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Groundwell Ridge, Blunsdon St. Andrew, Swindon. Report on ground penetrating radar survey, July 2002

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Summary

A limited trial GPR survey was conducted over well preserved building remains revealed during a previous geophysical survey covering an apparent complex of Roman activity discovered, unexpectedly, at Groundwell Ridge to the north of Swindon in 1996. Despite unfavourable, clay-rich soil conditions the GPR survey provided a detailed plan of the Roman remains to a depth of approximately 1m, confirming their survival in the very near surface. The GPR results complement the previous earth resistance and magnetic surveys and together the data suggests the presence of a high status Roman building possibly incorporating thermoremanent features, for instance associated with a hypocaust system.

Keywords

Geophysics

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GROUNDWELL RIDGE, BLUNSDON ST. ANDREW, SWINDON.

Report on ground penetrating radar survey, July 2002.

Introduction

Following the unexpected discovery of a substantial Roman site at Groundwell Ridge to the north of Swindon in 1996 the site was further investigated through both topographic (Corney 1997) and geophysical surveys (Linford 1996, Linford 1997, Linford and Martin 2002). This work led to the statutary protection of the site and its removal from plans to include this area in an encroaching housing estate development. The geophysical results identified the location of near surface Roman buildings and it was proposed that these might be better defined through investigation with a ground penetrating radar (GPR) survey. Given the disappointing results that might be expected from a GPR survey over a highly conductive, clay-rich soil a limited 60m square was surveyed encompassing one of the suspected Roman buildings identified in the previous resistivity survey. The aim of this survey was to test the response of GPR over the site and provide additional geophysical results for presentation as part of the National Archaeology Day held at the site on Sunday 21st July 2002.

The site (NGR: SU 141 894) lies on what would appear to be a series of deliberately landscaped terraces cut into the south-facing slope of the Groundwell ridge. This ridge of Corallian "Coral Rag" limestone meets Oxford Clay towards the bottom of the slope with the two separated by a thin layer of sand and gravel (Geological Survey of Great Britain 1974), through which springs issue. Shallow, well drained, brashy calcareous clayey soils of the Sherborne (343d) association have developed over both the limestone and clay (Soil Survey of England and Wales, 1983). The lower-most terrace, including the location of a suspected Roman building identified in the previous geophysical results, was chosen for the trial GPR survey.

Method

Field trials were conducted with a Pulse Ekko PE1000 console and antenna with centre frequencies of 450MHz and 225MHz. From this data the 450MHz antenna was selected as the most suitable centre frequency for obtaining the optimum depth of penetration and lateral resolution required. The velocity of the radar wavefront in the subsurface was estimated through a common mid-point (CMP) velocity analysis conducted in the field and a constant velocity test subsequently performed on extracts of the data (Leckebusch 2000). Both methods suggested that a velocity of 0.065 m/ns was a reasonable average value to adopt for processing the data from this site and for the estimation of depth to reflection events in the recorded profiles.

The 60m survey grid, established with a Trimble kinematic differential geographical positioning system (GPS), was surveyed with parallel EW traverses separated by 0.5m resulting in a total of 120 recorded GPR profiles (Figure 1). Individual traces along each profile were separated by 0.05m. Post acquisition processing 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). Amplitude time slices were subsequently created from the entire data set, after applying a 2D-migration algorithm, by averaging data within successive 2ns (two-way travel time) windows (David and Linford 2000; Sensors and Software 1996).

Representative individual profiles are displayed in Figure 3 together with annotation identifying significant anomalies discussed in the following text. However, the identification of significant reflection events is greatly enhanced through the display of data as a series of horizontal amplitude time-slices. In this case, the data is illustrated as greyscale images produced from all of the combined GPR profiles (Figure 4) presented together with both earth resistance and magnetic data from the same area. Each time-slice represents the variation of reflection strength at successive 2ns (~0.065m) intervals from the ground surface.

A graphical summary of significant anomalies is also provided with numerical annotation that refers to the following discussion of the results (Figure 5).

Results

Despite the high clay content of the soil the site responded well to GPR survey and significant reflections were recorded to a maximum two-way travel time of approximately 30ns, equating to a penetration depth of ~1m.

