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ARCHAEOLOGICAL
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Land north of Brickhill
Bedford

Geophysical Survey

August 2002

Report No. 1033

CLIENT
Albion Archaeology

1:5000, showing the greyscale gradiometer data superimposed onto an Ordnance Survey digital base map supplied by the client. The detailed survey comprised eleven discrete areas (Blocks 1 - 11) the data from which are displayed in greyscale format, at a scale of 1:1000, in Figures 3, 5, 7, 9 and 11. The accompanying interpretations are shown at the same scale in Figures 4, 6, 8, 10 and 12. Large scale, 1:500, greyscale and X-Y trace plots are shown in Appendix 4. Details on data processing and display are given in Appendix 1 and the survey location information is presented in Appendix 2. The composition of the archive comprises Appendix 3.

2.4 The survey methodology and report presentation 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.

2.5 All greyscale plots are displayed in the range –1nT to 2nT.

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. Magnetic Scanning; Results and Discussion

3.1 'Iron spike' responses (see Appendix 1) were noted in all parts of the site but their location was not recorded unless they occurred in significant concentrations. Areas of magnetic disturbance were also noted adjacent to most of the field boundaries and trackways but these were deemed to be modern in origin unless spatially congruent with concentrations of possible archaeological magnetic anomalies. Similarly the overgrown areas in Fields 2 and 4 were highly disturbed, probably as a result of fly tipping and bonfires. A strong, dipolar, linear anomaly was identified crossing Field 4 from north to south. This was caused by a sewer pipe.

3.2 There was very little variation in the magnetic background across the site, in general fluctuating by less than +/- 1nT from the mean background in any given area. This flat background is common on boulder clay geologies.

3.3 Very few anomalies worthy of further investigation were identified during the scanning. Consequently only Blocks 5, 9 and 11 were positioned to investigate possible archaeological type responses. The remainder of the blocks were located to evaluate the higher parts of the site and to give an even sample spread across the site.

4. Detailed Survey; Results and Discussion

4.1 General

4.1.1 Numerous 'iron spike' responses (see Appendix 1) have been identified across all parts of the site. These are indicative of ferrous material in the topsoil or subsoil and, although archaeological artefacts may cause them, they are more often caused by modern material. Unless there is strong supporting evidence to the contrary, for example if they are located close to obvious areas of archaeological activity, they are assumed not to be of archaeological importance.

4.2 Blocks 1 and 2 (Figs 3 and 4)

4.2.1 These two blocks were positioned on high ground in the north-western part of the site. No anomalies of a possible archaeological origin have been identified in either of these two blocks.

4.3 Blocks 3 and 4 (Figs 5 and 6)

4.3.1 No anomalies were identified during scanning in this part of the site. However, evidence for ridge and furrow ploughing having taken place on the high ground at the northern edge of the site was identified during the initial site assessment.

4.3.2 Three very weak, parallel linear anomalies have been identified in the north-western corner of Block 4. These anomalies may be caused by ridge and furrow ploughing although they might also be due to field drains.

4.4 Blocks 5 and 6 (Figs 7 and 8)

4.4.1 Several isolated areas of magnetic enhancement were noted during the scanning in Block 5 and these have been confirmed by the detailed survey. However, due to the lack of any supporting evidence a geological origin is considered probable for these anomalies.

4.4.2 Two parallel linear anomalies aligned from north-east to south-west have been identified in Block 6. These anomalies are not thought to be archaeological in origin but are interpreted as a recently infilled field boundary and a field drain respectively.

4.5 Blocks 7, 8, 9 and 10 (Figs 9 and 10)

4.5.1 Blocks 7, 8 and 10 were positioned at random to ensure an even sample distribution. Several small areas of magnetic enhancement were identified during scanning in the southern part of Field 4 thus accounting for the location of Block 9.

4.5.2 No anomalies, other than ferrous responses have been identified in Block 8, although three weak, linear anomalies have been noted in Blocks 7 and 10. It is thought that these linear anomalies are probably caused by field drains or other recent agricultural activity.

4.5.3 The detailed survey has confirmed the presence of a number of small areas of enhancement in Block 9 that are probably geological in origin. Nevertheless the location of these anomalies, adjacent to an area where a cluster of Roman pottery has been reported, means that an archaeological origin for these anomalies should not be dismissed.

4.6 Block 11 (Figs 11 and 12)

4.6.1 This is the only block that was centred around anomalies, identified during the scanning, that were considered to have a possible archaeological origin. It is also the block located closest to the reported cluster of pottery sherds.

4.6.2 Two areas of magnetic enhancement and an adjacent curvilinear anomaly have been identified in close proximity in the south-eastern corner of this block. A smaller area of magnetic enhancement is noted about 15m north of the major anomalies. These anomalies are considered to have good archaeological potential, especially given the results of the field walking (M. Phillips pers. Com.).

5. Conclusions

5.1 The magnetic scanning, although almost completely negative, did locate one area that has been confirmed by subsequent detailed survey to have 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.

