Not My Fault: Of foreshocks and aftershocks

Lori Dengler/For the Times-Standard
Posted July 18, 2019

It's an unsettled time in much of the state. Aftershocks continue in the Mojave Desert where M6.4 and M7.1 earthquakes struck on July 4th and 5th. Felt earthquakes in other parts of the state immediately raise hackles and concerns, "Might these only be foreshocks?" And earthquake speculation continues to find front-page space on newspapers.

As I write this, over 13,000 small earthquakes have been detected in the Searles Valley region since the sequence began on July 4th. If they had been spread out evenly, it would mean an earthquake occurring about every minute and a half. But there were many more on the first few days, with several quakes detected every minute right after the two largest quakes and the number has been slowly tapering off. Fortunately, more than 90% of these earthquakes were too small to be felt. But the 600+ made it into the M3 range, felt by many in the Searles Valley and Ridgecrest areas and 70 were over M4, felt over an even larger area.

The earthquakes can be placed into three pots. The first category is those occurring on July 4th, before the M6.4. There are five earthquakes in this pot, three M1s, two in the magnitude 2 range and a 4.0. The only one felt was the M4, and most people noted it as an earthquake but were not particularly concerned. About a half hour afterwards, the M6.4 occurred. Pot one earthquakes became foreshocks of the 6.4. On the order of 10% of larger earthquakes are preceded by foreshocks, so they aren't unusual but aren't the general rule.

The second category is aftershocks of the M6.4. More than 1500 earthquakes were recorded in the 33 hours between the 6.4 and the 7.1. USGS and other seismologists working on regional seismicity patterns would consider this within the typical range for earthquakes of this size for this region. The number of earthquakes per hour was slowing and the largest aftershock (M5.4) was one unit less than the mainshock, both as expected. There was nothing in the character of these earthquakes that gave any inkling that the sequence was about to suddenly change. But the USGS had issued an aftershock forecast that included the small but real chance that an earthquake as large or larger could still occur.

The third pot is aftershocks of the M7.1. As I write, the 7.1 is the mainshock, the largest earthquake in the sequence. All earthquakes that occurred after 8:19 pm on July 5th are aftershocks of the mainshock. This is the largest pot, containing more than 12,000 earthquakes. Most have been below the felt threshold, but 48 have been in the M4 range and six had magnitudes of M5 – 5.5, large enough to be felt by many in the central and southern part of the state.

When the 7.1 occurred on the evening of July 5th, the M6.4 became a foreshock. In an instant, the five quakes in pot 1 became foreshocks of the foreshock, and the pot 2 quakes, aftershocks of the foreshock. Confused? The terms are what seismologists use to organize earthquake sequences, and by analyzing the timing and location trends, can sometimes identify anomalies that suggest heightened or lesser risk. While scientists can describe the likelihood of aftershocks in statistical terms and probabilities, it is not possible to predict the time or location of aftershocks large enough to cause damage.

There is nothing physically different between foreshocks and aftershocks. They all involve slip on a fault, produce seismic waves and are capable of producing damage depending on their size and location. Typically, the larger the magnitude of the main earthquake, the longer the duration of the aftershock sequence. Aftershocks are still being detected from the January 2018 M7.9 Gulf of Alaska earthquake and the 2011 M9.1 Japan earthquake is still producing a few aftershocks.

One concern in the Searles Valley aftershocks that has caught media attention is the northward trend of epicenter locations. "Ridgecrest earthquake aftershocks move toward dangerous faults, sparking concerns of triggered temblors," said Los Angeles Times July 16 headline. It's typical for aftershocks to concentrate at the ends of the main rupture. In the case of Searles Valley, the southern end abuts the Garlock fault, a massive fault that has produced no major earthquakes in historic times but there is paleoseismic evidence of significant ruptures over 500 years ago and the fault slip of the July 5th earthquake slightly increased stress on the fault.

At the northern end of the rupture, aftershocks have been migrating further north, towards the Owens Valley fault, site of the M7.8 1872 earthquake which shook so strongly it knocked mules off their feet and left a fault scarp that

can still be seen today. Interferometry, the analysis of before and after space images, can delineate how fault slip changes the regional stress field. The stress change images suggest that many of the regional fault systems north of the M7.1 rupture were brought slightly closer to failure by the July 5th slip. But it is less clear what the effect may have been on the Owens Valley fault.

Felt earthquakes whether aftershocks or not put people on edge. The Tuesday M4.3 in the East San Francisco Bay area had many people thinking, "Is this a foreshock?" The best thing to do to assuage your anxiety is to take action. No you can't stop earthquakes, but you can make your home and workplace safer and you can make yourself and your loved ones much more comfortable during the days or even weeks you could be isolated from markets, power and water. Use our Living on Shaky Ground magazine to take the first steps or call our regional Red Cross office at (707) 832-5480.

Lori Dengler is an emeritus professor of geology at Humboldt State University, an expert in tsunami and earthquake hazards. Questions or comments about this column, or want a free copy of the preparedness magazine "Living on Shaky Ground"? Leave a message at (707) 826-6019 or email Kamome@humboldt.edu

https://www.times-standard.com/2019/07/18/lori-dengler-of-foreshocks-and-aftershocks/