Estimation of mean one-dimensional model from heterogenous magnetotelluric impedances

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three-dimensional (3-D) magnetotelluric (MT) forward calculation and inversion. Fast and stable convergence of forward calculation is essentially important for MT inversion problems to be practical, which requires the condition number of the system matrix of the forward problem to be as small as possible. Avdeev (2005) showed that the appropriately preconditioned system matrix has small condition number of at most $(Cl)^{1/2}$ where Cl is a lateral contrast of conductivity. This implies that the system matrix will be well-conditioned, if we use a mean one-dimensional (1-D) model as a background. Then, next problem is how to estimate the mean 1-D model, especially in case of seafloor MT data which we are mostly working on. One possible way of such estimation was proposed in the work by Baba et al. (2010), in which the optimum 1-D model is estimated iteratively from spatially averaged rotationally invariant impedance. In this presentation we propose a new approach that allows a direct estimation of mean 1-D model from heterogeneous MT impedances.

We assume a number of MT observations were made on the surface of the Earth consisting of a 3-D heterogeneous surface layer and 1-D structure below. In the part of forward calculation, we use the integral equation method with the modified Neumann series (MNS), which is effective to avoid the calculation of large-scale linear equations (Singer, 1995; Avdeev et al., 2000). Based on the method of MNS and the work of Zhang et al. (2012) for full 3-D inversion, the gradient of the model response (sensitivity) was also modified so as to be adapted to the one-dimensional inversion. In addition, the model parameter was modified from logarithm of block conductivity, to logarithm of layer conductivity in the present case.

We tested this new method by using synthetic models and compared the inversion result and its misfit. The synthetic model is composed of the laterally heterogeneous first layer and a 1-D layered conductivity structure below. The number of layers, the layer depth and the value of conductivity in each layer could be given in random. The starting model of inversion is composed of the first layer as same as that of the synthetic model and the bellowing layers far from that of the synthetic model. We evaluated the misfits between the inverted and modeled data and between the synthetic and inverted models of the inversion process, which to some extent reveals the quality of the inversion result after iteration. The result of synthetic tests indicates sufficiently high performance and reliability of this method. Furthermore, future application of the method to seafloor MT array data would be developed.