Bibliography

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

Acknowledgements

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Figures

Appendices

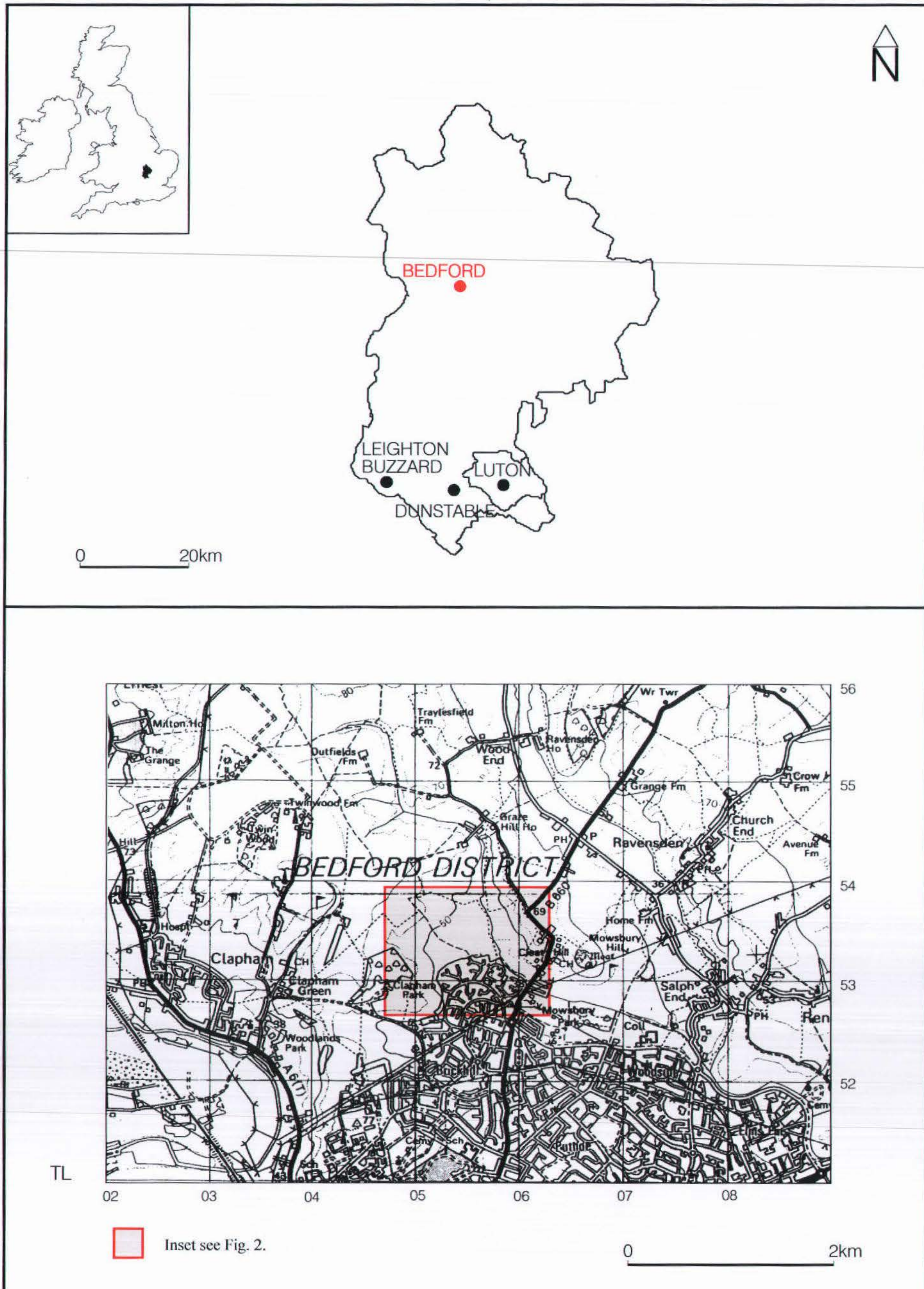


Fig. 1. Site location

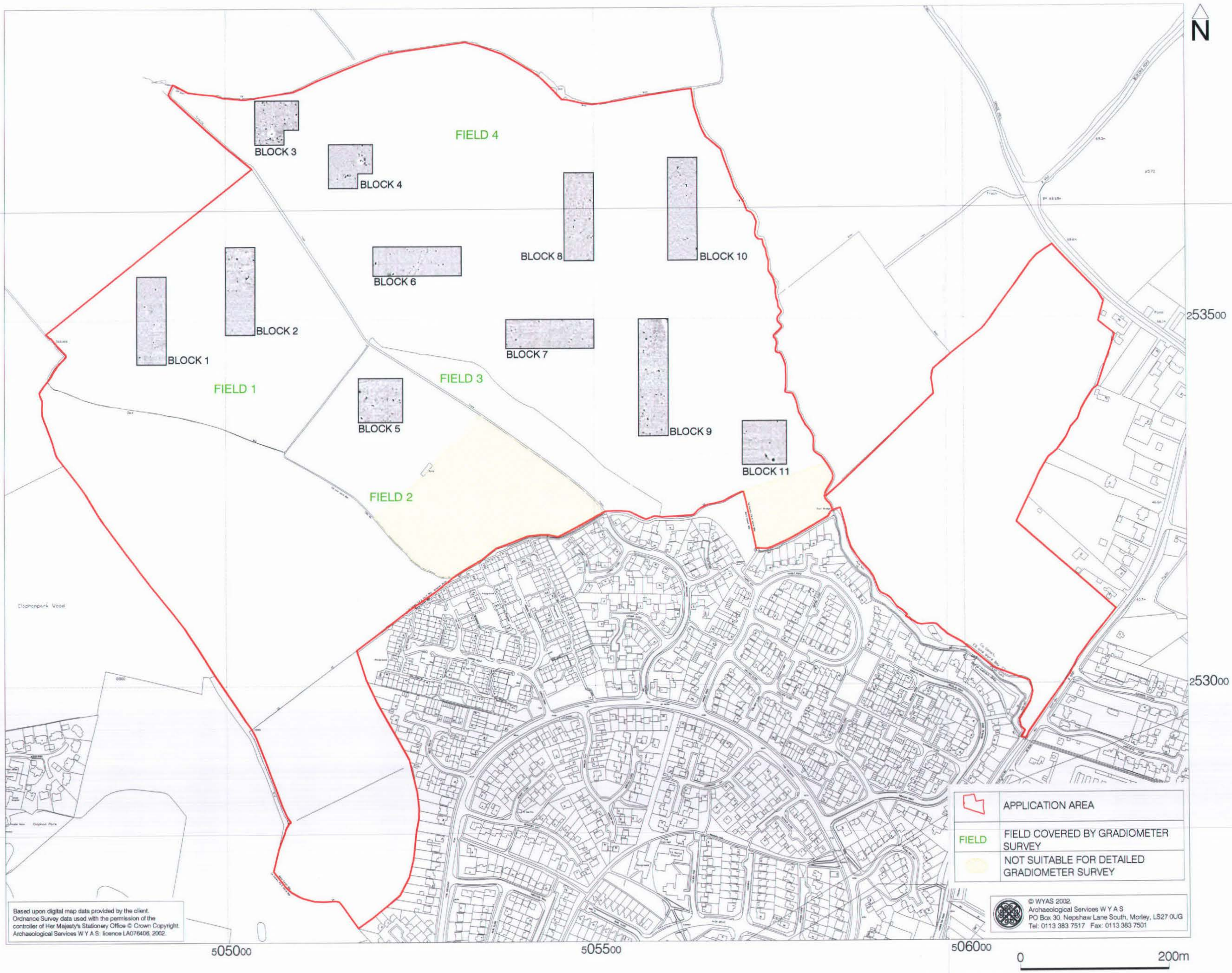


Fig. 2. Site location showing greyscale gradiometer data

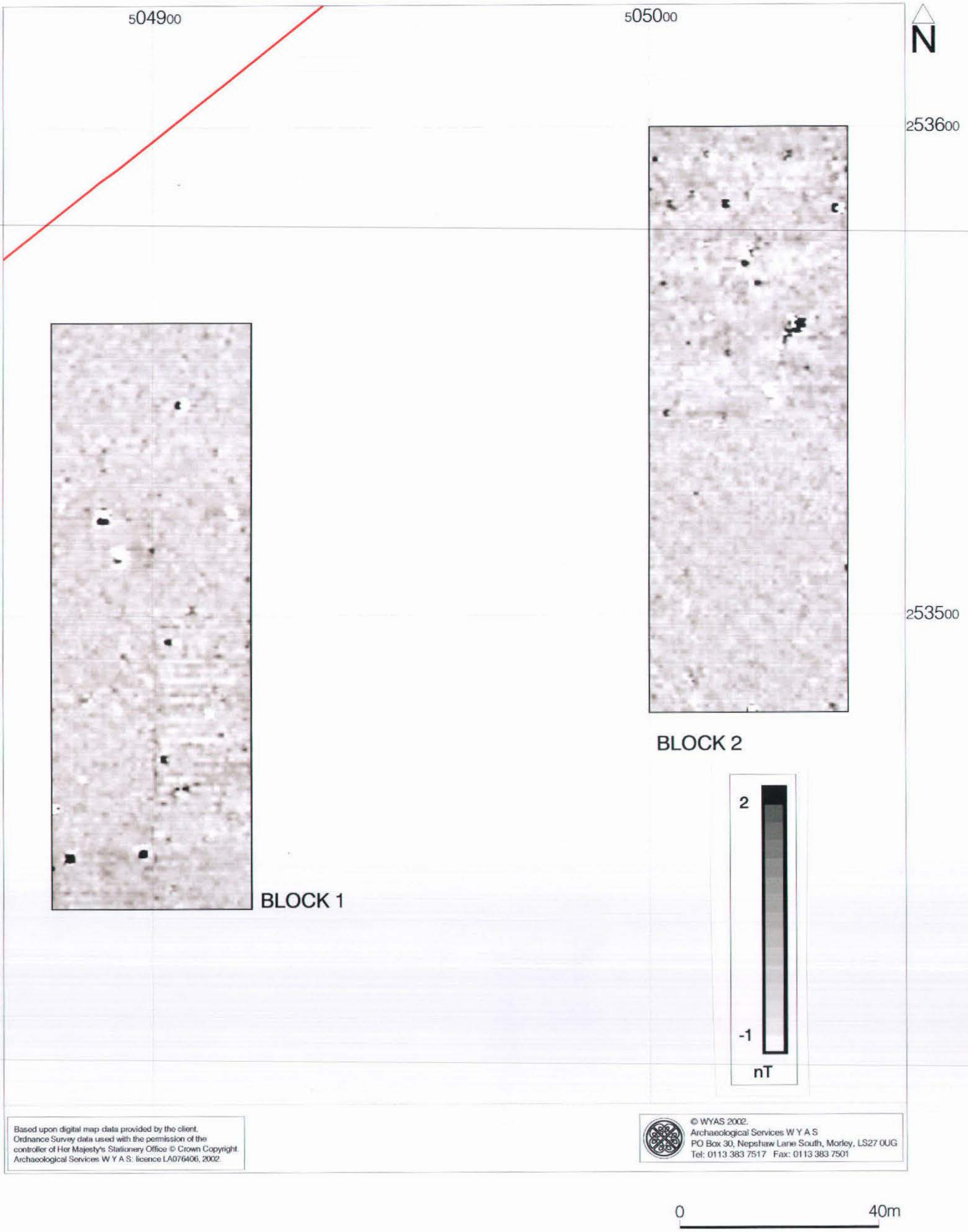


Fig. 3. Greyscale gradiometer data; Blocks 1 and 2

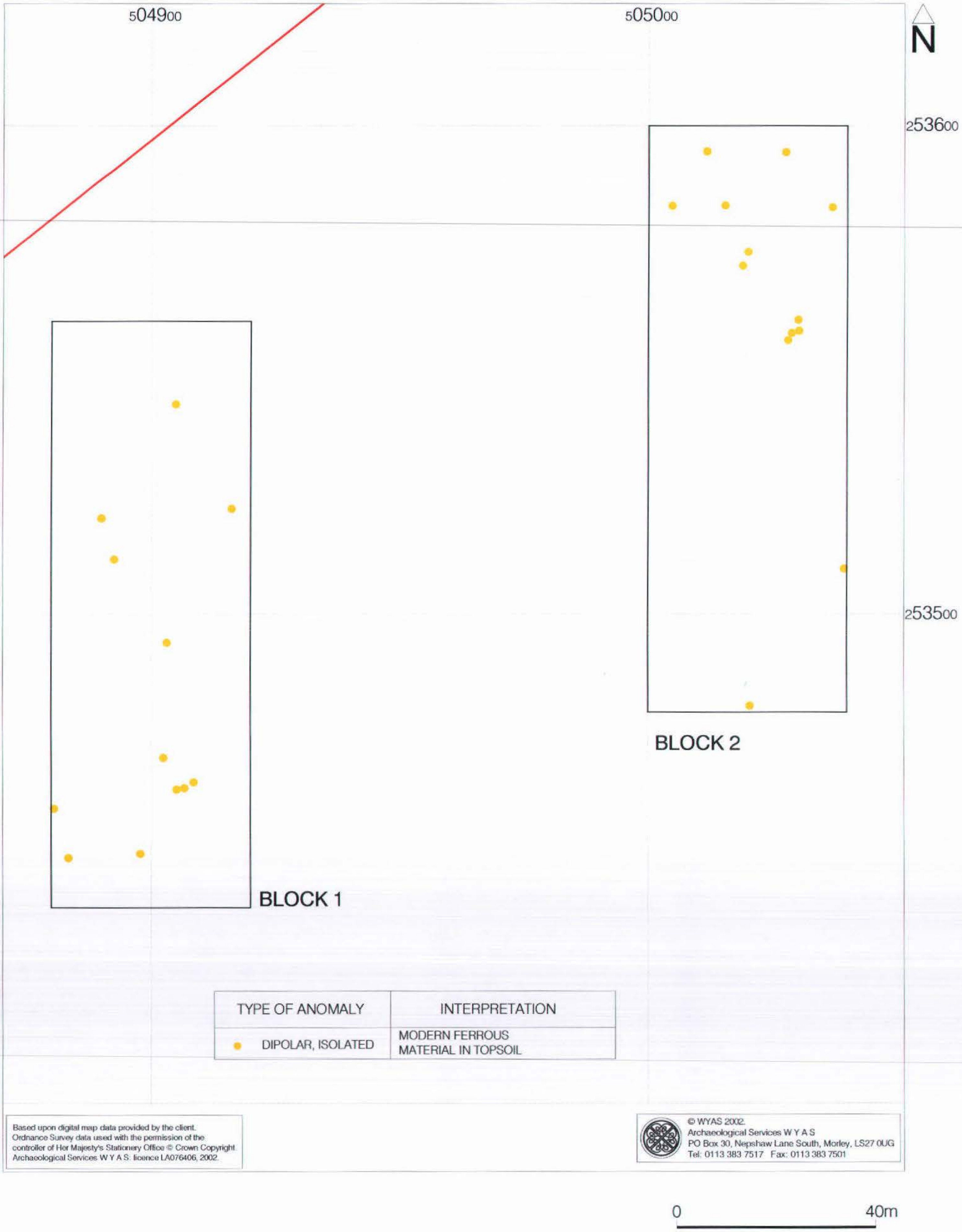


Fig. 4. Interpretation of gradiometer data; Blocks 1 and 2

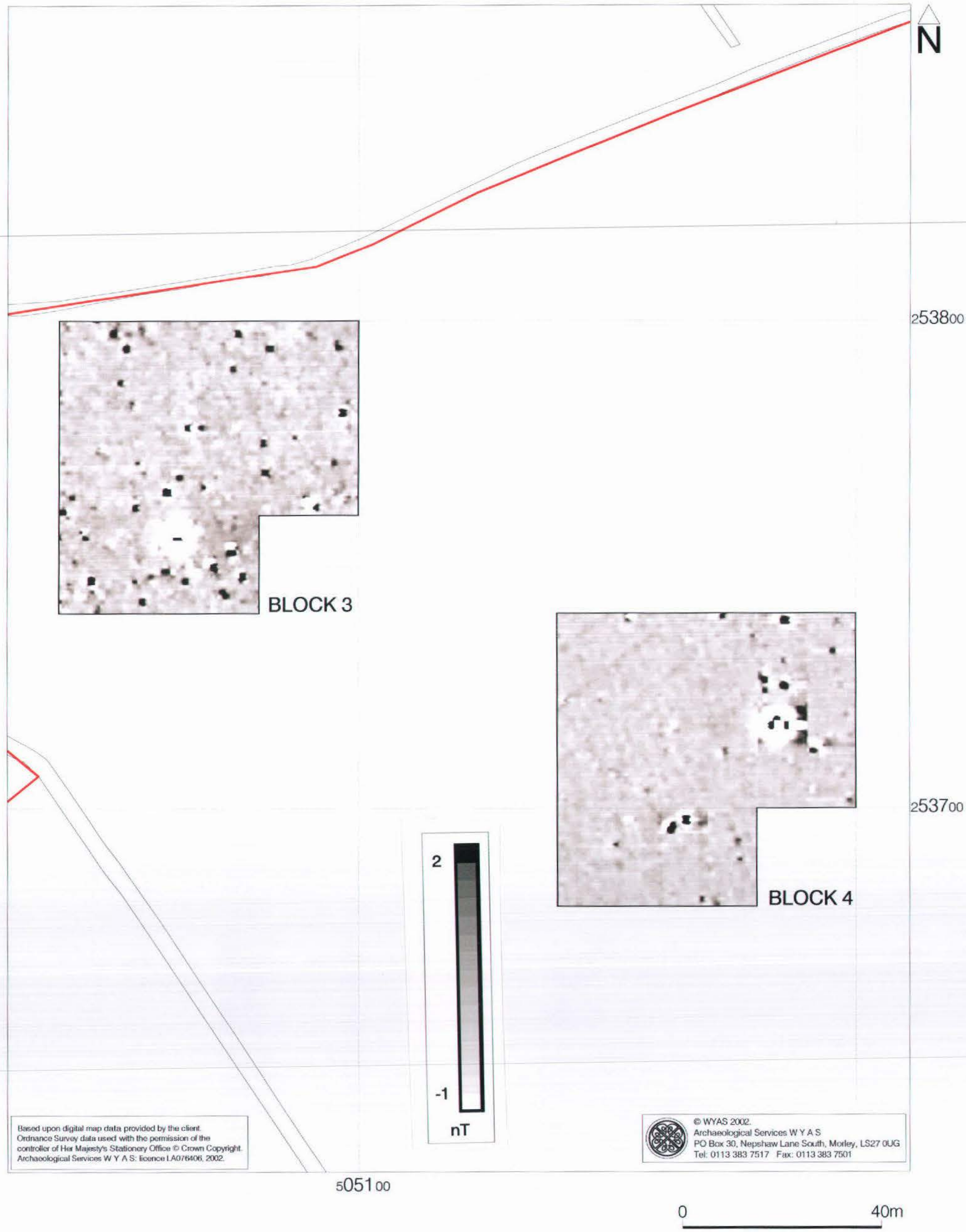


Fig. 5. Greyscale gradiometer data; Blocks 3 and 4

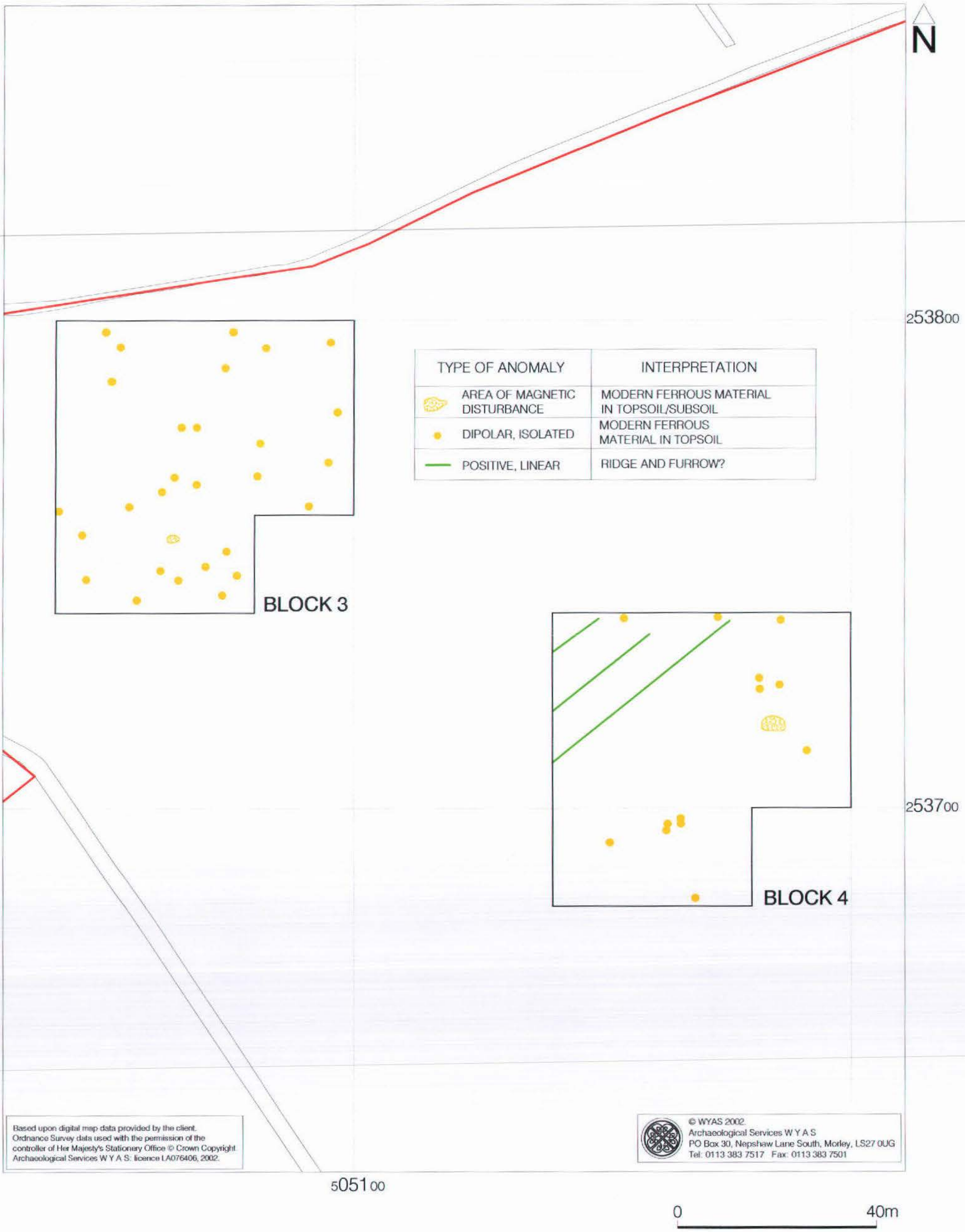


Fig. 6. Interpretation of gradiometer data; Blocks 3 and 4

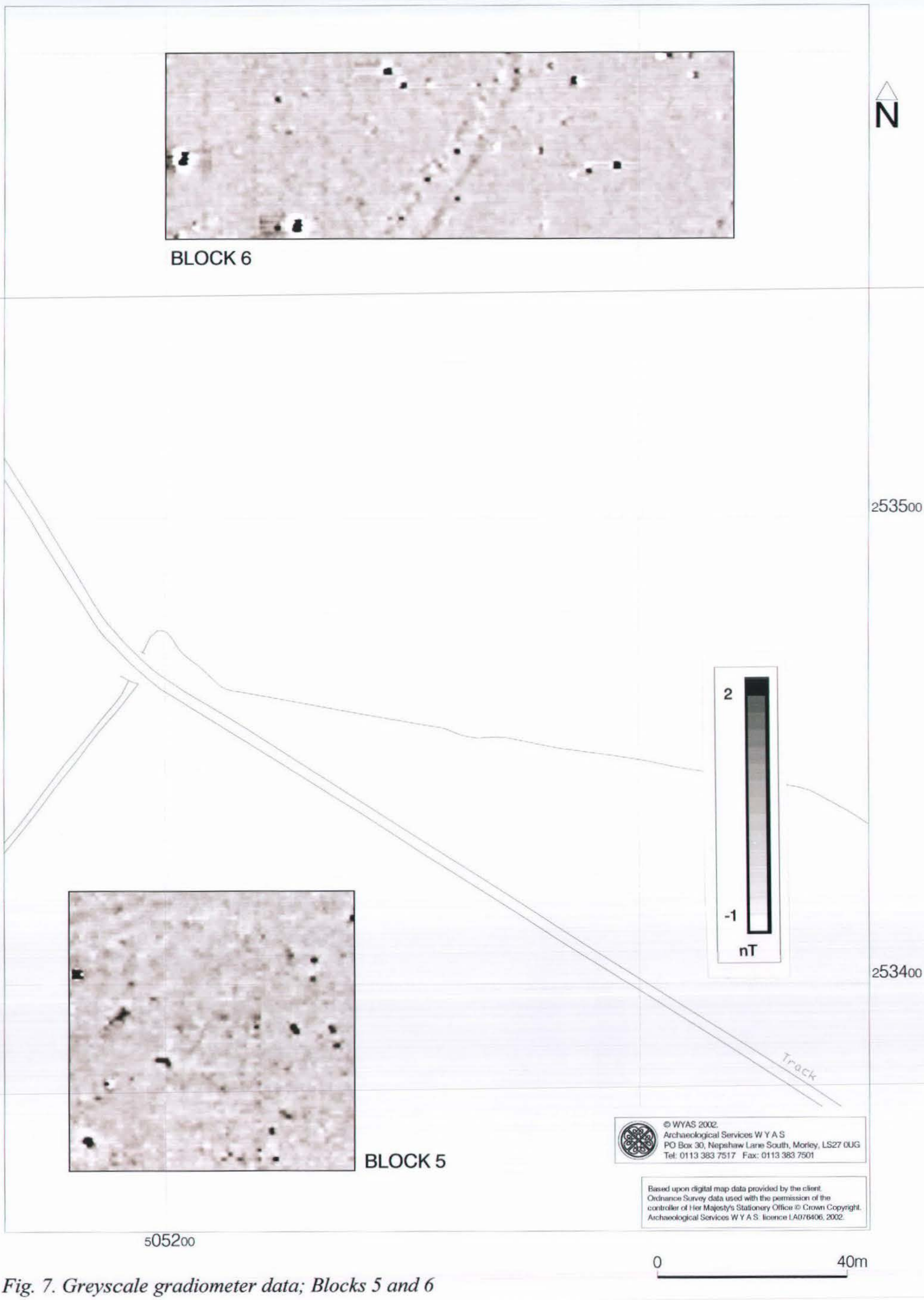


Fig. 7. Greyscale gradiometer data; Blocks 5 and 6

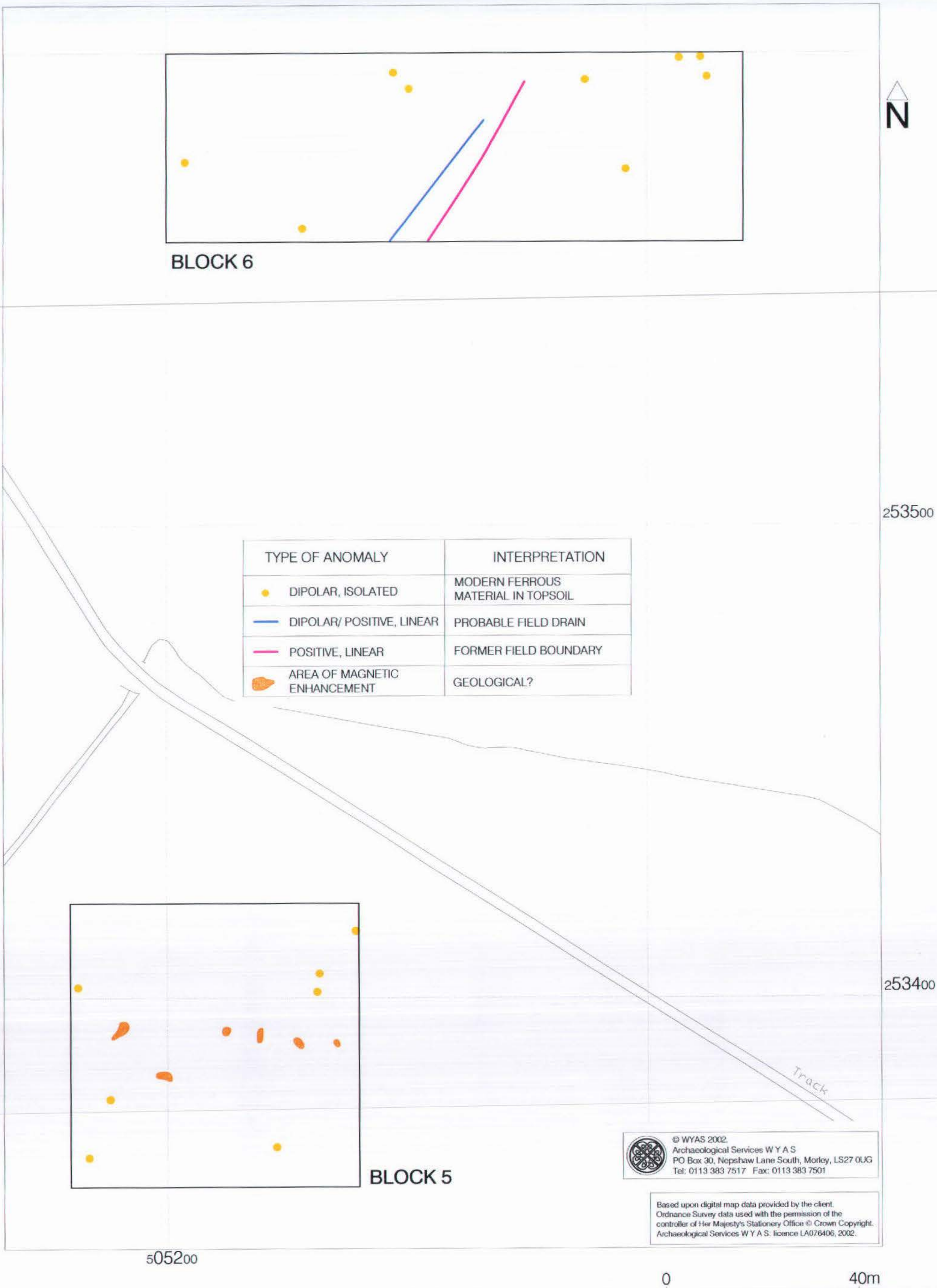


Fig. 8. Interpretation of gradiometer data; Blocks 5 and 6

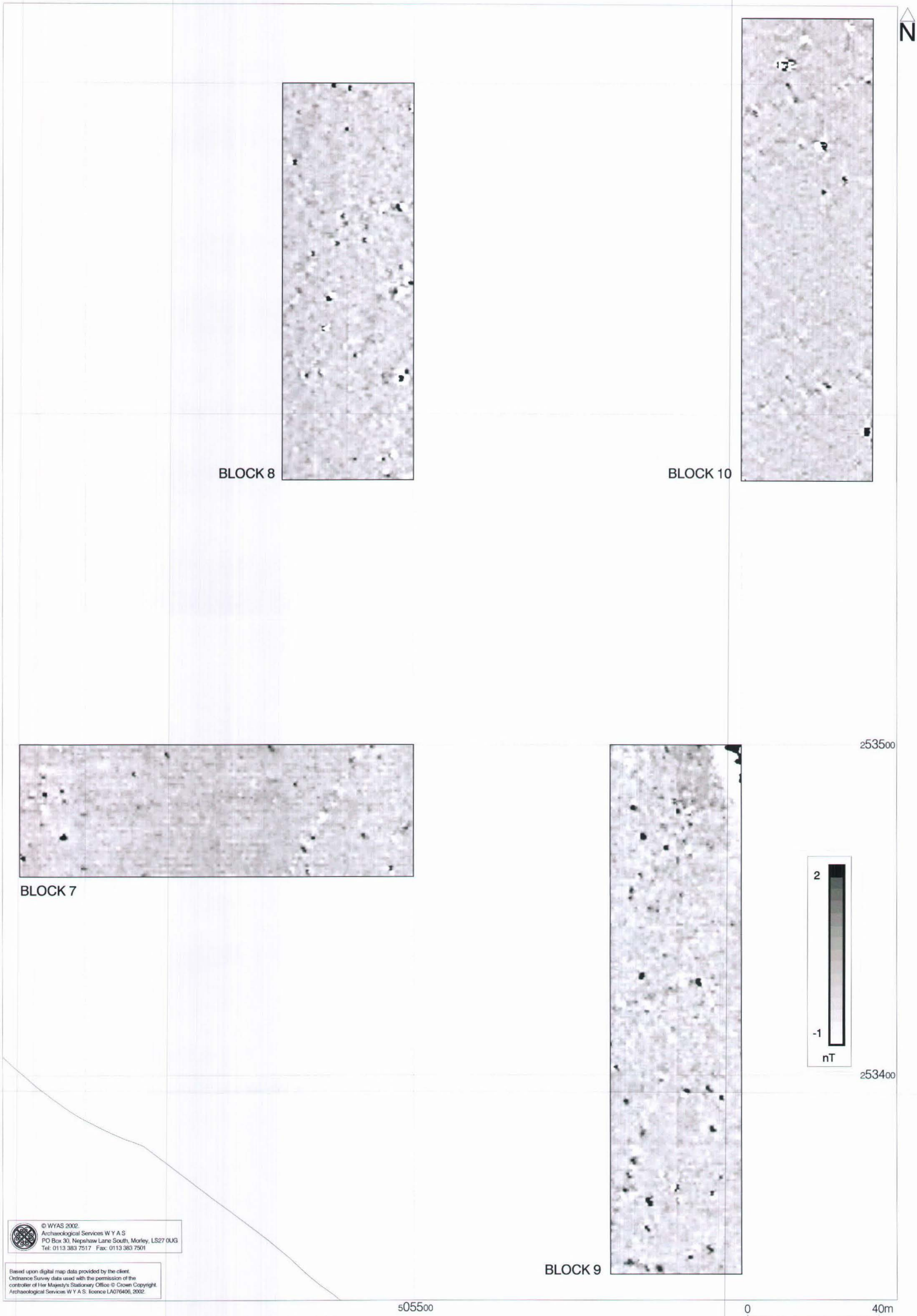


Fig. 9. Greyscale gradiometer data; Blocks 7, 8, 9 and 10

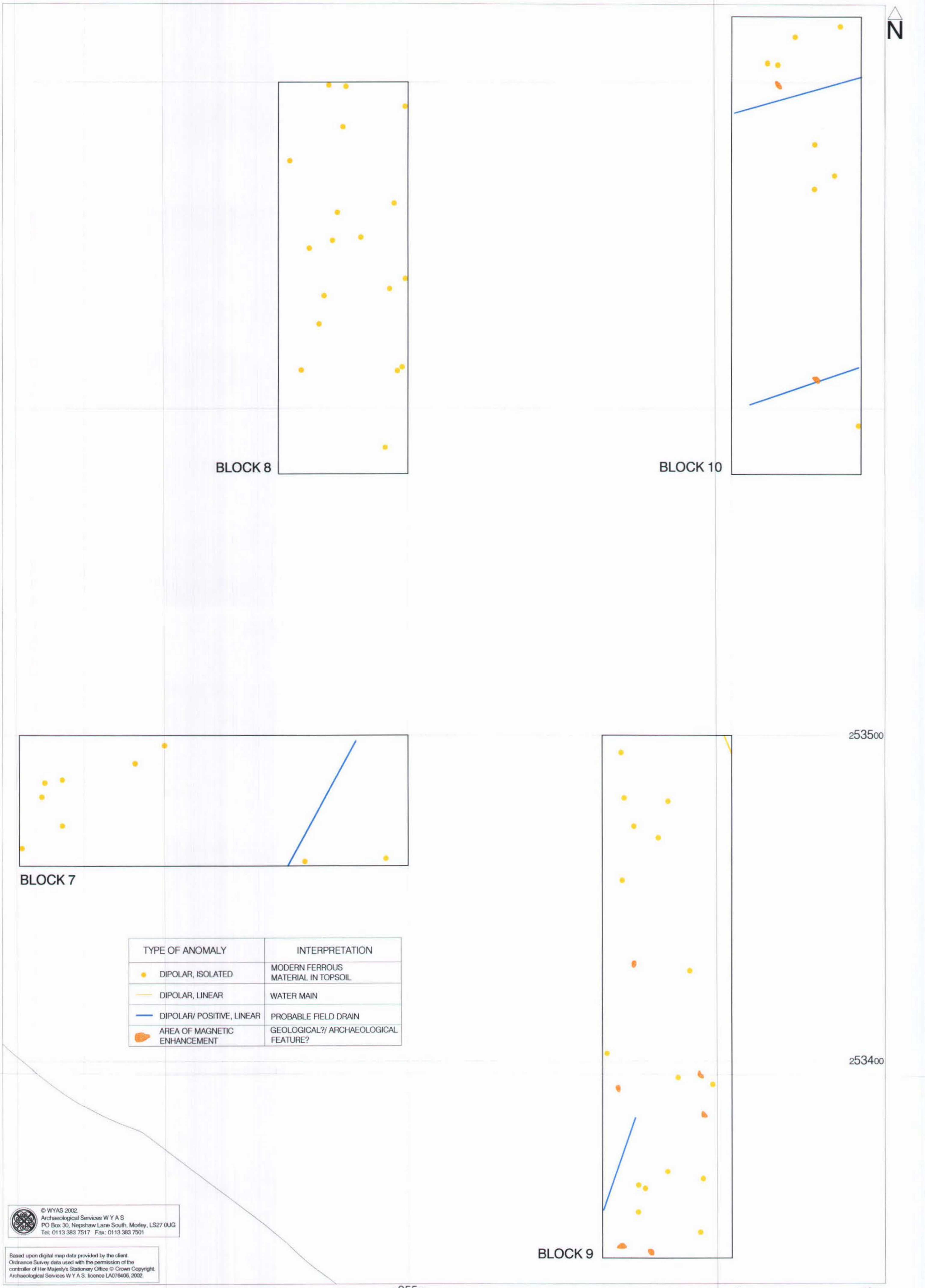


Fig. 10. Interpretation of gradiometer data; Blocks 7, 8, 9 and 10

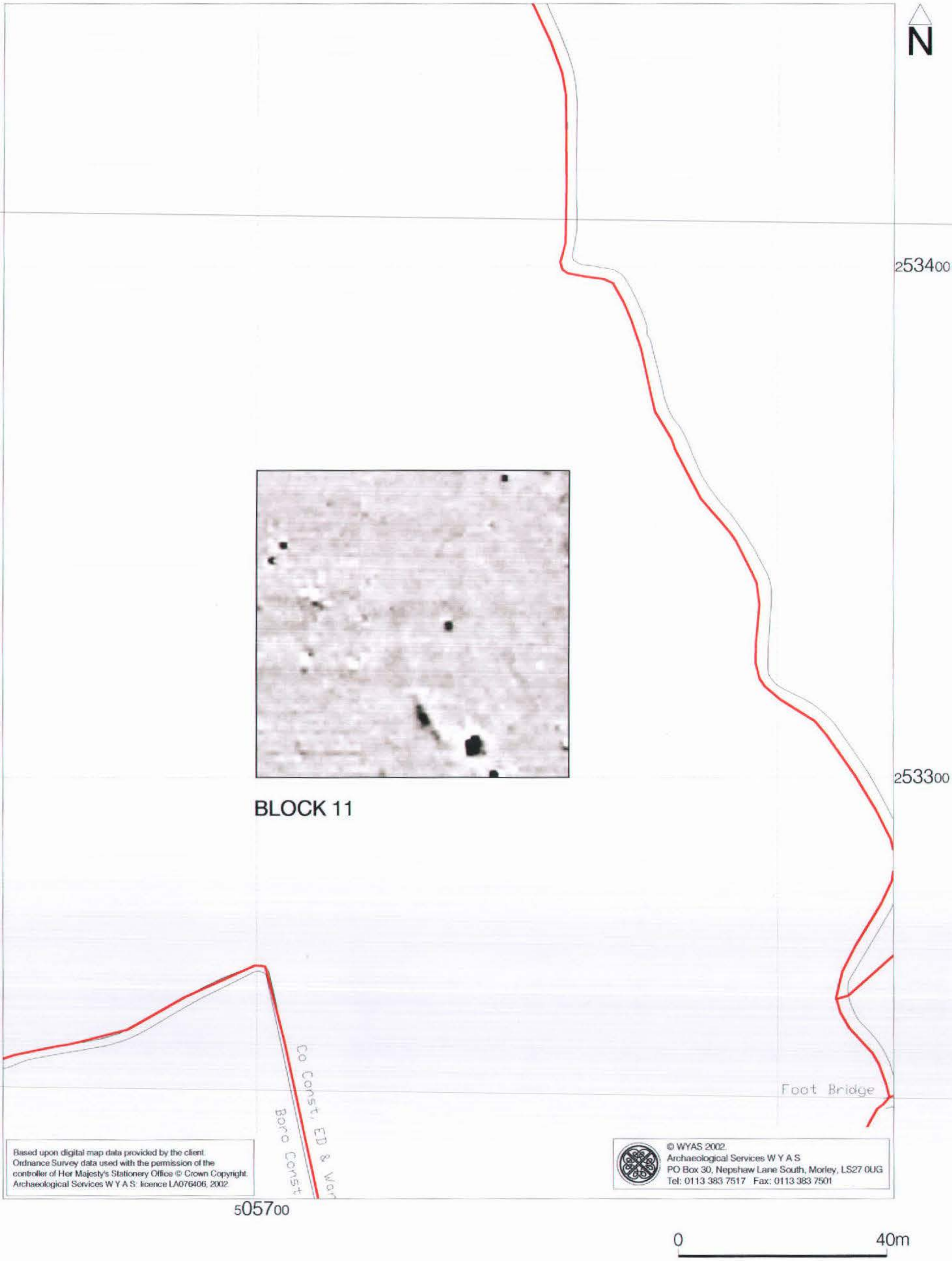


Fig. 11. Greyscale gradiometer data; Block 11

