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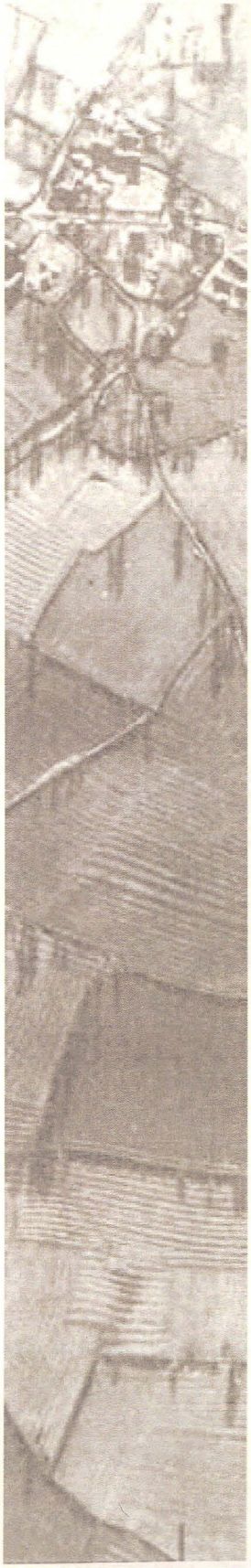

ARCHAEOLOGICAL SURVEYS

GEOPHYSICAL SURVEY REPORT

Park Farm, Tattershall Thorpe, Lincolnshire

Magnetic Susceptibility and Magnetometer Survey

for

Cotswold Archaeology

David Sabin and Kerry Donaldson

February 2007

Ref no. 170

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ARCHAEOLOGICAL SURVEYS

Park Farm, Tattershall Thorpe, Lincolnshire

Magnetic Susceptibility and Magnetometer Survey
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Report and fieldwork by David Sabin and Kerry Donaldson

Survey date – **from 26th January to 23rd February 2007**
Ordnance Survey Grid Reference – **TF 2050 6000**

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SUMMARY

Magnetic susceptibility survey with targeted detailed magnetometry was carried out across an area of approximately 125ha near Tattershall Thorpe in Lincolnshire, the site has been outlined for the extraction of sand and gravel. The magnetic susceptibility measurements were affected by the presence of 'red gypsum' which had been spread as a soil conditioner across a large proportion of the survey area. The gypsum is a by-product of titanium oxide production and contains a significant proportion of magnetically enhanced iron compounds. Magnetic susceptibility measurement was also affected by natural variations in iron compounds within the soils and gravels. Five areas were chosen for targeted detailed magnetometry based on a combination of the results of the magnetic susceptibility reconnaissance survey and the presence of cropmarks possibly indicative of archaeological features. The detailed magnetometry survey located a number of linear anomalies and discrete pit-like features to the west of Park Farm, pottery sherds visible within this area suggest the features belong to a settlement site occupied within the Romano-British period. A curvilinear anomaly located to the south of Park Farm may be associated with a cut feature of prehistoric date. Although many anomalies were located within other survey areas to the north and east of Park Farm, there is little evidence that these relate to significant archaeological features.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys was commissioned by Cotswold Archaeology on behalf of Cemex to undertake a geophysical survey of an area of land at Tattershall Thorpe in Lincolnshire that has been outlined for development as a gravel quarry. This survey formed part of an assessment of any potential archaeology that may be affected by the gravel extraction and follows a brief prepared by Cotswold Archaeology (CA, 2007). The brief was approved by Dr Beryl Lott, Historic Environment Team Leader for Lincolnshire County Council.

1.2 Survey objectives

1.2.1 The objectives of the survey were to carry out magnetic susceptibility reconnaissance at a coarse resolution in order to identify broad zones of magnetic enhancement that may indicate areas of human occupation or activity. Enhanced magnetic zones potentially related to archaeological features were then to be targeted with detailed magnetometry.

1.2.2 Targeted detailed magnetometry is an efficient method of archaeological prospection across large areas. The technique was used to sample approximately 20% of the site.

1.3 Site location

1.3.1 The site is located at Park Farm, Tattershall Thorpe, Lincolnshire and centred on OS grid reference TF 2050 6000.

1.4 Site description

1.4.1 The geophysical survey covers an area of approximately 125ha of flat agricultural land currently used for arable cultivation. There are six fields within the survey area separated by ditches and tracks, the land cover within each field is labelled in Figure 02. Park Farm and associated barns are located within the southern part of the survey and have excluded from survey due to the presence of hard standing and modern debris.

1.4.2 Observations were made in Fields 1, 2, 3 and 5 of a widespread distribution of 'red gypsum' which has been used as a soil conditioner. Field 4 contained fragmented iron pan (up to 300mm across) towards the south eastern corner. Wide variations in the percentage of gravel within the topsoil was also observed across the site.

1.4.3 Vegetation cover within areas of self-seeded and sown rape crop (Fields 1,2 and 3) was up to 500mm in depth although generally around 250mm. Areas of self-seeded rape also contained a thick layer of dead vegetation. Areas of open soil (Fields 4, 5 and 6) contained ridges with surface variations of up to 300mm within a soft and well aerated soil matrix.

Plate 1 Field 1 with self-seeded rape crop looking southwest

Plate 2 Fields 5 (left) and 3 (right) looking west towards Park Farm

1.5 Site history and archaeological potential

1.5.1 No detailed information on the archaeological potential of the site was available to Archaeological Surveys, however, a Written Scheme of Investigation issued by Cotswold Archaeology (CA, 2007) ahead of survey work, draws on information contained in a Desk-Based Assessment produced by Oxford Archaeological Associates (OAA, 2005). Paragraph 1.5.2 is a brief synopsis of this information.

1.5.2 The survey area contains prehistoric findspots including Neolithic/Bronze Age worked flint and Bronze Age and Iron Age metal work. An Iron Age site and a probable Romano-British site have been identified to the northwest and south of the site respectively. Aerial photography has also revealed cropmarks which suggest the presence of archaeological features, although the interpretation of the cropmarks has been hindered by underlying geological/pedological features across the site.

1.5.3 Immediately to the east of the survey area lies the former airfield of RAF Woodhall Spa. The airfield was originally built as a satellite to RAF Coningsby but became the base for the infamous 617 squadron otherwise known as the 'Dam Busters'. There is no evidence that the survey area was utilised by the RAF although enemy bombing was known to have occurred in the vicinity (pers. comm. Thorpe Camp Preservation Group).

1.6 Geology and soils

1.6.1 The underlying geology is Ampthill Clay and Kimmeridge Clay (BGS 2001) with overlying River Terrace Deposits (BGS 1977). The latter is of economic value for the production of sand and gravel.

1.6.2 The overlying soils across much of the site are from the Blackwood association which are typical sandy gley soils. These consist of deep

permeable sandy and coarse loamy soils formed over glaciofluvial drift. (Soil Survey of England and Wales 1983).

1.6.3 Sandy and coarse gravely soils generally form relatively poor conditions for magnetic survey, however, the hydrology of the site and the type of former anthropogenic activity are important unknown factors that will influence the effectivity of magnetometry in such an environment.

2 METHODOLOGY

2.1 Technical synopsis

2.1.1 Iron minerals within the soil can be altered through biological decay and burning which can enhance the magnetic susceptibility of the soil. Field equipment can be used to measure the magnetic susceptibility of the soil allowing zones to be mapped which may indicate areas of potential archaeological activity. This also allows subsequent targeting of higher resolution survey techniques such as magnetometry or resistivity in order to obtain more detail.

2.1.2 Magnetic susceptibility is only measurable in the presence of a magnetic field and is defined as a ratio between the intensity of the induced field to that of the magnetising field. As the two fields are measured in the same units the ratio can effectively be defined using no units although it is common practice to add SI to distinguish measurements from an older system.

2.1.3 Detailed magnetometry records localised magnetic fields that can relate to former human activity. Alteration of iron minerals present within topsoil is related to activities such as burning and the break down of biological material. These minerals become weakly magnetic within the Earth's magnetic field and can accumulate in features such as ditches and pits that are cut into the underlying subsoil. Mapping this magnetic variation can provide evidence of former settlement and land use. Additional technical details can be found in Appendix A.

2.1.4 The localised variations in magnetism for detailed magnetometry are measured as sub-units of the tesla which is a SI unit of magnetic flux density. These sub-units are nanoteslas (nT) which are equivalent to 10^{-9} tesla (T).

2.2 Equipment configuration, data collection and survey detail

2.2.1 The magnetic susceptibility survey was conducted using an MS2 meter with MS2D field coil manufactured by Bartington Instruments Ltd. The instrument was used in conjunction with a CSI Wireless Differential Global Positioning System (dGPS) receiver used to navigate to measuring positions.

2.2.2 Magnetic susceptibility data was collected every 20m. Each position was recorded 3 to 5 times to ensure a representative value free from erratic or

spurious readings created by ferrous debris or poor soil contact. The values were entered into PocketGIS software as a point attribute attached to the coordinates of each recording station.

2.2.3 The detailed magnetic survey was carried out using a Bartington Grad601-2 gradiometer. This instrument effectively measures a magnetic gradient between two fluxgate sensors mounted vertically 1m apart. Two sets of sensors are mounted on a single frame 1m apart horizontally. The instrument is extremely sensitive and is able to measure magnetic variation to 0.1 nanoTesla (nT). All readings are saved to an integral data logger for analysis and presentation.

2.2.4 Data was collected at 0.25m centres along traverses 1m apart. The survey area was separated into 30m by 30m grids giving 3600 recorded measurements per grid. This sampling interval is very effective at locating archaeological features and is the recommended methodology for archaeological prospection (English Heritage, 1995).

2.2.5 The survey grids were set out using a Topcon GTS802 robotic total station and CSI Wireless dGPS (differential Global Positioning System). The dGPS was used to establish and reference a baseline orthogonal to the Ordnance Survey National Grid using the OSGB36 datum. Positional accuracy achievable using dGPS is considered as sub-metre as correction signals are received either from ground-based beacons or a geostationary satellite. A number of parameters are constantly monitored by the system in order to achieve best accuracy.

2.3 Data processing and presentation

2.3.1 Magnetic susceptibility readings recorded in the field using PocketGIS were downloaded into MapInfo GIS software with Vertical Mapper and displayed as an interpolated colour plot using a fifth order polynomial solution, see Figure 03. No processing is required for this data.

2.3.2 Magnetometry data downloaded from the Grad 601-2 data logger is analysed and processed in specialist software known as ArcheoSurveyor. The software allows greyscale and trace plots to be produced for presentation and display. Survey grids are assembled to form an overall composite of data (composite file) creating a dataset of the complete survey area. Appendix B contains specific information concerning the survey and data attributes and is derived directly from ArcheoSurveyor, this should be used in conjunction with information provided by referencing plots.

2.3.3 Only minimal processing is carried out in order to enhance the results of the survey for display. Raw data is always analysed as processing can modify anomalies. The following schedule sets out the data and image processing used in this survey :

- Clipping of processed data at either ±2nT or ±3nT to enhance low magnitude anomalies
- Clipping of trace plots at ±100nT in order to minimise strong readings obscuring low magnitude responses
- De-stagger is used to enhance linear anomalies
- Zero median traverse is applied in order to balance readings along each traverse.

(Reference should be made to Appendix B for details on the processing used for each survey area.)

Data processing explanation notes:

Clipping

Clipping replaces the values outside the specified minimum and maximum with those values. The process is useful for displaying detail as extreme values are removed allowing greyscale shades to be allocated to a narrower range of values which improves the definition of anomalies.

Zero Median/Mean Traverse

The median (or mean) of each traverse is calculated ignoring data outside a threshold value, the median (mean) is then subtracted from the traverse. The process is used to equalise slight differences between the set-up and stability of gradiometer sensors and is used to remove striping.

De-stagger

Compensates for small positional errors within data collection by shifting the position of the readings along each traverse by a specified amount.

2.3.4 An abstraction and interpretation is offered for all geophysical anomalies located by the survey. A brief summary of each anomaly with an appropriate reference number is set out in list form within the results (Section 3), to allow a rapid assessment of features within each survey area. Where further interpretation is possible or where a number of possible origins should be considered, further more detailed discussion is set out in Section 4.

2.3.5 The main form of data display used in this report is the greyscale plot. Magnetic data is also displayed as a trace plot. Processed data has been shown followed by an abstraction and interpretation plot.

2.3.6 Graphic raster images in TIFF format are initially prepared in ArcheoSurveyor. These images are combined with base mapping using MapInfo Professional creating TAB file formats. All images are geographically referenced. A digital archive including raster images is produced with this report allowing separate analysis if necessary, see 2.4 below. Quality can be compromised by rotation of graphics in order to allow the data to be orientated with respect to grid north; this is considered acceptable as the survey results are effectively

georeferenced allowing relocation of features using GPS, resection method etc.. A digital archive including raster images is produced with this report allowing separate analysis if necessary, see 2.4 below.

2.4 Archive

2.4.1 Survey results are produced in hardcopy using A4 for text and A3 for plots (all plots are scaled for A3). In addition digital data created during the survey is supplied on CD. Further information on the production of the report and the digital formats involved in its creation are set out below.

2.4.2 This report has been prepared using the following software on a Windows XP platform:

- ArcheoSurveyor version 2.1.2.2 (magnetometry data analysis)
- Vertical Mapper 2.6 (magnetic susceptibility data analysis)
- MapInfo Professional 6.0 (report figures)
- JASC Paint Shop Pro 8 (image rotation)
- Microsoft Word 2000 (document text)
- PDF Creator version 0.9 (PDF archive).

2.4.3 Digital data is supplied on CD ROM and includes the following files:

- ArcheoSurveyor grid and composite files for all geophysical data
- CSV files for raw and processed composites and magnetic susceptibility data
- Geophysical composite file graphics as TIFF images
- MapInfo TAB files in 2000 version
- Report text as a Word 2000 doc file
- Report text as rich text format (RTF)
- Report text as PDF
- PDFs of all figures
- Photographic record in JPEG format.

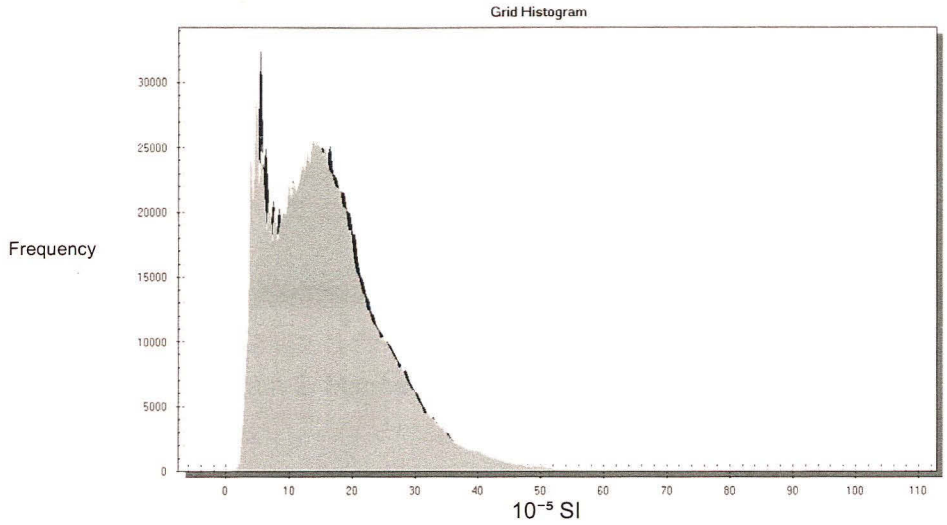
2.4.4 The CD ROM structure is formed from a tree of directories under the title J170 Tattershall – CD. Directory titles include Data, Documentation, MapInfo, PDFs and Photos. Multiple directories exist under Data for magnetometry and magnetic susceptibility.

3 RESULTS

3.1 Magnetic susceptibility

3.1.1 The survey records SI values ranging between 2 and 105 x 10^{-5} SI with a mean of 16.46 and a standard deviation of 10.54 for the entire site. Histogram 1 indicates two peaks within the data at 5 and 15 x 10^{-5} SI, however as there are a number of factors influencing magnetic susceptibility survey, such as

ground cover, compaction of soil, presence of contamination etc. the results from each field are dealt with separately in the following paragraphs. Reference should be made to Figure 03.

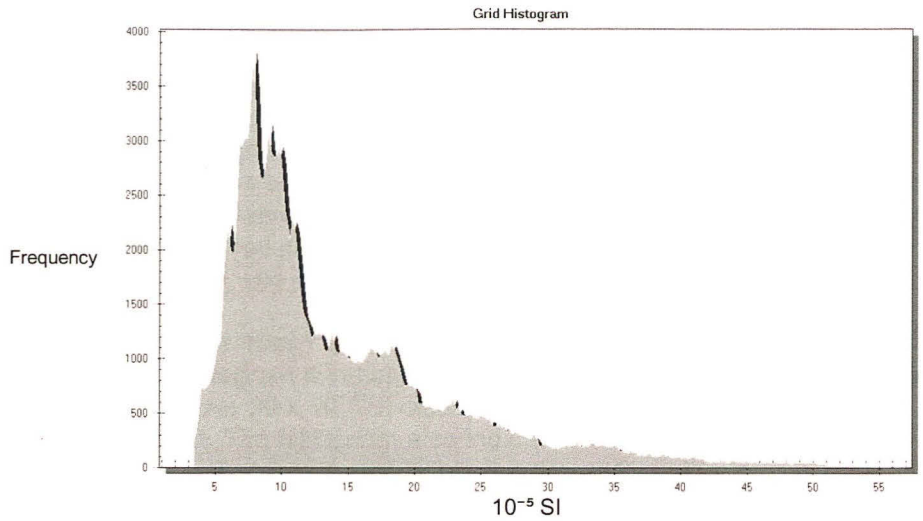


Histogram 1 Magnetic susceptibility data from the entire survey area

3.2 *Field 1*

3.2.1 Magnetically enhanced zones exist toward the southern and eastern sections of Field 1. The ground cover was self seeded rape up to 500mm in depth with an undercover of dead vegetation. Rape growth is very variable but the undercover of vegetation is consistent across the field. Soil was moderately compacted and even, 'red gypsum' soil conditioner was observed, see 4.1.2.

3.2.2 SI values range from 4 to 53 with a mean of 14.717 and a standard deviation of 9.044. Histogram 2 indicates a significant number of values between 15 and 40 x 10^{-5} SI suggesting magnetic enhancement with an anthropogenic origin.

