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# STONESFIELD ROMAN VILLA, OXFORDSHIRE
# REPORT ON GEOPHYSICAL SURVEYS, SEPTEMBER 2013

Neil Linford, Paul Linford, Ian Hardwick and Andy Payne

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Research Report Series 59-2013

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## SUMMARY

Geophysical survey was conducted over the scheduled area surrounding the Stonesfield Roman villa, immediately south of Stonesfield village, Oxfordshire, in an attempt to more precisely locate any surviving remains and place these in a wider archaeological context. A vehicle-towed, caesium magnetometer array was used to cover an area of approximately 12ha and revealed a large Roman settlement, abutting Akeman Street and extending beyond the currently scheduled area. Subsequent earth resistance (1.5ha) and Ground Penetrating Radar (1.0ha) survey was targeted over possible masonry remains identified from the magnetic data, and confirmed the location of both the original building discovered in the C18th together with a much larger corridor villa within the same enclosed settlement. The geophysical survey successfully confirmed the location and survival of significant archaeological remains protected by the scheduling and will help inform the ongoing management in response to revised land use at the site.

## CONTRIBUTORS

The field work was conducted by Neil Linford, Paul Linford and Andy Payne from the English Heritage Geophysics Team, together with Ian Hardwick who joined the team as part of a Historic Environment Placement sponsored by the Institute of Field Archaeologists.

## ACKNOWLEDGEMENTS

The authors wish to express their thanks to the land owners and tenants, Messrs Aran and Tudor Stone, the Blenheim Estate and Mr Robert Stobo, and to Mr Roger Evins, for permission in granting access to their land to allow the survey to take place.

## ARCHIVE LOCATION

Fort Cumberland.

## DATE OF FIELDWORK AND REPORT

The fieldwork was conducted between 9th to 13th September 2013 and the report was completed on 3rd December 2013. The cover shows a view of the site from the S with the earth resistance survey in progress.

## CONTACT DETAILS

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# INTRODUCTION

A large Roman building at Stonesfield was first discovered through ploughing the field known as Chesthill Acres to the S of the village, in January 1712 and was subsequently revealed to contain both a hypocaust and elaborate mosaic pavements (AMIE UID 336649, Taylor 1941). This discovery led to much interest at the time and the site became a popular tourist attraction. However, disagreement between the land owner and tenant farmer over the profits raised from these visitors led to reports of the partial destruction of the remains in 1724, although subsequent excavations in 1779-80 revealed two other geometric pavements that were removed from the site. In 1801 the property was divided between three land owners and both the precise location and state of preservation of the remains was uncertain. Whilst currently protected through the Scheduled Ancient Monuments Act (OCN OX25) both the full extent of the site and fidelity of contemporary records are unknown despite detailed appraisal by Freshwater *et al* (2000).

The Stonesfield site sits in a landscape of Roman farmstead settlements, for example the villa estates at Fawler, Oaklands Farm and North Leigh are all within a radius of 3km, in close proximity to the course of Akeman Street. Aerial photography in the immediate area has produced mixed results and does not appear to have identified remains associated with the Stonesfield villa, although Roman artefacts have been recovered through surface recovery from the adjacent arable land (Gilman 1984; Freshwater *et al.* 2000). Current interest in the site has been raised by unauthorised tree planting within the scheduled area that prompted a request for geophysical survey from the Inspector of Ancient Monuments, through: NHPP Activity 8A5 Offsetting loss through knowledge dividend; Protection Result 8A5.2 Emergency investigation assistance for threatened heritage outside the planning process. The aim of the survey was to locate and determine the likely preservation of any surviving remains with particular concern for the areas affected by recent tree planting.

The site lies predominantly over an area of White Limestone Formation with limestones from the Hampen and Taynton formations found in a dry valley to the W of the survey area (Geological Survey of England and Wales 1998). Shallow soils of the 511a Aberford Association have developed over the limestone, with some deeper calcareous soils in alluvium at the bottom of the slope down to the S along the course of Akeman Street (Soil Survey of England and Wales 1983). Land use at the time of the survey was a mixture of pasture, a small livestock holding and fruit tree orchard within the scheduled area, and the arable field to the E was fallow following a rape crop. Weather conditions during the field work were generally dry, following a prolonged dry summer, with one day of persistent rain.

# METHOD

## Magnetic survey

The magnetometer data was collected along the instrument swaths shown on Figure 1 using an array of six high sensitivity Geometrics G862 caesium vapour magnetometer sensors mounted on a non-magnetic sledge. This sledge was towed behind a low impact, all-terrain vehicle (ATV) which also provided the power supply and housed the data logging electronics. Five of the sensors were mounted in a linear array transverse to the direction of travel 0.5 m apart and, vertically, ~0.2m above the ground surface. The sixth was fixed 1.0 m directly above the central magnetometer in the array to act as a gradient sensor. The sensors were set to sample at a rate of 16 Hz based on the typical average travel speed of the ATV (3.2 m/s) giving a sampling density of ~0.2 m by 0.5 m along successive swaths. Each swath was separated from the last by approximately 2.5 m, navigation and positional control being achieved using a Trimble 4700 series Global Positioning System (GPS) receiver mounted on the sensor platform 1.75 m in front of the central sensor. Sensor output and survey location were monitored during acquisition to ensure data quality and minimise the risk of gaps in the coverage due to the use of a grid-less system.

After data collection the corresponding readings from the gradient sensor were subtracted from the measurements made by the other five magnetometers to remove any transient magnetic field effects caused by the towing ATV. The median value of each instrument traverse was then adjusted to zero by subtracting a running median value calculated over a 60m 1D window. This operation corrects for slight biases added to the measurements owing to the diurnal variation of the Earth's magnetic field and any slight directional sensitivity of the sensors. A linear greyscale image of the combined magnetic data is shown superimposed over the base Ordnance Survey (OS) mapping on Figure 2 and minimally processed versions of the range truncated data ($\pm$50 nT) are shown as a traceplot and linear greyscale image in Figures 5 and 6 respectively.

## Earth resistance survey

Measurements were recorded over a series of 30m grids established with a Trimble 4700 series RTK GPS (Figure 1) using a Geoscan RM15 resistance meter, a PA5 electrode frame in the Twin-Electrode configuration and a MPX15 multiplexer, to allow two separate surveys, with electrode separations of 0.5m and 1.0m, to be collected simultaneously. The 0.5m electrode separation coverage was designed to detect near-surface anomalies in the upper 0.5m of the subsurface whilst the 1.0m separation survey allowed anomalies to a depth of about 1-1.25m to be detected. For the 0.5m electrode separation survey readings were taken at a density of 0.5m by 1.0 m whilst for the 1.0m separation survey they were taken at a density of 1.0m by 1.0m.

Extreme values caused by high contact resistance were removed from both datasets using an adaptive thresholding median filter with radius 1m (Figure 7(B) and 7(F) Scollar *et al.* 1990, 492). The results for the near-surface 0.5m electrode separation survey are depicted as a linear greyscale image in Figure 3 superimposed on the OS map and Figure 7 shows the minimally processed raw data, presented as both an X-Y traceplot and an equal area greyscale, together with greyscale representations following the application of a contrast enhancing Wallis filters (radius 25m). To better visualise the vertical separation of the anomalies an Hotelling transform was applied to the 0.5m and 1.0m mobile probe separation data sets to indicate both the difference and similarity between the two sets of results (González and Woods 2002). In this case, the two resulting images may be due to near surface anomalies and more deeply lying regional trends within the data (cf Figure 7(D) and 7(H); Linford 2003).

## Ground Penetrating Radar survey

The Ground Penetrating Radar (GPR) data was collected along the instrument swaths shown on Figure 1 using Sensors and Software Pulse Ekko PE1000 console with a 450MHz centre frequency ground coupled antenna, to record reflections through a 60ns window. The antenna was mounted in small sledge towed behind an ATV together with a Trimble 4700 series GPS receiver to provide positional data. Individual GPR traces were collected at 0.05m intervals along profiles separated by approximately 0.5m, although the cross-line spacing was varied to accommodate obstructions such as the fruit tree saplings that has, potentially, degraded the quality of the areal data compared to acquisition over an unobstructed grid.

