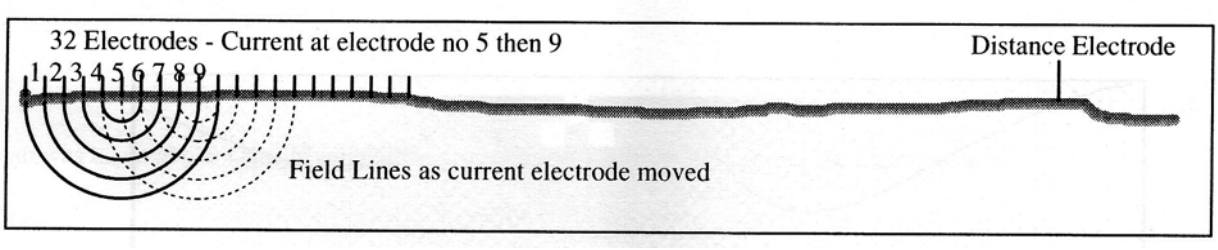
The Greensites Resistivity Project

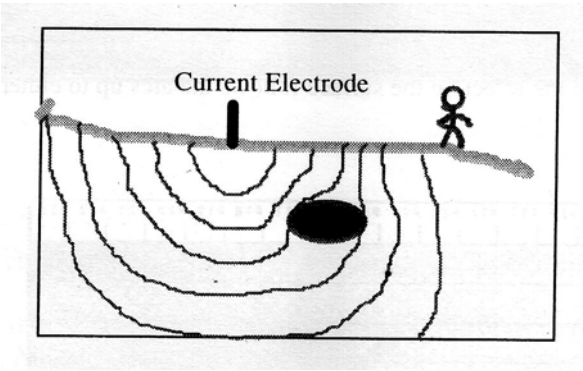
by Neil Weymouth

The recent interest in earth resistivity in the SWCC was started in 1990 by Stuart France who took a commercial resistivity meter and attached it to the ground using 16 electrodes and a manual switch box. The measurements made were so encouraging that it was decided to build an integrated meter and automatic switch, to be controlled by a portable PC and drive 32 electrodes. This was designed and built in 1992 by Neil Weymouth and Dave Edwards. Also a computer program was written to control the equipment and process the results to produce an image depicting a vertical slice through the ground.

Earth resistivity as a means ofcave detection works in the following way. Ifyou put two electrodes into the ground and attach a battery between them, a small current will flow through the ground from one electrode to the other. The highest current will be along the line directly between the electrodes, but it will also spread out horizontally and vertically to flow through all of the ground in the area of interest. The shape of the current field can be calculated for homogenous ground and gives theoretical voltage readings on the surface. If the readings actually measured on the surface differ from the theoretical this indicates the presence of a geological feature. Several configurations of electrodes are used commercially but are more suitable for detection of beds rather than cavities. The configuration we use was taken from a paper by C Bristow and is the Single Electrode configuration. The two current electrodes are placed a large distance apart and readings taken in the region close to one electrode where the field lines are roughly spherical.

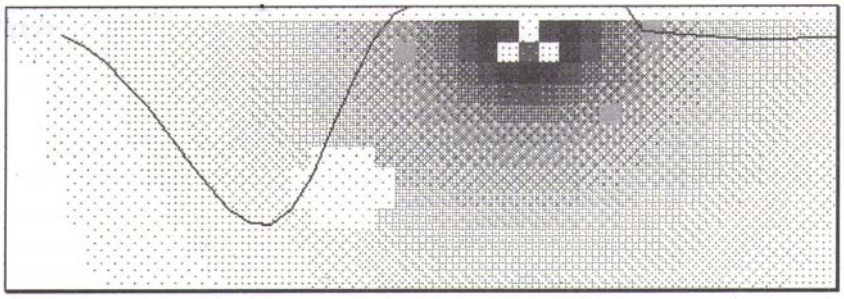


The 32 electrodes are laid out 3m apart and connected to the meter by two 16-core cables, each cable has tap points at 3m intervals. Current is applied to each electrode in turn while the voltage is measured between all the others. As the current electrode moves along the line a pattern of overlapping arcs is created for a particular slice of ground. The pattern of arcs is then processed by the computer into a vertical section of the ground below the electrode array.

