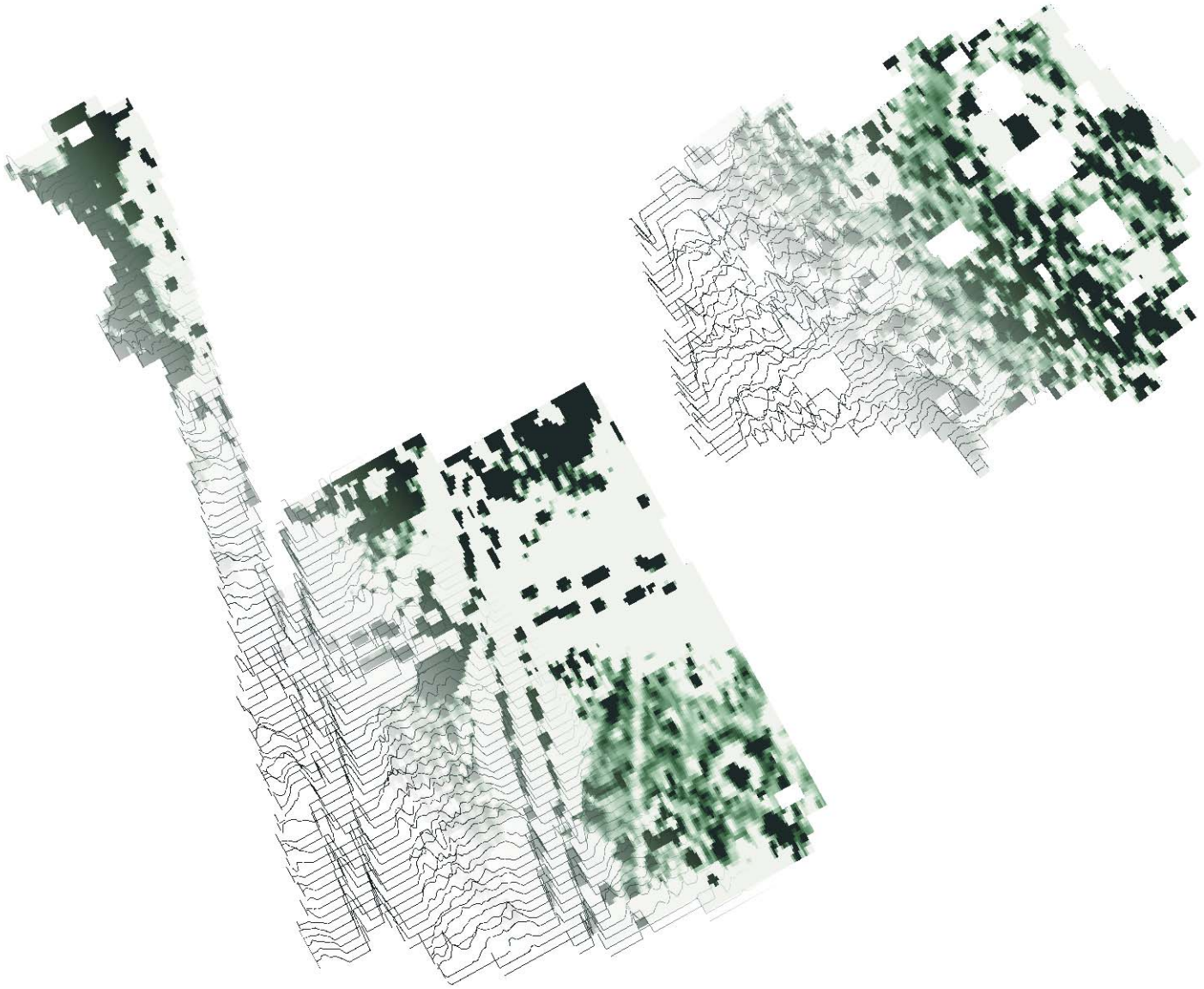
Wessex Archaeology

Wakehurst Place, West Sussex

Magnetometer and Earth Resistance Survey Report



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May 2010

WAKEHURST PLACE

WEST SUSSEX

Magnetometer and Earth Resistance Survey Report

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WAKEHURST PLACE

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Magnetometer and Earth Resistance Survey Report

