Tectonic corridors of the northern San Andreas plate boundary system: Developing a new framework crustal deformation modelt

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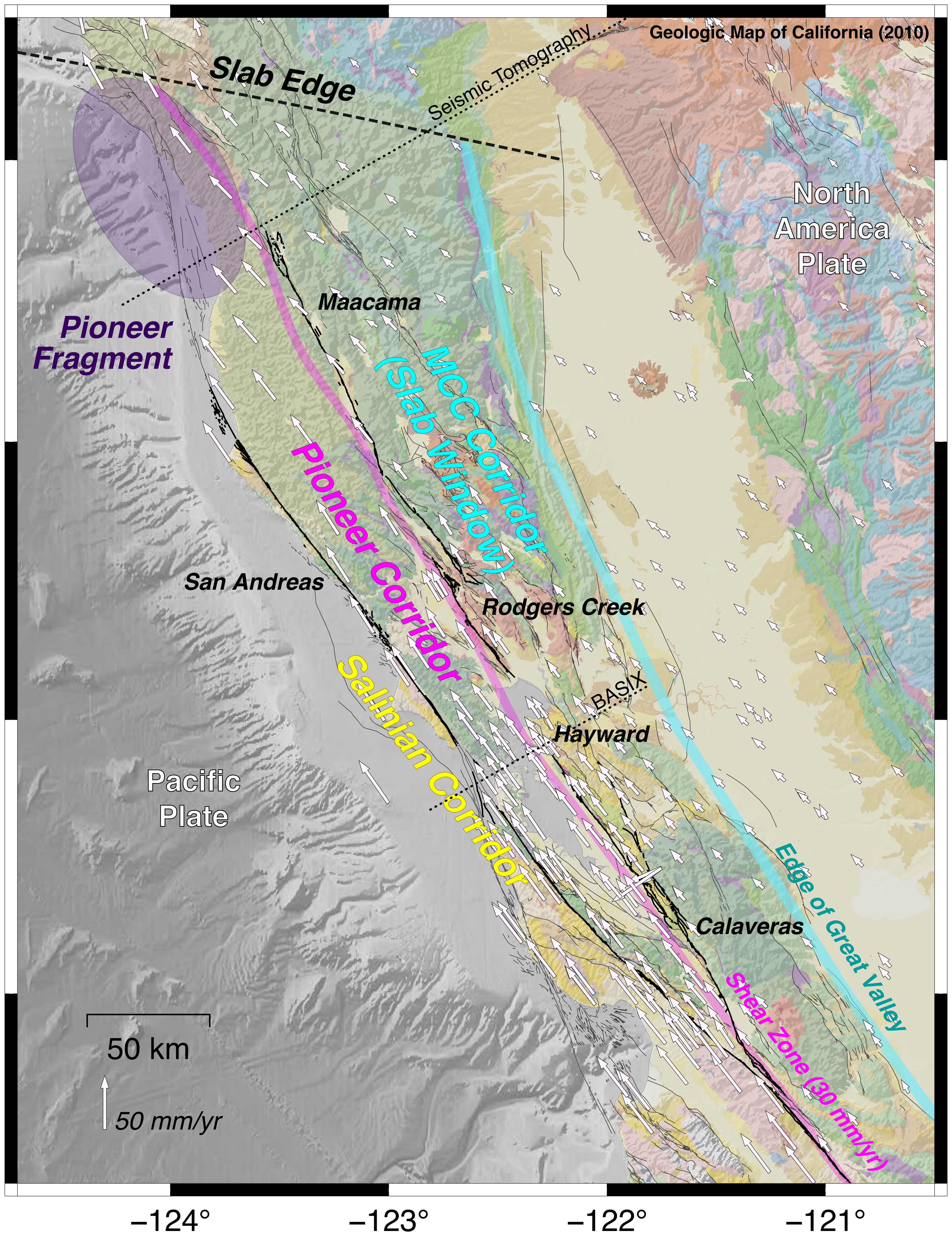
Observational Constraints on Tectonic Corridors

