Slabs in the mantle - dynamic topography and mantle rheology in the south-western pacific

Stuart R. Clark*
Simula Research Laboratory, Martin Linges v. 17, Snarøya 1367, Norway

Michael Gurnis

Seismological Laboratory, California Institute of Technology, Pasadena, California 91125

R. D. Müller

School of Geoscience, University of Sydney, NSW 2006, Australia

* corresponding author: stuart@simula.no

Keywords: Subduction, dynamic topography, mantle rheology, lithosphere

Abstract

The study of mantle convection has been strongly linked to the effect such convection has on the Earth's surface and vice versa. We have constructed a coupled plate kinematic/mantle convection model for the Southwest Pacific from the Vitiaz trench to New Zealand to evaluate the origin of Tertiary volcanics on Northland, New Zealand and the driving forces of anomalous subsidence of the Taranaki and South Fiji Basins.

The coupled mantle convection/plate kinematic model accurately constrains the location of slabs in the mantle implied by particular plate reconstructions. The veracity of the kinematic model is checked by

utilizing spherical shell overlays in the visualisation program 4DLM to compare the generated slabs in the mantle convection model with seismic anomalies.

The mantle rheological model – the viscosity contrast between upper and lower mantle and the strength of the clapeyron slopes at the transition zones - used also has an effect on the location of slabs in the mantle, as slabs are various deflected at the transition zone, held up for a time or move straight through. The rheological model affects the dynamic topography outcome and the mantle model can therefore be constrained with reference to data-derived anomalous depth, in particular in the South Fiji Basin.

Lastly, we test alternative plate reconstruction scenarios for the region, investigating the importance of the surmised Loyalty slab, and corresponding north or south dipping subduction zone close to North Island, on the dynamic topography in the Taranaki Basin.

We will demonstrate how the ability to visualise the virtual evolution of dynamic topography, plate boundaries and the mantle through time provides for an intuitive understanding of the time-dependent development of the system, while comparing the models with observables

enables the computer-simulations to constantly be referred back to the real earth.