Seeing beneath the ground using geophysics at the former ecclesiastical site of Clonard, Co. Meath

P. J. GIBSON

Abstract

The geophysical investigation undertaken in this project has uncovered many features, which may be related to the ecclesiastical settlement at Clonard. A 300m long palaeochannel dominates the magnetic data and four areas of concentrated magnetic anomalies, up to 50m in extent, probably indicate the presence of extended anthropogenic activity. A sub-square 60m across enclosure is also evident. In addition, there are four distinct zones which have large concentrations of high resistance values suggesting that buildings were located in these areas. Resistivity and ground penetrating radar depth slices show that one of these zones has characteristics which indicate the presence of an east-west aligned building approximately 7m wide in a north-south direction and about 15m long in an east-west direction. This structure may represent a small church.

Introduction

The town of Clonard, in south County Meath was of great importance in the ecclesiastical framework of the Irish Church (Cogan 1874). A monastic school, was founded here in the 6th-entury by St. Finian (Finnian) and it has been associated with various important figures in Irish history such as St. Brendan of Birr, St. Columba of Iona and St. Canice of Aghaboe. Later, Clonard became the diocesan town of east Meath in the 12th-entury (Hickey, 1998). In keeping with its importance, various buildings have been associated with Clonard over many centuries such as the Augustinian Abbey of St. Peter and St. Paul, a round tower, the high cemetery and the Abbey of St. Mary. In addition, there would have been housing, kitchens, prayer cells and small chapels for the students. Today no archaeological structures remain at the surface in Clonard associated with its long history, except for a Norman motte. All that remains are the historical record and small ecclesiastical artefacts found in the vicinity such as an 11th-entury crozier and a 9th-entury small house shaped shrine.

The primary aim of this research is to geophysically investigate the area south of St. Finian's Church of Ireland church which has traditionally been seen as the location of the main ecclesiastical centre, Figure 1. Many crop marks can be observed in the field immediately south of the church and south of the Clonard River and archeological work in the 1970s has shown that many are 13th-entury drainage channels. The geophysical investigation was undertaken in the period May-August 2004 under permit number 04R022. Data were collected by Paul Gibson, Dot George and Lorraine O'Reilly.

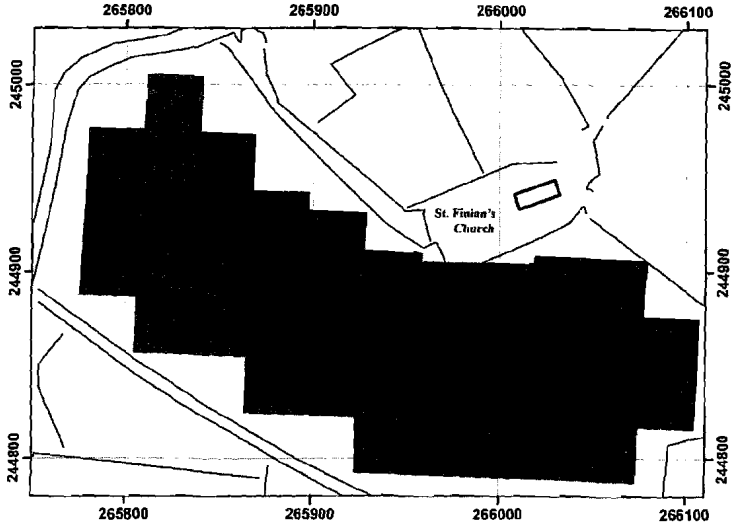

Figure 1: Location map of Clonard area, shaded region shows where data were collected. Irish grid co-ordinates.

Geophysical data collection, techniques and processing

Magnetic and resistance data were collected for 42 grids, each 30 x 30m in size. The resistance survey was undertaken using a TRCIA twin electrode array with a 0.5m electrode spacing and the data collected in a zig-zag fashion at 1m intervals along 1m spaced parallel lines. 900 data points were collected for a 30 x 30m grid resulting in 37,800 readings. The individual grids were combined in Geoplot software and the individual grids were matched were needed. The processed data were output and gridded in Surfer software.

Magnetic data were collected along the same survey lines as those employed in the resistance survey using a Bartington 601 gradiometer. Data were also collected in a zig-zag pattern along 1m spaced lines with a station spacing of 0.25m for each line. Thus 3,600 reading were acquired for each 30 x 30m grid (151,200 readings in all). A similar processing stream was employed for the magnetic data as for the resistance data. However, in addition, the data were despiked in order to remove spurious high or low readings and where necessary a zero mean traverse algorithm was employed.

