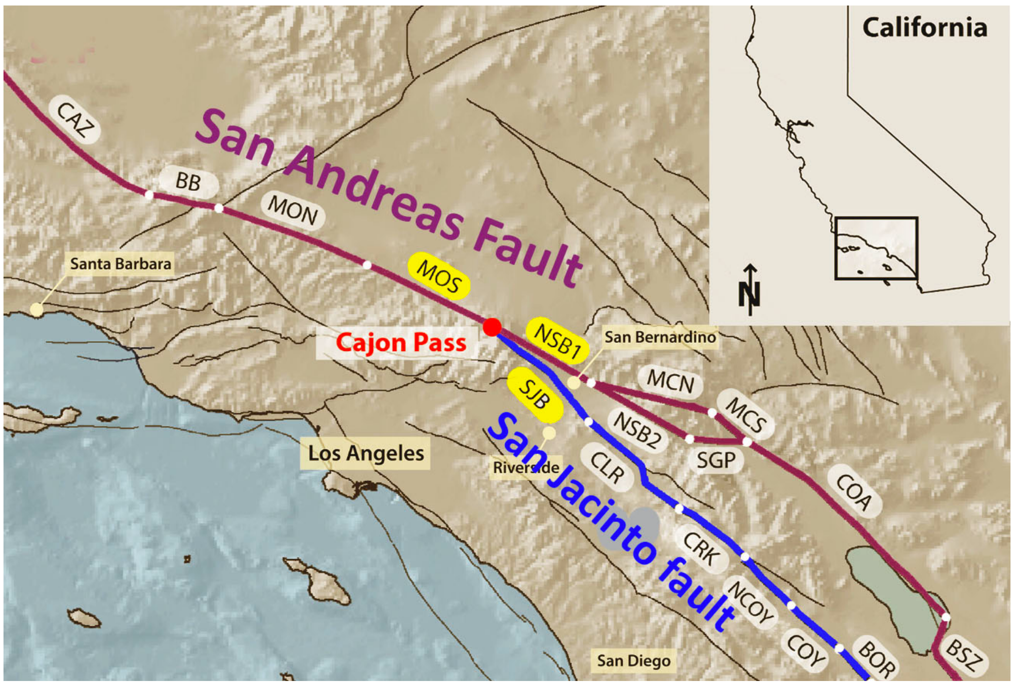
Times Standard

Not My Fault: An earthquake "gateway" and what it means about earthquake risk

Lori Dengler for the Times-Standard
Posted July 11, 2026
https://www.times-standard.com/2026/07/11/lori-dengler-an-earthquake-gateway-and-what-it-means-about-earthquake-risk/



This map shows the faults modeled by the team examining fault stress levels in Southern California. The main stem of the San Andreas is shown in purple, and the San Jacinto fault is in blue. Each fault was divided into segments delineated by the white dots and labeled. The three segments that determine whether the Cajon Pass gateway is open or closed are highlighted in yellow. Some of the other faults in the region that were not part of the study are shown by black lines, adapted from Burkhard et al.

"LA on earthquake alert as fault lines hit highest stress levels in history" claimed a headline from the NY Post on July 5th. Granted, the NY Post tends to hyperbole, but similar stories ran in dozens of national news outlets, many science news websites, and on the front page of this paper (7/4/26). What were these stories based on and is there a reason to be concerned?

In early June, a paper came out in the Journal of Geophysical Research (JGR) about stress levels on faults in the southern San Andreas fault system. The publication, led by Liliane Burkhard of the University of Bern in Switzerland, asserts that stress has now reached "high levels" and that two major faults interact, sometimes limiting ruptures and at other times allowing a rupture to jump from one fault segment to another, producing a larger earthquake than either segment would by itself. JGR is a prestigious journal and getting published requires extensive peer review. It was solid work and presents a new analysis of the relation between two major southern California faults.

Fault rupture is something we can't observe directly. Earthquakes occur at depths of miles to several hundreds of miles beneath the surface in areas where we have no direct sensors. Our understanding of what causes an earthquake and how a rupture happens is based on surface observations, laboratory studies, and modeling. Unlike classroom models or some animations, a fault doesn't slip all at once, one side moving instantaneously relative to the other. The rupture always starts at a point and proceeds to grow in one direction or two, displacing the rock on the two sides as it grows.

Faults are weaker zones in the earth that have repeatedly produced earthquakes in the past but are no means uniform. In the case of long fault systems like the San Andreas, they cut across many different rock types with varying strength. Fault lines on a map may look smooth and straight, but in reality, are complex with rough spots and bends. The rocks on the two sides of a fault are not only held together by the intense pressure of the ground around them, but over the years since the past rupture, the zone may have partially recrystallized. Changes in temperature, pressure, and fluids in the fault zone all affect the strength of different regions.

Stronger patches are called asperities. Thorne Lay and Hiroo Kanamori developed the earthquake asperity model in 1981, defining an asperity is a strong patch that locks a fault together. For a large earthquake to occur, the accumulated strain on the fault must exceed the strength of the asperity. It's a little like a zipper. It takes a certain amount of pull to start a zipper moving and if you've got a sticky one, momentum to move it past the rough spots. Lay and Kanamori initially applied to idea to subduction zones where the largest earthquakes occur, but it was soon applied to all fault types. In between asperities, small earthquakes occur, but to get a 'big one,' you need to break one or several of these stronger patches. Asperities are both the starting and stopping points of great earthquakes and it is just as important to consider their role in controlling when an earthquake stops as when it starts.

