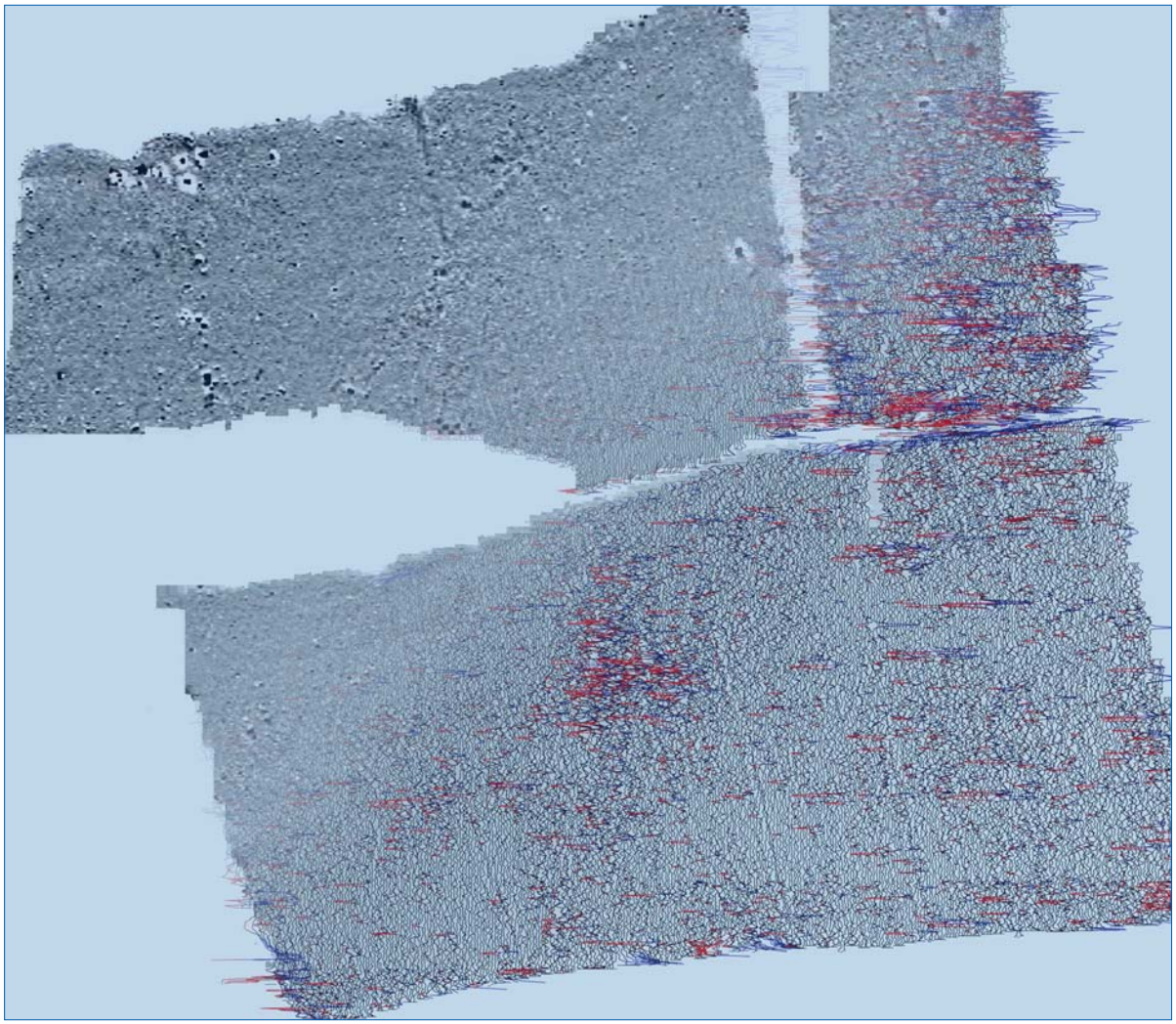
Wessex Archaeology

Exeter Science Park Drive (North and South) Exeter, Devon

Geophysical Survey Report



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October 2010

Exeter Science Park Drive (North and South) Exeter, Devon

Geophysical Survey Report

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Exeter Science Park Drive (North and South) Exeter, Devon

Magnetometer Survey Report

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Magnetometer Survey Report

Summary

Wessex Archaeology (WA) has been commissioned by Roger North of Parsons Brinckerhoff, on behalf of Devon County Council (the Client), to undertake a programme of geophysical survey and a metal detector survey of land within the Exeter Science Park site (NGR 297285 93710).