A number of anomalies are evident in the data related to surface features or the topography of the site. These include the compacted soil associated with the unmarked track [1] traversing the site and the edge of the apparently deliberate terracing [2] on which the building sits. A faint linear anomaly [3] is also found in the near surface time-slices following the course of the ferrous pipe identified during the magnetometer survey. This latter anomaly fades at a depth of ~0.3m before a more coherent, higher amplitude response returns between ~0.5 to 0.8m. It seems likely that the GPR survey has resolved both disturbance associated with the top of the pipe trench and a much stronger reflection at a greater depth due to the location of the ferrous pipe itself.

More significant near surface anomalies include the outline of a Roman building [4] with wall foundations that apparently rise close to the current ground surface. The building has a rectangular outline 20m by 15m and appears to consist of two winged corridors with a larger central room to the south of the structure. Additional structure to the building becomes apparent within the deeper time-slices from a depth of ~0.5m to ~1.0m where the clarity of the data becomes impaired. Tests made on the site suggest that the maximum depth resolution of ~1m with a 450MHz antenna is due to signal attenuation within the clay-rich soil and it is possible, therefore, that the remains of the building extend beyond this depth.

Comparison with the earth resistance and magnetic data demonstrates a general agreement regarding the extent of the building. However, the GPR data provides considerably improves the internal detail of the building allowing individual room divisions to be identified. In addition, the magnetic data indicates a concentration of enhanced magnetic response (>10nT) enclosed by the footprint of the building. Whilst this may be due to more recent ferrous disturbance it is possible that this represents the effects of thermoremanent features, for

instance associated with a hypocaust system.

A series of other linear anomalies are also found at a similar depth to the remains of the building including a wall or track-way [5] and a possible walled enclosure [6]. Both these latter anomalies respect the alignment of [4], with the track-way running NS to the W and the enclosure apparently abutting the Roman building to the E. However, the location of the enclosure is partly obscured in the very near surface data by the course of the modern track [1]. A further extension to the enclosure may be found to the N of the building at [7] suggesting, perhaps, a wider complex of enclosed courtyards.

Less substantial linear anomalies that fail to respect the orientation of the Roman building are found at [8], [9], [10] and [11]. Anomaly [10] appears as a linear negative response in the magnetic data and as a low amplitude reflector from 10 to 14ns in the GPR time-slices. This suggests a ditch-type causative feature, possibly a recent service trench containing a non-ferrous pipe or cable. The near surface soil disturbance has been detected as a low amplitude response by the GPR with the cable or pipe apparently detected as a stronger reflector at a similar depth (14 to 18ns) to [3]. Anomaly [11] appears as a more substantial reflection between 10 to 16ns and correlates with a tentative ferrous response within the magnetic data suggesting it too may represent a more recent service, although a more significant interpretation cannot be entirely dismissed.

Conclusion

GPR survey at this site has proved to be highly successful despite the presence of unfavourable, clay-rich soils. This is, in part, due to the near surface nature of the apparently very well preserved Roman remains at the site. However, the maximum depth of investigation provided by the 450MHz centre frequency antenna employed does not, necessarily, indicate the full extent of the surviving remains that may well extend beyond the indicated depth of at least 1m. Both the GPR and earth resistance data suggest better survival of walls in the southern part of the building. Additional GPR survey with a lower centre frequency antenna might resolve the depth of the structure further but this would be at the expense of the lateral resolution provided by the current data.

The GPR survey also complements the earth resistance and magnetic data previously collected over the site revealing additional detail both within the Roman building and its immediate surroundings. The size, division into multiple rooms and possible association with a thermoremanent feature suggest a high status building incorporating a hypocaust, such as an extended aisled villa. Given the apparent ritual significance of the surrounding Roman activity interpretation as a public building such as a mansio or, perhaps, bath house utilising the head of water developed from the spring line issuing from the top of the ridge should also be considered. However, the size of the building revealed by the geophysical survey is, perhaps, too small to confidently support either of the latter interpretations and the internal room divisions do not appear to follow the sequential layout expected from a bath house (P. Wilson *pers comm*). Although more limited in extent, the GPR survey corroborates the earth resistance data suggesting a series of walled enclosures and track-ways associated with the building, that perhaps extend throughout the complex of high status Roman buildings revealed through out this site.

