

New advances in geophysical inversion in mineral exploration

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The geophysical inversion is an ill-posed problem. The solution of this problem requires the application of the corresponding regularization methods (Tikhonov and Arsenin, 1977). The traditional way to implement regularization in the solution of the inverse problem is based on a consideration of the class of inverse models with a smooth distribution of the model parameters. Within the framework of classical Tikhonov regularization, one can select a smooth solution by introducing the corresponding minimum norm, or "smoothing" stabilizing functionals. This approach is widely used in geophysics and has proven to be a powerful tool for stable inversion of geophysical data.

The traditional inversion algorithms providing smooth solutions for geological structures have difficulties, however, in describing the sharp boundaries between different geological formations. This problem arises, for example, in inversion for the local mineral target with sharp boundaries between the ore body and the host rocks, which is a typical model in mining exploration. In these situations, it can be useful to search for a stable solution within the class of inverse models with sharp geological boundaries. The mathematical technique for solving this problem was described in Zhdanov (2002). It is based on introducing a special type of stabilizing functionals, the so-called focusing functionals. This new technique was successfully applied in the solution of different inverse geophysical problems, including gravity and magnetic inversion, gravity gradiometer data inversion, electromagnetic geophysical data inversion, etc. In this paper I present several examples of model study and case histories illustrating the effectiveness of the new inversion technique in 3-D interpretation of geopotential and electromagnetic field data. The case histories include 3-D inversion of the gradient gravity data collected by BHP Billiton World Exploration in the Cannington Ag-Pb-Zn ore body in Queensland, Australia, and 3-D inversion of airborne and MT data collected by INCO Exploration in the Voisey's Bay area of Canada.