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NEWS

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Could we speed up quake warnings?

Data hint that the first moments may reveal a tremor's magnitude.

David Cyranoski

Seismologists have come up with some surprising data that could improve earthquake-warning systems. They say that the first second of an earthquake can give away information about how big it will ultimately be. This would allow officials to send out warnings precious seconds earlier than they do today.



Seconds of warning for a quake can help emergency planners shut down trains and turn on backup power systems.

© Nature

A few seconds' warning might not seem a lot, but it can allow trains to be stopped and gas to be shut off. Furthermore, the information is given by the first shock waves (called P waves), when an earthquake begins to tear deep within the earth. So any warning could arrive several tens of seconds before surface vibrations begin to knock down buildings.

Japan currently issues warnings three seconds after an initial

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rupture, with those warning messages travelling faster than the destructive energy from the earthquake. Anything that can be done to reduce the delay, experts say, would be extremely helpful.

earthquake ear  
 Yutaka Nakam  
 affiliation

The data analysis<sup>1</sup> is controversial, however. It adds to a long-standing debate in the earthquake community about whether it is theoretically possible to determine the outcome of an earthquake from its beginnings.



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**Quick step**

Most earthquakes are very brief. A magnitude-4 tremor typically peters out after less than a second. A magnitude-5 earthquake may last on the order of seconds. And a devastating event of magnitude 7 or 8 may last tens of seconds.



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According to a traditional theory, called the cascade model, we cannot know anything about an earthquake's ultimate magnitude until it is finished. This is because spread along a fault line depends on the stress in each individual part of the fault. Given that this information is not available to the initial rupture point, it should be impossible to tell from that first slip how far it will go or how long it will last.

But research from Japan flies in the face of this idea. During the 1980s, Yutaka Nakamura, an earthquake engineer at a Tokyo company called System and Data Research, found that the frequency of the P wave in the first few seconds allowed people to distinguish earthquakes of more than magnitude 6 from smaller tremors that did not require warnings<sup>2</sup>.

"Basically, a high-pitched squeal means that you'll get a smaller quake. A low-groan means something bigger," says the University of California's Richard Allen.

**Just one second**

In a paper in this week's *Nature*, Allen shows that we might be able to do even better than that, and distinguish small earthquakes from big ones from the very first second of information<sup>1</sup>.

He says that an analysis of the P waves of 71 world-wide earthquakes, including 24 events topping magnitude six, show that the final magnitudes could be

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'predicted' from the first few seconds of information. In more than 60 of these earthquakes, the first second alone was sufficient.

But geophysicist Satoshi Ide, of the University of Tokyo, is not convinced. He says the data for earthquakes of more than magnitude 6.5, which last longer than a few seconds, is not well correlated with initial P-wave information.

Allen agrees that the data are not as clean as one might hope. "This is not a slam-dunk case," he says. But he hopes that the idea could help plans for a warning system in California, which aims to send out alerts within a few seconds of an earthquake.



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