*A dense GNSS network shows interseismic velocities decreasing from 50 mm/yr in the Pacific plate to 10 mm/yr in the Great Valley. The line of symmetry (30 mm/yr) defines the location of the lithospheric-scale plate boundary shear zone. From the Bay Area to the Mendocino triple junction, this lies under the Maacama, Rodgers Creek, Calaveras, and Hayward (**MaRCH**) faults, not the **San Andreas** fault.*

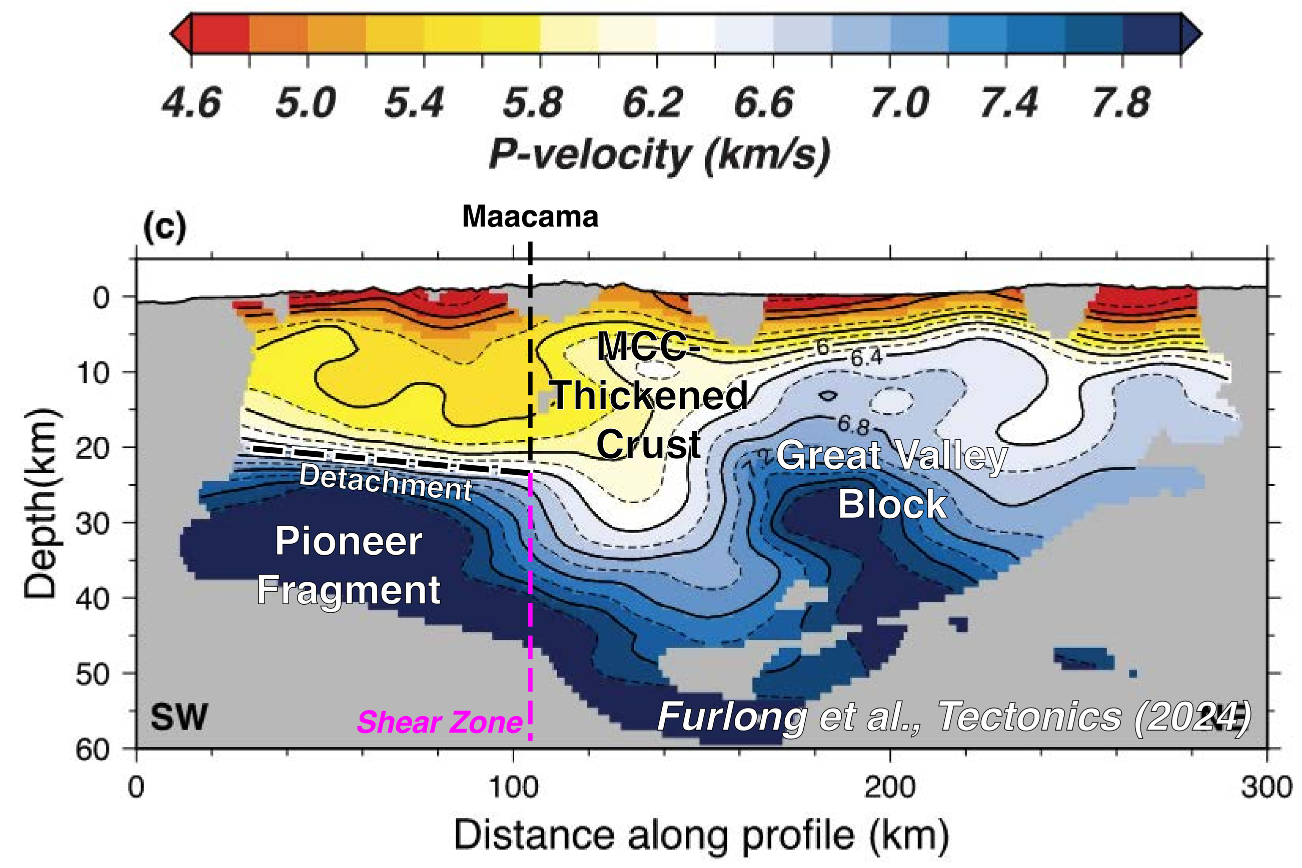
*The **Salinian Corridor** lies west of the San Andreas fault. The Salinian terrane (similar to the Sierra Nevada) has been transported from the east to behind the **Pioneer Fragment** and thrust over the Pacific plate as it travels north. The terrane boundary between the Salinian and Franciscan defines the **San Andreas** fault. The Salinian terrane ends at ~39.4°N (the southern end of the Pioneer Fragment), as does the San Andreas fault.*

