SUFFOLK ARCHAEOLOGY

• A HISTORY OF EXPERTISE •

Garden Field

Sutton Hoo, Suffolk

Client:
National Trust

Date:
May 2016

BML 037
Geophysical Survey Report
SACIC Report No. 2016/035
Author: Timothy Schofield HND BSc MCIfA
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Illustrator: Timothy Schofield

Editor: Rhodri Gardner

Report Date: May 2016

HER Information

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Site Name:	**Garden Field, Sutton Hoo, Suffolk**
Report Number	**2016/035**
Planning Application No:	**n/a**
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Oasis Reference:	**248405**
Curatorial Officer:	**n/a**
Project Officer:	**Timothy Schofield**
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Any opinions expressed in this report about the need for further archaeological work are those of Suffolk Archaeology CIC. Ultimately the need for further work will be determined by the Local Planning Authority and its Archaeological Advisors when a planning application is registered. Suffolk Archaeology CIC cannot accept responsibility for inconvenience caused to the clients should the Planning Authority take a different view to that expressed in the report.

Prepared By: Timothy Schofield
Date: May 2016

Approved By: Rhodri Gardner
Position: Director
Date: May 2016
Signed:

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Summary

In March 2016 Suffolk Archaeology Community Interest Company undertook a detailed fluxgate gradiometer and magnetic susceptibility meter survey on land currently set aside for sheep pasture at Garden Field, Sutton Hoo, Suffolk.

The detailed fluxgate gradiometer survey was successful in recording a range of geophysical anomalies that complement the preceding non-intrusive surveys. Positive linear trends indicative of former settlement ditches or field boundaries from at least three separate phases, thermoremanent responses indicative of a kiln type anomaly, a plethora of discrete pit type anomalies, two areas of magnetic disturbance and sparse isolated dipolar responses of potential archaeological derivation, one broad geological anomaly, a dipolar linear trend delineating a modern service run and negative linear trends of agricultural origin were prospected.

A magnetic susceptibility meter survey undertaken over the majority of Garden Field revealed that peaks of higher soil magnetisation were predominant in the eastern half of the existing enclosure, these higher readings may derive from settlement type activity. Lower readings were recorded in the western half of the field where potential colluvial deposits located on the side of the slope may be masking deeper lying areas of cultural enhancement.

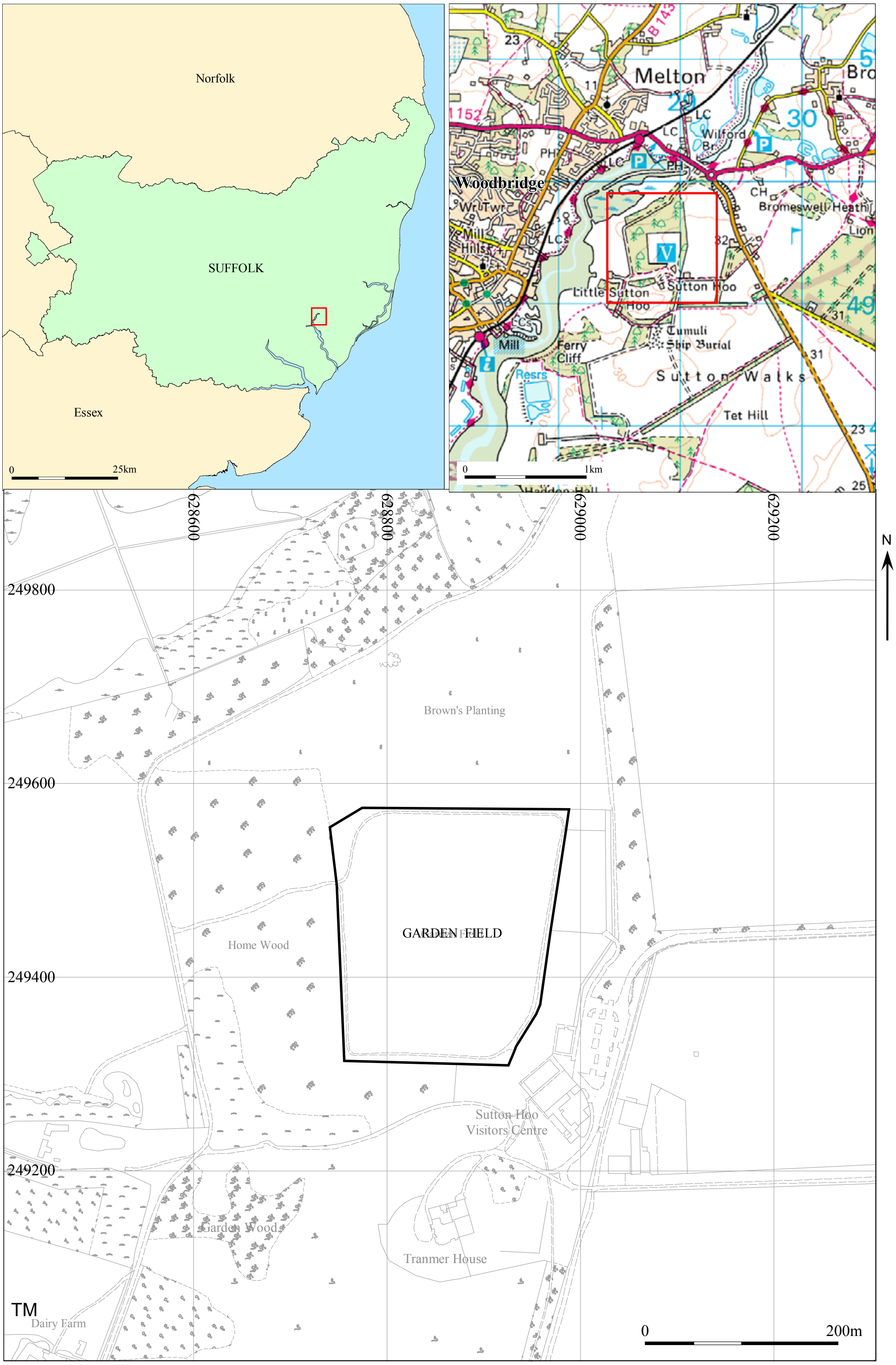
1. Introduction

In March 2016 detailed fluxgate gradiometer survey covering *c*.2 hectares and area magnetic susceptibility meter survey on *c*.5 hectares of land, set aside to sheep pasture at Garden Field, Sutton Hoo, Suffolk (Fig.1) was undertaken by Suffolk Archaeology Community Interest Company (SACIC).

The detailed fluxgate gradiometer survey was carried out in two 60m separated areas that were not surveyed during a previous geophysical survey undertaken by English Heritage in 2001. Magnetic susceptibility meter survey was also carried out within 10m centres, to cover both the former 2002 and current detailed geophysical survey areas, this comprised an area totalling *c*.5 hectares. The project was undertaken by SACIC as a trial exercise to determine whether geophysical survey techniques were suitable for visitor participation as a part of the Sutton Hoo experience.

Suffolk Archaeology CIC were commissioned to undertake the work by Angus Wainwright on behalf of the National Trust.

Figure 1. Location plan



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2. Geology and topography

Garden Field is situated in the grounds of Tranmer House, adjacent to the Suffolk town of Woodbridge in the parish of Bromeswell (Fig. 1). The survey area (centred on NGR TM 2885 4937) comprises a single field currently set aside to pasture and grazed by rare breed sheep. The eastern side of site is located on a plateau at a height of *c*.30m AOD, which slopes down to the western boundary to a height of *c*.20m AOD.

The Bedrock geology is described as Thames Group clay and silt, formed 34 to 56 million years ago in the Palaeogene Period as shallow water sediments redeposited as graded beds. Superficial geology is described as River Terrace sand and gravel formed up to 3 million years ago in the Quaternary Period deposited as sand and gravel detrital material in channels to form river terrace deposits with fine silt and clay forming floodplain alluvium and some bogs depositing peat (BGS, 2016).

