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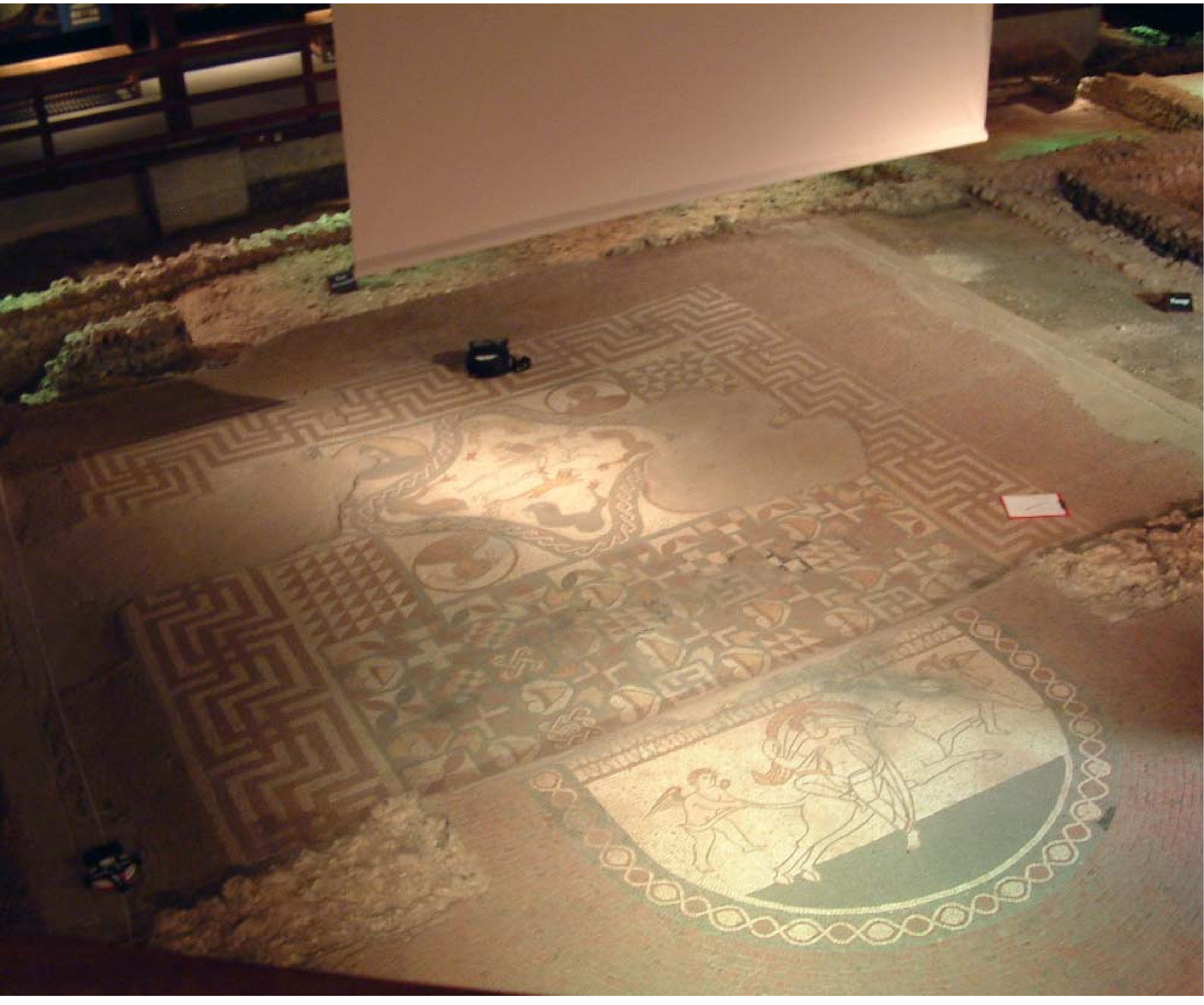
LULLINGSTONE ROMAN VILLA, EYNSFORD, KENT

REPORT ON GEOPHYSICAL SURVEY, JANUARY 2010

Neil Linford



ARCHAEOLOGICAL SCIENCE

ENGLISH HERITAGE

Research Department Report Series 62-2011

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REPORT ON GEOPHYSICAL SURVEY, JANUARY 2011

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SUMMARY

A detailed Ground Penetrating Radar (GPR) survey was conducted over the mosaic pavements in the audience chamber and dining room at Lullingstone Roman villa, Eynsford, Kent (TQ 530 651, SMR 1007463). The aim of the survey was to investigate irregularities identified in the mosaic surround that suggest these rooms may have been remodelled from an earlier, unrecognised, phase of construction. A number of linear anomalies were identified by the survey, related to both the predicted course of building remains projected from adjacent rooms and possible wall footings that correlate with the observed alteration to the overlying mosaic. In addition, some near-surface areas of anomalous response may well be related to localised delamination of the constituent tesserae.