CONTENTS

FIGURES

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Magnetometer and Earth Resistance Survey Report

Summary

Wessex Archaeology was commissioned by the National Trust and Kew at Wakehurst to undertake geophysical survey of Wakehurst Place, West Sussex, centred approximately on NGR 533978 131394. The survey was undertaken as part of the 'Historic Buildings and Structures Survey' which will form the baseline 'Understanding the Asset' section of the Conservation Management Plan for Wakehurst Place; a joint project with Richard Griffiths Architects.

The earth resistance survey was conducted on the lawn to the south of Wakehurst Place whilst the magnetometer survey was conducted on the east, west and south ranges.

The magnetometer survey proved to be an unsuitable method for the majority of the survey area, due to the inclusion of steel in the construction of the pathways and an increased magnetic response in other areas such as the east lawn. The earth resistance survey however successfully located a number of anomalies, some of which are thought to be structural, while others are most likely evidence of previous landscaping.

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Detailed Gradiometer and Earth Resistance Survey Report

Acknowledgements

The geophysical survey was commissioned as part of the Conservation Management Plan for Wakehurst Place, a joint venture with Richard Griffiths Architects for the National Trust and Kew at Wakehurst.

The project was managed on behalf of Wessex archaeology by Anne Upson. The fieldwork was directed by Lucy Parker, and assisted by Ross Lefort. Lucy Parker processed and interpreted the geophysical data with the help of Ben Urmston, and compiled this report. The geophysical survey was managed by Paul Baggaley. Illustrations were prepared by Kitty Brandon.

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Magnetometer and Earth Resistance Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by the National Trust to undertake geophysical survey at Wakehurst Place, West Sussex (**Figure 1**), centred on NGR 533978 131394 (hereafter 'the Site').

1.1.2 The primary objective of the geophysical survey is to locate any remnants of former structures associated with the mansion and chapel, specifically the east, west and south ranges.

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 Survey areas

1.2.1 The Site was divided into two for the purposes of the magnetometer survey: the first was the area to the west and the lawns to the south of the main building; the second was the garden to the east. The earth resistance survey was conducted only on the south lawn, which is where the former wings of the building were thought to be situated.

1.2.2 The total area available for was approximately 0.9ha with the majority of the survey was centred on the lawns to the south of the house. The area to the east contained many trees and sections which had been fenced off to prevent various plant life being disturbed, reducing the area available for the proposed magnetometer survey area.

1.2.3 Due to the number of obstructions and boundaries within the survey area it was decided to use 20m x 20m grids, rather than 30m x 30m grids, as stated in the WSI (WA 2010) to facilitate data collection around the obstructions.

1.2.4 The drift geology of the survey areas are largely the Stagnogleyic argillic brown earths of the 572i Curtisden association and the typical stagnogley soils of the Wickham 1 association (SSEW 1983). These superficial geologies are considered likely to produce a magnetic contrast suitable for the identification of archaeological remains using a Bartington Grad 601-2 gradiometer system and be suitable for earth resistance survey using a Geoscan Research RM15 resistance meter.

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 15th and 16th April 2010 and the conditions on site were dry over the two days.

2.1.2 Survey grids were established at 20m x 20m 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).

2.1.3 A discrepancy was noted between the Ordnance Survey mapping supplied to WA and the GPS location of the survey grids. Given the high precision and accuracy of the GNSS equipment, it is recommended that any further work is planned using the GPS locations and does not rely solely upon the background mapping shown in the report figures; this should be regarded as indicative only.

