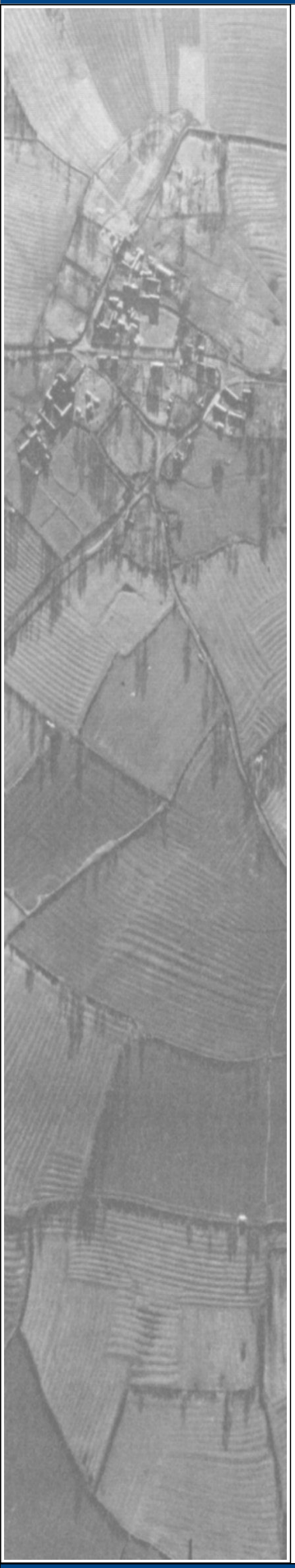

Land south of Burford Road
Minster Lovell
Oxfordshire

MAGNETOMETER SURVEY REPORT

for

Catesby Strategic Land Limited

Kerry Donaldson & David Sabin

September 2022

Ref. no. J930

ARCHAEOLOGICAL SURVEYS LTD

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Minster Lovell
Oxfordshire

MAGNETOMETER SURVEY REPORT

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Catesby Strategic Land Limited

Fieldwork by David Sabin BSc (Hons) MCIfA
Report by Kerry Donaldson BSc (Hons) MCIfA
Report checked by David Sabin
Primary archive location - Archaeological Surveys Ltd, Yatesbury, Wiltshire

Survey dates – 23rd to 25th August 2022
Ordnance Survey Grid Reference – **SP 30730 10525**

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SUMMARY

Detailed magnetometry was carried out by Archaeological Surveys Ltd on land to the west of Minster Lovell in Oxfordshire. Magnetic anomalies include an L-shaped feature in the southern part of the site that appears to relate to a rectilinear enclosure with a linear group of magnetically enhanced pit-like features to the east. The site contains numerous pit-like anomalies relating to naturally formed soil-filled features and pit-like features relating to disturbance through ploughing within the limestone geology; at times it is difficult to distinguish those with an anthropogenic origin from those with a natural origin. Larger pit-like features could also relate to naturally formed features, although an association with former quarrying is possible. A number of linear anomalies appear to relate to former linear boundary ditches, but these are generally unmapped. Anomalies relating to ridge and furrow and land drainage can also be seen in the dataset.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Pegasus Group, on behalf of Catesby Strategic Land Limited, to undertake a magnetometer survey of an area of land to the south of Burford Road on the western edge of Minster Lovell in Oxfordshire. The site has been outlined for a proposed residential development and the survey forms part of an archaeological assessment.

1.1.2 The geophysical survey was carried out in accordance with a Written Scheme of Investigation (WSI) produced by Archaeological Surveys (2022) and approved by Richard Oram, Lead Archaeologist for Oxfordshire County Council, prior to commencing the fieldwork.

1.2 Survey objectives and techniques

1.2.1 The objective of the survey was to use magnetometry to locate geophysical anomalies that may be archaeological in origin so that they may be assessed prior to development of the site. The methodology is considered an efficient and effective approach to archaeological prospection.

1.2.2 Geophysical survey can provide useful information on the archaeological potential of a site; however, the outcome of any survey relies on a number of factors and as a consequence results can vary. The success in meeting the aims and objectives of a survey is, therefore, often impossible to predetermine.

1.3 Standards, guidance and recommendations for the use of this report

1.3.1 Archaeological Surveys Ltd is a Registered Organisation with the Chartered Institute for Archaeologists and both company directors are Members of the Chartered Institute for Archaeologists (MCIfA) and have therefore been assessed for their technical competence and ethical suitability and abide by the CIfA Codes of Conduct. The survey and report follow the recommendations set out by: European Archaeological Council (2015) *Guidelines for the Use of Geophysics in Archaeology;* Institute for Archaeologists (2002) *The use of Geophysical Techniques in Archaeological Evaluations.* The work has been carried out to the Chartered Institute for Archaeologists (2014) (updated 2020) *Standard and Guidance for Archaeological Geophysical Survey.*

1.3.2 Archaeological Surveys Ltd provide a detailed geophysical survey report and it is recommended that where possible the contents should be considered in full. The Summary provides a brief overview of the results with more detail available in the Discussion and/or Conclusion. The *List of anomalies* within the Results provides a detailed assessment of the anomalies within separate categories which can be useful in inferring a level of confidence to the interpretation. Quality and factors influencing the interpretation of anomalies is also set out within the results.

1.3.3 It is recommended that the full report should always be considered when using data and interpretation plots; where this is not possible, in the field for example, the abstraction and interpretation plots should retain their colour coding and be used with a corresponding legend.

1.3.4 Where targeting of anomalies by excavation is to be carried out, care should be taken to place trenches over solid lines or features visible on the abstraction and interpretation plots. Archaeological Surveys abstraction and interpretation avoids the use of dashed or dotted line formats, and broken or fragmented lines used in interpretive plots may well correspond closely with truncation of archaeological features.

1.4 Site location, description and survey conditions

1.4.1 The site is located to the south of Burford Road (B4047) on the western edge of Minster Lovell in Oxfordshire. It is centred on Ordnance Survey National Grid Reference (OS NGR) SP 30730 10525, see Figs 01 and 02.

1.4.2 The geophysical survey covers approximately 11.5ha within two arable fields which had recently been drilled prior to survey. The site is generally level ground at around 120m AODN. Field boundaries are mainly hedgerows, although the northern boundary of the eastern field was an area of rough vegetation and a ditch with newly constructed houses to the north. The north eastern corner of the western field contained a construction site compound, and there are private houses adjacent to the north western corner and inset within the central part of the western boundary.

1.4.3 The ground conditions across the site were generally considered to be favourable for the collection of magnetometry data. Shallow furrows associated with cultivation were considered likely to cause weak linear anomalies and steel objects within the site compound were potential sources of magnetic disturbance. Weather conditions during the survey were sunny and warm, occasionally hot.

