Phase relation of the $MgSO_4$-H_2O system under high pressure

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Resent planetary exploration projects suggest existence of internal ocean in the several icy satellites. Spectral analysis of surface material of such satellite indicate sulfate materials as solute in the water ocean. Salts change generally the phase relation such as melting temperature and generation of a kind of hydrate, and affects the internal structure of the satellite. For the $MgSO_4$-H_2O system, which was considered as a possible major component in internal ocean, Nakamura and Ohtani (2011) has proposed the phase relation under pressure condition up to 4.5 GPa with existence of epsomite($MgSO_4 \cdot {}_7H_2O$), and discussed a deep internal ocean in the Ganymede. However, the X-ray diffraction pattern they reported as epsomite includes many unidentified diffraction peaks. In this study, we re-examined the phase relation in the system $MgSO_4$-H_2O under pressure by optical observation, micro-Raman, X-ray diffraction at synchrotron facility. High pressure experiments was performed using diamond anvil cell(DAC) up to about 5GPa at room temperature for 5 to 25wt% $MgSO_4$ solution. The results show a quite different phase relation from Nakamura and Ohtani(2011) in $MgSO_4$-rich side and solidified phases. The eutectic composition is almost same as previous report, but pentahydrate($MgSO_4 \cdot 5H_2O$) is newly observed as coexisting phase with Ice VI-VII in solid, and also liquidus phase in $MgSO_4$-rich solution. We observed direct conversion from low-pressure pentahydrate to high-pressure pentahydrate which reported by Wang et al.(2018). We also evaluate the relative density difference between liquid and solid for all composition by gravitational method in DAC. Ice VI is always denser than liquid while hydrate is always less denser than liquid. We will discuss internal structure and evolution of icy satellite based on this new results.

Keywords: Europe, high-pressure experiment, structure of internal ocean

