ARCHAEOLOGICAL SERVICES WYAS

Land at Thame Oxfordshire

Geophysical Survey

Report no. 2602

April 2014

Client: Stoford Properties Limited

Land at Thame
Oxfordshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering 5 hectares, was carried out on agricultural land south-east of Thame, Oxfordshire in advance of the determination of a planning application for the proposed redevelopment of a farm. No anomalies of obvious archaeological potential have been identified by the survey although some anomalies have been ascribed an archaeological potential based upon their increased magnitude and proximity to the Iron Age/Roman finds and features to the south of the site. Ridge and furrow cultivation has also been identified. On the basis of the geophysical survey, the archaeological potential of the site is thought to be low to moderate.

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Report Information

Client:	Stoford Properties Ltd
Address:	Lancaster House, 67 Newhall Street, Birmingham, B3 1N2
Report Type:	Geophysical Survey
Location:	Thame
County:	Oxfordshire
Grid Reference:	SP 72243 05095
Period(s) of activity:	Iron Age?/Roman?/Medieval
Report Number:	2602
Project Number:	4224
Site Code:	THO14
OASIS ID:	archaeol11- 177347
Planning Application No.:	n/a
Museum Accession No.:	n/a
Date of fieldwork:	March 2014
Date of report:	April 2014
Project Management:	David Harrison BA MSc MIfA
Fieldwork:	Chris Sykes BA MSc
	Thomas Fildes BA
Report:	David Harrison
Illustrations:	David Harrison
Photography:	Chris Sykes
Research:	n/a

Authorisation for distribution: ---

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1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Ben Stephenson of BSA Heritage (the Consultant) on behalf of Stoford Properties Limited (the Client), to undertake a geophysical (magnetometer) survey of agricultural land on the south-eastern edge of Thame, prior to the determination of a planning application for the redevelopment of Cotmore Wells Farm and its surrounding land. The work was undertaken in accordance with a Project Design (Harrison 2014) supplied to and approved by the Consultant and Richard Oram (Planning Archaeologist at Oxfordshire County Council), with guidance contained within the National Planning Policy Framework (2012) and in line with current best practice (David *et al.* 2008). The survey was carried out on March 25th and March 26th 2014 in order to provide additional information on the archaeological potential of the site.

Site location, topography and land-use

The Proposed Development Area (PDA) comprises a rectangular shaped parcel of land with Cotmore Wells Farm at its centre (see Fig. 2). Geophysical survey was undertaken within an L-shaped area along the southern and western site boundaries, an area of 5 hectares. The survey area comprised three fields of grazed pasture (see plates) which are bound to the south by the former Wycombe Railway Line and to the west by the B4012 Howland Road. The topography of the site undulates from approximately 75m above Ordnance Datum (aOD), rising to 78m aOD at its southern extent and sloping down towards a stream in the east at 70m aOD.

Soils and geology

The underlying bedrock comprises Gault Formation Mudstone which is overlain in the west by superficial deposits of River Terrace sands and gravels. A band of Head (clay, silt, sand and gravel) is recorded alongside the stream which forms the eastern site boundary (British Geological Survey 2014). The soils are unclassified but are likely to be in the Denchworth association, characterised as slowly permeable, seasonally waterlogged clays with fine loams (Soil Survey of England and Wales 1983).

2 Archaeological Background

No heritage assets are known from within the surveyed area. However, a Heritage Statement (BSA Heritage 2013) has identified a number of discoveries to the immediate south of the PDA (see Fig. 2), which indicate the site of a late Iron Age and Roman activity, including burials. It is thought possible that sub-surface remains associated with this settlement may extend into the south of the PDA. The Heritage Statement also records the potential for the survival of remains associated with medieval and later agricultural activity including ridge and furrow cultivation.

3 Aims, Methodology and Presentation

The main aim of the geophysical survey was to provide sufficient information to enable an assessment to be made of the impact of the proposed development on potential sub-surface archaeological remains and for further evaluation or mitigation proposals, if appropriate, to be recommended. To achieve this aim a magnetometer survey was carried out covering all of the areas suitable for magnetometer survey.