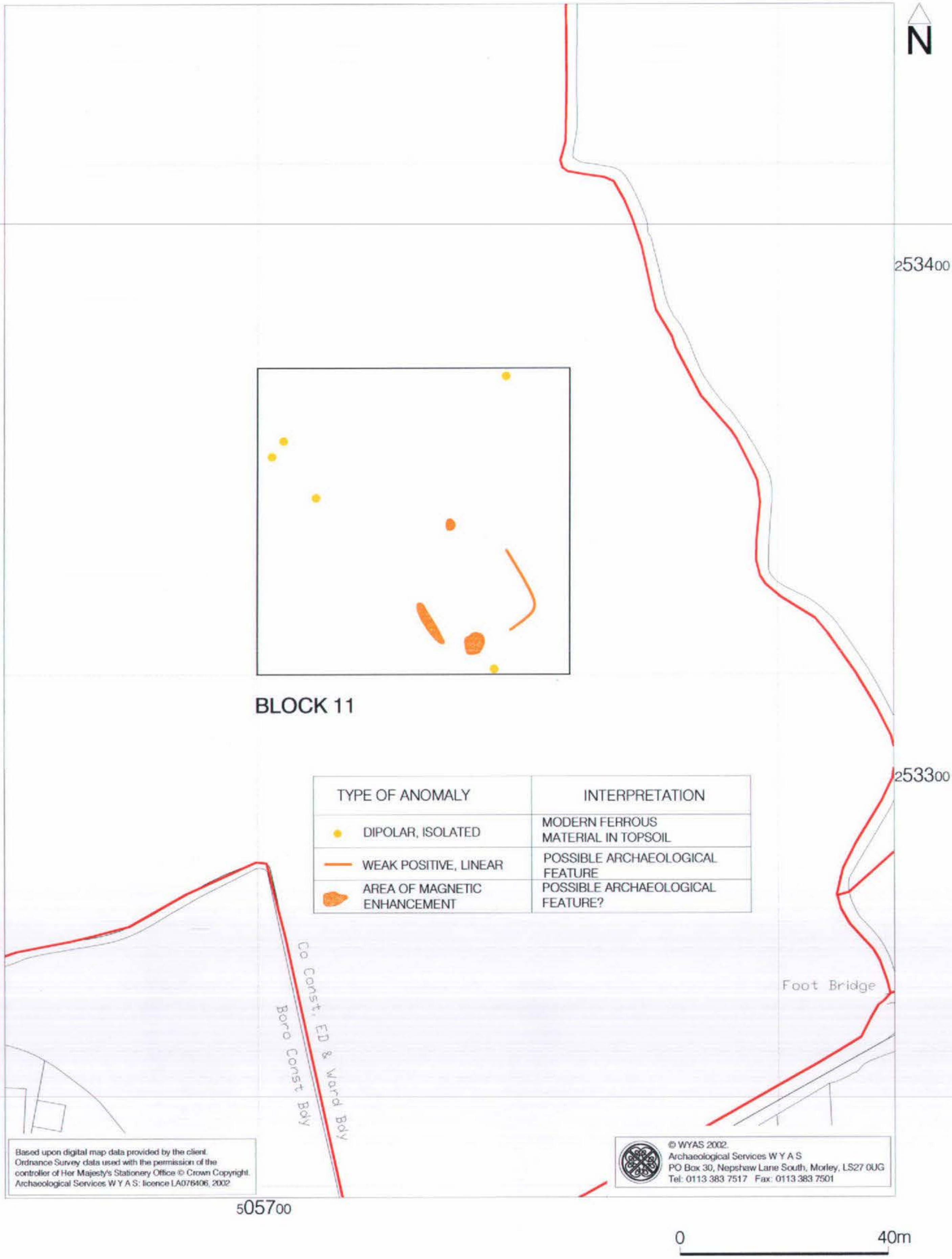


Fig. 12. Interpretation of gradiometer data; Block 11

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 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).

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 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.

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 0.5m intervals on zig-zag traverses 1m apart within 20m by 20m square grids. The instrument was facing north for improved data collection and was checked for electronic and mechanical drift at a common point after every three grids and calibrated as necessary. The drift from zero was not logged.

3.2.4. The detailed gradiometer data has been presented in this report in X-Y trace and greyscale formats. The former option shows the 'raw' data with no processing other than grid biasing whilst in the latter the data 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.

3.2.5. 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'. In-house software (XY3) was used to create the X-Y trace plots.

