Inversion of magnetotelluric data with seismic constraints using a structural approach

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SUMMARY

The inverse problem in diffusive electromagnetic (EM) geophysics is studied and solved with a variety of different numerical techniques. Although its broadly used in geophysics, some disadvantages are inherent to the magnetotelluric (MT) method, especially its lack of resolution beneath conductive structures, that introduces major interpretation problems. Moreover, regularization techniques in inversion schemes bias the results, leading to regularization artifacts. A possible solution for these problems involves joint inversion of techniques that are sensitive to different physical parameters. In this work, we invert MT data (sensitive to electrical resistivity) in both one-dimensional (1D) and two-dimensional (2D) environments using a Genetic Algorithm (GA). In order to reduce the non-uniqueness of the problem, seismic data (sensitive to shear-wave velocity) are introduced as additional constraints to the MT inversion process. This constraint is built on a structural approach: where the physical model parameters change, they bring a smaller contribution in the objective function if they change in the same spatial location. Common structures are thus highlighted. This also introduces a measure of the difference between MT and seismic structures in the minimized objective function. Synthetic tests have been conducted and show promising results in both 1D and 2D environments, increasing the model resolution beneath conductors and reducing the presence of regularization artifacts.

Keywords: Inverse Problem, Parameter Estimation, Genetic Algorithm