STRATASCAN

Geophysical Survey Report

St John the Baptist Church, Ashbrittle, Somerset

For

Charles Doble

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D J Sabin

REGISTERED IFA ORGANISATION

Geophysical Survey Report
St John the Baptist Church, Ashbrittle, Somerset

Client: Charles Doble

Stratascan Job No: 1860

Techniques: Ground Probing Radar

National Grid Ref: ST 050 214

Field Team: Hannah Heard

Project Manager: Richard Smalley

Report written by: David Sabin

CAD illustration by: David Sabin

Checked by: Kerry Donaldson

Stratascan Ltd.

Vineyard House
Upper Hook Road
Upton upon Severn
WR8 0SA

Tel: 01684 592266
Fax: 01684 594142
Email: ppb@stratascan.co.uk

www.stratascan.co.uk

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1 SUMMARY OF RESULTS

A ground penetrating radar (GPR) survey was carried out at St John the Baptist Church, Ashbrittle, Somerset. Broad crested and discrete reflections towards the eastern end of the nave are possibly related to vaults. Complex reflections are notable from the northern aisle and suggest a different subsurface make-up to other areas within the nave. Other reflections are likely to relate to surface changes and geological variation. A broad crested response located outside of the building on the southern side is possibly associated with a former water pipe.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned by Charles Doble of Ashbrittle, Somerset to undertake a ground penetrating radar survey (GPR) within St John the Baptist Church and an additional GPR trial survey outside the church.

2.2 Site location

Ashbrittle is approximately 10km west of Wellington, Somerset at OS NGR ref. ST 050 214.

2.3 Description of the survey area

The survey was carried out across available floor space within the church and a small section outside the building on the south side (see Figure 2).

The underlying geology is Carboniferous sandstone and shale (British Geological Survey South Sheet, Third Edition Solid, 1979). The overlying soils are Neath soils which are typical brown earths. These consist of well drained fine loamy soils over rock (Soil Survey of England and Wales, Sheet 5, South West England).

2.4 Site history and archaeological potential

No specific details were made available to Stratascan although it is known that the church was re-built in the Victorian period. A possible Bronze Age barrow is located in the churchyard.

2.5 Survey objectives

The objectives of the survey were to locate vaults within the church and any structures that may relate to the building prior to the Victorian alterations. In addition, survey was carried out in order to locate a water pipe outside the south wall.

2.6 Survey methods

GPR was considered to be the most suitable technique for surveying through stone flooring, in addition GPR can provide an excellent resolution.

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

3 METHODOLOGY

3.1 Date of fieldwork

The survey was carried out on the 26th May 2004 when the weather was dry and sunny.

3.2 Grid locations

The survey grid has been plotted in Figure 2 along with the referencing information.

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 survey within the church was carried out with a 400MHz antenna. This mid-range frequency offers a good combination of depth of penetration and resolution. The trial survey was carried out with 400 and 900Mhz antennas.

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

3.4.1 Sampling interval

Radar scans within the church were carried out along traverses 0.5m apart on an orthogonal grid as shown in Figure 2. Radar survey of the trial area consisted of parallel traverses separated by 0.5m. Data was collected at 40 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 0.07/ns which is typical for the type of sub-soils on the site. With a range setting of 70ns this equates to a maximum depth of scan of 2.43m 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. No processing was undertaken.

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.

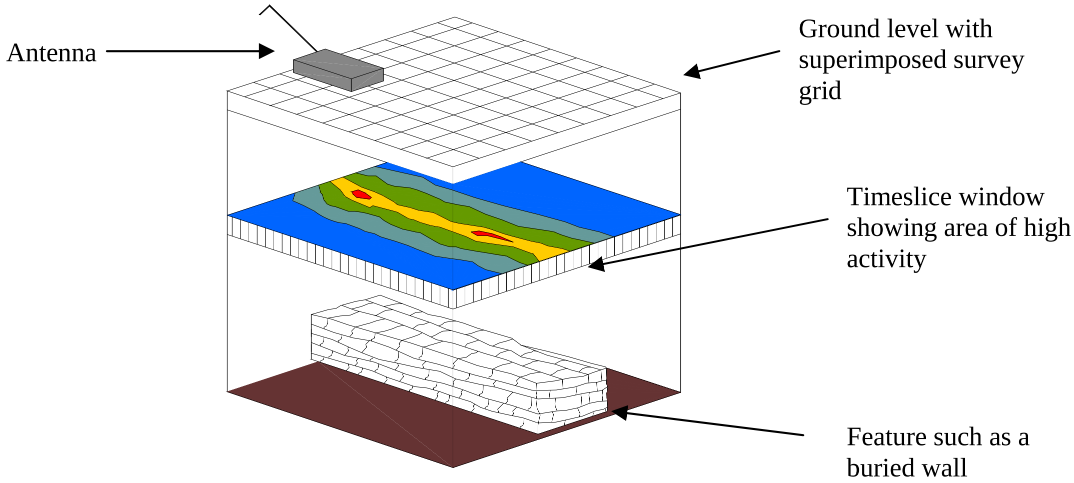
ii. Complex reflectors.
These would generally indicate a confused or complex structure to the subsurface. An occurrence of such returns, particularly where the natural soils or rocks are homogeneous, would suggest artificial disturbances. These are subdivided into both strong and weak giving an indication 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 (Figures 3 - 5). 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 Figures 3 - 5).

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.

