High Pressure Science

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Time resolved X-ray diffraction of chlorite dehydration under high pressure and high temperature

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Introduction

Many hydrous phases should exist in the subduction zone, and serpentine and chlorite should be important hydrous phases in the hydrous peridotite layer of the descending slab. We have already studied the dehydration of antigorite, which is one of the polymorph of serpentine, by time resolved X-ray diffraction method to determine the stability region and the dehydration kinetics of antigorite [1].

In this study, we adopted the same experimental method (time-resolved dehydration experiment) to chlorite to determine the stability region and the dehydration kinetics of chlorite, because chlorite is another important hydrous phase in the subducting slab.

Experimental

Natural chlorite was used as a starting material, and the chemical composition is as follows: MgO 34.0, Al_2O_3 14.0, SiO_2 33.3, FeO 3.0 and H_2O 15.6 (wt%). The sample was sealed by Au lids plus diamond sleeve, which enabled us to get high quality of diffraction because of high X-ray transparency of diamond [1]. Temperature was measured by W-Re thermocouple, and pressure was calculated by equation of state of NaCl proposed by [2]. Experiments were conducted between 3 and 7 GPa and up to 900°C. Time-resolved X-ray diffraction was measured at intervals of 50°C with checking diffraction change.

Results and discussion

Chlorite was dehydrated to garnet (Gar) + olivine (Ol) + fluid below ~5 GPa. At ~6 GPa, Orthopyroxene (Opx) was also observed. The observed phase boundary was shown in Fig. 1. The dehydration phase boundary had a negative dT/dP slope, and the degree of the slope was much steeper than that of serpentine (Fig. 2). This result shows that chlorite is stable higher temperature than serpentine below ~6 GPa, and should be an important water carrier in the relatively high temperature subducting slab.

Time resolved X-ray pattern was shown in Fig.3 as the example at 5.0 GPa and 750°C. Chlorite dehydrated quickly at ~ 20 minutes, and garnet and olivine were formed. The detail analysis is now conducting to clarify the kinetics mechanism.

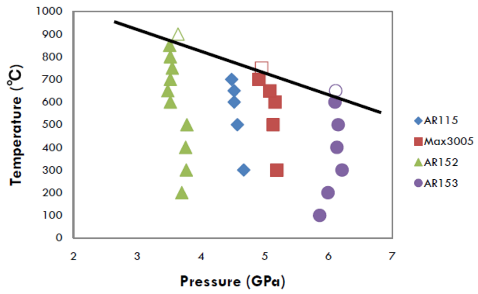

Fig.1 The dehydration phase boundary of chlorite determined by in situ X-ray diffraction experiments. Solid and open symbols show the runs before and after dehydration, respectively.

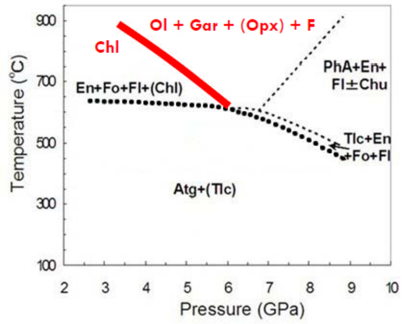

Fig.2 The comparison of the dehydration phase boundary between serpentine (antigorite: Atg) and chlorite (Chl). The solid and broken lines show those of chlorite and serpentine[1], respectively. Ol: olivine, Gar: garnet, Opx: orthopyroxene.

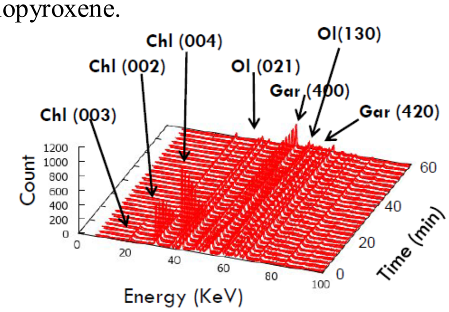

Fig.3 Time resolved X-ray diffraction profile of dehydration of chlorite at 5.0 GPa and 750°C. Chl: chlorite, Ol: olivine, Gar: garnet.

References

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