Southern California M 6.4 earthquake stressed by two large historic ruptures

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Ross S. Stein, Ph.D., and **Volkan Sevilgen**, M.Sc., Temblor, Inc.

The site of the 4th of July shock was stressed by the great 1872 Owens Valley quake and the 1992 Landers quake. Their overlapping stress lobes may have raised the stakes for this region.

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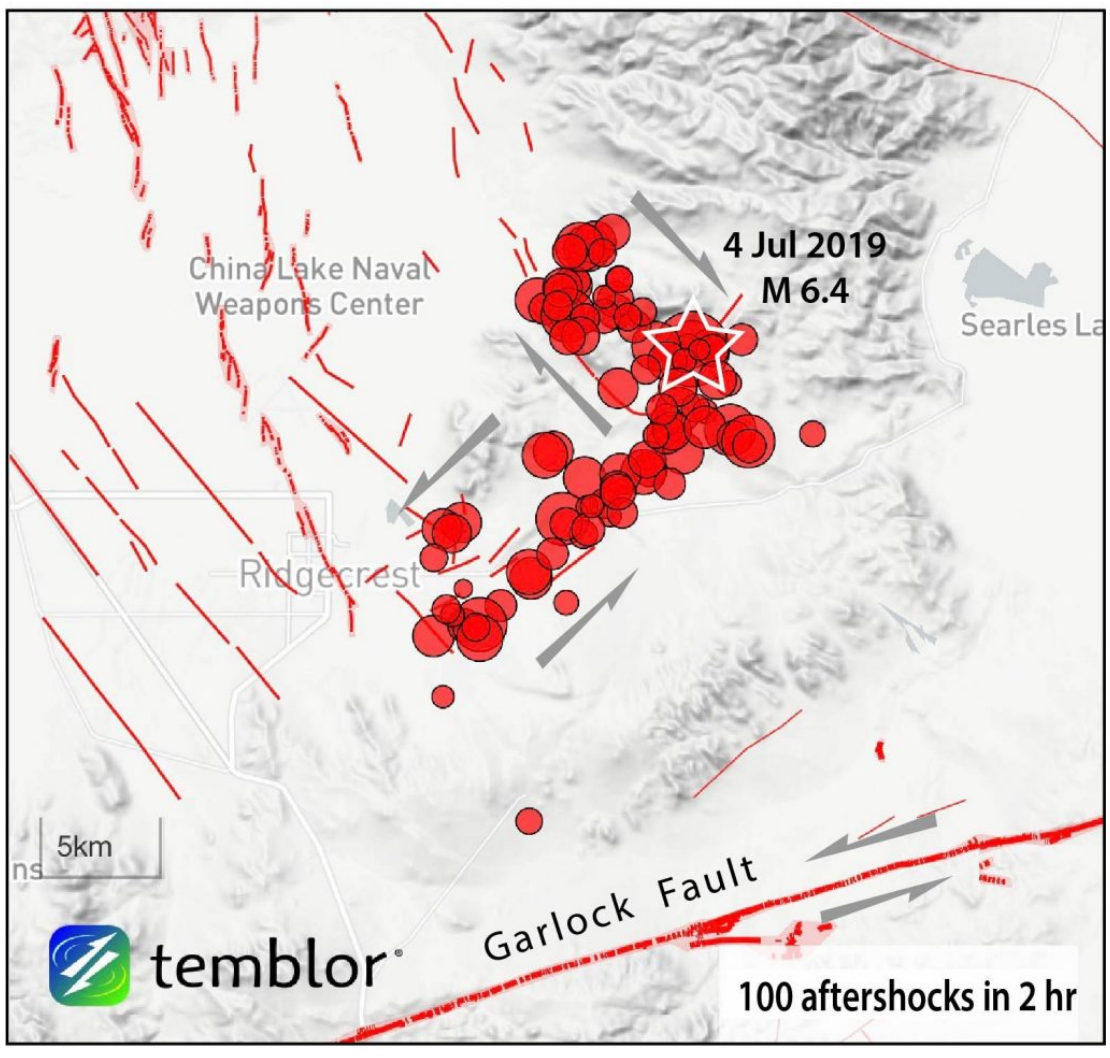