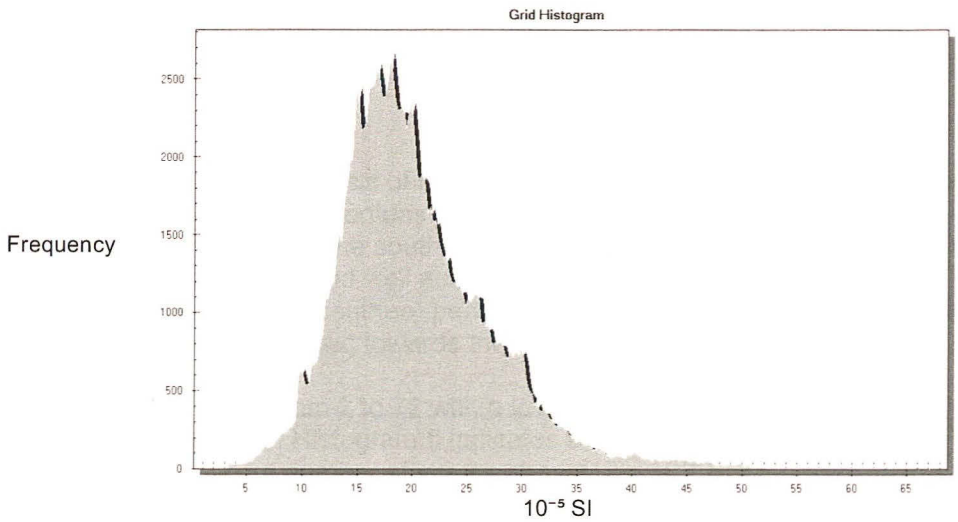


Histogram 2 Magnetic susceptibility data collected from Field 1

3.3 Field 2

3.3.1 Magnetic enhancement is widespread across the survey area although it does not tend to form coherent zones except possibly towards the northern end of the field. The ground cover was self seeded rape up to 500mm in depth with an undercover of dead vegetation. Rape growth is very variable but the undercover of vegetation is consistent across the field. Soil is moderately compacted and even, 'red gypsum' soil conditioner was observed, see 4.1.2.

3.3.2 SI values range from 4 to 63 with a mean of 20.068 and a standard deviation of 7.914. Histogram 3 reflects the relatively high mean value of data collected within Field 2.

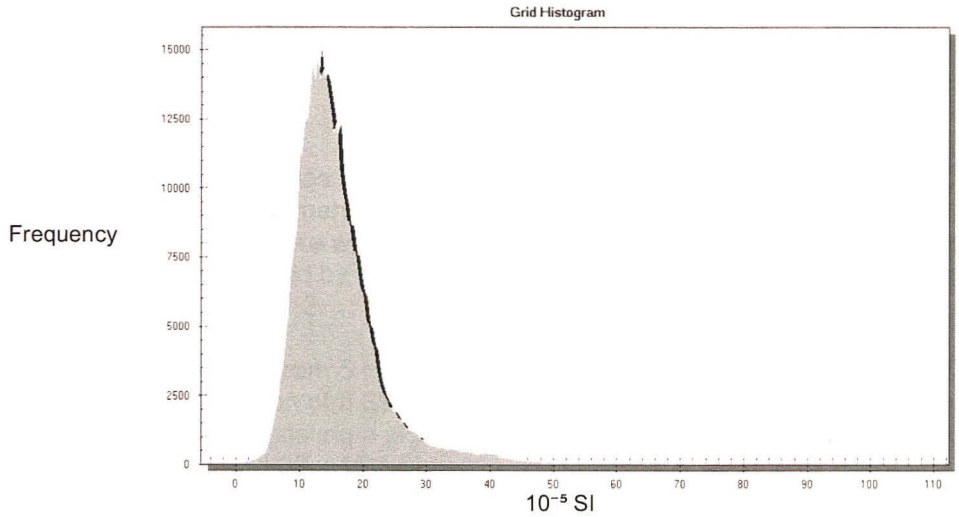


Histogram 3 Magnetic susceptibility data collected from Field 2

3.4 Field 3

3.4.1 Magnetic enhancement is widespread across Field 3. Areas close to the northern boundary of the field and close to the south western corner are most enhanced. The ground cover was a sown rape crop up to 500mm in depth but with no vegetative undercover and moderate soil compaction. Germination was variable however, with patches of open soil and plants stripped by wild birds. Areas of 'red gypsum' soil conditioner were observed, occasionally in large quantities, see 4.1.2.

3.4.2 SI values range from 1 to 105 with a mean of 16.78 and a standard deviation of 10.144. Histogram 4 indicates a sharp curve around the mean value with an extension above 20 x 10^{-5} SI clearly representing zones of magnetic enhancement. The histogram also indicates that any values above 45 x 10^{-5} SI are of very low occurrence within the dataset.

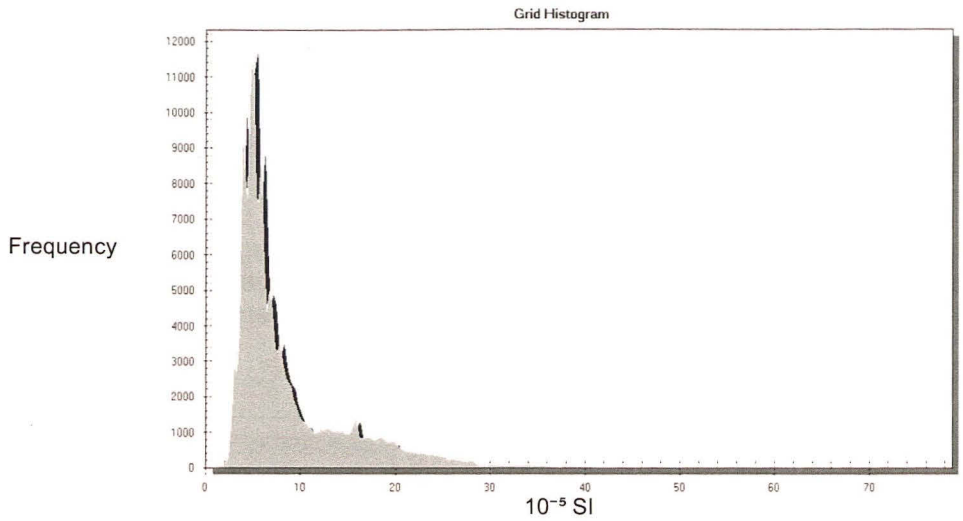


Histogram 4 Magnetic susceptibility data collected from Field 3

3.5 Field 4

3.5.1 Generally very low levels of magnetic susceptibility were measured across the central and northern portions of the field with some zones of moderate enhancement within the southern half. There was no ground cover although the soil was ridged and well aerated. A zone of worked flint implements was noted in the central southern part of the field and lumps of iron pan were frequently encountered towards the south eastern corner.

3.5.2 SI values range from 2 to 72 with a low mean of 9.591 and a standard deviation of 8.78. Histogram 5 indicates a sharp peak around the mean value with a significant number of values above 12 x 10^{-5} SI representing the enhanced zones.

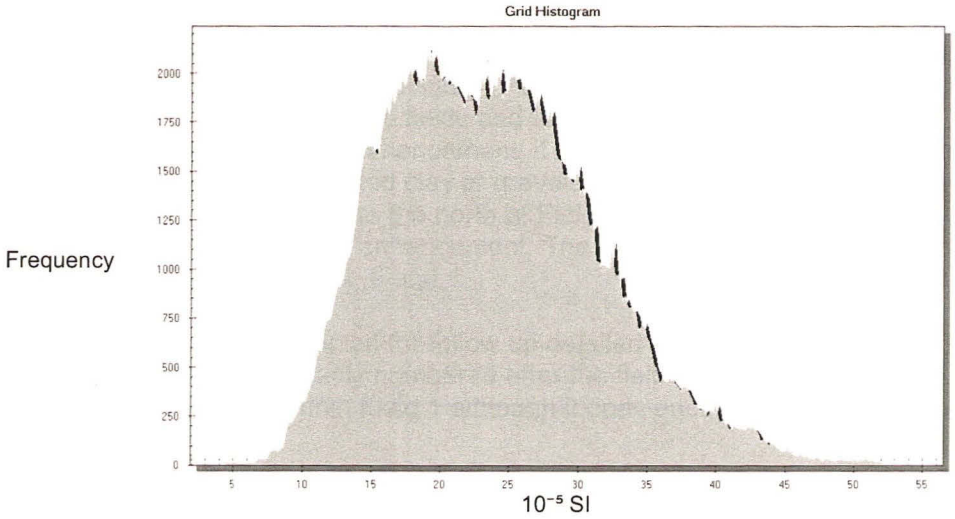


Histogram 5 Magnetic susceptibility data collected from Field 4

3.6 Field 5

3.6.1 Much of the field has enhanced magnetic susceptibility with possible coherent zones of enhancement located within the central southern area and towards the northeast. There was no ground cover although the soil was ridged and moderately aerated by recent cultivation. 'Red gypsum' soil conditioner was observed, see 4.1.2.

3.6.2 SI values range from 5 to 54 with a very high mean value of 23.573 and a standard deviation of 8.39. Histogram 6 indicates the high mean value with the broad peak suggesting a significant proportion of the data collected falls between 15 and 30 x 10^{-5} SI.

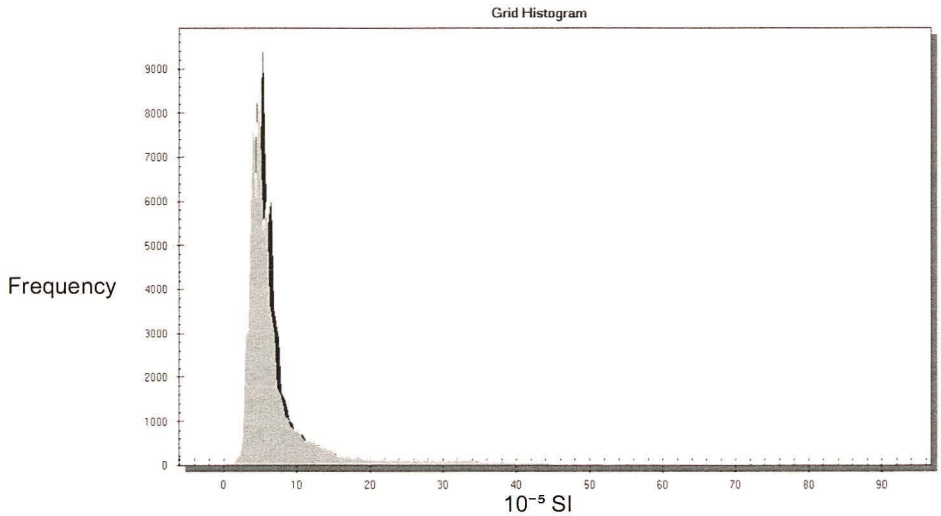


Histogram 6 Magnetic susceptibility data collected from Field 5

3.7 Field 6

3.7.1 Very low levels of magnetic susceptibility were measures across most of the field although significantly high readings were collected close to the southern boundary. There was no ground cover although the soil was ridged and well aerated.

3.7.2 SI values range between 2 and 92 with a mean values of 9.736 and a standard deviation of 12.46. Histogram 7 indicates the low mean value with enhanced values producing an extended curve and relatively large standard deviation.



Histogram 7 Magnetic susceptibility data collected from Field 6

3.8 Variability and targeting

3.8.1 The results show the highest levels of enhancement can be seen in the south of Field 6 and the north of Field 3. Former clay pits are also located within the boundary between the two fields and to the north of Field 2 which also displays high levels of enhancement; it is possible that the enhancement is associated with excavated clay or gravels although large quantities of 'red gypsum' was apparent to the north of Field 3, see 4.1.2. Field 5 also displays relatively high levels of enhancement. The lowest levels of enhancement can be seen within Fields 4, 6 and 1.

3.8.2 Five areas were selected for follow up detailed magnetometry, see 3.9.1. Each survey area is arbitrarily numbered after the field in which it is situated. Area 1 is predominantly within Field 1 although it does encompass a small zone in the south of Field 2.

3.9 Detailed magnetometry

3.9.1 The detailed magnetic survey was carried out over a total of five survey areas (Figure 04) covering a total area of 25ha. These target areas were approved by Dr Beryl Lott of Lincolnshire County Council. These target areas were initially chosen to sample areas of high magnetic susceptibility particularly where coherent enhanced zones were visible within the dataset (Area 1 also included known cropmarks). The premise for selecting more coherent zones of enhancement was an increased likelihood that consistently high readings could be associated with areas enhanced by anthropogenic occupation rather than the wide variability associated with enhancement caused by 'red gypsum', see 4.1.2. However, although the gypsum may be observed as a more heterogeneous dataset, the effects of other natural enhancement (such as may occur within zones of shallow iron pan or enhanced gravel) cannot be readily distinguished from anthropogenic activity.

3.9.2 During the survey there was some modification to the targeting strategy based on preliminary analysis. This consisted of contraction to Area 5 where few anomalies were located and expansion of Area 1 where anomalies of archaeological potential were visible. These revised target areas were approved by Dr Beryl Lott.

3.9.3 Geophysical anomalies located can be generally classified as positive linear and discrete positive responses of possible archaeological origin, positive and negative linear anomalies of an uncertain origin, linear anomalies of an agricultural origin, areas of magnetic debris and strong dipolar anomalies relating to ferrous objects and material in the topsoil. Anomalies located within each survey area have been numbered and will be outlined below with subsequent discussion in Section 4.

3.9.4 The listing of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the survey. A basic explanation of the characteristics of the magnetic anomalies is set out for each category in order to justify interpretation. Sub-headings are then used to group anomalies with similar characteristics for each survey area.

Anomalies with a possible archaeological origin

Positive anomalies

The category is used where anomalies have the characteristics of a range of archaeological features such as pits, ring-ditches, enclosures etc.

Anomalies with an uncertain origin

Positive anomalies
Negative anomalies

The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features but equally relatively modern

features, geological/ pedological features and agricultural features should be considered.

Anomalies with an agricultural origin

Agricultural anomalies

Where confidence is high that anomalies have been caused by agricultural features this category is applied. The anomalies are often linear and form a series of parallel responses or are parallel to extant land boundaries.

Anomalies with a modern origin

Magnetic disturbance
Strong multiple dipolar linear anomaly – pipeline/service

The magnetic response is often strong and dipolar indicative of ferrous material and may be associated with extant above surface features such as wire fencing, cables etc. Often a significant area around such features has a strong magnetic flux which may create magnetic disturbance – such disturbance can effectively obscure low magnitude anomalies if they are present.

Anomalies associated with magnetic debris

Magnetic debris
Strong discrete dipolar anomaly

The response often appears as areas containing many small dipolar anomalies that may range from weak to strong in magnitude. Magnetic debris often occurs where there has been dumping or ground make-up and is related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous material. This type of response is occasionally associated with kilns, furnace structures or hearths and may therefore be archaeologically significant. It is also possible that the response may be caused by natural material such as certain gravels and fragments of igneous or metamorphic rock. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.

Anomalies of pedological/geological origin

Positive area anomaly

Amorphous or broad linear response likely to be caused by geological/pedological features.

3.10 Area 1

Area centred on OS grid coordinates 520405, 359500 (see Figures 5-8).

Anomalies with a possible archaeological origin

(1) – Positive linear anomalies appear to form a rectilinear enclosure which contains several discrete positive anomalies. It is surrounded by a series of positive linear anomalies (2 & 3, see below) that are likely to be associated cut features.

(2) – Positive linear anomalies with a general north-northwest to south-southeast orientation. These are clustered towards the north-western part of Field 1 with one extension northwards into Field 2. They often join anomalies (3) to form rectilinear enclosures.

(3) – Positive linear anomalies with a general west-southwest to east-northeast orientation form enclosures and possible field systems with anomalies (2).

(4) – Area 1 contains many discrete positive anomalies with a magnitude generally between 2nT and 6nT and a diameter of between 2m and 6m. Due to their proximity to and apparent association with anomalies (1, 2 & 3) they have been interpreted as pit-like anomalies with a possible archaeological origin.

(5) – An area of low magnitude magnetically thermoremnant debris situated within the main area of archaeological anomalies (1 to 4) and possibly associated with them. It is possible that this debris is related to burnt or fired material with an archaeological origin.

(6) – Situated within the zone of archaeological anomalies is a small curvilinear positive anomaly. Although it appears curvilinear in form, it should also be considered that this anomaly is a series of closely spaced pit-like features.

(7) – Towards the eastern edge of Area 1 is a very low magnitude positive curvilinear anomaly that appears to form a penannular feature. Although this anomaly surrounds a modern electricity pole it appears as a distinct cut feature such as a ring-ditch with a diameter of approximately 40m.

Anomalies with an uncertain origin

(8) – Extending across the survey area are several positive linear anomalies. They are broadly parallel with positive linear anomalies (3) and it is possible that they also have an archaeological origin. However their magnitude and appearance is generally less enhanced than anomalies coded (3) and an origin cannot be determined.

(9) – Two parallel positive linear anomalies extend northwards from the most southern linear anomaly coded (8). They have a similar orientation to anomalies coded (2) and although an archaeological origin is possible, it is not certain.

(10) – A broad negative linear anomaly appears to extend across the most southerly positive linear anomaly coded (8) and is parallel to positive linear anomalies (9).

(11) – Several areas of low magnitude positive response can be seen within the eastern part of Area 1. Although it is possible that these also relate to underlying geological/pedological features, their response is slightly higher than the geological anomalies and they have a more discrete nature.

(12 & 13) – These discrete positive responses, have been coded separately as they have a relatively high magnitude (up to 53nT and 263nT respectively) which may suggest an area of intense burning such as a hearth or kiln. The origin is uncertain however, as a strong response may suggest the presence of ferrous material.

(14, 15 & 16) – Three positive linear anomalies can be seen in the west of the survey area (14 and 16 are in the south of Field 2, 15 is in the northwest of Field 1). These anomalies are generally northeast to southwest in orientation, and anomaly (3) in the north of the survey area, appears to butt-up against or be cut by anomaly (14).

(17) – Two parallel positive linear anomalies with several discrete positive responses in between (in the north of the survey area, south of Field 2). It is not possible to ascertain the origin of these anomalies, but they are parallel with the modern agricultural anomalies seen to the west.

(18) – Several short curvilinear anomalies appear to form a larger fragmented curvilinear feature. Several discrete positive anomalies are also seen within the vicinity.

(19) – A positive area anomaly extending approximately north-westwards from an area of magnetic debris close to the south-eastern entrance of Field 2. This anomaly also appears to extend towards anomaly (17), however its origin is uncertain.

Anomalies with a geological origin

(20) – Extending across much of the southern part of Area 1 is a widespread zone of positive anomalies with associated negative responses. Part of this zone comprises a sinuous feature, likely to be a response to a former palaeo-channel, other parts appear more pit-like in form but are also likely to relate to features formed during the Pleistocene epoch.

Anomalies with an agricultural origin

(21 & 22) – Linear anomalies caused by agricultural activity can be seen within Area 1, both in the south of Field 2 and within Field 1. In Field 1 the linear anomalies are widely spaced, however in Field 2 linear anomalies appear similar to tracks caused by tractor wheels although the exact process of magnetic enhancement cannot be determined.