The general objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the presence/absence and extent of any buried archaeological features; and
- to prepare a report summarising the results of the survey.

Magnetometer survey

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). Bartington Grad601 magnetic gradiometers were used during the survey, taking readings at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m grids, so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Geoplot 3 (Geoscan Research) software was used to process and present the data. Further details are given in Appendix 1.

Reporting

A general site location plan, incorporating the 1:50000 Ordnance Survey (OS) mapping, is shown in Figure 1. Figure 2 is a large scale (1:2000) location plan displaying the processed magnetic data as greyscale images. Also depicted on Figure 2 is contour detail and data from the Oxfordshire Historic Environment Record (HER). Detailed data plots (‘raw’ and processed) and a full interpretative figure are presented at a scale of 1:1250 in Figures 3, 4 and 5.

Further technical information on the equipment used, data processing and survey methodologies is given in Appendix 1 and Appendix 2. Appendix 3 describes the composition and location of the site archive.

The survey methodology, report and any recommendations comply with the Project Design (Harrison 2014) and guidelines outlined by English Heritage (David *et al.* 2008) and by the Institute for Archaeologists (IfA 2013). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The figures in this report have been produced following analysis of the data in 'raw' and processed formats and over a range of different display levels. All figures are presented to most suitably display and interpret the data from this site based on the experience and knowledge of Archaeological Services staff.

4 Results and Discussion (see Figs 3, 4 and 5)

Generally, a distinct difference in background magnetic variation has been recorded to the south-east of Cotmore Wells Farm characterised by a uniform grey tone to the data in the east of the site and a variable, 'speckled' background to the west. The reasons for this disparity are discussed further below. The anomalies identified by the survey fall into a number of different types and categories according to their origin and these are discussed below and cross-referenced to specific examples and locations within the site. It should be noted that the results and subsequent interpretation of data from the geophysical survey 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.

Ferrous Anomalies

Ferrous responses, either as individual 'spike' anomalies or more extensive areas of magnetic disturbance, are typically caused by modern ferrous (magnetic) debris, either on the ground surface or in the plough-soil, or are due to the proximity of magnetic material in field boundaries, buildings or other above ground features. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation as ferrous debris or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling. Throughout the survey area, individual iron 'spike' anomalies are common but there is no obvious pattern or clustering to their distribution to suggest anything other than a random background scatter of ferrous debris in the topsoil.

A high magnitude dipolar linear anomaly, **A**, within the east of the site locates the route of a sub-surface pipe. To the west of the pipe a large ferrous 'spike', **B**, is due to a telegraph pole at this location.

Linear bands of high magnitude magnetic disturbance around the perimeters of the PDA, and in between fields, are due to the close proximity of magnetic material within the adjacent fencing and are of no archaeological interest. Areas of magnetic disturbance along the eastern edge of Field 1 and the north of Field 3 are likely to be due to areas of dumping close to the adjacent farm buildings. To the south-east of the farm, magnetic material filling a former pond, **C**, which is depicted on the first edition Ordnance Survey map (1881) accounts for an increase in magnetic disturbance at this location.

Agricultural Anomalies

Analysis of historical OS maps indicates that the division and layout of land within the survey area has altered little since the publication of the first edition OS map in 1881, albeit with the construction of the B4012 Howland Road. No former field boundaries have been detected by the survey although the alignment of ferrous 'spikes', **D**, between Field 2 and Field 3 is likely to locate ferrous material within former fencing.

Series of parallel and slightly sinuous linear anomalies have been identified on a north\south orientation within Field 1 and on an east/west orientation within Field 3. These anomalies are due to the medieval and post-medieval agricultural practice of ridge and furrow cultivation. The anomalies are caused by the contrast between the soil-filled furrows and the surrounding soils. Elsewhere, occasional faint linear trends have been identified by the survey within Field 1 and Field 3. These are interpreted as being agricultural in origin, perhaps being caused by field drains, whilst the curvilinear trend, **E**, within the east of Field 3 is likely to locate a former ploughing headland.

