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PENHALE ROUND, CORNWALL
REPORT ON GEOPHYSICAL SURVEYS, FEBRUARY AND NOVEMBER 1991

Andrew Payne

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SUMMARY

A series of fluxgate magnetometer surveys were undertaken prior to archaeological investigation by Cornwall Archaeological Unit in advance of the Fraddon-Indian Queens A30 road improvement scheme. The surveys revealed anomalies related to the multiple ditch circuit of Penhale Round (an enclosed later prehistoric settlement site) and evidence for internal activity within the settlement. Indications of further associated settlement and field systems were also detected outside the Round in the wider surrounding landscape.

CONTRIBUTORS

The field work was conducted by Gregory Fookes and Andrew Payne during February and November 1991.

ACKNOWLEDGEMENTS

Supplementary information from the subsequent A30 road improvement excavation project (between 1992 and 1994) was supplied by Jacky Nowakowski of Cornwall County Council, Historic Environment Service (previously Cornwall Archaeological Unit) for the preparation of this report. Andy Hood of Foundations Archaeology helpfully provided information on a second excavation carried out in advance of building development over part of the interior of Penhale Round in 2006. The cover photograph shows an oblique aerial view looking west over the southern portion of the Penhale Round enclosure in the process of excavation on the line of the subsequently constructed A30 road improvement corridor (copyright Historic Environment, Cornwall Council, © Penhale Round PR93 CAU archive).

ARCHIVE LOCATION

Fort Cumberland.

DATE OF FIELDWORK AND REPORT

The fieldwork was conducted over a period of two separate weeks during 25th February to 1st March 1991 and 19th to 21st November 1991. The report was completed on 13th December 2011.

CONTACT DETAILS

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INTRODUCTION

Fluxgate magnetometer survey was undertaken during February and March 1991 along the construction corridor for the proposed Fraddon-Indian Queens A30 road improvement scheme in the environs of the enclosed settlement at Penhale Round (NGR SW 907572; NMR No. SW 95 NW6). The survey initially examined 3 separate fields to the south and east of the round running in a strip along the proposed course of the new by-pass from Trewheela Farm in the east to New Road in the west (Figure 1). Although lying largely to the north of the proposed route, the southern extremity of the Penhale Round enclosure was also expected to be truncated by the road development and therefore a further magnetometer survey was carried out over the enclosed settlement in November 1991, improving on the evidence available from an earlier magnetometer survey at a time when only relatively crude analogue data capture methods were available (David 1982). The site of the Round and surrounding archaeological activity detected by the geophysical surveys in 1991 was subsequently excavated by Cornwall Archaeological Unit in 1993 and the area has since seen significant modern building development (Nowakowski 1998; Johnston *et al.* 1999) generated by the new road construction in the form of a motel and inn complex (appropriately named the "Penhale Round").

The local geology consists of Lower Devonian Meadfoot Beds (calcareous slate, grit and thin limestone) overlain by fine loamy and silty soils of the Manod association (Geological Survey of Great Britain 1973; Soil Survey of England and Wales 1983).

METHOD

A series of local grids consisting of 30m by 30m squares were set out using a Nikon DTM01 total station theodolite to best fit with the boundaries of the individual land-parcels sub-dividing the site (Areas 1-5, Figure 1). The tall vegetation covered field banks separating the different survey areas prevented the establishment of a uniform grid across the whole site due to a lack of intervisibility between the adjacent land units.

Magnetometer survey was carried out over each 30m grid square using Geoscan FM36 fluxgate gradiometers with readings recorded at intervals of 0.25m along successive parallel traverses spaced 1.0m apart using the 0.1 nT resolution setting of the instrument. The data is presented as a greyscale image superimposed upon the Ordnance Survey (OS) map (Figure 2) and larger scale traceplot and greyscale images are presented at 1:1250 in Figures 3 and 4. The data displayed in greyscale form on Figures 2 and 4 has been enhanced by the application of a 1.0m radius low pass Gaussian filter to suppress image noise (Scollar *et al* 1990); following i) initial truncation of the recorded data-range to remove extreme values outside the range of +/- 50 nT caused by strong ferrous disturbance from fences, buildings and electricity pylons adjacent to the survey areas; and ii) setting of each traverse to a zero mean to remove directional sensitivity and instrument drift. The data displayed in traceplot form in Figure 3 was subject to range truncation and drift correction only with no further processing applied.

