Historic England

Geophysics

Silchester Environs Project, Bridle's Copse, Pamber, Hampshire
Report on Geophysical Survey, May 2016

Neil Linford, Paul Linford, Andrew Payne and Cara Pearce

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SILCHESTER ENVIRONS PROJECT, BRIDLE'S COPSE, PAMBER, HAMPSHIRE

REPORT ON GEOPHYSICAL SURVEY,

MAY 2016

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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 linear bank and ditch monument, surviving as both a well preserved earthwork in the adjacent woodland and crop marks crossing an arable field, at Bridle's Copse, Pamber, Hampshire. The vehicle towed caesium magnetometer survey (6.2 ha) discerned a weak linear anomaly extending into the field, possibly the line of the linear monument that appears to terminate at a stronger response to the east. However, there is no indication of the linear monument continuing any further eastwards across the field, as suggested by the aerial photography. The vehicle towed GPR survey (6.7 ha) with the very near-surface data dominated by animal burrows and, to the south of the survey, the course of the buried electricity cable. A pattern of field drains are apparent across the site together with a tentative, broad linear anomaly which appears to indicate the course of the ploughed out linear monument beyond the extent of the magnetic response. Unfortunately, data could not be acquired in the central portion of the field, due to poor weather conditions that hampered access to the field.

CONTRIBUTORS

The geophysical fieldwork was conducted by Neil Linford, Paul Linford, Andrew Payne and Cara Pearce (Historic England Placement).

ACKNOWLEDGEMENTS

The authors are grateful to the landowner for allowing access for the survey.

ARCHIVE LOCATION

Fort Cumberland, Portsmouth.

DATE OF SURVEY

The fieldwork was conducted between 9th and 10th May 2016 and the report completed on 2nd May 2019. The cover image shows the vehicle towed caesium magnetometer in the field during the survey.

CONTACT DETAILS

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INTRODUCTION

Caesium magnetometer and Ground Penetrating Radar (GPR) surveys were conducted at Bridle's Copse, Pamber, 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 aim of the survey at Bridle's Copse was to find evidence for a late Iron Age linear monument, which survives as a well preserved earthwork within the woodland (AMIE Monument HOB UID 1431462, SAM 1008728), as it emerges into the adjacent arable field. The linear monument is visible as a cropmark on aerial photographs to the east of the arable field, together with scattered areas of pits to the north and south (AMIE Monument HOB UID 1602374), and two parallel banks of uncertain date (AMIE Monument HOB UID 1602384).

The site is situated on Eocene Lower Bagshot sand, with some superficial plateau gravel to the south, over which fine loamy soils with slowly permeable subsoils of the 572j Bursledon association have developed (Geological Survey of Great Britain 1974; Soil Survey of England and Wales 1983). The field was fallow at the time of the survey, with stubble from the previous maize crop. Poor weather conditions at the time of the survey hampered access to the field meaning that it was not possible to obtain either magnetic or GPR coverage over the central ~3 ha of the field.

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 ($\pm$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 2.3ns (two-way travel time) windows (e.g. Linford 2004). An average sub-surface velocity of 0.131m/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 ~0.15m intervals from the ground surface in Figures 9 and 10. 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 [**m1-9**] discussed in the following text superimposed on base OS map data is provided in Figure 13.

The magnetic data has been obscured in places by a buried electrical cable across the south of the survey area [**m1**] and an overhead power line crossing the western strip north-south [**m2**]. Nevertheless a weak linear anomaly [**m3**] can be discerned on a northwest-southeast alignment extending 100 m into the field from its western boundary. The anomaly at [**m3**] appears to extend the line of the linear bank which survives as a topographic feature in Bridle’s Copse immediately to the west. At ~0.5 nT/m its peak magnitude is typical of the very weak archaeological anomalies encountered over London Clay, but a stronger response reaching ~3 nT/m is evident at its eastern terminal [**m4**] suggesting different construction or nature of the buried ditch fill here. However, there is no indication of the linear bank continuing any further eastwards as suggested by the aerial photography. There is little further indication of archaeological activity apparent across the site, although a tentative curving linear ditch [**m5**] together with some indistinct responses [**m6**] have been detected in the northern corner of the field, and a possible former field boundary [**m7**] extends from the linear bank anomaly [**m3**] towards the south of the field.

Other isolated short curvilinear sections of possible ditches, [**m8**] and [**m9**], are of uncertain archaeological significance.

Ground Penetrating Radar survey

A graphical summary of the significant GPR anomalies, [**gpr1-4**] 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 there are few significant later reflections beyond ~20ns The very near-surface data are dominated by animal burrows [**gpr1**] and, to the south of the survey, the course of the buried electricity cable [**gpr2**]. From between 6.9 and 16.1ns (0.45 and 1.06 m) a pattern of field drains [**gpr3**] are apparent across the site with a 'herring-bone' layout in the bottom of the dry valley to the west. A tentative, broad linear anomaly [**gpr4**] is evident throughout approximately the same depth range and appears to indicate the course of the ploughed out linear monument extending from Bridle's Copse. Unfortunately, as data could not be acquired in the central portion of the field, it is difficult to assess the apparent change in orientation of the ditch to the east where the geophysical anomaly correlates with the aerial survey evidence.

CONCLUSIONS

Both techniques have been hampered by wet field conditions at the site at the time of the survey, restricting access to the full extent of the field and, for the radar, leading to the rapid attenuation of the signal in the soil. Further magnetic interference was encountered along the course of the buried electricity cable and from an overhead power line. Despite these impediments tentative magnetic anomalies suggesting the continuation of the linear monument were detected to the west of the survey area, including a possible terminal pit-type response. Further magnetic anomalies, partly corroborating activity identified through aerial photography have also been suggested. The GPR data has also revealed subtle anomalies on the course of the linear monument, potentially suggesting a continuation further to the east partially replicating the recorded crop mark here

LIST OF ENCLOSED FIGURES

REFERENCES

Barnett, C and Fulford, M 2015 Between Kennet and Loddon: The Silchester Iron Age Environs Project. Reading, University of Reading, School of Archaeology, Geography and Environmental Science (unpublished project design document).

