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Resistivity Vertical Filtering for Horizontal Prospecting Physical Basis and Archaeological Case Histories

An important question in archaeological geophysical prospection is the separation between anthropic and natural geological features. Generally the archaeological features are near the surface so that it is possible to distinguish them from the natural ones through suited investigation depths.

It is well known that electrical resistivity prospecting is a good method for the adjustment of the investigation depth owing to the electrode spacing. But the investigation depth and the electrical image are strongly dependent on the electrodes arrangements. The "archaeological" arrays are the twin electrode, the pole-pole, the square and the Wenner. In this paper it is shown that the pole-pole yields a very good discrimination between shallow and deep buried features. The pole-pole array is an improvement of the twin electrode (1) in the sense that remote electrodes are far from each other so that the readings provide the true apparent resistivities without any problem of continuity between adjacent grids.

The physical basis of the behaviour of the pole-pole array can be deduced from synthetic results about the anomaly created by a small body on a pseudo-section. Indeed, when comparing the anomalies of a small body imbedded in homogeneous ground obtained with several archaeological arrays, one sees that the pole-pole anomaly has a better resolution in the horizontal direction and also in pseudo-depth (2). This advantage of the pole-pole over the other arrays for depth discrimination is reinforced by two other properties: its technical simplicity (only two mobile probes) and its largest investigation depth (3). Thus, for a given investigation depth, the pole-pole array has the smallest dimensions of all arrays.

We show that multi-spacing pole-pole maps allow an efficient vertical filtering of anomalies in cases which would be otherwise hard geophysical problems. Case histories are the search for ditches in karstic geology, the detection of stony burial structures on very shallow resistive substratum, the separation of superimposed structures in a Roman town (4) or, on the country, the proof of the absence of any buried anthropic structures.

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Reconstructing the 3-D Distribution of the Magnetic Field Data and its Application

In geomagnetic survey, we usually measure the magnetic field only on one 2-D plane. In this study, the authors will propose the method of reconstructing the 3-D distribution of the magnetic field data from the 2-D magnetic field data and its application to estimate of the shape and the depth of the magnetic bodies. For example, in the case that two magnetic bodies are buried and one magnetic body is just above another one, only one magnetic anomaly is observed on a horizontal plane over these bodies. However, if we could assume a vertical observation plane in the ground and obtain the magnetic field data on the plane, we would find two magnetic anomalies on this virtual plane.

The magnetic field distribution on z = z1 plane can be calculated from the magnetic field on $z = z_0$ plane using 2-D Fourier transform as

$$F\,[\mathbf{B}_{Z_1}] = F\,[\mathbf{B}_{Z_0}]\,\exp\,(-\,|\,\mathbf{k}\,|\,(z_0 - z_1)),$$

where $\mathbf{B}_{z0}$ and $\mathbf{B}_{z1}$ are magnetic field on $z = z_0$ and $z = z_1$ plane, F[•] is the 2-D Fourier transform, $\mathbf{k} = (k_x, k_y)$ is the 2-D wavenumber vector and $z_0 > z_1$. Applying this equation repeatedly to the 2-D magnetic field data on 2-D planes with various inclinations, the 3-D distribution of the magnetic field data in regular region can be reconstructed.