Times Standard

Not My Fault: A hiccup on the San Andreas transform system

Lori Dengler for the Times-Standard
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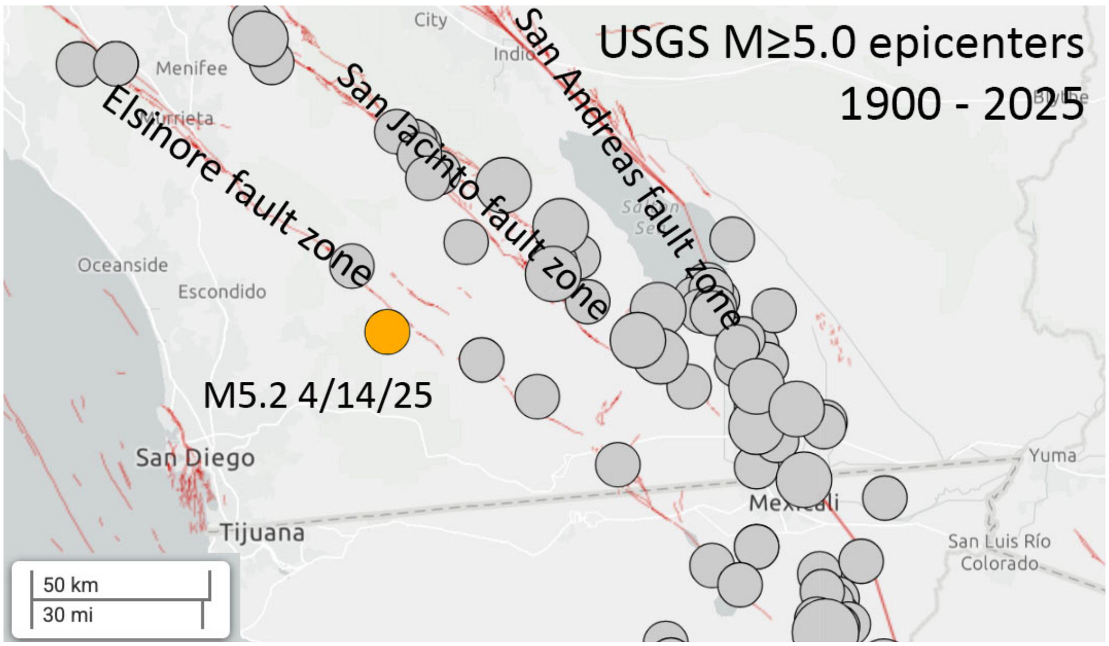

USGS earthquakes of magnitude 5 and larger are shown in Southern California since 1900. The location of the April 14 M5.2 is shown in orange.

Last Monday April 14th, an earthquake caught many people's attention in Southern California. It was centered near the town of Julian about 35 miles inland from San Diego and triggered the USGS ShakeAlert system. Several million Californians received texts to "expect shaking." When the rumbling was over and seismologists analyzed the data, the magnitude stood at 5.2.

For those of us on the North Coast, M5.2 is not very big. In terms of energy released, it was roughly 500 times weaker than our 7.0 on the Mendocino fault last December. But there were a lot more people who felt it. Over 40,000 people filed reports on the USGS "Did You Feel It?" web site following Monday's temblor, more than double the reports from our 7.0. The Julian earthquake is worth closer examination not for its size or damage (there was very little), but for a demonstration of what worked and where it was located, highlighting a part of the San Andreas fault system that is often overlooked.

ShakeAlert worked. This is the system that detects the earthquake within the first few seconds of rupture, estimates magnitude, and sends out an alert via Wireless Emergency Alert (WEA) to people in areas likely to feel it. It took only 4.5 seconds for the first WEA alerts to be sent out, far more quickly than the 15 seconds after our M7.0 in December. The Julian quake was centered on land in an area of dense instrumentation, and it took only 2 seconds for three seismographs to detect the initial seismic waves. Our quake was nearly 40 miles offshore and we have no ocean bottom detectors.

We've become fairly familiar with ShakeAlert. It's been triggered seven times on the North Coast since it became public in 2019. But for many people receiving the WEA on April 14th, it was a first and the response was positive. School children throughout the felt area did what they have been trained to do – scoot under their desks and hold on. Unlike October's annual ShakeOut drill, this time they got to actually experience shaking. Many fire stations doors automatically opened on receiving the alert.

April 14th was a gentle introduction to ShakeAlert. Almost everyone got the alert before the seismic waves arrived. The 1800 people in Julian, only three miles from the epicenter, did not. But folks in San Diego got a two second heads up and Angelinos got nearly 10 seconds. Unlike our December 20, 2022, M6.4 earthquake, the 5.2 occurred in daytime and the shaking was relatively gentle. For North Coast folks at 2:30 AM, the screech of the WEA alert arriving at the same time as violent shaking exacerbated the experience.

