

Shaking up system of quake predictions

Pair's alarm could save people, buildings

David Perlman, Chronicle Science Editor

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Predicting earthquakes has long been the hope of scientists who study the motion of the planet's huge tectonic plates and the seismic faults that crisscross Earth's crust like a tangle of torn tapestries.

Even brief warnings that a major temblor is about to strike could save countless lives, but despite a few claims of successful forecasts by scientists in quake-prone countries, no consistent quake prediction technique has been devised. The mobile Earth's behavior is still filled with mysteries.

Now, however, a seismologist in Wisconsin and a geophysicist in California have developed an alarm system that promises to offer at least a few crucial seconds of warning that a major quake is about to strike. Simulations so far suggest that the technique can signal a quake's magnitude and where the most dangerous ground motion might threaten people and buildings.

Less than a minute's warning is time enough, the scientists say, for ambulances and fire engines to fire up, for schoolchildren to "duck and cover" beneath their desks, or for airport control towers to warn approaching pilots to veer off.

The new system has been devised by Richard Allen, a seismologist at the University of Wisconsin, and Hiroo Kanamori, a geophysicist at the California Institute of Technology. They published their first description of the concept in the current issue of the journal *Science*.

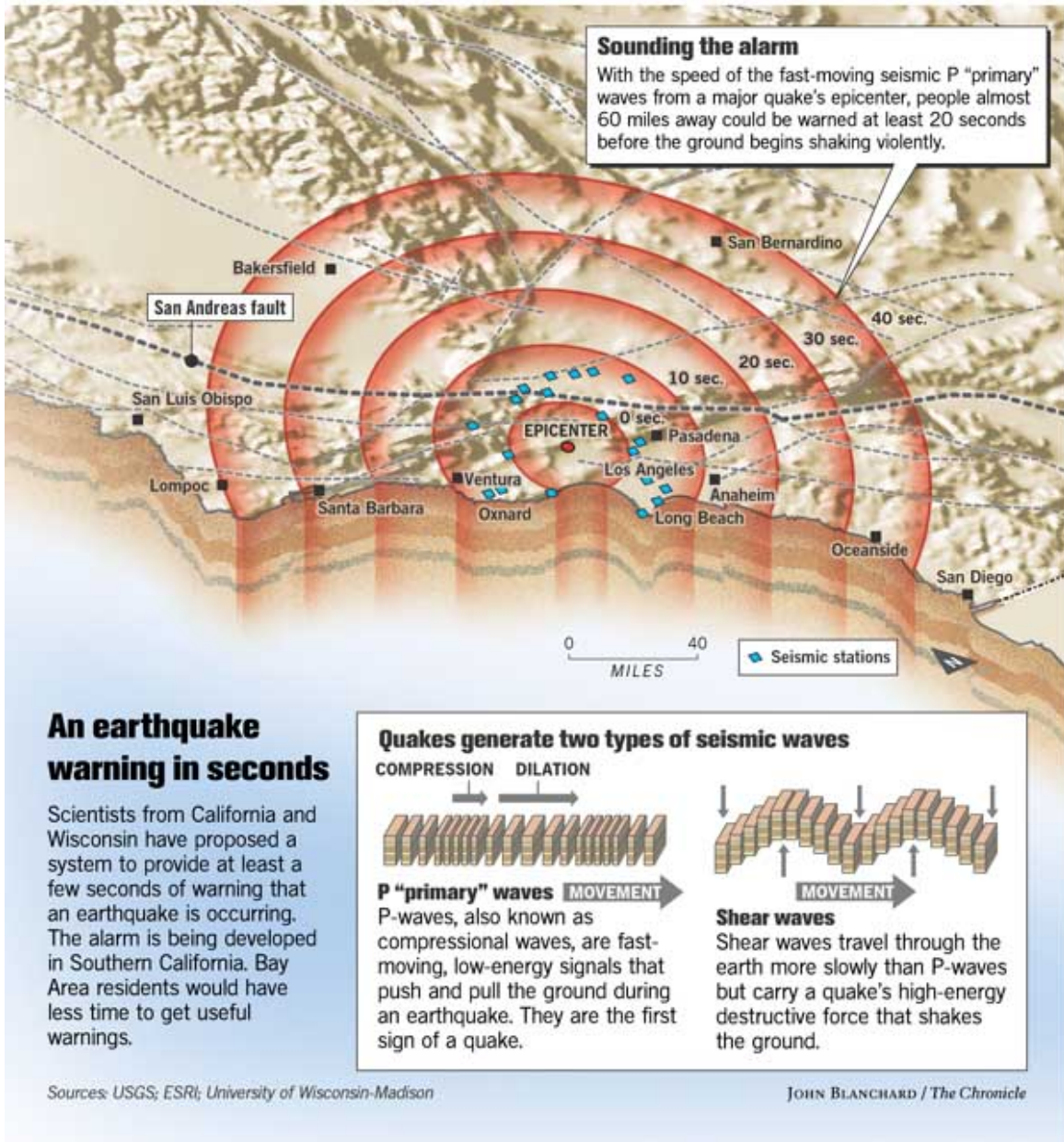
It would exploit a \$20 million instrument array called TriNet -- 155 highly sensitive broadband seismographs deployed throughout the Los Angeles Basin, plus sophisticated software written for the newest generation of high-speed computers.