Creighton, J and Fry, R 2016 *Silchester: Changing Visions of a Roman Town: Integrating geophysics and archaeology: the results of the Silchester mapping project 2005-10*, Roman Society Publications.

Geological Survey of Great Britain 1974 Basingstoke. England and Wales Sheet 284. Solid and Drift Geology, 1:50,000 scale geology map: Ordnance Survey for Institute of Geological Sciences, Southampton.

Linford, N 2004 'From Hypocaust to Hyperbola: Ground Penetrating Radar surveys over mainly Roman remains in the U.K.'. *Archaeological Prospection*, 11 (4), 237-246.

Linford, N 2013. *Rapid processing of GPR time slices for data visualisation during field acquisition*. In Neubauer, W, Trinks, I, Salisbury, R and Einwogerer, C (Editors), Archaeological Prospection, Proceedings of the 10th International Conference, May 29th - June 2nd 2013 2013 (Vienna: Austrian Academy of Sciences Press). 176-78.

Linford, N, Linford, P, Martin, L and Payne, A 2010 'Stepped-frequency GPR survey with a multi-element array antenna: Results from field application on archaeological sites'. *Archaeological Prospection*, 17 (3), 187-198.

Linford, N, Linford, P and Payne, A 2015 'Chasing aeroplanes: developing a vehicle-towed caesium magnetometer array to complement aerial photography over three recently surveyed sites in the UK'. *Near Surface Geophysics*, 13 (6), 623-631.

Linford, P 2015 7226 Between Kennet and Loddon: The Silchester Environs Survey, HE Geophysical Survey contribution. Portsmouth, Historic England, Research Group (unpublished supplementary project design document).

Mauring, E, Beard, L P, Kihle, O and Smethurst, M A 2002 'A comparison of aeromagnetic levelling techniques with an introduction to median levelling'. *Geophysical Prospecting*, 50 (1), 43-54.

Sala, J and Linford, N 2012 ' Processing stepped frequency continuous wave GPR systems to obtain maximum value from archaeological data sets '. *Near Surface Geophysics*, 10 (1), 3-10.

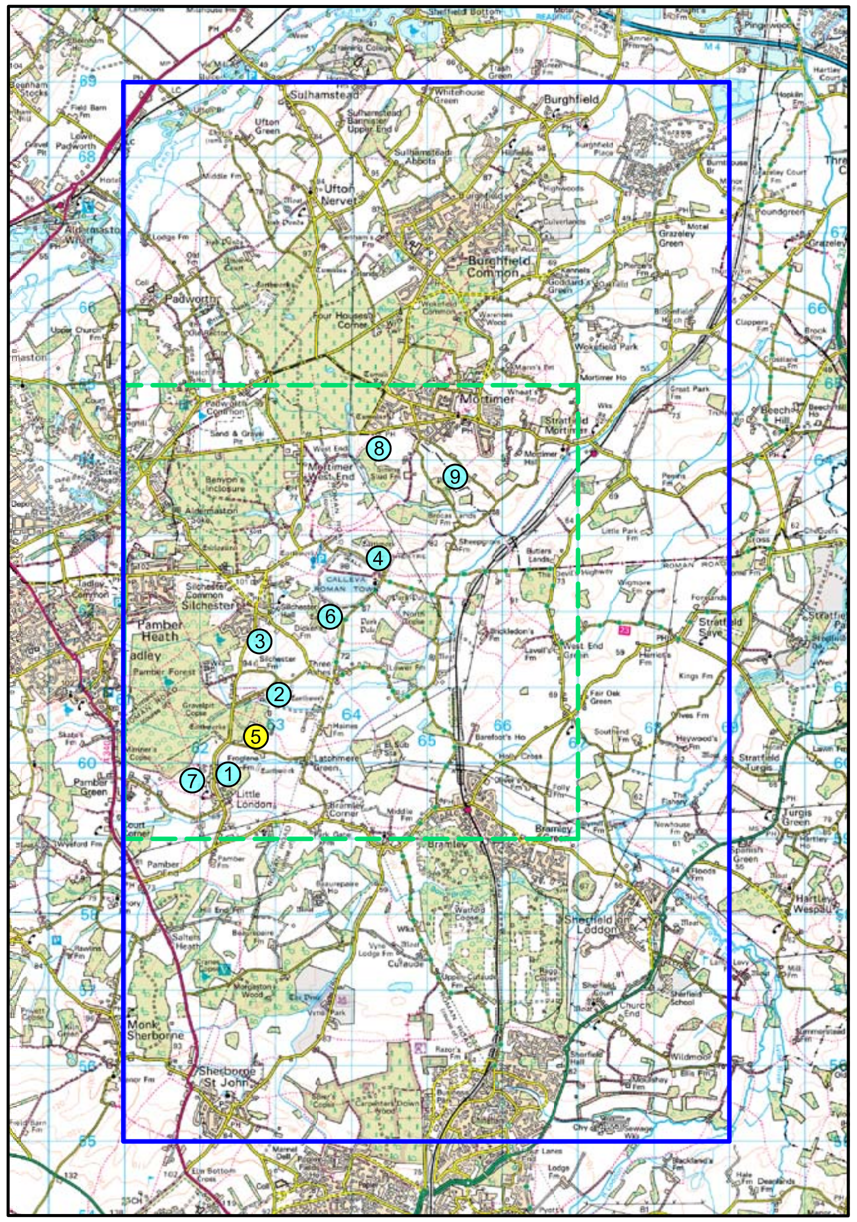
Soil Survey of England and Wales 1983 Soils of England and Wales, Sheet 5 - South West England, 1:250,000 scale soil map: Lawes Agricultural Trust, Harpenden.

