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WREST PARK, SILSOE, BEDFORDSHIRE REPORT ON GEOPHYSICAL SURVEY, JULY 2010

Neil Linford

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SUMMARY

A Ground Penetrating Radar (GPR) survey was conducted over an area of approximately 2.4 ha at Wrest Park, Silsoe, Bedfordshire. The survey was undertaken as part of a wider multi-disciplinary research project in support of a bid to investigate and potentially restore the designed landscape at the site. The specific aim of the GPR survey was to enhance the existing, more limited, earth resistance and magnetic coverage over the remains of the original location of the house and to determine whether any remains of the former parterre gardens survive further to the south beneath the croquet lawns. The GPR survey confirmed the location of the original house and identified a number of anomalies known either from historic mapping, topographic or parch-mark evidence. Additional anomalies, recorded to a depth of approximately 2m, provided more detailed information from the croquet lawns where the recent land use history, including episodes of ploughing during the 1950s, were likely to have destroyed any near-surface remains.

CONTRIBUTORS

The field work was conducted by Neil Linford and Andy Payne.

ACKNOWLEDGEMENTS

The author wishes to express his thanks to our colleagues Chris Slatcher and his team at the site, and to Magnus Alexander and Derwin Gregory (Archaeological Investigation and Survey Team, Cambridge) for both practical assistance with the survey and very useful discussions regarding the results. Access to the croquet lawns was kindly granted by John Bevington on behalf of the Wrest Park croquet club and John also kindly provided a copy of the photograph reproduced in Figure 9.

ARCHIVE LOCATION

Fort Cumberland.

DATE OF FIELDWORK AND REPORT

The fieldwork was conducted on the 19th to 23rd of July 2010. The report was completed on 7th March 2011. The cover photograph shows the antenna array crossing the broadwalk whilst the survey was in progress with the current house seen in the distance to the N.

CONTACT DETAILS

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INTRODUCTION

The current rectangular mansion at Wrest Park was designed and built by its owner, Thomas Philip 2nd Earl de Grey, between 1834-39 following the demolition of the original house. Surrounding the mansion lies an extensive 40ha pleasure ground of formal gardens, parkland, woodland carriage drives and canalised water features (Scheduled Ancient Monument BD48). Whilst a considerable degree of remodelling to this designed landscape has occurred, including the addition of buildings for the Silsoe Research Institute for Agricultural Engineering Research that occupied the site until 2006, an ambitious restoration project been proposed to present four centuries of garden history to the public (Cocroft 2010).

The main aim of the geophysical survey was to assess the nature, extent and survival of the original house and whether any trace of the parterre garden could be revealed under the croquet lawns, lying between the broadwalk and the long canal. A combination of historic mapping, parch marks and slight earthwork traces reveals the location of the original house, that has also been the subject of a partial earth resistance survey (Gater 1991) and a trial magnetic survey in 1993. During the course of the current field work a more recent, extensive earth resistance survey of the original house came to light that produced most encouraging results (Fadden and Turner 2001, 2004). It was decided that a Ground Penetrating Radar (GPR) survey might best complement the existing geophysical results, with a contingency for further earth resistance coverage should the conditions prove unsuitable for GPR.

The site covered by the GPR survey is centred on TL 09 35 and extends over an area of approximately 2.4ha from the remains of the old house to the long canal and is laid mainly down to well kept lawns, interrupted by gravel pathways, planting and statues. The former parterre garden, south of the broadwalk, lies on a lower level and has been subject to considerable recent intervention due to ploughing trials conducted by the research institute in the 1950s followed by the establishment of a well manicured croquet lawn. Soils of the Evesham 3 association have developed over Gault Clay (Soil Survey of England and Wales 1983; Geological Survey of Great Britain (England and Wales) 1992). Weather conditions were generally dry and sunny throughout the field work.

METHOD

A survey grid (Figure 1) was first established over the site using a Trimble kinematic differential global positioning system (GPS). The roving GPS receiver was subsequently mounted on the GPR array to provide continuous positional control for the survey, although this was compromised by deciduous tree cover in some areas.

Ground Penetrating Radar (GPR) survey

A 3d-Radar GeoScope Continuous Wave Stepped-Frequency (CWSF) radar system was used to conduct the survey collecting data with a multi-element V1821 vehicle towed, air launched antenna array (Linford *et al.* 2010). Data were acquired at a 0.075m x 0.075m sample interval across a continuous wave stepped frequency range from 50 to 1250MHz in 2MHz 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.

Post acquisition processing involved conversion of the raw data to time-domain profiles (through a time window of 0 to 50ns, although few significant reflections were recorded beyond 30ns), 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 Figures 2 and 3. To aid visualisation amplitude time slices were created from the entire data set, after applying a 2D-migration algorithm, by averaging data within successive 1.2ns (two-way travel time) windows (e.g. Linford 2004). An average sub-surface velocity of 0.117m/ns was assumed following constant velocity tests on the data, and was used for both the migration velocity field and the time to estimated depth conversion. Each of the resulting time slices, shown as individual greyscale images in Figures 4, 5 and 6, therefore represents the variation of reflection strength through successive ~0.06m intervals from the ground surface. Further details of both the frequency and time domain algorithms developed for processing this data, including the variable hyberbola velocity model used for the migration can be found in Sala and Linford (2010).

Topographic survey

An interpolated digital terrain model (DTM) was created using data captured by a GPS receiver mounted on the GPR antenna array at an approximate sample spacing of 1.5m x 2m. Rapid topographic survey data collected in this manner will be of limited accuracy, compared to a static measurement, but can still provide a useful ground surface model for the correction and presentation of the GPR results. Figure 7 shows a false perspective view of the GPR data from between 10.2 and 11.4ns (0.61 and 0.68m) draped as greyscale images over the DTM. The vertical scale has been exaggerated by a factor of 8.

RESULTS

Graphical summaries of significant anomalies discussed in the following text, superimposed on the base Ordnance Survey map data, are provided in Figure 8.

Ground Penetrating Radar data

General response and modern interference

The prevailing dry weather at the time of the survey combined with the well kept nature of the grass at the site combined to produce excellent conditions for data acquisition. Some interruption to the available survey area occurred, due to the presence of extant garden features, although the current gravel pathways were included.

Significant anomalies

As expected, the site of the old house produced a plethora of rectilinear anomalies

related to the original range of buildings. The location of some of these, such as the site of the chapel [gpr1] and the laundry [gpr2], may be readily discerned from extant earthworks on the grass. However, it is clear from both the previous earth resistance surveys and the current GPR data that an extensive range of building remains survives at the site (cf Fadden and Turner 2004). The GPR results suggest the majority of the building remains lie relatively close to the surface, appearing from between 2.2 and 3.4ns (0.13-0.2m), and with the exception of some more substantial walls, have faded out by the 17.4 - 18.6ns (1.04 - 1.12m) time slice. The response from the circular anomaly [gpr3] found in the east courtyard of the old house is even more ephemeral with the two concentric walls existing to a depth of approximately 0.5m. Anomaly [gpr3] is, however, well described showing a much closer correlation with the feature depicted on the 1735 Roque plan than that recorded by the 2004 earth resistance survey. It is also possible to discern a subtle linear feature [gpr4] apparently heading from the north-east wing of the old house through the centre of [gpr3] and exiting towards the current north-south gravel pathway. It does not seem unreasonable to suggest that [gpr4] represents a water supply pipe or, perhaps, a drain servicing the function of [gpr3] as a fountain or other decorative water feature.

