

Introduction of Network-MT method - toward elucidating nation-wide deep electrical conductivity structure -

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To determine a nation-wide 3-D deep electrical conductivity structure e.g. of several hundreds times several hundreds km² scale, electric field had better be measured with a typical dipole length of 10km or more. In order to estimate spatial variation of the structure in this scale, all the electrodes ideally mutually connected by the observation network. Then, referring to the pioneering works in employing telephone lines for electric dipoles (e.g., Mori, 1985, 1987), Uyeshima et al. (2001) developed an observation technique named Network- MT method. In this method, the telephone line network is fully used to determine horizontal distribution of voltage differences with long electrode spacings. The dipoles in the method are telephone lines connected to electrodes, which are either earths installed for telecommunications facilities by the telephone company, or electrodes purpose built for the experiment. Dipole lengths range from ten to several tens of kilometers. As a reference magnetic field, magnetic records obtained by three component magnetometers at geomagnetic observatories or at purpose built stations are used. Data loggers are often installed at the central telephone station. If we deploy long dipoles, the S/N ratio of electrical records will be enhanced. This enhancement will enable us to extend the experiment both in space and frequency domain (especially toward the lower frequency range). We also obtain responses relatively free from the static effect.

After the telluric voltage difference records are obtained, response functions in the frequency domain between each voltage difference and 2 component horizontal magnetic fields are estimated. Period range is from several s to 10⁵⁻⁶ s. If all the electrode points are connected by the observation network, virtual voltage difference between any pairs of electrodes can be estimated by linear combination of the response functions for real (or measured) dipoles. In this way, after selecting three electrode points in the observation area, voltage differences along two sides of the triangle made by the selected electrode points can be estimated, and then, average 2 component electric fields in the triangle, when a unit magnetic variation occurs in the x- or y-direction at the reference site, can be estimated by linear combination of the response functions. Thus the average impedance tensor for the triangle can be estimated and will be inverted to yield the electrical conductivity structure. At the same time, the response functions or the impedance tensors can be used to evaluate spatial distribution of GIC at large geomagnetic storms.

In order to obtain regional 2-D or 3-D structures from the Network-MT data, several methods were developed. One way is to first compose averaged impedance tensors for triangles made by three electrode points, as mentioned above, and then, conventional inversion schemes are applied to those impedance tensors (Yamaguchi et al., 1999; Shiozaki et al., 1999; Satoh et al., 2001). In Uyeshima et al. (2001, 2002), the response functions between respective voltage difference and magnetic field are directly reproduced in the 2-D or 3-D forward calculations. This method is adopted in a subsequent 3-D inversion scheme by Siripunvaraporn et al. (2004), which is based on a 2-D and 3-D data space Occam's inversions designed for inverting conventional MT datasets (Siripunvaraporn and Egbert, 2000; Siripunvaraporn et al., 2005). Recently, a new 2-D inversion technique for combining conventional and Network MT response functions was developed (Usui, 2010). The technique will be extended for the 3-D problem.

Keywords: Network-MT method, nation wide deep electrical conductivity structure, spatial distribution of induced currents