Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

STT58-P03 Room:Poster Time:April 30 18:15-19:30

Three dimensional inversion for the Grounded Electrical-Source Airborne Transient Electromagnetic (GREATEM) data

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Previous studies conducted by the Grounded Electrical-Source Airborne Transient Electromagnetic (GREATEM) have shown that, this system is a promising method for modelling 3D resistivity structures in coastal areas, in addition to inaccessible area such as volcano, mountainous area covered by deep forest. To expand the application of the GREATEM system in the future for studying hazardous wastes, sea water incursion,geothermal exploration and hydrocarbon exploration, a 3D-resistivity modelling that considers large lateral resistivity variations is required in case of large resistivity contrasts between land and sea in surveys of coastal areas where 1D resistivity model that assumes a horizontally layered structure might be inaccurate. In this abstract we present the preparation for developing a consistent three dimensional electromagnetic inversion algorithm to calculate the EM response over arbitrary 3D conductivity structure using GREATEM system. In forward modelling the second order partial differential equations for scalar and vector potential are discretized on a staggered-grid finite difference method (Fomenko and Mogi, 2002, Mogi et al., 2011). In the inversion method the 3D model discretized into a large number of rectangular cells of constant conductivity and the final solution is obtained by minimizing a global objective function composed of the model objective function and data misfit. To deal with a huge number of grids and wide range of frequencies in air borne datasets, a method for approximating sensitivities is introduced for the efficient 3-D inversion. Approximate sensitivities are derived by replacing adjoint secondary electric fields with those computed in the previous iteration. These sensitivities can reduce the computation time, without significant loss of accuracy when constructing a full sensitivity matrix for 3-D inversion, based on the Gauss?Newton method (Han, N.et al., 2008).

Firstly, we started testing the algorithm in the frequency domain electromagnetic response of synthetic model considering a 3D conductor embedded in uniform half space. In the second step we tested more complex synthetic model, considering vertical contact between two different high and low resistivity quarter-spaces and a conductor embedded in a high resistive quarter-space. Frequency-domain computation is executed at frequencies of five equal logarithm spacings in one decade in the frequency range of (10^5-10^{-2}) Hz. After the computation, we transformed into time domain using FFT and compared forward value with inverted value.The inverted results in case of the simple model, appear to highlight a conductive zone of potential interest within the resistive region. In addition, in case of two quarter spaces model, it was able to the reveal the clear resistivity contrast between the two quarters spaces and highlight a conductive zone within the high resistive quarter space. Both of the forward and inverted models have almost the same EM response which can confirm the accuracy of the inverted method. The next step for preparing this algorithm will be using the field data from previous GREATEM surveys to demonstrate this technique

Keywords: 3D EM inversion, GREATEM, Numerical approximations, Airborne Electromagnetic