Historic England

Geophysics

Manor Farm, East Kennett, Wiltshire
Report on Geophysical Surveys, August 2020

Neil Linford, Paul Linford and Andrew Payne

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MANOR FARM, EAST KENNETT, WILTSHIRE
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SUMMARY

Caesium magnetometer and Ground Penetrating Radar (GPR) surveys were conducted at Manor Farm, East Kennett, Wiltshire, to investigate a recently collapsed void in an agricultural field exposing a probable megalithic square chamber formed from sarsen boulders. Results from the vehicle-towed caesium magnetometer survey (2.3 ha) were partly obscured by ferrous interference from farm buildings and two pipes, but revealed a series of ditch-type anomalies suggestive of a field or enclosure system extending from beyond the current survey area to the west. This occupation activity appears to be concentrated to the north of the field in the vicinity of the exposed sarsens. The GPR coverage (1.2 ha) provided some additional detail regarding the extent and depth of the sarsen structure and identified a number of similar, discrete anomalies in the survey area. A group of rectilinear anomalies, possibly representing buildings or structures with shallow surviving foundations, have also been revealed to the west of the exposed sarsens and, together with the field system, are suggestive of a small Roman agricultural settlement.

CONTRIBUTORS

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

ACKNOWLEDGEMENTS

The authors are grateful to the landowner for allowing access to conduct the survey and to Archaeological Surveys Ltd for allowing comparison with magnetic survey data from the adjacent field.

ARCHIVE LOCATION

Fort Cumberland, Portsmouth.

DATE OF SURVEY

The fieldwork was conducted on the 18th August 2020, with the report completed on 2nd October 2020. The cover image shows a view of the find spot looking towards the East Kennett long barrow with the magnetometer survey in progress in the background.

CONTACT DETAILS

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CONTENTS

INTRODUCTION

Caesium magnetometer and Ground Penetrating Radar (GPR) surveys were conducted in the vicinity of a recently exposed void lined by sarsen boulders at Manor Farm, East Kennett, Wiltshire, in response to a request received from the South West Team to map and assess the find before the field was ploughed again following the harvest. The proposed survey was designed to improve understanding of the surviving archaeological resource and was agreed as a Planning Group casework request addressing Historic England Action Plan objective 2.2.3. "Assess the significance of our heritage to protect it better".

The site is located to the south of the village of East Kennett, just within the south east boundary of the Avebury World Heritage Site, approximately 200 m north east of the East Kennet Long Barrow (NHLE 1012323). To the south possible remains of a Later Prehistoric or Roman field system are visible as low spread banks on images derived from airborne laser scanning (lidar) flown in 2006. A more extensive geophysical survey has been conducted in the adjacent field to the east, although ditch-like anomalies extending into the current survey area were thought to be of periglacial origin (Donaldson and Sabin 2014).

The exposed sarsens, thought most likely to represent a largely intact but infilled megalithic square chamber, first came to light early in July 2020 when the landowner noticed a small, approximately 0.8 m circular hole in the lower part of the field. A 1 m deep cavity was observed lined by four large sarsen blocks with two additional boulders on top. During a site visit on 22nd July 2020 by Wiltshire Council Archaeology Service approximately 100 litres of spoil was removed from the cavity in an attempt to find a fallen cap stone. No additional stone was found but one piece of worked flint, possibly the snapped end of a blade (Early Bronze Age?) and one piece of Roman pottery-greyware rim were recovered. There did appear to be voids behind the boulders on all sides, suggesting there may be further cavities or chambers.

In this locality, shallow well drained calcareous silty soils of the ANDOVER 1 association (343h) have developed over Cretaceous New Pit Chalk formed approximately 90 to 94 million years ago. Superficial deposits of gravel, sand, silt and clay Head may also be present (Institute of Geological Sciences 1974; Soil Survey of England and Wales 1983). The field was fallow at the time of the survey with the remains of stubble extant following recent harvest. Weather conditions were warm and dry with some light rain immediately before the survey commenced.

METHOD

Magnetometer survey

Magnetometer data were collected along the instrument swaths shown on Figure 1 using an array of six Geometrics G862 caesium vapour sensors mounted on a non-magnetic sledge (Linford *et al.* 2018). 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, ~0.36m 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 were 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 R8s Global Navigation Satellite System (GNSS) receiver mounted on the sensor platform 1.65m in front of the central sensor and a second R8s 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 (see Linford *et al.* 2018). The median value of each instrument traverse was then adjusted to zero by subtracting a running median value calculated over a 72m 1D window (see for instance Mauring *et al.* 2002). This operation corrects for any remaining biases added to the measurements owing to the diurnal variation of the Earth's magnetic field. A linear greyscale image of the combined magnetic data is shown superimposed over the base Ordnance Survey (OS) mapping in Figure 2 and minimally processed versions of the range truncated data ($\pm$100nT/m) are shown as a trace plot and a linear greyscale image following the processing discussed above in Figure 5. Field data in the vicinity of the exposed sarsens (Figure 6) was used to suggest a magnetic model to describe the underlying void (Figure 15) using the polyhedron face modelling method of Bott (1963). A volume magnetic susceptibility of 75 x 10^{-6} less than the surrounding soil was assumed in all cases for modelling the voids.

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; Eide *et al.* 2018). A roving Trimble R8s Global Navigation Satellite System (GNSS) receiver, together with a second R8s 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 2. Data were acquired at a 0.075m x 0.075m sample interval across a continuous wave stepped frequency range from 40MHz to 2.99GHz in 6MHz increments using a dwell time of 3ms. 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 75ns), 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 synthetic profiles from the full GPR survey data set are shown on Figure 7. To aid visualisation amplitude time slices were created from the entire data set by averaging data within successive 1.6ns (two-way travel time) windows (e.g. Linford 2004). An average sub-surface velocity of 0.103m/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 therefore represents the variation of reflection strength through successive ~0.08m intervals from the ground surface, shown as individual greyscale images in Figures 4, 8, 9, 10 and 11. In addition, the high amplitude response in the vicinity of the find spot has been rendered as an isovolume to visualise the buried sarsens and an associated linear anomaly (Figure 7 (B) and (C)). 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 13. The algorithm uses edge detection to identify bounded 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 (Linford and Linford 2017).

RESULTS

Magnetometer survey

A graphical summary of significant magnetic anomalies [**m1-24**] discussed in the following text superimposed on base OS map data is provided in Figure 12.

The survey has been affected by intense magnetic disturbance from two intersecting ferrous pipes [**m1**] and [**m2**], a series of telegraph poles [**m3**] and [**m4**], and farm buildings [**m5**] along the east edge of the field. It would appear that the pipe [**m1**] continues to the west beyond the current survey (Figure 14). Fortunately [**m5**] does not obscure smaller variations in the immediate vicinity of the exposed sarsens where a negative response [**m6**] has been detected due to a combination of the air-filled void and the buried, low magnetic susceptibility, sarsens contrasting with the more magnetic soil (Figure 15).

The northern part of the field surrounding **[m6]** contains a series of weak linear [**m7-12**] and curvilinear [**m13**] anomalies suggestive of a field system or group of enclosures. However, their form is not sufficiently characteristic to suggest a date and it is unclear whether this system is associated with the exposed sarsens or the juxtaposition merely coincidental. It is, however, likely that [**m7-13**] represent a continuation of the ditch system detected in the adjacent field to the west (Figure 14; Donaldson and Sabin 2014) with some of the more prominent anomalies [**m7**] apparently changing orientation quite markedly. Three more isolated ditch-type anomalies [**m14-16**] may represent outlying elements of this system although their form and alignment differ somewhat.

A higher density of pit-type anomalies [**m17**] is found in the northern part of the field within the area enclosed by [**m7-13**] although this activity reduces towards the south and, beyond a distance of 60m, only isolated pits such as [**m18**] are present. Smaller pit-like anomalies [**m19**] also occur close to the exposed sarsens and, while their interpretation is tentative as it is based on just three of four measurements in each case, their proximity to **[m6]** may be significant. A group of discrete negative responses [**m20**] are apparent to the south and west of the exposed sarsens (see Figure 15) and magnetic modelling suggests these would be consistent with covered voids or non-magnetic stones similar to **[m6]**. However, they form no obvious pattern and there are no concomitant anomalies in the GPR survey so their archaeological significance remains questionable.

A group of stronger and slightly larger negative anomalies, [**m21**], 20m to the west of [**m6**] appears to be arranged on the alignment of ditch anomaly [**m7**]. The linear arrangement and close grouping may be significant (cf [**gpr12**]), although these anomalies could also, perhaps, indicate buried stones moved to boundaries as part of field clearance associated with [**m7-13**]. Further west a weakly defined oval pattern of negative anomalies [**m22**] also correlates with an anomaly in the GPR survey, [**gpr4**], and as noted below, may relate to a former building.

Broad sinuous and amorphous anomalies [**m23**] to the southeast of the survey area likely relate to geomorphological soil variation associated with valley bottom deposits, similar to responses mapped in the vicinity of the Swallowhead

Spring in the environs of Silbury Hill (Linford *et al.* 2009). Variations in the colour and tone of the vegetation in the field at the time of the survey were observed to largely correlate with [**m23**]. A possible continuation of this geomorphological response has been detected further north at [**m24**], immediately west of disturbance from the farm buildings [**m5**].

Ground Penetrating Radar survey

A graphical summary of the significant GPR anomalies, [**gpr1-18**] discussed in the following text, superimposed on the base OS map data, is provided in Figure 13.