*The **Pioneer Corridor** lies between the **San Andreas** fault and the plate boundary shear zone. This Franciscan crust has experienced the passage of the **Pioneer Fragment**, and is now underlain by asthenosphere that filled in the wake of the Pioneer fragment. In this corridor, a horizontal detachment connecting the base of the **San Andreas** fault to the plate boundary shear zone separates shallow North American crust from deeper mafic material.*

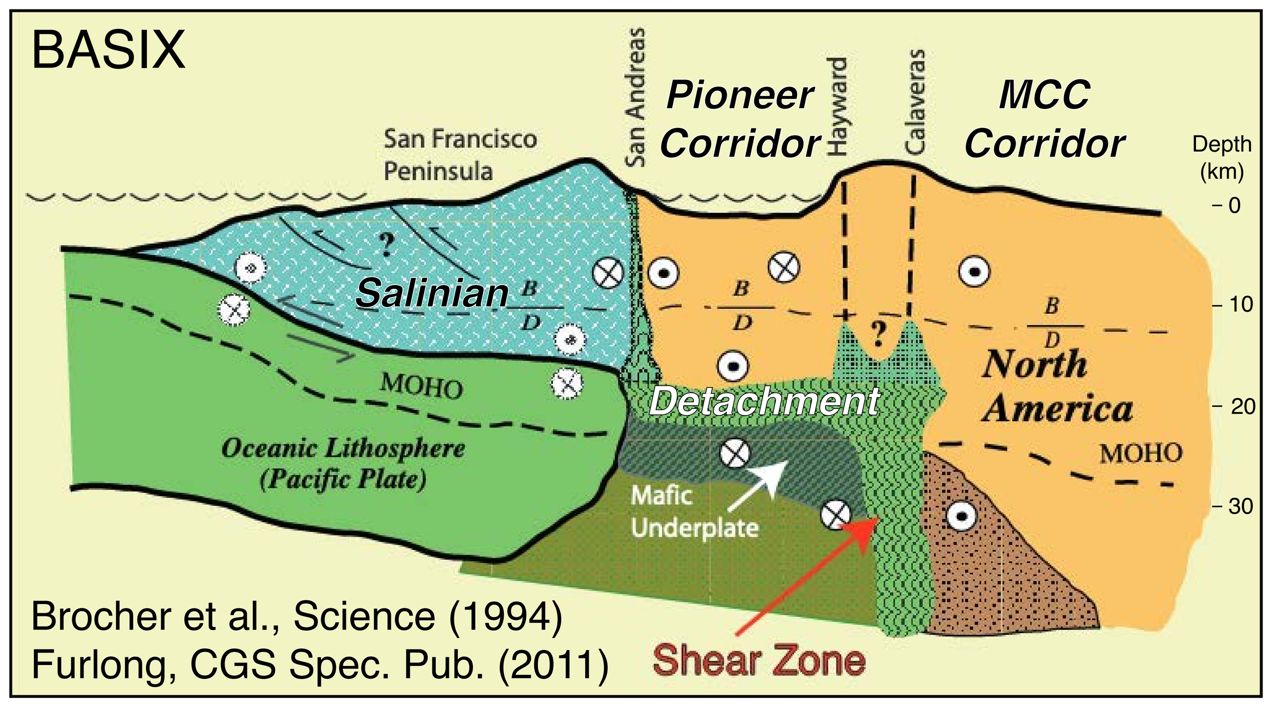
*The **Mendocino Crustal Conveyor (MCC) Corridor** lies between the lithospheric-scale shear zone and the western edge of the rigid Great Valley province. This corridor is where slab window effects dominantly occur, including the transient thickening and thinning of the MCC (Furlong and Govers, 1999) as the edge of the Juan de Fuca pulls slab window asthenosphere to the north.*