Electrical resistivity and ground penetrating radar (GPR) data were collected at one location (Zone 1, Figure 5). Eleven parallel lines of resistivity data were collected in a south-north direction along 13m long lines spaced 1.5m apart.. Two dimensional electrical imaging allows the acquisition of apparent resistivity variations in both the vertical and horizontal directions, producing a 2D slice known as a pseudosection. Although this pseudosection provides some information about the subsurface, the data were modeled using RES2DINV inversion program in order to determine how the true resistivity varies with depth. The data were also combined using the RES3DINV inversion program which allowed the production of areal resistivity maps for different depths.

A Sensors & Software pulseEKKO 100 system operating in constant separation mode at a central frequency of 200 MHz was used

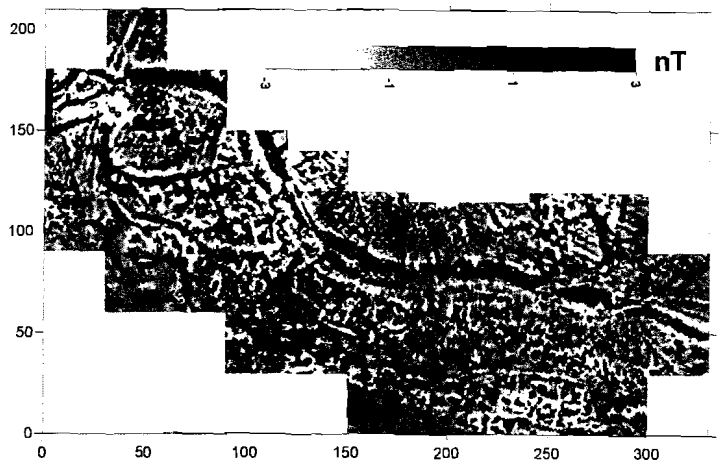

Figure 2: Magnetic gradiometer data for study area.

to collect ground penetrating radar data at the same location as the resistivity data. Twenty-one 13m long parallel ground penetrating radar lines of data were collected in a south-north direction. Data were collected at 10 cm intervals along each line and each line was separated by 50 cm from adjacent ones. All data were 'gained' using an automatic gain control (AGC) in order to compensate for the considerable attenuation in energy as the waves travel deeper into the ground. A time window of 100 ns was employed and 16 fold stacking used to improve the signal to noise ratio. A subsurface velocity of 0.08 m/ns was employed in all depth calculations. This value was obtained using a hyperbola matching technique (Gibson and George, 2004). The 21 closely spaced parallel lines of ground penetrating radar data were merged use the EkkoMapper program to produce a sequence of 2D plots showing the spatial variation in amplitude for different depth slices. The deviation from the norm is important and no differentiation is made between positive or negative amplitudes (Conyers and Goodman, 1997).

Results of Magnetic investigation

The magnetic data for the study area is dominated by a 300m long undulating structure that crosses the entire image (Figure 2). This feature is approximately 6m wide and has a dark (high) magnetic signature in the core and is often flanked on either side by a paler (lower) signature. This feature is not of archaeological origin but

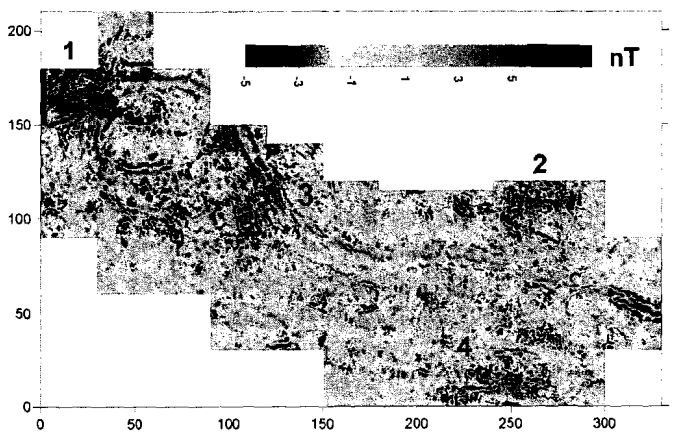

Figure 3. Modified version of Figure 2 illustrating areas of anomalous magnetic readings.

represents an old unknown river channel which may have become silted up during the drainage of this area in the 13th-entury. A very prominent 70m arc can be observed in the northwestern part of the field, which may also be a former channel. Two distinct areas in this field are evident where there are zones of fine parallel lines extending for 60-70m. These lines most likely represent old plough marks. They have different trends and are most prevalent in the northern section of the field. They have a NE-SW and a WNW-ESE trend.