The geophysical survey was conducted using a Bartington Magnetic Gradiometer to cover a large area relatively quickly. The results of this survey indicate the presence of a range of anomalies, some of which are thought to be of archaeological origin. Included among these anomalies are two possible structures **4000** and **4002**. There also appear to be two separate phases of field boundaries. The boundaries most easily identified are **4003** to **4008** in the southern field and **4018** to **4021** in the northern fields. These are probably the later phase of boundaries. The possible earlier phase of boundaries is less easily identified as can be seen with anomalies **4009**, **4010** and **4022**.

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Detailed Gradiometer Survey Report

Acknowledgements

The geophysical survey was commissioned by Roger North of Parsons Brinckerhoff, on behalf of Devon County Council prior to the construction of the Exeter Science Park.

The project was managed on behalf of Wessex archaeology by Abigail Rolland. The fieldwork was directed by Patrick Dresch and assisted by Lucy Parker and Sophie Thorogood. Ben Urmston and Patrick Dresch processed and interpreted the geophysical data. Patrick Dresch compiled this report. The geophysical survey was managed by Paul Baggaley. Illustrations were prepared by Rob Goller.

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Magnetometer Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology (WA) has been commissioned by Roger North of Parsons Brinckerhoff, on behalf of Devon County Council (the Client), to undertake a programme of geophysical survey of land within the Exeter Science Park site; NGR 297285 93710 (hereafter 'the Site') (**Figure 1**).

1.1.2 The primary objective of the geophysical survey is to survey the fields to the north of Blackhorse Lane prior to the development of the Exeter Science Park.

1.1.3 This report presents a brief description of the methodology followed, the survey results, and the archaeological interpretation of the geophysical data.

1.2 Archaeological and historical background

1.2.1 In 2007 an area of land overlapping with the western half of the Site was assessed to establish the likely impacts resulting from the provision of a new junction link road. A series of WebTAG assessments, an archaeological desk-based assessment (Wessex Archaeology 2007), a geophysical survey (Archaeological Surveys Ltd 2007) and a programme of archaeological evaluation by trial trench excavation (Wessex Archaeology 2008) were undertaken.

1.2.2 Together these surveys identified numerous field ditches and hedged land boundaries dating to the post-medieval period, the majority of which corresponded to features on historic maps of the area, dating to between 1801 and 1889. Several smaller undated field boundaries were also recorded and an abraded sherd of Iron Age pottery was recovered. Evidence of land division and slight remodelling of the Site, prior to and during the imparkment in the late 19th century is still evident both as extant earthworks and buried features within the parkland.

1.3 Survey areas

1.3.1 The Site was divided into three areas for the purposes of the magnetometer survey: the first was the field south of Tithebarn Lane to the west of the second area; the second was the field on the north-east corner of the Site at the intersection of Tithebarn Lane and Langaton Lane; the third was the field to the south of the first and second areas in the central area of the Site at the intersection of Langaton Lane and Blackhorse Lane.

1.3.2 The total area surveyed was approximately 9.8ha. The majority of the survey took place in fields with long maize stubble standing up to 40cm high. The field at the intersection of Tithebarn Lane and Langaton Lane was overgrown with long grass and thorny bushes and contained many burrows. The fields were separated by a combination of hedgerows and wire fencing.

1.3.3 The survey was based on a 30m by 30m grid oriented so that the initial traverse of each grid was walked south to north.

1.3.4 The underlying geology is Permian sandstone (BRS 2001). The overlying soils across the site are from the Bridgnorth association which are typical brown sands. These consist of well drained sandy soils (Soil Survey of England and Wales 1983).

1.3.5 Permian and Triassic sandy soils often produce moderate to poor conditions for magnetic survey, similar geology in other parts of the UK has revealed magnetic anomalies although these are often of low contrast. Good drainage across the survey area is likely to assist in the formation of useful magnetic enhancement.

2 METHODOLOGY

2.1 Magnetometer Survey

2.1.1 The magnetometer survey was conducted by Wessex Archaeology's in-house geophysical team using a Bartington Magnetic Gradiometer 601-2 dual sensor system with a sample interval of 0.25m along transects at 1m spacing in accordance with English Heritage Guidelines for Geophysical Surveys (English Heritage 2008). The survey was undertaken between 27th of September and 1st of October 2010 with an additional day on the 6th of October. Conditions on site ranged from dry to heavy rain over the six days of survey.