The remains of the original house appear as a series of wall-type responses, with reasonably well bounded ranges of individual rooms defined to the N, E (including the chapel [gpr1]) and S at [gpr5-7] respectively, agreeing with the general layout suggested by the historic plans (Fadden and Turner 2004). To the W an "L" shaped area of bright reflections [gpr8] visible between 3.4 and 12.6ns (0.2 to 0.76m) may well represent a rubble spread associated with former building remains and is found in the vicinity of more wall-type anomalies at [gpr9]. There is also some evidence for building remains extending under the main extant pathways, particularly at [gpr10-17] and this would, in part, concur with the results of the earlier earth resistance survey that identified the location of the "Great Dining Room" at [gpr15]. Other broader, linear anomalies such as [gpr11 and 13] respect the orientation of overlying modern paths and may therefore be more likely to represent drainage or perhaps water supply conduits - particularly where a supply to an extant water feature seems plausible.

The previous resistance survey also identified an anomaly interpreted as the remains of a presumed bridge crossing a former moat. This anomaly is replicated in the GPR data at [gpr18] where it appears to be formed of two 3m square wall-type structures aligned approximately east-west and, possibly, associated with some fragmented linear responses found further to the west. However, convincing evidence for a former moat in this area is more difficult to ascertain from the GPR data, perhaps suggesting that a more open interpretation of [gpr18] as the remains of a building is equally valid. A low magnitude linear anomaly [gpr19] cut by two wall-type responses to the east of the original house may be more likely to represent a ditch or moat, although this appears to continue to the N as a positive reflector [gpr20], perhaps suggesting a service trench or robbed-out wall. Two similar high magnitude anomalies [gpr21] and [gpr22] are found running beneath the extant gravel path to the west, crossing the east-west metalled path from the Orangery.

Whilst [gpr21] and [gpr22] could represent service trenches or walls, the presence of a parallel linear response [gpr23] together with a pattern of diagonal anomalies [gpr24-26] suggests these may, as a group, represent a previous garden design of paths in the area to

the N of the fountain. The two linear anomalies [gpr25-26] emanating from the north-south path are visible as both parch-marks and slight topographic features, although the GPR data indicates a more complex arrangement including several apparently structural elements [gpr27-30] that, in part, extend from the lawn beneath the central walk from the main house [gpr10].

Further to the south two linear anomalies [gpr31 and 32] cross the broadwalk and head down from the upper terrace towards the lower-lying croquet lawns. Again, these are most likely to represent either drains or services and [gpr32] may well provide the electricity supply to the croquet clubhouse in the woods to the east of the survey area. The very near-surface data between 0.0 and 2.2ns (0 to 0.13m) contains three bands of amorphous response [gpr33-36] that appears to represent the divisions between the individual playing surfaces of the croquet lawn. Observations in the field suggest this may be due to the extremely short cropped grass over the playing surfaces or, perhaps, localised compaction of the soil from the intensive lawn care.

Other visible parch marks reproduced in the GPR survey include the edging wall [gpr37] of the lower terrace with a return along the western extent of the survey area, and the central plinths [gpr38 and 39] of two fountain bases shown on the 1719 Lawrence plan of the garden. The fountain to the east [gpr39] was also recorded by the previous earth resistance survey and revealed a water-retentive circular bowl surrounding the central base. Similar circular anomalies were detected by the GPR survey, particularly around [gpr38] to the west, between 2.2 and 9.0ns (0.13 to 0.54m). Some evidence for the north-south paths leading to the fountains shown on the Lawrence plan is found at [gpr40] and, perhaps better preserved at [gpr41] along the eastern extent of the survey area.

The central north-south path that forms a consistent feature of all the historic garden designs surviving to the present day on the upper terrace, extends as a subtle linear anomaly [gpr42] for approximately 100m south from the broadwalk before it appears as a pair of wall-type responses [gpr43] leading towards the long canal. This may suggest that any surviving edging walls have, in part, been removed perhaps during the intensive mechanical ploughing trials conducted by the research institute during the 1950s (Figure 9). The change in response along [gpr42-43] does not appear to be related to the position of the present day croquet lawns or the width of the path across the lawn left for visitors between the playing surfaces. The whole of the lower terrace is also cut by a 'herring-bone' pattern of field drains [gpr44] spaced at approximately 6m intervals between 5.6 and 15.0ns (0.34 to 0.9m), which appear to be contemporary with the historic garden and have survived the more recent episodes of ploughing. The fall of the drains would appear to be towards the middle of the lower terrace where the two alignments meet, although there is no evidence here for a central east-west collect.

Other discrete anomalies [gpr45-56] seem likely to represent plinths for statues or other ornamental garden features, particularly the pair at [gpr50 and 51] positioned symmetrically approximately 16m to either side of the central north-south axis of the design from the house. A further extension to the network of paths associated with the Lawrence plan is found at [gpr57], perhaps representing the east-west path from the North broad water as this appears to coincide with a fountain base or statue plinth [gpr56] on the alignment suggested for this previous garden design.

Figure 9 Photograph showing mechanical ploughing trials conducted during the 1950s by the National Institute for Agricultural Engineering underway over what is now the site of the croquet lawns.

As the central walk continues further south to meet the long canal a series of linear anomalies [gpr58-62] indicate the location of additional surviving garden features. The distinctive morphology suggests that [gpr58-60] form the edging walls depicted on the 1735 Rocque plan of the garden. Other elements of this design, such as the path [gpr61] to the W and the circular garden feature at [gpr62], are also reproduced in the GPR data and it seems likely that the other anomalies have a similar origin. The sharp slope down to the edge of the long canal itself has produced a complex response [gpr63] related, no doubt, to the underlying construction of the retaining terrace, similar to the response [gpr64] found immediately south of the broadwalk. One linear wall fragment [gpr65] is also found in this area and may, perhaps, suggest some relic of the original bounding wall surrounding the long canal recorded by Rocque plan of 1735.

Topographic data

Figure 7 shows a false perspective view of the 10.2 and 11.4ns (0.61 and 0.68m) time slice data draped over a DTM depicting the site topography. Given the relatively coarse nature of the GPS survey sample interval used to calculate the DTM (approximately 1.5m x 2m) and the poor signal quality recorded in the vicinity of the mature trees at the edges of the survey area the topographic data is, perhaps, of rather limited use. However, Figure 7 does provide a general topographic context for the survey showing the break in slope immediately S of the broadwalk from the raised terrace to the croquet lawn, and then down again to the long canal. Despite the relatively poor quality of the DTM the central north-south walk to the long canal [gpr42 - 43] is shown as a consistent linear depression across the croquet lawn, together with a slight hollow marking the bowl of the former fountain [gpr39] to the E.

CONCLUSION

The GPR survey has successfully identified a wealth of archaeological activity associated with both the original site of the house and surviving remains from earlier garden designs. This work builds on the body of historical plans and depictions of the garden designs together with the long-term observation of recurrent parch marks and previous geophysical survey over parts of the site. The current survey adds some considerable detail to this record and provides a common georeferenced data set for comparison with the recent, much wider topographic survey of the site. In particular, the GPR survey has provided a significant enhancement of detail over the site of the former house to complement both of the previous earth resistance data sets from this area. A number of significant anomalies, apparently related to former garden designs, have also been identified on the lower terrace where the survival of near-surface remains was doubtful due to earlier episodes of ploughing and landscaping for the croquet lawns. Further extension of the GPR survey may well be warranted; however, the presence of mature trees limits access in parts of the site and hampers accurate positional control through use of a GPS receiver.

