Creep on the Hayward Fault

Jeremy Miller, The New Yorker, 12-28-16

California's Hayward Fault is considered one of the most dangerous seismological zones in the United States. It runs through the densely populated hills of the East Bay, sketching a diagonal line between San Jose and Richmond. Technically speaking, the Hayward is a right-lateral strike-slip fault. This means that it shows its everyday action in the form of aseismic creep, the slow, steady sliding of land along the fault's margin. The symptoms of this tectonic origami are visible across the region—in cracked asphalt, off-kilter curbstones, and leaning walls. Every day, I drive on roads and hike on trails that crisscross the Hayward. My children attend a school and play soccer on fields that straddle it. The official state zoning map covering my neighborhood puts an "active trace" of the fault on Kensington Avenue, directly in front of our small wood-frame house. All of which is to say that the Hayward cuts an uncanny transect through our lives—as it does for hundreds of thousands of Bay Area residents.

According to the U.S. Geological Survey, the average rate of creep on the Hayward is 4.6 millimetres per year—about the length of a standard black garden ant, or a quarter of a jelly bean. After a century, in other words, my house will have migrated a foot and a half closer to Alaska. But the engine of this movement is far to the south, in the Gulf of California, where the seabed along the margin of the Pacific and North American Plates is spreading apart, putting pressure, in turn, on the San Andreas Fault. (The Hayward, along with other Bay Area faults, can be thought of as a branch of the main trunk of the San Andreas.) The sliding poses a threat to the built environment, of course, but it also has a beneficial function, according to Richard Allen, the director of the Seismological Laboratory at the University of California, Berkeley, which sits not far from the fault. "In one sense, creep is our enemy, since it can damage buildings and infrastructure," Allen told me. "In another sense, creep is our friend, because it helps relieve the strain on fault lines."

What makes the Hayward so concerning, Allen explained, is that it is not creeping quickly enough. In theory, it should be slipping about ten millimetres a year, roughly twice its observed rate. Over time, the deficit mounts until the rock formations along the fault can no longer tolerate it. "That distance has to be accommodated eventually by sudden land movement, which is an earthquake," Allen said. Studies of pond sediments along the fault suggest that these large, strain-relieving tremors have happened regularly in the past. James Lienkaemper, a geologist at the U.S.G.S., estimates that they occur every hundred and forty or hundred and fifty years. The last one took place on October 21, 1868—a hundred and forty-eight years ago—and caused significant damage. Dozens of buildings, including an eighteenth-century Spanish mission in Fremont, were destroyed, and a twenty-mile-long crack opened in the earth between Fremont and Oakland. Miraculously, only thirty people were killed, largely because the population of the Bay Area was about four per cent of its present-day size. Until 1906, when a magnitude-7.8 quake devastated San Francisco, the Hayward event was known across the region as "the big one."-

Seismologists aren't sure whether the Hayward's current built-up tectonic stress will be relieved in one large tremor or a series of smaller, less damaging ones. But what seems certain is that a repeat of the 1868 event would be catastrophic, resulting in heavy damage to thousands of structures and likely causing hundreds of deaths. A Hayward-based company called Risk Management Solutions has estimated that a magnitude-7.0 quake would result in between ninety-five billion and a hundred and ninety billion dollars in damage to commercial and residential property. An earlier study by the Association of Bay Area Governments laid out a "nightmare" scenario, predicting the destruction of a hundred and fifty-five thousand housing units and the

displacement of three hundred and sixty thousand people. The average amount of slip in the magnitude-7.0 quake scenarios is four feet—two hundred and sixty-five years' worth of aseismic creep triggered in an instant.

Schwartz, another U.S.G.S. geologist, near the likely epicenter of the 1868 quake. We met in the parking lot of an Indian restaurant on Mission Boulevard, in downtown Hayward. Nearby, a paving crew was preparing to resurface a portion of the lot. Schwartz launched into action, explaining to the workers that this particular patch of asphalt was unconquerable. He pointed at a ragged line of so-called en-echelon cracks running through the ground, one of the finest visible traces in the entire Bay Area of the Hayward's slow crawl. "This is an active fault," Schwartz said. "This will happen again and again." Schwartz has worked for the U.S.G.S. for the past thirty-one years, and public outreach and education have been a key part of his job. "We've been talking about this stuff for decades, but it's very hard to break through," Schwartz told me later. "The infrastructure people"—municipal utilities, transit authorities, and so on—"have all been really good about trying to strengthen their resources. But to the average person it's not pressing."

We relocated to a site just north of the Indian restaurant, where there was a stand of distressed-brick buildings. Schwartz slapped his palm on a wall studded with steel bracing rods—short-term solutions to an intractable long-term problem. Structures like this, he said, have helped seismologists map the Hayward's course and measure its creep with precision. But they are also a sign of regional apathy. "Throughout the East Bay, there are unreinforced masonry buildings," Schwartz said. Such structures should be retrofitted to make them more tremor-resistant, or perhaps demolished altogether and replaced, but many have been left in their original condition. (One exception is Hayward's old city hall, a bulky, beautiful Art Deco affair that was built directly atop the fault in the nineteen-thirties and had to be abandoned permanently in the sixties after creep rendered it unusable.) In neighboring Oakland, the East Bay's largest city, roughly eighty-five per cent of the residential dwellings built before seismic provisions were introduced to building codes remain highly vulnerable to heavy ground shaking. "If you happen to be standing here when a quake hits, you're out of luck," Schwartz said.

Our final stop was the intersection of Rose and Prospect Streets, where a famous offset curbstone was repaired last June. Though the sidewalk's concrete was fresh and its margins were tidy, Schwartz noted that the cracks delineating the Hayward were still visible, running diagonally across the road. "Give this a few years and the offset will be there again," he said with a faint smile. I asked Schwartz whether it was right to call the Hayward America's most dangerous fault. "How can I say 'most dangerous' without actually saying the words 'most dangerous'?" he asked after a moment. He noted the threats posed by other faults, including the San Andreas and its many subsidiaries in and around Los Angeles, as well as the Cascadia subduction zone, which, when it eventually ruptures, could produce a tsunami that would inundate swaths of the Pacific Northwest. But the threat of the East Bay faults felt more immediate. "Since 1906, we've probably accumulated enough strain for a couple of magnitude-7.0 earthquakes," Schwartz said. "Whichever fault you pick, it's just time."

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