Post acquisition processing involved the adjustment of time-zero to coincide with the true ground surface, background and noise removal, and the application of a suitable gain function to enhance late arrivals. Representative profiles from the GPR survey are shown on Figure 8. An average sub-surface velocity of 0.08m/ns was assumed following constant velocity tests on the data, and was used for the migration velocity field, the time to estimated depth conversion and the static topographic correction applied to the profiles on Figure 8. In addition, owing to antenna coupling between the GPR transmitter and the ground to an approximate depth of $^{\lambda}/_{2}$, very near-surface reflection events should only be detectable below a depth of 0.09m if a centre frequency of 450MHz and a velocity of 0.08m/ns are assumed. However, the broad bandwidth of an impulse GPR signal results in a range of frequencies to either side of the centre frequency which, in practice, will record significant near-surface reflections closer to the ground surface. Such reflections are often emphasised by presenting the data as amplitude time slices. In this case, the time slices were created from the entire data set, after applying a 2D-migration algorithm, by averaging data within successive 2ns (two-way travel time) windows (Linford 2004). Each resulting time slice, illustrated as a greyscale image in Figure 9 represents the variation of reflection strength through successive 0.08m intervals from the ground surface.

# RESULTS

## Magnetic survey

A graphical summary of the significant magnetic anomalies, [m1-30], discussed in the following text, superimposed on the base OS map data, is provided in Figure 10.

### General response

A good magnetic response is recorded across the site with some areas of ferrous disturbance at the boundaries of the survey close to the housing development along the Combe road and surrounding agricultural machinery at [m1], which was excluded from the magnetic coverage. The course of the most recent ploughing is evident across the arable field to the E and some relic agricultural patterns are also found within the scheduled area at [m2 and 3]. A broad, diffuse linear anomaly [m4] runs through the survey area following the topography of the dry valley and together with [m5] would appear to be related to the underlying limestone bedding.

The more diffuse response at [m6] may represent an outfall from the pump-house on the Combe road, together with ceramic field drains [m7], which run down slope from a boggy area of the site to the N where vehicle rutting is evident within the magnetic data. Anomaly [m6] turns abruptly through the field boundary to rejoin the course of the dry valley and meets a group of rectilinear responses [m8] that, possibly, represent unrecorded quarrying activity. Historic mapping shows similar rectilinear quarries, approximately 40m x 20m, in the field immediately to the W of the Combe road following the same contour as [m8] which may well represent similar, earlier activity (OS Historic County Mapping Series: Oxfordshire, Epoch 1, 1843 to 1893).

### The Roman Villa and associated settlement

Three sides of a double ditched enclosure [m9], approximately 140m square, extend over both the scheduled area and the arable field to the E, abutting Akeman Street to the S. A rectilinear negative anomaly [m10] found within [m9] represents the location of the Stonesfield villa and appears to extend through the field boundaries immediately to the N and E, in accordance with the location suggested by both Taylor (1941, Figure 1) and contemporary accounts of the enclosure of the parish in 1801 (Mavor 1806). The building at [m10] has dimensions of 34m x 20m with some evidence for the subdivision of internal rooms and, possibly, a courtyard wall extending to the S. This fits well with the contemporary plan presented to the Society of Antiquaries by William Lewington in 1780 that suggested the main features of the villa extended to approximately 38m x 16m, although this is based on the partial excavation of the individual mosaic pavements (Freshwater *et al.* 2000, Figure 5).

The presence of additional building remains enclosed by [m9] within the scheduled area is suggested by negative magnetic anomalies forming a small (10m x 5m) rectangular structure [m11] to the south of the villa, possible wall foundations at [m12], and a range of masonry type responses [m13] running along the southern boundary of the site. The anomalies at [m13] are associated with a high degree of magnetic enhancement in surrounding ditch-type responses (>30nT/m, Figure 5) suggesting, perhaps, association with some form of semi-industrial activity. However, of greater significance is the identification of a larger building [m14] found outside the currently scheduled area but still within [m9]. The footprint of [m14] is slightly larger than the original villa (25m x 40m) and is divided into a series of NS orientated corridors, a large room at the northern end of the range and an additional veranda or courtyard extending to the W. Three discrete positive magnetic responses (10nT/m) to the E of [m14] may well represent thermoremanent anomalies, perhaps stoke-holes for a hypocaust. Comparison of the magnetic results with aerial photography over the Ditchley Park villa suggests both a similar size of ditched enclosure and distribution of the internal buildings (A Payne pers comm; Johnson 1994, Plate 6).

A series of well magnetised linear anomalies [m15-19] pass through enclosure [m9], but do not necessarily respect this phase of activity. Some of these anomalies appear to form a wider field system, together with the more intermittent response [m20], and others either terminate within the enclosure (e.g. at [m21], perhaps a well head) or be suggestive of other sub-enclosures, such as [m22]. One of these linear anomalies, [m16], passes directly through a sub-circular enclosure [m23] to the N which is difficult to interpret but may, perhaps, represent an earlier pre-historic phase of activity at the site. Additional enclosures ditches [m24] extend beyond [m9] to the E and appear to respect a strong, linear anomaly [m25] which defines the southern extent of the activity, possibly indicating the course of the Roman road. Anomaly [m25] appears to continue through [m9] to the W as a negative, wall-type response and is strongly magnetised (>20nT; Figure 5), although it does not seem consistent with a more recent service pipe or cable.

Some possible evidence for further quarrying activity is found at [m26 and 27], together with a series of discrete pit-type anomalies [m28] that appear, perhaps coincidently, to follow a recently introduced fence line subdividing part of the scheduled area. A scatter of more distributed, discrete anomalies throughout the survey area are difficult to fully interpret, although those at [m29 and 30] along the course of [m4] may represent small, localised borrow pits.

## Earth resistance survey

A graphical summary of the significant magnetic anomalies, [r1-10], discussed in the following text, superimposed on the base OS map data, is provided in Figure 11.

A more limited earth resistance survey was targeted over the potential building remains indicated by the magnetic results, with particular attention to the unauthorised tree planting within the scheduled area (Figures 1 and 3). The main villa building is reproduced as an area of high resistance [r1] that correlates well with the magnetic anomaly [m10] and confirms the likely continuation of building remains across the field boundaries immediately to the N and E. Rooms to the E and W of the range exhibit a more continuous, high resistance response which together with the enhanced magnetic anomalies suggest, perhaps, the presence of tile floors with an underlying hypocaust.

Part of the double-ditched enclosure [m9] immediately to the N of the villa is replicated for a short length as a high resistance anomaly [r2], perhaps suggesting rubble from the destruction of the building is concentrated in the cut features here. Other ditch-type magnetic anomalies, including the continuation of [m9], fail to be reproduced within the resistance data, with the exception of [m22] / [r3] found in the arable field to the E. This may, in part, be due to what appears to be a geological response [r4] following the 105m contour below the villa that produces a complex series of masking anomalies that are not replicated in the magnetic data. The tentative courtyard wall and small rectangular building [m11] do correspond with weak, resistance anomalies [r5 and r6], more clearly visible on the processed versions of the data (Figure 7). Two prominent pit-type responses [r7 and r8] appear to be due to pits dug for the unauthorised tree planting, although it is unclear why only two of these have produced discernible earth resistance anomalies.

To the S of [r4] the range of masonry wall footings suggested by [m13] are confirmed by [r9]. The southern boundary wall abutting the Roman road runs across the survey area and some, potential building remains are only partially described within the data. A single, grid was placed to the W of the main survey, in an area where magnetic survey was not possible, although this did not produce any significant anomalies.

The location of the large building [m14]  in the arable field is also confirmed by [r10], although few additional internal details are revealed beyond the continuous high resistance of the room to the N of the range which may, again, possibly indicated either the survival of an intact floor or significant building rubble contained within the walls. A similar, but more diffuse high resistance response, is found to the S of [r10], perhaps associated with the wall-type anomalies identified in the magnetic data immediately to the W. Analysis of the 0.5m and 1.0m mobile probe separation data sets suggests a broadly similar range to the readings and similar response to the underlying, and comparatively near surface, causative features (Figure 7(D) and 7(H)).

## Ground Penetrating Radar survey

A graphical summary of the significant GPR anomalies, [gpr1-11], discussed in the following text, superimposed on the base OS map data, is provided in Figure 12.

