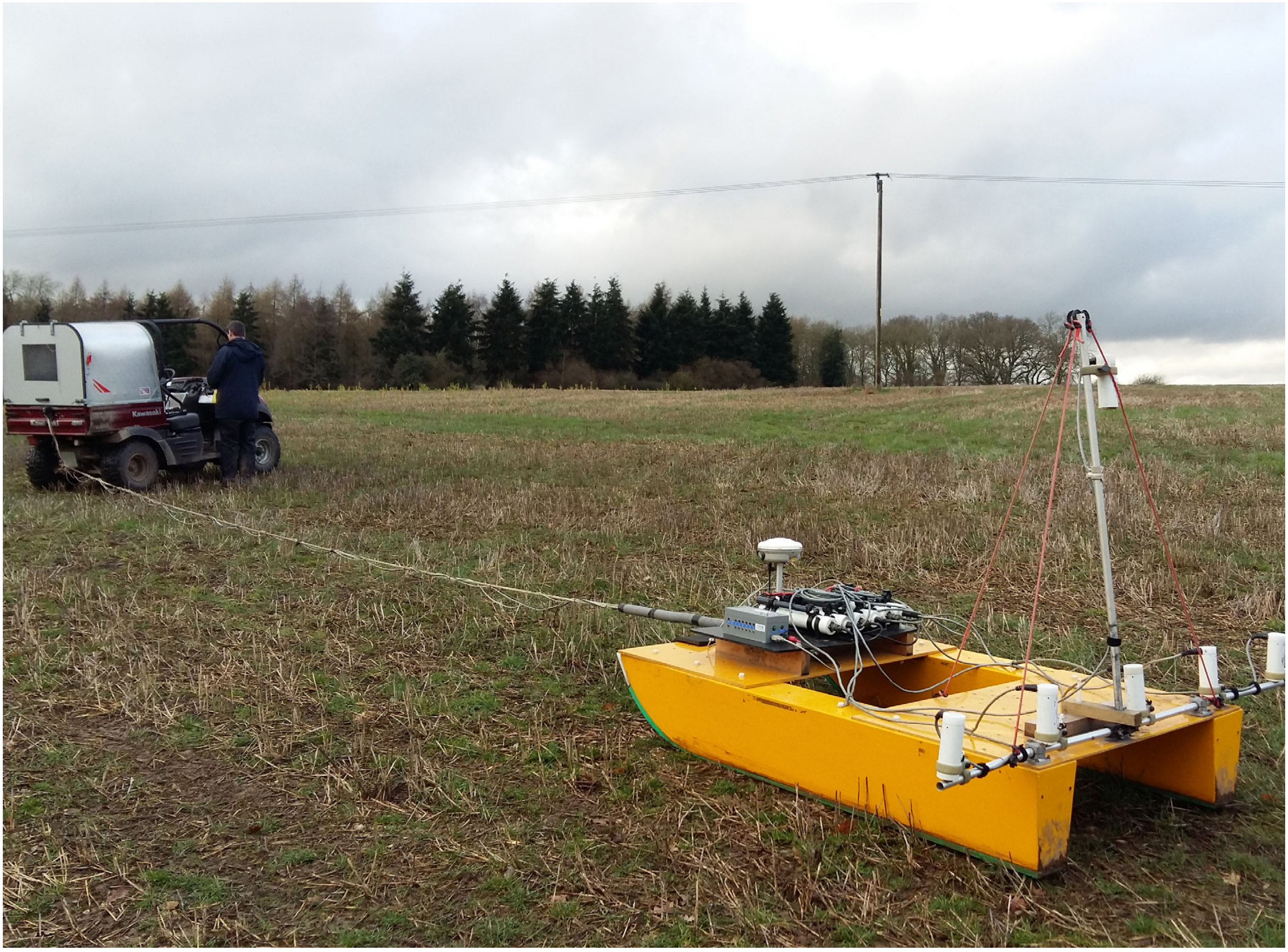
Historic England

Geophysics

Silchester Environs Project, Windabout Copse, Mortimer West End, West Berkshire Report on Geophysical Survey, February 2017

Neil Linford, Paul Linford and Andrew Payne

Discovery, Innovation and Science in the Historic Environment



Research Report Series no. 41-2017

SILCHESTER ENVIRONS PROJECT, WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE

REPORT ON GEOPHYSICAL SURVEY,

FEBRUARY 2017

Neil Linford, Paul Linford and Andrew Payne

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SUMMARY

Caesium magnetometer and Ground Penetrating Radar (GPR) surveys were conducted as part of the University of Reading Silchester Environs Project over an extensive early and late Iron Age complex, initially identified from crop marks, at Windabout Copse, Mortimer West End, West Berkshire. The vehicle towed caesium magnetometer survey (20ha) extended previous, targeted fluxgate coverage in advance of an evaluation excavation in summer 2016, to encompass all accessible areas of the fallow arable field. Despite the relatively weak magnetic response over the site and the presence of both geomorphological and modern disturbance, the caesium survey revealed a series of ditch and pit type anomalies to enhance the existing evidence. GPR survey (7.8ha) was targeted over the location of the main excavation trenches and, despite highly saturated soil conditions, revealed linear anomalies associates with the Iron Age complex together with a hitherto unrecognised circular enclosure to the north of the field. The presence of a large soil stack, in close proximity to a late Iron Age chambered cremation grave revealed by the excavation, partially hindered the recovery of additional information with either technique in this area.

CONTRIBUTORS

The geophysical fieldwork was conducted by Neil Linford, Paul Linford and Andrew Payne.

ACKNOWLEDGEMENTS

The authors are grateful to the landowner, Mr Angus Hodge, for allowing access for the surveys, and to Dr Rob Fry, University of Reading, for providing both details of his own survey work at the site and useful discussion of the combined results.

ARCHIVE LOCATION

Fort Cumberland, Portsmouth.

DATE OF SURVEY

The fieldwork was conducted between 30th January to 3rd February 2017 and the report completed on 7th August 2017. The cover image shows the vehicle towed caesium magnetometer in the field during the survey.

CONTACT DETAILS

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CONTENTS

INTRODUCTION

Caesium magnetometer and Ground Penetrating Radar (GPR) surveys were conducted at Windabout Copse, Mortimer West End, in a field on the border between West Berkshire and Hampshire, as part of the Historic England contribution to the Silchester Environs Survey (RASMIS 7226), undertaken in partnership with the University of Reading (Barnett and Fulford 2015). This project aims to investigate the origins and early development of the Iron Age and Roman town at Calleva Atrebatum (Silchester, Hampshire), through a study of prehistoric settlement, activity and agriculture in the hinterland of the Iron Age *Calleva* to address the local context for the emergence of the *oppidum*.

The geophysical survey component of the project aims to test the magnetic and GPR response over the varying gravel, clay and chalk geologies of the Silchester area, using a vehicle towed high sensitivity caesium vapour magnetometer array together with a high sample density multi channel GPR system. It is hoped that this will complement the extensive fluxgate magnetometer and GPR coverage conducted by the University of Reading, particularly where the geophysical response has proved indistinct (Creighton and Fry 2016). Trial sites for ground based survey have been identified from aerial photography and lidar coverage within the project area (Figure 1), including the plough truncated remains of long, linear earthwork banks crossing the landscape where these survive in areas of woodland and may extend into the surrounding farmland (Linford 2015).

The survey at Windabout Copse followed the evaluation of a series of cropmarks found through the interpretation of aerial photographs, with the excavation in the summer of 2016 revealing an early and late Iron Age complex, including a late Iron Age chambered cremation grave (Wheeler and Pankhurst 2016). A targeted fluxgate gradiometer survey was conducted in advance of the excavation over the site of the planned trenches and confirmed a weak, but still detectable magnetic response over the site (R Fry *pers comm*). The aim of the current survey was to extend coverage over the whole field to complement the existing data, and to test the response of the site to the use of GPR.

The site is situated on sand and gravel drift deposits of the Silchester Gravel Member on the higher ground to the north, over sand deposits of the London Clay Formation, with some superficial gravel head deposits accumulating at the bottom of sub-aerial slopes (Geological Survey of Great Britain 1946). Well drained flinty coarse loamy and gravelly soils of the 581c Sonning 2 association have developed over this geology, associated with fine and coarse loamy over clayey soils with slowly permeable subsoils (Soil Survey of England and Wales 1983). The field was fallow at the time of the survey, with mixed weather conditions during the field work and locally water logged ground conditions.

