Geophysical Research Abstracts, Vol. 9, 10776, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10776

Horizontal tectonic stress in lithosphere overlying subducting slab, dynamic topography and subduction mass balance

N.J. Kusznir (1), A. Kennedy (1), C. Izarra (2), S. Nippress (1) and S. Booth (1)

(1) Department of Earth and Ocean Sciences, University of Liverpool, Liverpool, L69 BX, UK, (2) Dpto. Ciencias de la Tierra, Universidad Simon Bolivar, Baruta, Edo. Miranda, Venezeula (n.kusznir@liverpool.ac.uk)

The relationships between subduction body force mass balance, dynamic topography and the horizontal tectonic stress within lithosphere overlying the subduction asthenosphere wedge have been investigated using finite element fluid-flow modelling of the subduction process. The dynamic force equilibrium associated with predicted subduction flow generates not only negative dynamic topography in the retroarc and ocean trench regions but also horizontal compression within lithosphere overlying the subducting slab. Measurements of the magnitude of retroarc subduction dynamic topography give upper bounds (air-loaded) ranging from 900 m at 500 km from the trench to 250 m at 1500 km from the trench. Finite-element models of subduction driven mantle flow show that both the magnitude and wavelength of surface retroarc dynamic topography and stresses within lithosphere overlying the subducted slab are highly sensitive to upper and lower mantle viscosity structure. Finite element modelling predicts that the observed amplitude and wavelength of subduction retroarc dynamic topography requires a layered mantle viscosity in which the viscosity rises by approximately two orders of magnitude across the 410 and 660 km phase transitions. A comparison of this observed mantle residual gravity anomaly of the Central Andes with that predicted by thermal models of the subducted Nazca plate under the Central Andes shows that the modelled gravity anomaly from the subduction process appears to be substantially greater than that observed by approximately 125 mgal. Finite-element models of subduction mantle flow predict a dynamic subsidence at the base of the Central Andean crust that deviates the crust from local isostasy by as much as 6-10 km and 4-6 km in the Eastern and Western Cordilleras respectively. The inclusion of this dynamic

subsidence in the determination of the observed residual gravity anomaly greatly improves the fit between observed and predicted mantle residual gravity anomalies from the mantle over the Central Andes. This suggests that dynamic topography and the depression of the Moho beneath subduction orogens may be important in compensating part of the mass excess arising from the cold subducting slab. Finite element modelling shows that horizontal tectonic forces and dynamic topography within lithosphere overlying the subducting slab are closely related. The magnitude of horizontal compressive tectonic force within the subduction orogen lithosphere overlying the subducting slab is predicted by finite element modelling of subduction flow to be of the order of 10**12 N/m. An increase in subduction rate and body force mass excess within the subducting slab is predicted to increase both the magnitude of subduction dynamic topography and horizontal tectonic force within the overlying lithosphere.