2.1.2 Survey grids were established at 30m x 30m and recorded using a Leica Viva RTK GNSS, which is able to provide OSGB coordinates in real-time, precise to within 2cm, and therefore exceeds English Heritage recommendations for geophysical surveys (English Heritage 2008).

3 RESULTS AND INTERPRETATION

3.1 Introduction

3.1.1 Despite high levels of background noise, due to the local geology, the survey indicates the presence of anomalies thought to be of probable archaeological origin. There are also several linear anomalies of possible archaeological origin. Many of the modern field boundaries have wire fencing incorporated into them, this can be seen as a high magnetic response around the edges of the fields.

3.1.2 The results of the magnetometer survey are presented as greyscale and XY trace plots (**Figures 2**, **3, 4** and **5**) and the results are discussed by anomaly number (**Figure 6**). The interpretation of the datasets highlights the presence of potential archaeological anomalies, trends, and areas of general increased magnetic response. Full definitions of these terms are provided in **Appendix II**.

3.1.3 Numerous small-scale ferrous anomalies are visible throughout the magnetometer survey dataset. These are presumed to be generally modern in provenance and are therefore not referred to in the interpretation, unless thought to be relevant to the archaeological interpretation.

3.2 Magnetometer survey results and interpretation

3.2.1 Anomaly **4000** is roughly U shaped and located in the western half in the southern field and may indicate the base of a former structure. **4000** lies immediately to the west of **4003**, a linear anomaly orientated approximately northwest to southeast which is thought to be a former field boundary. Immediately to the north of **4000** is the roughly C shaped trend **4001**. This weak magnetometer anomaly may represent an enclosure associated with a structure.

3.2.2 **4002** is a roughly L shaped anomaly identified as possible archaeology to the east of **4000**. This may relate to archaeology in the area, possibly a structure.

3.2.3 Further to the east there are two more linear anomalies identified as probable archaeology, **4004** and **4005**, which are orientated north-northwest to south-southeast. **4003**, **4004** and **4005** all appear very similar and are probably former field boundaries similar to those identified during a previous phase of geophysical survey by Archaeological Surveys Ltd. (2007). Similar linear anomalies **4006** and **4007** also appear to be part of the same former field system. These are both fainter anomalies identified as possible archaeology. **4006** is a linear anomaly directly to the north of **4005**. This may be a continuation of the same field boundary further to the north. **4007** is a faint linear anomaly aligned on the same orientation as **4004** and **4005**. This may be a further division of the field from the same phase of use as represented by the probable archaeological anomalies. There are also a number of trends, **4008**, on a similar alignment which may also relate to former field boundaries.

3.2.4 **4009** is a roughly Y shaped anomaly identified as possible archaeology located to the east of **4003** in the southern part of the Site. The longest arm of the anomaly runs on a northeast by southwest orientation. This may be part of a field boundary relating to a different, possibly earlier, phase of use than seen with **4003**. Similar to this is **4010**, an amorphous, roughly Y shaped anomaly to the east of **4006** near the modern field boundary between the southern and northern fields. This may also show the intersection of earlier field boundaries.

3.2.5 **4011** is possibly an earlier linear anomaly running roughly parallel to the southern limit of the Site on an east west orientation. This may be another

field boundary, however it should be noted that it is located next to the modern field entrance and may not be archaeological.

3.2.6 **4012** is located immediately to the east of **4010** and runs roughly parallel to the modern field boundary to the north on a similar alignment to **4011**. This may be associated with an earlier field boundary. **4013** represents a number of linear trends in the southern field of the Site on a roughly east west orientation. These may be related to earlier field boundaries or could be associated with modern farming since the modern maize crop is planted in rows on a similar orientation.

3.2.7 **4014** represents the roughly northwest southeast aligned linear trends in the southern field of the Site. These trends are broad textural anomalies which roughly follow the contours of the slope of the field and may be caused by the geology of the Site. **4028** relates to the roughly northwest southeast trends in the northern part of the site. These are similar to **4014** and may be related to geology.

3.2.8 There are several areas of increased magnetic response in the southern field. **4015** is an area in the northwest corner of the southern field which contains a number of possible ferrous anomalies and generally an area of increased magnetic response. This may be caused by local geology.**4016** is an area of increased magnetic response near the centre of the southern field. This is probably a result of local geology there is, however, the possibility that some of the anomalies in this area may be related to archaeology. **4017** is a small, sub-circular area directly to the south of **4010**. This is probably related to the geology of the area.

