1D modeling of TEM data influenced by IP effects

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Abstract
Transient electromagnetic (TEM) data can be significantly distorted by induced polarization (IP) effect, leading to a sign reversal feature and, if overlooked, false geological interpretation. The aim of this paper is to incorporate IP effects in the forward modelling and recover the distorted TEM data using an efficient inversion algorithm. To achieve this aim, we developed a 1D forward solver to incorporate the IP effects using various IP parameterizations including Cole-Cole, maximum phase angle (MPA), maximum imaginary conductivity (MIC) (Fiandaca et al., 2018) and the Jeffrey transform of Cole-Cole parameters (Ghorbani et al., 2007). For 1D inversion of distorted TEM data we used Levenberg-Marquardt and very fast simulated annealing algorithms. The result of 1D forward calculation and inversion of synthetic IP-distorted TEM data revealed that, for incorporation the IP effects into the TEM data, the Cole-Cole parametrization is more robust and reliable than MPA, MIC, and Jeffrey transform. Moreover, the result of inversion using Levenberg-Marquardt algorithm is strongly depends on the starting model. We successfully implemented these algorithms for 1D inversion of synthetic IP-affected TEM data (Fig. 1). For synthetic data generation, a 3-layered half space model with the thickness of the first and second layers of 5 m was considered. The resistivities of the layers from top to bottom are 10, 5 and 300 Ωm, respectively. To include the IP effect, second layer considered to be chargeable with Cole-Cole parameters of m = 0.5, τ = 0.01 s and c = 0.5. TEM central-loop configuration with a loop size of 50*50 m2 and step-off current of 1 A with a zero ramp time was used for data simulation. We evaluated the performance of our algorithm using field data, successfully.

Keywords: Transient Electromagnetic; Induced Polarization; Inversion

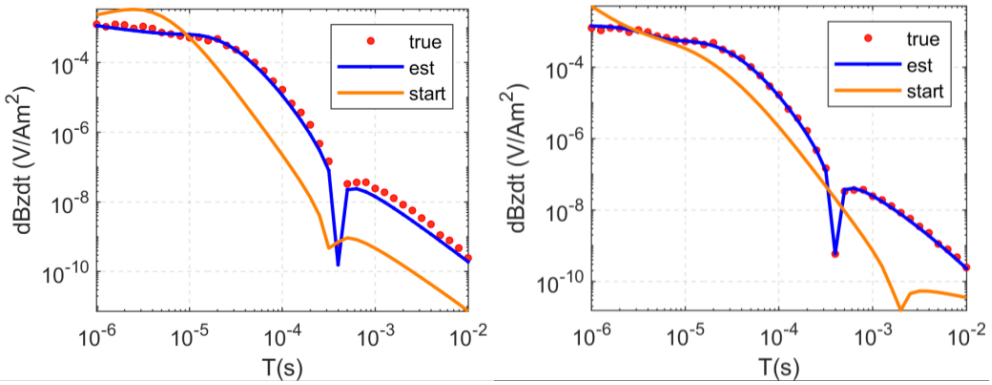

Figure 1: Inversion of synthetic noisy TEM data, with 10% noise, using Levenberg-Marquardt (left) and very fast simulated annealing algorithms (right). The IP effects included in the TEM data using Cole-Cole model.

Reference / more information
Fiandaca, G., Madsen, L. M., and Maurya, P. K., 2018. Re-parameterisations of the Cole–Cole model for improved spectral inversion of induced polarization data. Near Surface Geophysics, 16(4), 385–399.
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