Terrestrial core stratification and subsequent mixing

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The pressures and temperatures at which metal-silicate equilibration occurs for newly accreted materials naturally increases as Earth and other terrestrial bodies grow. These changing conditions increasingly add more light elements (Si, O, S and H) to the core forming liquids, which are then accreted onto the core. Since the core more-or-less accretes isothermally and moreover the compositional expansivity due to the presence of light elements is a much stronger effect than thermal expansivity due to thermal variations, layers are much less dense as a function of radius than an isentropic, compositionally mixed core with the same bulk properites. In other words, the core is constructed with a stably stratified structure. This stable stratification would likely interfere with the maintenance of a core dynamo.

We simulate this construction using a model that incorporates realistic accretion from N-body simulations [1], metal-silicate equilibration during differentiation [2], and a newly developed core layering model, which tracks the evolution of the core as new layers of core forming liquids reach the core-mantle boundary.

This stratification is robust to both thermal and double-diffusive instability as shown by a Rayleigh number analysis, and so should have persisted to the current day. However, giant impacts like the Moon-forming impact would have been energetic enough to overcome this stratification and homogenize the core. Perhaps, no such giant impact occurred on Venus leaving it with a stably stratified core to this day.

[1] S. A. Jacobson et al., (2014) *PSTRA*, 372, 0174.
[2] D. C. Rubie et al., (2015) *ICARUS*, 248, 89–108.