Times-Standard
Times-Standard / Humboldt Beacon

Not My Fault: Big thrust faults dominate Humboldt topography

Lori Dengler/For the Times-Standard
Posted: Jan. 25, 2017

Three hundred seventeen years ago today, the last really Big One let loose in our area. A great earthquake on the Cascadia subduction zone ruptured a 600 to 700 mile-long fault from Humboldt County to British Columbia, shaking the peoples of Northern California and the Pacific Northwest and spawning a tsunami large enough to cause damage in Japan more than 5000 miles away. It had a magnitude of about 9. For the next few installments of this column, I look at how and what we know about this earthquake and how this can help us prepare for the next one.

The Great Cascadia earthquake of January 26, 1700 reads like a detective novel with chapters unfolding as new techniques and ways of studying earthquakes became available. It's been my luck to have an insider's view of this extraordinary story. Friends and colleagues contributed to many of the important discoveries and helped to piece the pages together. It is such a fascinating and compelling tale that I will break it into several 'Not My Fault' segments.

For me the story starts in 1978 as a newly arrived part-time lecturer at HSU with a not-quite-finished PhD dissertation. At that time the term "Cascadia subduction zone" was yet to be coined, the prevailing wisdom was the San Andreas drove our seismicity and our greatest earthquake threat was a mid magnitude 7. I barely knew what a tsunami was and we were only worried about the ones caused big earthquakes far away like 1964 Alaska.

Plate tectonic theory was still in its adolescence. It did a good job of explaining why most earthquakes, mountain building and volcanism were associated with the boundaries between plates. Boundaries – areas where the earth's outer surface was spreading apart, zones like the San Andreas where the movement was all side-by-side, and subduction zones where the crust is recycled, pulled by gravity back down into the mantle – had been identified. The interface between the overlying earth and the subducting plate is the megathrust, the largest fault types on earth and the location of most really large earthquakes.

When I came to Humboldt, we knew there was a subduction zone extending from Northern California to British Columbia, and that it explained the location of the Cascade volcanoes. But almost no one was concerned that it posed a major earthquake risk and it didn't rank having a name. Some scientists argued that it was 'aseismic', that our subducting Gorda plate was quietly slipping beneath the overlying North American plate like a well-oiled machine and the boundary too warm to generate much friction and accumulate the strain needed to make a big earthquake. In the 150 years or so of written records, the interface seemed to be nearly devoid of earthquakes. The first seismic risk map of the US had just been published, based only on known earthquakes. From the hazard perspective, Oregon looked a lot like Florida with much of the State's earthquake threat listed as "none or minor".

The first challenge to this view came from the new field of paleoseismology. Earthquakes cause faulting and offset. Strong shaking may produce liquefaction and landslides. Large earthquakes may cause the land to drop (subsidence) or produce a tsunami all of which may leave tell tale evidence in the geologic record. In the 1970s, it occurred to some geologists to look for this geologic evidence.

In our area, the research driver was the Humboldt Bay Nuclear Power Plant. It was California's first nuclear facility opening in 1963 at PG&E's King Salmon facility. A group of local citizens called interveners (including the late Fred Cranston of the HSU Physics Department and Wesley Chesbro) petitioned the nuclear regulatory agency about the hazard posed by faults near the plant and PG&E was required to address the concern. Two of my colleagues, Gary Carver and Bud Burke, got a grant to look for evidence of recent faulting in Humboldt County. So look they did and faults they found – the Little Salmon, Fickle Hill, Blue Lake, Mad River, McKinleyville, Trinidad and many smaller splays. All of these faults are now classified as 'active' under California's Earthquake Fault Zone legislation.

These were big thrust faults with one side heaved up atop the other and associated with large folds, nothing like the strike-slip faults that dominate the world of the San Andreas. And they dominate our coastal topography. Drive on G or H Street in Arcata and notice the large hump where Wildberries Market sits and the smaller one next to the Jacoby Store House. You have just crossed two strands of the Fickle Hill fault. Humboldt Hill? It's the fold over the top of the Little Salmon fault.

Carver and Burke gave the world a picture of the crumpled 'fold and thrust belt' atop the subduction zone. There are about 12 major subduction zones on the earth's surface and almost all of them are too far offshore or remote to observe directly. But our subduction zone breaks the seafloor only about 50 miles off the coast and we live work and play on the crumpled crust above it. Our surface faults are the "icing on the cake" so to speak – deforming and adjusting to the larger motions beneath.

Gary Carver and Bud Burke's contribution to understanding Cascadia are included in the book "Cascadia's Fault" by Jerry Thompson available in many local bookstores.

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