

## Decarbonation and melting of $\text{MgCO}_3$ with $\text{SiO}_2$ under high temperature and high pressure

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### Introduction

Carbon is one of the most important volatile elements on Earth. It is found as  $\text{CO}_2$  in the atmosphere, as dissolved ions in seawater (e.g.,  $\text{CO}_3^{2-}$ ,  $\text{HCO}_3^-$ ), and as carbonate minerals deposited from seawater (e.g., calcite, aragonite). Further, it is conceived that carbonate minerals, C-O-H fluid, and diamond exist in the deep mantle. The carbonate minerals ( $\text{CaCO}_3$ : calcite, aragonite) are transported into the mantle within marine sediments by subducting slabs.

In the  $\text{MgCO}_3$ - $\text{SiO}_2$  system, it is reported that the following reaction occurs up to pressures of 80 GPa:  $\text{MgCO}_3 + \text{SiO}_2 \rightarrow \text{MgSiO}_3 + \text{CO}_2$  (e.g. [1-4]). The  $P$ - $T$  slope of the boundary showed as negative above 30 GPa. In addition, the  $\text{CO}_2$  generated decomposes to diamond and oxygen ( $\epsilon$ -phase) [4]. On the other hand, Litasov [5] indicated that the  $\text{MgCO}_3$ - $\text{SiO}_2$  system shows a melting reaction in the pressure range of 6-30 GPa. Thus, these results are inconsistent with each other. In this study, we thoroughly investigated the stability and the reaction of magnesite with silica ( $\text{SiO}_2$ ) up to 26 GPa to clarify whether decarbonation or melting occurs under these conditions.

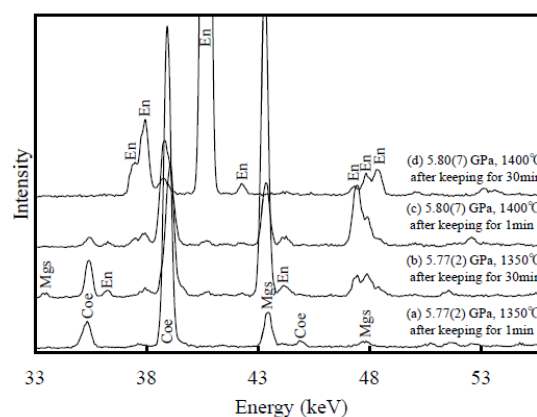
### Experimental

High-pressure in situ X-ray experiments were performed at the AR-NE5C beam line of PF-AR in KEK, Tsukuba, Japan, using the MAX 80 cubic-type high-pressure apparatus. The 6-6 type compression method was used. The TEL of the second stage anvils made by WC was 6 mm and 4 mm. We used boron epoxy as the pressure medium and cylindrical graphite as a heater. The experiments were conducted at pressures of 4-6 GPa and temperatures up to 1400 °C. First, we compressed the cell to a certain pressure at room temperature and then temperature was gradually increased to ~ 1000 °C. The diffraction data were collected at 50 °C intervals as the temperature increased. A mixture of magnesite and  $\alpha$ -quartz (1:1 molar ratio) was used as the starting material.

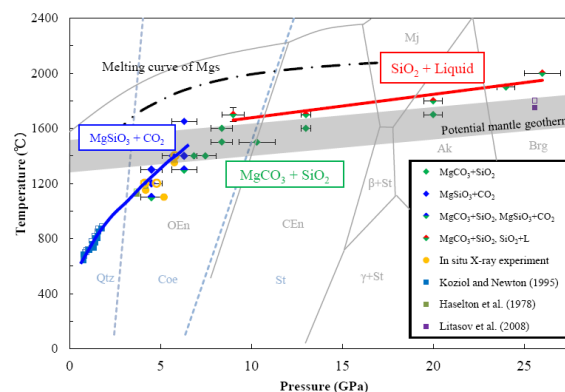
### Results and discussion

We conducted three in-situ runs up to 6 GPa and 1400 °C. In run AR288, the sample was compressed to ~ 8 GPa, and then temperature was increased gradually to 1350 °C. The main peaks of magnesite and coesite remained for 30 min at 1350 °C. Then, the temperature was increased to 1400 °C. After 30 min, the magnesite and coesite peaks disappeared and enstatite peaks appeared. This indicates that decarbonation started to occur at ~5.8 GPa and 1350-1400 °C.

Combined the present in situ X-ray results with the quench experiments in Ehime University, we could determine that the decarbonation reaction ( $\text{MgCO}_3 + \text{SiO}_2 \rightarrow \text{MgSiO}_3 + \text{CO}_2$ ) occurs below 8 GPa, but it becomes a melting reaction above 8 GPa. This work is published in [6].



**Fig.1** X-ray diffraction patterns of the in situ X-ray experiment (AR228). Mgs, magnesite; Coe, coesite; En, enstatite.



**Fig.2**  $P$ - $T$  diagram of  $\text{MgCO}_3$ - $\text{SiO}_2$  ( $\text{MgCO}_3$ :  $\text{SiO}_2 = 1:1$ ).

### References

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