Experimental study of aqueous fluid distribution in amphibolitic lower crust

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Purpose: Recent observations of seismic wave velocity and electrical resistivity have revealed the detailed physical properties of the lower continental crust. For example, conspicuous heterogeneities were found beneath some active volcanoes and near the seismic centers (e.g. Ogawa et al., 2001). The seismic reflectors and low electrical resistivity are also observed worldwide in the lower crust. These geophysical observations are often attributed to the presence of free aqueous fluid phase (e.g. Nakajima et al., 2001). Since physical properties of fluid-bearing rocks are controlled by the rock microstructures such as connectivity and shape of the fluid, microstructures of various fluid-bearing rocks have been studies experimentally. However, no experimental study has been reported for the *realistic* lower crust, namely, for the mineral assemblages in the lower crustal pressure and temperature. The purpose of this study is to investigate the texturally equilibrated microstructure in the amphibole-plagioclase-fluid (amphibolite-fluid) system in these conditions.

Method: The experiments have been performed by using a piston-cylinder apparatus at 0.7 GPa and 600 degree C for 1 - 2 weeks. The preliminary experiments were carried out to determine the adequate capsule configurations and the starting materials. The Ag and Pt-lined Ni capsules were tested. The synthesized gel and natural amphibolite powder from Ichinomegata Maar (2 micron in grain size) were prepared as starting materials. The 1 - 3 wt.% deionized distilled water was added into the capsules. The run products were observed with a FE-SEM (HITACHI S-4300).

Results: In the run products synthesized in the Ag capsule from the gel powder, hornblende crystals with subordinate augite were formed. Their maximum grain sizes were 40 and 30 micron for hornblende and augite, respectively, but the average grain size was too small (10 micron) to observe the equilibrium microstructures and the overall crystallinity might be poor. In the Ni-Pt capsules, 30 micron Cpx (diopside) and 5 micron hematite crystals were found. This shows that the oxygen fugacity in the capsule was increased during the run due to a loss of hydrogen through the Pt liner. The run products synthesized in the Ag capsule from the natural fine powder was composed of homogeneously distributed hornblende and plagioclase crystals that showed fairly satisfactory textural adjustment. The crystals were idiomorphic in form and 1 - 5 micron in size. Hornblende exhibited extensive faceting and the facets were observed even in 100 nm scale at the tip of triple junctions. The degree of faceting seems stronger than the F-tremolite, which was used as a model material of hornblend in the previous experiments (Price et al., 2002). The plagioclase crystals showed poor wettability, as reported in the previous experiments in the higher temperature (Yoshino et al., 2002) . These results suggest that the microstructures of amphibolite in the lower crust conditions may be approximates as a mechanical mixture of the F-tremolite and plagioclase, and reinforce the prediction on the fluid connectivity in the two previous studies that the connectivity of aqueous fluid is low at a small fluid fraction.