



Earthquakes as A Way of Life

Special construction and earthquake insurance are
Loma Linda's first lines of defense against the Big One.

by Sandra Elikeslee

Recently, the Loma Linda University Medical Center withstood two major earthquakes with epicenters less than 50 miles away. [Landers 7.4, Big Bear 5.6. See below.] Since then the "inland empire," which includes Riverside, San Bernardino, and Loma Linda, has felt hundreds of tremors.

Not just residents of Loma Linda, but Adventists generally find it difficult to ignore this seismic activity, since the medical center is located only seven miles from the San Andreas fault, next to one of its tributaries.

The story explores the possibility of even more cataclysmic earthquakes in the area around Loma Linda. (Copyright © 1992 by The New York Times Company. Reprinted by permission.)

The university has consulted with engineers, who have established that the medical center was originally built to withstand an earthquake up to 8.3 on the Richter Scale. Even at that high level and close proximity, buildings would not collapse, and people would be safe, although the building would sustain some damage. More recently built wings, including the section housing the proton accelerator, have been constructed to withstand even stronger earthquakes. That may be one reason it has been possible for the medical center to purchase earthquake insurance.

The Editors

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LOS ANGELES, July 12—Two weeks ago yesterday, one of [the] largest earthquakes in California history slammed through the Mojave desert, leaving one person dead, hundreds injured and scores of scientists astonished and shaken.

Astonished because this

earthquake did weird things, like setting off earthquakes more than 500 miles to the north, ripping across four existing faults to make a single larger fault, and helping give rise to a new tectonic system that is shearing California away from the rest of North America and nudging it toward Alaska.

And shaken because the nation's

most dangerous fault, the San Andreas, just got more dangerous.

Having examined their preliminary data, scientists now say the twin earthquakes that struck on June 28—7.4 on the Richter scale of ground motion near Landers and a magnitude of 5.6 near Big Bear—significantly increased the likelihood that the south part of the San Andreas will soon generate a magnitude 8 or greater earthquake, popularly called the Big One.

Precisely how soon they cannot say. Four years ago the United States Geological Survey estimated the probability of a huge quake's striking the southern end of the San Andreas fault at 60 percent in 30 years. But in interviews last week, most scientists said they expect it to happen much sooner.

"Most of us have an awful feeling that 30 years is wishful thinking," said Dr. Allan Lindh, director of the U.S.G.S. Seismology Branch in Menlo Park, Calif. "Everyone agrees that Los Angeles and San Bernardino should treat this like a final warning. It's like when you clean up camp. It's time to make that last pass through our cities, homes and lives and act as if the damn thing will

happen tomorrow."

Don't Panic, But Prepare

Dr. Lucile Jones, a leading expert on the southern San Andreas at the geological survey's office in Pasadena, Calif., said: "This is a wake-up call. I think we're closer than 30 years. It could be two years or five years or longer. But that doesn't mean people should panic this week. I ask them: 'What are you willing to do for the next two years? We have a higher hazard.'"

Scientists usually take each other's claims with reserve until they have been reviewed by independent experts and published in a scientific journal. The California seismologists have only just begun to analyze the data from the June 28 earthquakes and have not had time to write any papers. But they at least are taking their results seriously.

Scientists at the agency, Dr. Jones said, have bolted down bookcases, put Velcro on computer equipment and double-checked water supplies, batteries and backup power systems.

Three Minutes of Destruction

The southern end of the San Andreas fault has not ruptured for over 300 years, Dr. Jones said. When it does, the shaking will be many times stronger than the Landers

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earthquake and could last up to three and [a] half minutes. The Landers quake lasted 32 seconds.

Such a catastrophic earthquake could devastate cities like San Bernardino, Riverside and Palm Springs, which are within 20 miles of the San Andreas fault, said Dr. Thomas Henyey, director of the Southern California Earthquake Center at the University of Southern California. But Los Angeles and San Diego, which lie farther west, could also sustain serious damage if the shaking lasted three minutes. Some older structures on soft soils, built before strict building codes were adopted, won't be able to handle that much shaking, Dr. Henyey said.

So geologists and seismologists are feeling a sense of urgency as they crawl over the newly ruptured faults to find out what happened and what is likely to happen next.

In the back of their minds is the great engine that drives earthquakes in California, plate tectonics. The earth's crust is composed of scores of relatively rigid plates that float on a hot, viscous mantle below. Driven by hot, up-welling fluids, the plates grind past one another at a rate of two to four inches a year, creating vast fault zones that produce earthquakes. California is bisected north to south by the 800-mile-long San Andreas fault, which is the boundary between the Pacific plate and the North American plate. The Pacific plate is moving northwest at about 2 inches a year, while the North American plate moves southeast.

