2018 SCEC Proposal FINAL REPORT

Detailed characterization of stress and strain parameters around the San Jacinto Fault Zone and Cajon Pass 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 provide high-resolution spatial variations of the stress patterns in South Central Transverse Ranges (SCTR) in southern California in relation to topography and the fault system in the area. The analysis is based on a refined stress inversion methodology employing a declustered focal mechanism catalog for the years 1981-2017. The stress inversion provides the orientation of the three principal stress axis, used to derive the maximum horizontal compressive stress direction (S_{Hmax}) and the stress ratio parameter $R=(\sigma_1-\sigma_2)/(\sigma_1-\sigma_3)$. The obtained spatial distribution of stress parameters is generally in agreement with the tectonic setting, showing strike-slip faulting type. The S_{Hmax} orientation is generally to the north with some variations toward NEN in the eastern and western sections of the SCTR. The S_{Hmax} orientation shows a significant clockwise rotation of about ~23º with depth near the Crafton Hills (CH). Over regional scale, the stress ratios *R* vary from transtensional stress regime in the east towards transpressional in the west. Sharp changes of *R* are observed near CH with significant transtensional components, and near Cajon Pass and San Gorgonio Pass with transpressional components. The stress patterns estimated from aftershocks amplify the sharp changes in stress ratios relative to those seen with the background seismicity. The seismicity distribution suggests significant variations of seismogenic depth in the region between the San Andreas Fault (SAF) and San Jacinto Fault (SJF). Initial results from separate analyses of focal mechanisms in sub-regions with different seismogenic thicknesses indicate changes of stress patterns between the eastern part of the SAF, the western part of the SJF, and the region between them, where the stress pattern no longer follows the regional stress variations.

Intellectual Merit

The preformed analyses reveal variations of stress parameters in different sections of the San Andrea fault, San Jacinto fault, and the region between them. The observed correlations of stress parameters with topographic variations can provide together with numerical modeling important constraints on absolute and relative stress levels at different locations. The observed variations of S_{Hmax} orientation near the Crafton Hills may indicate a progressive weakening of the fault with depth and/or aseismic creep at depth in that region. The different results obtained with analyses

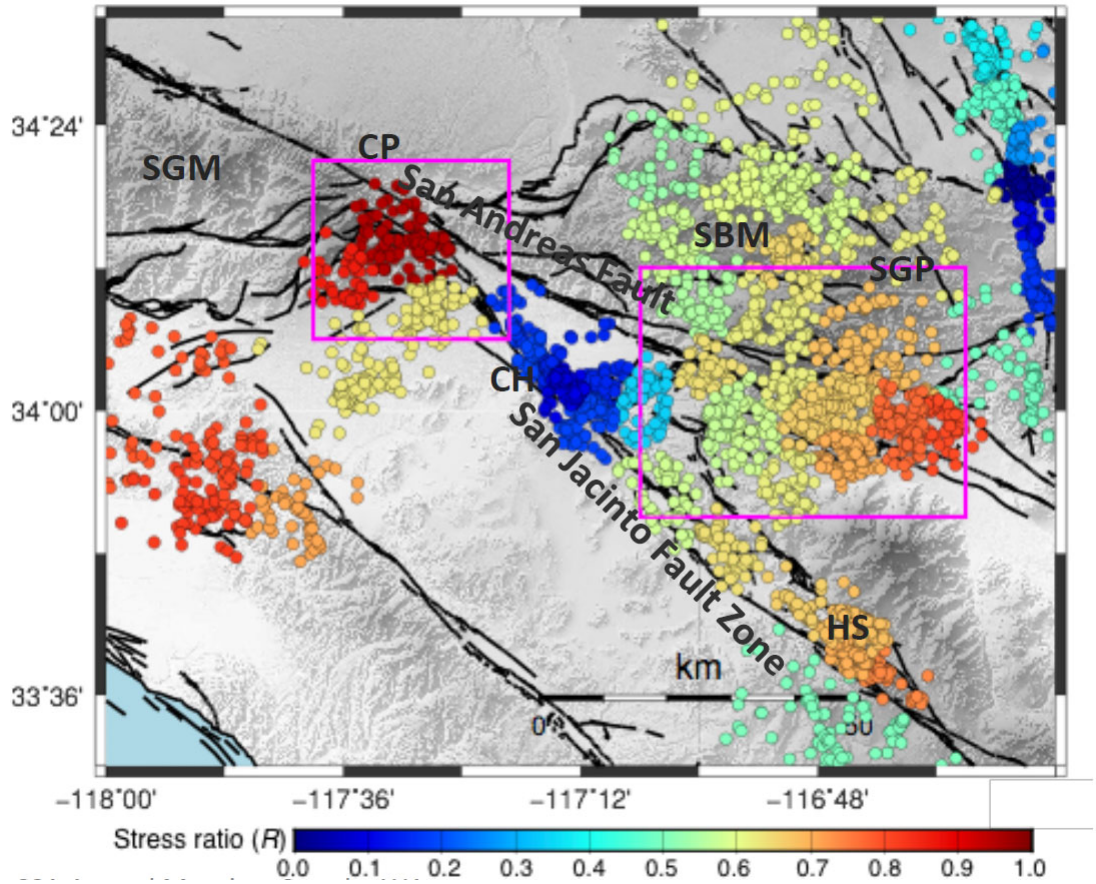
using the decluttered and entire catalogs have implications on the interpretation of results obtained by typical stress inversions using entire catalogs.

Broader impact

The results are relevant to broad issues of crustal and fault dynamics in the complex region of the southern San Andreas system near Cajon Pass. The project supported directly a female PhD student and contributed to the education of a young female researcher. The techniques developed in the project may be used to derive high resolution results on 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, 2019. Spatial variations of stress patterns near the South Central Transverse Ranges in Southern California, *Annual meeting of the Seismolo. Soc. of America* (also ms. in preparation).



Variations of stress ratio R parameter in the southern San Andreas fault system near Cajon Pass. The results show changes toward transpressional stress regime in regions with high topography, sharp changes near Cajon Pass, and transtensional regime in the region between the SAF and SJF. From Abolfathian et al. (2019).