CONTRIBUTORS

The field work was conducted by Neil Linford with the assistance of Dr David Neal.

ACKNOWLEDGEMENTS

The author wishes to express his thanks to colleagues at the site who kindly allowed access to the villa out of normal operating hours and to David Neal for his help and subsequent discussions of the resulting survey data. Mark Fenton and Richard Lea kindly supplied an electronic plan of the villa remains for use in the figures accompanying this report.

ARCHIVE LOCATION

Fort Cumberland.

DATE OF FIELDWORK AND REPORT

The fieldwork was conducted on the 18th January 2011 and the report was completed on 14th June 2011. The cover photograph shows a view of the audience chamber and dining room mosaics

CONTACT DETAILS

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CONTENTS

INTRODUCTION

A Ground Penetrating Radar (GPR) survey was conducted over the mosaics found in the audience chamber and adjacent dining room at Lullingstone Roman villa, Eynsford, Kent (TQ 530 651, SMR 1007463). The villa complex, discovered in 1939, is situated on the west bank of the River Darent and comprises the well preserved remains of the main dwelling house including heated rooms, a cellar, verandahs, kitchens, baths, a dining room and audience chamber (both with mosaic floors), bedrooms and store rooms. Excavations begun in 1949 suggested the villa was originally built in *circa* AD 75 and underwent constant updating, including extensive remodelling in the mid fourth century, when the large apsed dining room was built and mosaic laid, before the house was abandoned in about AD 420.

The aim of the current survey was to examine whether discontinuities identified in the surround to the mosaics laid in the audience chamber and dining room may be related to a previously unrecognised phase of alteration to these rooms (D. Neal *pers comm.*). It was hoped that the GPR data may be able to identify anomalies due to underlying wall-footings in the vicinity of the discontinuity noted in the mosaic surround.

The site today is covered by a modern protective structure, to allow both presentation to visitors and the ongoing survival of the excavated remains. This building includes a metal roof covering at a height of approximately 4m above the remains.

METHOD

The GPR survey was conducted over the audience chamber and dining room mosaics along the individual profile lines shown in Figures 1 and 2. The position of the survey grid was established by measuring the corners of the grid to extant features of the villa and should be accurate to approximately 0.1m. A Sensors and Software Pulse Ekko PE1000 console was used with a 900MHz centre frequency antenna and varying sample intervals, necessitated by the time available for the survey, detailed in Table 1. The position of the survey lines was illuminated by use of a laser level at the edge of the grid and great care was taken during the transport of the antenna over the mosaic pavement, including the use of soft-soled foot wear by the surveyors.

Table 1: Details of GPR sampling strategy.

Area of site	Survey type	Sample interval		Antenna centre frequency	Time window
		Line	Trace		
Audience Chamber	Area	0.1m	0.02m	900MHz	50ns
Dining room	Area	0.2m	0.02m	900MHz	50ns

The average subsurface velocity of 0.11m/ns was estimated from constant velocity tests applied to the recorded data. However, this estimate was derived from the analysis of hyperbolic diffractions found within wall-type anomalies and may over-estimate the velocity (and hence depth) in non-structural areas. Post acquisition processing of the data involved the adjustment of time-zero to coincide with the true ground surface, removal of any low frequency transient response (dewow), noise removal and the application of a suitable gain function to enhance late arrivals (Figure 3).