3.2.9 The northern field also contains a number of similar linear features. **4018** is a linear anomaly of probable archaeological origin located at the northern limit of the site with a roughly north-northwest by south-southeast orientation. This anomaly is seen as two separate segments on the greyscale image. Similarly **4019** and **4020** are linear anomalies with a similar orientation and may be another field boundary created during the same period. **4021** refers to the roughly north south trends in the northern part of the site. These may represent earlier field boundaries similar to **4008**.

3.2.10 **4022** is a roughly C shaped anomaly in the south west part of the northern field. Identified as possible archaeology, this could be associated with a field boundary or a small enclosure. **4023** is further to the east along the limit of the surveyed area. This anomaly is relatively strong and may have been produced as a result of burning or large pit.

3.2.11 Near the northern edge of the Site is **4024**, a linear anomaly orientated west-northwest by east-southeast. To the south of this is a smaller linear anomaly, **4025**, which shares a similar orientation. These anomalies may indicate the presence of earlier field systems.

3.2.12 **4026** is an amorphous anomaly to the east of **4020**. This could be associated with the large number of burrows in this part of the Site, or could be related to possible archaeology.

3.2.13 **4027** are faint linear trends in the northern fields on a roughly east west orientation. They are similar to **4013** and may be related to modern farming activities.

3.2.14 **4029** is a collection of ferrous anomalies near the gate at the northern entrance to the Site which are probably related to modern material. Some of the anomalies may be associated with the roughly linear alignment of ferrous anomalies which form **4030**, these may be the result of a former fence or boundary roughly in line with the extant field boundary separating the fields to the south.

3.2.15 **4031** is a strong magnetic response located at the eastern edge of the larger of the two northern fields. It is probably modern in origin. **4034** is a scatter of ferrous anomalies running roughly north to south in the smaller of the northern fields. The spread of the anomalies may be partially due to bioturbation. The anomalies are probably modern in origin.

3.2.16 **4033** is a large, sub-circular area in the northern part of the survey area near the northern entrance to the Site. **4033** lies between **4029** and **4030**. This could be related to a possible field boundary but may also be related to geology.

3.2.17 **4034** is a large area of increased magnetic response in the northwest field of the Site. It extends from the northern to southern field boundaries on a roughly northeast southwest orientation. There are a number of possible archaeological anomalies in this area including **4019**, **4024** and **4025**. Although this anomaly is probably caused by geology there is the possibility of additional archaeology in this area. Similarly **4035** is a roughly T shaped area composed of two areas of broad textural anomaly. It is probably a result of the local geology.

4 CONCLUSION

4.1 Introduction

4.1.1 Due to the geology of the area the archaeological magnetic anomalies were not as strong as might be seen on different geologies. There are, however, a number of anomalies which can be identified as either probable or possible archaeology. In addition to these there are a number of trends which may hint at more archaeological features.

4.1.2 The majority of the anomalies identified as being of archaeological interest are most likely the product of earlier divisions of the fields. These seem to from two phases of land use with **4003** to **4008** in the southern field and **4018** to **4021** in the northern fields forming long boundaries on a roughly north-northwest by south-southeast alignment. Similar anomalies were identified previously by Archaeological Surveys Ltd. (2007) and further investigation showed them to be probable field boundaries. In addition to these there are several possible boundaries which may be linked to an earlier phase of land use, namely **4009**, **4010** and **4022**.

4.1.3 In addition to the probable field systems, the survey has identified anomalies **4000** and **4002** which may indicate structural remains, which are probably of further archaeological interest.

4.1.4 The local geology and presence of numerous modern ferrous signatures means that there is the potential for small archaeological features such as pits or postholes being misidentified. Although previous work in the area has not identified features of this type that is not a guarantee that they will not be present in this area.

5 REFERENCES

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APPENDIX I: SURVEY EQUIPMENT AND DATA PROCESSING

Survey Methods and Equipment

The magnetic data for this project was acquired using a Bartington 601-2 dual magnetic gradiometer system. This instrument has two sensor assemblies fixed horizontally 1m apart allowing two traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 1m separation, and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have a resolution of 0.01nT over a ±100nT range, and measurements from each sensor are logged at intervals of 0.25m. All of the data are stored on an integrated data logger for subsequent post-processing and analysis.

The magnetometer surveys consist of 30m x 30m grids, and data are collected at 0.25m intervals along traverses spaced 1m apart. This gives 3600 measurements per grid and is the recommended methodology for archaeological surveys of this type (English Heritage, 2008).

Both surveys depend upon the establishment of an accurate 30m site grid, which is achieved using a Leica Viva RTK GNSS system and then extended using tapes. The Leica Viva RTK GNSS system receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined to an accuracy of 1-2cm in real-time and therefore exceed the level of accuracy recommended by English Heritage (2008) for geophysical surveys.

