Geophysical Research Abstracts
Vol. 18, EGU2016-16611, 2016
EGU General Assembly 2016

Testing Predictions of Continental Insulation using Oceanic Crustal Thicknesses

Mark Hoggard (1), Oliver Shorttle (2), and Nicky White (1)

(1) University of Cambridge, Bullard Labs, Madingley Road, Cambridge, UK (mjh217@cam.ac.uk), (2) California Institute of Technology, 1200 E. California Blvd, Pasadena, CA 91125, USA

The thermal blanketing effect of continental crust has been predicted to lead to elevated temperatures within the upper mantle beneath supercontinents. Initial break-up is associated with increased magmatism and the generation of flood basalts. Continued rifting and sea-floor spreading lead to a steady reduction of this thermal anomaly. Recently, evidence in support of this behaviour has come from the major element geochemistry of mid-ocean ridge basalts, which suggest excess rifting temperatures of ~ 150 °C that decay over ~ 100 Ma.

We have collated a global inventory of ~ 1000 seismic reflection profiles and ~ 500 wide-angle refraction experiments from the oceanic realm. Data are predominantly located along passive margins, but there are also multiple surveys in the centres of the major oceanic basins. Oceanic crustal thickness has been mapped, taking care to avoid areas of secondary magmatic thickening near seamounts or later thinning such as across transform faults. These crustal thicknesses are a proxy for mantle potential temperature at the time of melt formation beneath a mid-ocean ridge system, allowing us to quantify the amplitude and duration of thermal anomalies generated beneath supercontinents.

The Jurassic break-up of the Central Atlantic and the Cretaceous rifting that formed the South Atlantic Ocean are both associated with excess temperatures of ~ 50 °C that have e-folding times of ~ 50 Ma. In addition to this background trend, excess temperatures reach > 150 °C around the region of the Rio Grande Rise, associated with the present-day Tristan hotspot. The e-folding time of this more local event is ~ 10 Ma, which mirrors results obtained for the North Atlantic Ocean south of Iceland. In contrast, crustal thicknesses from the Pacific Ocean reveal approximately constant potential temperature through time. This observation is in agreement with predictions, as the western Pacific was formed by rifting of an oceanic plate.

In summary, variations in oceanic crustal thickness support the existence of continental insulation effects. Characteristic e-folding times are ~ 50 Ma, but excess break-up temperatures are significantly lower than previously expected at around ~ 50 °C. We tentatively suggest that higher excess temperatures of > 150 °C occur in the vicinity of upwelling mantle plumes, which are associated with shorter e-folding times of ~ 10 Ma.