But for the past few million years, the boundary has been changing, said Dr. Tanya Atwater, a leading authority on plate tectonics at the University of California at Santa Barbara. Twelve million years ago, she said, the San Andreas ran a straight north-south line, passing offshore of Los Angeles near Catalina Island. But then, for reasons that remain a mystery, the vast block of crust carrying land from Baja California to Los Angeles broke away from North America and by five million years ago had attached itself firmly to the Pacific plate. Since it is now attached to the Pacific plate, the Baja crust region is moving northward.

When the Baja region jumped plates, the San Andreas fault had to make a big bend to the east to get around it, before heading south again through the Imperial Valley and to its terminus at the Sea of Cortez, Dr. Atwater said. Because of the northward movement of the Baja crust region, the San Gabriel and San Bernardino mountains that lie north of the Los Angeles basin are "flying up in the air," she said. Los Angeles, on the Pacific plate, is "with shocking speed" ramming into Northern California, which is mostly on the North American plate, she said.

But another mystery remained, Dr. Atwater said. Measurements show that the two plates are moving at an approximate rate of only 1.4 inches a year along most of the San Andreas. The remaining 0.6 inch of relative plate motion was unaccounted for.

The Landers earthquake may have provided the clue to the riddle, she said. The fault that broke two weeks ago headed north from the San Andreas into the Mojave Desert. At least six significant earthquakes fell along this same path in the last 50 years, said Dr. Amos Nur, a professor of geophysics at Stanford University.

New Path for San Andreas

Many scientists now believe that the San Andreas fault is trying to take a new route through the Mojave, through Death Valley and past the eastern edge of the Sierra Nevada range, Dr. Nur said.

This path, called the Eastern California shear zone, accounts for the missing plate motion, said Dr. Roy Dokka, a geology professor at Louisiana State University in Baton Rouge who first recognized the zone in the late 1980's.

If the San Andreas succeeds in breaking through this zone, it would head north past some active volcanoes on the eastern Sierras where the crust is thin and hot, Dr. Atwater said. But "if it can't find an easy way up through Oregon," she said, it might stop or it might try to head east or west.

The rest of California would attach itself to the Pacific plate and head northwest toward Alaska, and

the old San Andreas fault would slowly fizzle. "California is already stuck to the Pacific plate," Dr. Dokka said. "It's like a broken arm dangling at the side and being dragged along for the journey."

The new fault system may form in 100,000 years, Dr. Nur said. In the meantime, scientists have plenty of mysteries to solve concerning the Landers earthquake.

For example, minutes after the Landers earthquake, hundreds of small earthquakes magnitude 1 to 3 occurred near Mammoth Lakes, Mount Shasta and Mount Lassen, a full 530 miles to the north. A magnitude 5.6 quake struck in southern Nevada 175 miles away.

"For years we've been saying we couldn't envision any mechanism to link distant quakes, that such happenings were just a fluke," said Dr. David Jackson, a professor of geophysics at the University of California in Los Angeles. "Well, there are too many flukes this time."

Several ideas have been advanced to explain the phenomenon, said Dr. David Hill, a volcano expert at the geological survey in Menlo Park. The earthquake waves may have disturbed gas bubbles trapped in

magma chambers along the eastern edge [of the] Sierra Nevada range, he said. As in a shaken cola bottle, he said, the force of the gases could have set off small quakes.

Another mystery centers on the fact that this portion of the Mojave Desert was able to produce a magnitude 7.4 earthquake, one of the largest in California's history.

The Landers earthquake broke parts of four or five smaller faults as it cut a new major fault approximately 43 miles long, said Dr. Tom Heaton, a leading earthquake expert at the geological survey's Pasadena office. "Before this, we would have said you can't have a magnitude 7.4 quake on multiple faults," he said. "But it happened."

"We have many multiple faults in California, lots of them in the L.A. basin. We can string them together right beneath the city. That reopens issues of how we build structures."

This and the fact that Southern California has been experiencing flurries of earthquakes since 1986 has scientists and disaster preparedness officials very worried. "When you get a rash of quakes, you can expect more," Dr. Jackson said. "They come in bunches as if one quake stirs up the pot."