LIST OF ENCLOSED FIGURES

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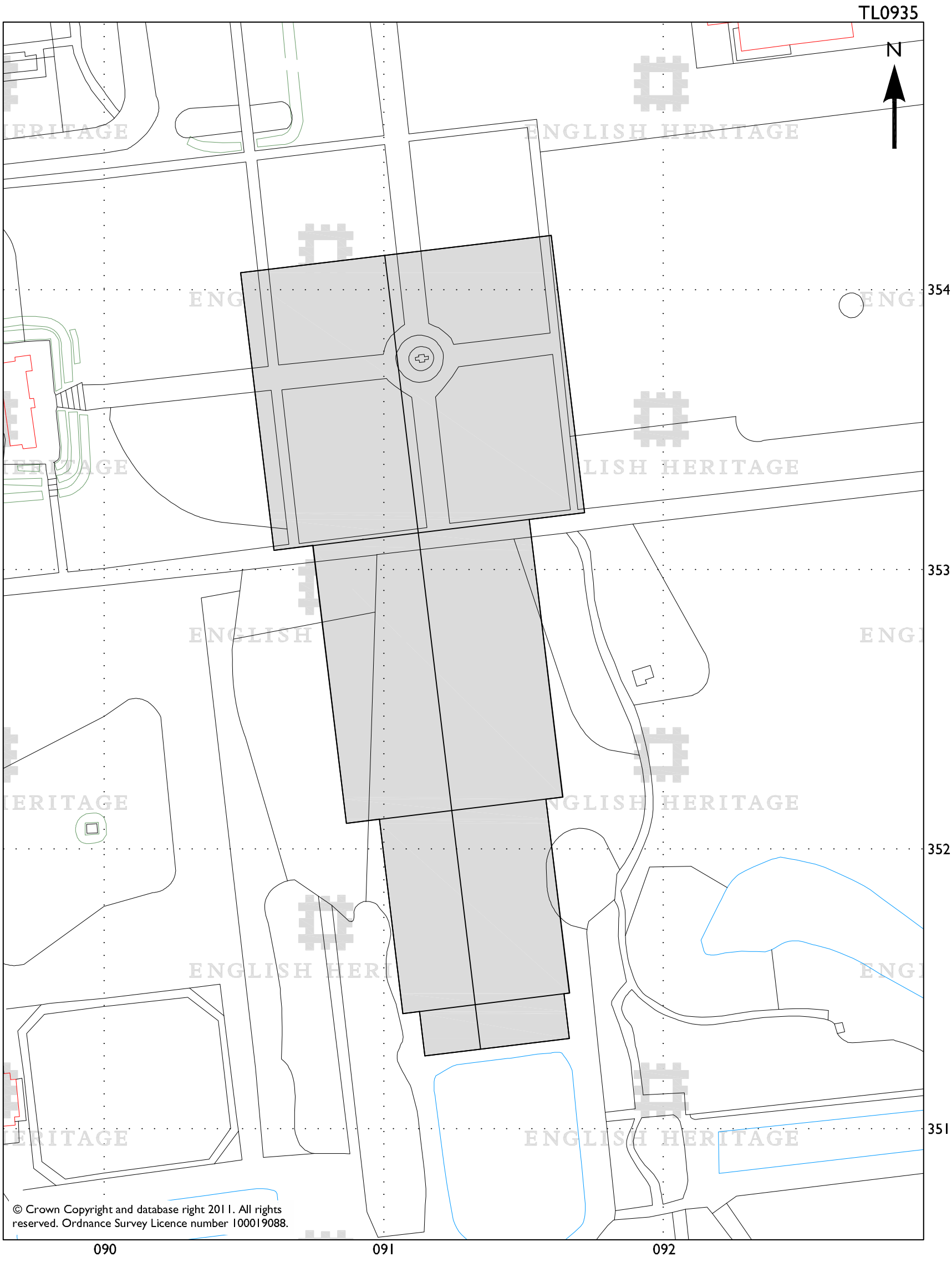
Figure 1

WREST PARK, SILSOE, BEDFORDSHIRE
Location of GPR survey, July 2010.



0 60m

1:1500

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Figure 2

WREST PARK, SILSOE, BEDFORDSHIRE

GPR amplitude time slice 10.2 - 11.4ns (0.61 - 0.68m), July 2010.

