Relative continent/mid-ocean ridge elevation: a reference case for isostasy in geodynamics

Thomas Theunissen¹, Ritske S. Huismans¹, Gang Lu¹, and Nicolas Riel²

¹University of Bergen, Earth Science, Geodynamics, Bergen, Norway (thomas.theunissen@uib.no)
²Johannes Gutenberg-Universität Institute for Geosciences Mainz Germany

The choice of crustal and mantle densities in numerical geodynamic models is usually based on convention. The isostatic component of the topography is, however, in most if not all cases not calibrated to fit observations resulting in not very well constrained elevations. The density distribution on Earth is not easy to constrain because it involves multiple variables (temperature, pressure, composition, and deformation). We provide a review and global analysis of the topography of the Earth showing that elevation of stable continents and active mid-ocean ridges far from hotspots on average is +400 m and -2750 m respectively. We show that density values for the crust and mantle, commonly used for isostatic modeling result in highly inaccurate prediction of topography. We use thermodynamic calculations to constrain the density distribution of the continental lithospheric mantle, sub-lithospheric mantle, the mid-ocean ridge mantle, and review data on crustal density. We couple the thermo-dynamic consistent density calculations with 2-D forward geodynamic modelling including melt prediction and calibrate crustal and mantle densities that match the observed elevation difference. Our results can be used as a reference case for geodynamic modeling that accurately fits the relative elevation between continents and mid-ocean ridges consistent with geophysical observations and thermodynamic calculations.