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Deep Geology: Methods and Results

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The two main techniques used as a basis for investigating deep geology are deep drill holes and reflection seismic data. However, the data from these sources was not used in isolation in interpreting subsurface geology. Evidence from other sources, including surface mapping, gravitational anomaly data and geophysical data was used in conjunction with it, to the extent that deep geology could be regarded as 'total geology'.

By way of introduction, the outcrop patterns of the major divisions of Britain's geology were pointed out with respect to the underlying geological structures. Careful mapping at the surface would give a good idea of the underlying geology. To illustrate this point, the Lower Palaeozoic where our knowledge is restricted to the main area of outcrop in the west highland area of Britain while knowledge of the Lower Palaeozoic rocks under the eastern side of Britain was restricted to a limited number of deep drill sites and remote sensing, seismic data.

The original technique in seismology of using explosions to generate energy waves has now been modified, on land anyway, by vibroseis. This uses the same trail of several kilometres of geophones but the energy/acoustic waves are passed into the ground by mobile trailers, with large electro-hydraulic vibrating pads, usually working in groups of three or four, which can be used on existing roads and in built up areas without damage. The reflection times are then recorded at the surface. The results are then interpreted, a complex process requiring much experience. This remote technique is then supplemented by data from boreholes.

There have been eight boreholes of up to three kilometres deep drilled by the BGS in the last nine years in various key areas. Data from boreholes comes not only from cored material but also from downhole geophysical logging. Using such techniques precise stratigraphical boundaries can be discerned. These can be matched with lithological divisions gleaned from drill cores.

A very high degree of precision is possible, for example, in the clays and shales of the Mesozoic, where lithological boundaries from cored material can be used to calibrate signatures in the geophysical data from downhole logging. This can provide, particularly in mudstone sequences, finer division of strata than is possible with ammonite zones. Additional, though confidential, borehole data comes from the oil companies, the BGS holding such information on behalf of the Government.

Using such techniques it has proved possible to produce accurate maps of the contours in the subsurface strata with the potential to solve many long standing geological problems. Ideally the seismic profiles have to be sited so as to pass through existing deep drill sites. The depth that can be reached using such techniques depends on the nature of the strata. Vertical or steeply dipping strata do not give good seismic reflections. Over much of Britain, however, a picture to the base of the crust/Mohorovicic discontinuity is possible (15-30 km). This has allowed a picture of the major structures present in the British crust to be understood for the first time.

Results from two such studies closer to home can now be considered.

First, a section across the Midlands massif/micro-craton. This revealed similar Lower Palaeozoic basins either side - the exposed Welsh basin and a concealed eastern basin. With one good seismic section sorting out the Malvern structure once and for all.

Second, a seismic profile across the southern part of the Church Stretton sheet. Although not completely worked out and with problems with the near vertical, steeply dipping strata of the

Longmyndian sediments, reducing the depth to which structures could be discerned to 3000 ft maximum, this nevertheless proved an invaluable insight and aroused considerable interest. A similar picture seemed to be emerging from all the seismic studies of sedimentary basins of recurring cycles of activity based on deep seated structures in the basal crust.

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