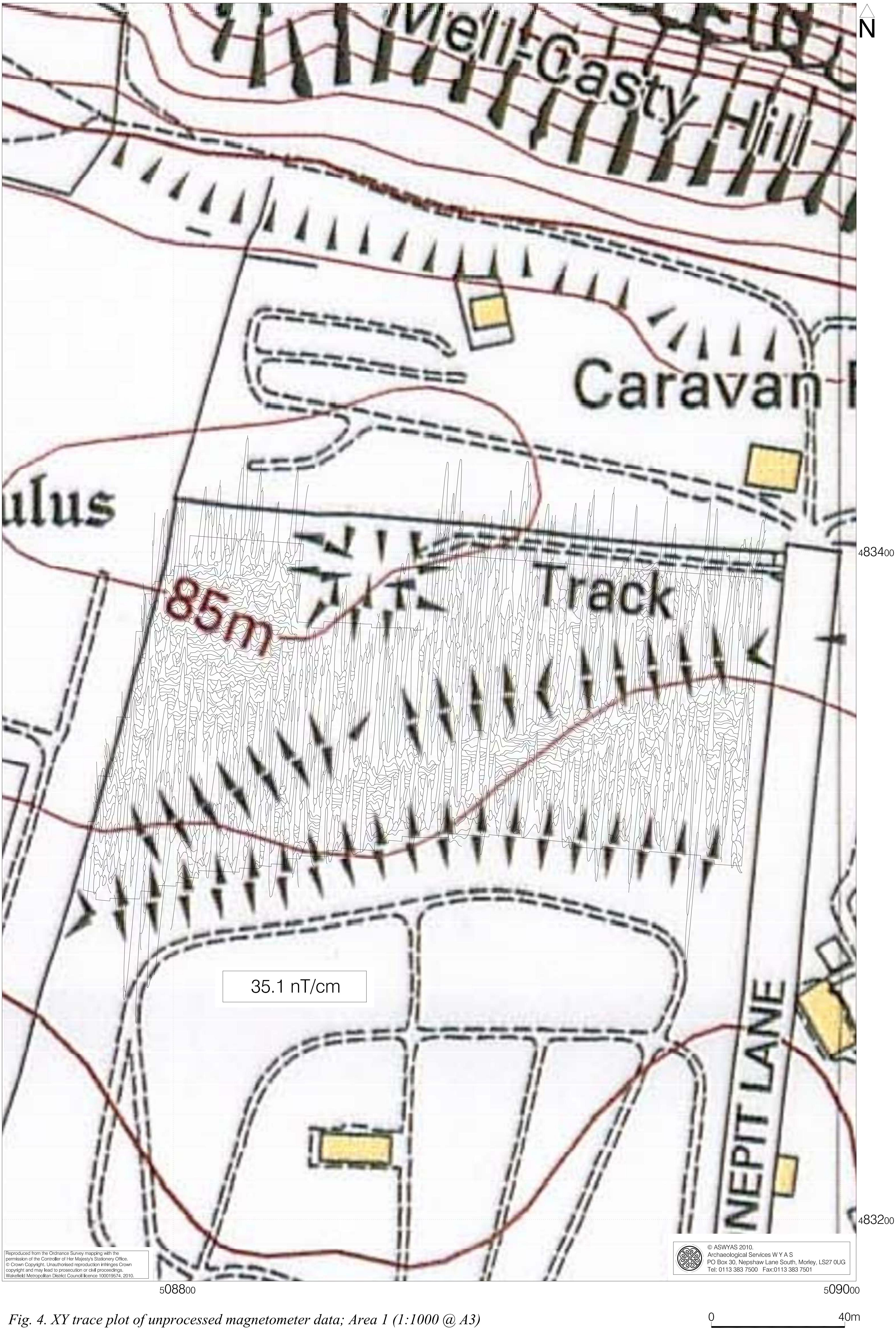

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Fig. 4. XY trace plot of unprocessed magnetometer data; Area 1 (1:1000 @ A3)