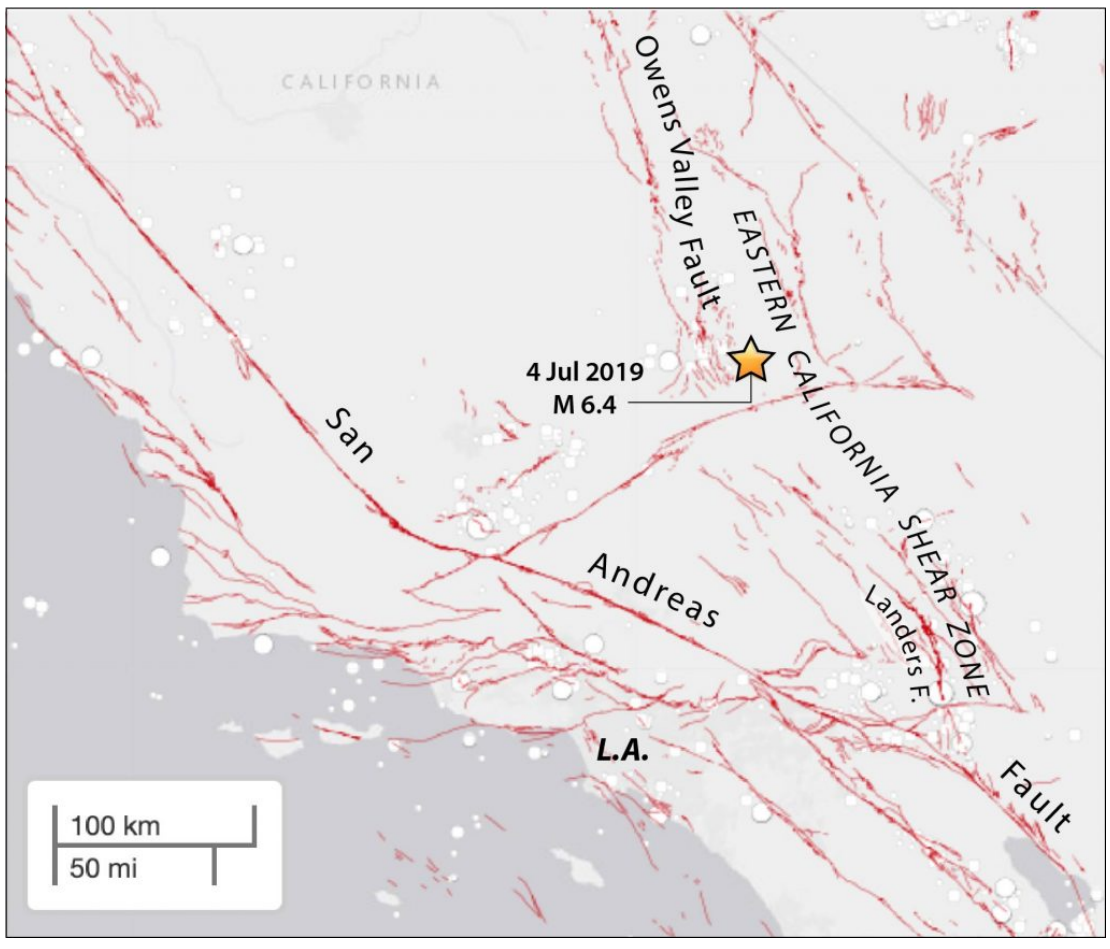
A Magnitude 6.4 earthquake struck the remote southern California high desert today, a region which has been the site of several moderate earthquakes over the past 30 years (Hauksson and Unruh, 2007), and tends to exhibit swarm-like behavior. Based on its aftershocks, the quake appears to have ruptured two perpendicular faults, one right-lateral (whichever side you are on, the other moves to the right), and the other left lateral, as shown below.



