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Thermo-elastic properties of Al-bearing hydrous bridgmanite

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Abstract

Water is the most abundant volatile component on the Earth, and significantly influences the chemical and physical properties of mantle minerals (e.g., melting temperature, elastic properties, electrical conductivity). Recently, Al-bearing hydrous bridgmanite with ~0.8 wt% H_2O was synthesized by our group. The thermo-elastic properties of Al-bearing hydrous bridgmanite are expected to drastically change by water. Therefore, we have studied the thermo-elastic properties of Al-bearing bridgmanite.

P-V-T experiments of Al-bearing hydrous bridgmanite with 0.4 wt% H_2O were conducted up to 50.6 GPa and 1300 K using multi-anvil high pressure apparatus with sintered diamond 2nd stage anvils by synchrotron X-ray diffraction at BL04B1, SPring-8. In addition, compression experiment of Al-bearing hydrous and anhydrous bridgmanite was conducted up to 52.5 and 50.2 GPa, respectively, under quasi-hydrostatic condition at room temperature using diamond anvil cell by synchrotron X-ray diffraction at BL18C, PF, KEK. The bulk modulus of Al-bearing hydrous bridgmanite was found to be much smaller than that of Mg-endmember bridgmanite (Tange et al. 2012). On the other hand, thermal expansion was larger than that of Mg-endmember bridgmanite.

We estimated the possible water content in the lower mantle by comparison with the adiabatic bulk modulus of Al-bearing hydrous bridgmanite and PREM. The calculation of the adiabatic bulk modulus of Al-bearing hydrous bridgmanite with 0.4 wt% H_2O was done along mantle geotherm in the lower mantle pressure. The adiabatic bulk modulus of Al-bearing hydrous bridgmanite with 0.4 wt% was smaller than that of PREM. This result indicates that the water content in the lower mantle should be lower than 0.4 wt%. The maximum water solubility in Al-bearing hydrous bridgmanite has been confirmed to be 0.8 wt% in our group experiments. Thus, the condition in the lower mantle should be water under-saturated. This indicates that all water in the lower mantle can dissolve into bridgmanite at mantle geotherm. Therefore, no hydrous minerals such as DHMSs (dense hydrous magnesium silicates) exist in the lower mantle except for the region around the subducting slab.

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