RESEARCH DEPARTMENT REPORT SERIES no. 83-2010 ISSN 1749-8775

BROMHOLM PRIORY, NORFOLK
REPORT ON GEOPHYSICAL SURVEYS, NOVEMBER 2005 AND MARCH 2006

Louise Martin

ARCHAEOLOGICAL SCIENCE

ENGLISH HERITAGE

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NORFOLK

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NGR: TG 347 332

ISSN 1749-8775

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SUMMARY

Magnetometer and earth resistance surveys were conducted over the precinct area of Bromholm Priory in Norfolk to provide comparison with data gleaned from detailed and comprehensive fieldwalking and metal detecting surveys. The overall distribution of finds correlates well with areas of increased magnetic response and some of the structural evidence from the resistance surveys.

CONTRIBUTORS

The field work in the E field was conducted by Andy Payne and Louise Martin. The fieldwork in the W field was conducted by GSB Prospection Ltd.

ACKNOWLEDGEMENTS

Many thanks go to Mr Jonathan Deane for permission to survey the land and to Tim Pestell for background information on the site, the metal detector data and his input into this report.

ARCHIVE LOCATION

Fort Cumberland.

DATE OF SURVEY

The fieldwork was conducted in the E field between 1st – 4th November 2005 and in the W field between 13th – 16th March 2006. The report was completed on 28th September 2010.

CONTACT DETAILS

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INTRODUCTION

Geophysical surveys of a total ground area of approximately 9.4 hectares were conducted over most of the original precinct of Bromholm Priory, Norfolk (SAM No. NF169). The Priory was founded as Cluniac monastery in 1113 by William de Glanville. After acquiring a relic of the True Cross, Bromholm (or Broomholm) became a nationally recognised place of pilgrimage and also achieved the royal patronage of Henry III and Edward II (Pestell 2000, 52; 2005, 166). Despite the popularity the Priory once achieved, few structural elements remain and the site is now mostly in ruins with a farmyard covering the main body of the church. Still standing are part of the east walls and the North Transept, though the latter was uniquely reused as a converted strongpoint during World War II (English Heritage 2005b). The precinct itself is now under cultivation, though the precinct boundary itself has been partially retained in modern field boundaries.

Little was known or understood of the physical history of Bromholm Priory until Tim Pestell of the Norfolk Museums and Archaeology Service and Phil Emery from Gifford and Partners initiated a structured and methodical survey of the precinct using fieldwalking and metal detecting to recover finds from the ploughsoil: a total of ~11.6 hectares of arable land around the Priory has been surveyed using a 25m x 25m master grid (Pestell 2005, 168, 171) although the metal detector survey was conducted on a 12.5m x 12.5m grid and focused on the northern most ~8.7 hectares after the first sweep (T Pestell, *pers comm.*). Historical maps have also been analysed and aerial photographs have been studied as part of the National Mapping Programme (NMP), revealing numerous cropmarks believed to pertain to buried building foundations, roadways, fishponds and field systems (English Heritage 2005a).

The aim of this geophysical survey was to further the knowledge of the buried archaeology and provide comparison with the material culture patterns so far deduced. An initial survey of the field to the north and east of the farmyard (referred to from here on as E field) was conducted by English Heritage in November 2005. Following on from this, English Heritage commissioned GSB Prospection Ltd to collect data from the field to the west and south of the farm (referred to from here on as W field) in March 2006.

The site (centred on TG347332) lies on deep well drained coarse loamy soils of the Wick 2 association (Soil Survey of England and Wales 1983) developed over Sand and Gravel over Quaternary and Palaeogene deposits (British Geological Survey 1999). At the time of the surveys the E field was under a young winter wheat crop, and the W field was under stubble.

METHOD

All areas for survey in the E field were gridded using a real-time kinematic Global Positioning System (GPS). Those to the W using measuring tapes and an electronic Distance Measurer (EDM).

Magnetometer survey

Magnetometry was chosen in an attempt to locate buried ditches and pits and also other features that may relate to on-site metal working. The survey was conducted over the shaded area in Figure 1 using Bartington *Grad601* fluxgate gradiometers following the standard method outlined in note 2 of Annex 1, though in the W field the survey was conducted over 20m grid squares and initial processing was conducted by GSB Prospection Ltd.

Linear false colour plots of the two data-sets are superimposed over the Ordnance Survey (OS) base map at a scale of 1:2500 on Figure 2. Additionally X-Y traceplots and linear greyscale plots of the data are presented at a scale of 1:1750 on Figures 3 and 4.

Corrections made to the measured values displayed in the plots were to zero-mean each instrument traverse to correct for instrument heading errors and to 'despike' the data through the application of a 2m by 2m thresholding median filter (Scollar *et al.* 1990). This latter operation reduces the distracting, localised, high-magnitude effects produced by surface iron objects. To improve the visual intelligibility of the traceplot presented in Figures 3a and 4a, the data-sets have had the magnitudes of extreme values truncated to ±25nT/m.

Earth resistance survey

Subsequent to the magnetometer survey of the E field, an earth resistance survey was conducted over the suspected location the foundations of priory buildings. Measurements were made with a Geoscan RM15 resistance meter and a PA5 electrode frame in the Twin-Electrode configuration. Readings were collected using the standard method outlined in note 1 of Annex 1, with readings taken at 1.0m along traverses separated by 1.0m. The data was 'despiked' to remove isolated high readings due to poor contact and additionally processed using a 5m high-pass Gaussian filter to reduced large-scale background trends. A linear greyscale plot of the filtered data is superimposed over the base OS map at a scale of 1:2500 in Figure 5. Plots of the raw data set are additionally presented as both an X-Y traceplot and equal area greyscale at a scale of 1:1000 in Figure 6.

RESULTS

Magnetometer survey

A graphical summary of the significant anomalies discussed below is provided on Figure 7. Numbers in [ ] refer to annotations in this figure.

The general background magnetic response across the survey area was fairly quiet with measurements varying within the range between ±1nT/m. However, the standard deviation of background measurements increases to 2-3nT/m or greater in the vicinity of a dense concentration of anomalies around the area of extant buildings, as marked with a dashed line at [m1]. A similar phenomenon can be seen north of here at [m2] and in the very northwest of the survey area near the school at [m3]. It should be noted that during the metal detecting surveys a lot of modern rubbish was observed in the vicinity of [m2] (T Pestell *pers comm.*) which is likely to be the origin of the stronger response here.

