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SERVICES
WYAS

A16 - A158 Partney Bypass
Partney
Lincolnshire

Additional Geophysical Survey

June 2002

Report No. 1017.

CLIENT

Babtie

A16 - A158 Partney Bypass

Partney
Lincolnshire

Additional Geophysical Survey

Contents

Summary

Additional geophysical (fluxgate gradiometer) survey, covering approximately 3 hectares, was carried out along the route of the proposed A16 - A158 Partney Bypass. The additional survey has helped to further define and characterise the archaeological sites located along the route of the proposed Partney bypass. At the northern end of the A16 bypass corridor archaeological activity around a previously identified enclosure has been shown to continue to the north and east. Along the A158 bypass corridor the continuation of previously identified interconnecting linear anomalies could suggest a possible ladder settlement. Adjacent to the stream further anomalies thought to be caused by natural processes have been identified.

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1. Introduction and Archaeological Background

1.1 Archaeological Services WYAS was commissioned by Mr A. Scruby, of Babtie Group, on behalf of Lincolnshire County Council to carry out additional geophysical (fluxgate gradiometer) survey at selected points along the proposed route of the A16 - A158 Partney Bypass (see Figs 1 and 2). The additional survey covered approximately 3 hectares.

1.2 The proposed A16 bypass is located to the west of Partney and runs for approximately 1.2km on a north to south alignment. The proposed A158 bypass is located to the south of Partney and runs for approximately 1.5km on an east to west alignment. However, ecological constraints have led to a proposed re-routing of the A158 section to the south of the previously proposed route. Additional geophysical survey was therefore required to evaluate along the proposed new route. Further survey was also carried out towards the northern end of the A16 bypass around a previously identified enclosure site.

1.3 Both bypass routes are on generally flat ground, at about 20 metres AOD, with the occasional gentle undulations or break of slope. The geology varies across the bypass routes and includes the Claxby Ironstone Formation, at the north of the A16 bypass, Spilsby Sandstone, possibly outcropping at the northern and central parts of the A16 bypass, and Kimmeridge clays, located at the western and southern ends of both schemes. Drift deposits, comprising recent age River Alluvium, Glacial Sands and Gravels and Glacial Till, are also present within the proposed bypass routes.

1.4 At the time of survey, between June 12th 2002 and June 17th 2002, all the additional areas contained mature arable crops. The height of these crops (at least 1m) severely affected both the speed with which the survey could be completed and the quality of the resulting data (see Section 4.4).

1.5 The village of Partney lies within the Lincolnshire Wolds, an area generally rich in archaeological remains, with evidence for settlement and farming dating from the Neolithic. Partney itself is believed to have a 6th century Anglian origin and a monastery, location now unknown, was founded there in the 7th century. A large round barrow, dated to circa AD600, that contained burials and grave goods is located at the eastern end of the proposed A158 bypass. There is also direct evidence for Romano-British and possibly earlier activity in the immediate vicinity of Partney. Within, and adjacent to, the proposed A16 bypass there are two cropmarked circular features, interpreted as Bronze Age funereal monuments, a cropmarked enclosure, interpreted as medieval in date, and Romano-British pottery findspots. The earlier geophysical survey (Whittingham 2002) identified four probable sites of archaeological activity along the proposed bypass corridor.

2. Methodology and Presentation

2.1 The objectives of the survey were:

- to use detailed magnetic survey to establish the presence, extent and character of any magnetic anomalies within the revised A158 road corridor

- to define the extent of an enclosure identified during an earlier survey.

2.2 The survey was carried out in accordance with the Specification for Geophysical Survey (Babtie Group 2002) although, as in the previous survey, the raw data dot density displays and the processed X-Y trace plots of all of the survey areas have not been presented as they did not provide any additional archaeological information. The survey methodology and report presentation also use the recommendations outlined in the English Heritage Guidelines (David 1995) as a minimum standard. All figures reproduced from Ordnance Survey mapping are done so with the permission of the controller of Her Majesty's Stationery Office, © Crown copyright.

2.3 A general site location plan incorporating the 1:50000 Ordnance Survey mapping is shown in Figure 1. Figure 2 is a composite showing the processed gradiometer data from both surveys, in a greyscale format, superimposed onto an Ordnance Survey digital base map at a scale of 1:5000. This figure also includes digital information of the proposed road scheme and historical and archaeological detail, provided by Babtie Group (dated March 2002). The processed greyscale data is also shown, at a scale of 1:1000, in Figures 3, 5, 7, 9 and 11; the alphabetical block labelling used in the previous survey is retained in this report. The accompanying interpretations are shown at the same scale in Figures 4, 6, 8, 10 and 12. All the figures incorporate the information from the previous survey (Whittingham 2002). The unprocessed data is shown at a scale of 1:500 as both greyscale and X-Y trace plots in Appendix 4.

2.4 Comprehensive technical details on the underlying principles of magnetic survey, the equipment used and general geophysical survey methodology are given in Appendix 1 along with details on data processing and display. The survey location information is presented in Appendix 2 and the composition of the archive is given in Appendix 3.

3. Results and Discussion

The interpretative figures should not be looked at in isolation but in conjunction with the relevant discussion section and with the information contained in the Appendices.

3.1 Blocks A16_D and A16_E (Figs 3 and 4)

3.1.1 A strip 20m wide was surveyed parallel with the western edge of A16_D and 40m wide on the eastern edge of A16_E in order to define the extent of the enclosure identified during the previous survey.

3.1.2 In Block A16_D the linear anomaly (typical of an infilled ditch) defining the western edge of the enclosure can be seen continuing to the north with a gap locating a possible entrance. Other less coherent linear and curvilinear anomalies are also identified to the west of the enclosure although there is no obvious link between these anomalies and the enclosure itself. These latter anomalies are therefore only interpreted as possible archaeological ditches.

3.1.3 The additional survey east of Block A16_E has also identified further interconnecting linear and curvilinear anomalies thus demonstrating that the enclosure identified previously is not isolated but is part of a complex of enclosures and sub-enclosures which continues to the east and north. It may be part of a much larger system of enclosure and land division which includes the possible enclosures identified in Blocks A16_G and A16_H during the initial geophysical survey. More discrete areas of magnetic enhancement (which may be caused by discrete features such as pits or by areas of burning) are again noted adding further to the argument that this enclosure may have been the focus of occupational activity.

3.2 **Block A158_A** (Figs 5 and 6)

3.2.1 Several broad areas of magnetic enhancement have been identified at the eastern end of this block. The breadth and shape of these anomalies strongly suggests a geological origin and, as in the previous survey, are interpreted as being caused by episodes of erosion and deposition associated with the stream located immediately to the north. No anomalies of archaeological potential have been identified in the additional survey undertaken in this block.

3.3 **Blocks A158_B and A158_C** (Figs 7 and 8)

3.3.1 Many more areas of magnetic enhancement, similar to those identified in Block A158_A, are identified in the additional survey undertaken in these two blocks. The very broad response of these anomalies allied to the proximity to the current stream course and the lack of any discernable pattern again makes a natural origin probable although an archaeological origin should not be totally dismissed.

3.4 **Blocks A158_D and A158_E** (Figs 9, 10, 11 and 12)

3.4.1 Further positive, linear anomalies within both survey blocks have been identified. The majority of these anomalies are aligned north-west to south-east with several anomalies perpendicular to these.

3.4.2 The linearity and regularity of these anomalies is strongly suggestive of a modern origin and it is probable that former agricultural regimes, possibly including ridge and furrow ploughing and drainage features, causes most of these anomalies.

3.4.3 At the western end of Block A158_E and in the eastern half of Block A158_D there are several stronger linear anomalies and areas of magnetic enhancement. These linear anomalies are on a slightly different alignment to the series of probable agricultural anomalies and some of them appear to have returns.

3.4.4 These factors coupled with the presence of the areas of magnetic enhancement, some of which are quite strong and linear, suggests archaeological activity, with possibly at least two archaeological enclosures. The complicating presence of the agricultural anomalies makes an exact interpretation of individual anomalies difficult and it could be that some of the anomalies are agricultural rather than archaeological in origin. However, the greater area now surveyed and the greater number of anomalies that are slightly oblique to the ridge and furrow anomalies enables a higher degree of confidence to be placed on an archaeological interpretation, possibly a ladder settlement.

4. Conclusions

4.1 The additional survey has helped to further define and characterise the archaeological sites located along the route of the proposed Partney bypass. Along the A16 section, in Blocks A16_D and E, what initially appeared to be a single isolated enclosure has been shown to continue to the north and east towards the river, possibly being part of the same system of enclosure identified in the previous survey 250m to the north in Blocks A16_G and H. Several curvilinear ditch type anomalies and areas of enhancement strongly suggest occupational activity.

4.2 In the A158 section of the bypass additional survey south of the original corridor in Block A158_D and E has demonstrated the continuance of the intersecting linear anomalies tentatively interpreted as archaeological ditches in the previous report. The increased area now surveyed enables an archaeological interpretation to be ascribed with a higher degree of confidence with the pattern of anomalies seeming to describe a possible ladder settlement. However, the presence of ridge and furrow anomalies on a very similar alignment still makes the precise nature of individual anomalies difficult to interpret with certainty.

4.3 Further west, south of A158_A, B and C, more broad anomalous areas of enhanced susceptibility have been identified. Given the proximity to the stream and the lack of any coherent pattern to the anomalies a natural, geological origin is considered likely.

