

# Mantle flow and crustal dynamics in southern California and the Pacific Northwest

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We calculate the small-scale convective flow of the southern California upper mantle and its influence on the dynamics and deformation of the overlying crust. Three dimensional anomalous upper mantle density structure, derived from shear wave tomography, is used to drive three dimensional viscous flow using the CIG finite element code GALE. Figure 1 shows the resulting stresses on the base of the crust caused by

flow of the underlying upper mantle. Regions overlying anomalously fast/dense upper mantle, such as in the Transverse Ranges and southern Great Valley (The Transverse Ranges and Sierra Nevada “drips”), are being compressed by mantle tractions (convergent vectors in Fig. 1) and regions overlying slow/buoyant upper mantle, such as the Salton Trough and southern Walker Lane Belt, are being extended (divergent vectors) by mantle tractions. We find a strong correlation between contemporary surface deformation (in particular dilatation) and crustal deformation predicted by the model suggesting these mantle tractions contribute significantly to the sum of forces deforming the southern California crust.

Reference: Fay, N. P., R. A. Bennett, J. Spinler, and E. D. Humphreys (2008), Small-Scale Upper Mantle Convection and Crustal Dynamics in Southern California, *Geochem., Geophys., Geosys.*, 9, Q08006, doi:10.1029/GC001988.

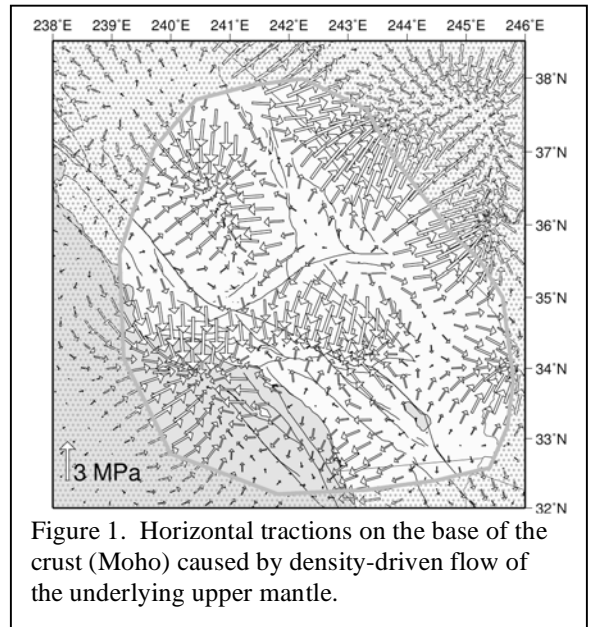


Figure 1. Horizontal tractions on the base of the crust (Moho) caused by density-driven flow of the underlying upper mantle.

Recent seismic tomography models suggest the Juan de Fuca (JdF) slab beneath the Pacific Northwest may contain a hole or tear, or otherwise be discontinuous. We use the CIG code GALE to estimate how variations in JdF slab structure influence the mantle flow it induces during subduction. The subduction and rollback of a continuous and finite-length slab (Fig. 2a) excites a strong counterclockwise toroidal flow around the edge of the slab. A

discontinuous slab (Fig. 2b) also excites a toroidal flow in addition to a flow through the ‘slab gap’ with a significant component of upwelling. Although speculative, this vertical mantle flow and associated decompression melting, and its progression through time as the slab subducts and possibly rolls back (to the west), may provide an explanation for the westward-migrating anomalous volcanism now located at Newberry caldera.

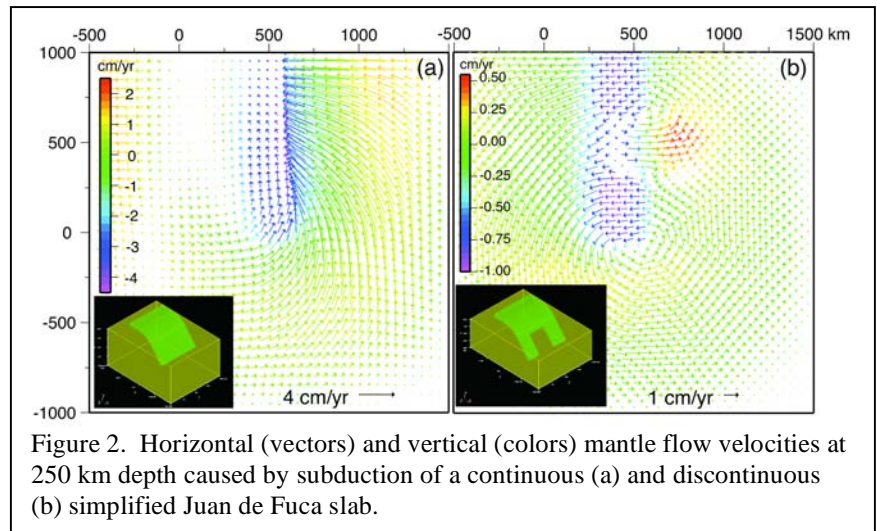


Figure 2. Horizontal (vectors) and vertical (colors) mantle flow velocities at 250 km depth caused by subduction of a continuous (a) and discontinuous (b) simplified Juan de Fuca slab.