STRATASCAN

Geophysical Survey Report

All Saints' Church, Shelley
St Peter and St Marys' Chuch, Stowmarket
Suffolk

For

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Figure 18 Radargram from transect 4.5S, chainage 6.5E-5.5E, St Peter and St Marys' Church

1 SUMMARY OF RESULTS

A GPR survey was carried out to locate any vaults that may exist beneath the floors of All Saints Church, Shelley and St Peter and St Marys Church, Stowmarket.

Two areas have been identified in both churches as the possible location of underground vaults.

Both areas in All Saints Church are smaller than 2m long, so that in order to be large enough to be burial vaults they would need to continue outside the survey area.

St Peter and St Marys Church has one large, strong anomalous area which is suggestive of a substantial underground arch with associated structural remains. One smaller weaker anomaly also exists which may pertain to a vault style feature.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned to undertake a geophysical survey of the interior of two churches. This survey forms part of an archaeological investigation being undertaken by National Geographic, USA.

2.2 Site location

The first site is located at All Saints' Church, Shelley, Suffolk at OS NGR ref. TM0309 3845. The second site is located at St. Peter and St. Mary's Church, Stowmarket at OS NGR ref. TM 0493 5868.

2.3 Site history and archaeological potential

No specific details were made available.

2.4 Survey objectives

The objective of the survey was to identify any anomalies that may relate to the presence of vaults beneath the churches.

2.5 Survey methods

A ground probing radar survey was carried out using a 400MHz antenna.

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 2 days from 31st January 2005 to 1st February.

3.2 Grid locations

The location of the survey traverses has been plotted in Figures 3 & 9.

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 a 400MHz antenna. This mid-range frequency 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 an orthogonal grid as shown in Figures 3 & 9. 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 following table gives the GPR velocity and depth calculation for each site.

Site	Velocity [m/ns]	Range [ns]	Penetration depth [m]
Shelley	0.075	60	2.25
Stowmarket	0.099	60	2.97

It must be remembered that the depth of any anomalies could vary by ± 10% or more as the calculated velocity is based on the average velocity across the survey range. 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.

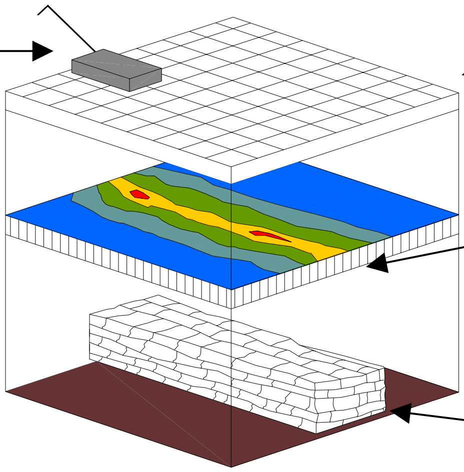
iii. Point diffractions.
These may be formed by a discrete object such as a stone or a linear feature such as a small diameter pipeline being crossed by the radar traverse (see also the second sentence in 4. below).

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 and 10-12). 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 and 10-12).

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

4.1 All Saints' Church, Shelley (Figures 1-7)

The timeslice plots show an increased level of activity in the eastern side of the survey area. This seems to appear at around 0.4m depth. The manual abstraction identifies the anomalies in this region as strong discrete, and broad crested (Figure 15).

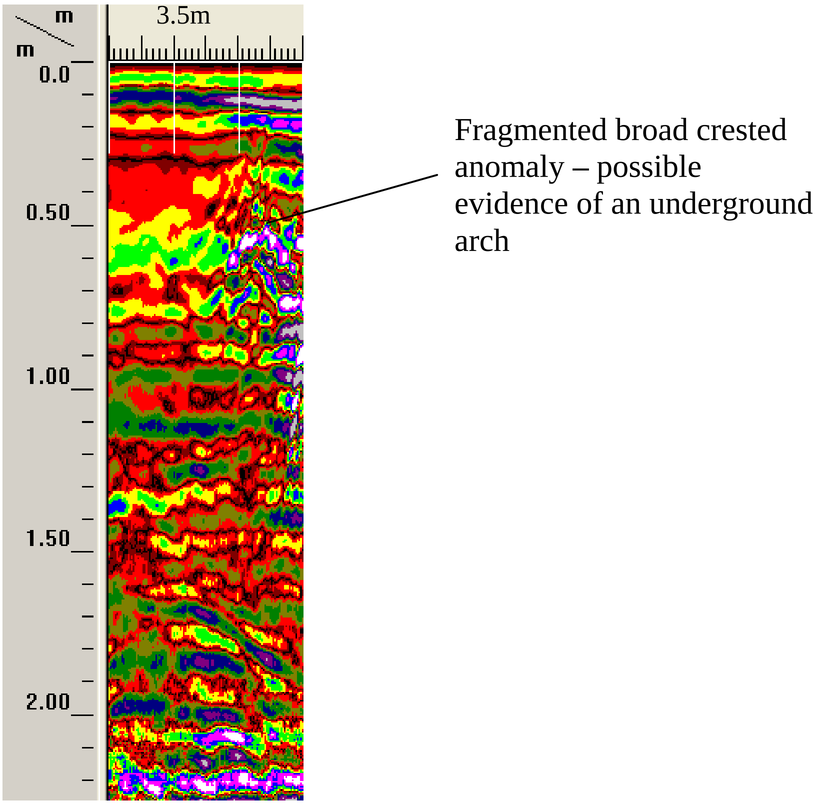


Figure 15. Example radargram from 8.5N, chainage 2.5E-5.5E, All Saints' Church.