Temblor app map of the mainshock and its first two hours of aftershock suggests that two orthogonal faults have ruptured together. The inferred sense of slip is represented by the half arrows.

The Eastern California Shear Zone lights up

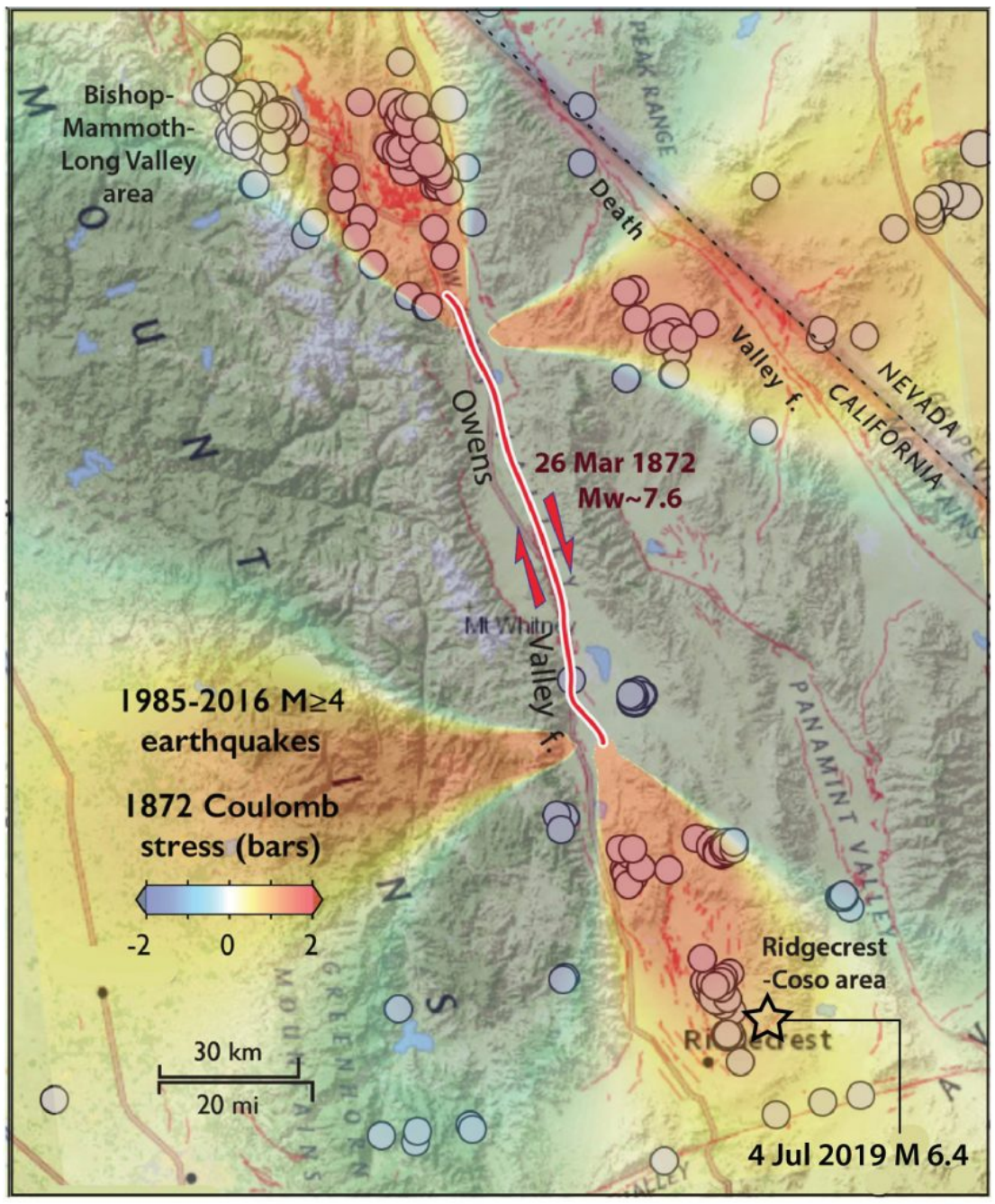
The quake lies west of Searles Valley and east of Ridgecrest, near the Naval Air Warfare Center on China Lake. This is a region of diffuse shear and extension, as indicated by the myriad of small distributed faults, and is part of the so-called 'Eastern California Shear Zone.' It also lies close to a geothermally active region that heats and locally thins the crust. While the San Andreas is the major fault system that accommodates the Pacific-North America plate motion, the Eastern California Shear Zone plays a secondary role, and so, in fact, the plate boundary spans the entire girth of California.