In addition, owing to antenna coupling between the GPR transmitter and the ground to an approximate depth of $^{\lambda}/_{2}$, very near-surface reflection events should only be detectable below a depth of 0.061m if a centre frequency of 900MHz and a velocity of 0.11m/ns are assumed. However, the broad bandwidth of an impulse GPR signal results in a range of frequencies to either side of the centre frequency which, in practice, will record significant near-surface reflections closer to the ground surface. Such reflections are often emphasised by presenting the data as amplitude time slices. In this case, the time slices were created from the entire data set, after applying a 2D-migration algorithm, by averaging data within successive 1ns (two-way travel time) windows (e.g. Linford 2004). Each resulting time slice, illustrated as a greyscale image in Figures 4 and 5 represents the variation of reflection strength through successive ~0.06m intervals from the ground surface.

RESULTS

General response and modern interference

Despite the use of a high centre frequency (900MHz) antenna to provide good horizontal resolution in the near-surface data, significant reflections have been recorded across the mosaic pavements to approximately 25ns (Figure 3). Profiles collected across the audience chamber show a well defined horizontal reflector [gpr1] at approximately 10ns (0.55m) and this may well represent the base of the surface layers supporting the mosaic. A similar, although less well resolved response [gpr2] is found in the profiles collected across the dining room to a slightly greater maximum depth of approximately 15ns (0.825m), perhaps accounting for the raised step up from the audience chamber to this room. A number of weaker reflections are recorded beyond 30ns and whilst these, in part, produce coherent anomalies within the time slice data analysis of the individual profiles suggest they may, possibly, be due to surface air-wave reflections from the overlying metal roof.

Significant anomalies

The very near-surface time slices between 0 and 7ns (0.0 to 0.39m) show few coherent anomalies beyond four areas of low amplitude response [gpr3-6] that, with the exception of [gpr3], do not directly correlate with areas of missing tesserrae visible on the surface of the mosaic. It seems likely that these anomalies are due to differential coupling of the antenna with the mosaic surface and may represent either areas of slight deformation or, perhaps, delamination. Whilst this may be due to the natural settling of the site the proximity to other visible areas of damage may be significant and it would seem prudent to monitor [gpr3-6] for early signs of any further deterioration.

From approximately 7ns onwards the response to the E of the audience chamber becomes more variable following the projection of the passageway from the cult room immediately to the NE. A substantial reflection [gpr7] from a wall-type anomaly emerges from between approximately 9 and 19ns (0.5 to 1.05m) and extends both E and W, although does not appear to fully reach the dining room. A less substantial response [gpr8] extends due S from [gpr7] from between 14 and 26ns (0.77 to 1.43m) and, no doubt, represents the extension of the wall bounding the passageway from the cult room recorded in part by Meates (1979). Some evidence for stub walls parallel to [gpr8] are also found heading E.

To the S a more subtle linear anomaly [gpr9] is found between 12 and 13ns (0.66 to 0.72m) and this is replicated at greater depth by a series of more discrete areas of partial response apparently following this linear trend. Whilst [gpr9] may represent the remains of a robbed out wall footing, analysis of the individual profiles suggests the more amorphous response recorded from 30ns onwards could be due to surface air-wave reflections. Certainly, the linear anomaly [gpr10] originating between 30 and 37ns (1.65 to 2.04m) migrates laterally with depth from S to N with an equivalent velocity indicative of an air-wave reflection.

Some evidence for the projection of [gpr9] beyond the audience chamber is found between 16 and 26ns (0.88 to 1.38m) in the dining room together with an amorphous area of response [gpr11] between 15 and 20ns (0.83 to 1.1m). A similar anomaly [gpr12] is found in the audience chamber between 12 and 18ns (0.66 to 0.99m) adjacent to [gpr11] and may represent a response to a causative feature at the same depth, given the difference in floor levels in the two rooms. Deeper time slices beyond 30ns (1.65m) apparently show some additional detail in the dining room, including a tentative apsidal area of low magnitude response. However, these anomalies may well be due to air-wave reflections and do not correlate directly with significant reflections identified in the relevant individual profiles (*cf* Figure 3).

CONCLUSION

The survey has successfully identified a number of linear anomalies apparently related to previous wall-footings underlying the audience chamber mosaic to the N and E, where a passageway from the adjoining deep cult room was partially known. The linear anomaly to the N accords with the discontinuity in the mosaic surround, suggesting an additional phase of development occurred resulting in the enlargement of this room. Evidence for a similar wall-footing along the southern edge of the mosaic is not so well defined and is, perhaps, partially confused by the presence of anomalies due to air-waves in the later time slices (beyond approximately 30ns), possibly due to reflections from the overlying metal roof covering. The data from the adjacent dining room is also not so well resolved due to the lower spatial sampling density in this area necessitated by the limited time available for the survey. Some discrete very near-surface anomalies may indicate areas of potential delamination of the tesserae.

