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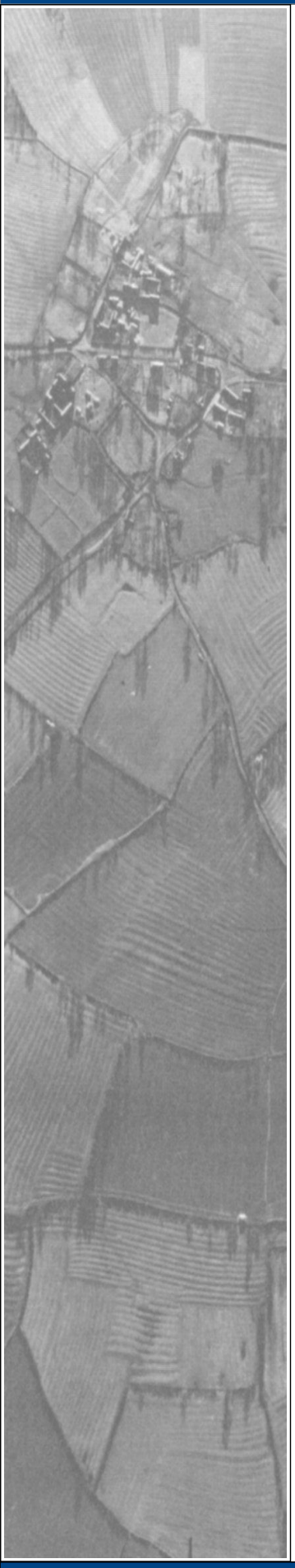

Land south of Banbury Rise
Banbury
Oxfordshire

MAGNETOMETER SURVEY REPORT

for

Cotswold Archaeology

Kerry Donaldson & David Sabin

March 2022

Ref. no. J907

ARCHAEOLOGICAL SURVEYS LTD

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Banbury
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Primary archive location - Archaeological Surveys Ltd, Yatesbury, Wiltshire

Survey dates – 14th to 17th February 2022
Ordnance Survey Grid Reference – **SP 43410 40240**

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

Detailed magnetometry has been carried out by Archaeological Surveys Ltd within two fields covering 13ha on the western edge of Banbury in Oxfordshire ahead of a proposed residential development. The results indicate the presence of widespread archaeological features, including long linear boundaries, three pit alignments, a single ring ditch, a possible enclosure and groups of strongly magnetically enhanced pits in the south eastern part of the site that appear to be associated with burning and fragmented ring ditches. The morphology of the majority of these anomalies indicates that they are likely to relate to prehistoric features, but their date and function cannot be confidently determined from geophysical survey alone.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Cotswold Archaeology to undertake a magnetometer survey of an area of land on the western edge of Banbury 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 issued to the client 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 a new development known as Banbury Rise and adjacent to Withycombe Farm on the western edge of Banbury in Oxfordshire. It is centred on Ordnance Survey National Grid Reference (OS NGR) SP 43410 40240, see Figs 01 and 02.

1.4.2 The geophysical survey covers approximately 13ha within two arable fields, at the time of survey the fields contained open soil with little or no vegetative cover. The northern field, Area 1, lies immediately north and east of Withycombe Farm. It is generally level ground with residential estates to the east, new housing under construction to the north and agricultural land to the west. Area 2 lies to the south of Area 1 and Withycombe Farm and is surrounded by agricultural land, except to the east where there is a residential estate. The eastern part of the area tends to slope down from south to north with the western part sloping down towards both the north and south. The southern and central parts of the eastern side of the field were waterlogged in places presumably due to emerging springs. The elevated part of the western side of the field was very stony due to thin soil over shallow solid geology.

1.4.3 The ground conditions across the site were generally considered to be suitable for the collection of magnetometry data. However, very wet and windy weather was encountered during the course of the survey and despite reasonably well-drained soil, traversing was often very difficult due to sticky soil. Small areas of standing water and boggy ground were encountered in the eastern part of the southern field.