1.5 Site history and archaeological potential

1.5.1 The site does not contain any designated or undesignated heritage assets, but there are several in the immediate and wider environs. The land immediately to the north and east has been subject to a geophysical survey and trial trench evaluation ahead of a recent development which located a single undated boundary ditch (TVAS, 2016 & TVAS 2019). A watching brief in 1982 located a Roman pottery vessel within this area to the north and east. A banjo enclosure and rectangular enclosure have been recorded from cropmarks between 300-700m to the south (MOX2464), and a late prehistoric flint flake was also located in the vicinity of the enclosures during field walking (MOX1616). A deposit of Bronze Age pottery was discovered in a natural feature during an evaluation within the area of the Charterville Allotments approximately 100m to the east (MOX26971). A large number of findspots have been located within land 400m to 1.5km to the south west including later prehistoric flint and pottery (MOX2461) and an Iron Age coin of Cunobeline (MOX2465), Roman pottery (MOX2442, MOX 2460), a Roman fibula brooch (MOX2495) and a number of Roman coins (MOX2497, MOX6837). An Anglo-Saxon inhumation cemetery was located in 1872 approximately 750m to the west (MOX2433). The nearest scheduled monuments are the Roman villa and associated bath house 450m north west of Lower Field Farm (Historic England List Entry No: 1015160) situated 480m to the north west and Asthall Barrow: an Anglo-Saxon burial mound 100m SSW of Barrow Farm (Historic England List Entry No: 1008414), located 1550m to the south west. The site lies immediately west of the Charterville Allotments, a development of smallholdings each with a dwelling set out by the National Land Company in 1847 under the Chartist movement.

1.6 Geology and soils

1.6.1 The underlying solid geology across the western part of the site is mudstone from the Forest Marble Formation with limestone from the Forest Marble Formation across the northern edge, centre and south eastern parts of the site. A zone towards the centre of the site contains limestone from the White Limestone Formation (BGS, 2022).

1.6.2 The overlying soil across the survey area is from the Elmton 3 association which is a brown rendzina and consists of a shallow, well drained, brashy, calcareous, fine loamy soil over limestone (Soil Survey of England and Wales, 1983).

1.6.3 Magnetometry survey carried out across similar soils has produced good results although at times it can be difficult to distinguish anomalies with a natural origin from those with an anthropogenic origin. The underlying geology and soils are therefore considered acceptable for magnetic survey.

2 METHODOLOGY

2.1 Technical synopsis

2.1.1 Magnetometry survey records localised magnetic fields that can be associated with features formed by human activity. Magnetic susceptibility and magnetic thermoremnance (also known as thermoremanence) are factors associated with the formation of localised fields.

2.1.2 Iron minerals within the soil may become altered by burning and the break down of biological material; effectively the magnetic susceptibility of the soil is increased, and the iron minerals become magnetic in the presence of the Earth's magnetic field. Accumulations of magnetically enhanced soils within features, such as pits and ditches, may produce magnetic anomalies that can be mapped by magnetic prospection.

2.1.3 Magnetic thermoremnance can occur when ferrous minerals have been heated to high temperatures such as in a kiln, hearth, oven etc. On cooling, a permanent magnetisation may be acquired due to the presence of the Earth's magnetic field. Certain natural processes associated with the formation of some igneous and metamorphic rock may also result in magnetic thermoremnance.

2.1.4 The localised variations in magnetism are measured as sub-units of the Tesla, which is a SI unit of magnetic flux density. These sub-units are nano Teslas (nT), which are equivalent to 10^{-9} Tesla (T). Additional details are set out in 2.2 below and within Appendix A.

2.2 Equipment configuration, data collection and survey detail

2.2.1 The detailed magnetic survey was carried out using a SENSYS MAGNETO®MXCOMPACT 6 channel cart-based system. The instrument has 6 fluxgate gradiometers (FGM650) spaced 0.5m apart with readings recorded at 20Hz. The cart is pushed at walking speed and not towed. Each sensor is not zeroed in the field as the vertical axis alignment is precisely fixed leaving sensor offsets that are removed during data processing. The fixing of the vertical alignment ensures the sensors are not unduly influenced by localised magnetic fields and that the vertical component of a magnetic anomaly is measured. The gradiometers have a measurement range of ±8000nT, although the recorded range is ±3000nT, and resolution is around 0.1nT. They are linked to a Leica GS10 RTK GNSS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged PDA computer system.

2.2.2 Due to the fixed offsets within the fluxgate sensors, as a result of the manufacturing and tensioning process, the survey data do not provide a visually useful dataset until a zero median traverse algorithm is applied. It is recognised that this has the potential to affect some anomalies detrimentally by removing linear features orientated parallel to survey transects. However, this has not been noted as a particular problem with the system due to the high resolution data collection, generally long length of traverses and variability within the magnetic characteristics of a linear anomaly.

2.2.3 Data are collected along a series of parallel survey transects to achieve 100% coverage of the surveyable land. The length of each transect is variable and relates to the size of the survey area and other factors including ground conditions. A visual display allows accurate placing of transects and helps maintain the correct separation between adjacent traverses. Data are not collected within fixed grids and data points are considered to be random even though the data are collected in a systematic manner covering all accessible areas (Aspinall, Gaffney and Schmidt, 2009).

2.2.4 Fluxgate sensors are highly sensitive to temperature change and this manifests as drift during the course of a survey. This can be particularly noticeable during the morning as temperatures rise and the equipment warms or cools. Sensor drift within the course of a traverse will appear as a line trending from negative to positive after processing with a zero median traverse algorithm. To remove the potential for temperature drift, data were collected after a 20 minute stabilisation period and traverses were limited to a time of generally <100s.

2.3 Data processing and presentation

2.3.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared using SENSYS MAGNETO®DLMGPS software. The software effectively allocates a geographic position for each data point and can compensate for fixed offsets present within the FGM650 sensors. The offsets are positive or negative values present on all fluxgate gradiometer sensors. Some systems use manual or electronic balancing to effectively zero the sensors; however, this is a short term measure that is prone to drift through temperature changes and vibration and can easily be incorrectly set due to localised magnetic fields. The FGM650 sensors are very accurately aligned to the vertical magnetic gradient and are highly stable showing negligible drift on long traverses. The offset values are removed using TerraSurveyor software.

2.3.2 Survey tracks are analysed and georeferenced raw data (UTM Z30N) are then exported in ASCII format for further analysis and display within TerraSurveyor. The removal of the offset values (compensation) of the sensors is also carried out in TerraSurveyor using a zero median traverse function. Data are then considered to be minimally processed. Note: without the zero median traverse function it is not possible to create a meaningful data plot as all sensors have

a different offset value. Although a zero median traverse algorithm can remove anomalies aligned with the survey tracks, in practice this rarely occurs due to the use of long traverses, high resolution measurement and variability within the magnetic susceptibility of long linear features.

2.3.3 The minimally processed data are collected between limits of ±3000nT and clipped for display at ±3nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.

2.3.4 Additional data processing has been carried out for Area 1 in the form of both low pass and high pass filtering. Low pass filtering effectively removes high frequency variation along a traverse that has been caused by uneven ground and associated vibration. High pass filtering effectively removes low frequency variation along a traverse that has been caused by large magnetic bodies, cultivation or rapid temperature change. Data treated to additional processing have been compared to unprocessed data to ensure that no significant anomalies have been removed.

2.3.5 Appendix C contains metadata concerning the survey and data attributes and is derived directly from TerraSurveyor. Reference should be made to Appendix B for further information on processing.