METHOD

Magnetometer survey

Magnetometer data was collected along the instrument swaths shown on Figure 2 using an array of six Geometrics G862 caesium vapour sensors mounted on a non-magnetic sledge (Linford *et al.* 2015). The sledge was towed behind a low-impact All-Terrain Vehicle (ATV) which housed the power supply and data logging electronics. Five sensors were mounted 0.5m apart in a linear array transverse to the direction of travel and, vertically, ~0.25m above the ground surface. The sixth was fixed 1.0m directly above the centre of this array to act as a gradient sensor. The sensors sampled at a rate of 25Hz resulting in an along-line sample density of ~0.15m given typical ATV travel speeds of 3.5-4.0m/s. As the five non-gradient sensors were 0.5m apart, successive survey swaths were separated by approximately 2.5m to maintain a consistent traverse separation of 0.5m. Navigation and positional control were achieved using a Trimble R8 Global Navigation Satellite System (GNSS) receiver mounted on the sensor platform 1.65m in front of the central sensor and a second R8 base station receiver established using the Ordnance Survey VRS Now correction service. Sensor output and survey location were continuously monitored during acquisition to ensure data quality and minimise the risk of gaps in the coverage.

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 or other nearby vehicles. The median value of each instrument traverse was then adjusted to zero by subtracting a running median value calculated over a 50m 1D window (see for instance Mauring *et al.* 2002). This operation corrects for 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 in Figure 4 and minimally processed versions of the range truncated data (±100nT/m) are shown as a trace plot and a histogram equalised greyscale image in Figures 6 and 7.

Ground Penetrating Radar survey

A 3d-radar MkIV GeoScope Continuous Wave Step-Frequency (CWSF) Ground Penetrating Radar (GPR) system was used to conduct the survey collecting data with a multi-element DXG1820 vehicle towed, ground coupled antenna array (Linford *et al.* 2010). A roving Trimble R8 Global Navigation Satellite System (GNSS) receiver, together with a second R8 base station receiver established using the Ordnance Survey VRS Now correction service, was mounted on the GPR antenna array to provide continuous positional control for the survey collected along the instrument swaths shown on Figure 3. Data were acquired at a 0.075m x 0.075m sample interval across a continuous wave stepped frequency range from 60MHz to 2.99GHz in 4MHz increments using a dwell time of 2ms. A single antenna element was monitored continuously to ensure data quality during acquisition together with automated processing software to produce real time amplitude time slice representations of the data as each successive instrument swath was recorded in the field (Linford 2013).

Post-acquisition processing involved conversion of the raw data to time-domain profiles (through a time window of 0 to 50ns), 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. To aid visualisation amplitude time slices were created from the entire data set by averaging data within successive 2.5ns (two-way travel time) windows (e.g. Linford 2004). An average sub-surface velocity of 0.104m/ns was assumed following constant velocity tests on the data, and was used as the velocity field for the time to estimated depth conversion. Each of the resulting time slices, shown as individual greyscale images, therefore represents the variation of reflection strength through successive ~0.13m intervals from the ground surface in Figures 9 to 12. Further details of both the frequency and time domain algorithms developed for processing this data can be found in Sala and Linford (2012).

Due to the size of the resultant data set a semi-automated algorithm has been employed to extract the vector outline of significant anomalies shown on Figure 14. The algorithm uses edge detection to identify bound regions followed by a morphological classification based on the size and shape of the extracted anomalies. For example, the location of possible pits is made by selecting small, sub circular anomalies from the data set.

RESULTS

Magnetometer survey

A graphical summary of significant magnetic anomalies [**m1-30**] discussed in the following text superimposed on base OS map data is provided in Figure 13.

A sub-oval enclosure in the centre of the survey is defined by a single ditch type anomaly [**m1**], a second outer ditch [**m2**] to the west, and a more enhanced response [**m3**] to the north. A more strongly magnetised ditch [**m4**] runs in to the enclosed area where a number of pit type responses are also present together with a pronounced anomaly [**m5**] in the centre. The enclosure is obscured to the east by an extensive area of magnetic disturbance [**m6**] with some vague positive and negative linear trends, including a series of interrupted ditch segments [**m7**], which may possibly suggest a more significant origin. While some of this unusual response may relate to activity associated with the enclosure [**m1-3**], the more amorphous anomalies could well be due to superficial clay drift geology possibly overlying a series of springs. The former site of Lambden Farm, now removed, lies to the north of [**m6**], and while elements of the associated field system shown on historic mapping have been detected [**m8**] these appear to be beyond the area of magnetic disturbance (OS Historic County Mapping Series: Berkshire 1843 - 1893 Epoch 1).

To the south a series of weakly resolved linear anomalies appears to define a rectangular enclosure [**m9**] set within a larger, but less distinct outer enclosure [**m10**]. Within [**m9**] there is evidence for a number of partitions [**m11**] and possible internal pit-type responses [**m12**], but this does not suggest a particularly high density of internal activity. A 'D'-shaped curvilinear ditch [**m13**], possibly part of a further enclosure circuit, partially overlaps with [**m9**] and [**m10**], and terminates to the south at [**m14**] where it appears to be continued as a line of small pit-type responses [**m15**] spaced about 3-4m apart, for a further 30m to the east. A gently curving linear ditch [**m16**] runs towards and intersects with the complex from the NE, and a series of weaker linear responses [**m17**] and [**m18**] are also apparent, together with an area of more pronounced disturbance [**m19**] suggestive of large in-filled pits or quarrying activity.

A few isolated linear anomalies [**m20**] are most likely related to former field boundaries, and partially correspond with the historic mapping (OS Historic County Mapping Series: Berkshire 1843 - 1893 Epoch 1). Other weaker linear trends, for example at [**m21**] and [**m22**], may also indicate former boundary ditches possibly associated with the enclosure complexes [**m1-7**] and [**m9-19**].

Several more diffuse positive, [**m23**] and [**m24**], and negative sinuous anomalies [**m25**] most likely represent responses to colluvial sediments deposited down slope into a series of shallow and narrow dry valleys running broadly south towards the lower lying damper ground containing the former pond bay within Windabout Copse. More intense disturbance [**m26-29**] in the NW area of the survey is associated with recent bonfires and possible control wires for a fireworks display.

There is little magnetic response in the area surrounding the excavated Late Iron Age chambered burial, except for a series of weak linear trends [**m30**] that do not appear to correlate with the enclosure ditches recorded by the aerial photography.

Ground Penetrating Radar survey

A graphical summary of the significant GPR anomalies, [**gpr1-38**] discussed in the following text, superimposed on the base OS map data, is provided in Figure 14.

Significant reflections have been recorded throughout the 50ns two-way travel time window, although later reflections beyond ~40ns become more highly attenuated in the lower lying, water logged areas of the site. The near surface data between 0 and 12.5ns (0.0 - 0.65m) has responded to the immediate surface conditions across the site including the most recent cultivation pattern and the outline of the excavation trenches [**gpr1**] in the south (Trenches 4-9) and central (Trenches 0-2) areas of the site.

To the south of the site the data has been partially obscured by a high amplitude response [**gpr2**] to the near surface gravel deposits, although the main group of rectilinear enclosures [**gpr3-5**] (cf [**m9**] and [**m10**]) are visible between 12.5 and 30ns (0.65 to 1.55m) on Figures 9 and 10. The outer most enclosure ditch [**gpr5**] appears to be more substantial and continues to a maximum extent of approximately 40ns (2.0m). It is of interest to note the complementary response to the enclosure ditches shown in the radar to the west, for example at [**gpr6**] and [**gpr7**], which replicates the symmetry shown in the more complete complex recorded by the aerial photography. A curvilinear anomaly [**gpr8**] corresponds with the 'D' shaped enclosure [**m13**] with a more tentative linear response [**gpr9**] to the pit alignment [**m15**], with the suggestion of a parallel ditch [**gpr10**] following this alignment to the south. Two linear anomalies [**gpr11**] and [**gpr12**] also head east from [**gpr8**] and, again, are partially replicated in the magnetic data (cf [**m16**]) and aerial photographic analysis.

