Thermal expansion of wadsleyite, ringwoodite and their hydrous polymorphs

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It is recognized that olivine is the main constituent mineral of the Earth's mantle and it transforms into wadsleyite(beta) and ringwoodite(gamma) at high pressure. On the other hand, H2O is one of the important components of the Earth, and the existence is expected by the transportation of hydrous phases in subducted slab into the mantle. Recently, it is clarified that beta and gamma have several wt% of H2O in those crystal structures, and these H2O should affect the physical properties of those phases. We investigated about one of the physical property, thermal expansion, of beta and gamma with and without H2O.

Experiments were conducted by high temperature X-ray diffraction measurement in atmospheric pressure. Samples, beta, gamma, hydrous beta and hydrous gamma were, in advance, synthesized using MA-8 type (Kawai-type) high apparatus. The H2O contents of hydrous beta and hydrous gamma in the present experiments were determined to be 2.4wt% and 2.6wt%,respectively. The temperature ranges of the present experiments were between 293K and 1073K at anhydrous system and between 303K and 773K at hydrous system at atmospheric pressure.

Volume thermal expansion coefficients of beta, gamma, hydrous beta and hydrous gamma were (beta)=31.6, (gamma)=27.0, (hydrous beta)=29.7, (hydrous gamma)=21.8 in unit of 10-6/K, respectively; these show that the degrees of thermal expansion of hydrous beta and hydrous gamma are much less than those of anhydrous forms.

Using the present results, the bulk sound velocity jumps at 410km discontinuity were calculated in anhydrous and hydrous mantle. In anhydrous mantle, ~40% olivine is needed to explain the velocity jump, which is inconsistent with pyrolite mantle (~60% olivine). Assuming the pyrolite mantle, ~1wt% of H2O is needed in beta phase which exist in mantle transition zone.