Surveyed by:	N Linford P Linford	Date of survey:	15-17/07/2002
Reported by:	N Linford	Date of report:	4/09/2002

Archaeometry Branch,
English Heritage Centre for Archaeology.

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List of enclosed figures

Figure 1 Survey location plan (1:1250).

Figure 1; GROUNWELL RIDGE, BLUNSDON ST. ANDREW, SWINDON
Location of Ground Penetrating Radar survey, July 2002

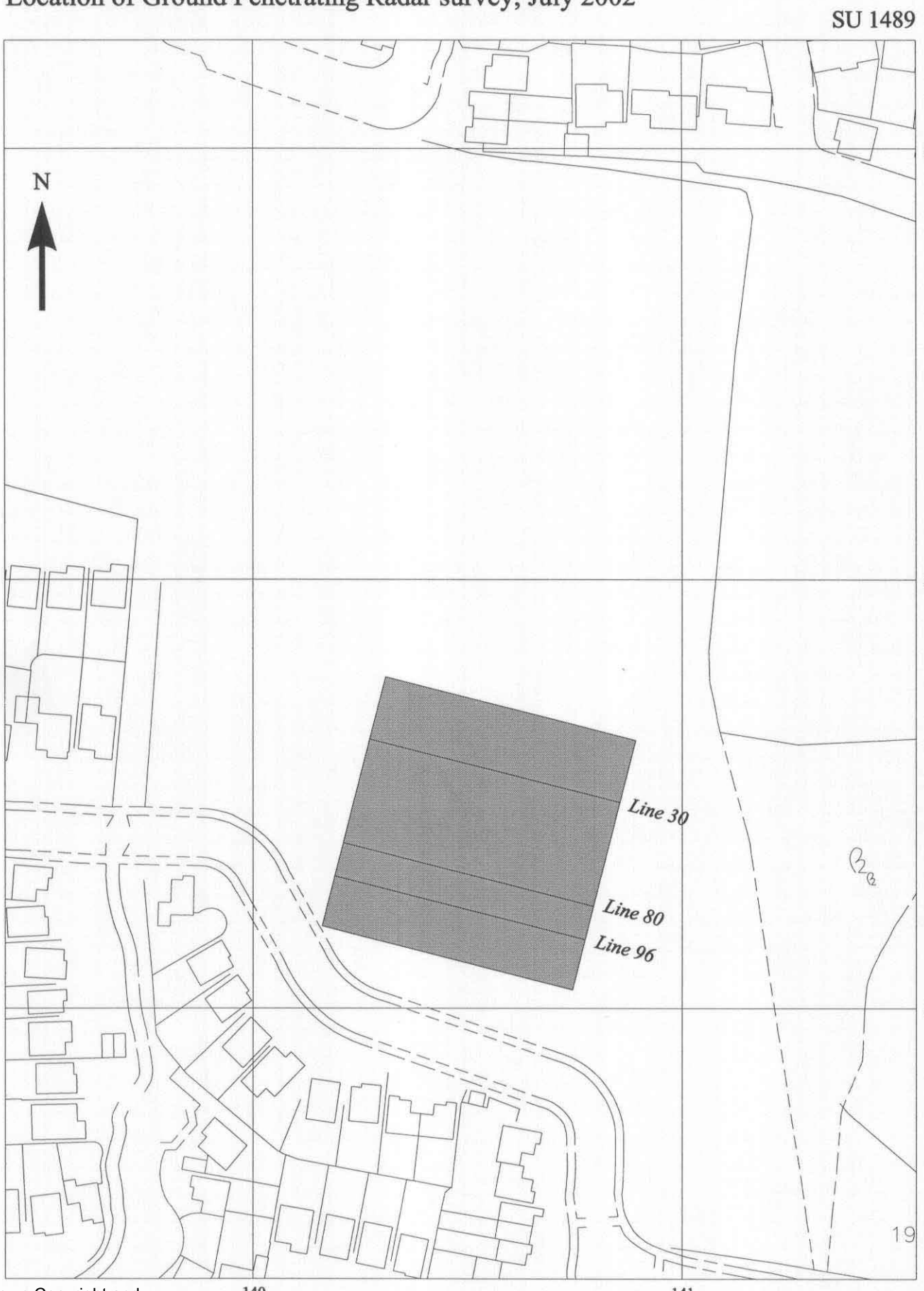


Figure 2; GROUNWELL RIDGE, BLUNSDON ST. ANDREW, SWINDON
Location of Ground Penetrating Radar survey, July 2002

Figure 3; GROUNDWELL RIDGE, BLUNSDON ST. ANDREW, SWINDON
Representative GPR profiles showing anomalies identified in the text.

