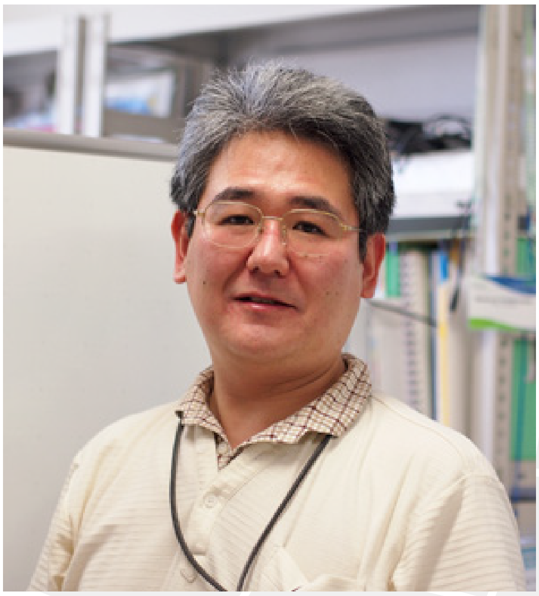
THE GEODYNAMICS SEMINAR №590



Numerical experiments on thermal convection in the mantles of super-Earths with various sizes: Roles of adiabatic compression and spherical geometry

Dr. Masanori Kameyama
Professor
Geodynamics Research Center

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Venue: Meeting Room #486
Science Research Bldg. 1, 4th floor.
Ehime Univ.

Keywords:
1. Mantle convection
2. Super-Earths
3. Adiabatic compression

We conduct a series of numerical experiments of thermal convection of compressible fluids with temperature-dependent viscosity, in order to study how the adiabatic compression and model geometries affect the mantle convection on super-Earths. A two-dimensional basally-heated convection is considered under the truncated anelastic liquid approximation (TALA), either in a rectangular box or in a cylindrical annulus. We varied the magnitude of adiabatic heating and the Rayleigh number as well as the depth profile of thermodynamic properties (thermal expansivity and reference density) in accordance with the planetary sizes. From our calculations by varying the planetary sizes up to 10 times the Earth's mass, we confirmed that the adiabatic compression affects the thermal convection more strongly for larger planets. Hot plumes originating from the core-mantle boundary become thinner and less vigorous with increasing the planetary mass. We also found that the overall strain rate in the top cold thermal boundary layers (TBLs) is almost independent of planetary mass for the planets larger than the Earth. Taken together with the effect of spherical geometry which tends to thicken the cold TBLs, we speculate that the emergence of plate tectonics is not likely to be enhanced for massive terrestrial planets larger than our Earth.

Contact: Steeve Gréaux, PhD. (e-mail: greaux@ehime-u.ac.jp)