3. Archaeology and historical background

Garden Field is located close to the famous Sutton Hoo ship burial and lies immediately to the northwest of the visitors centre and treasury. Archaeological fieldwork undertaken over the last thirty years on Garden Field has most significantly recovered remains of a rare imported artefact known as the 'Bromeswell Bucket', it is of eastern Mediterranean origin dating from the 6th century and was present in the southeastern corner.

Survey work undertaken in the preceding years includes fieldwalking in 1984 and 1986 by Suffolk County Council Archaeological Service (SCCAS), confirming the presence of early Anglo Saxon pottery alongside later Ipswich ware in two areas of Garden Field (Gardner and Sommers 2013).

In 1997 Field Archaeology Specialists Ltd (Copp, 1997) undertook a topographic survey in Garden Field as well as geophysical surveys in fields to the east and south of the site.

In 2001 English Heritage (Linford, 2002) undertook a geophysical survey over a large part of Garden Field. Perpendicular running positive linear trends interpreted as former field boundaries, two short and narrow irregular linear anomalies that could represent structural remains or linked rubbish pits and a plethora of positive discrete pit type anomalies were prospected. One curving broad linear anomaly indicative of a geological response was also recorded. A strong dipolar linear trend orientated northwest to southeast is likely to delineate the route of a buried ferrous service run.

Further fragments of the 'Bromeswell Bucket' were recovered in the 2012 metal detecting survey (Gardner and Sommers, 2013), the bucket has been associated with a potential burial that may have been unintentionally damaged by the construction of the buried service run, recorded in the preceding geophysical survey. Forty other objects were recovered, of which eleven could be dated. Thirteen were described as droplets, which may indicate the presence of a metalworking site nearby. Two objects were identified as modern replicas of Anglo Saxon objects, a consequence of re-enactment activities undertaken on the field over recent years.

4. Methodology

Instrument type

A Bartington DualGRAD 601-2 fluxgate gradiometer was employed to undertake the detailed geophysical survey, a Bartington Magnetic Susceptibility Meter with field coil (MS2D) was deployed to cover the current and previous detailed magnetometer survey areas.

Instrument calibration and settings

The magnetic susceptibility of the soil was found to be relatively homogenous towards the centre of the site, allowing the location of a suitable zero station (to correct diurnal drift) to be found with ease. One hour was allowed for the instruments sensors to reach optimum operating temperature before the survey commenced. The weather was sunny with interspersed showers and overcast conditions. The detailed magnetometer sampling interval was set to 0.25m along 1m traverses (four readings per metre). Magnetic susceptibility meter readings were recorded at 10m centres.

Survey grid layout

The detailed survey was undertaken within 20m grids (Figure 2, magenta grid), orientated east to west and geolocated employing a Leica Viva GS08+ Smart Rover RTK GLONASS/GPS, allowing an accuracy of +/- 0.01m. Data were converted to National Grid Transformation OSTN02. The magnetic susceptibility area survey was undertaken on the same grid at 10m centres (Figure 2, green grid) with each recorded point geolocated by the RTK GPS.

Data capture

Detailed fluxgate gradiometer survey data points were recorded on an internal data logger that were downloaded and checked for quality at midday and in the evening, allowing grids to be re-surveyed if necessary. A pro-forma survey sheet was completed to allow data composites to be created. Data were filed in unique project folders and backed-up onto an external storage device and then a remote server in the evening.

Geo-located magnetic susceptibility meter readings were hand-logged on a survey grid sheet, with readings inputted manually into the software package creating a grid composite. The composite was backed-up onto an external storage device and then a remote server.

Data software, processing and presentation

High quality raw survey data was collected despite the uneven terrain, steep slope, and brambles, allowing minimal data processing to be required. Datasets were composited and processed using DW Consulting's Terrasurveyor v.3.0.27, the raw grid files will be stored and archived in this format. Minimal processing algorithms were undertaken on the raw (Figure 4) and processed (Figure 5) datasets, schedules are presented in Appendix 3. The magnetic susceptibility meter composite is presented as total SI units with no processing (Figure 3), high magnetic susceptible readings are depicted black and conversely low are presented in white.

Data composites were exported as raster images into AutoCAD, An interpretation plan based on the combined interpretations of the raw, processed and xy trace plots (Figures 4, 5 & 6) has been produced in Figure 7. A combined magnetic susceptibility data plot overlain with the magnetometer interpretation plan is illustrated at Figure 8.

Survey grid restoration

Three permanent survey grid stations were placed on survey grid nodes along the baselines in the field (Figure 2), which will allow the position of the grid and the geophysical anomalies to be accurately relocated.

5. Results

Trial visitor participation geophysical surveys

A trial geophysical survey undertaken over two days with participants comprising Sutton Hoo visitors using both a fluxgate gradiometer and a magnetic susceptibility meter across Garden Field, were carried out by SACIC aided by National Trust volunteers.

As suspected the fluxgate gradiometer survey data collected by the visitors, who wore their ‘normal’ day wear, was found to be too ‘noisy’ to allow the low magnetic contrast anomalies known to be present, to be recorded. Despite this, the visitors physically enjoyed walking the grids and getting to grips with the principles and methods of carrying out a detailed magnetometer survey. For this technique to be a success and anomalies to be prospected, the visitors would need to be completely non-magnetic, which may prove difficult to organise.

The magnetic susceptibility meter survey proved to be more successful in terms of data that could be used, the visitor’s magnetic clothing does not affect the instrument’s function. It is relatively simple to operate compared with the fluxgate gradiometer, with two buttons to press, one to zero and one to take a reading. The survey methodology is also simple and the visitors grasped the process with ease. Readings were written on to a grid that directly correlated with that viewed on the screen of the GPS, allowing the visitors to build a dataset in which areas of increased magnetic enhancement could be immediately identified. This instant feedback was particularly gratifying, with readings added to the dataset as the field was traversed.

One geophysicist was in charge of each instrument, allowing two groups to undertake the surveys simultaneously, before the visitors swapped techniques. Having the geophysical surveyors on site allowed visitor questions to be answered as the survey progressed. National Trust volunteers helped to keep the visitors experience positive by welcoming them on to site, signing them on to the activity and moving them between the surveys. The volunteers also handed out feedback forms that were completed and will be collated to evaluate the day, this will allow any improvements to be made in time for the next geophysical survey experience.

Professional Detailed Fluxgate Gradiometer Survey

The results of the professional detailed geophysical survey are illustrated in Figure 7 and are further discussed below. A combined greyscale magnetic susceptibility meter survey plot overlain with magnetometer interpretation, find spot data and topographic survey can be found at Figure 8.

A strong dipolar linear anomaly (dark blue line) bisects the northeastern corner of the southern survey area, orientated northwest to southeast, it is the continuation of a modern ferrous service run also recorded during the English Heritage Centre for Archaeology (EH CfA, Linford, 2002) geophysical survey.

Three linear areas of magnetic disturbance (brown linears) located on the northern boundary represent ferrous fence readings recorded close to the sites periphery.

Isolated dipolar responses (yellow spots) were sparsely recorded within the two survey areas, their close proximity with nearby important archaeological remains increases the likelihood that they are buried cultural artefacts. This relatively low occurrence of isolated dipolar responses compares favourably with the EH CfA survey results.

Two narrow negative linear anomalies (cyan lines) delineate the location of agricultural furrows that are of probable modern agricultural origin, they are similar in character to the asparagus bed anomalies recorded by Linford during the English heritage survey of 2001 (EH CfA, Linford, 2002).

Two discrete areas of magnetic disturbance (yellow block colour) have been recorded on either side of a ditched type enclosure anomaly in the southern survey area, buried ferrous debris is likely to have caused these readings and their location suggests an archaeological derivation.

A single broad positive linear anomaly (green block colour) of probable geological derivation is recorded in the northern area, visible on both the topographic survey undertaken by FAS in 1997 (Copp et al 1997) and also recorded during the geophysical survey carried out by EH CfA. Paul Linford in his report (2002) surmises that this anomaly may have been a former conduit for the River Deben.

