3D Inversion of Controlled-Source Electromagnetic Data using Non-linear Conjugate Gradients

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SUMMARY

We present first results of our 3D inversion software developed to image the resistivity distribution of the subsurface with frequency-domain controlled-source electromagnetic data.

Our 3D finite-element forward solver was implemented into an inversion framework using non-linear conjugate gradients. The software can handle CSEM setups with multiple source locations. Impedance tensor elements generated by a set of two coincident perpendicularly oriented horizontal electric or horizontal magnetic dipole sources serve as input data for the inversion. Using tensor measurements instead of scalar or vector measurements or single field components brings two advantages: First, complex 3D structures can be better resolved. Second, the source current strength, which is not always recorded alongside the field data, does not have to be known for the inversion as the amplitude and phase of the source current cancel out in the tensor formulation.

In our contribution, we investigate the influence of different regularisation schemes and structural weights on the inversion of synthetic datasets. The regularisation on unstructured meshes is a non-trivial part in the inverse computation, especially the regions around the sources must be handled with caution. To prevent large model updates near sources and receivers, we designed a depth weighting function. A similar depth weighting has been successfully applied to 3D magnetic and gravity inverse problems in order to distribute the model update more evenly in the domain.

Keywords: Three-dimensional inversion, controlled-source, frequency-domain, regularisation, conjugate-gradients