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Getting the shakes

By Julie Sevreus Lyons
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Scientists have long known a big earthquake on the Hayward Fault -- which runs through some of the most densely populated parts of the Bay Area -- could kill hundreds, destroy tens of thousands of homes and close more than a thousand roads.

But new research suggests that may be an underestimate.

After looking at historical records of a huge quake that occurred on the fault more than 135 years ago, a Bay Area scientist has concluded that it was bigger than the one the region has been preparing for.

While it may not sound like a huge difference -- a magnitude 7.0 quake vs. a magnitude 6.7 -- it is. With the way quakes are measured, the larger magnitude represents a doubling in the amount of energy released, which translates into much more damage.

Assessing the 1868 quake is important because a repeat of that quake is considered the most likely and devastating scenario for the Big One in the Bay Area. In fact, it was known as the "great San Francisco earthquake" until the 1906 temblor came along, and it's the only major quake on the fault in historical times. Scientists estimate there is a 27 percent chance a quake of magnitude 6.7 or greater will occur on the Hayward Fault by 2032.

"The Hayward Fault stands out as the most likely fault in the Bay Area to do lots of damage," Jim Lienkaemper, a geophysicist at the U.S. Geological Survey, said. "It's going through the most populated areas that have a lot of weak structures. That's its claim to fame."

The early-morning earthquake of Oct. 21, 1868, killed 30 people and toppled homes, church turrets, water towers and courthouses from San Jose to Suisun City, then a sparsely populated landscape of small towns, farms and ranches.

Jack Boatwright, a geophysicist at the USGS in Menlo Park, mapped the damage in meticulous detail, identifying about a dozen cracked homes and fallen edifices that had not been previously mapped and plotting their locations using old atlases. His new map shows the intensity of shaking felt between Santa Rosa and Gilroy.

"The 1868 earthquake gives us an idea of what may well be the next large earthquake in the Bay Area, and it's something we should focus our planning for," he said. "The 1868 quake was *twice* as big as the standing model we had of it."

As bad as the 1868 quake was, it could have been much worse. Only a portion of the fault ruptured at that time. Scientists are concerned that the whole thing could go at once, creating even more devastation.

In his assessment, Boatwright drew from the earlier work of Tousson Topozada, a researcher who combed through old newspapers and personal correspondence to find mentions of the quake.

In San Jose, "buildings and trees seemed to pitch about like ships in a storm at sea," recounted the Oct. 22 edition of the San Jose Mercury. "Fire walls and chimneys were thrown down, in all parts of the city."

For each of more than 125 sites where damage occurred, Boatwright determined the intensity of shaking according to the Mercalli scale, which ranges between 1 (not felt) to 10-plus (extreme). When shaking hits around 7, chimneys start to fall down. With 8s, poorly built buildings collapse, Boatwright said.

In 1868, Fremont, San Leandro, Hayward and Oakland all ended up with 8s and 9s, violent shaking that caused heavy damage. Most of San Jose was an 8 -- severe shaking and moderate to heavy damage. Even outlying areas like Livermore, Redwood City and Santa Cruz sustained a fair amount of damage and experienced more intense shaking than they did during 1989's Loma Prieta earthquake.

Surprisingly, Mission San Jose and Oakland weren't rocked as hard as researchers thought they would have been, and Boatwright isn't sure why. But points in between fared much worse. And the Sacramento-San Joaquin River Delta experienced considerable shaking, indicating that the area's levees, which protect much of the state's fresh water supply, are at even greater risk than previously thought.

"I think these pieces of information are extremely valuable," said seismologist Mary Lou Zoback, vice president of earthquake risk applications for Newark-based Risk Management Solutions. "They will contribute more to our better understanding of future earthquakes and how shaking varies."

The problem researchers have when gauging the size of historical earthquakes is that modern instruments were not around then. So there is no way to know an old quake's exact magnitude.

"The reality is that no one was sitting around with seismographs in 1868, so there is a range" of magnitudes that could be considered most likely or accurate, said David Schwartz, chief of the San Francisco Bay Area Earthquake Hazards Project at the USGS.

Given that the Bay Area was sparsely populated then, scientists have had a difficult time determining the damage in some regions, such as the Evergreen area of San Jose.

In 2003, a team of scientists put together their best predictions for a "Big One" on the Hayward Fault, figuring it could range from magnitude 6.4 to a 6.9. The average estimate, 6.7, has been extensively used in disaster planning.

Analysts at the Association of Bay Area Governments, for instance, anticipate 1,100 road closures and 94,000 destroyed homes and apartment units from a magnitude 6.7 quake, said Jeanne Perkins, an earthquake and hazards specialist. With the new research suggesting the quake could be even bigger, those figures could grow considerably.

"It would be devastating to people's lives, not only in the short-term, but in the months and even years it takes to get the housing back to near-normal," she said. "All people have to do is remember Hurricane Katrina, and they've got a mental image of the length of time it takes for the recovery of a community."

Boatwright used the same method in 2006 to plot shaking from the 1906 San Francisco earthquake, and other researchers believe his estimates for that event are on the mark. Although scientists would prefer to have quantitative information gleaned from sophisticated instruments, his method appears to work, Zoback said.

"It's another tool in our toolbox that is turning up extremely useful," she said. "This is an incredible bonus for us as scientists -- the fact we can extract very useful information out of basically newspaper reports or personal letters people had written."

But Schwartz said he thinks too much emphasis is being placed on the quake's magnitude, which he deems uncertain. The real issue is where the shaking occurred, how strong it was and what that says about future quakes on the fault, he said.

"Whether it was 6.7, 6.8, 6.9, 7.0, we know it was large and it did damage," he said. "It did damage in San Francisco. It did damage in the East Bay."

If anything, the new research should serve as a reminder to be prepared for a major earthquake, said Arrietta Chakos, president of the Northern California chapter of the Earthquake Engineering Research Institute.

"There's an annual survey done to ask Californians what are their top issues in the state. I don't think earthquake preparedness has made the Top 20. It's not been a terribly popular topic," Chakos said.

"One of the things that happens between big earthquakes is people forget, or they don't want to think about them. This report brings it back to the front burner for a lot of us."

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