

Thermal structure of old oceanic upper mantle: Constraints from electrical conductivity imaging in the NW Pacific

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Northwestern part of Pacific plate is very old as the crustal age is over 100 Ma. Seafloor subsidence and heat flow change with age for such old ocean have been explained by cooling of a plate with constant thickness (e.g., Parsons & Sclater, 1977; Stein & Stein, 1992). Electrical conductivity of the upper oceanic mantle typically has resistive layer over a conductive zone reflecting the thermal structure. However, our recent results on the electrical conductivity of the upper mantle beneath northwestern Pacific suggest that a simple plate cooling model can not explain the observations.

We have run marine electromagnetic observation in two areas (Areas A and B) of the northwestern Pacific since 2010. Areas A and B locate northwest and southeast of Shatsky Rise, respectively. Although a part of the observation is still going on, we analyzed the data collected by the last year to obtain magnetotelluric responses and one-dimensional (1-D) electrical conductivity structure beneath the observation areas. Here, we compare the results together with a model obtained for the mantle beneath the Pacific ocean off the Bonin Trench (Area C) by a past project. The mean lithospheric ages of Area A, B, and C are about 130, 140, and 147 Ma, respectively. Based on a plate cooling model, the age differences for the thermal structure among the areas are very small. However, the obtained electrical conductivity models show significant difference in the thickness of the resistive layer. The depth the mantle become more conductive than 0.01 S/m are about 80 km for Area A, about 110 km for Area B, and about 200 km for Area C. These differences can not be reconstructed from the age difference of a single plate cooling model.

Our observations revealed that there is large scale lateral heterogeneity in electrical conductivity. We need to consider another factors rather than age difference of the thermal structure to explain such the lateral heterogeneity.

Keywords: oceanic upper mantle, northwestern Pacific, magnetotellurics, electrical conductivity structure, thermal structure