J246-008 Room: 303 Time: May 30 11:00-11:15

Water circulation and material differentiation within the Earth

Hikaru Iwamori[1]

[1] Dept. Earth Planet. Sci., Univ Tokyo

The Earth's surface is characterized by the presence of life, surface water (sea) and continent, as well as active geological processes such as earthquakes, magmatism and plate tectonics. Recent studies show that water plays important roles in creating these characteristics, yet many aspects and processes remain unresolved, especially those within the solid Earth. To understand the transportation and the circulation of water within the Earth, the maximum H2O content of rocks under variable pressure-temperature conditions are reviewed. The maximum H2O content is also important for assessing the potential storage of H2O in the mantle, which shows that the mantle can contain 4.6 to 12.5 times more H2O than the current ocean mass, assuming a standard geothermal gradient (Iwamori, 2007). Although the estimation has a large degree of uncertainty, the mantle is a significant storage, and plays an important role in global water circulation, especially due to the unexpectedly high capacities of nominally anhydrous minerals (NAMs). Based on this information, water circulation in subduction zones and the mantle are discussed with the relevant numerical modeling and geophysical and geological observations.

Consequently, the following points have been clarified: (1) although major dehydration of subducting slabs occurs at depths shallower than 200 km, triggering arc magmatism or regional metamorphism, the subducting slab and the bottom portion of the overlying mantle wedge above the slab transport several 100 to several 1000 ppm of H2O with NAMs to the transition zone; (2) the influx of H2O into the transition zone by this mechanism is comparable to or exceeds outgassing by magmatism at mid-ocean ridges and hotspots; (3) the influx was suppressed in the past where the potential temperature was high (hot-dry regime), while it will be enhanced in the future as the Earth cools (cold-wet regime), resulting in stabilization and prolongation of mantle convection; and, (4) considering the presence of very cold subduction zones such as central Japan, where a significant amount of water is exceptionally transported to the deep mantle, the present-day Earth is probably in a transition from a hot-dry regime to a cold-wet regime. The fate of subducted materials (water and the associated elements and isotopes) and how they circulate in the mantle are important issues also for understanding the mantle dynamics. Recently Iwamori and Albarede (2007) have explored the isotopic compositional space of the oceanic basalts of the Earth by Independent Component Analysis, and have found that the Earth's major material differentiation has been caused only by two independent processes. They are likely to be differentiations associated with melting and aqueous fluid processes, where again water plays a key role. By tracing the detected 'water' signature, we are able to trace the mantle flow in the past, which bring new insights into the studies of mantle dynamics and the evolution of the Earth.