Water and carbon cycle in global-scale mantle dynamics modeling

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Abstract

Here we show recent accomplishments on mantle water cycle with vigorous surface plate motion in numerical mantle convection simulations with experimentally-determined water solubility maps, which are an efficient occurence of surface plate motion in hydrous mantle convection and its influence to water absorption in the deep mantle and ocean-plate-mantle-core system evolution. On first accomplishement, the efficient plate motion caused by water-dependnet rheology may enhance the heat transfer in mantle convection so that the mantle transitin zone can absorb the huge amount of water. As a result, the mantle water content may be rapidly increased as a function of time when the surface plate motion is efficiently ocurred, which suggests that the water-dependent rheology may work for a positive feedback of mantle water cycle but a negative feedback to thermal state in the mantle. Second, the evolution of mass of ocean water is included in the hydrous mantle convection model with parameterized core heat balance. Using this improved model, the total amount of water in the entire Earth's system may be 4_~5 Ocean Masses suggested from early plananetary formation rather than 2 Ocean Maasses in tradiational solid Earth geodynamics. This also causes the water solubility maps of hydrous mantle minerals that may have the large value in the mantle transition zone. This suggests that the large amount of water should be found in the present Earth but it is not very clear when and where the water can be distributed in the early Earth formation. In addition, if possible, we also indicate an effects of phase-H in the hydrous mantle convection model as well as show the preliminary result of the carbon cycle model across the surface and its influence to surface environement, which strongly affects the volcanic degassing from deep interior to surface.

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