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Equation of State of Antigorite at High Pressure and Tempearture

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Introduction

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 [1], EoS is still poorly understood at high temperatures. We have investigated EoS of antigorite by in-situ synchrotron X-ray powder diffraction.

Experimental

The sample is a natural antigorite collected from Inner Mongolia, China. The chemistry is shown in Table 1. The dark part in a BSE image has distinctly higher Al content than the bright part.

Table 1: Chemistry of antigorite sample (wt%)

	Dark	Bright
SiO_2	45.00	45.16
Al_2O_3	0.26	0.07
FeO	0.47	0.45
MgO	40.29	40.53
CaO	0.00	0.01
Total	86.04	86.24

Selected-Area Electron Diffraction reveals that most of antigorite grains has m-value of 15 (the number of tetrahedra within a wave). There are also grains with 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 0.5~6 GPa and temperatures of 200~500 ºC. The pressure was estimated from the compression of NaCl. Diffraction peaks of antigorite were indexed with the aid of reported indices [2]. Lattice parameters *a*, *b*, *c* and β were estimated by the least square method.

Results

Isothermal Compression

The compression in the *c*-axis dominates the isothermal compression in bulk. Fig.1 shows lattice parameters at temperature of 500 ºC as a function of pressure. The lattice parameters are normalized by the values at pressure of 0 GPa, which are obtained by fitting linear (*a* and *b*) or 2nd-order (*c*) equations to data. 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 previous studies [2, 3]. The isothermal bulk modulus is estimated to be 64±2 GPa at T=500 ºC.

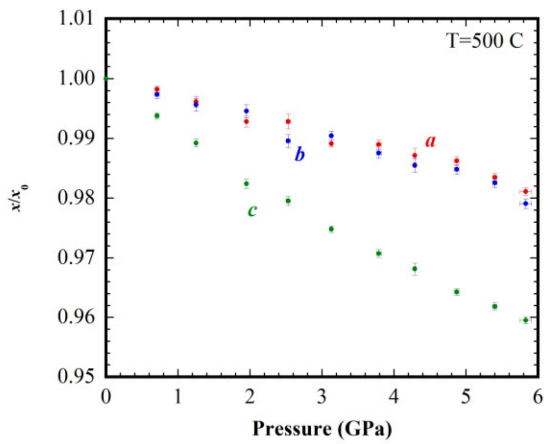

Fig.1 Normalized lattice parameters at T=500 ºC.

Isobaric Expansion

The linear expansivity is estimated from lattice parameters at a given pressure and temperatures of 200, 300, 400, 450, 500 ºC, which are calculated by using the fitted equations. At low pressures (< 2 GPa) the expansivity in the *c*-axis is three times as large as those in the *a*- and *b*-axes. It largely decreases with increasing pressure, while those in the *a*- and *b*-axes show little change. No significant difference in the expansivity can be seen between axes at the pressure of 5 GPa.

Superstructure

The crystallographic structure of antigorite is characterized by the supercell parameter *A*. The ratio M=*A*/*a* is estimated from a diffraction peak of (1+1/M 0 1). The estimated M values for different pressures are 7.3±0.1 at T=500 º C. No change in superstructure was observed during experiments.

References

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