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## RESEARCH

# Earthquake alarm system may ease risk for southern Californians

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[Terry Devitt](#)

Capitalizing on the low-energy waves that invariably precede major earthquakes, scientists have designed and demonstrated the feasibility of an early-warning system that promises southern Californians as much as 40 seconds of advanced notice of major temblors.

The system, described in the Friday, May 2 issue of the journal *Science*, could help mitigate disaster by giving people a few moments to take shelter under solid furniture, evacuate buildings, divert aircraft, stop trains, shut down pipelines and computer networks and distance themselves from dangerous machinery and chemicals.

The system is based on [TriNet](#), a dense network of modern seismic stations deployed in southern California.

"An early warning system is the next generation of seismic information," says Richard M. Allen, a University of Wisconsin-



[Informational graphic - view full-size version](#)

Madison professor of geology and geophysics and the lead author of the paper that describes a prototype earthquake alarm. "There is a capability now of detecting earthquake parameters within a matter of seconds" and transmitting that information in a way that could provide some early warning to the densely populated, earthquake-prone region.

The earthquake alarm system, developed by Allen in collaboration with Hiroo Kanamori of the California Institute of Technology's [Seismological Laboratory](#), is designed to use a network of 155 seismic stations now in place in southern California. It utilizes what seismologists call P-waves, low-amplitude waves of energy that are the first to emanate from the underground source of an earthquake. These low-energy waves, which usually cause little damage, travel at greater speeds than the ground-rollicking S-waves that are the biggest threat of any earthquake to life and property.

"The system estimates how serious the danger is and how much warning time there is," says Allen.

Seismic stations can sense the P-wave and - given the advent of technology that permits near-instantaneous data processing and transmission - send signals to trigger alarms to warn the public, Allen says.

The system, known as ElarmS, is capable of quickly determining the location, origin, time and magnitude of an

earthquake before there is any significant ground motion. The amount of warning time people would receive depends on their proximity to the epicenter of the earthquake; the farther from the origin of the event, the more warning time is available.

"People who need warning the most will have less time, but at least the system can give people a chance to react," Allen says. "In an earthquake, every second counts."

A few seconds is enough time to take shelter under a desk or in another protected area. As the amount of warning time increases, people can take other steps to protect themselves, mitigate property damage and danger to others.

For example, with 15 to 20 seconds of warning, air traffic controllers can wave off inbound aircraft, factories can stop production lines, traffic can be prevented from entering freeways, gas pipelines can be shut off, and trains can be stopped. With that much time, people can also evacuate some buildings and schools can take steps to protect children.

One concern, however, is the relative infrequency of large earthquakes. Given their infrequent occurrence, people may not respond to an early warning, says Kanamori: "The most exciting and effective applications of early warning systems would be to include them in automated control systems for buildings and structures."

With ElarmS, the outside

warning time would be about 40 seconds for people at some distance from the epicenter.

For some large earthquake events, there may even be more warning time available as they tend to occur deeper within the earth.

In Japan, an early warning system employing P-waves, known as UrEDAS, has been used to maintain safe operation of bullet trains during large earthquakes. The new system devised for southern California, combines P-wave information from several stations of TriNet to get rapid and accurate magnitude estimates.

Other earthquake-prone countries such as Mexico and Taiwan have developed early warning systems based on measurements of peak ground motion the instant the ground-shaking S-wave is detected by a seismic station. The advantage of the new system, says Allen, is that it uses the low-energy P-waves, providing precious seconds to react before the damaging S-waves arrive.

Some early warning systems, such as the one that serves Mexico City, capitalize on the distance between a seismologically active area and the densely populated region the system is intended to warn. Such a luxury is not available to southern California, almost all of which is densely populated and which is laced with many active faults, some of which are unknown.

With this system, "we don't need any knowledge about the

distribution of faults," Allen says.

Among the drawbacks to the new system described in Science, is that it would require a massive campaign of public education, and there is a potential for false and missed alarms, Allen says.

For the 'Big One,' the anticipated major earthquake that would rupture a significant portion of a big fault, the new system would continually update its estimate of earthquake magnitude, perhaps initially suggesting a smaller earthquake, but increasing the magnitude and hazard estimate as the event evolves, Allen says.

However, most earthquakes, including those that take life and do significant damage to property, tend to be more isolated events that would lend themselves to early detection, according to the Wisconsin seismologist.

The advantage of the system is that, from a technical and infrastructure perspective, nearly everything is already in place. Southern California has hundreds of state-of-the-art seismic stations that could be harnessed to such an alarm system, Allen notes.

"The seismic infrastructure to do this has only been installed in the last five years," Allen says. "Ten years ago, we didn't have the technology to do this."

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