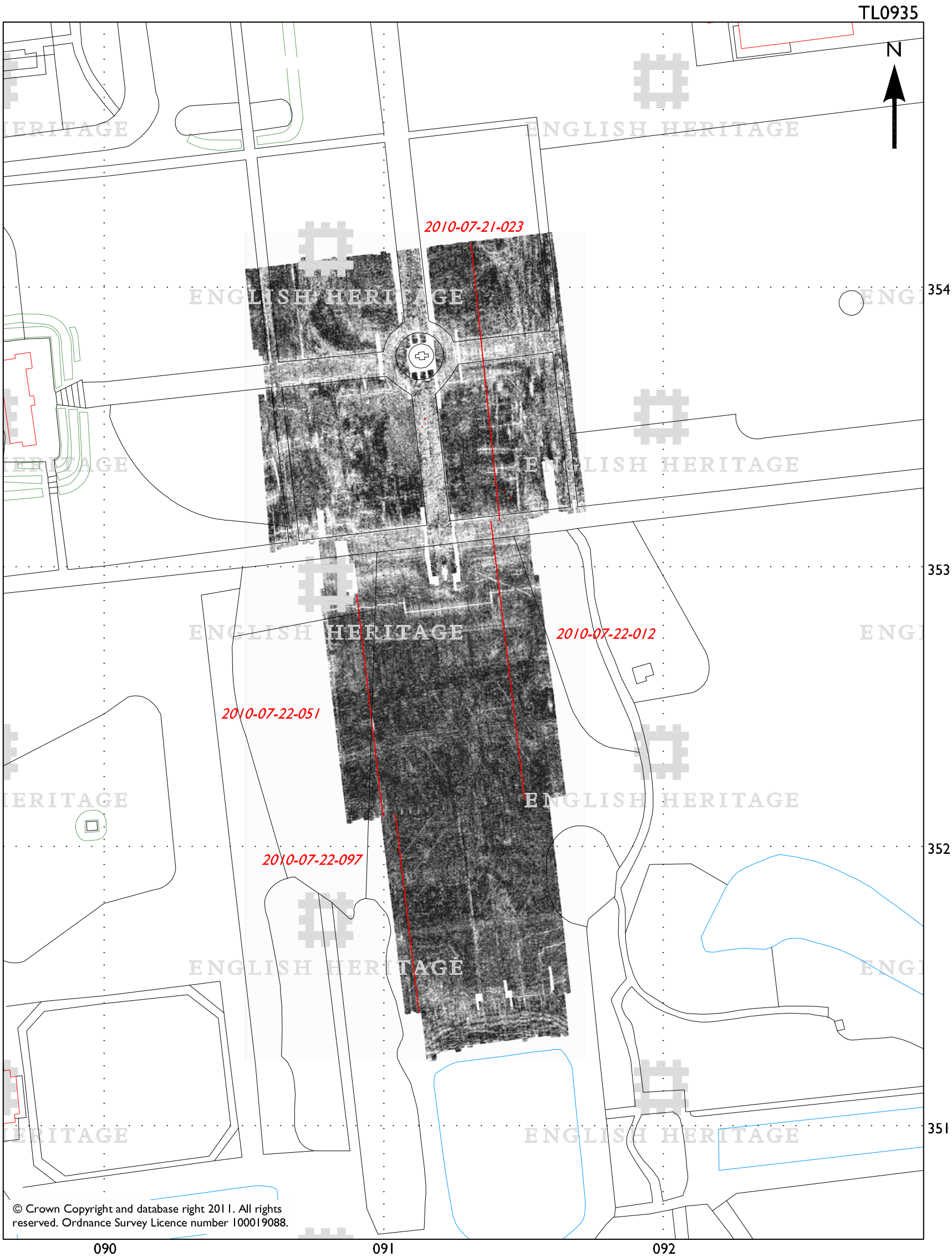

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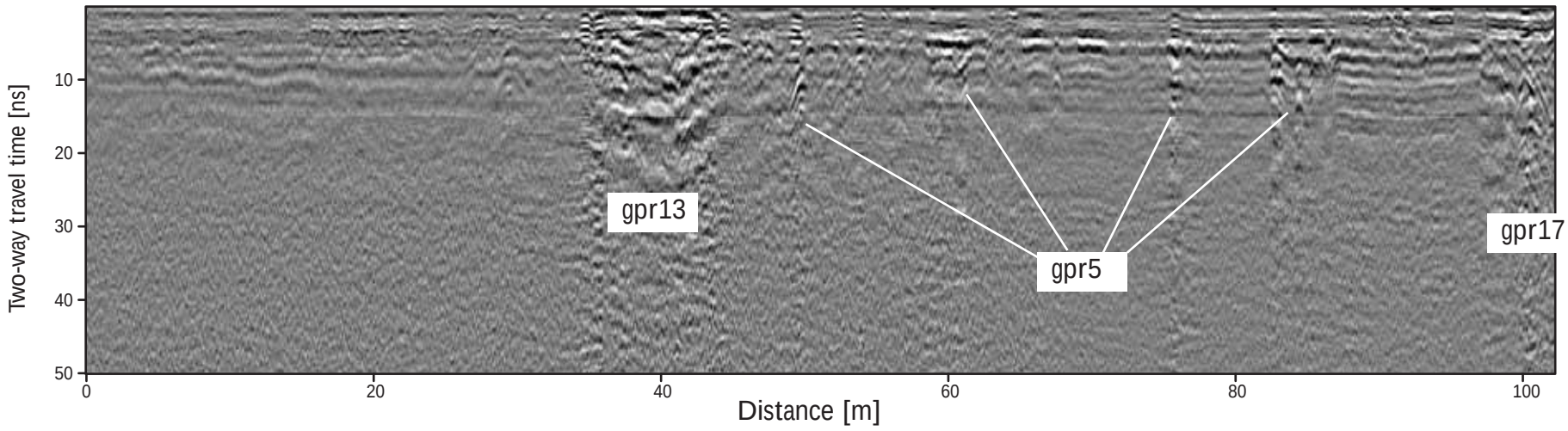
Figure 3

WREST PARK, SILSOE, BEDFORDSHIRE
Selected GPR profiles, July 2010

N S

2010-07-21-023, channel 11



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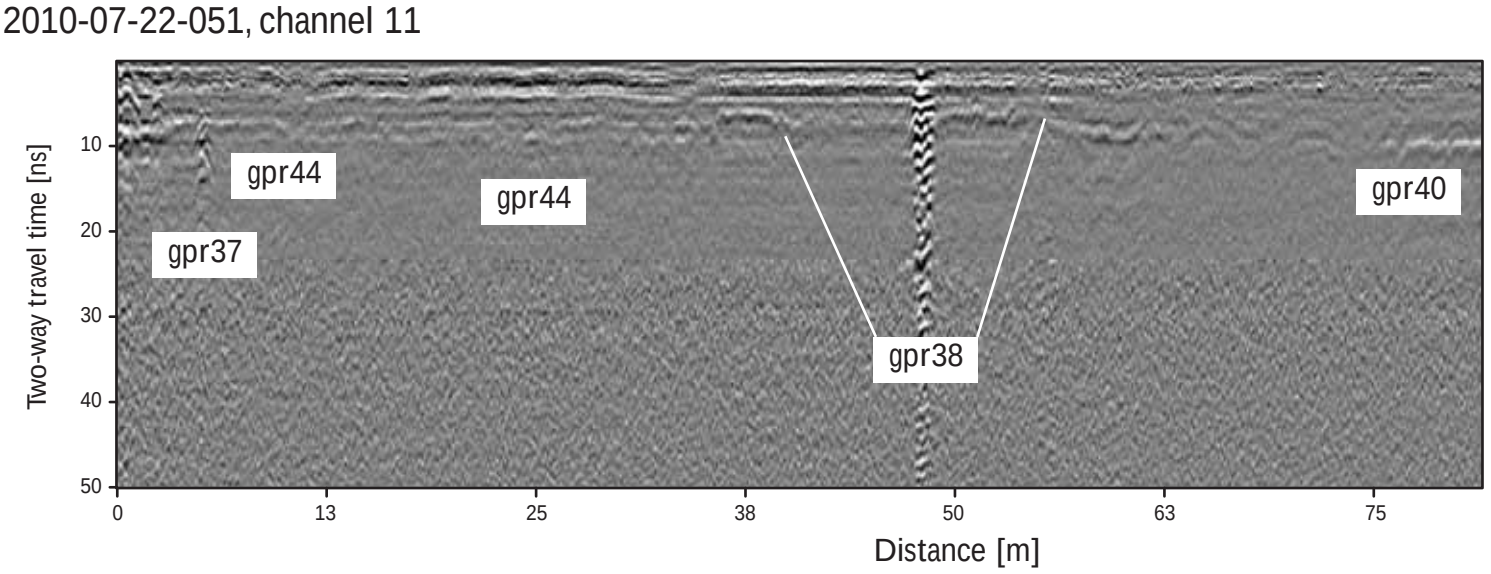

