ARCHAEOLOGICAL
SERVICES
WYAS

Settrington Quarry
Settrington
Malton
North Yorkshire

Gradiometer Survey

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Settrington Quarry,

Settrington,

Malton,

North Yorkshire.

(SE 8285 6975 site centred)

Geophysical Survey

Contents

Summary

A geophysical survey, covering 1 hectare, was carried out on land earmarked for the expansion of a limestone quarry. Two curvilinear anomalies and several isolated anomalies have been identified. These may be archaeological but a geological origin cannot be discounted. There was no evidence for the cropmark which is shown at the extreme western edge of the site.

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1. Introduction & Archaeological Background

1.1 Archaeological Services (WYAS) was commissioned by Ms A. Finney of MAP Archaeological Consultancy Ltd. to carry out a geophysical (fluxgate gradiometer) survey immediately south of Settrington Quarry near Malton (see Figs 1 & 2). The area for survey, which covers 1 hectare, is the proposed site of an extension to the existing limestone quarry.

1.2 The survey area was bounded to the north by the current limit of the quarry and to the east by a field boundary. Topographically the site was relatively flat forming a plateau that sloped gently to the south but which dropped off steeply at the western edge of the survey area. A plot of the cropmarks in the immediate vicinity (see Fig. 2) suggests a system of field divisions and enclosures with a marked concentration to the north, west and south of the site. One cropmark might fall within the bounds of the site itself. The orientation of these cropmarks tends to parallel that of the 50m to 60m contour lines.

1.3 At the time of survey (October 26th 1999) the site was under a very young cereal crop with the exception of a narrow strip, approximately 7m wide, adjacent to the northern edge of the site that was planted with a rape/mustard fodder crop; the height and density of this crop precluded survey in the majority of this area.

1.4 The objectives of the survey were:

- to establish the presence and extent of any geophysical anomalies within the survey area
- to characterise any such anomalies.

2. Results & Discussion

2.1 The magnetic data is presented as a greyscale plot superimposed on a local survey plan base at a scale of 1:1000 in Figure 3 with an interpretation at the same scale as Figure 4. Large scale (1:500) greyscale and X-Y trace plots of the data are presented as Figure 5.

2.2 The most apparent feature of the data is the very low background magnetic response (approximately +/- 0.5nT). This is not uncommon on soils derived from organically deposited sedimentary rocks, such as the Cretaceous limestones and chalks that underly this site, because of their low ferrous oxide content.

2.3 Two linear trends are also obvious in the data; those on a west to east orientation reflect the direction of the current agricultural planting regime while those at right angles to this, which are roughly 7m to 10 m apart, are probably due to older ridge and furrow ploughing.

2.4 Several isolated dipolar anomalies have been highlighted. Whilst they could be caused by archaeological artefacts it is more likely that they are due to modern ferrous objects, such as shotgun cartridges, on the surface of the field or in the topsoil. Often such objects are introduced through manuring.

2.5 Two very weak, parallel, curvilinear anomalies have been identified. These responses are perhaps indicative of an infilled archaeological ditch but a fault or crack in the solid bedrock into which soil has percolated could also cause a similar response.

2.6 Several isolated anomalies have also been identified. These responses could also be caused by infilled cut features such as small pits or post holes. Nevertheless, as above, it should be recognised that on geologies that are susceptible to erosion and/or faulting or cracking along bedding planes magnetic anomalies can be caused by naturally occurring infilled features. However, an archaeological origin cannot be discounted.

3. Conclusions

3.1 One curvilinear anomaly and several isolated anomalies have been identified that could have an archaeological origin. However, it is thought that any or all of these anomalies could have a natural/geological origin given the prevailing solid geology.

3.2 There is no evidence in the data of the linear cropmark shown on Figure 2 at the western edge of the survey area. This could reflect a slight locational error in the rectification of the cropmarks from the aerial photographs or the truncation of the feature by deep ploughing since the aerial photographs were taken. However, if it does fall within the surveyed area it would suggest that there is a lack of magnetic contrast between the fill of the feature causing the cropmark and the surrounding topsoil/subsoil thereby rendering it undetectable by conventional magnetic survey. If this is the case there could be other undetected archaeological features within the site.

