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Land east of Went Edge Quarry North Yorkshire

Geophysical Survey

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CLIENT
T & T Aggregates

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North Yorkshire

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Contents

Summary

A geophysical survey, covering an area of 1 hectare, was carried out immediately to the east of Went Edge Quarry prior to a proposed expansion in quarrying activity. Aerial photographs identify a cropmark in the north-western part of the survey area. The gradiometer survey has identified anomalies corresponding with the location of the cropmark. These responses are indicative of infilled ditches and appear to form the boundary of an enclosure of unknown date. A weaker linear anomaly and a linear trend may indicate the presence of other archaeological features although these may be caused by infilled natural features. Isolated discrete anomalies are also identified. Whilst these may because by archaeological features it is considered that a natural origin for most of these anomalies is probable.

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1. Introduction and Archaeological Background

1.1 Mr Kevin Thacker, of T. and T. Aggregates, was advised by Ms Gail Falkingham of the North Yorkshire County Council Heritage Unit that prior to the proposed expansion of aggregate extraction to the east of Went Edge Quarry a geophysical (fluxgate gradiometer) survey would be required in a field immediately adjacent to the eastern boundary of the quarry (see Figs 1 and 2). Archaeological Services WYAS was commissioned to carry out this survey.

1.2 The survey area covers approximately 1 hectare (centred at SE 501 172) and comprises the northern part of a single field bounded to the north by the River Went and to the south by West Edge Road. The part of the field designated for future aggregate extraction is bounded to the south and west by earth bunds and to the east by a north/south aligned field boundary. The site enjoys relatively good visibility over the gently undulating arable landscape to the east, west and south. To the north the land slopes down to the River Went whilst within the site boundaries the land exhibits little variation in elevation. The geology comprises Permian Magnesian Limestone bedrock overlain by thin soils of the Aberford Association.

1.3 Site conditions were generally good; the majority of the area was covered with short vegetation that increased to calf or knee high in some areas while the southern quarter had no vegetation at all. No problems were encountered during the survey.

1.4 No textual information was provided detailing the presence or absence of archaeological sites or finds within the site boundary or in the immediate area prior to the survey although it is understood that aerial photographs show a curvilinear cropmark in the north-western corner of the application area.

2. Methodology and Presentation

2.1 As the site was small (approximately 1 hectare), and contained a probable archaeological cropmark, detailed survey of the entire site was undertaken, the specific objective of the survey being to use detailed magnetic survey to establish the presence, extent and character of any magnetic anomalies within the proposed quarry extension area.

2.2 A general site location plan incorporating the 1:50000 Ordnance Survey mapping is shown in Figure 1. Figure 2 shows the greyscale gradiometer data superimposed onto an Ordnance Survey base plan supplied by North Yorkshire County Council Heritage Unit, whilst Figure 3 shows the same data at a larger scale (1:1000) superimposed on to a local grid supplied by the client. The data is presented at a scale of 1:500 in Figure 4 with an accompanying interpretation at the same scale as Figure 5. Figure 6 comprises an X-Y trace plot of the data. 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.

2.3 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.

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. Results and Discussion

3.1 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.

3.2 Areas of magnetic disturbance are evident adjacent to the earthen bund that bounds the southern and western edges of the site. Visual inspection of the more recently constructed southern part of the bund showed that a significant amount of modern detritus had been incorporated into its matrix. Undoubtedly a percentage of this detritus is ferrous and such material will have made a contribution to the disturbance.

3.3 There are numerous irregular, linear and curvilinear anomalies, broadly aligned north to south and east to west, which have responses that are typical of those caused by infilled cut features. Weathering cracks or fissures are common on Magnesian Limestone and it can often be difficult to differentiate between the magnetic anomalies caused by infilled archaeological features and those due to infilled natural features. A definitive interpretation of these anomalies is therefore difficult, but the linearity and regularity of the anomalies does offer some clues to their origin.

