Assessment and implication on the thermal and chemical state of the Earth’ s core in the 1-D radial convective structure tracking over 4 billion years

*Takashi Nakagawa[1]

1. Department of Earth Sciences, The University of Hong Kong

We investigate the possibility on finding the stable region beneath the core-mantle boundary (CMB) in one-dimensional radial convective structure of the Earth’ s core as result of thermal and chemical evolution of the Earth’ s core for over 4 billion years. With the realistic density profile in Earth’ s core and time evolution for 4.6 billion years, the stable region may be found between 9.8 and 11.3 TW of the present-day CMB heat flow for no chemical coupling across the CMB and between 11.1 TW and 13.2 TW of the present-day CMB heat flow with the chemical coupling across the CMB. Those ranges are shifted to much higher value of CMB heat flow compared to the previous assessment of the convective structure of the Earth’ s core with a simplified approach (Takehiro and Sasaki, 2018). For matching the current constraint of the CMB heat flow and geophysical observations on the stable region beneath the CMB, the thermal conductivity of the Earth’ s core may be increased up to the upper-bound of experimental constraint (~220 W/m/K). Such a high thermal conductivity may be unlikely to have the thermal convection of the Earth’ s core. Hence, the additional power source of dynamo actions would be required for getting the magnetic field in earlier Earth’ s core, that is, the compositional convection caused by the dissolution of light elements in core alloy. Although this type of compositional convection seems to be unlikely to form the stable region beneath the CMB, the time-scale of chemical state of the Earth’ s core changing from the over-saturated to under-saturated condition is very significant for finding the stable region at the present.

Keywords: Earth's core, Stable region, convective structure