Further to the west a rectilinear anomaly [**gpr13**] appears to represent a continuation of an enclosure ditch, identified from the aerial photography, heading north to meet the field boundary recorded by the historic mapping in the centre of the field (OS Historic County Mapping Series: Berkshire 1843 - 1893 Epoch 1). Other fragmented linear responses [**gpr14-22**] are difficult to interpret, but may possibly indicate additional enclosure ditches, or perhaps more recent drainage. Some discrete responses may be related to the geomorphology, for example at [**gpr23**], but the apparent linear alignment of pit-type anomalies [**gpr24**] runs parallel to both [**gpr9**] and [**m13**], and [**gpr10**] perhaps suggests a greater significance.

In the GPR coverage over the central area of the site a prominent linear anomaly [**gpr25**] follows the field boundary shown on the historic mapping (OS Historic County Mapping Series: Berkshire 1843 - 1893 Epoch 1), and appears to form part of a wider system of enclosures which correlate [**gpr26-30**] and enhance [**gpr31-34**] the aerial record. Whilst the 'D' shaped enclosure surrounding the cremation burial could only be partially covered by the survey, it has been replicated in the radar data [**gpr27**], with an additional linear anomaly [**gpr34**] running parallel to the ditches known from the aerial photographs. There are also a number of linear anomalies over the site of Lambden Farm (OS Historic County Mapping Series: Berkshire 1843 - 1893 Epoch 1), but this area also contains a more complex response to the geomorphology from 15ns (0.78m) onwards that correlates with the magnetic data (cf [**m7**]).

Further to the north a pattern of field drains [**gpr35**] is found between 15 and 25ns (0.78 to 1.29m) together with a linear anomaly [**gpr36**] which most likely represents a recent field boundary also mapped in the aerial photography. Perhaps of greater significance are the linear anomaly [**gpr37**], possibly part of the wider system of enclosures, and a sub circular ditched enclosure [**gpr38**] which is only partially described within the survey. It is interesting to note that there appears to be no evidence for [**gpr38**] within the aerial photographic record, possibly due to the later field boundary [**gpr36**] passing through the ditch circuit and obscuring the more subtle response.

CONCLUSIONS

Despite a very subtle geophysical response at the site both the magnetic and GPR surveys have successfully identified significant anomalies which corroborate and enhance the existing aerial photographic analysis. It is of interest to note the varying response over the site, with no single methodology able to detect all of the activity revealed by a combination of the geophysical data and the aerial photography. In particular, the geophysical survey has revealed a sub circular enclosure to the north of the site, and although this is partially truncated by the road it seems to be very similar in size and morphology to other enclosures in the vicinity, such as two examples found at Simms Copse approximately 800m to the west. The more complete magnetic coverage suggests two main groups of ditched, multi-phase enclosures with large portions of the overall survey area empty of further significant activity. In between the main areas of activity there is some evidence for former field boundaries and ditches possibly associated with the main enclosure complexes. The geophysical results have, in part, been obscured by a strong geomorphological response.

LIST OF ENCLOSED FIGURES

Figure 13 Graphical summary of significant magnetic anomalies superimposed over the base OS mapping (1:3000).

Figure 14 Graphical summary of significant GPR anomalies superimposed over the base OS mapping together with the aerial photographic transcription (1:3000).

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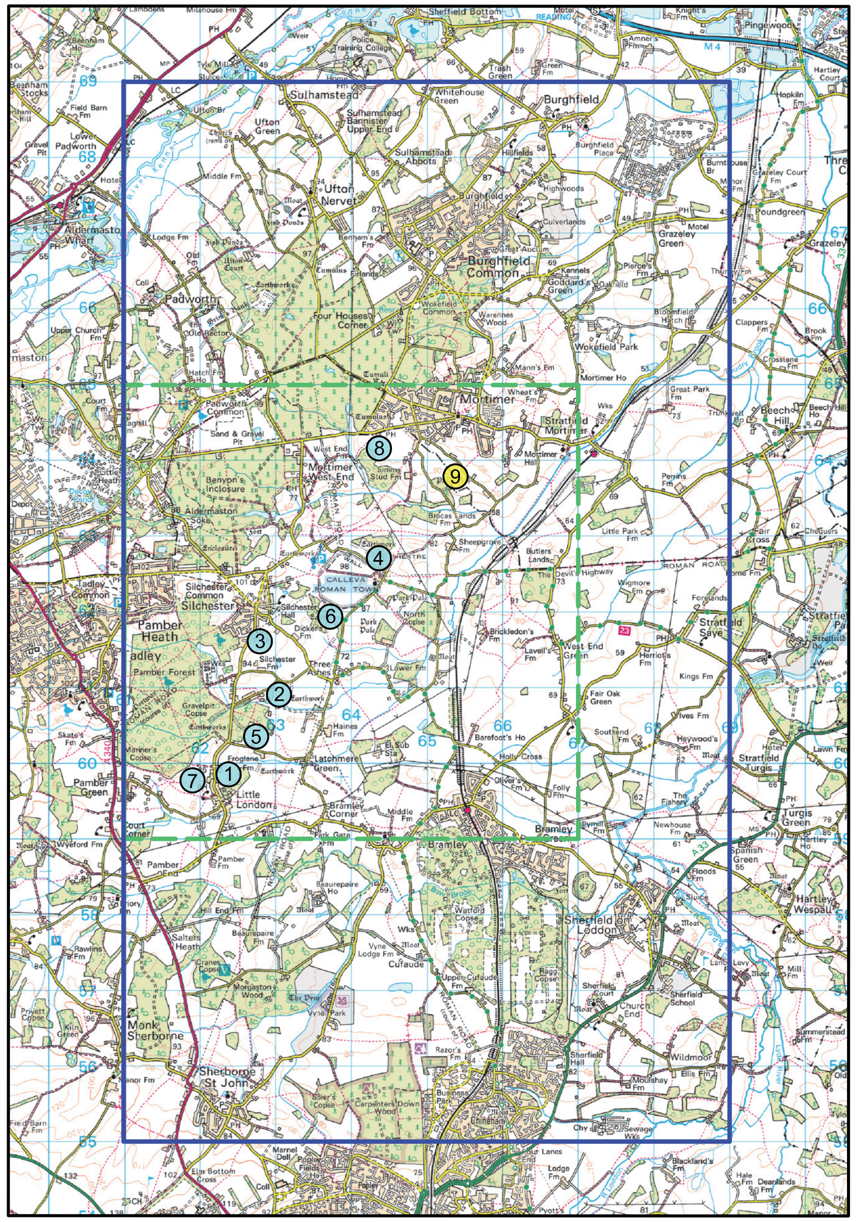
Figure 1

SILCHESTER ENVIRONS PROJECT, WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE
Location of survey

(A)