Modern disturbance is also in evidence across other parts of the site. Specific instances include a discontinuous negative linear anomaly [m4] likely to be a buried plastic pipe. Linear responses of alternating extreme readings recorded at [m5-6] are the typical signature for service pipes. Two large discrete areas at [m7] suggest a highly ferrous causative feature and could relate to World War II activity, such as previously unrecorded defences or perhaps post-war clearance pits that have been noted elsewhere (T Pestell *pers comm.*); however, they may be more recent in origin. The anomaly at [m8] was the response to a partially visible concrete and metal feature on the unsurveyed grassed bank to the west: possibly a spigot mortar emplacement as has been noted elsewhere at the site during the Norfolk Defensive Structures Survey (English Heritage 2005b). Other extreme responses may relate to further military activity or to agricultural practices.

The collections of anomalies in the area of raised response at [m9] are suggestive of a former structure, with anomalies possibly caused by brick rubble or other similarly magnetically enhanced material. A negative linear anomaly [m10] is probably a former field boundary perhaps relating to the priory precinct as it respects the line of the boundary to the southwest better than the current line to the west of [m9]. This anomaly has been recorded in the NMP report and is thought to be a pre-1827 boundary as it was not recorded on a local enclosure map of that date (English Heritage 2005a).

Two broad bands of raised magnetic readings [m11] are perhaps geomorphological in origin, but could relate to a former boundary or other earlier archaeological feature. Two linear positive magnetic anomalies [m12] running east-west appear to correlate with the known priory gateway into the precinct. Further positive magnetic anomalies in this vicinity suggest possible activity in relation to the gate.

Other linear magnetic responses, such as [m13-14], are possibly short ditches or large pits but it is hard to interpret their purpose as they appear largely in isolation. Two parallel stronger responses [m15] also do not seem to relate obviously to other known features.

A large broad linear positive magnetic anomaly [m16] running parallel to a modern track is likely to be a wide ditch, possibly associated with the original precinct boundary. A section of this towards the north end is considerably stronger than the rest of the length indicating the fill of this section must be different to that in the rest of the feature. In addition, evidence for flint precinct walling has been observed in parts of the bank along here (T Pestell, *pers comm.*).

West of here is the main concentration of anomalies recorded at the site. These mostly take the form of discrete positive magnetic responses indicative of pits, e.g. [m17]. Some, however, have both a large spatial extent and high magnitude of response and are likely to be thermoremanent in nature: those around [m18] could well be evidence of metalwork activity. This would concord with the copper alloy slag and lead caming recovered from this area during the metal detecting survey conjectured to indicate the presence of workshops (T Pestell *pers comm.*). A few of the pit-type anomalies recorded around [m17] correlate with a cluster noted in the NMP survey but many more have been recorded by the magnetometer.

To the south end of the E field two linear positive magnetic anomalies [m19] could be the drainage ditches for a former trackway, now re-routed to the southwest. Some 40m to the north and parallel to these is a similar but much weaker pair of linear responses [m20] which could have a similar origin. Alternatively, together [m19-20] might form two sides of an enclosure.

To the northwest of the North Transept is a rectangular negative magnetic anomaly and a circular cluster of negative readings [m21]. The low magnetic field gradient in an area that appears generally enhanced suggests that there could be buried stonework here, or alternatively this could be evidence for a robbed out feature: however, it would have had to have been in-filled with material other than the local topsoil otherwise a more enhanced response would be detected.

Around the west side of the farm buildings in the W field are further concentrations of pit-type anomalies [m22] although these are not as numerous as those at [m17]. Again, these correlate with a cluster of pits recorded by the NMP survey, but, as before, the anomalies here appear more plentifully than the cropmark evidence would suggest.

Elsewhere across the site are various other small pit-type responses and short stretches of weakly positive linear anomalies. In general though, either their distribution is not as concentrated as in the areas mentioned above or their alignments are not easy to comprehend.

Earth resistance survey

A graphical summary of the significant anomalies discussed below is provided on Figure 8. Numbers in [ ] refer to annotations in this figure.

A large area of high resistance [r1] has been recorded in the footprint of the North Transept, relating to building rubble from this building. A low resistance linear anomaly [r2] describes a dog-leg around the northeast corner of [r1]. This is probably due to a cut feature, perhaps relating to drainage, previous excavation or military activity from when the North Transept was used as a strongpoint in World War II.

A further low resistance linear anomaly [r3] to the west of [r1-2] correlates with a possible ditch or drain recorded by the NMP survey. However, a rectilinear area of low resistance near the northwest corner of [r1] was not recorded by the NMP survey.

Two linear anomalies [r4] run eastwards parallel to the north of [r1]. They may be responses to a wall, perhaps once continuous. A further small high resistance anomaly [r5] may be a return to this wall but this is a highly speculative interpretation, since the corner where [r4] and [r5] would putatively join lies outside the survey area. Other anomalies in the vicinity may also relate to other structural remains, however, high contact resistance in this area makes it difficult to clearly identify the responses.

To the S another linear high resistance anomaly [r6] is on the same alignment as those at [r4]. It also partially correlates with an AP anomaly believed to relate to buried wall foundations. Another high resistance anomaly [r7] may also be due to a wall footing, however, it should be noted it runs on a different alignment to the previously mentioned anomalies.

A high resistance area [r8] adjacent to the south range of the priory may correspond to further building rubble, however, within this several discrete low resistance anomalies [r9] correspond with a collection of pit cropmarks recorded by the NMP and believed to be man-made.

An area of slightly raised resistance with a curving boundary [r10] runs out of the survey area to the east. It is not clear what this could relate to, though perhaps it is geological in origin as it roughly corresponds to a break of slope away from the centre of the priory.

DISCUSSION

A distribution plot of metal detected finds has been overlaid on greyscale plots of the magnetometer and earth resistance surveys on Figure 9.

