

## The Effects of Temperature and Pressure on Hydromagnesite

\*Gen-ichiro Yamamoto<sup>1</sup>, Atsushi Kyono<sup>1</sup>, Jun Abe<sup>2</sup>, Takanori Hattori<sup>3</sup>, Yoshitaka Matsushita<sup>4</sup>, Yasuhiro Yoneda<sup>3</sup>

1. University of Tsukuba, 2. CROSS, 3. JAEA, 4. NIMS

In recent years, the global warming is the most important environment problem. Therefore, attempts of CO<sub>2</sub> geological storage have been made to reduce carbon dioxide in the atmosphere all over the world (Xue and Nakano 2008). Among some CO<sub>2</sub> geological storage methods, the CO<sub>2</sub> mineral trapping can store the carbon dioxide safely for a long time. In the case of geological storage, magnesium carbonate hydrates are important minerals since they precipitate easily from water saturated with carbon dioxide. The major magnesium carbonate hydrates formed from aqueous solution are nesquehonite MgCO<sub>3</sub> · 3H<sub>2</sub>O and hydromagnesite Mg<sub>5</sub>(CO<sub>3</sub>)<sub>4</sub>(OH)<sub>2</sub> · 4H<sub>2</sub>O. The stability of these minerals are critically important factors to assess environmental safety and phase stability over geological time scale, but they have not been fully investigated yet, especially of hydromagnesite. Here, we investigated the effects of pressure and temperature on hydromagnesite by using thermal analysis, high-temperature X-ray diffraction, X-ray total scattering, high-pressure X-ray diffraction, and high-pressure and high-temperature neutron diffraction techniques.

With temperature, hydromagnesite was decomposed into periclase MgO through the poor crystalline phase, accompanied with dehydration, dihydroxylation, and decarbonation of hydromagnesite. The *a* and *c* lattice parameters were monotonously increased as increasing temperature whereas *b* lattice parameter almost remained unchanged. At just before the dehydration reaction, the unit cell was contracted due to the dehydration. With pressure, hydromagnesite structure was maintained up to 8.7 GPa. Decomposition into magnesite MgCO<sub>3</sub> or periclase was unobserved up to at least 21.0 GPa. With compression, the unit cell was isotopically contracted. The fit to the Birch-Murnaghan equation of state gives  $K_0 = 32(2)$  and  $V_0 = 658(4)$  with  $K' = 4.0$  (fixed). Under high-pressure and high-temperature conditions, hydromagnesite broke down into magnesite and brucite Mg(OH)<sub>2</sub> at 200 °C and 1.2 GPa. The unit cell was isotopically expanded up to just before the breakdown. The breakdown of hydromagnesite could be caused by the dissolution by dehydration water, and subsequently magnesite and brucite were hydrothermally grown from the solution at the condition. The results obtained from this study would provide insight the CO<sub>2</sub> geological storage.

Keywords: Hydromagnesite, magnesite, phase change, high-pressure, high-temperature, CO<sub>2</sub> geological storage