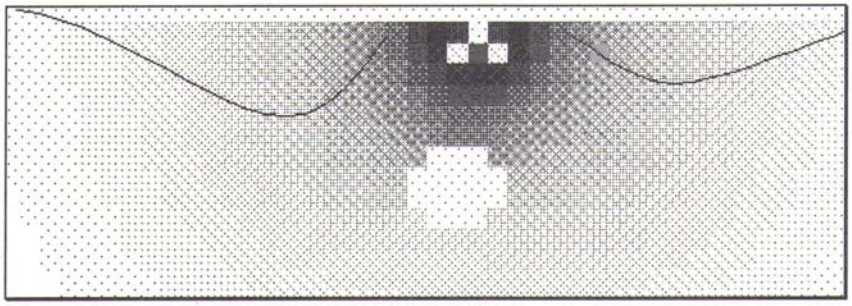


The diagram shows the field lines which are equally spaced on the LHS of the electrode but are distorted by the cavity on the RHS of the electrode.

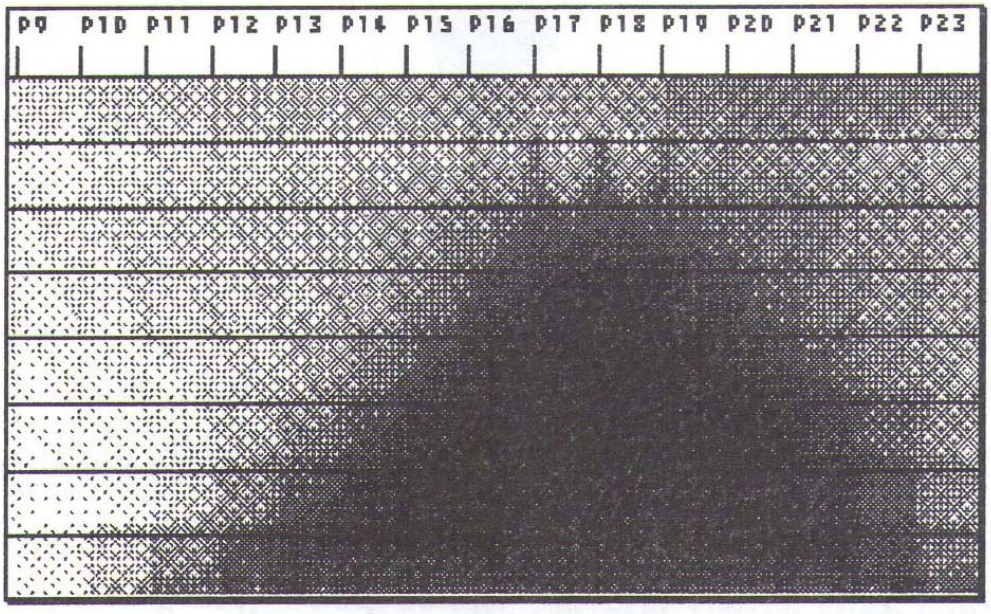
The distortion caused by the cavity follows the potential arcs up to the surface rather than appearing directly above the cavity. To investigate this, a computer simulation of the ground was written with the ability to insert cavities as shown below. The shading indicates equal potentials and the line the variation from the theoretical voltage at the ground surface.



