Modeling and hybrid inversion of mineral deposits using the dipping dike model with finite depth extent

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Abstract

The dipping dike model has shown to be a useful approximation for mineral deposits. To make this model more realistic, we include the thickness, which yields the depth to the bottom, as an additional parameter. The magnetic anomaly is obtained by combining the anomalies of two infinite dikes, so that the resulting expression is simpler than the classical prismatic models with polygonal cross section. A Metropolis-Hasting (MH) algorithm coupled with the Levenberg-Marquardt (LM) method is employed to invert magnetic profiles assuming a model of multiple dike-like sources. We use a few iterations of the LM method to improve the candidate solutions in the random walk generated by MH. Moreover, after the MH iterations we perform a regular LM local search using the MH solution as the initial model. The following parameters are obtained: depth to the top, thickness, half-width, horizontal location of the top center, the geological dip, in addition to two effective parameters that depend on the intensity of magnetization and the directions of the induced and remanent fields. For synthetic anomalies, both noise-free and noisy magnetic data are considered, with examples presented for each scenario. These examples highlight the discrepancy between models with finite and infinite sources. They also illustrate the higher accuracy of the hybrid MH-LM method over the pure MH approach. Afterwards, we apply our method to the inversion of a magnetic profile over iron ore deposits located in Laje, northeast Brazil, corroborating previous studies in this area.