Geophysical Research Abstracts
Vol. 20, EGU2018-19434, 2018
EGU General Assembly 2018

Hot upper mantle beneath the Tristan da Cunha Hotspot, from probabilistic Rayleigh-wave inversion and petrological modeling

Raffaele Bonadio (1), Wolfram Geissler (2), Sergei Lebedev (1), Javier Fullea (1), Matteo Ravenna (1), Nicolas Celli (1), Wilfried Jokat (2), Marion Jegen (3), Christoph Sens-Schonfelder (4), and Kiyoshi Baba (5)

(1) Dublin Institute for Advanced Studies, Dublin, Ireland, (2) Alfred Wegener Institute, Helmholtz Centre for Polar Research, Bremerhaven, Germany, (3) GEOMAR, Helmholtz Centre of Ocean Research Kiel, Germany, (4) Helmholtz-Zentrum Potsdam, Deutsches Geoforschungszentrum, Potsdam, Germany, (5) Earthquake Research Institute, The University of Tokyo, Japan

Understanding the enigmatic intraplate volcanism in the Tristan da Cunha region requires knowledge of the temperature of the lithosphere and asthenosphere beneath it. We measured phase-velocity curves of Rayleigh waves using cross-correlation of teleseismic seismograms from an array of ocean-bottom seismometers around Tristan, constrained a region-average, shear-velocity structure, and inferred the temperature of the lithosphere and asthenosphere beneath the hotspot. The ocean-bottom dataset presented some challenges, which required data-processing and measurement approaches different from those tuned for land-based arrays of stations. Having derived a robust, phase-velocity curve for the Tristan area, we inverted it for a shear-wave velocity profile using a probabilistic (Markov chain Monte Carlo) approach. The model shows a pronounced low-velocity anomaly from 70 to at least 120 km depth. V_S in the low velocity zone is 4.1–4.2 km/s, not as low as reported for Hawaii (~4.0 km/s), which probably indicates a less pronounced thermal anomaly and, possibly, less partial melting. Petrological modeling shows that the seismic and bathymetry data is consistent with a moderately warm mantle (mantle potential temperature of 1420–1440°C, an excess of about 85–105°C compared to the global average) and a melt fraction smaller than 1%. Both purely seismic inversions and petrological modeling indicate a lithospheric thickness of 65–70 km, consistent with recent estimates from receiver functions. The presence of warmer-than-average asthenosphere beneath Tristan is consistent with a hot upwelling (plume) from the deep mantle. However, the excess temperature we determine is smaller than that reported for some other major hotspots, in particular Hawaii.

Reference:

Bonadio, R., W.H. Geissler, S. Lebedev, J. Fullea, M. Ravenna, N.L. Celli, W. Jokat, M. Jegen, C. Sens-Schönfelder, K. Baba. Hot upper mantle beneath the Tristan da Cunha Hotspot, from probabilistic Rayleigh-wave inversion and petrological modeling. Geochem. Geophys. Geosyst., in review, 2018.