Most large fields are often associated with numerous small isolated high and low magnetic anomalies caused by, for example, screws, nails, slag etc. However, any large concentration of such material extending over a wide area tends to suggest enhanced anthropogenic activity and possibly the location of settlement (Gaffney and Gater, 2003). Figure 3 is a modified form of Figure 2 in which large deviations from the norm are shown in black whereas 'background' values are illustrated in a mid grey tone. Four areas of concentrated magnetic anomalies (1-4, Figure 3), extending up to 50m, are evident and indicate the presence of extended anthropogenic activity.

Results of Resistance investigation

The river channel observed on the magnetic data (Figure 2) can still be discerned on the resistance data though it is not as clearly defined, Figure 4. A 60 x 60m sub-square enclosure with a double boundary is located in the northwestern part of the field. A distinctive ploughing

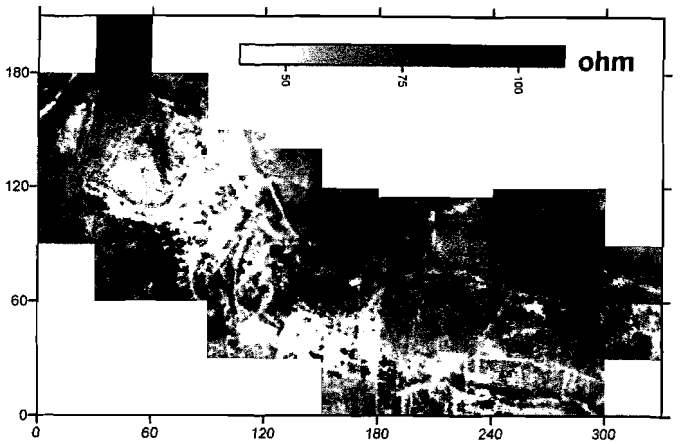

Figure 4: Resistance data for study area.

pattern similar to that seen on the magnetics is also evident at this location.

The presence of stone walls and buildings was recorded at Clonard by Archdall (1786) and such features are generally associated with high resistances (Gibson and George, 2004). Figure 5 shows the high resistance values displayed by black. It is evident that the high resistance areas are not randomly scattered but concentrated in small compact zones, which suggest that these areas may represent the locations of walls or buildings. Four such zones are shown in Figure 5. The Irish grid co-ordinates for the centre of the zones are:

Zone 1 265826 E 244874N
Zone 2: 265918E 244862N
Zone 3: 265963E 244906N.
Zone 4: 265816E 244978N.

Zone 4 is a distinct 'L' shape suggesting 2 walls at right angles are still preserved and Zone 1 is clearly rectangular in shape. Zone 1 was investigated further using resistivity and ground penetrating radar.

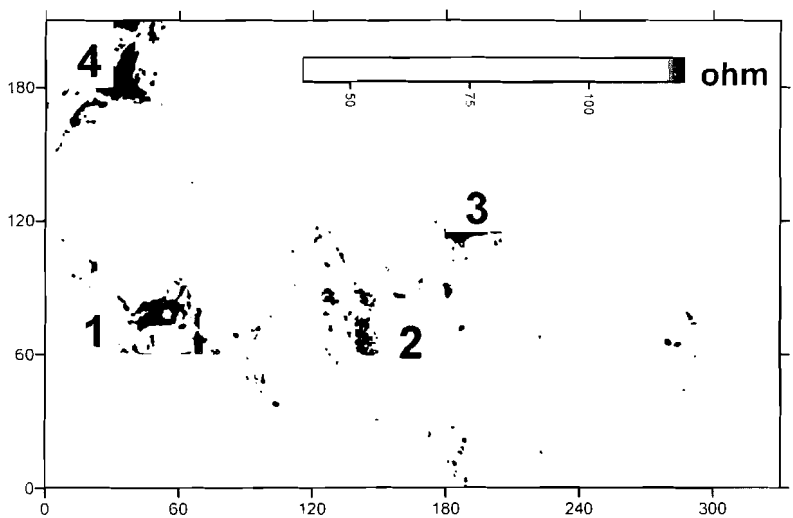

Figure 5. Modified version of Figure 4 illustrating zones of anomalously high readings.

