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Not My Fault: Recent Mexico quakes were unusual for subduction zones

Lori Dengler/For the Times-Standard
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Two days ago, a magnitude 7.1 earthquake struck central Mexico causing fires, the collapse of buildings and casualties in at least five Mexican states. As I write, the death toll stands at 225, and this earthquake has become the deadliest quake to 2017 to date.

Tuesday's earthquake was the second deadly earthquake to strike Mexico in less than two weeks. Last week I wrote about the September 7 magnitude 8.1 off the coast of of Chiapas. Tuesday's M 7.1 was nearly 400 miles to the NW and not an aftershock of the earlier quake. The two earthquakes were related, both caused by the complex stresses generated by subduction as the Cocos plate is pulled beneath the North American plate.

Both earthquakes were unusual for earthquakes in or near subduction zones where the primary force is compression. But Mexico's September tremors weren't on the plate interface, but rather intraplate events within the subducting slab. They were on normal faults and the product of extension related to bending and deformation within the Cocos plate. They were also a bit deeper than most quakes – the 8.1 at 44 miles and the 7.1 at 32 miles beneath the surface.

The big differences between the two were size and location. At first glance, 7.1 and 8.1 seem pretty close. But magnitude is logarithmic and each unit increase is 32 times more powerful. The 8.1 earthquake was deadly – the toll just under 100 with at least 300 injuries. For 12 days, it was the deadliest quake of 2017. With its far smaller size, why was the 7.1 more deadly?

When it comes to earthquakes, size can't trump location. The 7.1 was 75 miles from Mexico City and 34 miles from Puebla, a city of more than 1.5 million people. The USGS estimates 14 million people experienced strong (intensity VI) or greater shaking on Tuesday, compared to fewer than 15,000 for the larger quake.

Dense populations mean many structures of varying structural integrity and vulnerable gas, water and communication systems. At least 44 structures in Mexico City collapsed and many more were severely damaged.

And what about the third earthquake of my title? Tuesday's M 7.1 occurred 32 years to the day after one of the deadliest Mexico quakes of all time, the September 19, 1985 Michoacán earthquake. The exact death toll is uncertain, but at least 10,000 people likely died and more than 400 buildings collapsed.

September 19 has become a national day of remembering and last Tuesday, many schools and other organizations had only just completed earthquake preparedness drills before the 7.1 struck.

I mention 1985 not only because of the irony of the dates, but because of what it taught us about the role of geology in shaking strength. This earthquake fault was more than 250 miles away from the Mexico City metropolitan area. A M 8.0 earthquake is quite capable of being felt at this distance but the shaking is usually much weaker than in the epicentral area. Mexico City is unique, built largely on the infilled Lake Texcoco basin. The fill creates a resonance effect. When seismic waves of just the right period hit the basin, they are amplified resulting in stronger and longer shaking.

The same amplification effects were in play on both September 7 and 19 with stronger shaking in the Mexico City area than would happen if the geology were uniform. But fortunately, the 8.1 was oriented a little differently than 1985 and didn't create nearly as strong an effect and the 7.1 wasn't as rich in longer period ground motion.

Could such an amplification effect occur in California? In every large California quake, shaking maps show that artificial fill and sediment-filled basins do shake more strongly than competent bedrock nearby. This soil amplification had a tragic impact in the 1989 Loma Prieta earthquake and the collapse of the Cypress freeway structure in Oakland.

But we really don't know what a much larger earthquake could do and I am concerned that a magnitude 8.5 to 9 earthquake on the Cascadia subduction zone could produce some surprising effects far from the near source area. In 1994, we had a M 7.0 earthquake offshore of Cape Mendocino. It was felt by many in Humboldt County but caused no damage. Some of the strongest shaking, however was felt in Sacramento. Not on the ground or lower floors of buildings but in high rises. It's time for someone to take a long and hard look of what

could happen in an earthquake nearly 1000 times stronger.

Lori Dengler is an emeritus professor of geology at Humboldt State University, an expert in tsunami and earthquake. Questions or comments about earthquakes or this column can be sent to Kamome@humboldt.edu or (707) 826-6019.

http://www.times-standard.com/general-news/20170920/local-expert-recent-mexico-quakes-were-unusual-for-subduction-zones