Geological anomalies

As mentioned above, a clear increase in magnetic background variation can be seen in the data to the south of Cotmore Wells Farm, caused by a denser concentration of magnetic anomalies. The eastern extent of this concentration is defined by a broad curvilinear band of anomalies, **F**, which corresponds closely to the geological boundary between the superficial deposit of River Terrance sands and gravels, to the west, and an area of no superficial deposits to the east (see Fig. 2). It is thought likely, therefore, that the majority of the anomalies to the west of the geological boundary, **F**, are caused by variations in the composition of the magnetic sands and gravels. It is also of note that the increase in magnetic background is concentrated towards the highest part of the site (see Fig. 2) where topsoil depth may be reduced and, if so, this area may have been more susceptible to mixing and redistribution of the superficial deposits by the plough.

Elsewhere, occasional discrete, low magnitude, anomalies have been identified. These are interpreted as geological in origin and are thought to be caused by localised variations in the depth and composition of the seasonally waterlogged soils and superficial deposits from which they derive.

Archaeological? Anomalies

Amongst the concentration of anomalies discussed above, several anomalies, **G**, **H** and **I**, have been assigned a possible archaeological origin based upon their high magnitude (relative to those interpreted as geological) and proximity to known Iron Age and Roman finds and features which are recorded to the immediate south of the PDA (see Fig. 2). Whilst it is possible that some of these anomalies might be caused by pits and spreads of enhanced archaeological material, no clear archaeological pattern is discernable and a geological origin is equally plausible. A fragmentary north/south aligned linear anomaly, **J**, has also been ascribed a potential archaeological origin. The anomaly is thought to be caused by enhanced material within a soil-filled ditch. The ditch runs north towards a gate at Cotmore Wells Farm and therefore an agricultural origin is possible, but an archaeological cause cannot be dismissed given the local archaeological context.

5 Conclusions

No anomalies of obvious archaeological potential have been identified by the magnetometer survey. The majority of the anomalies identified can be confidently interpreted as being due to the agricultural use of the land since the medieval period or to localised geological variation. However, a dense concentration of anomalies has been identified to the immediate north of the late Iron Age and Roman finds and features. Whilst the majority of these anomalies are thought to be due to the underlying sand and gravel superficial deposits, some of them may be of interest and an archaeological origin is considered possible.

Therefore, on the basis of the geophysical survey, the archaeological potential of the PDA is assessed as being low within the east and west and moderate to the south of Cotmore Wells Farm.

Appendix 1: Magnetic survey - technical information

Magnetic Susceptibility and Soil Magnetism

Iron makes up about 6% of the Earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haemetite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected. The magnetic susceptibility of a soil can also be enhanced by the application of heat and the fermentation and bacterial effects associated with rubbish decomposition. The area of enhancement is usually quite large, mainly due to the tendency of discard areas to extend beyond the limit of the occupation site itself, and spreading by the plough. An advantage of magnetic susceptibility over magnetometry is that a certain amount of occupational activity will cause the same proportional change in susceptibility, however weakly magnetic is the soil, and so does not depend on the magnetic contrast between the topsoil and deeper layers. Susceptibility survey is therefore able to detect areas of occupation even in the absence of cut features. On the other hand susceptibility survey is more vulnerable to the masking effects of layers of colluvium and alluvium as the technique, using the Bartington system, can generally only measure variation in the first 0.15m of ploughsoil.

Types of Magnetic Anomaly

In the majority of instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

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

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

Isolated dipolar anomalies (iron spikes)

These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic ‘spiky’ trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

Areas of magnetic disturbance

These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

Linear trend

This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

Areas of magnetic enhancement/positive isolated anomalies

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an ‘iron spike’ anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

Linear and curvilinear anomalies

Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

Methodology: Magnetic Susceptibility Survey

There are two methods of measuring the magnetic susceptibility of a soil sample. The first involves the measurement of a given volume of soil, which will include any air and moisture that lies within the sample, and is termed volume specific susceptibility. This method results in a bulk value that it not necessarily fully representative of the constituent components of the sample. For field surveys a Bartington MS2 meter with MS2D field loop is used due to its speed and simplicity. The second technique overcomes this potential problem by taking into account both the volume and mass of a sample and is termed mass specific susceptibility. However, mass specific readings cannot be taken in the field where the bulk properties of a soil are usually unknown and so volume specific readings must be taken. Whilst these values are not fully representative they do allow general comparisons across a site and give a broad indication of susceptibility changes. This is usually enough to assess the susceptibility of a site and evaluate whether enhancement has occurred.

