MARLIPINS, NEW SHOREHAM, WEST SUSSEX.

Report on ground penetrating radar survey, March 2003.

Summary

A limited Ground Penetrating Radar (GPR) survey was conducted within the ground floor of the Marlipins museum, an historic building dating from C12th found on the New Shoreham High St., currently undergoing extensive refurbishment. The GPR survey was requested to confirm whether an in-filled vaulted structure observed beneath the ground floor level of the exterior north elevation continued under the building. Unfortunately, no reliable evidence for the continuation of the vaulted structure was revealed by the GPR data due to a combination of the restricted area available for the survey and the presence of multiple airwaves reflected from construction equipment within the building.

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Introduction

Marlipins is a stone building situated on New Shoreham High Street dating from the C12th used as a local museum for the area administered by the Sussex Archaeological Society (Figure 1). Current redevelopment of the site, to incorporate a new extension to the N, has included detailed architectural and archaeological evaluation of the site (Martin and Martin 2002). This latter work has revealed an in-filled, vaulted structure apparently passing through the N wall and possibly continuing beneath the floor of the building. The probable location of this structure also correlates with an interior photograph taken during the 1920s showing an extant void within the NE corner of the building.

To assist with the evaluation of the site the English Heritage Inspector for Ancient Monuments requested that a trial Ground Penetrating Radar (GPR) survey be performed to determine whether the structure or the void visible in the 1920s photograph could be detected inside the building.

The site (TQ 2152 0501), a grade II* listed building, lies on the north side of the high street on the ground floor of the Marlipins museum. This floor level is approximately 2m below the current high street and is covered with a thin layer of concrete. Due to the ongoing building works at the time of the survey the available area was highly restricted and access was further hampered by the presence of tools and materials associated with these works.

Figure 1, South elevation of Marlipins photographed from New Shoreham High Street as part of the Images of England Project (© Mr Robin Earl LRPS, IoE No. 297291).

Method

A trial Ground Penetrating Radar (GPR) survey was conducted with a Pulse Ekko PE1000 console using antennas with centre frequencies of 900MHz, 450MHz and 225MHz. The 450MHz antenna was selected as the most suitable centre frequency for obtaining the optimum depth of penetration and lateral resolution required to image the expected archaeological targets. 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 0.05 m/ns was a reasonable average value to adopt, both for processing the data from this site and for the estimation of depth to reflection events in the recorded profiles. The CMP analysis also revealed velocities of ~0.3m/ns, close to the velocity of a radiowave in air, at both the surface and at later arrival times down the profile. This suggests the presence of significant multiple airwave reflections from the immediate surroundings of the survey area.

A series of parallel traverses separated by 0.1m were established over the available survey area (Figure 2). Individual traces along each profile were separated by 0.05m and recorded the amplitude of reflections through a 100ns time-window. 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.

Due to antenna coupling of the GPR transmitter with the ground to an approximate depth of $^{\lambda}/_{2}$ very near surface reflection events should only be detectable below a depth of 0.06m, assuming a centre frequency of 450MHz and a velocity of 0.05m/ns. 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 2ns (two-way travel time) windows (David and Linford 2000; Sensors and Software 1996). Each resulting time slice, illustrated as a greytone image in Figures 3, represents the areal variation of reflection strength through successive ~0.05m intervals from the ground surface.

Results

Regrettably, the most obvious anomalies identified by the radar appear to be airwave reflections represented by a series of linear, high amplitude responses [1], [2], [3] and [4]. These responses are found principally to the E of the survey where the available area was curtailed by the presence of an aluminium access ramp. This metallic feature would, no doubt, act as a strong radar reflector and is the most likely source of the airwave reflections detected within the data. A more amorphous area of high amplitude reflection [5] is found in the later times slices (42 – 50ns) superimposed over the linear airwaves and it is possible that this represents a more significant subsurface feature. An airwave reflection is also evident at [6] due to the steel pit prop erected to support the upper storey of the building during the construction work.

The linear response at [7] may also be due to an airwave but is not continuous across the survey and appears at a slight angle to the other airwave responses. This may suggest a more significant source for this reflection, such as a buried wall footing at a depth of ~1.0m, although this must remain a highly tentative interpretation given the limited description of [7] within the survey area and the presence of highly confusing airwave responses.

Perhaps of greater significance are two areas of amorphous response to the W of the survey in the expected vicinity of the observed void. The first of these is a near surface scatter of high amplitude response [8] found to an apparent depth of approximately 0.5m. This anomaly could, possibly, represent the presence of buried stone work associated with the vaulted structure although the response is limited to the near surface and may also be explained by the presence of building rubble used to level the concrete floor surface. The second area of amorphous response, [9], is equally tentative but appears as a low amplitude reflection in the immediate vicinity of the expected void. Anomaly [9] is not well defined and appears from the near surface (8 – 10ns time slice) onwards as an apparent absence of high amplitude reflections within this area of the survey. It is possible that [9] represents the differential back filling of the observed void with, say, rubble or clay producing an anomalous radar response.

