# Iron-titanium oxyhydroxides as a water transporter into the Earth's mantle transition zone

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We experimentally discovered a new hydrous phases, iron-titanium oxyhydroxides, 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 (Matsukage et al. submitted). These new hydrous phases have chemical compositions in the system $FeOOH$-$TiO_2$. However, their small grain sizes in basalt + $H_2O$ system has hindered efforts to determine their crystal structures and to confirm the presence of water.
We synthesized single phase in the system $FeOOH$-$TiO_2$ 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 (Nishihara and Matsukage, 2016). Seven different compositions in the $FeOOH$-$TiO_2$ system having molar ratios of $x$ = Ti/(Fe + Ti) = 0, 0.125, 0.25, 0.375, 0.5, 0.75 were used as starting materials. High-pressure and high-temperature experiments were carried out using Kawai-type multi-anvil apparatus (Orange-1000 at Ehime University, SPI-1000 and SAKURA at Tokyo Institute of Technology). In this system, we identified two stable iron-titanium oxyhydroxide phases whose estimated composition is expressed by $(FeH)_{1-x}Ti_xO_2$ . One is the Fe-rich solid solution ($x < 0.23$) with e-FeOOH type crystal structure (e-phase, orthorhombic, $P2_1nm$) that was described by the previous studies (e.g., Suzuki 2010), and the other is the more Ti-rich solid solution ($x > 0.35$) with a-$PbO_2$ type structure (a-phase, orthorhombic, *Pbcn*). The a-phase is stable up to 1500ºC for a composition of $x$ = 0.5 and at least to 1600ºC for $x$ = 0.75. Our result means that this phase is stable at average mantle temperature in the Earth's mantle transition zone.
We also found that the hydrous phase with a-$PbO_2$ 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, which is one of major water carriers in deep mantle, was stable (Liu et al., this meeting). 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.

Keywords: deep upper mantle, mantle transition zone, water, titanium, hydrous phase, basaltic crust

 