The very near-surface data between 0.0 and 3.2ns (0.0 to 0.17m) contains anomalies due to the north-south orientated stubble and vehicle tracks crossing the field following harvest. The agricultural pattern from the uneven surface stubble reverberates through the deeper time slices and partially obscures the identification of more significant anomalies. A high amplitude anomaly [**gpr1**] is evident over the location of the exposed sarsens, presumably in part due to an air wave reflection from the sides and floor of the void. To the south of the survey area the ferrous service has been replicated as a high amplitude anomaly [**gpr2**] between 8.1 and 16.2ns (0.42 to 0.83m), although the radar response attenuates with depth as [**gpr2**] appears to fall to the north and to the east along the spur to the farm buildings [**gpr3**]. This variation in response may also be due to the local topography and greater soil depth over the lower lying areas of the field.

A high amplitude rectilinear anomaly [**gpr4**] appears between 4.9 and 16.2ns (0.25 to 0.83m) and seems likely to represent wall footings of a small 12 x 8 m building. There is some suggestion of internal detail within the walls and it would appear that the corners of the building, particularly to the southeast, extend to the greatest depth. Some areas of more diffuse high amplitude response [**gpr5**] and [**gpr6**] appear through a similar depth range and it is unclear whether these represent metalled surfaces associated with the buildings or, perhaps, the more recent introduction of hard core in the vicinity of the field gate [**gpr6**].

A second rectilinear building [**gpr8**] is found to the east between 9.7 and 16.2ns (0.5 to 0.83m), perhaps with the suggestion of further structural remains partially described within the survey area at [**gpr9**]. Elements of the field system found in the magnetic survey [**m7**] have also been replicated in the radar [**gpr10**] and appear to pass through [**gpr7**] suggesting a different phase of activity. Two approximately rectilinear high amplitude anomalies, [**gpr11**] and [**gpr12**], are possibly associated with the buildings, although [**gpr12**] correlates with a negative magnetic [**m21**] response that may indicate a further void.

The response over the exposed sarsens [**gpr1**] is dominated by the airwave reflected through the hole from the interior of the void, although with depth additional structure becomes apparent (Figure 7(B)). The high amplitude anomaly, presumably a reflection from the outer face of the sarsens forming the chamber, suggests an approximately 2 x 1.5m rectilinear anomaly orientated NE to SW between approximately 8.1 and 24.3 (0.42 to 1.25m). There is also a subtle linear anomaly [**gpr13**] between 8.1 and 16.2 (0.42 to 1.25m) and it is unclear whether this is associated with the sarsen chamber or not (Figure 7(C)). It is possible that [**gpr13**] represents a fragment of the wider field systems found across the north of the survey area, although there is no correlation here with a ditch-type anomaly in the magnetic data. Other fragments of the field system [**gpr14**] are evident in the radar data to the south of the survey area.

A number of discrete high amplitude anomalies [**gpr15-17**], similar to [**gpr1**], are also found through the survey area, but it is not possible to determine conclusively whether these are due to similar subsurface voids. There appears to be no correlation between [**gpr15-17**] and any negative anomalies in the magnetic data, and the discrete anomalies at [**gpr17**] may well be associated with what appears to be a geomorphological anomaly [**gpr18**] to the south of the field at the foot of the slope up to the East Kennett long barrow. Analysis of profiles extracted through these anomalies suggests [**gpr15**] is most likely to represent the location of a buried void, with a low amplitude anomaly approximately 7.5ns (0.4m) below the ground surface and a subsequent high amplitude reflection with reversed polarity at 15ns. A tentative interpretation might be a sarsen capstone over an air-filled void with the deeper anomaly representing a reflection from floor at approximately 1.4m from the ground surface.

CONCLUSIONS

While both techniques have responded to the location of the exposed sarsens neither has provided evidence for the presence of an encircling barrow or ring-ditch. Given that other ditch-type anomalies have been detected in the vicinity, particularly in the magnetic survey, the absence is most likely genuine and suggests this may represent a relatively small-scale megalithic square chamber or, perhaps, even stone clearance for setting out fields for cultivation. A negative magnetic anomaly was mapped over the exposed sarsens together with a high amplitude GPR response that support the suggestion of a megalithic square chamber approximately 2 x 1.5 m in dimension (Figure 7) enclosing a void measuring about 1 x 0.5 m (Figure 15).

Other negative magnetic anomalies, [**m20**], have been detected in the immediate vicinity and it is possible that these might represent similar, covered, voids or non-magnetic stones. However, a buried void that does not have a hole opening to the surface creates a much weaker magnetic anomaly (-1.5 nT as opposed to -4.0 nT) with a peak magnitude within the range caused by natural background variation. Furthermore, in all but one case there are no corresponding GPR responses so the interpretation of anomalies [**m20**] as voids must be treated as speculative. However, a group of higher magnitude negative magnetic responses [**m21**] about 20m west does correlate with a discrete high amplitude GPR response and [**gpr12**] offering some evidence that further voids might exist.

In addition, the survey has confirmed the continuation of an extensive field or enclosure system to the north of the site that was partially revealed in a previous magnetic survey in the adjacent field to the west. There is also evidence from the GPR data for a group of shallow building remains [**gpr4**], [**gpr11**] and [**gpr12**] in the vicinity of the exposed sarsens, although this would appear to represent subsequent phases of possibly Iron Age or Roman settlement activity.

List of Enclosed Figures

Figure 14 Reverse linear greyscale image of the 2016 and 2020 magnetometer data superimposed over base OS mapping (1:2000).

Figure 15 (A) trace plot and (B) linear greyscale image of the magnetic data in the area of the exposed sarsens together with (C) a trace plot and (D) linear greyscale image of modelled magnetic anomalies. A linear greyscale image of the field magnetic data from (B) with the modelled anomalies (D) removed is shown in (E) (1:250). The geometry of the magnetic void used to model the exposed sarsens is shown in (F) and for the nearby possible covered voids in (G).

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Figure 1

MANOR FARM, EAST KENNETT, WILTSHIRE
Location of caesium magnetometer survey, August 2020

SU1267

0 60m
1:1000

Caesium magnetometer survey swaths

area displayed in Figure 6

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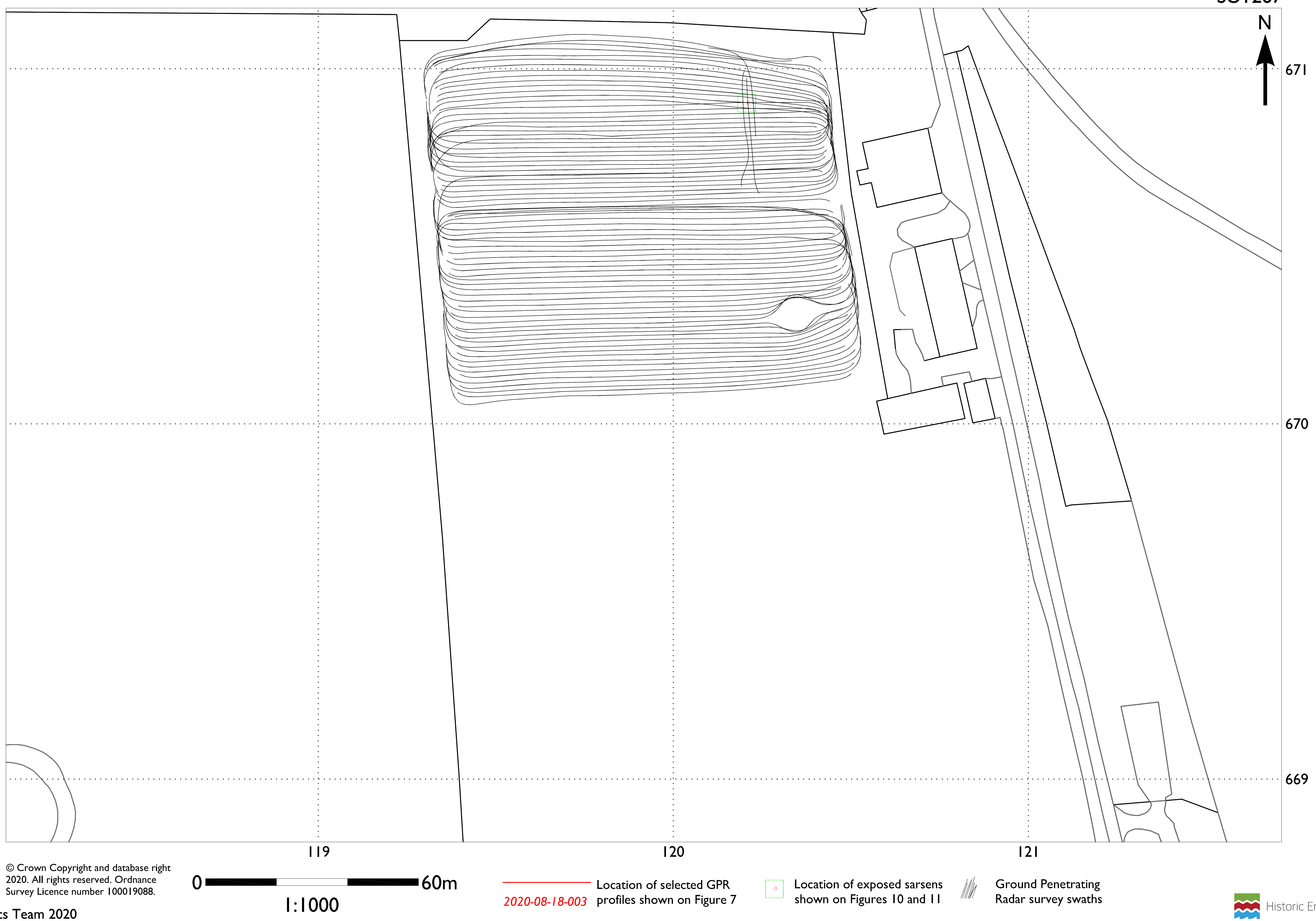
Figure 2

MANOR FARM, EAST KENNETT, WILTSHIRE
Location of GPR swaths, August 2020



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2020-08-18-003 Location of selected GPR profiles shown on Figure 7