The absence of geophysical anomalies should not be interpreted as indicating an absence of archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits. This is usually undertaken by means of targeted trial trenching.

The results and subsequent interpretation of geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. The nature of any sub-surface remains can normally be determined by direct investigation of these deposits by targeted trenching.

Acknowledgements

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Report
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Figures

Appendices

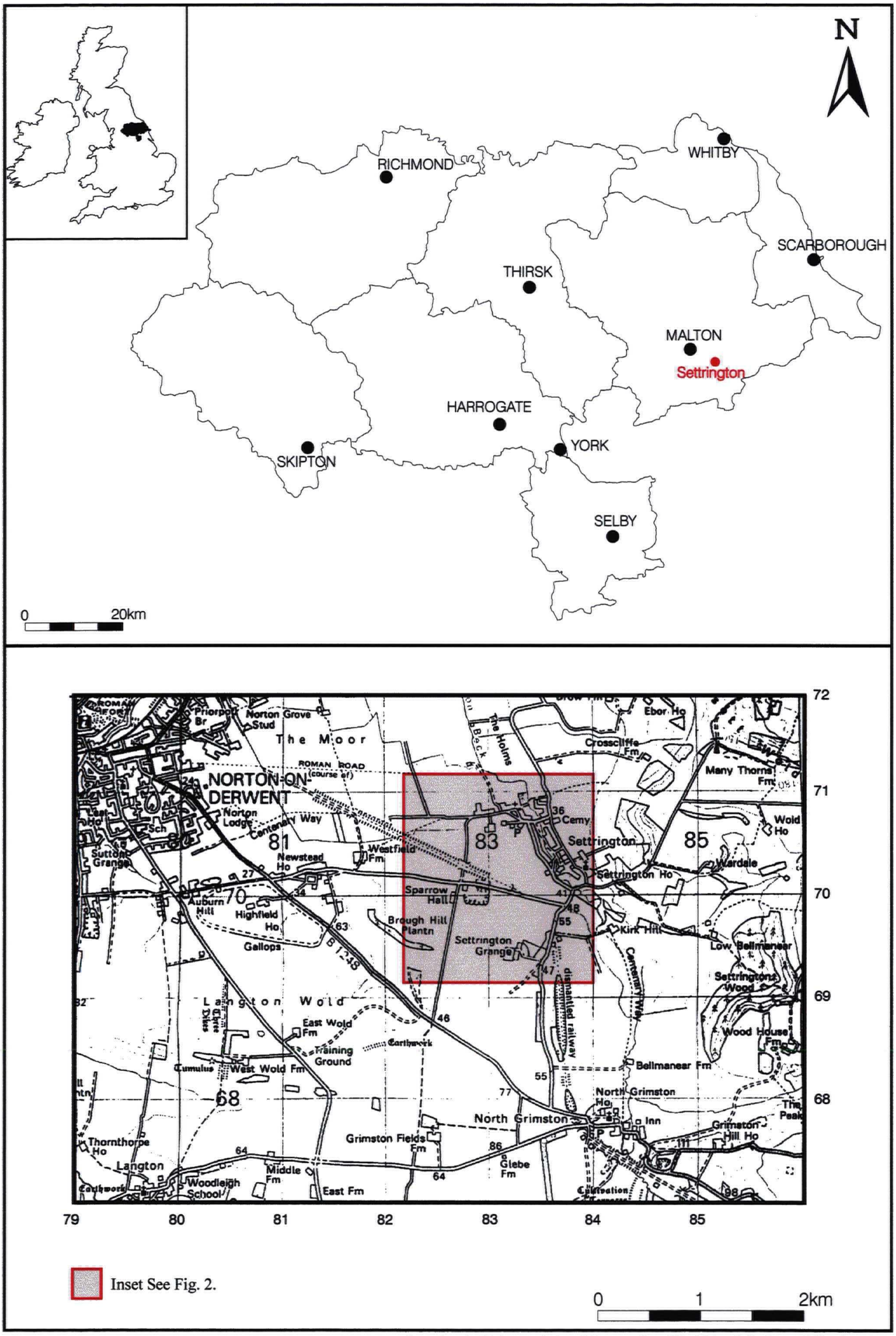

Fig. 1. Site location

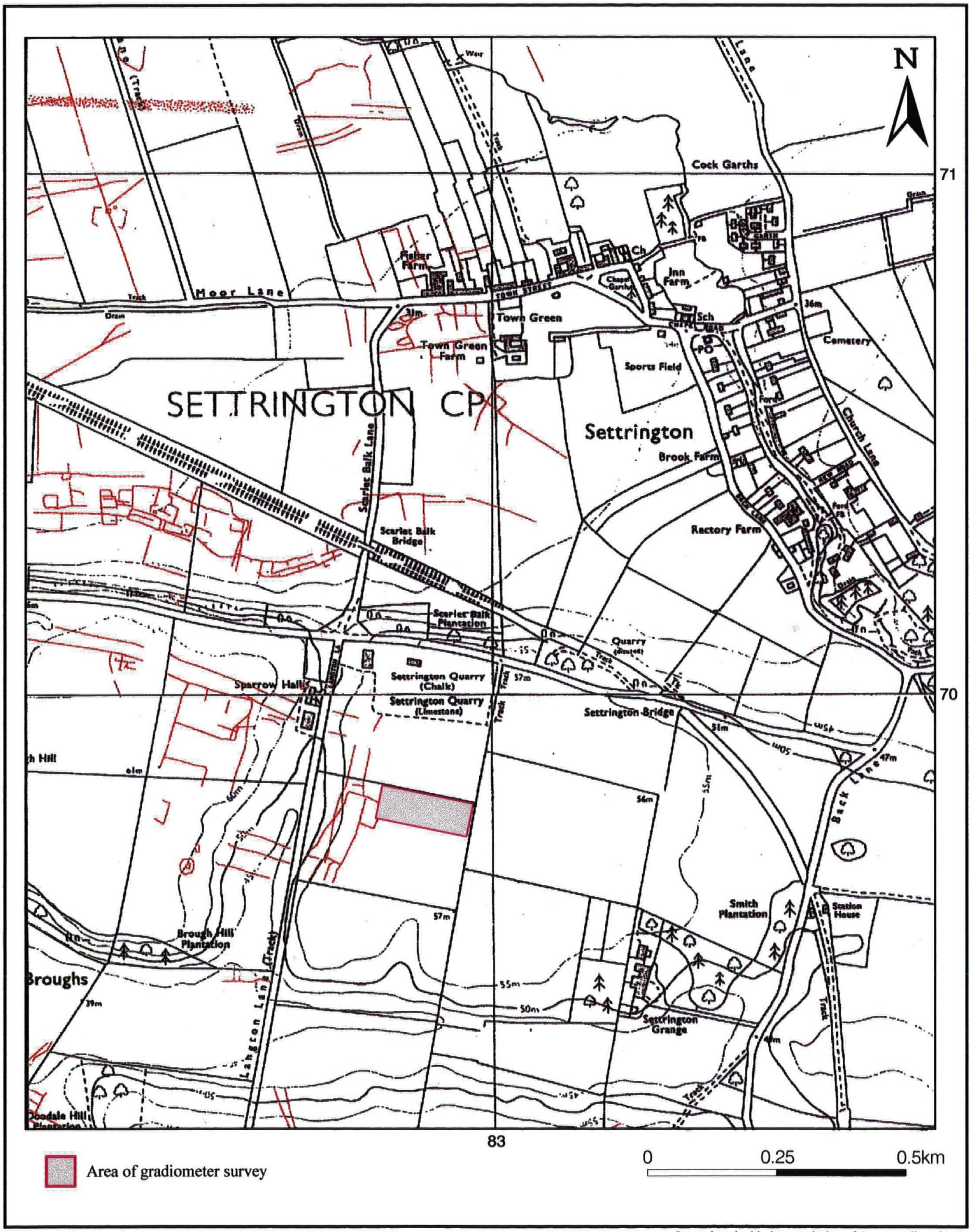

Fig. 2. Survey location showing adjacent cropmarked features (1:10000)

