In-situ Measurement of Rheology of Silicate Garnet at High Pressure and Temperature Conditions

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To examine the rheological behavior of silicate garnet (Pyrope50%Majorite50%) at in-situ high pressure and temperature conditions, we have conducted the relaxation experiment using the multi-anvil high pressure apparatus (SPEED-1500) with the aid of a synchrotron X-ray at the 04B1 beam line. We focused on the changes in diffraction peak width diffracted from polycrystalline sample in the course of experimental process. These data lead micro-scopic strain, micro-scopic stress and then mechanical data of plastic deformation of sample. This kind of experimental technique was devised by Weidner et al.[(1)(2)]. The most excellent point of this method is that the time dependence of the micro-scopic stress at high pressure and temperature can provide a measurement of rheological behavior of mantle minerals at the corresponding in-situ mantle conditions.

We used the ground Py50%Mj50%-garnet which was synthesized with the multi-anvil high pressure apparatus (ORANGE-2000) at Ehime University. The sample was compressed to 17 GPa at room temperature, and then heated to 450℃, 550℃, 650℃ and finally 750℃ during about 300, 240, 180 and 60 minutes, respectively. The pressure was increased to 19.5 GPa just after heating to 450℃ by thermal expansion and kept there all through the heating treatment. Keeping the pressure at 19.5 GPa and the constant temperatures, we studied the relaxation processes with time. The experiment could be conducted under very stable conditions. Now we are calculating the micro-scopic strain in the sample from the changes in the diffraction peak width. In addition to such the mechanical data, we will observe the microstructures of recovered sample to determine the mechanism of plastic deformation.

We have conducted previously the relaxation experiments of Py50%Mj50%, Py100%, Py68%Al18%Gr14%Sp1% and Py23%Al48%Gr28%Sp1% garnets at 7 GPa and 10 GPa by the same temperatures and technique as used here. Therefore, the comparison of all these garnet data will indicate the both effects of composition and high pressure on the rheological behavior of silicate garnets.

Rerference: 1 D.J.Weidner et al., Science, 266, p419-422, 1994 ; 2 D.J.Weidner et al., Geophysical Monograph Series, 101, p473-482, 1998