3.4 The majority of the linear anomalies are discontinuous and irregular, which suggests that that they are natural rather than anthropogenic in origin. However, a positive, linear anomaly and a linear trend, both aligned north to south in the western half of the survey block, are more regular and may, therefore, be archaeological in origin, although a geological origin is also possible. The breadth of the linear trend is not typical of an archaeological ditch and it may indicate the presence of a former field boundary.

3.5 The positive, linear, anomalies in the north-western corner of the survey block have strong responses and they appear to form a rectilinear shape that suggests that they make up the boundaries of an enclosure. These anomalies correspond with the location of a cropmark and are probably archaeological in origin. The most northerly part of this enclosure appears to extend beyond the area of the geophysical survey. Gaps in the magnetic anomaly on the east-west aligned southern part and north-south aligned western part of the enclosure ditch may indicate the position of entrances although these gaps may also be caused by a greater truncation of the cut feature(s) in these places.

3.6 As well as the linear anomalies there are a number of spatially discrete magnetic anomalies (areas of magnetic enhancement) evident both within the probable enclosure and to its exterior. Those that are within the enclosed area may reflect the presence of archaeological features such as pits, hearths and post-holes and hence indicate small-scale settlement activity. However, differential weathering of the limestone bedrock can cause discrete natural features and so, as with the linear anomalies, any or all of the areas of magnetic enhancement could be natural origin. The significance of the isolated magnetic responses outside the enclosure is harder to determine given the susceptibility of Magnesian limestone to solution weathering and a definitive interpretation is not possible.

4. Conclusions

4.1 Parts of the boundary ditches of a probable archaeological enclosure have been identified in the north-western corner of the survey area. A number of small discrete anomalies within the area bounded by the enclosure ditches may indicate the presence of pits or hearths and could suggest small-scale settlement activity.

4.2 Two other linear anomalies and several other areas of magnetic enhancement may indicate the presence of other archaeological features although a natural origin for these anomalies is also possible.

4.3 Other irregular linear magnetic anomalies and trends within the survey block are harder to interpret. The most probable explanation is the presence of geological features caused by solution weathering. However, given the presence of probable archaeological features nearby an archaeological origin for some of these features cannot be completely ruled out.

