Geophysical Research Abstracts
Vol. 20, EGU2018-11023, 2018
EGU General Assembly 2018

Numerical simulations of the thermo-compositional evolution of the solid mantle bounded by magma oceans

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Several studies suggest that after the Moon-forming impact, our planet's solid mantle was created by two fronts of crystallisation of magma oceans: upwards by the surface magma ocean, and downwards by the basal magma ocean. Thermal and compositional evolution of the growing solid mantle is then controlled by its interaction with the two magma oceans, above and below. In this work we investigate how the thermo-compositional evolution affects the dynamics of solid mantle.
We use the convection code StagYY, in which the solid mantle is represented by 2D spherical annulus geometry, and magma oceans are parameterised as 0D objects at top and bottom boundaries. In order to have interaction between magma oceans and solid mantle, our model makes use of a new boundary condition that allows matter to flow through the boundaries. Thus, melting and crystallisation processes can occur at the boundaries and evolution of the solid part can be modelled.
Our results show that the thermo-compositional evolution of solid part is strongly dependent on the timescale at which melting and crystallisation processes occur, and that different patterns of convection are possible to happen. If this timescale is very short, we show that the translation case, i.e. degree-1 mode of convection is possible. When the system reaches an equilibrium state, we show that the basal magma ocean is enriched in iron and is denser than the solid part.