3.2.6. In-house software (Geocon 9) was used to interpolate the gradiometer data so that 1600 readings were obtained for each 20m by 20m grid. Contors software (University of Bradford) was used to produce the greyscale images. All gradiometer greyscale plots are displayed in the range –1nT to 2nT, unless otherwise stated, using a linear incremental scale.

Appendix 2

Survey Location Information

A 100m Ordnance Survey site grid was established by Albion Archaeology prior to the commencement of the geophysical survey.

Intermediate points for the geophysical survey grid were laid out using a Geodimeter 600s total station theodolite.

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:-

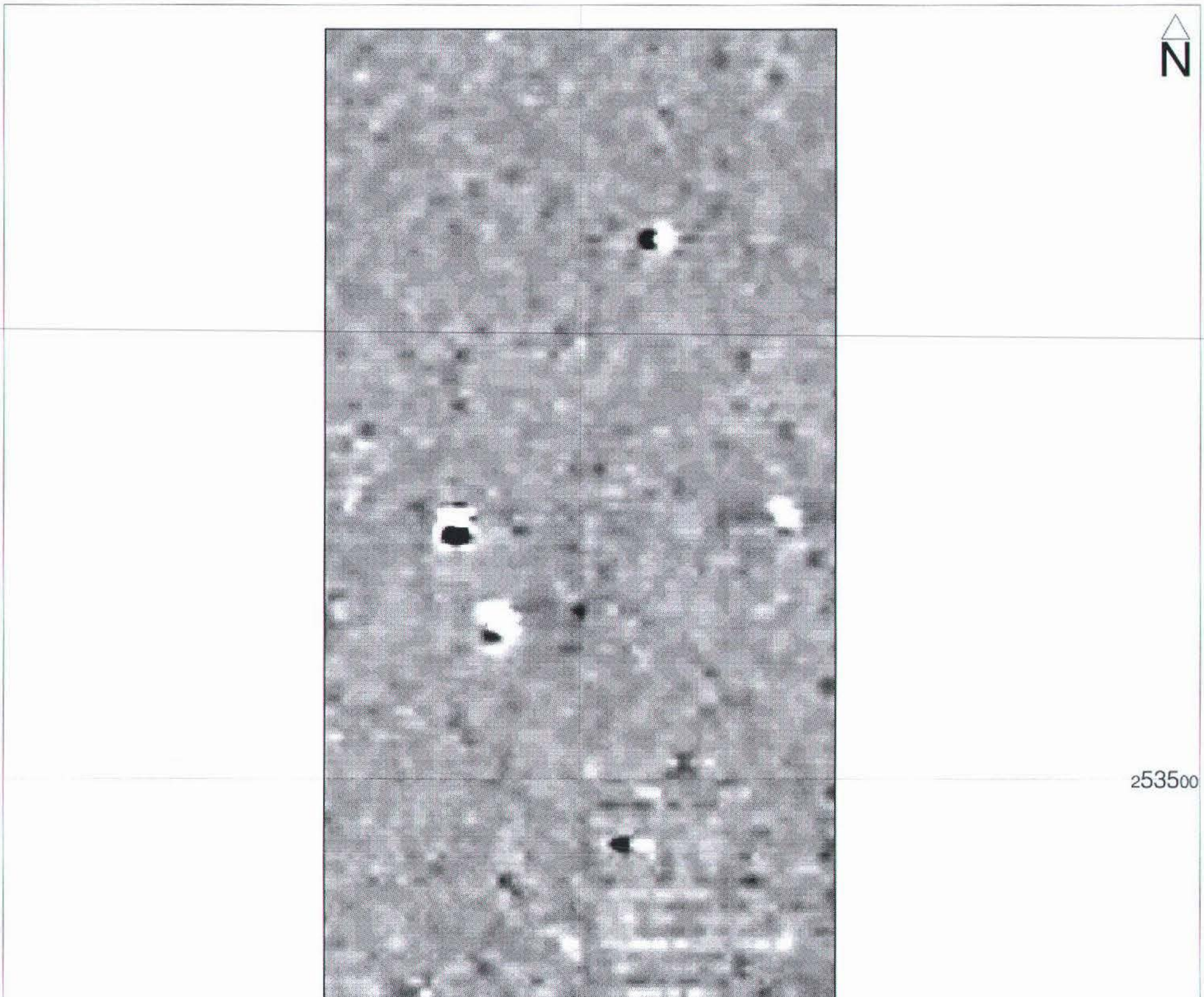
- an archive disk containing compressed (WinZip 6) files of the raw data, report text (Word 97), and graphics files (CorelDraw6 and AutoCAD 2000) files.

- 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 Sites and Monument Record Office).

Appendix 4

Gradiometer Data (1:500)



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Greyscale gradiometer data; Block 1

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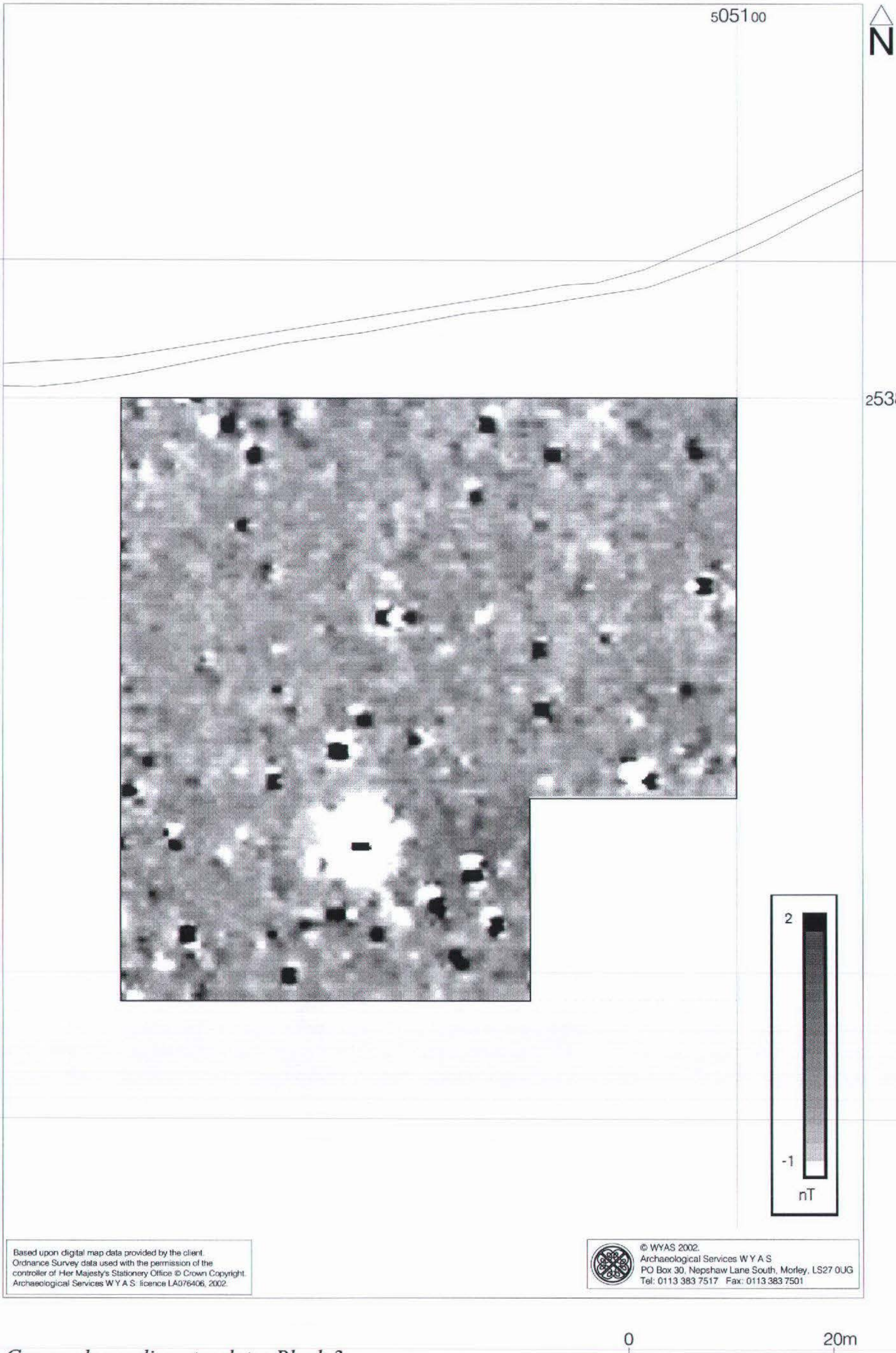

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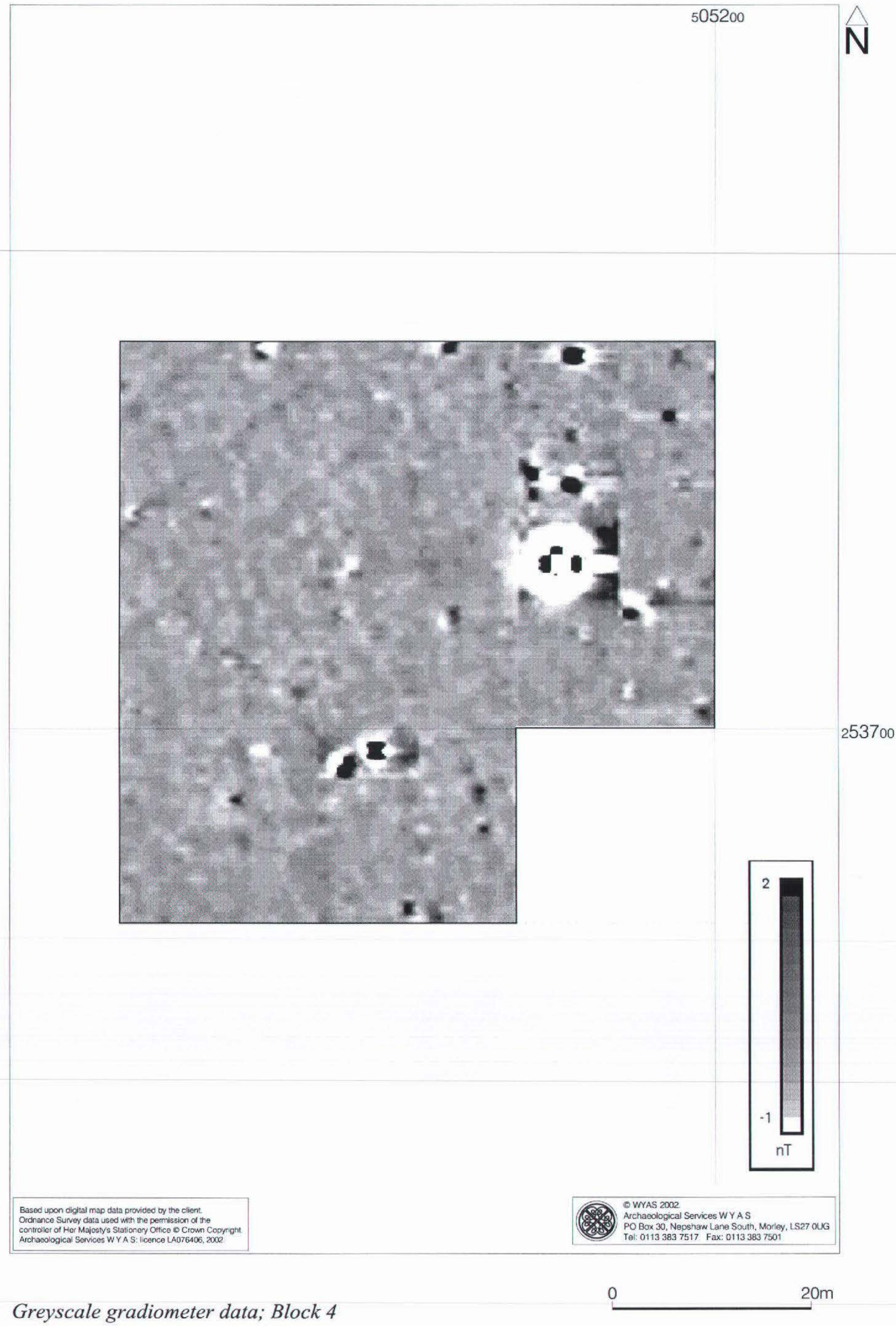

