High-pressure phase transitions in AlOOH and FeOOH

Masayuki Nishi*[1,2], Yasuhiro Kuwayama[3], Jun Tsuchiya[1,2], Taku Tsuchiya[1,2], and Tetsuo Irifune[1,2]

[1]Geodynamics Research Center, Ehime University (GRC, Ehime Univ.) – Japan
[2]Earth-Life Science Institute, Tokyo Institute of Technology (ELSI, Tokyo Tech.) – Japan
[3]Department of Earth and Planetary Science, School of Science, University of Tokyo (Tokyo Univ.) – Japan

Abstract

Hydrogen is transported into deep Earth's mantle regions as a form of hydrous minerals via subduction of oceanic plates. CaCl2-type hydroxides such as (Mg,Si)OOH phase H, δ-AlOOH, and their solid solutions were reported to have large P–T stability fields that encompass conditions representative of the lower mantle, implying the possibility that surface water may be transported as far as the core–mantle boundary. Also, compositional analysis of phase H grains synthesized from natural serpentine shows a presence of the FeOOH component in this phase (Nishi et al., 2015). This result suggests that phase H and δ-AlOOH would also form solid solutions with ϵ-FeOOH, since ϵ-FeOOH is isostructural to phase H and δ-AlOOH. In addition, ab initio calculations have predicted that some CaCl2-type hydroxides transform to the pyrite-type structure at higher pressures (Tsuchiya and Tsuchiya, 2011). Here we report the stability of AlOOH, FeOOH, and their solid solutions based on in-situ X-ray diffraction (XRD) measurements combined with multi-anvil apparatus and laser-heated diamond anvil cell techniques. The XRD patterns showed clear diffraction peaks that can be accounted for by the pyrite-type structure, which matches that predicted by theoretical calculations (Nishi et al., 2017). We also found that δ-AlOOH transforms to the pyrite-type structure at higher pressures. Further experiments revealed that solid solutions over a wide composition range in the system AlOOH–FeOOH were maintained through the spin transition of Fe and the structural phase transition from CaCl2-type to pyrite-type structure. Based on these experimental and theoretical results, we will disscuss stability of the hydrous phase in the lower mantle and the deep interiors of other planets.

*Speaker