STRATASCAN

Geophysical Survey Report

Arkenside Hotel, Cirencester

For

Oxford Archaeology

May 2005

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REGISTERED IFA ORGANISATION

Document Title:	**Geophysical Survey Report** **Arkenside Hotel, Cirencester**
Client:	**Oxford Archaeology**
Stratascan Job No:	**1959**
Techniques:	**Ground Probing Radar**
National Grid Ref:	**SP 027 018**

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1 SUMMARY OF RESULTS

A ground penetrating radar survey was carried out in, and around Arkenside Hotel, Cirencester. The area surveyed totalled around 0.28ha.

The survey has identified anomalies across the site which are likely to represent structural remains. Rectilinear anomalies have been identified which may correspond to Victorian features around No. 15 and to the rear of the hotel. Complex anomalies have been located in the hotel basement which may have an archaeological origin. The drive way contains long planar responses suggesting the presence of a former surface. The possible position of the well next to No.15 has also been defined.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned to undertake a geophysical survey of an area outlined for development. This survey forms part of an archaeological investigation being undertaken by Oxford Archaeology.

2.2 Site location

The site is located at Arkenside Hotel, Cirencester and 15, The Avenue, Cirencester, at OS NGR ref. SP 027 018.

2.3 Description of site

The site is composed of several areas totalling 0.28ha, much of which is scheduled. This is split between the grounds of the hotel, the gardens and driveway of 15, The Avenue, and 11 rooms in the hotel basement.

The underlying geology is Cornbrash (a type of limestone) from the Jurassic Period (British Geological Survey South Sheet, Third Edition Solid, 1979). The overlying soils are unsurveyed due to the urban environment (Soil Survey of England and Wales, Sheet 5 South West England).

2.4 Site history and archaeological potential

Much of the site is within the boundary of a scheduled ancient monument.

The drive way to No.15, The Avenue is thought to contain a mosaic floor (Weaver, pers comm., 2005). No further specific details were available.

2.5 Survey objectives

The objective of the survey was to locate any anomalies that may be of archaeological origin.

2.6 Survey methods

The survey method used was ground probing radar (GPR).

More information regarding this technique is included in the Methodology section below.

3 METHODOLOGY

3.1 Date of fieldwork

The fieldwork was carried out over 5 days from 29th March 2005 to 1st April 2005. During this time the weather was mixed.

3.2 Grid locations

The location of GPR traverses has been plotted together with the referencing information (e.g. Figure 2).

3.3 Description of techniques and equipment configurations

Two of the main advantages of radar are its ability to give information of depth as well as work through a variety of surfaces, even in cluttered environments and which normally prevent other geophysical techniques being used.

A short pulse of energy is emitted into the ground and echoes are returned from the interfaces between different materials in the ground. The amplitude of these returns depends on the change in velocity of the radar wave as it crosses these interfaces. A measure of these velocities is given by the dielectric constant of that material. The travel times are recorded for each return on the radargram and an approximate conversion made to depth by calculating or assuming an average dielectric constant (see below).

Drier materials such as sand, gravel and rocks, i.e. materials which are less conductive (or more resistant), will permit the survey of deeper sections than wetter materials such as clays which are more conductive (or less resistant). Penetration can be increased by using longer wavelengths (lower frequencies) but at the expense of resolution (see 3.4.2 below).

As the antennae emit a "cone" shaped pulse of energy an offset target showing a perpendicular face to the radar wave will be "seen" before the antenna passes over it. A resultant characteristic *diffraction* pattern is thus built up in the shape of a hyperbola. A classic target generating such a diffraction is a pipeline when the antenna is travelling across the line of the pipe. However it should be pointed out that if the interface between the target and its surrounds does not result in a marked change in velocity then only a weak hyperbola will be seen, if at all.

The Ground Probing Impulse Radar used was a SIR2000 system manufactured by Geophysical Survey Systems Inc. (GSSI).

The radar surveys were carried out with both 200MHz and 400MHz antennae. This offers a good combination of depth of penetration and resolution.

3.4 Sampling interval, depth of scan, resolution and data capture

3.4.1 Sampling interval

Radar scans were carried out along traverses 0.5m apart on a parallel grid as shown in Figure 3. Data was collected at 60 scans/metre. A measuring wheel was used to put markers into the recorded radargram at 1m centres.

