Fabric and petrological characteristics of sheared peridotites in Marion transform fault, Southwest Indian Ridge

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The ultraslow spreading (14 mm/yr) Southwest Indian Ridge (SWIR) lies between the Bouvet and Rodriguez Triple Junctions. The SWIR is volcanically inactive, possibly reflecting poor advection of heat and intensive conductive cooling. Accordingly, there are only partly thin basaltic crusts, and peridotites exposed to the sea floor. Dredge surveys have been performed along the SWIR, and basalt, gabbro and peridotite specimens have been derived since 1980s.

In this study, we studied the microstructural development of 7 peridotite samples obtained from Marion Fracture Zone of the SWIR by the PROTEA cruise Leg.5 in 1983. The peridotites consisted of olivine, orthopyroxene and clinopyroxene with amphibole, plagioclase and chlorite, as well as secondary minerals such as serpentine and magnetite. The peridotites were classified into two groups based on their microstructures: 2 ultramylonites consisting of extremely fine grains (3-5 μm) with several porphyroclasts (~15 μm) and 5 heterogeneous tectonites consisting of deformed coarse-granular textures with subsequently developed fine-grained textures. In both types of peridotites, some of olivine grains had subgrain boundaries, whereas phase mixing occurred. These textural features suggest that heterogeneous textures of tectonites had been developed as lowering temperature and decreasing grain size, and subsequently became to ultramylonites.

Major element compositions of olivine and spinel indicated that these peridotites had fertile to moderately depleted mantle composition. Amphibole grains have the chemical compositions of tremolite, magnesio-hornblende and pargasite.

The ultramylonites have intensely deformed amphibole grains, whereas the heterogeneous tectonites have amphibole ranging from undeformed to highly deformed grains, indicating that amphibole formed before and/or during intensive shearing in the mantle. Moreover, olivine crystal-fabrics within the deformed amphibole bearing peridotites have B and E types developed under hydrous conditions. Consequently, the petrophysical characteristics of peridotites indicate that the uppermost mantle below the Marion transform fault has been hydrated during shearing.

Fine olivine grains in heterogeneous tectonites showed weak crystallographic preferred orientation (CPO) patterns. In contrast, those in the ultramylonites exhibited strongly concentrated CPOs. Furthermore, olivine grains were distorted more strongly in the ultramylonites than in the tectonites. These textural characteristics imply that fine-grained textures within the tectonites were deformed by mainly grain boundary sliding/diffusion creep under relatively low differential stress, whereas the ultramylonites were mainly deformed by dislocation creep under high differential stress.

Keywords: transform fault, peridotite, deformation mechanism