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# The interaction between oceanic subduction and deep mantle structures in the positioning of mantle plumes

Philip Heron (1), Juliane Dannberg (2), Rene Gassmoller (2), Grace Shephard (3), Jeroen van Hunen (1), and Russell Pysklywec (4)

(1) Durham University, Department of Earth Sciences, Durham, United Kingdom (philip.j.heron@durham.ac.uk), (2) University of California Davis, Davis, CA 95616-5294, United States, (3) C.E.E.D., University of Oslo (UiO), Oslo, Norway, (4) University of Toronto, Dept of Earth Sciences, Toronto ON, Canada

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, based on data from geochemistry, mineral physics, and seismology. The paleo-position of mantle upwellings deduced from large igneous provinces (LIPs) has previously been attributed to plume generation zones at the edges of these LLSVPs. However, the geodynamic genesis of the upwellings, as well as the geodynamic nature of LLSVPs, are not well understood. One hypothesis is that subduction can mould LLSVPs to control the location of upwellings. In this study, we implement 3D global numerical models of mantle convection to explore the role of subduction and thermo-chemical piles on the position of upwellings following supercontinent formation.

Using the open-source geodynamic code ASPECT, our models combine a compressible mantle with Earth-like material properties, a strongly temperature dependent viscosity, chemical heterogeneities tracked by compositional fields, and prescribed surface velocities. In previous studies, a hypothesized thermo-chemical nature of the hot anomalies has been shown to be essential in developing appropriate plume positions over time, yet conversely these same structures at the base of the mantle have also been put forth to be purely thermal. In our study, these two opposing hypotheses are both able to explain the positions of hot spots and large igneous provinces from 100 Myr ago until the present day equally well. By demonstrating that a purely thermal mantle can generate appropriate global dynamics, we show the power of downwelling oceans to stir mantle flow and control the thermal evolution of the mantle. A greater understanding of subduction history in the Paleozoic era and through modelling the supercontinent cycle has improved our geodynamic simulations.

Based on the findings shown here, we posit the deep hot anomaly in the mantle (e.g., LLSVPs) may only be passive in global dynamics, with subduction playing a more active role in the planet's thermal evolution and the positioning of hotspots and large igneous provinces.

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