Positive discrete anomalies (orange block colour) commonly indicative of pits are numerous within both survey areas, recorded close to the positive linears, which is comparable with the EH CfA survey. Magnetic variations within the superficial geology could also account for these readings (Linford, 2002) or alternatively naturally occurring features like the tree hollows recorded by SCCAS to the south (Abbott, 1997).

Two thermoremanent responses (purple block colour) have been recorded in the north-western corner of the field that are indicative of potential hearths, ovens, kilns or furnaces. Fieldwalking undertaken by SCCAS field team in 1984 and 1986 recovered two fragments of oven/kiln daub as well as Roman pottery sherds in this area (Gardner and Sommers, 2013) which gives credence to this hypothesis (see Figure 8).

Positive linear anomalies (red block colour) were also numerous within the two survey areas that are indicative of enclosure and trackway ditches, the orientations of which are located on at least three different alignments. The earliest of which comprises a slightly curving positive anomaly orientated east-south-east to west-north-west before heading in a north-westerly direction beyond the bounds of the survey to the west. This appears to be overlain by positive linear anomalies recorded north-north-east to south-south-west and perpendicular and parallel running linears indicative of a trackway with an approximate two metre separation recorded along the 25-30m contour. A third phase 'cuts' through the potential trackway anomalies on a northwest to southeast and perpendicular arrangement.

Area Magnetic Susceptibility Meter Survey

A greyscale plot of the magnetic susceptibility survey can be found at Figure 3, a combined magnetometer interpretation plot, greyscale magnetic susceptibility meter, topographic survey and find spot data plot has also been produced (Figure 8).

The magnetic susceptibility meter survey readings range from 3 to 35 SI units across the survey area. Higher magnetic susceptibility values (black) are predominantly recorded in the eastern half of the field where the topsoil horizon plateau's at a height of around 30m AOD. The results seem to suggest that the topsoil has been culturally enhanced to a greater extent on top of the rise to the east than on the side of the slope to the west.

Low magnetic susceptibility readings (white) have been recorded in the western half of Garden Field, here the site slopes down to 23m AOD on the western boundary. It was expected that relatively high magnetic susceptibility readings would also be recorded here corresponding with the anomalies of high archaeological potential prospected by the fluxgate gradiometer survey (Figure 8). This discrepancy may be caused by low magnetically susceptible colluvial deposits masking deeper-lying higher magnetically enhanced soils from being detected. Alternatively the results may show that site activity was zonal, with high magnetic enhancement caused by cultural activity and settlement on the plateau to the east and lower magnetic enhancement perhaps due to agriculture practices undertaken on the side of the hill to the west.

Areas recorded with relatively high magnetic susceptibility are more likely to be of an archaeological derivation, further non-invasive investigations could be targeted here to see if this hypothesis is correct. Similarly the areas of low magnetic susceptibility could be further targeted by geophysical survey to identify whether there is a difference in site use within this area.

Find spot evidence recovered from Garden Field

Four separate fieldwalking and metal detector surveys undertaken over a period spanning 30 years have covered 3.63ha of the total 5.7 hectares available at Garden Field. The results are collated together by phase in Figure 8, combined with the interpretation of the geophysical surveys, the topographic survey and the magnetic susceptibility plot, to aid the interpretation of the geophysical anomalies.

The 1984 and 1986 fieldwalking surveys were undertaken on a grid format recording finds within a formal grid pattern in the northwestern and southeastern corners. A Total Station and GPS were employed during the 2000 and 2012 surveys to individually georeference each find.

Fieldwalking and metal detector surveys reveal that the majority of artefacts were recovered from the northwestern and southeastern corners of the field. These two areas were most intensively searched during the surveys and therefore the data may be slightly biased towards increased finds recovery in these locations.

The highest concentration of prehistoric finds are located in the southeast of Garden Field, where knapped flint flakes were most common, one pottery sherd and a single Bronze Age copper alloy spearhead tip were further recovered.

Romano-British findspots were clustered in the northwestern quarter, with sparse remains recovered in the southern half of the field. Pottery sherds were found to be most numerous and include a potential sherd of amphora along with two sherds of oven or kiln lining clustered in the northwestern corner. A single fibulae catchplate was further recovered in the middle of the western boundary. Five coins and a brooch were collected in the southern half along with a few sherds of Roman pottery.

Anglo-Saxon finds were recovered only in the southern half of the field with a particular cluster of finds recovered in the southeastern corner. These finds comprise early and middle saxon pottery sherds, copper alloy brooches, a buckle and a pin, a gold pendant and loop and the 6^{th} century brass situla known colloquially as the 'Bromeswell bucket'.

Late and post medieval finds were most numerous in the southeastern corner with coins, buckles and buttons metal detected and pottery sherds recovered that are likely to relate to small scale farming undertaken in the vicinity from at least the 16^{th} century (Fern, 2015).

Two objects were identified as modern replicas of Anglo Saxon brooches worn during re-enactment activities undertaken on Garden field in the recent past (Gardner and Sommers, 2013).

A selection of undated copper alloy droplets were further recovered in the south-eastern corner of Garden Field (Gardner and Sommers, 2013).

6. Discussion

Evidence from seven different fieldwork phases of non-intrusive archaeological survey undertaken at Garden Field over a 30 year period have been collated in order to analyse the type of cultural activity potentially present beneath the surface.

Early prehistoric finds have been recovered predominantly in the southeastern corner of the field where struck flint flakes and a single Bronze-Age spearhead were discovered during fieldwalking and metal detector surveys, magnetic enhancement of the topsoil in this location further suggests a higher potential for cultural activity to have taken place in this area. The detailed magnetometer survey undertaken in 2001 (EH CfA, Linford, 2002) records a single linear anomaly in the southeastern corner interpreted as the northern extent of an Iron Age boundary ditch (Fern, 2015) that may form an enclosure with perpendicular and parallel ditches recorded in the excavations immediately to the east (Topham-Smith, 2000). Ditch-type anomalies indicative of Bronze Age or Late Iron Age - Romano-British enclosures were further recorded during the current phase of geophysical survey in the western half of the field, running northerly along the 25 to 30m contour on the side of the slope into the northwestern corner of the field. At least three different phases of ditch type enclosure alteration is recorded in the dataset which is likely to have continued into the Romano-British period.

Three Romano-British coins are recorded in the southwestern corner close to an enclosure ditch-type anomaly, orientated northwest to southeast and perpendicular that ‘cuts’ through probable earlier trackway-type parallel positive linear anomalies. Further Romano-British evidence is recorded where a cluster of Romano-British pottery including two possible kiln fragments were recovered during fieldwalking in the northwestern corner, two intriguing thermoremanent responses prospected in this same location increase the likelihood that these anomalies may relate to a potential kiln.

A cluster of Anglo-Saxon jewellery was recovered in the southeastern corner, together with the Bromeswell bucket, these finds provide evidence of funerary activity in this area. An increase in the levels of topsoil magnetic enhancement, reveal that funerary activity may also have included cremation practices. Undated copper alloy droplets and heat affected Anglo-Saxon artefacts that include items of jewellery, may provide further evidence for cremation activity within this locale.

Late and post medieval finds located in the southeastern corner are likely to relate to small scale farming regimes undertaken in the vicinity from at least the 16^{th} century (Fern, 2015).

7. Archive deposition

The paper, and digital archive will be kept at the SACIC office in Needham Market, before deposition in the Suffolk County Council Stores.

8. Acknowledgements

The fieldwork was carried out by Tim Schofield and Ed Palka and directed by Tim Schofield.

Project management was undertaken by Rhodri Gardner.

The report illustrations were created by Tim Schofield and the report was edited by Rhodri Gardner.