LIST OF ENCLOSED FIGURES

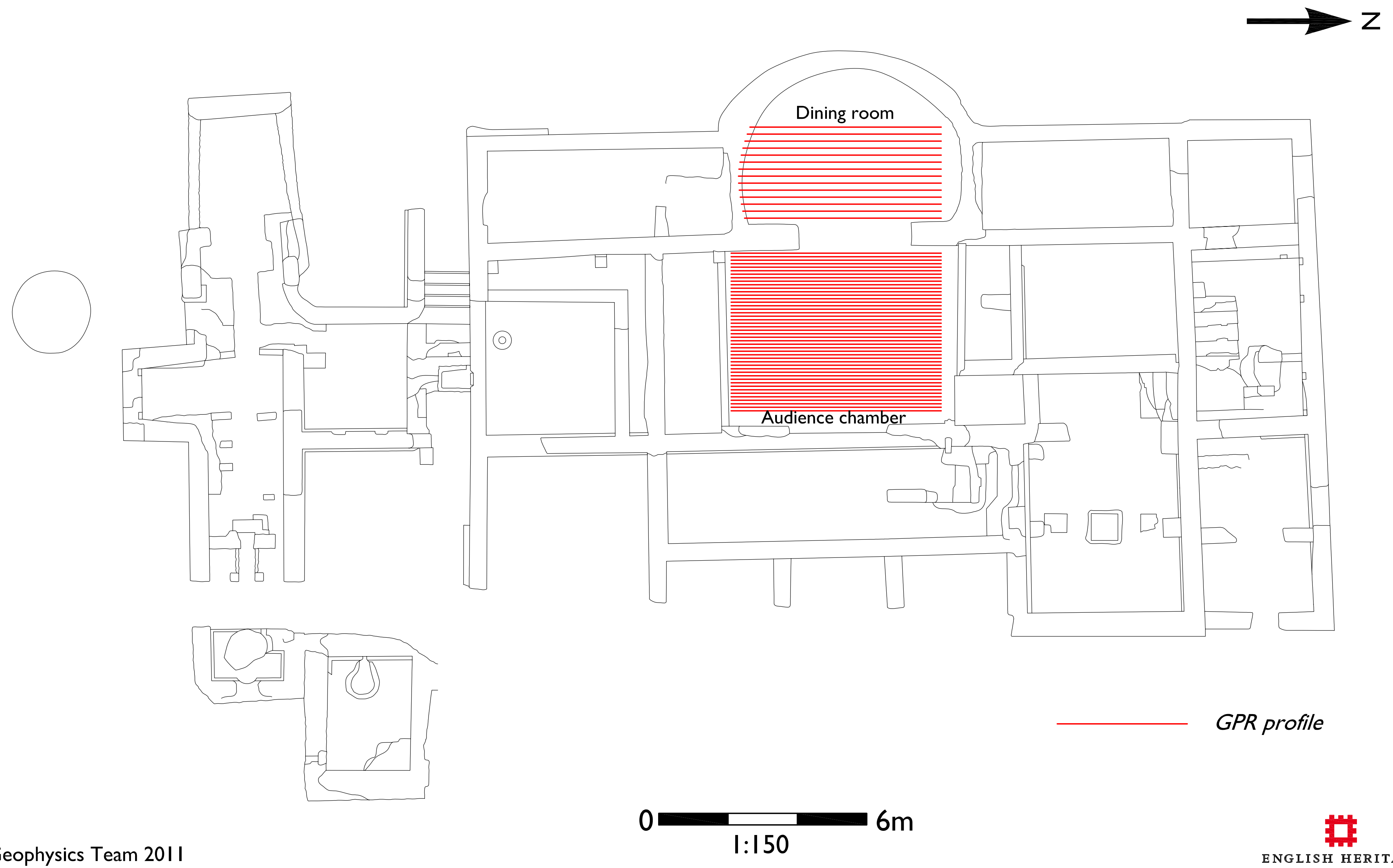
REFERENCES

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.

Meates, G W 1979 *The Lullingstone Roman Villa. Volume I – The Site*, Maidstone, Kent Archaeological Society

LULLINGSTONE ROMAN VILLA, KENT
Location of GPR survey, January 2011.