Anomalies associated with magnetic debris

(23) – Spreads of magnetic debris can be seen along the trackways between Fields 1 and 2 and to the east of Field 1. These are likely to be a response to thermoremnant material such as brick or tile used as a base for the tracks.

(24) – A spread of magnetic debris along the northern edge of the ditch that separates Fields 1 and 2 may relate to material that has been removed from the ditch. It is not possible to ascertain if this is magnetically enhanced gravels or if it is a response to magnetically thermoremnant material with an archaeological origin that has been removed from the ditch.

3.11 Area 2

Area centred on OS grid coordinates 520225, 359500 (see Figures 9-12).

Anomalies with a geological origin

(25) – Within Area 2 there are widespread amorphous positive anomalies with associated negative responses that are related to features within the underlying Pleistocene deposits.

Anomalies with an agricultural origin

(26) – A series of positive linear anomalies parallel with the eastern field boundary. Not all anomalies have been abstracted and only the plough trend has been shown.

Anomalies associated with magnetic debris

(27) – A sinuous anomaly comprising magnetic debris that relates to the former line of a field boundary ditch. This is likely to be a response to material used within the backfilling of the ditch.

(28) – Situated close to the eastern field boundary ditch are two patches of magnetic debris. Their origin is uncertain, but it is possible that they relate to material removed from the ditch.

Anomalies caused by magnetic disturbance

(29) – A very strong dipolar anomaly has caused widespread magnetic disturbance of over 30m in diameter. Although this anomaly is of uncertain origin, as a health and safety precaution, it is worth considering that this may be a response to buried ordnance. The dipolar response could be consistent with a large elongated ferrous object and unexploded ordnance has been located immediately to the east of the B1192.

3.12 Area 3

Area centred on OS grid coordinates 520595, 360220 (see Figures 13-16).

Anomalies with an uncertain origin

(30 & 31) – Situated primarily within the northern half of the survey area are several positive linear anomalies (30). A negative linear anomaly (31) appears to extend between the positive anomalies. Although some of these appear rectilinear in form is it possible that they relate to geological features.

(32) – Several weak short positive linear anomalies with a general northwest to southeast orientation appear within the survey area. Some appear to extend towards and join anomaly (33).

(33 & 34) – A low magnitude positive linear anomaly extends across the centre of the survey area from east to west (33). A second positive linear anomaly (34) appears to join (33) towards the centre of the survey area and then extend west southwest towards the western edge.

(35) – Several positive area responses appear within the northern part of the survey area. Although of uncertain origin, it is possible that they are a caused by geological features (see 36 below), or pits associated with former mineral/clay extraction.

Anomalies with a geological origin

(36) – Area 3 contains a zone of positive response that is likely to represent geological features.

Anomalies associated with magnetic debris

(37) – Along the northern edge of the survey area is a zone of magnetic debris. It is uncertain whether this relates to material brought to the site and dumped or extracted within the vicinity.

3.13 Area 4

Area centred on OS grid coordinates 520305, 360490 (see Figures 17-20).

Anomalies with an uncertain origin

(38) – Several low magnitude positive anomalies situated in the south of the survey area. It is possible that these are geological features, however their form is more discrete than the general zone of positive responses seen to the west (39).

Anomalies with a geological origin

(39) – A zone of amorphous positive responses likely to be related to geological features.

Anomalies with an agricultural origin

(40 & 41) – Two series of parallel linear anomalies are located within Area 4. Anomalies coded (40) are parallel with the western field boundary and can be seen most clearly within the zone of positive response attributed to geological features. Anomalies (41) are located close to the south eastern corner of the survey area and are parallel with the southern field drain.

Anomalies associated with magnetic debris

(42) – In the south eastern corner of Area 4 is a zone of magnetic debris that corresponds to an area of ploughed up iron pan that is visible in the field.

(43) – A patch of magnetic debris close to the north western corner of the survey area appears in a general linear form. It is possible that this is a response to an infilled ditch or drain but this is not certain.

3.14 Area 5

Area centred on OS grid coordinates 521020, 359615 (see Figures 21-24).

Anomalies with an uncertain origin

(44 & 45) – In the north of Area 5 are three positive linear anomalies that appear to be associated. Two form an "L" shaped feature (44), and the other (45) is parallel with the east-west extension of this feature. Although it is possible that these relate to cut features their origin cannot be confidently interpreted.

(46 & 47) – Extending across the centre of the survey area with an east southeast to west northwest orientation is a positive linear anomaly (46). Another positive linear anomaly (47) with a southeast to northwest orientation appears to join it close to the western edge of the survey area.

Anomalies with a geological origin

(48) – Several patches of amorphous positive and negative response have been located within Area 5 along with a zone of pit-like anomalies. It is likely that all of these anomalies have been caused by geological features.

Anomalies with an agricultural origin

(49 & 50) – Two series of parallel linear anomalies are located within Area 5 and relate to modern ploughing patterns within the field. Only the plough trend has been abstracted.

Anomalies associated with magnetic debris

(51) – Close to the eastern edge of Area 5 are several patches of magnetic debris. They are uncertain in origin, although it is possible that they relate to dumped material, infilling material, or ploughed up iron pan.

4 DISCUSSION

4.1 Magnetic susceptibility survey

4.1.1 The results of the magnetic susceptibility survey revealed zones of magnetic enhancement subsequently used to guide the targeting of detailed magnetometry. Little evidence for any correlation between magnetically enhanced areas and magnetic anomalies of archaeological significance was revealed and this is likely to relate to a number of separate factors. The discussion below deals with the results measured within each individual field as it is likely that factors affecting the magnetic susceptibility are similar within each land package but may vary across the site as a whole.

4.1.2 Significantly influencing the magnetic susceptibility results is a substance known as 'red gypsum' which is applied to the fields as a soil conditioner (Peacock and Rimmer, 2000). Communication with the farmer and ground observations suggests that the material has been deposited over Fields 1, 2, 3 and 5 with spreading in Fields 2 and 3 within the last year and 1 and 5 within the last two years. The substance was visible as lumps up to approximately 200mm in diameter on the surface although the material is clearly very friable and disintegrates within a few years of ploughing. In air tests on large pieces of the 'red gypsum' suggest that very significant levels of magnetic enhancement can exist and to a degree this may depend upon the size of the fragments surviving within the plough soil. Further research has indicated that the material is a by-product of the manufacture of titanium oxide used for paint and originates from Hull. The material is described as iron oxide rich and has a similar chemical make-up to other forms of gypsum.

4.1.3 Field 1:

The results have been influenced by a compact layer of dead vegetation and dense growth of self-seeded rape. Although care is taken in the positioning of the field coil, dead vegetation effectively increases the air gap between the measuring coil and the ground surface and can lower the recorded SI value. 'Red gypsum' soil conditioner was observed where soil was visible although it is uncertain as to the quantity and size of the material. The magnetic susceptibility results may have been influenced to a degree by the gypsum but this is much less apparent than in Fields 2, 3 and 5 (mean values are lowest from the group of fields known to have this material, see 3.2.2). Detailed magnetometry Area 1 targeted enhanced magnetic susceptibility towards the eastern side of the field and cropmarks close to the northern boundary. It is of note that magnetic susceptibility values close to an area of archaeological features near the northern boundary, located by the magnetometry, is quite unremarkable and would not have been targeted without the additional cropmark evidence. There may be other geological/pedological factors influencing the magnetic susceptibility within Field 1 as these natural features were clearly visible within the magnetometry data.

4.1.4 Field 2:

Similar to Field 1, it is possible that vegetation cover has suppressed the results although this is unlikely to be significant. The 'red gypsum' has also produced significant levels of enhancement with a mean value of over 20 x 10^{-5} SI. Magnetometry results in this area show strongly enhanced natural geological/pedological features and it is very likely that the increased levels of magnetic enhancement within the northern half of Field 2 are a combination of the gypsum soil conditioner and natural soil enhancement.

4.1.5 Field 3:

The surface of the field was clearly covered with 'red gypsum' soil conditioner which could be demonstrated as having and enhanced susceptibility when the field coil of the MS2 was placed adjacent to it. Carefully positioning the coil away from the larger pieces of gypsum lowered recorded values to a degree although gypsum just under the soil surface could not be avoided and probably accounts for most of the enhancement across the area. A coherent zone of high magnetic susceptibility was located close to the northern boundary and it is likely that this has been caused by a combination of gypsum and natural enhancement within a shallow valley. High values in the south western corner of the field correlate with the position of a relatively recently demolished building (structures are visible in aerial photographs from 1970).

4.1.6 Field 4:

Very low readings were recorded across much of the field; these are in a range typically expected for the soil type and have not been influenced by soil conditioners. A zone of moderate enhancement within the southern central

part of the field was targeted with detailed magnetometry as a number of flint implements were visible during collection of the magnetic susceptibility data. The magnetometry revealed little of archaeological significance and it is possible that the enhancement relates to natural variation of iron compounds within the soil. Natural iron pan in fragmented lumps up to 300mm across was frequently observed towards the south eastern corner of the field and is likely to account for much of the magnetic enhancement.

4.1.7 Field 5:

The highest mean values of magnetic susceptibility were observed within Field 5. The enhancement is fairly widespread and few features were located by targeted magnetometry within the area suggesting that 'red gypsum' may be the dominant signature within the dataset.

4.1.8 Field 6:

Similar to Field 4, very low readings were observed across most of the area. The strong enhancement close to the southern boundary is in a low lying area close to a stream and likely to be related to naturally enhanced gravels.

4.2 Detailed magnetometry

4.2.1 The underlying geological and pedological conditions have created magnetic anomalies within all of the survey areas. The emphasis in the following discussion of each survey area is on the archaeological potential of the site and is not concerned with these natural features or with features of modern origin. It should be realised that there are limitations to the interpretation of anomalies and it may not be possible to confidently separate some natural or modern features from those of archaeological significance; a cautious approach is pursued.

4.2.2 Area 1:

The area contains evidence for archaeological features across more than 3ha. Primarily situated within Field 1, but spreading into the southern part of Field 2, these features appear predominantly as positive linear anomalies and discrete anomalies representing ditches and pits. It appears that the features represent at least one enclosure with associated pits and surrounding field systems. Many discrete positive anomalies have been located, these generally have a low magnitude of between 2nT and 6nT which would suggest that they relate to pit-like features containing magnetically enhanced material with an archaeological origin. Their relatively low magnitude is not typical of areas of intense burning such as hearths or kilns and it is possible that some are associated with geological/pedological features. A habitation effect may be evident as the anomalies appear stronger in the northern central part of the plot becoming weaker towards the west, north and south. Area 1 also contains a possible penannular ring ditch feature towards the eastern edge of the survey area which may be of archaeological potential.

4.2.3 Area 2:

No anomalies could be characterised as having archaeological potential within the area. Background information supplied by the Client indicated cropmarks crossing the survey area, one of which was clearly apparent on the ground as significantly taller self-seeded rape. It is of note that there was no corresponding magnetic anomaly associated with this cropmark. Also of note is the lack of response to a former field ditch which crossed the survey area with a north to south orientation. Typically, on most soils this would be visible as a positive linear anomaly with good contrast but within Area 2 the feature can only be partially defined by a small amount of magnetic debris. The inference here is for poor contrast between topsoil and subsoil magnetic susceptibility.

4.2.4 Area 3:

Magnetometry targeted on Area 3 was guided by a coherent zone of enhanced magnetic susceptibility. A number of uncertain anomalies were located by the magnetometry and no further comment on their archaeological potential is possible.

4.2.5 Area 4:

The magnetometry targeted zones of enhanced magnetic susceptibility with the central southern area containing a notable scatter of worked flint including scrapers and blades. No anomalies could be defined as archaeological in origin despite the obvious flint scatter. Large chunks of natural iron pan were visible towards the south eastern corner of the survey area which although may not be of archaeological significance, the material does indicate a potential source of raw iron for smelting in a form more easily processed than other sources and possibly attractive to early iron manufacture.

4.2.6 Area 5:

Despite the area containing some of the most enhanced and coherent zones of magnetic susceptibility, there was no evidence from the detailed magnetometry to indicate an increased archaeological potential and it is likely that the 'red gypsum' has influenced the survey.

5 CONCLUSION

5.1 Magnetic susceptibility

5.1.1 Magnetic susceptibility results have been influenced by the use of 'red gypsum' soil conditioner which has been spread across a significant proportion of the survey area. This material is magnetically enhanced as it contains a large proportion of iron oxides and is a by-product of an industrial

process. Any archaeological signature within the magnetic susceptibility data may have been obscured by this material.

5.1.2 The mobility of iron compounds within the soils due to natural processes is clearly demonstrated by the observation of fragmented iron pan that has probably been turned up by deep ploughing. This may effectively result in areas of very low soil susceptibility, where iron compounds are lost within the upper part of the soil profile, contrasting with zones of enhanced susceptibility where iron pan is shallow or has been re-worked into the plough soil. The results of the detailed magnetometry would tend to suggest that natural variation in iron compounds occurs over much of the site although the specific processes involved cannot be determined by geophysics alone.

5.1.3 There is no clear relationship between topsoil magnetic susceptibility and archaeological features located within Area 1 by detailed magnetometry.

5.2 Detailed magnetometry

5.2.1 The detailed magnetometry survey located a number of positive linear and discrete anomalies within Area 1. These anomalies appear to represent enclosures, ditches and pits related to a settlement site. The stronger responses are situated within the centre of the cluster of anomalies with generally weaker responses towards the periphery indicating a habitation effect although small-scale industrial activity may be partially responsible. Pottery sherds noted during survey in this area suggest a Romano-British date.

5.2.2 The location of archaeological anomalies within Area 1 clearly demonstrates that magnetic contrast within the soils and subsoils can exist. It is possible that sufficient magnetic enhancement occurs where relatively intense burning, possibly associated with minor industrial activity, has taken place. Where activity is less intense, sufficient magnetic enhancement may not be achieved with obvious consequences for the utility of magnetic survey.

6 REFERENCES

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Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremnant material.

Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth's magnetic field.

Thermoremnant magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth's magnetic field on cooling.

Enhancement of magnetic susceptibility can occur in areas subject to burning and complex fermentation processes on biological material; these are frequently associated with human settlement. Thermoremnant features include ovens, hearths and kilns. In addition thermoremnant material such as tile and brick may also be associated with human activity and settlement.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil can create an area of enhancement compared with the surrounding soils and subsoils into which the feature is cut. Mapping enhanced areas will produce linear and discrete anomalies allowing an assessment and characterisation of hidden subsurface features.

It should be noted that areas of negative enhancement can be produced from material having lower magnetic properties compared to topsoil. This is common for many sedimentary bedrocks and subsoils which were often used in the construction of banks and walls etc. Mapping these 'negative' anomalies may also reveal archaeological features.

Magnetic survey or magnetometry can be carried out using a fluxgate gradiometer and may be referred to as gradiometry. The gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the upper sensor measures the Earth's magnetic field as does the lower sensor but this is influenced to a greater degree by any localised buried field. The difference between the two sensors will relate to the strength of magnetic field created by the buried feature. If no enhanced feature is present the field measured by both sensors will be similar and the difference close to zero.

There are a number of factors that may affect the magnetic survey and these include soil type, local geology and previous human activity. Situations arise where magnetic disturbance associated with modern services, metal fencing, dumped waste material etc., obscures low magnitude fields associated with archaeological features.

Appendix B – survey and data information

Area 1 processed data

COMPOSITE
Filename: Area1-proc2.xcp
Instrument Type: Grad 601
(Magnetometer)
Units: nT
Surveyed by: on 22/02/2007
Assembled by: on 22/02/2007
Direction of 1st Traverse: 0 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702
Origin: One

Dimensions
Composite Size (readings): 1560 x 450
Survey Size (feet): 390 ft x 450 ft
Grid Size: 30 x 30
X Interval: 0.25
Y Interval: 1

Stats
Max: 3.00
Min: -3.00
Std Dev: 0.74
Mean: 0.05

Processes: 11
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4 DeStripe Mean Traverse: Grids: 130+88.asg Threshold: 1.5 SDs
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6 DeStripe Mean Traverse: Grids: 129+87.asg Threshold: 2.5 SDs
7 DeStripe Mean Traverse: Grids: 90+110.asg 111+91.asg 112+92.asg 93.asg 83.asg Threshold: 2.5 SDs
8 De Stagger: Grids: All Mode: Both By: -1 intervals
9 De Stagger: Grids: 81.asg 82.asg Mode: Both By: 1 intervals
10 De Stagger: Grids: 97.asg Mode: Both By: -1 intervals
11 Clip from -3 to 3

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Area 2 processed data

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(Magnetometer)
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Assembled by: on 15/02/2007
Direction of 1st Traverse: 0 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702
Origin: One

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Composite Size (readings): 480 x 210
Survey Size (feet): 120 ft x 210 ft
Grid Size: 30 x 30
X Interval: 0.25
Y Interval: 1

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Max: 3.00
Min: -3.00
Std Dev: 1.37
Mean: -0.05

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2 Clip from -10 to 10
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4 Clip from -3 to 3
5 De Stagger: Grids: All Mode: Both By: -2 intervals
6 Clip from -3 to 3
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Area 3 processed data

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(Magnetometer)
Units: nT
Surveyed by: on 18/02/2007
Assembled by: on 18/02/2007
Direction of 1st Traverse: 0 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702
Origin: One

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Survey Size (feet): 120 ft x 210 ft
Grid Size: 30 x 30
X Interval: 0.25

Y Interval: 1

Stats
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Min: -3.00
Std Dev: 1.00
Mean: 0.07

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4 DeStripe Median Traverse: Grids: All
5 Clip from -3 to 3

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8 Col:1 Row:0 grids\15.asg
9 Col:1 Row:1 grids\16.asg
10 Col:1 Row:2 grids\17.asg
11 Col:1 Row:3 grids\18.asg
12 Col:1 Row:4 grids\19.asg
13 Col:1 Row:5 grids\20.asg
14 Col:1 Row:6 grids\21.asg
15 Col:2 Row:0 grids\11.asg
16 Col:2 Row:1 grids\12.asg
17 Col:2 Row:2 grids\13.asg
18 Col:2 Row:3 grids\14.asg
19 Col:2 Row:4 grids\08.asg
20 Col:2 Row:5 grids\09.asg
21 Col:2 Row:6 grids\10.asg
22 Col:3 Row:0 grids\01.asg
23 Col:3 Row:1 grids\02.asg
24 Col:3 Row:2 grids\03.asg
25 Col:3 Row:3 grids\04.asg
26 Col:3 Row:4 grids\05.asg
27 Col:3 Row:5 grids\06.asg
28 Col:3 Row:6 grids\07.asg