Figuring out where asperities are, how strong they are, and how close the regional stress is to exceeding their strength is one of the fundamental problems of earthquake risk analysis. There are several tools in the seismologist's bag for finding them. The location, magnitude, and frequency of past earthquakes is a good starting point. For example, the San Andreas fault has well-defined segments of distinctly different behavior. There's a zone in central California that is continuously creeping and only produces small earthquakes and other sections that are currently stuck but have produced major quakes widely spaced in time.

The recent JGR paper delves into this latter category in more detail by looking at past earthquakes and modeling the regional stresses of the two most important faults in the southern San Andreas transform fault system: the main stem of the San Andreas fault that passes to the north of the Los Angeles basin, through San Bernardino, and southeast to the Salton Sea and the San Jacinto fault that parallels it to the west. They are the main players when it comes to the relative movement between the Pacific and North American plates in the Southern California region. Both of these faults have produced earthquakes in the mid to upper M7 range but have been notably devoid of major events for over a century. They are also closely connected, the San Jacinto fault branching off from the San Andreas at Cajon Pass.

The instrumental record of earthquakes in California only goes back 130 years. That record can be stretched back a little further by looking at newspapers in print at the time, but the details of older earthquakes require paleoseismic investigations. There have been many trench investigations along both the southern San Andreas and the San Jacinto fault, documenting major ruptures spanning nearly 4000 years. A trench can't tell you the precise day an earthquake occurred or exactly how large it was, but it can provide reasonable estimates.

Burkhard's team took the data from trench investigations along many segments of both faults and combined it with other estimates of slip rates and stress parameters to model how the earthquake histories of the past millennium changed regional stresses and the relative vulnerabilities of the two faults to failure. Their work identified one spot as an important juncture in determining the potential length of a rupture.

Cajon Pass in San Bernardino County not only separates the San Bernardino Mountains and the San Gabriels, but it also marks the point where the San Jacinto fault bifurcates from the main San Andreas. Burkhard's team call it an "earthquake gateway." It's a three-way gate, sometimes allowing an earthquake that starts on the San Andreas to the north or the south of the gate to travel through, sometimes allowing a San Andreas-San Jacinto fault rupture, and sometimes stopping a rupture from any direction cold. It's a new term for me, a spot that sometimes stops a rupture and at others allows it to propagate through. I think of it as a special kind of asperity that, depending on stress, may block the rupture or let it continue. There is some historic evidence. In 1857, a M7.9 earthquake ruptured 225 miles of the San Andreas fault from Parkfield to Wrightwood, stopping at Cajon Pass. Forty-five years earlier, an earthquake of about M7.5 is thought to have initiated near Wrightwood and to have ruptured both to the north and on the main San Andreas but also along much of the San Jacinto fault to the south. In 1812 the "gate" appears to be opened but shut in 1857.

The gist of the Cajon Pass gateway story lies in the three adjacent fault segments, the northern section of the San Joaquin fault (SJB), and the two sections of the San Andreas above and below that juncture (MOS and NSB!). The authors calculate the stress on these segments since 1100 AD and, as earthquakes occur, the stress changes. There are 12 major earthquakes in this time window, five that allowed the rupture to pass through the gateway from the main San Andreas to the north to the south (or vice versa), one that allowed rupture on all three segments, and six where the gate seems to be closed and the fault rupture stopped at Cajon Pass.

The modeling shows that the current stress level on MOS, the northern San Andreas segment is at an all time high, just surpassing the 1856 value before it ruptured. The San Jacinto segment is likewise at a peak for this time window. NSB!, the San Andreas segment to the south of the Pass, has reached its second highest value. The authors make it clear that this does not constitute an earthquake prediction or that a major earthquake is likely within days or months, but "given the elapsed time since these faults have ruptured, the probability of an earthquake in the near future is high," and that the high levels on all three segments suggest the gateway is currently open and an extended on all three limbs of the Cajon Pass junction is possible.

The authors acknowledge many uncertainties in their modeling. While the dates of past earthquakes from trench studies are fairly robust, estimating the magnitude has more error. The study makes simplifications about the characteristics of fault materials and ignores possible influence of other faults that make up the larger plate boundary environment, both within the San Andreas system and the Eastern California Shear Zone which has produced major earthquakes more recently. The long time since the last major earthquake in the southern San

Andreas has led most seismologists to consider it to be at higher risk than the northern section for many years. The new study quantifies the threat and suggests a mechanism for why some ruptures are much longer than others.

For a more detailed explanation of the stress story, see https://temblor.net/earthquake-insights/southern-california-cajon-pass-earthquake-gate-17272/, the full publication is at https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2025JB033213

Lori Dengler is an emeritus professor of geology at Cal Poly Humboldt, and an expert in tsunami and earthquake hazards. The opinions expressed are hers and not the Times--Standard's. All Not My Fault columns are archived online at https://kamome.humboldt.edu/taxonomy/term/5 and may be reused for educational purposes. Leave a message at (707) 826-6019 or email Kamome@humboldt.edu for questions and comments about this column or to request copies of the preparedness magazine "Living on Shaky Ground."