# MECHANICAL DEFORMATION MODEL OF THE WESTERN UNITED STATES INSTANTANEOUS STRAIN-RATE FIELD

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We present a relationship between the long-term fault slip rates and instantaneous velocities as measured by Global Positioning System (GPS) or other geodetic measurements over a short time span. The main elements are the secularly increasing forces imposed by the bounding Pacific and Juan de Fuca plates on the North American plate, viscoelastic relaxation following selected large earthquakes occurring on faults that are locked during their respective interseismic periods, and steady slip along creeping portions of faults in the context of a thin-plate system. In detail, the physical model allows separate treatments of faults with known geometry and slip history, faults with incomplete characterization (i.e., fault geometry but not necessarily slip history is available), creeping faults, and dislocation sources distributed between the faults. We model the western United States strain-rate field, derived from 746 GPS velocity vectors, in order to test the importance of the relaxation from historic events and characterize the tectonic forces imposed by the bounding Pacific and Juan de Fuca plates. Relaxation following major earthquakes (M & 8.0) strongly shapes the present strain rate field over most of the plate boundary zone. Equally important are lateral shear transmitted across the Pacific - North America plate boundary along _ 1000 km of the continental shelf, downdip forces distributed along the Cascadia subduction interface, and distributed slip in the lower lithosphere. Post-earthquake relaxation and tectonic forcing, combined with distributed deep slip, constructively interfere near the western margin of the plate boundary zone, producing locally large strain accumulation along the San Andreas fault (SAF) system. However, they destructively interfere further into the plate interior, resulting in smaller and more variable strain accumulation patterns in the eastern part of the plate boundary zone. Much of the right-lateral strain accumulation along the SAF system is systematically underpredicted by models which account only for relaxation from known large earthquakes. This strongly suggests that in addition to viscoelastic-cycle e_ects, steady deep slip in the lower lithosphere is needed to explain the observed strain-rate field.