Figure 1

SILCHESTER ENVIRONS PROJECT, BRIDLE'S COPSE, PAMBER, HAMPSHIRE

Location of survey

(A)



Core project area

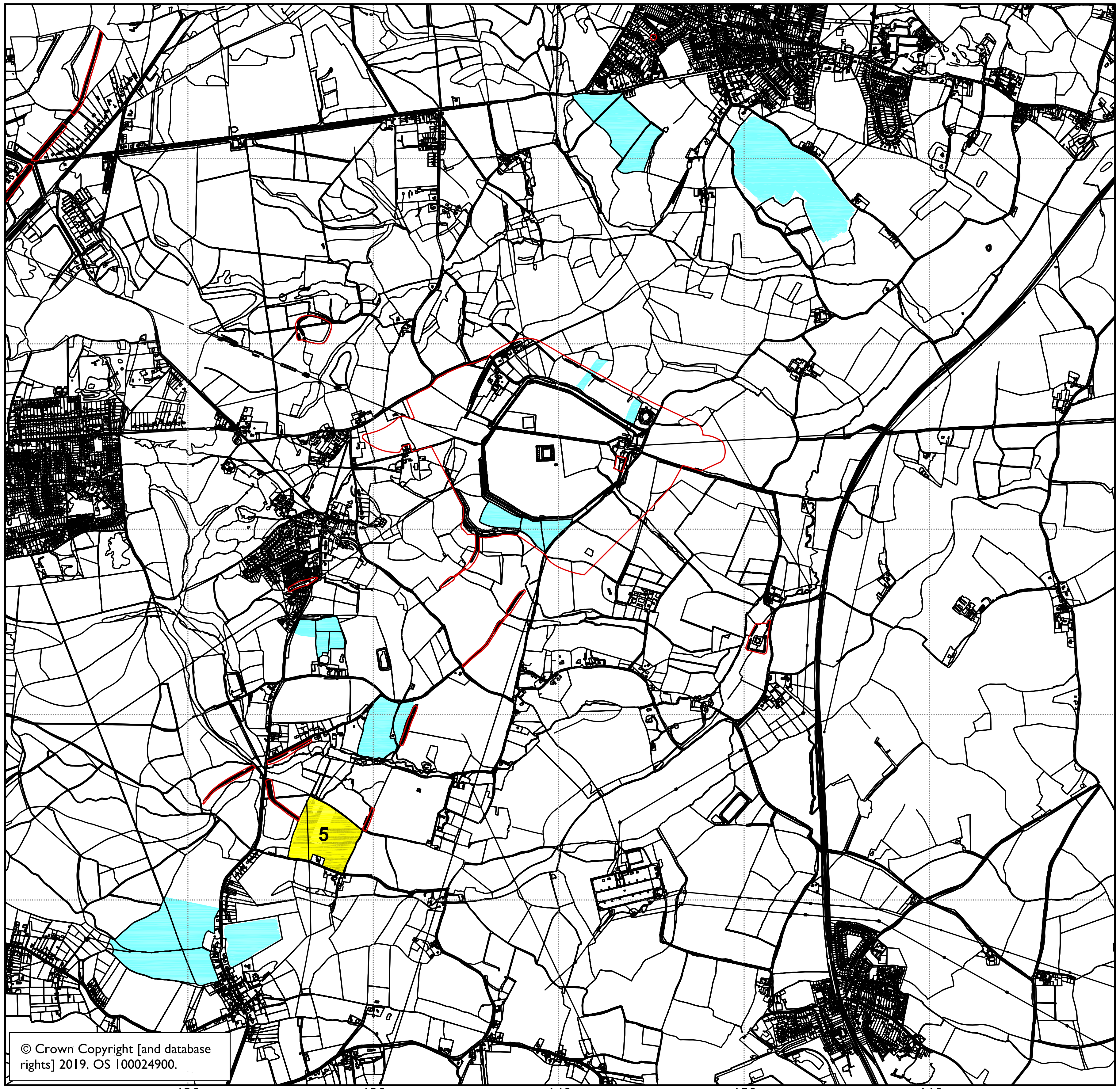
Detailed OS mapping area (B)

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

(B)



0 1500m
1:25000

5 Bridle's Copse survey area

Other HE geophysical survey areas

Scheduled areas

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Figure 2

SILCHESTER ENVIRONS PROJECT, BRIDLE'S COPSE, PAMBER, HAMPSHIRE
Location of caesium magnetometer survey swaths, May 2016

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Figure 3

SILCHESTER ENVIRONS PROJECT, BRIDLE'S COPSE, PAMBER, HAMPSHIRE
Location of GPR survey swaths, May 2016

0 90m
1:2500

2016-05-09-015 Location of selected GPR profiles shown on Figure 8

Ground Penetrating Radar survey swaths

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Figure 4

SILCHESTER ENVIRONS PROJECT, BRIDLE'S COPSE, PAMBER, HAMPSHIRE

Location of caesium magnetometer survey, May 2016

0 90m
1:2500

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Figure 5

SILCHESTER ENVIRONS PROJECT, BRIDLE'S COPSE, PAMBER, HAMPSHIRE
GPR amplitude time slice between 9.2 - 11.5ns (0.6 - 0.75m) May 2016

0 90m
1:2500

2016-05-09-015 Location of selected GPR profiles shown on Figure 8

Low High
relative reflector strength

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Figure 6

SILCHESTER ENVIRONS PROJECT, BRIDLE'S COPSE, PAMBER, HAMPSHIRE
Trace plot of minimally processed caesium magnetometer data, May 2016