A graphical summary of significant magnetic anomalies mapped by the survey [m1-13] is presented on Figure 5.

RESULTS

Areas 1-3: The course of the A30 road improvement

This consisted of 3 main survey areas located in separate fields running from west to east along the course of the new road corridor. The initial coverage in Area 2 undertaken in February 1991 was subsequently extended to the south during the November 1991 survey visit, but using the different grid orientation employed in the adjacent Area 3. The coverage in Area 3 was broken up into three separate blocks of data due to to the presence of modern fences.

Area 1

Numerous linear positive magnetic anomalies on varying alignments mapped in this area are indicative of ditches. Some of these linear anomalies cross over each other, suggesting several phases of ditch cutting and modification. In the eastern part of Area 1 several ditches running on a N-S alignment [m1, Figure 5] appear to terminate at and respect the multiple enclosure ditches of the round [m2] to the north and are likely to represent ditches defining contemporary field systems, boundaries and trackways radiating out from the enclosed settlement. Parallel ditches at [m3] may indicate an approach running from a probable entrance in the south of the round enclosure towards a further series of ditch type responses [m4], perhaps defining outworks. Directly south of [m4] and adjacent to a pair of N-S aligned ditches is a possible area of occupation activity indicated by a cluster of irregular positive magnetic anomalies [m5]. A double linear anomaly [m6], following a curving course from the south towards the round, is a response typical of a Medieval field boundary in Cornwall and is similar to results from the site at Penhale Moor (Linford 1994). A number of single ditches running E-W appear to terminate at [m6] and to the west of it magnetic activity falls away almost completely. A broad weak linear positive magnetic anomaly [m7] may be indicative of a response to a natural geological feature.

Area 2

This area has significantly less evidence of archaeological activity compared to Area 1. However, a substantial linear positive magnetic anomaly [m8] is present in the NE with two narrower ditches running off it to the south, possibly representing an adjoining enclosure. Continuation of [m8] has been mapped in the adjacent survey areas north of Trewheela Farm through Area 5 to the western extent of Area 4.

Area 3

This area contains the eastward continuation of [m8] together with a narrower, weaker curvilinear anomaly [m9]; possibly part of an enclosure circuit that has not been fully described within the survey area. A number of weaker linear anomalies are also found in this area and may relate to patterns of former land allotment or, perhaps, ridge and furrow cultivation to the north and west of Trewheela farm.

Areas 4 and 5: Penhale Round enclosed settlement

The slightly irregular oval form of the round enclosure [m2] is defined by a double circuit of ditches with a strong positive magnetic response. The inner circuit appears to be more substantial than the outer ditch and on the eastern side of the enclosure two further narrower concentric ditch-type responses are interleaved with the main continuous ditches. A break in the wider inner ditch on the south side of [m2] indicates the presence of a probable entrance feature in this area, although the outer circuit appears continuous here (perhaps suggestive of a staggered entrance approach through the multiple ditch circuit). An internal, weakly defined circular anomaly [m10],15m in diameter located in the western half of the round, is likely to represent the ring gully of a circular habitation structure. To the east of the enclosure a three-sided arrangement of postive anomalies [m11] indicates further significant activity, subsequently identified through excavation as a stone-lined subterranean fogou or souterrain (Foundations Archaeology 2007; *cf* the similar magnetic response recorded over the fogou at Boden Vean reported in Linford 1998). A number of positive linear anomalies, terminating at the round, are suggestive of boundaries integrated with the settlement while others that are seen to continue across the enclosure are more likely to represent later superimposed features. The most obvious of these, a double ditched anomaly [m12] cutting across the western half of the round, was subsequently identified by excavation as a post Medieval boundary. A large localised positive pit-type response [m13] lying immediately outside [m2] to the south-west was also notable due to its enhanced magnitude of response (>25nT, relative to an average 10 nT signal from the inner ditch of the Round enclosure).