Methodology: Gradiometer Survey

There are two main methods of using the fluxgate gradiometer for commercial evaluations. The first of these is referred to as ***magnetic scanning*** and requires the operator to visually identify anomalous responses on the instrument display panel whilst covering the site in widely spaced traverses, typically 10m apart. The instrument logger is not used and there is therefore no data collection. Once anomalous responses are identified they are marked in the field with bamboo canes and approximately located on a base plan. This method is usually employed as a means of selecting areas for detailed survey when only a percentage sample of the whole site is to be subject to detailed survey.

The disadvantages of magnetic scanning are that features that produce weak anomalies (less than 2nT) are unlikely to stand out from the magnetic background and so will be difficult to detect. The coarse sampling interval means that discrete features or linear features that are parallel or broadly oblique to the direction of traverse may not be detected. If linear features are suspected in a site then the traverse direction should be perpendicular (or as close as is possible within the physical constraints of the site) to the orientation of the suspected features. The possible drawbacks mentioned above mean that a ‘negative’ scanning result should be validated by sample detailed magnetic survey (see below).

The second method is referred to as ***detailed survey*** and employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0.25m intervals, on zig-zag traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation. Detailed survey allows the visualisation of weaker anomalies that may not have been detected by magnetic scanning.

During this survey a Bartington Grad601 magnetic gradiometer was used taking readings on the 0.1nT range, at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m square grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

Data Processing and Presentation

The detailed gradiometer data has been presented in this report in XY trace and greyscale formats. In the former format the data shown is ‘raw’ with no processing other than grid biasing having been done. The data in the greyscale images has been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

An XY plot presents the data logged on each traverse as a single line with each successive traverse incremented on the Y-axis to produce a ‘stacked’ plot. A hidden line algorithm has been employed to block out lines behind major ‘spikes’ and the data has been clipped. The main advantage of this display option is that the full range of data can be viewed, dependent on the clip, so that the ‘shape’ of individual anomalies can be discerned and potentially archaeological anomalies differentiated from ‘iron spikes’. Geoplot 3 software was used to create the XY trace plots.

Geoplot 3 software was used to interpolate the data so that 3600 readings were obtained for each 30m by 30m grid. The same program was used to produce the greyscale images. All greyscale plots are displayed using a linear incremental scale.

Appendix 2: Survey location information

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). The accuracy of this equipment is better then 0.01m. The survey grids were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if co-ordinates are measured off hard copies of the mapping rather than using the digital co-ordinates.

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 compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2008) files; and
- 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 Oxforshire Historic Environment Record).

