ABSTRACT

In the present work the analogy between a two-dimensional fluid flow and two-dimensional fields has been exploited for studying fields of geophysical interest. In these 'fluid mappers' water is allowed to flow in the form of a film of thicknesses upto about 2 mm between parallel glass plates and the flow lines are made visible with the help of a dye. Material properties like electrical conductivity and magnetic permeability simulated in this analogue are proportional to the cube of the thickness of the flow space. Inhomogeneities are simulated by wax plates of varying thicknesses. The flow lines represent equipotential surfaces and it is possible to directly read off potential differences or their gradients. In effect the fluid mapper is a computer with a visual display of the equipotential lines characterising a field. A simple and inexpensive method of getting permanent records of fields is also described.

Using one model of the mapper the effects of inhomogeneities on uniform fields have been demonstrated. These correspond to the electro-telluric fields observed in case of basement features and topographic effects. In these cases the main aim is to bring out the feasibility of the technique. Under the head of magnetic fields the magnetic effects due to horizontal cylinders have been considered for a wide range of directions of the magnetic induction and experimental results have been shown to be in very satisfactory agreement with theoretical results. These studies have been extended to prismatic bodies of square and triangular cross-sections.

The major part of the work however is devoted to electrical resistivity profiling with line electrodes using the Schlumberger configuration. Under this head cylindrical bodies have been studied covering a resistivity contrast of 125 to 1.73 with respect to the surrounding medium. Further, the effects of depth of burial and size of the inhomogeneity as well as the combined effects of these parameters have been illustrated. In all these cases experimental results have been compared with computations based on the work of Parasnis, and the agreement between them is found to be highly satisfactory with regard to the main features of the anomaly. As an extension of this the resolution of conducting and resistive cylinders has been illustrated. Examples have also been cited to illustrate the equivalence of inhomogeneities ad also the effects of composite bodies.

The effects of outcropping conductive and resistive semicylindrical bodies have been studied and compared with theoretical computations. Here too the agreement between experiment and theory in case of conducting bodies has been found to be very good whereas for resistive bodies a maximum deviation of about 15% was detected. In general it turns-out that in its present state the instrument is more successful in simulating the effects of conducting inhomogeneities than for resistive bodies.

The effects of depth extent, depth, width, resistivity contrast as well as inclination of dykes have been considered and it is shown that the resistivity anomalies bring out finer details. While it is not possible in these cases to compare them with theoretical computations, it has nevertheless been possible to account qualitatively for all the features on the basis of theoretical anomalies available for outcropping dykes. Resistivity profiles over a few prismatic bodies have been cited to bring out the differences brought about by the differences in the shape of the inhomogeneity.

Attempts to utilise the fluid mapper for resistivity soundings were not particularly successful due to the limited size of the device, but an alternative method has been suggested and is shown to yield the correct trends of sounding curves although numerical values are far from satisfactory.

In an Appendix a fairly large number of profiling curves computed using Parasnis' formula have been introduced to support some of the conclusions based on experimental data. In conclusion some suggestions are offered for possible improvements of the device.

In summary it may be said that the fluid mapper provides qualitatively reliable data, is versatile, inexpensive and has the advantage of providing a visual display of the field in the entire experimental region. It may be expected to be particularly useful for studies of resistivity profiling and related phenomena.