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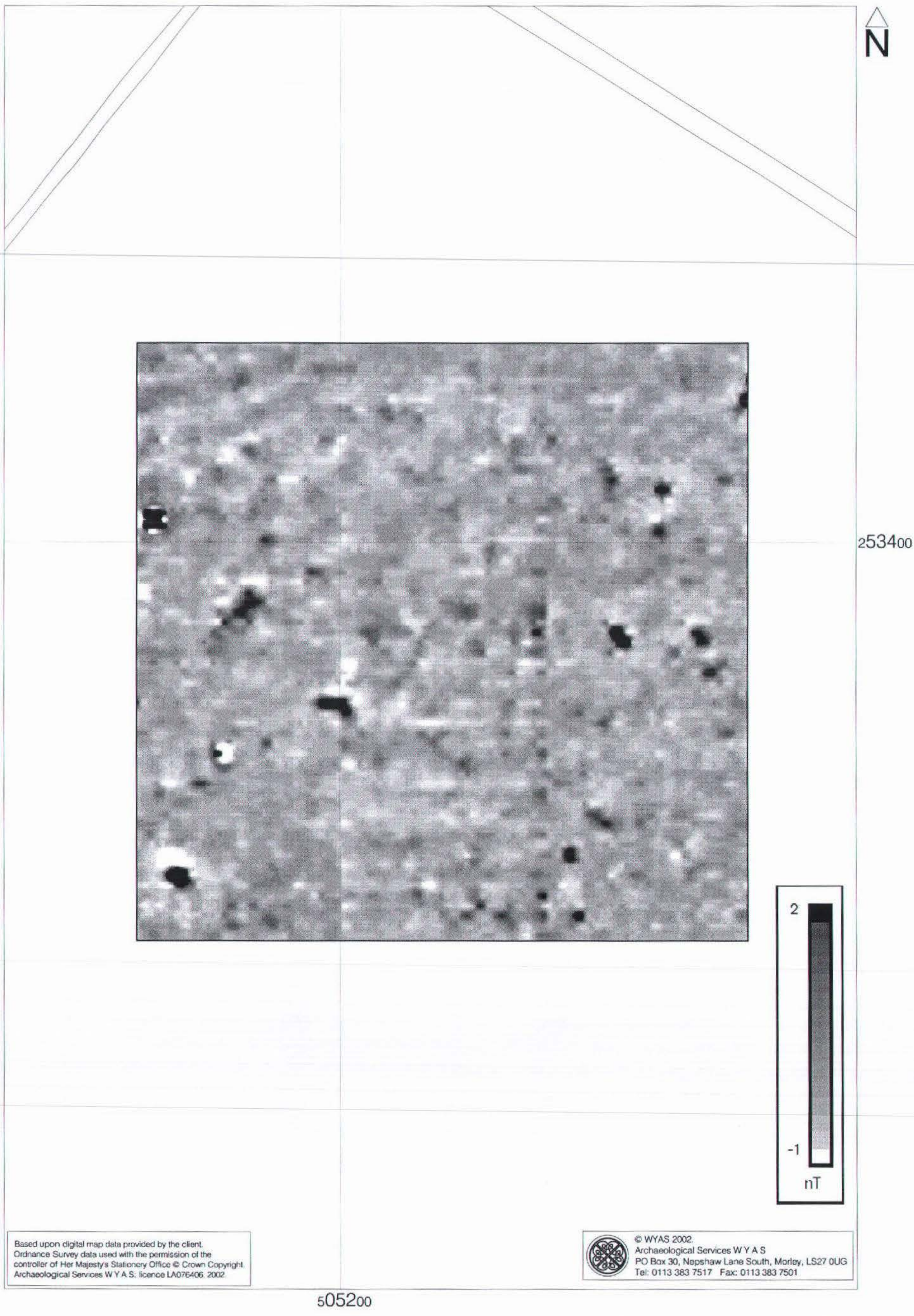

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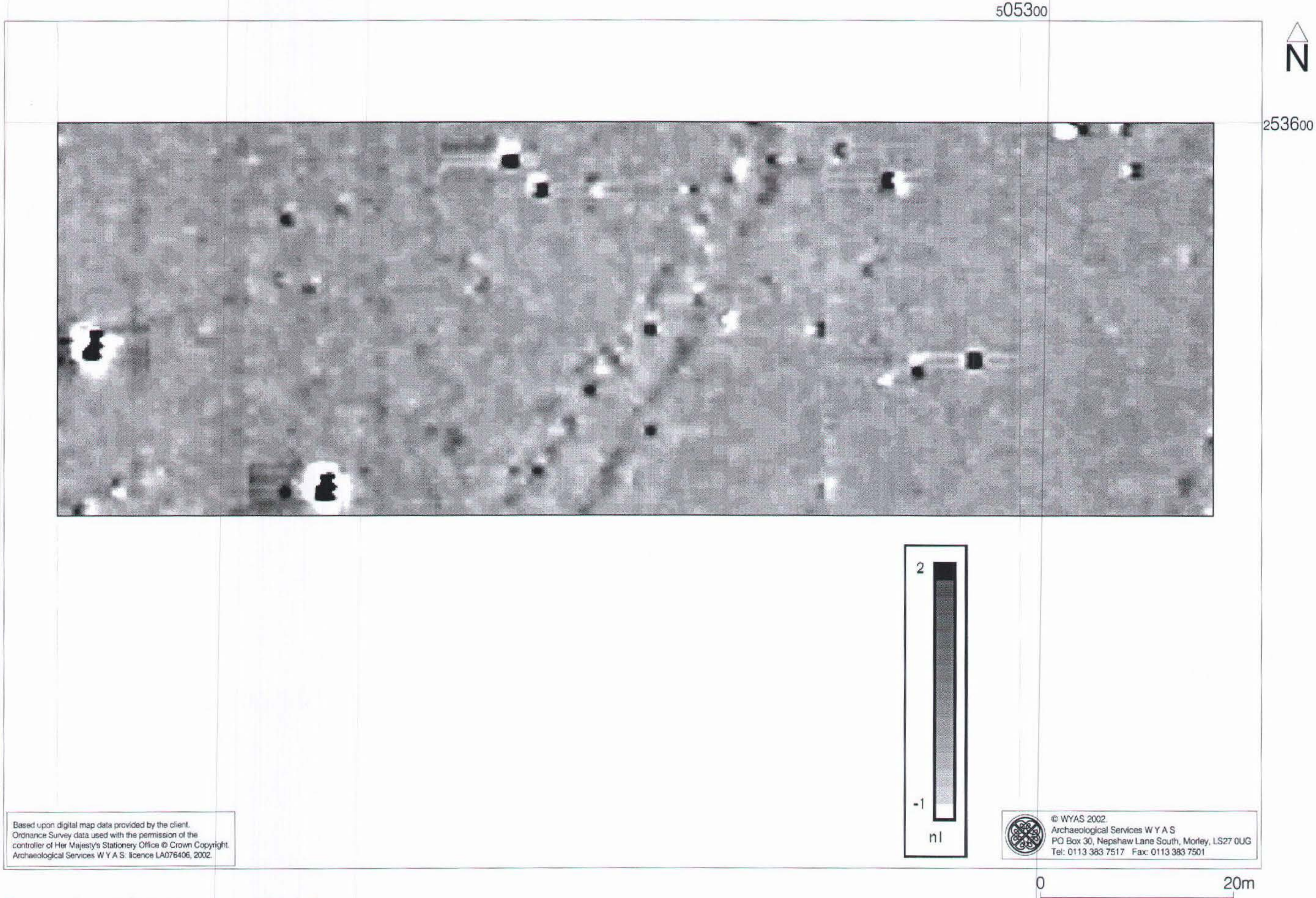

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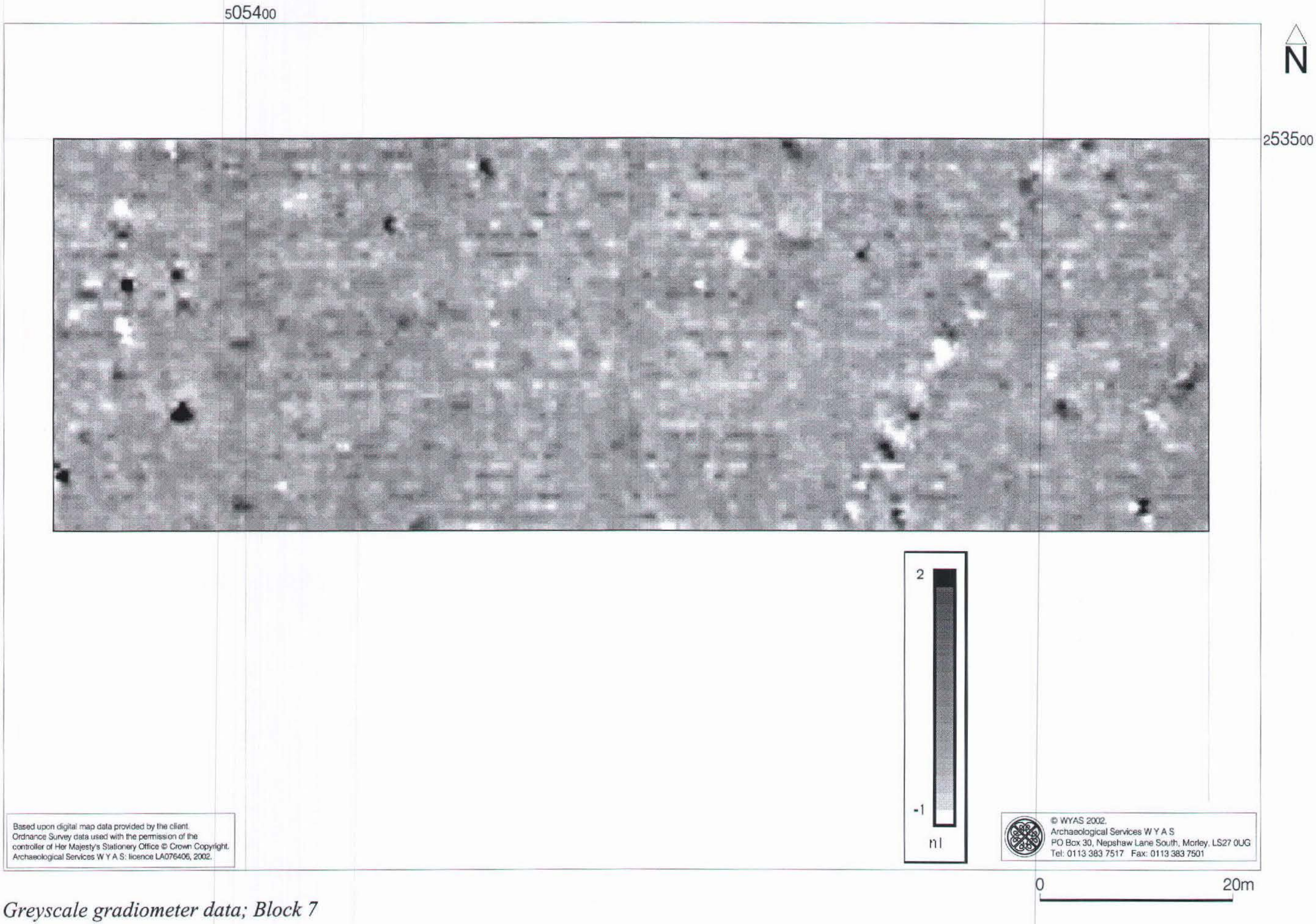

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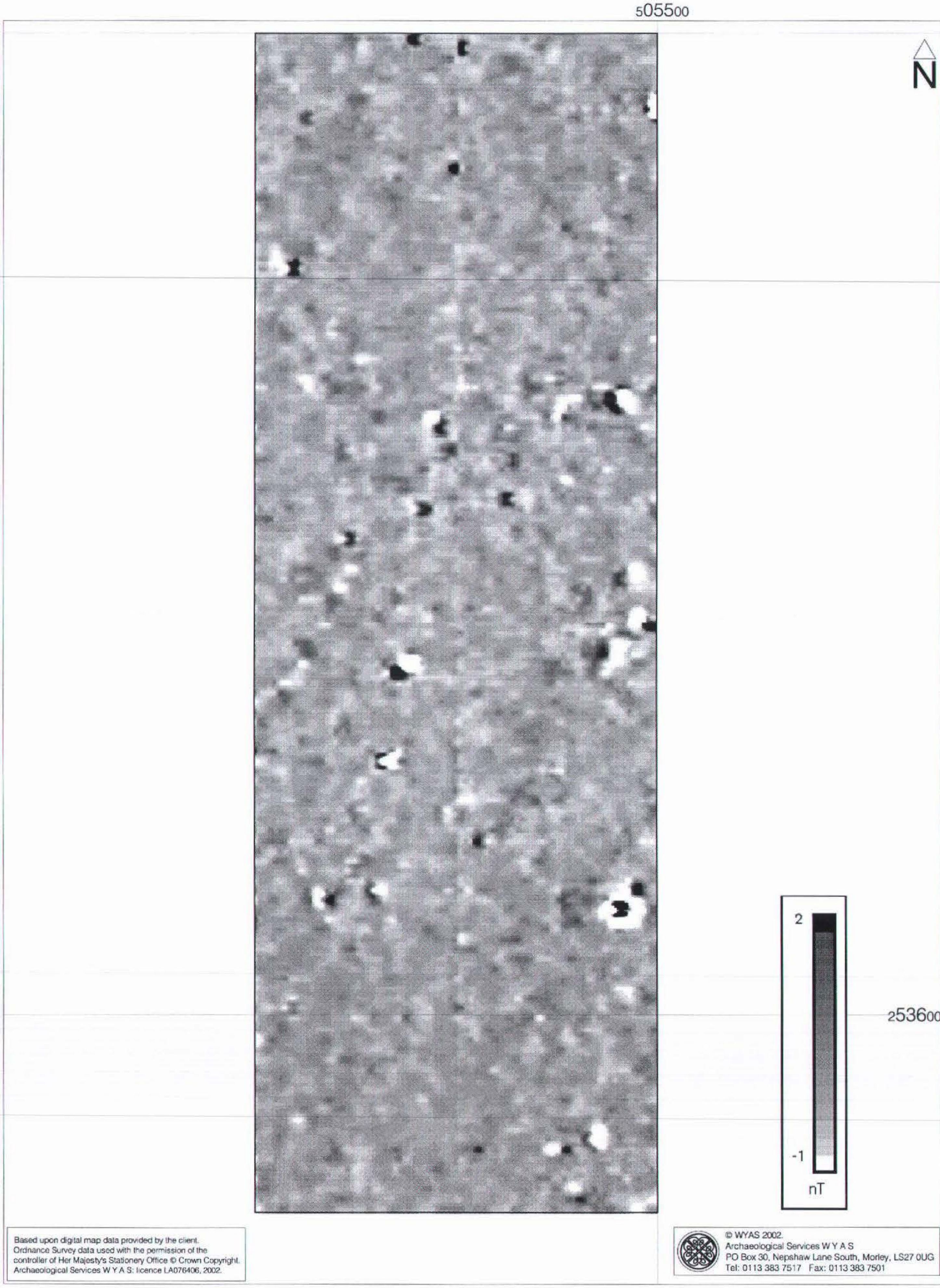