Core project area

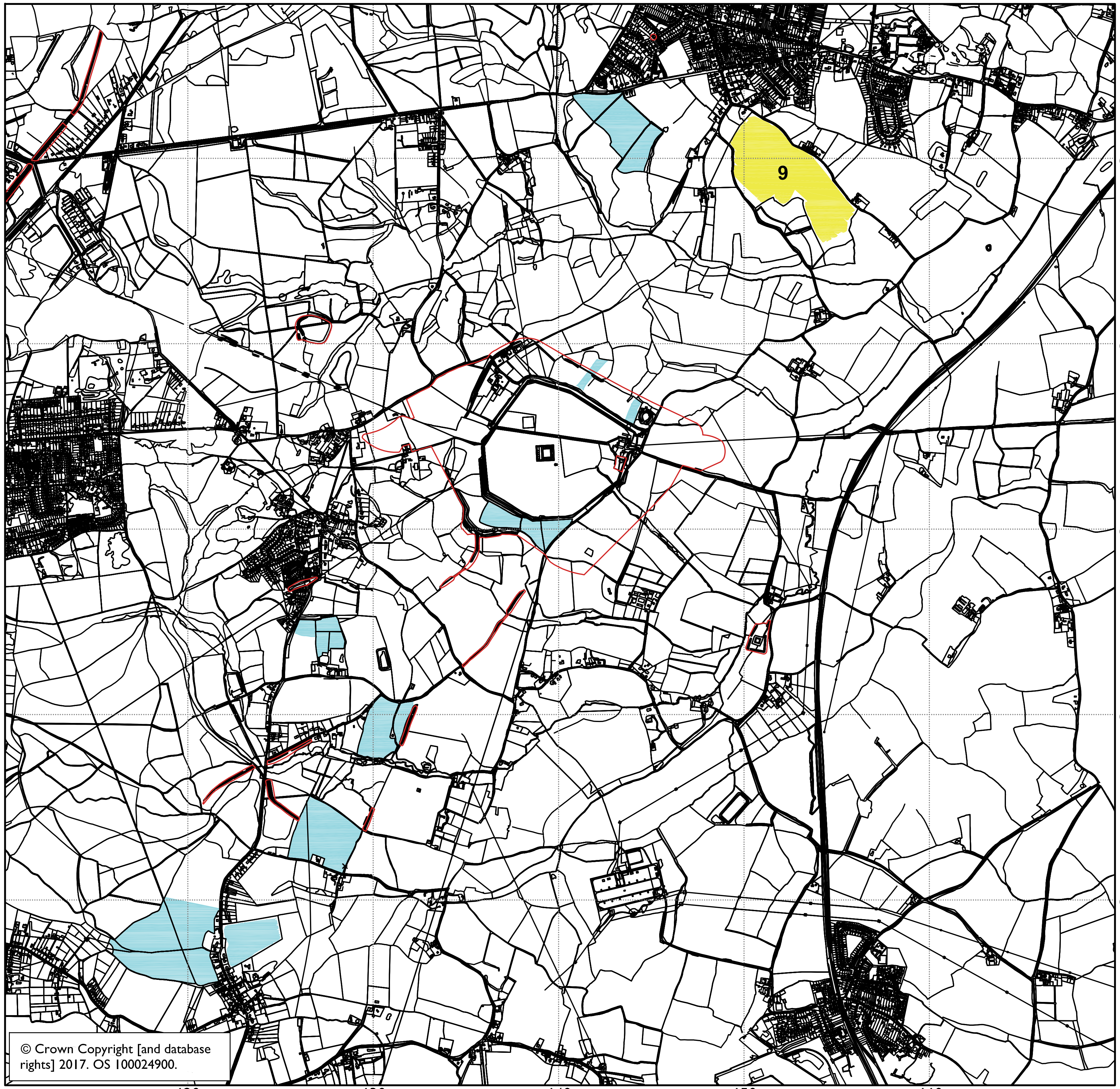
Detailed OS mapping area (B)

0 3km
1:100000

HE geophysical survey locations:
1. Little London Roman tilery
2. Woods Farm Dyke
3. Silchester Farm
4. Chitty Farm
5. Bridle's Copse
6. Rampier Copse
7. King's Hogsty Copse
8. Simms's Copse
9. Windabout Copse

SU6159

(B)



0 1500m
1:25000

9 Windabout Copse survey area

Other HE geophysical survey areas

Scheduled areas

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SILCHESTER ENVIRONS PROJECT, WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE

Location of caesium magnetometer instrument swaths, February 2017

Figure 3

SILCHESTER ENVIRONS PROJECT, WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE

Location of GPR instrument swaths, February 2017

SU6563

0 150m
1:3000

2015-07-21-047 Location of selected GPR profiles shown on Figure 8

Ground Penetrating Radar survey swaths

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Figure 4

SILCHESTER ENVIRONS PROJECT, WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE

Location of caesium magnetometer survey, February 2017

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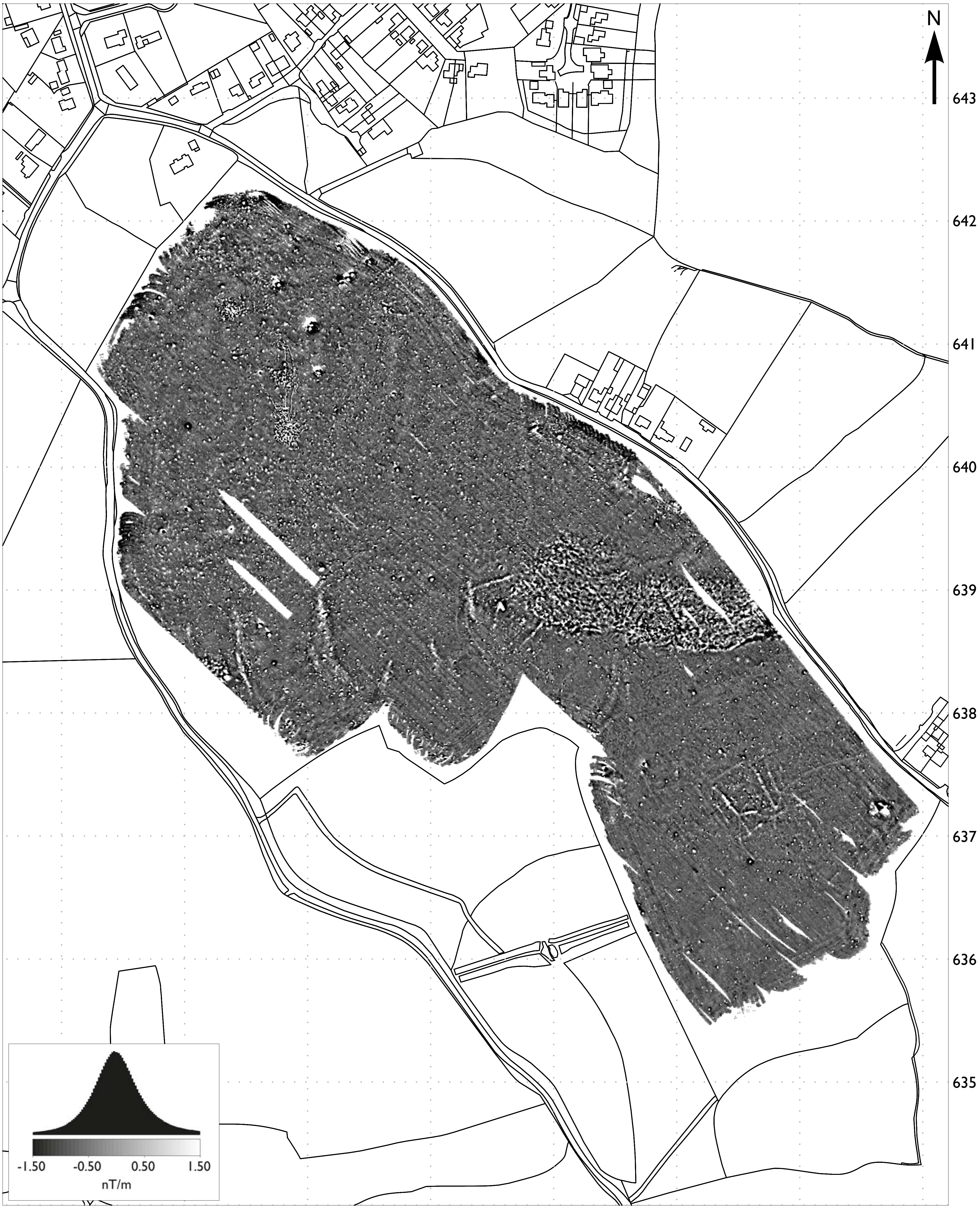

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Figure 5

SILCHESTER ENVIRONS PROJECT,
WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE
GPR amplitude time slice between 25.0 - 27.5ns (1.29 - 1.42m), February 2017

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Figure 6

SILCHESTER ENVIRONS PROJECT, WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE