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STATION	EASTING	NORTHING
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03	628798.134	249558.459

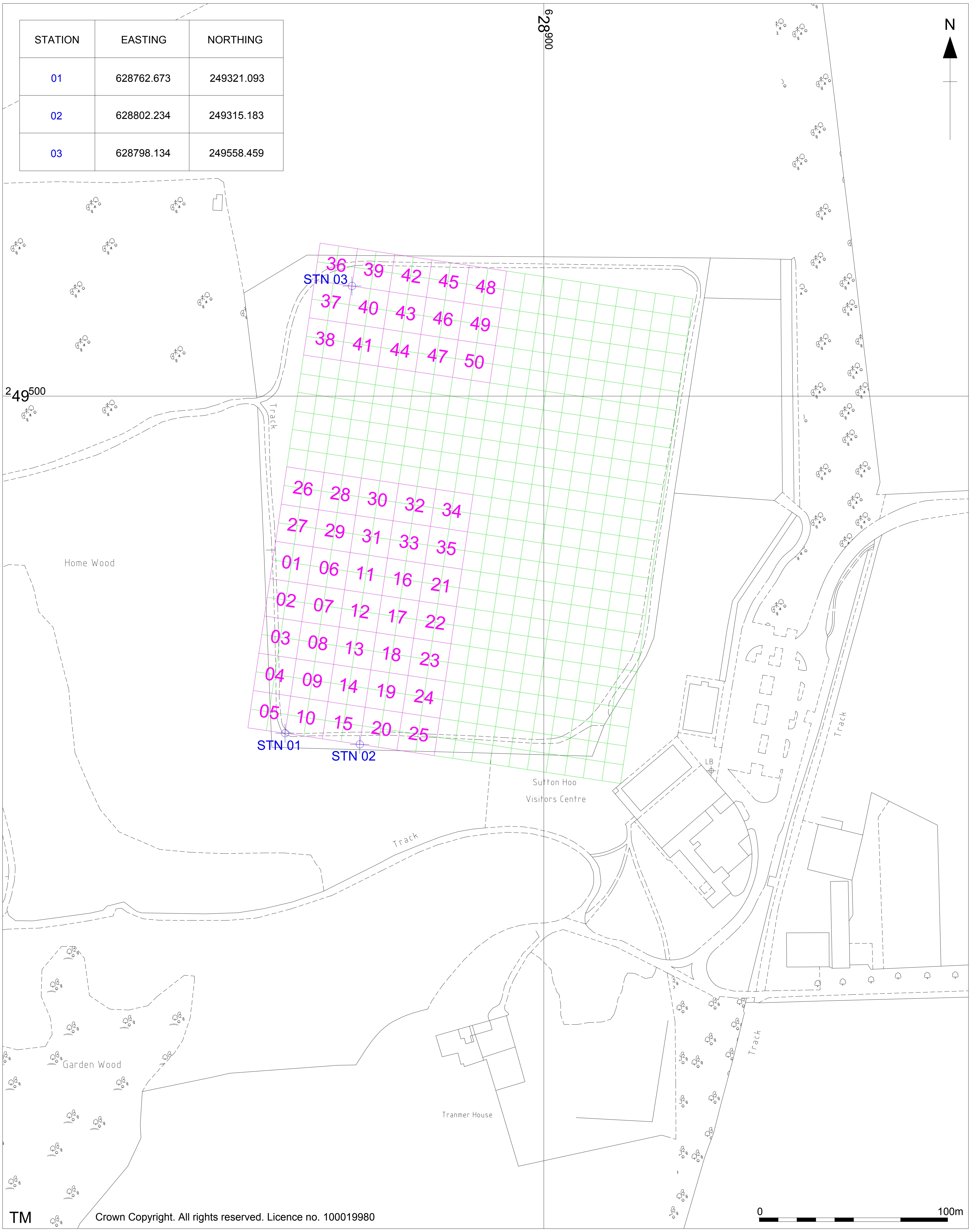

Figure 2. Survey grid & station location

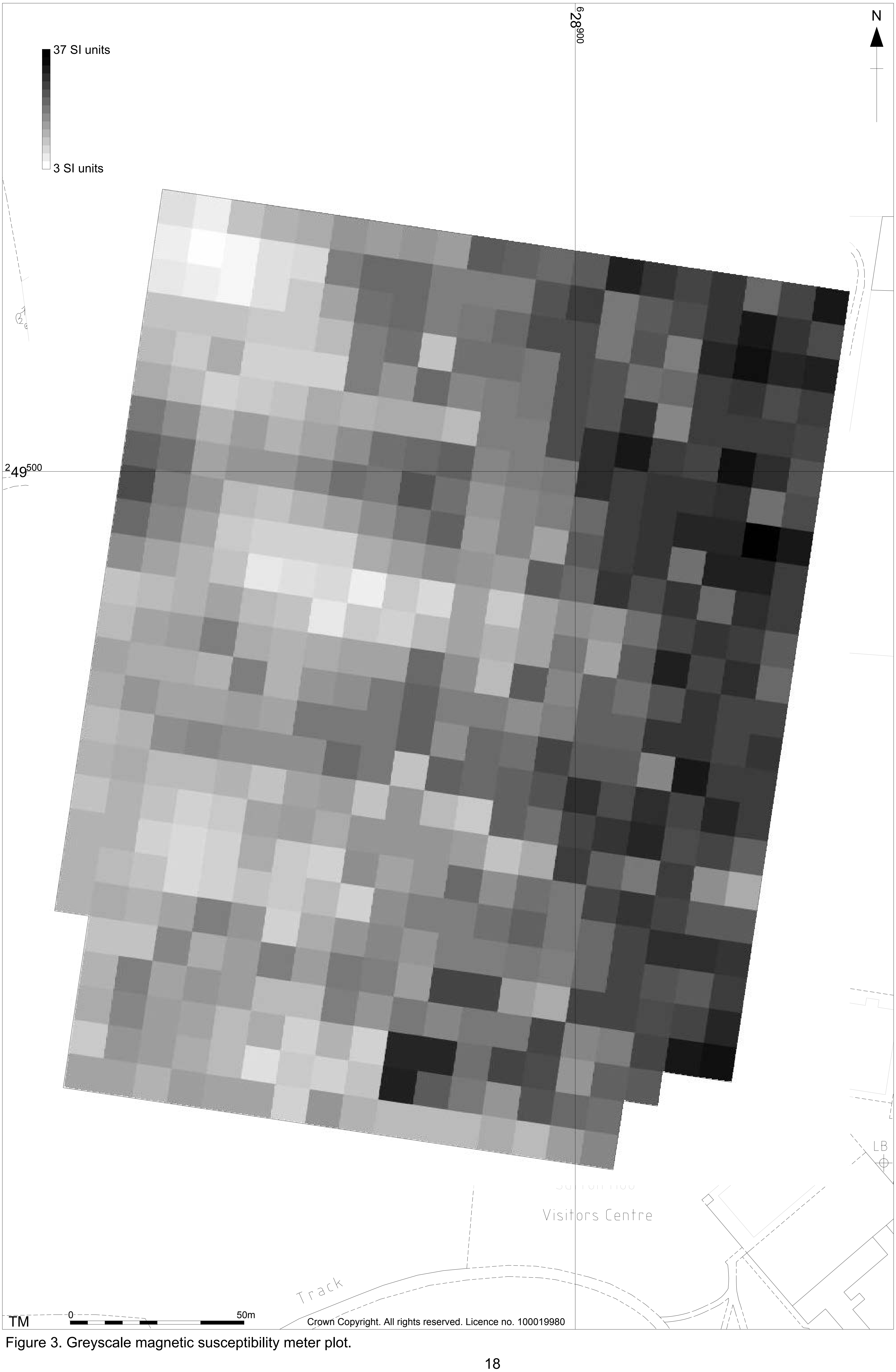

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Figure 3. Greyscale magnetic susceptibility meter plot.