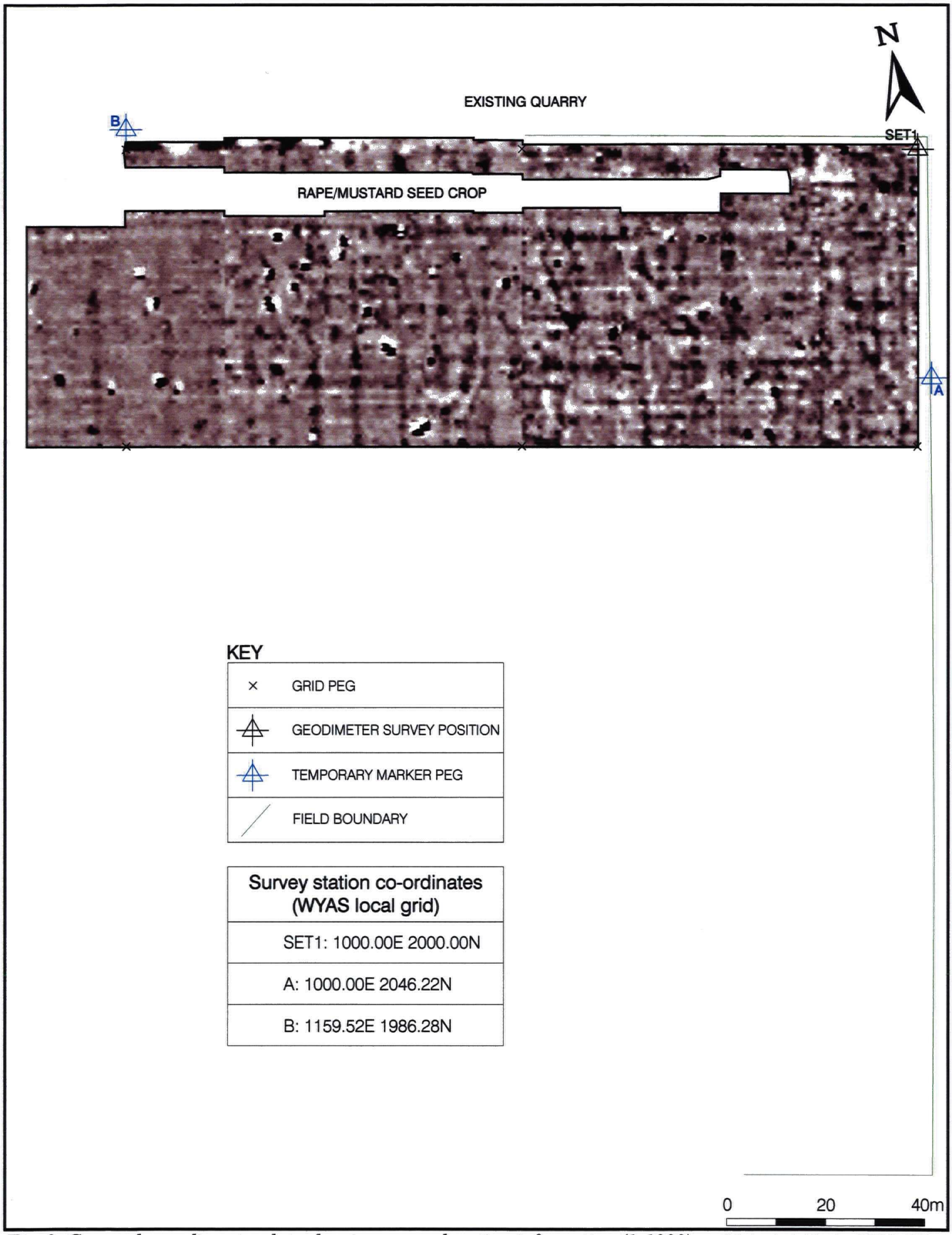

Fig. 3. Greyscale gradiometer data showing survey location information (1:1000)

