Modification of forward part of 3-D MT inversion WSINV3DMT to be applied to seafloor

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Recently, three-dimensional EM inversion has become practical and widely applied to field data. However, an inversion code applicable to seafloor EM data is not present yet. It is because that a forward solver must properly treat coast and bathymetry effects resulting from the high conductivity of seawater. Here we try to modify one of the most well used three-dimensional inversion code, WSINV3DMT (Siripunvaraporn et al., 2005), to be able to handle seafloor EM data. In this study, we will present how we have modified the forward part of this inversion code.

Major difference between original land version and modified seafloor version are the presence of seawater, seafloor topography, and points that EM responses are calculated. The original version only treats flat ground surface for the calculation of responses. Thus, the data applied must be located only at the surface that is a boundary of non-conducting air and conducting Earth. Further, in horizontal, the calculation points must be located only at the middle point of the block surface. To be applicable to seafloor EM data, we need to consider three points. First, the calculation points can be located at the seafloor. Second, the seafloor may not be flat, but may have spatial variations. Finally, model responses should be calculated at various depths corresponding to actual observation site locations. It is important to treat topographic effect, because seawater is a very conductive medium, which affects significantly observed electric and magnetic fields. Topography is so complex that we need a good many blocks to express in detail. This fact increases calculation time to non-realistic level. We, therefore, improve mesh design in a cost-effective manner.

Two modification techniques are introduced into the modified version; a volume-weighted average of resistivity for each block, and an interpolation of observation sites in grid. Resistivity in a block is calculated as a volume-weighted average of resistivity when media with different resistivity are incorporated into a block. This enables us to model complex bathymetry without substantial increase of memory requirement. The second technique is an interpolation of the EM field values calculated on staggered grids to obtain MT impedances at arbitrary observed (output) points. A MT impedance at an arbitrary point is interpolated by tri-linear method using eight MT impedances around the point.

Accuracy of our modified forward program, especially for the interpolation technique, was checked to be compared to FS3D (Baba and Seama, 2002) by using a three-dimensional resistivity structure model which includes L-shape conductive anomalous body within a half-space. We focused on off-diagonal components of MT responses because diagonal components are much smaller than off-diagonal components. Phase differences between our program and FS3D are less than 1 degree. Relative errors of apparent resistivity, even calculated above the anomalous body, are 4 % at most. We, however, have been improving the interpolation method to calculate electric field and magnetic field separately before calculating MT responses in order to reduce relative errors of apparent resistivity calculated above the anomalous bodies.

To the next step, our modified three-dimensional forward part of WSINV3DMT will be incorporated into three-dimensional inversion which is applicable to seafloor data.

References:

Baba, Kiyoshi and Nobukazu Seama (2002), A new technique for the incorporation of seafloor topography in electromagnetic modeling, *Geophys.J.Int*, **150**, 392-402.

Siripunvaraporn, Weerachai, Gary Egbert, Yongwimon Lenbury and Makoto Uyeshima (2005), Three-dimensional magnetotelluric inversion: data-space method, *PEPI*, **150**, 3-14.