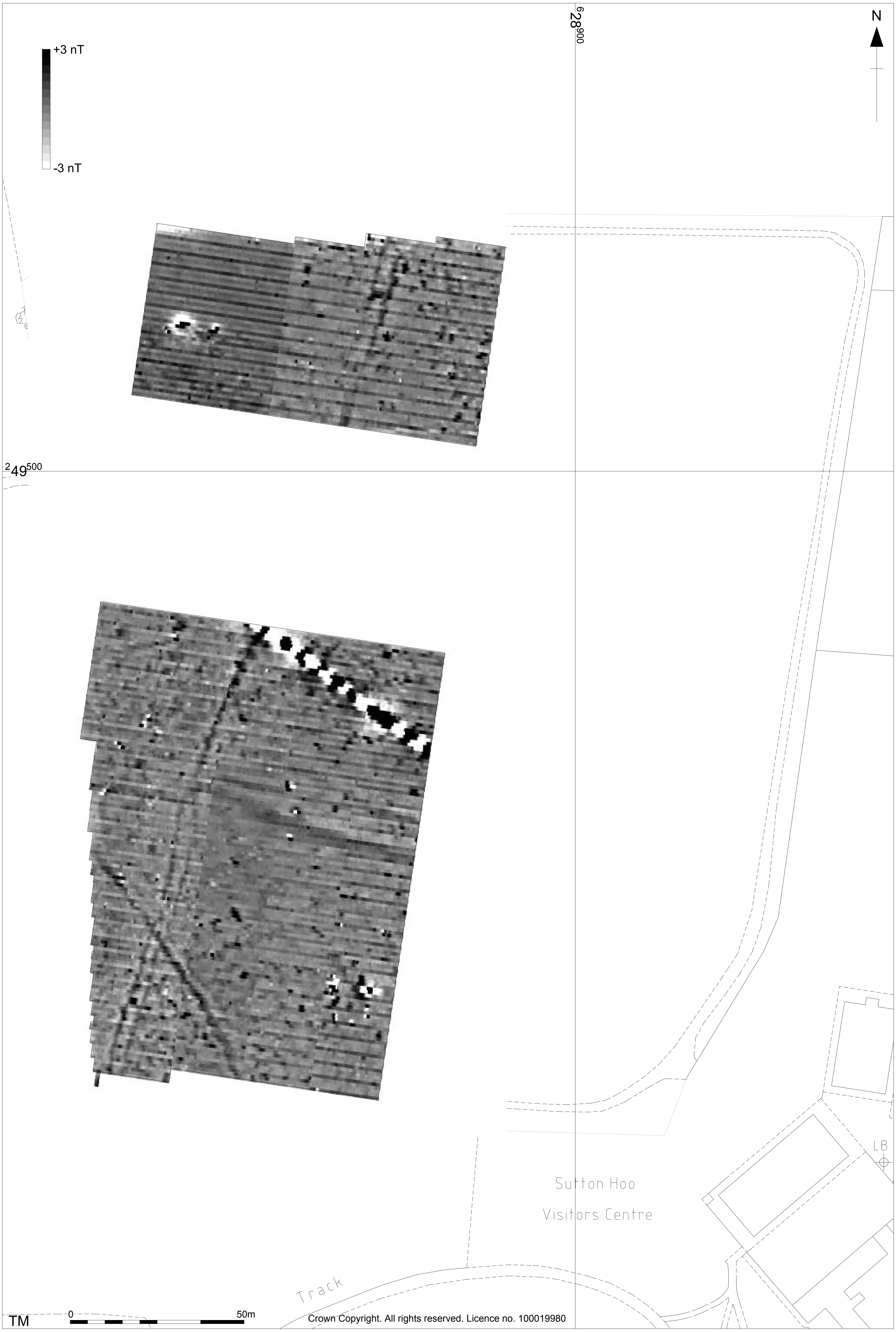

Figure 4. Raw magnetometer greyscale plot.

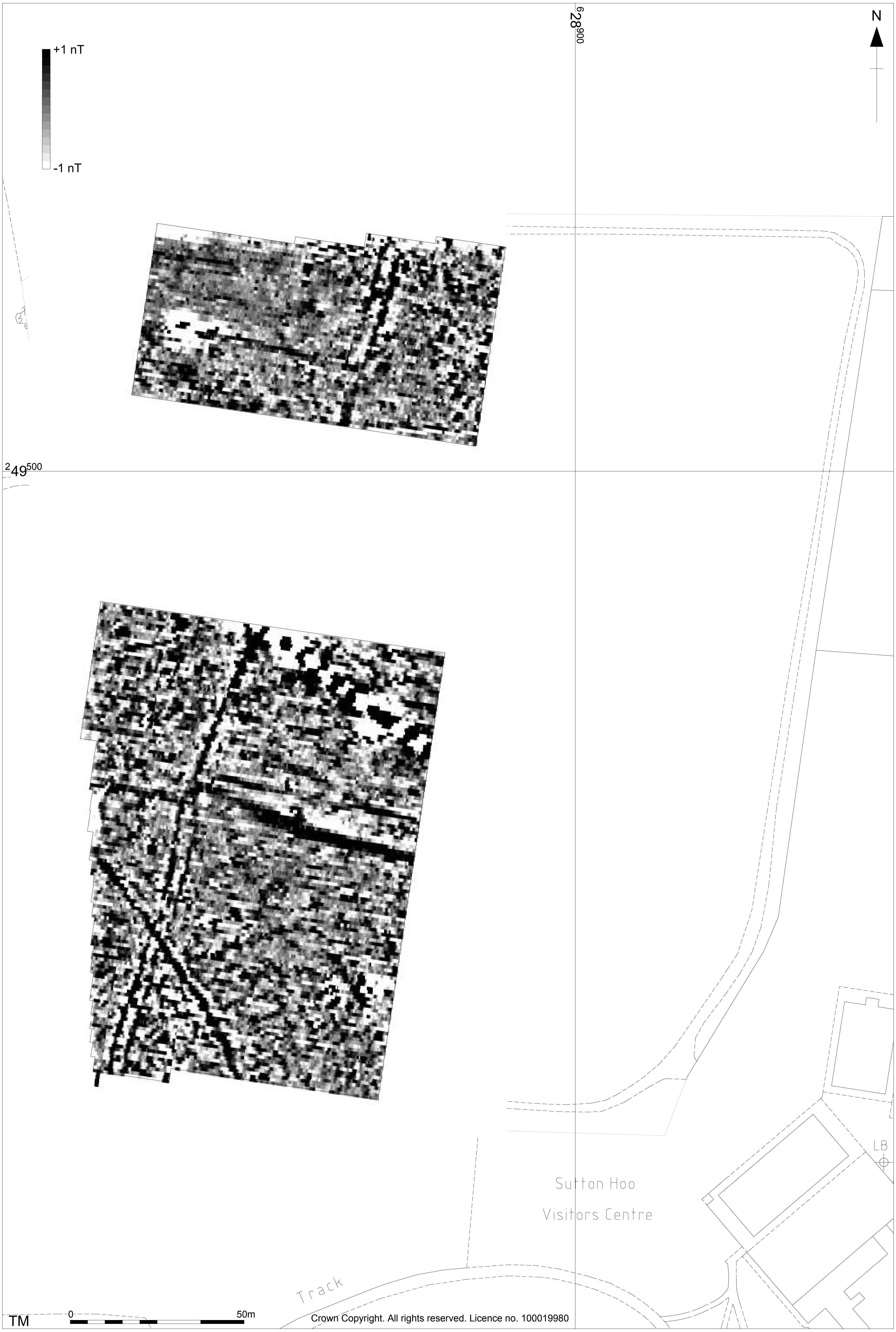

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Figure 5. Processed magnetometer greyscale plot.