Location of exposed sarsens shown on Figures 10 and 11

Ground Penetrating Radar survey swaths

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Figure 3

MANOR FARM, EAST KENNETT, WILTSHIRE
Location of caesium magnetometer survey, August 2020

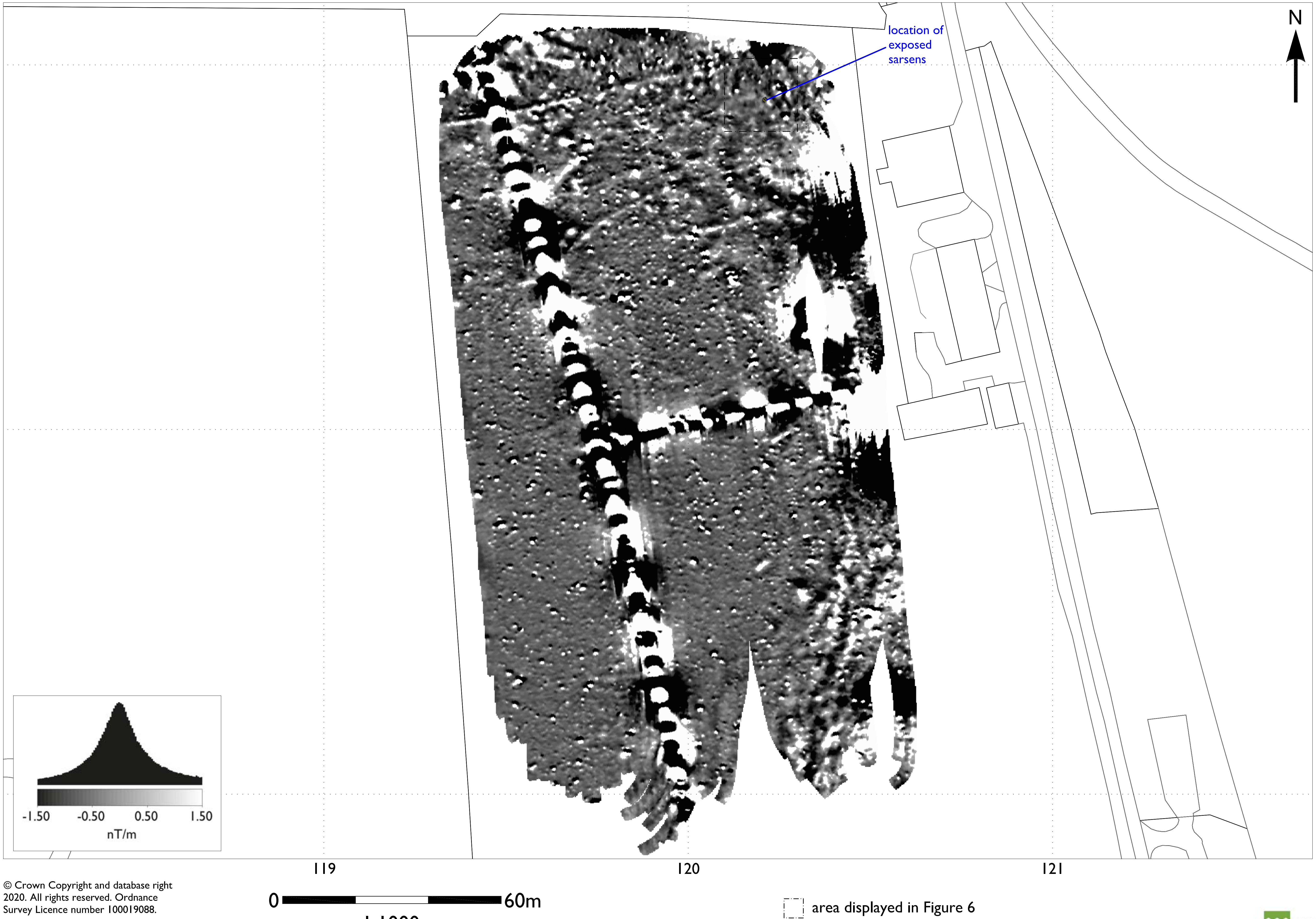

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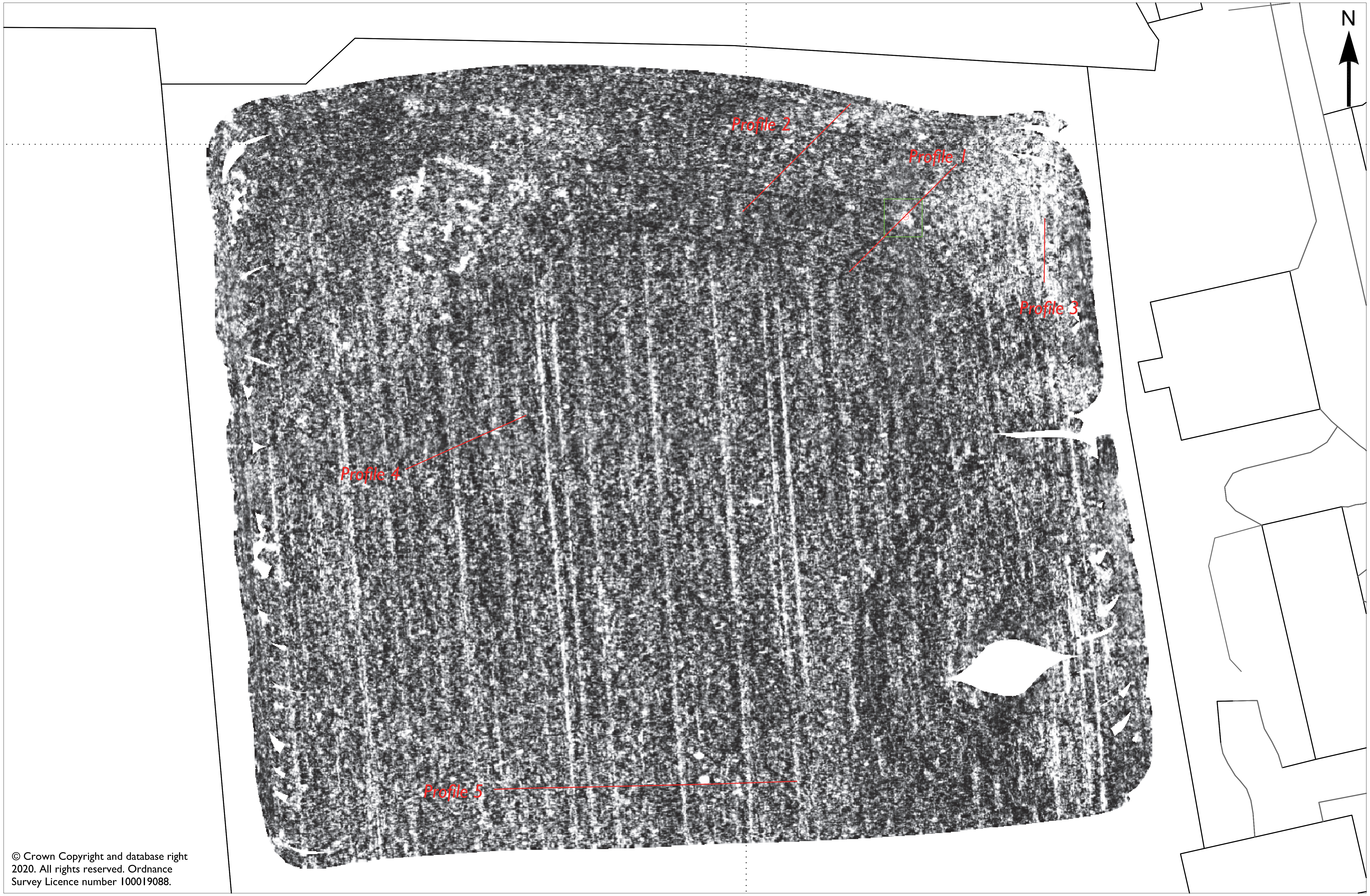
Figure 4

MANOR FARM, EAST KENNETT, WILTSHIRE
GPR amplitude time slice between 4.9 and 6.5ns (0.25 - 0.33m), August 2020