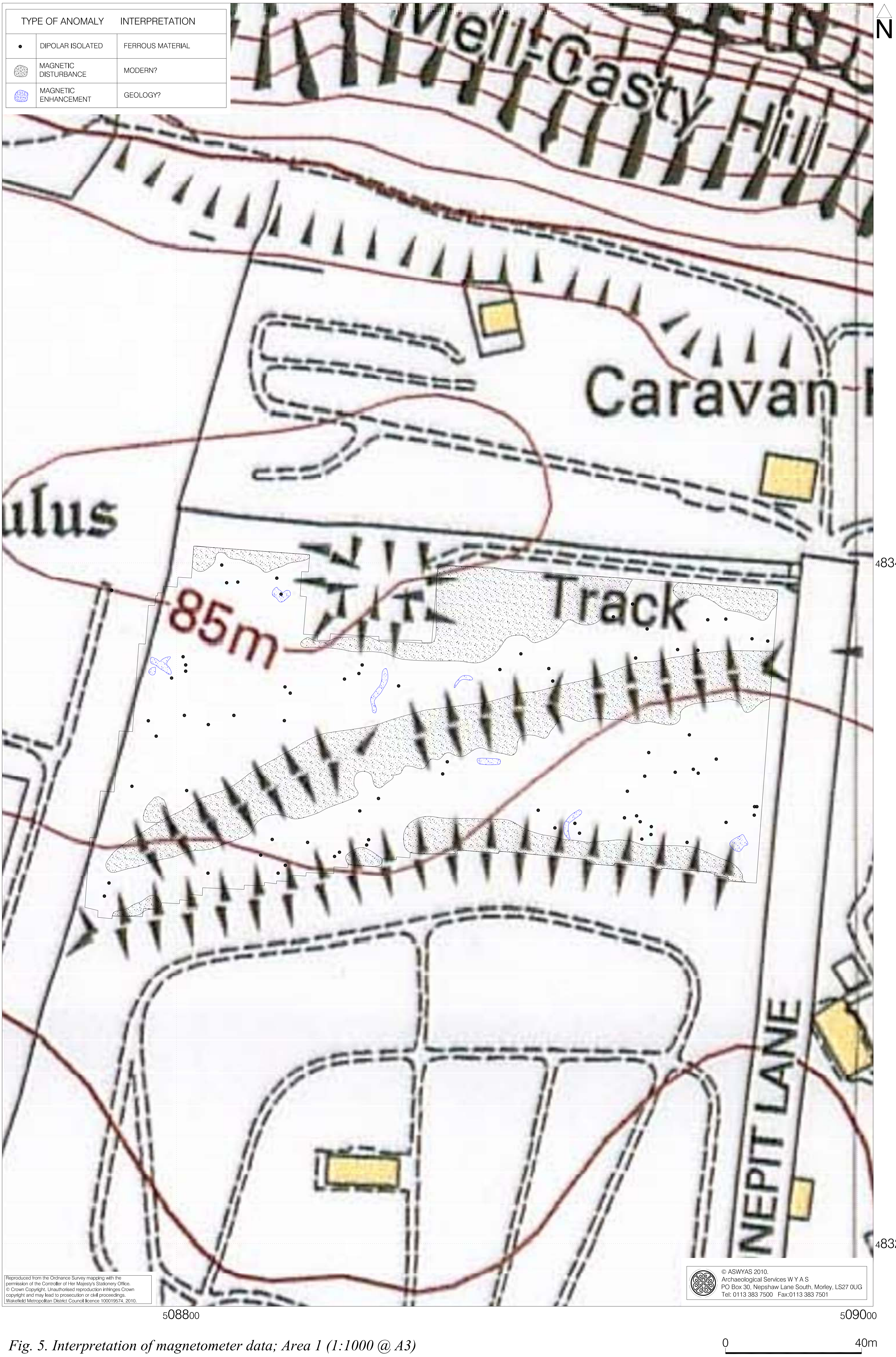

Fig. 5. Interpretation of magnetometer data; Area 1 (1:1000 @ A3)