2.2 Earth Resistance Survey

2.2.1 The earth resistance survey was also conducted by Wessex Archaeology's in-house geophysical survey team using a Geoscan Research RM15 resistance meter with a sample interval of 1m along transects at 1m spacing in accordance with English Heritage Guidelines for Geophysical Surveys (English Heritage 2008) and was undertaken in the same phase as the magnetometer survey. The survey was conducted using the same grids as set out for the magnetometer survey.

2.2.2 The earth resistance survey was to be targeted using the results of the magnetometer survey. Unfortunately the magnetometer survey results did not give sufficient detail to target the subsequent earth resistance survey therefore a larger area was surveyed to ensure satisfactory data was collected.

2.2.3 Further details of the geophysical and survey equipment, methods and processing are described in **Appendix I**.

3 RESULTS AND INTERPRETATION

3.1 Introduction

3.1.1 The magnetometer survey proved to be an unsuitable method for the majority of the survey area, due to the inclusion of steel in the construction of the pathways, clearly interpreted as ferrous. The survey did however suggest anomalies that are thought to be of possible archaeological origin despite these difficulties, as well as a linear anomaly that is of probable archaeological origin.

3.1.2 The results of the magnetometer survey are presented as greyscale and XY trace plots (**Figure 2**) and the results are discussed by anomaly number (**Figure 3**). 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.

3.1.4 The earth resistance survey was successful in locating a number of anomalies potentially of archaeological origin. The results of this survey are presented as greyscale plots (**Figure 4**) and discussed by anomaly number (**Figure 5**). The values given refer to the processed dataset; the negative values are the product of high-pass filtering and are therefore relative to zero.

3.2 Magnetometer survey results and interpretation

3.2.1 Anomaly **4000** is a negative linear anomaly aligned northeast-southwest measuring 24.2m by 1.5m with a maximum value of -5.2nT. It is most probably one of the latest phases in this area as it appears to cut a number of other anomalies. Anomaly **4001** has a maximum value of 5.1nT with a diameter of 9m and width of 2.1m, but the similar trend to the east is much lower at 1.8nT with a diameter of 4.8m. Anomaly **4002** is aligned northeast-southwest measuring 15.6m by 3.7m with a maximum value of 6.4nT.

3.2.2 Anomaly **4003** is a linear anomaly aligned northwest-southeast measuring 15.3m by 2.3m with a maximum value of 17.5nT and may be related to modern services. Anomaly **4004** is mostly obscured by the ferrous response from the pathway, however, it measures 6.2m by 3.6m with a maximum value of 30.2nT with an almost rectangular form and aligned northwest-southeast.

3.2.3 Anomaly **4005** in the east lawn survey area is an almost linear anomaly interpretated as possible archaeology, aligned northwest-southeast, measuring 10.5m by 5.3m with a maximum value of 24.7nT and probably extends to the southeast. The majority of the east lawn is dominated by ferrous and increased magnetic responses which probably relate to relatively modern groundworks.

3.3 Earth resistance survey results and interpretation

3.3.1 Anomaly **4006** is an almost linear anomaly against the eastern edge of the dataset, measuring 11m by 4.9m with a maximum value of -27.1Ω. There are four probable archaeology anomalies to the west of this (**4007**) which may be related. Anomaly **4008** is linear anomaly measuring 7.3m by 2.4m with a maximum value of -16.3Ω which appears to turn at the ends so could extend under the path.

3.3.2 Anomaly **4009** measures 16m by 4.8m with a maximum value of 49.9Ω. **4009** appears to be on a similar alignment to **4010** which exhibits low resistance with another similar anomaly running parallel to the east, both irregular linear in shape. It measures 38.3m by 7.3m with a maximum value of -30Ω. The eastern anomaly measures 22.3m by 5.3m with a maximum value of -43Ω.

3.3.3 Anomaly **4011** measures 29.8m by 11m and has a maximum value of -46Ω and is on a similar alignment to **4010**. An apparent rectangular anomaly is formed together with the probably archaeological anomaly to the south, measuring 22.6m by 3.1m with a maximum value of -49.5Ω.