3.4.2 Depth of scan and resolution

The average velocity of the radar pulse is calculated to be 0.05m/ns which is typical for the type of sub-soils on the site. With a range setting of 100ns for both antennae this equates to a maximum depth of scan of 2.5m respectively but it must be remembered that this figure could vary by ± 10% or more. A further point worth making is that very shallow features are lost in the strong surface response experienced with this technique.

Under ideal circumstances the minimum size of a vertical feature seen by a 200MHz (relatively low frequency) antenna in a damp soil would be 0.1m (i.e. this antenna has a wavelength in damp soil of about 0.4m and the vertical resolution is one quarter of this wavelength). It is interesting to compare this with the 400MHz antenna, which has a wavelength in the same material of 0.2m giving a theoretical resolution of 0.05m. A 900MHz antenna would give 0.09m and 0.02m respectively.

3.4.3 Data capture

Data is displayed on a monitor as well as being recorded onto an internal hard disk. The data is later downloaded into a computer for processing.

3.5 Processing, presentation of results and interpretation

3.5.1 Processing

The radar plots included in this report have been produced from the recorded data using Radan software. Some radargrams have been subject to an FIR filter to remove background noise.

3.5.2 Presentation of results and interpretation

Manual abstraction
Each radargram has been studied and those anomalies thought to be significant were noted and classified as detailed below. Inevitably some simplification has been made to classify the diversity of responses found in radargrams.

i. Strong and weak discrete reflector.
These may be a mix of different types of reflectors but their limits can be clearly defined. Their inclusion as a separate category has been considered justified in order to

emphasise anomalous returns which may be from archaeological targets and would not otherwise be highlighted in the analysis.

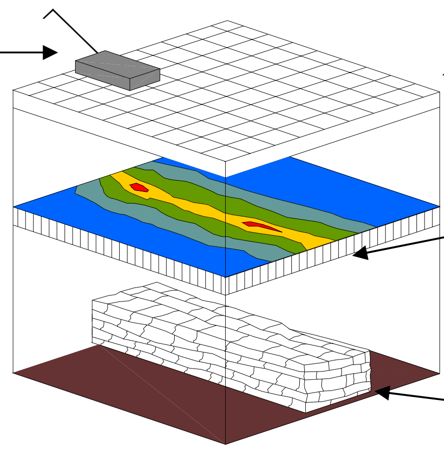
ii. Complex reflectors.
These would generally indicate a confused or complex structure to the subsurface. An occurrence of such returns, particularly where the natural soils or rocks are homogeneous, would suggest artificial disturbances. These are subdivided into both strong and weak giving an indication of the extent of change of velocity across the interface, which in turn may be associated with a marked change in material or moisture content.

iii. Point diffractions.
These may be formed by a discrete object such as a stone or a linear feature such as a small diameter pipeline being crossed by the radar traverse (see also the second sentence in 4. below).

iv. Convex reflectors and broad crested diffractions.
A convex reflector can be formed by a convex shaped buried interface such as a vault or very large diameter pipeline or culvert. A broad crested diffraction as opposed to a point diffraction can be formed by (for example) a large diameter pipe or a narrow wall generating a hybrid of a point diffraction and convex reflector where the central section is a reflection off the top of the target and the edges/sides forming diffractions.

v. Planar returns.
These may be formed by a floor or some other interface parallel with the surface. These are subdivided into both strong and weak giving an indication of the extent of change of velocity across the interface which in turn may be associated with a marked change in material or moisture content.

Timeslice plots
In addition to a manual abstraction from the radargrams, a computer analysis was also carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots (e.g. Figure 3). In this way it is easy to see if the high activity areas form recognisable patterns.



The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within range. The data was then modelled to produce activity plots at various depths. As the radar is actually measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Based on an average velocity calculations have been made to show the equivalent depth into the ground. The data was sampled between different time intervals effectively producing plans at different depths into the ground.

The weaker reflections in the time slice windows are shown as dark colours namely blues and greens. The stronger reflections are represented by brighter colours such as light green, yellow, orange, red and white (see key provided in e.g. Figure 3).

Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as foundations or surfaces within the soil matrix.