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

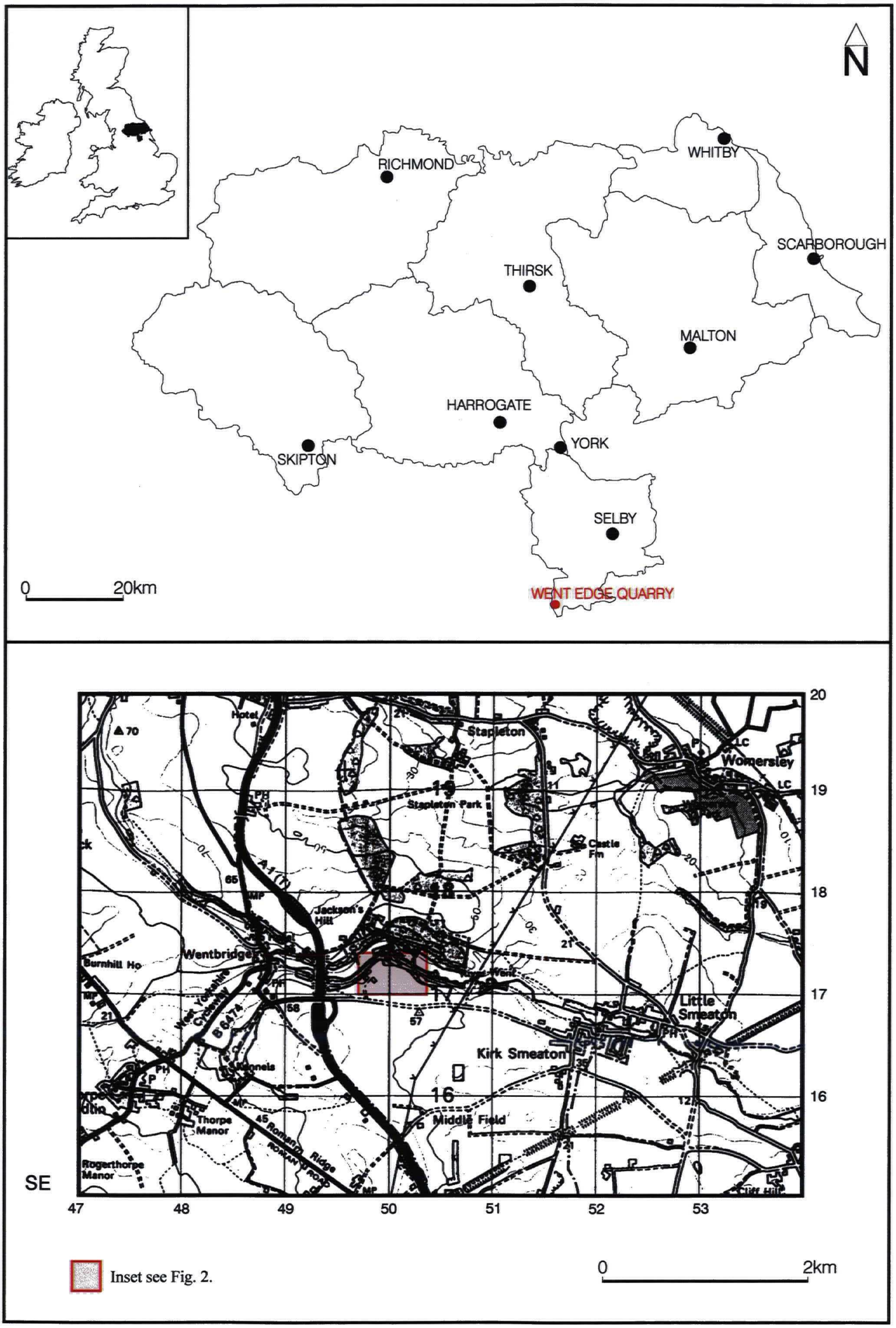

Fig. 1. Site location