Comparison with subsequent excavation results

The subsequent excavation evidence from the site can be briefly summarised as follows: The earliest remains in the vicinity were the boundaries of an early field system, a well-preserved oval building (anomaly [m13] in the magnetic data), a circular stake-built enclosure and the traces of a sub-rectangular structure which contained a domestic hearth pit. Embedded in the floor of the oval building was a dense spread of Middle Bronze Age Trevisker Ware pottery dating to around 1300-900 BC, together with the charred fragments of structural oak timber, perhaps accounting for the strong magnetic response of [m13] (Nowakowski 1998: Phase 4, Middle Bronze Age structure 358).

Excavations at Penhale Round centred on the ramparts, external ditches and main entranceway to the south, suggested by the break in the response of [m2] noted above. At least five major phases of complex modification to this site were identified. Occupation extended from at least the end of the second or first century BC up to the third/fourth centuries AD, during which time the site gradually developed from a single-ditched enclosed settlement into one with double ditches. The anomalies at [m5] in Area 1 may possibly reflect the presence of external Romano-Cornish occupation activity encountered in this area of the site during the 1993 excavations (Nowakowski 1998: Areas 6 and 7; R-B structure 5517).

After its abandonment, the area seems to have been largely deserted and not later reused for settlement by medieval farmers, although traces of a medieval field wall (anomaly [m12] in the magnetic data) were found running more or less centrally across the site.

In addition to the fogou, a stone-built hut-type building was also recorded in the 2006 excavation area together with numerous other features including post-holes, pits, gullies, hearth pits and a cobbled surface (Foundations Archaeology 2007). With the exception of the fogou [m11] none of the other features appear to have been distinctively resolved in the magnetometer survey.

CONCLUSION

The ditch circuit of the enclosed settlement of Penhale Round and the nature of the internal activity within the enclosure were successfully defined by the magnetometer surveys, although more precise interpretation of some of the internal anomalies was only possible with the aid of subsequent excavation. Most notably a curious but indistinct arrangement of positive magnetic anomalies ([m11] in the magnetic data) was found to relate to remains of a fogou structure (a stone-lined subterranean passage). The form of the ditches defining the enclosure circuit of the round is strongly suggestive of several phases of elaboration and re-definition of the boundaries over the lifetime of the settlement, as subsequently confirmed by excavation. The survey additionally mapped the presence of numerous linear boundary ditches in the locality of the round, some of which appear to respect the settlement enclosure while others cut straight across it, suggesting several different periods of construction and associated landuse in the neighbouring landscape. The major E-W linear anomaly extending across the survey area [anomaly m8] appears to represent a significant boundary work traversing the landscape. The ditches of the round enclosed settlement appear to be integrated with the linear boundary work, but the precise relation between the two is unclear from the survey.

LIST OF ENCLOSED FIGURES

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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).