4 CONCLUSION

4.1 Introduction

4.1.1 The magnetometer survey was overall not a suitable method of survey for this site due to the way in which the pathways were constructed. Although most of the survey area was masked by the ferrous response of the pathways some possible archaeological anomalies were visible. However, interpretation of these anomalies was difficult as their full extent was often obscured by the magnetic response of the pathways.

4.1.2 The magnetometer survey has shown a modern service running through the south lawn (**4001**) and a probable archaeological anomaly (**4000**). However, the orientation of **4000** does not match the orientation of the building and is therefore unlikely to be related.

4.1.3 The earth resistance survey proved a successful method and revealed a number of possible and probable archaeological anomalies. The low resistance probable archaeological anomalies (**4006** and **4007**) are approximately 20m from the extant building and would therefore be positioned where the former wings would be expected. However, not all of these anomalies have a clear relationship with each other.

4.1.4 The lawns further south revealed interesting linear low resistance anomalies that respect the alignment of the extant building. The most likely to be related is the central linear within (**4010**), but the similar anomalies could be related (**4011**). The former wing of the building is not expected to have extended into this area and these anomalies may relate to former garden features.

4.2 Recommendations

4.2.1 Although the magnetometer survey proved to be unsuitable for this site, geophysical techniques not relying on measuring magnetic fields are suitable, as demonstrated by the earth resistance survey which successfully located anomalies which may be related to the house.

4.2.2 The inability to survey the pathways has hampered the project, as anomalies are not fully visible or could be hidden beneath them.

4.2.3 The earth resistance survey proved successful, but due to the time-consuming nature of acquisition was not used on the eastern study area. If further information is required on this area then this method could be used to locate possible features.

4.2.4 The earth resistance survey has shown former features beneath the current landscaping and a Ground-Penetrating Radar (GPR) survey should be able to provide a higher resolution image of these features if required. This would add further understanding to the anomalies identified in the earth resistance survey, as well as increase the study area as it would be possible to survey over the pathways.

4.2.5 As discussed earlier, discrepancies were noted between the Ordnance Survey data provided for the Wakehurst Place environs and the GPS locations of the survey grids. The Ordnance Survey mapping shown in the report figures is therefore to be regarded as indicative only. As the GPS positions were precise to 0.02m and accurate to approximately 0.05m, any further work targeted upon the geophysical anomalies identified in this report should be directed by the original GPS locations and not measured from the figures.

5 REFERENCES

English Heritage, 2008. *Geophysical Survey in Archaeological Field Evaluation*. Research and Professional Service Guideline No 1.

Soil Survey of England and Wales, 1983. *Soils of South East England: Sheet 6*. Ordnance Survey, Southampton.

Richard Griffiths Architects, 2010. *Wakehurst Place: Tender for conservation management plan*.

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 20m x 20m grids, and data are collected at 0.25m intervals along traverses spaced 1m apart. This gives 1600 measurements per grid and is the recommended methodology for archaeological surveys of this type (English Heritage, 2008).

The earth resistance data were acquired using a Geoscan Research RM15 with a MPX15 Multiplexer. These instruments were attached to a PA20 Probe array using three probes connected at 1m spacing to allow two traverses to be recorded simultaneously. Readings were recorded at 1m spacing along each traverse.

Both surveys depend upon the establishment of an accurate 20m site grid, which is achieved using a Leica 1200 RTK GPS system and then extended using tapes. The Leica 1200 RTK GPS 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.

The earth resistance data were downloaded from the Geoscan Research 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.

Typical data and image processing steps may include:

- Despike - removes random, spurious readings often present in resistance data.
- High Pass Filter - removes low frequency, large scale spatial detail, .typically used to remove a slowly changing geological "background" response.
- Low Pass Filter - removes high frequency, small scale spatial detail and is useful for smoothing data or for enhancing larger weak features.

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.