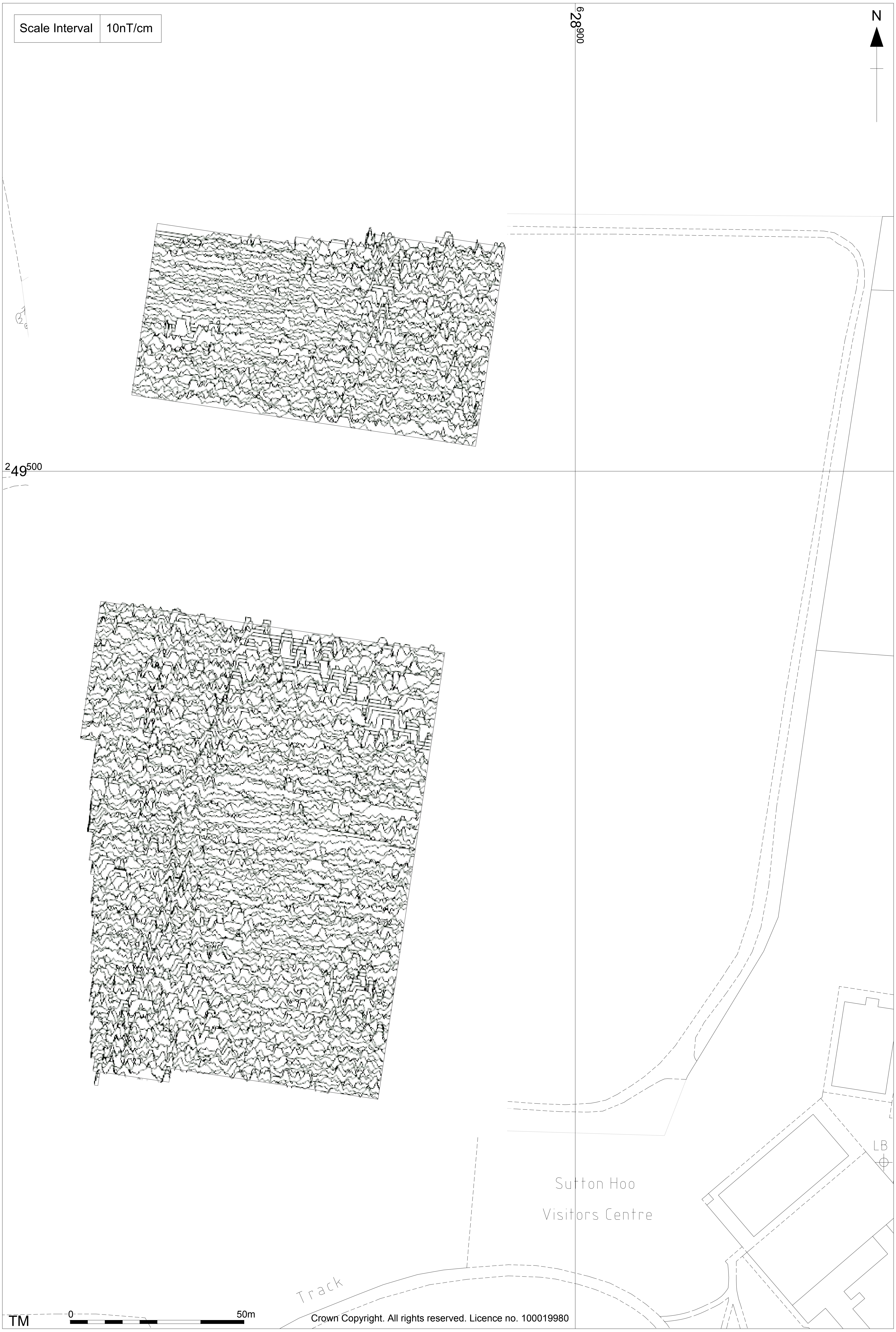

Figure 6. Processed magnetometer xy trace plot.

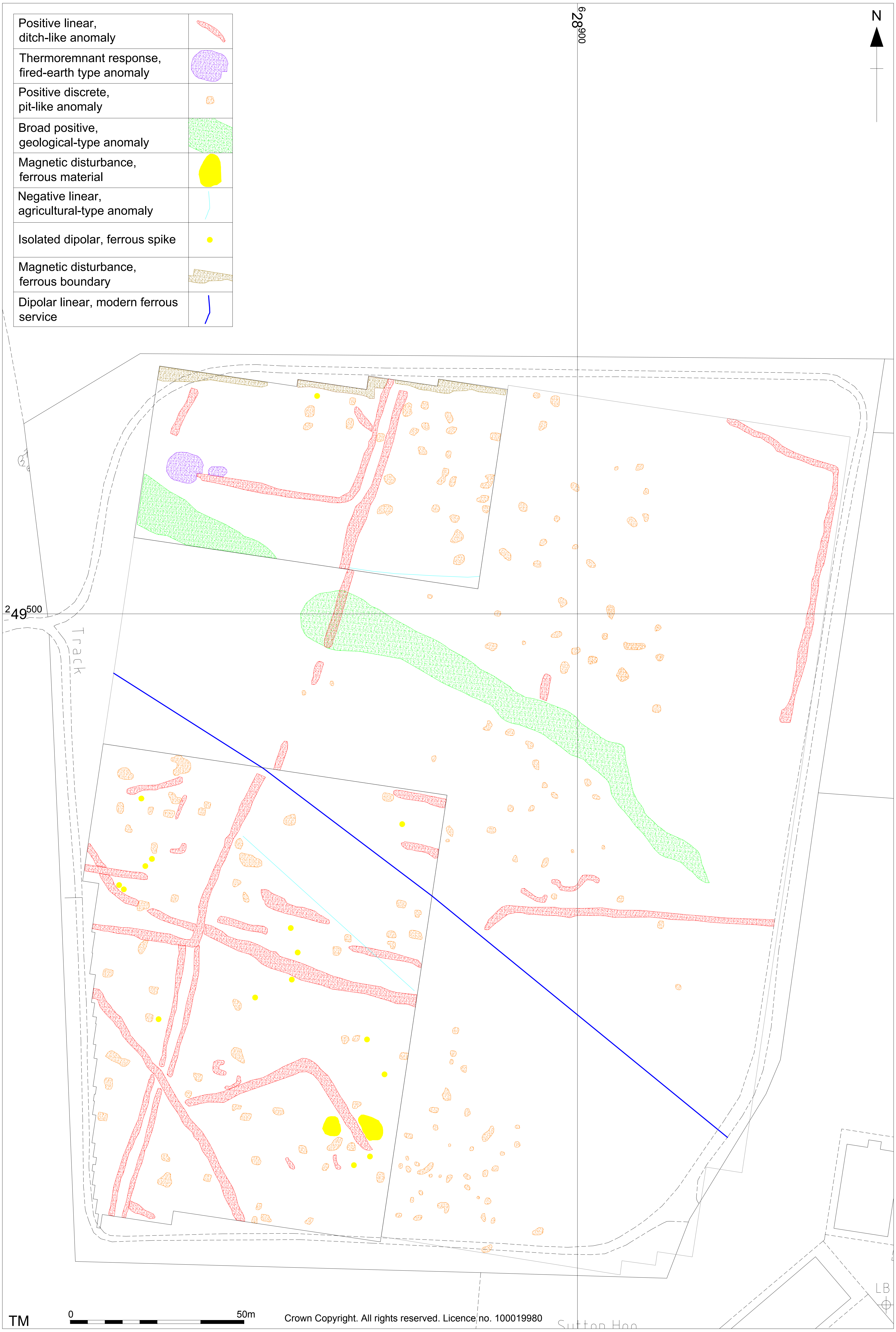

Figure 7. Interpretation plot of magnetometer anomalies, combined with Linford's survey of 2002.

