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Geodynamics of the Gulf of California from surface wave tomography

Xiaomei Zhang (1) and Hanneke Paulssen (2)

(1) TNO Built Environment and Geosciences, Utrecht, The Netherlands (mei.zhang@tno.nl), (2) Dept of Geophysics, Utrecht University, Utrecht, The Netherlands (paulssen@geo.uu.nl)

The Gulf of California is a tectonically young and active rift system that links the East Pacific Rise to the San Andreas transform fault. Its formation is associated with the cessation of subduction of the Farallon plate beneath the North American continent which occurred approximately 12 Myr ago at the latitudes of central Baja California. We used data from the NARS-Baja project (2002-2008) and other seismic networks to measure Rayleigh- and Love-wave dispersion along interstation paths across and around the Gulf of California to obtain a detailed 3-D model of the crustal and upper mantle shear-velocity structure. We computed anisotropic phase velocity maps and inverted these for shear-velocity structure. Our most important result is the finding of a relatively high shear-velocity anomaly in the mantle beneath the central part of the Gulf of California that is interpreted as a remnant of the subducted (Farallon-derived) Guadalupe slab. The absence of such a slab remnant beneath the northern part of the gulf is in agreement with the presence of a 'slab window' as suggested from the tectonic evolution of the area. The patterns of azimuthal and radial anisotropy point to differences in mantle flow between the slabless region and the region with the slab remnant. It is inferred that the presence of a slab remnant beneath the central gulf can account for the different styles of rifting along the Gulf of California as well as for the variability of the magmatism (<12 Ma) in central Baja California. Changes in radial anisotropy at uppermost mantle depths (40-60 km) likely reflect variations in mantle flow between the northern 'slabless' region (with Vsv > Vsh) and the central gulf area (with Vsh > Vsv) where the slab remnant is present at larger depths.