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Influence of early thermal state in the deep mantle on the thermal evolution of Earth's core resulting from thermo-chemical spherical mantle convection

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The initial CMB temperature is expected to be much higher than the solidus temperature of silicates at the base of the mantle if the one of early Earth hypothesis for the deep mantle can be acceptable (Basal Magma Ocean hypothesis) [Labrosse et al., 2007] but the initial thermal state of the Earth is highly uncertain because the Earth's mantle is likely to experience episodic dynamics [e.g. Tackley et al., 1994; Honda, 1995]. Here we present a wide-ranging parameter study of the effect of initial core-mantle boundary (CMB) temperature, concentration of radioactive potassium in the core, and density difference between harzburgite and mid oceanic ridge basalt (MORB) in a coupled spherical model of thermo-chemical mantle convection and parameterized core heat balance. Other two parameters except for the initial CMB temperature are also highly uncertain because of difficulties of experiments and theoretical calculations to determine actual amounts. The results indicate that as with previous, purely thermal convection models, the final state of the system is only weakly dependent on initial CMB temperature, unless the CMB becomes blanketed by a global layer of dense material. Obtaining a successful thermal evolution, in the sense of obtaining the correct present-day inner core size and maintaining a geodynamo over geological time, is helped by the accumulation of piles of dense material at the CMB (subducted MORB in the present calculations) and a concentration of radiogenic K in the core in the range 400-800 ppm with 5000 to 6000 K of initial CMB temperature that can find the melting region in the deep mantle for early Earth stage.
Reference: Honda, EPSL(1995); Tackley et al., JGR(1994); Labrosse et al., Nature(2007)