4.4 In the period between the initial survey and the additional work the crops increased substantially in height. This resulted in extremely difficult survey conditions and meant that the instrument had to be held at a much higher height above the ground than was the case during the initial survey. Consequently the data quality was poor and needed a high degree of processing. In addition, as demonstrated where parts of the same area were surveyed during both surveys, the strength of the anomalies is reduced. As a result there may be more, weak anomalies that could not be detected due to the poor survey conditions, particularly in Blocks A158_D and E.

Bibliography

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Whittingham, M., 2002. A16-A158 Partney Bypass, Partney, Lincolnshire, ASWYAS, unpubl., R1013

Acknowledgements

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Figures

Appendices

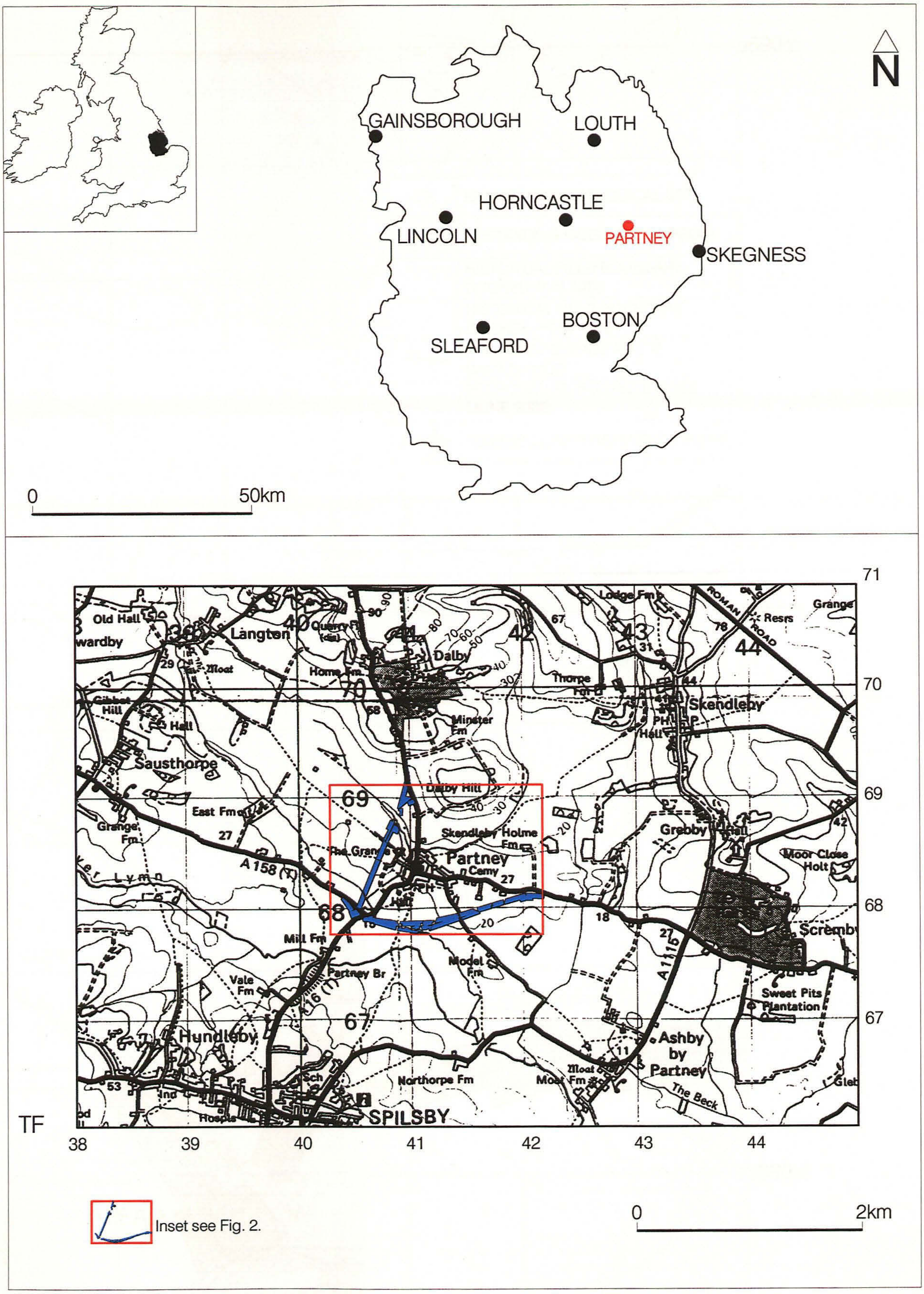

Fig. 1. Site location

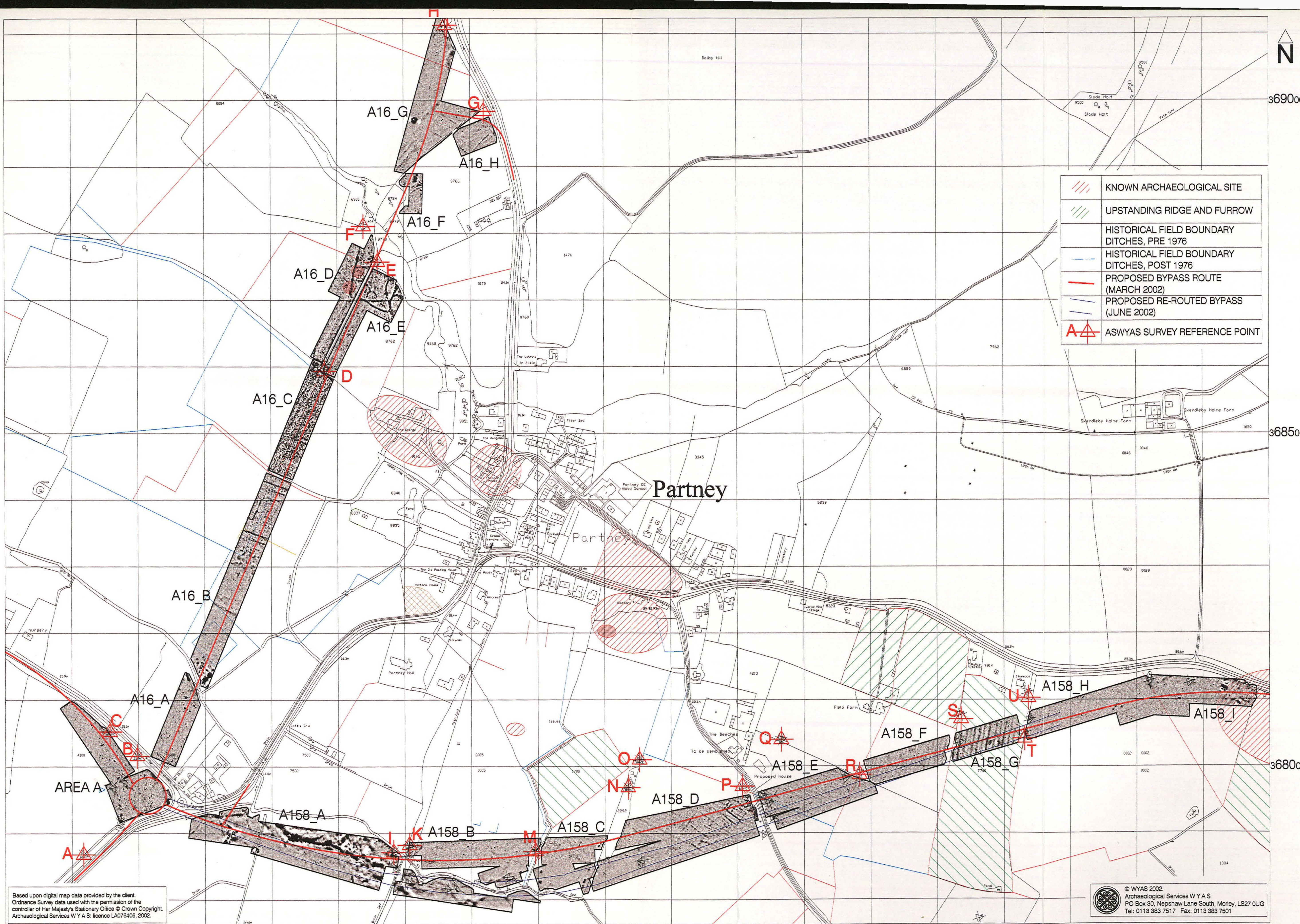

Fig. 2. Survey location information showing composite of processed greyscale gradiometer data

