3D Inversion and resolution study of CSEM and CS/RMT data in the radio frequency band for extended sources

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ABSTRACT

Over the last two decades, controlled source (CS) methods in frequencies ranging from 1-1000 kHz have been developed. These methods effectively complement the passive electromagnetic (EM) method Radiomagnetotellurics (RMT) by providing a wider range of frequencies and a greater depth of investigation. Additionally, they enable remote array work without the need for radio antennas in the vicinity of the measurement area. While initially, controlled sources were only considered in far-field conditions, recently data from the intermediate zone, closer to the transmitter, has been included. This approach has several advantages over solemnly far-field consideration: (i) easier logistics, as we do not need to place the source far enough to maintain far-field conditions; (ii) better signal-to-noise ratio; (iii) combined unique resolution properties of CSEM and RMT, among others. Since EM fields in intermediate zone depend on the source geometry, it is crucial to model the source accurately.
Our study presents an inversion and resolution study of different inductively and galvanically coupled sources on synthetic forward modeling results. We use (i) conventional CSEM single source configurations and (ii) CS/RMT source configurations with two perpendicular transmitters. In case (i) we invert univariate CSEM transfer functions, while in case (ii) we also invert MT-type transfer functions. The models employed in this study include both classical 3D-RMT examples and models representing regions with high resistive environments. For modeling we use our in house developed software package MR3DMod. The inversion package of MR3DMod follows recipes of well-established codes like MODEM. The CS 3D- forward modeling is based on a secondary field approach including quasi analytical primary field solutions. We tested the stability of the primary field solution extensively for stability in high frequencies including displacement currents.
Based on the outcomes of the conducted analysis, we can propose further recommendations regarding CSEM in the radio frequency band as well as CS/RMT survey planning. This includes the identification of favorable source configurations for the resolution of specific problems.

Keywords: 3D Inversion, resolution study, displacement currents, CSEM, CS/RMT

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