Figure 1



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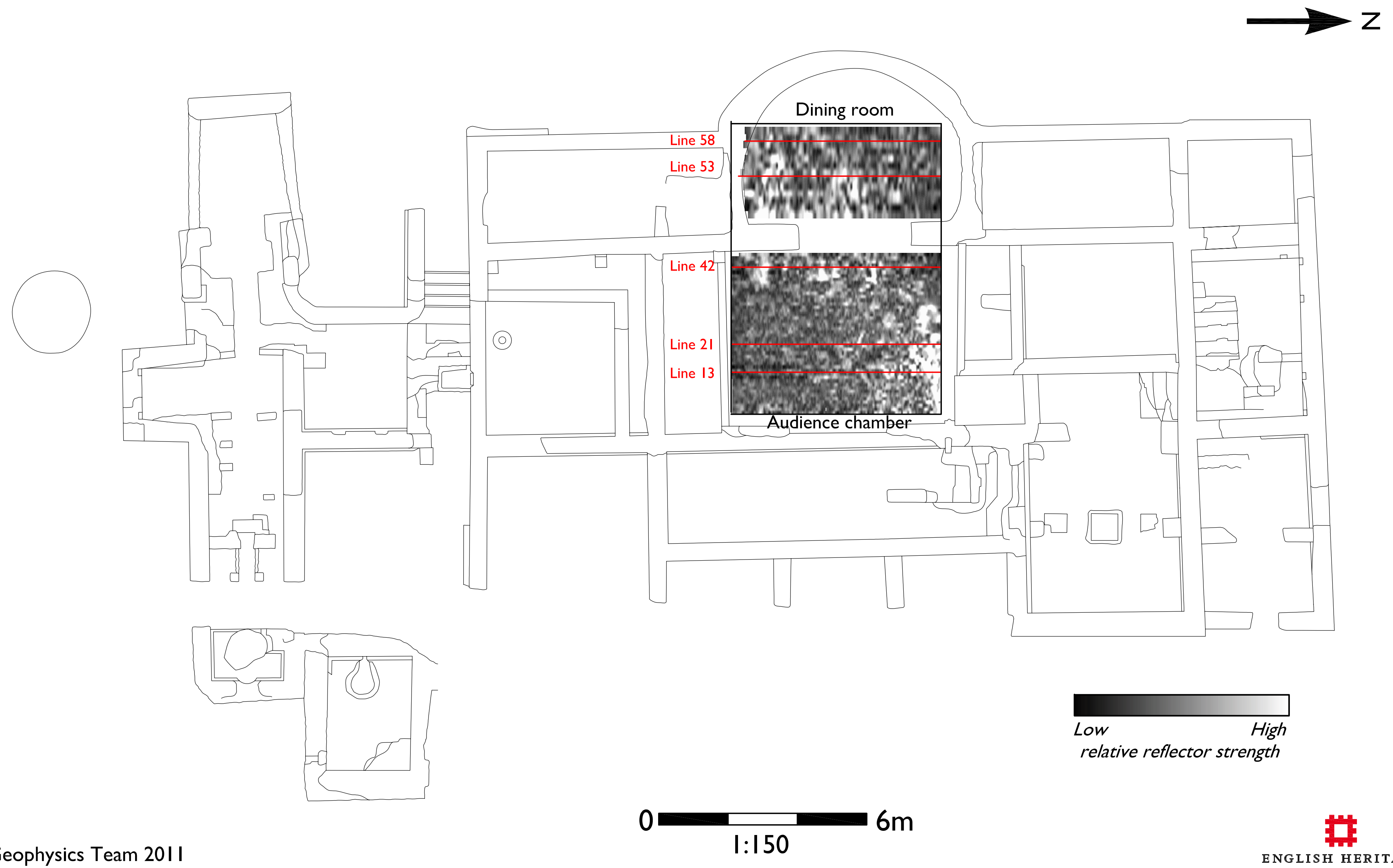
LULLINGSTONE ROMAN VILLA, KENT

GPR amplitude time slice between 17.0 and 18.0ns (0.94 to 0.99m).