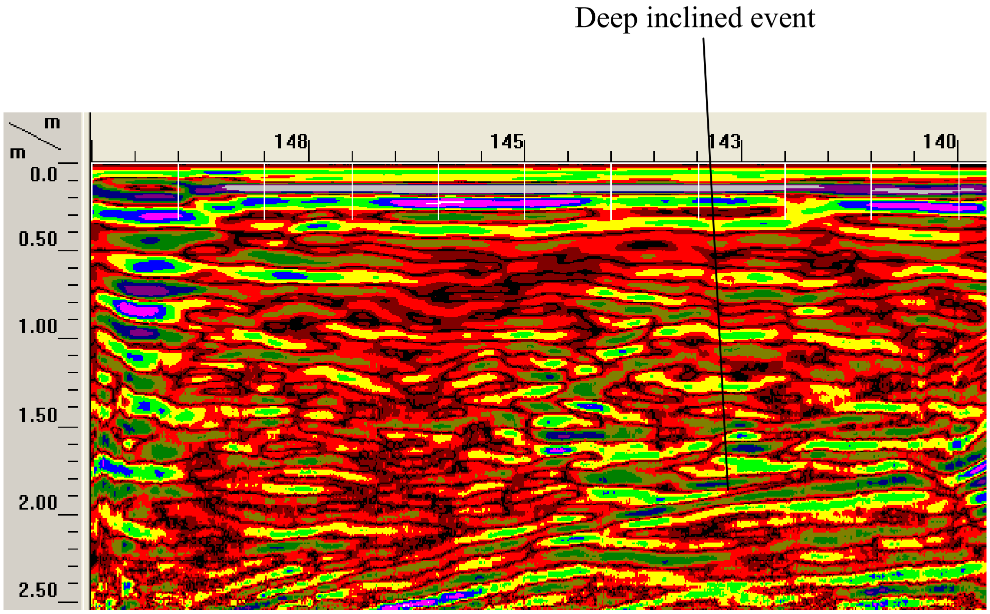
4 RESULTS

Geophysical anomalies have been identified which include the major categories of:

- Complex areas which may relate to structural remains of an archaeological origin
- Planar responses possibly related to archaeological horizons
- Planar responses of probable modern origin
- Complex areas which may have a modern origin - possibly associated with drainage

4.1 Arkenside Hotel area

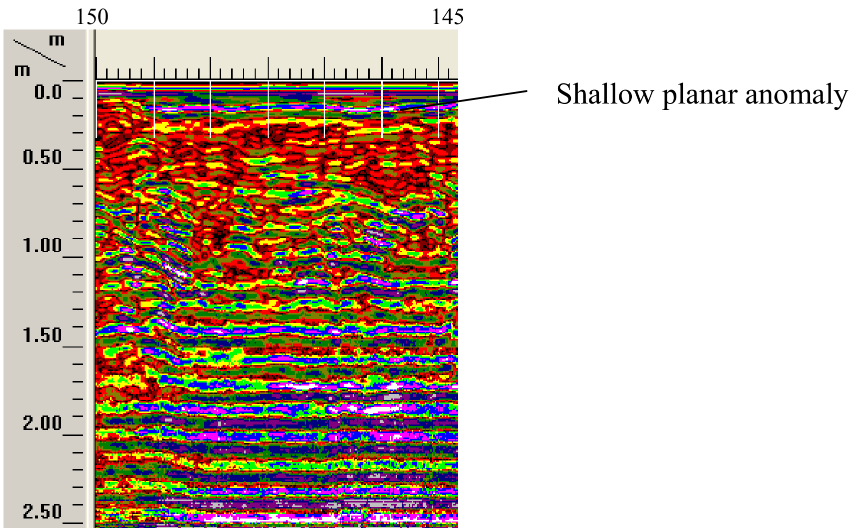
Immediately north of the hotel is an area of deep inclined events dipping away from the hotel (Example radargram 1). This seems to be mirrored by two areas just to the south of the hotel. While it is possible these are real anomalies caused by a buried dipping surface, it remains more likely they are caused by air waves. These occur when stray electromagnetic pulses are emitted through the air from the GPR antenna. They reflect off structures above ground and return back to the antenna where they are detected. Although the antenna used is shielded from this phenomenon under some circumstances it can still occur. The nature of these anomalies dipping away from the hotel suggest they may be the result air waves reflecting off the building above ground and are 'pseudo' anomalies and not caused by real buried features.