Conclusion

This site has not proved particularly responsive to GPR survey due to a combination of the limited area available for survey and presence of multiple airwaves produced by metallic objects in the immediate vicinity. Three anomalies, [7], [8] and [9], have been identified close to the expected location of the vaulted structure or the observed void. However, these anomalies are highly tentative and should not be considered reliable without further ground truthing of the results. As anomalies [8] and [9] are found within the very near surface minimally invasive ground truthing could, perhaps, be achieved through removing the thin layer of concrete flooring and recording the underlying structures.

Despite the difficulties presented by this site it seems unlikely that a substantial air-filled void could exist beneath the survey area and not be detected by the GPR survey. This suggests, perhaps, that the originally observed void has been back-filled with material similar to the surrounding area producing little or no detectable contrast between the two. The nature of the material used to back-fill the void is also pertinent as the inclusion of high conductivity clay will severely attenuate the incident GPR wavefront and limit the depth of effective penetration.

Surveyed by: N Linford   Date of survey: 27/03/2003

Reported by: N Linford   Date of report: 31/03/2003

Archaeometry Branch,
English Heritage Centre for Archaeology.

References

David, A. and Linford, N., 2000, Physics and Archaeology, *Physics World*, **13**, No. 5, pp27-31.

Leckebusch, J. (2000) Two- and Three-Dimensional Ground Penetrating Radar Surveys Across a Medieval Choir: A Case Study in Archaeology. *Archaeological Prospection,* **7**, 189-200.

Martin, D. and Martin, B., 2002, An archaeological interpretative survey of Marlipins, Shoreham, West Sussex, *Archaeology South-East Report, Project Ref. 1501*.

Sensors and Software, 1996, *pulseEKKO IV RUN User's Guide*, Technical Manual 20.

List of enclosed figures

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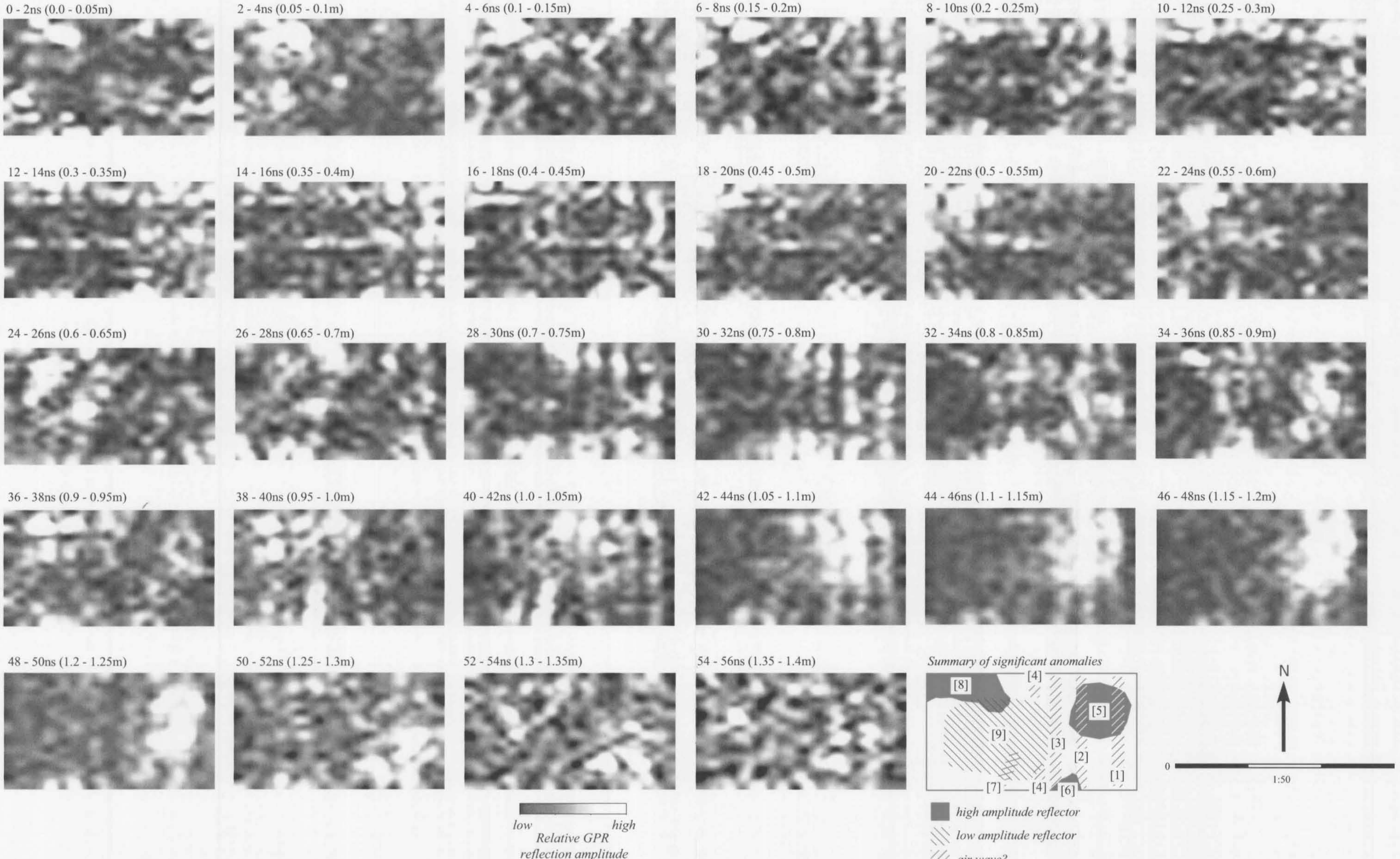
Figure 3