The metal detector data was provided by Tim Pestell and is based on the combined summary totals for all finds relating to clothing, medieval coinage, jettons, weights, religious and literary items and horse furniture collected during the detailed surveys up until 2005. This information was used to create a distribution map of hot-spots of finds but does not discriminate between object type: a comprehensive analysis of this data can be found elsewhere (Pestell 2005). Further repeat surveys have since been undertaken and the results are still being processed, however, the overall distribution patterns appear to further corroborate those already produced (T Pestell *pers comm.*).

The main concentrations of metal detector finds correlate well with the increases in background response observed in the magnetometer data at [m1-2] and further serve to demonstrate a concentration in activity to the east of the site. The highest concentrations of finds do not obviously tie-up with specific magnetic anomalies, although they do appear to relate more closely to possible structural anomalies in the earth resistance data. However, as noted above, the distribution map presented in Figure 9 does not identify find-type and it is hoped that future analyses might shed further light on specific useage zones at the site, for example: do finds relating to metal-working occur in particular spatial relationships to the magnetic anomalies at [m18]?

CONCLUSION

The geophysical surveys at Bromholm have revealed a wealth of anomalies around the priory buildings. The magnetometer surveys have demonstrated a concentration of activity around the extant remains, correlating with the overall metal finds distribution, and providing additional detail over that recorded by the NMP survey. In addition, the magnetometry results have highlighted possible industrial activity particularly to the southeast. Further traces of the precinct boundary have also been detected where they deviate from the current field layout.

The earth resistance survey has recorded anomalies that may relate to structural remains though these are not as comprehensive as in the cropmark evidence and it is possible that the majority of the remains have now been ploughed out. The suggestion of buildings to the east and also around the north transept corresponds to increased numbers of metal finds indicating a focus of activity in these areas.

LIST OF ENCLOSED FIGURES

REFERENCES

British Geological Survey 1999 Mundesley and North Walsham, England and Wales Solid and Drift Geology Sheet 132 and 148. 1:50000

English Heritage 2005a Bromholm or Broomholm Priory. Monument Record SMR Number 1073 - MNF1073.

English Heritage 2005b World War Two Defences at Abbey Farm/Bromholm Priory. Monument Record SMR Number 27255 - MNF45749.

Pestell, T 2000 'New Surveys at Bromholm Priory'. Church Archaeology, 4, 52-54.

Pestell, T 2005 'Using Material Culture to Define Holy Space: the Bromholm Project' in Spicer, A and Hamilton, S (eds), Defining the Holy: Sacred Space in Medieval and Early Modern Europe   Aldershot: Ashgate, 161-186

Scollar, I, Tabbagh, A, Hesse, A and Herzog, I, Eds. 1990. Archaeological Prospecting and Remote Sensing. Cambridge.

Soil Survey of England and Wales 1983 Soils of England and Wales Sheet 4, Eastern England. 1:250000

ANNEX 1: NOTES ON STANDARD PROCEDURES

1) Earth Resistance Survey

Each 30 metre grid square is surveyed by making repeated parallel traverses across it, all aligned parallel to one pair of the grid square's edges, and each separated by a distance of 1 metre from the last; the first and last traverses being 0.5 metres from the nearest parallel grid square edge. Readings are taken along each traverse at 1 metre intervals, the first and last readings being 0.5 metres from the nearest grid square edge.

Unless otherwise stated the measurements are made with a Geoscan RM15 earth resistance meter incorporating a built-in data logger, using the twin electrode configuration with a 0.5 metre mobile electrode separation. As it is usually only relative changes in earth resistance that are of interest in archaeological prospecting, no attempt is made to correct these measurements for the geometry of the twin electrode array to produce an estimate of the true apparent resistivity. Thus, the readings presented in plots will be the actual values of earth resistance recorded by the meter, measured in Ohms (Ω). Where correction to apparent resistivity has been made, for comparison with other electrical prospecting techniques, the results are quoted in the units of apparent resistivity, Ohm-m (Ωm).

Measurements are recorded digitally by the RM15 meter and subsequently transferred to a portable laptop computer for permanent storage and preliminary processing. Additional processing is performed on return to Fort Cumberland using desktop workstations.

2) Magnetometer Survey

Each 30 metre grid square is surveyed by making repeated parallel traverses across it, all parallel to that pair of grid square edges most closely aligned with the direction of magnetic N. Each traverse is separated by a distance of 1 metre from the last; the first and last traverses being 0.5 metre from the nearest parallel grid square edge. Readings are taken along each traverse at 0.25 metre intervals, the first and last readings being 0.125 metre from the nearest grid square edge.

These traverses are walked in so called 'zig-zag' fashion, in which the direction of travel alternates between adjacent traverses to maximise survey speed. Where possible, the magnetometer is always kept facing in the same direction, regardless of the direction of travel, to minimise heading error. However, this may be dependent on the instrument design in use.

Unless otherwise stated the measurements are made with either a Bartington Grad601 or a Geoscan FM36 fluxgate gradiometer which incorporate two vertically aligned fluxgates, one situated either 1.0m or 0.5 metres above the other; the bottom fluxgate is carried at a height of approximately 0.2 metres above the ground surface. Both instruments incorporate a built-in data logger that records measurements digitally; these are subsequently transferred to a portable laptop computer for permanent storage and preliminary processing. Additional processing is performed on return to Fort Cumberland using desktop workstations.

It is the opinion of the manufacturer of the Geoscan instrument that two sensors placed 0.5 metres apart cannot produce a true estimate of vertical magnetic gradient unless the bottom sensor is far removed from the ground surface. Hence, when results are presented, the difference between the field intensity measured by the top and bottom sensors is quoted in units of nano-Tesla (nT) rather than in the units of magnetic gradient, nano-Tesla per metre (nT/m).