It was hoped that the GPR survey would provide further information regarding the depth and survival of the remains, through collecting profiles across the location of the buildings identified from the magnetic and earth resistance results (Figure 8). This initial aim was extended to the collection of area GPR surveys, allowing amplitude time slices to be produced from the data over the most significant buildings (Figures 4, 9 and 10). The location of the Stonesfield villa has been clearly identified on the GPR profiles and time slices with wall-type reflections [gpr1] extending from between 4 and 25ns (0.16 to 1.0m), although little additional detail from the building has been revealed. A more amorphous scatter of near surface rubble deposits become resolved into the rectilinear footprint of the villa from 10ns (0.4m) onwards but the discrete wall-type reflectors visible in some of the individual profiles have failed to reproduce the clarity seen in both the magnetic and earth resistance data sets. This may, in part, be due to the presence of masking rubble deposits noted in contemporary accounts of the discovery of the villa (Taylor 1941), perhaps suggested by the high amplitude horizontal reflectors at approximately 12ns (0.48m). A tentative low amplitude anomaly [gpr2] appears to correlate with the ditch-type response [m15] found in the magnetic data.

A more complex group of high amplitude reflectors are found to the W of the villa from between 4 and 24ns (0.16 and 0.96m) composed of a linear anomaly [gpr3] close to the surface that correlates with the location of [m9]/[r4], together with a more deeply lying, geological response [gpr4]. The earth resistance data shows a similar, apparently geological boundary in this area, but from the depth to the corresponding GPR anomalies and the absence of any significant negative magnetic responses it seems unlikely that these represent significant archaeological activity. Addition of a topographic correction to the GPR profile data (Figure 8; LINE0004) shows the geological response to be relatively flat lying with near surface anomalies, perhaps due to ditch cuts of [m9] found closer to the surface at [gpr3].

A similar, apparently geological anomaly [gpr5] is found in the paddock immediately to the S, although this falls beyond the area covered by the earth resistance survey. Again, this anomaly appears to be quite complex but a more distinct rectilinear response [gpr6] is discernible between 8 and 14ns (0.32 and 0.56m) that, from its dimensions of 8m x 14m, may well represent the presence of additional building remains. There is some correlation here between [gpr6] and [r8], but the anomaly is not fully described within the current earth resistance data. Other, similar GPR anomalies are found at [gpr7-9] and although data acquisition was compromised due to the presence of the orchard planting there is a good correlation with the range of building remains [gpr8]/[r9] and the linear boundary [gpr9]/[m25].

Evidence for the large building [m14]/[r10] in the arable field appears in the GPR data between 6 and 22ns (0.24 to 0.8m) and reveals part of the W wall [gpr10] and the high amplitude rectilinear reflector [gpr11] corresponding with the room to the N of the range. It is of interest to note the slope that this building is cut into, with a rise of 2m from the S to [gpr10] at the northern extent of the building.

## CONCLUSION

Despite the influence of geological variation, historic quarrying activity and modern land use the geophysical survey has successfully confirmed both the location of the Stonesfield villa remains and revealed a much wider extent of significant activity at the site. The magnetic survey proved particularly useful identifying anomalies due to building remains, ditches and pits extending beyond the scheduled area into the adjacent arable field. The Roman settlement at Stonesfield can be seen now in the context of a large double ditched enclosure containing both the original villa to the N together with a substantial, previously unrecognised aisled or corridor type building just beyond the scheduled area abutting Akeman Street to the S. Evidence for further masonry structures has been revealed throughout the enclosure including a range of buildings, possibly related to semi-industrial activity, running adjacent to the Roman road. The precise function of the site is not entirely clear, but appears to be on a similar scale as the Ditchley Park villa estate although at Stonesfield there may be a more directly association with the Roman road, perhaps a mansio or other way-side settlement. The presence of the buildings was confirmed through more limited earth resistance and GPR coverage, with the latter technique confirming the preservation of significant remains from the near surface to a depth of approximately 1m. Whilst the unauthorised tree planting at the site has avoided the location of the Stonesfield villa, it has impinged upon other archaeological remains within the area protected by the current scheduling order to a depth likely to cause significant, localised damage.

## LIST OF ENCLOSED FIGURES

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Figure 1

STONESFIELD ROMAN VILLA, OXFORDSHIRE
Location of geophysical surveys, September 2013