0 30m
1:500

Profile 1 — Location of selected GPR profiles shown on Figure 7

Location of exposed sarsens shown on Figures 10 and 11

Low High
relative reflector strength

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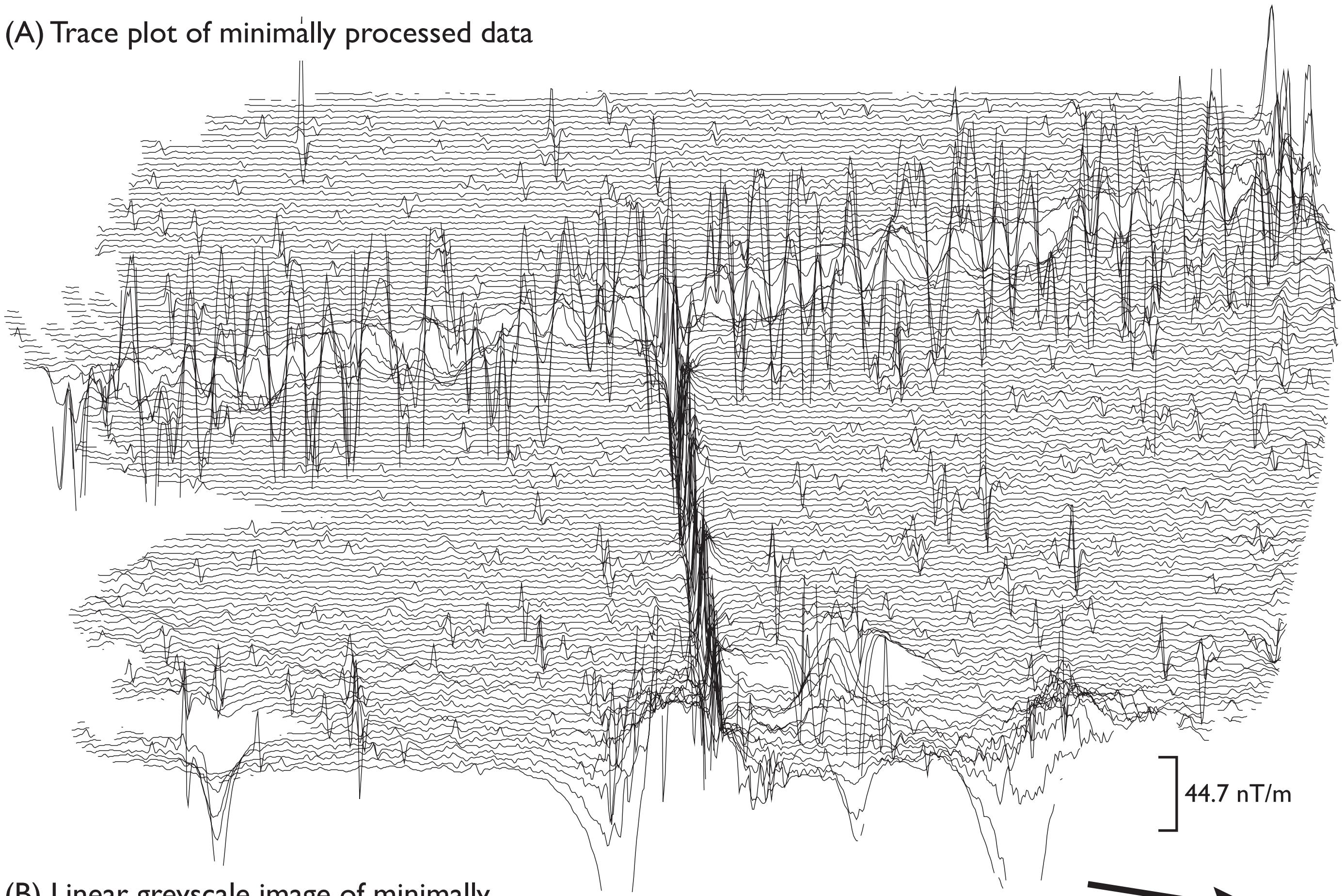
Figure 5

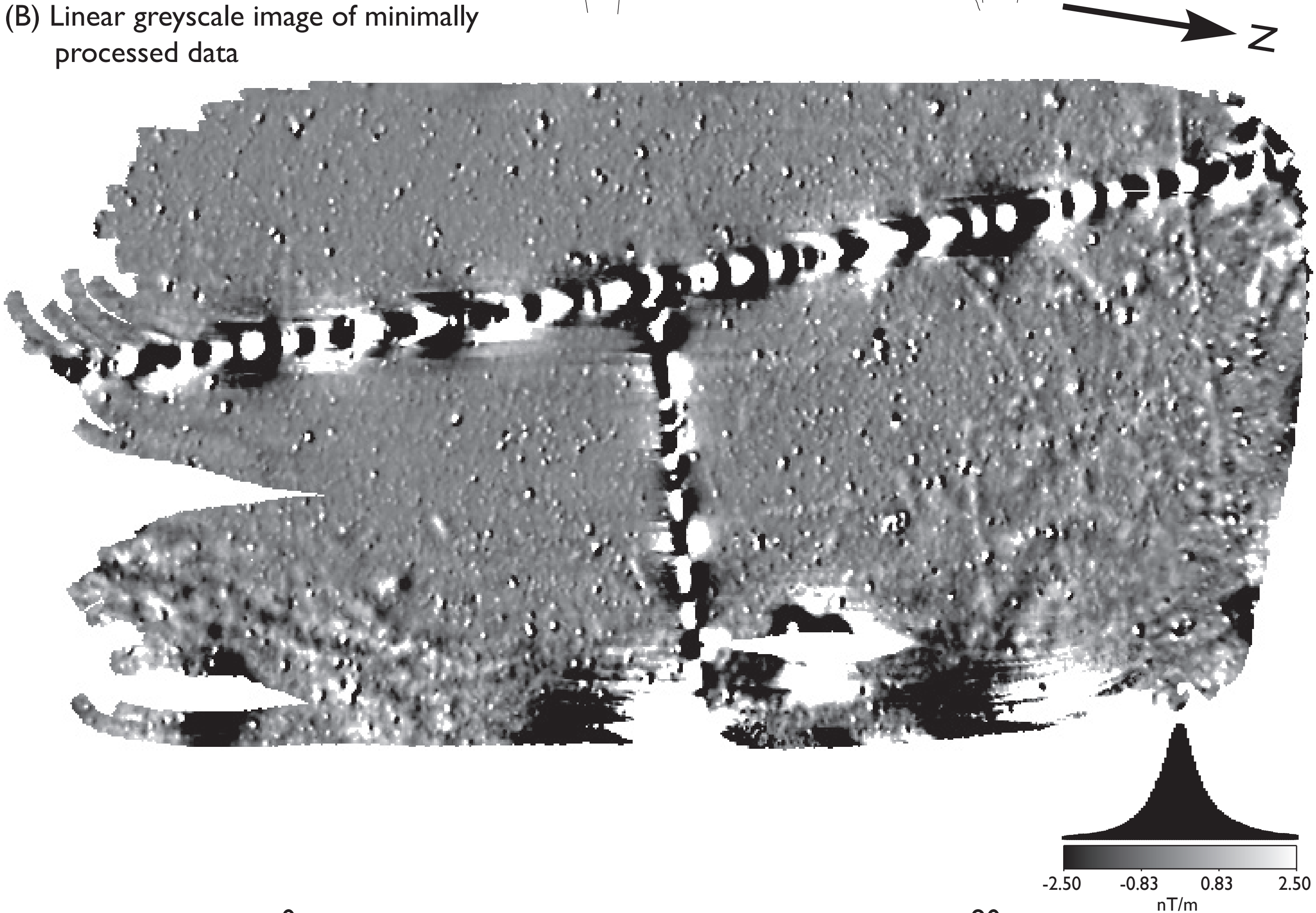
MANOR FARM, EAST KENNETT, WILTSHIRE

Caesium magnetometer survey, August 2020

(A) Trace plot of minimally processed data



(B) Linear greyscale image of minimally processed data



0 90m

1:1000

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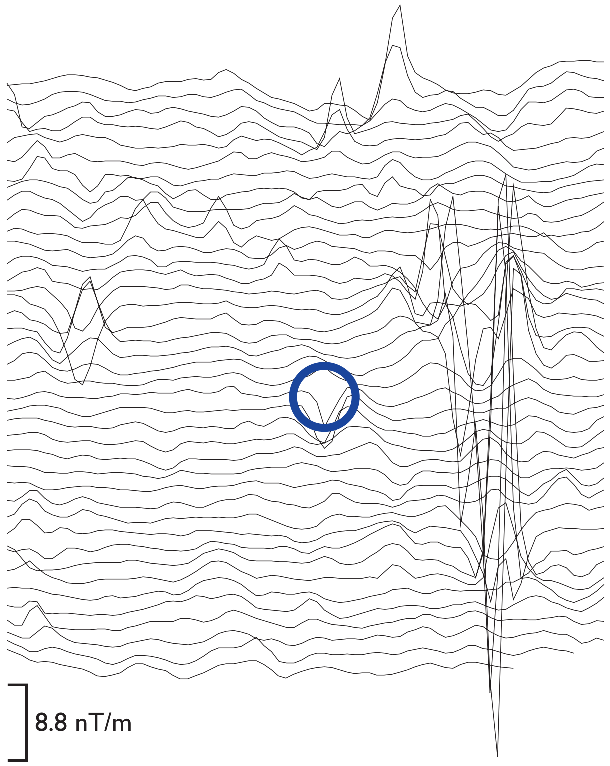
Figure 6

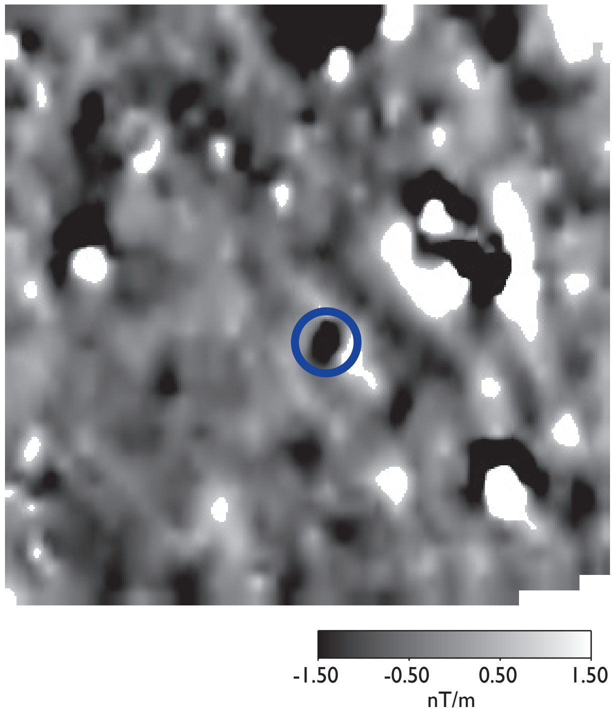
MANOR FARM, EAST KENNETT, WILTSHIRE

Detail of caesium magnetometer survey in area of exposed sarsens

(A) Trace plot of minimally processed data with data from 0.5m traverse interval displayed

