NE5C /2009G216, 2011G100

Equation of state and elastic softening of antigorite under pressure and high temperature

Toru INOUE *[1], Cuiping YANG[1] and Takumi KIKEGAWA[2]
[1]Geodynamics Research Center, Matsuyama, Ehime 790-8577, Japan
[2]High Energy Accelerator Research Organization, Tsukuba, Ibaraki 305-0801, Japan

Introduction

Serpentine is an important hydrous phase in the hydrous peridotite layer of the descending slab, and one of the high pressure polymorph of serpentine, antigorite, should be the most important hydrous phase to discuss the transportation of water into the Earth's interior.

The single crystal X-ray diffraction in the diamond anvil cell, done by [1], showed an abnormal compression behaviour of antigorite. At pressures above 6 GPa, antigorite displays a significant volume softening. This compression behaviour change was proved with calculations by [2]. Recently, [3] found a slight discontinuity in the evolution of the elastic modulus near 7GPa by Brillouin scattering measurement, and they defined this discontinuity as a phase transition.

However, there exist few data on high temperature EoS of antigorite, and the effect of the high temperature on the phase transition of antigorite around 7GPa remained unclear. We reported *P-V-T* data of natural antigorite, which were measured *in situ* by using energy-dispersive X-ray diffraction in a cubic type multi-anvil apparatus, MAX80, PF-AR, KEK.

Experimental

We used 6-6 type multi-anvil (MA) system for the experiments. The details of the 6-6 type MA were described by [4]. Natural antigorite was used as a starting material. Temperature was measured by W-Re thermocouple, and pressure was calculated by equation of state of NaCl proposed by [5]. Experiments were conducted up to ~10 GPa and 500℃. The diffraction data of sample and pressure standard were collected alternatively for 150 seconds each at intervals of 100℃ with decreasing temperature to release the deviatric stress.

Results and discussion

The room temperature *P-V* data below 7 GPa have been fitted to Birch-Murnaghan EoS, yielding $V_{0,300K}$ = 366.9(7) $Å^3$, bulk modulus $K_{0,\ 300K}$ = 65.2(31) GPa, and the K' fixed to 6.1. The high pressure phase transition was observed through volume softening behavior at around 7 GPa (Fig. 1), and the dP/dT slope seems to be flat or slightly positive, which is consistent with the recent report by [3]. High temperature Birch-Murnaghan EoS was used to fit the *P-V-T* data below 7GPa. We obtained $V_{0,\ 300K}$ = 367.3(2) $Å^3$, dK/dT = -0.0265(41) GPa/K, thermal expansion $\alpha_0 = 3.92(50) \times 10^{-5}$ /K, when the bulk modulus $K_{0,\ 300K}$, and the pressure derivative were fixed to 62.9 GPa and 6.1 which was obtained by single crystal X-ray diffraction in a diamond anvil cell with angle dispersive method [1]..

Our measurements show that the anomaly of volume around ~7 GPa occurs at even high temperature of ~400℃ (Fig. 1), which is outside the phase equilibrium stability region of antigorite. But our previous experiment shows that antigorite can exist metastably at ~400℃ and ~9 GPa [6]. In the present experiment, the antigorite at ~400℃ and ~9 GPa also did not show the dehydration reaction. So the transition may occur within the coldest subducition geotherms which has temperature below ~400℃ at ~9 GPa. For the details of our present results, please refer [7].

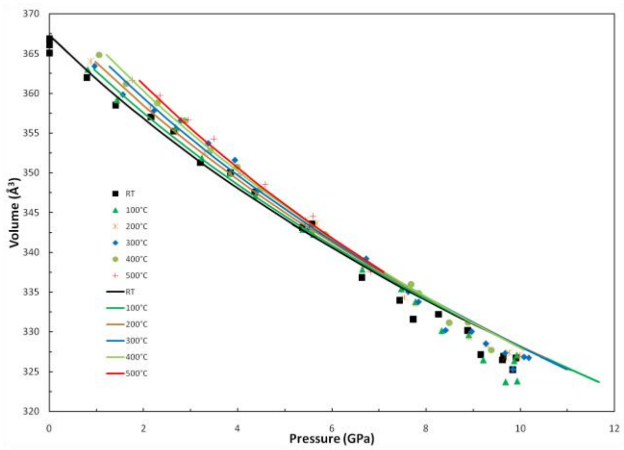

Fig.1 *P-V-T* data of antigorite with the high temperature B-M EoS fit. Data below 7 GPa was used only for fitting. Solid lines are isothermal compression curves at room temperature (RT), 100 °C, 200 °C, 300 °C, 400 °C, and 500 °C, respectively.

References

[1] F. Nestola et al., Contrib. Mineral. Petrol. **160**, 33 (2010)
[2] G.C. Capitani & L. Stixrude, Am. Mineral. **97**, 1177 (2012)
[3] L. Bezacier et al., J. Geophys. Res., **118**, 527 (2013)
[4] N. Nishiyama et al., 2008. High Pres. Res. **28**, 307 (2008)
[5] D.L. Decker, J. Appl. Phys., **42**, 3239 (1971)
[6] T. Inoue et al., J. Mineral. Petrol. Sci., **104**, 105 (2009)
[7] C. Yang et al., Phys. Earth Planet. Inter., **228**, 56 (2014)

* inoue@sci.ehime-u.ac.jp