Report for the Joint Use/Research of the Institute for Planetary Materials, Okayama University

2023 fiscal year first call / second call / <u>others</u>

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Name of the research project: Experimental investigation of the effect of temperature and composition on the lattice preferred orientation of bridgmanite

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Research report:

1) Please write the research report with free format, but include followings: research purpose, actually conducted research, and research outcomes. If necessary, you can add another page.
2) For the workshop, please write the report for the workshop. Also, attach the program, abstracts, and list of the participants etc.
3) Please add Collaborator's Name, Affiliated institution and department as needed.
4) Please answer the question on the next page.

Seismic anisotropy has been widely observed in the lower mantle. The lattice preferred orientation (LPO) of bridgmanite is the most plausible origin for these seismic observations. However, previous studies show inconsistent results about the LPO of bridgmanite at 1773 to 2130 K. Therefore, in this study, we investigated the effect of temperature on the lattice preferred orientation of bridgmanite.

First, I synthesized pure and Al/Fe-bearing bridgmanite with 10/4 and 10/5 cells at 24-25 GPa and ~2100 K by using 1000-ton multianvil high-pressure apparatus. In total, 12 synthesis experiments were conducted as shown below.

Run no.	Cell	Load (MN)	Starting material	Remark
1K3653	10/4	8	$MgSiO_3$ glass	
1K3656	10/5	9.5	$En_{95}Cor_5$ glass	
1K3660	10/4	8	$MgSiO_3$ glass	
1K3661	10/5	9	$(Mg_{0.9}Fe_{0.1})SiO_3$ enstatite powder	
1K3662	10/4	8.8	$En_{95}Brm_5$ glass	
1K3663	10/5	9	$(Mg_{0.97}Fe_{0.03})SiO_3$ enstatite powder	
1K3664	10/4	8	$MgSiO_3$ glass	
1K3666	10/5	8.8	$En_{90}Brm_{10}$ glass	
1K3670	10/4	8	$MgSiO_3$ glass	
1K3677	10/4	8	$MgSiO_3$ glass	Blow out during heating
1K3678	10/5	8.8	$(Mg_{0.97}Fe_{0.03})SiO_3$ enstatite powder	Blow out during decompression
1K3685	10/4	8	$MgSiO_3$ glass	
1K3691	10/4	8.8	$(Mg_{0.9}Fe_{0.1})SiO_3$ enstatite powder	

Except for the experiments of 1K3677 and 1K3678, I successfully synthesized bridgmanite aggregates. Then, I performed the pure shear and simple shear deformation experiments on bridgmanite aggregates at 1700-2100 K and 25 GPa by using the D111-type apparatus with 6.5/2 cell. The experimental run numbers are: D100 (blow out), D101 (annealing experiment), D102 (pure shear), D103 (simple shear), D104 (pure shear), D105 (simple shear), D106 (simple shear), D107 (simple shear), D108 (simple shear), D111 (simple shear), D112 (pure shear) and D113 (pure shear). For the simple shear deformation experiments, the shear strain was a little bit small with largest number to be ~0.4. It is hard to deform bridgmanite especially at relatively low temperature. For the pure shear deformation experiments, the strain was 0.1-0.3. After the microstructure observation, I double polished the samples for the LPO measurement. The LPO was obtained (expect for D111, D112 and D113) through the two-dimensional (2D) monochromatic X-ray diffraction pattern method at BL04B1 of synchrotron facility of SPring-8, Hyogo, Japan.

Based on present results, the LPO of bridgmanite changed with temperature: (100) at low temperature (~ 1700 K) and (010) at high temperature (higher than 1900 K) for pure and Fe-bearing bridgmanite. The transition temperature was about 1800 K. Perhaps, the strain rate or stress would have influence on the transition temperature. After LPO measurement of last three deformation samples, it would be much clear. Next time, I will conduct the simple shear deformation experiments at relatively low temperature to further confirm our results.