Area 4 processed data

COMPOSITE
Filename: Area4-proc.xcp
Instrument Type: Grad 601
(Magnetometer)
Units: nT
Surveyed by: on 19/02/2007
Assembled by: on 19/02/2007
Direction of 1st Traverse: 0 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702
Origin: One

Dimensions
Composite Size (readings): 720 x 210
Survey Size (feet): 180 ft x 210 ft
Grid Size: 30 x 30
X Interval: 0.25
Y Interval: 1

Stats
Max: 3.00
Min: -3.00
Std Dev: 0.85
Mean: 0.04

Processes: 7
1 Base Layer
2 Clip from -10 to 10
3 De Stagger: Grids: All Mode: Both By: -2 intervals
4 DeStripe Mean Traverse: Grids: 34.asg Threshold: 4 SDs
5 DeStripe Median Traverse: Grids: 21.asg 22.asg 23.asg 24.asg 25.asg 26.asg 17.asg 18.asg 19.asg 20.asg 28.asg 29.asg 30.asg 13.asg 14.asg 15.asg 16.asg 31.asg 32.asg 33.asg 09.asg 10.asg 11.asg 12.asg 35.asg 36.asg 05.asg 06.asg 07.asg 08.asg 37.asg 38.asg 01.asg 02.asg 03.asg 04.asg 39.asg 40.asg
6 Clip from -3 to 13
7 Clip from -3 to 3

Source Grids: 40
1 Col:0 Row:0 grids\21.asg
2 Col:0 Row:1 grids\22.asg
3 Col:0 Row:2 grids\23.asg
4 Col:0 Row:3 grids\24.asg
5 Col:0 Row:4 grids\25.asg
6 Col:0 Row:5 grids\26.asg
7 Col:0 Row:6 grids\27.asg
8 Col:1 Row:0 grids\17.asg
9 Col:1 Row:1 grids\18.asg
10 Col:1 Row:2 grids\19.asg
11 Col:1 Row:3 grids\20.asg
12 Col:1 Row:4 grids\28.asg
13 Col:1 Row:5 grids\29.asg
14 Col:1 Row:6 grids\30.asg
15 Col:2 Row:0 grids\13.asg
16 Col:2 Row:1 grids\14.asg
17 Col:2 Row:2 grids\15.asg
18 Col:2 Row:3 grids\16.asg
19 Col:2 Row:4 grids\31.asg
20 Col:2 Row:5 grids\32.asg
21 Col:2 Row:6 grids\33.asg
22 Col:3 Row:0 grids\09.asg
23 Col:3 Row:1 grids\10.asg
24 Col:3 Row:2 grids\11.asg
25 Col:3 Row:3 grids\12.asg
26 Col:3 Row:4 grids\34.asg
27 Col:3 Row:5 grids\35.asg
28 Col:3 Row:6 grids\36.asg
29 Col:4 Row:0 grids\05.asg
30 Col:4 Row:1 grids\06.asg
31 Col:4 Row:2 grids\07.asg
32 Col:4 Row:3 grids\08.asg
33 Col:4 Row:4 grids\37.asg
34 Col:4 Row:5 grids\38.asg
35 Col:5 Row:0 grids\01.asg
36 Col:5 Row:1 grids\02.asg
37 Col:5 Row:2 grids\03.asg
38 Col:5 Row:3 grids\04.asg
39 Col:5 Row:4 grids\39.asg
40 Col:5 Row:5 grids\40.asg

Area 5 processed

COMPOSITE
Filename: Area5-proc.xcp
Instrument Type: Grad 601
(Magnetometer)
Units: nT
Surveyed by: on 21/02/2007
Assembled by: on 21/02/2007
Direction of 1st Traverse: 0 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702
Origin: One

Dimensions
Composite Size (readings): 840 x 240
Survey Size (feet): 210 ft x 240 ft
Grid Size: 30 x 30
X Interval: 0.25
Y Interval: 1

Stats
Max: 2.00
Min: -2.00
Std Dev: 0.63
Mean: 0.03

Processes: 7
1 Base Layer
2 Clip from -30 to 30
3 DeStripe Median Traverse: Grids: All
4 Clip from -10 to 10
5 De Stagger: Grids: All Mode: Both By: -2 intervals
6 Clip from -3 to 3
7 Clip from -2 to 2

Source Grids: 56
1 Col:0 Row:0 grids\25.asg
2 Col:0 Row:1 grids\26.asg
3 Col:0 Row:2 grids\27.asg
4 Col:0 Row:3 grids\28.asg
5 Col:0 Row:4 grids\29.asg
6 Col:0 Row:5 grids\30.asg
7 Col:0 Row:6 grids\31.asg
8 Col:0 Row:7 grids\32.asg
9 Col:1 Row:0 grids\21.asg
10 Col:1 Row:1 grids\22.asg
11 Col:1 Row:2 grids\23.asg
12 Col:1 Row:3 grids\24.asg
13 Col:1 Row:4 grids\33.asg
14 Col:1 Row:5 grids\34.asg
15 Col:1 Row:6 grids\35.asg
16 Col:1 Row:7 grids\36.asg
17 Col:2 Row:0 grids\17.asg
18 Col:2 Row:1 grids\18.asg
19 Col:2 Row:2 grids\19.asg
20 Col:2 Row:3 grids\20.asg
21 Col:2 Row:4 grids\37.asg
22 Col:2 Row:5 grids\38.asg
23 Col:2 Row:6 grids\39.asg
24 Col:2 Row:7 grids\40.asg
25 Col:3 Row:0 grids\13.asg
26 Col:3 Row:1 grids\14.asg
27 Col:3 Row:2 grids\15.asg
28 Col:3 Row:3 grids\16.asg
29 Col:3 Row:4 grids\41.asg
30 Col:3 Row:5 grids\42.asg
31 Col:3 Row:6 grids\43.asg
32 Col:3 Row:7 grids\44.asg
33 Col:4 Row:0 grids\09.asg
34 Col:4 Row:1 grids\10.asg
35 Col:4 Row:2 grids\11.asg
36 Col:4 Row:3 grids\12.asg
37 Col:4 Row:4 grids\45.asg
38 Col:4 Row:5 grids\46.asg
39 Col:4 Row:6 grids\47.asg
40 Col:4 Row:7 grids\48.asg
41 Col:5 Row:0 grids\05.asg
42 Col:5 Row:1 grids\06.asg
43 Col:5 Row:2 grids\07.asg
44 Col:5 Row:3 grids\08.asg
45 Col:5 Row:4 grids\49.asg
46 Col:5 Row:5 grids\50.asg
47 Col:5 Row:6 grids\51.asg
48 Col:5 Row:7 grids\52.asg
49 Col:6 Row:0 grids\01.asg
50 Col:6 Row:1 grids\02.asg
51 Col:6 Row:2 grids\03.asg
52 Col:6 Row:3 grids\04.asg
53 Col:6 Row:4 grids\53.asg
54 Col:6 Row:5 grids\54.asg
55 Col:6 Row:6 grids\55.asg
56 Col:6 Row:7 grids\56.asg

Archaeological Surveys

Tattershall Thorpe

Location map

Scale 1:50 000 (A3)

0 1 2
kilometres

Fig 01

Archaeological Surveys

Tattershall Thorpe

General site map showing field cover and field numbers

Scale 1:10 000 (A3)

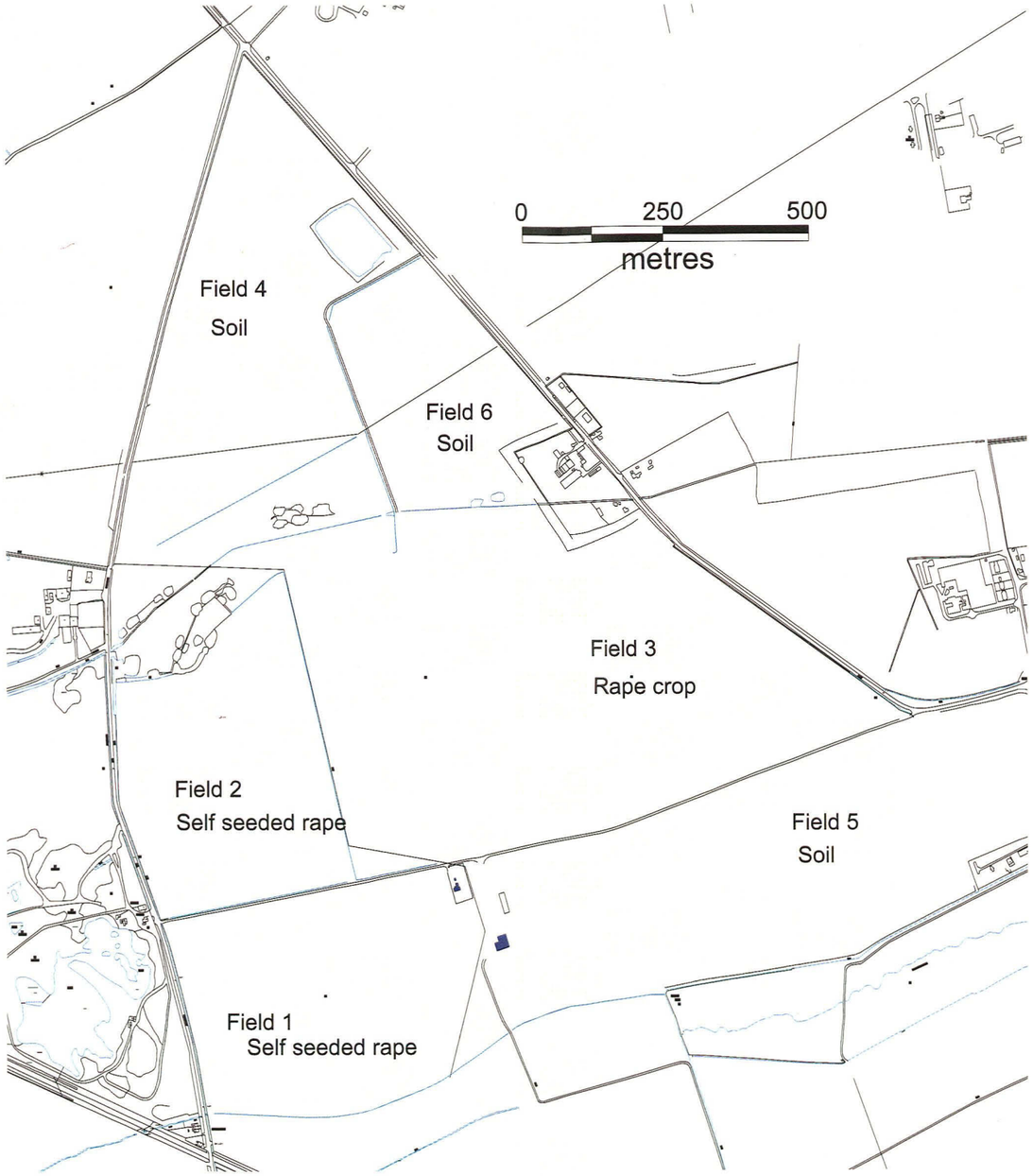


Fig 02

Archaeological Surveys

Tattershall Thorpe

Magnetic susceptibility interpolated colour plot

Scale 1:10 000 (A3)

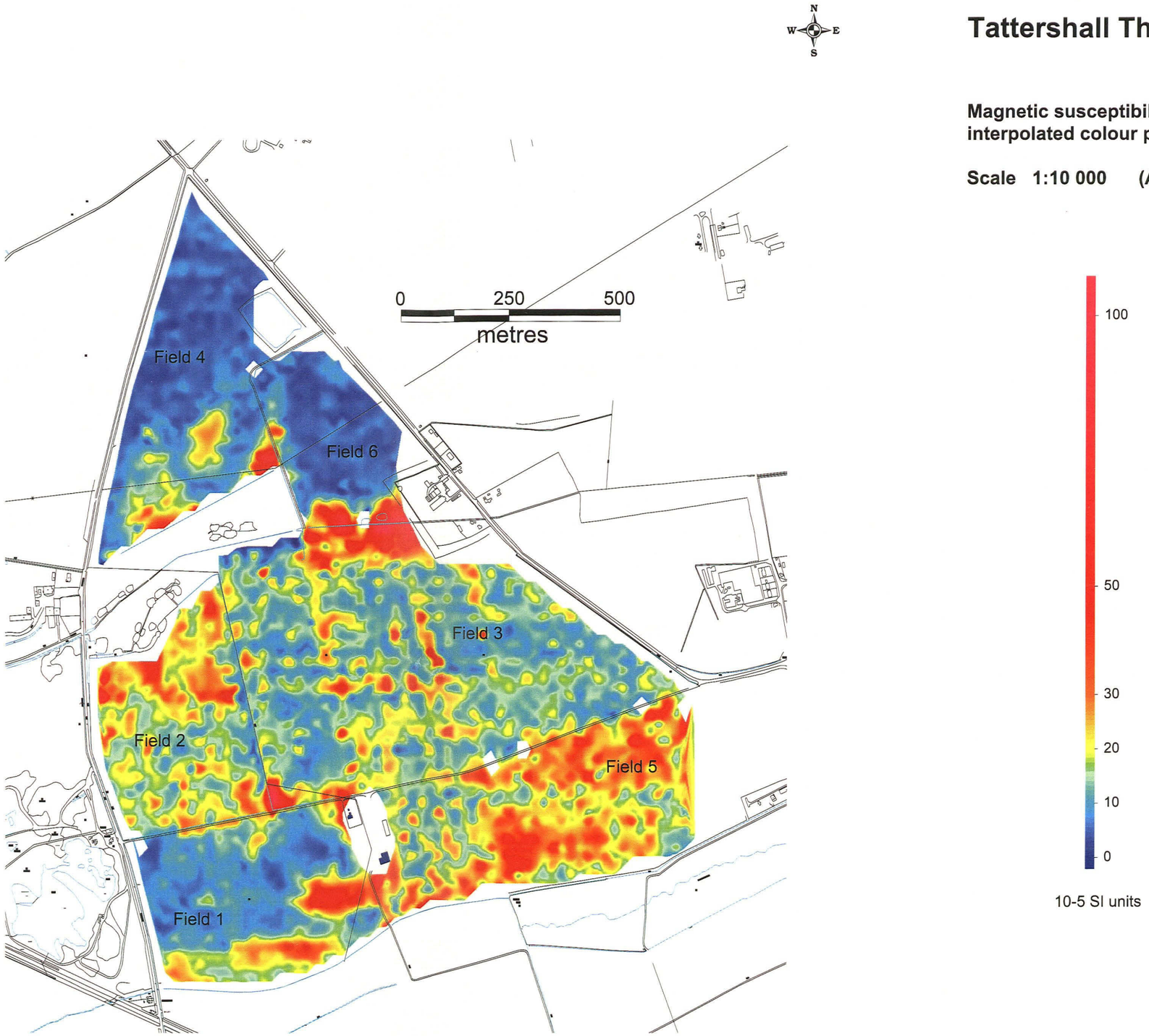


Fig 03

Archaeological Surveys

Tattershall Thorpe

Location of magnetometry survey areas

Scale 1:10 000 (A3)

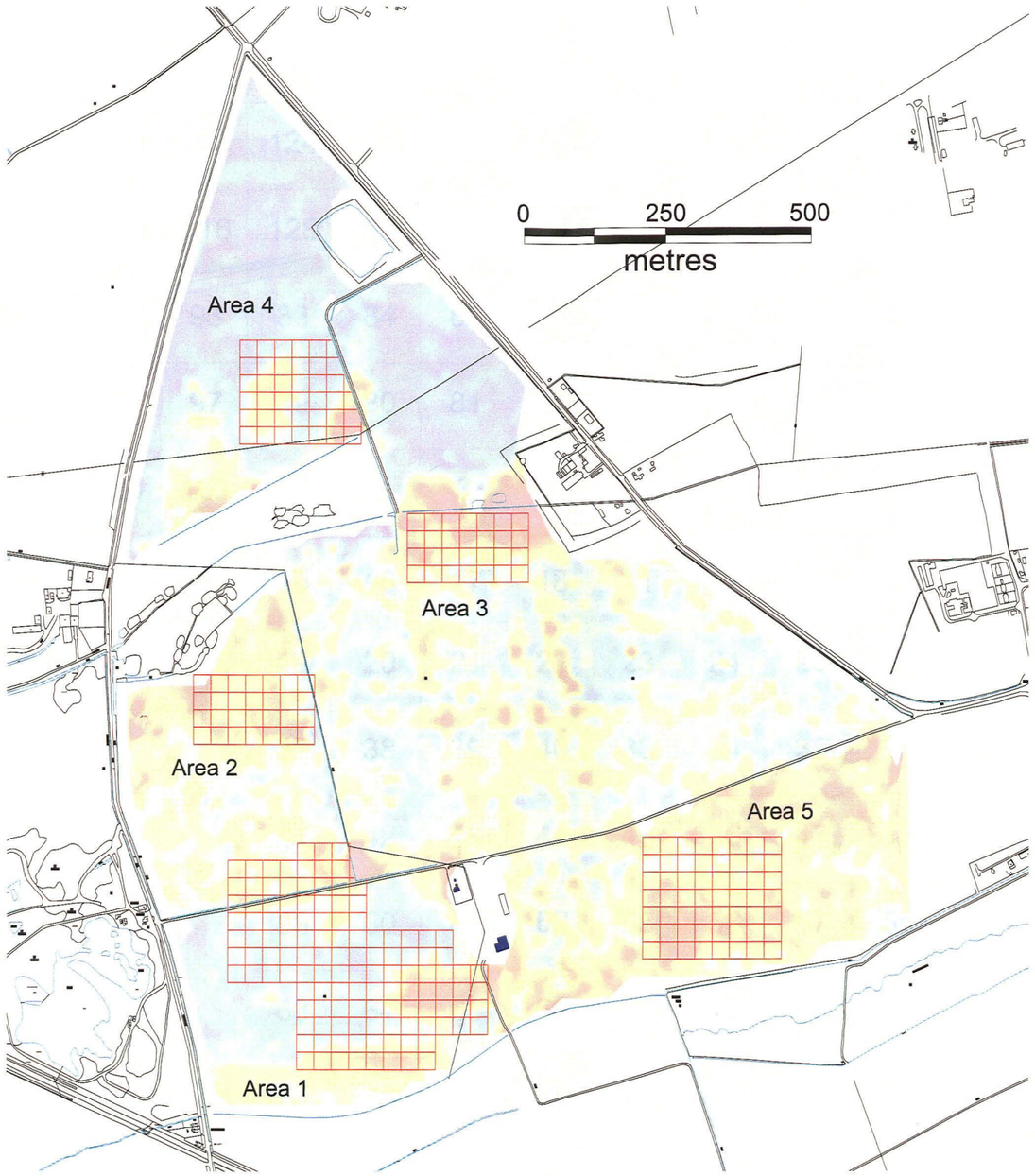


Fig 04

Archaeological Surveys

Tattershall Thorpe

Area 1 referencing and grid numbers

OSGB36 coordinates

30m grids

Scale 1:2000 (A3)