Figure 2



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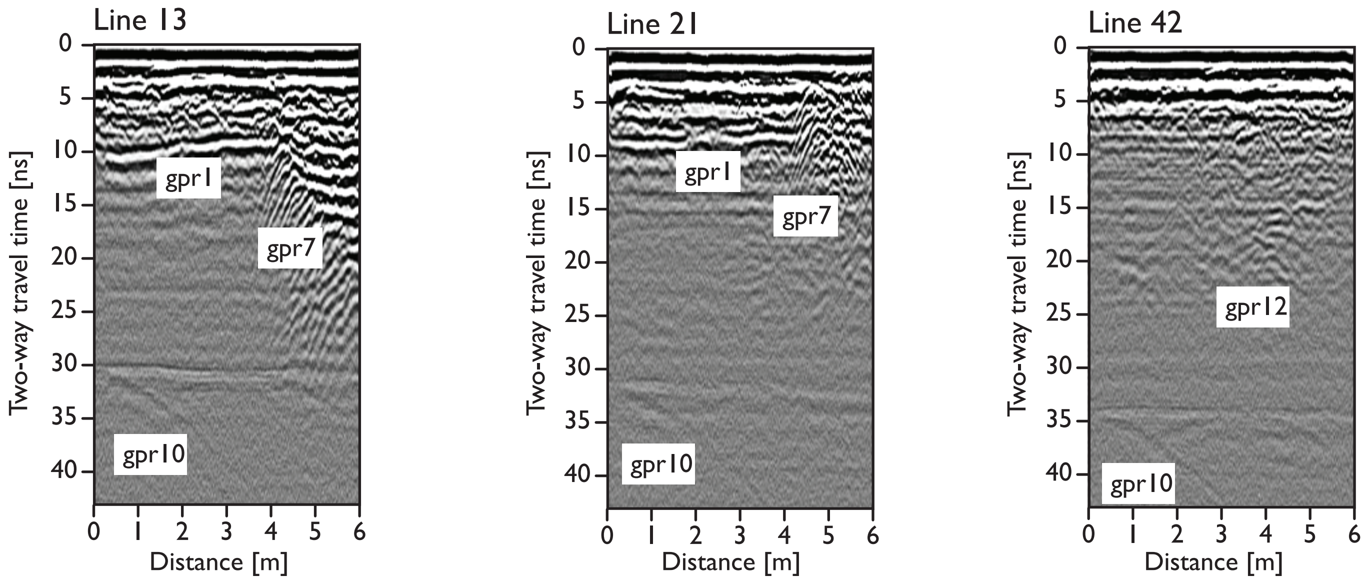
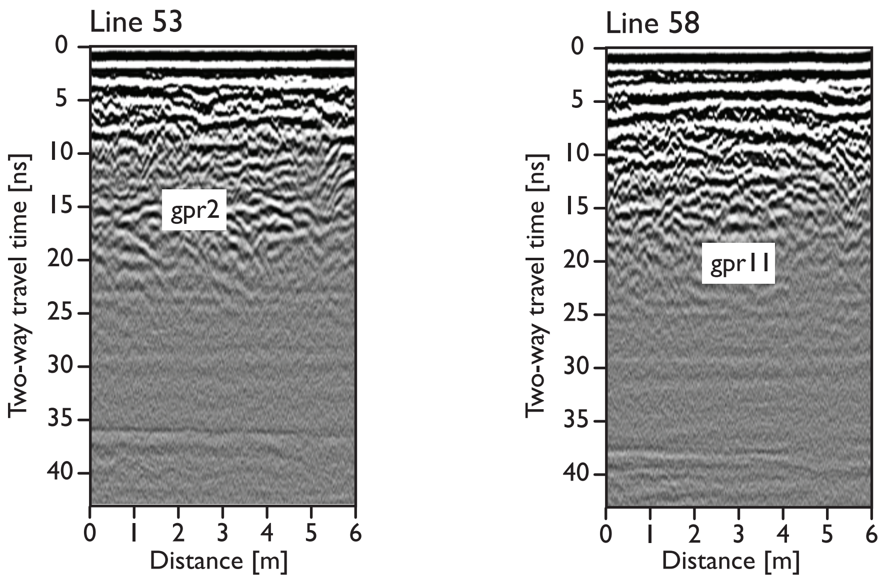
LULLINGSTONE ROMAN VILLA, KENT.
Selected GPR profiles

Figure 3

Audience chamber



Dining room



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GPR amplitude time slices from 0.0 to 21.0ns, January 2011.