Only a few seismographs of this type are installed in Northern California, scattered from Monterey to Clearlake (Lake County). But given the funds, a similar network could be created here, according to David Oppenheimer of the U. S. Geological Survey's western earthquake hazards team in Menlo Park.

ALARM LESS USEFUL IN BAY AREA

In Northern California, U.S. Geological Survey experts, together with the state and other agencies, have installed an even larger array of other seismic instruments. Called accelerometers, they yield the detailed data needed to generate high-resolution "shake maps" within minutes after any quake with a magnitude greater than 3.5. The maps allow some time to survey or evacuate dangerous buildings, divert traffic and pinpoint other hazards, Oppenheimer said.

An alarm system like the one being developed for Southern California probably would prove less useful here, he said.



"The Bay Area is riddled with faults, and people are living right on top of them," Oppenheimer said, "so we'd have a much shorter time -- not even a few seconds -- to get any useful warning out if a big quake hit here."

The system that Allen and Kanamori have devised is based on one of the two principal seismic waves

that shake the ground and move in all directions when an earthquake strikes.

The first, called primary or P-waves, are much like sound waves. Although their impulses hit the ground like a series of punches, they carry little energy and are only rarely damaging or even felt.

The second type of seismic waves from an earthquake are the destructive Shear waves, which carry much more energy as they shake and rupture the ground in waves like the wobbles of a Slinky toy.

Although speeds vary, on average P-waves travel much faster than Shear waves -- about 3 miles a second versus 2 miles a second, according to Kanamori.

So detecting P-waves can provide advance warning before the powerful high- energy ground motions from a large quake have arrived.

If another big quake, such as the disastrous Loma Prieta temblor in 1989, were to hit the Bay Area, the P-waves from the temblor would reach the Cypress freeway structure in the East Bay, almost 60 miles away, a full 20 seconds before the slower and destructive Shear waves.

In 1989, it was the Shear waves from Loma Prieta that caused the Cypress structure to collapse, killing 42 people. Oppenheimer recalled that when fresh P-waves were detected from Loma Prieta days later, scientists were able to signal freeway workers that within seconds they would feel a moderate aftershock but could safely continue working.

JAPANESE SYSTEM'S INFLUENCE

Different early warning systems for earthquakes have been used in many countries, but they are based on radio signals triggered by Shear waves from the powerful ground motion of the quake itself -- and so move much more slowly.

In California, sirens in several communities are programmed to sound warnings when seismographs detect unusually strong P-waves from a quake, but they do not pinpoint a temblor's epicenter or calculate magnitude.

Allen and Kanamori's system is based partially on a somewhat similar Japanese early-warning method that has been used successfully to stop Japan's famed bullet trains safely before running into quake-damaged ground.

The two scientists have dubbed their technique ElarmS, for Earthquake Alarm System, and they say it can swiftly determine an earthquake's location, point of origin, time and magnitude.

The first tests of the system, aimed solely at determining whether in P- waves can be analyzed accurately within two or three seconds, are due this summer, Allen said.

With the blazing speed of today's advanced computers and their newly designed computer program, the arrival of the first P-waves from a potentially damaging earthquake could trigger an alarm that reaches communities 100 miles away in less than a minute, according to their calculations.

STATE SEEKING DETAILED REVIEW

Richard Eisner, coastal chief of the state Office of Emergency Services, called the concept intriguing but said: "It would need a dense array of instruments and telemetry to get the information out to hospitals and schools and safety personnel."

Nonetheless, Eisner's office will seek a detailed review by a panel of experts next month to decide

whether the science is credible, whether it's applicable for California, and what its costs might be.

Kanamori and Allen concede that their system would require elaborate and expensive hardware to link all the state's emergency services to the ElarmS system and that specialized personnel would have

to be trained to respond instantly. The problem of false alarms must be resolved too, they agree.

"But we believe this is technically feasible," Kanamori said in an interview. "It's a small step but hopefully a useful step toward what seismology can do to save lives."

E-mail David Perlman at dperlman@sfnchronicle.com.

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