1.5 Site history and archaeological potential

1.5.1 There are no designated or undesignated heritage assets within the site, although it has not be subject to previous archaeological investigation. The land immediately to the north has been subject to geophysical survey and trial trench evaluation which revealed the presence of a late Iron Age and early Romano-British occupation site (MOX26981). A possible Romano-British farmstead has been identified from a pottery scatter approximately 660m to the north west (MOX4250) and a Roman/Anglo-Saxon settlement approximately 380m to the east (MOX4244). Withycombe farmhouse is a Grade II listed building dating from the early to mid 17th century.

1.5.2 The location of archaeological features within the surrounding landscape may indicate that there is potential for similar features to be identified during the geophysical survey should they be present within the site.

1.5.3 The surface conditions within the site were suitable for the observation of cultural material during the course of the survey. Within the northern field, Area 1, occasional worked flints in the form of small broken blades were noted but were widespread with no particular concentrations. Within the southern part of the southern field, on elevated ground close to the southern boundary in the eastern part of the field, numerous pottery sherds and burnt stone fragments were observed. The sherds were considered consistent with prehistoric pottery as the material is not wheel-thrown, rims appeared very simple and the fabric is tempered with small fragments of limestone and shell.

1.6 Geology and soils

1.6.1 The underlying solid geology is Ferruginous limestone and ironstone from the Marlstone Rock Formation across the majority of the site with a fault running through the southern part of the site from south west to north east. To the south east of the fault the geology changes from the Whitby Mudstone Formation to sandstone from the Northampton Sand Formation to sandstone from the Horsehay Sandstone Formation to ooidal limestone from the Chipping Norton Limestone Formation over a distance of approximately 200m within the south eastern corner of the site (BGS, 2017).

1.6.2 The overlying soil across the majority of the survey area is from the Banbury association and is a ferritic brown earth. It consists of a well drained, brashy, fine and coarse loamy, ferruginous soil over ironstone. Where the geology changes in the south eastern part of the site the soil is from the Denchworth

association which is a pelo-stagnogley consisting of a slowly permeable, seasonally waterlogged, clayey soil (Soil Survey of England and Wales, 1983).

1.6.3 Magnetometry survey carried out across similar ferruginous soils has produced good results with very strong responses and clear magnetic contrast. The stagnogley soils tend to be associated with less magnetic contrast; however, where there has been long term occupation and/or industrial activity the soils do have the potential for magnetic enhancement. 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®MXPDA 5 channel cart-based system. The instrument has 5 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 ±20nT with an additional image showing data clipped between ±70nT with anomalies over 50nT highlighted in red and below -50nT highlighted in blue. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.

2.3.4 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.

2.3.5 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.

2.3.6 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.

2.3.7 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.

2.3.8 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.

2.3.9 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 two survey areas covering approximately 13ha.

3.1.2 Magnetic anomalies located can be generally classified as positive linear and discrete positive responses of archaeological potential, positive and negative anomalies of an uncertain origin, anomalies associated with quarrying, linear anomalies of an agricultural origin, areas of magnetic debris, strong discrete dipolar anomalies relating to ferrous objects and strong multiple dipolar linear anomalies relating to buried services or pipelines.

3.1.3 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 The ferruginous nature of the soil and underlying geology allows the formation of strongly contrasting magnetic anomalies due to enhancement of soil magnetic susceptibility by human activity. The overlying soil is also likely to have a higher magnetic susceptibility than the underlying subsoil/solid geology due to natural weathering processes, and this will result in magnetic anomalies regardless of any significant human activity, although where former burning or occupation has occurred, significantly stronger anomalies are likely.

3.2.3 The results demonstrate clear anomalies associated with the fill of former cut features, such as pits and ditches, considered likely to be of archaeological potential. Former ridge and furrow cultivation has also formed clear anomalies. Numerous naturally formed anomalies are also present within the data, most notably elongated discrete anomalies probably caused by ancient tree-throw pits but also weak linear anomalies indicative of joints within the bedrock. The modern cultivation trend has also produced a series of widespread, narrow, linear, positive and negative anomalies.

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 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	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. They often occur where there has been dumping or ground make-up and are 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, hearths and nail spreads from former wooden structures or rooves 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 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.
Anomalies associated with ground disturbance/quarrying	Magnetically variable anomalies which may be negative indicating a response to geology/drift deposits and/or positive indicating an increased depth of topsoil. Very strongly magnetic anomalies are a response to highly magnetic material of modern origin which can be used to infill a quarry depression. It should be considered that former quarry pits may be of archaeological potential.