Zone 1

Figure 6a shows a detailed resistance plot of Zone 1 with an interpretation in Figure 6b. The average background resistance values for this grid is 80 ohms whereas the linear features that can be seen,

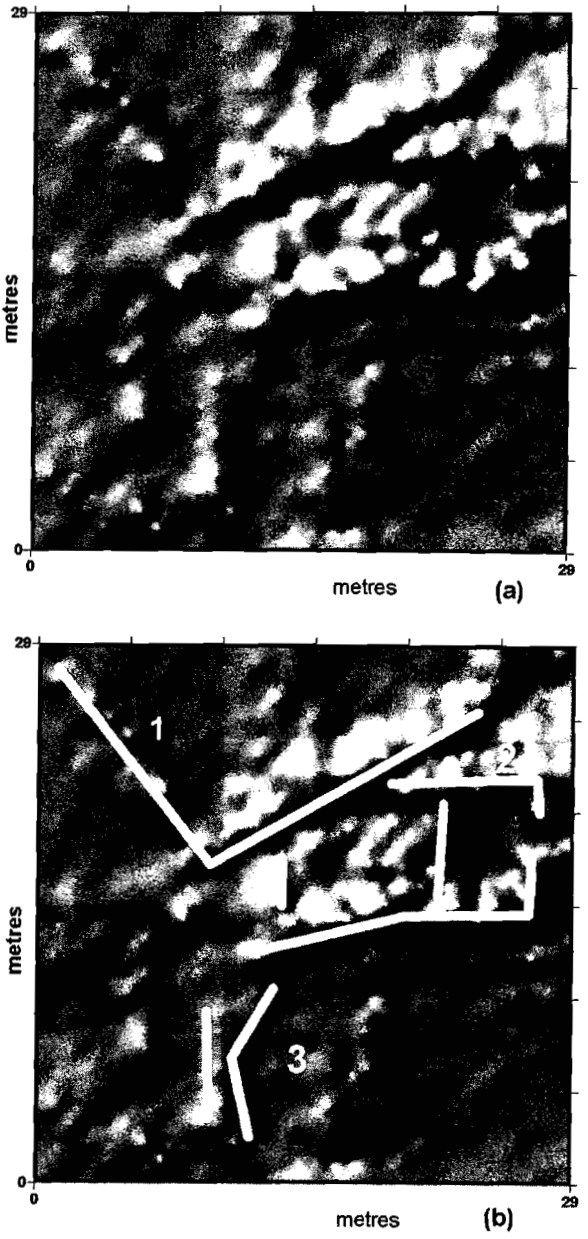

Figure 6: Detail of resistance data for Zone 1 and interpretation.

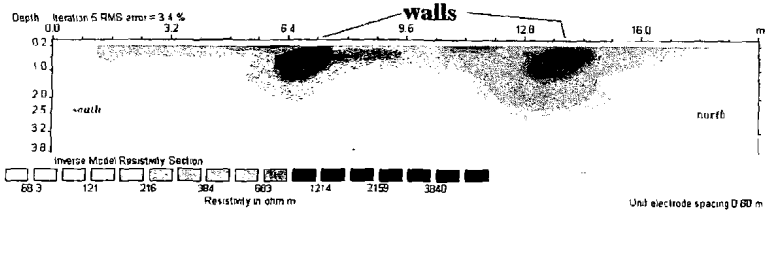

Figure 7. Resistivity line across Zone 1 showing walls at depth.

have resistances of up to 300 ohms which suggests the presence of stone. It appears that two walls which meet approximately at right (1, Figure 6b) cut across an older feature, (2, Figure 6b) which, due to its shape and resistance signature is interpreted as a building. This building is oriented E-W and an opening can be determined on the east wall. It is approximately 7m wide in a N-S direction and about 15m long (E-W). An internal division can be distinguished with the western half of the building being associated with higher resistance than the eastern part. This suggests different surfaces on the floor. The western part may simply be earth (same resistance values as background) whereas the eastern part of the building may have a stone floor. The building was further investigated using ground penetrating radar and resistivity.

A series of parallel south-north resistivity lines were obtained across the building in Zone 1, all of which showed the same consistent pattern (Gibson et al., 2004). Figure 7 shows the modeled results of one of these traverses. Resistivity values are generally low (c. 100 ohm m) except where the traverses cut across the east-west aligned walls. These are located at 6.4m and 13.6m and are represented by very high resistivity values in the range 1000-3000 ohm m, an order of magnitude greater than the background readings. These high values are consistent with stone walls. The walls appear to continue to a depth of about 1 m below the surface suggesting that this was a substantial building of some importance. The parallel lines of resistivity data were combined and processed using RES3DINV in order to yields a series of 'plan' depth slices of the building. Figure 8 illustrates the results of such an approach. The parallel walls of the building are clearly defined between 40-86 cm and continue on to greater depths but below about 2m there are no longer present (Gibson et al., 2004).

