A three-dimensional electrical conductivity model in the subduction zone of Tohoku district, northeastern Japan

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We acquired magnetotelluric (MT) data at 65 sites in Tohoku district, northeastern Japan for the aim of three-dimensional (3-D) electrical conductivity distribution in the wedge mantle. Typical observation duration were three months at each site, and MT response functions from 10 to 20000 s in period have successfully collected with fine quality. The site location was arranged with ca. 20 km distance. We integrated the MT data observed on the seafloor in Japan Sea using the ocean bottom electromagnetometers (OBEM) (Toh et al., 2006) into these inland data, and estimated a conductivity model.

The MT phase response functions at some sites show over 90° longer than 5000 s period and suggest that 3-D conductivity distribution beneath those sites. The distribution of phase tensor ellipses (Caldwell et al., 2004) shows more clearly the degree of lateral heterogeneity or dimensionality. The phase tensor ellipses of the sites in Akita and Iwate Prefectures have major axes aligned with NW direction. The direction is almost parallel to the Pacific plate motion. On the other hand, the major axes around Naruko and Kitakami river have random directions and the ellipticity of the phase tensor ellipses is very large (>10).

We carried out the 3-D inversion using WSINV3DMT code (Siripuvaraporn et al., 2005) and gave a prior model composed of subducting slab (10^{-4} S/m) and seafloor bathymetry. The plate boundary information by Kita et al. (2010), Nakajima et al.(2009) and Nakajima and Hasegawa (2006) was used. Before inverting the observation data, simple checker board resolution tests were performed to estimate a resolution. We tested the three models composed of cubes with the same size (60, 40 and 20 km on side) and 1 S/m conductivity in the wedge mantle of 0.01 S/m. Each cube with 40 and 60 km on side was imaged using the synthetic data, while the adjacent cubes sticking together were imaged in the model composed of cubes with 20 km on side. Furthermore, any cubes beneath no observation site were not imaged at all using the synthetic data. The east-west profile (across the Japan Arc) of the obtained model shows that conductive region appears from 20 km to just above the subducting slab beneath Tohoku backbone range. This image is well consisted with the seismic tomographic model (Nakajima et al., 2001), provided that conductive and low velocity zone should corresponds with each other. Obtained the final 3-D model, we plan to estimate the mantle geotherm and fluid distributions in the wedge mantle using seismic tomographic and electrical conductivity images.