Exploring the model space of thermo-chemical convection using spherical geometry

Deschamps F.(1), P.J. Tackley(1), Duchoiselle L.(1)

(1) Federal Institute of Technology, ETH Honggerberg HPP L8.1, 8093 Zurich, Switzerland

Inferring the thermo-chemical structure of the Earth's mantle is a key problem in geophysics. Both thermal and chemical sources contribute to lateral variations in density, and the mode of convection strongly depends on the relative strength of these two sources. The thermo-chemical structure of the Earth's mantle is a central framework, because it can be linked to many fields of geophysics: mineral physics gives insight on the thermo-chemical properties of the mantle mineral assemblage; seismic tomography maps heterogeneities in the mantle from observed seismic data; geodynamics, and in particular numerical models of convection, predict mantle flow and structure for a given set of input parameters and properties. Among the important parameters that control the mode of convection are the buoyancy ratio, the thermal expansion, the geometry, and the presence of a phase transition. Because each mode of convection predicts a distribution of temperature and composition, it can be tested against geophysical observations that are sensitive to these distributions, mainly seismic data. In particular, probabilistic tomography maps chemical heterogeneities throughout the lower mantle and a successful thermo-chemical model of convection will have to be able to maintain such heterogeneities over long period of time : Exploring the model space of 3D cartesiens thermo-chemical convection, we found that a phase transition at 660km can play that role. The viscosity ratio between the dense and regular material is also likely to play an role we now focus our search on the role of the post-perovskite phase transition using thermo-chemical models of convection with spherical geometry.

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