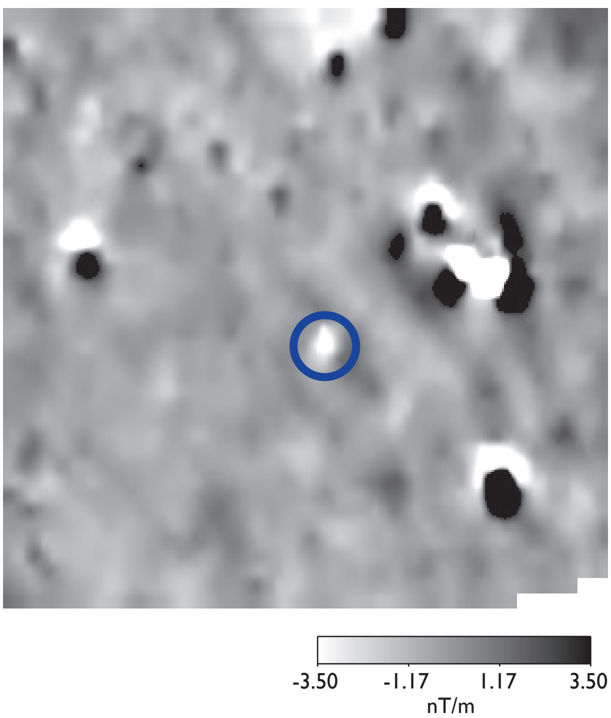


(B) Linear greyscale image of minimally processed data

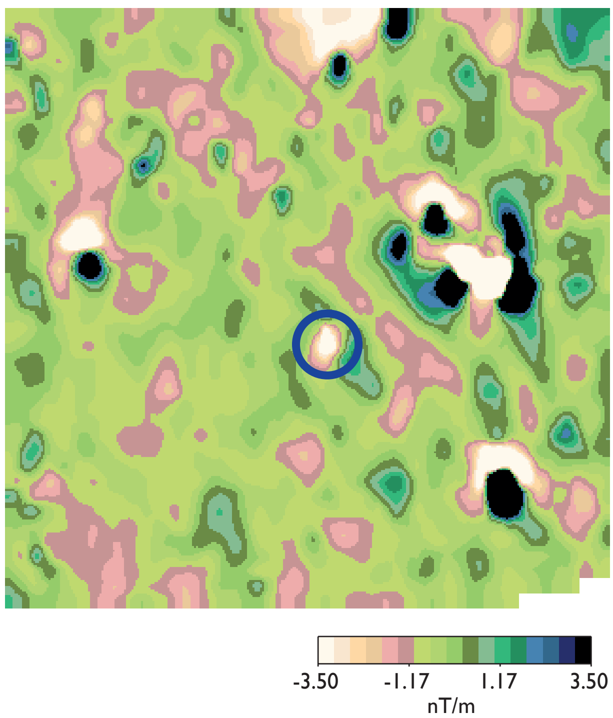


N

(C) Reverse linear greyscale image of minimally processed data (black tones are positive)



(D) False colour image of minimally processed data (darker colours are positive)



Location of exposed sarsens

0 15m

1:250

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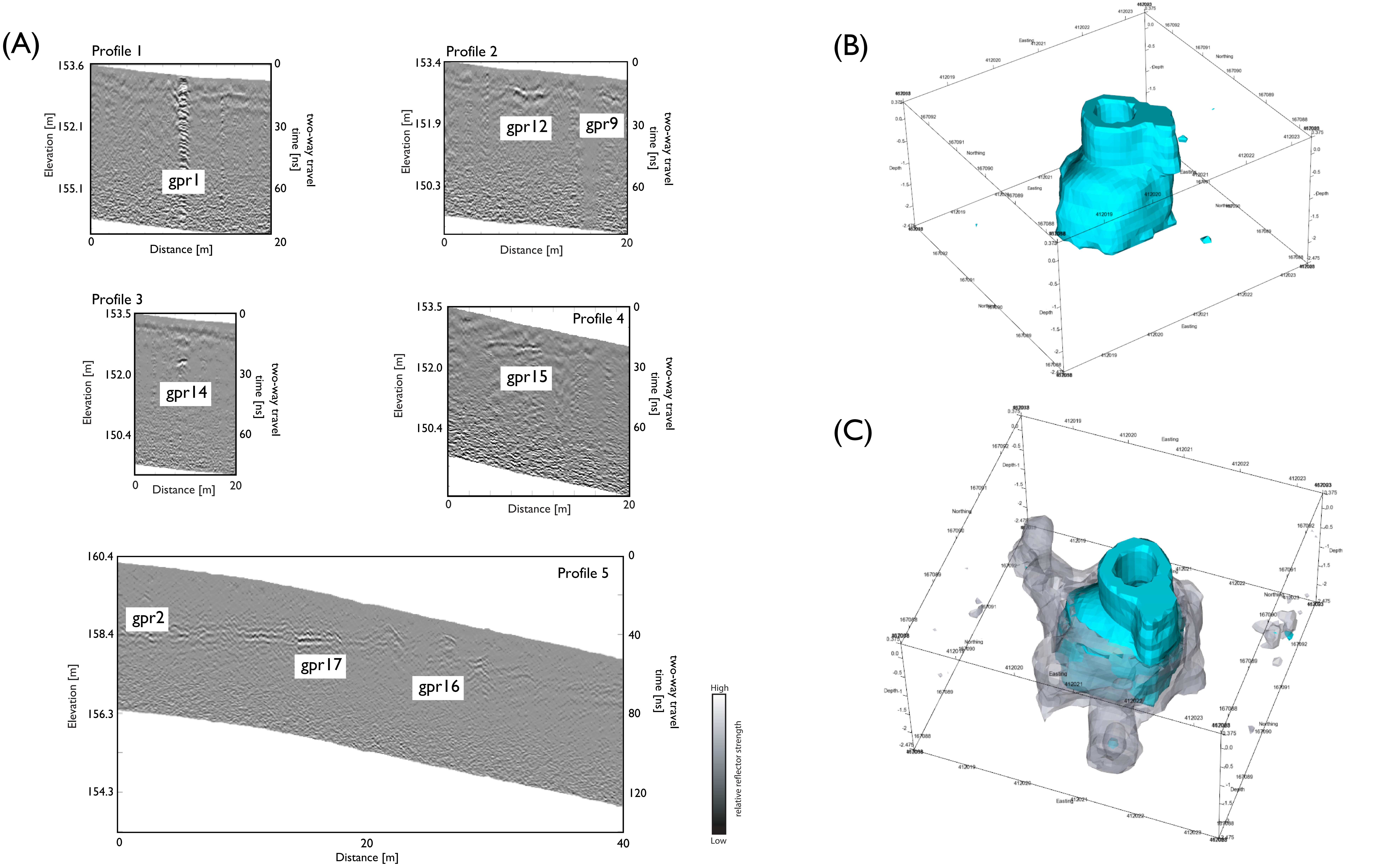
MANOR FARM, EAST KENNETT, WILTSHIRE

Topographically corrected GPR profiles and isovolume visualisations, August 2020

Figure 7



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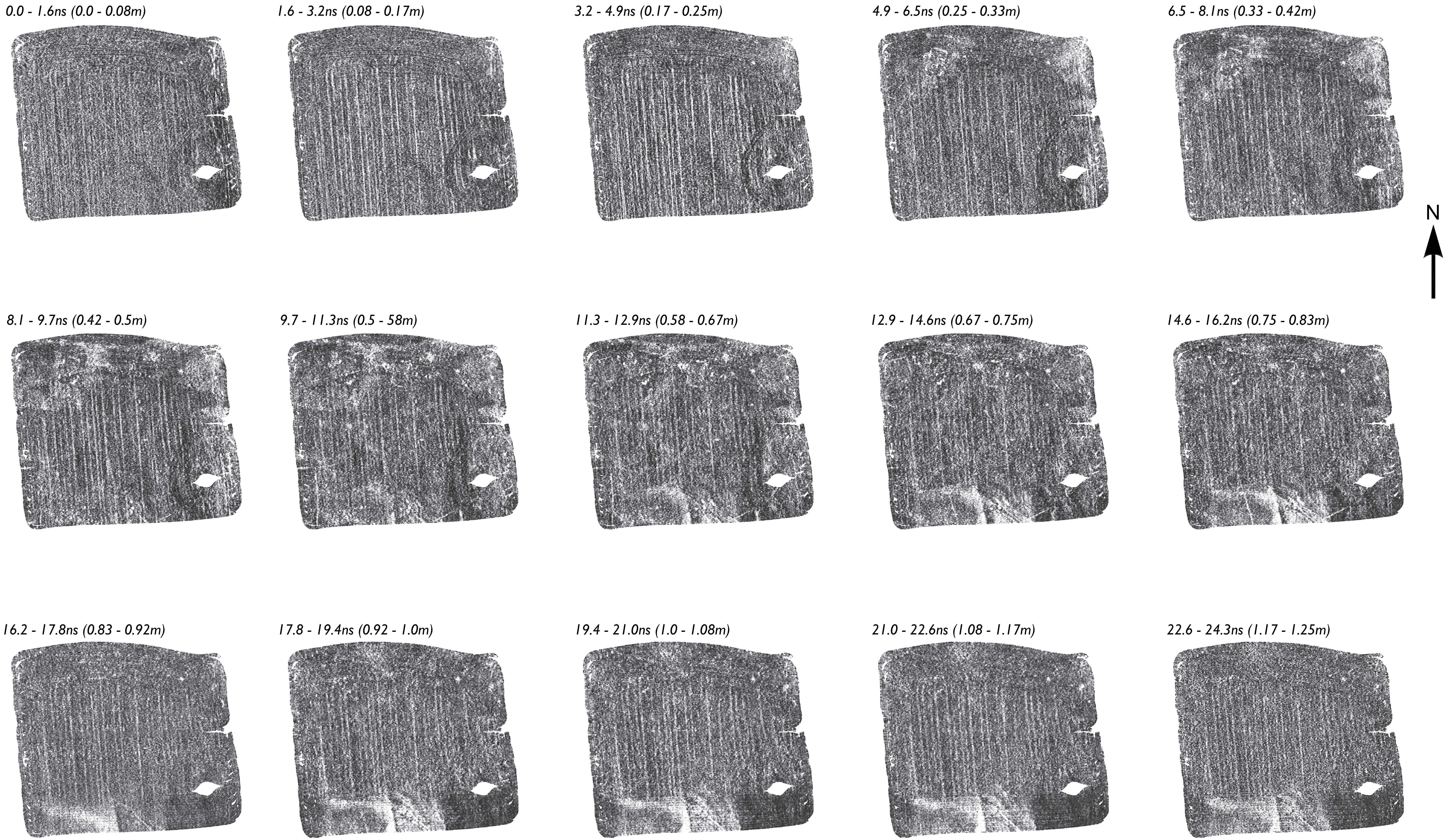
MANOR FARM, EAST KENNETT, WILTSHIRE
GPR amplitude time slices between 0.0 and 24.3ns (0.0 to 1.25m), August 2020

