Reinvestigation of high pressure phase boundary between wadsleyite and ringwoodite by in-situ X-ray observation

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Olivine is the most abundant mineral in the Earth's mantle, and it is believed that the high-pressure transformation of olivine from wadsleyite to ringwoodite is responsible for the 520km seismic discontinuity. Katsura et al. (1989) clarified the phase boundary by conventional quench experiment, and Akaogi et al. (1989) clarified that by thermochemical calculation. However even in the thermochemical calculation, they used one transformation P-T point from Katsura et al. (1989) to calculate the transformation entropy. Therefore, the absolute value of the transformation pressure has some uncertainty. Suzuki et al. (2000) also conducted the in situ X-ray experiment to determine the phase boundary, but these data are restricted in low temperature region (700~1000 degree C). In this study, we have determined the phase boundary between wadsleyite and ringwoodite in Mg2SiO4 by in situ X-ray experiment in the condition of mantle transition zone (~1500 degree C). Especially in the present experiments, we focused on the determination of the transition from wadsleyite to ringwoodite, because we have already some data of the transition from ringwoodite to wadsleyite.

High pressure in site X-ray experiments were conducted in SPring-8 BL04B1 beam line using the SPEED-MkII. The starting material of wadsleyite was prepared in advance to determine the phase boundary from wadsleyite to ringwoodite. The mixture of MgO and Au powers was used as pressure standards, and Au power was also mixed with the starting wadsleyite as a pressure standard. These two mixtures have been arranged up and down on both sides of thermocouple. The pressure was calculated by some equations of state of Au and MgO.

In the experiment which determines a phase boundary above 1300 degree C, grain growth is remarkable and makes the identification difficult. In order to solve this problem, the about 8 degrees oscillation was done, and we succeeded to get the ideal X-ray pattern. The results show that the transformations to rinwoodite were occurred at 18.4 GPa, 1400 degree C and 18.2 GPa, 1300 degree C, if we adopted the Anderson scale of Au. We also observed the clear transformation from ringwoodite to wadsleyite at the condition from 18.4 GPa and 1400 degree C to 18.0 GPa and 1450 degree C. This result is well in agreement with the phase transition boundary which we have reported before. For example in 1400 degree C, the transformation pressure is ~1 GPa lower than that of Akaogi et al. (1989).