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高温高圧におけるアンチゴライトの状態方程式
Equation of state of antigorite at high pressure and temperature

渡辺 了[1*], 浦川 啓[2], 安東 淳一[3], 水上 知行[4], 亀掛川　卓美[5]
Tohru Watanabe[1*], Satoru Urakawa[2], Jun-ichi Ando[3], Tomoyuki Mizukami[4], Takumi Kikegawa[5]

[1] 富山大学, [2] 岡山大学, [3] 広島大学, [4] 金沢大学, [5] 高エネルギー加速器研究機構
[1]University of Toyama, [2]Okayama University, [3]Hiroshima University, [4]Kanazawa University, [5]KEK

Antigorite plays key roles in subduction zone processes including transport of water and seismogenesis. The equation of state (EoS) of antigorite is critical for understanding of its stability field and for interpretation of seismological observations. Although a few compression tests have been conducted at room temperature, EoS is still poorly understood at high temperatures. We have investigated EoS of antigorite by in-situ synchrotron X-ray powder diffraction. Measurements were conducted at a beamline NE5C of Photon Factory-Advanced Ring (KEK, Tsukuba).

The sample was a natural antigorite collected from Inner Mongolia, China. Most of the Selected Area Electron Diffraction (SAED) patterns show the presence of the polysomes m=15, where m is the number of tetrahedral along a wave (Mellini et al., 1987). Some have m=16 and 17. The sample was finely ground and mixed with NaCl, and pressurized in a multi-anvil type high-pressure apparatus (MAX80). Measurements were made at pressures of 0~6 GPa and temperatures of 25~500 C. The pressure was estimated from the compression of NaCl. Diffraction peaks of antigorite were indexed with the aid of indices reported by Uehara and Shirozu (1985) and Capitani and Mellini (2004). Lattice parameters A, a, b, c and beta were estimated by the least square method.

The compression in the c-axis dominates the isothermal compression in bulk. The compressibility in the c-axis is larger than those in the a- and b-axes by a factor of ~3. This is consistent with Hilairet et al. (2006). The linear compressibility in the c-axis significantly increases with increasing temperature ((6+-3)x10^{-11} $Pa^{-1}K^{-1}$), while those in a- and b-axes are almost independent of temperature. The isothermal bulk modulus is estimated to be 60 GPa at room temperature, which is close to the previously reported value.

The expansivity in the c-axis is the largest and largely decreases with increasing pressure, while that in the b-axis the smallest and almost independent of pressure. No significant difference can be seen between axes at the pressure of 5 GPa. The volumetric thermal expansivity is calculated to be (3.8+-0.6)x10^{-5} K^{-1} at P=0 GPa, which is consistent with the previous estimation (Holland and Powell, 1998). Our result clearly shows that the expansivity decreases with increasing pressure.

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