Figure 8



Low High
relative reflector strength

0 90m
1:2000

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MANOR FARM, EAST KENNETT, WILTSHIRE
GPR amplitude time slices between 24.3 and 48.5ns (1.25 to 2.5m), August 2020

Figure 9

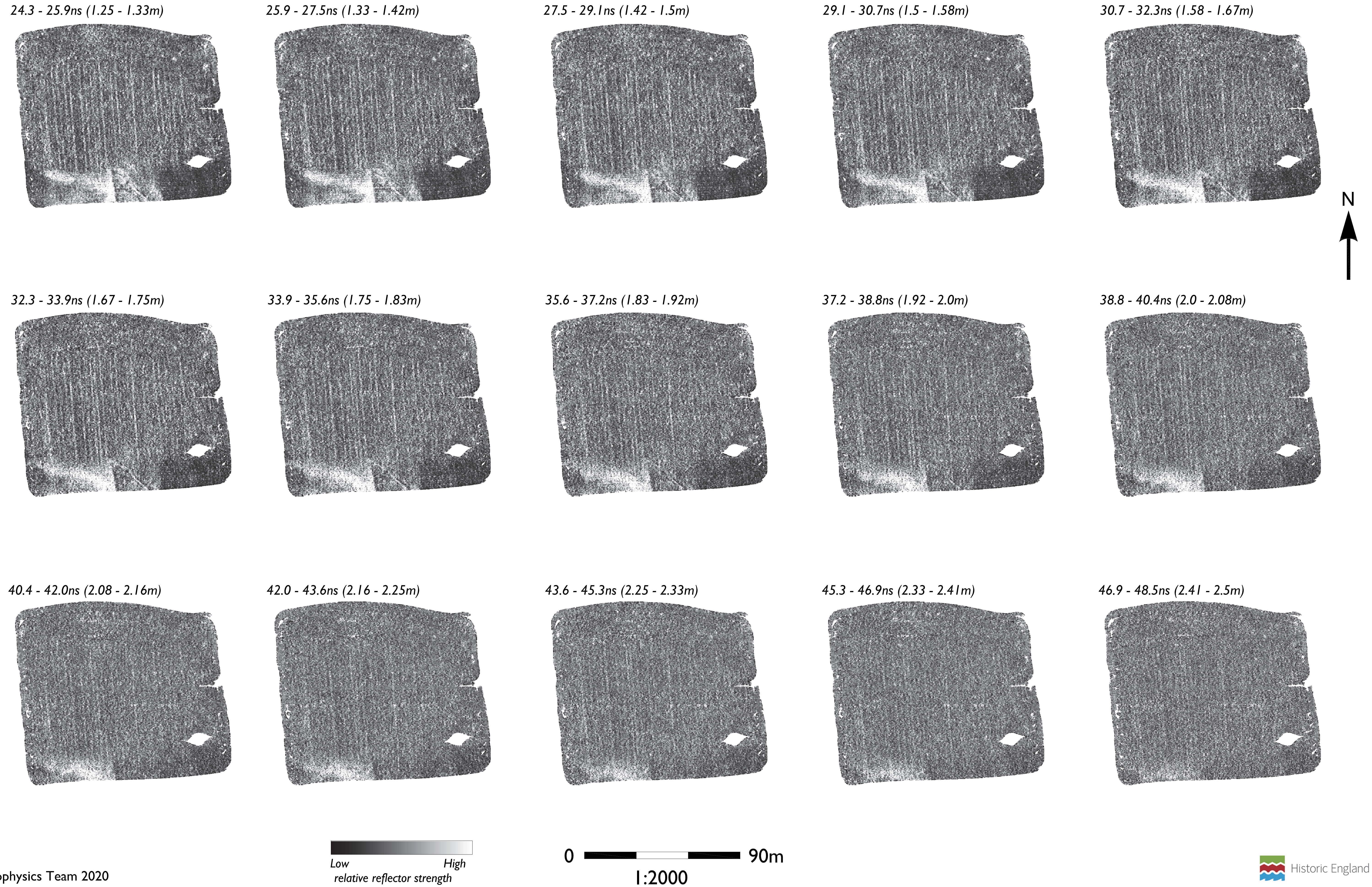

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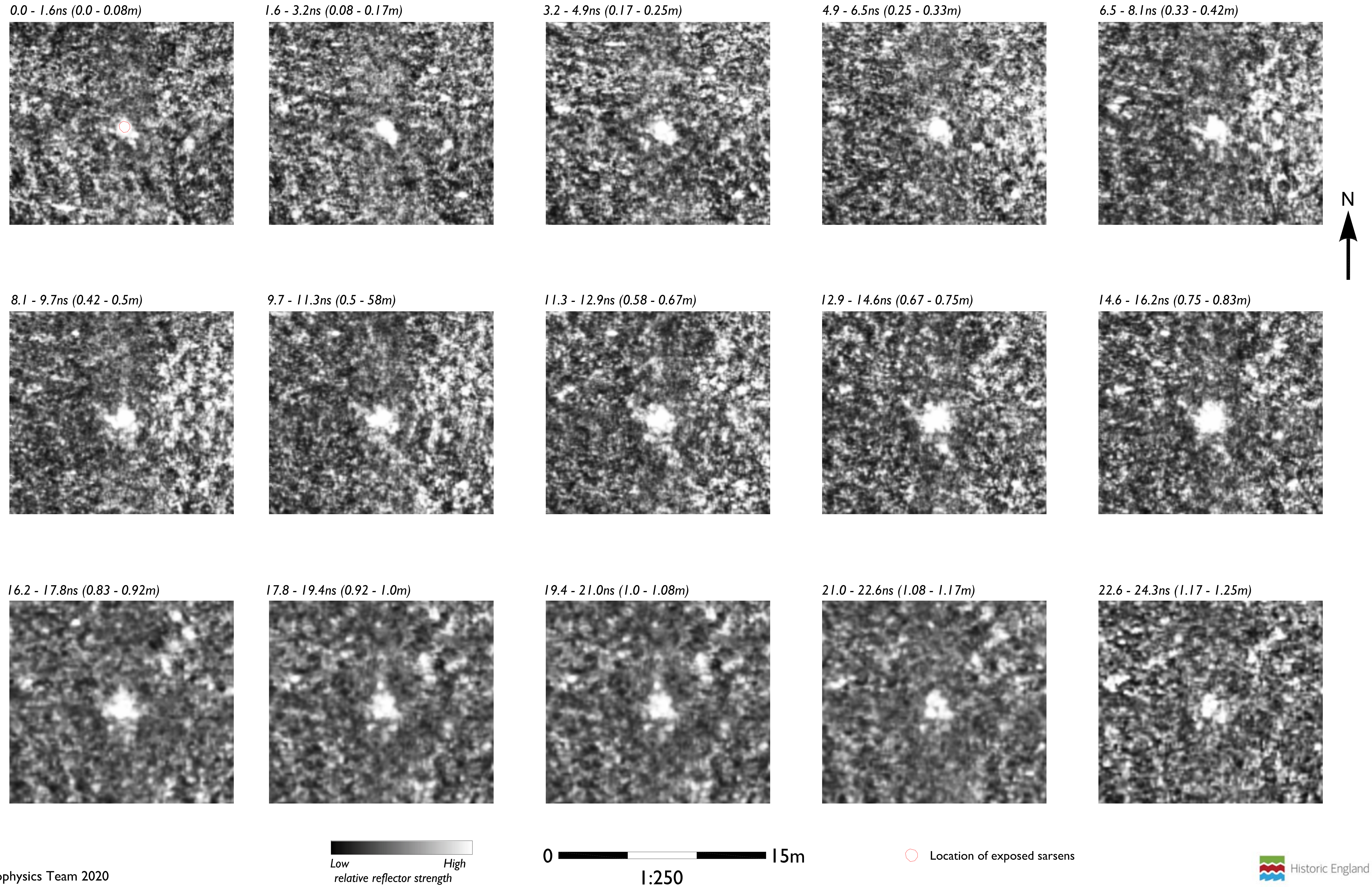
Figure 10

MANOR FARM, EAST KENNETT, WILTSHIRE
GPR amplitude time slices between 0.0 and 24.3ns (0.0 to 1.25m), detail surrounding exposed sarsens, August 2020