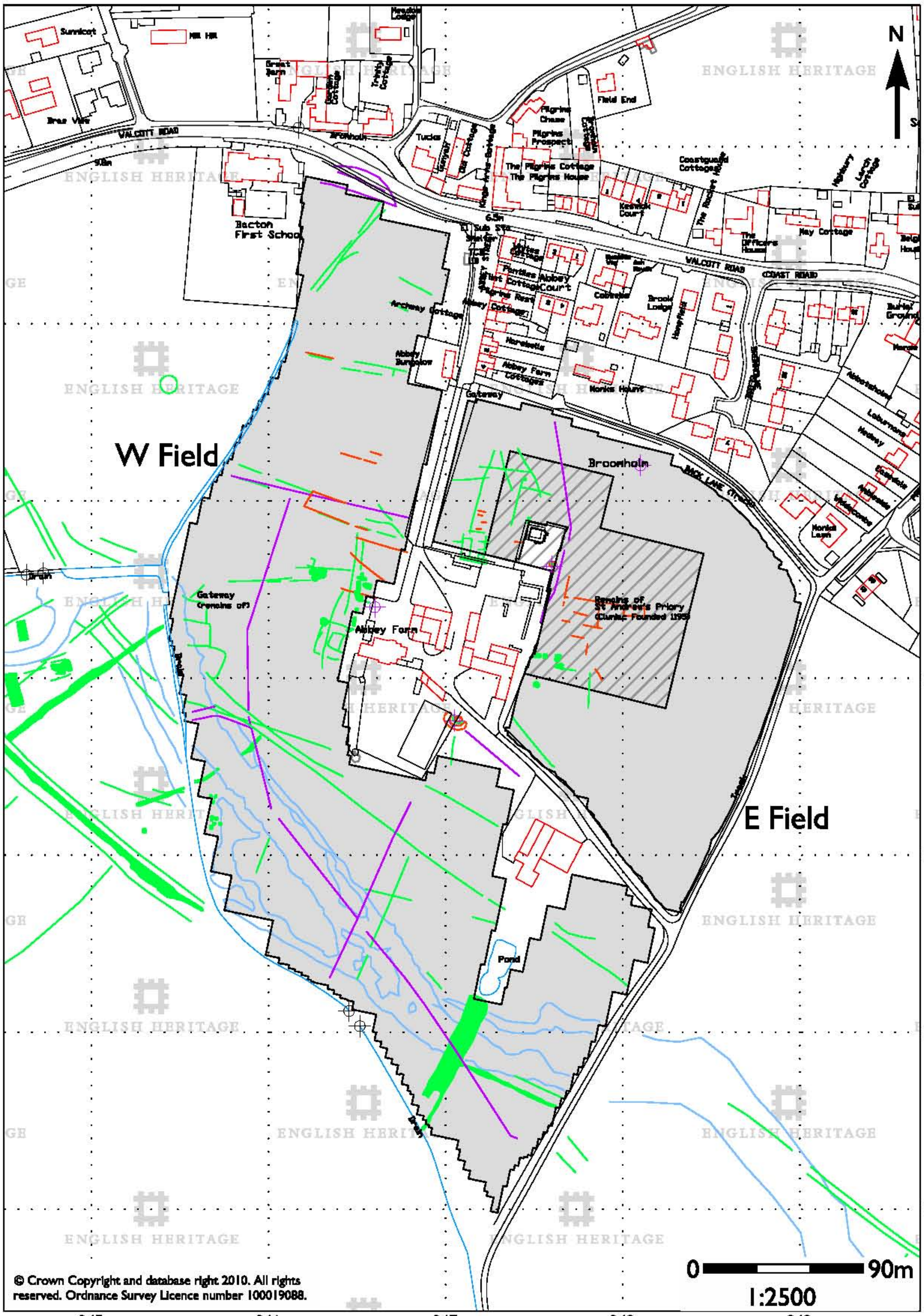
3) Resistivity Profiling

This technique measures the electrical resistivity of the subsurface in a similar manner to the standard resistivity mapping method outlined in note 1. However, instead of mapping changes in the near surface resistivity over an area, it produces a vertical section, illustrating how resistivity varies with increasing depth. This is possible because the resistivity meter becomes sensitive to more deeply buried anomalies as the separation between the measurement electrodes is increased. Hence, instead of using a single, fixed electrode separation as in resistivity mapping, readings are repeated over the same point with increasing separations to investigate the resistivity at greater depths. It should be noted that the relationship between electrode separation and depth sensitivity is complex so the vertical scale quoted for the section is only approximate. Furthermore, as depth of investigation increases the size of the smallest anomaly that can be resolved also increases.

Typically a line of 25 electrodes is laid out separated by 1 or 0.5 metre intervals. The resistivity of a vertical section is measured by selecting successive four electrode subsets at increasing separations and making a resistivity measurement with each. Several different schemes may be employed to determine which electrode subsets to use, of which the Wenner and Dipole-Dipole are typical examples. A Campus Geopulse earth resistance meter, with built in multiplexer, is used to make the measurements and the Campus Imager software is used to automate reading collection and construct a resistivity section from the results.

Figure 1

BROMHOLM PRIORY, NORFOLK
Location of geophysical surveys, November 2005 and March 2006.



Magnetometer survey
Earth resistance survey
NMP survey: Bank
NMP survey: Ditch
NMP survey: Palaeochannel
NMP survey: Structure

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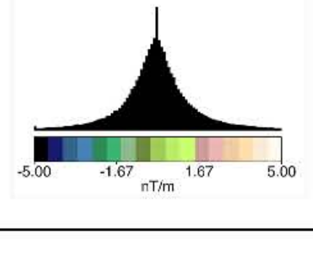
Figure 2

BROMHOLM PRIORY, NORFOLK

Magnetometer surveys, November 2005 and March 2006.