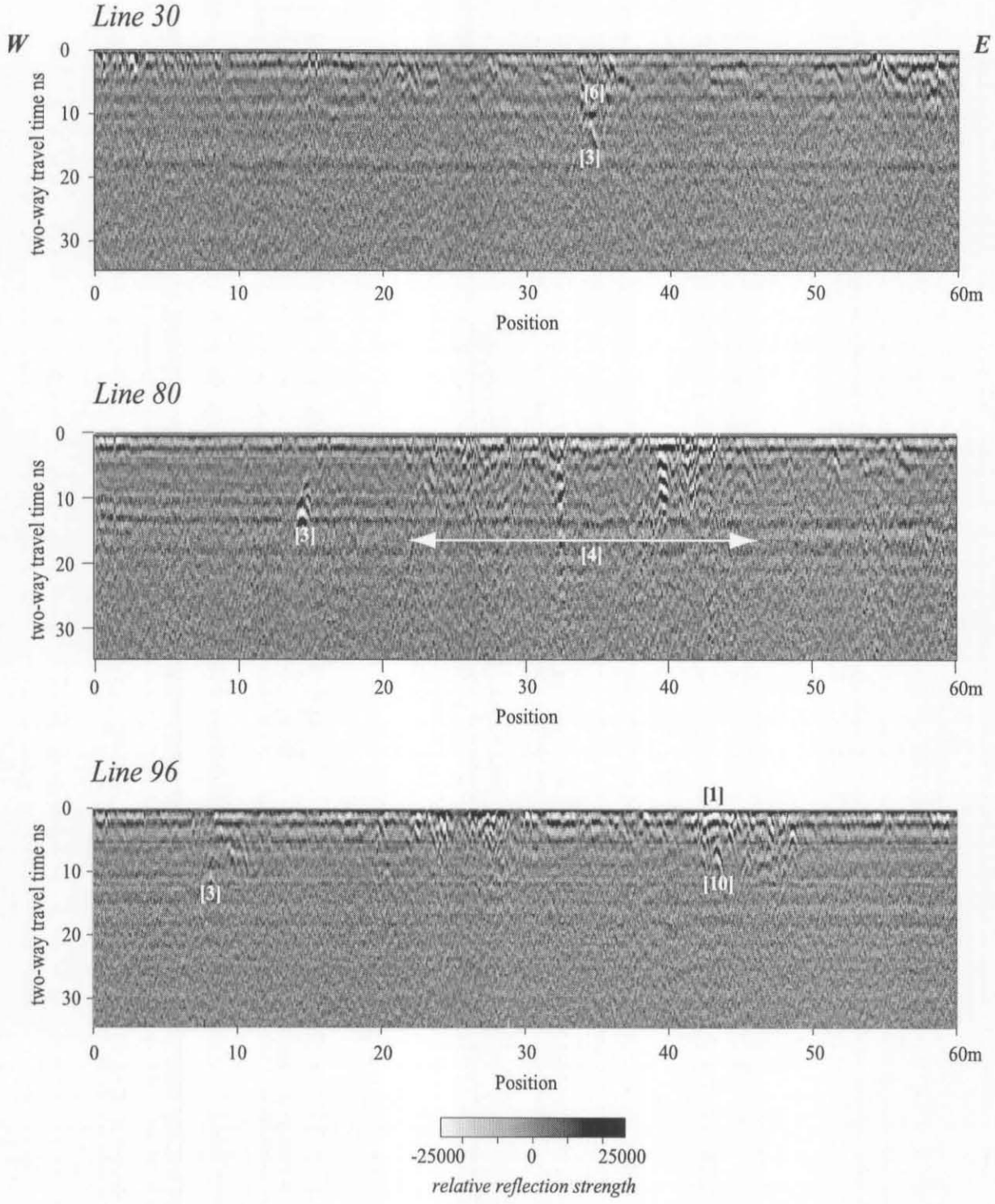
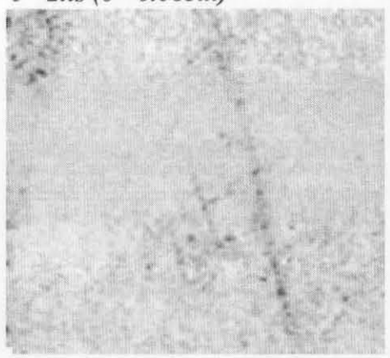
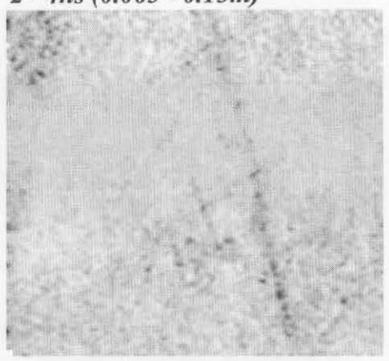