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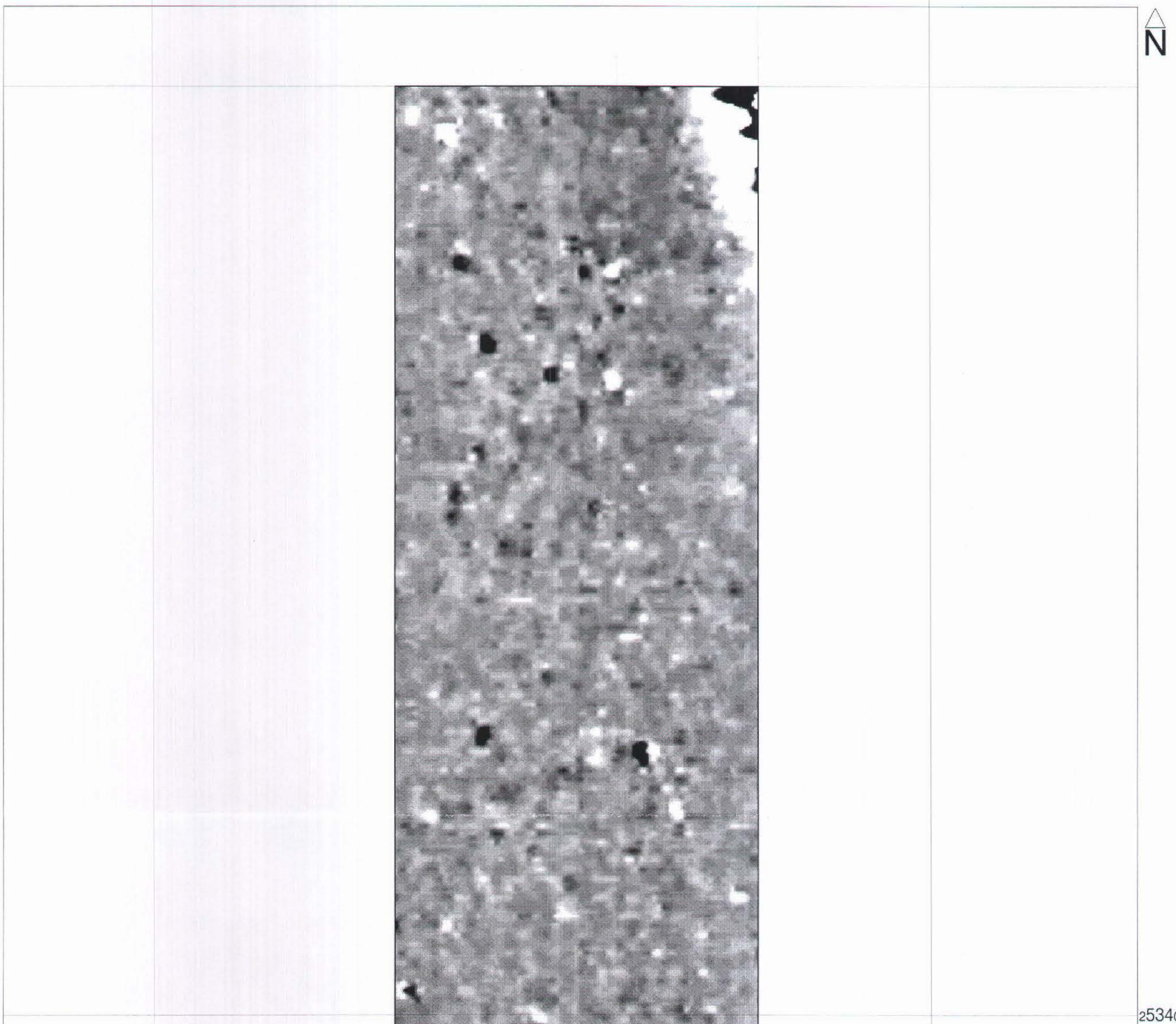

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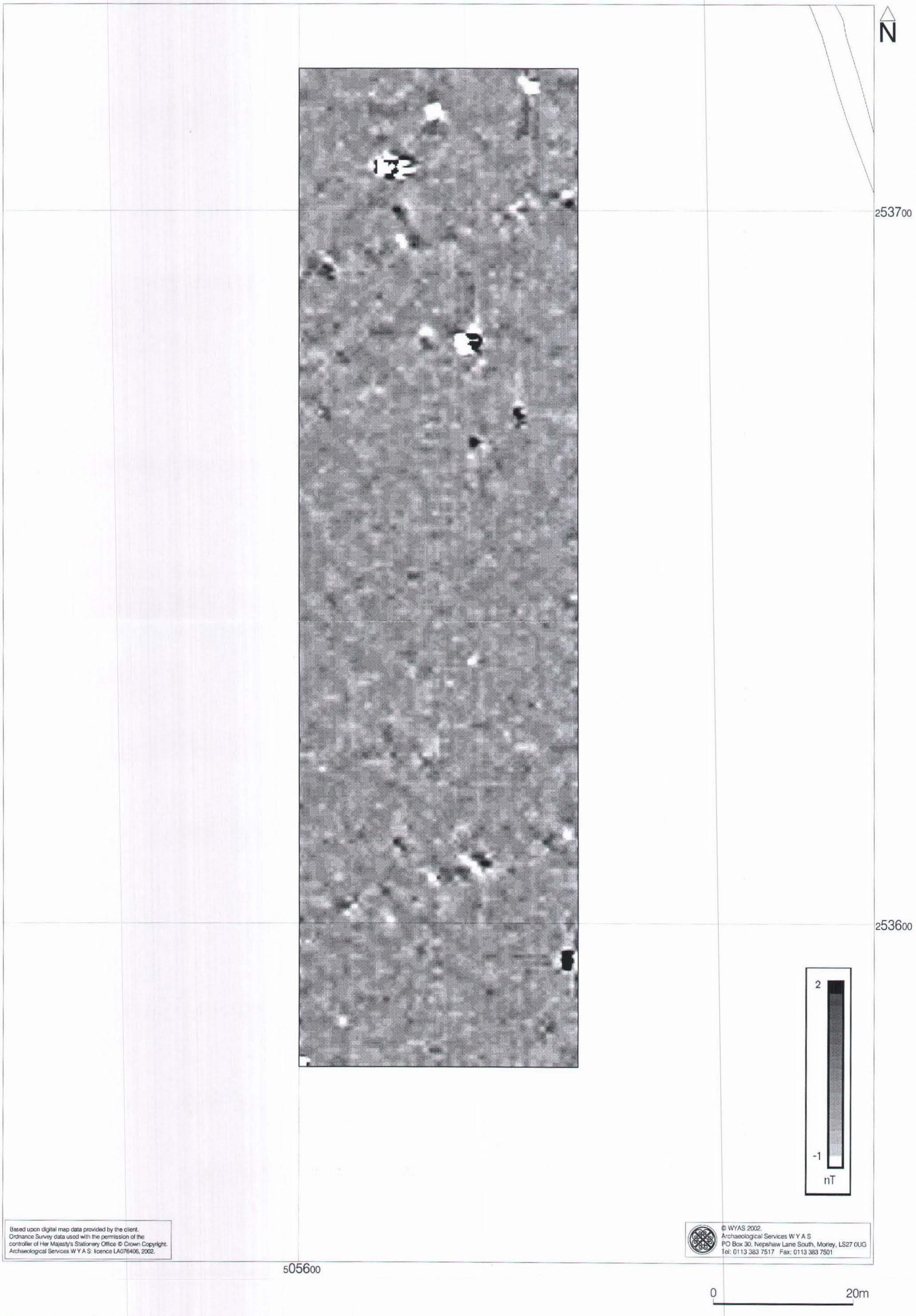

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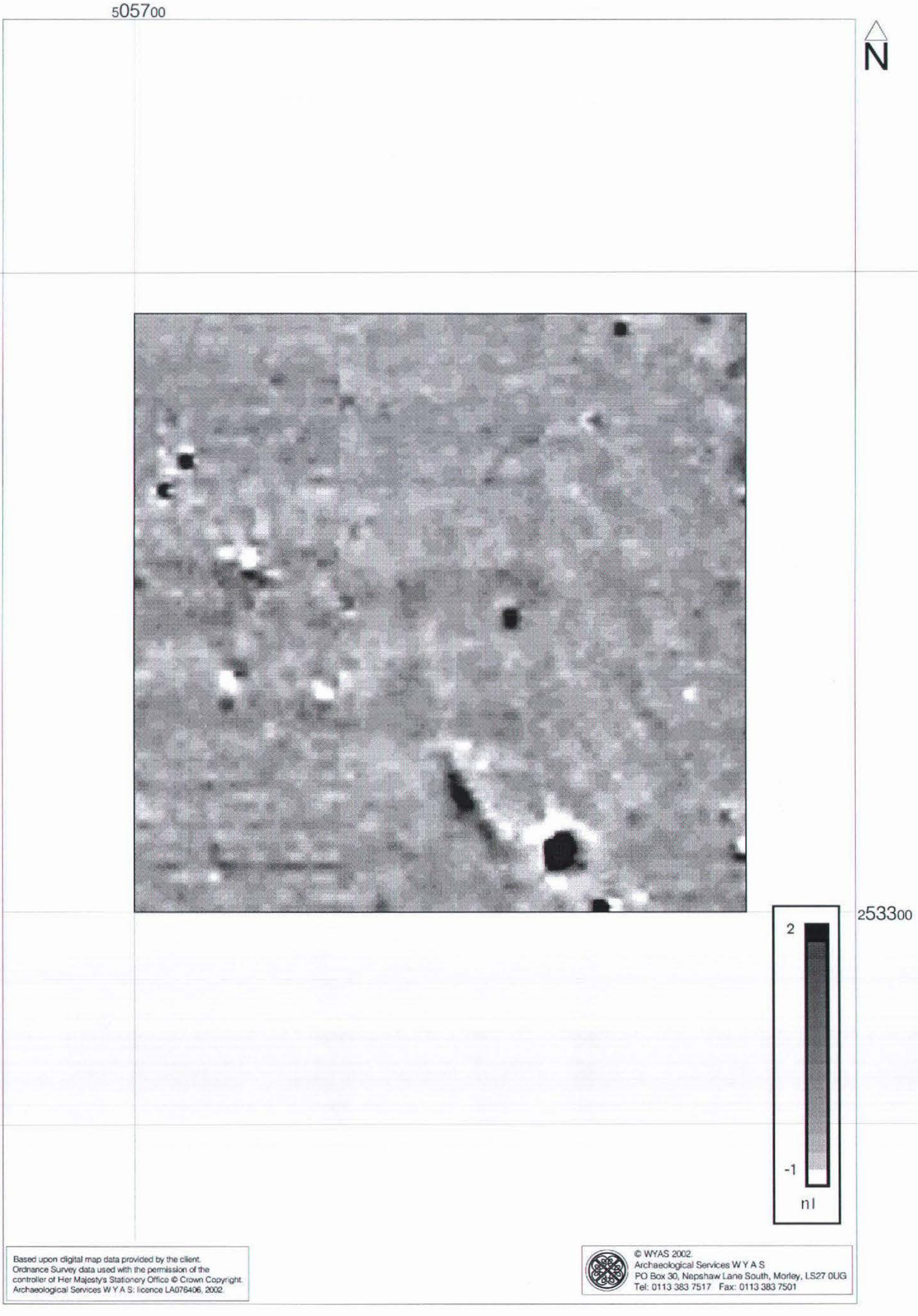

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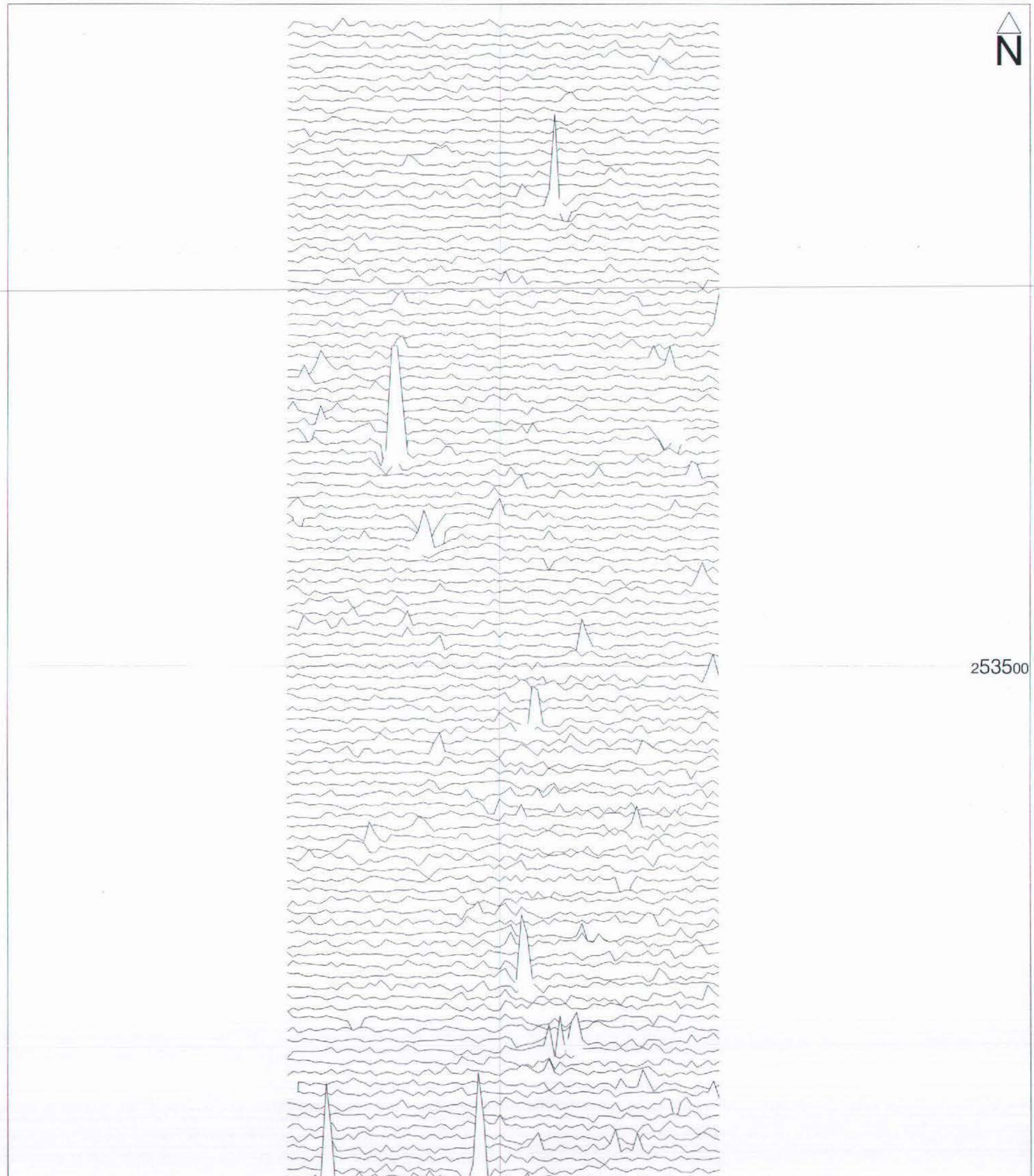

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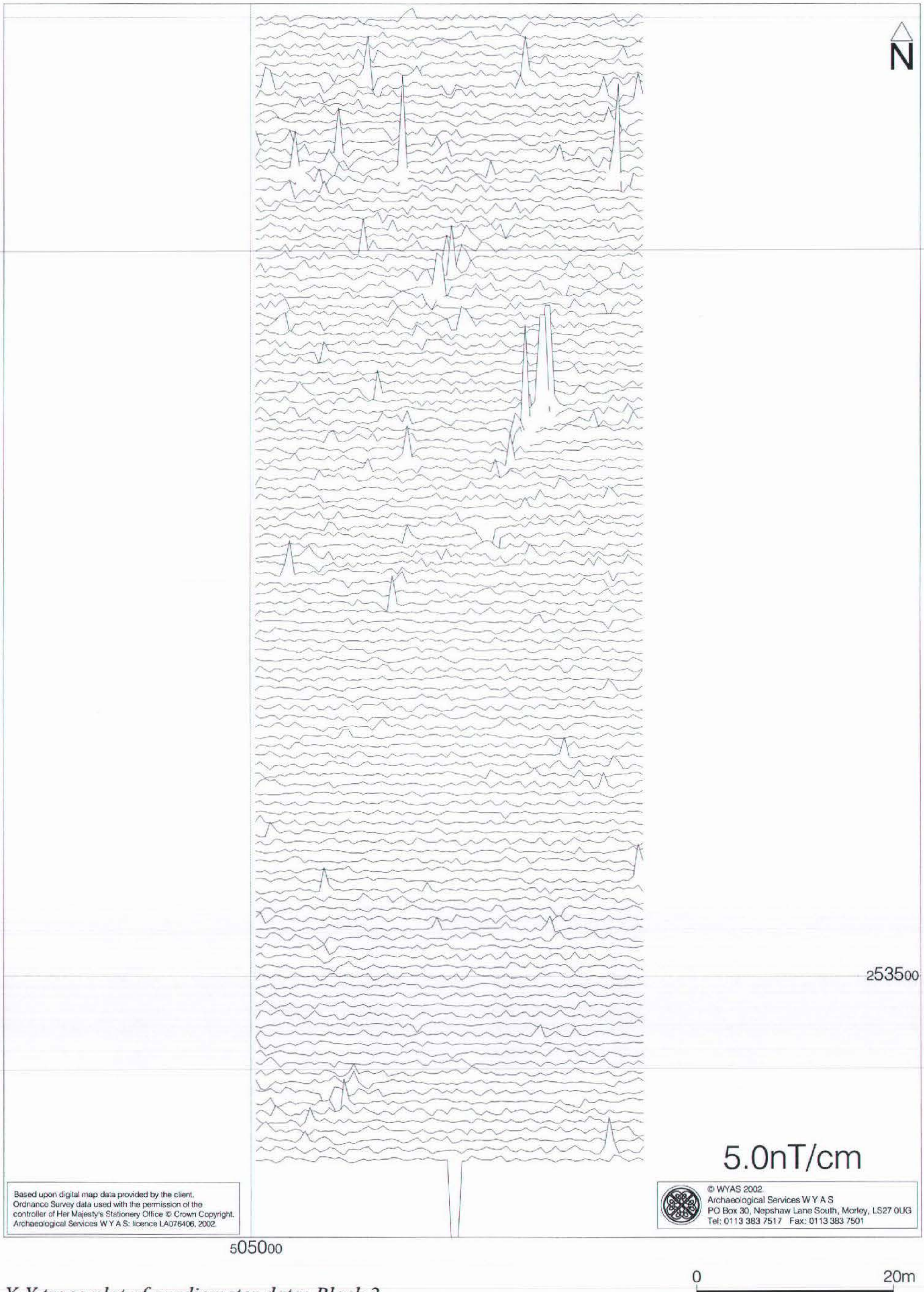