Post-Processing

The magnetic data collected during the detail survey are downloaded from the Bartington system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed in order to enhance the results for analysis; however it should be noted that minimal data processing is conducted so as not to distort the anomalies. They are georeferenced using the GPS information.

Typical data and image processing steps may include:

- Destripe – Applying a zero mean traverse in order to remove differences caused by directional effects inherent in the magnetometer;
- Destagger – Shifting each traverse forward or backward by a number of readings. This corrects for operator errors and is used to enhance linear features;
- Clipping – Limiting the displayed range of the processed data to either ±3nT or ±3s.d. in order to enhance the appearance of smaller anomalies.
- Despike – Filtering any data points that exceed the mean by a specified amount to reduce the appearance of dominant anomalous readings caused by modern, small ferrous objects at the surface.

Typical displays of the data used during processing and analysis:

- XY Plot – Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This image can include a hidden line algorithm to remove certain lines and

enhance the image. This type of image is useful as it shows the full range and shape of individual anomalies.

- Greyscale – Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during analysis of the data.

APPENDIX II: GEOPHYSICAL INTERPRETATION

The interpretation methodology used by WA separates the anomalies into two main categories: archaeological and unidentified responses.

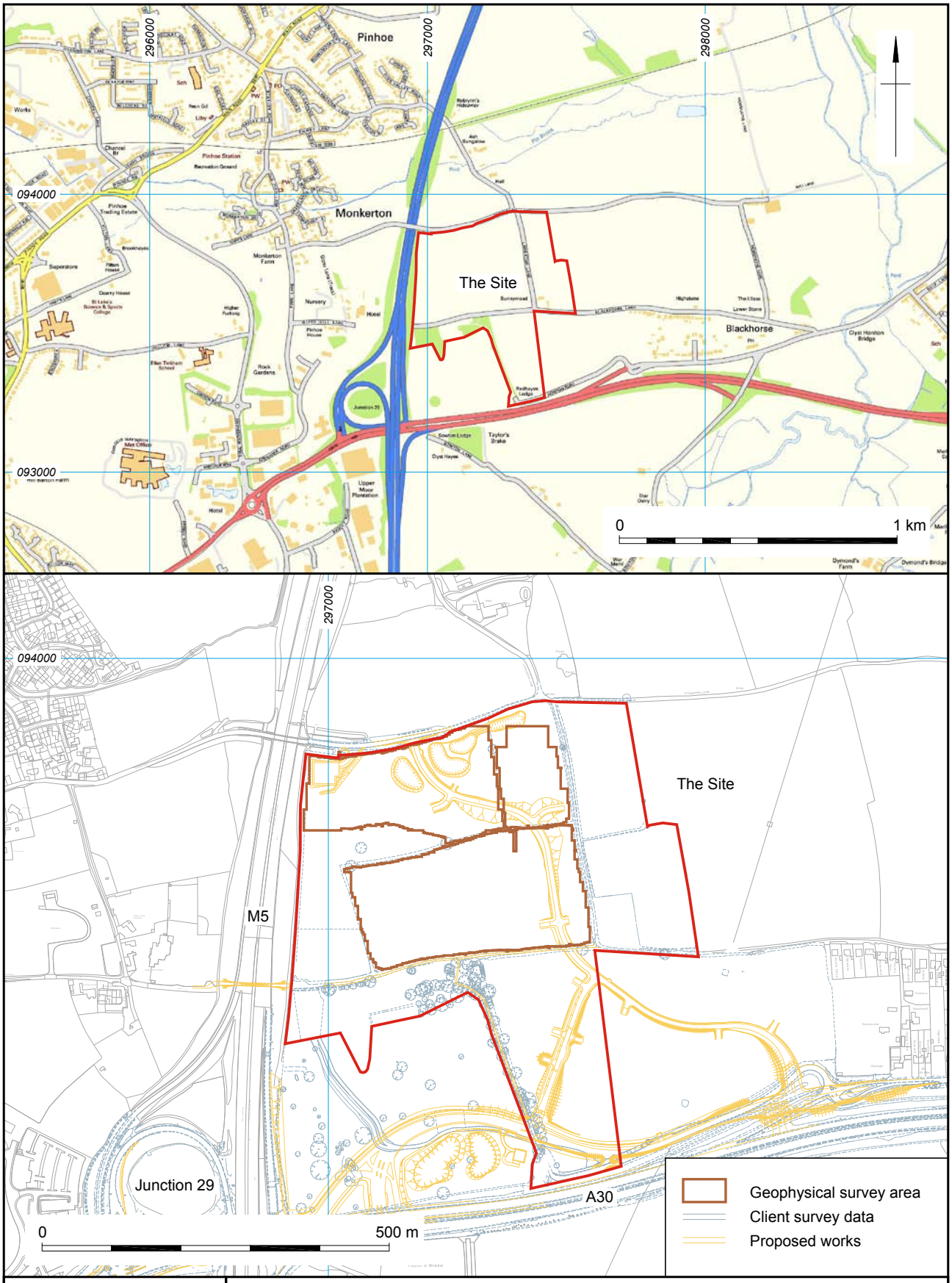
The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided into three groups, implying a decreasing level of confidence:

- Archaeology – used when there is a clear geophysical response and anthropogenic pattern.
- Probable archaeology – used for features which give a clear response but which form incomplete patterns.

The unidentified category is used for features when the form, nature and pattern of the anomaly are not sufficient to warrant a classification as an archaeological feature. This category is further sub-divided into:

- Possible archaeology – used for features which give a response but which form no discernable pattern or trend.
- Increased magnetic response – used for areas dominated by indistinct anomalies which may have some archaeological potential.
- Trend – used for low amplitude or indistinct linear anomalies.
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.

Finally, services such as water pipes are marked where they have been identified.



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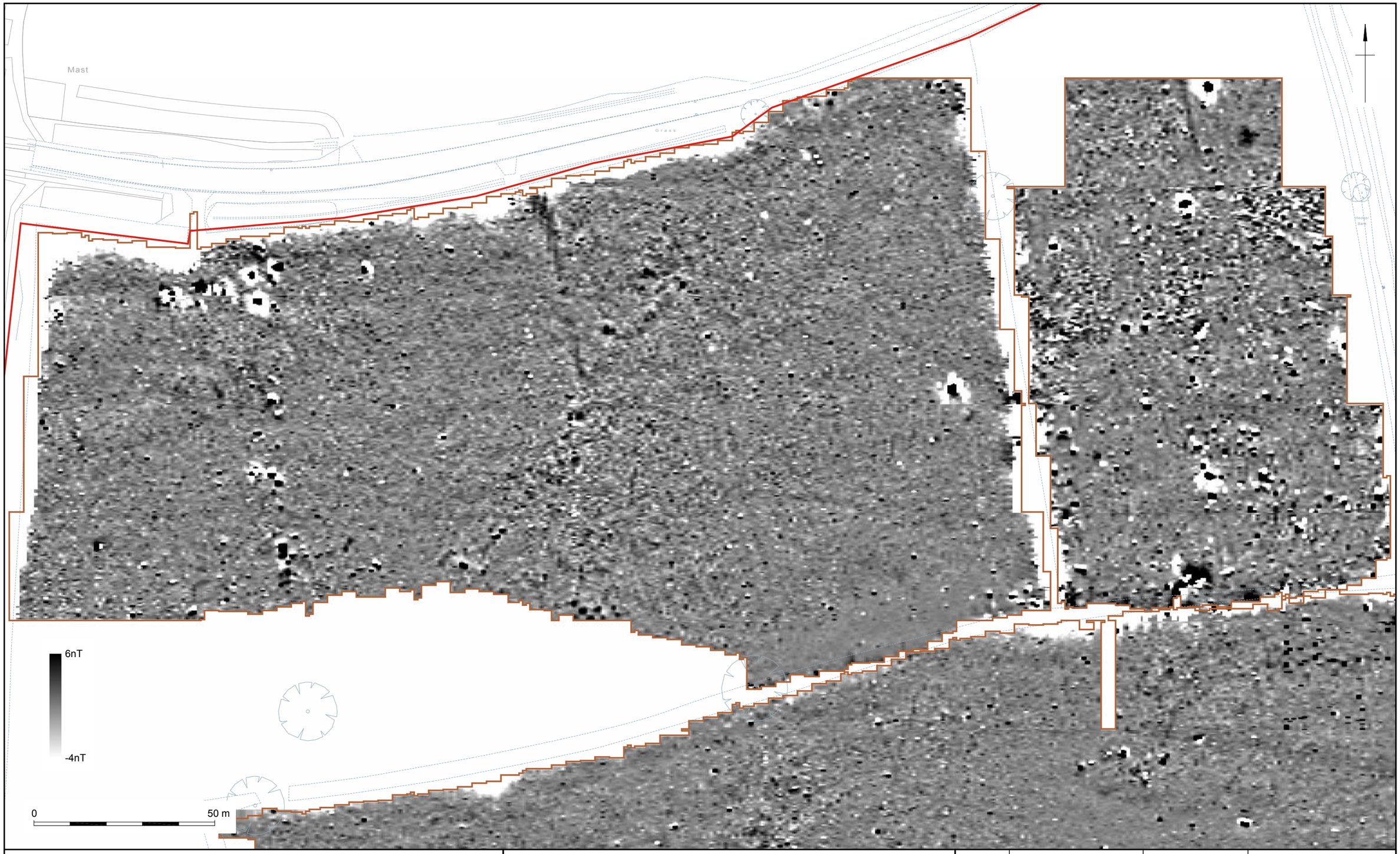
Wessex Archaeology

