Electrical conductivity structure of the oceanic lithosphere beneath the Northwest Pacific Basin

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We have been conducting seafloor electromagnetic (EM) observation at site called NWP on the Northwest Pacific basin since July, 2001 (Toh et al., 2004). The objectives of the seafloor observation are to operate the world's first seafloor geomagnetic observatory, and to reveal the mantle electrical conductivity structure beneath the Northwest Pacific basin by long-term EM responses of the conducting Earth.

Toh (2005) applied the magnetotelluric (MT) and geomagnetic depth sounding methods to the 5-component EM filed of 500-day long, and yielded a one-dimensional (1D) electrical conductivity model by Occam Inversion (Constable et al., 1987) with smooth constrains. The 1D model resolved three conductors at depths of 40km, 125km and 260km, respectively. However, the presence of the 40km conductor is arguable, since the oceanic lithosphere at NWP is as old as 124Ma, and hence presumably very thick and cold. The most likely cause of the 40km conductor is the so-called coast effect, which has been pointed out (e.g., Cox, 1980; Heinson and Constable, 1992) as the source of fictitious structures. Since both the resistive lithospheric mantle and the conductive seawater have significant thicknesses, the coast effect may not be neglected even at NWP which is as close as 700 km to the Kurile trench nearby.

We tested the coast effect at NWP using non-uniform thin sheets (McKirdy et al., 1985), which showed that the calculated MT responses at period 1,000 - 10,000 s were far below the observed responses. Although the result may suggest that the coast effect at NWP can not be ignored, the non-uniform thin-sheet estimate is the upper limit of the coast effect assuming no leakage of the induced currents in the ocean to the conductive mantle. We, therefore, will report how the presence of the subducting Pacific plate reduces the coast effect using 2D forward modeling. The coast effect can be greatly reduced if there is an effective conductive path from the ocean to the mantle. This means that the 40km conductor can be interpreted as a source region of intra-plate volcanism of the old oceanic plate, provided that the subducting Pacific plate is proved to serve as the conductive passage to the mantle.

References

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