Table 1: List and description of interpretation categories

3.4 List of anomalies - Area 1

Area centred on OS NGR 443415 240330, see Figs 05 – 06.

Anomalies of archaeological potential

(1 & 2) – A segmented, positive linear anomaly (1) crosses the central part of Area 1. A similar parallel, but narrower linear anomaly is located approximately 6m to the south. Another linear anomaly appears to join it from the north west (2), and this is joined by a pair of linear ditches towards the north west corner. Their morphology indicates that they may relate to linear boundary features that may be prehistoric or Roman in date.

(3 & 4) – Two linear series of discrete positive responses can be seen in the eastern part of Area 1. Anomalies (3), extend from the northern edge of the site for over 100m, where there appears to be a c84m gap before then continue again south eastwards for at least another 93m. The responses generally appear circular, with a diameter of between 0.3m and 1m with often 1m between them. Anomalies (4) have a similar form and layout but only appear to extend for 85m towards the centre of the site from close to the south eastern corner. Where they cross anomalies (3), they have a slight deviation in their orientation. These anomalies are likely to relate to pit alignments dating to the prehistoric period.

(5) – A single, positive, curvilinear anomaly appears to relate to a ring ditch with an outer diameter of 10m and an east facing entrance 4m wide. It may contain pits or post holes and is likely to relate to a prehistoric round house.

Anomalies with an uncertain origin

(6) – A small number of discrete positive responses are situated in the vicinity of anomaly (5). While it is possible that they relate to naturally formed pit-like anomalies, an anthropogenic origin is possible.

(7) – A series of pit-like anomalies and a curvilinear anomaly are situated close to the pit alignment (4). They may relate to anomalies with a natural origin like (12), but an association with cut features is possible.

(8) – A number of discrete positive anomalies appear to be situated at the southern end of the linear row of pits (3); however, it is not possible to distinguish them from others nearby with a natural origin.

(9) – A broad, weakly positive response appears to correspond with a low bank in the field and which may be associated with a formerly mapped field boundary.

Anomalies with an agricultural origin

(10) – Former ridge and furrow extends across much of the survey area.

(11) – Modern agricultural activity has resulted in a series of parallel linear anomalies extending parallel with the eastern field boundary within Area 1. In order not to obscure other anomalies, only a single line has been abstracted.

Anomalies with a natural origin

(12) – The northern and southern parts of Area 1 contain widespread and numerous discrete positive responses with relatively less towards the centre. Some are circular, but most are elongated and many slightly curved indicative of former tree throw pits. It can be difficult to distinguish pits with an anthropogenic origin from such features.

Anomalies associated with magnetic debris

(13) – A patch of magnetic debris can be seen at the south western corner of Area 1 with a very strongly magnetic response towards the centre. Such a response could relate to a demolished building or infilled pond.

(14) – Strong, discrete, dipolar anomalies are responses to ferrous and other magnetically thermoremnant objects in the topsoil.

Anomalies with a modern origin

(15) – A weak, multiple dipolar, linear anomaly extends from the south east towards Withycombe Farm and indicates a response to a buried pipe or service.

3.5 List of anomalies - Area 2

Area centred on OS NGR 434000 239675, see Figs 07 – 09.

Anomalies of archaeological potential

(16) – A positive linear anomaly in the western part of Area 2 is a continuation of anomaly (1) seen 135m north east in Area 1. It is segmented in the north, and slightly weaker in the south (10nT rather than 15-20nT) and becomes very narrow as it extends towards the southern edge of the survey area.

(17) – A row of discrete anomalies is located adjacent and parallel to anomaly (16) in the south western corner of the survey area. As it extends northwards they appear to be cut into anomaly (16); however, the sequence is uncertain as it is possible that the pits could be deeper features than the linear response (16) and therefore pre-date them.

(18) – A broad, weakly positive linear response extends across the centre of the survey area in a broad curve which generally reflects that of anomalies (1) and (16) seen between 170m to the north and 120m to the west. A similar response can be

seen 85m to the south east although this is shorter. They appear to relate to broad boundary features that are likely to be prehistoric in date.