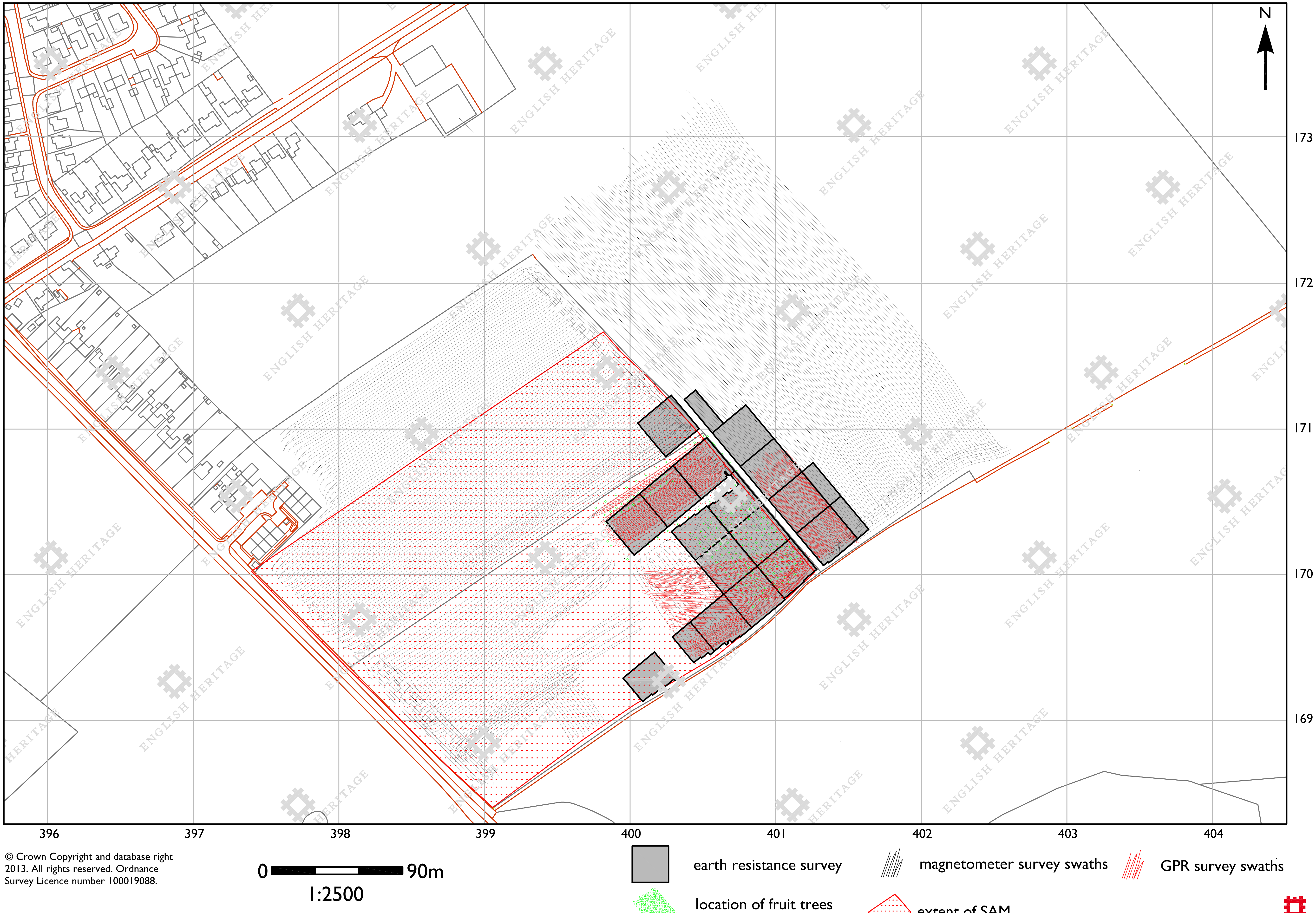




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Figure 2

# STONESFIELD ROMAN VILLA, OXFORDSHIRE

Location of caesium magnetometer survey, September 2013

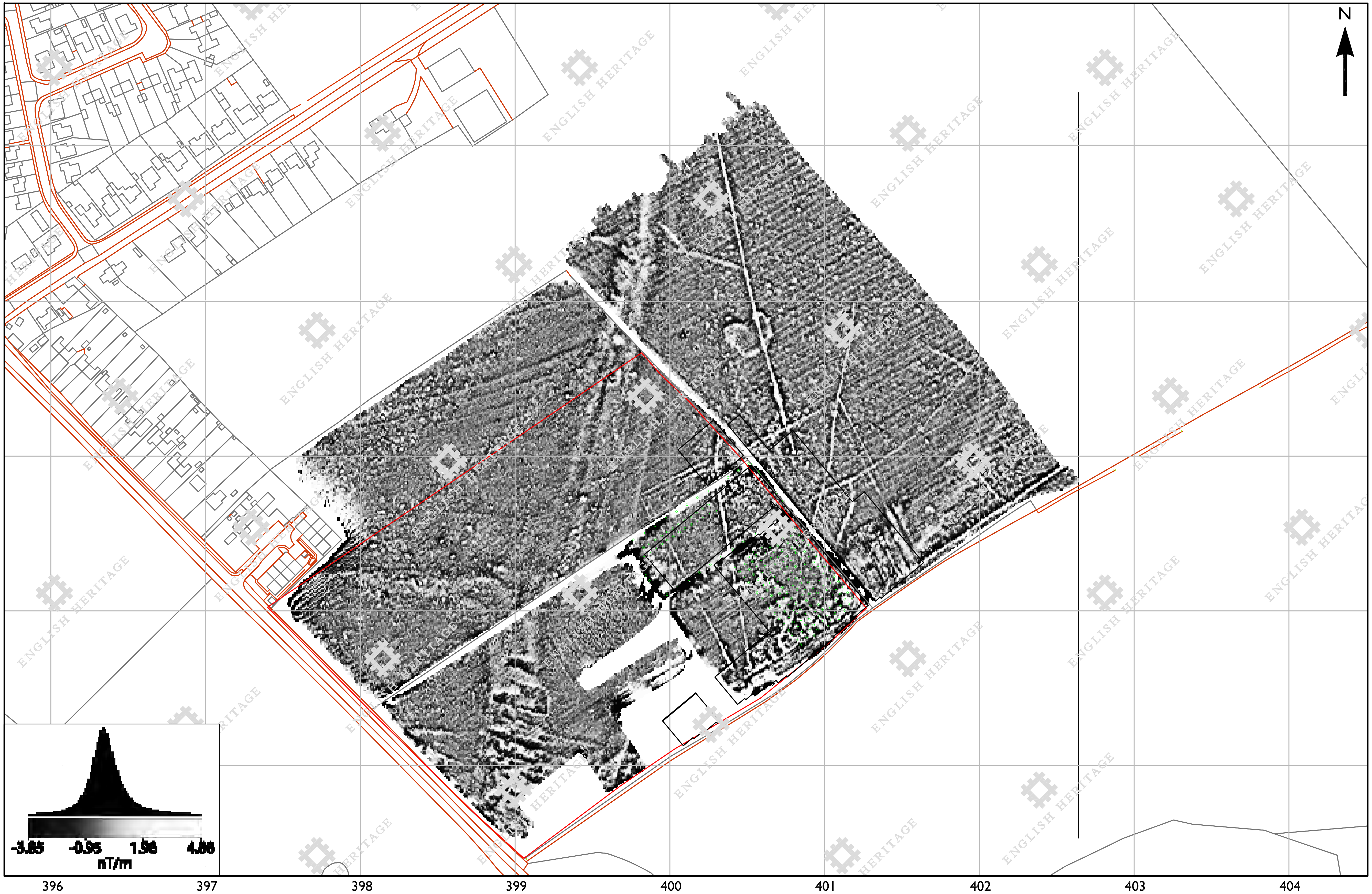




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Figure 3

# STONESFIELD ROMAN VILLA, OXFORDSHIRE

Location of earth resistance survey, September 2013




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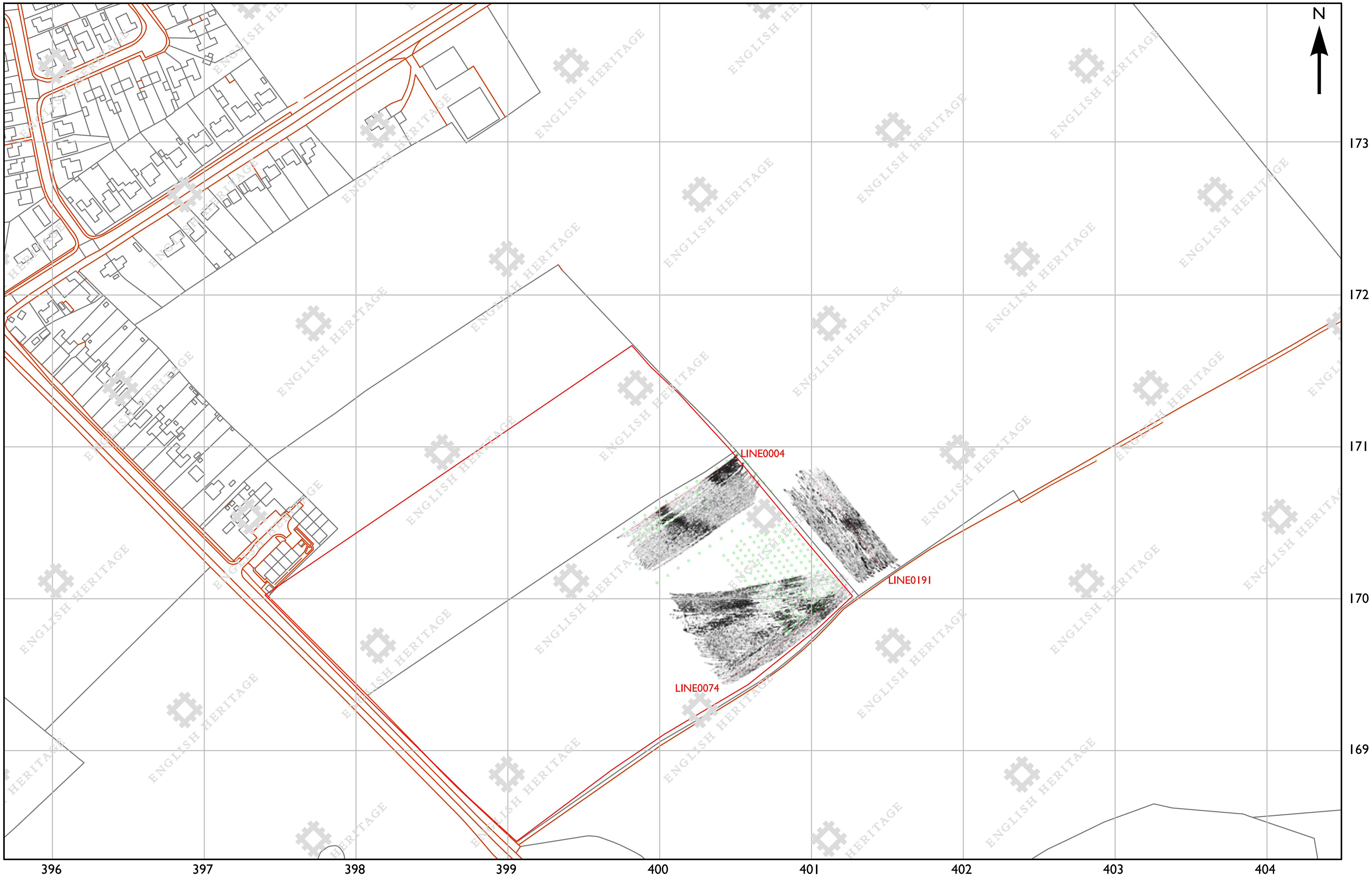
Figure 4

STONESFIELD ROMAN VILLA, OXFORDSHIRE
Location of GPR amplitude time slice between 14 and 16ns (0.56 - 0.64m), September 2013