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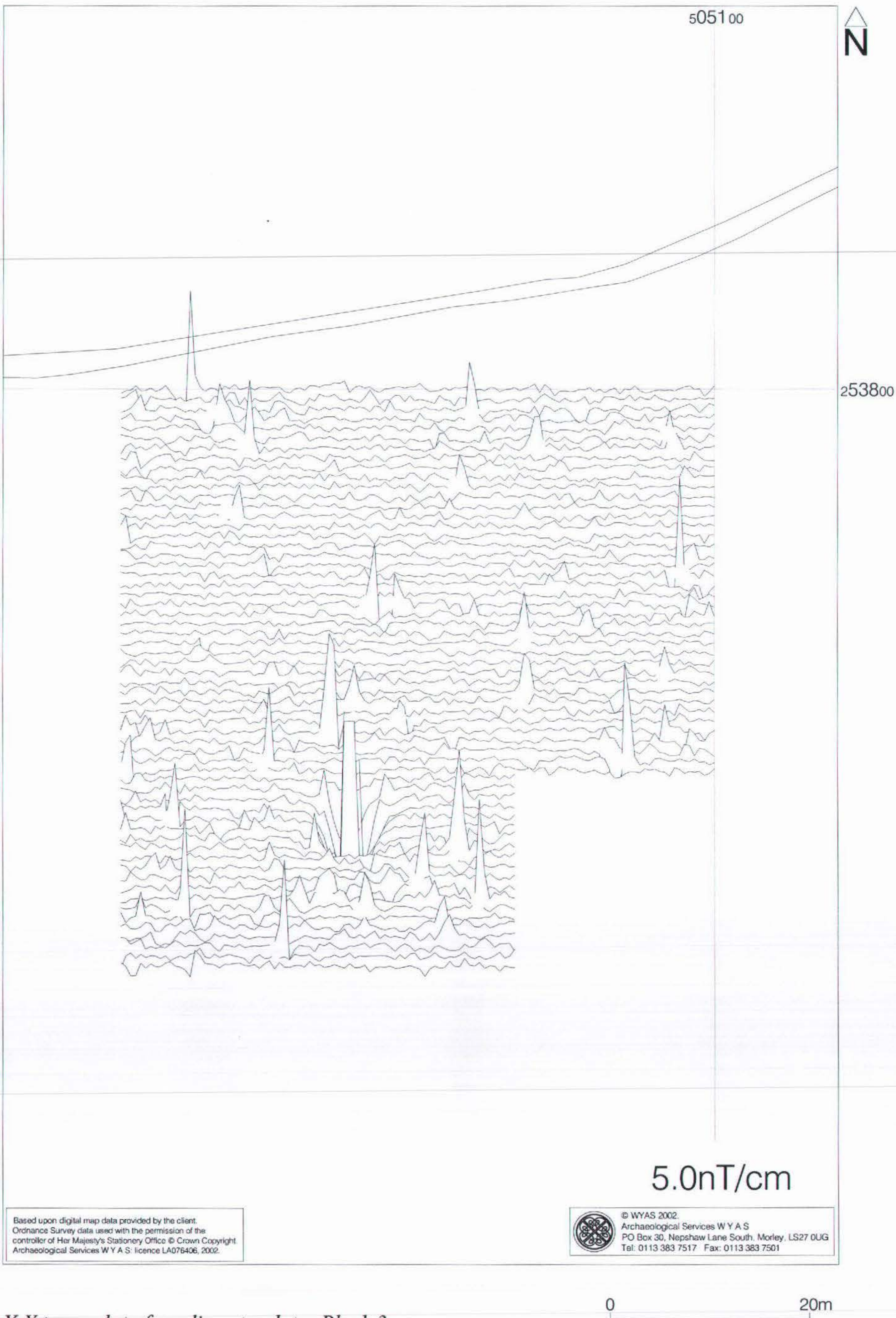

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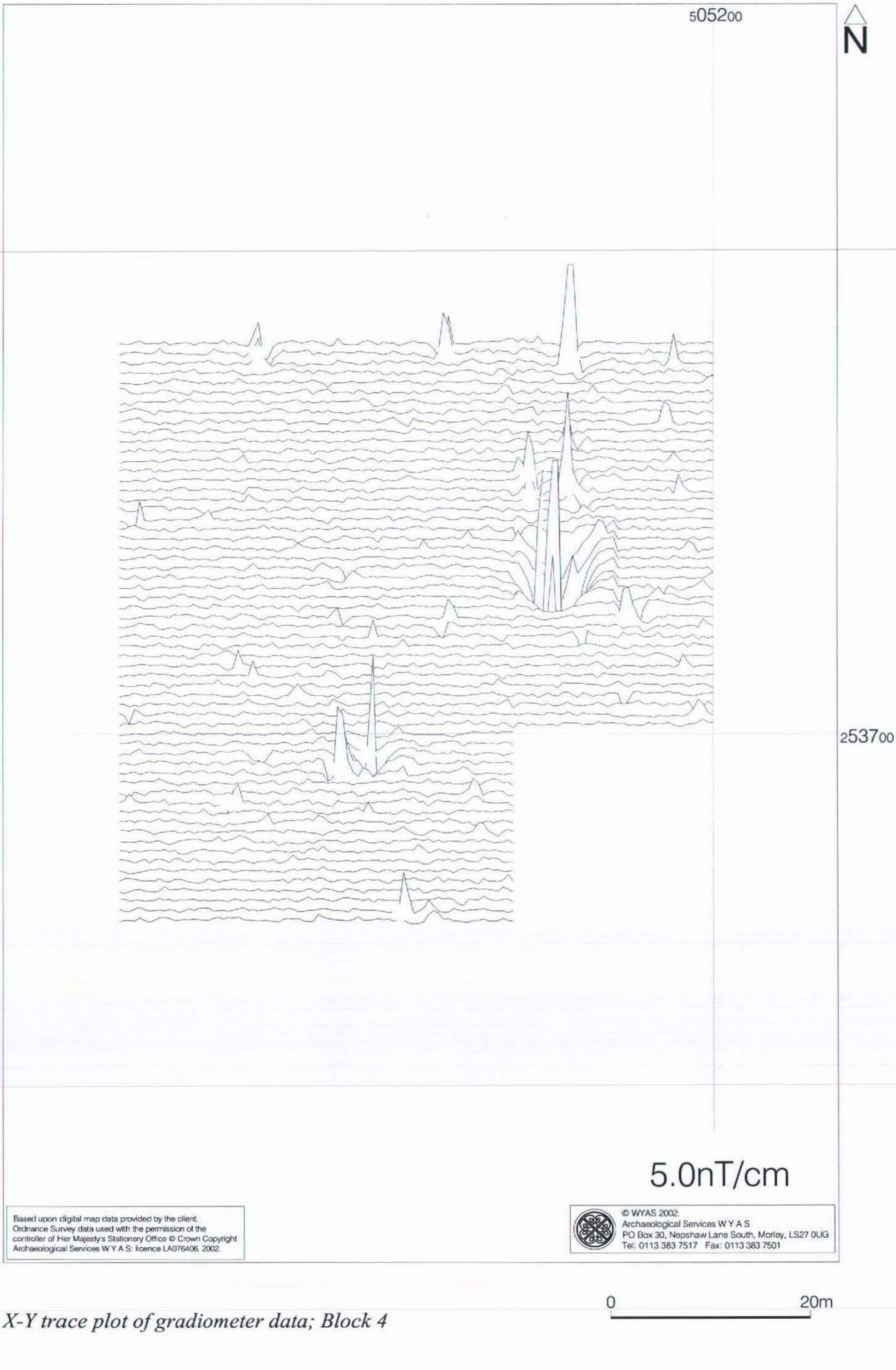

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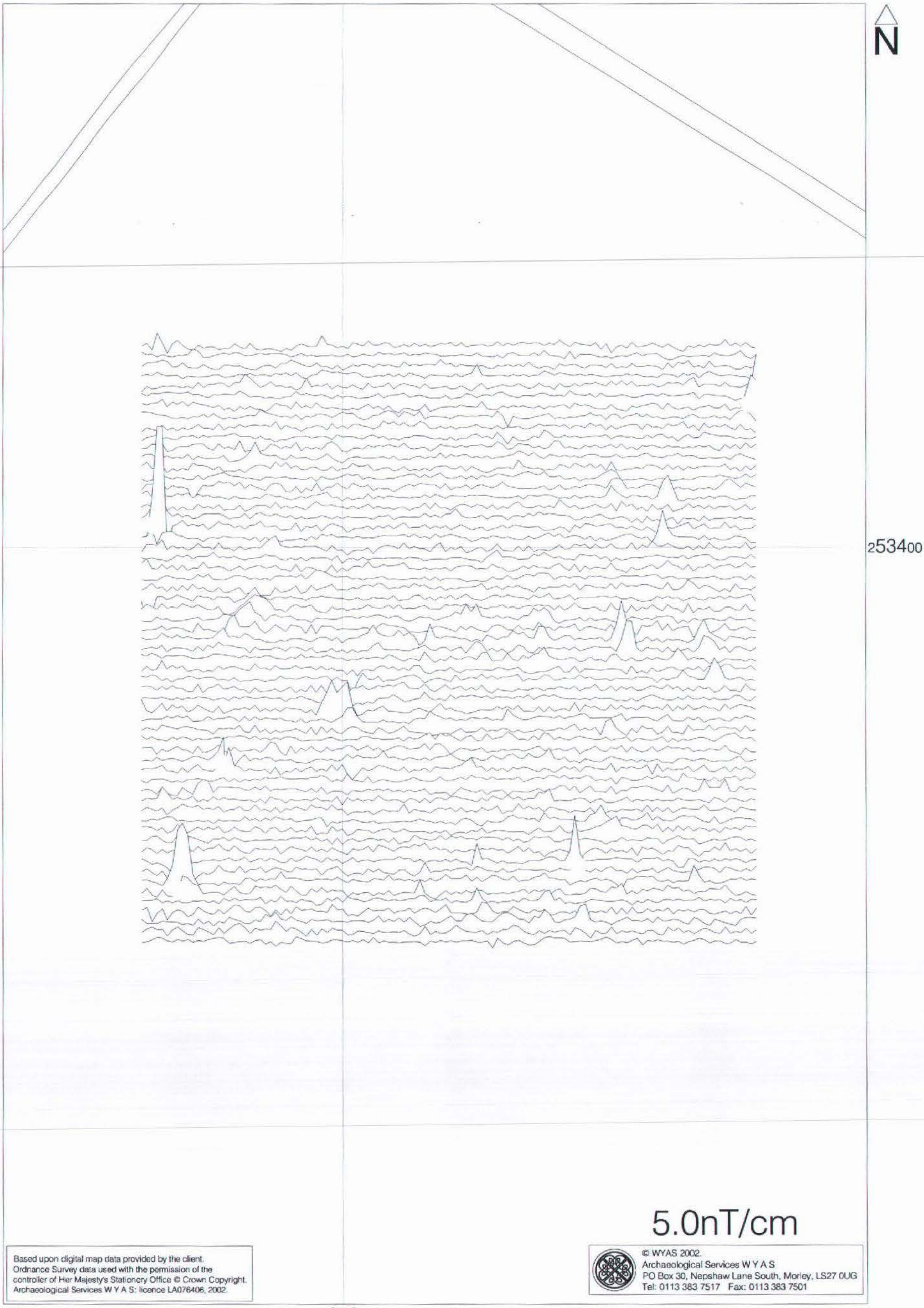

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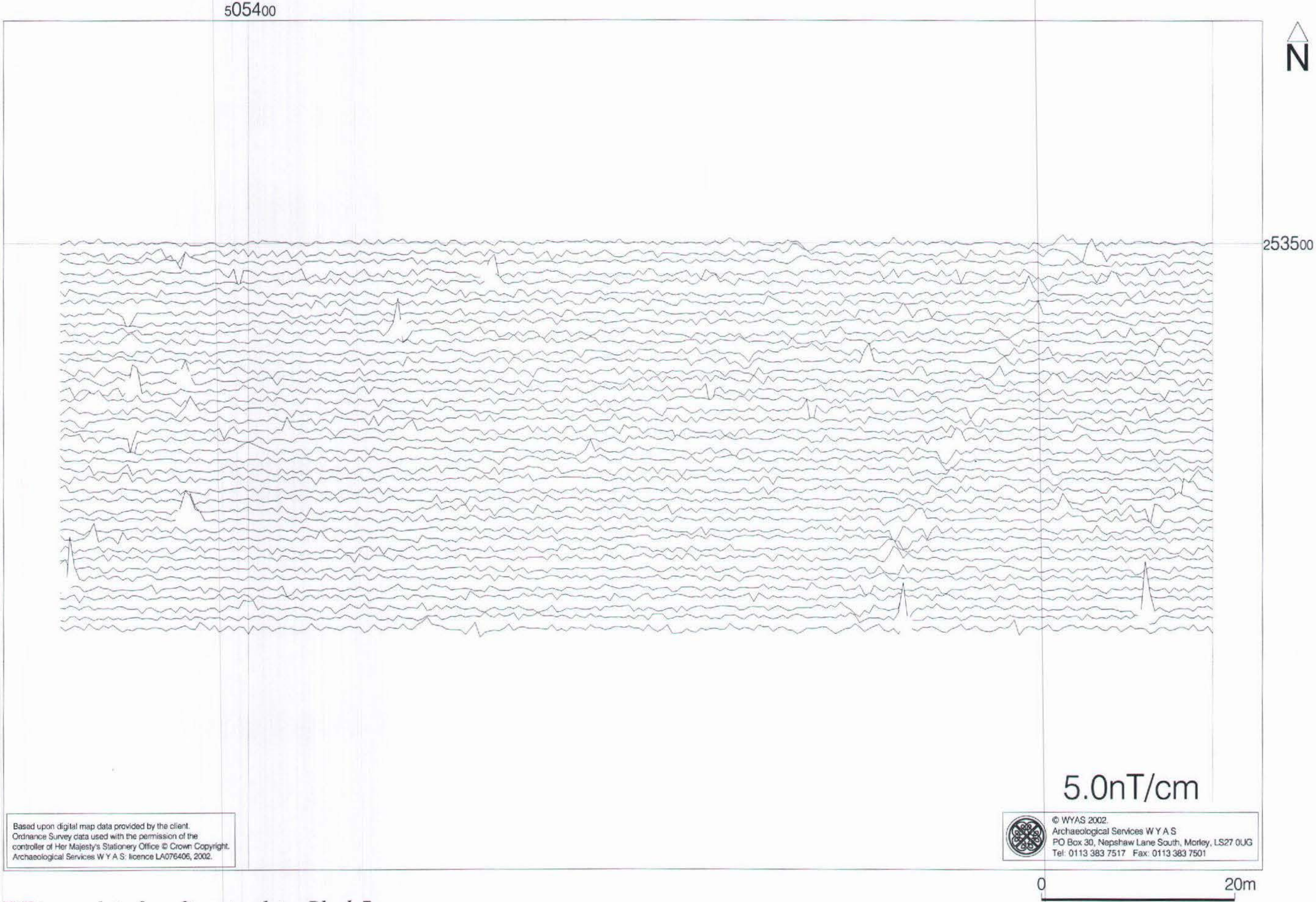
X-Y trace plot of gradiometer data; Block 5

