LLSVPs of primordial origin: Implications for the evolution of plate tectonics

Philipp Hellenkamp, Claudia Stein, and Ulrich Hansen
University of Münster, Institute for Geophysics, Germany (p_hell02@uni-muenster.de)

Early periods of Earth's history are of great interest for the evolution of plate tectonics. For instance, neither the formation of lithospheric plates nor the nature of Archean plate tectonics is well known. As a remnant of the magma ocean period, a compositionally dense layer at the core-mantle boundary is assumed to interact with the convective flow of the Earth's mantle forming todays LLSVPs. Since plate motions are strongly coupled to the convection of mantle material, stabilizing effects of compositionally dense material have a profound impact on mantle convection and plate tectonics and will be of major importance for its evolution.

To investigate the influence of a dense basal layer, we use a numerical approach employing thermo-chemical mantle convection models with self-consistent plate generation. Considering different possible scenarios of the post magma ocean period we analyze the influence of different parameters, i.e. the density contrast between the dense basal material and the ambient mantle and the volume of the enriched layer.

Generally we observe that a stagnant lid forms which is initially mobilized episodically before turning to a permanently mobile surface. However, the temporal evolution of the episodic stage is considerably altered due to the presence of dense basal material. The time when an episode occurs, is determined by the mechanism which induces this mobilization. The mechanism itself is controlled by the density and volume of the enriched layer. Therefore, we distinguish between four different initiation mechanisms, which occur for different configurations of the density and volume of enriched material.