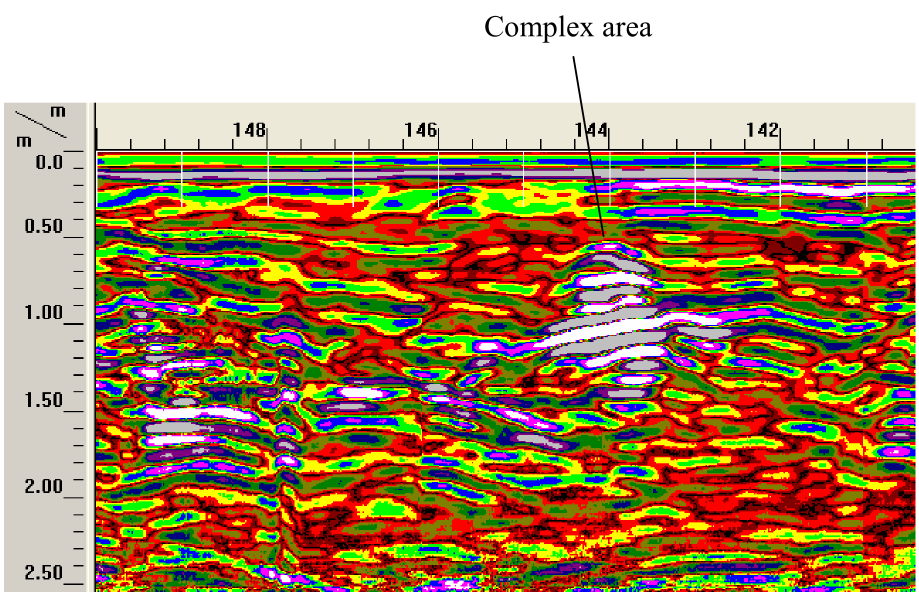
Example radargram 1. Transect 2E, chainage 150N – 140N (200MHz).

Overlying these 'pseudo' anomalies to the north east is an area of shallow planar anomalies (Example radargram 2). There is a further area of shallow planar responses adjacent to this. These are located only 0.12cm below the surface suggesting they are related to either the current road surface or a former surface.

Several manholes are known to be located at the front of the hotel. Linear anomalies have been defined which appear to consist of complex and discrete responses (Example radargram 3). The exact cause of these is unclear. Their nature suggests they may be related to structural remains, although their proximity and orientation towards manhole covers implies they may be caused by services.



Example radargram 2. Transect 12E, chainage 150N – 145N (400MHz).

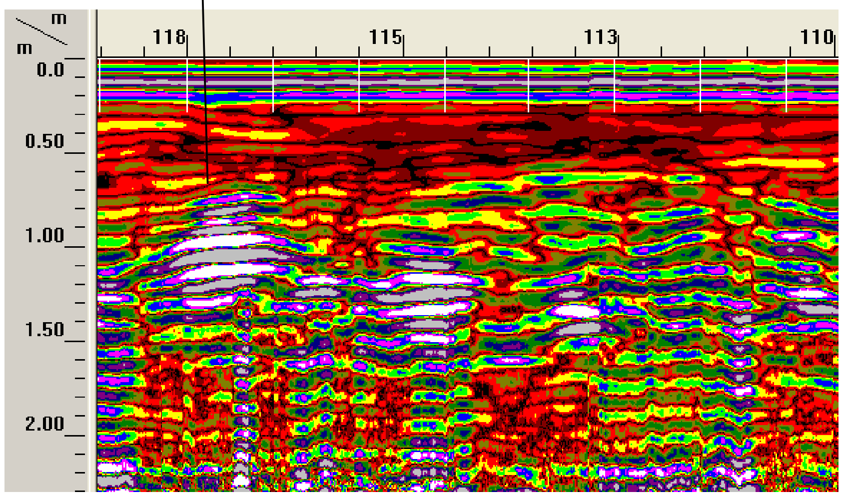


Example radargram 3. Transect 25E, chainage 150N – 141N (200MHz).

To the rear of the hotel the abstraction of the 200MHz data is very noisy with densely packed discrete and complex responses. The 400Mhz data however shows more clarity and less noise. This may be due to the 200MHz antenna having a reduced resolution giving the effect of joining together smaller, indistinct anomalies into larger discrete and complex responses.

Within this area 3 linear anomalies can be defined. The anomaly nearest the hotel can be seen in the data from both antennae and appears to be composed of complex and discrete responses (Example radargram 4).

