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3-D inversion of marine magnetotelluric data

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In recent years, a number of seafloor electromagnetic (EM) experiments have been carried out by using ocean bottom electromagnetometers (OBEMs). The density of marine magnetotelluric (MT) data has been increasing so that imaging electrical conductivity structures under the seafloor in three dimensional is now feasible. As shown in presentation by Baba et al. (2010, in this session), we deployed OBEMs in a two-dimensional array in the Philippine Sea in order to image three-dimensional (3-D) electromagnetic feature of a stagnated slab and surrounding mantle. However, 3-D MT inversion code has not been in practical use for the seafloor data so far. Thus we modified a full 3-D inversion code, WSINV3DMT (Siripunvaraporn et al., 2005), which can treat only flat topography and land data, to apply data on complex seafloor topography.

Two major modifications are required to allow inversion of seafloor data: 1) incorporating topographic change to a conductivity structure model, and 2) calculating MT responses at arbitrary position in a model blocks. For the first point, we express the topographic geometry (boundary in conductivity) not by finer model block boundaries but blocks with moderate dimensions conserving horizontal conductance within a block if it covers seawater and crustal rock portions. This procedure enables us to express complex topography inexpensively. For the second point, transform vectors, for which compute electric and magnetic field at an observation point from electric field calculated on staggered grids, are modified in order that we can calculate MT responses at arbitrary location using interpolation and extrapolation methods. These modifications were applied to not only the forward part but also the inversion part of the original WSINV3DMT code. The inversion part includes calculation of sensitivity, which is a measure of the extent by which a change in a model parameter results in a change in the MT response. The computation of sensitivity needs four forward calculations which have a different source field each other. A point source is put at an observation points in two of these forward calculations, and a value of the point source depends on the transform vectors.

The modified version of WSINV3DMT is now being tested using synthetic models and data. The synthetic data are calculated from 3-D conductivity structures with seawater and topographic variation. We confirm that assumed structures are reconstructed from the synthetic data with the modified version of WSINV3DMT. In this presentation, we will show the detail results of the synthetic tests.

Keywords: 3-D inversion, ocean bottom electromagnetometer, magnetotellurics, topographic effect