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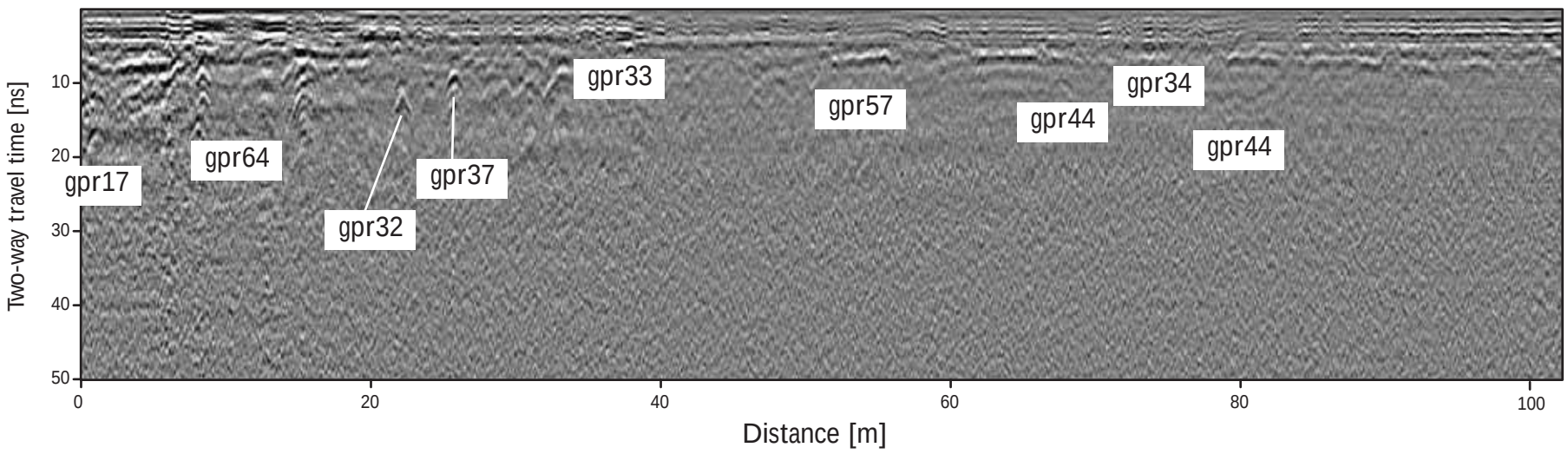

2010-07-22-097, channel 11

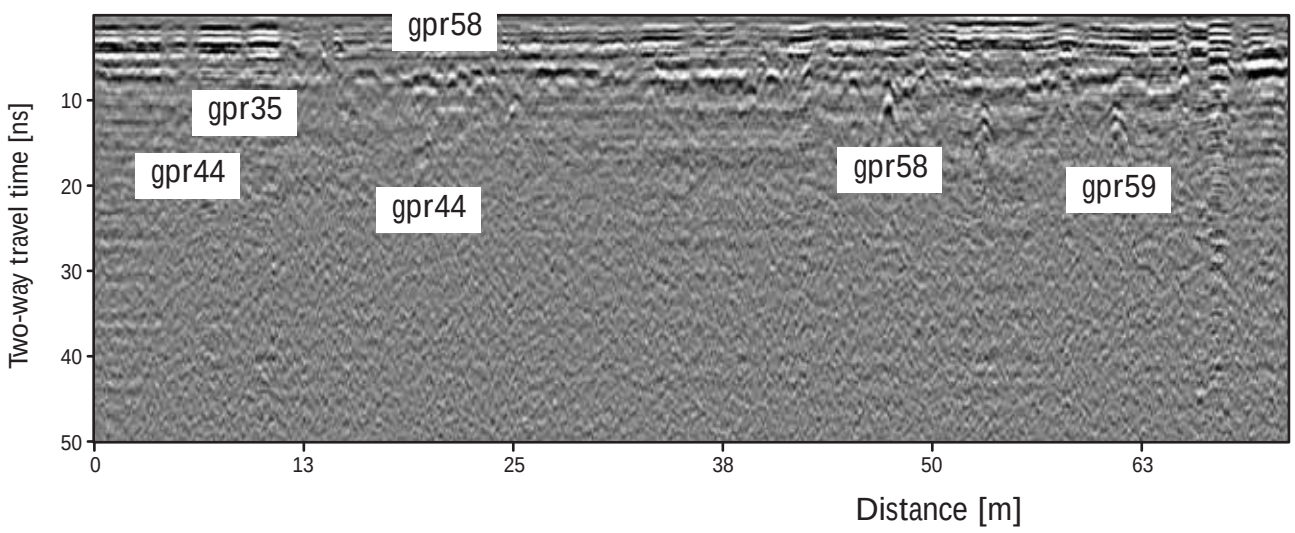

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Figure 4

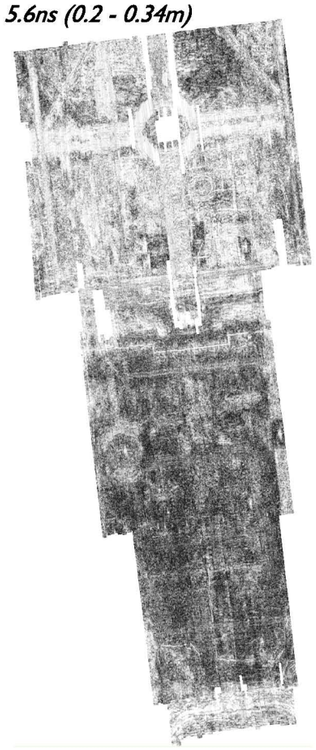
WREST PARK, SILSOE, BEDFORDSHIRE
GPR amplitude time slices from 0.0 to 11.4ns, July 2010.

0 - 1.0ns (0.0 - 0.06m)

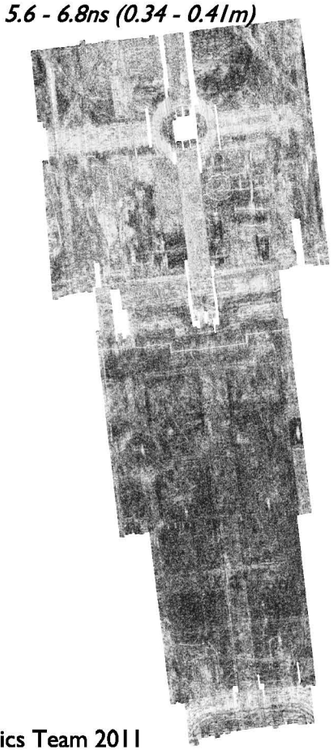
1.0 - 2.2ns (0.06 - 0.13m)

2.2 - 3.4ns (0.13 - 0.20m)

3.4- 5.6ns (0.2 - 0.34m)



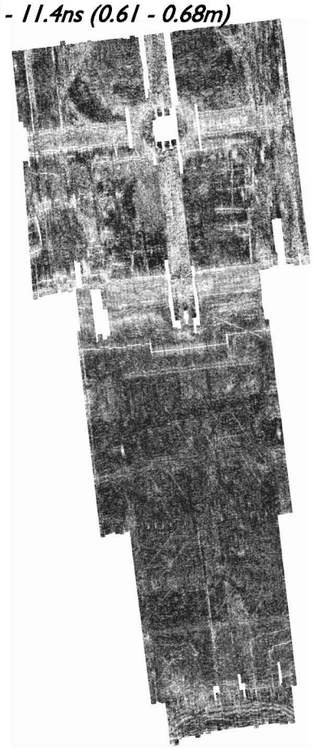
5.6 - 6.8ns (0.34 - 0.41m)



6.8- 9.0ns (0.41 - 0.54m)

9.0 - 10.2ns (0.54 - 0.61m)

10.2 - 11.4ns (0.61 - 0.68m)



