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Multi-physics Inversion of Gravity and Magnetic Data with Application to Geothermal Fields

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Abstract Text:

Current research is aimed at joining different geophysical techniques to take full advantage of particular resolution of every single method, i.e., multi-property characterization of subsurface targets. We developed a versatile algorithm to jointly estimate density and magnetization 3D structures using gravity and magnetic data that take advantage of direct unknown relationships that allows to preserve resolution of individual methods and rely more in the properties values themselves in contrast to structural minimization approaches that relies more in the properties changes. We contemplate a petrophysical relationship between parameters (e.g. density and magnetization), a priori models from geology and borehole data which are incorporated as a constraint in a nonlinear square problem. We tested our algorithm with synthetic examples and the joint 3D inversion scheme results show a better accuracy and resolution than the individual ones. We applied the algorithm over Los Humeros and Acoculco geothermal fields, in Mexico, and demonstrated that our approach is viable in real Earth applications. The strategy demonstrated to be stable and adequate for a complex scenario such as geothermal fields, where a structural coupling between density and magnetization is not evident. Moreover, the joint inversion using unknown relationships approach seems to preserve the original resolution of individual methods but adding noticeable improvements such as a better delimitation of anomalous bodies in exchange for a slight RMS data misfit increment when compared with separate inversion.

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