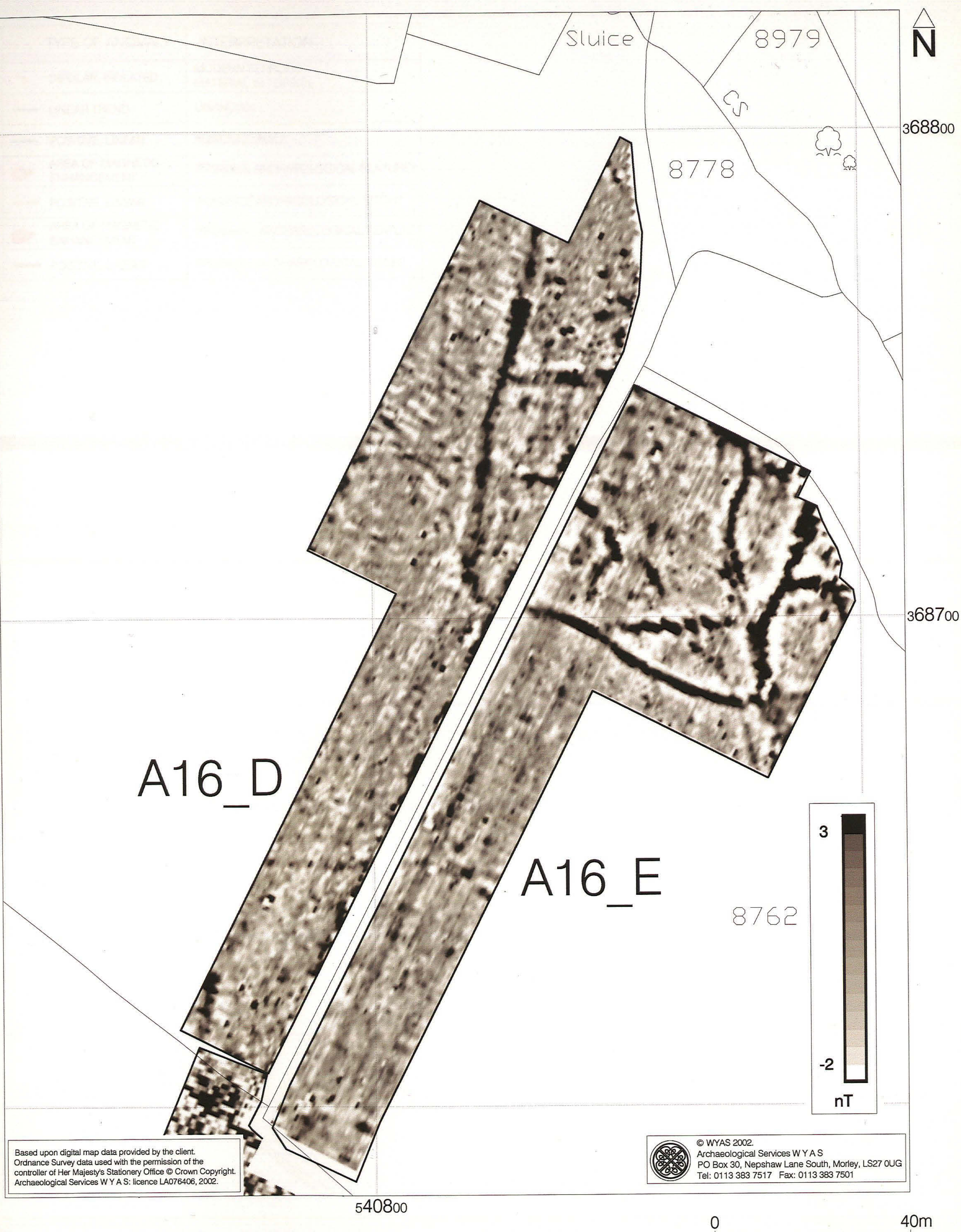

Fig. 3. Greyscale plot of the processed gradiometer data; Blocks A16_D and A16_E

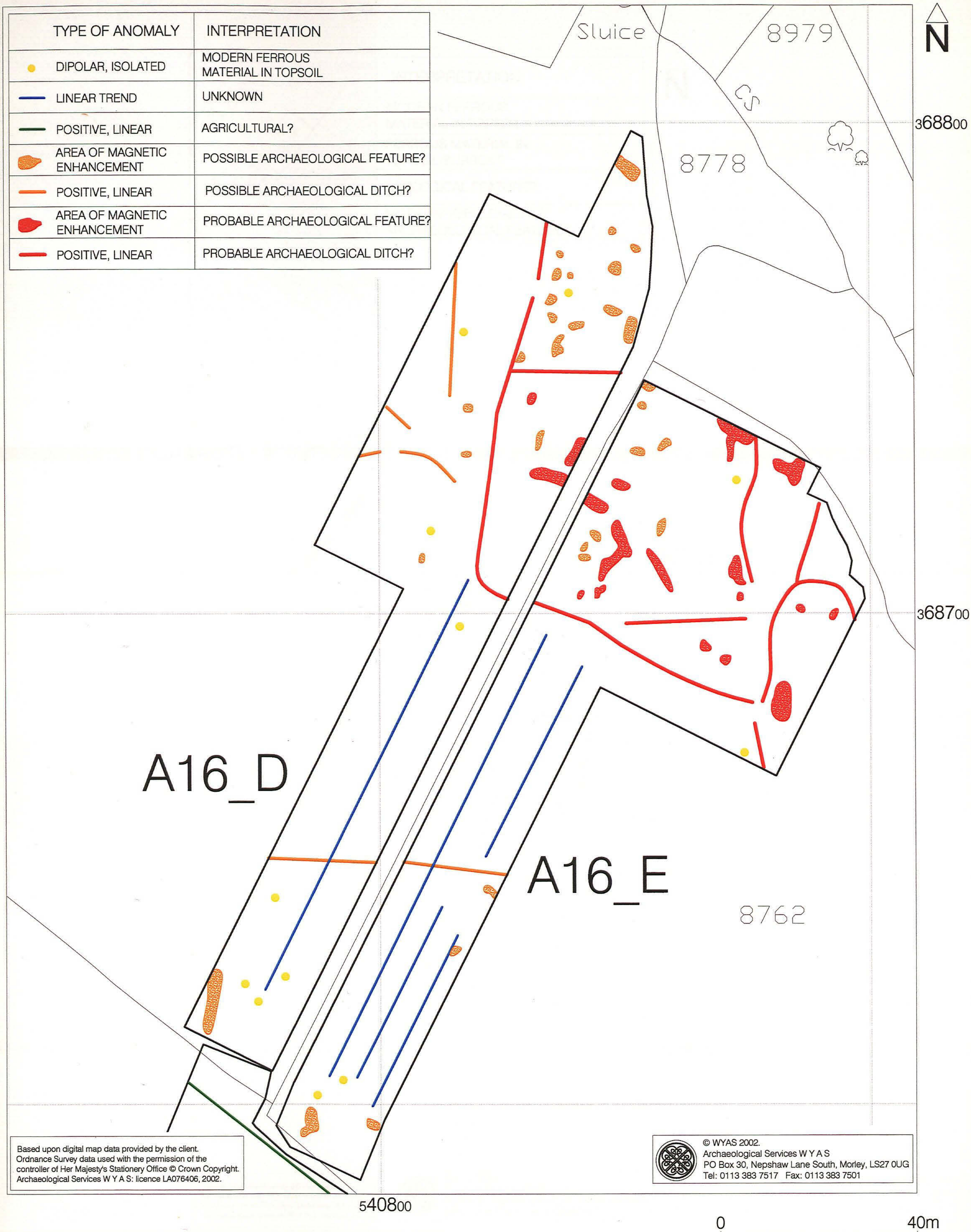

Fig. 4. Interpretation of the processed gradiometer data; Blocks A16_D and A16_E

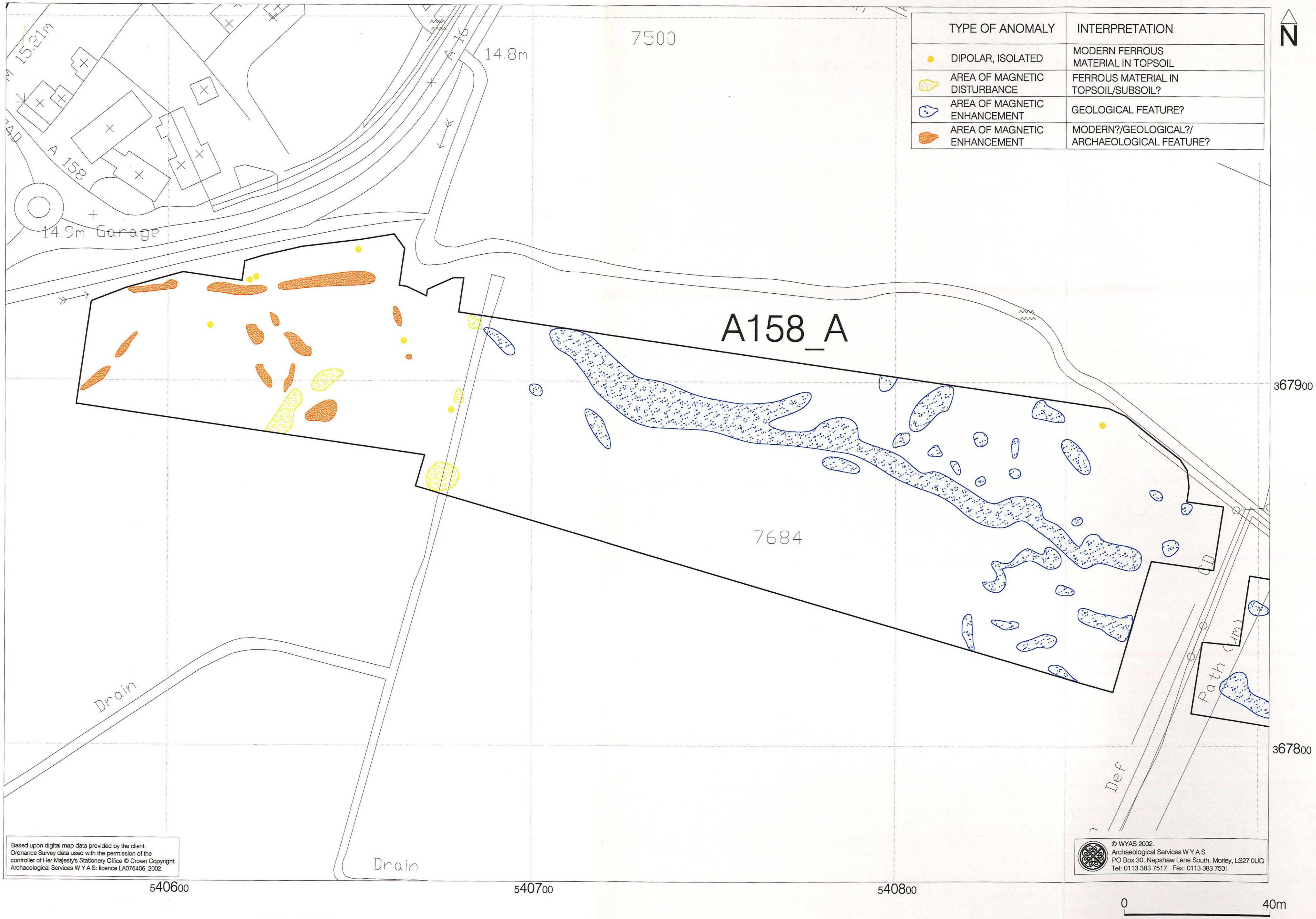