Site location and survey extents

Figure 1



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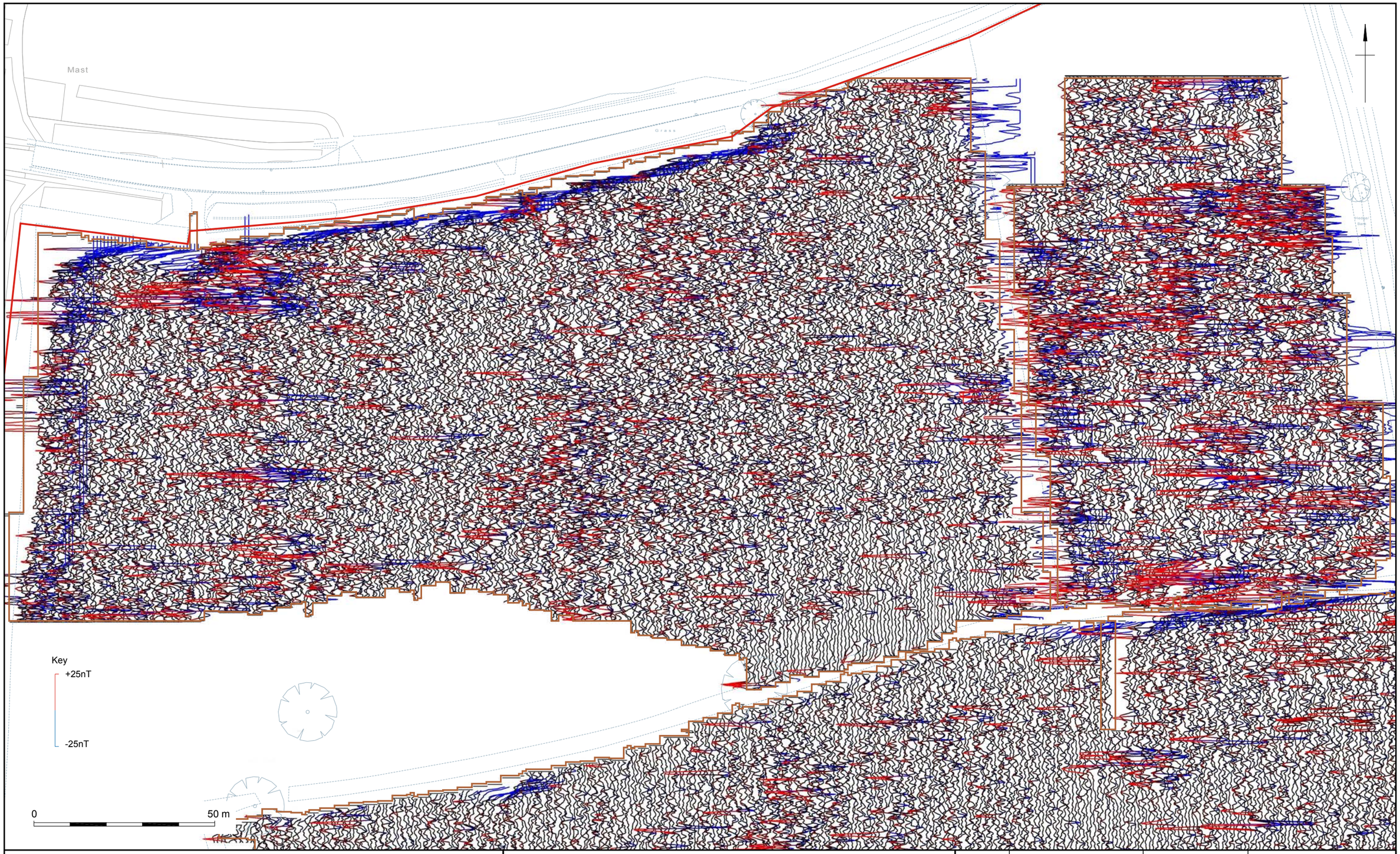
Magnetometer greyscale of northern fields (1:1000)