2.3.6 A TIF file is produced by TerraSurveyor software along with an associated world file (.TFW) that allows automatic georeferencing (OSGB36 datum) when using GIS or CAD software. The main form of data display used in the report is the minimally processed greyscale plot. With regard to the Sensys MXPDA, minimally processed data are considered by the manufacturer to be data that are compensated by SENSYS MAGNETO DLMGPS software, see 2.3.1 and 2.3.2. Note: traceplots are not considered to be appropriate as they do not provide an accurate or useful assessment of the magnetic anomalies due to the very high density of data collection. In addition, traceplots cannot be meaningfully plotted against base mapping and in areas of complexity traces may be lost or highly confused. Traceplots may be used to demonstrate characteristic magnetic profiles across discrete features where it is considered beneficial.

2.3.7 The raster images are combined with base mapping using ProgeCAD Professional 2021, creating DWG (2018) file formats. All images are externally referenced to the CAD drawing in order to maintain good graphical quality. The CAD plots are effectively georeferenced facilitating relocation of features using GNSS, resection method, etc.

2.3.8 An abstraction and interpretation is drawn and plotted for all geophysical anomalies located by the survey. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing. Appendix E sets out CAD layer names with colour and graphic content for each interpretation category, see 3.3.

2.3.9 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 and objective assessment of features within each survey area.

2.3.10 A digital archive is produced with this report, see Appendix D below. The main archive is held at the offices of Archaeological Surveys Ltd.

3 RESULTS

3.1 General assessment of survey results

3.1.1 The detailed magnetic survey was carried out over a total of 2 survey areas covering approximately 11.5ha.

3.1.2 Magnetic anomalies located can be generally classified as positive responses of archaeological potential, positive anomalies of an uncertain origin, anomalies associated with land management, anomalies with a natural origin, linear anomalies of an agricultural origin, areas of magnetic disturbance, strong discrete dipolar anomalies relating to ferrous objects and strong multiple dipolar linear anomalies relating to buried services or pipelines. Anomalies located within each survey area have been numbered and are described in 3.4 and 3.5 below.

3.2 Statement of data quality and factors influencing the interpretation of anomalies

3.2.1 Data are considered representative of the magnetic anomalies present within the site. There are no significant defects within the dataset.

3.2.2 High magnitude magnetic disturbance associated with an underground service is present along the northern edge and within the north west corner of the western field (Area 1). Although the magnitude of the disturbance has the potential to obscure weaker anomalies, should they be present within this part of the site, the affected zone is narrow. Additional filtering was carried out in order to minimise the extent of the disturbance, a comparison is made with the unfiltered data to ensure no other anomalies have been removed or altered by the additional processing.

3.2.3 The results demonstrate good magnetic contrast typical of the soils and solid geology within the Cotswolds. However, the strong magnetic contrast has produced numerous and widespread anomalies relating to naturally and agriculturally formed features in the shallow solid geology. These are frequently associated with soil-filled hollows where rock has eroded or has been dislodged by ploughing. The morphology of these anomalies can be identical to infilled pit-like features of anthropogenic origin, and as a consequence, it may not be possible to confidently separate them from similar anomalies of archaeological potential.

3.3 Data interpretation

3.3.1 The list 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 general explanation of the characteristics of the magnetic anomalies is set out for each category in order to justify interpretation, see Table 1.

Interpretation category	Description and origin of anomalies
Anomalies with archaeological potential	Anomalies have the characteristics (mainly morphological) of a range of archaeological features such as pits, ring ditches, enclosures, etc. The category is used where there is a high level of confidence which may be due to additional supporting information where morphology is unclear or uncharacteristic.
Anomalies with an uncertain origin	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. Morphology may be unclear or uncharacteristic and there may be a lack of additional supporting information. Positive anomalies are indicative of magnetically enhanced soils that may form the fill of 'cut' features or may be produced by accumulation within layers or 'earthwork' features; soils subject to burning may also produce positive anomalies. Negative anomalies are produced by material of comparatively low magnetic susceptibility such as stone and subsoil.
Anomalies relating to land management	Anomalies are mainly linear and may be indicative of the magnetically enhanced fill of cut features (i.e. ditches). The anomalies may be long and/or form rectilinear elements and they may relate to topographic features or be visible on early mapping. Associated agricultural anomalies (e.g. headlands, plough marks and former ridge and furrow) may support the interpretation. Land drains can appear in a classic herringbone pattern of interconnected multiple dipolar linear anomalies, or as parallel linear anomalies. The multiple dipolar response indicates ceramic land drains.
Anomalies with an agricultural origin	The anomalies are often linear and form a series of parallel responses or are parallel to extant land boundaries. Where the response is broad, former ridge and furrow is likely; narrow response is often related to modern ploughing. This category does not include agricultural features of early date or considered to be of archaeological potential (e.g. animal stockades, enclosures, farmsteads, etc).
Anomalies associated with magnetic debris	Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.
Anomalies with a modern origin	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, pylons etc. Often a significant area around these features has a strong magnetic flux which may create magnetic disturbance; such disturbance can effectively obscure low magnitude anomalies if they are present. Fluxgate sensors may respond erratically adjacent to strong magnetic sources. Buried services may produce characteristic multiple dipolar anomalies dependant upon their construction.
Anomalies with a natural origin	Naturally formed magnetic anomalies are caused by localised variability in the magnetic susceptibility of soils, subsoils and other drift or solid geologies. Anomalies may be amorphous, linear or curvilinear and may appear 'fluvial' or discrete; the latter are almost impossible to distinguish from pit-like anomalies with an anthropogenic origin. Fluvial, glacial and periglacial processes may be responsible for their formation within drift material and subsoil. Igneous and metamorphic activity can lead to anomalies within more solid geology.

Table 1: List and description of interpretation categories

3.4 List of anomalies - Area 1

Area centred on OS NGR 430630 210540, see Figs 03 – 09.

Anomalies of archaeological potential

(1) – Situated in the south eastern corner of Area 1 is an L-shaped positive

rectilinear anomaly. It appears to form the western and northern sides of an enclosure.

(2) – A discrete positive anomaly with a response of up to 30nT and a 3m diameter appears to relate to a pit-like feature or area of burning within the northern part of the enclosure (1).

Anomalies with an uncertain origin

(3) – A positive curvilinear anomaly (3) is situated within the north western corner of the enclosure (1). It could relate to a cut feature, but a natural origin is also possible. It may continue westward as a ditch-like feature, but this is parallel with former ridge and furrow cultivation, and it is not clear if it is a cut feature or if it is associated with the earlier cultivation trend.

(4) – A linear group of discrete positive anomalies could be a continuation of anomaly (3).

(5) – A positive linear anomaly appears to extend southwards from anomaly (3) and could relate to a continuation of it; however, it could also relate to a continuation of the land drain situated to the north.

(6) – Two discrete, pit-like anomalies are situated within and to the north of the enclosure (1). They have a response of over 25nT, which could indicate an association with burning and an archaeological origin is possible.

(7) – A group of linear pit-like responses appear in the vicinity of the north eastern part of the enclosure (1). It is not clear if these are cut, pit-like features directly associated with the ditch, or if they are natural features or a combination of both.

(8) – A number of discrete, positive responses can be seen within the confines of enclosure (1). They have a similar form and response to the numerous naturally formed pit-like features situated throughout the site, and it is likely that they are also natural, although an anthropogenic origin is possible.

(9) – A linear group of of three discrete positive anomalies is situated towards the north eastern corner of Area 1. They have a much stronger response of 10-15nT compared with the majority of the naturally formed pits (17) across much of the area (1-3nT), and an association with magnetically enhanced or burnt material is possible.