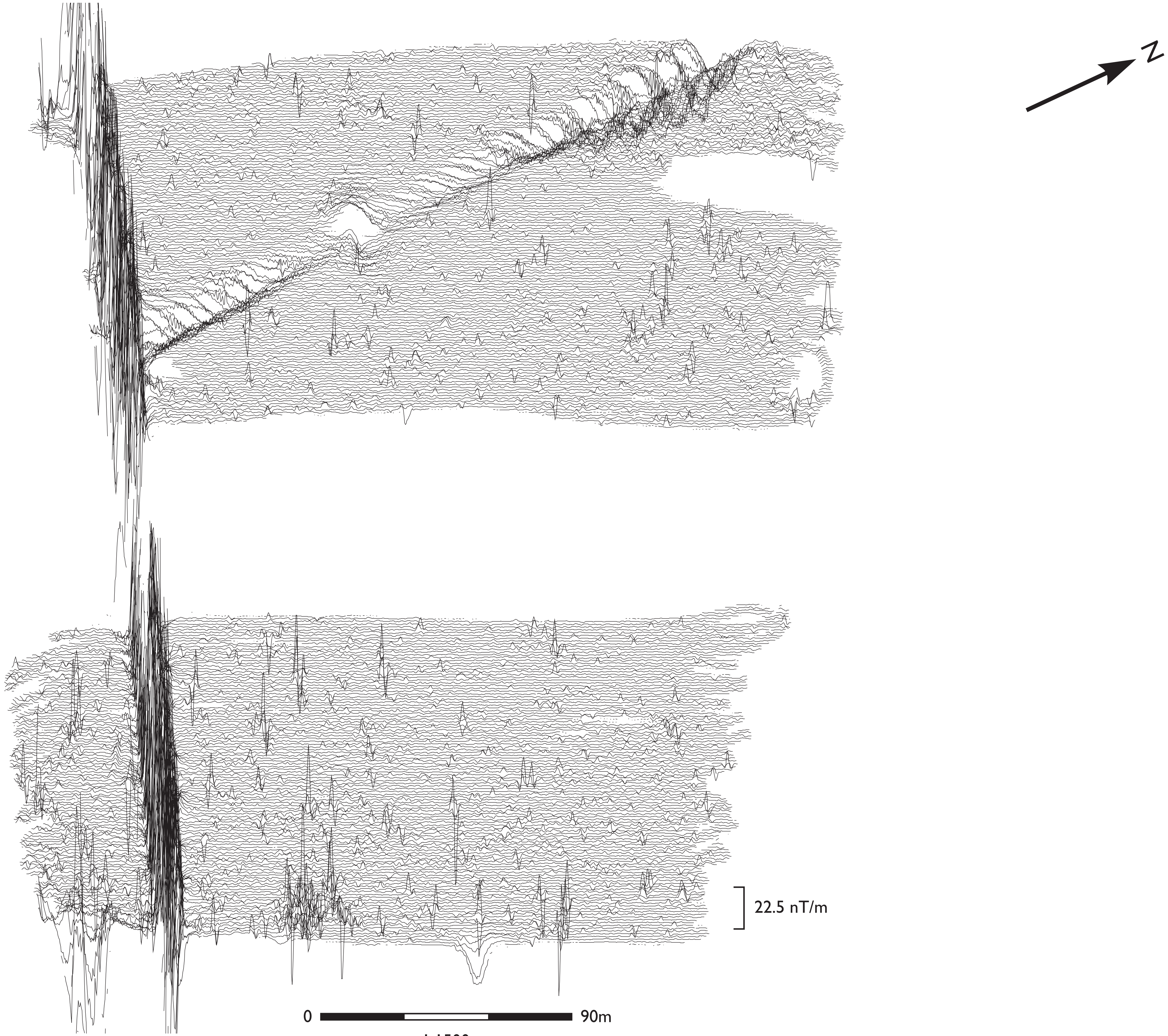

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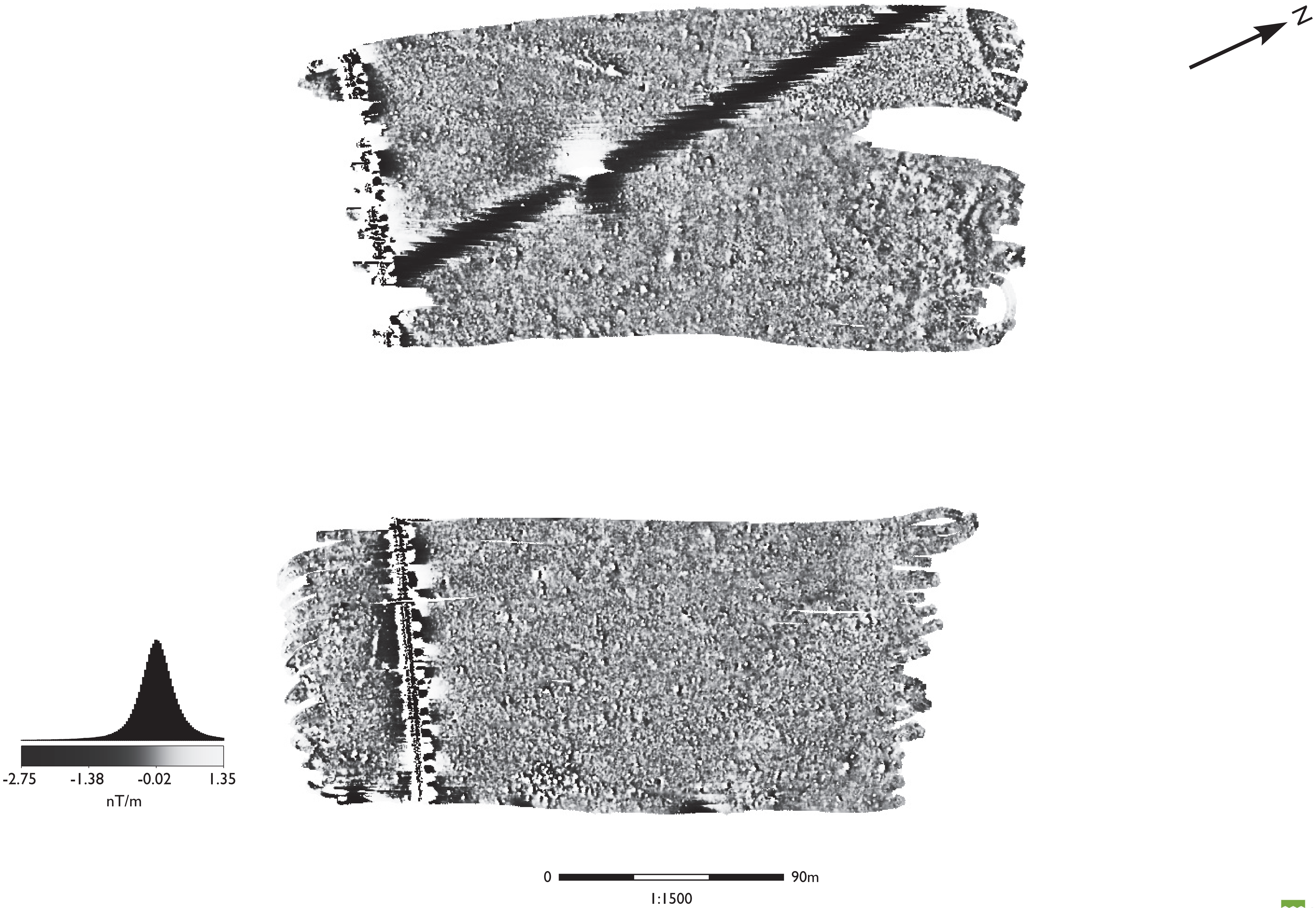
Figure 7

SILCHESTER ENVIRONS PROJECT, BRIDLE'S COPSE, PAMBER, HAMPSHIRE