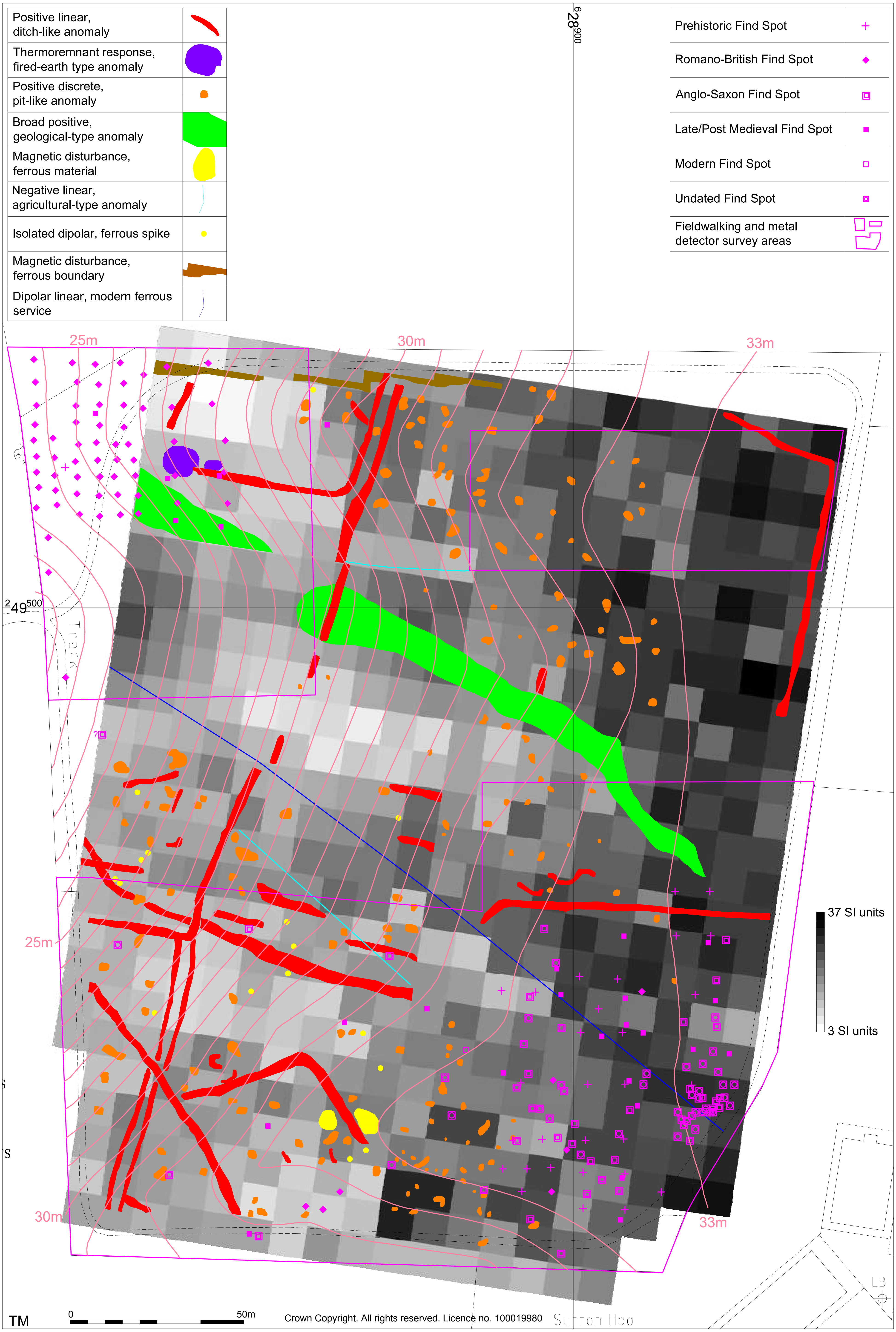

Figure 8. Magnetometer interpretations combined with magnetic susceptibility results and find spots by phase.

Appendix 1. Metadata Sheets

Magnetic susceptibility meter survey

Filename	S Hoo Mag SUS.xcp
Description	
Instrument Type	Bartington MS 2D
Units	
Direction of 1st Traverse	0 deg
Collection Method	Parallel
Sensors	1
Dummy Value	32702
Dimensions	
Composite Size (readings)	27 x 27
Survey Size (meters)	270 m x 270 m
Grid Size	10 m x 10 m
X Interval	10 m
Y Interval	10 m
Stats	
Max	37.00
Min	3.00
Std Dev	7.31
Mean	19.51
Median	19.00
Composite Area	7.29 ha
Surveyed Area	5.07 ha
Program	
Name	TerraSurveyor
Version	3.0.27.0

Magnetic susceptibility meter survey data presentation

No Processing.

Fluxgate gradiometer survey

Source Grids: 50

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50	Col:4	Row:12	grids\25.xgd

Raw data

Filename	Sutton Hoo R.xcp
Description	
Instrument Type	Grad 601-2 (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	400 x 260
Survey Size (meters)	100 m x 260 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	3.00
Min	-3.00
Std Dev	0.90
Mean	0.23
Median	0.15
Composite Area	2.6 ha
Surveyed Area	1.7502 ha
Program	
Name	TerraSurveyor
Version	3.0.27.0

Raw data presentation

Clip from -3.00 to + 3.00 nT.

No processing.

Processed data

Filename	Sutton Hoo P.xcp
Description	
Instrument Type	Grad 601-2 (Gradiometer)
Units	nT
Direction of 1st Traverse	90 deg
Collection Method	ZigZag
Sensors	2 @ 1.00 m spacing.
Dummy Value	2047.5
Dimensions	
Composite Size (readings)	400 x 260
Survey Size (meters)	100 m x 260 m
Grid Size	20 m x 20 m
X Interval	0.25 m
Y Interval	1 m
Stats	
Max	1.00
Min	-1.00
Std Dev	0.51
Mean	0.03
Median	0.00
Composite Area	2.6 ha
Surveyed Area	1.7502 ha
Program	
Name	TerraSurveyor
Version	3.0.27.0

Processed data presentation

Destripe median sensors all

Clip from -2.00 to +2.00 nT

Appendix 2. Technical Data

Detailed magnetometer survey

Detailed magnetometer survey is the most commonly employed archaeological geophysical prospection method in Britain, sensitive sensors can cost-effectively cover large areas of ground, rapidly recording anomalies that are indicative of cultural settlement activity. These anomalies can then be further investigated by field archaeologists to quantify a form and function. The magnetometer is a passive instrument that detects both permanent thermoremanent and temporary magnetic responses.

Thermoremanent Magnetism

When a material containing iron oxides, for example clay, is heated above the Curie point, weakly magnetic compounds transform in to highly magnetic oxides that can be detected by the sensors of a magnetometer (Clark, 1996). For instance the iron oxide haematite has a Curie temperature of 675 Celsius and magnetite 565 Celsius. Once these temperatures are reached, the oxides become demagnetised, on cooling their magnetic properties become permanently re-magnetised and align in the direction of the Earth’s magnetic field (Gaffney and Gater, 2002). Over time the direction of the Earth’s magnetic field changes allowing these directional differences to be detected by the magnetometer.

Strongly heated features such as hearths, kilns or furnaces frequently reach the Curie temperature and become permanently magnetised. These permanent magnetic responses are some of the strongest cultural features that can be recorded.

Temporary Magnetism

Magnetic susceptibility is the ease with which a magnetic field can pass through a material, therefore the higher the materials magnetic susceptibility, the stronger the induced magnetic field will be. Temporary magnetisation occurs within material that is magnetically susceptible, this material acquires its own local magnetic field that combine with the Earth’s magnetic field causing an anomaly to stand out from the background noise (Clark, 1996). These anomalies are more subtle in nature, being derived from material that has been magnetically enhanced by cultural activity and become concentrated into features over time. Anomalies that have temporary magnetisation include backfilled pits, ditches, field systems, occupation areas, land drains, remnant and existing field boundaries (David, 2011).

The key to a successful survey is having good contrast between the magnetic susceptibility of an archaeological feature with the surrounding superficial deposits. If there is no discernible difference between the two mediums it may be unlikely that the magnetometer will successfully prospect the feature. Archaeological features can also be masked by high magnetically susceptible topsoil, or deep overlying subsoil and colluvial deposits.

Ferrous anomalies

Ferrous objects are a common source of permanent magnetism, usually isolated with a strong dipolar signature. Some of these responses may have an archaeological derivation, however they are probably more indicative of modern iron objects introduced through manuring or lost within the topsoil.