Fig. 6. Interpretation of the processed gradiometer data; Block A158_A

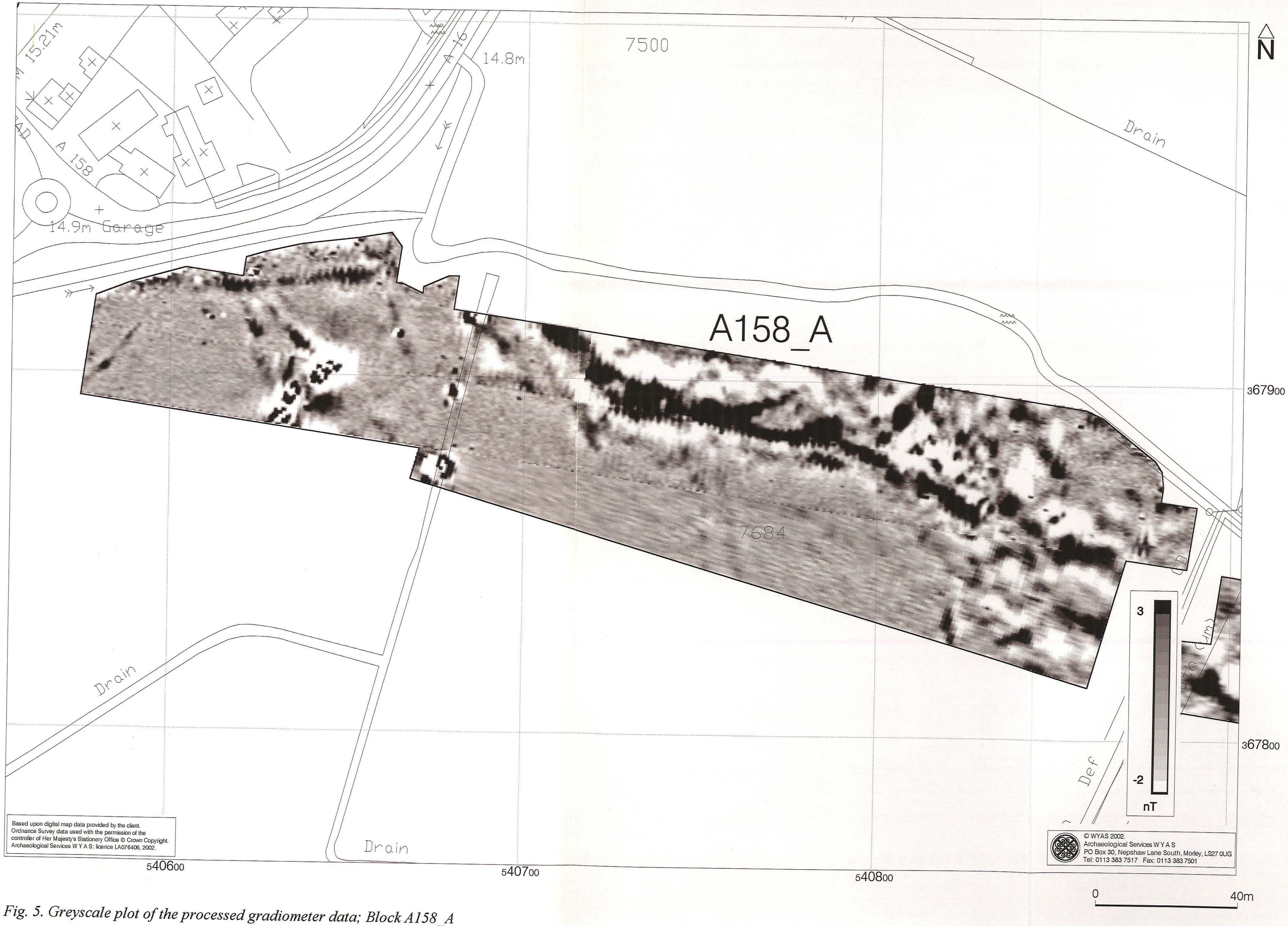

Fig. 5. Greyscale plot of the processed gradiometer data; Block A158_A

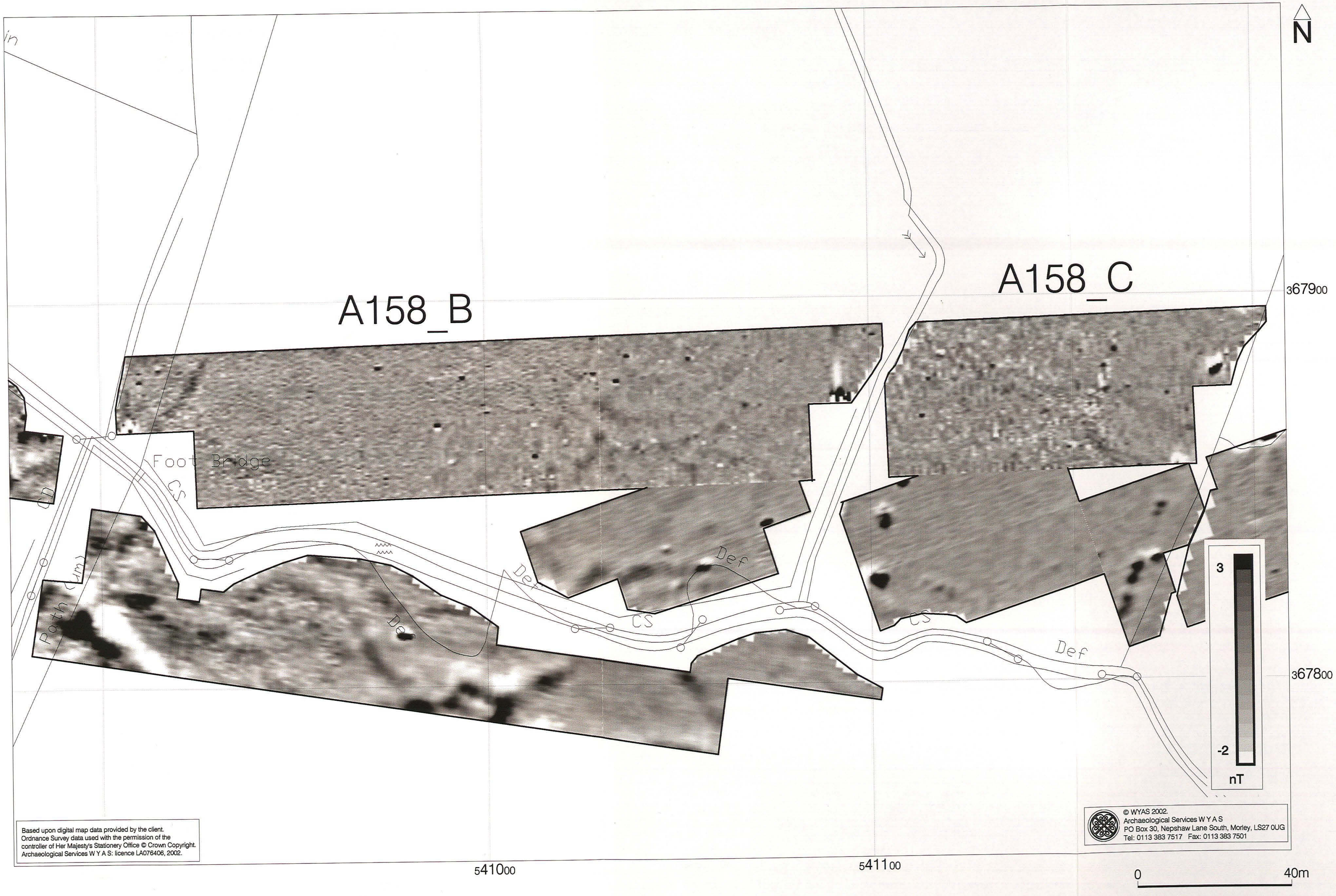

Fig. 7. Greyscale plot of the processed gradiometer data; Blocks A158_B, and A158_C

