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Not My Fault: SoCal earthquake study find ten times more earthquakes. What does it mean?

Lori Dengler/For the Times-Standard
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On April 18th, a paper was published in Science, the nation's premier publication for high profile studies in science and engineering fields. The paper summarized three years of research on the characteristics of very small earthquakes in Southern California and documented many more events than were previously known.

The four authors (Ross and Hauksson - CalTech, Trugman - Los Alamos National Lab, and Shearer - Scripps Institute of Oceanography) hoped for response from the earth science community but were a little surprised when their work made the front page of the Los Angeles Times, just below the story on the release of the Mueller Report and their phones began ringing nonstop from reporters and media sites.

It was the biggest earthquake story to hit the Los Angeles Times of the past month, getting more attention than an April 4th piece that chronicled California's "exceptional earthquake drought." So what is it – more earthquakes or fewer? Turns out both are correct and depend on your perspective.

The April 18th Science paper documented very tiny earthquakes – most of which were smaller than magnitude 1. For a feel for how small a M1 quake is, imagine a fault about twenty feet long and the quake produces little more than an inch of offset. You wouldn't feel it even if you were sitting on top of it.

Seismologists weren't surprised when the group found many more tiny quakes than were previously known. Gutenberg and Richter published a paper in 1956 with a famous relationship between magnitude and the expected number of earthquakes. It's called the Gutenberg-Richter Law and predicts that, in seismically active areas, the number of quakes as the magnitude range goes down a notch, increases by roughly a factor of ten. This means for every magnitude 6 quake, there are about ten magnitude 5s and 100 magnitude 4s.

The global earthquake catalog supports the Gutenberg-Richter Law. The average number of magnitude 7 earthquakes is around 15 per year, 130 in the M 6 range, and 1300 M5s. There is considerable variation from year to year, but the general pattern holds. But, as the magnitudes range gets lower, the fit isn't so good. Where the Law would predict 13,000 M4s in a year, the actual number recorded is closer to 10,000. The misfit gets worse for magnitude 3s where the number recorded is closer to 5000 and the predicted number is 130,000. It's not the Law that is wrong. We just don't have a dense enough network of seismic stations to catch every small quake.

Southern California has the densest regional network of seismic stations in the U.S. For the last twenty years, the catalogs have been considered complete down to the magnitude 1.5 to 2 range. But it's hard to detect smaller earthquakes, even with a dense network. The noise from cars, wind, surf and other environmental sources can easily mask the small signals from tiny quakes.

Ross and his group developed a method to tease out these small wiggles. They developed templates of known earthquakes from various regions in Southern California and shrank them down to the size a smaller earthquake would be. These templates became combs for sifting through ten years of signal from more than 10,000 stations, looking for vibrations that matched the master. It wouldn't have been possible a few decades ago, but the team was able to use powerful graphics processing units to crunch through the massive amount of data. The result was ten-fold increase in the number of detected earthquakes in the 2008 – 2017 time window, from 180,000 earthquakes to over 1.8 million.

The new data suggests an earthquake occurs in Southern California roughly every three minutes. But you won't feel them and there is no suggestion that the rate of earthquake activity is changing. The value of the new data is in the detail it gives about the character of faults and a suggestion that the seismic waves from larger earthquakes might trigger very small earthquakes at distances hundreds of miles from the epicenter. These results don't change the assessment of regional risk. But the methods may provide a new tool for assessing faults and looking at seismic activity patterns. A caveat, however. This method is extremely labor intensive and requires months of analysis. It can't be done in real time. It also primarily identifies earthquakes in areas that are currently seismically active. The technique is not applicable to areas that are quiet.

Could it be applied elsewhere? Yes, in other regions with robust regional seismic networks. But not likely on the

North Coast where our seismic instruments are still sparse and most of our earthquakes come from offshore. The conclusion that there are many more earthquakes occurring on a daily basis than are currently detected, certainly holds true here as well.

As to the "earthquake drought," this is at the other end of the spectrum. The San Andreas and its associated faults have not produced a significant earthquake in past century. This is a marked change from the previous century. Between 1800 and 1918, there were eight earthquakes of magnitude 6.5 or larger, big enough to produce visible fault rupture at the surface. Even early 20th century seismographs won't miss earthquakes of this size. There was lively discussion about this topic at the SSA meeting I attended last week. The consensus, the hiatus is real and unusual in both the historic and paleoseismic record. It's a good reason for governments, businesses, families and individuals to take preparedness seriously.

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

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