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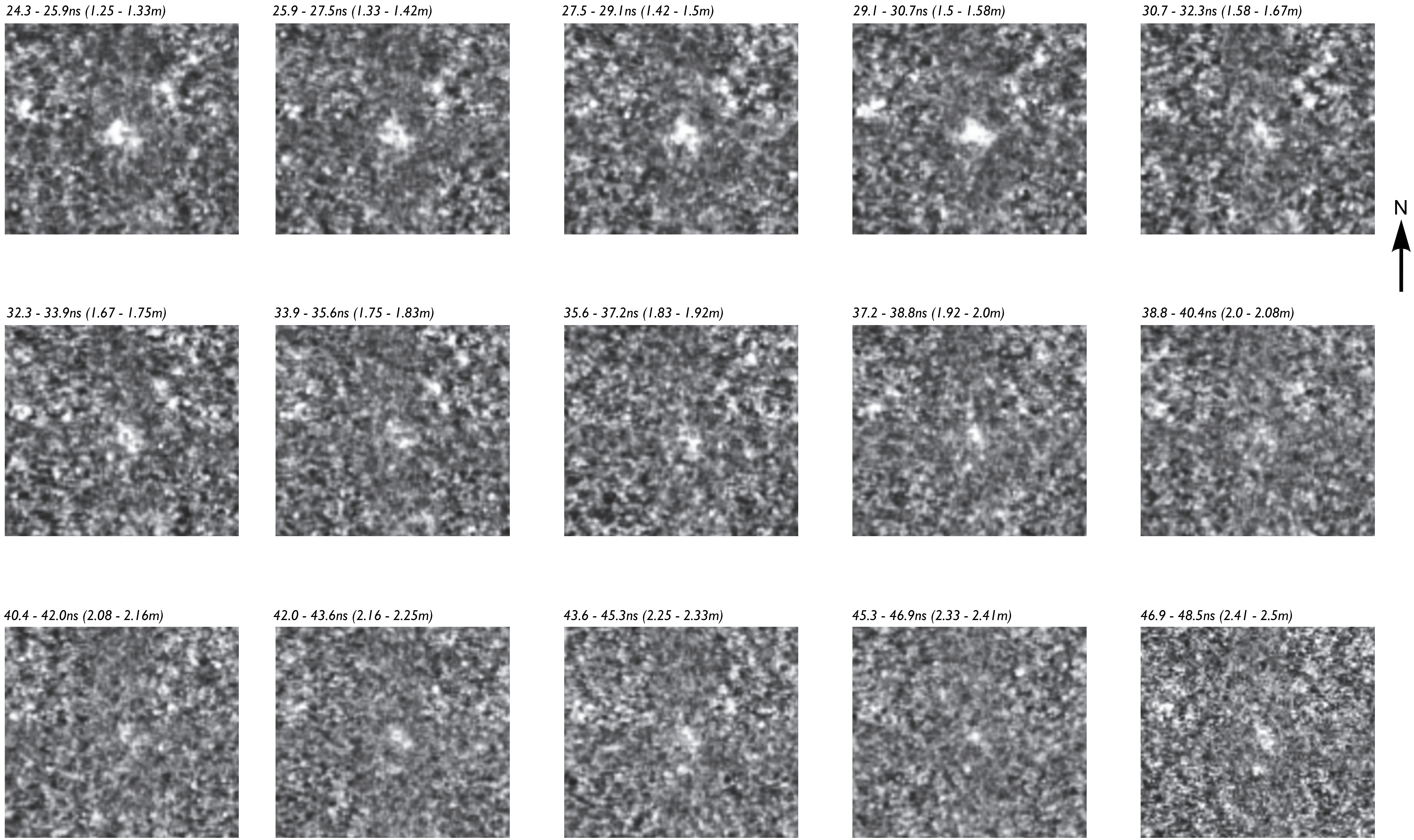
MANOR FARM, EAST KENNETT, WILTSHIRE

GPR amplitude time slices between 24.3 and 48.5ns (1.25 to 2.5m), detail surrounding exposed sarsens, August 2020



Low *High*
relative reflector strength

0 15m
1:250

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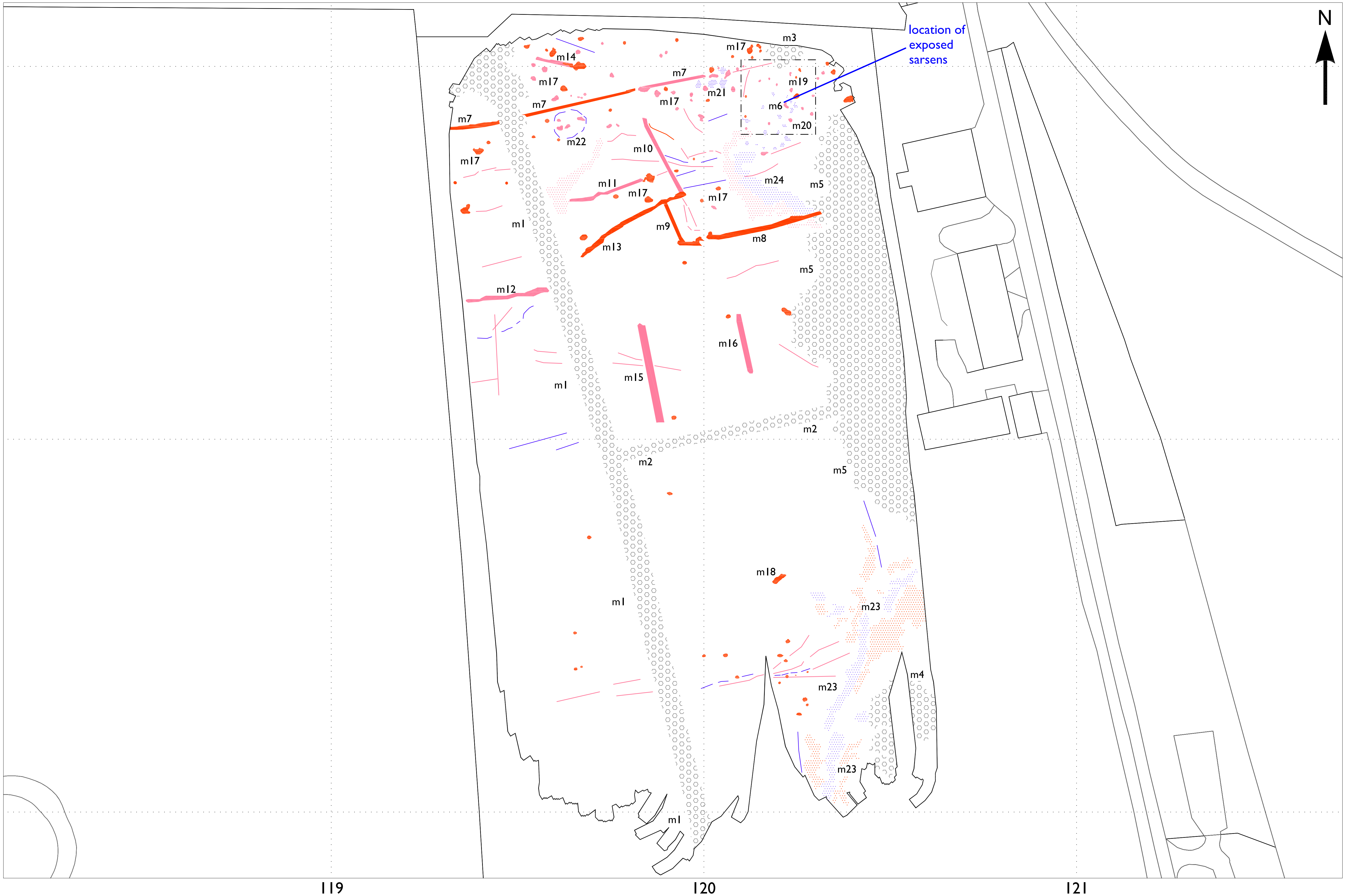
Figure 12

MANOR FARM, EAST KENNETT, WILTSHIRE

Graphical summary of significant magnetic anomalies, August 2020

SU1267



0 60m

1:1000

positive magnetic
negative magnetic
strong positive magnetic
raised magnetic
magnetic noise
area displayed in Figure 6

Geophysics Team 2020

Historic England

Figure 13

MANOR FARM, EAST KENNETT, WILTSHIRE
Graphical summary of significant GPR anomalies, August 2020