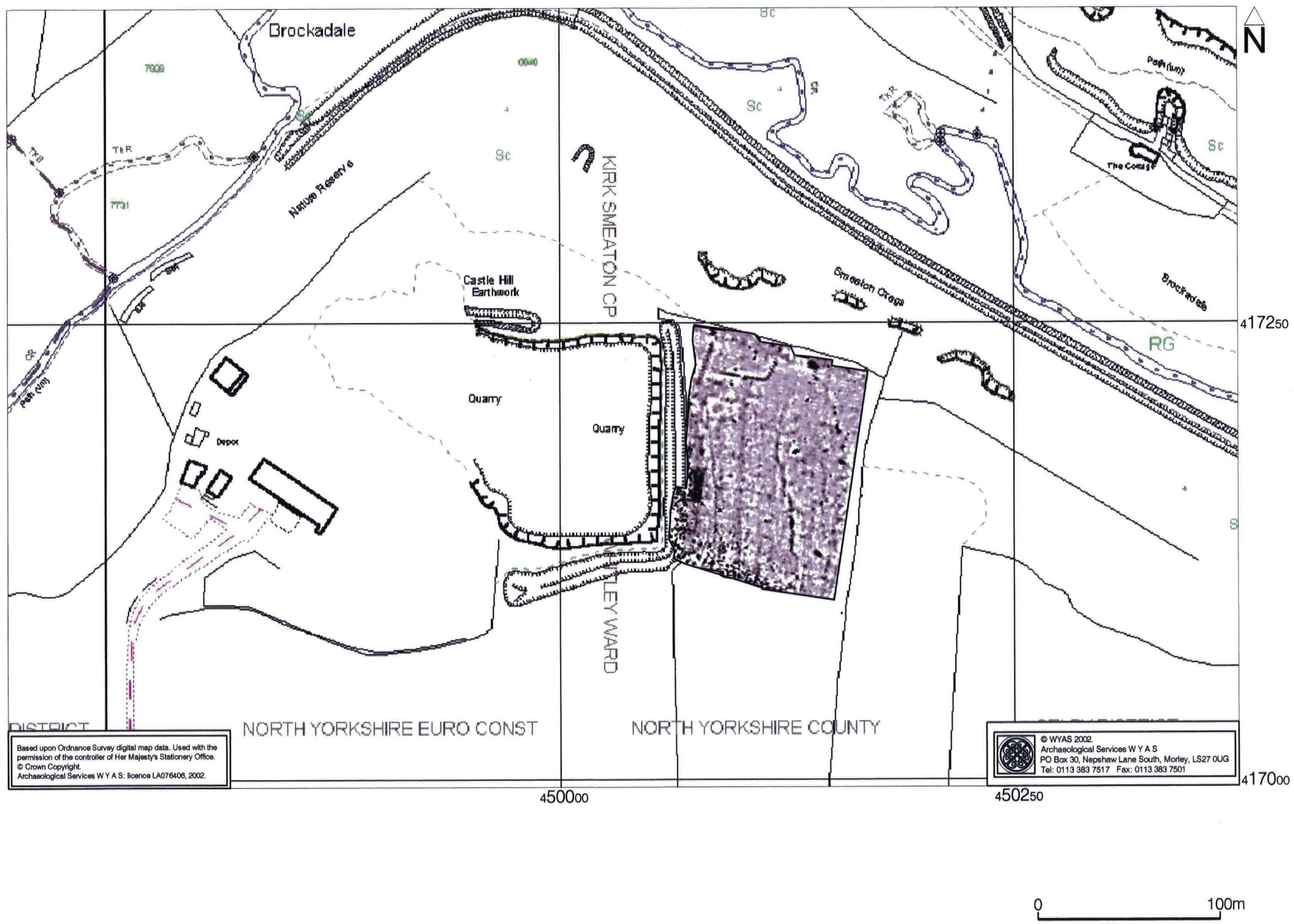

Fig. 2. Site location showing greyscale gradiometer data

