A hypothesis to explain asymmetry seafloor spreading in back-arc basins: Evidences from the Southern Mariana back-arc basin and Numerical modelling

*Nobukazu Seama[1], Tomoeki Nakakuki[2], Tetsuo Matsuno[3], Kyoko Okino[4]

1. Department of Planetology, Graduate School of Science, Kobe University, 2. Department of Earth and Planetary Systems Science, Graduate School of Science, Hiroshima University, 3. Kobe Ocean Bottom Exploration Center, Kobe University, 4. Atmosphere and Ocean Research Institute, University of Tokyo

Asymmetry seafloor spreading in many back-arc basins has been recognized using geomagnetic anomaly identification. Seama and Okino (2015) proposed a hypothesis to explain the highly asymmetric seafloor spreading of the Southern Mariana Trough back-arc basin; much faster spreading in the west side of the spreading axis compared to the east side, based on bathymetry and geomagnetic field data. Their hypothesis suggests that the influence of the low viscosity region in the mantle wedge due to hydration driven by water release from the subducting slab leads to the highly asymmetric seafloor spreading; the low viscosity mantle would preferentially capture the mantle upwelling zone beneath the spreading axis as the spreading axis has been kept in the area closed to the low viscosity region in the mantle wedge, resulting in the highly asymmetric seafloor spreading. We obtained further observation evidences to support this hypothesis, and conducted a numerical simulation, which shows that this hypothesis can be a real mechanism to lead highly asymmetric seafloor spreading. The Southern Mariana Trough has two spreading segments, which has fast spreading morphologic and geophysical characteristics (e.g. axial high), suggesting an abundant magma supply, even though the full spreading rate is categorized as slow spreading (e.g. Seama et al., 2015). A marine magnetotelluric (MT) experiment along a 120 km-length transect across the southern spreading segment was conducted to image a 2-D electrical resistivity structure (Matsuno et al., in prep.). This result shows that a low resistivity region exists beneath the slightly trench side of the spreading axis and is asymmetrically extended to the subducting slab; the low resistivity region is interpreted as asymmetric melting in the mantle wedge due to hydration driven by water release from the subducting slab, which is well consistent with the low viscosity region that leads to the highly asymmetric seafloor spreading. Further, the distribution of fault scarps and lineaments parallel to the axial axis obtained from a near-bottom acoustic survey using the AUV Urashima together with sediment distribution data acquired by eight submersible Shinkai 6500 dives show small scale (< 1 km scale) asymmetric geomorphological features near the current spreading axis in the southern segment (Okamoto et al., in prep.). The asymmetric geomorphological features are probably due to a current spreading axis migration toward the trench, and this migration is probably led by the melt region beneath the slightly trench side of the spreading axis. Moreover, Nakakuki et al. (in prep.) conducted numerical simulation including two factors; water release from the subducting slab based on crust and mantle hydrous phases, and effects of water that is lowering viscosity in mantle. Their result indicates that the spreading axis is kept locating above the low viscosity mantle zone that capture the mantle upwelling zone due to water release from the subducting slab. All the new results support the hypothesis that the low viscosity region in the mantle wedge due to hydration driven by water release from the subducting slab leads to the highly asymmetric seafloor spreading of the back-arc basin.

Keywords: asymmetry seafloor spreading, back-arc basin, Southern Mariana Trough, upper manlte electrical resistivity structure, near-bottom acoustic survey, numerical simulation