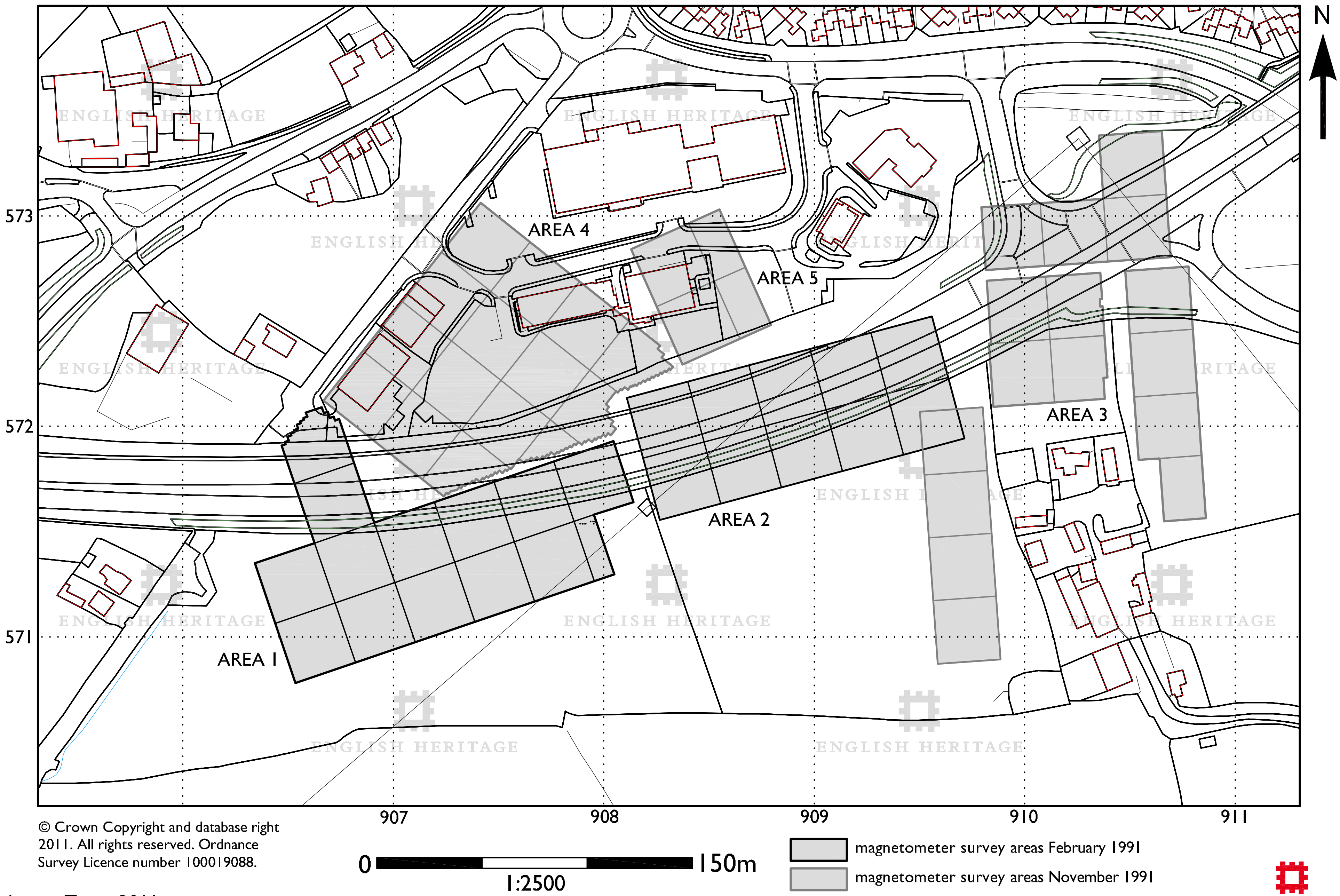
3) Resistivity Profiling

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

PENHALE ROUND, CORNWALL
Location of fluxgate magnetometer surveys, February and November 1991



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PENHALE ROUND, CORNWALL
Fluxgate magnetometer surveys, February and November 1991