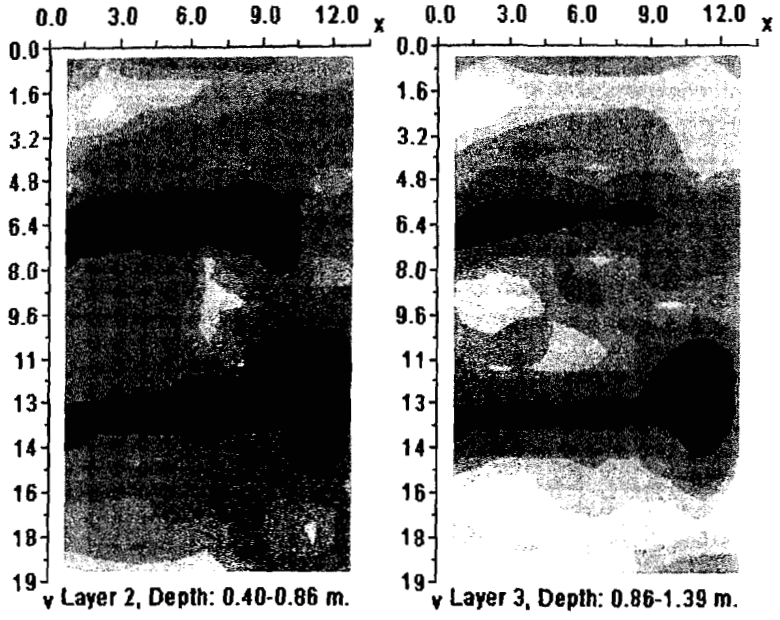

Figure 8: Resistivity plan views of resistivity data across the building.

Figure 9 show the results of depth slicing ground penetrating radar data for a 13m (N-S) by 10m (E-W) area which encompasses part of the building. The presence of the walls are clearly delineated at a depth of around 1.2m depth range as two linear pale bands extending across the image which represent high radar returns. Note how the southernmost wall is also cutting an older right-angled feature.

An excavation in the 1970s (Sweetman, 1978) located nine skeletons buried together at a depth of about 15 cm approximately 5m south of this building (location 3, Figure 6b). The skeletons appear to have been buried hurriedly, presumably in a location, which was considered 'sacred' ground. Their close proximity to the building in Zone 1 and their alignment parallel to the walls of the building support the hypothesis that it had a religious significance and was a building associated with Clonard monastery. The E-W alignment of the building suggests it may have been a small church or mortuary chapel.

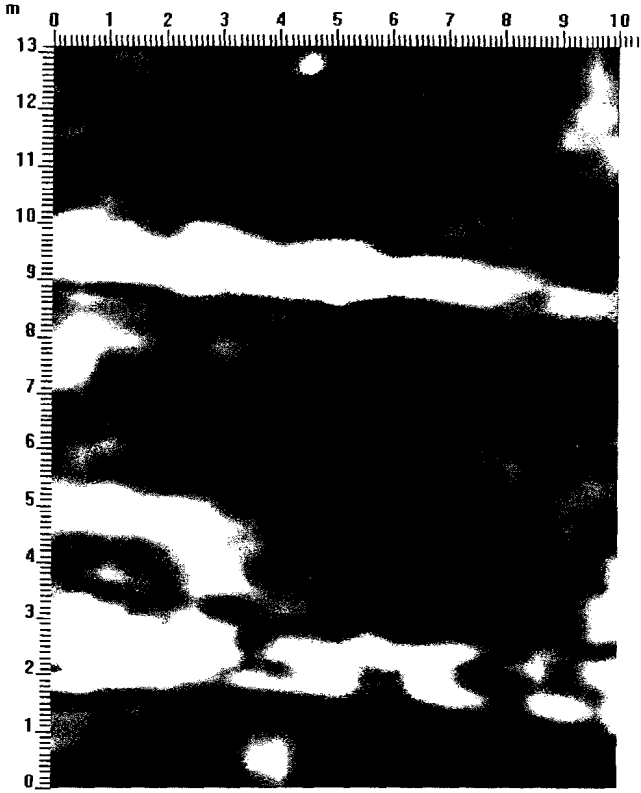

Figure 9: Ground penetrating radar amplitude slice showing location of walls at a depth of 1.2m.

Conclusions

The geophysical investigations undertaken in this project have uncovered many features which may be related to the monastic settlement at Clonard. A 60m sub-square enclosure is adjacent to a 300m long palaeochannel. There are four areas in which anomalously high magnetic readings are recorded which probably indicate sites of human activity. In addition, four zones show large concentrations of high resistance readings suggesting that buildings were located in these areas. One of these (Zone 1) has resistivity and ground penetrating radar characteristics which indicate the presence of an E-W aligned building approximately 7m wide (N-S direction) and about 15m long (E-W). This may be the site of a small church.

Acknowledgements

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