

## Dehydration sequence of chrysotile serpentine at high pressure

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### Introduction

Problems related to water circulation and storage in the Earth's interior are of fundamental importance to understand the material distribution and the chemical evolution, because water can activate the transport processes. Serpentine minerals (antigorite, chrysotile, and lizardite) are produced by hydration of mantle peridotite in ubiquitous environments, such as hydrothermal alteration of the oceanic plate and fluid metasomatism in the wedge mantle of the subduction zone [1,2]. Efforts have been paid to elucidate their stability fields and kinetic aspects of mutual reactions, as release and accumulation of water (dehydration and rehydration) proceed irreversibly under the geothermal conditions [3,4]. We, here, report the dehydration sequence of chrysotile serpentine at 3.6 GPa and its possible geoscientific implications.

### Experimental

Natural chrysotile serpentine (collected from Horoman ultramafic complex, Hokkaido) was used as a starting material. In-situ X-ray diffraction experiment was performed by using MAX-III system installed at BL-14C2, and complementary beamless experiments by quenching method were made with MAX90 at Kyushu University. Time-resolved X-ray diffraction profiles are acquired by energy dispersive method using Ge-SSD at a fixed 2 theta angle. Before attaining the final heating condition, the samples are annealed at 400 C for 2 hours to realize the uniformity of the strain state.

### Results and Discussion

Fig.1 shows backscattered electron image of the run product after 120 minutes heating at 3.6 GPa and 560 C. Dark grains are chrysotile and bright spots are magnetite impurities. Dehydrated assemblage of forsterite + talc appears along the grain boundaries (grey, intermediate contrast). The textural observation suggests that the thermal decomposition of chrysotile occur with the incoherent grain boundary nucleation and growth mechanism. Fig.2 is the time-resolved X-ray diffraction profiles at 3.6 GPa between 550 and 700 C. Chrysotile starts to decompose almost instantly with temperature elevation and the final assemblage at higher temperature is found to be forsterite + enstatite

The results indicated that chrysotile decomposes in two steps: (1) quasi-stable assemblage talc + forsterite and (2) anhydrous assemblage of forsterite + enstatite with released free water. Formation of quasi-stable talc in the dehydration sequence would decrease the transformation kinetics to the stable anhydrous

assemblage, because its peculiar slippery rheology could relieve the grain boundary strain and suppress further nucleation. The characteristic properties of phyllosilicates and their dehydration behavior may affect transport of materials and fractionation of elements in water-available conditions in the Earth and Martian interiors.

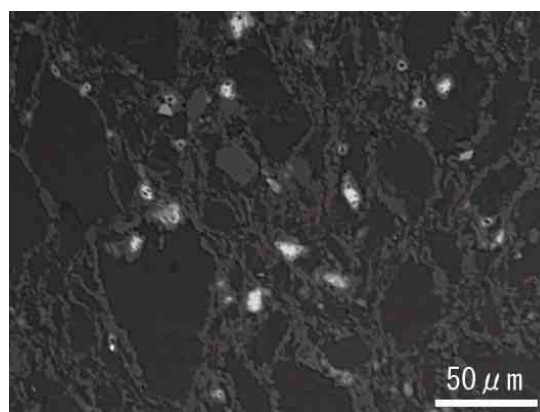


Fig.1. Backscattered electron image showing grain boundary nucleation of talc + forsterite assemblage at 560 C and 3.6 GPa after 120 min heating.

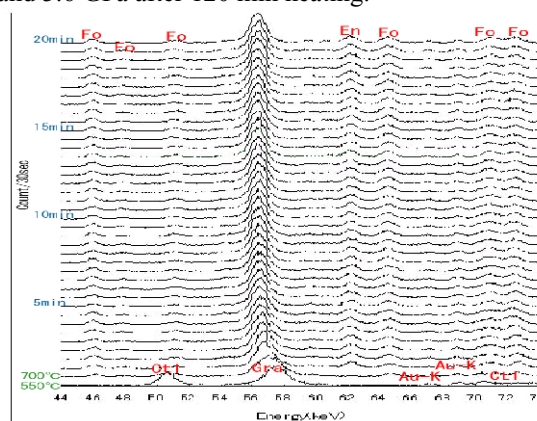


Fig.2. Time-resolved profiles at 3.6 GPa, 560-700 C. Ch, chrysotile; Fo, forsterite; En, enstatite; Au, Gold; Gra, graphite.

### References

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