Mining Sessions

Mining I — IP and Resistivity (SAMT, MT)

Discovery of a Mineralized Breccia Pipe Using Gradient Array Induced Polarization — M-1 §

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The Promontorio breccia pipe in southern Sonora, Mexico has been mined intermittently for silver since the turn of the century. Mineralization occurs as sulfides in the matrix of the breccia. 1-2 percent pyrite also occurs in the premineral andesite that the breccia pipe has intruded. Another small breccia was discovered 200 m west of Promontorio but postmineral cover obscures most of the remaining premineral rocks in the area.

Time-domain IP and resistivity test lines over Promontorio indicated that the breccia pipe is anomalous, although high background response occurs in the pyritized host rocks. The gradient array was chosen for this survey because it could efficiently provide the required detailed coverage over a large area. Several anomalous zones were located. The most interesting zone has an apparent response of 60-90 msec in low-resistivity rocks similar to Promontorio and measures 30 × 120 m. Additional information was provided by 3 dipole-dipole array lines which suggested that the zone was 20 m wide at surface with a vertical to large dip.

This interpretation was confirmed by 2 angle drill holes which encountered a 20 m wide breccia with sulfide mineralization in the matrix. The zone is apparently an elongate breccia pipe similar to Promontorio. Silver grades were marginal for making ore in 1977.

An Examination of 2-D Earth Model Resolution With the Dipole-Dipole Resistivity Method — M-2

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Algorithms for computing apparent resistivity over 2-D earth structures for various electrode configurations have been in use for several years. Despite the extensive use of these algorithms, no one has reported detailed studies on the resolution of 2-D earth structures using grounded electrode systems.

Model resolution using the popular dipole-dipole electrode array is examined. A study is made of both forward models developed during routine data interpretations and inverse models developed in an experiment design sense. The forward model interpreted from a set of data is perturbed sufficiently to illustrate the sensitivity of the data to the interpreted 2-D earth structure. The interpreted model is further examined by generating parameter statistics via the nonlinear inversion method. Parameter resolution is dependent upon resistivity contrasts and the complexity of the model, and is depth-limited by resistivity, dipole length, and dipole separations.

Experience is the best ingredient for dipole dipole resistivity interpretation using 2-D earth structures. However, we have found that the Dar Zarrouk parameters which are mathematically rigorous only for layered, homogeneous strata can be used to estimate the depth of resolution for complex 2-D resistivity distributions. The Dar Zarrouk-based depth of resolution estimate is best adapted to 2-D sections which mimic the type H or type K 1-D sections.

Log Pseudosections for IP and Resistivity — M-3 §

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The masking effect of thin surficial layers in IP and resistivity surveys is generally acknowledged, but the need to acquire data necessary to interpret shallow layers is usually overshadowed by the desire to obtain high quality "deeper" readings. Obviously, this approach is not used without good reason, as detecting economic targets is the normal objective of most surveys and, typically, the survey is performed within certain production constraints.

The research presented here has resulted in a field survey procedure that enables the user to collect adequate data to resolve both shallow layers and deep targets in an effective and efficient manner. A unique way of presenting the data in a logarithmic pseudosection format is described. Mathematical analysis of the dipole-dipole array supports the concept of logarithmic plotting and simultaneously confirms some empirical "rules of thumb." These rules of thumb can be expressed analytically as functions of the dipole spacing coefficient n. Three sought after characteristics of the array are: (a) optimal depth of investigation, (b) relative contribution to the surface signal from the optimal depth of investigation, and (c) the vertical resolution. For a homogeneous isotropic earth, the respective relations are: (a) $Z_{DIC} \doteq .3n^{.9}$; (b) $Q_{DIC} \doteq 1.6n^{.8}$; and (c) $R_{vert} \doteq .6n^{-.8}$.

Extensions of the Magnetometric Resistivity (MMR) Method — M-4

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The development of computer programs for calculating MMR responses of two-dimensional structures has created the problem of classifying and characterizing the type curves succinctly. For a simple body of resistivity ϱ_2 in a host half-space of resistivity ϱ_1, it is possible to express the amplitude A of the MMR anomaly on a given profile as

$$A = F(\alpha)\, A_p;$$

where α is a dimensionless current channelling number, and A_p is the anomaly on the profile when the body is a perfect conductor relative to the host medium, i.e., when $\varrho_2 << \varrho_1$. The number α is the ratio of the conductance of the body for unit length to the *effective* conductance of the host medium for unit length.

The true or intrinsic induced polarization response $m(f)$ of the body may be estimated as the change $\delta A(f)$ normalized by A, although the equation

$$\frac{\delta A(f)}{A} = m(f) \frac{\partial(\ln F)}{\partial(\ln \varrho_2)}$$

The form of $F(\alpha)$ may be computed for simple structures and, if α is small, it reduces to α itself. Because α is proportional to ϱ_2/ϱ_1, under these conditions

$$\frac{\delta A(f)}{A} \doteq M(f);$$

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§Preprint available from SEG Business Office.