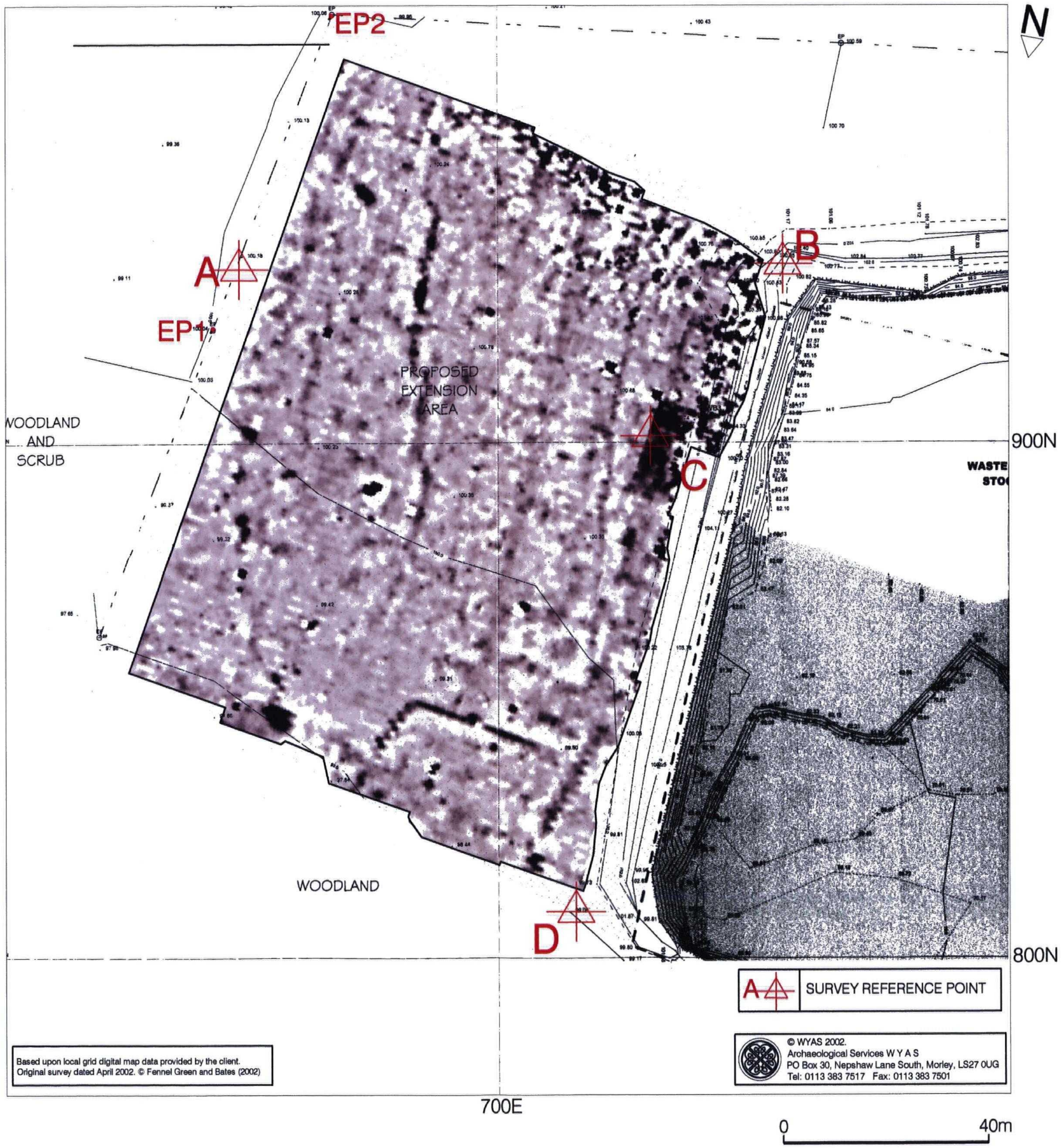

Fig. 3. Detailed site location showing greyscale gradiometer data (local grid)