Figure 4

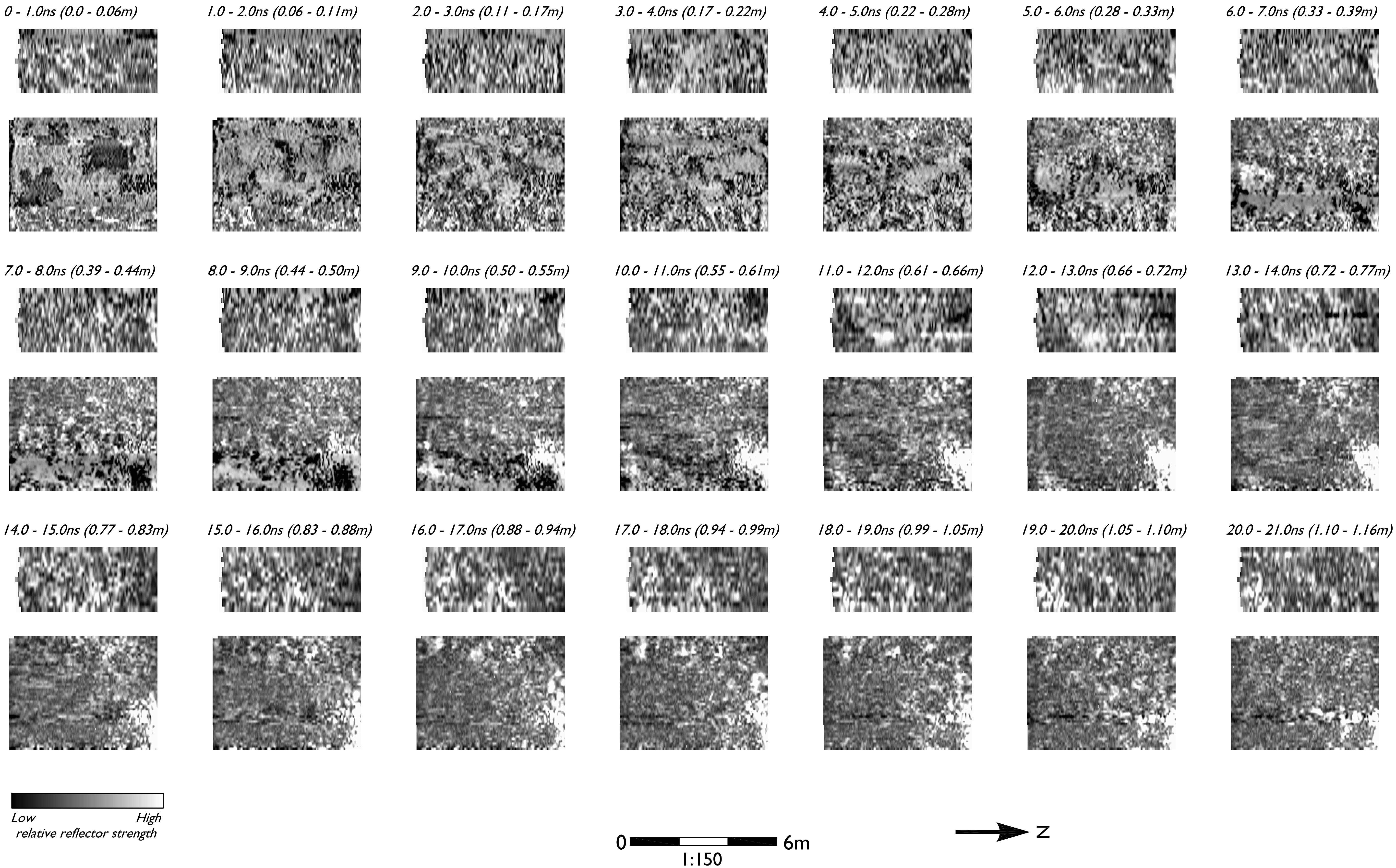

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Figure 5

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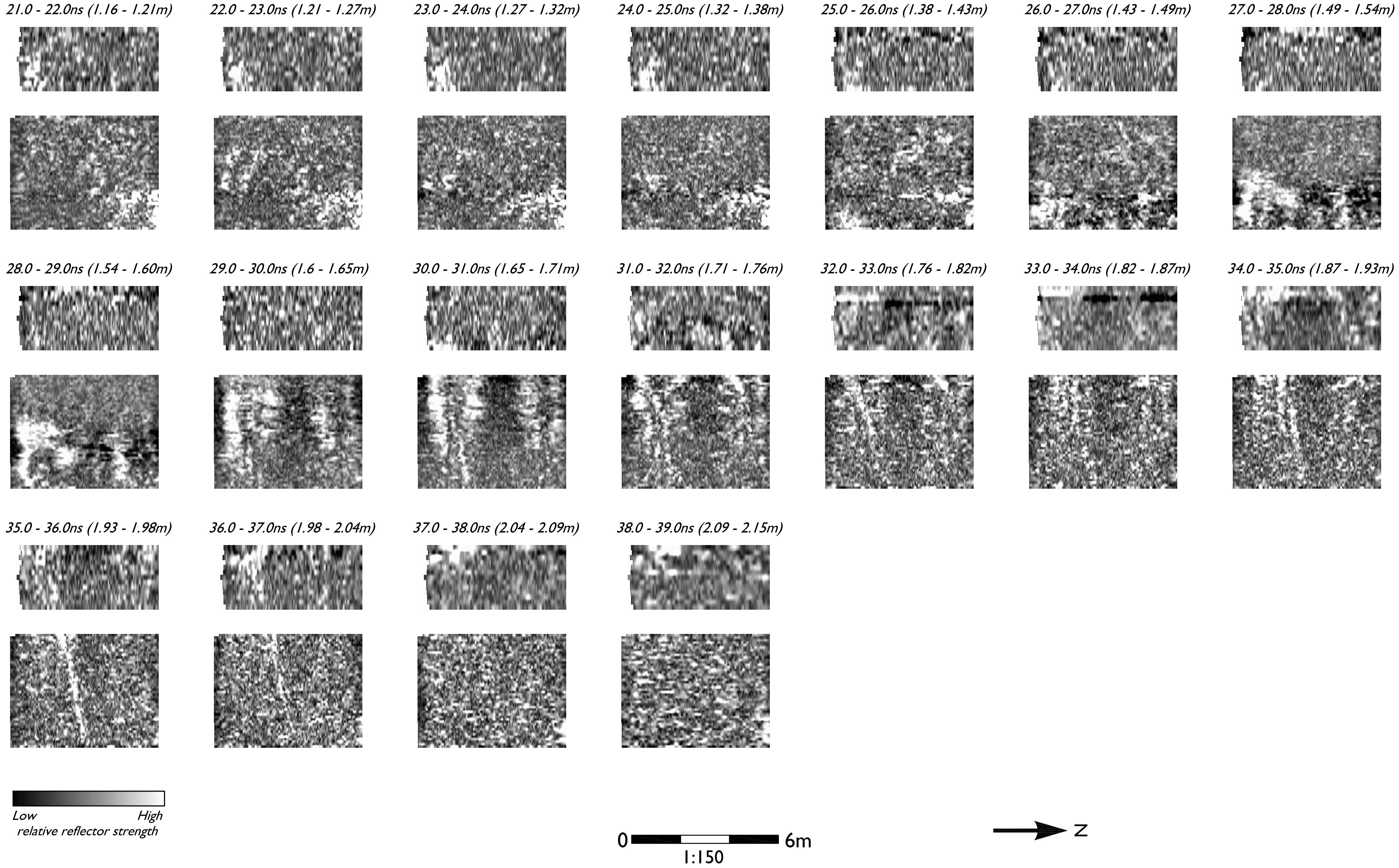
GPR amplitude time slices from 21.0 to 39.0ns, January 2011.



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LULLINGSTONE ROMAN VILLA, KENT
Graphical summary of signifcant GPR anomalies

Figure 6

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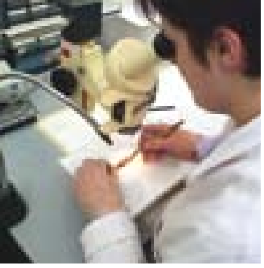
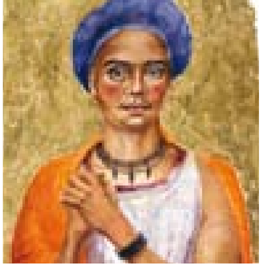



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