Survey start and traverse direction

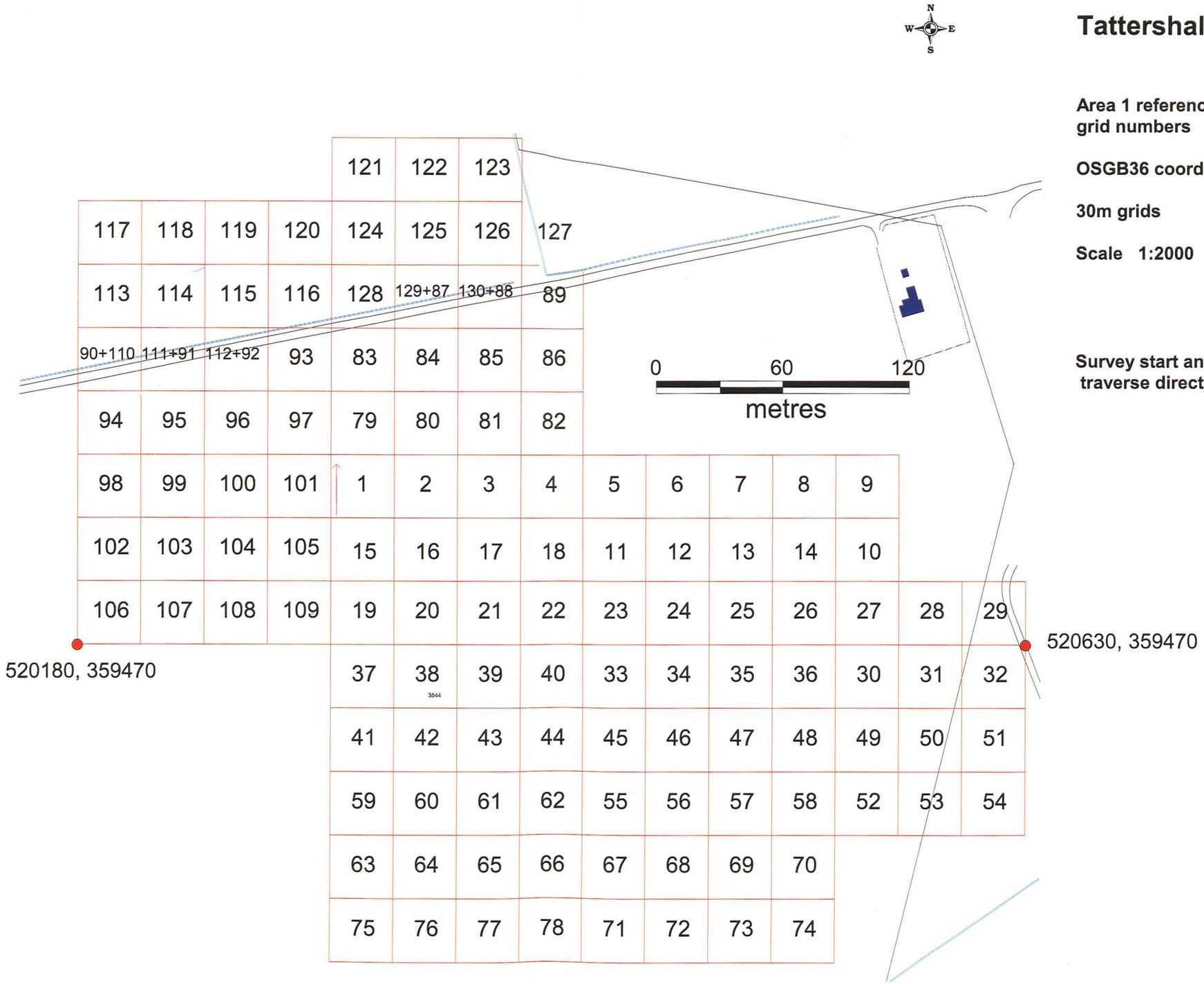


Fig 05

Archaeological Surveys

Tattershall Thorpe

Area 1 traceplot

Approximate scale: 20nT/cm

Data clipped at ±100nT

Scale 1:2000 (A3)

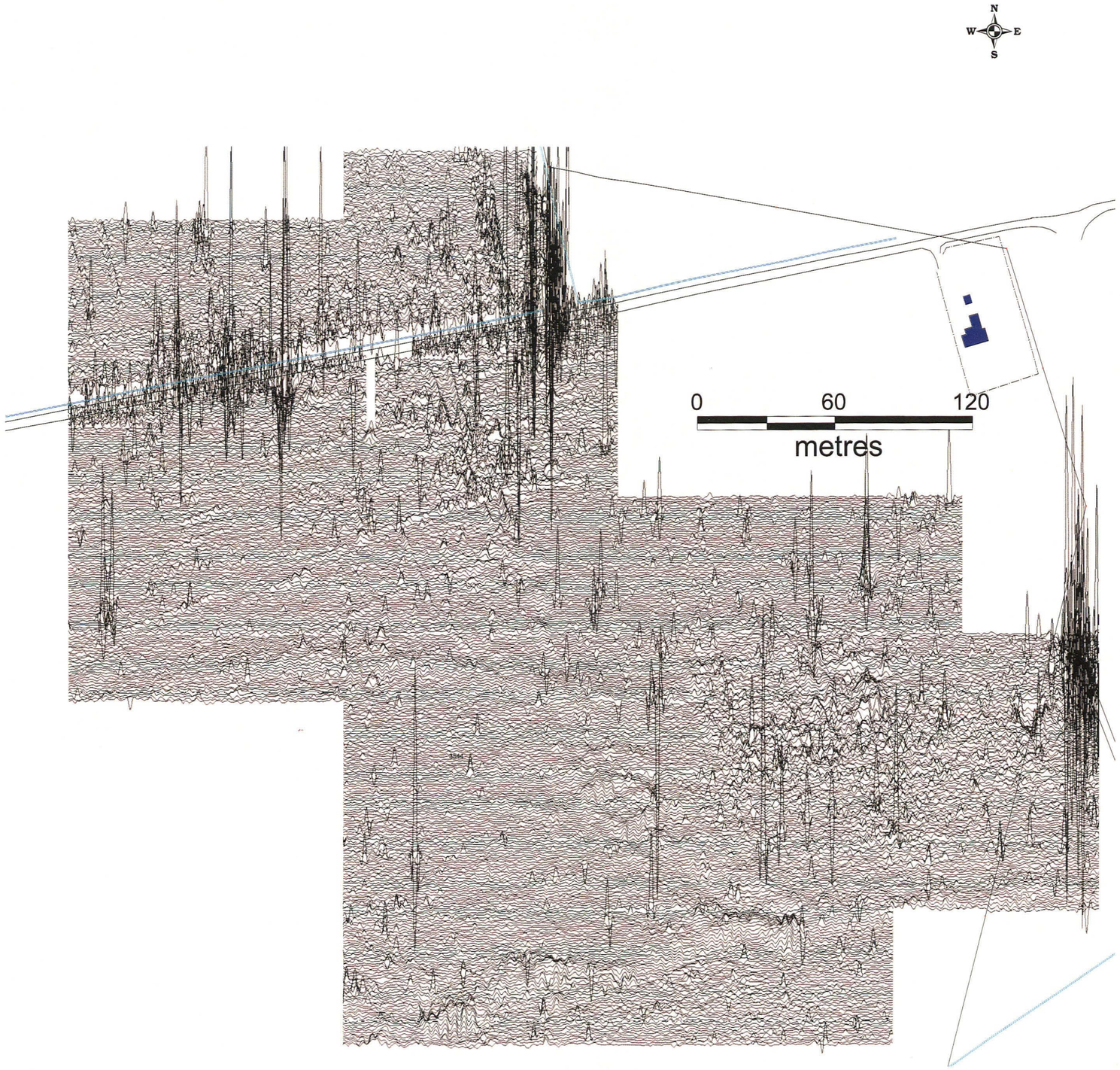


Fig 06

Archaeological Surveys

Tattershall Thorpe

Area 1 processed magnetometry

Scale 1:2000 (A3)

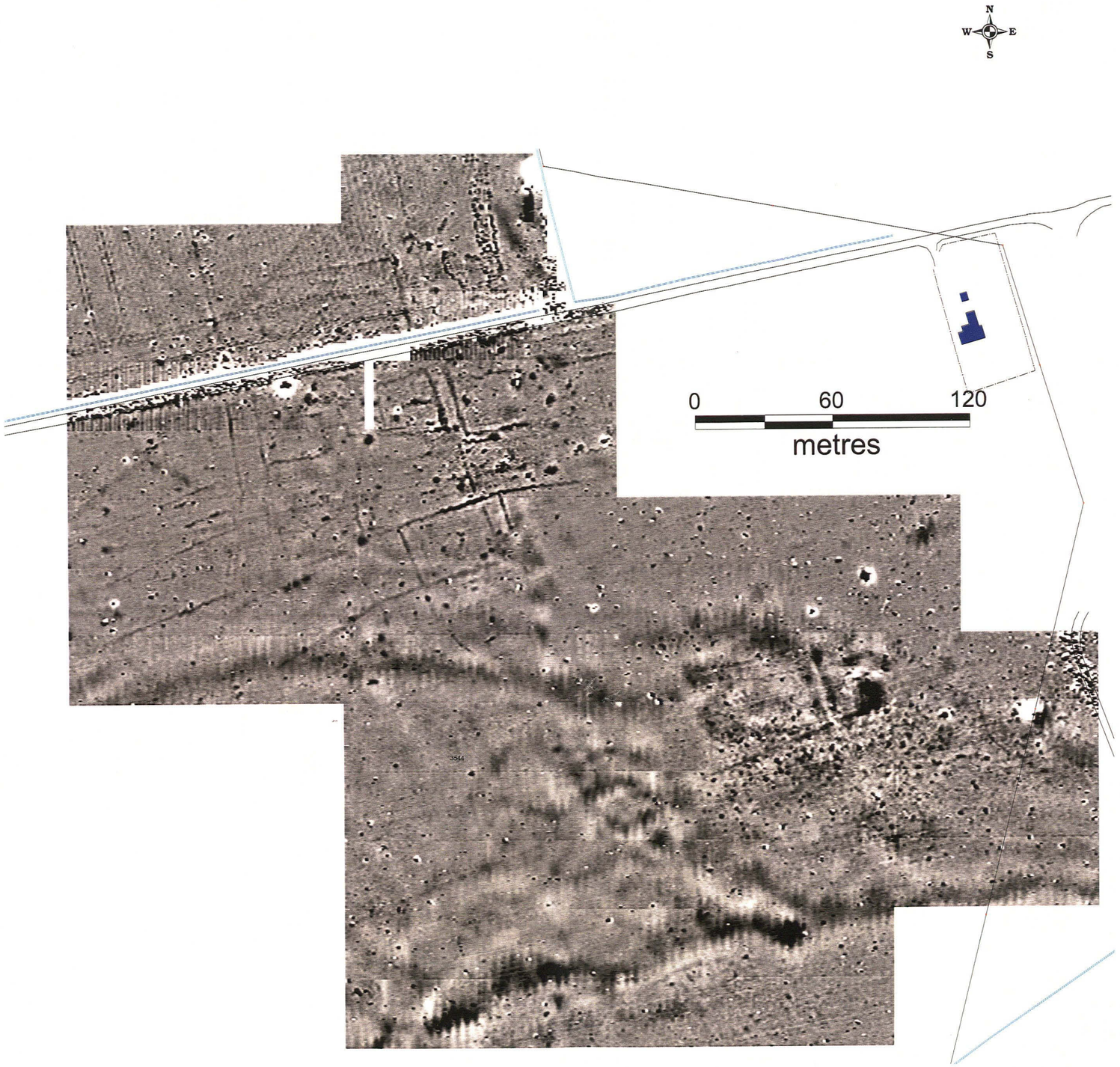


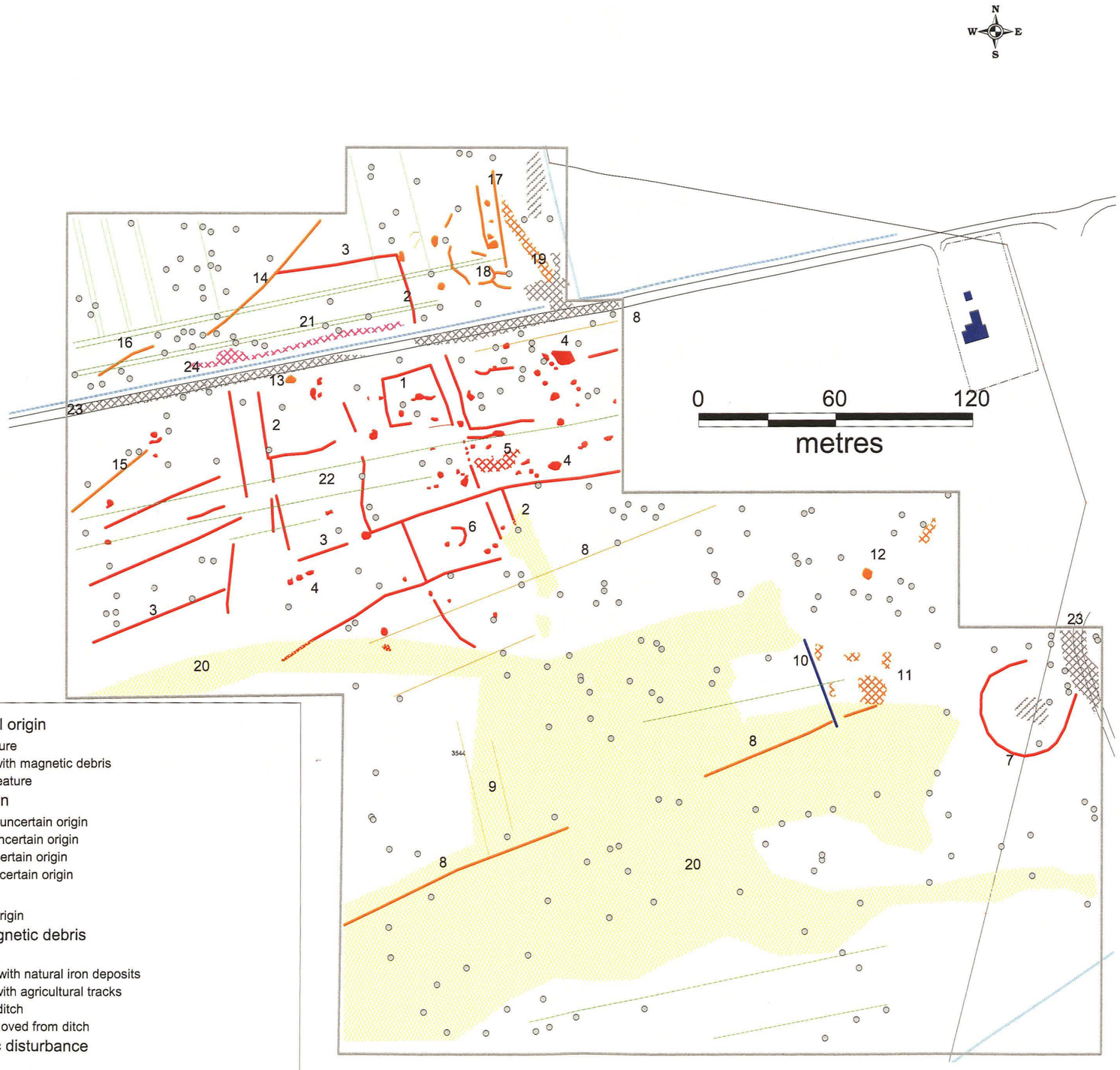
Fig 07

Archaeological Surveys

Tattershall Thorpe

Area 1 abstraction and interpretation

Scale 1:2000 (A3)



Anomalies of an archaeological origin
- Positive anomaly - pit-like feature
- Positive anomaly associated with magnetic debris
- Positive linear anomaly - cut feature

Anomalies of an uncertain origin
- Discrete positive anomaly - of uncertain origin
- Negative linear anomaly - of uncertain origin
- Positive area anomaly - of uncertain origin
- Positive linear anomaly - of uncertain origin

Agricultural anomalies
- Linear anomaly - agricultural origin

Anomalies associated with magnetic debris
- Magnetic debris
- Magnetic debris - associated with natural iron deposits
- Magnetic debris - associated with agricultural tracks
- Magnetic debris - infilled field ditch
- Magnetic debris - possibly removed from ditch

Anomalies caused by magnetic disturbance
- Magnetic disturbance

Magnetic dipolar anomalies
- Dipolar anomaly - ferrous object

Anomalies associated with geology
- Anomaly associated with geological/pedological features

Fig 08

Archaeological Surveys

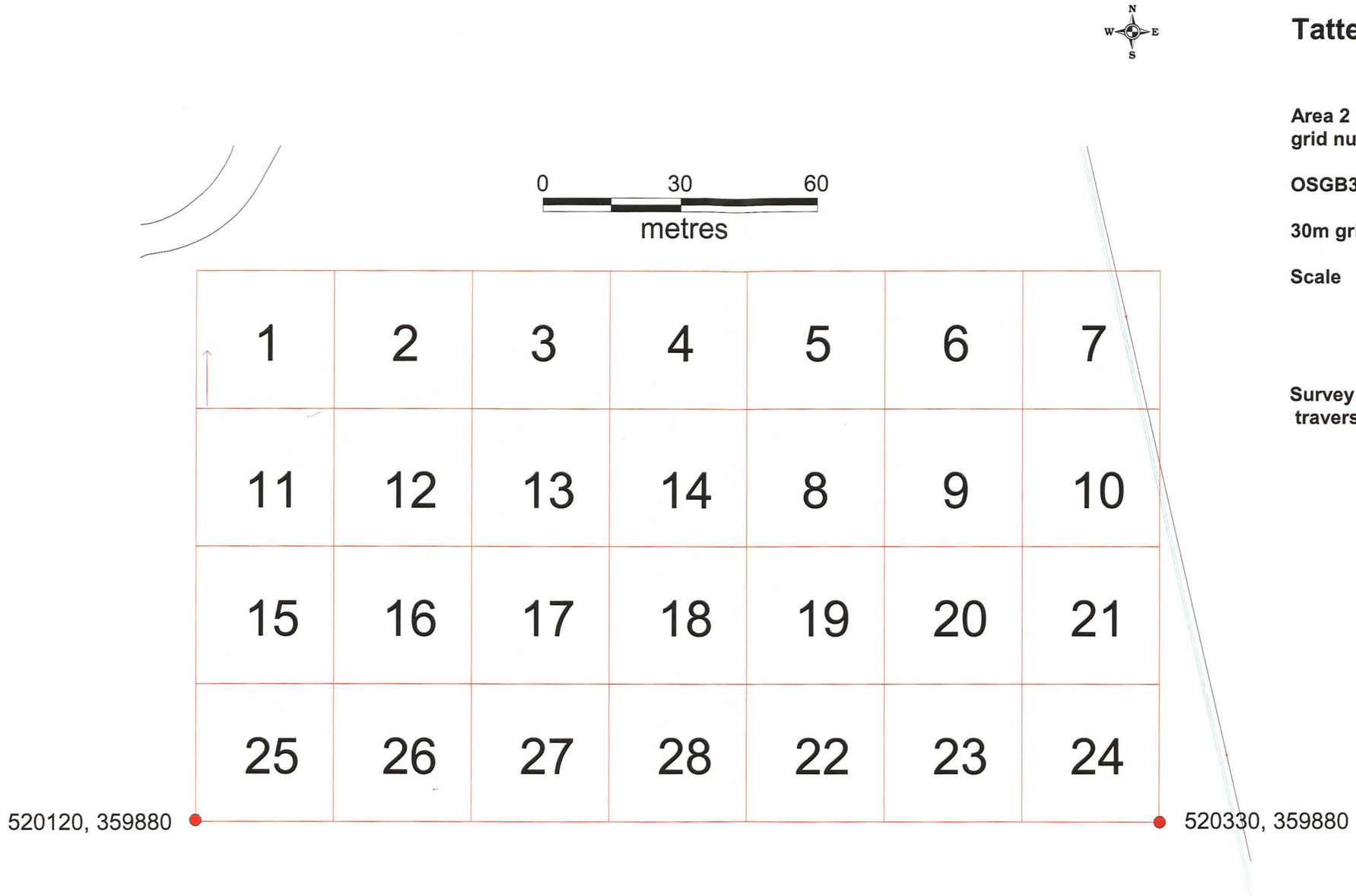
Tattershall Thorpe

Area 2 referencing and grid numbers

OSGB36 coordinates

30m grids

Scale 1:1000 (A3)