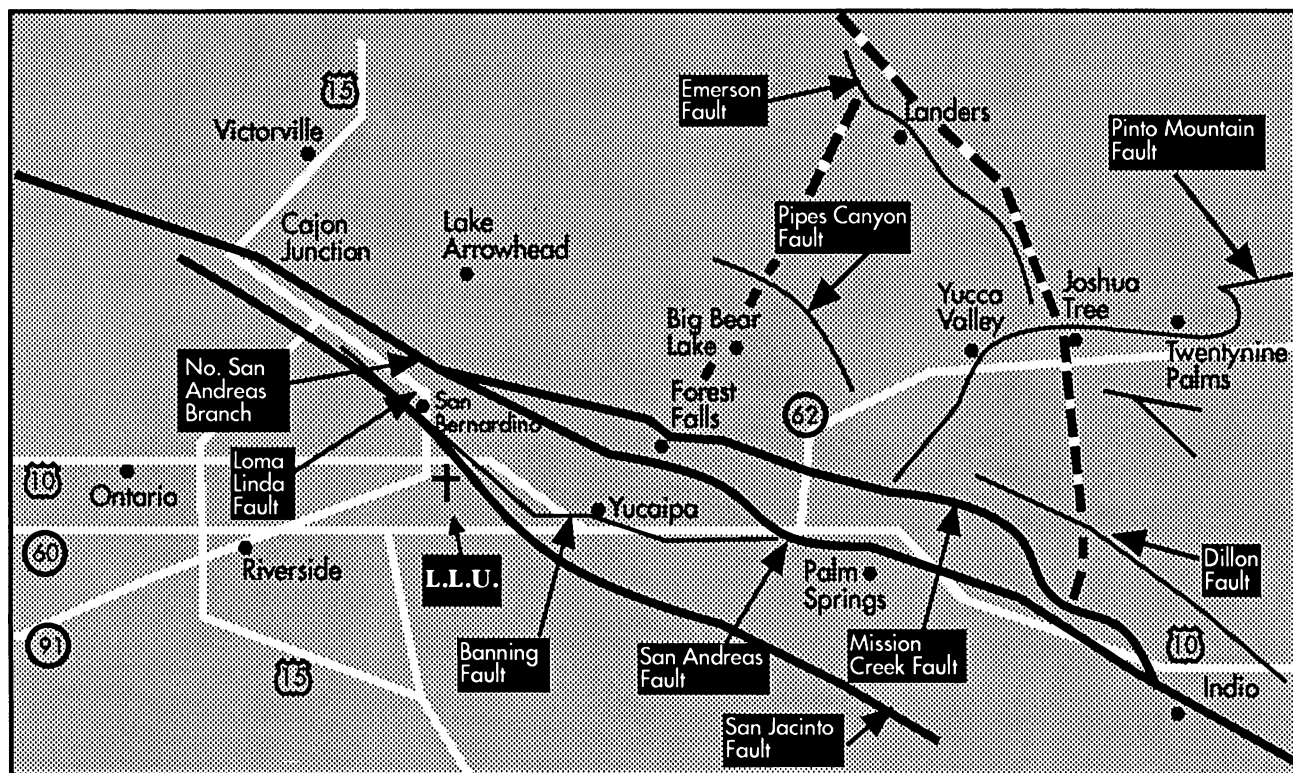
This notion is called the seismic cycle theory, said Dr. Lindh of the Menlo Park seismology office. For example, Northern California experienced flurries of magnitude 6.5 to 7 earthquakes in the 1830's, 1860's and again in the 1890's, just before the catastrophic 1906 San Francisco earthquake, he said. Southern California could be in a flurry heralding the Big One, or the area could quiet down for a few decades before it happens, he said.

From 1986 until the Landers quake, there were nine good-sized earthquakes in Southern California, and after the Landers quake, another 13 magnitude 5 quakes—some aftershocks, some on different faults—have shaken the region, indicating that a flurry is under way. Most have occurred at the head or tail of the San Andreas's southern section.

Because the tail has been locked in place since 1680, scientists are watching the northern end, near the Landers and Big Bear quakes, with trepidation.

"I'm calling the area the Bermuda triangle" because it lies near the Bermuda Dunes, Dr. Jackson said.

It is an apt name. The Landers fault and Big Bear fault both begin at



the San Andreas and then intersect to the north, forming a triangular block of crust, Dr. Lindh said. The base of the triangle is a 40-mile long segment of the San Andreas that has been profoundly changed.

During the earthquakes, this block of crust stretched an average of 10 feet to the north, up and away from the San Andreas, Dr. Lindh said. This reduced the clamping forces along the 40-mile segment, making it easier for the San Andreas to slip, seismologists said. Moreover, the relative motions of the Landers and Big Bear faults pushed the San

Andreas in exactly the right direction to help it snap.

"We can't say this is the straw that breaks the camel's back," Dr. Jackson said. "All we can say is that there is a straw and there is a camel. But there is wide agreement that this is one step toward a major earthquake on the San Andreas."

In a worst case, 240 miles of fault from the Salton Sea to Fort Tejon could break at once, Dr. Jones said. A break that long would release enough energy to cause three and [a] half minutes of shaking for hundreds of miles around.

Scientists will meet throughout the year to revise estimates of when the Big One might happen on the San Andreas's southern section, Dr. Henyey said. After the Loma Prieta earthquake in [sic] Oct. 17, 1989, scientists recalculated the risk of a huge quake in the northern section to be 67 percent in 30 years, from 40 percent.

In the meantime, Southern Californians are doing a good job of getting ready, Dr. Jones said. "They are not panicking," she said. "No one is flying out of town. But people are taking this warning seriously."