Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SCG62-P04 Room:Poster Time:May 2 16:15-17:30

Equation of state of topaz-OH in the subducted sediment under high pressure and high temperature

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Dehydration reactions of hydrous minerals in the subducted sediment produce a H_2O-rich fluid which causes generations of magma, decreases of melting temperature of sediment, and variations of magma compositions. Topaz-OH [$Al_2SiO_4(OH)_2$], which is one of hydrous minerals, is considered to be existed in the sediment of the subducting slab. Topaz-OH is the end-member of natural topaz [$Al_2SiO_4(OH,F)_2$]. The stability field of topaz-OH extends to 1500 degree C at 5-10 GPa (Wunder *et al*., 1993; Ono. 1998; Schmidt *et al*., 1998). The equation of state (EoS) for the natural topaz has been also estimated (Komatsu *et al*., 2003; Gatta *et al*., 2003). However, the EoS of the end-member topaz-OH has not been performed yet. In this study, we performed *in situ* X-ray diffraction (XRD) experiments under high pressure and high temperature for determining the thermal elastic properties of topaz-OH.

The starting material of topaz-OH was synthesized at 10 GPa and ˜1000 degree C from the quench experiment using multi-anvil apparatus. The high pressure (3-8 GPa) and high temperature (up to 800 degree C) *in situ* XRD experiments were carried out using MAX80 installed at beam-line NE5C at PF-AR, KEK, Japan. These XRD patterns were collected by the energy dispersive method. Thermal elastic properties were calculated from EoS fit v5.2 software (Angel, 2000) using 3rd order Birch-Murnaghan EoS.

From *in situ* XRD experiments, we successfully determined thermal elastic properties using all-data for fixed K'=4 as below: V_0=354.7(1) Å ^{3}, K_0=169.8(22)GPa, $(dK_T/dT)_P$=-0.013(7) GPaK^{-1}, a_0=1.61(23)$\times10^{-5}K^{-1}$, b_0=1.36(41)$\times10^{-8}K^{-2}$. From the detailed analysis of compression data, we found the change of the compression properties near 7 GPa. This change was also seen in a- and b-axis. Therefore we re-calculated the thermal elastic properties using two data sets: (I) below 7 GPa (II) above 7 GPa at room temperature. These calculation results from low pressure data show V_0=355.2(1) Å ^{3}, K_0=160.1(2)GPa, however those from the high pressure data show V_0=356.5(9) Å ^{3}, K_0=153.1(89) GPa (K'=4 fixed). Compared to the natural topaz, topaz-OH shows relatively large volume and bulk modulus. This shows that the volume and bulk modulus increase with increasing OH content. Compared bulk modulus with density, topaz-OH locates near the line for Birch's law and indicates large bulk modulus and density as same as Phase D [$Mg_2SiO_4(OH)_2$]. We suggest that high density topaz-OH enhances the slab subduction and transports water to deeper earth's interior.

Keywords: topaz-OH, high pressure hydrous phase, subducting slab, equation of state, synchrotron X-ray in-situ experiment