Stratification of the Earth’s core by SiO_2 crystallisation

*George Helffrich[1], Satoshi Kaneshima[2], Kei Hirose[1,3]

1. Earth-Life Science Institute, Tokyo Institute of Technology, 2. Earth and Planetary Sciences, Kyushu University, 3. Earth and Planetary Sciences Department, University of Tokyo

Based on various studies reporting seismic wavespeed deviations from PREM in the outermost outer core, the core appears to be stratified. Compositional layering, where liquids of different densities overlie one another is one stratification possibility. This mechanism, however, inhibits vertical flows in the liquid near the surface of the core implied by models of secular variation of the Earth’s magnetic field. To avoid this limitation, we propose a mechanism by which the layering arises in an analogous way to atmospheric cloud formation. If liquid metal containing dissolved Si+O reaches a saturation level in the outermost outer core, SiO_2 will crystallize and rise to the core-mantle boundary (CMB), causing density changes in the liquid by release of latent heat and changing composition. We present an physical model for this process and show that it explains the observed outer core wavespeed variations better than previous parameterizations. For a CMB temperature of 3800 K and a core light element content of 5 wt% Si+O, SiO_2 begins crystallizing 260 km below the CMB through an interval about 160 km thick, yet core liquid can flow freely through the crystallization interval, facilitating magnetic field changes on decadal to century time scales.