Figure 4; GROUNDWELL RIDGE, BLUNSDON ST. ANDREW, SWINDON
GPR Amplitude time slices

0 - 2ns (0 - 0.065m)



2 - 4ns (0.065 - 0.13m)

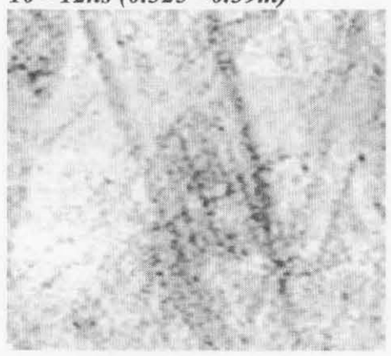


4 - 6ns (0.13 - 0.195m)

6 - 8ns (0.195 - 0.26m)

8 - 10ns (0.26 - 0.325m)

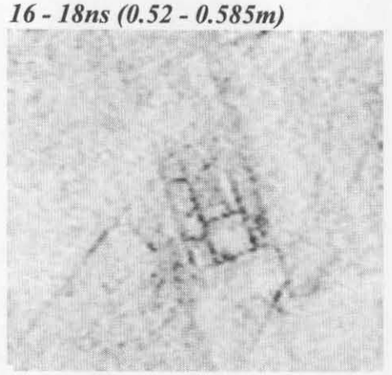
10 - 12ns (0.325 - 0.39m)



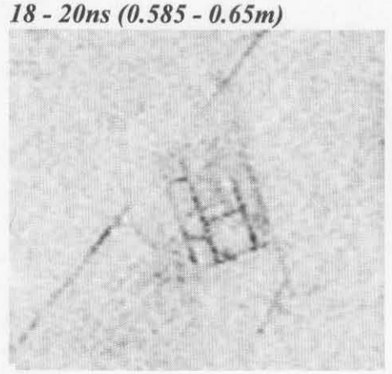
12 - 14ns (0.39 - 0.455m)

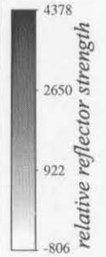
14 - 16ns (0.455 - 0.52m)

16 - 18ns (0.52 - 0.585m)

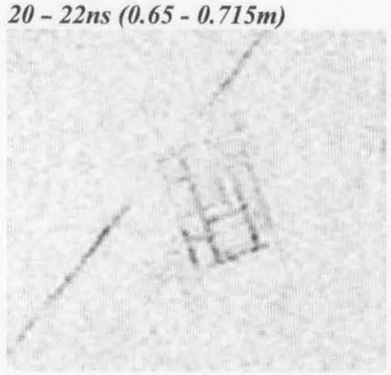


18 - 20ns (0.585 - 0.65m)

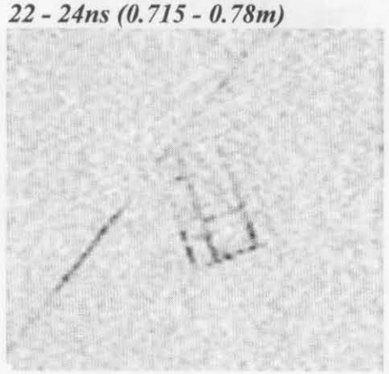




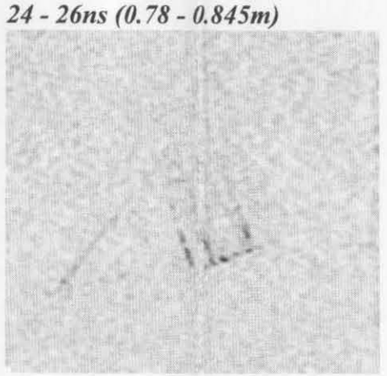
20 – 22ns (0.65 - 0.715m)



