Occurrence of plate-like behavior and deep mantle water absorption in hydrous mantle convection system – 'Burst' of mantle water content

*Takashi Nakagawa[1], Hikaru Iwamori[2,3]

1. MAT, JAMSTEC, 2. D-SEG, JAMSTEC, 3. Department of Earth and Planetary Sciences, Tokyo Institute of Technology

We investigate the occurrence of plate-like behavior in hydrous mantle dynamics as a function of friction coefficient and its influence on evolution of the mantle water content. The hydrous mantle model can generate the long-term plate-like behavior with the higher friction coefficient, taken from Byerlee's law of brittle deformation, than the dry mantle, which is consistent with petrological estimate. The strength of oceanic lithosphere corresponding to friction coefficient plays a significant role with creating the global-scale mantle heterogeneity in hydrous mantle convection as well as strength of viscosity dependence due to water content. In vigorous plate motion, the mantle water content indicated rapid increase by up to 4–5 ocean masses called as the 'burst' effect. A 'burst' is related to the mantle temperature and water solubility of mantle transition zone. When the mantle cools below ~2380 K, mantle transition zone could store water transported by subducted slabs that can pass through the 'choke-point' of water solubility. The onset of 'burst' effect is strongly dependent on the friction coefficient, which gets delayed as the friction coefficient gets higher. The 'burst' effect of mantle water content could have seriously influenced the evolution of surface water ocean if the burst started early in which the Earth's surface cannot preserve the surface water ocean over the age of the Earth. This suggests that the boundary condition should be represented as a finite volume of surface ocean rather than constant water content of oceanic crust as a function of time (infinite water reservoir).

Keywords: water, mantle, plate motion