Low High
*relative reflector strength*

0 90m
1:2500

extent of SAM

location of fruit trees

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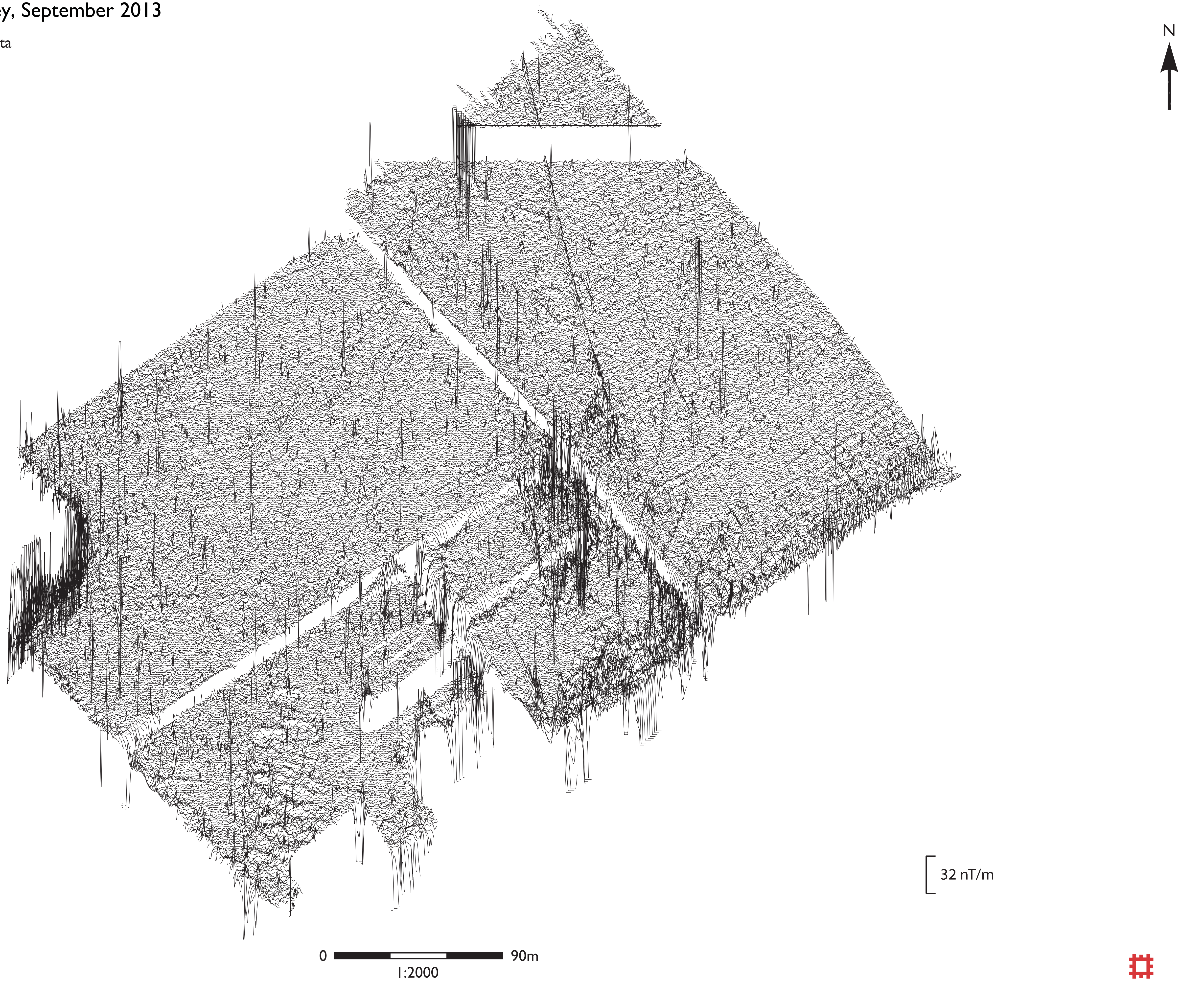
Caesium magnetometer survey, September 2013

Traceplot of the minimally processed data

Figure 5

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Caesium magnetometer survey, September 2013

Linear greyscale of the data processed to suppress near-surface ferrous responses