(10) – A weakly positive liner anomaly is situated close to the north western corner of Area 1 and which could relate to a cut, ditch-like feature.

(11) – The central part of Area 1 contains a small number of positive linear anomalies with a general north east to south west orientation. They may relate to former cut features.

(12 & 13) – A positive linear anomaly (12) extends through the majority of the centre

of Area 1. It is joined at right angles by a series of other ditch-like features from the west (13). They appear to relate to former land boundary ditches, although none have been mapped within the site, they are parallel with existing field boundaries.

(14) – A positive linear anomaly extends towards anomaly (12) from the east and it is possible that it is associated.

(15) – A small number of large, pit-like anomalies are located in the central, eastern part of Area 1. These are situated within a zone of White Limestone Formation and it is not clear if the anomalies relate to infilled former solution features or possible former quarry pits.

Anomalies associated with land management

(16) – A small number of land drains are evident within the survey area with three extending north to south and another two extending north west to south east.

Anomalies with an agricultural origin

(17) – A series of parallel linear anomalies relate to former ridge and furrow cultivation.

Anomalies with a natural origin

(18) – The eastern and northern part of Area 1 contains numerous and widespread positive discrete and some linear anomalies. These generally lie within the zones of underlying White Limestone and Forest Marble Limestone and relate to pit-like features within the underlying geology. These may relate to a number of processes including soil-filled naturally formed joints, cracks and solution features, tree-throw pits and also disturbance of the underlying limestone through the action of ploughing.

Anomalies with a modern origin

(19) – A strong, multiple dipolar, linear anomaly crosses the northern edge of the survey area and extends towards the south west in the north western corner. This relates to a buried pipe or service.

3.5 List of anomalies - Area 2

Area centred on OS NGR 430850 210445, see Figs 10 – 11.

Anomalies of archaeological potential

(20) – A linear group of approximately 12 discrete, pit-like features are located within the south western part of Area 2. They are situated between 50m and 100m to the east of the enclosure (1) and are also on a similar orientation and could be

associated with it. The response is generally 6-8nT, stronger than the numerous naturally formed pits across the survey area (25) (1-3nT), and although there is a possibility that these could relate to further natural features, the enhancement and linear formation appear to indicate that they are of archaeological potential.

Anomalies with an uncertain origin

(21) – A positive linear anomaly extends northwards from close to the south western corner of Area 2. This appears to relate to an unmapped linear boundary ditch of uncertain age.

(22) – A linear anomaly in the southern part of the survey area is generally parallel with the main trend of the ridge and furrow (23), but then extends northwards at its eastern end. It is not clear what has formed this feature.

Anomalies with an agricultural origin

(23) – Parallel linear anomalies oriented north east to south west relate to ridge and furrow.

(24) – Parallel linear anomalies oriented north to south relate to modern agricultural activity.

Anomalies with a natural origin

(25) – The entire survey area contains numerous discrete anomalies that are responses to naturally formed pit-like features within the underlying limestone.

4 CONCLUSION

4.1.1 The results of the geophysical survey indicate the presence of a small number of anomalies with archaeological potential within the southern part of the site. These include a rectilinear enclosure and a linear group of pits. Other anomalies in the vicinity could also relate to cut features; however, widespread and numerous naturally formed pit-like features are also evident, and it can be difficult to distinguish those with an anthropogenic origin from those that relate to natural features. A group of large, pit-like anomalies could also relate to large naturally formed solution features; however, the response could indicate former quarrying. A number of linear anomalies have also been located and these appear to relate to boundary features of an unknown date. Evidence for former ridge and furrow cultivation and land drainage is also present within the data.

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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 upon 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 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 the 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 SENSYS gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 65cm apart. The instrument is carried about 10-20cm 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 magnetic field. The difference between the two sensors will relate to the strength of the magnetic field created by the buried feature.

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 – data processing notes

Clipping

Minimum and maximum values are set and replace data outside of the range with those values. Extreme values are removed improving colour or greyscale contrast associated with data values that may be archaeologically significant. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

High Pass Filter

Removes low frequency anomalies within the data that are not considered to be archaeologically significant and may be natural in origin. A window passes over the data, the mean of all the data within the window is subtracted from the centre value. The size of the window is adjusted as is the weighting which may be uniform or Gaussian. The process is used to improve the visibility of anomalies of interest.

Zero Median/Mean Traverse

The median (or mean) of data from each traverse is calculated ignoring data outside a threshold value, the median (or mean) is then subtracted from the traverse. The process is used to equalise differences between the offset values of the gradiometer sensors. The process can remove archaeological features that run along a traverse but with the high resolution datasets created by the Sensys FGM650 sensors and the method of data collection this has not been a notable problem. In fact, the removal of offsets using software avoids carrying out a balancing procedure on site, which inevitably can never be done in magnetically clean

conditions and results in improperly aligned fluxgate sensors and/or electronic adjustment values.

Appendix C – survey and data information

Area 1 minimally processed data
Filename: J930-mag-Area1-proc.xcp
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 430500.31, 210768.05 m
Southeast corner: 430747.45, 210334.97 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Source GPS Points: 2222280
Dimensions
Composite Size (readings): 1373 x 2406
Survey Size (meters): 247 m x 433 m
Grid Size: 247 m x 433 m
X Interval: 0.18 m
Y Interval: 0.18 m
Stats
Max: 3.32
Min: -3.30
Std Dev: 1.09
Mean: 0.04
Median: 0.01
Composite Area: 10.703 ha
Surveyed Area: 7.7968 ha
PROGRAM

Name: TerraSurveyor
Version: 3.0.32.4
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 Clip from -3.00 to 3.00 nT

Area 1 filtered data
Filename: J930-mag-Area1-proc-hpf-lpf.xcp
Stats
Max: 3.32
Min: -3.30
Std Dev: 0.94
Mean: 0.03

GPS based Proce6
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 High pass Uniform (median) filter: Window dia: 300
5 Lo pass Uniform (median) filter: Window dia: 13
6 Clip from -3.00 to 3.00 nT

Area 2 minimally processed data

Filename: J930-mag-Area2-proc.xcp
Northwest corner: 430747.80, 210524.37 m
Southeast corner: 430960.02, 210360.21 m
Source GPS Points: 845280
Dimensions
Composite Size (readings): 1179 x 912
Survey Size (meters): 212 m x 164 m
Grid Size: 212 m x 164 m
X Interval: 0.18 m
Y Interval: 0.18 m
Stats
Max: 3.32
Min: -3.30
Std Dev: 1.00
Mean: 0.09
Median: 0.00
Composite Area: 3.4838 ha
Surveyed Area: 3.0886 ha
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 Clip from -3.00 to 3.00 nT

Appendix D – digital archive

Archaeological Surveys Ltd hold the primary digital archive at their offices in Wiltshire. Data are backed-up onto an on-site data storage drive and at the earliest opportunity data are copied to CD ROM for storage on-site and off-site.

A draft copy will be supplied to the Oxfordshire county archaeological officer for comment and the agreed final copy supplied in PDF format to the Oxfordshire Historic Environment Record. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS).

