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Cross-Gradient Joint Inversion Coupled with Euler Deconvolution of Gravity and Magnetic Anomalies

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Abstract

The cross-gradient joint inversion strategy has been successfully applied to various combinations of geophysical data in the search of models with enhanced structural similarity that facilitates the interpretation of the subsurface characteristics. While resolution of the models depends on the geophysical data resolution or on direct measurements from borehole or surface exposures, this condition can be increased by supplying direct property values or imposing alternative hypotheses such as a preferred homogeneity (smoothness) or value-to-value cross-correlations. It is well known that potential-field data have limited resolution power and therefore data-independent restrictions are readily supplied for their inversion. Thus, the cross-gradient joint inversion of gravity and magnetic data has succeeded in finding commonly collocated density and magnetization structures. However, the inherent lack of depth resolution in the inversion of potential data still yields density and magnetization models with ambiguities at depth. In an attempt to improve this difficulty, we introduce higher-resolution "a priori" models derived by a strategy known to provide redundant subsurface structures such as Euler deconvolution. In this work, we generalize the Euler deconvolution method to a joint scheme, which consists of locating the horizontal and vertical position of the top of potential field 3D sources. These results are then used to constrain the depth to the top of the models obtained by cross-gradient joint 3D inversions, imposing fixed known values in the a priori models. The coupling of both methods produces more realistic density and magnetization models for both separate and joint inversions, relative to those obtained by applying cross-gradient joint inversion only. We show these advantages and test this strategy on a 3D synthetic experiment, and on a real field data set, concluding that the combination of both methodologies reduces the ambiguity in depth resolution that occurs when potential-field data are jointly inverted.