Survey start and traverse direction

Fig 09

Archaeological Surveys

Tattershall Thorpe

Area 2 traceplot

Approximate scale: 12nT/cm

Data clipped at ±100nT

Scale 1:1000 (A3)

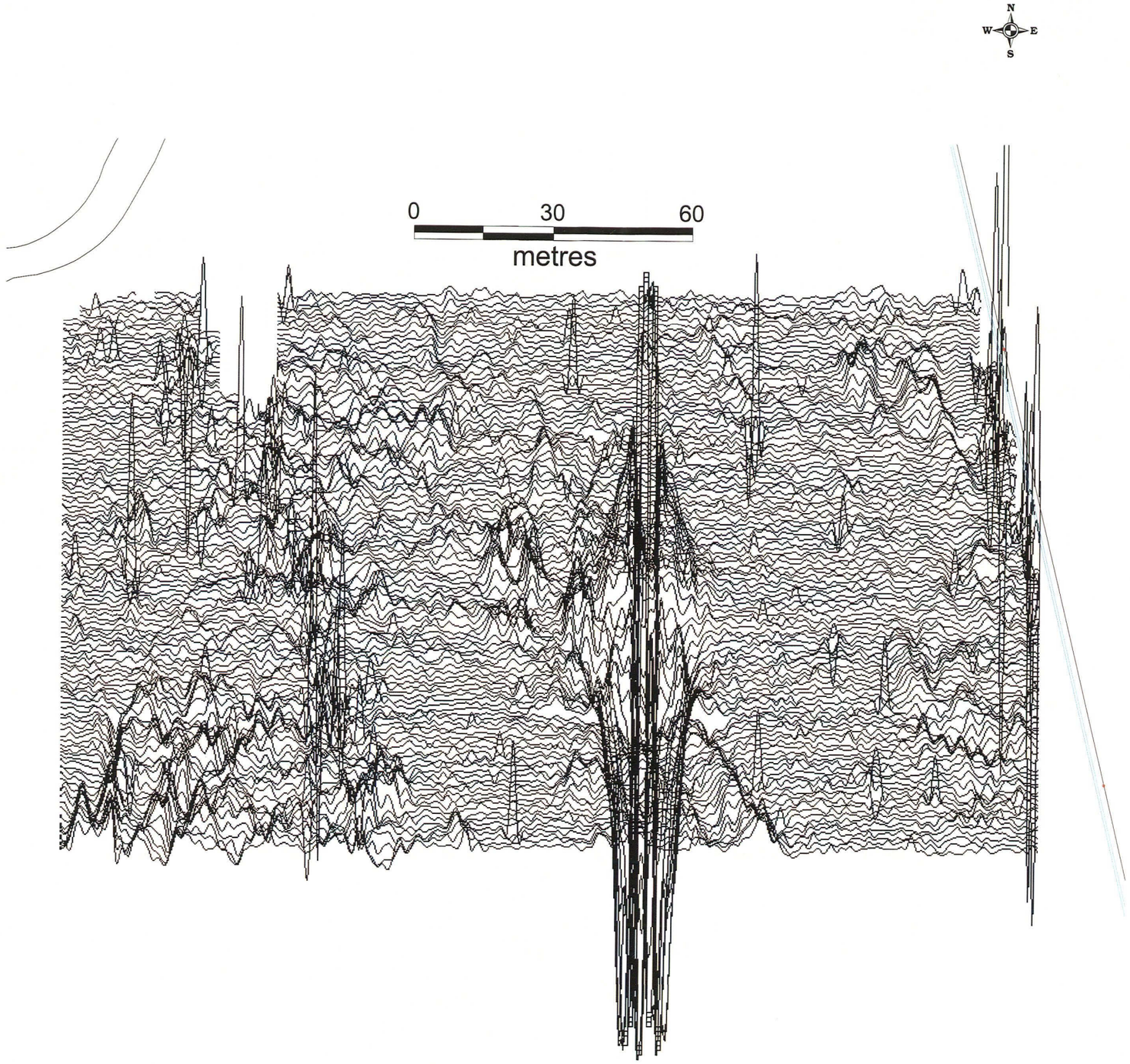


Fig 10

Archaeological Surveys

Tattershall Thorpe

Area 2 processed magnetometry

Scale 1:1000 (A3)

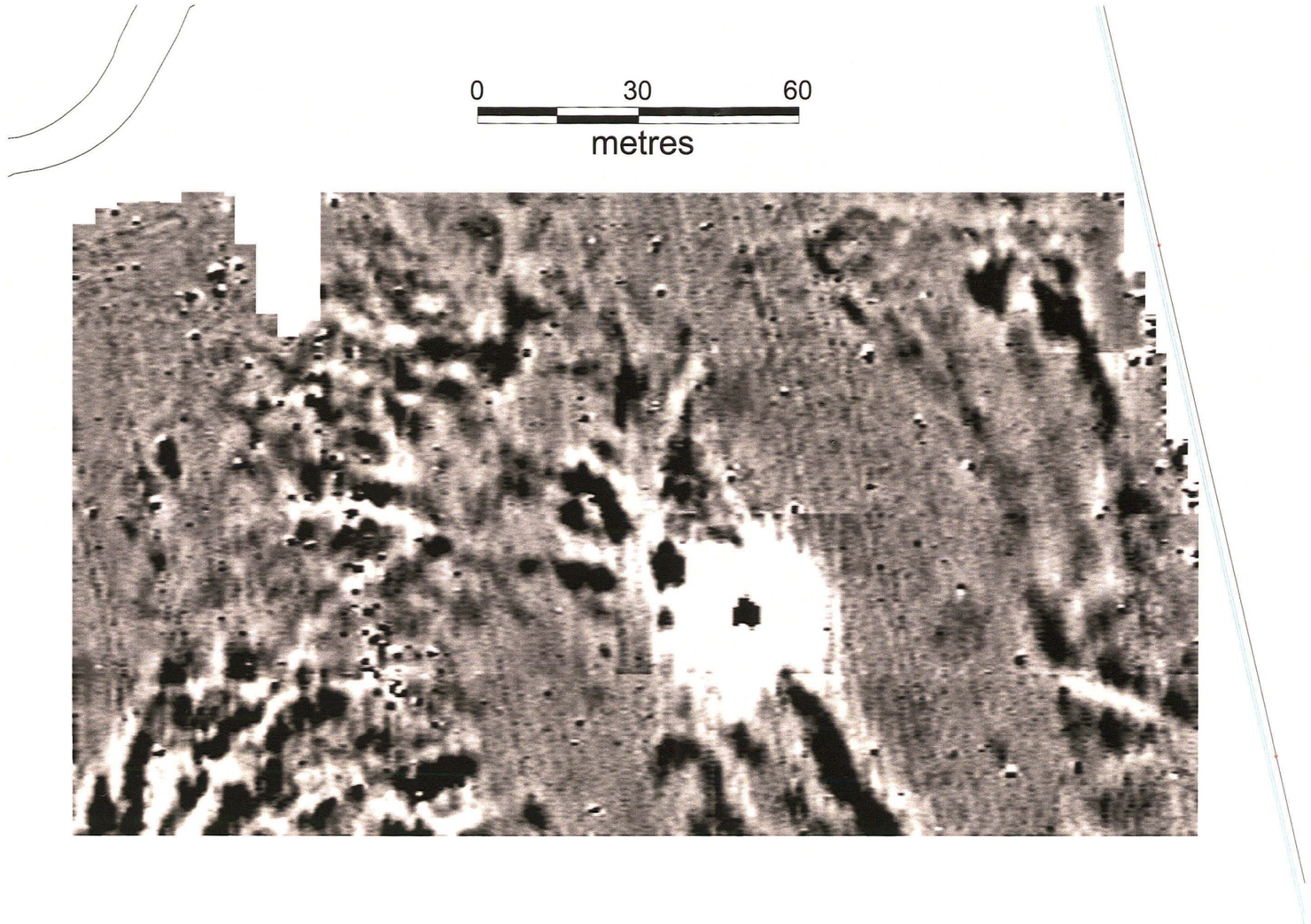


Fig 11

Archaeological Surveys

Tattershall Thorpe

Area 2 abstraction and interpretation

Scale 1:1000 (A3)

Fig 12

Archaeological Surveys

Tattershall Thorpe

Area 3 referencing and grid numbers

OSGB36 coordinates

30m grids

Scale 1:1000 (A3)

Survey start and traverse direction

Fig 13

Archaeological Surveys

Tattershall Thorpe

Area 3 traceplot

Approximate scale: 12nT/cm

Data clipped at ±100nT

Scale 1:1000 (A3)

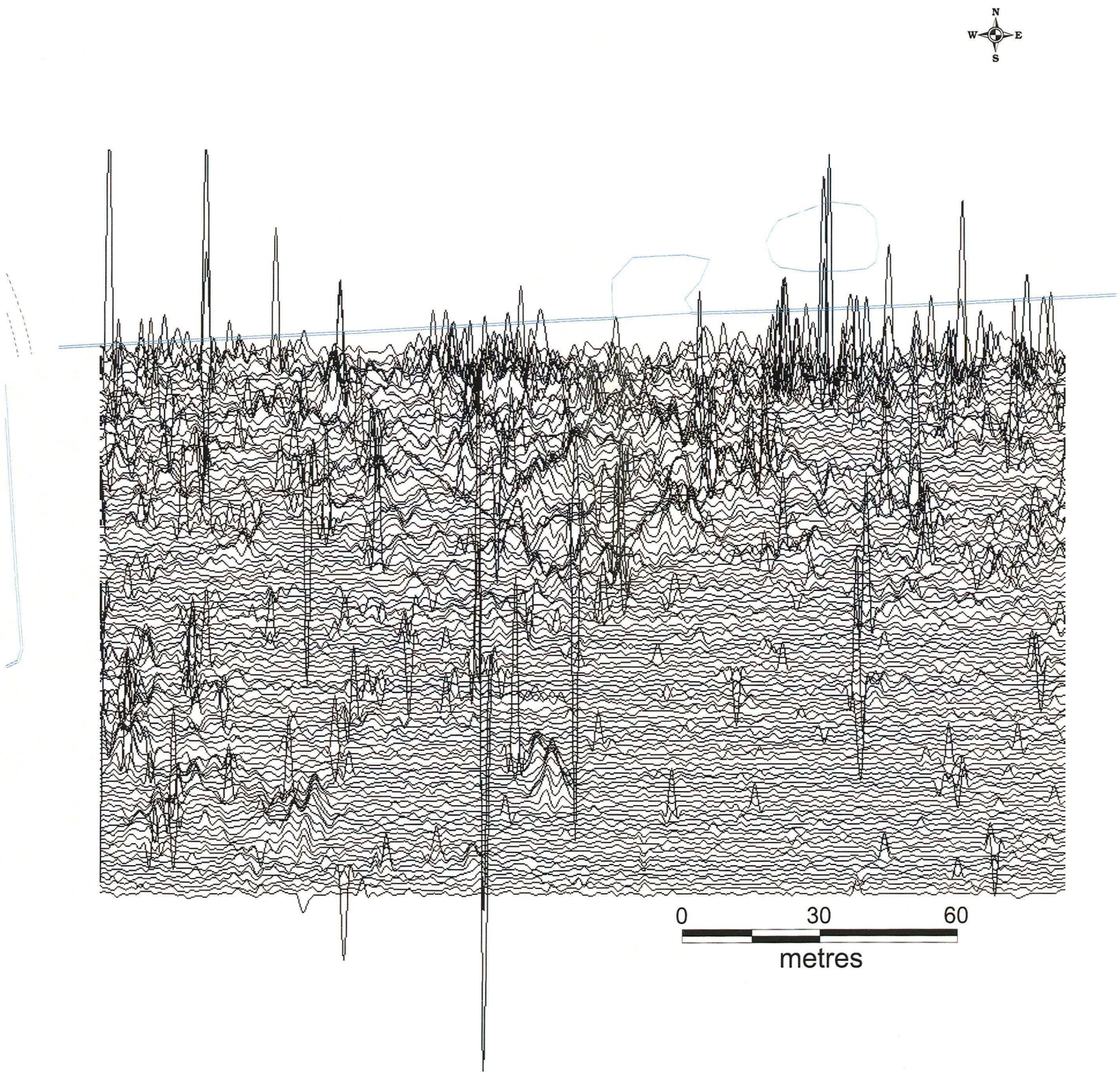


Fig 14

Archaeological Surveys

Tattershall Thorpe

Area 3 processed magnetometry

Scale 1:1000 (A3)