Equal area greyscale image of minimally processed caesium magnetometer data, May 2016



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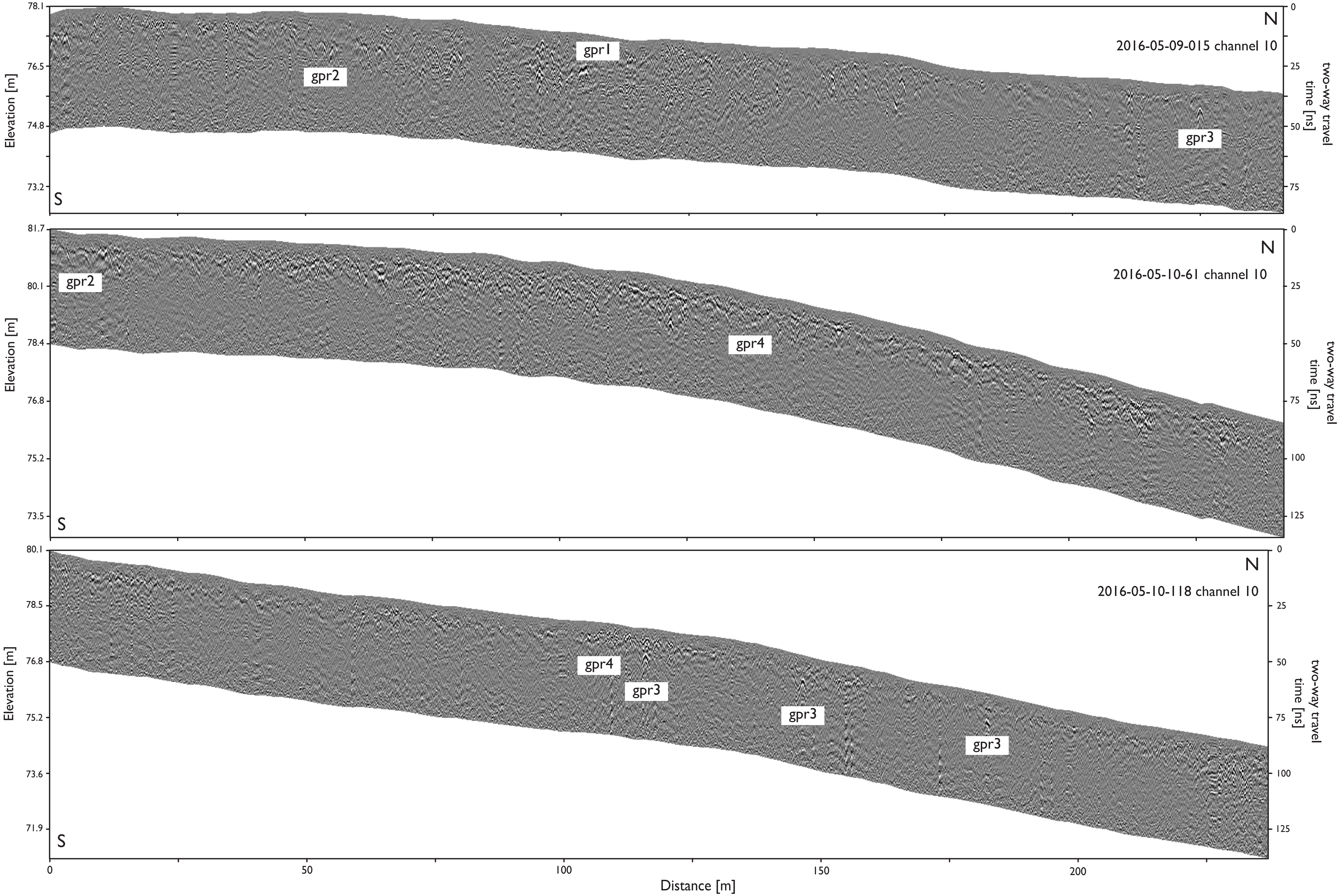
Topographically corrected GPR profiles, May 2016