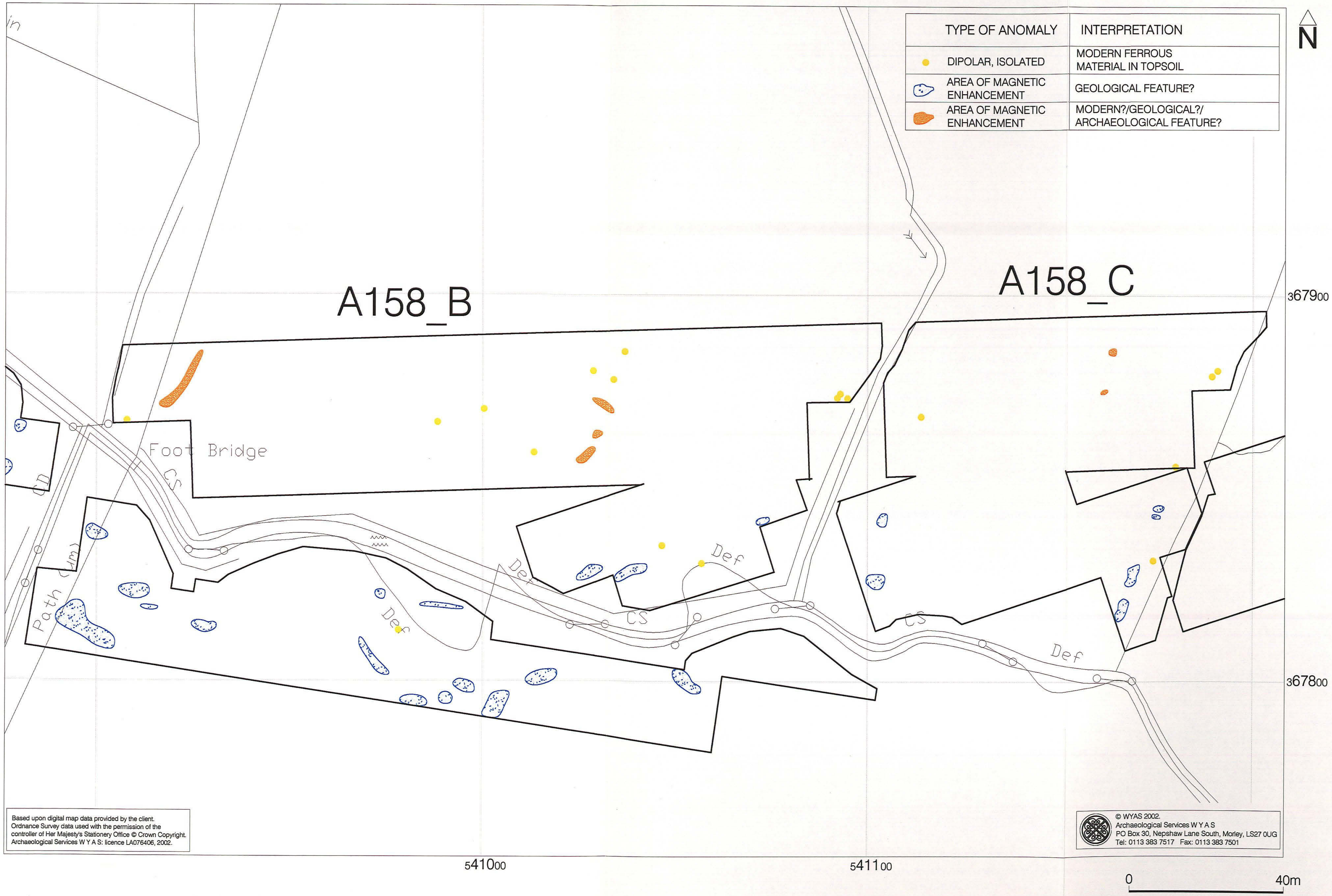

Fig. 8. Interpretation of the processed gradiometer data; Blocks A158_B, and A158_C

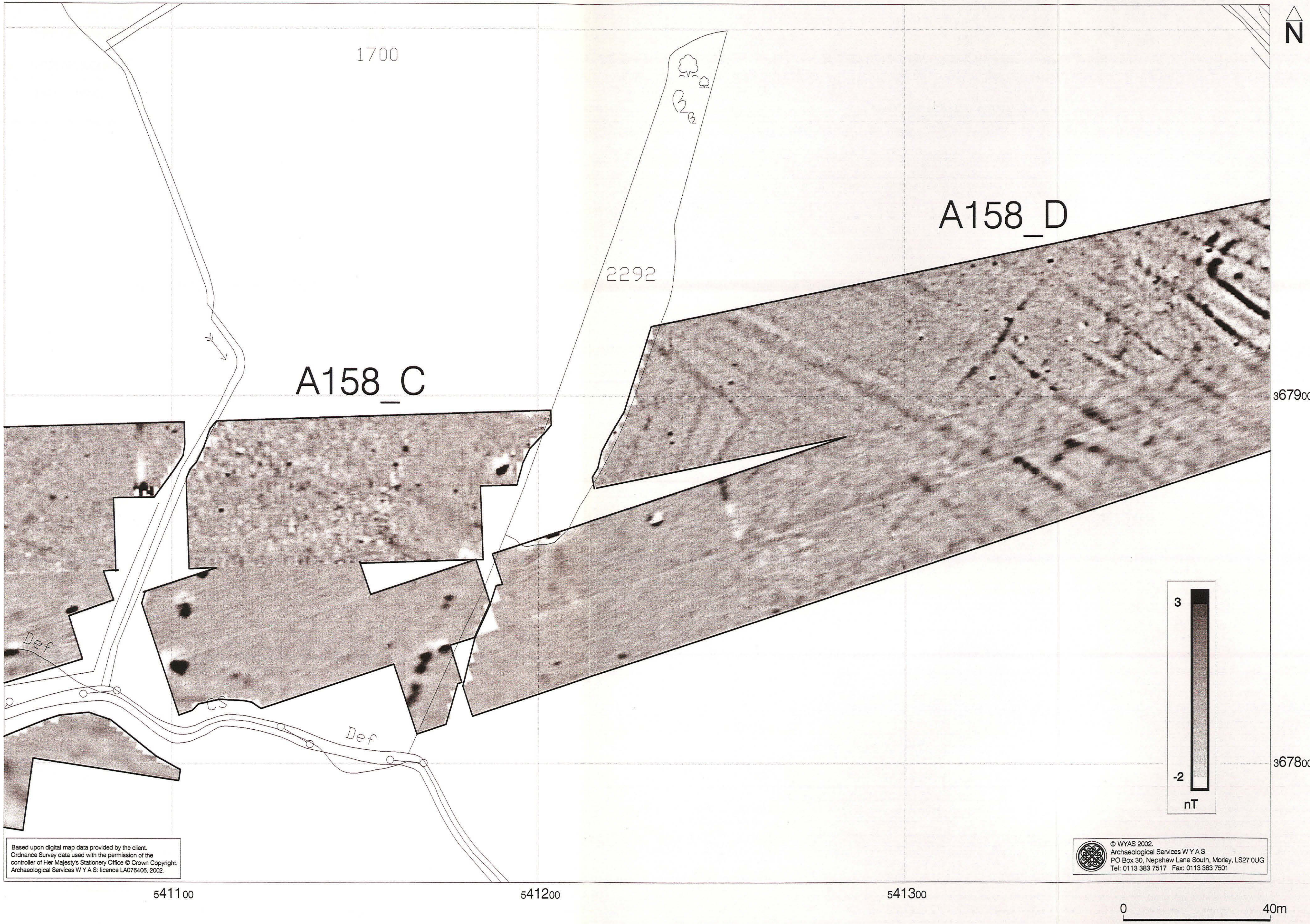

Fig. 9. Greyscale plot of the processed gradiometer data; Blocks A158_C, eastern part of A158_B and western part of A158_D