Figure 2

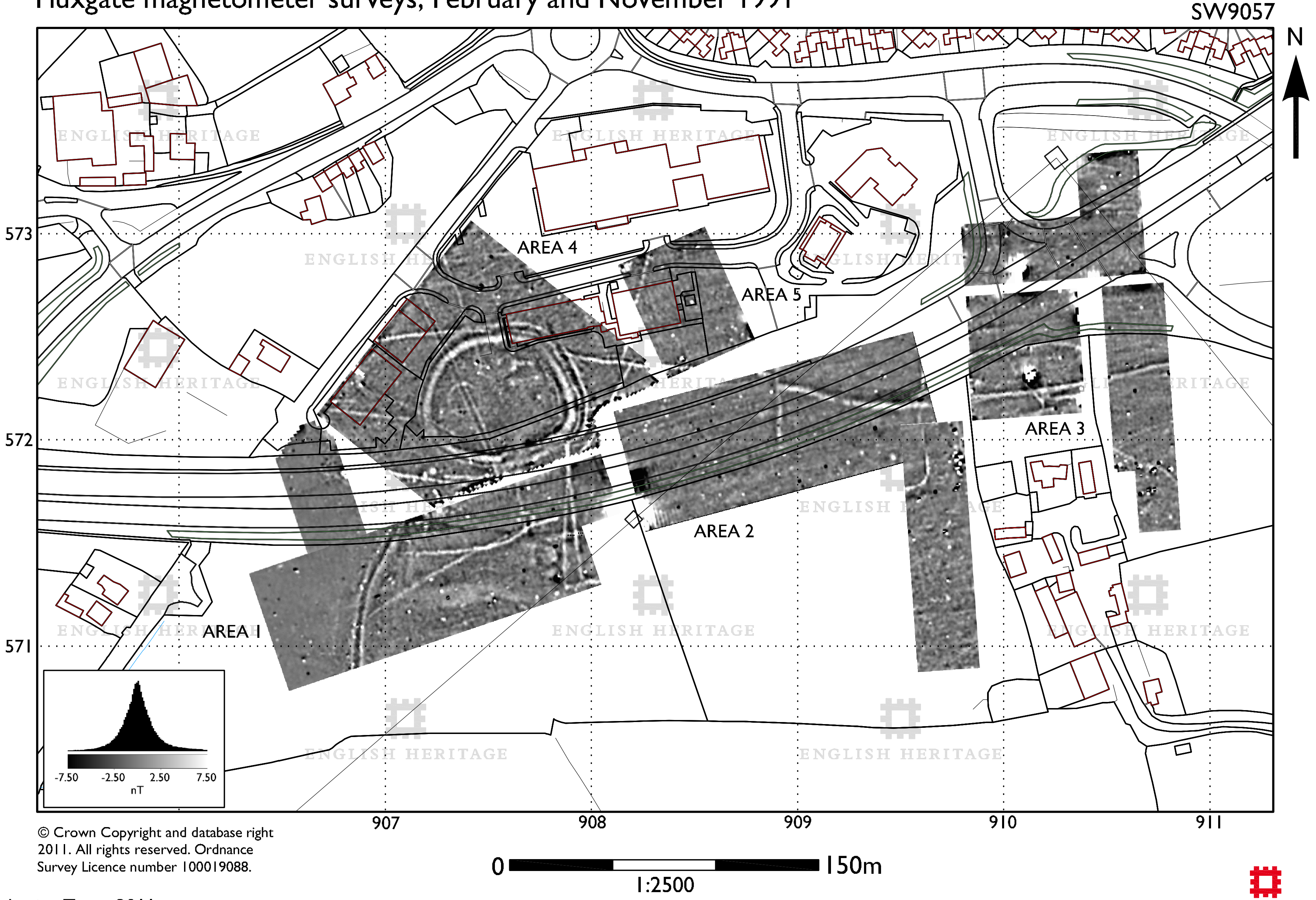

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Figure 3

PENHALE ROUND, CORNWALL Fluxgate magnetometer surveys, February and November 1991