Figure 8



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SILCHESTER ENVIRONS PROJECT, BRIDLE'S COPSE, PAMBER, HAMPSHIRE
GPR amplitude time slices between 0.0 and 18.4ns (0.0 - 1.21m), May 2016

Figure 9

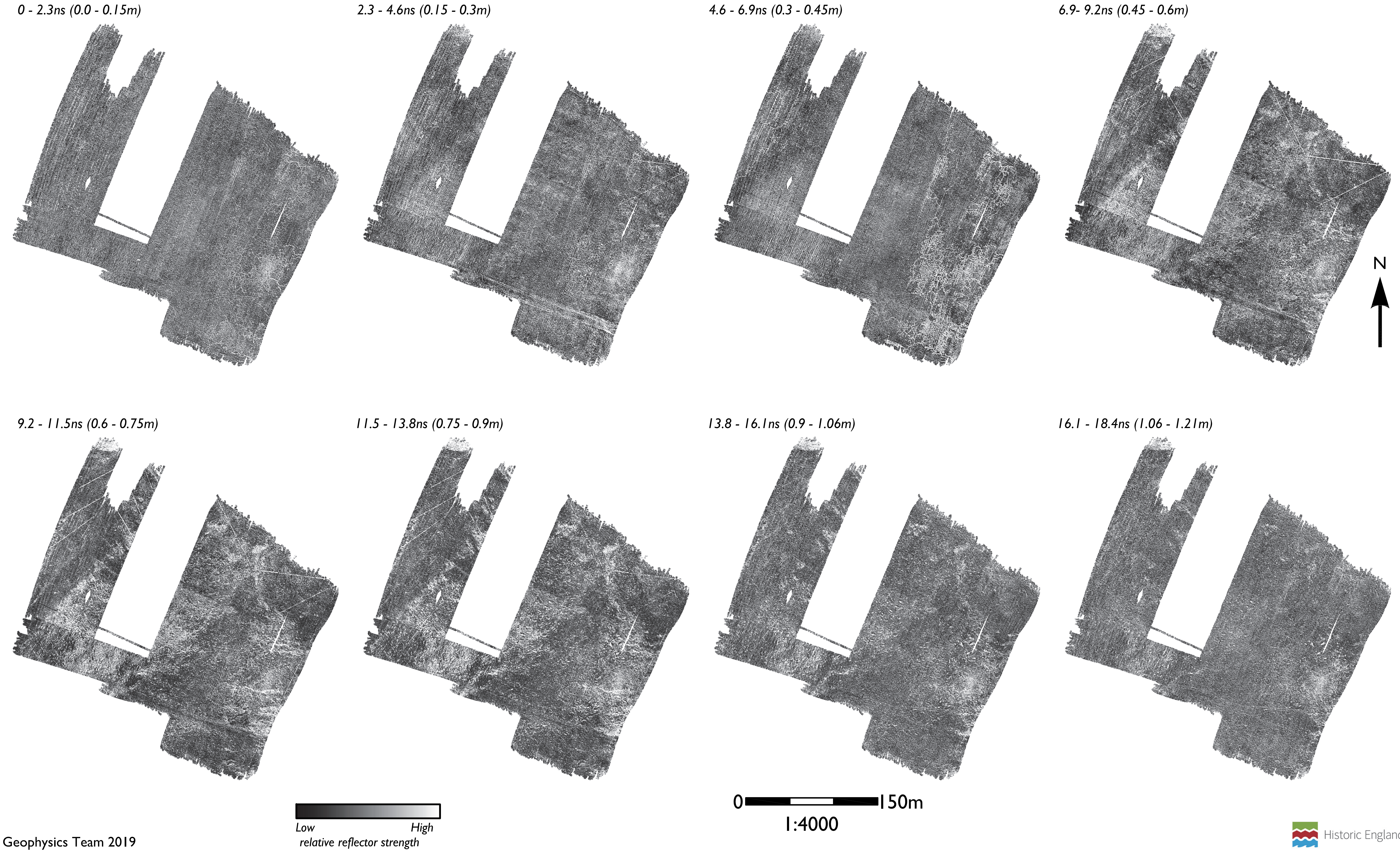

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Figure 10

SILCHESTER ENVIRONS PROJECT, BRIDLE'S COPSE, PAMBER, HAMPSHIRE
GPR amplitude time slices between 18.4 and 34.5ns (1.21 - 2.26m), May 2016