Figure 6

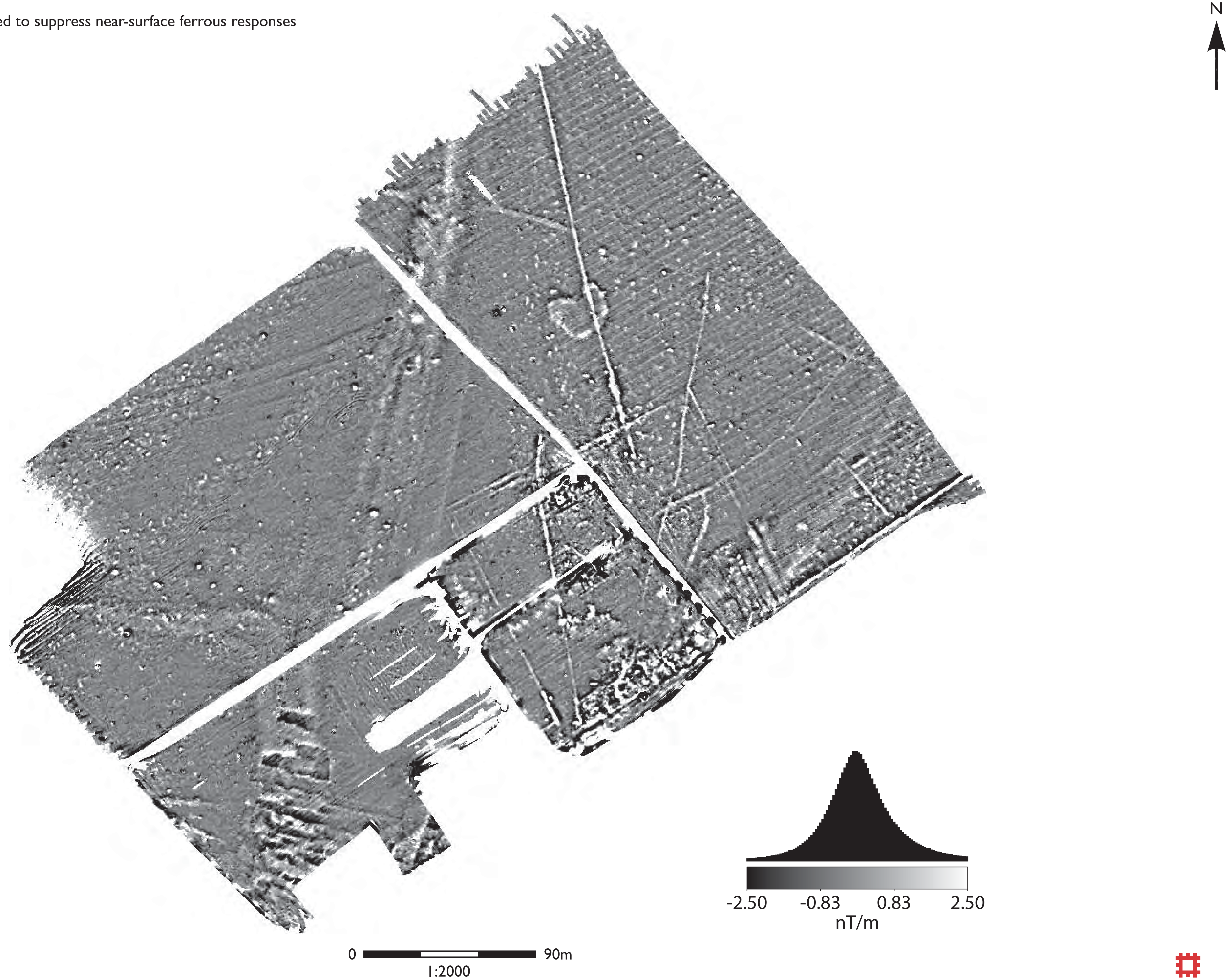


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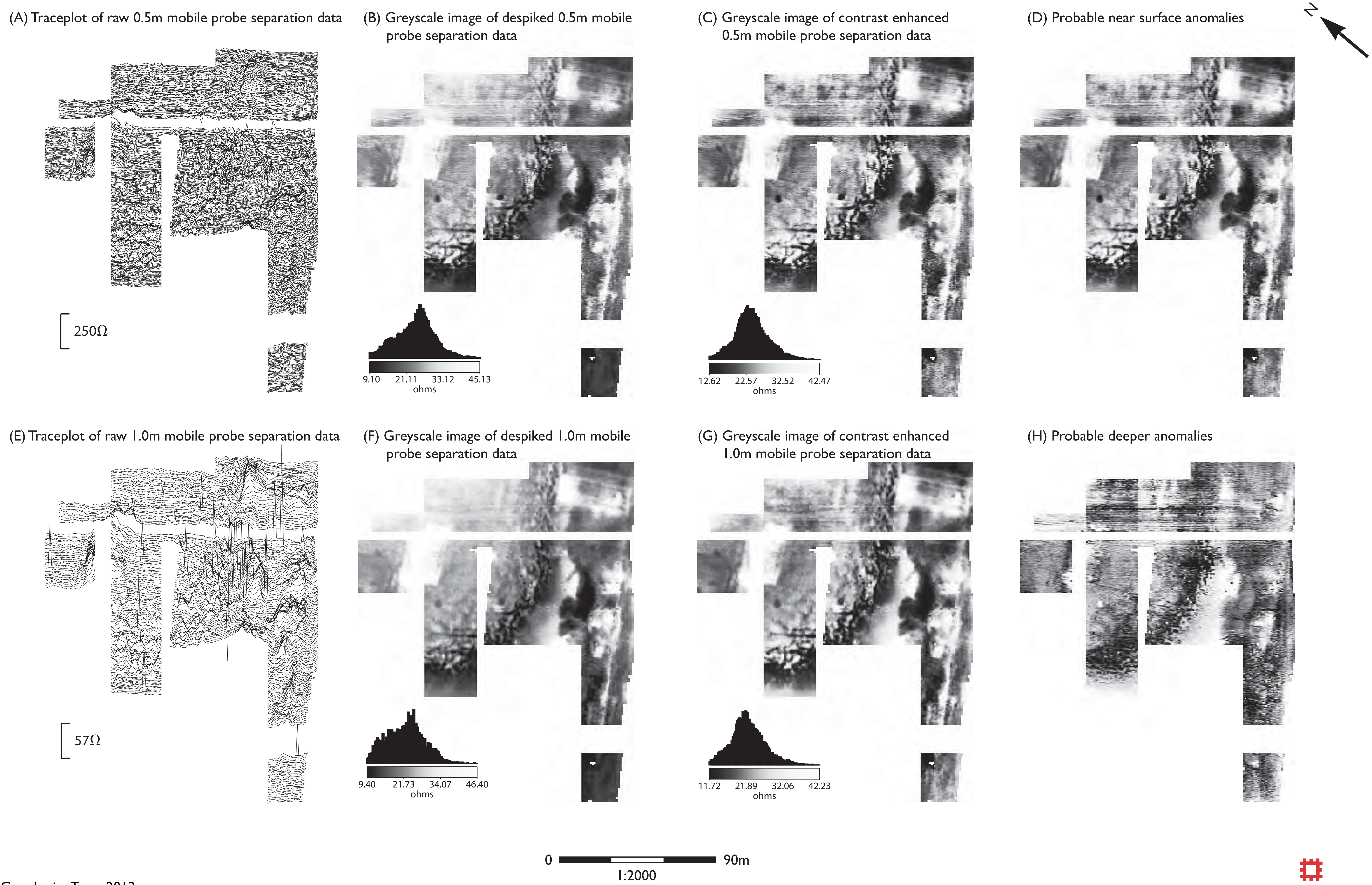
Figure 7

# STONESFIELD ROMAN VILLA, OXFORDSHIRE
## Earth resistance survey, September 2013

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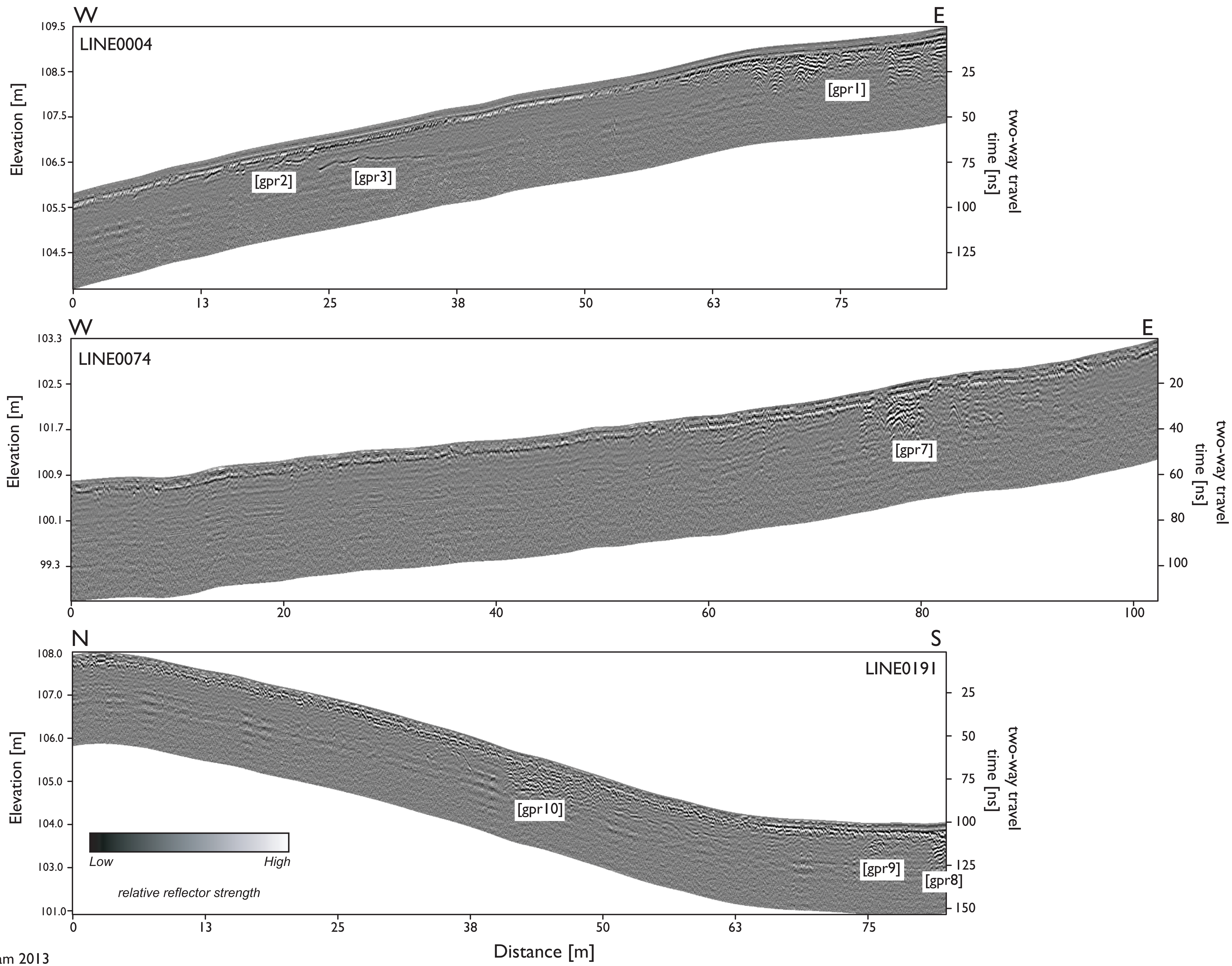
Selected GPR profiles, September 2013

Figure 8

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GPR amplitude time slices from between 0.0 and 24ns (0 - 0.96m), September 2013

