I131-P016 **Room: Poster Session Hall** **Time: May 18**

Mantle convection with degree-one and -two dominant thermal structures

Masaki Yoshida[1]

[1] IFREE, JAMSTEC

The present-day Earth's mantle convection pattern is certainly dominated by a spherical harmonic degree of two, as illustrated by almost all seismic tomography models. However, it is still not clear (1) whether mantle convection has been dominated by thermal heterogeneity with degree-two or a longer component (i.e., degree-one) throughout the Earth's history, and (2) which geophysical mechanism principally induces such a long-wavelength thermal heterogeneity.

Previous numerical calculations have shown that degree-one convection is never present in three-dimensional (3-D) spherical models of iso-viscous mantle convection. In recent years, however, degree-one convection has been produced by some numerical models that considered temperature-dependent rheologies in Boussinesq fluid convection. When internal heating is included with moderately temperature-dependent viscosity, degree-one convection occurs. Yoshida and Kageyama (2006) have shown that degree-one convection occurs even without internal heating when temperature-dependence of the viscosity is moderately strong.

In this study, to clarify further whether degree-one and -two convection (i.e., "low-degree convection") originate in mantle convection for both entirely basal heating and mixed (i.e., basal and internal) heating modes, I performed numerical calculations of mantle convection in a 3-D spherical geometry. The effects of a pseudo visco-plastic rheology on the low-degree convection are also investigated.

When the layer is the Boussinesq fluid and bottom-heated mantle, and the viscosity contrast due to temperature-dependent viscosity is 10^2, the convection pattern is dominated by a spherical harmonic degree of two with two cylindrical downwellings surrounded by several upwellings on a "great-circle ridge". On the other hand, when the viscosity contrast is 10^4, the convection pattern is still in the sluggish-lid regime, but becomes degree-one dominant. I found that, even when internal heating is considered, the convection shifts to one with the iso-viscous pattern with high degree modes, the degree-two pattern to the degree-one pattern with increasing the viscosity contrast. To investigate the extended-Boussinesq effects on low-degree convection, I performed the models with the dissipation number of 0.36. In the entirely bottom heated mantle, the degree-two pattern changes into a new pattern dominated by low degree modes, characterized by three columnar downwellings and a network of sheet-like upwellings. However, when the viscosity contrast is 10^4, thermal structures do not change from the Boussinesq case and retain the degree-one pattern. On the other hand, when internal heating is considered, the convection patterns change from Boussinesq cases. When the viscosity contrast is 10^4, the pattern shifts to one with high-degree modes because the bottom of the highly viscous lid becomes unsteady presumably with enhanced viscous dissipation heating.

I next imposed the pseudo visco-plastic rheology at the top part of the model with bottom heating, Boussinesq approximation, and the viscosity contrast of 10^3. The relatively lower level of the yield stress (50 MPa) results in the development of long, linear convergence zones like the circum-Pacific. The resultant "subducting plate" induces short-wavelength heterogeneity in the mantle. This result shows a potential effect of surface plate-like motion on the breakdown of low-degree convection. The subduction zone surrounding the margins of the past supercontinents since the Palaeozoic era and its temporal stability (e.g., Collins, 2003) may be an inherent characteristic of mantle convection only with thermally induced driving force, that is, without any chemical heterogeneity like the compositionally distinct continent.