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Not My Fault: A 'good' earthquake swarm in the Pacific Northwest

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Last Tuesday, a magnitude 4.2 earthquake was reported far off the Central Oregon coast. Centered in the Blanco fault zone (BFZ), it marked the beginning of a swarm of earthquakes, and by weeks end, over 100 earthquakes had been recorded.

100 earthquakes in a three-day period sounds ominous, so why call it a good? Because these earthquakes were too far offshore to cause damage, not large enough to produce a tsunami, and unlikely to trigger larger, more hazardous earthquakes. The sequence helps to understand the BFZ, generated earthquake discussions and, I hope, nudged you to taking preparedness actions.

How can I be so sure that Blanco earthquakes aren't a problem? I am never 100% confidant about anything, but we know a lot about the BFZ from its tectonic setting and past behavior, and I don't think I am sticking my neck out when I put it into the benign category.

My guess is few have heard about the BFZ, even though its annual earthquake production often exceeds the San Andreas fault. In 2021 before the current sequence, 27 magnitude 4 and larger earthquakes were reported on the Blanco fault compared to only seven in the San Andreas fault zone. This week brings the 2021 BFZ tally to 101.

The reason for its obscurity is location. The 260-mile-long fault is entirely offshore. The southeastern edge is about 85 miles west of Bandon Oregon, and northwestern termination 300 miles west of Newport. Few BFZ earthquakes are reported felt and even the occasional M6 is felt only lightly along the coast.

The Blanco fault is an important part of the Juan de Fuca – Gorda plate system. Fifty million years ago, the entire west coast of what is now the US and Canada was a subduction zone. The giant Farallon plate extended over much of the eastern Pacific. Subduction slowly consumed the Farallon until only a tiny section remains along the Northern California to Southern British Columbia coast. Today, this small remnant consists of three sections: the Explorer plate (smallest) off British Columbia, the Juan de Fuca off of Washington and Oregon (largest), and Gorda in the south off of Northern California and Southern Oregon.

The Blanco fault is a transform plate boundary (horizontal motion) across which the Juan de Fuca moves toward the coast relative to the Pacific plate. At its western end, it abuts the Juan de Fuca ridge, an active spreading center with nearly continuous submarine volcanic activity. The eastern end connects it to the Gorda ridge.

Since 1980, 150 earthquakes of M≥5 have been recorded on the Blanco fault. Ten were in the M6 range and the largest a 6.5. Only a handful of these earthquakes were reported felt as most were more than 100 miles from populated areas. More than a third of these quakes were part of swarms, short bursts of earthquake activity lasting no more than a week or two. Swarms differ from more typical mainshock-aftershock sequences where the largest earthquake occurs early in the sequence and is followed by aftershocks that become fewer and generally smaller as time passes.

In swarms, the earthquakes are of similar size. The current BFZ swarm included two 5.8s, six 5.5s, and nine other earthquakes in the M5 range scattered throughout the sequence. Similar sequences have occurred in the past. A swarm in January 2001 lasted about a week, producing a M6.3, four earthquakes in the M5 range and 14 M4s. At least 14 swarms have occurred since 2000, all centered along the western half of the fault closer to the ridge.

It is interesting to compare the Blanco behavior to a transform fault much closer to us. The 150-mile-long Mendocino fault zone (MFZ) extending west from Cape Mendocino to the Gorda ridge is a close cousin of the Blanco system. Only 200 to 300 miles south to southeast of the BFZ, it is also a transform fault, marking the plate boundary between the Gorda and the Pacific plate.

The MFZ is also very seismically active producing 48 M≥ 5 earthquakes since 1980, similar to the rate of Blanco activity. But a closer look reveals significant differences. The Mendocino fault has produced larger quakes including a 7.1 in 1994 and several 6.6s and 6.7s. Larger earthquakes mean more seismic energy released. In the past forty years, the Mendocino fault has released nearly twice as much earthquake energy as the BFZ. MFZ earthquake sequences are not swarms; they have mainshocks followed by smaller aftershocks.

Why are these nearby faults so different? Warmer temperatures and fluids significantly weaken a fault zone.

The rocks on both sides of the Blanco fault are very young and the swarm behavior on the younger, warmer half of the Blanco fault closer to the ridge suggests it plays a role. The Mendocino fault abuts the relatively young Gorda plate against the much older colder Pacific plate. It may also be stronger because of the pressure exerted by the Juan de Fuca to the north. The Blanco fault and the Mendocino fault are not parallel and plate motion produces compression in the Gorda plate and along the Mendocino fault.

As I write, the current BFZ sequence appears to be over. It goes down in the books as the most vigorous Blanco swarm of the past two decades, although similar in terms of energy release and duration to other sequences. The earthquakes weren't large enough to affect stresses further away and the seismologists at the USGS Pacific Northwest Seismic network concur that it has had no impact on other fault systems in the region (https://pnsn.org/blog/2021/12/10/blanco-fracture-zone-swarm-active-unusual-interesting-but-not-concerning).

The Blanco fault and its behavior are important pieces of our regional tectonic neighborhood. Although these earthquakes posed no threat, we have plenty of other fault systems closer to populated areas and/or capable of producing much larger earthquakes at any time. The recent earthquakes are a reminder that we live in earthquake country and the next sequence might not be benign.

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