N

Low *High*
relative reflector strength

0 90m
1:2500

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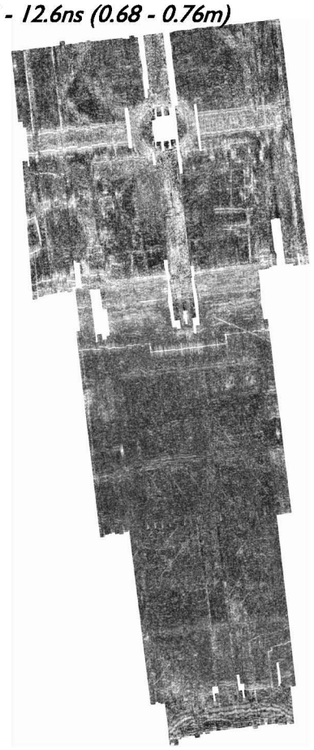
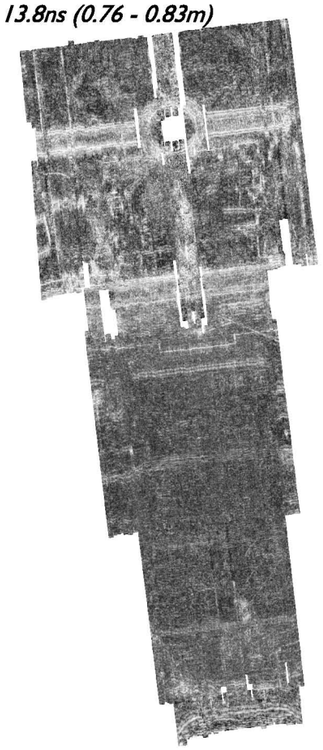
Figure 5

WREST PARK, SILSOE, BEDFORDSHIRE
GPR amplitude time slices from 11.4 to 21.0ns, July 2010.

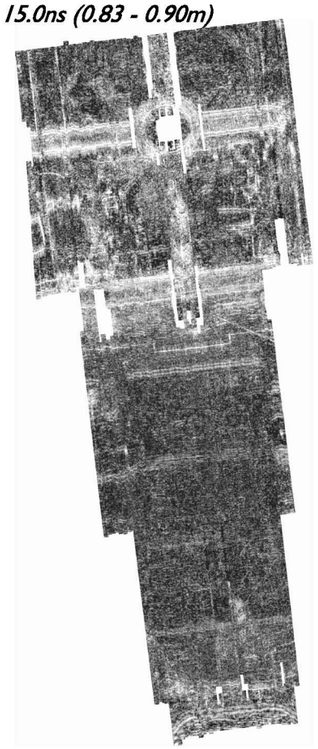
11.4 - 12.6ns (0.68 - 0.76m)



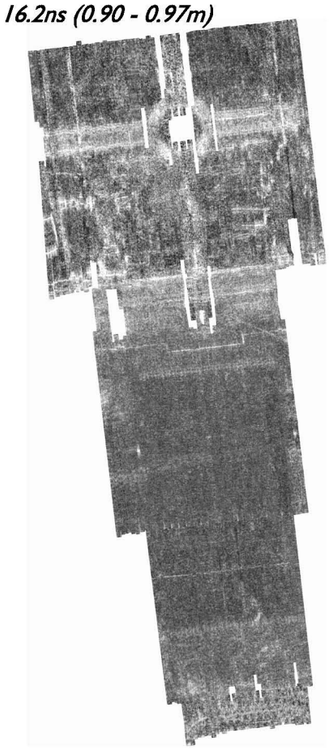
12.6 - 13.8ns (0.76 - 0.83m)



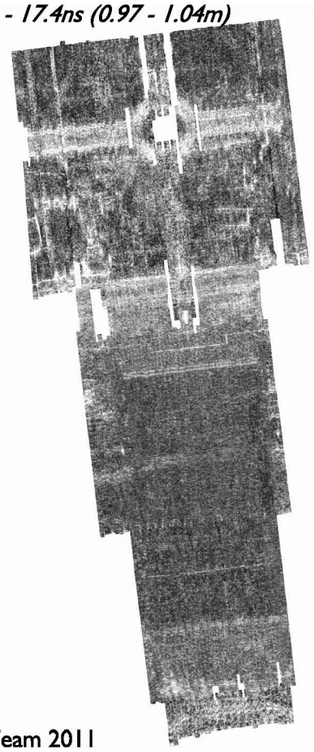
13.8 - 15.0ns (0.83 - 0.90m)



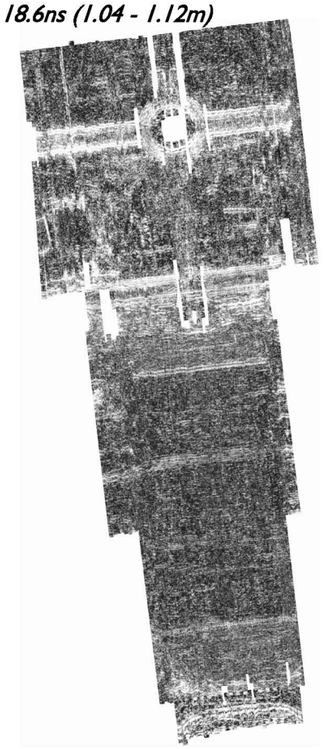
15.0- 16.2ns (0.90 - 0.97m)



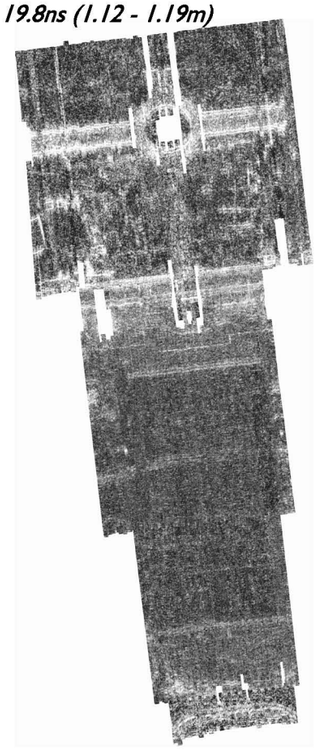
16.2 - 17.4ns (0.97 - 1.04m)



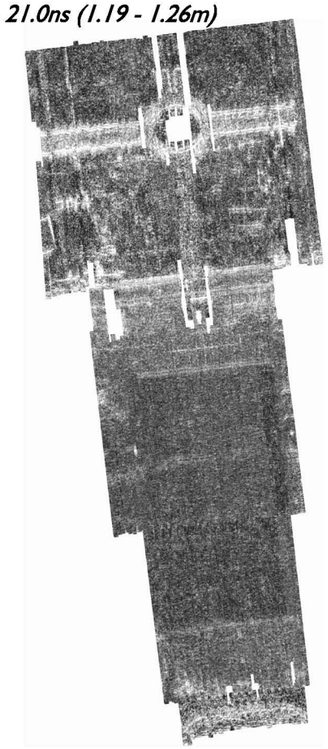
17.4 - 18.6ns (1.04 - 1.12m)



18.6 - 19.8ns (1.12 - 1.19m)



19.8 - 21.0ns (1.19 - 1.26m)