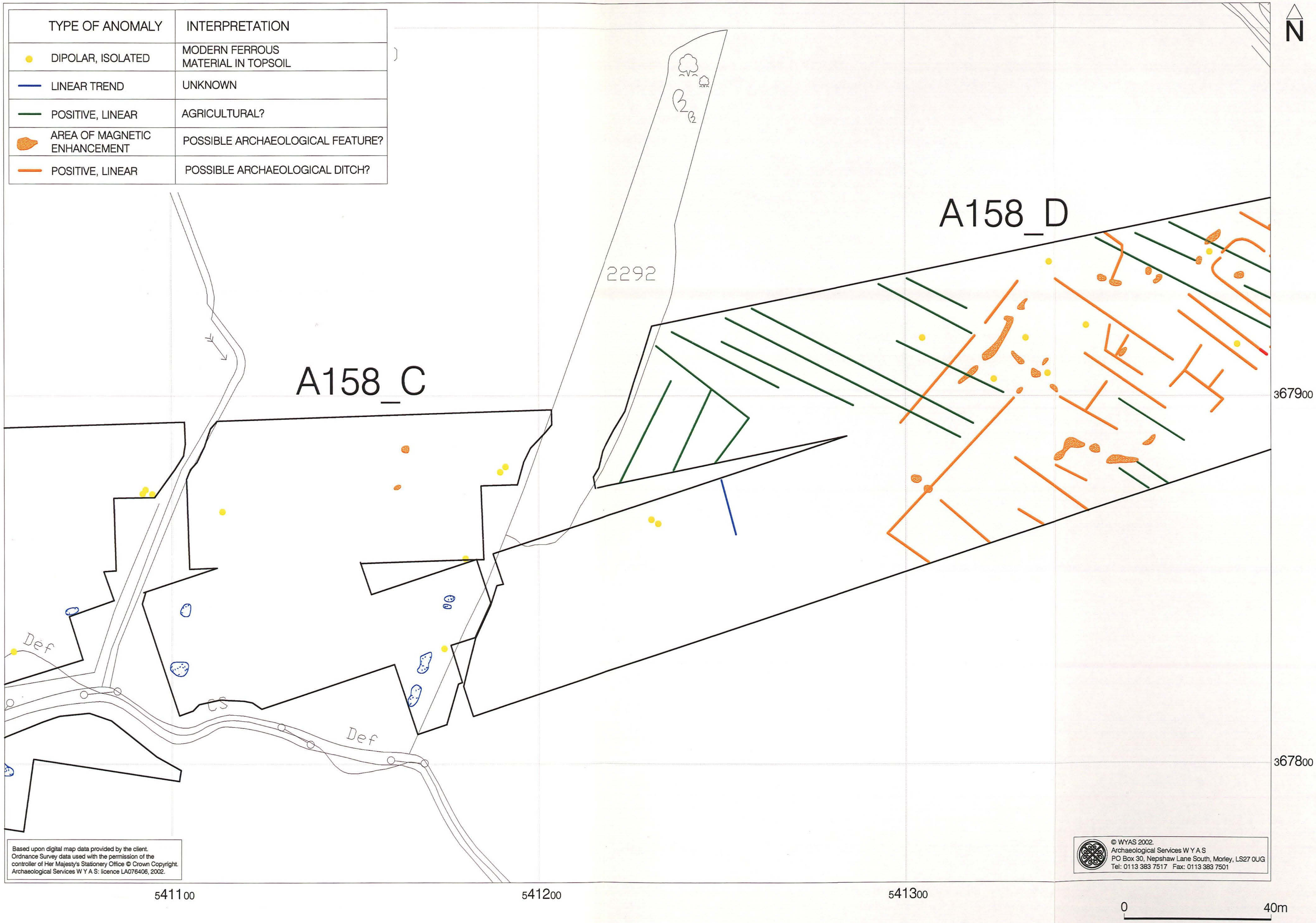

Fig. 10. Interpretation of the processed gradiometer data; Blocks A158_C, eastern part of A158_B and western part of A158_D

Fig. 11. Greyscale plot of the processed gradiometer data; Blocks A158_E, eastern part of A158_D and western part of A158_F

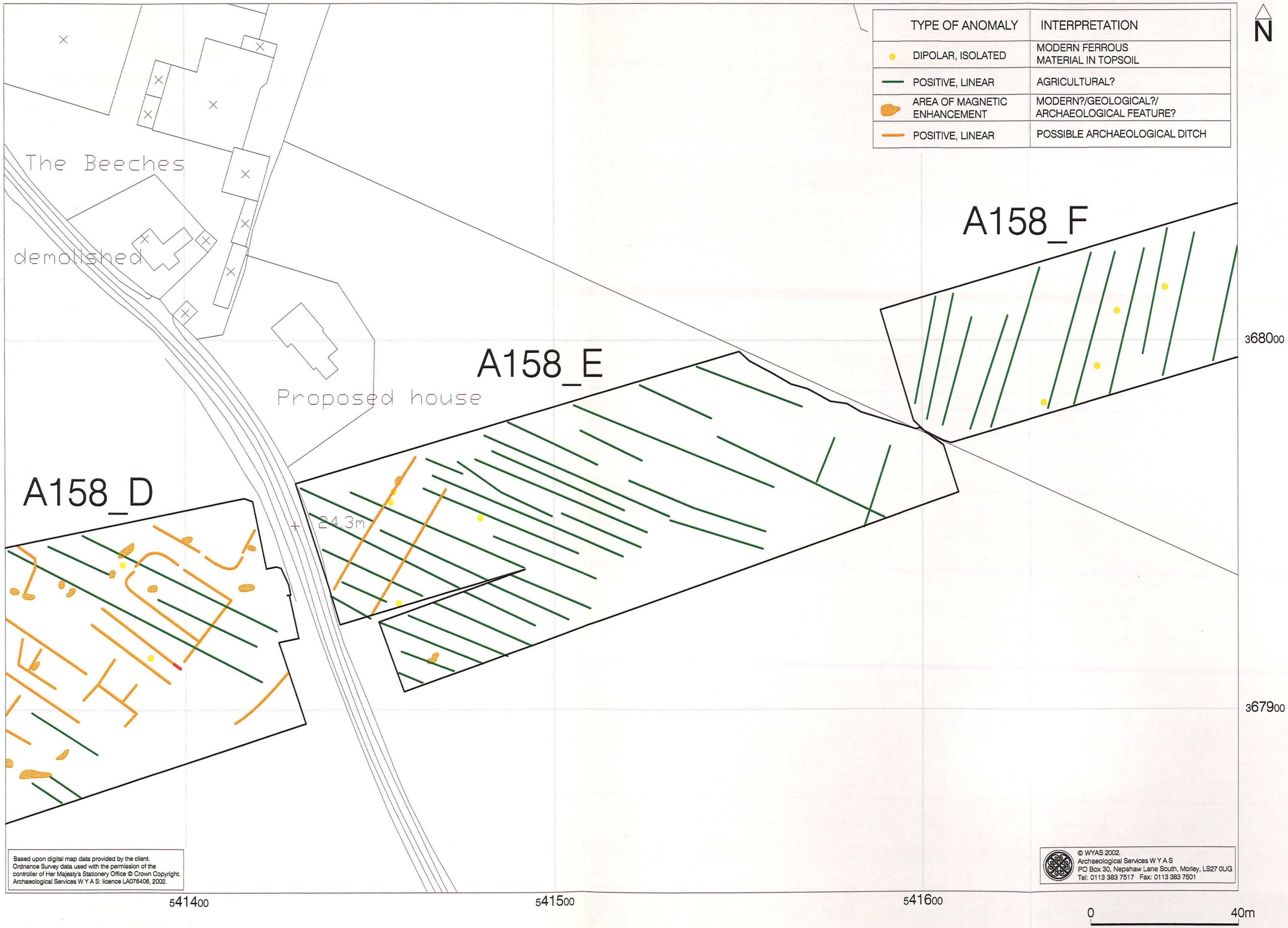

Fig. 12. Interpretation of the processed gradiometer data; Blocks A158_E, eastern part of A158_D and western part of A158_F

Appendix 1

Magnetic Survey: Technical Information

1. Magnetic Susceptibility and Soil Magnetism

1.1 Iron makes up about 6% of the Earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haematite. 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).

1.2 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 which intrude into the topsoil may give a negative magnetic response relative to the background level.

1.3 The magnetic susceptibility of the soil can also be enhanced significantly by heating. This can lead to the detection of features such as hearths, kilns or burnt areas.

2. Types of Magnetic Anomaly

2.1 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 which, 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 geologies.

2.2 Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

2.3 It should be noted that anomalies that are interpreted as modern in origin may 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.

2.4 The types of response mentioned above can be divided into five main categories which 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. This type of anomaly is characterised by very strong, 'spiky' variations in the magnetic background. 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 X–Y trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic of an area of magnetic disturbance or of an 'iron spike' (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post holes or by kilns, with the latter often being characterised by a strong, positive double peak response. 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.

3. *Methodology*

3.1 Magnetic Susceptibility Survey

3.1.1. 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

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3.2 Gradiometer Survey

3.2.1. There are two main methods of using the fluxgate gradiometer for commercial evaluations. The first of these is referred to as scanning and requires the operator to visually identify anomalous responses on the instrument display panel whilst covering the site in widely spaced traverses, typically 10-15m 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. In favourable circumstances scanning may be used to map out the full extent of features located during a detailed survey.

3.2.2. 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 0.5m 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.

3.2.3. The Geoscan FM36 fluxgate gradiometer and ST1 sample trigger were used for the detailed gradiometer survey. Readings were taken, on the 0.1nT range, at 0.25m intervals on zig-zag traverses 1m apart within 20m by 20m square grids.

3.3 Data Processing and Presentation

3.3.1. The detailed gradiometer data has been presented in this report in X-Y trace and greyscale formats. An X-Y 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 at 10nT. 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'. The X-Y trace plots were produced using Geoplot 3.0 (Geoscan Research) and were printed out at a range of 0.3 (12nT/cm). These print-outs were scanned and imported into AutoCAD 2000 as Tiff files so that the data could be superimposed onto the digital map base. The greyscale plots were also produced using Geoplot 3.0 (Geoscan Research). All greyscale plots are displayed in the range –2nT to 3nT using a linear incremental scale.

3.3.2. The 'raw' data, presented in Appendix 4 has had a grid biasing algorithm applied to balance the girds so that they all have mean of zero but has otherwise not undergone any processing. The processed data, as shown in Figures 2 to 12, has been selectively filtered to remove spurious errors such as striping effects and edge discontinuities caused by instrument drift and inconsistencies in survey technique caused by poor field conditions. A low pass filter has been applied and the data has been interpolated by 0.5 along both the X and the Y axes.

