Geophysical Research Abstracts
Vol. 20, EGU2018-8255, 2018
EGU General Assembly 2018

LLSVP survival from an early Earth mantle: analysing stability beneath a stagnant-lid

Philip Heron (1), Craig O'Neill (2), Siqi Zhang (2), and Jeroen van Hunen (1)

(1) Durham University , Department of Earth Sciences, Durham, United Kingdom (philip.j.heron@durham.ac.uk), (2) Macquarie University, Department of Earth and Planetary Science, NSW, Australia

Data from geochemistry, mineral physics, and seismology indicates that the Large Low Shear Velocity Provinces (LLSVPs) below Africa and the Pacific may be evidence of compositionally dense and chemically distinct material deep in the Earth's mantle. Although the origin and composition of LLSVPs are uncertain, a theory persists that they are primordial in nature. Heterogeneities in recent geochemical studies have suggested that portions of the mantle (e.g., LLSVPs) have remained stable since the Hadean. In this study, we apply numerical models of thermo-chemical mantle convection to analyse the stability of simulated LLSVPs over time. We implement an initial setup of a hot mantle interior with a stagnant lid surface, resembling a possible Hadean-age early Earth system. Using a modified version of the open-source geodynamics code ASPECT, 2D spherical numerical simulations spanning 2 billion years of mantle convection are analysed to understand an open problem: what parameters are required to stop an LLSVP from mixing into a hot, stagnant lid mantle?

We present a suite of numerical models changing LLSVP density, mantle heating rates, core radioactive heating rates, and surface yield strength. Overall, we find it is difficult for our simulated LLSVP layer to survive 2 billion years of hot stagnant lid mantle convection - with most models producing an unstable chemical layer after 1 billion years. However, there are scenarios that can aid longevity of an early Earth LLSVP; increasing the density of the chemical layer increases its stability, as shown in many previous studies. Furthermore, we discuss the role, if any, that some form of primitive plate tectonics would play in mixing LLSVPs into the mantle. Our models highlight a complex relationship between surface tectonics and the deep mantle which has evolved over time.