Attempts at numerical modeling of mantle convection of terrestrial bodies: from Moon, Earth, to super-Earths

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We are developing advanced numerical models of mantle convection of solid rocks, in order to deepen the insights into the thermo-chemical evolution of the mantles of terrestrial bodies. The key ingredients in our models include the effects of mantle magmatism, plate tectonics, and adiabatic compression. The mantle magmatism is modeled by the generation of liquid phase (magma) owing to the pressure-release melting induced by ascending flows of solid-state convection and the motion of the generated magma as a permeable flow through the solid matrix driven by a buoyancy due to the density difference between the solid and the liquid phases. The coherent motion of tectonic plates is, on the other hand, helped by the narrow zones of low viscosity within the highly viscous "lithosphere" along the top cold surface generated by the stress-history-dependent rheology. In addition, the adiabatic change in temperature, which is caused by the changes in volume of fluid parcels during their vertical motion, is expected to strongly affect the convecting motion particularly in the mantles of massive super-Earths. In this presentation, we will show the current status and outcrops of our attempts, together with some examples of our experiments running on massive (super)computers.

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