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Relation between the upper mantle seismic, thermal and compositional structure in the Gulf of California

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The San Andreas fault system and the Gulf of California (GofC) mark the plate boundary between the North American and Pacific plates. It is a complex zone that changes character from transform faulting in southern California, to rifting in the north and middle parts of the Gulf, to seafloor spreading at the mouth of the Gulf. The tectonic complexity of the region is associated with past subduction of Farallon microplates.

Understanding of the tectonic evolution of this region has been pursued by geoscientists from varies disciplines. Whereas the region of southern California is well studied, the upper mantle structure beneath the GofC was still largely unknown. The seismic data recorded by NARS-Baja seismic network (deployed around the Gulf since 2002) allowed us to image the upper mantle in detail. Phase velocity dispersion curves of fundamental mode Rayleigh waves were measured for station pairs of 58 broadband stations from seismic networks around the GofC, southern California, Arizona, New Mexico and Texas. The inferred phase velocity maps were inverted for a 3D shear velocity model of the GofC and its surroundings.

Some notable features of this model are: (1) Crustal thickness variations indicative of crustal thinning within the Gulf Extensional Province; (2) An upper mantle low-velocity anomaly that can be associated with asthenospheric upwelling in the region of a proposed slab window; (3) A relatively high-velocity anomaly in the upper mantle beneath the Gulf that is interpreted as a Farallon microplate remnant.

The observed variation in styles of rifting in the GofC (Lizarralde et al., 2007;

González-Fernández et al., 2005) can be well explained by thermal anomalies inferred from our mantle model. We propose that the slab remnant beneath the Gulf influenced the upwelling from the deeper mantle, causing a wide rift above the slab remnant, whereas narrow rifts are found above the slab window and at the East Pacific Rise. Furthermore, we show that our upper mantle structure with its inferred tectonic interpretation explains the geochemical diversity of magmas emplaced between 13 and 7 Ma along Baja California, revealed by 40K - 40Ar dating and petrologic data (Pallares et al., 2007).