海洋上部マントルの電気伝導度構造の解釈

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Interpretation of electrical conductivity structure of oceanic upper mantle

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Abstract

Electrical conductivity structure of oceanic upper mantle can be interpreted in terms of geothermal structure of the lithosphere that is cooled with the age since its creation at a mid-ocean ridge, direct (enhancing the conductivity) and indirect (reducing the mantle solidus and leading partial melting) effect of volatile components such as H_2O and CO_2 in the mantle rock. It is a key issue how we can constrain these parameters at once from electrical conductivity with other independent information and/or reasonable assumptions for mutual relation between the parameters. The consideration of the reduction of peridotite solidus due to the H_2O and CO_2 and partition of them in solid mineral phases and melt can couple the parameters mutually and they can be constrained more by self-consistent manner. Assuming a one-dimensional thermal structure based on the plate cooling model and reasonable mantle adiabat, five parameters, mantle potential temperature, the thickness of thermally conductive plate, contents of H_2O and CO_2 in the bulk mantle and the crustal conductivity, were investigated by a grid search inversion to reconstruct a MT response data. This approach guarantees that the preferred model parameters can explain the observed MT data in a statistical sense such as 95% confidence limit of χ^2 misfit. Furthermore, the interpretation is free from the discussion about the uncertainty because of possible artifact in the conductivity structure model obtained by conventional regularization inversion approach. The new approach was applied to two real data obtained through Normal Oceanic Mantle (NOMan) project (Baba et al., 2017). These are the averages in the determinants of MT impedance tensors after the correction of the topographic effect for the array northwest (Area A) and southeast (Area B) of Shatsky Rise in the northwestern Pacific. The trade-off relations between the acceptable range of the model parameters were demonstrated. The result quantitatively verified that the thickness of the thermally conductive layer significantly thinner for Area A than for Area B suggested by the conventional approach in the previous study. Also, the investigation of the acceptable range of the model parameters can answer some questions, e.g., if the mantle is necessary to be partially molten.

Reference

Baba, K., N. Tada, T. Matsuno, P. Liang, R. Li, L. Zhang, H. Shimizu, N. Abe, N. Hirano, M. Ichiki, and H. Utada (2017), Electrical conductivity of old oceanic mantle in the northwestern Pacific I: 1-D profiles suggesting differences in thermal structure not predictable from a plate cooling model, *Earth, Planets Space*, **69**, http://dx.doi.org/10.1186/s40623-017-0697-0.