Peridotite xenoliths from Kawashimo, SW Japan: Evidence of deformation during Japan Sea opening

*Miki Tasaka[1], Yuga Nakai[1]

1. Shizuoka University

In order to better understand plate dynamics, it is critical to know why and how back-arc spreading/rifting occurs near the convergent plate boundaries. In this presentation we focus on Japan Sea as an example of back arc. Two possible models have been proposed as the formation mechanism of the Japan Sea back-arc basins, which are “slab rollback model” and “plume model”. We investigated 12 spinel peridotite xenoliths in the Cenozoic Kawashimo alkali basalt, SW Japan. These peridotite xenoliths are dominantly harzburgite with minor lherzolite. Harzburgite and lherzolite showed coarse-grained or porphyroclastic texture, recording the variable degrees of deformation. Forsterite content of olivine and Cr# of spinel suggested that these samples are residual mantle peridotite with the various decree of partial melting. Olivine crystallographic preferred orientation in the peridotite xenoliths have orthorhombic pattern characterized by strong [010] axis point maxima normal to the foliation and [100] axis parallel to the lineation in both coarse-grained and porphyroclastic texture. This orthorhombic pattern implies that the peridotite xenoliths deformed under dislocation accommodated creep with (010)[100] slip system. Using a sub-grain size piezometer, the maximum differential stress varies from 5 to 15 MPa in the samples. Combining the olivine flow laws from previous deformation experiments with the obtained flow stress and grain size, we found that the peridotite xenoliths deformed under dislocation accommodated grain boundary sliding creep with relatively high strain rate such as 10^{-11} - 10^{-9} s^{-1}. The range of high strain rate is comparable to that predicted from a thermomechanical model of back-arc spreading. Therefore, it is likely that the peridotite preserves deformation texture during the Japan Sea back-arc spreading. We also obtained the equilibrium temperature of 1239±18C based on two-pyroxene geothermometer, which is higher than those of any previously reported peridotite xenoliths in SW Japan. The obtained equilibrium P-T condition for the peridotite xenoliths implies that the hot mantle plume hypothesis is a more likely explanation as the formation mechanism of Japan Sea back-arc basins.

Keywords: peridotite xenoliths, Olivine crystallographic preferred orientation, back-arc spreading

