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Mg, Si-bearing delta-AlOOH as a reserver of water in the lower mantle

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Earth's lower mantle is mainly composed of $MgSiO_3$-perovskite. Additionally, subducting slabs transport water stored in hydrous minerals into the lower mantle. It has been considered that almost hydrous minerals decompose and dehydrate at the lower mantle. On the other hand, delta-AlOOH can be stable up to the CMB condition and be as a reserver of water transported into the deep lower mantle (e.g., Sano et al., 2008). However, it is unknown whether delta-AlOOH can coexist with $MgSiO_3$-perovskite in the lower mantle or not. In this study, we performed high pressure and temperature experiments in the hydrous $MgSiO_3$-Al_2O_3-H_2O system, and we evaluated the possibility of the coexistence of delta-AlOOH and $MgSiO_3$-perovskite in the lower mantle.

We synthesized a gel-sample, of which composition was 70 mol.% $MgSiO_3$-30 mol.% Al_2O_3. H_2O contents of the starting gel samples were 1.5 wt.% or 7.0 wt.%.

High pressure and temperature conditions were generated using a laser heated diamond anvil cell. X-ray diffraction experiments were performed at high pressure after quenched from 2000 K at BL10XU, SPring-8. The present results showed that delta-AlOOH and $MgSiO_3$-perovskite coexist up to 68 GPa at 2000 K. Chemical analyses of recovered samples were performed using STEM-EDS (JEM-3000F). The recovered sample from 68 GPa and 2000 K showed that $MgSiO_3$-perovskite coexisting with delta-AlOOH contains 3.1(12) mol.% Al_2O_3 and this delta-AlOOH contains about 50 wt.% $MgSiO_3$. In contrast, $MgSiO_3$-perovskite in the dry $MgSiO_3$-Al_2O_3 system can contain at least 25 mol.% Al_2O_3 (e.g., Liu, 1977). Present results revealed that the Al_2O_3 content in $MgSiO_3$-perovskite in the hydrous system is dramatically less than that in $MgSiO_3$-perovskite in the dry system because of the existence of delta-AlOOH. Moreover, the Al_2O_3 content in the hydrous system is less than that in $MgSiO_3$-perovskite in the pyrolite composition. This suggests that delta-AlOOH can coexist with $MgSiO_3$-perovskite in the lower mantle composition.

Therefore, it can be concluded that delta-AlOOH coexists with $MgSiO_3$-perovskite in the lower mantle if the lower mantle contains at least 1.5 wt.% water even along the lower mantle geotherm.

Keywords: Earth's lower mantle, $MgSiO_3$-perovskite, delta-AlOOH