Caesium magnetometer survey, February 2017

Trace plot of minimally processed data

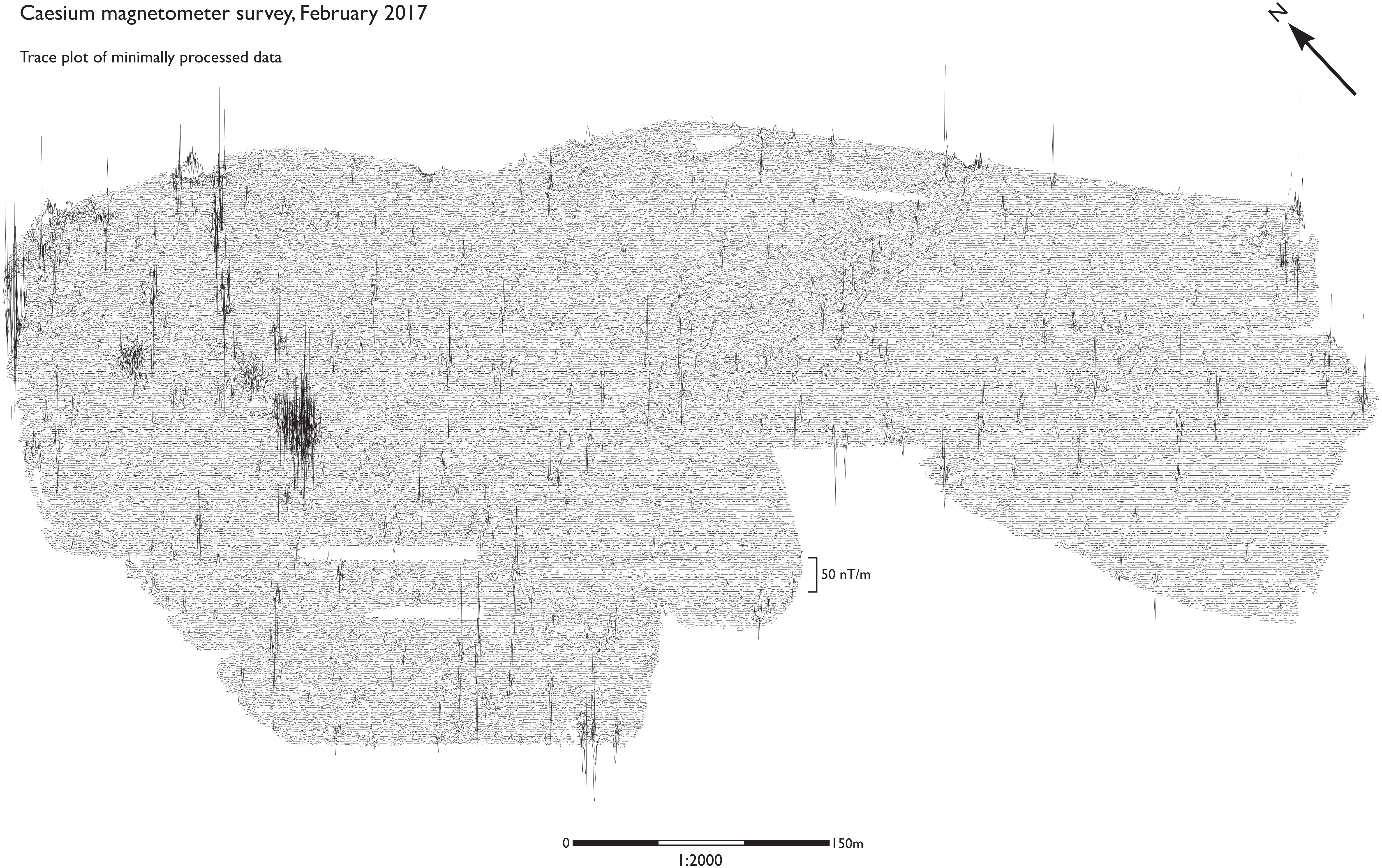

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Figure 7

SILCHESTER ENVIRONS PROJECT, WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE

Caesium magnetometer survey, February 2017

Histogram equalised greyscale image of minimally processed magnetometer data

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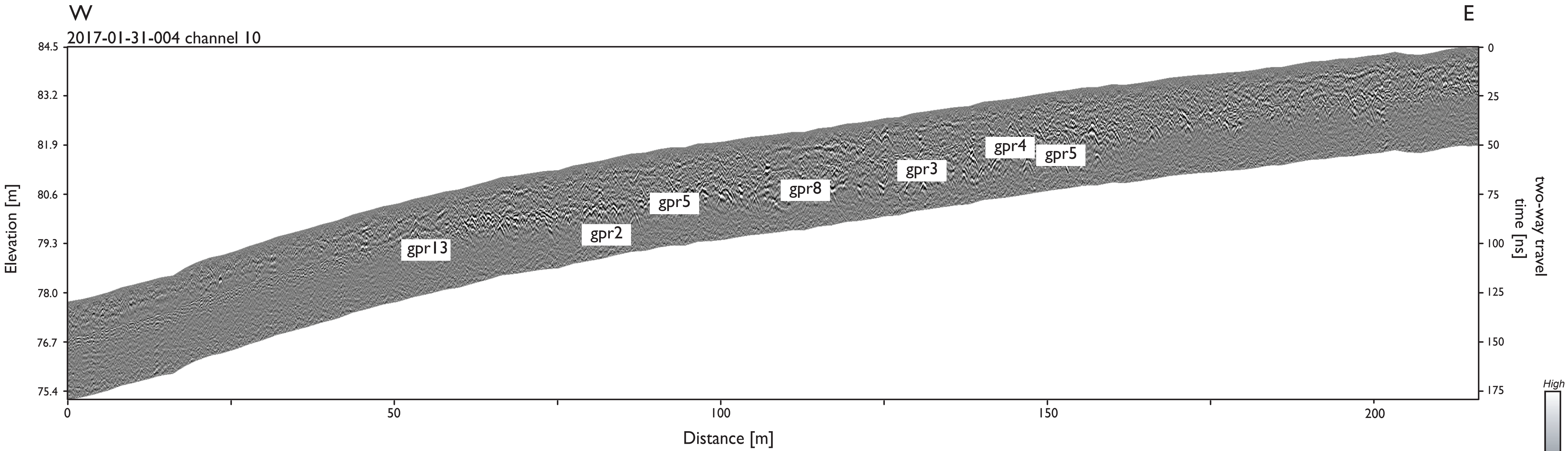
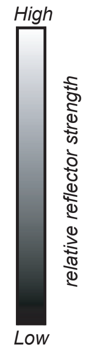
SILCHESTER ENVIRONS PROJECT, WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE

Topographically corrected GPR profiles, February 2017

Figure 8





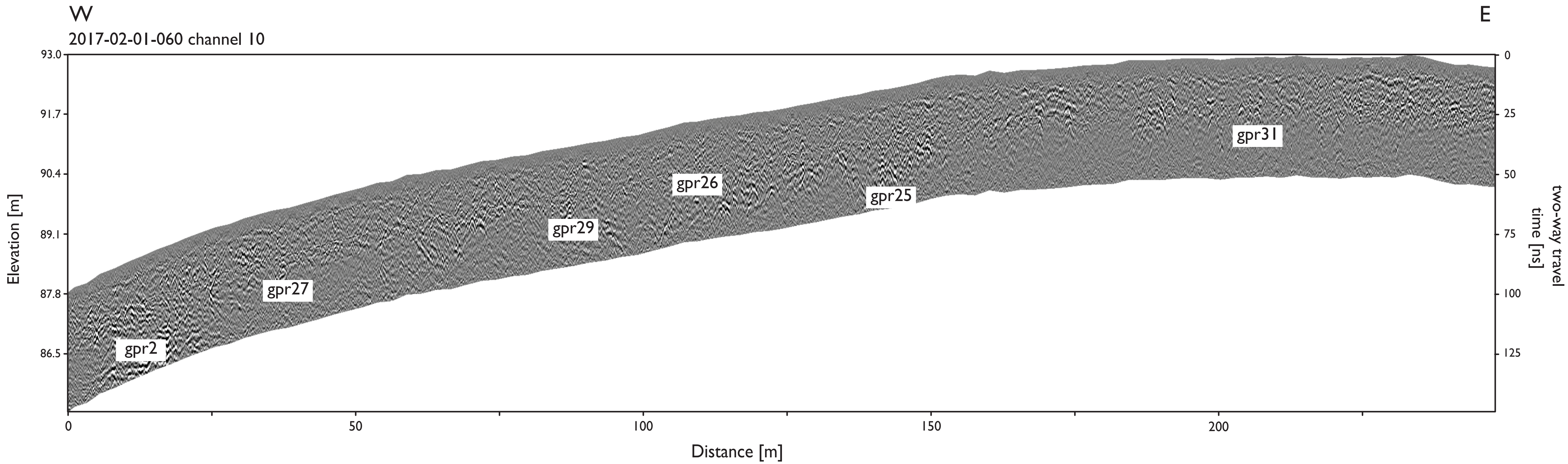


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Figure 9

SILCHESTER ENVIRONS PROJECT, WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE
Trenches 4-9, GPR amplitude time slices between 0.0 and 25.0ns (0 to 1.29m), February 2017