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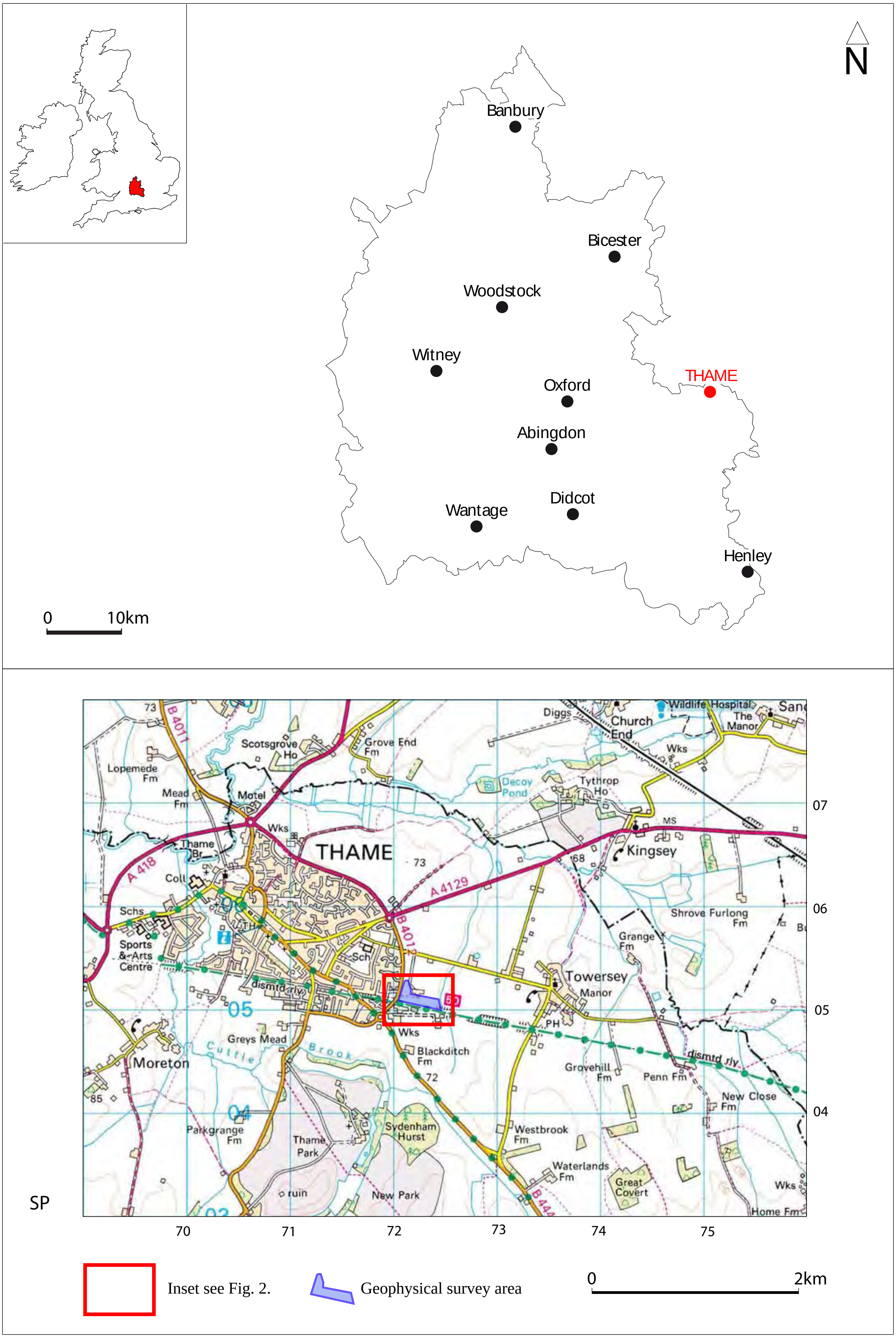

Fig. 1. Site location

Fig. 2. Site location showing greyscale magnetometer data, contour detail and Oxfordshire HER data (1:2000 @ A3)

Fig. 3. Processed greyscale magnetometer data (1:1250 @ A3)