Appendix 2

Survey Location Information

1. The original grid was re-established for the additional survey at Blocks A16_D and A16_E by a Trimble Geodimeter 600s total station theodolite using the reference points D and F (the standard deviation in re-establishing the gird co-ordinate system was 0.001).

2. The corridor for the proposed re-routed bypass was provided by Babtie Group on three 1:2500 hardcopy plans. The original geophysical survey had shown that many of the field boundaries crossed by the proposed A158 bypass were not accurately located on the Ordnance Survey mapping and it was therefore decided that the centreline of the road corridor could be most accurately laid out using a Racal Landstar IV differential GPS system. The route of the new proposed corridor was digitised from the hardcopy plans onto an Ordnance Survey map base. The map base was then accessed by the Landstar system using Penmap 500 as the software interface and the centreline of the road corridor was laid out. The GPS system is generally accurate to better than ±1m.

3. Each survey grid was then laid out, relative to this baseline, and tied in to the temporary reference points established during the previous survey (Fig. 2 and below), using a Trimble Geodimeter 600s total station theodolite. Points J and L were no longer in place (they appeared to have been removed by the mowing of the verges along a footpath) but the grids could still be accurately tied in using points I, K, N, O and Q. The accuracy of the geophysical survey grids relative to the reference points is approximately ±0.05m.

4. There was generally a good correlation between the geophysical survey data from the previous survey and the digital map base and it is estimated that the average 'best fit' error is better than ±0.5m. Despite this good correlation it is recommended that if any of the survey grids need to be re-established accurately then the reference points listed below should be used. If other points are used then the error quoted by the Ordnance Survey for their digital data (±1.08m at 1:2500) must be considered.

5. The following is a brief description of the additional survey grids and their respective reference points:

   A16_D and A16_E. These additional areas in these blocks were established using points D and F.

   A158_A. Tied in to points I, and K.

   A158_B, A158_C and A158_D. These blocks were on the same survey grid and were also tied in to points N and O.

   A158_E. Tied in to points P and Q.

Station	Easting	Northing
A (wooden stake)	540417.22	367867.99
B (wooden stake)	540497.72	368015.89
C (wooden stake)	540456.85	368052.32
D (wooden stake)	540780.44	368593.49
E (wooden stake)	540860.55	368757.23
F (wooden stake)	540839.33	368810.70
G (wooden stake)	541020.27	368983.25
H (wooden stake)	540962.33	369112.57
I (borehole cover)	540882.72	367871.59
K (wooden stake)	540906.59	367882.40
M (borehole cover)	541095.62	367872.55
N (wooden stake)	541235.26	367968.43
O (wooden stake)	541252.46	368009.94
P (borehole cover)	541407.03	367970.15
Q (wooden stake)	541465.45	368040.11
R (survey marker)	541583.12	367987.26
S (wooden stake)	541735.42	368070.95
T (wooden stake)	541831.12	368042.05
U (survey marker)	541836.66	368102.67

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

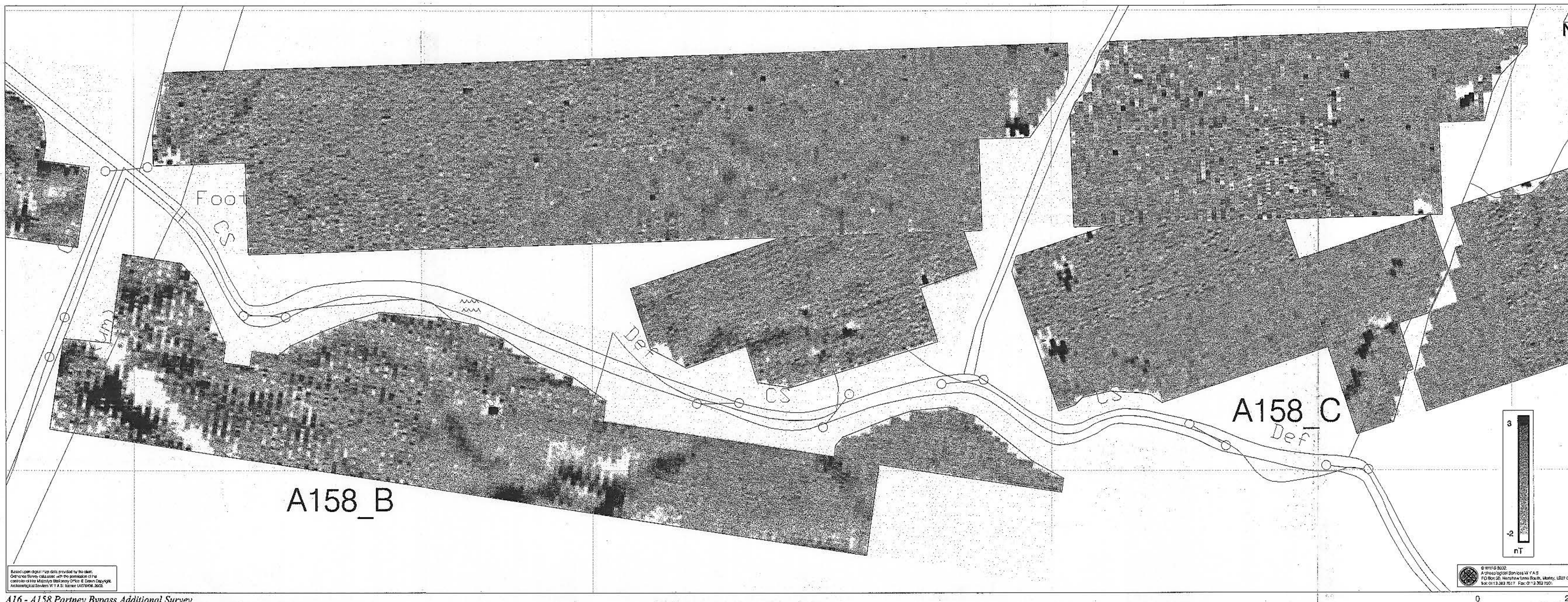
The geophysical archive comprises:-

- A digital archive containing compressed (WinZip 6) files of the raw data, report text (Word 97), and graphics files (CorelDraw6 and AutoCAD 2000).
- a full copy of the report

At present the archive is held by Archaeological Services WYAS although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). Brief details may also be forwarded for inclusion on the English Heritage Geophysical Survey Database after the contents of the report are deemed to be in the public domain (i.e. available for consultation in the relevant Sites and Monument Record Office).

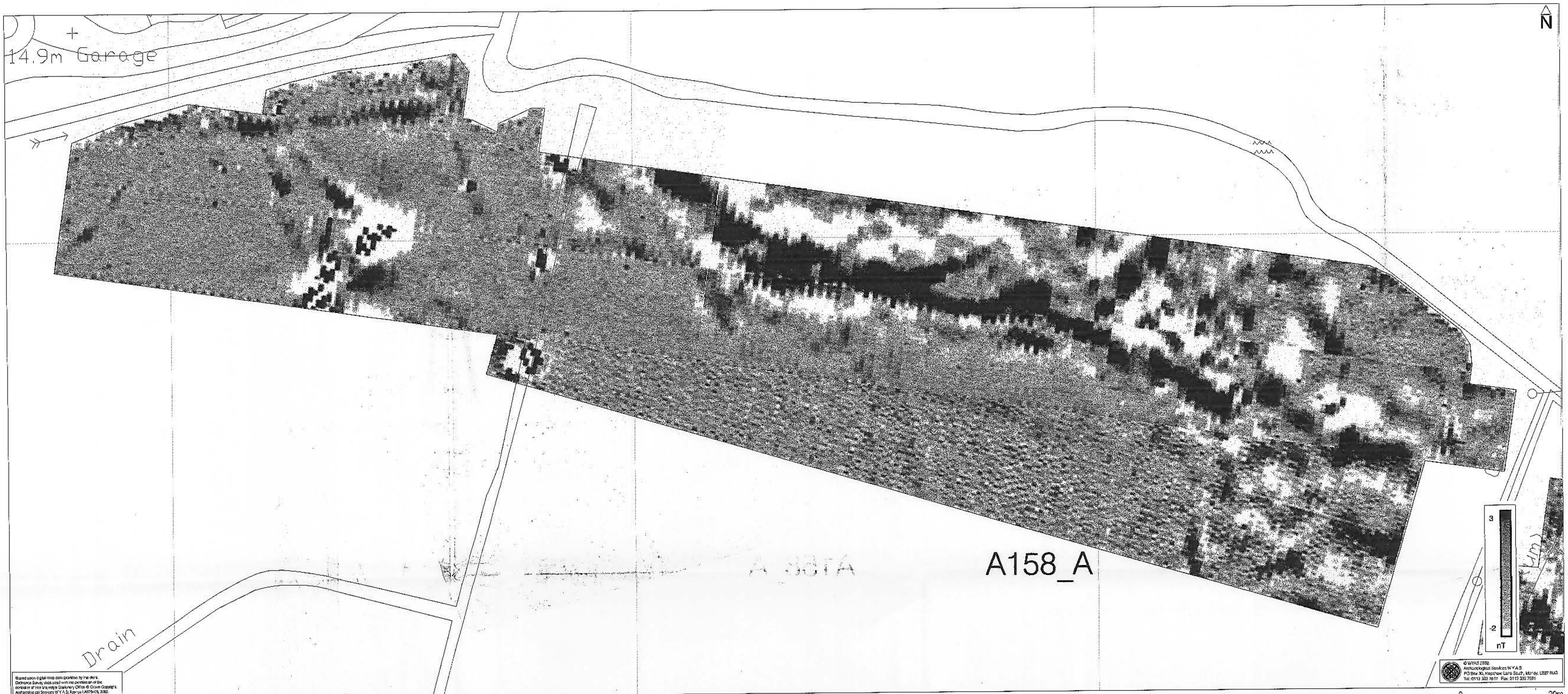
Appendix 4

Gradiometer Data (1:500)