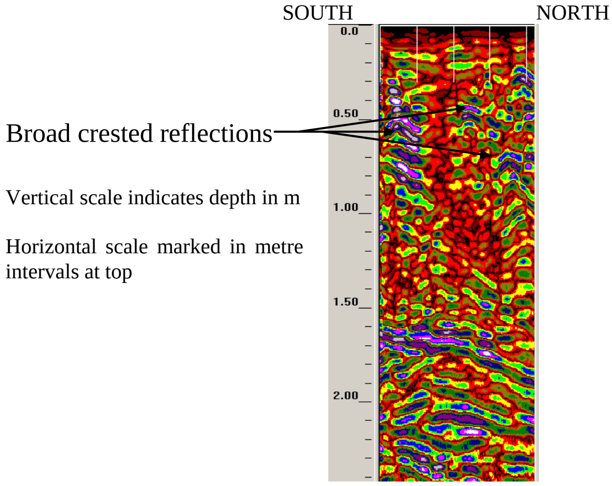
4 RESULTS

The following discussion of results should be considered along with the radar abstraction and interpretation, see Figures 6 and 7 respectively.

Radar reflections have been categorised into discrete, complex, planar, broad crested and point diffraction; relative strengths are indicated where possible. Anomaly depths range from 0.1m to 1.5m.

Possible vaults

Broad crested and weak discrete anomalies form clusters of reflections towards the eastern end of the nave (see Radargram 1 below). These clusters have been highlighted as discrete areas (Figure 07, red hatching) suggesting associated responses to separate features. Although weak discrete reflections occur within other areas of the interior of the church, the responses highlighted here are generally of greater depth at approximately 0.5m. In addition broad crested anomalies do not occur in other areas of the interior suggesting that the response is to a distinct class of feature.



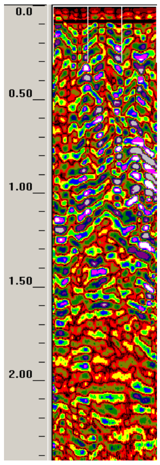
Radargram 1. Broad crested and discrete anomalies towards the eastern end of the nave (File 89 collected at 17E from -2 to 2N).

Timeslice plot Figure 04 indicates high energy responses probably associated with the above reflections at 1m depth; below approximately 1.5m the discrete areas indicated in the timeslice are less distinct probably due to strong reflections associated with changes in the geology.

Considering the above evidence and the approximate dimensions in plan of around 1 to 2m, it is possible that these clusters of reflections may well relate to subsurface structures such as vaults. It should also be considered that similar responses would be expected for other structural features possibly relating to different church layouts or features prior to more recent alterations.

Complex responses

Variable in depth but generally less than 1.5m, these reflections are located in several areas across the interior and exterior of the church (see Radargram 2 below). Typically these reflections would by expected for areas of rubble fill or ground make-up and may be associated with changes in floor construction or other layout changes.



Complex reflections across the radargram

Vertical scale indicates depth in m

Horizontal scale marked in one metre intervals at top

Radargram 2. Complex responses within the northern aisle (File 117 collected at 15E from 3 to 6N).

Observation of the 1m and 1.3m deep timeslices, Figures 04 an 05 respectively, reveals a correlation between areas having high energy returns within the northern aisle and complex anomalies abstracted onto Figure 06. Although there are other pockets of similar reflections at the eastern end of the nave, within the chancel and outside of the building, the concentration of complex responses within the northern aisle may indicate a different subsurface make up to other areas.

Shallow discrete responses

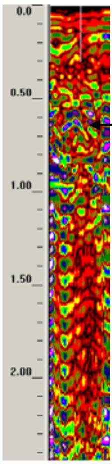
Shallow reflections were noted from several areas including the northern aisle, chancel and close to the font. It is likely that these reflections are related to surface or near surface changes that are part of current internal features.

Discrete response at depth

A single discrete response at approximately 1m deep was abstracted from the western end of the nave. The origin of the anomaly is uncertain but may be a former structural feature.

Possible pipeline

A small area of survey outside of the church on the southern side was carried out where a pipeline was suspected. Three transects approximately 2 or 3m away from the building have broad crested anomalies that would be expected from a pipe (see Radargram 3 below). The depth of the anomaly is around 0.5m. It should be noted that the response does not appear continuous towards the building and that other discrete features may cause similar responses.



Radargram 3. Broad crested anomaly related to a pipe outside of the church (File 186 collected at 1N from 0E to 2E – exterior grid).

Planar inclined events

A small number of inclined planar type reflections have been abstracted from the nave area. These responses show dipping surfaces from about 0.8m to over 1.5m in depth that are approximately 3m long underneath the eastern end of the nave. At the western end of the nave the reflections relate to a convex surface some 6m or more in length. Due to the dimensions and depths of these anomalies it is likely that they are a response to geological variations.

5 CONCLUSION

The GPR survey has located areas of discrete and complex reflections that may address some of the main objectives of the survey. Interpretation is tentative because the GPR response to subsurface features is not clearly resolved due to reflections from surface materials and high 'noise' levels probably relating to geology.

Clusters of discrete and broad crested anomalies form discrete areas having dimensions that would be suitable for small vaults. Broad crested response may be a characteristic of a convex shaped buried interface such as vaulting but it is possible that other former structural features, such as truncated or partially removed masonry, may give a similar response. Widespread complex response within the northern aisle area in particular may suggest major differences in floor make-up compared with the rest of the interior. This may be associated with changes in level or different material and method of construction for the subsurface.