Subducting basaltic crust as a water transporter into the Earth's mantle transition zone

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In our resent experimental study in $FeOOH-TiO_2$ system (Nishihara and Matsukage, 2016, Am. Min.), we found new hydrous phases (FeTi oxyhydroxides) at pressures of 8-16 GPa and temperatures of 900–1600°C which corresponds to conditions of the deep upper mantle and the mantle transition zone. In this system, two stable phases were identified whose composition is expressed by $(FeH)_{1-x}Ti_xO_2$, and one of them with α-PbO_2 type structure (orthorhombic, Pbcn) is stable in the system basalt + H_2O at pressure of 12 GPa and temperature of 1000°C which corresponds to condition of the deep upper mantle in the slab.

Here, we perform high-pressure and high-temperature experimets to identify the stability field of the new hydrous minerals in hydrous basaltic system (water content = 2 wt%). The experiments were carried out at 9-18 GPa and 800–1200°C using Kawai-type multi-anvil apparatus (SPI-1000 and SAKURA at Tokyo Institute of Technology). Au/Pt double capsules were used as sample containers, and the oxygen fugacity was buffered at ~NNO by using Ni + NiO + $Ni(OH)_2$ powder. The run products were analyzed by FE-EPMA.

We found that the FeTi oxyhydroxide phase with α-PbO_2 type structure was stable in basalt + H_2O system at wide pressure range at deep upper mantle and mantle transition zone (8-17 GPa), and it dehydrate at pressure of ~17 GPa. Above 17 GPa, CaTi perovskite was formed as a Ti-bearing phase. After dehydration of FeTi oxyhydroxide, Al-bearing phase D (Pamato et al., 2015), which is one of major water carriers in deep mantle transition zone and lower mantle, was stable. Therefore our findings suggest that water transport in the Earth's deep interior by basaltic crust is probably much more efficient than had been previously thought.