Numerical models of magmatism and mantle convection

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Magmatism and mantle convection as well as the thermochemical state of the mantle are numerically modeled. The thermochemical state of the mantle changes as a result of magmatism and mantle convection. The nature of mantle convection becomes largely different from the nature of thermal convection under the strong influence of mantle magmatism. It is therefore crucial to take into account the effect of mantle magmatism to understand mantle evolution. Here, I discuss the nature of the coupled magmatism-mantle convection system as well as how I modeled magmatism in convecting mantle.

How to numerically model mantle evolution is discussed. The thermochemical state of the mantle changes with time as a result of chemical differentiation by mantle magmatism and heat and mass transport by mantle convection and magmatism. The nature of mantle evolution has been inferred based on an assumption that mantle convection is a thermal convection. Under the strong influence of mantle magmatism, however, this assumption leads to wrong conclusions. An efficient heat extraction from the mantle expected in the early earth, for example, has been thought to be equivalent to efficient convective stirring that makes the mantle chemically homogeneous. Under the strong influence of mantle magmatism, however, an efficient heat extraction from the mantle implies an efficient chemical differentiation of the mantle. This is because the efficient heat extraction from the mantle is caused by migrating magma, which also causes chemical differentiation in the mantle, with a characteristic time much shorter than the time scale of mantle convection. It is also found that mantle magmatism makes the vigor of mantle convection pulsating when the barrier effect of 660 km phase transitions on mantle convection is sufficiently strong. This pulsation is a robust feature of coupled magmatism-mantle convection system with the phase transitions in contrast to the "flushing events" of thermal convection induced by the phase transitions, which occur only under a restircted condition. Here, I discuss this nature of the coupled magmatism-mantle convection system together with how I modeled mantle magmatism in convecting mantle influenced by the 660 km phase transitions.