450MHz Antenna amplitude time slices



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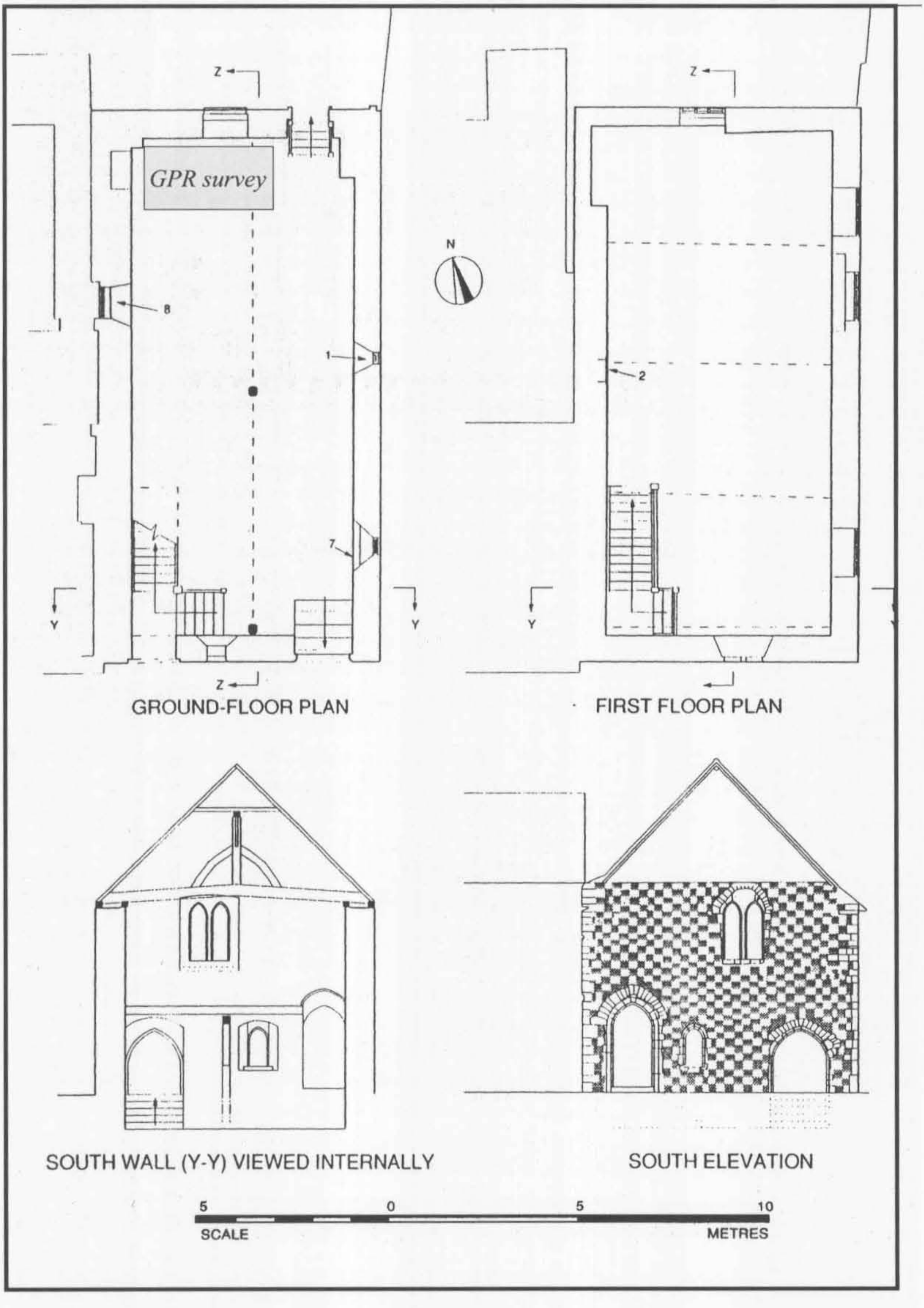

Figure 2; Marlipins, New Shoreham, West Sussex, *Location of the GPR survey superimposed o*\ *the outline details of the building as existing, 2002 (after Martin and Martin 2002; 1501/1).*