Experimental investigation of high-pressure phase transitions in AlOOH and FeOOH

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Hydrogen is transported into deep Earth's mantle regions as a form of hydrous minerals via subduction of oceanic plates. Recently discovered $CaCl_2$-type hydroxides such as (Mg,Si)OOH phase H, delta-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. However, although Epsilon-FeOOH has $CaCl_2$-type structure as well, the solid solution of FeOOH component in $CaCl_2$-type structure has not been studied. Since FeOOH was recently reported to decompose under the lower-mantle conditions to form FeO_2 releasing H_2, FeOOH could be a key component that strongly affect the stability of $CaCl_2$-type hydroxide. Here, we report the results of in-situ X-ray diffraction and theoretical studies on AlOOH and FeOOH using a laser-heated diamond anvil cell technique at up to ~200 GPa. In contrast to the previous work suggesting the dehydration of FeOOH in the middle of the lower mantle, we report the formation of a pyrite-type FeOOH that is significantly denser than the surrounding mantle and stable to conditions representative of its base. Furthermore, delta-AlOOH and $CaCl_2$-type (Al,Fe)OOH also transform to a pyrite-type structure at higher pressures. Based on these experimental and theoretical results, the stability of hydrous phase in the lower mantle and deep interiors of icy planets will be discussed.

Keywords: hydrous mineral, high pressure

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