X-Y trace plot of gradiometer data; Block 6



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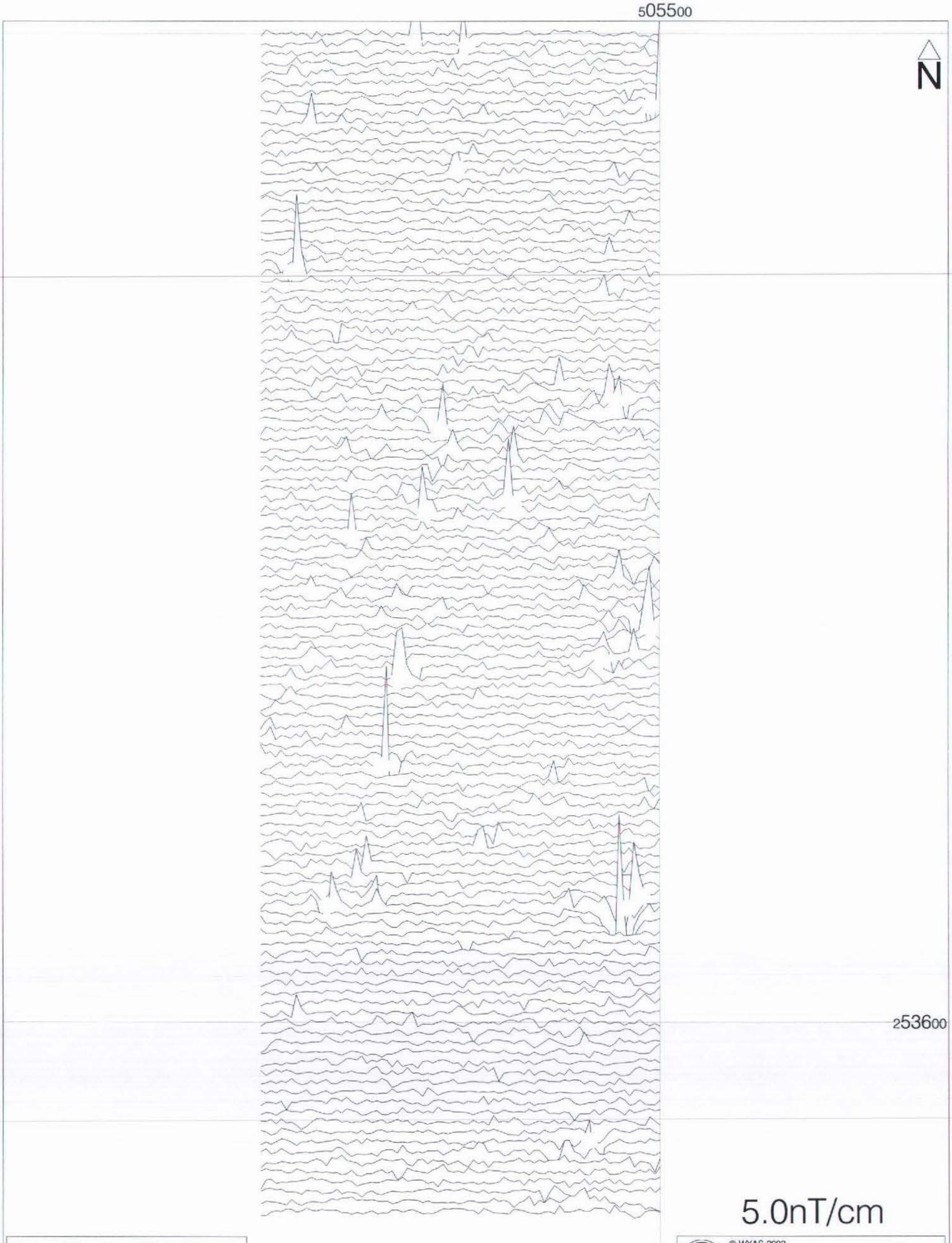

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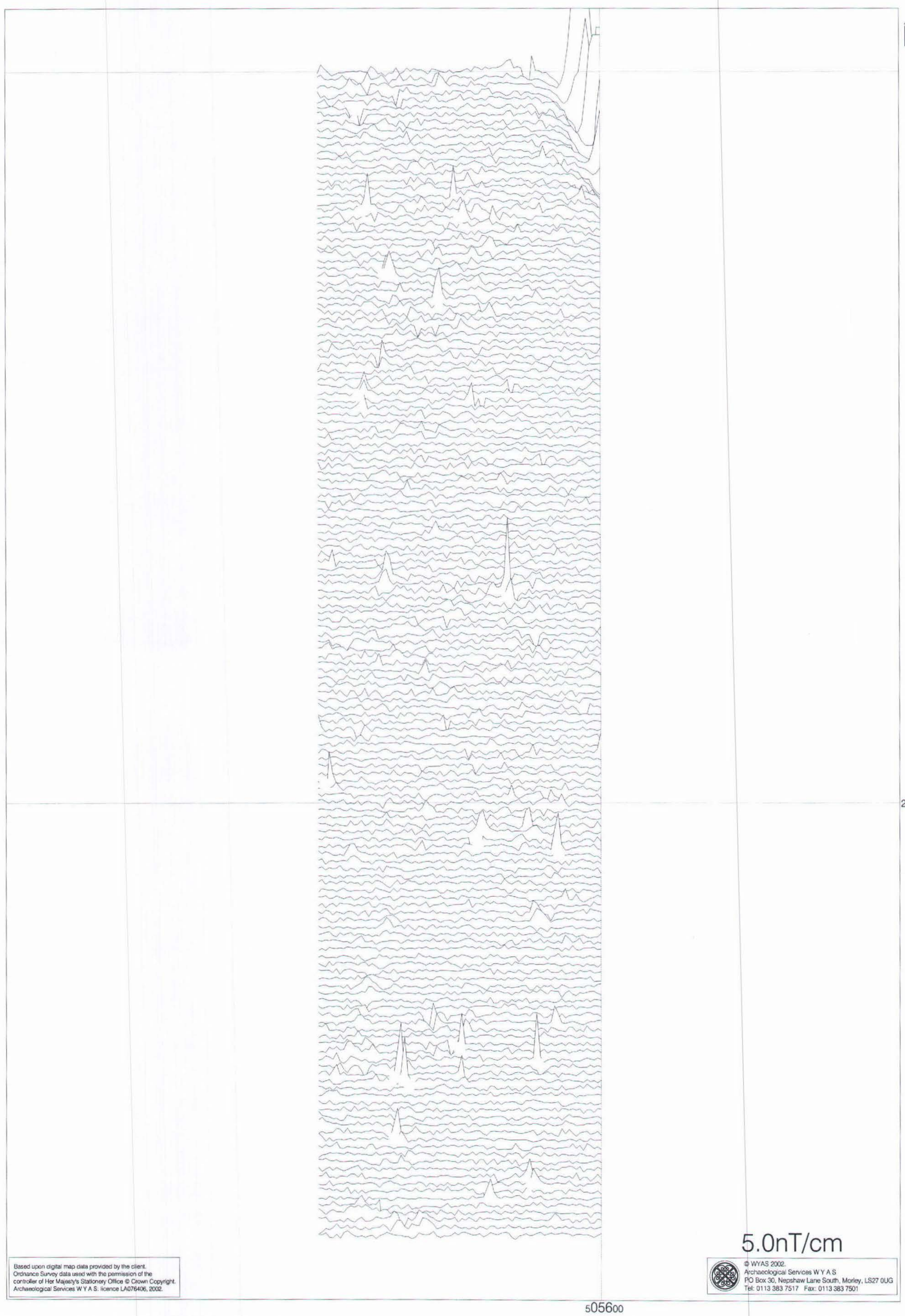

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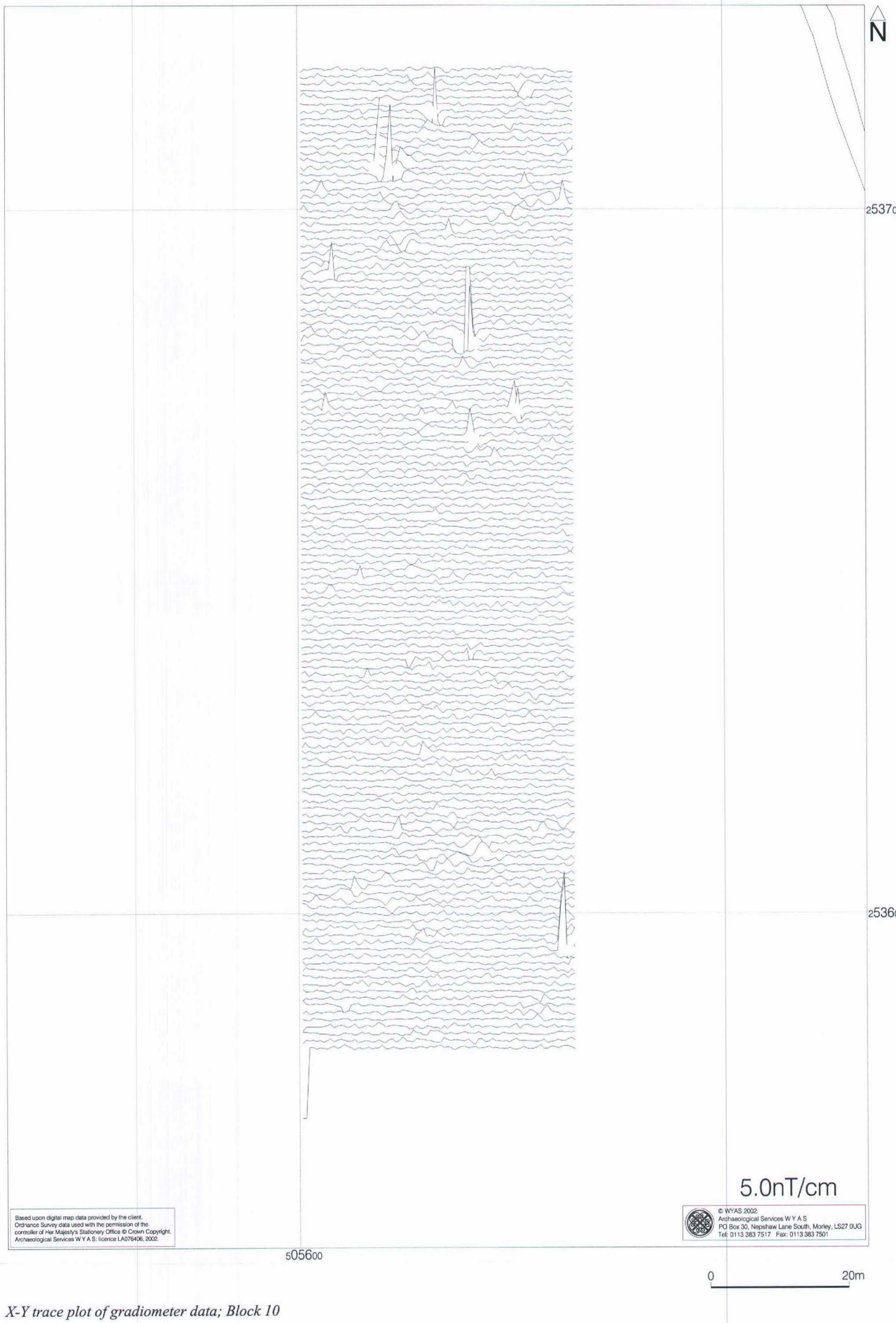

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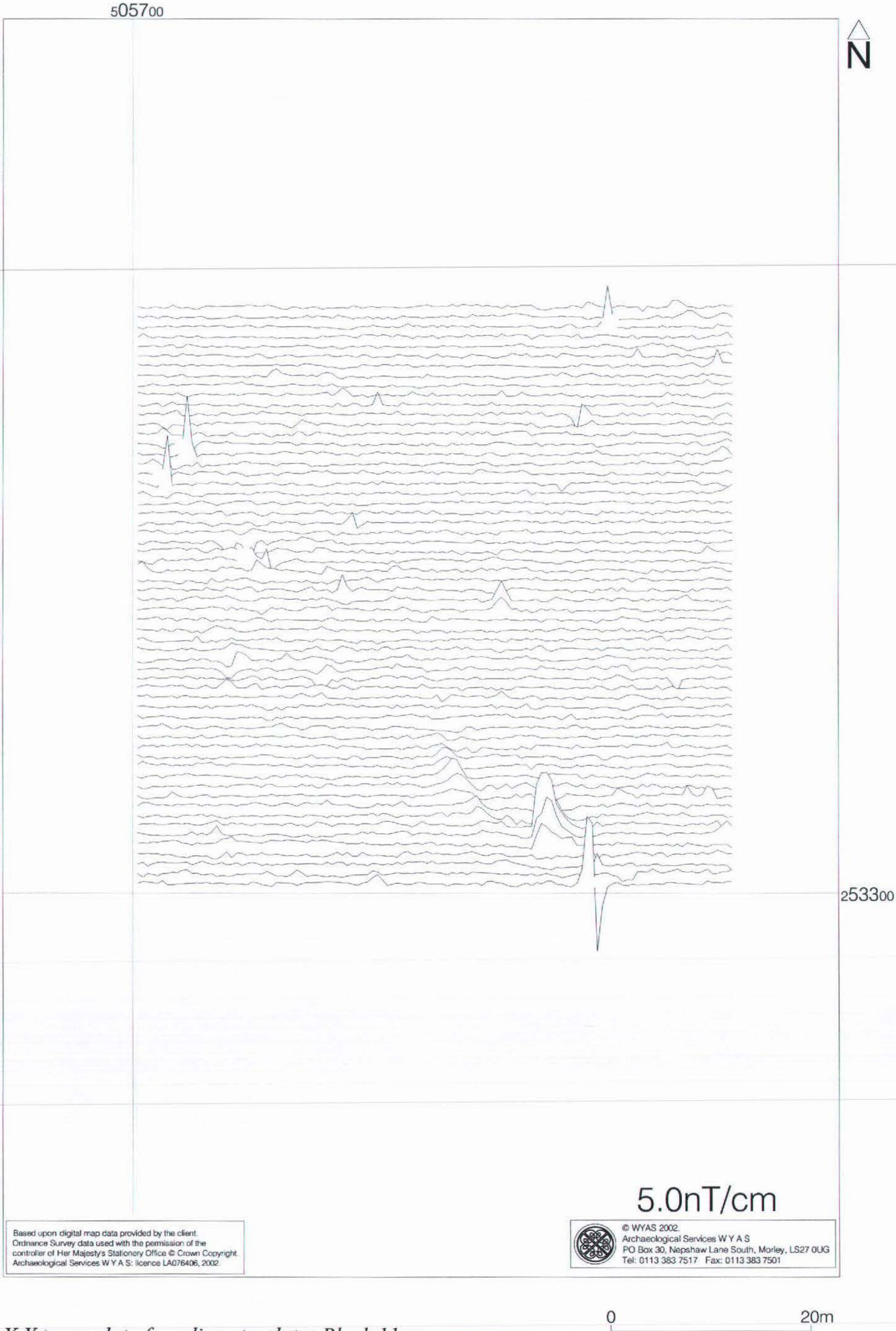

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X-Y trace plot of gradiometer data; Block 11