Most interesting about Monday's earthquake is its location. For many people, "earthquake in California" equates to the San Andreas fault. The 5.2 was not on the San Andreas, but on the Elsinore fault, part of the San Andreas transform fault system. The difference is important, and this week's earthquake highlights the earthquake hazard posed by the multiple faults in both Southern and Northern California that are part of this complicated plate boundary.

The San Andreas transform system marks the boundary between the Pacific and North American plates, accommodating the horizontal movement between the two. Many maps show the boundary as a single line, but this is a simplification. The main strand of the San Andreas is the longest continuous fault in California extending 800 miles from the Salton Sea to Cape Mendocino. It has rightfully earned its notoriety with the 1906 M7.9 119 years ago and a similar-sized quake on the central part of the fault in 1857. But it's not the only game intown. There are eight other major faults and a number of minor ones that also contribute to the relative Pacific – North American plate movement. In Southern California, the Elsinore and San Jacinto faults are main subsidiary faults, both subparallel to and west of the main San Andreas.

In written historic times, the San Jacinto fault has been the most active. It splays off of the San Andreas fault near San Bernadino and extends at least 130 miles to the southeast, disappearing north of Seeley near the Salton Sea. It has produced six earthquakes in the magnitude 5 range since 2000 and at least nine magnitude 6s since 1800. The 1899 San Jacinto earthquake (~M6.7) killed six people and damaged most buildings in the Hemet to San Jacinto area.

Lesser known but potentially as potent is the Elsinore fault, the likely genesis of Monday's earthquake. Unlike the San Jacinto fault which splays off of the San Andreas, the northern end of the Elsinore fault is not as clear. It begins somewhere in the Chino Hills area and extends over 100 miles to near the Baja border. A fault map of the southern part of the State shows the three parallel faults – the Elsinore fault furthest west, the San Jacinto fault about 20 - 30 miles to the east, and the main San Andreas another 30 miles further east. All of these faults have the same type of right-lateral strike-slip movement (like cars on a British highway), all are active, and all contribute to the Pacific – North American plate motion.

The Southern California Earthquake Data Center describes the Elsinore fault as "one of the largest in southern California, and in historic times, one of the quietest." The southeastern end of the fault produced a M7 quake in 1892, but the main trace has produced no magnitude 6s and only five in the M5 range since 1900. Monday's earthquake is the largest quake to occur in the central part of the Elsinore fault in over a hundred years.

One has to be careful using our short historic earthquake window to extrapolate earthquake hazards. Looking only at our written historic window, the main San Andreas appears to pose no problem. The southernmost segment from the Salton Sea to San Bernardino has been eerily quiet during that time. But no earthquakes in the past 200 years doesn't mean benign. Trench studies have found evidence of at least five earthquakes large enough to rupture through to the surface (M≥7), the most recent in the 15th century.

Paleoseismic studies on the Elsinore fault also show evidence of large earthquakes in the past. The last major slip event (magnitude 6.5 – 7.5) was in the 1700s. It's hard to pin down how frequently these larger earthquake recur, estimates range from 250 to 600 years apart. That puts a major Elsinore earthquake into a similar probability window as our Cascadia megathrust, not likely to occur this afternoon (although possible), but worth paying attention to.

An earthquake in the magnitude 7 range on any of these relatively sleepy (from our short-term human perspective) faults in Southern California would not only wreak havoc on nearby communities but cost all of us. After the 1989 Loma Prieta earthquake (M6.9), a .25% increase in the State sales tax was imposed on all Californians for 13 months. Total losses in 1989 were about $6 billion, only a fraction of what a similar-sized quake on the Southern California faults could cause today.

It's not possible to prevent earthquakes from happening but we can reduce casualties and economic losses by smart investments now. ShakeAlert is expensive. It depends on a dense network of high-quality instruments to detect an earthquake rupture as it begins and robust algorithms to process the data as quickly as possible. Paleoseismic research is expensive. It requires hi-tech tools such as LIDAR to reveal potential faults, especially in rough terrain. It requires trained crews to trench and analyze data. Building earthquake-resistant structures is more expensive than unregulated development. It requires investment in structural engineering studies and post-earthquake field investigation of how structures perform.

Investing in earthquake resilience may seem like an extra burden – until AFTER an earthquake occurs. Cutting construction costs in Turkey proved fatal to tens of thousands in 2023. We live in earthquake country and maintaining and improving our scientific and engineering capability is a smart investment in my book.

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