Unlike most types of GPR anomaly broad crested anomalies reflect the actual shape and dimensions of the causative feature. The presence of broad crested anomalies is evidence of buried arch shape structures. The anomaly described in Figure 15 is 1m wide, which is perhaps suggestive of a burial feature.

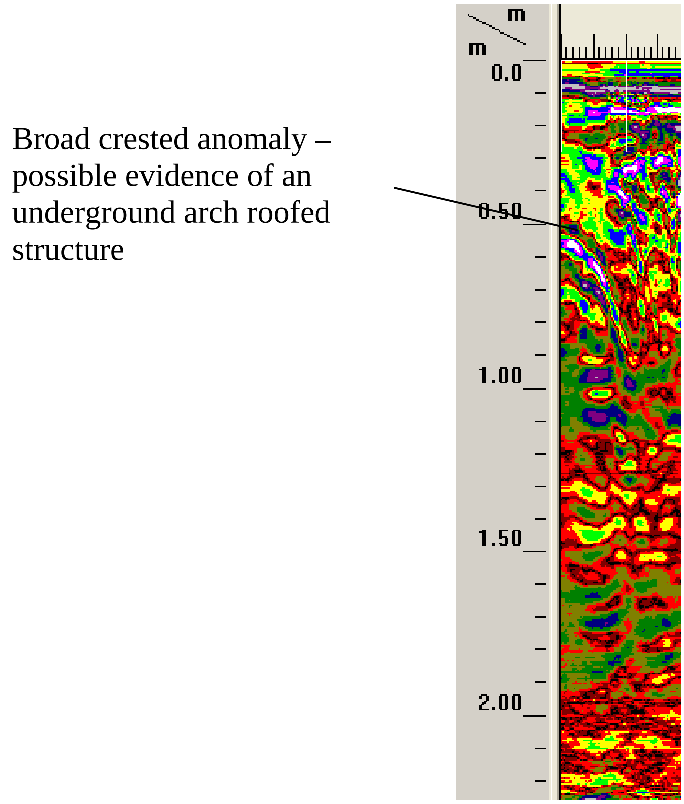


Figure 16. Example radargram from the southern transect in the room adjacent to the nave, All Saints' Church.

Figure 16 shows a much larger and less fragmented broad crested anomaly than that seen in Figure 15. It is possible this is related to a more substantial underground arch feature.

4.2 St. Peter and St. Marys' Church, Stowmarket (Figures 8-14)

The central linear area running west-east is marked by planar responses. These are surface anomalies and are therefore likely to be associated with ledgers on the floor surface. At the east end is a series of broad crested anomalies, strong complex anomalies, and discrete anomalies. The broad crested anomalies are possibly indicative of underground arches (Figure 17). Supporting this evidence are the complex and discrete responses which suggest the presence of structural remains.

The south west corner also displays broad crested and complex anomalies (Figure 18). This is the typical response expected from a vault. However, the anomalous area spans less than 2m. It is likely that this is too small to be a burial vault. It may represent other structural remains.

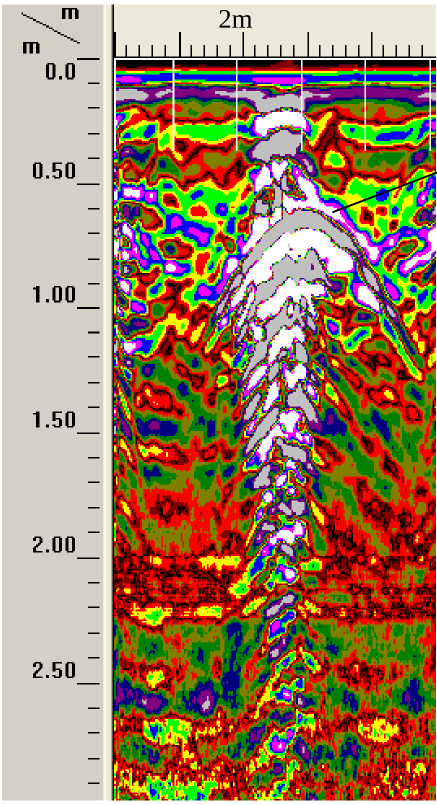


Figure 17. Radargram from transect 10E, chainage 0S-5S, St Peter and St Marys' Church.

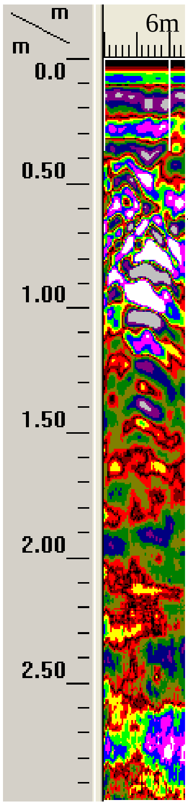


Figure 18. Radargram from transect 4.5S, chainage 6.5E-5.5E, St Peter and St Marys' Church.

In the west of the survey area there is a region of complex anomalies that is suggestive of structural remains. This feature may extend further west outside of the survey area.

5 CONCLUSION

All Saints Church has two areas which are the possible locations of burial vaults. The first area consists of a weak and fragmented broad crested anomaly with strong discretes covering a small area in the eastern side. The second is a stronger, larger broad crested anomaly in the room adjacent to the nave. This anomaly is seen in only one transect, but it may continue beyond the survey area.

The survey at Stowmarket church has also identified two areas where vaults may be located. The area in the east is larger, with stronger responses, possibly indicating the presence of a substantial feature with an arched roof. The area to the south west is smaller and weaker but still displays the type of anomaly associated with buried vaults.