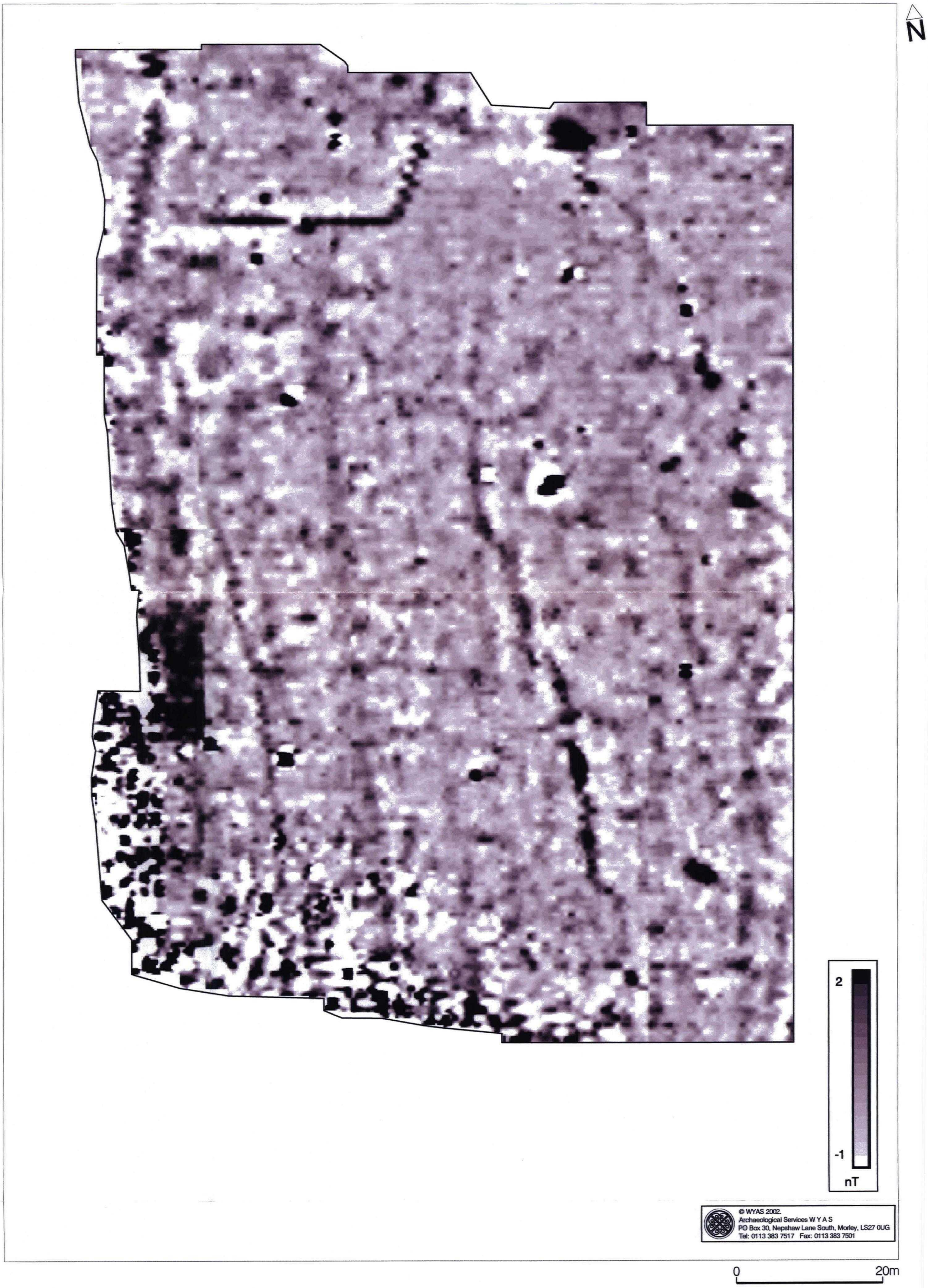

Fig. 4. Greyscale gradiometer data

TYPE OF ANOMALY	INTERPRETATION
AREA OF MAGNETIC DISTURBANCE	MODERN FERROUS MATERIAL
DIPOLAR, ISOLATED	MODERN FERROUS MATERIAL IN TOPSOIL
POSITIVE, LINEAR	NATURAL FEATURE?
POSITIVE, LINEAR TREND	NATURAL?/ ARCHAEOLOGICAL FEATURE?
AREA OF MAGNETIC ENHANCEMENT	ARCHAEOLOGICAL?/ GEOLOGICAL FEATURE?
POSITIVE, LINEAR	POSSIBLE ARCHAEOLOGICAL FEATURE
POSITIVE, LINEAR	PROBABLE ARCHAEOLOGICAL FEATURE