(19) – Positive anomalies that appear to form a rectilinear feature with (18) that enclosures a group of strongly magnetic discrete features (21).

(20) – Positive anomalies forming an L-shaped rectilinear feature with a further parallel linear anomaly to the west and a curvilinear anomaly on the south western side. While the L-shaped feature is parallel with two sets of ridge and furrow, and the parish boundary extends directly in between the two parallel linear responses, it is possible that these relate to earlier cut features.

(21) – Three groups of discrete positive responses can be seen in the south eastern part of Area 2. They are generally strongly magnetically enhanced, with the majority over 50nT, with several peaking at over 100nT, which would indicate an association with burning. While several are irregularly shaped, many appear circular with a diameter of between 1.2m and 1.6m. Those close to the southern edge of the area are situated near evidence of former quarrying (29), but it is not clear if they are contemporary, or pre or post-date the quarrying as there are similar responses within the quarry infill. They are likely to relate to clusters of former pits

(22) – To the west of anomalies (20) are a group of discrete anomalies forming an arc of five pits with a very strong discrete response (>150nT) located 7m to the north east.

(23) – The central southern part of the survey area contains at least three partial curvilinear anomalies that may be related to former ring-ditches. They appear to be associated with the location of two of the pit clusters described in (21) and they have approximate diameters of 10m which could be indicative of prehistoric round houses.

Anomalies with an uncertain origin

(24) – Parallel linear anomalies are located in the northern part of Area 2 and appear to extend towards, but not join, anomaly (18). Other linear anomalies are located to the east and although these responses are not well defined, their archaeological potential should be considered.

(25) – Discrete positive responses in the northern part of the survey area appear to be grouped in an arc and in a possible circular formation. The morphology may suggest an archaeological origin; however, this is not certain as widespread, naturally formed responses can be seen in the vicinity.

(26) – A zone of magnetic enhancement is located in the south western part of the survey area. It is situated near the base of a narrow combe, and it is unclear whether it has an anthropogenic or natural origin, such as a build-up of soil caused by colluviation.

(27) – A fragmented negative linear anomaly extends across the south eastern part

of Area 2 towards anomaly (26). It is possible that it relates to a natural feature, such as a joint or crack and could be associated with the fault line that extends across this part of the site on a similar orientation.

(28) - A number of weakly positive linear anomalies appear to extend north westwards from anomaly (26). It is not clear if they relate to cut features, or if they relate to soil-filled joints within the underlying bedrock

Anomalies associated with quarrying

(29) – Situated along the south eastern edge of Area 2 are a number of magnetically variable responses indicative of former quarrying. They are associated with depressions within the ground surface, which extends into the land to the south. The strength of the response does not indicate a modern infill, which would usually contain ferrous items, and they may be of antiquity, possibly associated with the discrete responses (21) situated in their immediate vicinity. The BGS geological map indicates the largest quarry is situated on the Chipping Norton Limestone in the south eastern corner of the site and extending into the Horsehay Sand Formation along with another small area of quarrying, with the furthest south west situated on a band of the Northampton Sand Formation

Anomalies with an agricultural origin

(30) – Former ridge and furrow is present on two different orientations.

(31) – Modern cultivation has resulted in widespread parallel linear anomalies oriented east to west. Only a small number have been abstracted.

Anomalies associated with a natural origin

(32) – A large number of discrete, positive responses are located in the western part of the survey area, with the largest concentration in the north west. These are a continuation of similar naturally formed features (12) seen within Area 1 to the north and north east.

(33) – Weakly positive linear anomalies can be seen in the central, western part of the site and these appear to be related to natural features, such as joints and cracks within the underlying geology.

4 CONCLUSION

4.1.1 The geophysical survey has located a number of extensive linear anomalies that relate to boundary ditches that may date to the prehistoric or Roman periods. Three linear pit alignments have also been located, two of which appear to cross each other, and these are considered likely to indicate former prehistoric boundary features. A single ring ditch has been identified in the north western part of the site.

4.1.2 Within the south eastern part of the site there are three groups or clusters of very strongly magnetic pit-like responses that would infer nearby prehistoric settlement. Three partial ring ditches, that may indicate former round houses, are located in the vicinity of two of the pit clusters. Coarsely made pottery sherds, correlating with the location of the pits, were visible on the field surface, as well as numerous small fragments of burnt limestone. Evidence for quarrying can also be seen in this part of the site, although the relationship of this with the pits cannot be confidently determined.