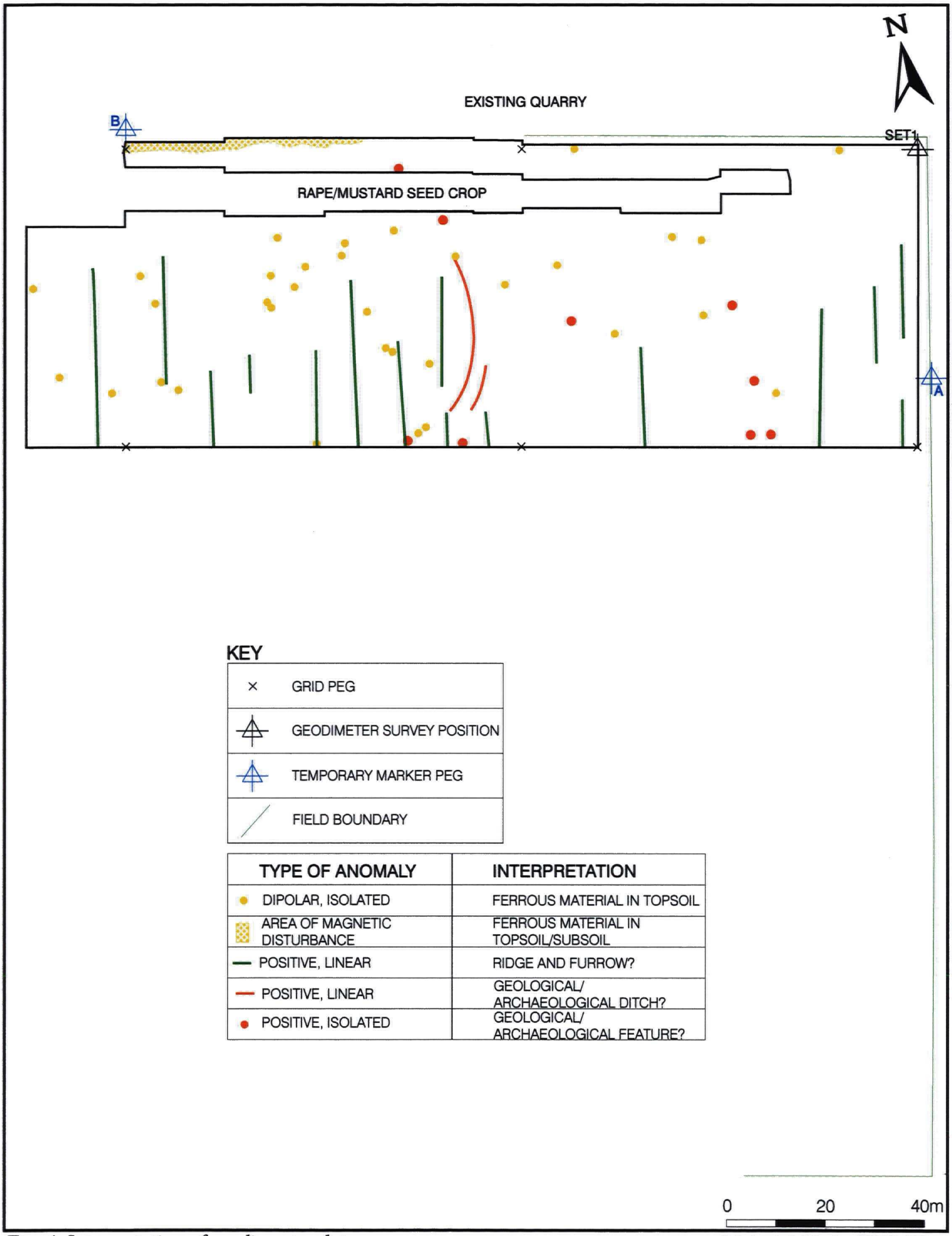

Fig. 4. Interpretation of gradiometer data showing survey location information (1:1000)