Figure 9

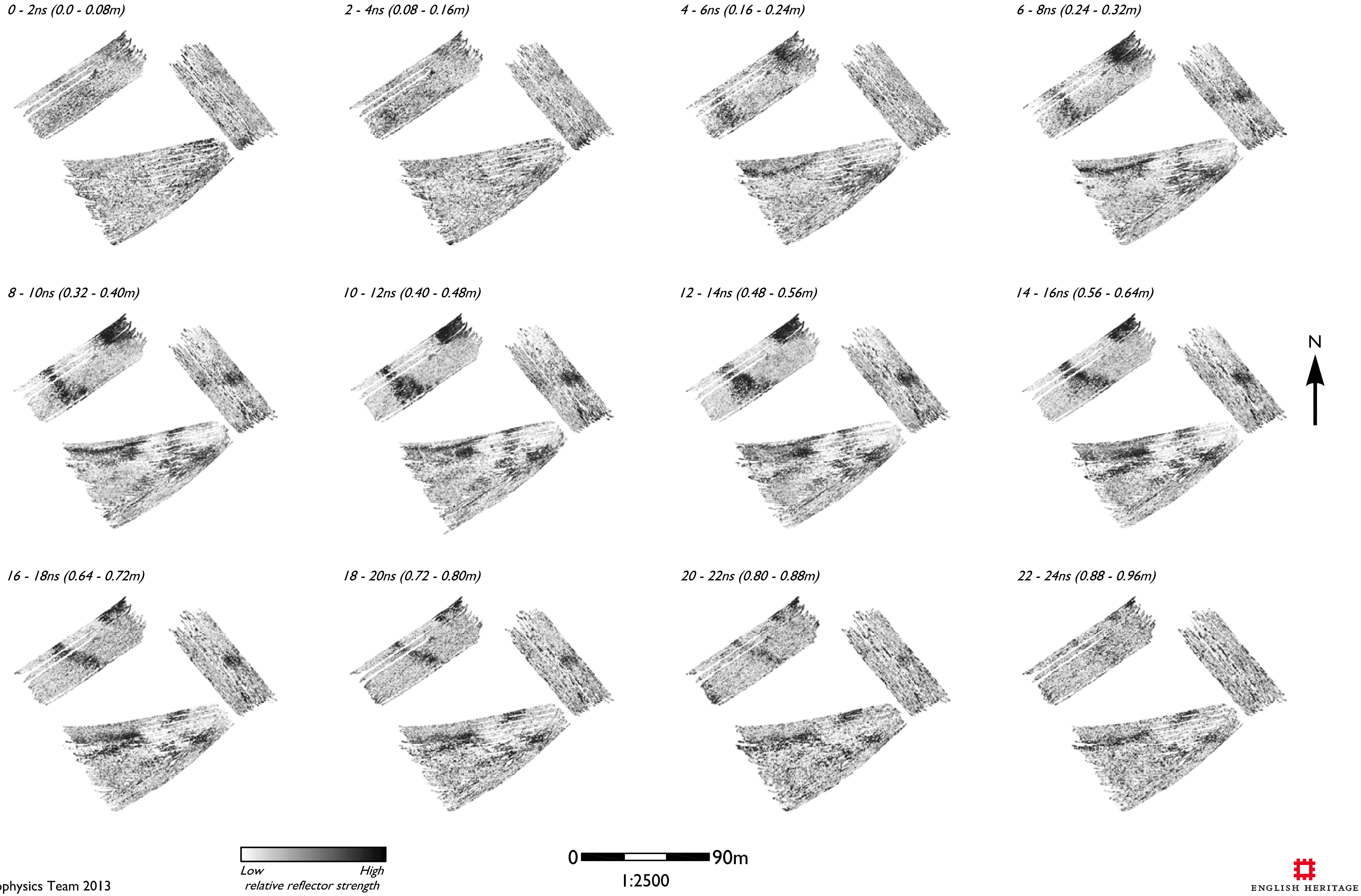


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Figure 10

# STONESFIELD ROMAN VILLA, OXFORDSHIRE

Graphical summary of significant magnetic anomalies

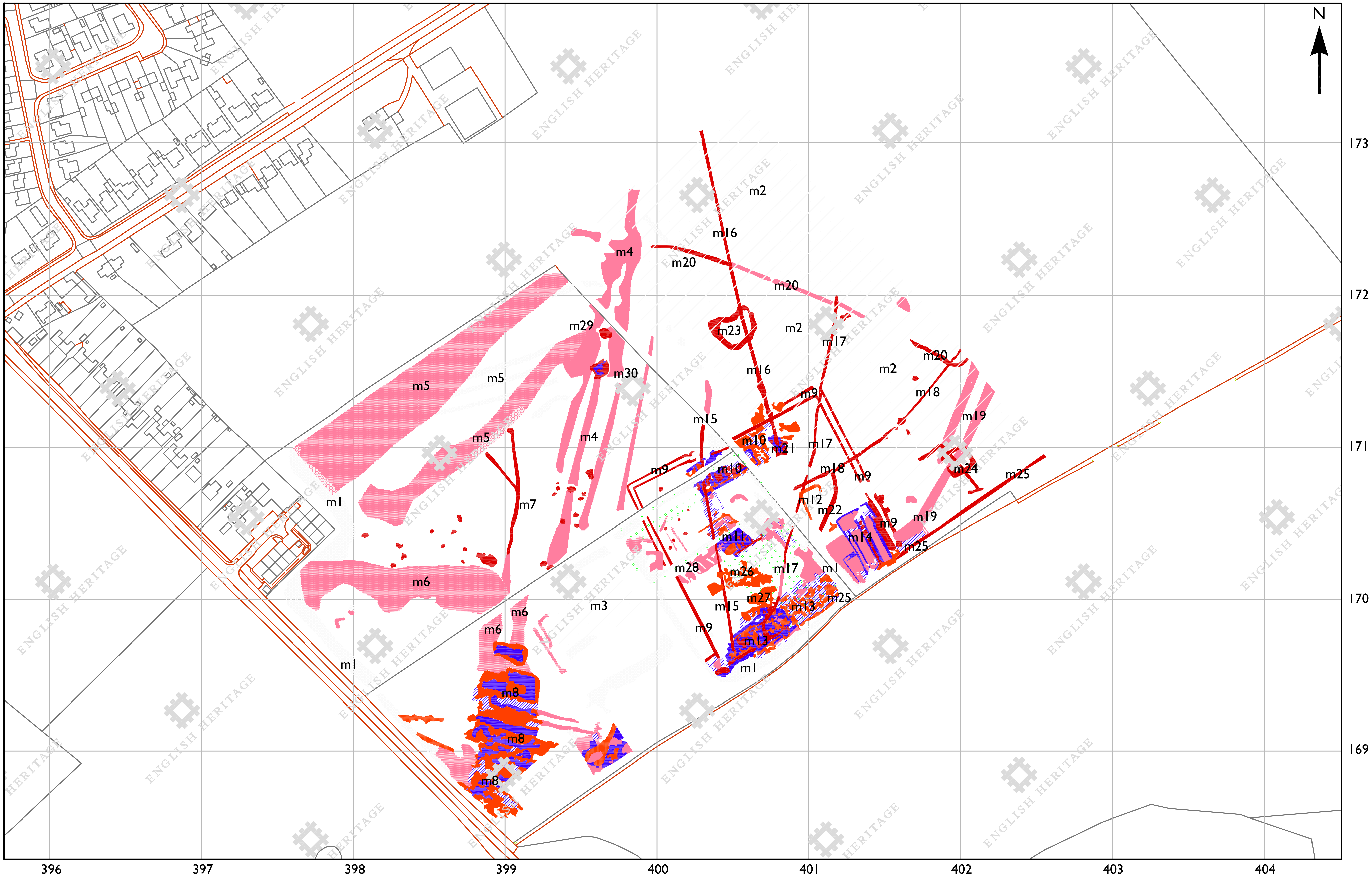




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Figure 11

# STONESFIELD ROMAN VILLA, OXFORDSHIRE

## Graphical summary of significant earth resistance anomalies

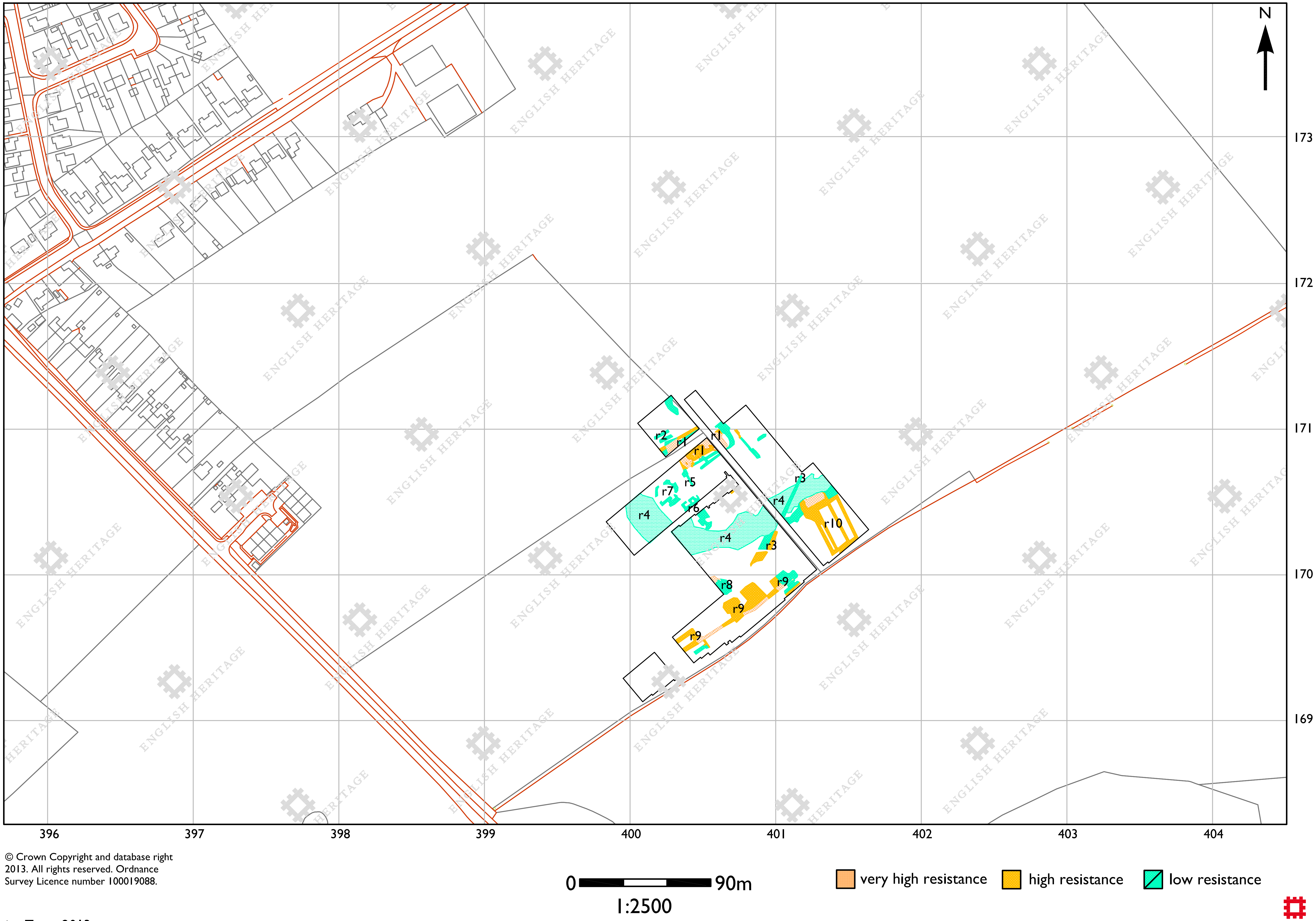




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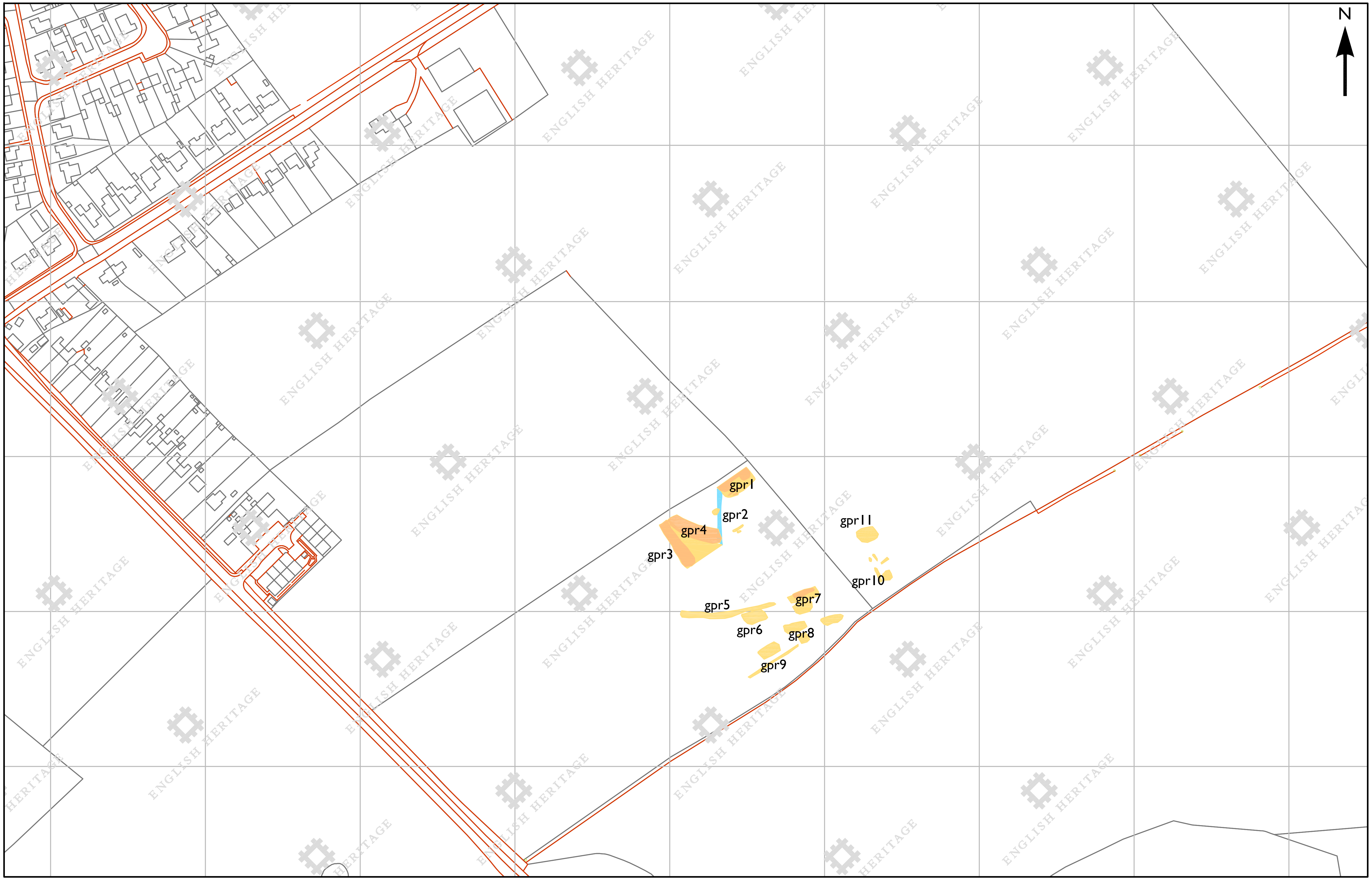
Figure 12

## STONESFIELD ROMAN VILLA, OXFORDSHIRE
Graphical summary of significant GPR anomalies






0 90m
1:2500

low amplitude reflectors
high amplitude reflectors

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*ENGLISH HERITAGE RESEARCH DEPARTMENT*

*English Heritage undertakes and commissions research into the historic environment, and the issues that affect its condition and survival, in order to provide the understanding necessary for informed policy and decision making, for sustainable management, and to promote the widest access, appreciation and enjoyment of our heritage.*

*The Research Department provides English Heritage with this capacity in the fields of buildings history, archaeology, and landscape history. It brings together seven teams with complementary investigative and analytical skills to provide integrated research expertise across the range of the historic environment. These are:*

- *Aerial Survey and Investigation*
- *Archaeological Projects (excavation)*
- *Archaeological Science*
- *Archaeological Survey and Investigation (landscape analysis)*
- *Architectural Investigation*
- *Imaging, Graphics and Survey (including measured and metric survey, and photography)*
- *Survey of London*

*The Research Department undertakes a wide range of investigative and analytical projects, and provides quality assurance and management support for externally-commissioned research. We aim for innovative work of the highest quality which will set agendas and standards for the historic environment sector. In support of this, and to build capacity and promote best practice in the sector, we also publish guidance and provide advice and training. We support outreach and education activities and build these in to our projects and programmes wherever possible.*

*We make the results of our work available through the Research Department Report Series, and through journal publications and monographs. Our publication Research News, which appears three times a year, aims to keep our partners within and outside English Heritage up-to-date with our projects and activities. A full list of Research Department Reports, with abstracts and information on how to obtain copies, may be found on www.english-heritage.org.uk/researchreports*

*For further information visit www.english-heritage.org.uk*

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