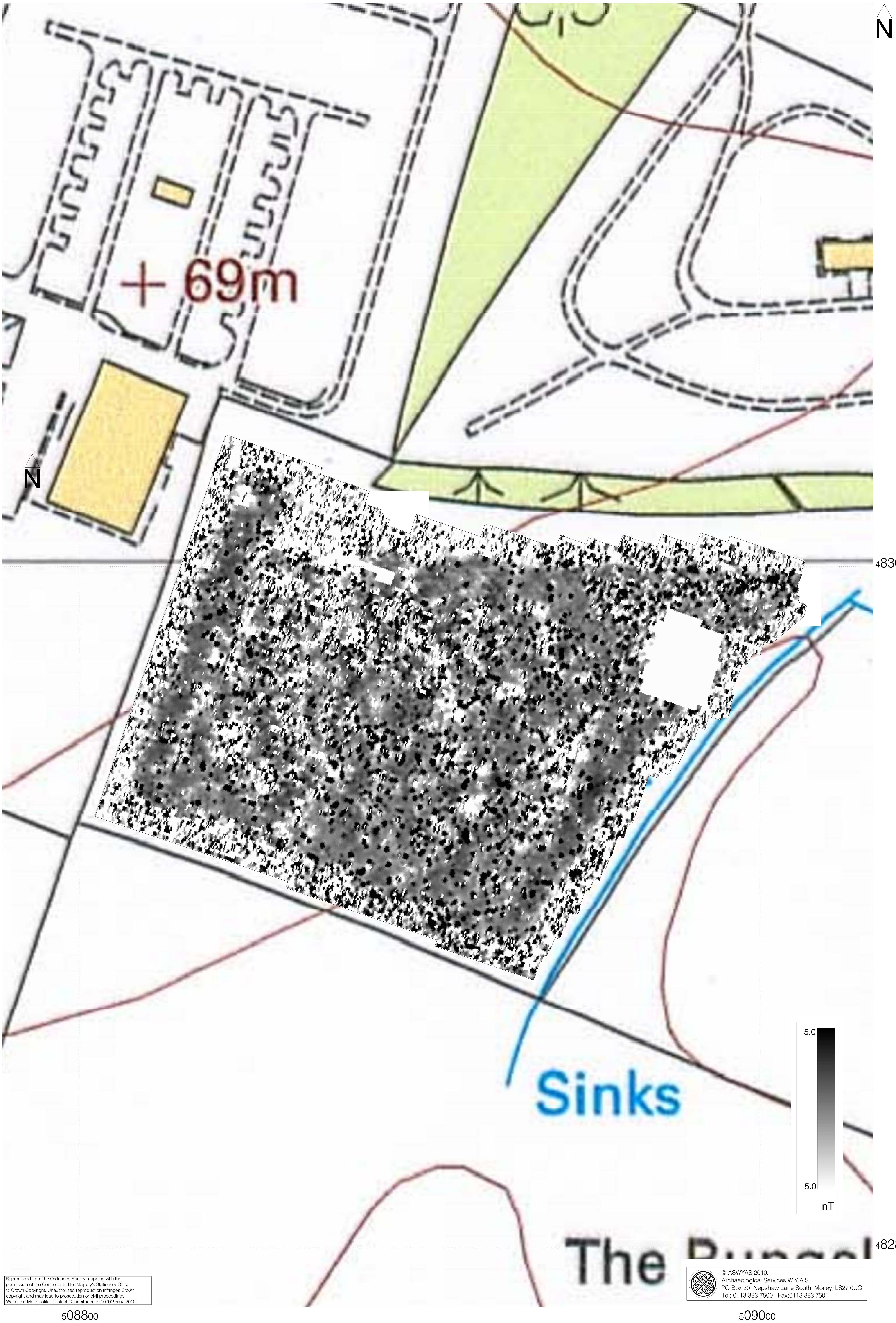

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Fig. 6. Processed greyscale magnetometer data; Area 2 (1:1000 @ A3)