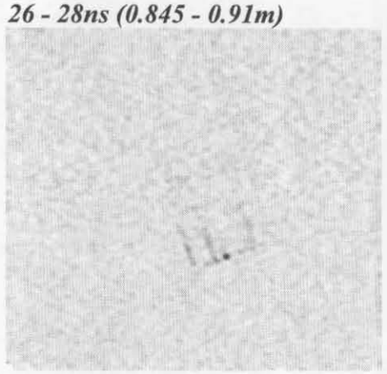
22 - 24ns (0.715 - 0.78m)



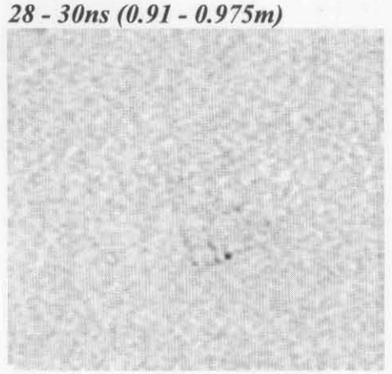
24 - 26ns (0.78 - 0.845m)



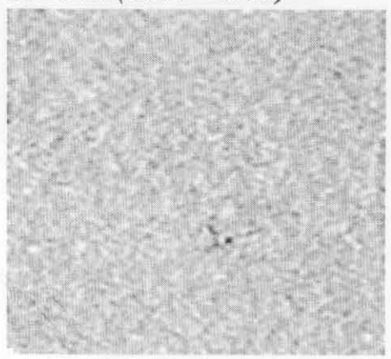
26 - 28ns (0.845 - 0.91m)



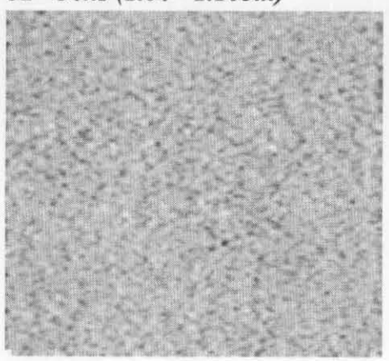
28 - 30ns (0.91 - 0.975m)



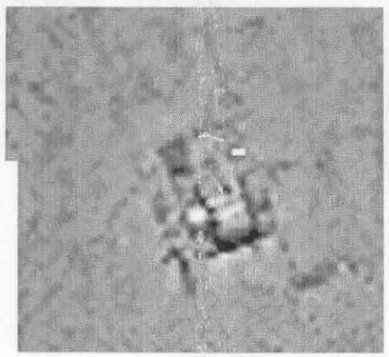
30 - 32ns (0.975 - 1.04m)



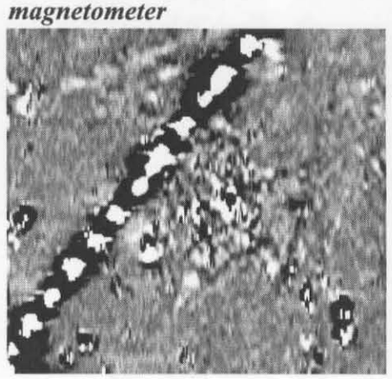
32 - 34ns (1.04 - 1.105m)



Earth resistance



magnetometer



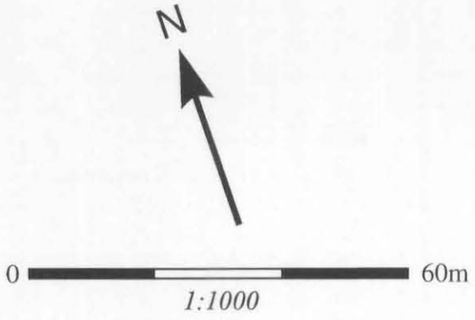


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Figure 5; GROUNWELL RIDGE, BLUNSDON ST. ANDREW, SWINDON
Location of Ground Penetrating Radar survey, July 2002

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