Figure 2



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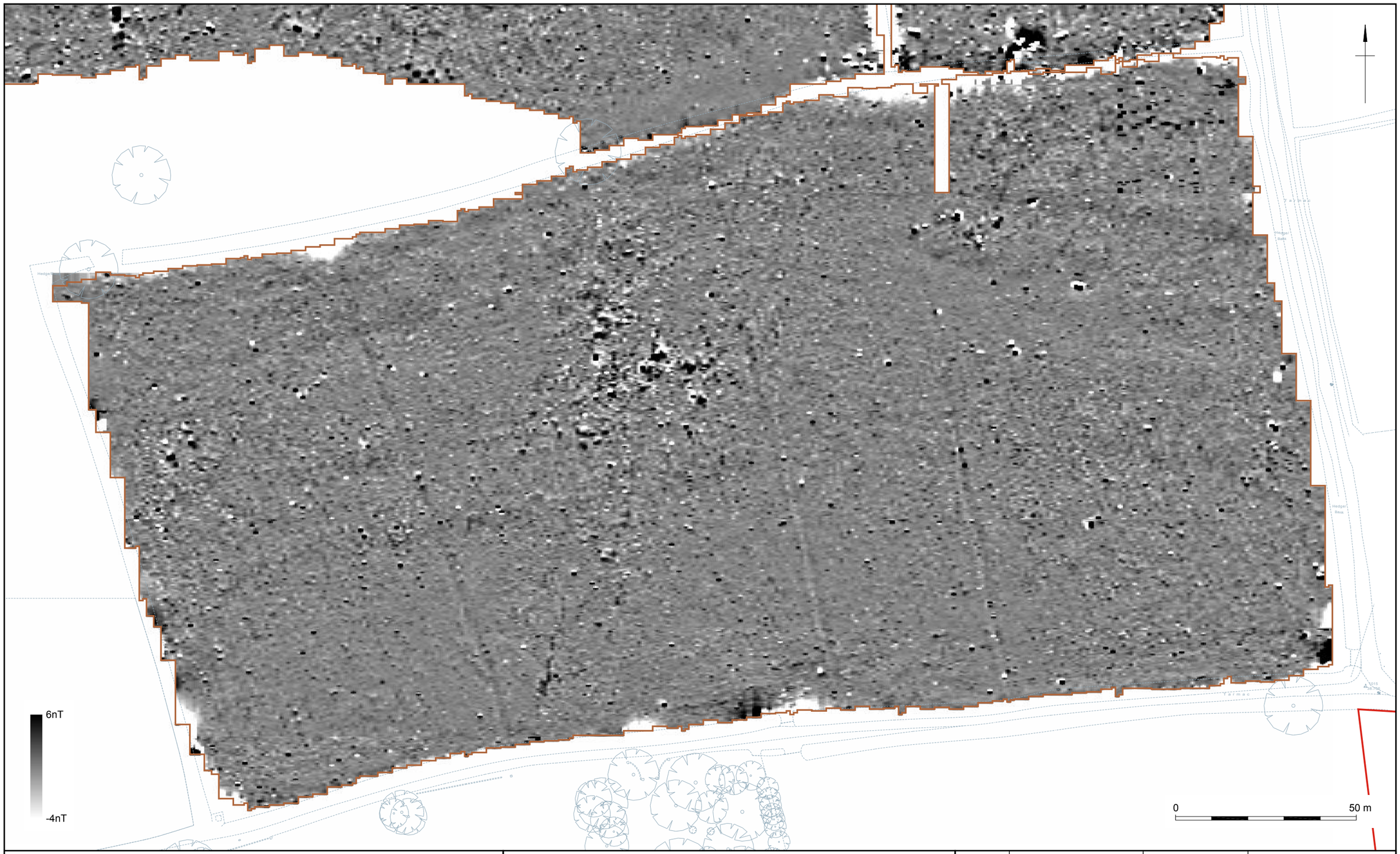
Magnetometer XY plot of northern fields (1:1000)

Figure 3



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Magnetometer greyscale plot of southern field (1:1000)

Figure 4

Key

+25nT

-25nT

0 50 m

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Magnetometer XY plot of southern field (1:1000)

Figure 5

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Magnetometer interpretation (1:2000)

Figure 6

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