Uniaxial deformation experiments of bridgmanite using D-111 type high pressure apparatus

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One dimensional viscosity models of the Earth’s mantle proposed by geophysical observations suggested that the lower mantle had the largest viscosity in the Earth’s mantle. In order to understand mantle dynamics in the Earth’s interior, it is important to know the viscosity of the Earth’s lower mantle. However, there are large variations of viscosity in the lower mantle between suggested models because of limitation of locations for geophysical observations. Therefore it is important to determine viscosity of lower mantle minerals by high pressure experiments in order to discuss mantle dynamics. Bridgmanite would be the most abundant mineral in the lower mantle. This mineral could dominate the lower mantle viscosity. In this study, we conducted in-situ stress-strain measurements of uniaxial deformation experiments of bridgmanite aggregate using D-111 type high pressure apparatus.
In-situ measurements were conducted using MAX III with D111 type guide block at PF-AR NE7A beam line. Mg-pure bridgmanite aggregates were used as starting material. Experimental conditions are 1473-1673 K and 24-27 GPa. WC second cubic anvils with cone (6.5˚) to take 2D X-ray diffraction, was used along X-ray path. Two-dimensional X-ray diffraction patterns were corrected for 240 s using flat panel detector. To calculate pressure and the stress magnitude of bridgmanite, (112) X-ray diffraction peaks were used. Strain of bridgmanite was measured by X-ray radiographies taken using an imaging system composed of a YAG crystal and a CMOS camera.
Largest strain was reached to approximately 20 %. It is confirmed that strain rate can be well controlled using stroke speed of differential rams. Steady state creep were observed at 1473 K –1673 K and 5 $\times 10^{-6}$ –3.8 $\times 10^{-5}$ /s. At normalized strain (10^{-5} /s), the creep strength of bridgmanite in this study is the largest in constituent mantle minerals reported by D-DAI apparatus.

Keywords: Bridgmanite, Deformation experiments, Creep strength