A16 - A158 Partney Bypass Additional Survey
Greyscale plot of the unprocessed gradiometer data; Blocks A158_B and A158_C (1:500)

A16 - A158 Partney Bypass Additional Survey
X-Y trace plot of the unprocessed gradiometer data; Blocks A158_B and A158_C (1:500)

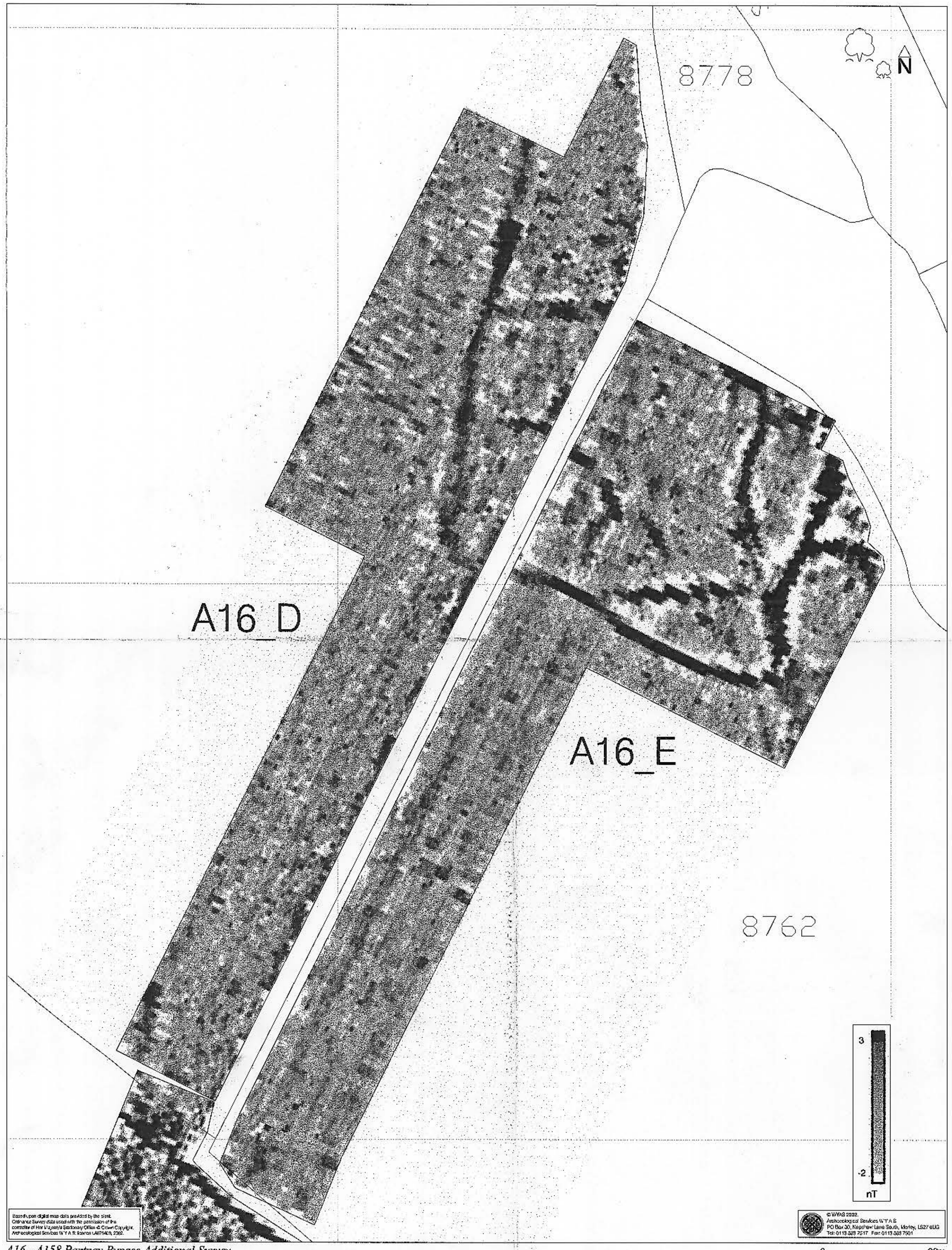


A16 - A158 Partney Bypass Additional Survey
Greyscale plot of the unprocessed gradiometer data; Block A158_A (1:500)

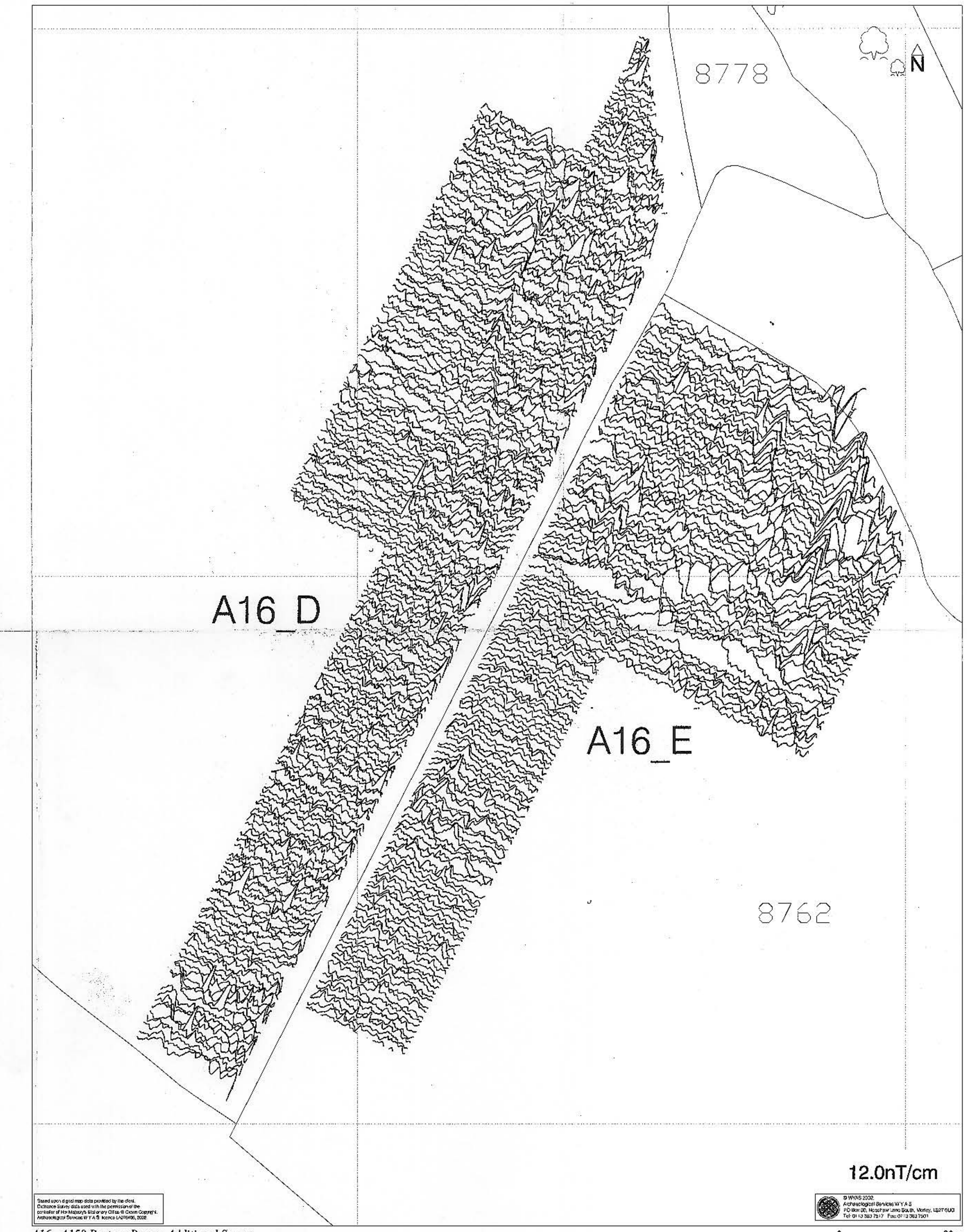
A16 - A158 Partney Bypass Additional Survey
X-Y trace plot of the unprocessed gradiometer data; Block A158_A (1:500)

A16 - A158 Partney Bypass Additional Survey
Greyscale plot of the unprocessed gradiometer data; Blocks A158_D and A158_E (1:500)

A16 - A158 Partney Bypass Additional Survey
X-Y trace plot of the unprocessed gradiometer data; Blocks A158_D and A158_E (1:500)



A16 - A158 Partney Bypass Additional Survey
Greyscale plot of the unprocessed gradiometer data; Blocks A16_D and A_16E (1:500)



A16 - A158 Partney Bypass Additional Survey
X-Y trace plot of the unprocessed gradiometer data; Blocks A16_D and A16_E (1:500)