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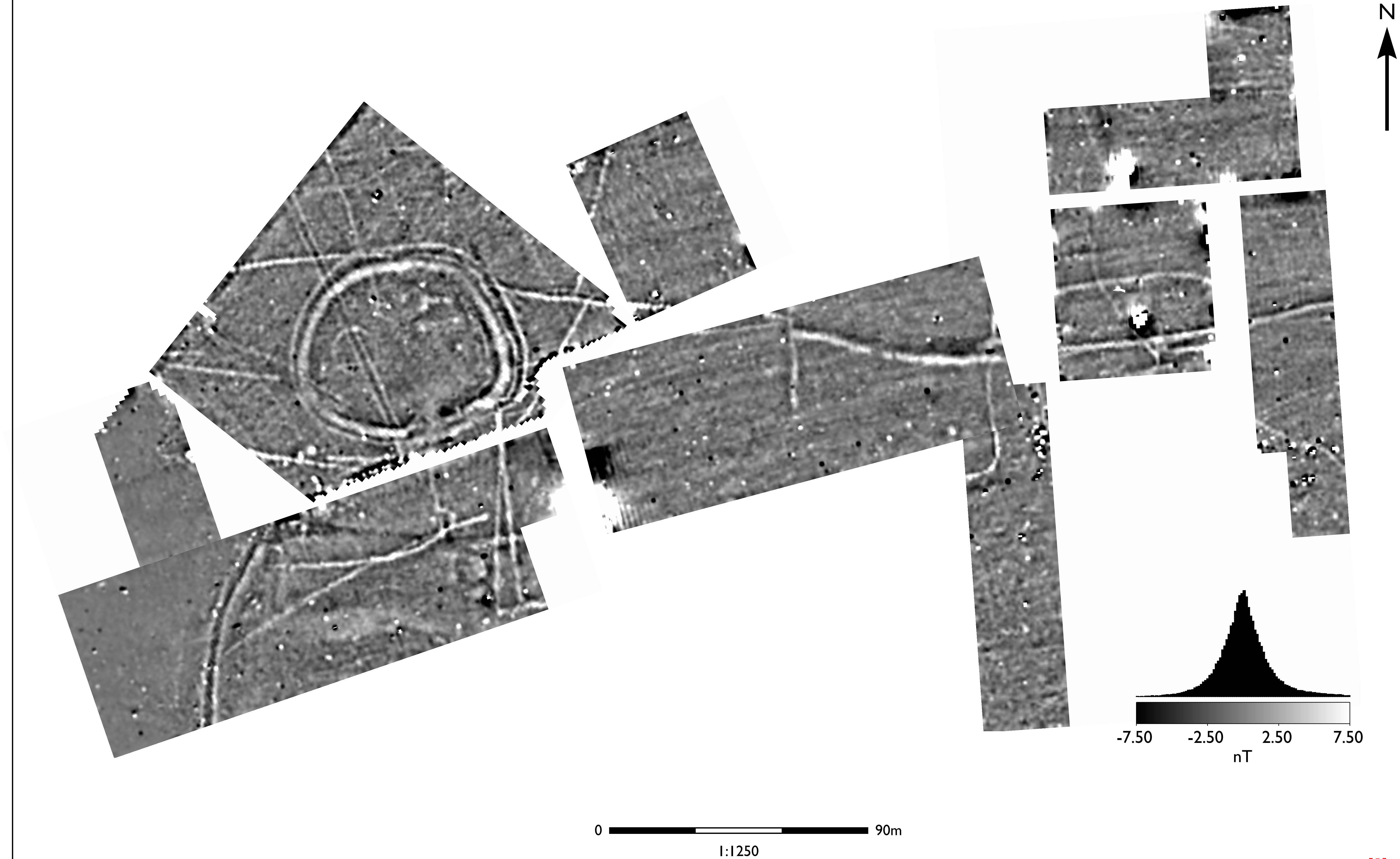
PENHALE ROUND, CORNWALL Fluxgate magnetometer surveys, February and November 1991

Figure 4



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Graphical summary of significant magnetic anomalies