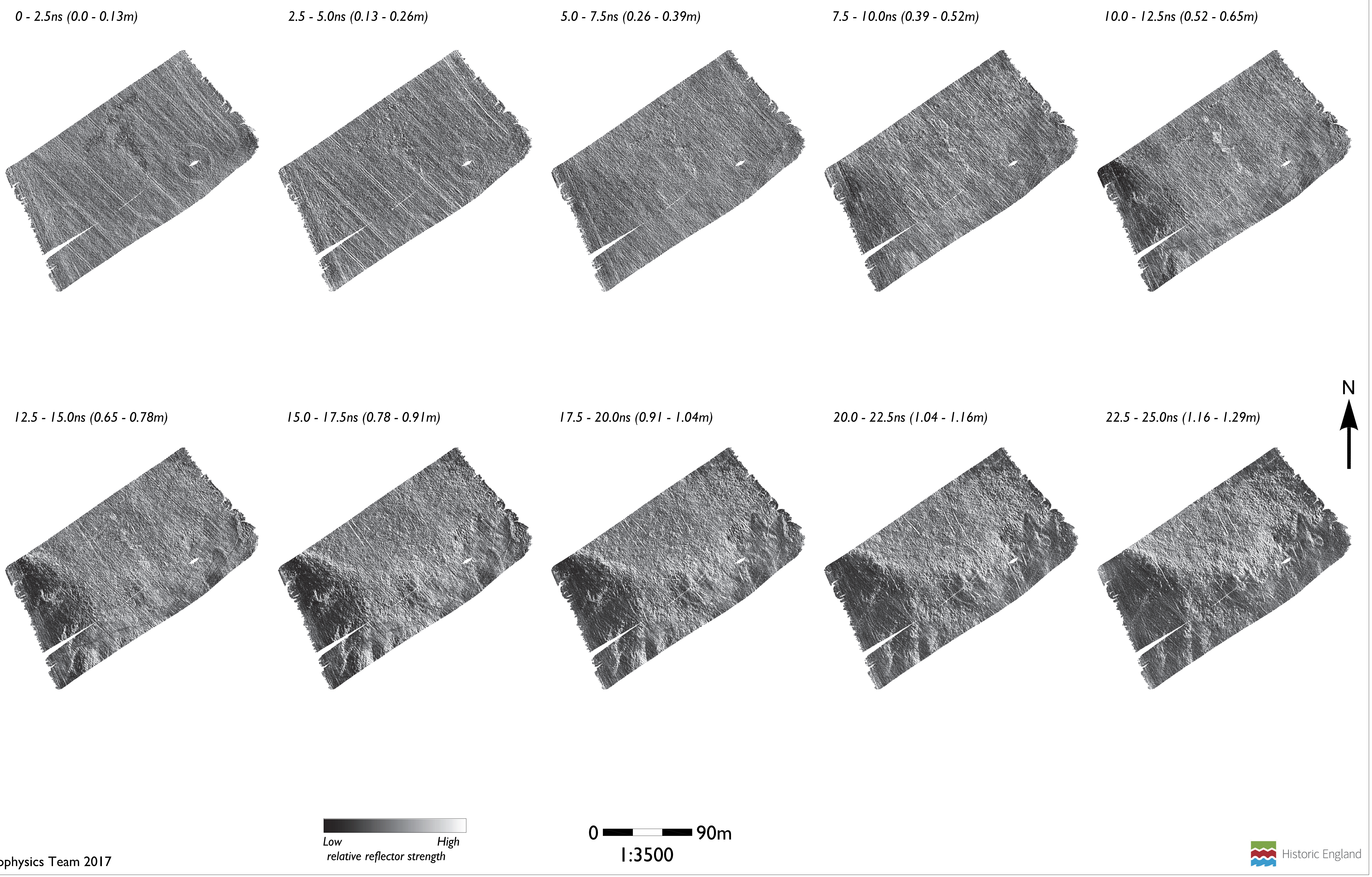

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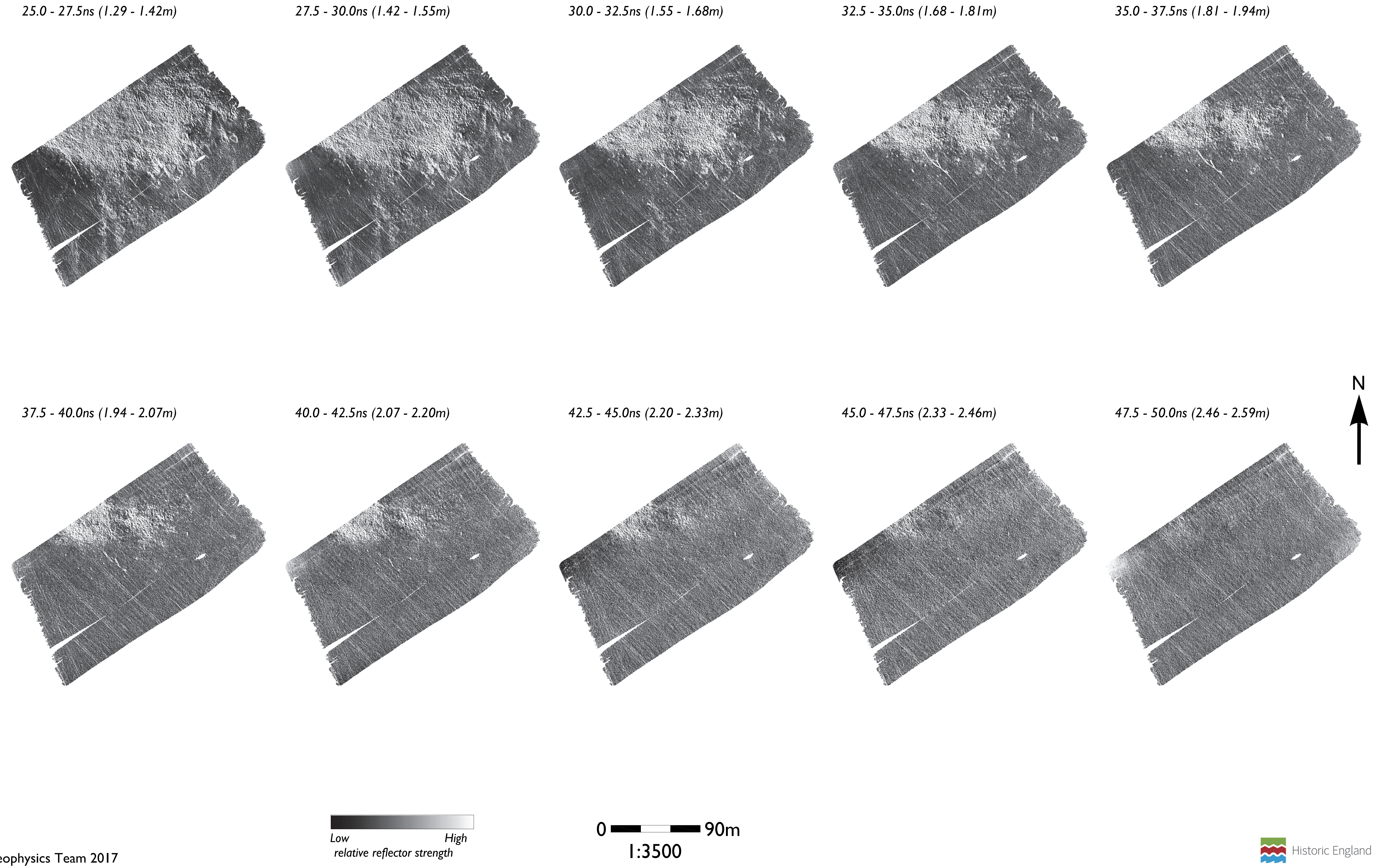
Figure 10

SILCHESTER ENVIRONS PROJECT, WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE

