San Andreas Earthquake Swarm -- How Mini-Quakes Affect Risk of Big Ones

Tia Ghose, Live Science, 10-3-16

A swarm of small quakes near the San Andreas fault spurred officials in California to issue an earthquake alert for residents of Southern California.

Based on the swarm activity, the risk of an earthquake of magnitude 7.0 or greater in Southern California shot up to between 1 in 300 and 1 in 100 over the weekend, according to the U.S. Geological Survey (USGS). The Office of Emergency Services in California issued an alert that is in effect until tomorrow (Oct. 4).

"I wouldn't say it's over until it's really over. We sort of just gradually get back to background, and it could tick back up later after we think it's settled down," said Kenneth Hudnut, a USGS research geophysicist in Pasadena, California.

On an average day, there is a 1 in 10,000 chance of a magnitude 7 or greater quake, meaning the risk is temporarily elevated 100 times above baseline, said Morgan Page, a research geophysicist with the USGS in Pasadena, California. [Photos: The Gorgeous San Andreas Fault]

But how exactly do seismologists estimate earthquake risk, and how do swarms like those seen over the past several days affectd the baseline risk?

It turns out, tiny earthquakes increase earthquake risk because they increase the overall earthquake frequency on a given fault, and because smaller temblors on cross-faults situated perpendicular to the main San Andreas fault can set off a larger one on the main fault, USGS scientists said.

Swarm of quakes

A series of 142 or 143 tiny earthquake swarms were detected near the Salton Sea, a saltwater lake that sits atop the 800-mile-long (1,287 kilometers) San Andreas Fault. The swarm occurred on cross-faults that connect the southern end of the San Andreas fault with the so-called Imperial fault.

This event is just the third time such a swarm has shaken this region on the southern tip of the San Andreas since 1932 when quake sensors were placed there. "We had a swarm in 2009 and a swarm that occurred in 2001," Page told Live Science.

The recent swarm triggered the earthquake alert for Southern California. However, the last quake recorded in the region occurred a day ago.

"Official advisory extends to Tuesday, but seismically the extra risk is all but over. But remember, everyday risk is high," Lucy Jones, a seismologist who formerly worked for the USGS, tweeted yesterday.

Risk calculation

But just how do seismologists account for earthquake swarmsin their seismic models?

The San Andreas Fault sits at the region where the North American Plate is sliding past the Pacific Plate, a boundary known as a strike-slip fault. It is actually a network of fault systems that snakes from the Salton Sea in the Mojave Desert to the Mendocino Coast in the north.

The region that experienced the swarms, near the Salton Sea, is a portion of the fault that has built up a lot of stress, and hasn't ruptured in 326 years, the Orange County Register reported.

"The amount of energy that's released by tiny earthquakes is just minuscule in terms of the total energy budget for earthquakes," Page said. "Even adding up all the little ones, they don't really count for much." [Image Gallery: This Millennium's Destructive Earthquakes]

For instance, a magnitude-7 earthquake releases 1 million times as much energy as a magnitude-3 temblor, according to the USGS.

"You really need those big earthquakes to make any difference," Page said.

But another phenomenon proposed by Hudnut in 1987 did create concern among geologists that the swarm could trigger "a big one." Hudnut proposed the hypothesis that activity on a cross-fault running perpendicular to a major fault can put enough stress on a major fault to cause an earthquake; that's what happened in 1987, leading to a quake along California's Superstition Hills fault.

During the swarm, Hudnut drove out and checked for possible "triggered slip" in the area of the cross-faults. Though there was some "cracking," he said, there was no evidence of movement that would have required actual tectonic slip behavior.

Smaller earthquakes can also trigger aftershocks, and aftershocks can sometimes be bigger than the quake that set them off.

Beyond that, earthquake models predict risk based on the frequency of earthquakes, and swarms of earthquakes temporarily increase that frequency, Page said.

Region at risk

The area around the Salton Sea is not near any major population centers, but some models show that a quake set off near the Salton Sea could trigger a rupture farther north, past cities such as Palm Springs and San Bernardino.

And while Los Angeles County wouldn't be directly affected by such a rupture, "You can have seismic waves basically funneled into the basins," Page said. "Because the LA basin is surrounded by mountains on all sides, the waves basically get trapped there."

Add to that the soft sediment in the Los Angeles region, and a quake set off near the Salton Sea could trigger fairly intense shaking in Los Angeles even if the epicenter of the quake was relatively far away, Page said.

The latest swarm may have died down, but Angelenos shouldn't breathe too big a sigh of relief, Page said.

"We live in earthquake country and we should be prepared for an earthquake at any time," Page said. "Events like this can change the probabilities from week to week but it never goes to zero."