The 'Eastern California Shear Zone,' within which the 4th July shock struck, rivals the San Andreas for great quakes, producing an M~7.6 shock in 1872, an M=7.3 shock in 1992, and an M=7.1 shock in 1999.

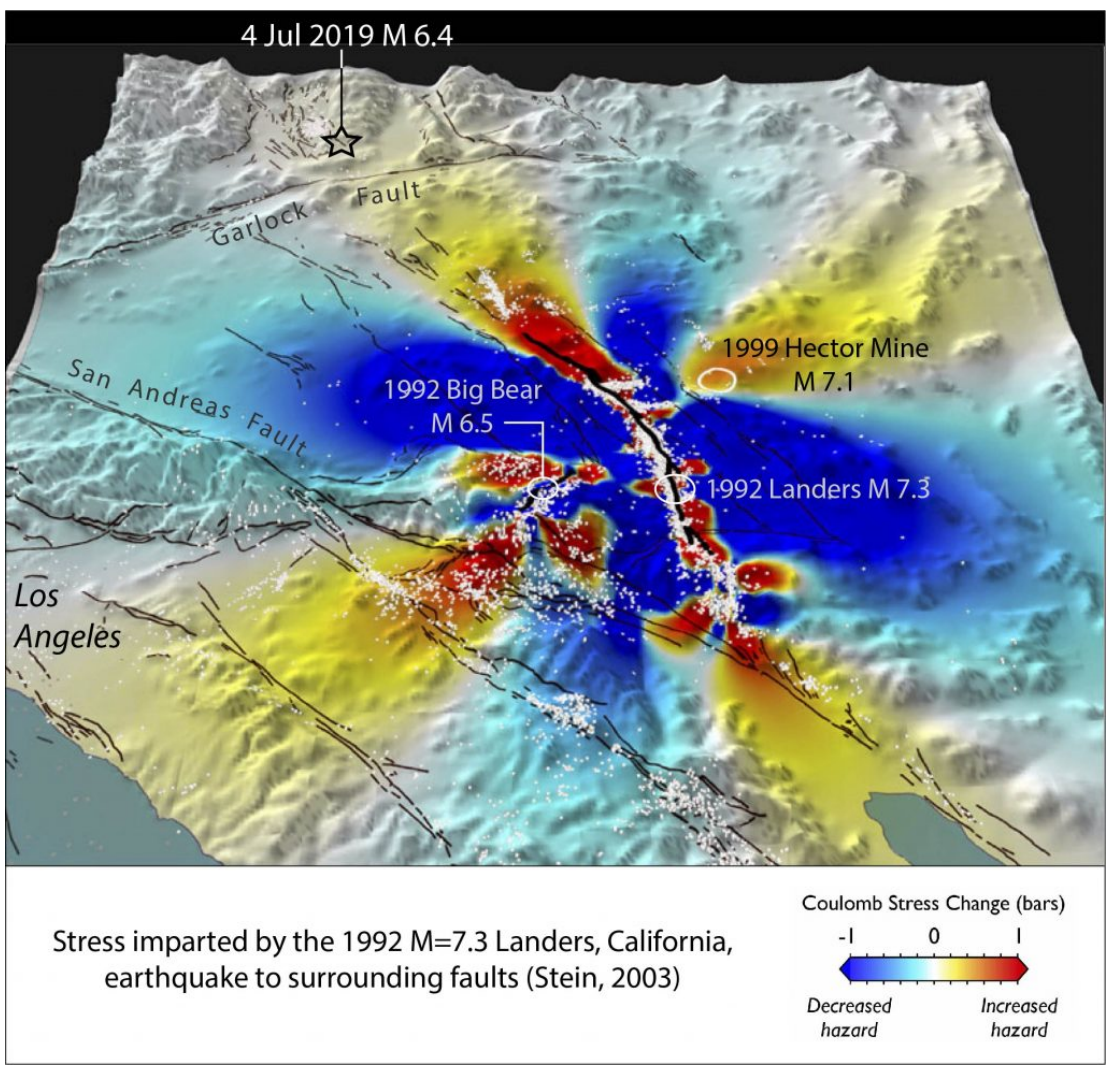
Two quakes gang up in Ridgecrest

We calculate that two large earthquakes, the 26 March 1872 M~7.6 Owens Valley shock, and the 29 June 1992 M=7.3 Landers shock, permanently imparted