Surveying the Big Ground Mound

Using the RES2DINV software package for resistance profiling on sloping ground at Stanton Drew

John Richards

After our work around Hautville's Quoit at Stanton Drew in 2012 (Richards et al 2012), we returned to Quoit Farm in 2013 to investigate the unusual mound in a field known as 'Big Ground'. This Mound has a striking appearance. It is elliptical in shape, 125 metres by 90 metres, with its elliptical flat top measuring 40 metres by 25 metres. When approaching on the downhill slope in Big Ground it rises 2 metres, and then falls 4 metres on the far side to re-join the slope running down to the river. The long axis is oriented towards the stone circles on the other side of the River Chew. The resistance survey and resistivity profiles have shown a lot of interesting detail, including apparent stone structures under the Mound. In particular, there may be a large trapezoidal block under its western end. Profiling revealed this to be of the order of 2m in thickness and sitting on low resistance earth. Our full report (Richards et al 2013) is available on the BACAS website and so I do not intend to reprise all our results here. Instead, I am going to describe how some of the data was processed.

Twin-probe resistance works by passing a current between two probes at a fixed separation, usually of 0.5m or 1m. The probes are attached to a frame and moved along and back on lines at fixed intervals to produce a set of resistance values that are plotted like a map to indicate what may lie beneath the surface. The idea of resistance profiling is to produce a vertical section image using resistivity, based on the principle that the further the probes are spaced apart, the deeper the resistance is measured. As a rough rule of thumb, probes 1m apart will penetrate 0.5m, and 2m apart will penetrate 1m into the ground.

A line of 32 metal rods is placed 1m apart along a straight 31m line of a grid (the first probe is at 0m). It is possible to join lines together to form a long line – we managed a 234m line across the stone circles in 2010. Each metal rod (probe) is connected by a cable back to a box with a patch panel that allows different combinations of four probes to be connected to the resistivity meter. The first four probes (0, 1, 2, and 3) are connected first. The outside two probes supply current (I). The inner two probes measure voltage (V). The resistance, R (=V/I), can then be measured. The next set of probes, numbers 1, 2, 3, and 4 are then connected up and another measurement taken. This is repeated until the end of the line is reached. We then return to the beginning of the line, and the whole process is repeated with an interval of 2m between each probe (so starting with probes 0, 2, 4, and 6) until the end of the line. Then we repeat for another three times at intervals of 3, 4, and 5m. This four probe configuration with constant spacing between each probe is called a Wenner array (Griffiths and Barker 1994). It may sound slow, and it is. Each complete set of readings takes about 30 minutes, so getting twelve sets done on a winter's day is considered a good effort.

The data is loaded into a computer and then a software package called RES2DINV (Loke 2002) is used to produce the vertical section. RES2DINV creates a 2-D model that divides the subsurface into a number of rectangular blocks. It then adjusts the resistivity of the blocks to try to reduce the difference between its own calculated values and the ones we have measured in a mathematical process called finite difference analysis. A measure of this difference is given by the root-mean squared (RMS) error. The software iterates until the RMS error stops changing significantly, which is usually between the third and fifth iterations. It then will draw a contour plot.

We use the free 'semi-demo' version of RES2DINV, as a licence for the full version would cost us over £2,000. It has some limitations but for most of our work it is perfectly adequate. It will only do 3 iterations before stopping, whereas the full version will usually do between 5 and 7 iterations so should be more accurate, but in practice the differences are fairly negligible. The demo version produces a graphical plot, but the full version also allows the export of the model data values which can then be passed to other programs for further processing, such as the production of 3D surface models. The full version also allows the import of topographical data which means that we can model results on sloping ground. For most of our work this really does not matter: a small slope does not greatly change the results. However, for steep slopes, as with the Big Ground Mound, or going over ramparts and through ditches, topography does affect our ability to interpret the results. The full version alters the shape of the blocks so that the electrical modelling correctly tracks changes in the ground surface. BACAS kindly funded a short-term rental of the full version and this proved to be extremely helpful in coming to conclusions about the nature of the Mound. Here, for example, is a section along the long axis of the Mound without any topographical data.