*The **Pioneer Fragment** is a remnant of the Farallon slab that got captured by the Pacific plate when the Mendocino triple junction first formed. It can be seen in new seismic tomography images across the northern end of the San Andreas plate boundary system, implying that it has traveled with the Pacific plate underneath North American crust along a shallowly dipping detachment.*

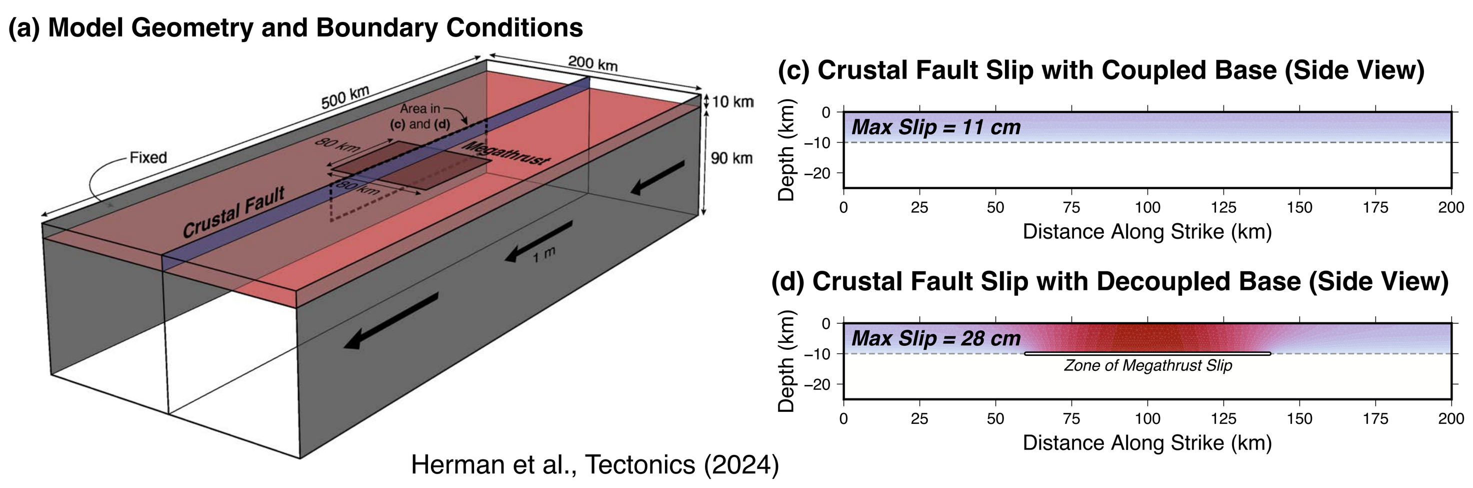


*Seismic reflection imaging done in the Bay Area Seismic Experiment (**BASIX**) shows the Salinian terrane thrust over Pacific oceanic crust, asthenospheric material under Franciscan crust in the **Pioneer Corridor**, and the lithospheric-scale shear zone. A sub-horizontal detachment connects the base of the San Andreas fault to the shear zone.*

