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The Really Big One

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There are two kinds of people in Southern California: those who think they've experienced a major earthquake, and those of us who know we haven't.

If you were here Jan. 17, 1994, you probably put yourself in the first group. Many of us were jolted out of bed at 4:31 a.m. that day, and some of us experienced earthquake shaking that was about as bad as it gets. All of us recall the images: apartment buildings pancaked, freeway overpasses torn apart. The Northridge quake, an abrupt lurch across a patch of a fault some 10 miles square, caused 57 deaths. Those eight seconds were an emotional seismogram etched indelibly onto our central nervous systems.

So it offends sensibility that seismologists consider Northridge to be only a strong temblor, two steps below the dreaded magnitude 8 Big One. But here's the reality: A Big One on the southern San Andreas fault will be the result of a lurch along a swath of a fault. A long swath. What seismologists call the earthquake rupture will extend 10 to 15 miles deep and 200 to 250 miles long. Maybe more. It will be the size of 20 Northridge earthquakes laid end to end.

It will feel like the Ft. Tejon earthquake that struck 150 years ago, the Big One none of us remember.

On Jan. 9, 1857, the San Andreas fault unzipped from near the central California town of Parkfield down to Cajon Pass, a distance of nearly 250 miles. Stream channels crossing the fault reveal that, at least in some places, fault motion reached a staggering 30 feet, with an average sideways movement of about 15 feet. It blasted down the Carrizo Plain, past the modern mountain communities of Frazier Park and Gorman, along the edge of Palmdale, running out of steam only miles from San Bernardino. The earthquake appears to have proceeded from north to south, a freight train barreling down on San Bernardino at 6,000 mph. (Only in bad TV movies do earthquakes chase trains.) It rivaled the great 1906 San Francisco earthquake in magnitude, power and extent–every aspect that matters to a seismologist. But for Angelenos, it's a history that precedes us, a moment in time that does not define us.

Those in proximity to the fault 150 years ago recalled effects not seen in this part of the world in recent times. A letter to the editor of the Los Angeles Star described "immense trees

… snapped off close to the ground" and of "every building between Fort Tejon and Lake Elizabeth leveled with the ground." The waters of Tulare Lake–at the time more than 500 square miles about 40 miles south of Fresno–were forced upward, leaving fish stranded on its shores. Estimates of the paroxysm's durationranged from one to several minutes. In the village of Los Angeles, one eyewitness said people "fled into the streets; many could not stand and in terror fell to their knees and cried out, 'Lord have mercy.' " Houses creaked and cracked; at least two homes collapsed in the San Fernando Valley, and many more were damaged.

One might be reasssured by the accounts. They seem to suggest that, although towns close to the San Andreas fault will be hard hit, the Greater Los Angeles region would be largely unscathed when the next huge quake strikes on the central San Andreas or on the more distant southern San Andreas, from Cajon Pass to the Salton Sea.

Seismologists aren't so sure. For one thing, 15 or 30 feet of lateral motion across the San Andreas will likely wrench apart many of the lifelines that Angelenos of 1857 couldn't have imagined but on which we depend, including power lines, aqueducts and major freeways.

And scattered among the accounts from 1857 are some that give a seismologist real pause: "The river was thrown out of its bed over the banks, and receded" … "only rarely do earthquakes last so long and have such strange motions" … "the motion of the earth resembled the long swell of the sea." With remarkable prescience one observer concluded: "The motions were long and lateral, instead of sudden, violent and vertical."

In 1857 seismology barely existed. Scientists didn't understand faults or their association with earthquakes; they didn't understand the nature of earthquake waves. Today there is still a lot we don't know, but some things we understand pretty well, including how the Los Angeles region will shake, rattle and roll when the next Big One hits the San Andreas. We know that the broad, flat expanse of Los Angeles is like the smooth top of the proverbial bowl of Jell-O, chilled and set over the ages, and that the bowl itself is made of the rock of surrounding mountains.

In 1985 the world saw what happened when waves from a distant earthquake reached another such bowl, the former lake-bed zone that underlies Mexico City. Armed with sophisticated theories about earthquake waves and powerful computers, seismologists can now set any bowl into motion with simulations. We can start to understand the nature of the long and lateral motions, and to find out what they will do to the types of buildings that weren't around in 1857.

Like the adobe houses of early Los Angeles, today's single-family homes might be able to ride the waves like small sturdy ships. But many concrete buildings–parking structures, office buildings, schools–built between the 1930s and the early 1970s will be extremely vulnerable to collapse. And more modern mid-rise structures will start to sway, and will continue to sway through the duration of the shaking. Two minutes or maybe three. Maybe as many as five.

As Mexico City showed, bad things happen when big buildings sway too much. As the top of a building moves sideways relative to the base, the weight at the top is no longer supported adequately; if pushed/swayed far enough, a building will topple. In 2006 a respected team of Caltech scientists and engineers published a results suggesting that, for at least some future big San Andreas fault earthquakes, modern mid-rise buildings in the Greater Los Angeles (they didn't identify any by name) region could be in particular danger. Other engineers pointed out that, because the study considered only two specific buildings and two possible future earthquakes, the results should not be generalized.

The authors of the study, having acknowledged these limitations in their article, described their research as a first attempt at a "rupture-to-rivets"–or "rupture-to-rubble," as some seismologists quipped darkly–simulations that begin with an earthquake on a fault and follow the waves all the way through a simulated building. This is state-of-the-art research, impressive and promising, but not yet definitive in its results. Not definitive, but also not exactly comforting.

The simulations will continue to improve as scientists and engineers push the edge of the envelope, but they will remain only simulations and therefore open to debate. One day, maybe 50 years from now, maybe tomorrow, the earth itself will run the experiment for us. The next Big One might look like the last Big One. Earth scientists think it might well look different, extending farther south, past desert communities such as Palm Springs, and not quite so far north as the 1857 break.

For those of us for whom earthquake science or earthquake engineering is a life calling, there is an acute awareness of how much we don't know, and we are loath to cry wolf. But we are starting to get nervous.

We are nervous enough to admit in public that we are nervous, not because we know when the next Big One will strike, but because we are certain that it will strike someday, and we are anything but certain what the Southland will look like when it does.

We are nervous enough to focus research efforts on just this question, and to help push for the personal and societal preparedness that can make a difference. Nervous enough to be working with partners in business and state and local public agencies to launch a yearlong “Dare to Prepare” campaign (http://daretoprepare.org) aimed at helping individuals and the community to get ready.

An anniversary of the last Big One isn’t an occasion one celebrates, exactly. It’s an occasion one commemorates. It’s a chance to embrace a history that didn’t manage to embrace us. Because in earthquake science it isn’t an adage but a certainty: History repeats itself. It’s not a question of “if,” it’s a question of “when.”

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