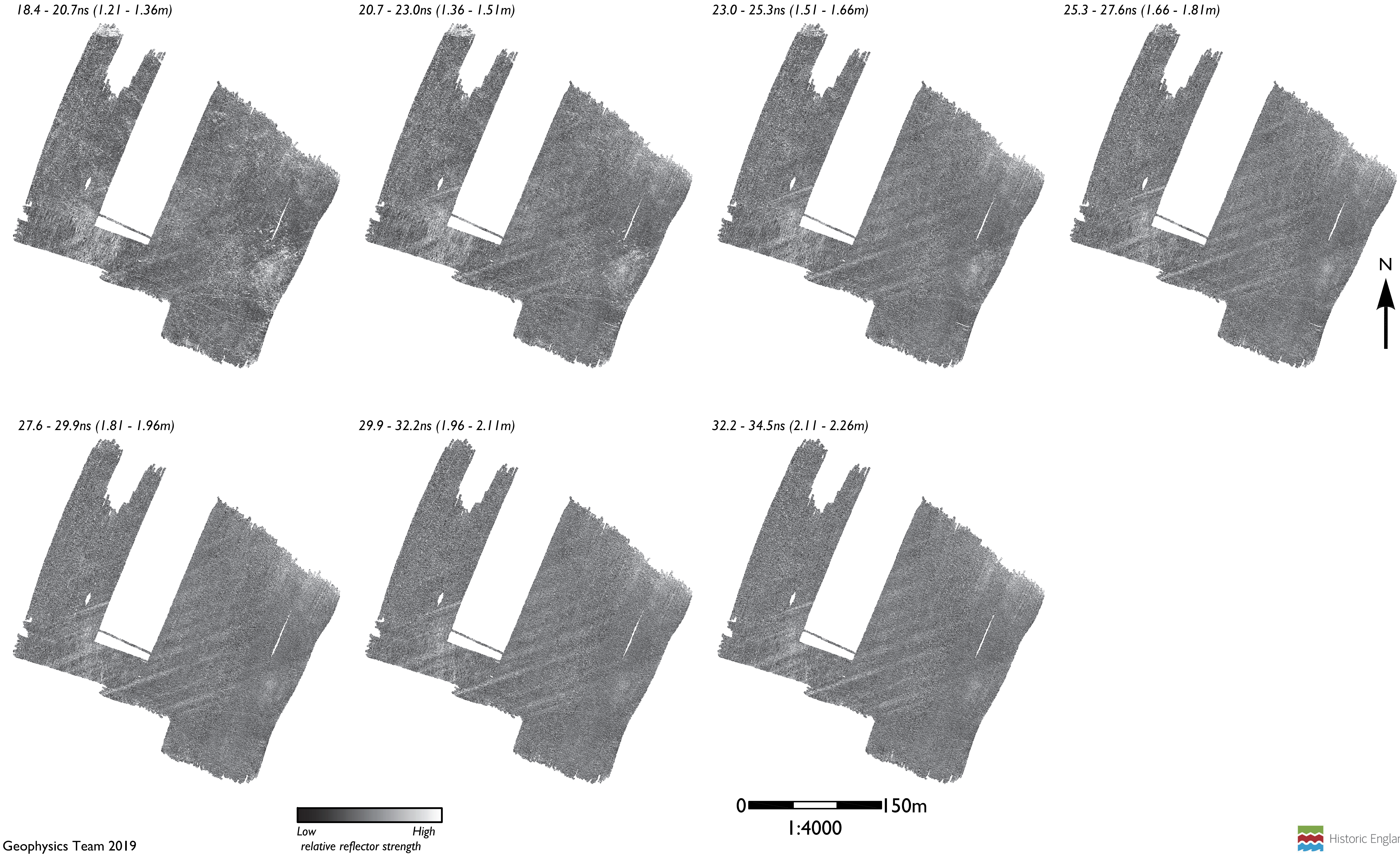

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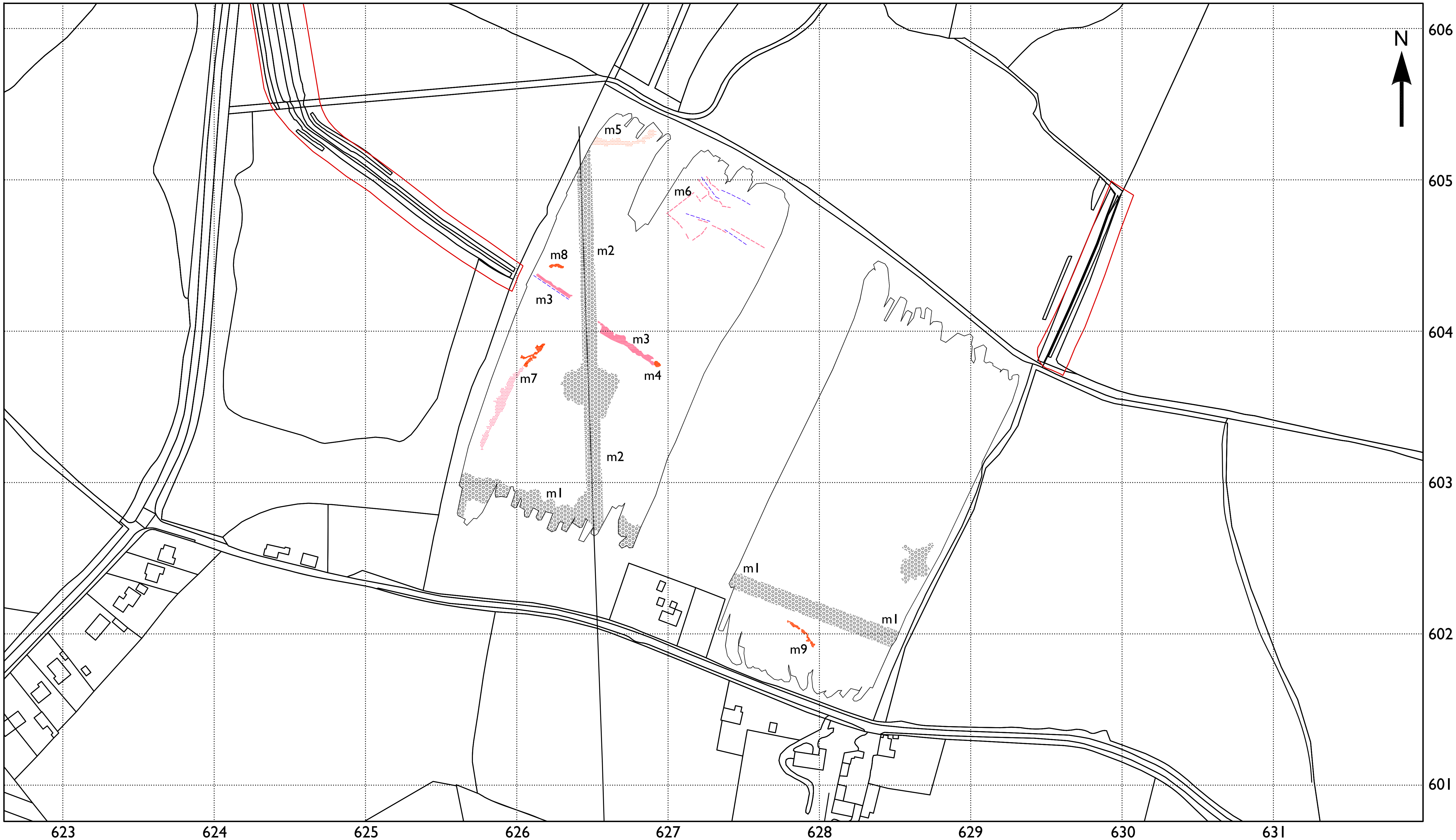
Figure 11

