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Three-dimensional electromagnetic modeling of topographic effects on electromagnetic field induction by GREATEM surveys

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A grounded electrical source airborne transient electromagnetics (GREATEM) survey was performed at Kujukuri beach in central Japan, where an alluvial plain is dominated by sedimentary rocks and shallow water. A reliable resistivity structure was obtained at a depth range of 300?350 m both on land and offshore, in areas where low-resistivity structures are dominant (Ito et al., 2011). Another GREATEM survey was performed at northwestern Awaji Island, where granitic rocks crop out onshore. Underground resistivity structures at depths of 1 km onshore and 500 m offshore were revealed by this survey. The absolute resistivity found onshore was much lower than existing results. To circumvent this problem and understand the reason for the inaccurate results, we used a three-dimensional (3D) electromagnetic (EM) modeling scheme based on the staggered-grid finite-difference (FD) method (Fomenko and Mogi, 2002) to study the effects of oceanic saltwater (or the sea effect) on EM field induction when conducting GREATEM surveys at coastal areas with topographic features. Topography in our model was represented as an anomaly (1E-8 S/m) in the air layer. We selected a 3D-topographic model consisting of a topographic feature (1E-2 S/m) placed on top of a uniform half-space earth medium (1E-3 S/m). The resistivity contrast was 1E+6 times between the air and the topography. In the topographic area we used X: 50 x Y: 50 x Z: 25 m cells. Outside the topographic area, irregular cells were used. The total number of nodes was 52 x 38 x 32 = 63232 cells. The computation was done for four topographic slope angles (90, 45, 26.5 and 14 Degree). A horizontal electric dipole source was directed along the y-axis situated at the origin (x = -1500)

The most significant effect of topography on EM field induction occurs at low flight altitudes and gradually decreases with increasing the flight altitude. The topographic effect of steep slope angles (e.g., 90 and 45 Degree) is higher than for gentler slopes (e.g., 26.5 and 14 Degree). Furthermore, the area of the topographic feature closer to the dipole source has a larger effect on EM field induction for several meters.

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