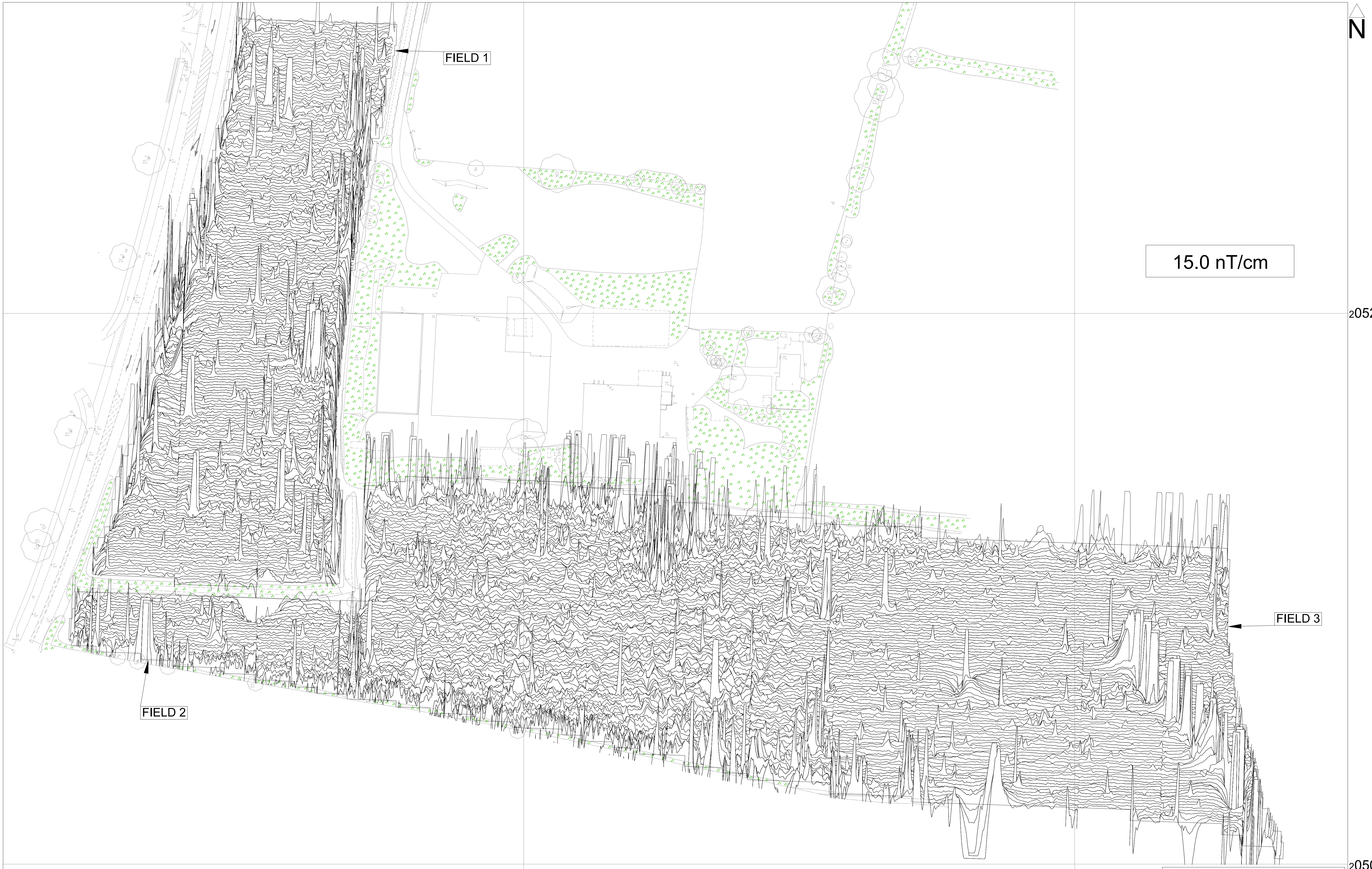

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Fig. 4. XY trace plot of minimally processed magnetometer data (1:1250 @ A3)