Figure 5

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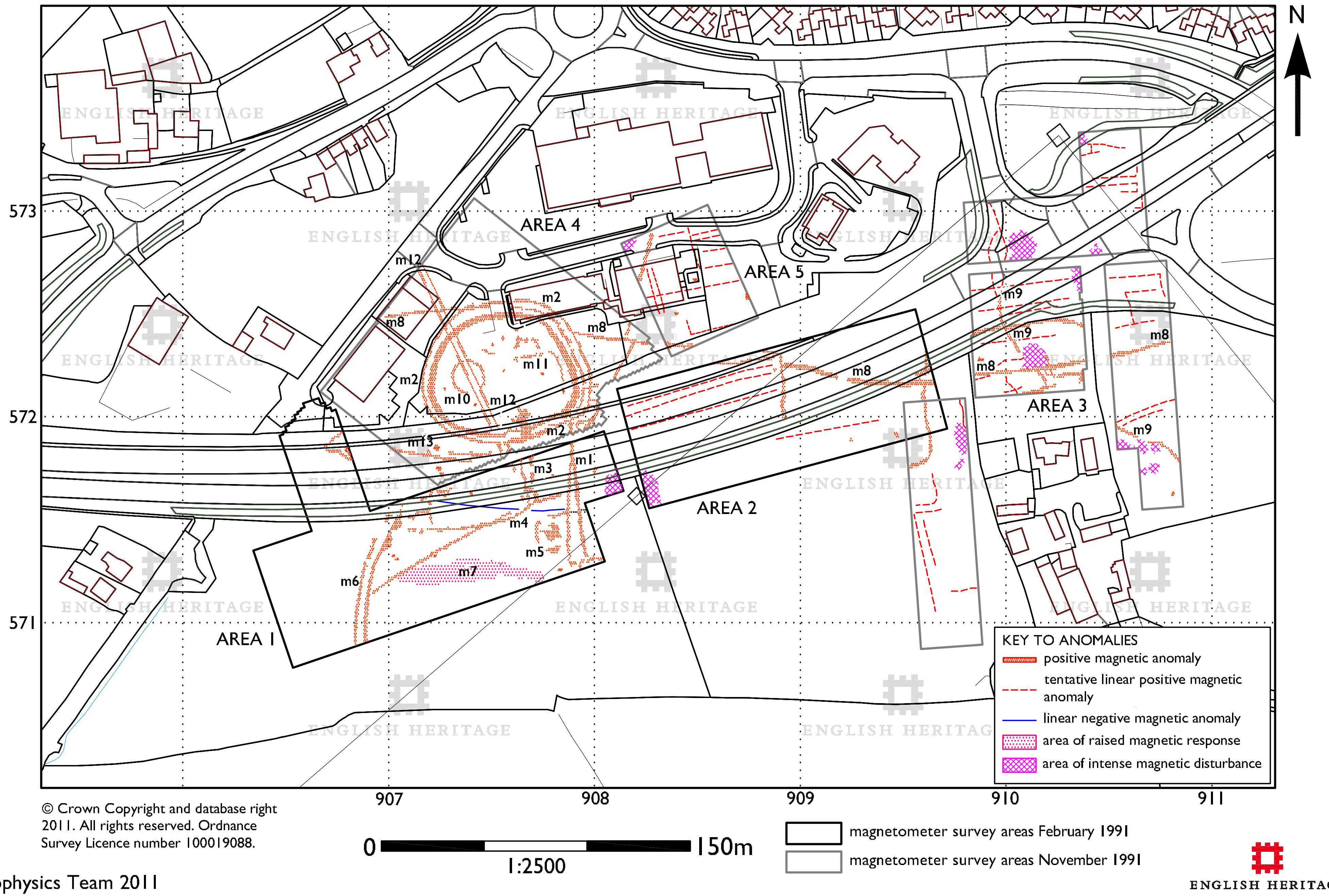

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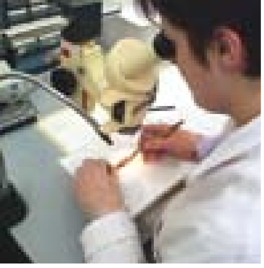
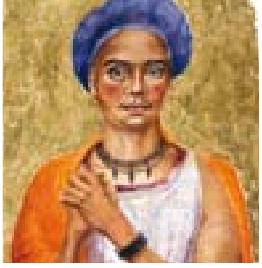



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