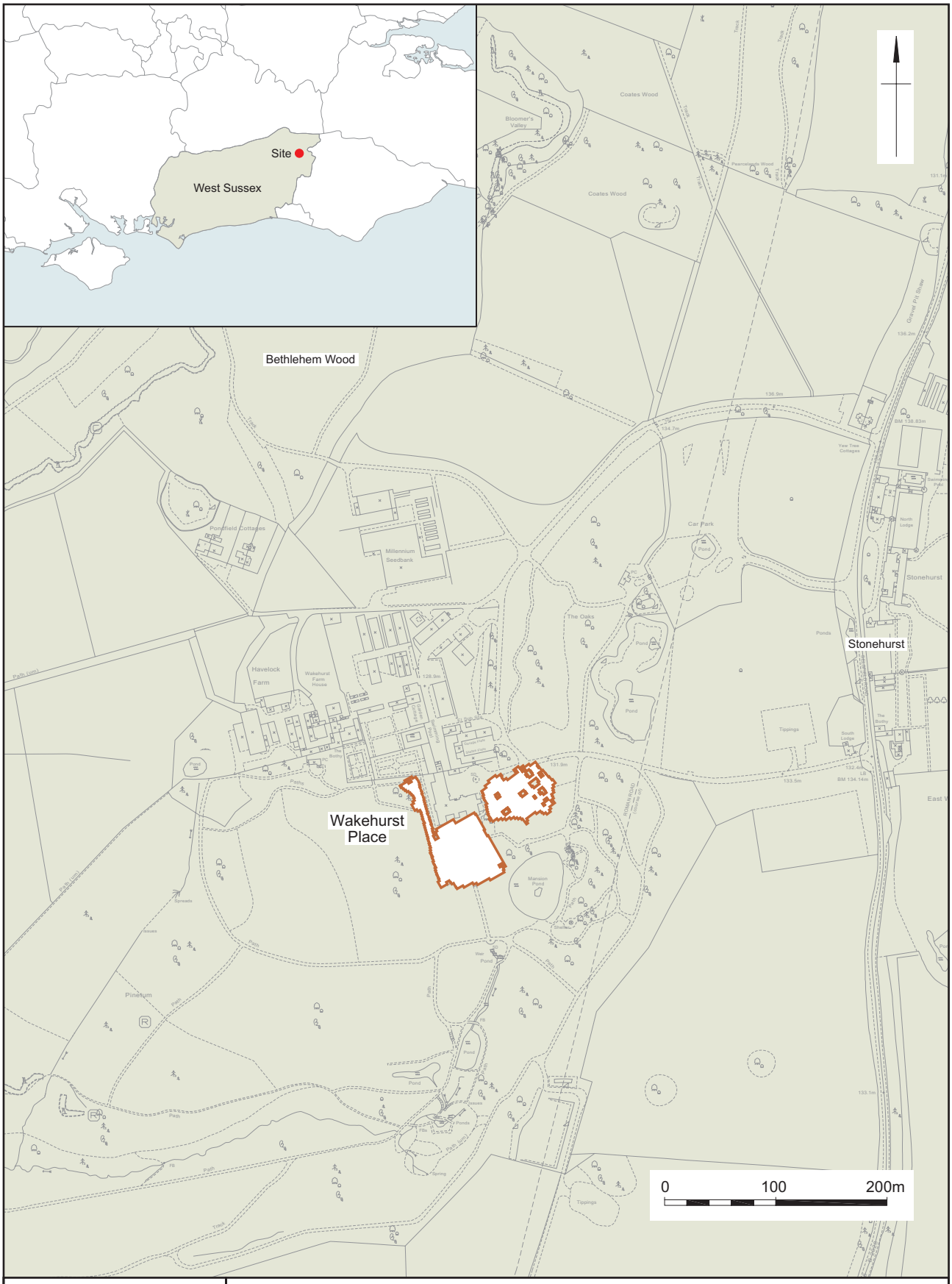
The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided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



Detailed survey area

OS mapping is indicative only.