Archive contents:

File type	Naming scheme	Description
Data	J930-mag-**[area number/name]**.asc J930-mag-**[area number/name]**.xcp J930-mag-**[area number/name]**-proc.xcp	Raw data as ASCII CSV TerraSurveyor raw data TerraSurveyor minimally processed data
Graphics	J930-mag-**[area number/name]**-proc.tif	Image in TIF format
Drawing	J930-**[version number]**.dwg	CAD file in 2018 dwg format
Report	J930 report.odt	Report text in LibreOffice odt format

Table 2: Archive metadata

Appendix E – CAD layers for abstraction and interpretation plots

The table below sets out Archaeological Surveys Ltd CAD layer names with associated colours and graphical content. Where CAD files are available layers may be extracted for further CAD/GIS use. Note: hatched polygon boundaries are contained within layers with the RGB colour code 254, 255, 255 (near white) in order to prevent their visibility.

Report sub-heading and associated CAD layer names	Colour with RGB index		Layer content
Anomalies with archaeological potential			
AS-ABST MAG POS DISCRETE ARCHAEOLOGY		Red 255,0,0	Solid donut, point or polygon (solid)

AS-ABST MAG POS ENCLOSURE DITCH		127,0,255	Line, polyline or polygon (solid)
Anomalies with an uncertain origin			
AS-ABST MAG POS LINEAR UNCERTAIN		255,127,0	Line, polyline or polygon (solid)
AS-ABST MAG POS DISCRETE UNCERTAIN		255,127,0	Solid donut, point or polygon (solid)
AS-ABST MAG POS UNCERTAIN		255,127,0	Polygon (cross hatched ANSI37)
Anomalies relating to land management			
AS-ABST MAG LAND DRAIN		Cyan 0,255,255	Line or polyline
Anomalies with an agricultural origin			
AS-ABST MAG AGRICULTURAL		Green 0,255,0	Line or polyline
AS-ABST MAG RIDGE AND FURROW		0,127,63	Line, polyline or polygon (cross hatched ANSI37)
Anomalies associated with magnetic debris			
AS-ABST MAG STRONG DIPOLAR		132, 132, 132	Solid donut, point or polygon (solid)
Anomalies with a modern origin			
AS-ABST MAG DISTURBANCE		132, 132, 132	Polygon (hatched ANSI31)
AS-ABST MAG SERVICE		132, 132, 132	Line or polyline
Anomalies with a natural origin			
AS-ABST MAG NATURAL FEATURES		205, 181,105	Solid donut, point or polygon (solid)

Table 3: CAD layering

Appendix F – copyright and intellectual property

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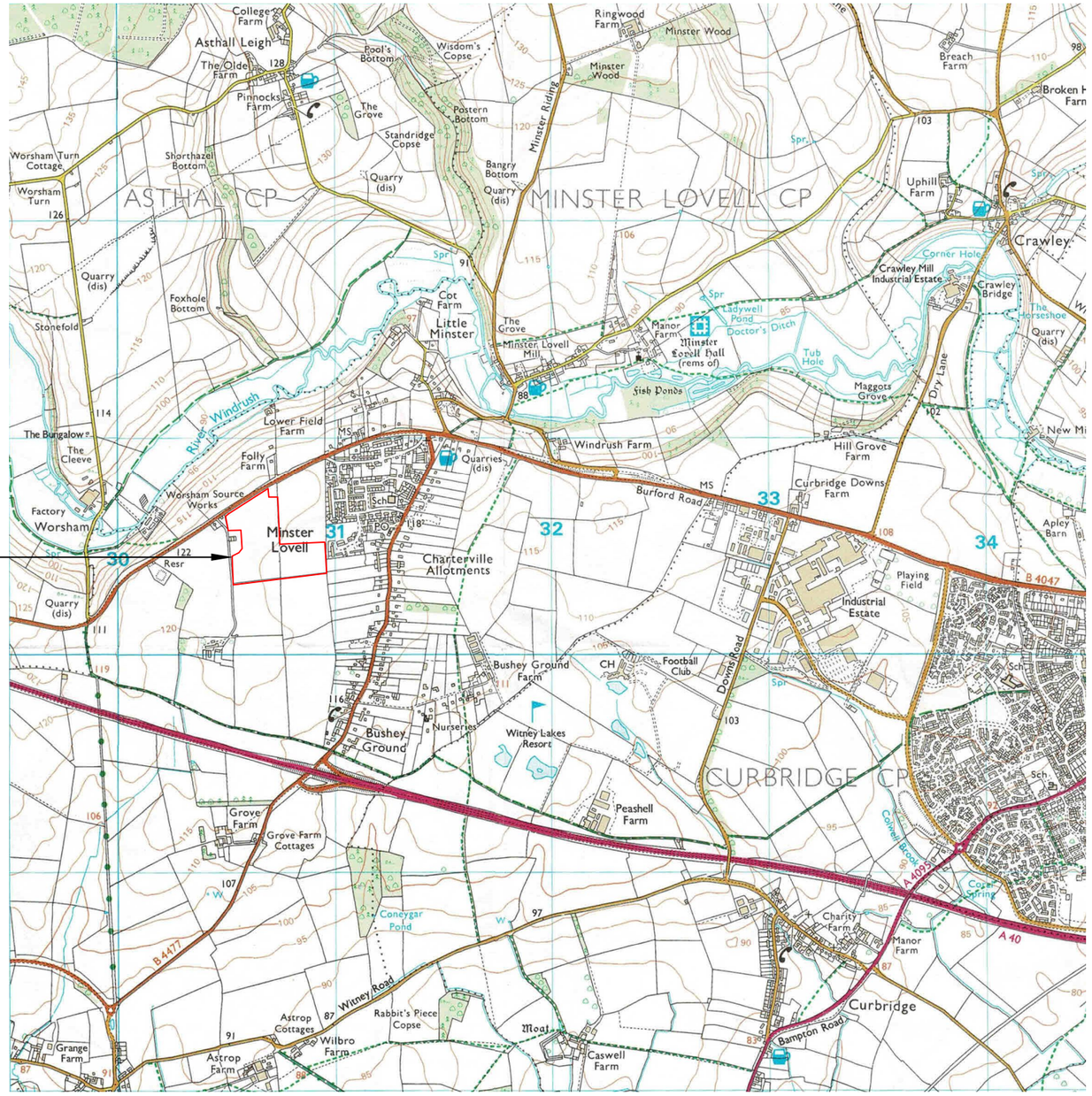
Tel: 01249 814 231