West field survey



East field survey

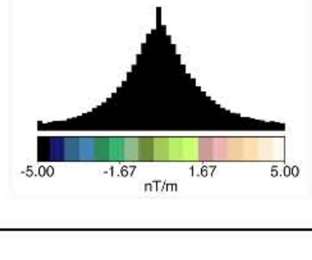


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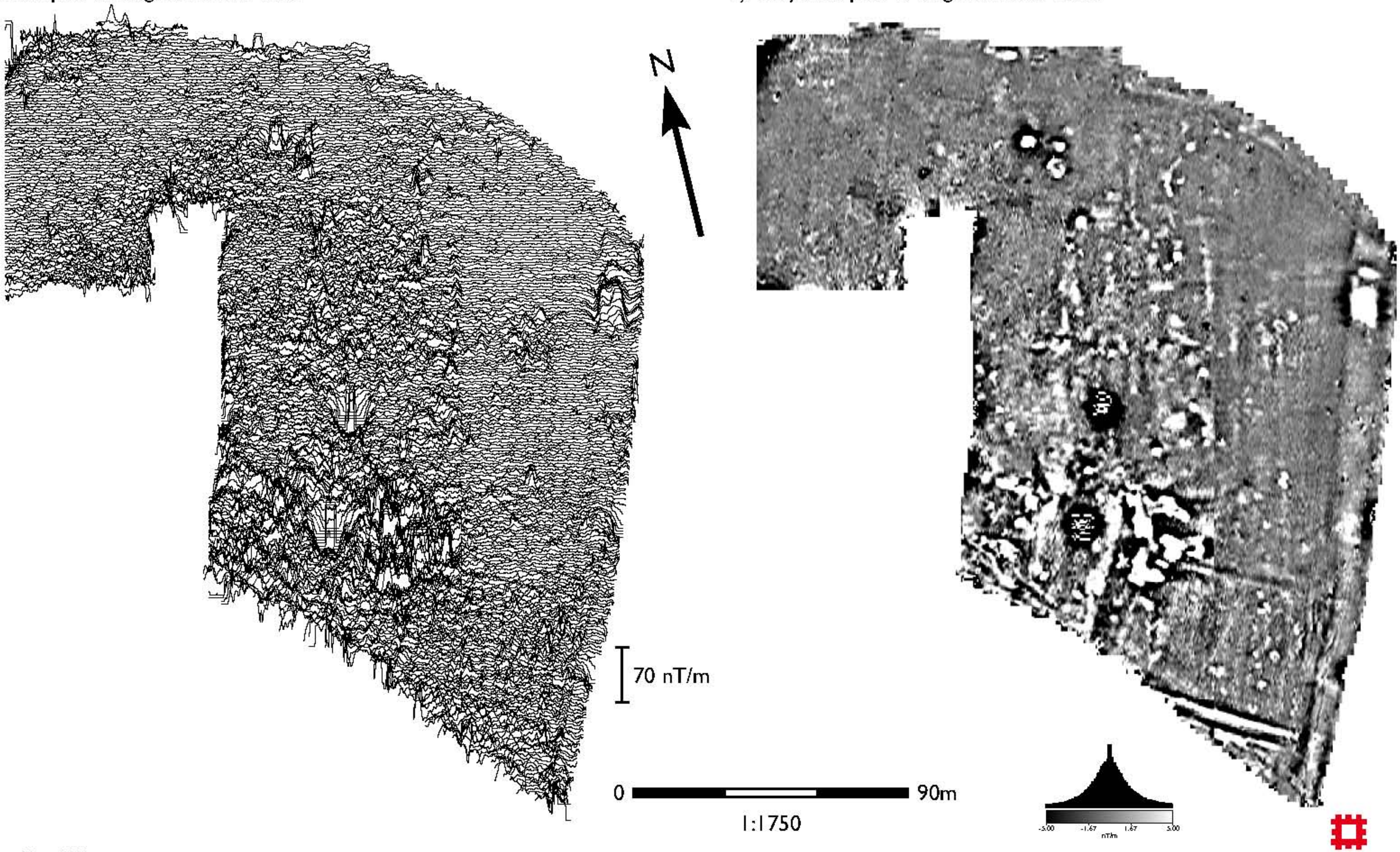
Figure 3

Magnetometer survey of E field, November 2005.

A) Traceplot of magnetometer data.

B) Greyscale plot of magnetometer data.



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Magnetometer survey of W field, March 2006