SILCHESTER ENVIRONS PROJECT, BRIDLE'S COPSE, PAMBER, HAMPSHIRE

Graphical summary of significant magnetic anomalies, May 2016

SU6260



0 90m
1:2500

positive magnetic
negative magnetic
raised magnetic
magnetic noise

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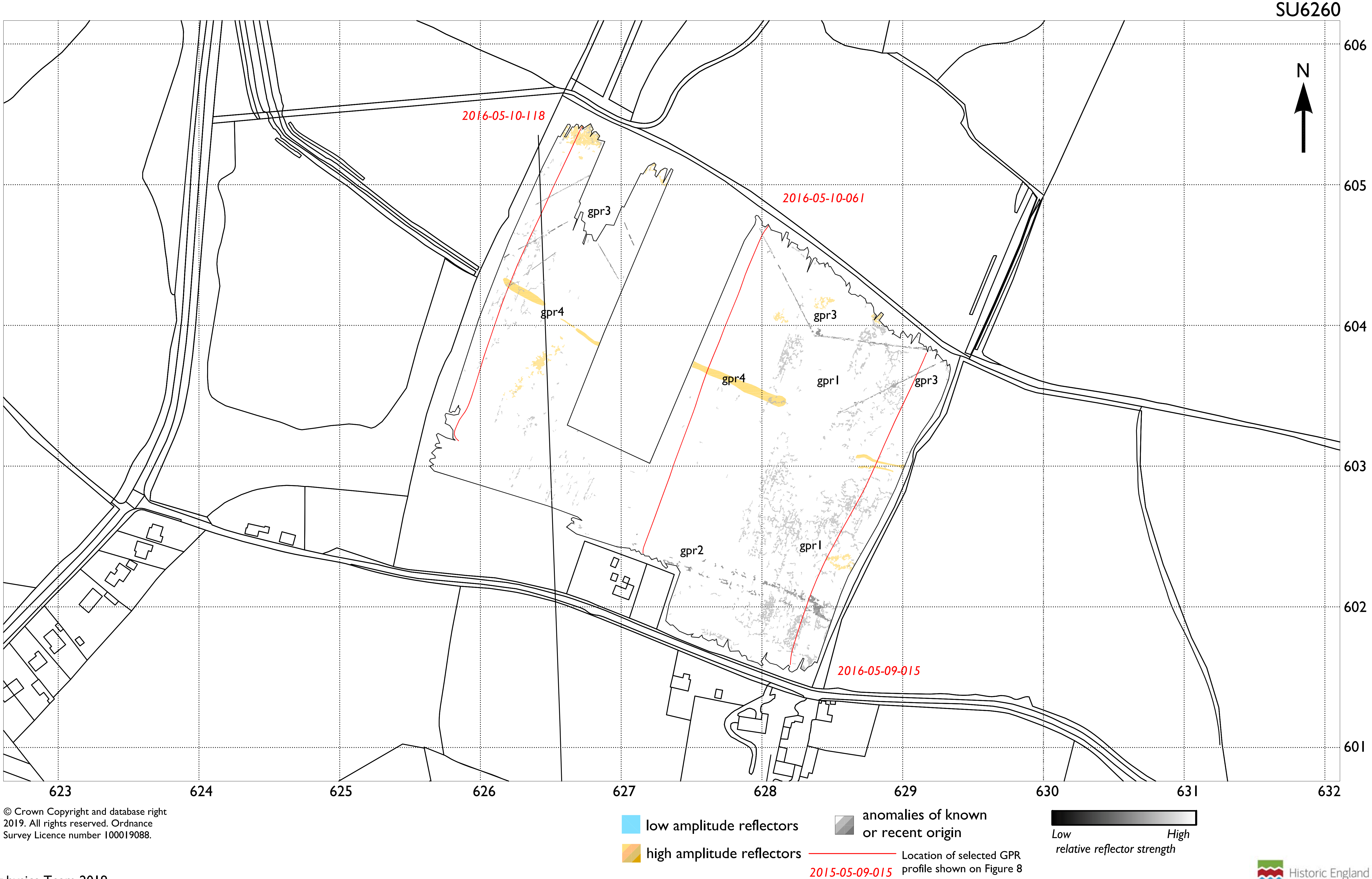
SILCHESTER ENVIRONS PROJECT, BRIDLE'S COPSE, PAMBER, HAMPSHIRE

Graphical summary of significant GPR anomalies, May 2016



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