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Big One's first jolt might be a lifesaver

Researchers say fast computer analysis could allow quake alert in early seconds

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Scientists studying the first jolts of an earthquake believe they have found the key to providing early warnings of imminent danger from a big one -- enough to give a few precious seconds to allow people to duck for cover before the earth shudders violently beneath them.

Their findings are by no means merely another in a long line of fanciful earthquake prediction claims but are based on careful study of the physics and different frequencies of the different waves that all quakes generate, the researchers say.

The first seismic waves that jolt the ground in the instant when a quake is beginning to rupture are the crucial clue to predicting just how strong the full-scale quake will become, they say.

In an article in today's journal Nature, researchers Richard M. Allen of UC Berkeley's Seismological Laboratory and his former graduate student, Erik L. Olson, report that they have developed a computer-based formula that analyzes the first pulse of high-speed seismic waves -- those that jolt the ground like a sharp punch when an earthquake starts -- and within seconds predicts the size of the violent high-energy waves that follow more slowly through the earth. Those waves become the major source of destruction.

"We can determine the magnitude within a couple of seconds of the initiation of rupture and predict the ground motion from seconds to tens of seconds before it's felt," Allen said.

For example, he said, if a truly large earthquake begins with its epicenter at the northern end of the San Andreas Fault, a warning of its ultimate magnitude and possible dangers to San Francisco could reach Bay Area officials within 80 seconds of the quake's start, given effective communications systems, Allen said.

That could give time for utilities to shut down or isolate gas and electric services, for airports to halt takeoffs and landings, for emergency crews to spot potential trouble areas and for residents to seek shelter.

Even a few seconds of advance notice could save lives and money, he said.

In their report in Nature, Allen and Olson note that when earthquakes rupture along underground seismic faults, they shake the earth in many ways, and a quake's first jolt sends out what scientists call fast-moving primary waves, or P waves. P waves are often likened to a sharp punch that compresses the earth much as a wave of compression moves swiftly through the coils of a stretched Slinky toy when it's pushed sharply at one end.

Later, more slowly, come the secondary, or shear, waves. These waves move the earth strongly up and down and side to side -- the violent motions that can

wrench poorly built houses apart, topple brick walls, shake cornices loose from unprotected buildings and cause quake-resistant skyscrapers to sway.

Ten years ago, geophysicists William L. Ellsworth of the U.S. Geological Survey in Menlo Park and Gregory C. Beroza of Stanford University studied 30 of the most recent earthquakes in California and South Africa and concluded that the strength of the jolts of the first P waves "exerts a strong influence on the size of the eventual earthquake."

That observation led Allen and Olson to study in much greater detail the relationship between the nature of a quake's P waves and its subsequent shear waves. They determined that the first jolts could indeed enable them to predict the ultimate magnitude of the temblor within seconds.

With thousands of seismometers arrayed above and below ground throughout California, those P waves could be detected and analyzed by computer, and a prediction of the size and location of ground shaking could be relayed to danger areas, all within seconds, Allen said.

A statewide network of earthquake research centers now posts "shake maps" on the Internet within minutes after every quake of any significant size in California, but those maps -- valuable as they are to emergency crews and reconstruction planners -- are completed only after a quake's ground motion has ended.

Allen believes his work could make instant "predictive shake maps" possible, showing the magnitude and direction of a quake just as it starts and before the ground has begun shaking several miles away from its epicenter, he said.

Teams of scientists at the USGS and other quake research centers are evaluating the researchers' work.

Previously, Allen and a colleague, noted Caltech seismologist Hiroo Kanamori, created a set of equations to predict the size and danger of full-scale quakes by measuring the P waves of the temblors at seismographs located close to a given quake's epicenter. They call their equations ElarmS -- short for Earthquake Alarm Systems -- and are testing them in Southern California.

Both Ellsworth and Beroza, the geophysicists involved in the study a decade ago, voiced reservations Wednesday about Allen and Olson's report.

"The question is whether the system offers truly useful information," said Ellsworth. "It may have limited usefulness, but it doesn't appear to be a cure-all."

"It's an interesting notion that needs to be tested thoroughly," said Beroza. "But it might indeed prove important for early warning of dangerous ground shaking at a time when every second counts."

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