N

Low *High*
relative reflector strength

0 90m
1:2500

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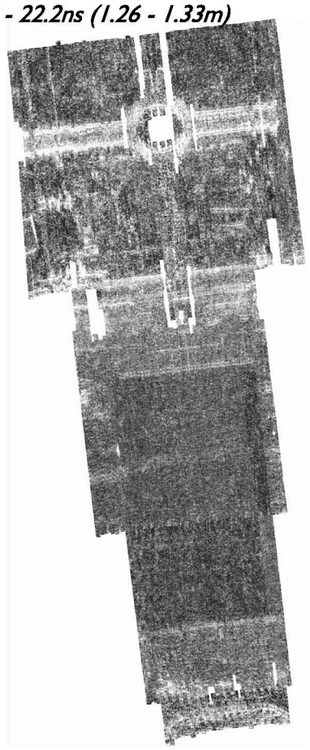
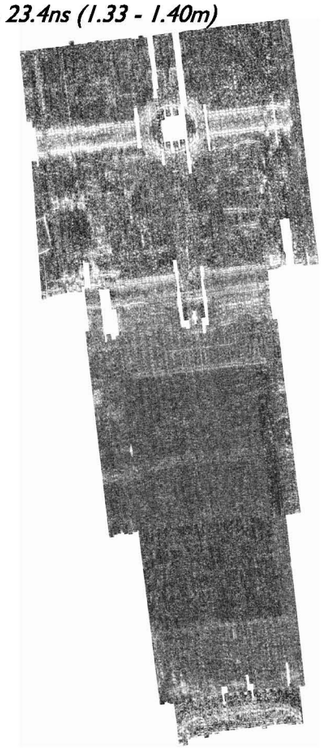
Figure 6

WREST PARK, SILSOE, BEDFORDSHIRE
GPR amplitude time slices from 21.0 to 30.2ns, July 2010.

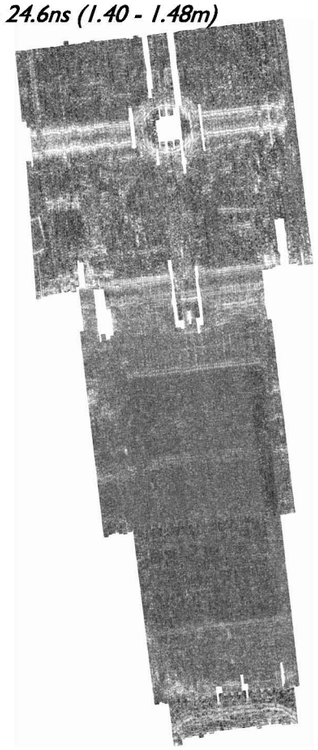
21.0 - 22.2ns (1.26 - 1.33m)



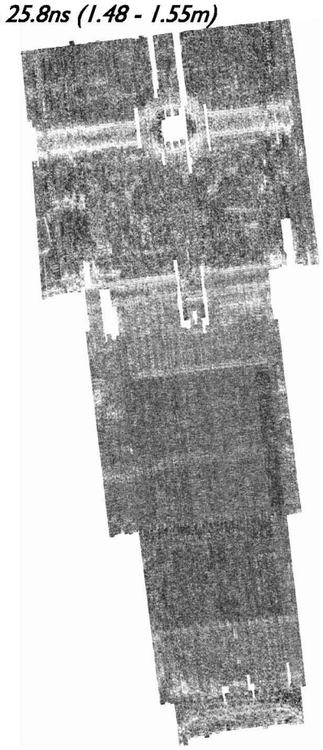
22.2 - 23.4ns (1.33 - 1.40m)



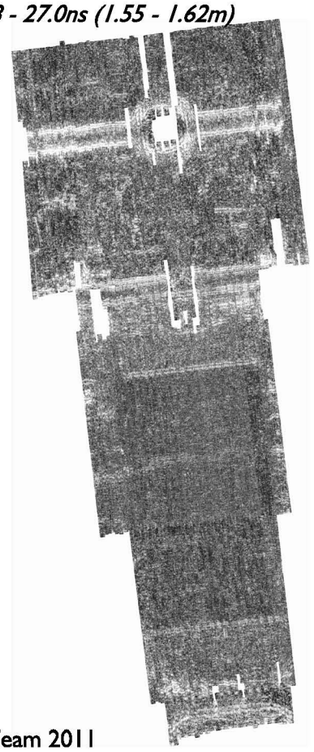
23.4 - 24.6ns (1.40 - 1.48m)



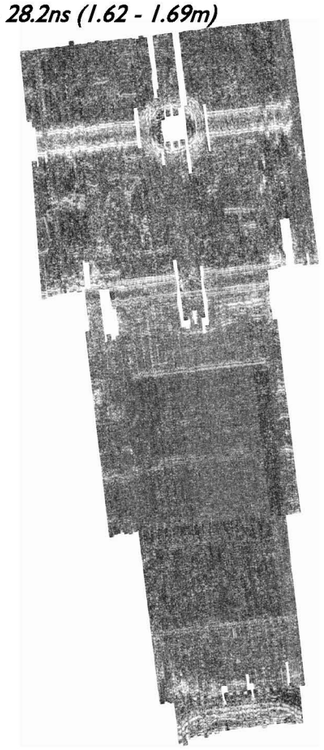
24.6 - 25.8ns (1.48 - 1.55m)



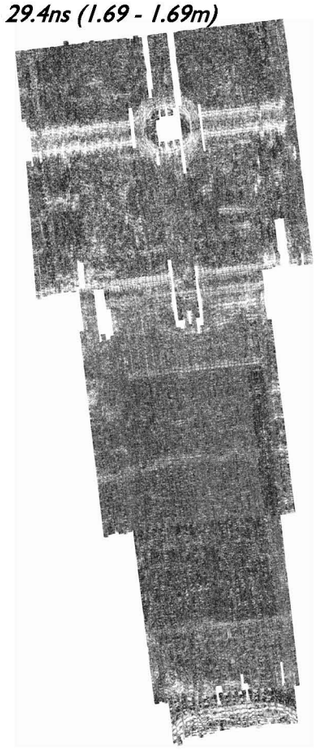
25.8 - 27.0ns (1.55 - 1.62m)



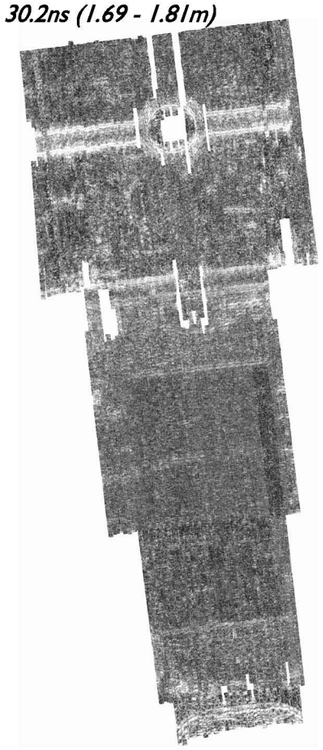
27.0 - 28.2ns (1.62 - 1.69m)



28.2 - 29.4ns (1.69 - 1.69m)



29.4 - 30.2ns (1.69 - 1.81m)



N

Low *High*
relative reflector strength

0 90m
1:2500

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Digital Terrain Model, July 2010.

