Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SIT003-09 会場:101 時間:5 月 26 日 11:05-11:20

Thermo-chemical convection in the inner core
Thermo-chemical convection in the inner core

Philippe CARDIN[1*], Renaud DEGUEN[2]
Philippe CARDIN[1*], Renaud DEGUEN[2]

[1]ISTerre, Grenoble, France, [2]EPS, Johns Hopkins University, USA
[1]ISTerre, Grenoble, France, [2]EPS, Johns Hopkins University, USA

The dynamics of the Earth inner core depends criticaly on whether it is stably stratified or unstably stratified. Solidification-induced partitioning of the light elements may induce a stable density stratification within the inner core. Whether the thermal field is stabilizing or destabilizing depends on the inner core solidification rate, on the thermal diffusivity of iron at inner core conditions, and on the ratio of the Clapeyron slope to the adiabatic gradient in the inner core. The temperature field within the inner core can be destabilizing - and could drive convection - if the growth rate of the inner core is large enough. While this possibility has often been thought implausible, the young inner core age predicted by the most recent core thermal evolution models and the low thermal conductivity value proposed recently (Stacey and Davis, 2009) leave this possibility open.We focus here on this case, taking into account a possible stabilizing effect of a compositionnal profile in addition to the destabilizing thermal field. We developed a numerical model of thermo-chemical convection in a growing inner core, coupling the thermal evolution of the inner core with a model of thermal and compositional evolution of the outer core. Melting and crystallization associated with deformation of the ICB would be of importance for the style of convection if the viscosity is large, but we focus here on the case of low viscosity ($< 10^{19}$ Pa.s) for which phase change associated with dynamic topography at the ICB is expected to play a secondary role. If a stabilizing compositional stratification is present, we show that convection develops in a regime close to the "diffusive" regime of double-diffusive convection. A particularly interesting feature of the regime we found is that the convective flow can be confined to the deep inner core. The radius of this inner convective region depends essentially on the relative effects of thermal and compositionnal fields, and is found to be similar to the seismically determined radius of the innermost inner core for plausible parameters. The thermal forcing generaly decreases as the inner core grows because the cooling rate at the ICB decreases. A second possible explanation for the origin of the innermost inner core is that the inner core has been convecting during its early history but is now quiescent.

キーワード: inner core, geodynamics, anisotropy, thermal convection
Keywords: inner core, geodynamics, anisotropy, thermal convection