4.1.3 Widespread, naturally formed, pit-like features can be seen across much of the northern and western parts of the site and can be difficult to distinguish from those with an anthropogenic origin. Evidence of former ridge and furrow cultivation is also present within the data.

5 REFERENCES

Archaeological Surveys, 2022. *Land south of Banbury Rise, Banbury, Oxfordshire, Geophysical Survey Written Scheme of Investigation.* Unpublished typescript document.

Aspinall, A., Gaffney, C. and Schmidt, A. 2009. *Magnetometry for Archaeologists*. Lanham (US), AltaMira Press.

British Geological Survey, 2017. *Geology of Britain 3D (Beta version), 1:50 000 scale [online]* available from http://mapapps.bgs.ac.uk/geologyofbritain3d/index.html? [accessed 9/2/2022].

Chartered Institute for Archaeologists, 2014 (updated 2020). *Standard and Guidance for archaeological geophysical survey*. CIfA, University of Reading.

European Archaeological Council, 2015. *EAC Guidelines for the Use of Geophysics in Archaeology: Questions to Ask and Points to Consider.* Europae Archaeologia Consilium and Association Internationale sans But Lucratif, Belgium.

Historic England, 2018. Geophysical Survey Advice [online] available from https://historicengland.org.uk/advice/technical-advice/archaeological-science/geophysics/ [accessed July 2018].

Institute for Archaeologists, 2002. *The use of Geophysical Techniques in Archaeological Evaluations*. IfA Paper No. 6. IfA, University of Reading.

Schmidt, A., 2013. *Geophysical Data in Archaeology: A Guide to Good Practice.* Oxbow Books.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 6 South West England.*

Oxfordshire Museums Service, 2020. *Requirements for Transferring Archaeological Archives 2020-2021.*

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.

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

Filename: J907-mag-Area1.xcp
Instrument Type: Sensys DLMGPS
Units:
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 443192.05, 240475.23 m
Southeast corner: 443570.05, 240131.43 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Dimensions
Survey Size (meters): 378 m x 344 m
X&Y Interval: 0.15 m
Source GPS Points: Active: 2261553, Recorded: 2261553
Stats
Max: 22.10
Min: -22.00
Std Dev: 5.04
Mean: 0.40
Median: -0.01
Composite Area: 12.996 ha
Surveyed Area: 7.1384 ha
PROGRAM
Name: TerraSurveyorPre
Version: 3.0.36.24
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 Clip from -20.00 to 20.00

Area 2

Filename: J907-mag-Area2-proc.xcp
Northwest corner: 443241.34, 240174.01 m
Southeast corner: 443585.14, 239921.26 m
Dimensions
Survey Size (meters): 344 m x 253 m
X&Y Interval: 0.15 m
Source GPS Points: Active: 1879238, Recorded: 1880758
Stats
Max: 22.10
Min: -22.00
Std Dev: 5.55
Mean: 0.22
Median: 0.02
Composite Area: 8.6895 ha
Surveyed Area: 6.057 ha
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 Clip from -20.00 to 20.00
Stats
Max: 71.82
Min: -71.50
Std Dev: 7.52
Mean: 0.39
Median: 0.07

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. The digital data will also be archived with the Archaeology Data Service.

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) and the data archived with the Archaeology Data Service.

Archive contents:

File type	Naming scheme	Description
Data	J907-mag-**[area number/name]**.asc J907-mag-**[area number/name]**.xcp J907-mag-**[area number/name]**-proc.xcp	Raw data as ASCII CSV TerraSurveyor raw data TerraSurveyor minimally processed data
Graphics	J907-mag-**[area number/name]**-proc.tif	Image in TIF format
Drawing	J907-**[version number]**.dwg	CAD file in 2018 dwg format
Report	J907 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 LINEAR ARCHAEOLOGY		Red 255,0,0	Polyline or polygon (solid)
AS-ABST MAG POS CURVILINEAR RING DITCH		Magenta 255,0,255	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 NEG LINEAR UNCERTAIN	Blue 0,0,255	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 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 DEBRIS	132, 132, 132	Polygon (cross hatched ANSI37)
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	Yellow 255,255,0	Polygon (cross hatched ANSI37)
Anomalies associated with ground disturbance/quarrying		
AS-ABST MAG QUARRYING/ GROUND DISTURBANCE	255,223,127	Polygon (net)