Discrete response



Example radargram 4. Transect 18E, chainage 119N – 110N (200MHz).

This is typical of buried structural remains and is likely to represent a wall feature around 0.7m depth of archaeological origin. The 1878 Ordnance Survey map shows a linear feature in this area which may be represented by this anomaly (Appendix A).

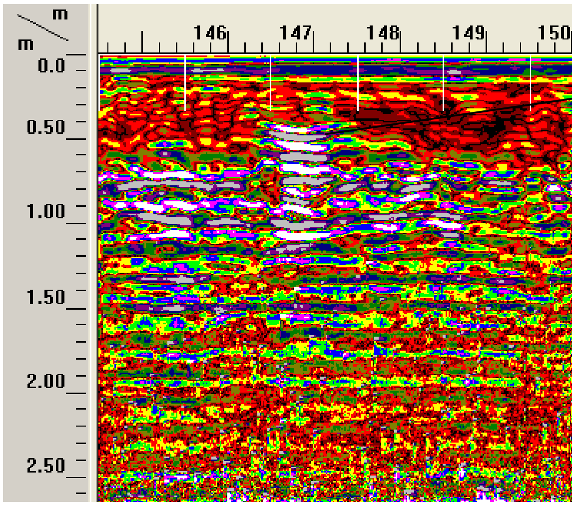
The two anomalies further south can be traced through many adjacent transects. They also consist of complex and discrete responses suggesting they may be structural remains. Their parallel form and similar size indicates they may be associated with each other.

Along with these three clear anomalies the timeslices have lead to the identification of a further linear anomaly in this area. Given the cluttered appearance in the data from this area it is not possible to rule out the presence of further linear and area anomalies which may have a structural origin.

4.2 <u>15, The Avenue</u>

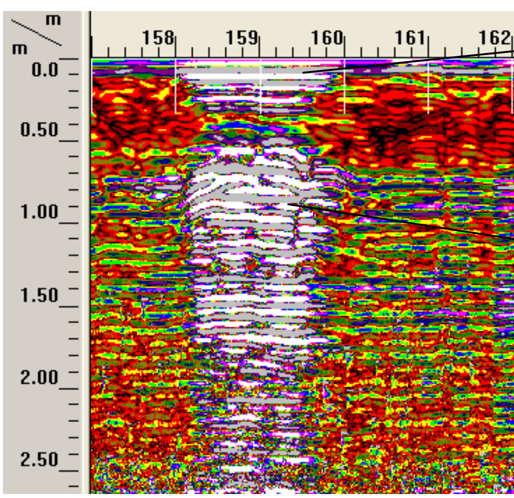
The timeslices from this area define clear linear anomalies which appear to form right angled corners. Closer inspection of the radargrams show these linear anomalies to be composed of discrete responses (Example radargram 5) occurring at around 0.5m depth. This is good evidence to suggest the presence of intact buried structural remains 0.5m below the surface. These anomalies may be correlated with features seen on the 1878 Ordnance Survey map suggesting they may have a Victorian origin (Appendix A).

Other complex areas are also observed spread around the bungalow, these may be structural remains of an archaeological origin.



Example radargram 5. Transect 155.5N, chainage 144.5E – 150E (400MHz).

There is an area south east of the bungalow which shows as a high amplitude response on the timeslice. Closer inspection of the radargrams shows this area to consist of many different types of anomaly. There are several conductive anomalies which are indicative of surface drains and manhole covers. Complex, discrete and planar anomalies are also observed which appear to be associated with these conductive anomalies (Example radargram 6).