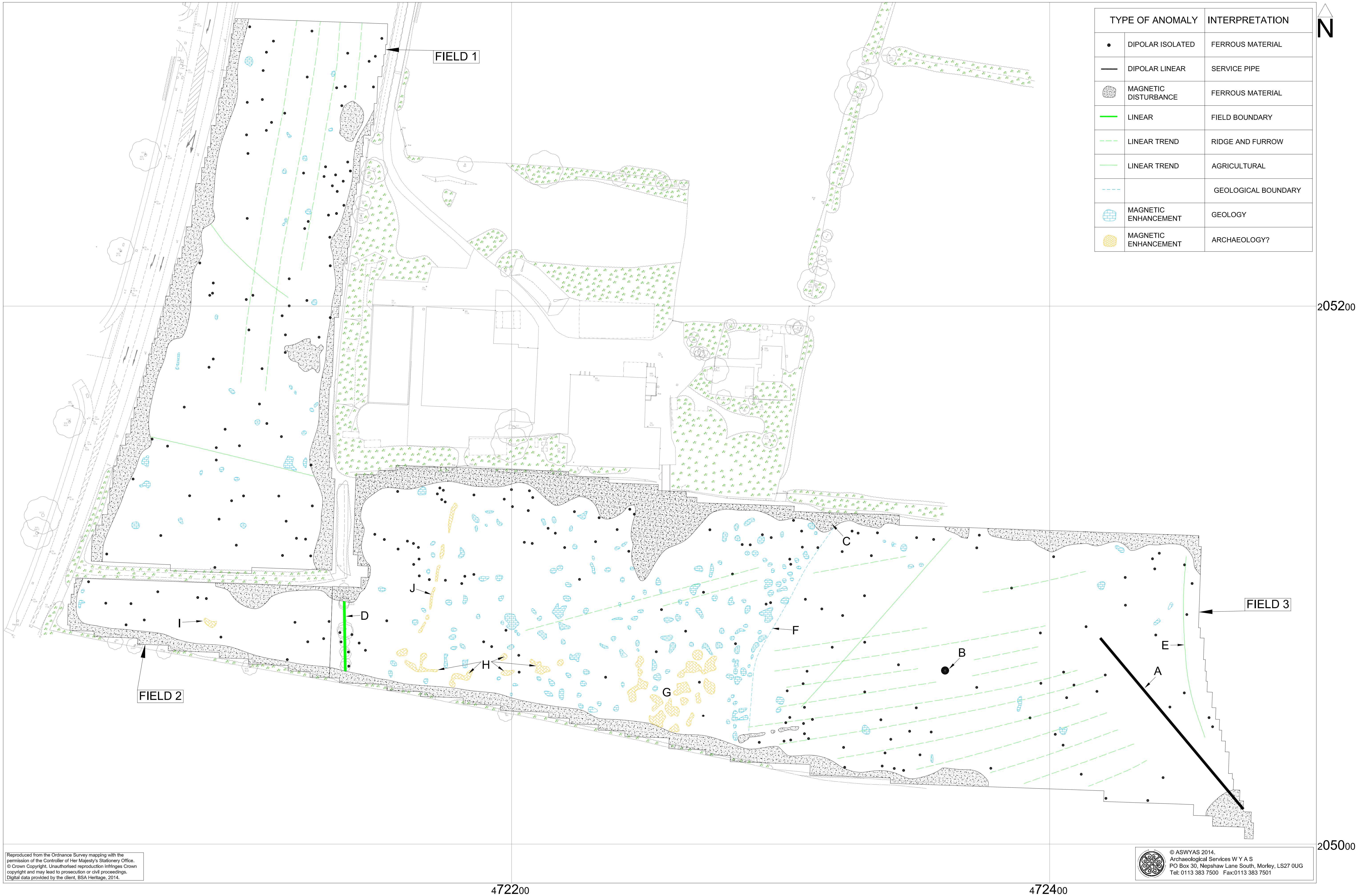

Fig. 5. Interpretation of magnetometer data (1:1250 @ A3)

Plate 1. General view of Field 1, looking south-west

Plate 2. General view of Field 1, looking north-west

Plate 3. General view of Field 2, looking west

Plate 4. General view of Field 3, looking south-east

Plate 5. General view of Field 3, looking east

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The detailed gradiometer data has been presented in this report in XY trace and greyscale formats. In the former format the data shown is 'raw' with no processing other than grid biasing having been done. The data in the greyscale images has been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

An XY plot presents the data logged on each traverse as a single line with each successive traverse incremented on the Y-axis to produce a 'stacked' plot. A hidden line algorithm has been employed to block out lines behind major 'spikes' and the data has been clipped. The main advantage of this display option is that the full range of data can be viewed, dependent on the clip, so that the 'shape' of individual anomalies can be discerned and potentially archaeological anomalies differentiated from 'iron spikes'. Geoplot 3 software was used to create the XY trace plots.

Geoplot 3 software was used to interpolate the data so that 3600 readings were obtained for each 30m by 30m grid. The same program was used to produce the greyscale images. All greyscale plots are displayed using a linear incremental scale.

Appendix 2: Survey location information

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). The accuracy of this equipment is better then 0.01m. The survey grids were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if co-ordinates are measured off hard copies of the mapping rather than using the digital co-ordinates.

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 compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2008) files; and
- 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 Oxfordshire Historic Environment Record).

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