Figure 7

GPR amplitude time slice from between 10.2 and 11.4ns (0.61 to 0.68m) draped over the DTM

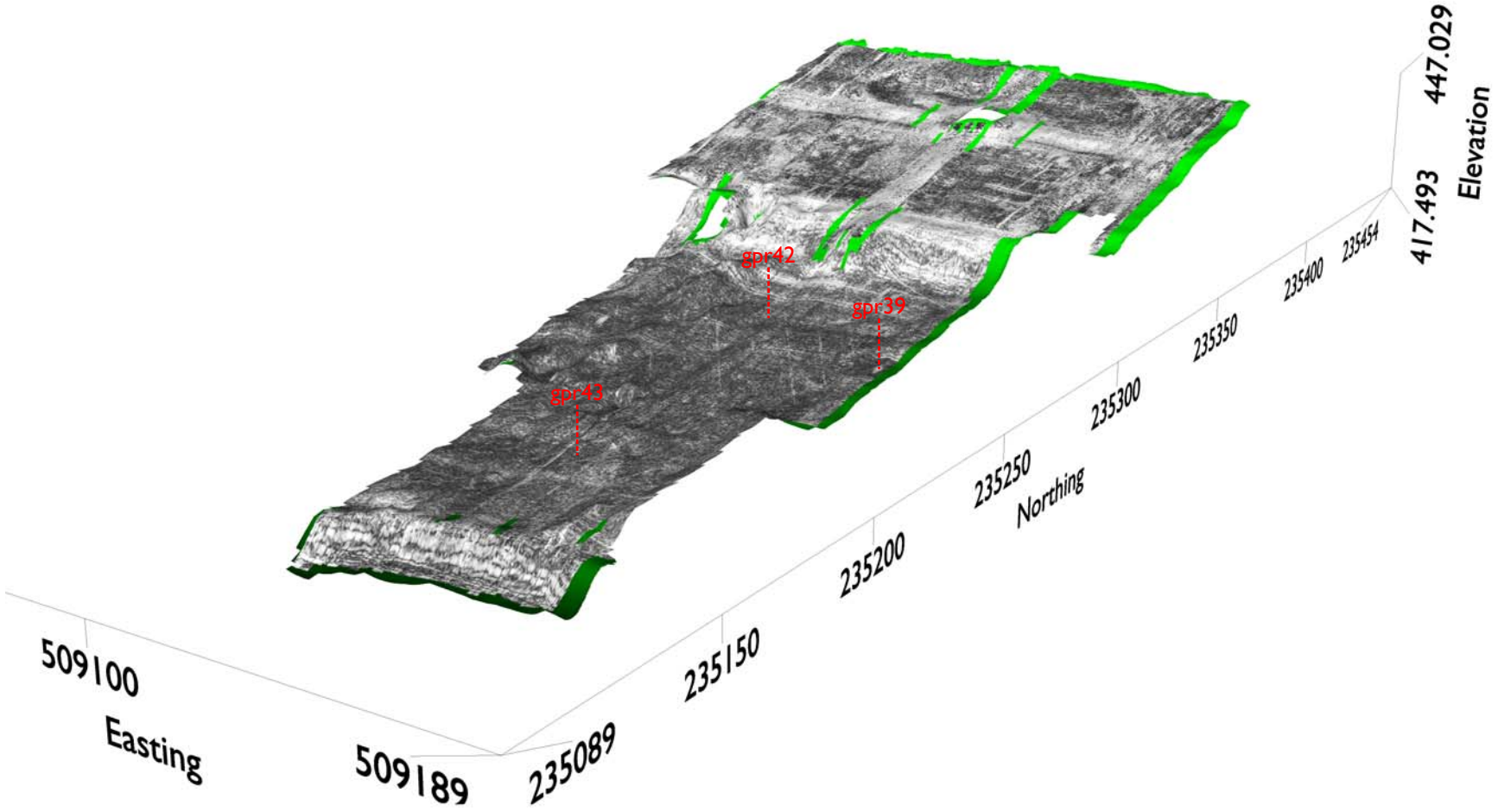

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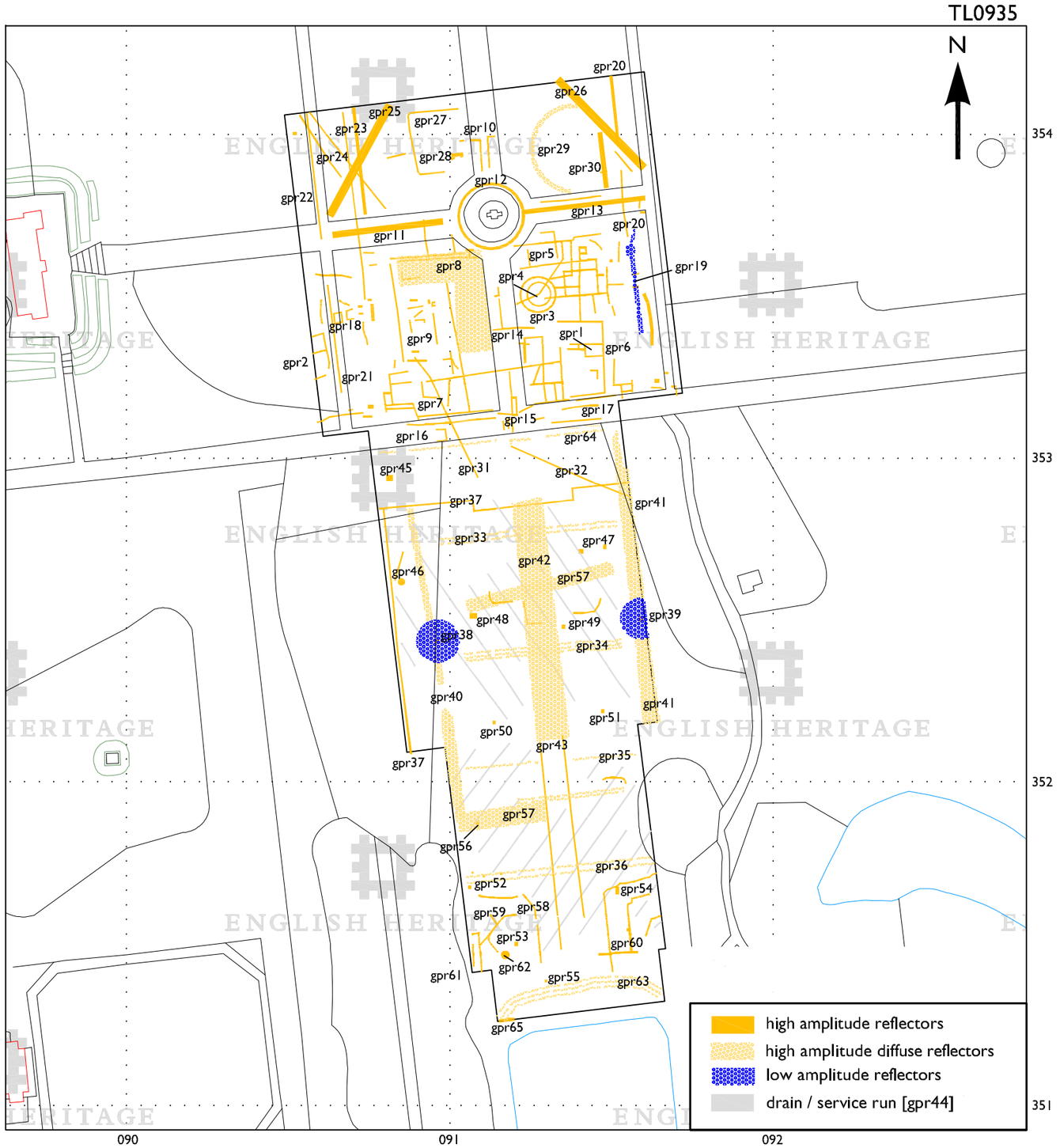
Figure 8

WREST PARK, SILSOE, BEDFORDSHIRE

Graphical summary of significant GPR anomalies, July 2010.



0 60m

1:1500

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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

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