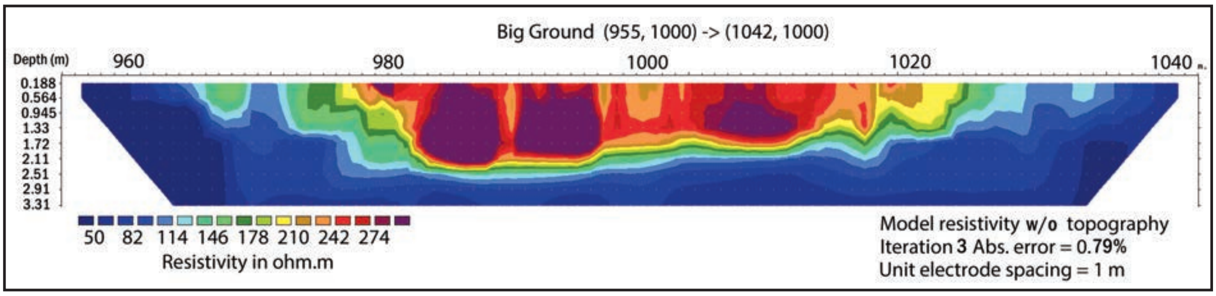

Figure 1
Profile along the long axis of the Mound, without topographical data.

Although this shows that there are large areas of high resistance extending down to a depth of about 2.5m, it is difficult to relate this to the terrain. We can measure the height of the ground at each probe, using an EDM. This topographical data can be provided to the full version of RES2DINV, which alters its model accordingly. The results are shown in Figure 2.

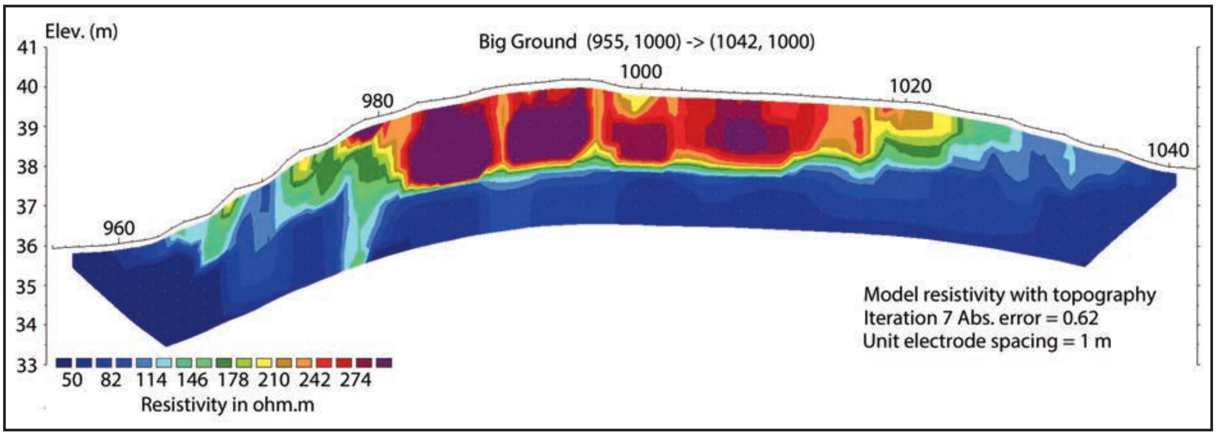

Figure 2
Profile along the long axis of the Mound, using topographical data.

Now it can be seen how closely the areas of high resistance correspond to the Mound, but are more concentrated at the west end, and that there is a distinct boundary in the resistance values about 2m down, so that the rockier ground (which we assume is responsible for the high resistance) appears to rest on ground of a similar lower resistance to the surrounding area. This supports a conjecture that the Mound is not completely natural. It is by no means conclusive, however, and at the moment excavation in a limited form seems the best way to decide one way or the other.

The other big advantage of using the full version of RES2DINV is that it allows the export of results as data that can be processed further in other software packages. One possibility is to combine data from a set of profiles and then use that to produce 3D surfaces and depth slices. For an example of the latter see Figure 4-17 in Richards et al (2013).

References

Griffiths, D. H., & Barker, R. D. 1994. "Electrical imaging in archaeology", Journal of Archaeological Science, 21(2): 153-158.

Loke, M. H. 2002. RES2DINV, Ver. 3.50, Rapid 2-D Resistivity and IP Inversion Using the Least Square Method. Geotomo Software, Penang.

Richards, John, J. Oswin, and V. Simmonds. 2012. Hautville's Quoit and other archaeological investigations at Stanton Drew, 2012. BACAS/BANES.

Richards, John, J. Oswin, and V. Simmonds. 2013. The Big Ground Mound and other archaeological investigations at Quoit Farm, Stanton Drew. BACAS.