Fore arc mantle fabrics: a petrophysical study of peridotites obtained from serpentinite mud volcanoes in Mariana convergent margin

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Large serpentinite mud volcanoes form on the overriding plate of the Mariana subduction zone. Fluids from the descending plate serpentinize the forearc mantle and enable serpentine muds to rise along faults to the seafloor, so that the seamounts are direct windows into subduction processes at depths far too deep to be accessed by any known technology (Fryer, 2012 Ann. Rev. Marine. Sci.). In this study, we focused on serpentinized peridotites obtained from nine serpentinite mud volcanoes in the Mariana convergent region.

The peridotite samples consist mainly of harzburgites with a few dunite samples. We analyzed olivine crystallographic fabrics as well as chemical compositions of olivine and spinel grains. Three types of olivine crystal fabrics were obtained: [010]-fiber type (AG-type), [100](010) type (A-type) and [100]{0kl} type (D-type). The chemical compositions show that Cr# ($Cr^{3+}/Al^{3+}+Cr^{3+}$) of spinel is 0.4 to 0.8 and Mg# ($Mg^{2+}/Mg^{2+}+Fe^{2+}$) of olivine is 89 to 92, which are in the range of Olivine-Spinel Mantle Array (OSMA) of Arai (1994 Chem. Geol.). The equilibrium temperatures induced by olivine and spinel compositions are 700 ˚C for D-type peridotites and 800 to 850 ˚C for AG-type peridotites.

We argue that AG-type peridotites may be derived from the older lithospheric mantle before the formation of the Mariana arc system, whereas D-type peridotites could be related to the supra-subduction tectonics during the relative plate motion between Philippine Sea Plate and Pacific Plate.

Keywords: fore arc mantle, Mariana, olivine fabrics