

Localized shear in the deep lithosphere beneath the San Andreas fault system

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The extent and geometry of strike-slip plate boundaries in the deep mantle lithosphere is an important, yet unresolved, aspect of plate tectonics. Models range from localized shear zones that are deep extensions of individual crustal faults, to broad zones of diffuse, distributed shear with widths of hundreds of kilometers. Here we use Sp receiver functions to calculate the depth and strength of the velocity gradient of the lithosphere-asthenosphere boundary (LAB) across the San Andreas fault system.

Using broadband data from permanent stations, including the Southern and Northern California Seismic Networks, the EarthScope Transportable Array, and numerous temporary deployments, we calculated ~115,000 Sp receiver functions and stacked them using a common conversion point approach. A clear Sp phase interpreted to be the LAB, based on comparison to surface wave tomography, is observed at 45 to 120 km depth. Generally, the depth varies gradually, with a few exceptions where rapid lateral variations can occur over distances of 25-50 kilometers (see **Fig. 1**).

The amplitudes of the Sp conversions indicate a systematically smaller shear-wave (vertical) velocity gradient across the LAB on the western side of the plate boundary than to its east (see **Fig. 1**). The change in shear-wave velocity gradient typically occurs over a horizontal length scale of less than 50 km. This result is best explained by the juxtaposition of mantle lithospheres with different properties across the plate boundary. The spatial correlation between the surface expression of the plate boundary and the laterally abrupt change in LAB properties points to the accommodation of relative plate motion on a narrow shear zone that extends throughout the entire thickness of the lithosphere (see **Fig. 2**).

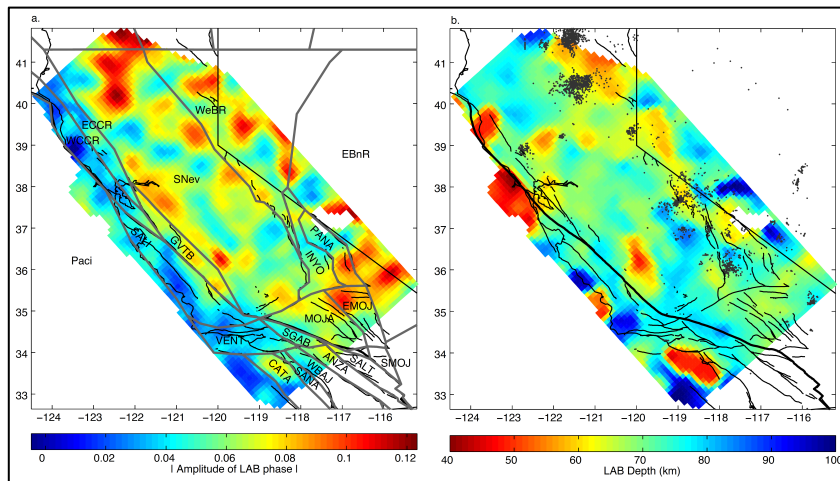


Fig. 1 (a) Map of LAB phase amplitude strength. Grey lines outline crustal blocks defined by faults and plate motion. Amplitudes are lower beneath crustal blocks translating close to Pacific Plate motion, relative to blocks translating close to North American Plate motion (see **Fig. 2**). (b) Map view of LAB depth. Dots show volcanism from the past 3 Ma.

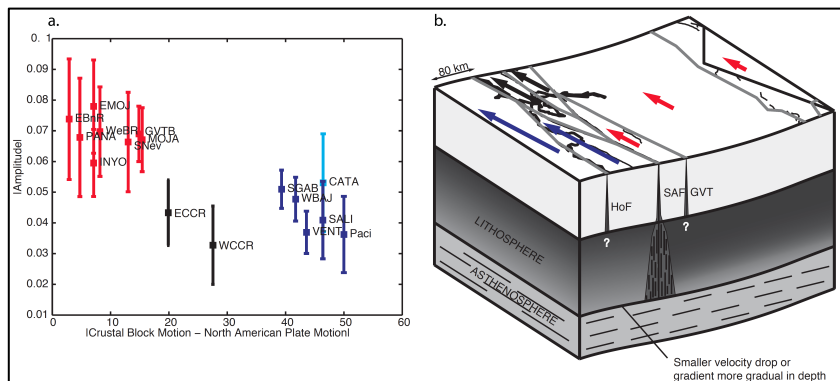


Fig. 2 (a) Mean LAB phase amplitude in each crustal block as a function of block velocity relative to North America and (b) Schematic view of deformation in the lithosphere beneath the San Andreas fault system. Faults in foreground are the San Andreas Fault (SAF), the Hosgri Fault (HoF) and the Great Valley Thrust (GVT).