stress to the site of today's shock, perhaps increasing the likelihood of earthquakes in this region over others.



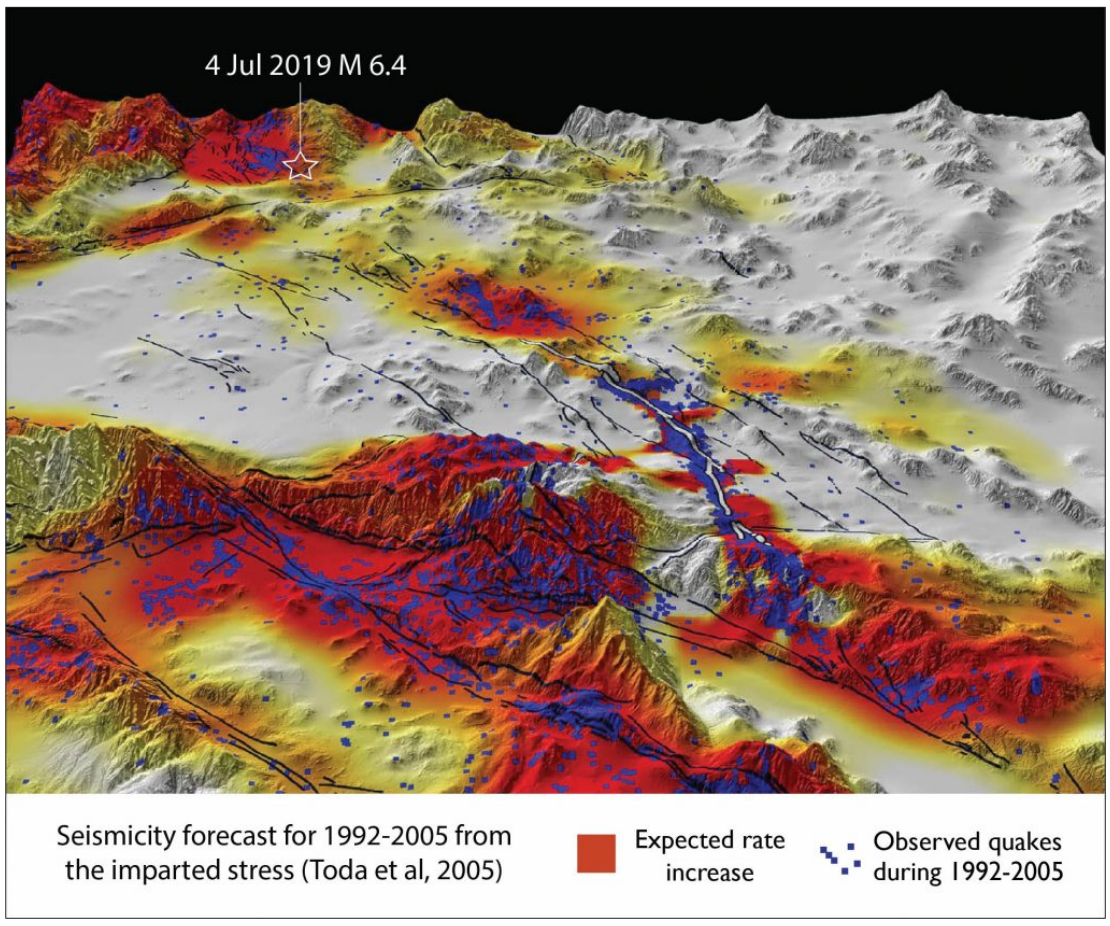
The site of the July 4th shock was likely brought closer to failure in the 1872 M~7.6 shock. Notice that the (red) stress trigger zones of the this 148-year-old quake are all seismically active today, whereas the (blue) stress shadows are generally devoid of shocks.