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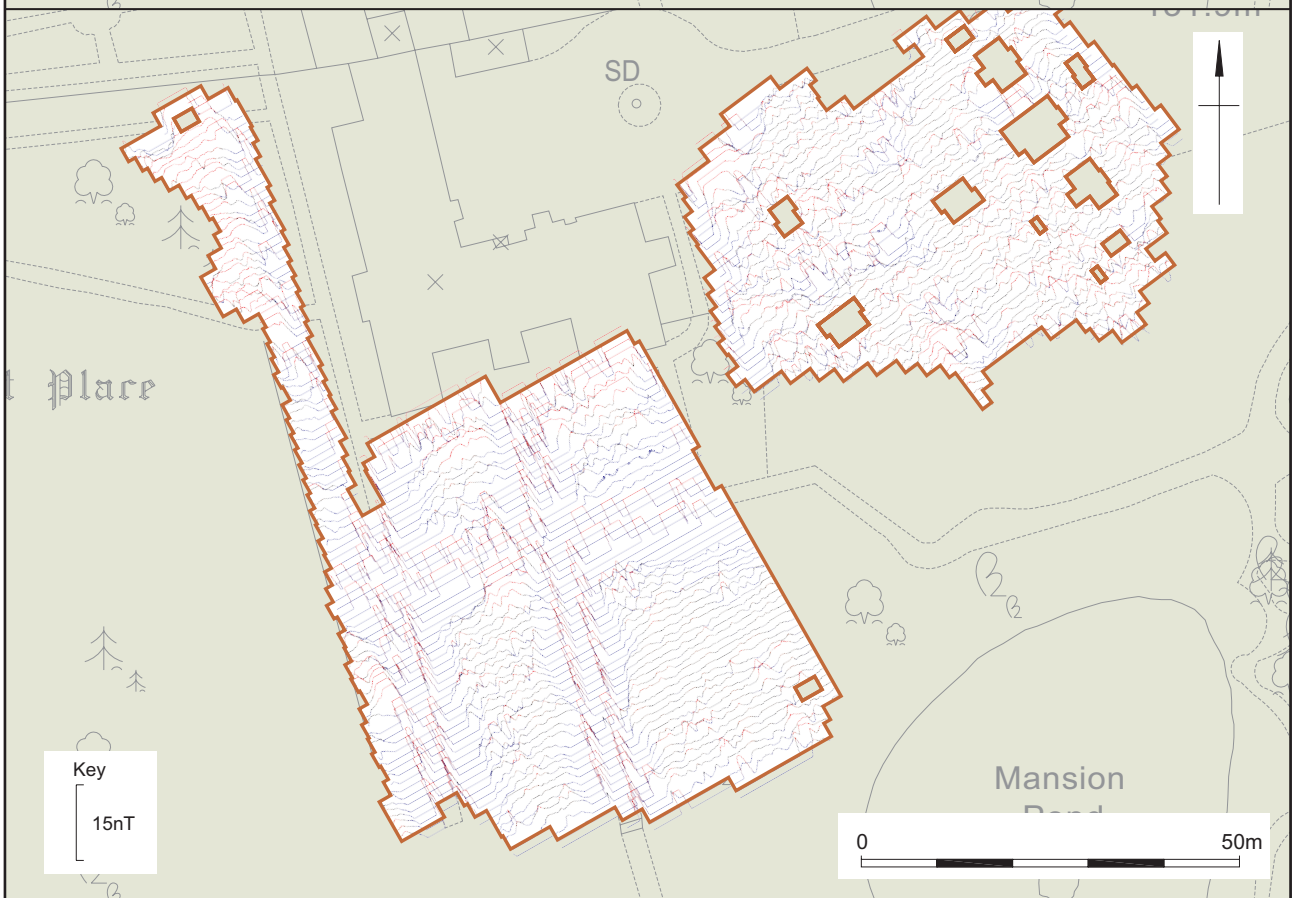
Site location and survey extents

Figure 1



Detailed survey area

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Magnetometer greyscale plot and XY trace