Figure 4

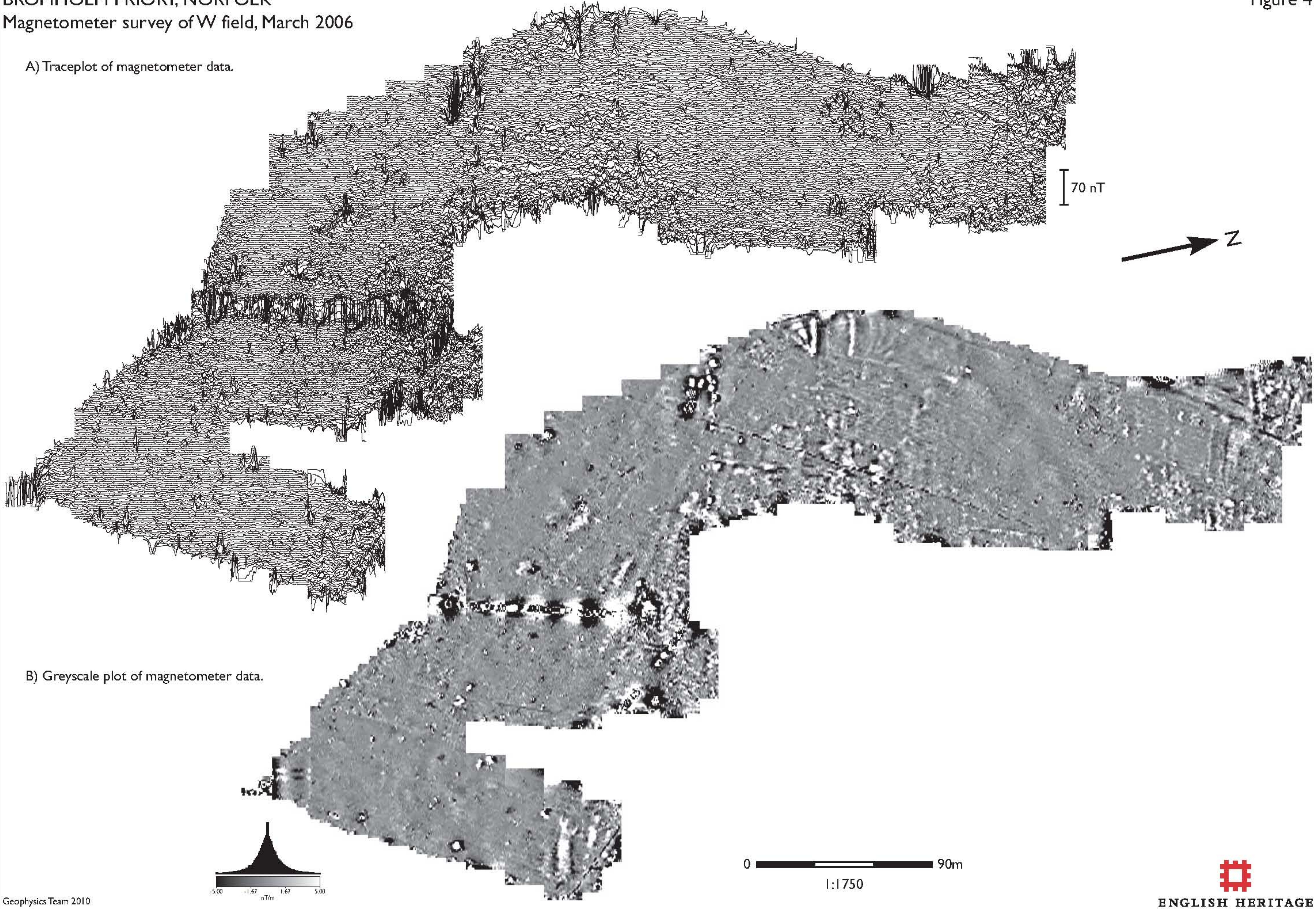

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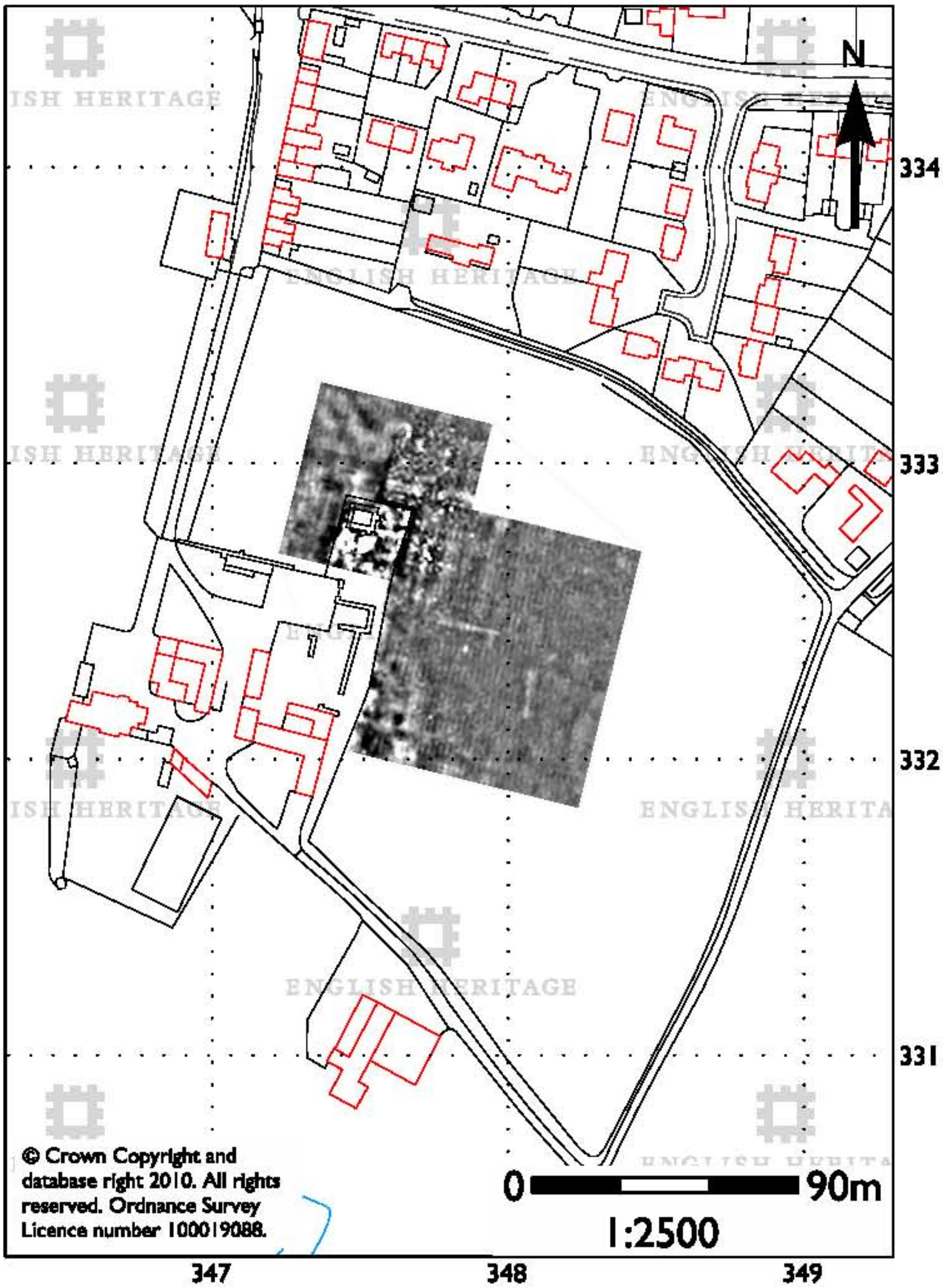
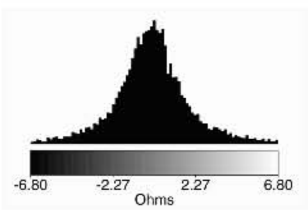
Figure 5

BROMHOLM PRIORY, NORFOLK
Earth resistance survey, November 2005.

TG3433





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Earth resistance survey, November 2005.

Figure 6

A) Traceplot of raw earth resistance data.

B) Greyscale plot of raw earth resistance data.

