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Investigating deep mantle evolution by linking geodynamic modelling to seismic data

Anna Schneider[1], Bernhard Schuberth[1], Paula Koelemeijer[2], Grace Shephard[3,4], Alex Myhill[5], and David Al-Attar[5]

[1]Ludwig-Maximilians-Universität München (LMU), Geophysics, Department of Earth and Environmental Sciences, Munich, Germany
[2]University of Oxford, Department of Earth Sciences, Oxford, United Kingdom
[3]University of Oslo, Centre for Planetary Habitability, Department of Geosciences, Oslo, Norway
[4]Australian National University, Research School of Earth Sciences, Acton, Canberra, Australia
[5]University of Cambridge, Department of Earth Sciences, Cambridge, United Kingdom

The alternation between superchrons and periods of rapid field reversals is comparable to timescales of mantle convection, suggesting that lowermost mantle evolution impacts the reversal frequency of the Earth's magnetic field. By controlling the heat flow from the outer core, the deep mantle temperature distribution can either support or hamper the convective pattern in the outer core that generates the dipolar field component.

Due to the long timescales, the main means of testing a potential correlation between reversal frequency rate and CMB heat flow distribution is through tectonically informed geodynamic modelling. However, even though state-of-the-art mantle circulation models (MCMs) typically explain statistical properties of seismological data, they do not consistently reproduce the location of present-day mantle features. The main influence on position is given by the assimilated absolute plate motion model, which is inherently restricted by the lack of longitudinal constraints as well as the need to separate plate motion and true polar wander signal in paleo-magnetic data. Geodynamic model predictions therefore need to be compared to independent observations.

In this contribution, we investigate predictions of present-day mantle structure that are based on differences in the absolute plate motion model. We compute synthetic seismic data by coupling MCM predicted structure with a thermodynamic mineralogical model. The analysis is predominantly focused on normal mode data, as they capture the longwavelength component of structures throughout the entire mantle. In addition, the global sensitivity of normal modes reduces the drawbacks of uneven data coverage. By quantifying the fit to seismic data, we evaluate different realisations of mantle structure that reflect plausible variations in the absolute plate motion history.