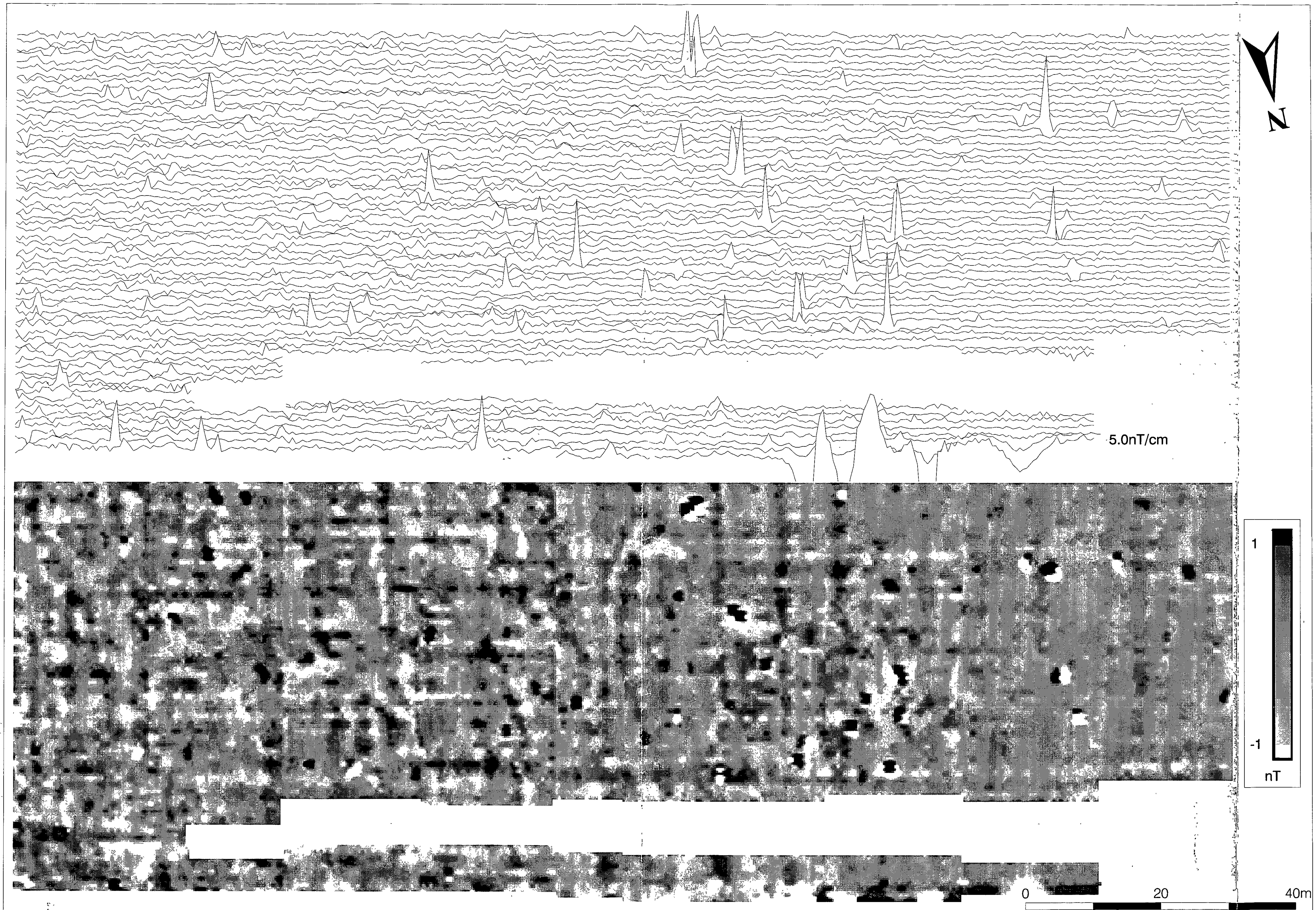

Fig.5. Gradiometer data, greyscale (bottom) and X-Y trace (top) plots, 1:500

Appendix 1

Gradiometer Survey: Technical Information

1. Magnetic Susceptibility and Soil Magnetism

1.1 Iron makes up about 6% of the Earth's crust and is mostly dispersed through soils, clays and rocks as chemical compounds. These compounds have a weak, measurable magnetic response which is termed its magnetic susceptibility. Human activities can redistribute these compounds and change (enhance) others into more magnetic forms. These anthropogenic processes result in small localised anomalies in the Earth's magnetic field which are detectable by a 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 the more magnetic compounds to concentrate 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 will tend to 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 The types of response mentioned above can be divided into five main categories which are described below:

Isolated Dipolar Anomalies (Iron Spikes)
These responses are typically caused by iron objects on the surface or in the topsoil. Whilst archaeological artefacts could cause such anomalies, unless there is supporting evidence for an archaeological interpretation, little emphasis is usually given to such anomalies as iron objects of recent origin are common on rural sites, often being present as a consequence of manuring.

Areas of Magnetic Disturbance
These responses can have several causes and are often associated with burnt material, such as industrial waste or other strongly magnetised/fired material. They are usually assumed to have a modern origin unless there is other supporting information.

Positive Curvi/Linear Anomalies
They are commonly caused by infilled ditches which may be archaeologically significant. Former or current agricultural practice can also result in such anomalies.

Isolated Positive Anomalies
These anomalies can exhibit a magnitude of response of between 2nT and 300nT and can be caused by pits or post holes, ovens or kilns. They can also be caused by natural/geological features on certain geologies. It can often be very difficult to establish an anthropogenic origin without intrusive investigation.

Negative Linear Anomalies
These are normally very faint and are commonly caused by features such as plastic water pipes which are less magnetic than the surrounding soils and geology. They too can be caused by natural features on some geologies.

3. Methodology

