**Three-Dimensional Fault Topology in the Ventura Basin, California, and a new technique for Creating Three-Dimensional Interseismic Mechanical Models in Complex Regions.**

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Geodetic data from the Southern California Integrated Geodetic Network (SCIGN) provides information on interseismic deformation patterns in the Ventura Basin, which can be compared to results from three-dimensional mechanical models. This comparison may determine the most realistic among differing three-dimensional active fault configurations and predict slip rates for unconstrained faults. Although the Ventura basin is one of the fastest converging areas within southern California, geodetic signals are complicated by seasonal fluid injection/withdrawal. We use geodetic data that has been corrected for seasonal and anthropomorphic effects for comparison to a set of three-dimensional mechanical models. For our models, we use three-dimensional triangulated fault surfaces defined by the Community Fault Model (CFM) for the Ventura Basin. Fault surfaces from the CFM have been modified to extend below the seismogenic portion of the crust (depth < 18 km) to a 27 km deep freely-slipping horizontal crack representing the Mohorovic Discontinuity. We establish a set of Boundary Element Method (BEM) models with 171˚ remote contraction determined from relative displacement of distal SCIGN stations. For each set of tectonic boundary conditions, we calculate fault slip rates over a simulated period of 5000 years, which should exceed the recurrence intervals for all faults. For validation of the three-dimensional model and tectonic boundary conditions, fault slip rates and rakes are calculated and are compared to available paleoseismic rates. Our results suggest that model-calculated dip-slip rates are generally within the range of published paleoseismic rates for the tectonic boundary conditions tested. We simulate interseismic deformation by locking all fault surfaces above 5 km depth and prescribing the slip rates from the best-fitting geologic slip model to the portions of fault surfaces that fall below the 5 km seismogenic locking depth. Model surface velocities are then compared to geodetic data. We observe that the modeled interseismic deformation patterns resemble that of the geodetic data. Furthermore, we assess the sensitivity of fault slip rates and surface velocities to amplitude of fault surface topology by comparison to a model with simple planar faults. Analysis of these two models indicates that average slip rates and rakes do not significantly change in a planar model; however, many localized aspects of slip rates and sense are much better explained by a model with more realistic fault topology. We observe that in our topology model, numerous individual faults have both left- and right-lateral slip at different along-strike locations. This indicates that paleoseismic trench sites and structural cross sections could possibly occur in non-representative locations. Our models can therefore be used to help correct for non-ideal location selection along a given fault trace as well as help guide in the location of future sites.