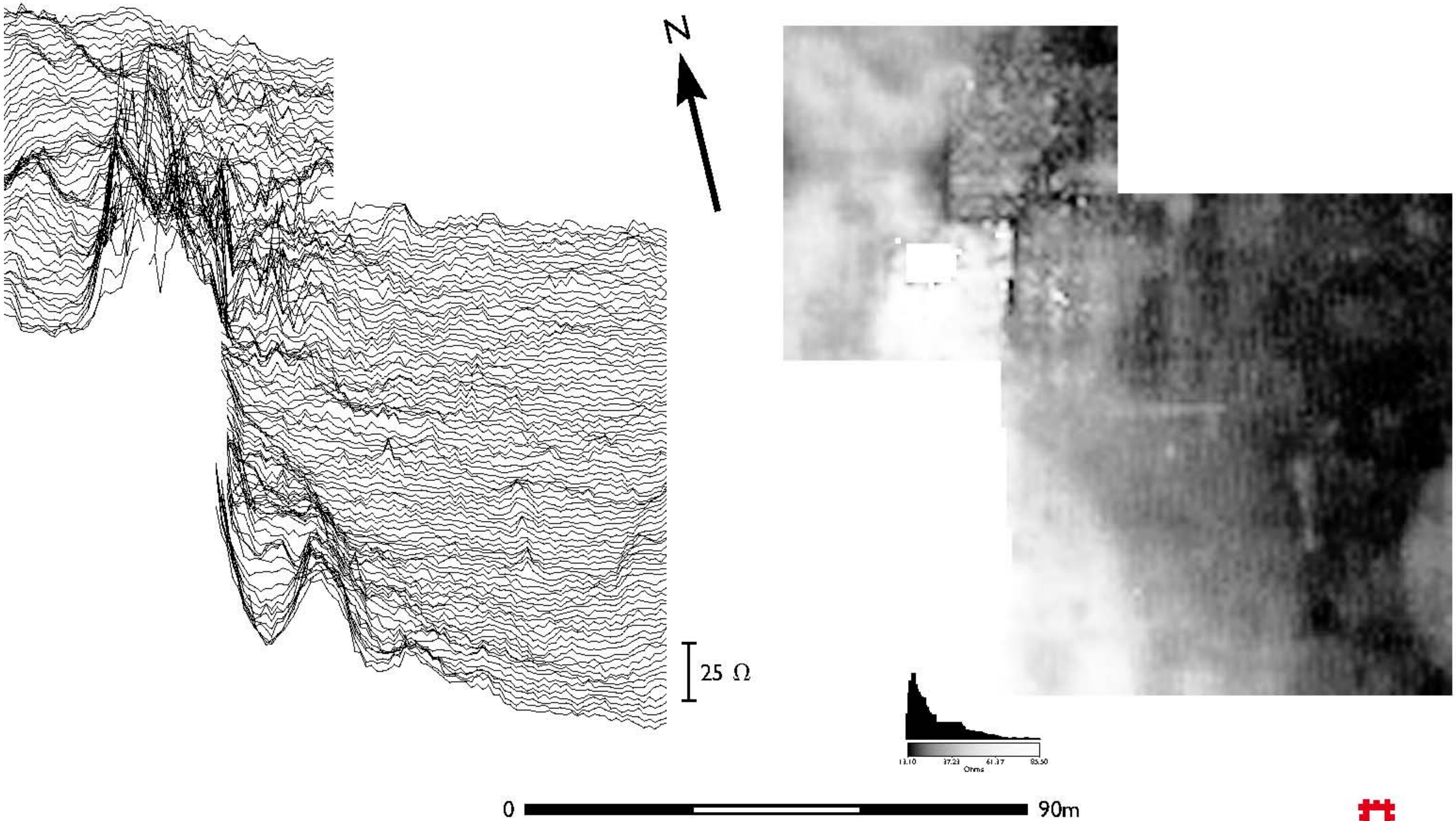

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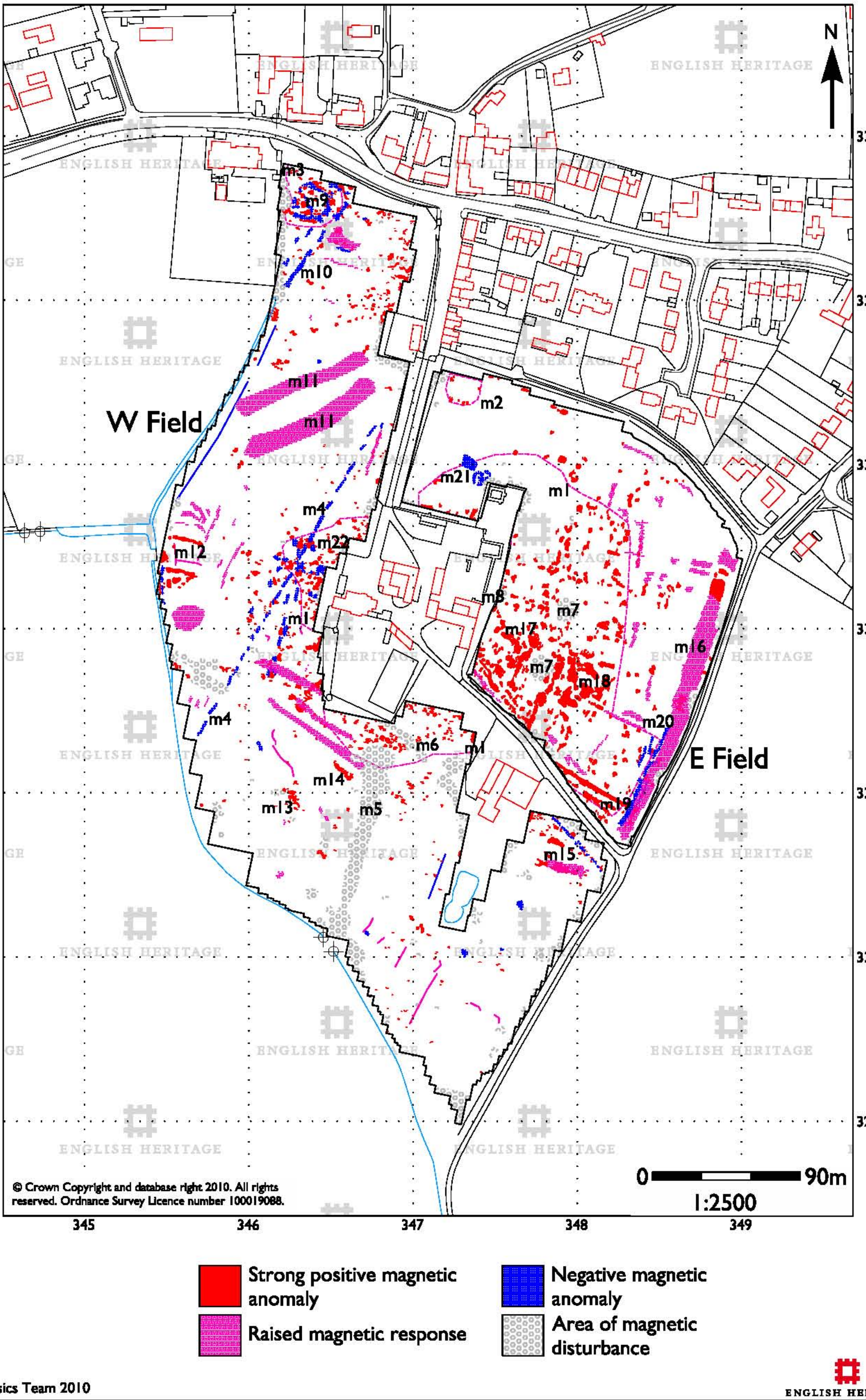
Figure 7

