Electrical structure of the upper mantle in the Mariana subduction system I: Results of the seafloor MT experiment in 2001-2002

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We have studied electrical conductivity structure of the upper mantle beneath the central Mariana region since 2001 in order to construct a standard electrical model for back arc - island arc - subduction systems. The electrical conductivity of mantle rock is primarily dependent on temperature, although partial melt and water dissolved in olivine can enhance conductivity. Both melting and mantle hydration are important parameters to constrain in a back-arc setting suggesting that the study of conductivity structure will be useful to furthering our understanding of these regions.

In this study, we have analyzed seafloor magnetotelluric (MT) data collected at eight stations. The five of them are newly acquired as part of this project. The other three are acquired in past experiments by Filloux (1983) and Seama et al. (2004). The stations locate on a line crossing the central Mariana Trough in the present spreading direction. The eastmost station locates in Pacific plate and the westmost station locates in Parece-Vela Basin. There are five stations in Mariana Trough. The other two stations locate in the fore arc basin and the volcanic arc, respectively.

The MT response, which is a transfer function between the electric and magnetic field, is calculated at each station. The obtained responses are corrected for topographic effect which is severely distort the response and prevents the information of underlying mantle structure. Then, the corrected responses are separated to TE and TM modes and then inverted in two-dimensional (2D) model space independently and jointly. The responses for the each mode is sensitive to electric current flowing either parallel or perpendicular to the 2D strike.

The obtained 2D models for both modes have common feature that the mantle resistivity decrease from several hundreds or more to several tens or less ohm-m at the depth of 70 km beneath Mariana Trough. The boundary depth is probably deeper beneath Pacific plate although it is not clearly resolved. The mantle below 70 km depth in the Mariana Trough is more conductive for the model by the TM inversion than that by the TE inversion. This may indicate anisotropy that is more conductive in the direction along the profile. The structure beneath the Mariana Trough is compared with that obtained in southern East Pacific Rise (EPR) by Baba et al. (2004). The Mariana Trough and EPR are controlled contrastive spreading regimes that the former is slow back arc spreading and the latter is super fast normal seafloor spreading.

Our model cannot resolve the source region of magma supply to the Maraiana Trough back arc spreading, nor the mantle wedge over the subducting slab. This is mainly because of limited number of stations collected to date. Additional data acquisition is required to detect such features. We have carried out numerical simulations to investigate reasonable array design for next experiment. A poster presentation coupled with this talk will show the results.