Table 3: CAD layering

Appendix F – copyright and intellectual property

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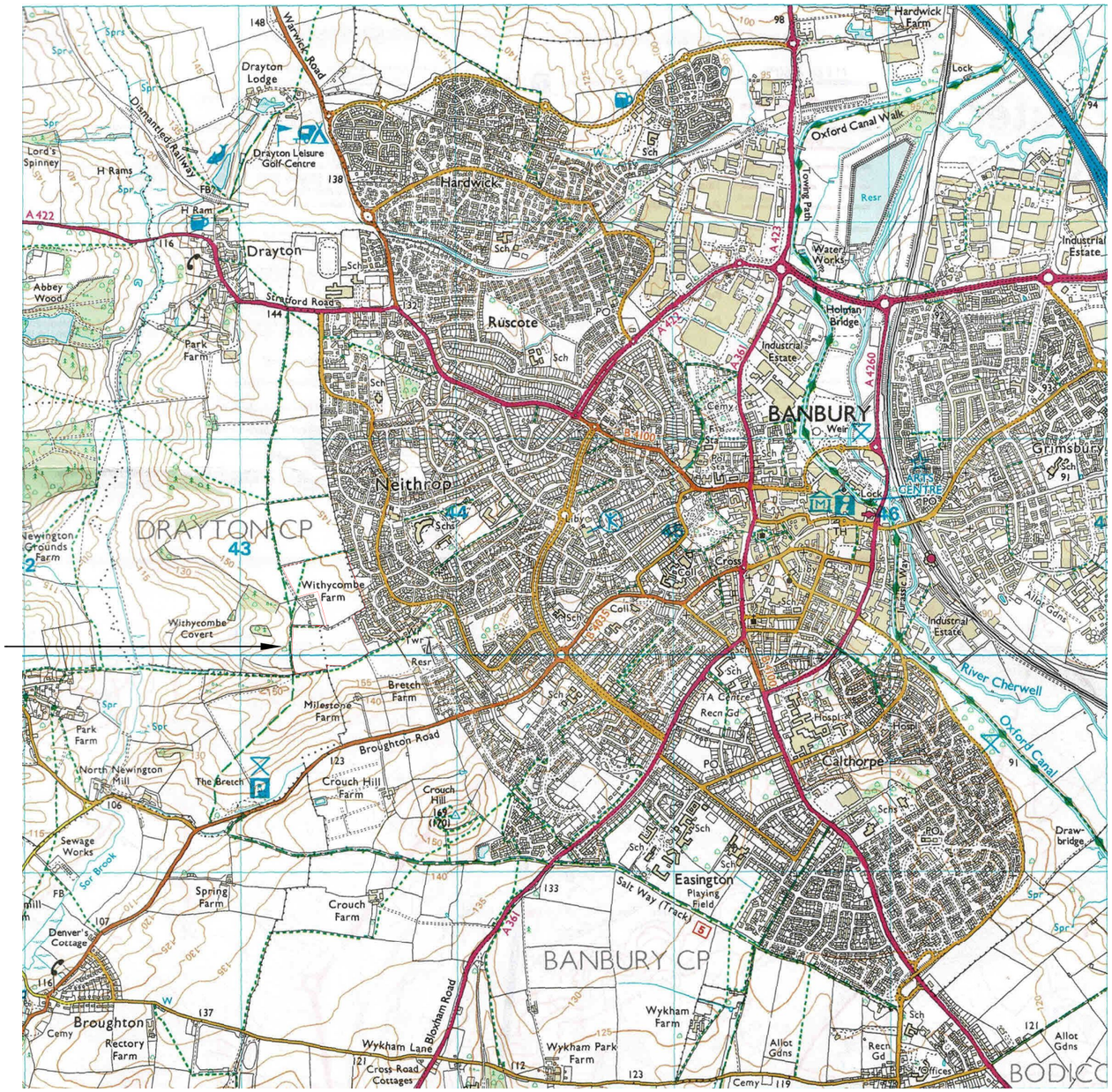
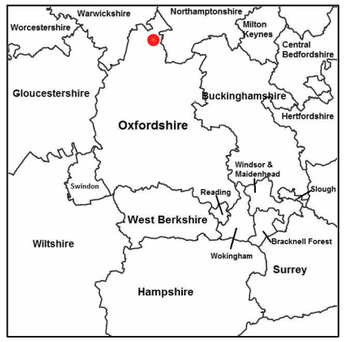
Tel: 01249 814 231