Bartington DualGRAD 601-2 Fluxgate Gradiometers

Fluxgate gradiometers are the most commonly employed class of instrument in the UK. Two 1m sensitive sensors are affixed to a frame mounted 1m apart in a vertical plane and harnessed to the trunk of a geophysical surveyor or attached two a pulled cart. Each sensor contains two fluxgate magnetometers with 1m vertical separation. The sensor above records the Earth's magnetic field (magnetic background) while the sensor below records the local magnetic field. The two sensors need aligning before recording can begin, a zero station is located in an area with low magnetic variation for this purpose. After the sensors have been aligned, the survey can begin. When differences in the magnetic field strength occur between the two vertical magnetometers within each sensor, a positive or negative reading is recorded that is relative to the magnetic background of the zero station. Positive anomalies include pits, ditches and agricultural furrows. Negative anomalies commonly prospected include earthwork embankments, land drains and geological features.

Sensors are normally mounted to a height of 0.30m above the surface, and can detect to a depth of between one and two metres below the ground. The first survey traverse is commonly undertaken in an east to west direction.

Bartington MS2D Magnetic Susceptibility Meters

Topsoil typically has a higher magnetic susceptibility than the underlying subsoil and bedrock geologies due to an increased concentration of iron minerals present within it, these ferrous compounds are weathered up from the underlying parent material or introduced from material once located above. These increased accumulations of iron minerals become further magnetically enhanced by natural firing, fermentation and oxidation-reduction cycles associated with alternating wet and dry soil conditions, which convert the weakly magnetic iron compounds into the strongly magnetic oxide maghaemite. The Earth's magnetic field also magnetises the soil along with enhancement by human occupation (and in particular fires) which leaves a strong permanent magnetic imprint on the soil (Clark, 1996).

The MS2D sensor works by creating a weak magnetic field from an alternating current that it inputs through the soil medium, the magnetisation of the material lying within is then detected, the magnetic susceptibility is calculated and its value is shown on a digital display. The instrument measures the response of the soil to its own internally generated field independent of the Earth's, therefore recording only the magnetic susceptibility level of the soil. To achieve this the sensor measures magnetic susceptibility by calibrating the sensor relative to the air. The instruments sensor is placed flat on the ground surface ensuring a good contact, three readings are taken around the survey point with the median value recorded, any large spike readings were ignored. A zero reading taken in the air before each survey point calibrates the instrument, the final reading taken is also in the air to check that the sensor has not drifted too far from zero (Dearing, 1999).

These surveys are undertaken across large areas at wide centres, in this case every 10 metres, in order to locate soils with an increased magnetic susceptibility, the high peaks are commonly further investigated using detailed magnetometer survey. The sensor typically records readings to a depth of 0.06m.

Magnetic Anomalies

Isolated dipolar responses

Isolated dipolar responses are commonly recorded throughout a dataset and are usually indicative of modern ferrous material deposited within the topsoil horizon. In some instances the anomalies may be of an archaeological derivation. They are isolated, strong and dipolar in character.

Areas of magnetic disturbance

These anomalies are usually caused by building demolition rubble, ferrous boundaries, slag waste dumps, modern buried rubbish, pylons and services. Strong and dipolar in character, they are commonly recorded over a wide area.

Linear trends

Linear trends can be either positive or negative magnetic responses depending on the nature of the material present within the feature. If the anomaly is broad and weak, it is more likely to be of geological origin. Stronger positive linear trends are more likely to be of archaeological derivation, caused by settlement activity washing rich humic, charcoal and fired deposits into a feature. Negative linear trends are more commonly associated with bank deposits or land drains, with the less magnetically susceptible superficial deposits deposited at the top of the feature. Curvilinear trends are usually of archaeological origin, commonly interpreted as ring ditches or drip-gullies.

Discrete anomalies

Discrete anomalies can either be positive or negative in nature recorded within a localised area. Those that are positive are more likely to be of an archaeological origin, with negative discrete anomalies more commonly interpreted as natural geological variations.

Thermoremanent responses

These responses are caused by the heating of material containing iron to above the Curie temperature, they are strong and discrete in nature, in Britain high positive readings are recorded to the south of the feature, and high negative readings are recorded to the north.

Appendix 3. OASIS Form

OASIS DATA COLLECTION FORM: England

List of Projects | Manage Projects | Search Projects | New project | Change your details | HER coverage | Change country | Log out

Printable version

OASIS ID: suffolka1-248405

Project details

Project name	Garden Field, Sutton Hoo, Suffolk, Geophysical Survey
Short description of the project	In March 2016 Suffolk Archaeology Community Interest Company undertook a detailed fluxgate gradiometer and magnetic susceptibility meter survey on land currently set aside for sheep pasture at Garden Field, Sutton Hoo, Suffolk. The detailed fluxgate gradiometer survey was successful in recording a range of geophysical anomalies that complement the preceding non-intrusive surveys. Positive linear trends indicative of former settlement ditches or field boundaries from at least three separate phases, thermoremanent responses indicative of a kiln type anomaly, a plethora of discrete pit type anomalies, two areas of magnetic disturbance and sparse isolated dipolar responses of potential archaeological derivation, one broad geological anomaly, a dipolar linear trend delineating a modern service run and negative linear trends of agricultural origin were prospected. A magnetic susceptibility meter survey undertaken over the majority of Garden Field revealed that peaks of higher soil magnetisation were predominant in the eastern half of the existing enclosure, these higher readings may derive from settlement type activity. Lower readings were recorded in the western half of the field where potential colluvial deposits located on the side of the slope may be masking deeper lying areas of cultural enhancement.
Project dates	Start: 22-03-2016 End: 29-03-2106
Previous/future work	Yes / Yes
Any associated project reference codes	BML 037 - HER event no.
Type of project	Field evaluation
Site status	National Trust land
Current Land use	Grassland Heathland 4 - Regularly improved
Monument type	CO-AXIAL FIELD SYSTEM Uncertain
Monument type	PITS Uncertain
Monument type	KILN Uncertain
Monument type	GEOLOGICAL ANOMALY Uncertain
Significant Finds	NONE None
Methods & techniques	"Geophysical Survey"
	Research

Development type	
Prompt	Research
Position in the planning process	Not known / Not recorded
Solid geology (other)	Thames Group Clay and Silt
Drift geology	RIVER TERRACE DEPOSITS
Techniques	Magnetometry
Techniques	Magnetic susceptibility

Project location

Country	England
Site location	SUFFOLK SUFFOLK COASTAL BROMESWELL Garden Field, Sutton Hoo, Suffolk
Study area	5.7 Hectares
Site coordinates	TM 2885 4937 52.094696775539 1.341401971468 52 05 40 N 001 20 29 E Point
Height OD / Depth	Min: 20m Max: 30m

Project creators

Name of Organisation	Suffolk Archaeology CIC
Project brief originator	National Trust
Project design originator	Tim Schofield
Project director/manager	Rhodri Gardner
Project supervisor	Tim Schofield
Type of sponsor/funding body	National Trust
Name of sponsor/funding body	National Trus

Project archives

Physical Archive Exists?	No
Digital Archive recipient	Suffolk HER
Digital Contents	"Survey"
Digital Media available	"Database","Geophysics","Images raster / digital photography","Images vector","Survey","Text"
Paper Archive recipient	Suffolk HER
Paper Contents	"Survey"

Paper Media available	"Survey ","Unpublished Text"

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Garden Field, Sutton hoo, Suffolk
Author(s)/Editor (s)	Schofield, T.P.
Other bibliographic details	2016/035
Date	2016
Issuer or publisher	SACIC
Place of issue or publication	Needham Market
Description	Bound A4 report with A3 fold-out figures.
URL	www.suffolkarchaeology.co.uk

Entered by	Tim Schofield (tim.schofield@suffolkarchaeology.co.uk)
Entered on	14 June 2016

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