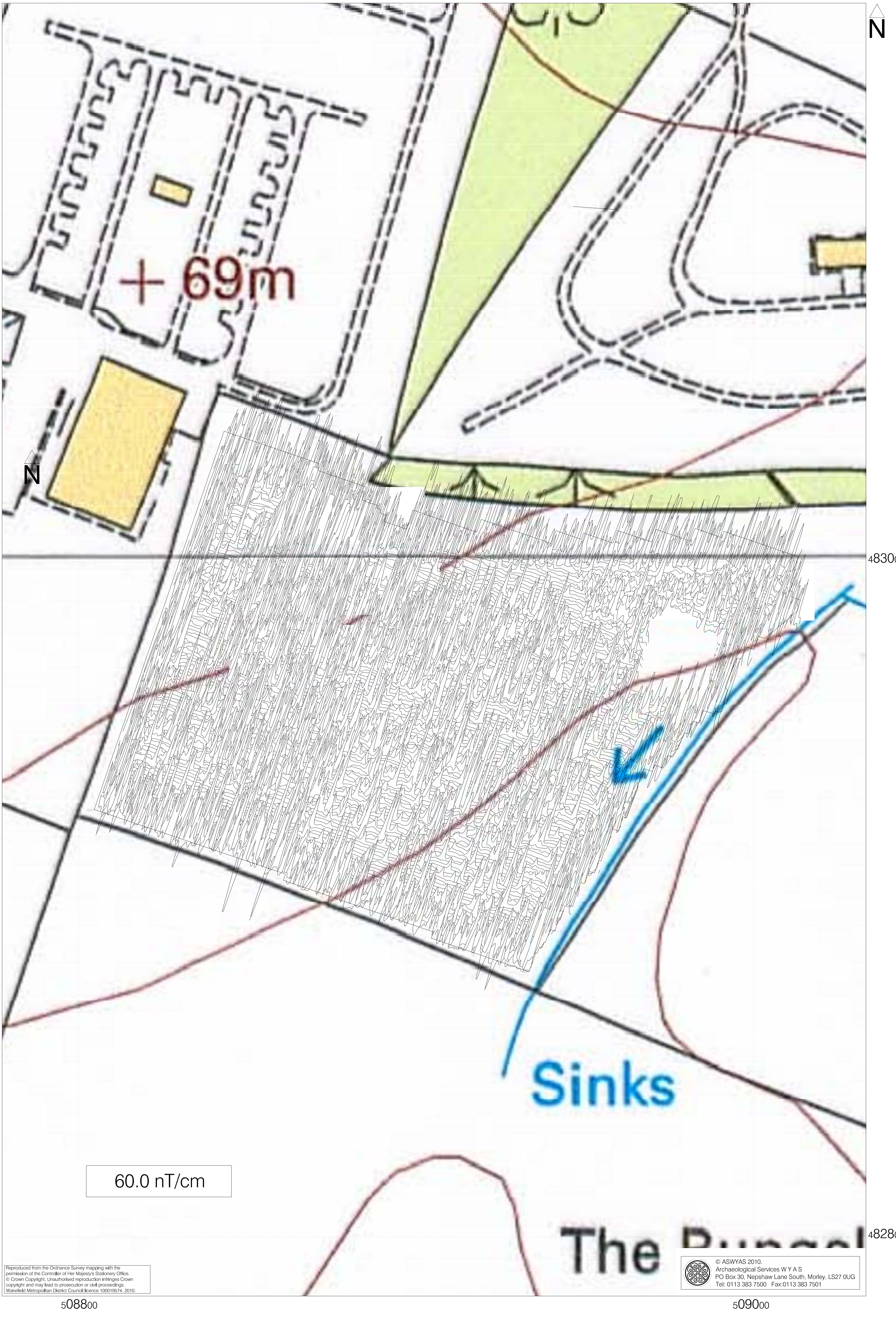

Fig. 7. XY trace plot of unprocessed magnetometer data; Area 2 (1:1000 @ A3)

