Can deformation rates across the Carrizo Plain segment of the San Andreas Fault be explained by vertical migration of the locked-to-creeping transition?

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Most geodetic inversions of surface deformation rates consider the depth distribution of interseismic fault slip-rate to be time invariant. However, some numerical simulations show down-dip penetration of dynamic rupture into regions with velocity-strengthening friction, with subsequent up-dip propagation of the locked-to-creeping transition. These models are particularly attractive to investigate the discrepancy between geodetically- and seismically-derived locking depths.

Recently, Bruhat & Segall (GJI, 2017) developed a new method to characterize interseismic slip rates, that allows slip to penetrate up dip into the locked region. This simple model considers deep interseismic slip as a crack loaded at constant slip rate at the down-dip end. It provides analytical expressions for stress drop within the crack, slip, and slip rate along the fault. These expressions make use of an expansion of the slip distribution in Chebyshev polynomials, with a constraint that the crack-tip stress be non-singular. The simplicity of the method enables Monte Carlo inversions for physical characteristics of the fault interface, establishing a first step to bridge purely kinematic inversions to physics-based numerical simulations of earthquake cycles.

This study extends this new class of solution to strike-slip fault environment. Unlike Bruhat & Segall (2017) which considered creep propagation in a fully elastic medium, we include here the long-term deformation due to viscoelastic flow in the lower crust and upper mantle. The surface predictions greatly change when including potential viscoelastic deformation and cumulative effect of previous earthquake cycles. We employ this model to investigate the long-term rates along the Carrizo Plain section of the San Andreas fault. This study reviews possible models, elastic and viscoelastic, for fitting horizontal surface rates. We improve the model presented in Bruhat & Segall (2017) to account for the coupling between creep and viscoelastic flow. Using this updated approach, we show that surface rates across the Carrizo Plain section of the San Andreas fault might be explained by slow vertical propagation of deep interseismic creep.

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