The more recent 1992 M 7.3 Landers shock was followed by the Ridgecrest earthquakes of M 5.4 in August 1995, and an M 5.8 in September 1995 (Hauksson et al., 1995). These earthquakes perhaps indicate that stress imparted by the Landers earthquake immediately brought this area closer to failure, and so the 1995 events might be regarded as remote aftershocks.



The 4th July earthquake lies at the northern edge of a stress trigger lobe of the 1992 Landers shock. Together, the 1872 and 1992 earthquakes increased the stress at the 4th July epicenter by about 0.25 bars, a small but significant amount.

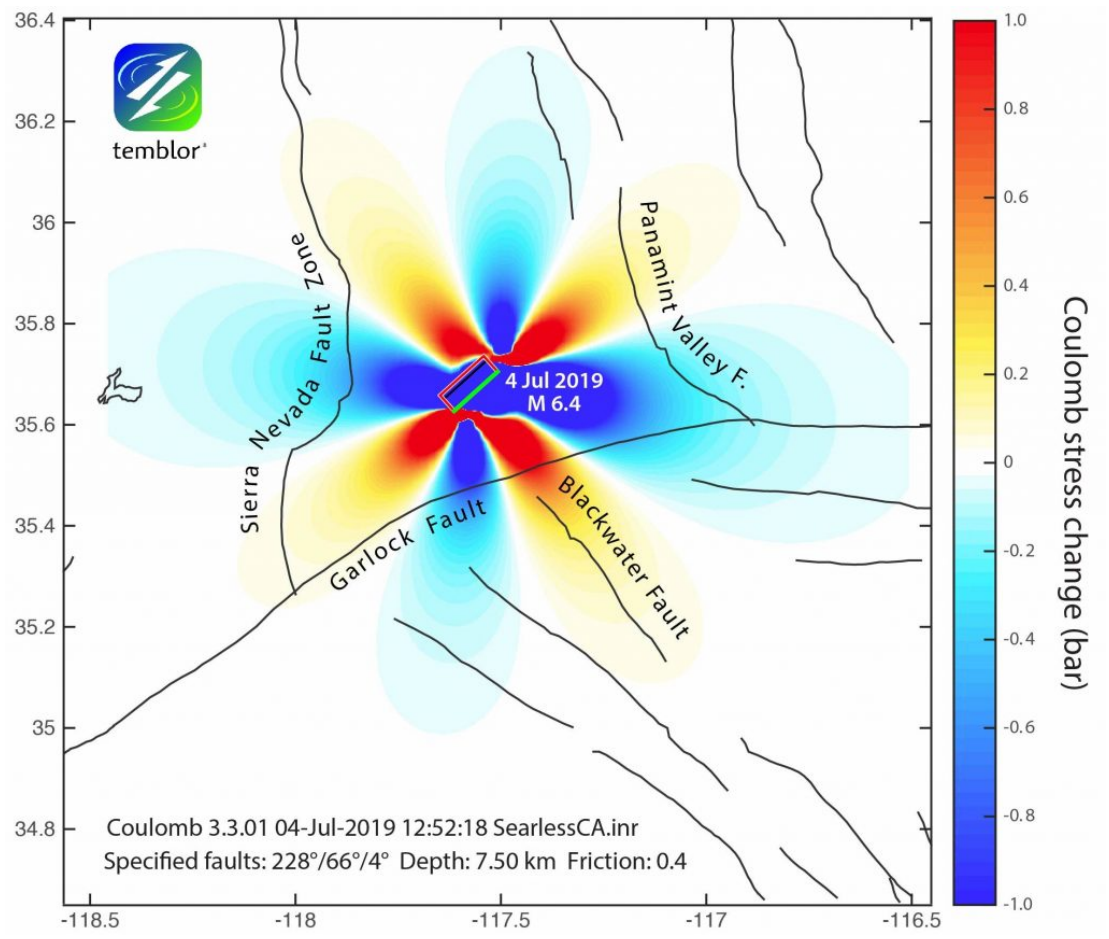
In 2005, Shinji Toda and his colleagues used the 1992 Landers stress changes and the pattern of seismicity to make a retrospective forecast of seismicity, below. The forecast is in red, the observed quakes that struck are in blue. Because of its voluminous background seismicity and the imparted stress, one can see that the site of the 4th July shock was indeed forecast for a high quake rate.