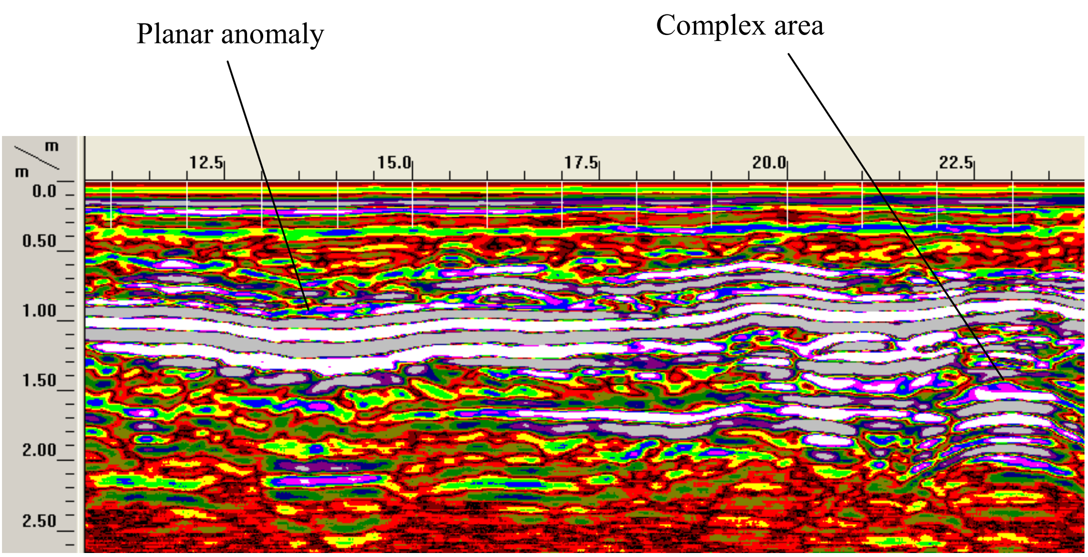


Example radargram 6. Transect 135N, chainage 157E – 162E (400MHz).

The deeper complex anomaly is likely to be an underground chamber associated with the drain, although the possibility of buried archaeology below the drain remains possible.

About 7m north of the drive way is a small area of discrete responses. Site notes record this as being the location of a concrete block covering a hole. This location also corresponds to the approximate position of a well. This provides strong evidence to support this for the position of the well.

The drive way leading to No. 15, is characterised by long planar anomalies which seem to be interspersed with areas of complex response (Example radargram 7). In some places these planar anomalies are bounded by inclined events dipping towards the planar response. Site history suggests the presence of a mosaic floor in this area. Given this information the planar responses may represent a floor surface while the more complex areas may suggest the presence of related structural remains. More structural remains may be present at the northern end of the drive.



Example radargram 7. Transect 0.8W, chainage 11S – 24S (200MHz).

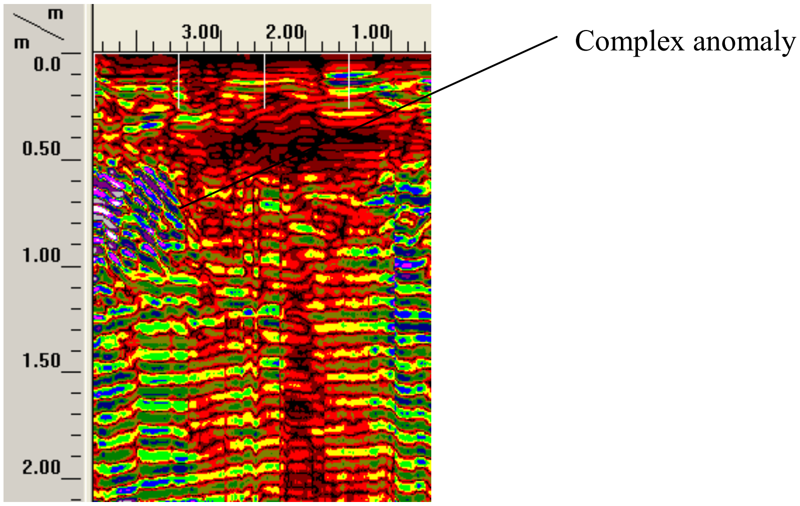
The southern end of the drive seems to contain conductive and complex responses which are probably caused by drains.

4.3 Hotel basement

The rooms in the basement of the hotel contain anomalies that may relate to:

- the presence of structural foundations (Example radargram 8)
- positions of drains
- unknown features

Example radargram 8 shows a complex response which is typical of an area of structural remains beneath the basement. These are likely to be archaeological in origin as opposed to belonging to the current building due to their depth. Foundations from the current building are likely to be seen starting from a much shallower depth.