Figure 2

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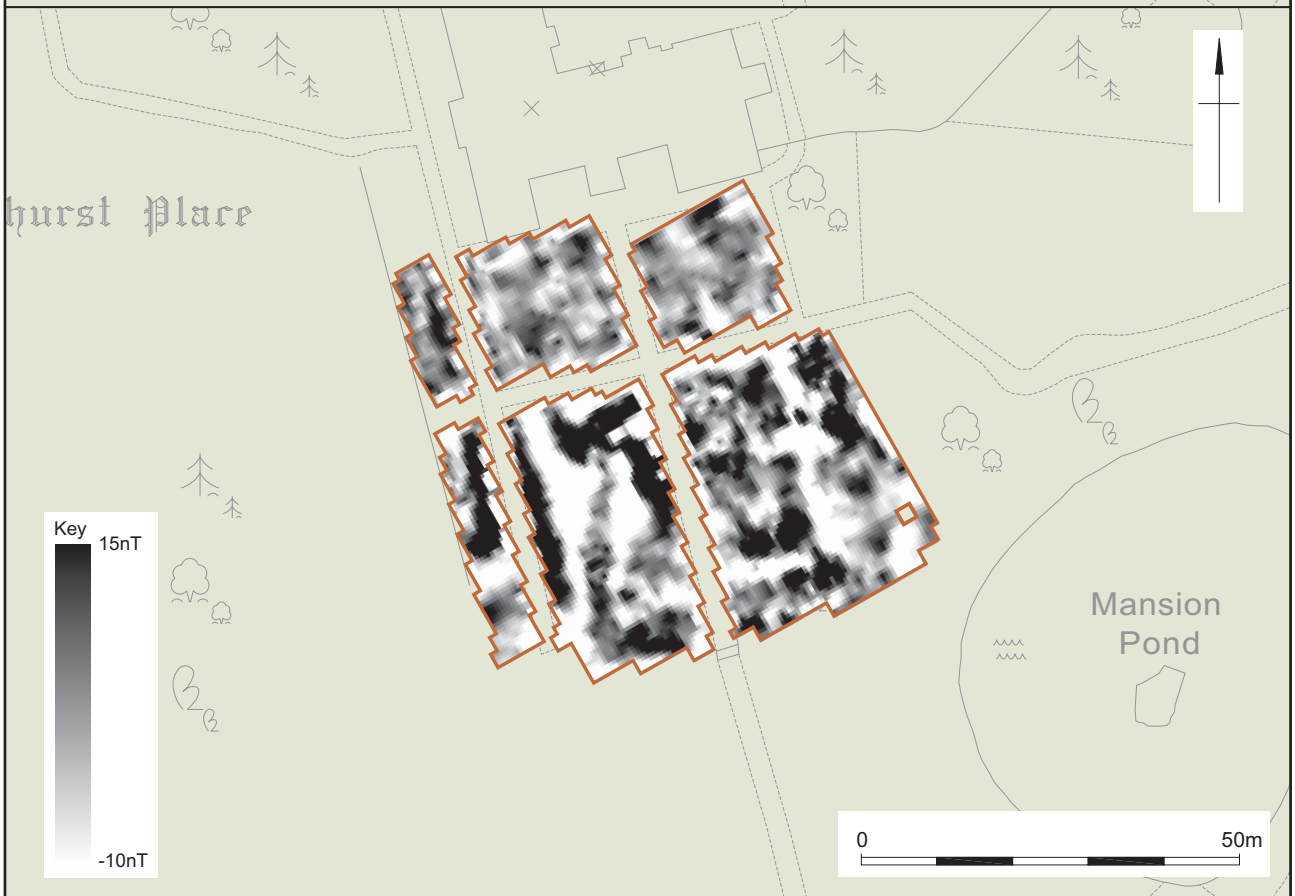
Magnetometer interpretation

Figure 3



Detailed survey area

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Earth resistance greyscale plots

Figure 4

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Earth resistance interpretation

Figure 5

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