Role of oceanic crust in deep water cycle

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The distribution of water in the deep mantle and its effects on mantle dynamics are the key issues to understand the evolution of the Earth. It is believed that water is transported from the surface into deep mantle by subducting slabs. Using multi-anvil press, we studied stability of hydrous minerals in deeply subducted oceanic crust [1]. Our results show that a continuous chain of hydrous phases may exist in subducting, cold oceanic crust: lawsonite (<8 GPa), Fe–Ti oxyhydroxide (8–17 GPa), Al-rich phase D (18–22 GPa), and Al-rich phase H (>23 GPa). The results demonstrate that oceanic crust can be a water carrier to the lower mantle in the case of fast subducting cold plate.

We have also studied fate of water after decomposition of hydrous phase [2]. In order to understand the connectivity of aqueous fluids in subducting slabs at the mantle transition zone (MTZ) conditions, experiments were performed to determine the dihedral angle of aqueous fluids within majoritic garnet crystals in a basalt-H_2O system at 17–19 GPa and 1000–1200 °C. The results show that θgrt-grt is between 44° and 55°, decreasing with increasing pressure and temperature. Our data indicate that the aqueous fluids can percolate through the subducting oceanic crust and hydrate the MTZ. We also show that the cold slab may contribute more water than the hot slab to the hydration of the MTZ, causing heterogeneous distribution of water in the MTZ.

[1] X. Liu et al. (2019) Stability of the hydrous phases of Al-rich phase D and Al-rich phase H in deep subducted oceanic crust. American Mineralogist, 104: 64-72.

[2] X. Liu et al. (2018) Aqueous fluid connectivity in subducting oceanic crust at the mantle transition zone conditions. Journal of Geophysical Research: Solid Earth, 123, 6562 – 6573.