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23GPa までの Ca-Pv 及び Mg-Pv のその場応力歪測定に関する予備的実験
Preliminary experiments on in-situ stress-strain measurements of Ca-Pv and Mg-Pv up to 23 GPa

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In order to discuss mantle dynamics in the Earth's interior, knowledge of viscosity of the Earth's lower mantle, which is the highest of the whole mantle, is important. Viscosity models of the Earth's lower mantle were reported by geophysical observations. However, observation values of viscosity have large variety (2~3 order magnitude). Although determination of viscosity of lower mantle minerals by high pressure experiments is needed to understand mantle dynamics, stress-strain relationship for $MgSiO_3$-perovskite (Mg-Pv) and $CaSiO_3$-perovskite (Ca-Pv), which are principal minerals of the Earth's lower mantle, are not reported due to difficulty of high pressure deformation experiments. In this study, we tried in-situ stress-strain measurements of Ca-Pv and Mg-Pv up to 23.0 GPa.

In-situ uniaxial deformation experiments were conducted using a deformation DIA apparatus (SPEED-Mk.II) as Kawai-type apparatus at SPring-8 BL04B1. Experimental conditions of Ca-Pv and Mg-Pv are 13.8 GPa, 1473 K and 23.0 GPa, 1273 K, respectively. cBN anvils, which was transparent material against X-ray, was used along X-ray path. Two-dimensional X-ray diffraction patterns were taken for 120-180 s using CCD detector. To calculate the stress magnitude from the X-ray diffraction data, we used a model of stress-lattice strain relationship (Singh et al. 1998),

$d_{hkl}(\psi)= d_{0hkl}$ $[1+(1-3\cos^2\psi)$ $\sigma/6$ $G_{hkl}]$ (1)

where d_{hkl} is the d-spacing measured as a function of azimuth angle ψ, d_{0hkl} is the d-spacing under the hydrostatic pressure, G_{hkl} is the appropriate shear modulus for a given hkl, and σ is the uniaxial stress. Pressure and stress were estimated using Ca-Pv (110) (200) and Au (111) diffraction in Pressure marker (Au : Fo = 1 : 2 volume ratio) at deformation experiments of Ca-Pv and Mg-Pv, respectively. An X-ray radiograph of the strain markers was taken using an imaging system composed of a YAG crystal and a CCD camera with an exposure time of 60 s.

Uniaxial stress of Ca-Pv at 13.8 GPa, 1473 K and ~1.2×10^{-5} /s and Mg-Pv at 23.0 GPa, 1273 K and ~1.5×10^{-5} /s were estimated as ~2GPa and ~0.25 GPa , respectively. Stress of Mg-Pv was significantly smaller than that of Ca-Pv though temperature condition of Mg-Pv was lower than that of Ca-Pv. This fact is doubtful. This reason is thought that stress estimated by Au was much smaller than that of Mg-Pv because of framework made by Ringeoodite, which was polymorphic phase of Fo in pressure marker.

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