The 4th July quake struck where the background rate of shocks is high, and where stress was transferred by the 1992 earthquake.

What's Next?

Our preliminary calculation, below, suggests that parts of the Garlock, Black Mountain, and Panamint Valley Faults were brought closer to failure by the 4th July quake. Fortunately, all of these are in remote, lightly populated regions.



Coulomb 3.3 calculation of stress transferred by the 4th July shock to the surrounding region and major faults. Here we use a simple source based on the moment tensor (geometry, sense of slip, and size) of the earthquake, as determined by the USGS.

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References

Egill Hauksson, Kate Hutton, Hiroo Kanamori, Lucile Jones, James Mori, Susan Hough, and Glenn Roquemore (1995), Preliminary Report on the 1995 Ridgecrest Earthquake Sequence in Eastern California, Seismological Research Letters, 66 (6), 54-60, doi.org/10.1785/gssrl.66.6.54

Hauksson, E., and J. Unruh (2007), Regional tectonics of the Coso geothermal area along the intracontinental plate boundary in central eastern California: Three-dimensional Vp and Vp /Vs models, spatial-temporal seismicity patterns, and seismogenic deformation, J. Geophys. Res., 112, B06309, doi:10.1029/2006JB004721.

Stein, R.S., Earthquake Conversations, Scientific American, vol. 288, 72-79, January issue, 2003. Republished in: Our Ever Changing Earth, Scientific American, Special Edition, v. 15 (2), 82-89, 2005.

Toda, S., Stein, R. S., Richards-Dinger, K. & Bozkurt, S. Forecasting the evolution of seismicity in southern California: Animations built on earthquake stress transfer. J. Geophys. Res. 110, B05S16 (2005) https://doi.org/10.1029/2004JB003415

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Dal Stanley • 15 days ago

Ross and coauthor: You have done a great job in analyzing this complex stress release, The only thing that might be interesting is that there was a M6.2 event today up at the north margin of the Juan de Fuca plate.

3 ^ | v • Reply • Share ›

Christopher T. Farrell • 7 days ago

Fascinating how well they were able to predict the area of high probability--the way the blue predictions overlapped the red--or was it the other way around?--but you surely know what I mean. Time for coffee.

^ | v • Reply • Share ›

David Edick Jr • 12 days ago

Timely and informative article. How does July 5th 7.1 quake fit into or otherwise affect this broad senario?

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Steve Riner • 14 days ago

Would the Hector Mine event have also added to stress in this area?

^ | v • Reply • Share ›

Ross Stein Mod ➚ Steve Riner • 14 days ago

Based on our calculations, probably not, because of its location and much smaller size.

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