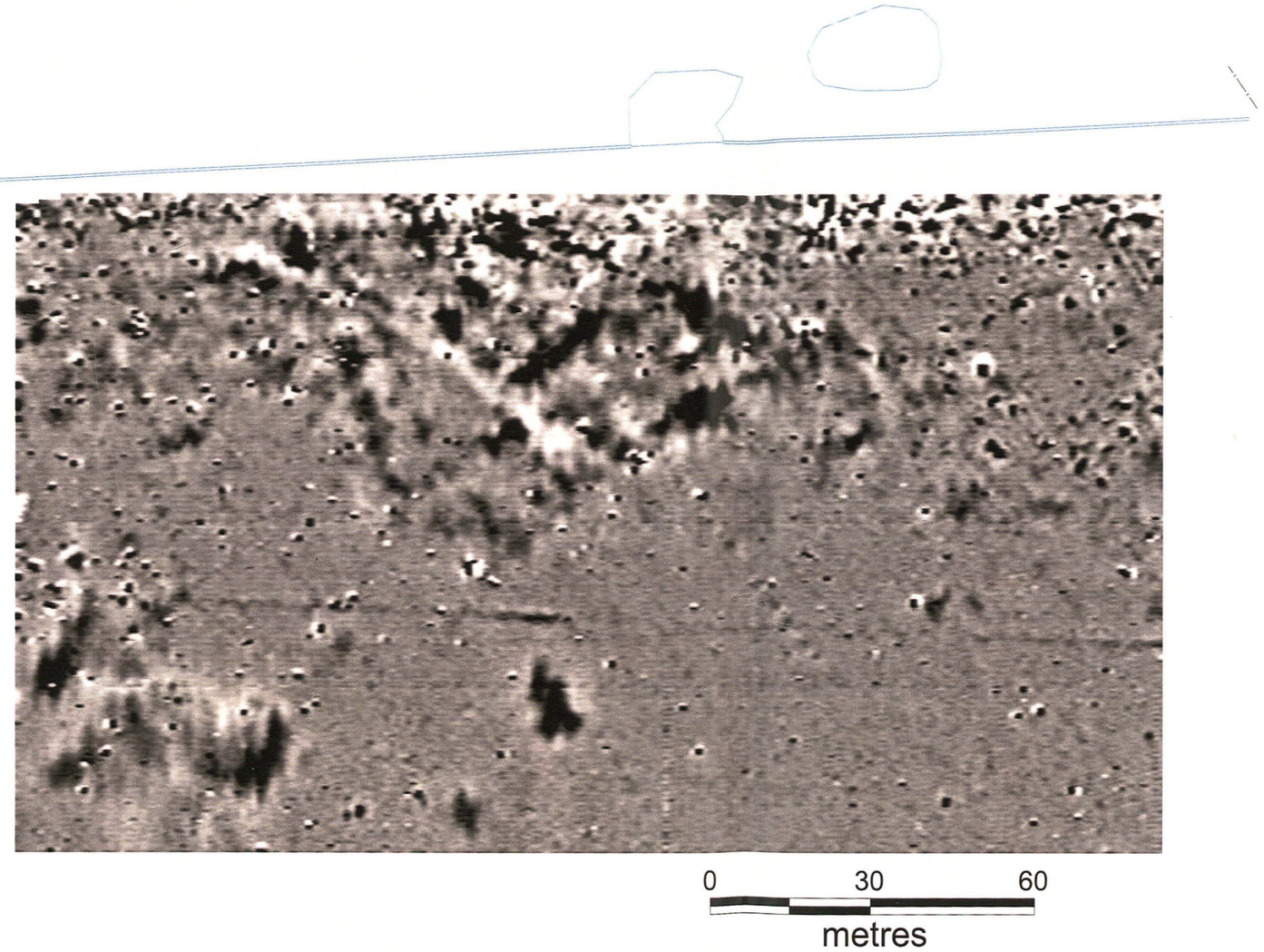


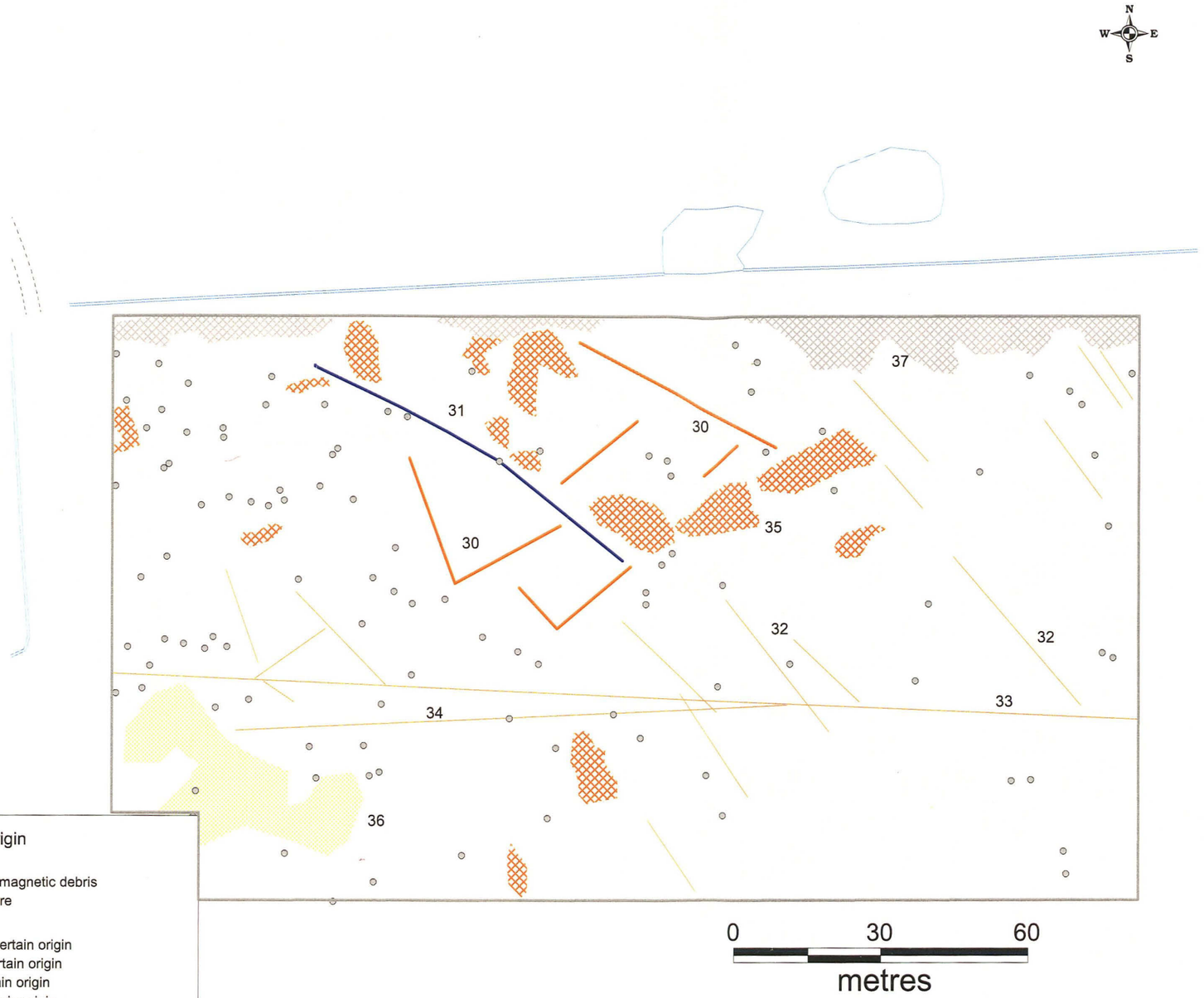
Fig 15

Archaeological Surveys

Tattershall Thorpe

Area 3 abstraction and interpretation

Scale 1:1000 (A3)



Anomalies of an archaeological origin
- Positive anomaly - pit-like feature
- Positive anomaly associated with magnetic debris
- Positive linear anomaly - cut feature

Anomalies of an uncertain origin
- Discrete positive anomaly - of uncertain origin
- Negative linear anomaly - of uncertain origin
- Positive area anomaly - of uncertain origin
- Positive linear anomaly - of uncertain origin

Agricultural anomalies
- Linear anomaly - agricultural origin

Anomalies associated with magnetic debris
- Magnetic debris
- Magnetic debris - associated with natural iron deposits
- Magnetic debris - associated with agricultural tracks
- Magnetic debris - infilled field ditch
- Magnetic debris - possibly removed from ditch

Anomalies caused by magnetic disturbance
- Magnetic disturbance

Magnetic dipolar anomalies
- Dipolar anomaly - ferrous object

Anomalies associated with geology
- Anomaly associated with geological/pedological features

Fig 16

Archaeological Surveys

Tattershall Thorpe

Area 4 referencing and grid numbers

OSGB36 coordinates

30m grids

Scale 1:1000 (A3)

Survey start and traverse direction

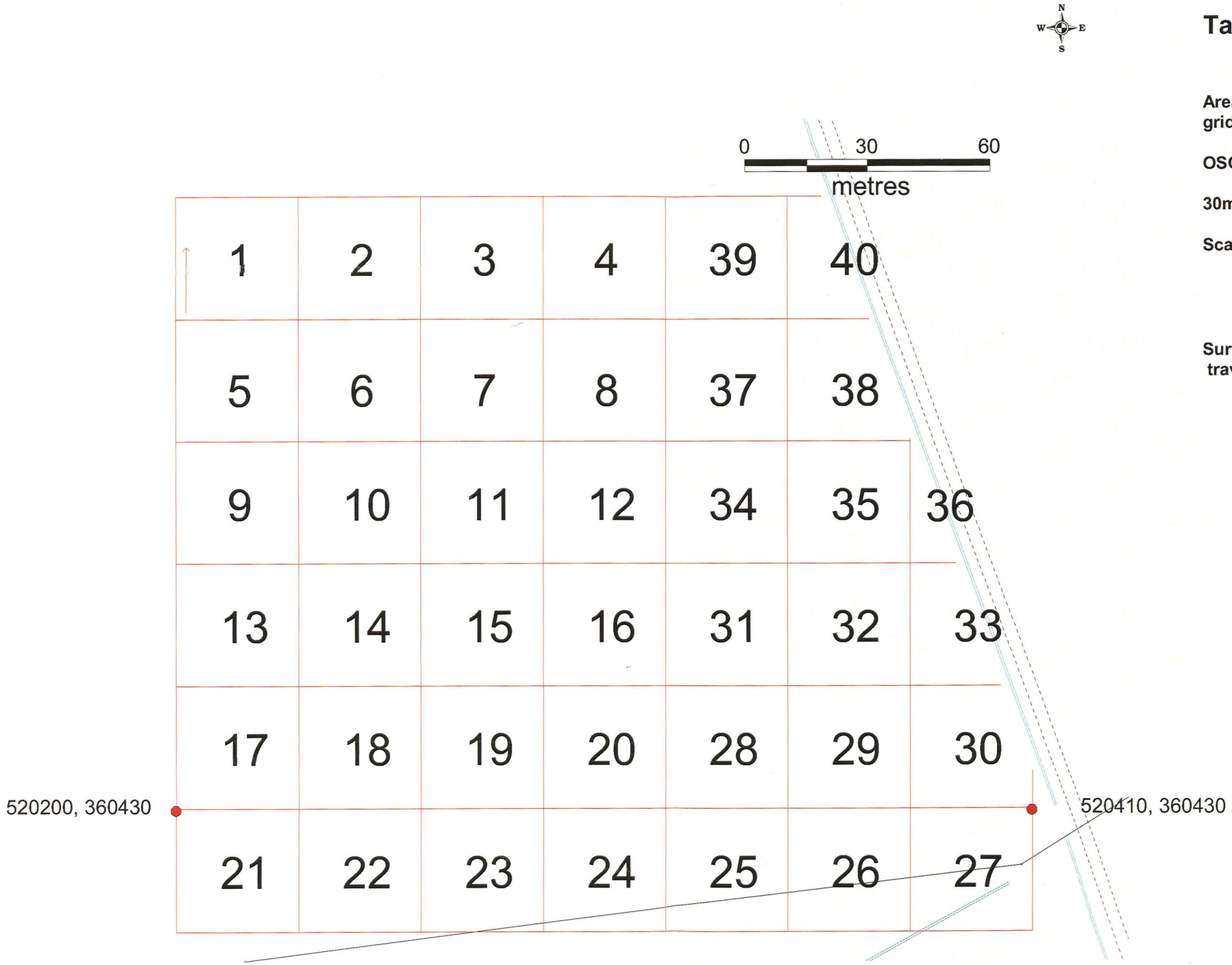


Fig 17

Archaeological Surveys

Tattershall Thorpe

Area 4 traceplot

Approximate scale: 12nT/cm

Data clipped at ±100nT

Scale 1:1000 (A3)

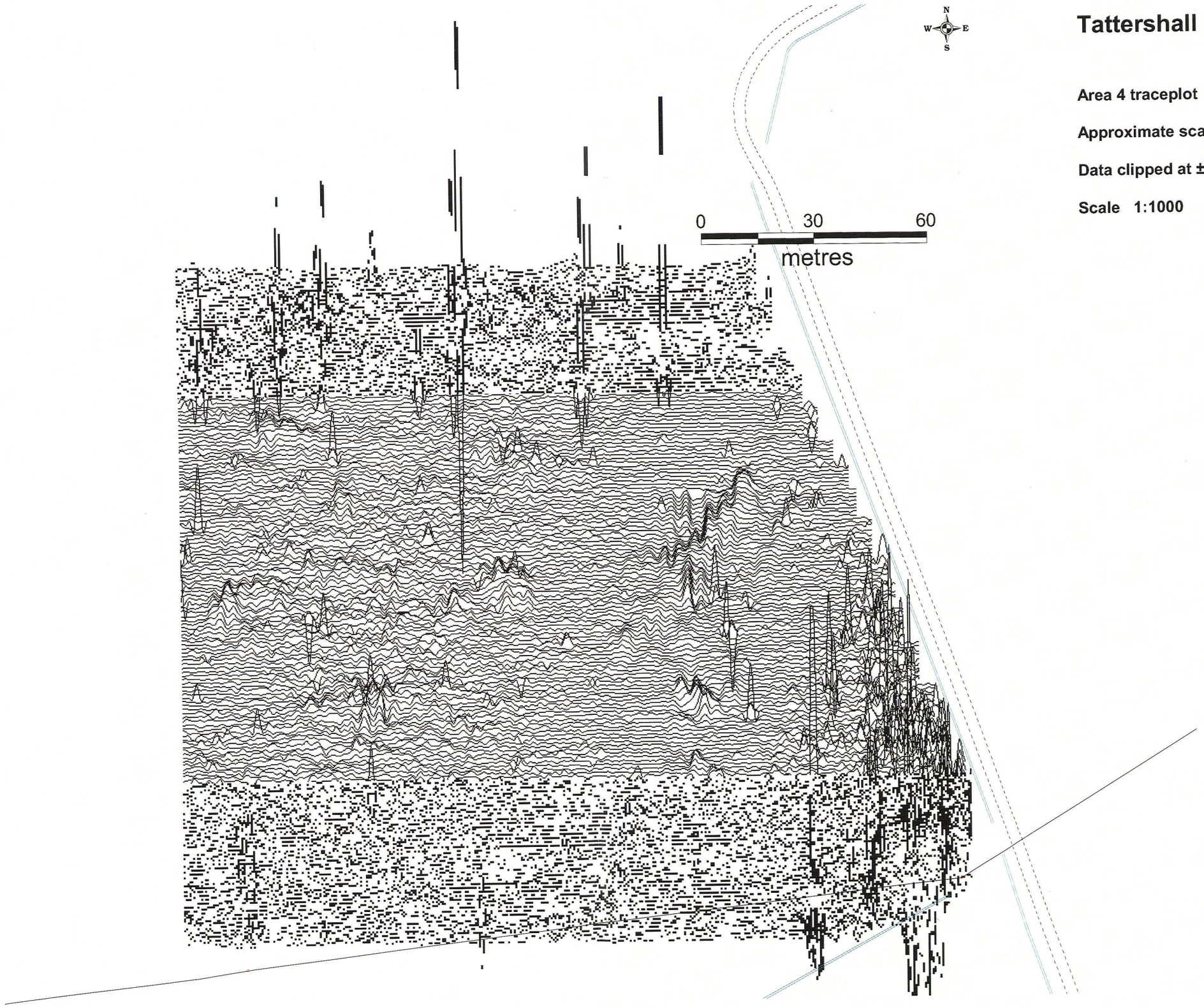


Fig 18

Archaeological Surveys

Tattershall Thorpe

Area 4 processed magnetometry

Scale 1:1000 (A3)

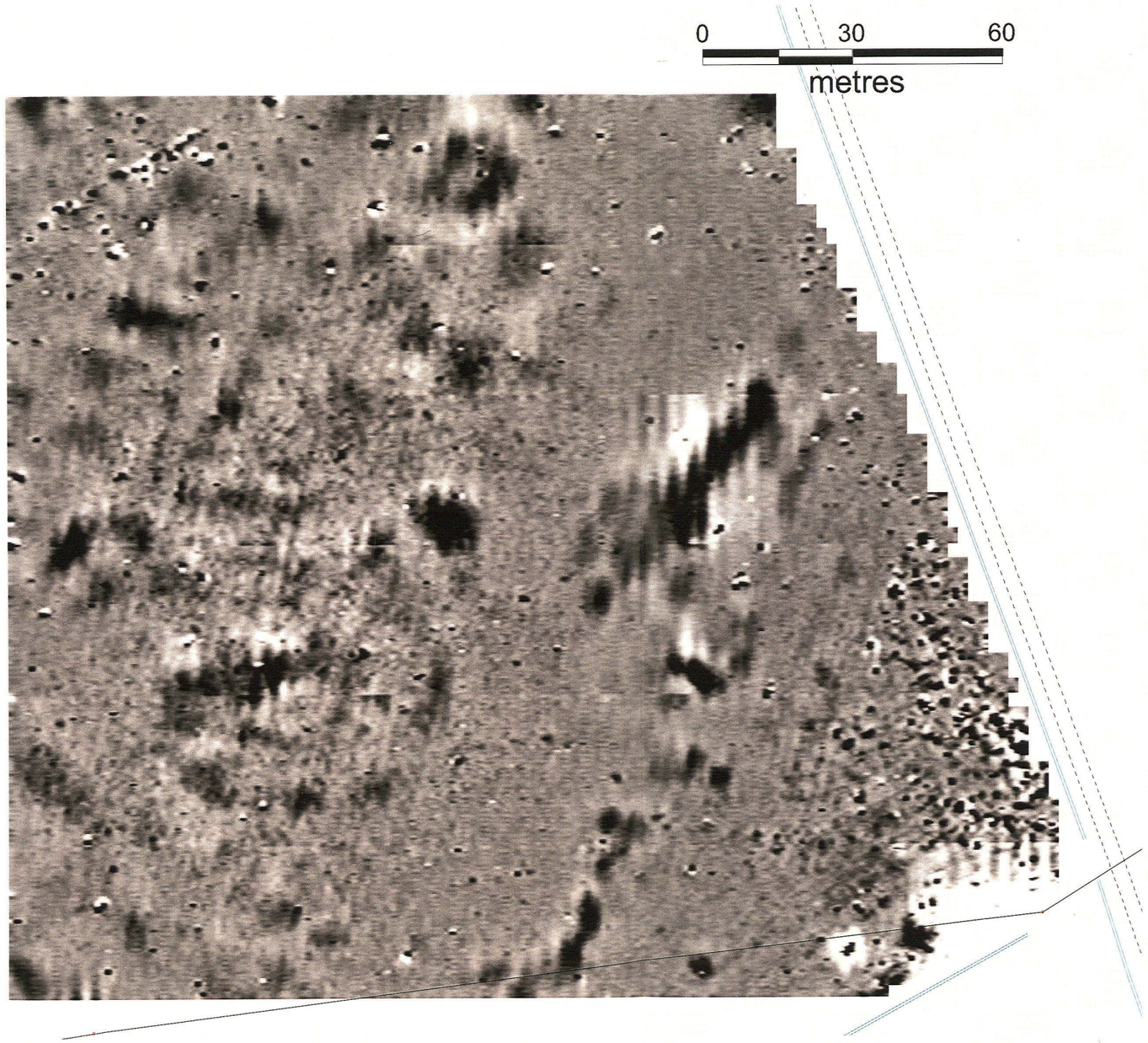


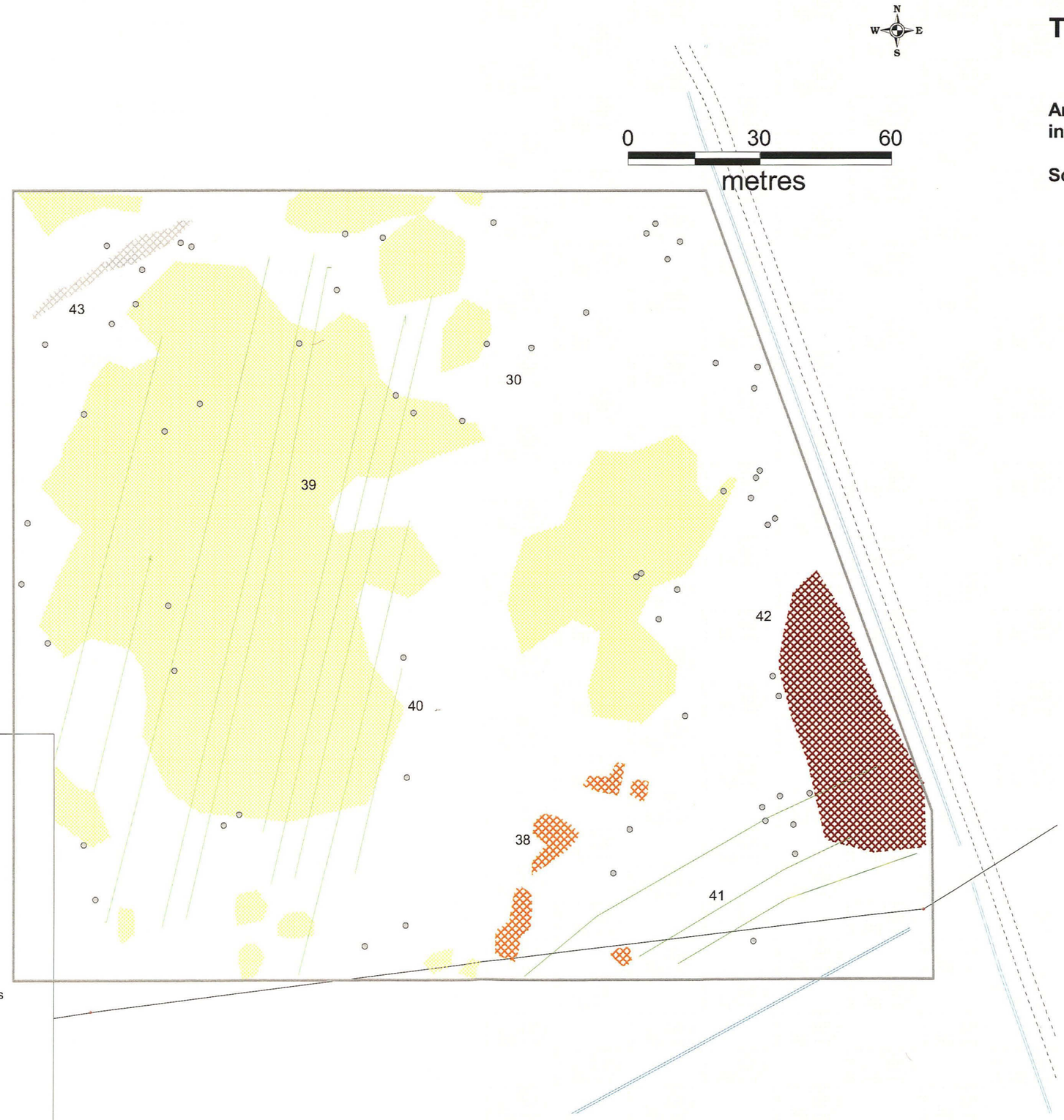
Fig 19

Archaeological Surveys

Tattershall Thorpe

Area 4 abstraction and interpretation

Scale 1:1000 (A3)



