Mini-Proposals of PBO: Comparison of Deformation Profiles Across Faults With and Without Recent Large Earthquakes

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Geodetic results in California admit two quite different interpretations. In one, the deformation results largely from faults locked near the surface but slipping below about 15 km, as proposed by Savage, Prescott, and many others. In this model the width of deformation is controlled by the geographical distribution and locking depth of the faults. In the other model, faults are fully locked between earthquakes, and visco-elastic deformation in the deep crust controls surface strain. According to this model each earthquake causes a basal shear stress at the bottom of the brittle zone, and the basal shear relaxes over a rather long time. In this model, the ongoing plate boundary deformation is the summed post-seismic effects of many past earthquakes. The second model helps to explain why the deformation field is so broad in southern California and across the San Francisco bay. It also requires that the postseismic effects persist for a long time (decades or centuries). Resolving this ambiguity in interpretation is very important for earthquake studies, as the implications for stress transfer and earthquake triggering are important. If we are to infer long term slip rates for individual faults, we must separate transient effects from steady state ones. The two models above are end members, the first assuming 100% steady state, the second assuming 100% transient.

One feature which might distinguish these models is a comparison of geodetic and geologic slip rates across reasonably well isolated faults having special conditions. Faults with relatively rapid slip rates and no historic large earthquakes should have comparable geologic and geodetic slip rates under the first hypothesis, but they should have lower geodetic slip rates under the second hypothesis, because they lack recent earthquakes to stimulate the lower crustal relaxation. Slow faults with recent earthquakes should have nearly equal geodetic and geologic slip rates under the first hypothesis, but faster geodetic slip under the second hypothesis.

A. Landers (slow, recent quake 1992)
B. Owens Valley, slow, recent quake 1872
C. Garlock, (fast, no recent quake)
D. White Wolf (slow, recent quake; a profile crossing the White Wolf and Garlock may be able to answer both C and D, and it may also help in the western Mojave proposal by Shen and Jackson.
E. Northern Hayward or other fault with substantial geologic slip rate but no known earthquake.