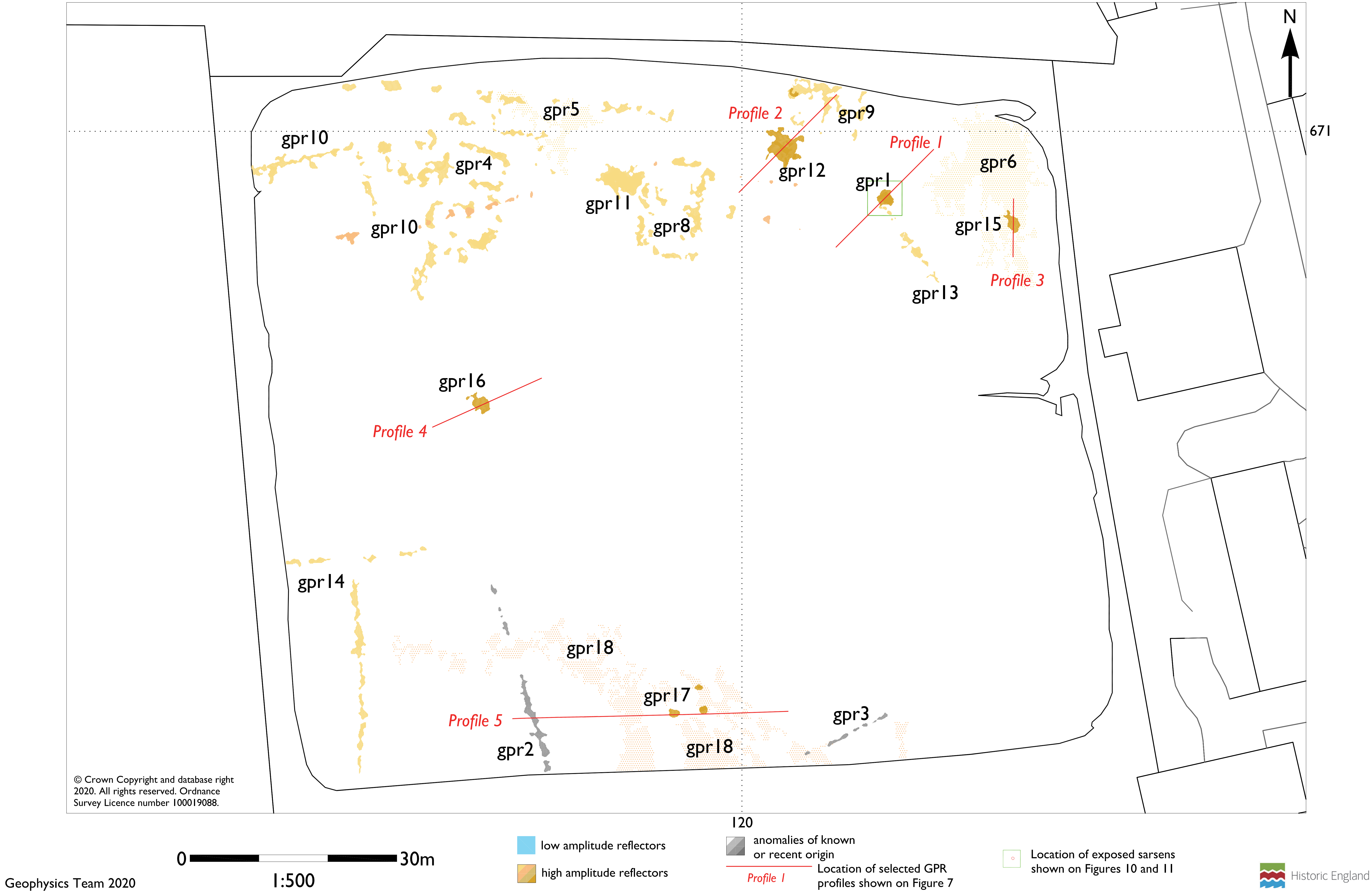


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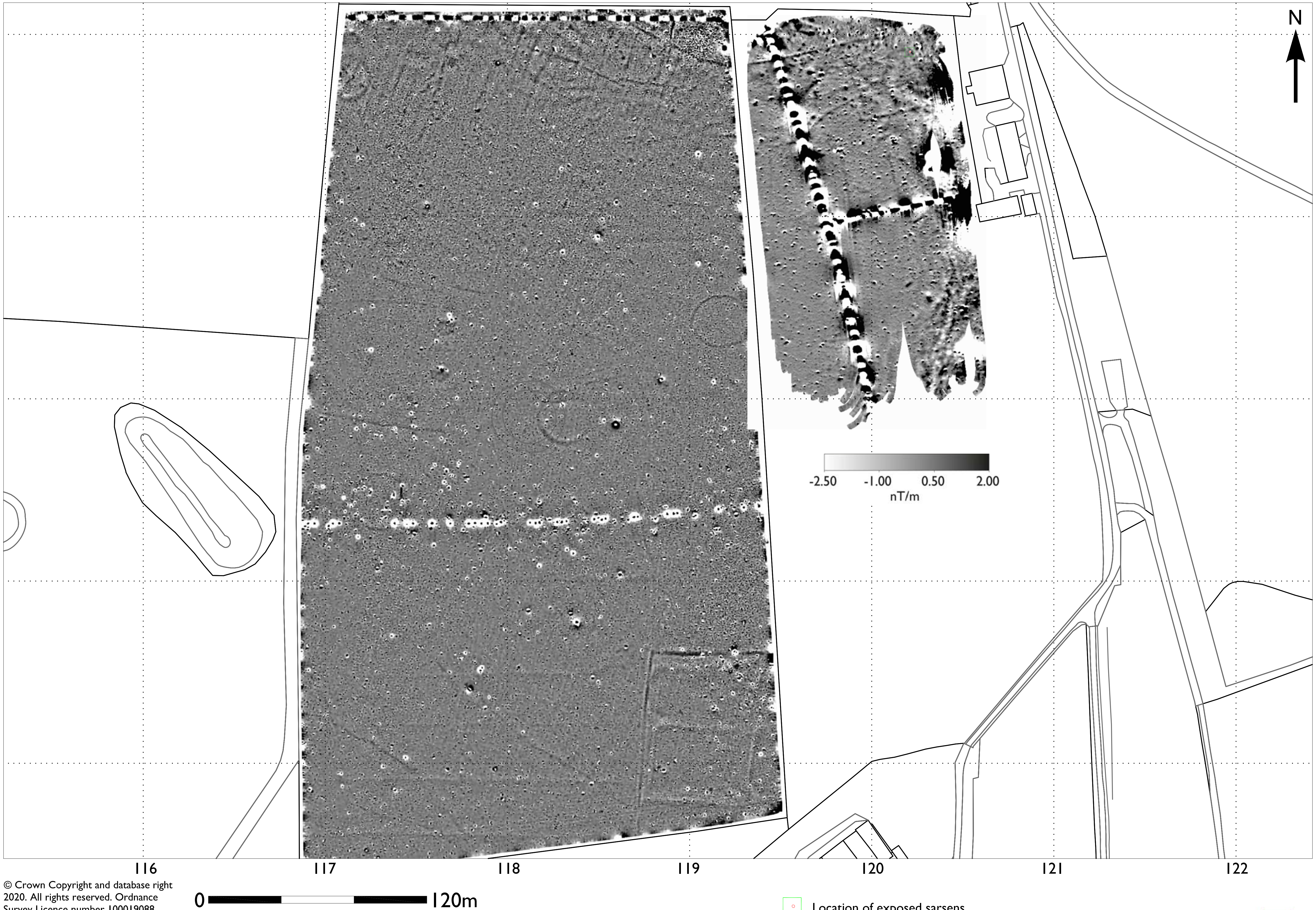
Figure 14

MANOR FARM, EAST KENNETT, WILTSHIRE
Location of magnetometer surveys, May 2014 and August 2020



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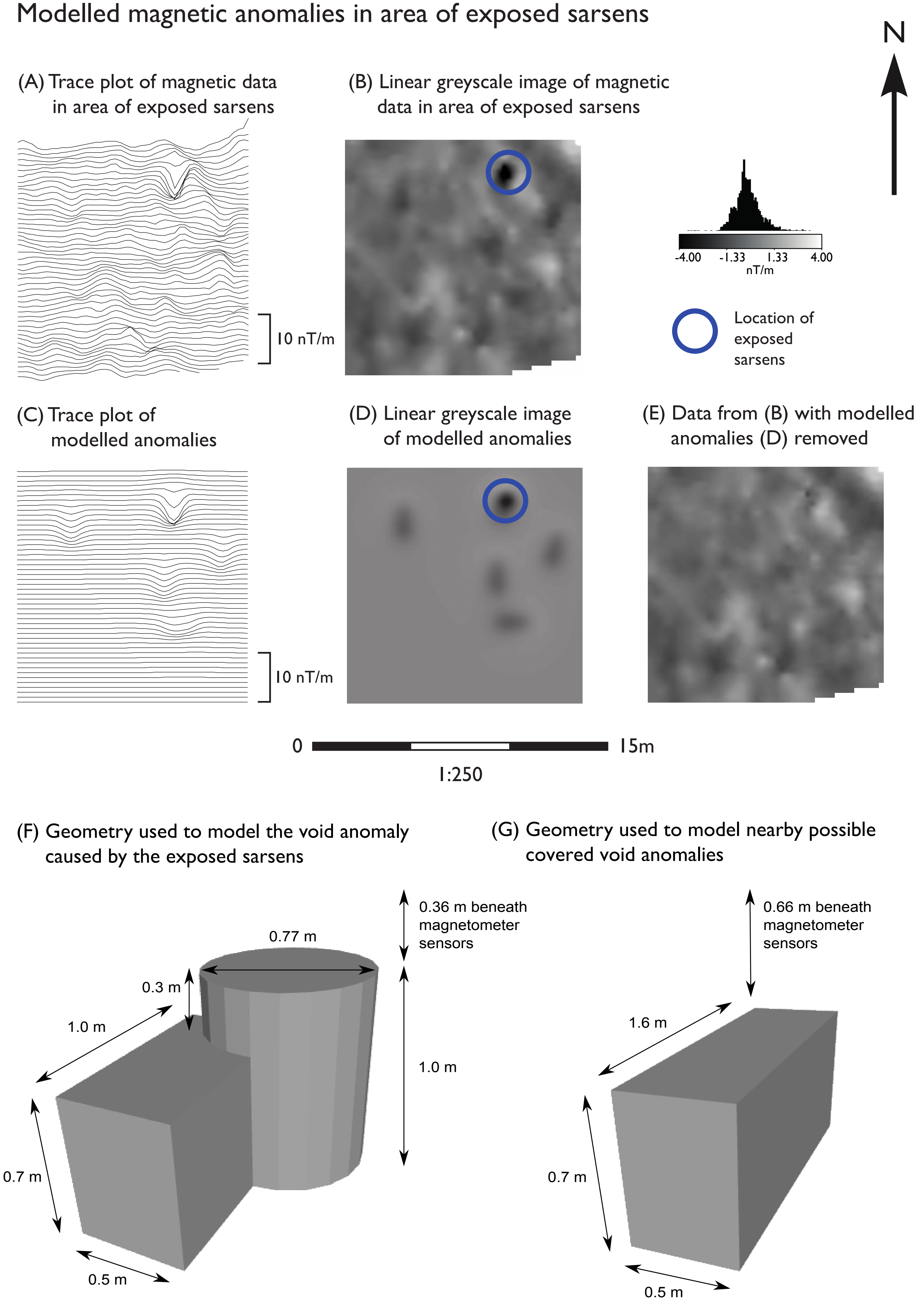
MANOR FARM, EAST KENNETT, WILTSHIRE
Modelled magnetic anomalies in area of exposed sarsens

Figure 15



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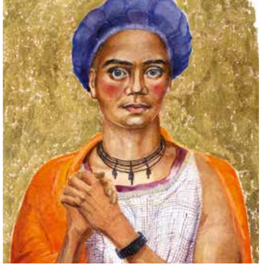

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