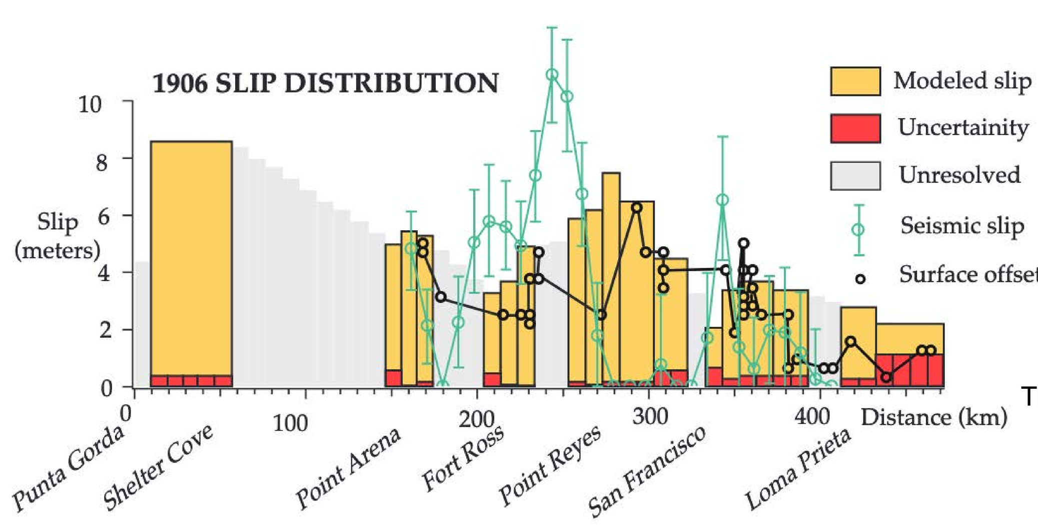


Enhancing Coseismic Slip in the 1906 Earthquake

One of the surprising observations from the 1906 San Andreas earthquake is that the maximum fault offsets occurred at the northern end of the rupture. This is a region where (a) there is no San Andreas fault, and (b) a detachment divides the top of the Pioneer Fragment from the Franciscan crust. If this detachment slips coseismically, our models indicate it could enhance slip on crustal faults above it.

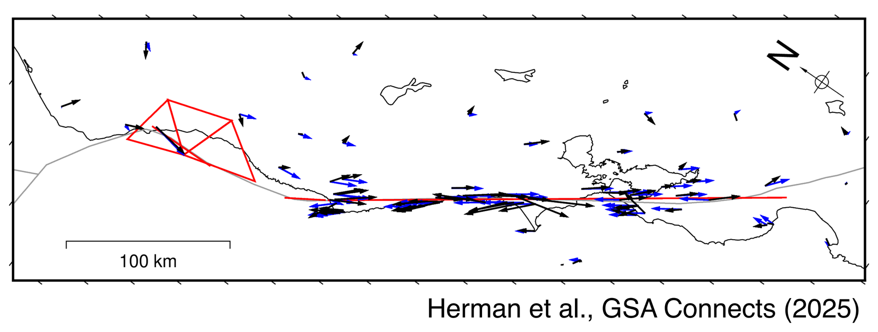


Herman et al., Tectonics (2024)



Lawson (1908)
Wald et al. (1993)
Thatcher et al. (1997)
Zoback (2006)
Song et al. (2008)

Slip on this detachment is also compatible with coseismic geodetic observations from the earthquake.



Herman et al., GSA Connects (2025)

Is the Pioneer Corridor Detachment Seismogenic?

The sub-horizontal detachment in the Pioneer Corridor sits at a depth near the brittle-ductile transition. Its could potentially participate in earthquakes occurring on the faults near the pioneer corridor. Our SCEC-funded project focuses on modeling earthquake scenarios within this system.

We have developed preliminary 2.5-dimensional (out-of-plane) models to show the effects of different co-seismic faulting scenarios. The MaRCH faults behave like a typical transform fault system, with symmetric slip. The involvement of the detachment as a weak, passive participant in a San Andreas earthquake tends to concentrate displacements in the Pioneer Corridor. Finally, if the detachment is seismogenic, the magnitude of displacements throughout the Pioneer Corridor is increased even further.