Trenches 4-9, GPR amplitude time slices between 25.0 and 50.0ns (1.29 to 2.59m), February 2017



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SILCHESTER ENVIRONS PROJECT, WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE
Trenches 0-2, GPR amplitude time slices between 0.0 and 25.0ns (0 to 1.29m), February 2017

Figure 11

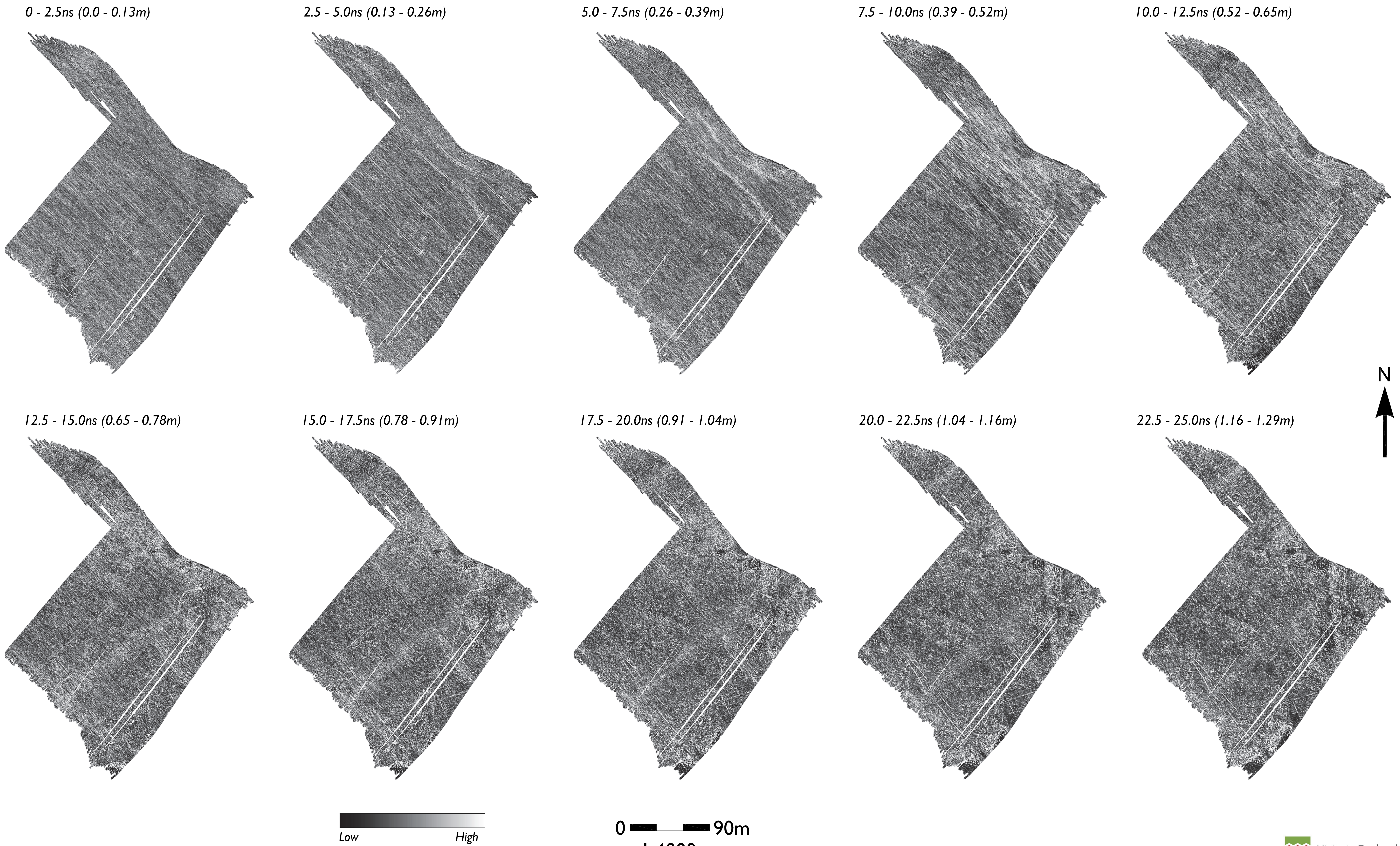

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Figure 12

SILCHESTER ENVIRONS PROJECT, WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE

Trenches 0-2, GPR amplitude time slices between 25.0 and 50.0ns (1.29 to 2.59m), February 2017

