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Sources of the San Andreas Fault Stress Field – Insights from 3D numerical Models

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The crustal stress field is the result of plate boundary forces, gravitational potential energy differences oΔGPE) and basal shear tractions. The Pacific-North American plate boundary including the San Andreas Fault (SAF) represents an interesting example for studying the interaction of various contributions to the 3D crustal state of stress. Using 3D finite element analysis we focus on how ΔGPE related to topography, plate boundary forces and fault geometries influence the 3D crustal state of stress.

In our modeling study we exposed a gravitationally pre-stressed model volume to Pacific Plate motion. Our results focus on the resulting tectonic regimes and the orientation of the maximum horizontal stress component S_H.

We find that the 3D crustal state of stress in California is strongly dependent on the present topography. The modeling results suggest that ΔGPE define provinces of different tectonic regimes which are further developed by Pacific Plate motion. In particular, we find that the SAF near fault stress field is dominated by the present-day topography generating fault normal compression and S_H orientations at high angles to the fault. The SAF, however, has a strong impact on the regional stress field, where distinct S_H orientations of NNE-SSW are established in the ECSZ and the Basin and Range.

Another major contribution to the state of stress is the geometry of the SAF Big Bend segment which results in relatively increased horizontal stresses in the Mojave Block and a transfer of strike-slip tectonics into the Eastern California Shear Zone to accommodate a part of the relative plate motion.

In our study we have shown that ΔGPE, plate motion and fault geometry play an important role in generating the crustal state of stress in California.