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0 20m

Fig. 5. Interpretation of gradiometer data

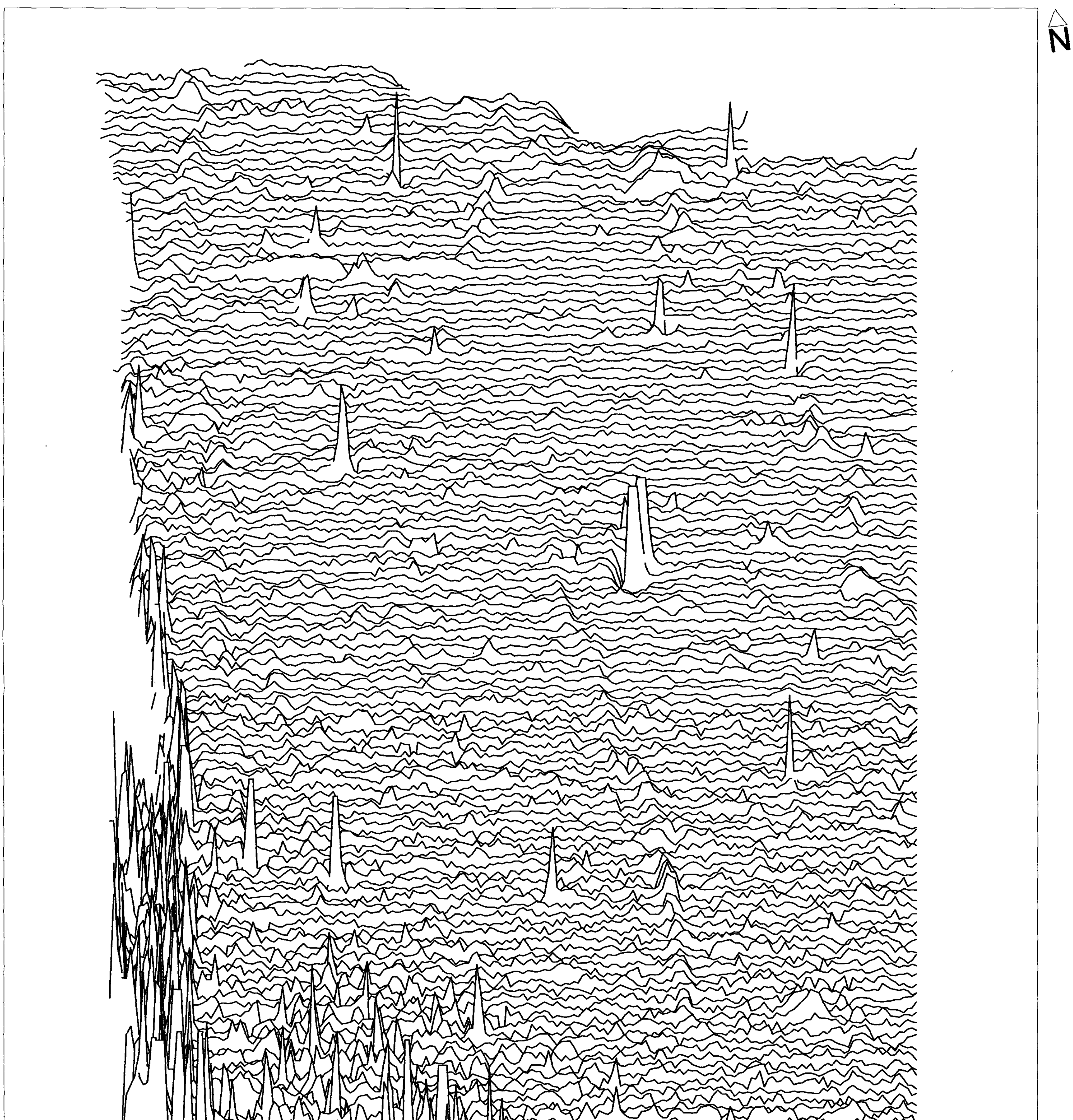

Fig. 6. X-Y trace plot of gradiometer data

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 generally facing north or north-west 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.

3.4.1 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.

3.4.2 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.

3.4.3 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

1. The geophysical survey grid was laid out and tied in to 'permanent' landscape features, such as field boundaries, electricity poles and temporary reference points (Fig. 2 and below), using a Geodimeter 600s total station theodolite. The survey block was then superimposed onto an Ordnance Survey map base (JPEG format), provided by the Heritage Unit of North Yorkshire County Council, using common reference features. There was a poor match between the features marked on the Ordnance Survey plan and those that were present on the ground and so the data was also superimposed onto a local grid plan, provided by the client, which was more representative of the features present.

2. Figure 2 shows the geophysical data on the Ordnance Survey map base and is intended for display purposes only. No accurate co-ordinates should be measured from this plan. Figure 3 has the geophysical data on the local grid map base and also shows the location of the reference points that the survey grid was tied in to. Local grid co-ordinates for these points are given below. The accuracy of the geophysical survey grid relative to these points is approximately ±0.05m.

Station	Easting	Northing
A (wooden stake)	649.30	933.77
B (wooden stake)	755.83	934.80
C (wooden stake)	729.91	901.39
D (wooden stake)	715.27	808.93
EP1 (telegraph pole)	644.13	922.20
EP2 (telegraph pole)	667.41	982.94

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).