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Thermal evolution of the Earth with a basal magma ocean

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Standard thermal evolution models including the feedback of temperature-dependence of viscosity on the heat transfer efficiency of mantle convection fail to satisfy the constraints on the surface heat flow and heat production in the mantle. A solution to this conundrum is to consider that the core has been cooling faster than the mantle. However, this implies that the core started several hundreds of K hotter than it is today, implying that the lowermost mantle has been molten for a significant part of the Earth history, leading to the idea of a basal magma ocean. The presence of a basal magma ocean has been shown to dramatically change the dynamics of the solid mantle and its thermal structure. In particular, as long as the solid mantle stays compositionally well mixed, no bottom boundary layer develops in the solid. Numerical models in this situation provide us with scaling laws that we use to develop a model of thermal evolution of the Earth coupling the solid mantle, the basal magma ocean and the core. This allows us to explore the condition under which the thermal catastrophe conundrum can be solved.