Archaeological Surveys
Specialist Geophysical Surveyors

Geophysical Survey
Land south of Burford Road
Minster Lovell
Oxfordshire

Map of survey area



● Survey location

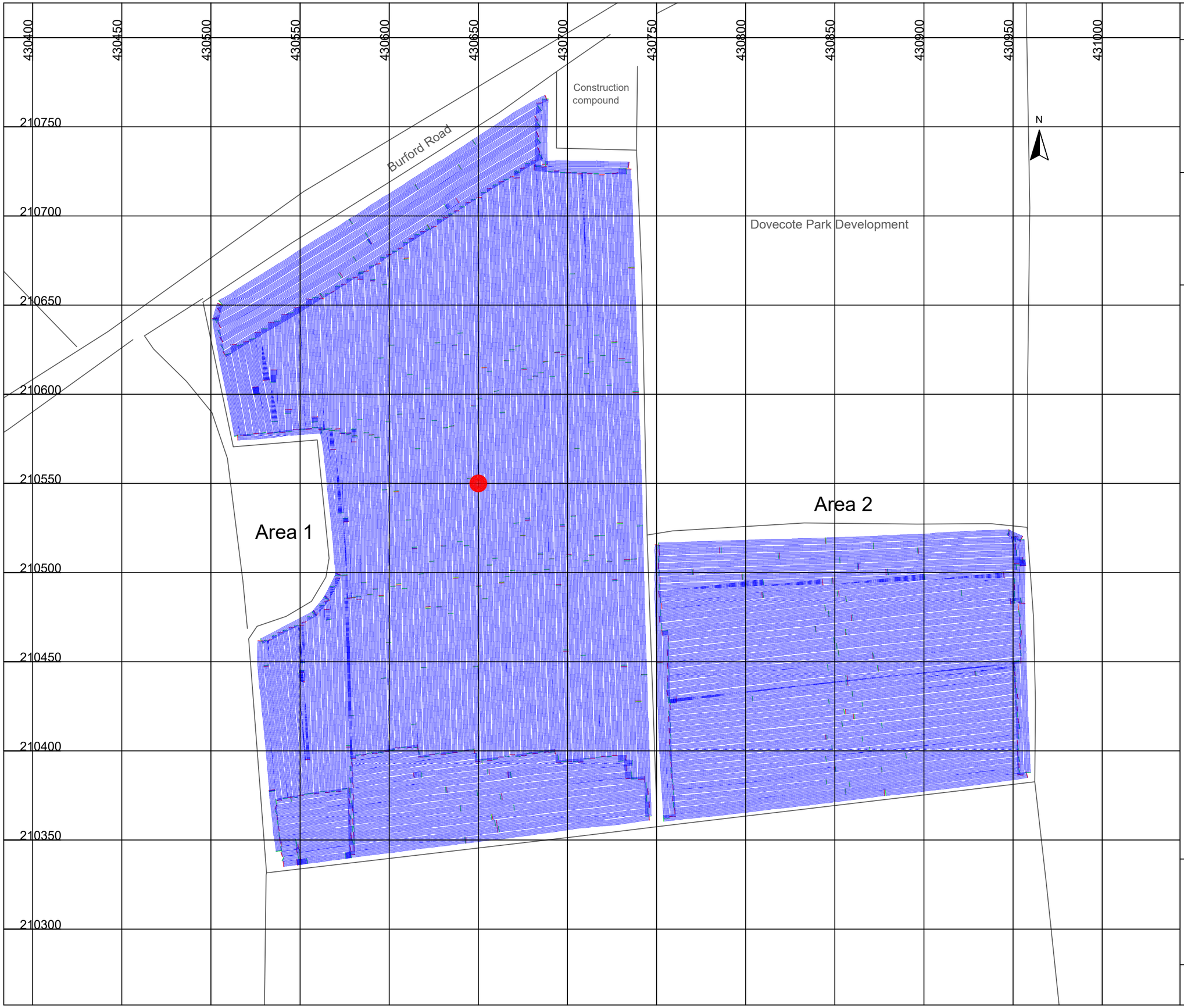
Site centred on OS NGR
SP 30730 10525

SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 01



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Land south of Burford Road
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Oxfordshire

Referencing information

Referencing grid to OSGB36 datum at 50m intervals

- 430650 210550
- Survey tracks
- Survey track start
- Survey track stop

SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 02

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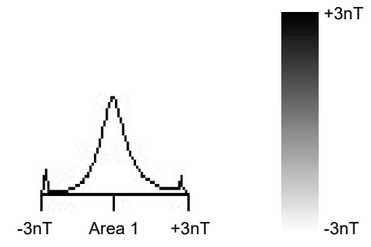
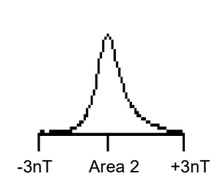
Oxfordshire

Greyscale plot of minimally processed magnetometer data





SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 03

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Abstraction and interpretation of magnetic anomalies

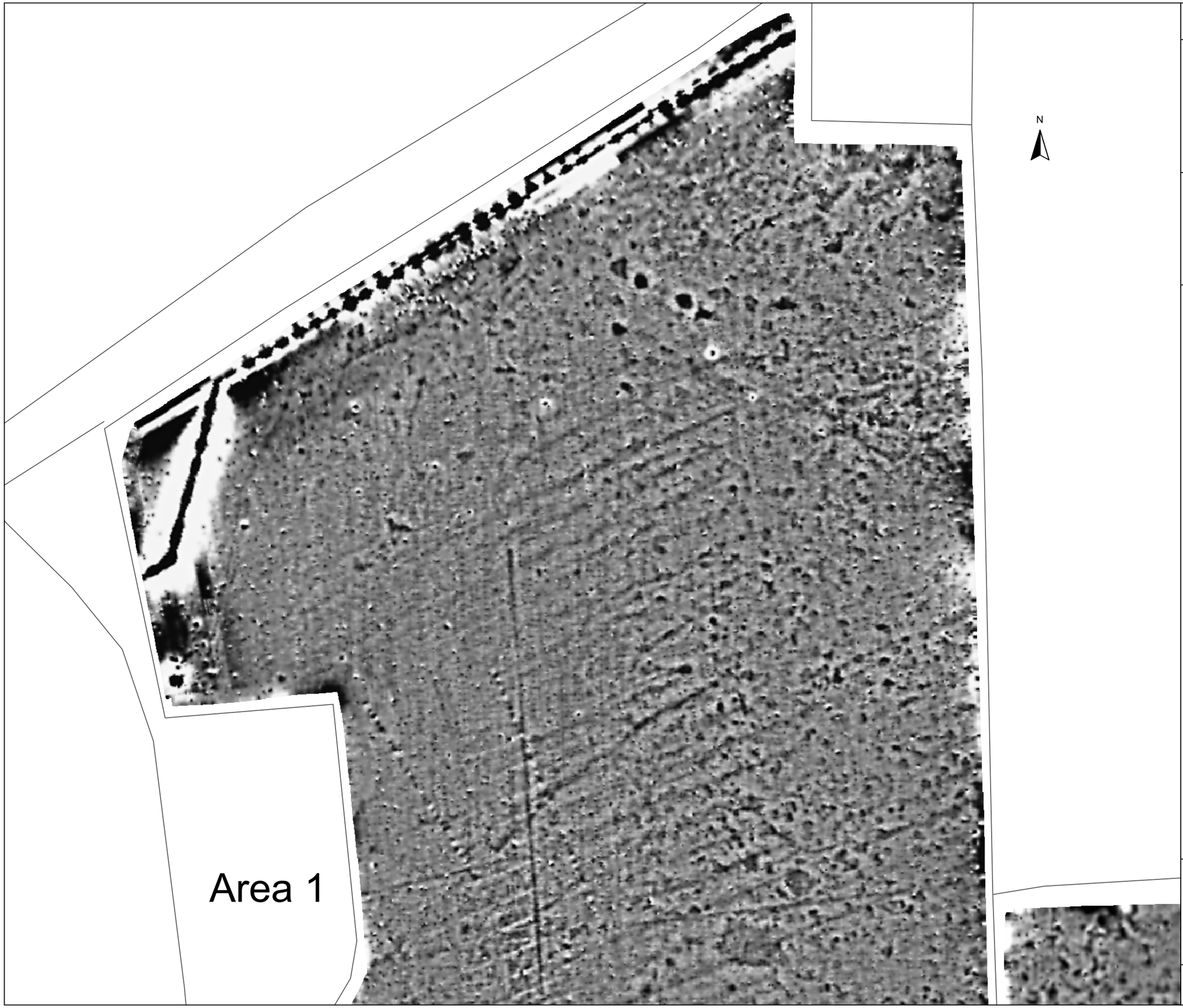
- Positive rectilinear anomaly - enclosure ditch
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - of agricultural origin
- Linear anomaly - ridge and furrow
- Weak multiple dipolar linear anomaly - land drain
- Positive linear anomaly - of natural origin
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Discrete positive response - of natural origin
- Positive anomaly - of uncertain origin
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - pipeline / cable / service
- Strong dipolar anomaly - ferrous object

SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 04



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Greyscale plot of minimally processed magnetometer data - Area 1 north

+3nT
-3nT
-3nT
+3nT

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 05

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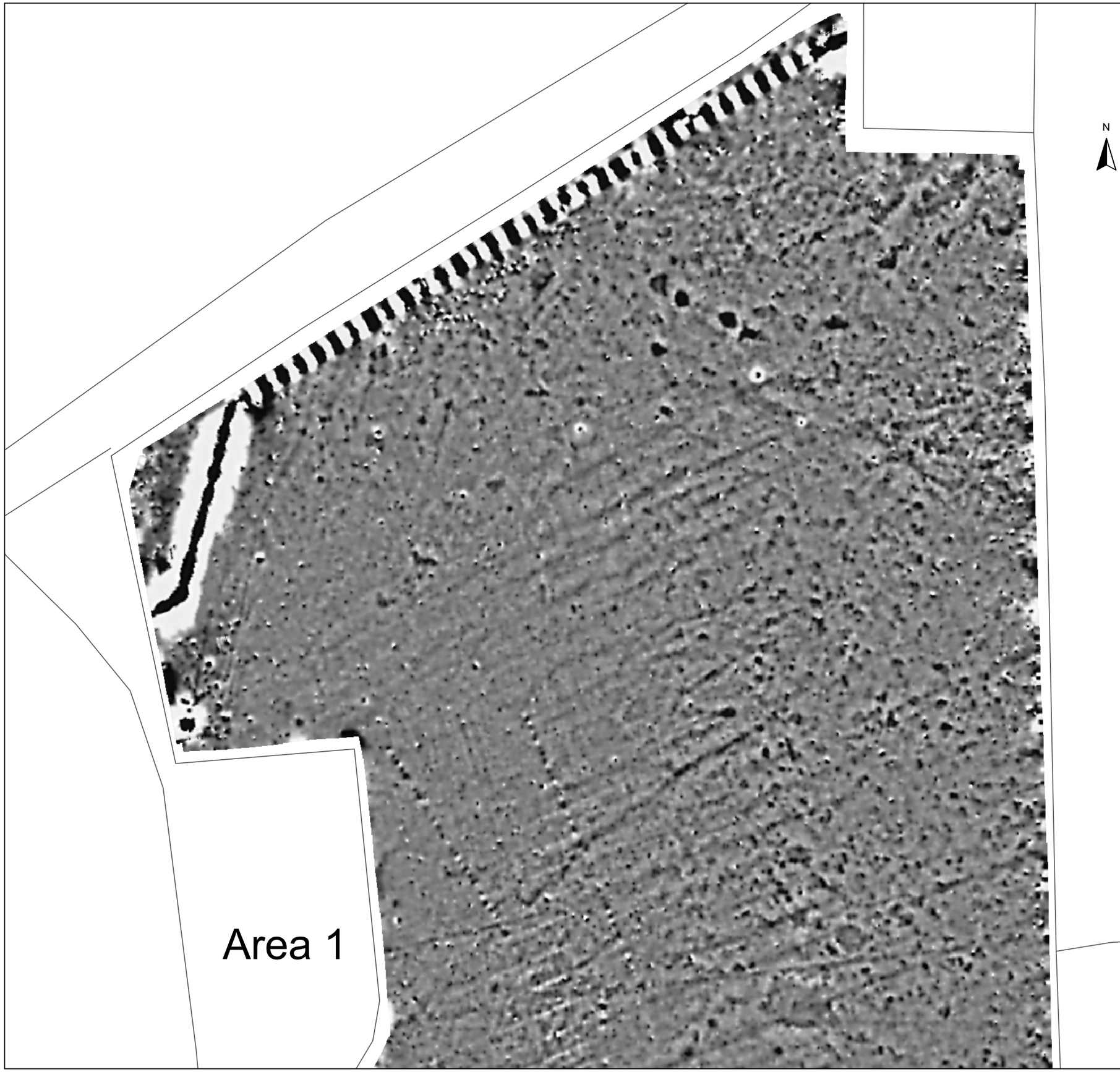
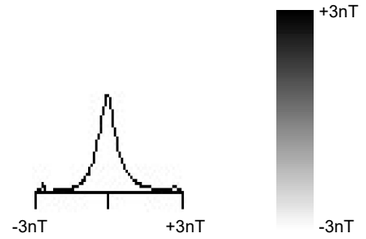
Greyscale plot of filtered magnetometer data





SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 06

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Abstraction and interpretation of magnetic anomalies - Area 1 north

N

9
18
19
10
11
13
14
Area 1

- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - ridge and furrow
- Weak multiple dipolar linear anomaly - land drain
- Positive linear anomaly - of natural origin
- Discrete positive response - possible pit-like feature
- Discrete positive response - of natural origin
- Positive anomaly - of uncertain origin
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - pipeline / cable / service
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 07

Area 1

N

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Greyscale plot of minimally processed magnetometer data - Area 1 south

+3nT
-3nT
-3nT
+3nT

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 08

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Abstraction and interpretation of magnetic anomalies - Area 1 south

Area 1

N

11
13
14
15
16
12
17
6
7
3
2
8
4
1
5
6
25
21
23
20

- Positive rectilinear anomaly - enclosure ditch
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - of agricultural origin
- Linear anomaly - ridge and furrow
- Weak multiple dipolar linear anomaly - land drain
- Positive linear anomaly - of natural origin
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Discrete positive response - of natural origin
- Positive anomaly - of uncertain origin
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 09