The diagram shows that the effect of the cavity on the surface is displaced to the left following the arcs and the peak is smeared across the arcs intersecting the cavity and neighbouring arcs

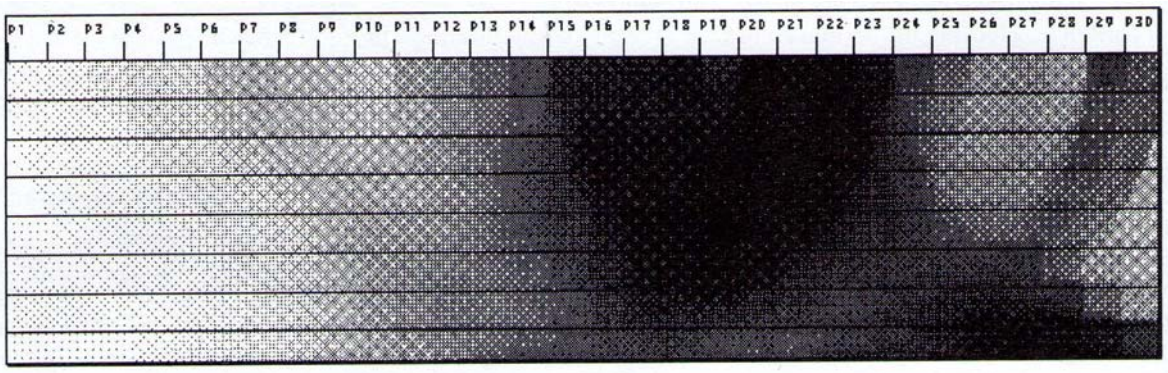


When the cavity is below the electrode the effect on the surface follows the arcs up to either side of the electrode.

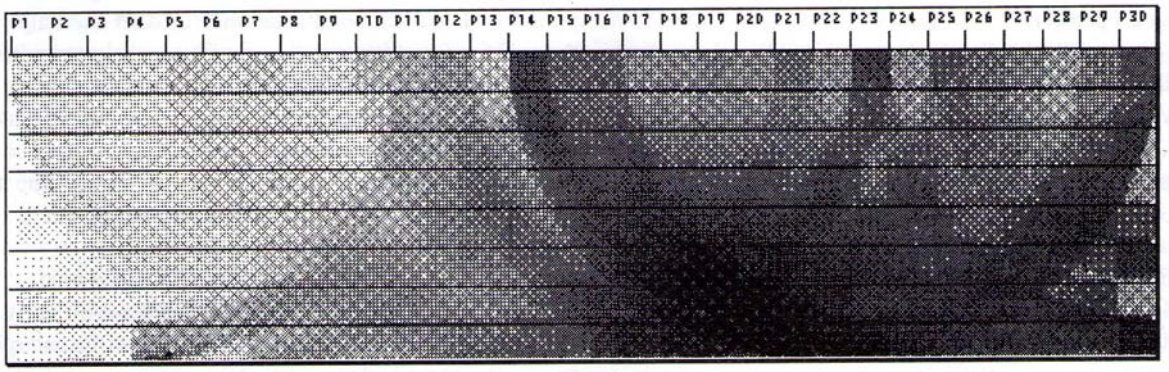


The results from the simulation can be fed into the imaging software used on real field readings and produce the image above. This shows that the position and top of the cavity may be accurately defined but the bottom is less distinct.

In the period since the equipment was constructed many scans have been done over known cave and "greensites". The following scans are over known caves.



This scan was taken above Ogof Ffynnon Ddu top entrance and accurately shows the main passage.



This scan was taken over the main chamber in Dan-y-Rhedyn and shows the entrance pitch leading down to the chamber.

This method of resistivity scanning should clearly detect passages up to a depth of twice their diameter i.e. a 5m diameter passage could be detected at a depth of 10m. Although theoretically smaller passages or greater depths can be scanned the images would be unreliable due to thickness of surface drift, peat depressions, shattered limestone etc.

As yet no new cave has been found using this method. In several areas we have scans that clearly show what we believe to be passages running close to the surface. However the technique will not show the small features like avens coming to the surface which would allow us access to the caverns below.