Pseudo 3-D resistivity model for Geomagnetic Induced Current (GIC) based on 3-D seismic velocity structure

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Geomagnetic Induced Current (GIC) is a natural hazard due to a huge geomagnetic storm, whose large current amplitude makes severe troubles on the electric power grid, pipe lines and other metallic elongated infrastructure. For prevention of this new-typed disaster, three-dimensional (3-D) resistivity structure of the crust and mantle is necessary for evaluation of degree of GIC. Magnetotelluric (MT) survey is effective for obtaining such deep resistivity structures. However, artificial noise around highly populated areas restrict the MT survey and no resistivity structures are obtained. Other geophysical information such as 3-D seismic velocity structures has been obtained in such populated areas. If the relationship between the crustal/mantle seismic velocity and resistivity can be found, the subsurface resistivity structure can be inferred from the 3-D velocity structure.

In this study, an integrated analysis of the subsurface resistivity structure and seismic velocity structure is attempted to find the correlation between these two physical properties and to promote quantitative understanding of the deep crust and the uppermost mantle. The target region is the east Hokkaido, where the GIC was observed together with the geomagnetic storm. The two-dimensional (2-D) resistivity structure by MT survey (Sato et al., 2001) and the 3-D seismic velocity structure deduced by seismic tomography (Matsubara et al., 2019) are used in this study. We first focus on the correlation between two different physical property with cross-plots, and approximately express the correlation at each geological area. We found a positive correlation of resistivity and P-wave velocity at the mantle depths. Based on a rock physics model, the feature can be interpreted with porosity distribution with fluid (magmatic material). On the other hand, negative correlations are often found at the crustal depths. It cannot be well fitted by the simple-pore model, but could be explained by the presence of conductive minerals such as graphite. Although the relationship between resistivity and seismic velocity is not simple, we try to construct a pseudo-resistivity model based on 3-D seismic velocity distribution. Finally, we compare the predicted GIC at the eastern Hokkaido area with the observed one.

Keywords: GIC, Magnetotellurics, Seismic Tomography