Archaeological Surveys
Specialist Geophysical Surveyors

Geophysical Survey
Land south of Banbury Rise
Banbury
Oxfordshire

Map of survey area





Survey location

Site centred on OS NGR
SP 43410 40240

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 Banbury Rise
Banbury
Oxfordshire

Referencing information

443100 443200 443300 443400 443500 443600 443700

240500 240400 240300 240200 240100 240000 239900

Area 1

Area 1

N

Referencing grid to OSGB36 datum at 100m intervals

443400 240200

Survey tracks

Survey track start

Survey track stop

Development boundary

SCALE 1:2500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 02

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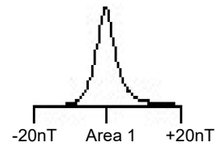
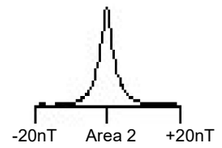
Greyscale plot of minimally processed magnetometer data

+20nT

-20nT





SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

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KTD	DJS	FIG 03

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Abstraction and interpretation of magnetic anomalies

- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear anomaly - ring ditch
- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - material of low magnetic susceptibility
- Linear anomaly - ridge and furrow
- Linear anomaly - of agricultural origin
- Linear anomaly - of natural origin
- Discrete positive response - cut feature of archaeological potential
- Strong discrete response - of archaeological potential
- Discrete positive response - possible pit-like feature
- Discrete positive response - of natural origin
- Variable magnetic response - former quarrying
- Weakly positive anomaly - linear feature of archaeological potential
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/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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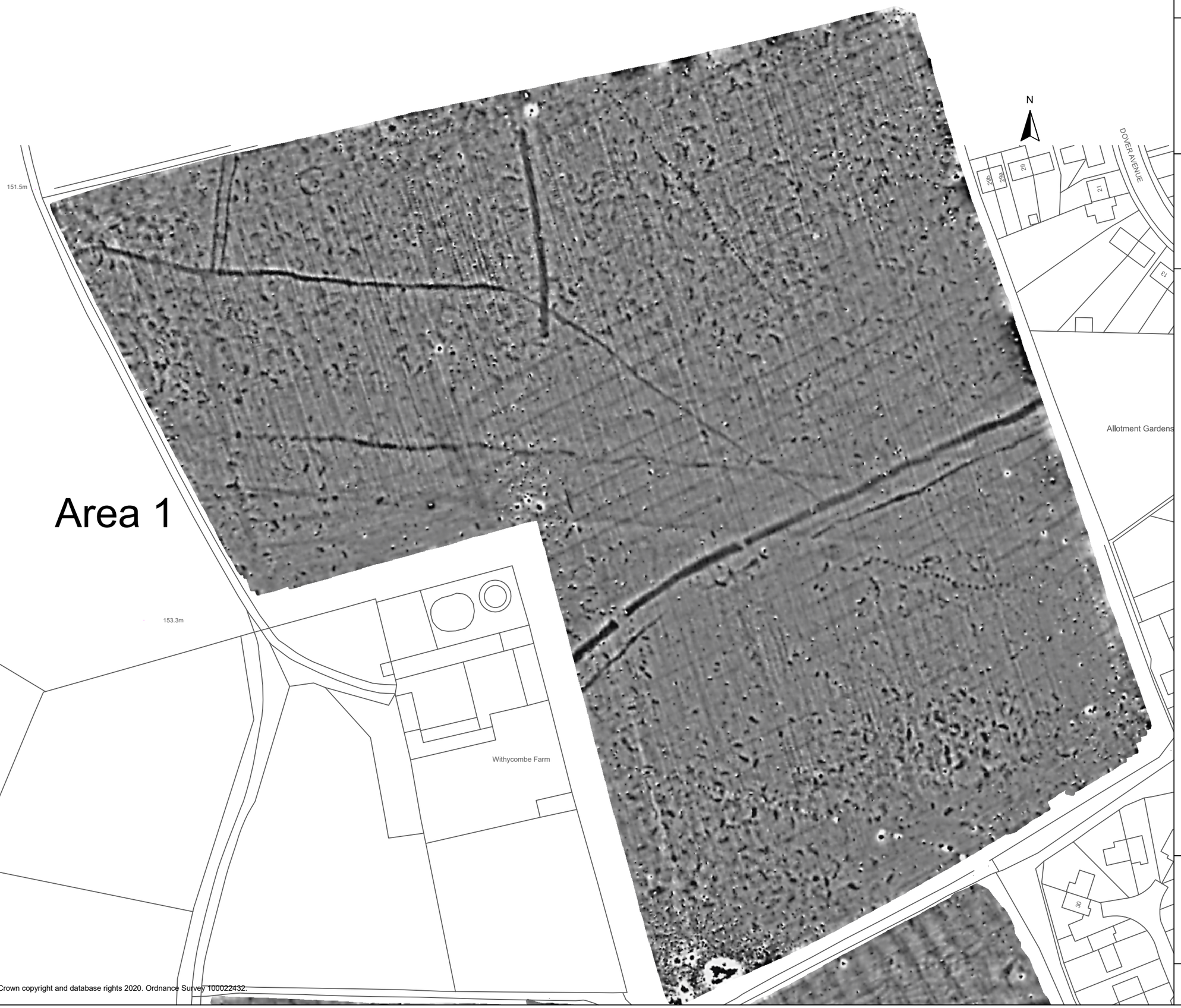
Greyscale plot of minimally processed magnetometer data clipped at ±20nT - Area 1