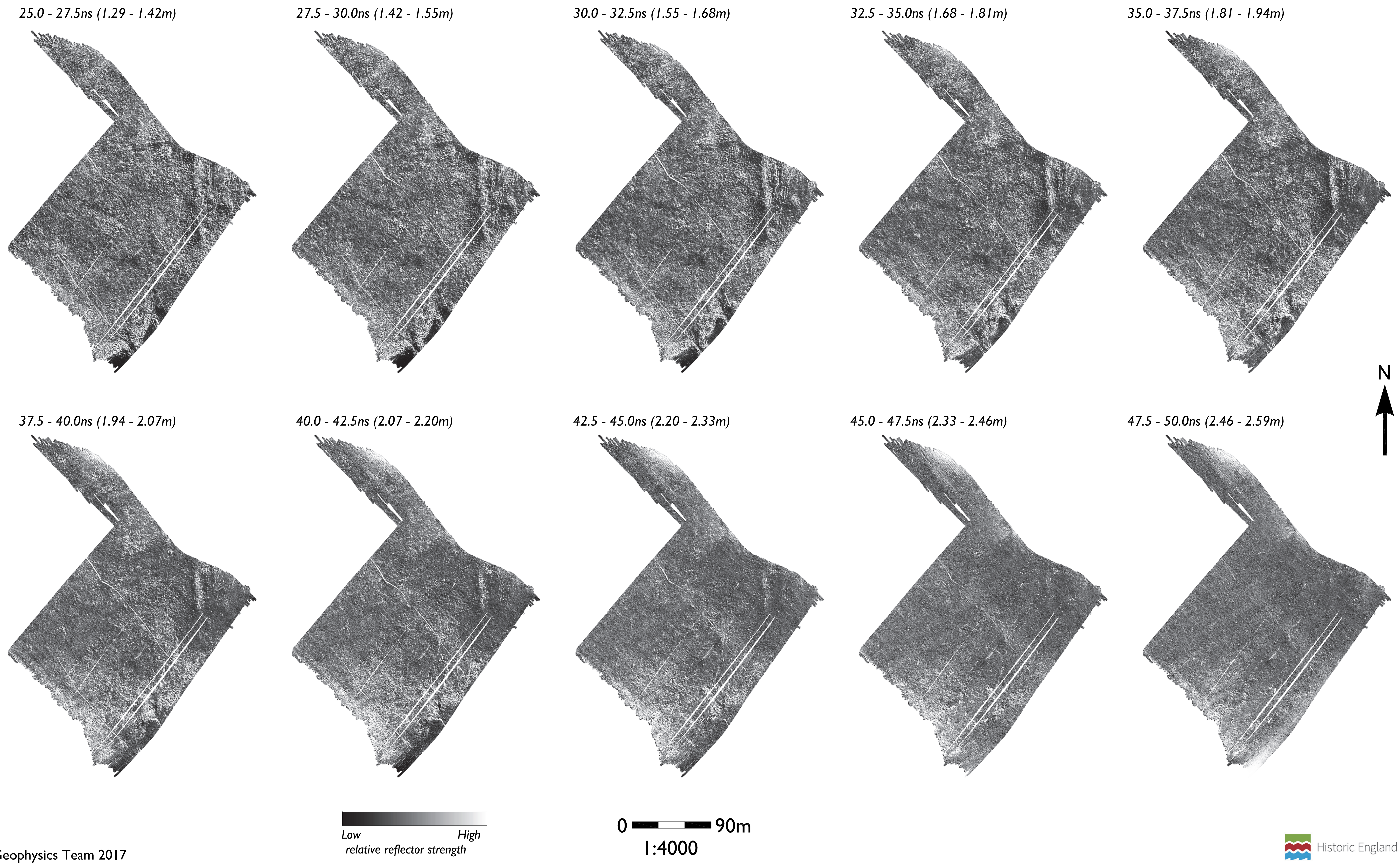

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Figure 13

SILCHESTER ENVIRONS PROJECT, WINDABOUT COPSE, MORTIMER WEST END, HAMPSHIRE

Graphical summary of significant magnetic anomalies, February 2017

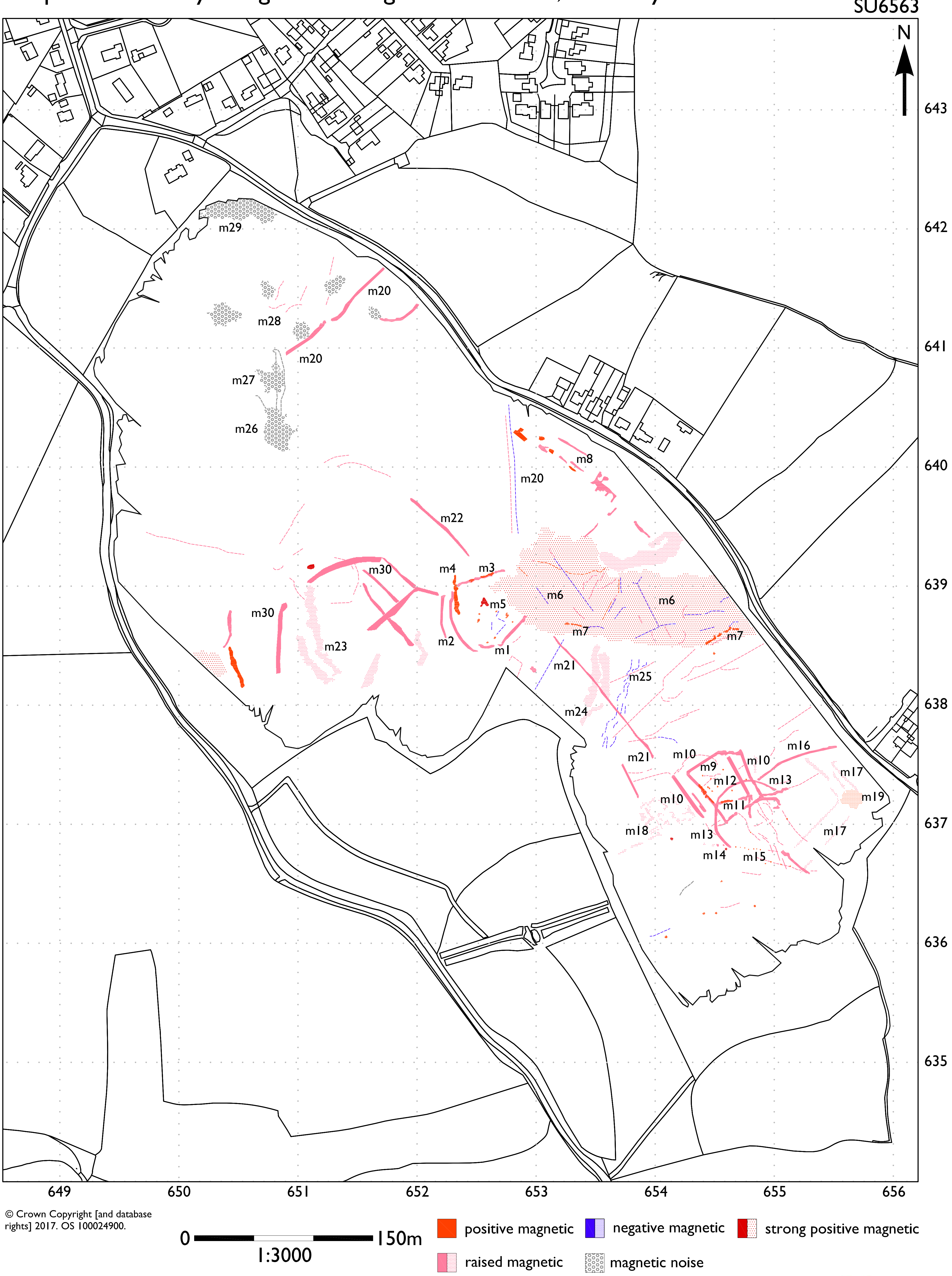

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Figure 14

SILCHESTER ENVIRONS PROJECT,
WINDABOUT COPSE, MORTIMER WEST END, WEST BERKSHIRE
Graphical summary of significant GPR anomalies, February 2017

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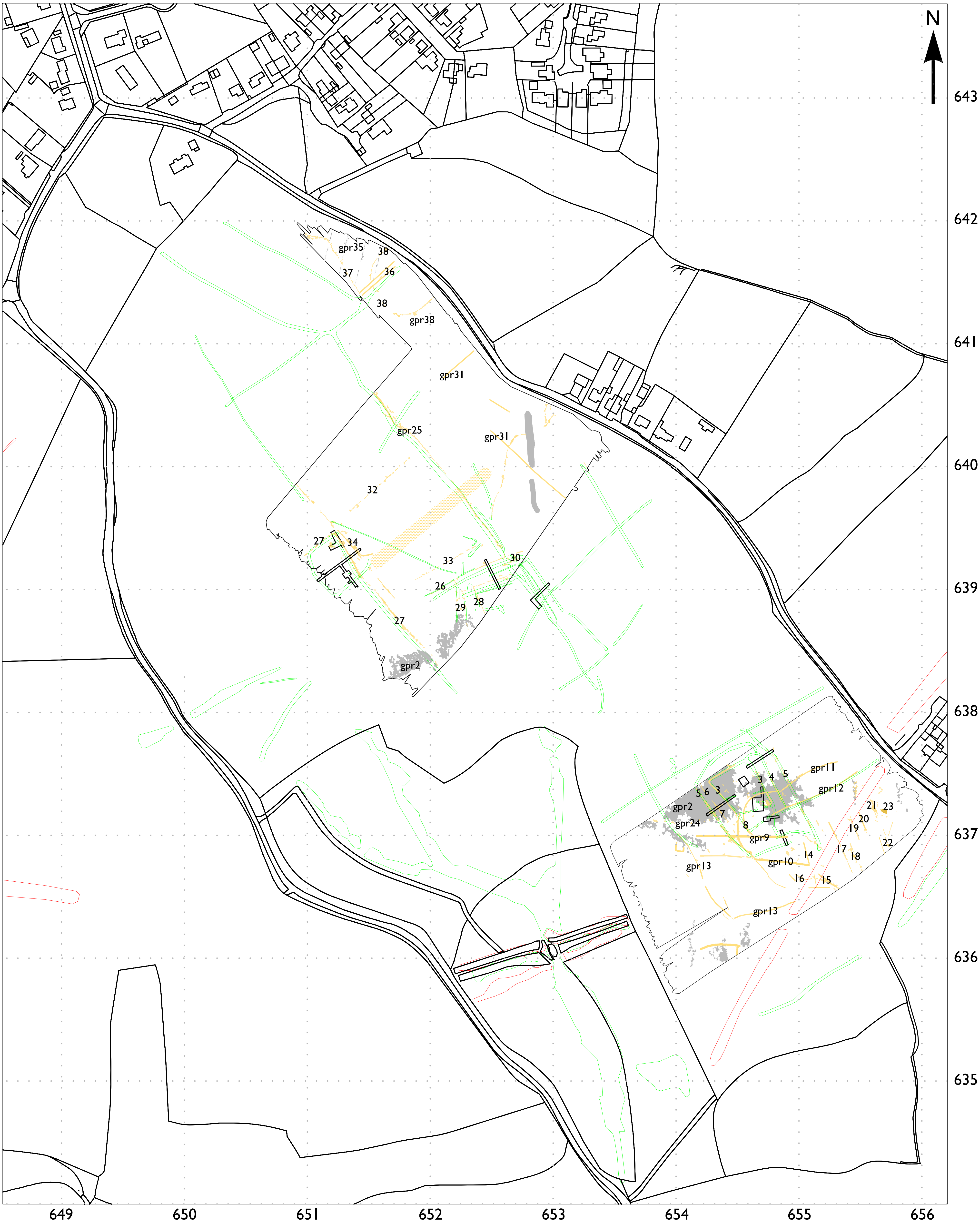

0 150m

1:3000

low amplitude reflectors

high amplitude reflectors

excavation trench [gpr1]

anomalies of known or recent origin

AP ditch

AP bank

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