2017 SCEC Proposal FINAL REPORT

Detailed characterization of stress parameters in the San Jacinto Fault Zone region from earthquake focal mechanisms

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***Proposal Categories*:**

Integration and Theory

SCEC Research Priorities:

P1.c, P1.d, P1.e

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Summary

The studies performed in this project provided high-resolution information on spatio-temporal variations of background stress field and coseismic strain release in the Jacinto fault zone (SJFZ) region. The study employed a refined inversion methodology and declustered focal mechanisms of background seismicity. Stress inversions applied to the entire fault zone, and 3 focus areas with high level of seismicity, provide 3D distributions of the maximum horizontal compression direction (S_{Hmax}), principal stress plunges and stress ratio $R = (\sigma_1 - \sigma_2)/(\sigma_1 - \sigma_3)$. The results are compared with coseismic strain parameters derived from direct summation of earthquake potencies and *b*-values of frequency-size event statistics. As expected, the main stress regime of the SJFZ is shown to be strike-slip, although the northwest portion near Crafton Hills displays significant transtension. The S_{Hmax} orientation rotates clockwise with increasing depth, with the largest rotation (23 degrees) observed near Crafton Hills. The principal stress plunges have large rotations below ~9 km, near the depth section with highest seismicity rates and inferred brittle-ductile transition zone. The rotations produce significant deviations from Andersonian theory for strike-slip faulting, likely generating observed increased dip-slip faulting of relatively deep small events. The stress ratio parameters and *b*-value results are consistent with increasing number of dip-slip faulting below ~9 km. The derived coseismic strain parameters are in good agreement with the stress inversion results. No large-scale stress rotations are observed across the time of the 2010 Mw 7.2 El Mayor-Cucapah earthquake. The stress ratio near the Trifurcation area of the SJFZ changes after the El Mayor-Cucapah earthquake toward transpression, but this may have been produced by a local M > 5.4 event.

Intellectual Merit

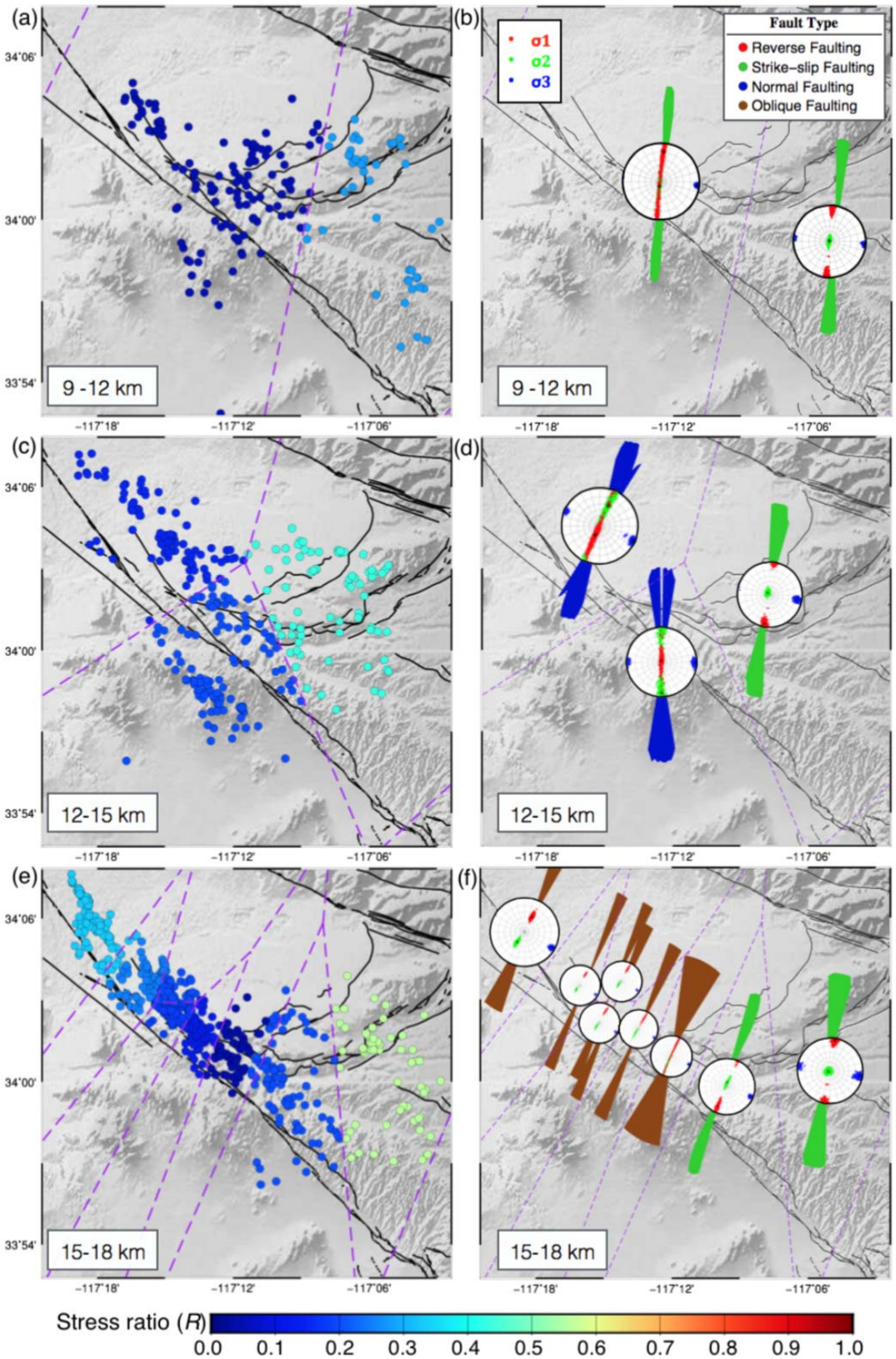
The preformed analyses provide improved constraints on the brittle-ductile transition depth in the analyzed sections of the SJFZ. In all regions, the brittle crust extends down to 9-12 km and the seismicity in that depth section displays mainly strike-slip events. A change towards dip-slip is observed through the brittle-ductile transition zone to 15-18 km. This depth appears to be shallower at the TR than at the other two regions. The angle between S_{Hmax} and the fault trace at the surface appears to increase especially at the depth interval of the inferred brittle-ductile transition depths (10-17 km). This may indicate a progressive weakening of the fault with depth and may also reflect partial change of main fault dip in the region. The distribution of stress and coseismic strain parameters appear to be largely consistent. This provides some validation of the stress inversion results with the direct input data and indicates that the velocity structure is on average approximately isotropic.

Broader impact

The results are relevant to broad issues of crustal and fault dynamics in the southern San Andreas system. The project supported directly a PhD student and contributed to the education of a postdoctoral fellow. The techniques developed in the project may be used to derive high resolution results on spatio-temporal variations of background stress field and coseismic strain in other regions.

Publications supported by the project

Abolfathian, N., Martínez-Garzón P. and Y. Ben-Zion, 2018. Spatio-temporal variations of stress and strain parameters in the San Jacinto fault zone, *Pure and Applied Geophysics*, in review.



Variations of SH max directions, faulting types and stress ratio R with depth in the Crafton Hills region of the San Jacinto fault zone near Riverside. From Abolfathian et al. (2018).