3.1 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. 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 some circumstances scanning can also be used to map out the full extent of features located during a detailed survey.

3.2 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.

3.3 During this survey a Geoscan FM36 fluxgate gradiometer and ST1 sample trigger were used to take readings at 0.5m intervals on zig-zag traverses 1m apart within 20m by 20m square grids.

4. Data Processing and Presentation

4.1 The data has been presented in this report using X-Y trace plots and greyscale images. The former option shows the 'raw' data with no processingother than grid biasing whilst in the latter the data has been selectively processed 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.

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.

4.2 In-house software (Geocon 9) was used to interpolate the data so that 1600 readings were obtained for each 20m by 20m grid. Contors was used to produce the greyscale images in which maximum and minimum cut-off limits have been chosen to best present the data; in the greyscale images the data is displayed using a linear incremental scale.

Appendix 2

Survey Location Information

1. Layout procedure

1.1 A baseline was established parallel with the northern edge of the site and all points on the site grid set out using a Geotronics Geodimeter 600 series total station theodolite. Two temporary marker pegs (wooden stakes) were left *in situ* on the northern and eastern hedge boundaries (see Figs 3 and 4) to enable the grid to be accurately relocated if further work is required. Additionally, the northern quarry edge and the adjacent hedge boundaries were tied-in.

1.2 No accurate large scale map was provided by the client. Therefore all co-ordinates relate to the local site grid. These co-ordinates are accurate to 0.005m.

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

Appendix 3

Geophysical Archive

The geophysical archive comprises:-

- an archive disk containing the raw data, grid location information, report text (Word 6), and compressed CorelDraw/AutoCAD files of the graphics
- a full copy of the report

At present the archive is held by Archaeological Services (WYAS) although it is anticipated that it will eventually be lodged with the Archaeology Data Service (ADS). Brief details will also be forwarded for inclusion on the English Heritage Geophysical Survey Database (no information on the client shall be included) 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).