-20nT +20nT +20nT -20nT

SCALE 1:1250

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 05

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Abstraction and interpretation of magnetic anomalies - Area 1

Area 1

N

151.5m

153.3m

DOVER AVENUE

Allotment Gardens

Withycombe Farm

- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear anomaly - ring ditch
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - ridge and furrow
- Linear anomaly - of agricultural origin
- 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
- Weakly positive anomaly - linear feature of archaeological potential
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Strong multiple dipolar linear anomaly - pipeline / cable / service
- Strong dipolar anomaly - ferrous object

SCALE 1:1250

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 06

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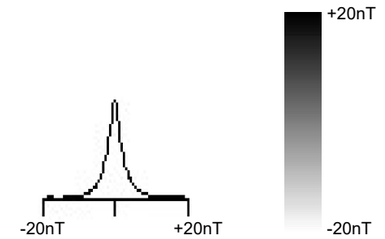
Greyscale plot of minimally processed magnetometer data clipped at ±20nT - Area 2



Withycombe Farm

N

THORNBURY RISE

Area 1

SCALE 1:1250

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 07

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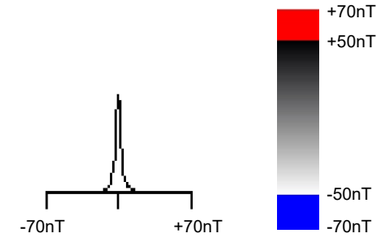
Greyscale plot of minimally processed magnetometer data clipped at ±70nT - Area 2



Withycombe Farm

N

THORNBURY RISE

Area 1

SCALE 1:1250

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 2

Withycombe Farm

THORNBURY RISE

Area 1

N

- Positive linear anomaly - cut feature of archaeological potential
- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - material of low magnetic susceptibility
- Linear anomaly - ridge and furrow
- Linear anomaly - of agricultural origin
- Linear anomaly - of natural origin
- Discrete positive response - cut feature of archaeological potential
- Strong discrete response - of archaeological potential
- Discrete positive response - possible pit-like feature
- Discrete positive response - of natural origin
- Positive anomaly - broad linear feature of archaeological potential
- Positive anomaly - magnetically enhanced material
- Strong dipolar anomaly - ferrous object

SCALE 1:1250

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 09