Towards revealing geomagnetic secular variations in numerical dymamo simulations with thermal heterogeneity in the plate-mantle system

*Takashi Nakagawa¹, Futoshi Takahashi², Hisayoshi Shimizu³

1. JAMSTEC, 2. Kyushu Univ., 3. ERI Univ. of Tokyo

It would be essential that the geomagnetic secular variations over billion years time-scale should be reconciled from geodynamo modeling approach but, due to a huge time-scale difference between a characteristic time variations of geomagnetic secular variations and geodynamo model, simplified convective energetics of Earth' s core in mantle convection simulations is still useful for long-term secular variations. In this energetics computation, it would be required for a scaling relationship between actual strength of magnetic field and magnetic dissipations as well as and convective power, which is not well understood from numerical dynamo simulations because of physical parameter choices. Despite of such a difficulty, there have been a set of modeling results on numerical dynamo simulations with thermal boundary heterogeneity computed from numerical mantle convection simulations for understanding geomagnetic secular variations, in particular of geomagnetic polarity reversals (Olson et al., 2013). However, their computations on numerical mantle convection are still simplified for rheological and material model as well as large Ekman and magnetic Prandtl numbers for numerical dynamo simulations. For improving current accomplishments on numerical dynamo simulations with boundary heterogeneities, we here investigate numerical dynamo simulations with thermal boundary heterogeneities caused by deep mantle thermo-chemical anomalies. The thermal boundary heterogeneities are computed from numerical mantle convection simulations incorporating melt-induced differentiation that can create the oceanic crust and geological data for the plate reconstruction up to 200 Ma with varying the density difference between pyrolitic and basaltic composition at the core-mantle boundary pressure. For numerical dynamo simulations, we use two orders of magnitude smaller Ekman number and one order of magnitude smaller magnetic Prandtl number. Because of time-scale difference between mantle and core dynamics, we impose the heat flow across the core-mantle boundary at a certain time (0, 50, 100, 150 and 200 Ma) computed from mantle convection simulation into numerical dynamo simulations as a static boundary condition. No polarity reversals are found in numerical dynamo simulations with boundary heterogeneities at a certain time computed from more realistic setting of numerical mantle convection simulations. A magnetic morphology at the core-mantle boundary indicates to have strong dipolar field in 200 Ma of plate reconstruction history. Further data analyses will be indicated in the presentation.

Keywords: geodynamo, secular variation, plate-mantle dynamics