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Quakes' 1st Rumblings Hint at Size

■ A new study finds that faint signals at the outset of a major temblor offer clues to its magnitude. Some see its potential for early warnings.

By Usha Lee McFarling, Times Staff Writer

Faint signals during the first moments of a large earthquake can be used to predict the severity of ground shaking before a fault has finished rupturing, potentially offering crucial seconds for early warning, according to a new study

A few seconds may not sound like much but could be enough to turn off natural gas to prevent fires, isolate electrical and phone systems to protect them from failure, order children to dive under desks and allow surgeons in the operating room to pull scalpels away from vital organs.

"Fifteen seconds, seems huge to me," said Lucy Jones, the scientist-in-charge at the U.S. Geological Survey office in Pasadena. "We have engineers who say, 'If you could give me 100 nanoseconds, it would be useful.' "

But although she would love to see more early warning of quakes, Jones is among several seismologists who questior whether the new study brings them any closer to a workable system.

In the study, Richard M. Allen, a seismologist at UC Berkeley, and Erik L. Olson of the University of Wisconsin, Madison, analyzed 71 recent earthquakes. They found that the weak pressure waves that radiate out immediately from faults, called P waves, give off distinct frequency informatior Larger earthquakes were preceded by P waves of low frequency, they found. That allowed them to describe the size and location of an earthquake within four seconds, and sometimes within two.

"We're not going to be able to predict earthquakes in the near future. The only other option is short-term warning of a few seconds," Allen said. The work is published in today's issue of the journal Nature.

If there were a system in place to transmit the information, notice of impending shaking could be disseminated in about five seconds, Allen estimated. Very large quakes, such as the magnitude 7.9 earthquake that hit Alaska in November 2002, can last for more than a minute.

Shaking begins almost immediately near an epicenter, but it can take seconds, or tens of seconds, for shaking to occur in areas farther away. An earthquake that began at the northern edge of the San Andreas fault, for instance, would not be felt in San Francisco for 80 seconds, Allen said. Damaged areas 40 miles from the epicenter of the magnitude 6.7 1994 Northridge quake, he added, did not feel shaking for 20 seconds.

One problem, Jones said, is that the information yielded in the early seconds of a quake is not precise. "It tells you i might be a magnitude 3.5 or it might be an 8," she said. "I wouldn't want to be issuing early warnings based on this.

Allen agreed there was imprecision in his method, which analyzed earthquakes around the world in areas where th underlying geology is vastly different. He expects more precision when it is confined to smaller regions.

The study, which suggests that larger earthquakes announce themselves differently than smaller ones, is controversial because it challenges a current scientific doctrine called "the cascade model." That model suggests a earthquakes start out the same. In small quakes, according to the cascade model, the rupture stops relatively soon In larger quakes, a small slip loads stress onto the patch of fault next to it, and the rupture continues, or cascades, through longer stretches of fault.

The cascade model is considered "pessimistic," because if earthquakes all start out the same, there is little hope that early information from earthquakes would be of any use.

By contrast, the new study says that when a large earthquake is but "a small fraction of what it's going to be, it's already played its cards and said, 'I'm going to be big,' " said Tom Jordan, a USC seismologist and director of the Southern California Earthquake Center. "That offers hope."

Bill Ellsworth, a geophysicist and former chief scientist at the Geological Survey in Menlo Park, published a controversial paper in 1995 suggesting that weak, irregular rumblings generated in the first seconds of an earthquake might provide information about its size.

He said the work being published today is encouraging but thinks the creation of meaningful predictions for early warning will take a lot more data — and close-up observations of quakes as they occur. "Is there something different about how big earthquakes begin?" he asked. "That's still an open question."

In Southern California, early-warning systems would be useful for large quakes generated on the San Andreas faul some distance from population centers. The information would not be as useful on the many faults that crisscross the Los Angeles Basin near the surface and densely populated areas. "Unfortunately, the reality is the damage is going to be [near the epicenter] where the earthquake begins, and there you don't have any warning," Ellsworth said.

Much simpler early-warning systems are already in place in Japan, where the detection of ground shaking slows and stops bullet trains to decrease the risk of derailments. Taiwan, Turkey and Mexico City also have simple early-warning systems based on the detection of distant shaking that work well, seismologists said. Italy and Romania have developed prototype early-warning systems.

Simple P-wave detectors are in place in some California fire stations. In some cases, they are rigged to automatically open firehouse doors when shaking occurs so jammed doors do not trap trucks inside.

Allen is testing a system he calls ElarmS to create early-warning maps. Jones said her Geological Survey office is taking preliminary steps to test whether early information from quakes could provide rapid warnings without generating an unacceptable level of false alarms. Both scientists foresee the possibility of having early warnings go to sirens at schools, personal computers or cellphones.

There are no plans in the offing for a statewide or regional early-warning system, said Eric Lamoureaux, a spokesman for the Governor's Office of Emergency Services. "It's something that's really in its infancy and needs a lot more research from the scientific community," he said.

James Goltz, who is with the earthquake and tsunami program of the Governor's Office of Emergency Services, said emergency managers are interested in an early-warning system, but only if it is accurate, reliable and can enhance public safety — a goal that he estimates is still several years away. "At this point, it's essentially in research and development, not something that's ready for deployment."

Jones said any early-warning system would require funding to improve the region's existing network of seismic sensors, which provides first responders with damage information minutes after a quake and collects data that engineers later use to improve building safety. The current network is not extensive enough near the San Andreas fault to provide the quick and accurate readings needed for early warning of a major quake. Many sensors also need telecommunications upgrades to relay instant information, she said.

The upgrades that would make the system usable for early warning are long overdue, seismologists say. "It's frankl appalling to me," Jordan said, "how far behind this country is in developing early-warning systems."