Geophysical Research Abstracts
Vol. 19, EGU2017-4197-2, 2017
EGU General Assembly 2017

Estimating long-wavelength dynamic topographic change of passive continental margins since the Early Cretaceous

Dietmar Müller (1), Rakib Hassan (1), Michael Gurnis (2), Nicolas Flament (3), and Simon Williams (1)

(1) Univ. of Sydney, School of Geosciences, Sydney, Australia (dietmar.muller@sydney.edu.au), (2) Seismological Laboratory, California Institute of Technology, Pasadena, USA, (3) Univ. Wollongong, School of Earth and Environmental Sciences, Wollongong, Australia

The influence of mantle convection on dynamic topographic change along continental margins is difficult to unravel, because their stratigraphic record is dominated by tectonic subsidence caused by rifting. Yet, dynamic topography can potentially introduce significant depth anomalies along passive margins, influencing their water depth, sedimentary environments and geohistory. Here we follow a three-fold approach to estimate changes in dynamic topography along both continental interiors and passive margins based on a set of seven global mantle convection models. These models include different methodologies (forward and hybrid backward-forward methods), different plate reconstructions and alternative mantle rheologies. We demonstrate that a geodynamic forward model that includes adiabatic heating in addition to internal heating from radiogenic sources, and a mantle viscosity profile with a gradual increase in viscosity below the mantle transition zone, provides a greatly improved match to the spectral range of residual topography end-members as compared with previous models at very long wavelengths (spherical degrees 2-3). We combine global sea level estimates with predicted surface dynamic topography to evaluate the match between predicted continental flooding patterns and published paleo-coastlines by comparing predicted versus geologically reconstructed land fractions and spatial overlaps of flooded regions for individual continents since 140 Ma. Modelled versus geologically reconstructed land fractions match within 10% for most models, and the spatial overlaps of inundated regions are mostly between 85% and 100% for the Cenozoic, dropping to about 75-100% in the Cretaceous. We categorise the evolution of modelled dynamic topography in both continental interiors and along passive margins using cluster analysis to investigate how clusters of similar dynamic topography time series are distributed spatially. A subdivision of four clusters is found to best reveal end-members of dynamic topography evolution along passive margins and their hinterlands, differentiating topographic stability, long-term pronounced subsidence, initial stability over a dynamic high followed by moderate subsidence and regions that are relatively proximal to subduction zones with varied dynamic topography histories. Along passive continental margins the most commonly observed process is a gradual move from dynamic highs towards lows during the fragmentation of Pangea, reflecting that many passive margins now overly slabs sinking in the lower mantle. Our best-fit model results in up to 500 $\pm$150 m of total dynamic subsidence of continental interiors while along passive margins the maximum predicted dynamic topographic change over 140 million years is about 350 $\pm$150 m of subsidence. Models with plumes exhibit clusters of transient passive margin uplift of about 200 $\pm$200m. The good overall match between predicted dynamic topography and geologically mapped paleo-coastlines makes a convincing case that mantle-driven topographic change is a critical component of relative sea level change, and one of the main driving forces generating the observed geometries and timings of large-scale shifts in paleo-coastlines.