0 40m

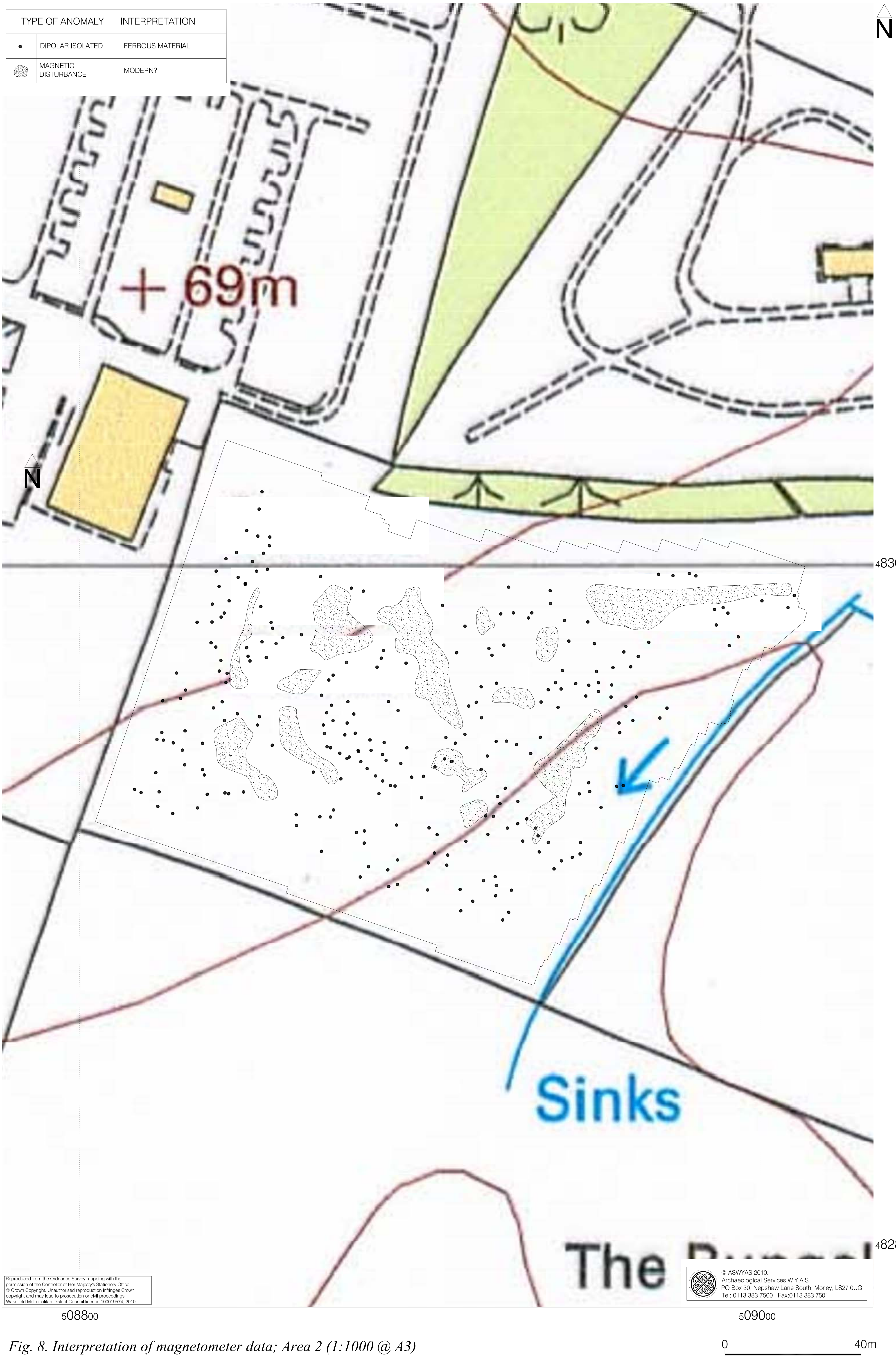

Fig. 8. Interpretation of magnetometer data; Area 2 (1:1000 @ A3)

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.

Data Processing and Presentation

The data from the magnetic susceptibility survey has been presented in this report as unprocessed. Mapinfo (Pitney Bowes) was used to display the results as a Thematic Map.

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	508964.455	483399.025
B	508993.576	483397.835
C	508982.661	483371.827
D	508669.838	483030.245
E	508771.615	482970.986
F	508632.138	482918.425

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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