Composition of the outermost outer core estimated from thermoelastic properties of liquid Fe alloys

*Hiroki Ichikawa[1], Taku Tsuchiya[2]

1. Earth-Life Science Institute, Tokyo Institute of Technology, 2. Geodynamics Research Center, Ehime University

The Earth's core is thought to include substantially large amounts of light elements (LEs), which account for observed density deficits of ˜10% for the liquid outer core and ˜5% for the solid inner core. Although studies have been made on candidate LEs such as oxygen, silicon, carbon, nitrogen, sulfur, and hydrogen, there is no established compositional model of the core so far due to technical difficulties in experiments and a lack of observational data. However, recent reports of low-velocity anomalies ($-\Delta V_P$=0.03-0.1 km/s) observed at the outermost 100-300 km of the outer core give another new constraint on the composition of the core. Due to the gravitational stability, such a layer should have a lower density than the ambient outer core liquid. Therefore, it seems reasonable to assume that the outermost layer consists of the LE-rich liquid. However, the sole LE incorporation leads to the increase of V_P of the liquid iron due to the reduction of its density. Therefore, complicated processes such as exchanges of two LE species might be responsible. The dynamically stable and chemically distinct topmost LE layer can be created either by the interaction at the CMB, the incomplete mixing of core merging, or the residue from crystallization.

Here, we show integrative analyses of the compositional model of the Earth’s outer core based on the ab initio thermoelasticity and diffusivity of iron-nickel-LE alloy liquids in order to restrict the both compositions of the outermost layer and the entire outer core.

Keywords: Outer core composition, Outermost layer of the core, Light elements