Anomalies of an archaeological origin
- Positive anomaly - pit-like feature
- Positive anomaly associated with magnetic debris
- Positive linear anomaly - cut feature

Anomalies of an uncertain origin
- Discrete positive anomaly - of uncertain origin
- Negative linear anomaly - of uncertain origin
- Positive area anomaly - of uncertain origin
- Positive linear anomaly - of uncertain origin

Agricultural anomalies
- Linear anomaly - agricultural origin

Anomalies associated with magnetic debris
- Magnetic debris
- Magnetic debris - associated with natural iron deposits
- Magnetic debris - associated with agricultural tracks
- Magnetic debris - infilled field ditch
- Magnetic debris - possibly removed from ditch

Anomalies caused by magnetic disturbance
- Magnetic disturbance

Magnetic dipolar anomalies
- Dipolar anomaly - ferrous object

Anomalies associated with geology
- Anomaly associated with geological/pedological features

Fig 20

Archaeological Surveys

Tattershall Thorpe

Area 5 referencing and grid numbers

OSGB36 coordinates

30m grids

Scale 1:1000 (A3)

Survey start and traverse direction

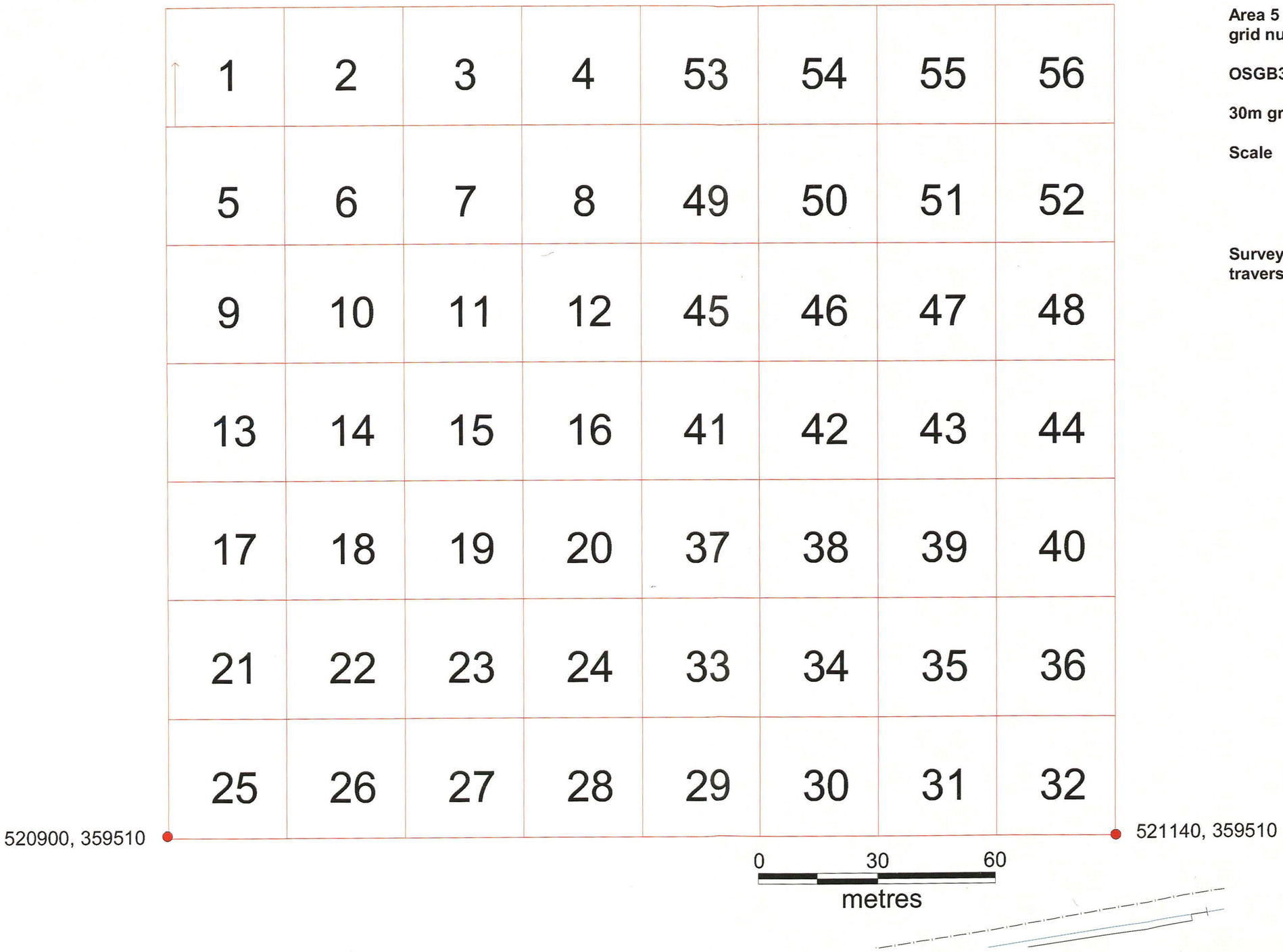


Fig 21

Archaeological Surveys

Tattershall Thorpe

Area 5 traceplot

Approximate scale: 12nT/cm

Data clipped at ±100nT

Scale 1:1000 (A3)

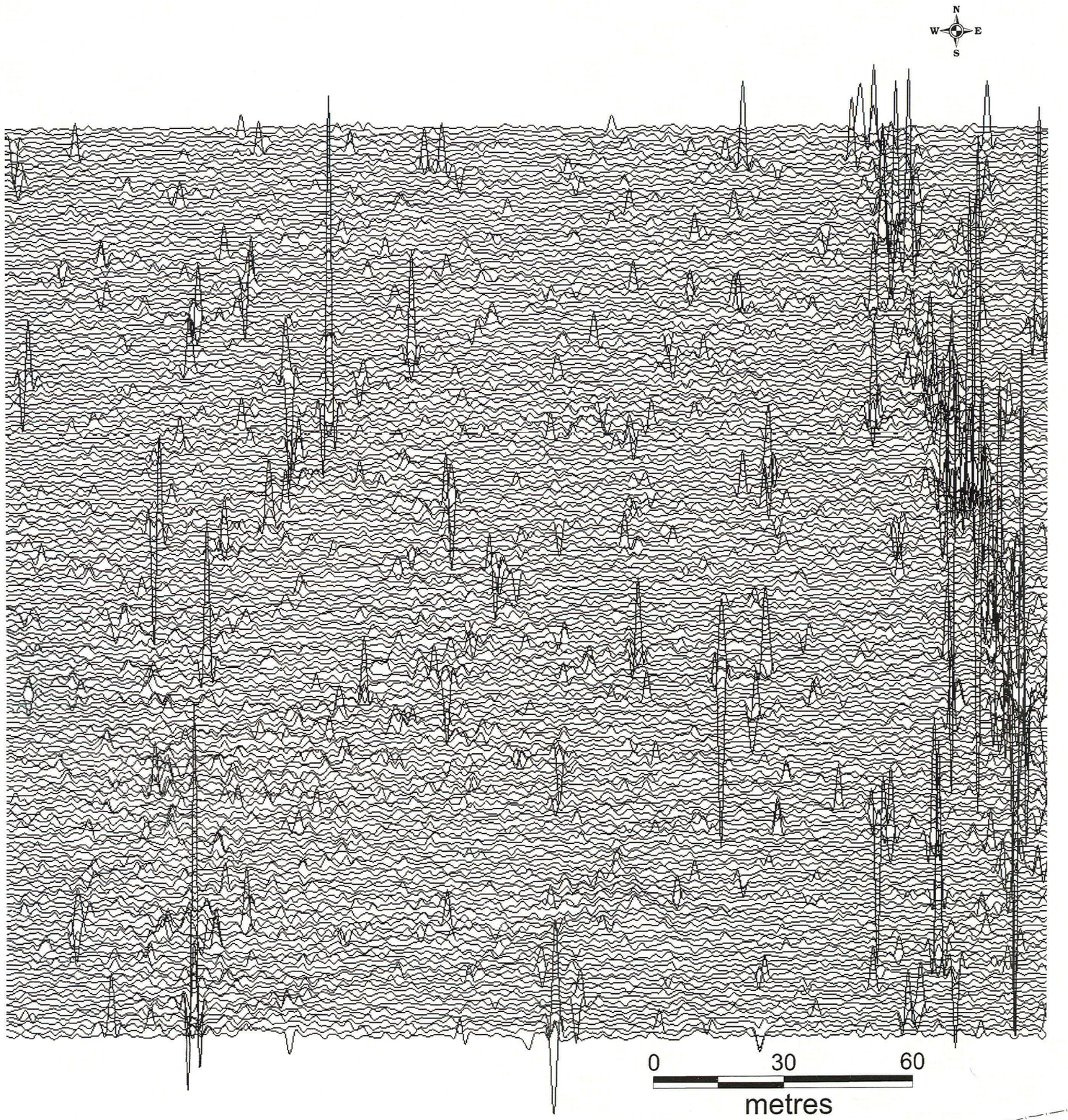


Fig 22

Archaeological Surveys

Tattershall Thorpe

Area 5 processed magnetometry

Scale 1:1000 (A3)

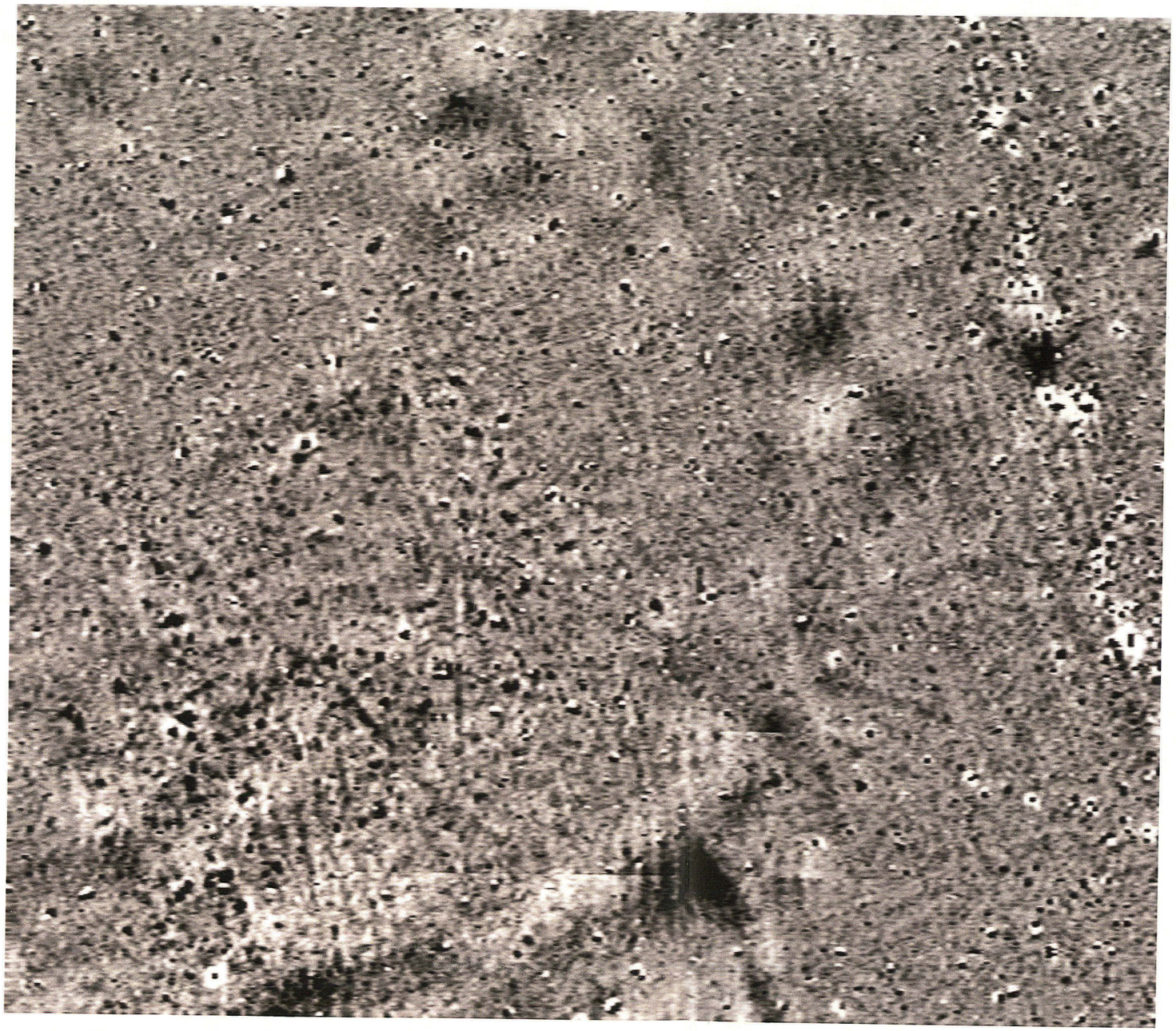


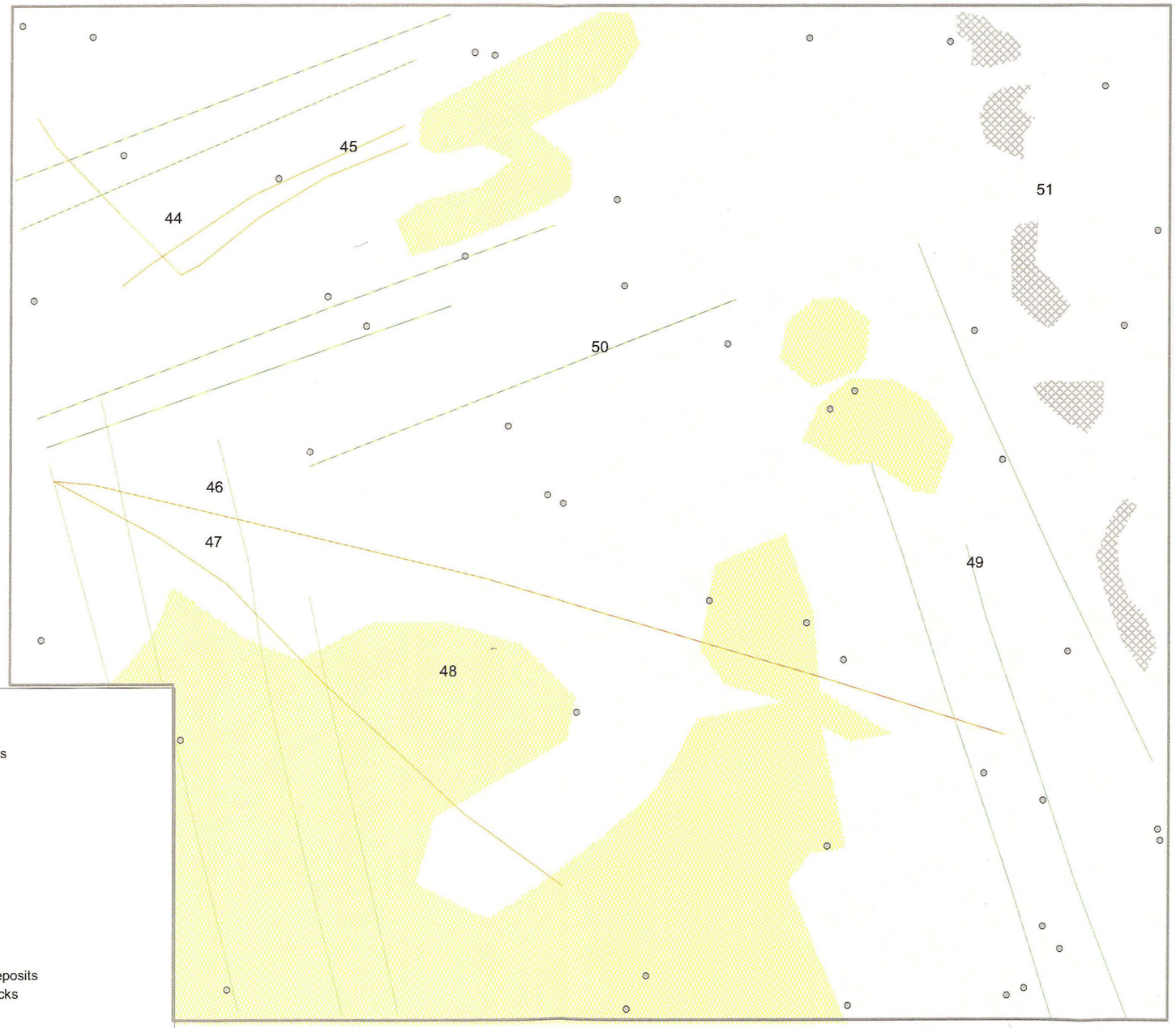
Fig 23

Archaeological Surveys

Tattershall Thorpe

Area 5 abstraction and interpretation

Scale 1:1000 (A3)



Anomalies of an archaeological origin
- Positive anomaly - pit-like feature
- Positive anomaly associated with magnetic debris
- Positive linear anomaly - cut feature

Anomalies of an uncertain origin
- Discrete positive anomaly - of uncertain origin
- Negative linear anomaly - of uncertain origin
- Positive area anomaly - of uncertain origin
- Positive linear anomaly - of uncertain origin

Agricultural anomalies
- Linear anomaly - agricultural origin

Anomalies associated with magnetic debris
- Magnetic debris
- Magnetic debris - associated with natural iron deposits
- Magnetic debris - associated with agricultural tracks
- Magnetic debris - infilled field ditch
- Magnetic debris - possibly removed from ditch

Anomalies caused by magnetic disturbance
- Magnetic disturbance

Magnetic dipolar anomalies
- Dipolar anomaly - ferrous object

Anomalies associated with geology
- Anomaly associated with geological/pedological features

0 30 60
metres

Fig 24