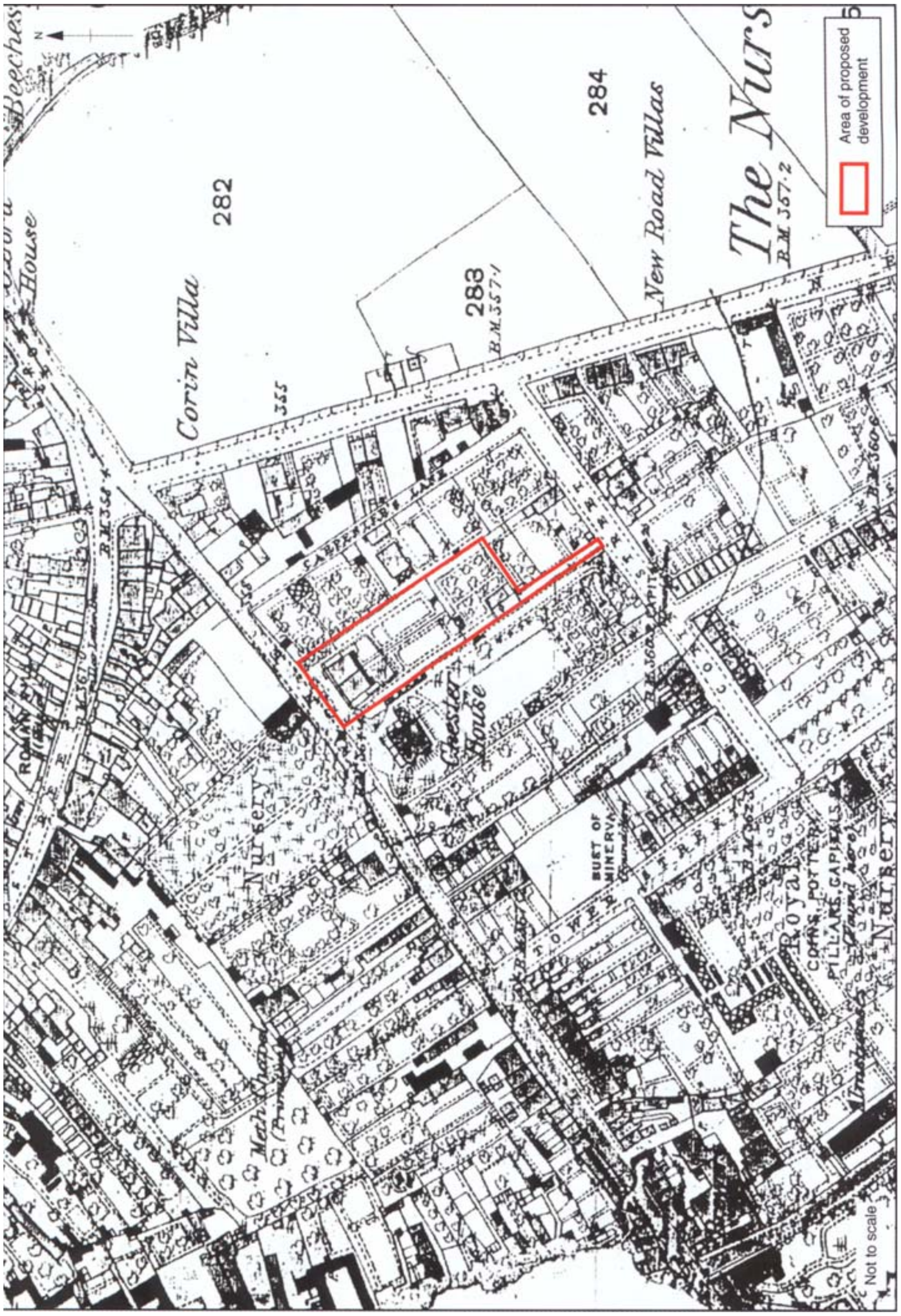
Example radargram 8. Transect 2E, chainage 4.5N – 0.5N, taken from room 4 (400MHz).

4 CONCLUSION

The GPR survey has defined several areas of probable survival of archaeological remains. These include rectilinear anomalies around No.15 and behind the hotel which may be related to features marked on the 1878 OS map, planar anomalies possibly representing former surfaces and other complex anomalies suggestive of structural remains. The likely location of the well in No.15's car park has also been identified.

Appendix A

1878 OS map - reproduced from Figure 5. Ordnance Survey 1st edition 25” map, 1878 (supplied by Oxford Archaeology)



REFERENCES

British Geological Survey, 1979. *Geological Survey Ten Mile Map, South Sheet, Third Edition (Solid)*. British Geological Society.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 5 South West England*.

Weaver, S. 2005 *pers. comm*. Telephone Conversation with Oxford Archaeology. 12/05/2005.