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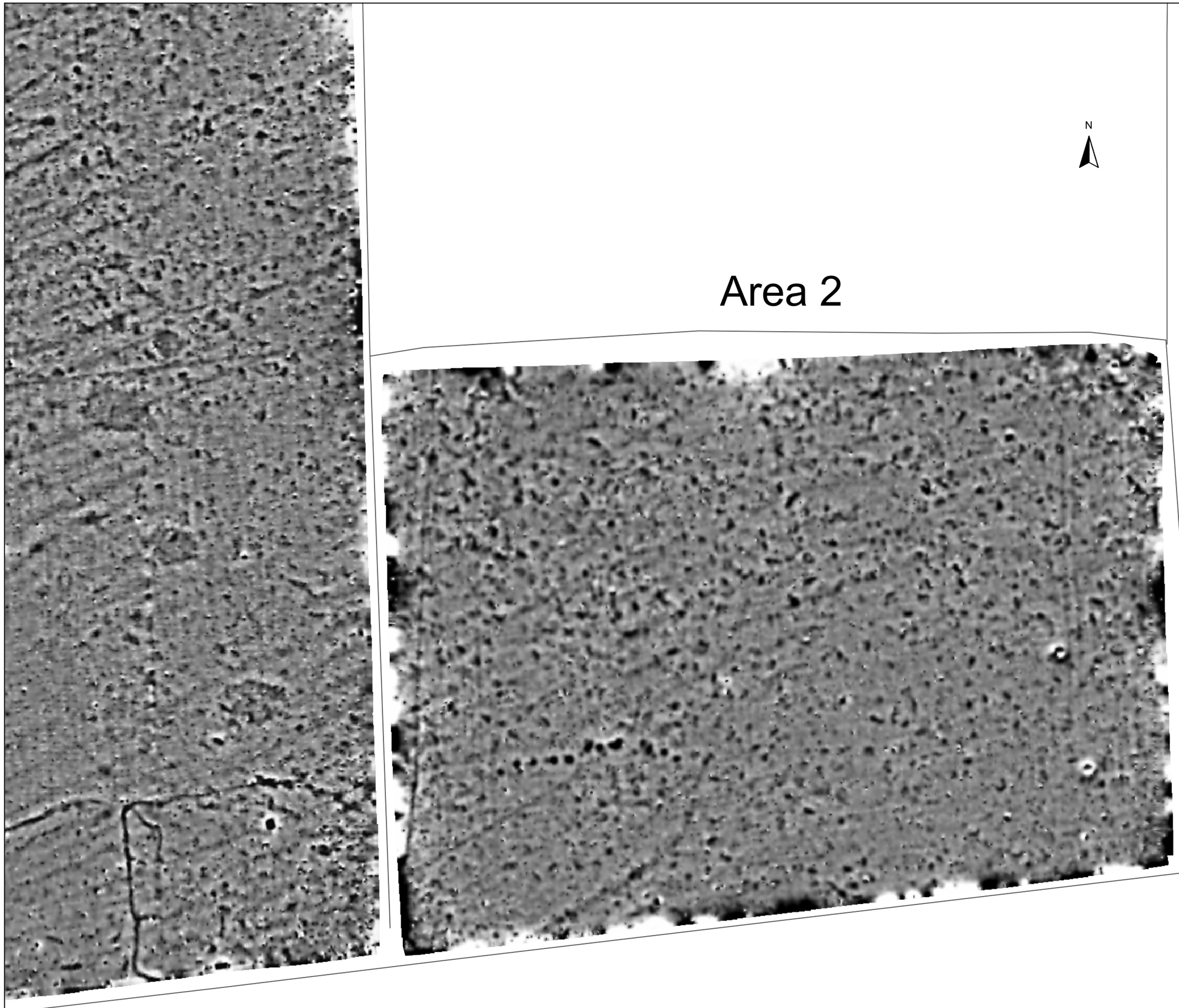
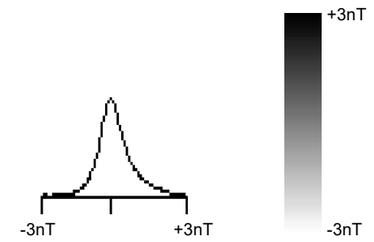
Greyscale plot of minimally processed magnetometer data - Area 2





SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 10

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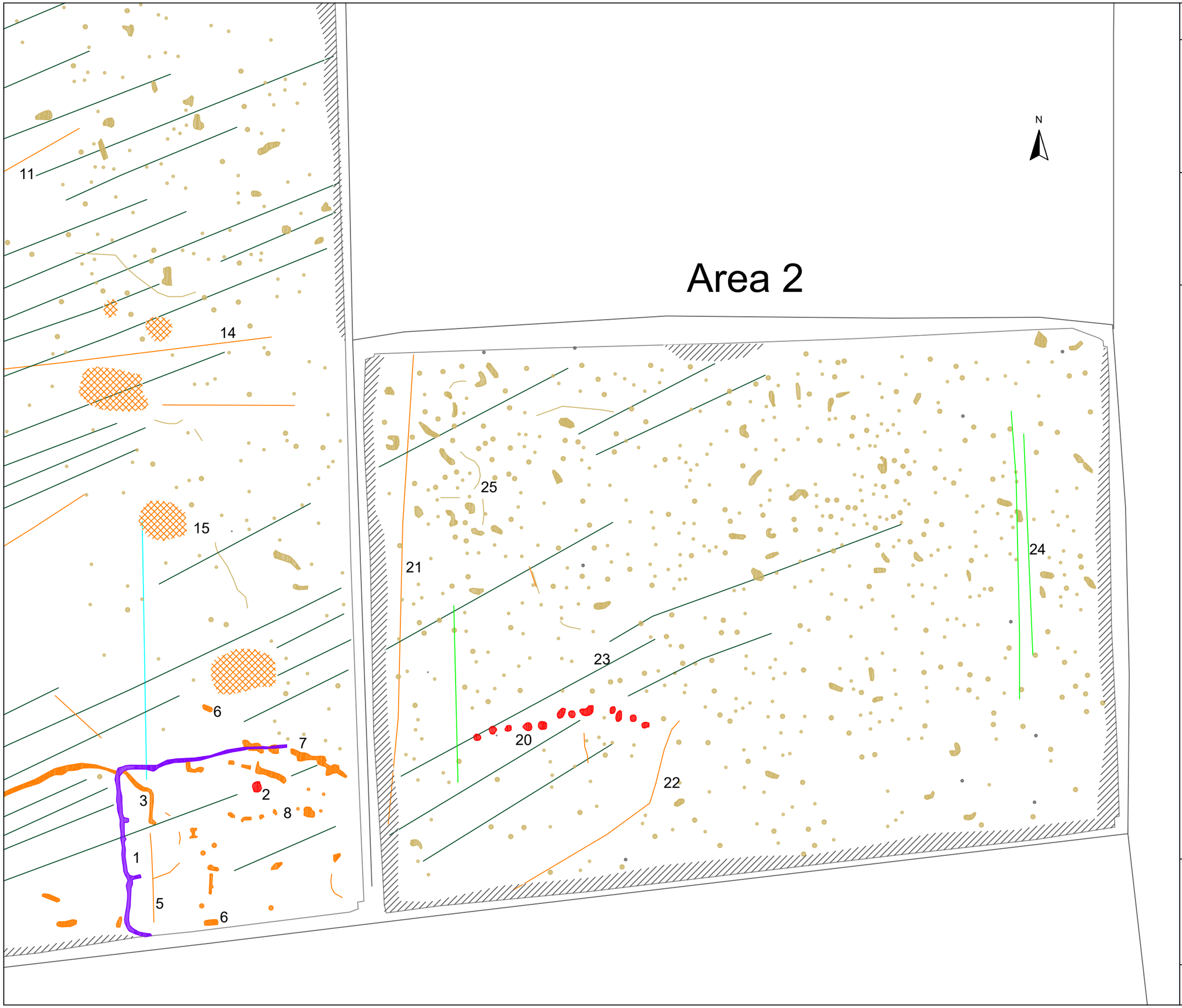
Abstraction and interpretation of magnetic anomalies - Area 2



- Positive rectilinear anomaly - enclosure ditch
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - of agricultural origin
- Linear anomaly - ridge and furrow
- Weak multiple dipolar linear anomaly - land drain
- Positive linear anomaly - of natural origin
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Discrete positive response - of natural origin
- Positive anomaly - of uncertain origin
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 11