BROMHOLM PRIORY, NORFOLK

Graphical summary of significant magnetic anomalies, November 2005 and March 2006.



Strong positive magnetic anomaly

Raised magnetic response

Negative magnetic anomaly

Area of magnetic disturbance

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Figure 8

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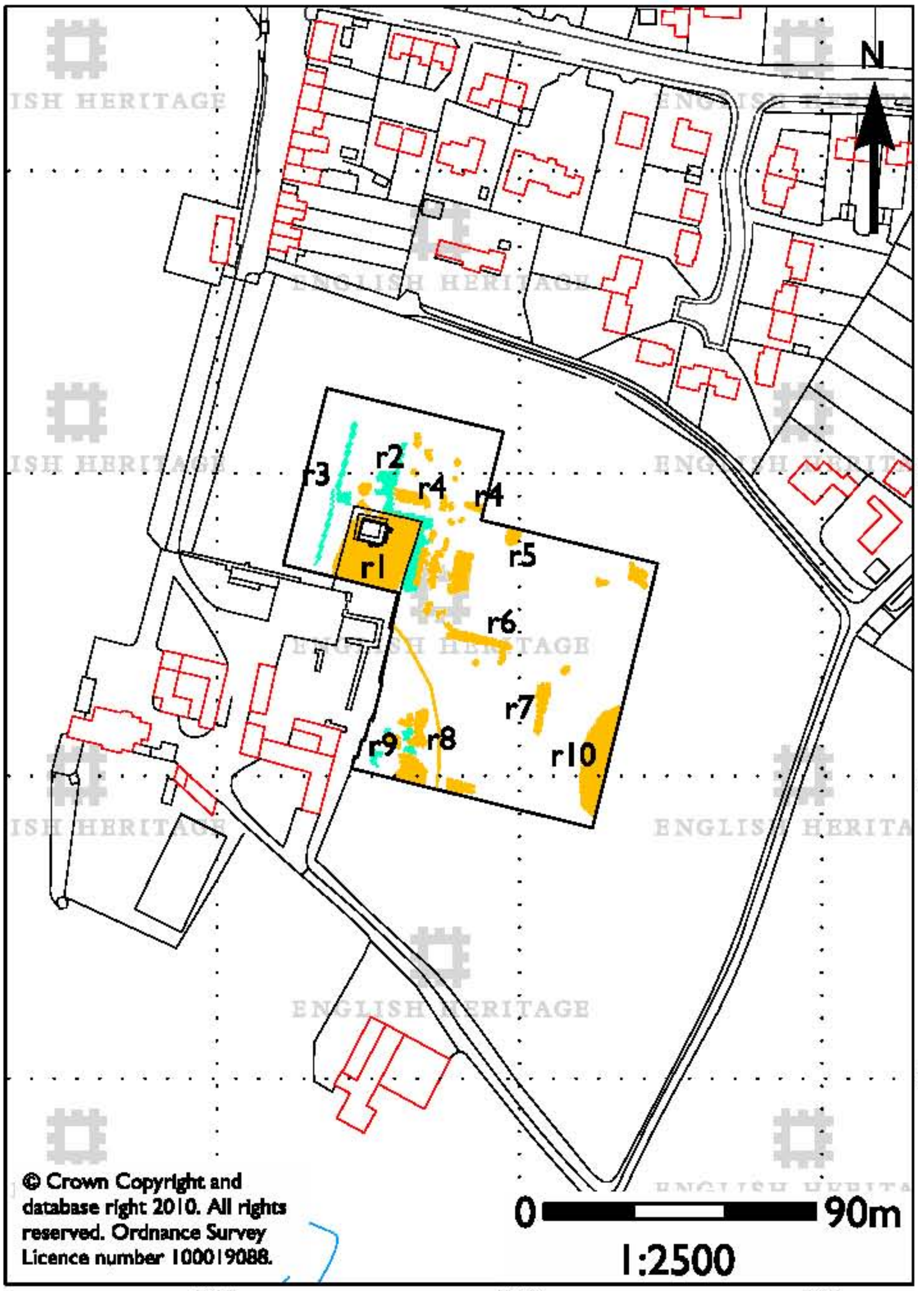
Graphical summary of significant earth resistance anomalies, November 2005.

TG3433



Strong positive magnetic anomaly

Negative magnetic anomaly

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Figure 9

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Comparison of metal detecting results with magnetometer and earth resitance surveys.

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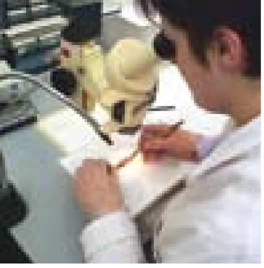
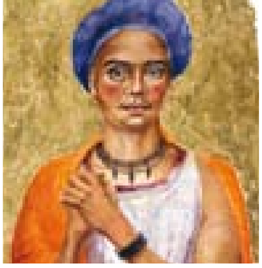



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