# Bright lights, big quake?

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**Does the earth have its own early warning system for earthquakes?**

Subtle changes in a regional magnetic field, the earth's ionosphere or other physical phenomena may portend a major earthquake, according to emerging research. The data isn't conclusive, and many experts are skeptical, but some researchers believe that monitoring these planetary stress symptoms--harvested in real time by sensors and magnetometers, which measure changes in magnetic fields--could someday help people prepare for earthquakes.

**NEWS.CONTEXT**

**What's new:**

Some researchers believe that radio crackling, surges in heat and other phenomena may be signs of a coming earthquake, and monitoring these planetary stress symptoms could someday help people prepare.

**High Impact**

**Bottom line:**

Predicting exactly when the next giant quake might hit next, however, has proved elusive, and many experts are skeptical that examining the behavior of rocks or other such data will prove promising.

"We all agree it would be worthwhile to have from a loss of life standpoint. You certainly can't stop it from happening," said Tom Bleier, president of QuakeFinder, which is developing technology that could one day predict quakes hours or even days in advance. "This is a tough nut to crack. It's taking a lot of time, and everybody is trying to report what they (observe) to see if there is a trend here."
Quake prediction will be one of the topics this week at a seismology conference in San Francisco that coincides with the 100th anniversary of the massive San Francisco quake that took place on April 18, 1906.

Earthquakes tend to occur in regular cycles, and seismologists can somewhat accurately predict the probability of earthquakes along a given fault over an extended period of time. There is a 60 to 70 percent chance of a major quake hitting California's Bay Area within the next 30 years, for example.

Predicting that the giant rumbler might hit next Monday, however, has proved elusive. One area of research that appears promising comes in examining the behavior of rocks immediately before a quake.

After a major quake in the greater San Francisco Bay Area in 1989, scientists at Stanford University, looking retroactively at data from a magnetometer, noted that two weeks before the quake, electromagnetic readings for an area near one of the faults active in the quake jumped significantly. Three hours before the quake, the readings from an electromagnetic field rose to 60 times the normal level. Magnetic readings further stayed elevated weeks after the quake as the ground subsided.

Friedemann Freund, a researcher who works with NASA and the SETI Institute, has conducted experiments on rocks under stress. When subject to pressure, normally inert rocks produce positive charges, Freund found. The positive charges, which increase as pressure does, in turn generate an electric field, which generates a magnetic field.

"A rock, when you squeeze it, becomes a battery," he said.

Freund's research was conducted in a lab, but when extrapolated to large areas, the changes could account for the fluctuations in the electromagnetic field in the region around a fault, under the right conditions.

Earthquakes occur when two tectonic plates hit head on or slide against each other. The changes in the electromagnetic field could be generated when the rocks bordering the two plates begin to grind against each other.

**Searching for clues**

The positive charges emitted by the pressured rock could also explain other so-called earthquake precursors. When the earth becomes positively charged, the positively charged particles of the ionosphere, a layer of the atmosphere that sits about 90 kilometers (56 miles) above the earth's surface, will get pushed away and get replaced by negatively charged particles.

The sudden rush of negatively charged electrons in that portion of the ionosphere in turn should interfere with radio waves and reception. Radio interference, in fact, occurred in the days before the huge 1960 Chilean earthquake and the Good Friday earthquake in Alaska in 1964.

**Video: Seismology turns to high tech**

NASA works with the U.S. Geological Survey to track and understand the earth's restless crust.

Rock stress may additionally explain surges of infrared energy, which manifests itself as luminescence, observed before some quakes. Eerie lights in the sky were seen before the earthquake swarm in Japan between 1965 and 1967, which could have been a manifestation of a burst of energy caused by an earthquake. Scientists at NASA's Goddard Space Flight Center have recorded data showing infrared blooms approximately 50 to 100 kilometers across occurring a few days before a quake. In experiments conducted by Freund, the positive charges generated by rock under pressure can convert to infrared energy.

"Lab experiments show two things. One, there is a current generated when you start to crack a rock before it crumbles and, two, there is infrared energy that comes out of the rock when the charged particles drop their energy," Bleier said. "The question now is, does the same happen when you are 15 kilometers underground? Do they generate big currents? Do they generate infrared blooms? What we've got to do is get more data from large earthquakes."

Strange animal behavior, conceivably, might be the reactions to these environmental changes, Freund and others have speculated.

Still, the data is far from conclusive, said Greg Beroza, a professor of geophysics at Stanford. After examining the magnetic readings from the San Francisco Bay Area 1989 quake, the same researchers examined magnetic field readings after a 1999 quake in Southern California. The readings didn't spike. Beroza further added that the pressures that Freund applied to rocks in the lab seem to exceed the pressures exerted in real earthquakes.

"I'm kind of skeptical," he said.

Other precursors aren't panning out so well either, Beroza said. About five years ago, geologists discovered that low-level earthquakes appear to occur below part of Japan, similar to the rolling tremors that occur below volcanoes. Intuitively, these would seem to be a kind of precursor, but so far the data hasn't panned out.

In an attempt to get real-world data, QuakeFinder has created a network of 70 ultra-low and extremely low frequency magnetometers, along faults stretching from Mexico to Eureka in Northern California.

The sensor network likely can't predict a quake--scientists would need a network of 200 sensors with one placed every 20 miles to do that--but the devices can gather data that can be analyzed retroactively to see if a correlation exists between spikes in electromagnetism and quakes.

The company, along with France's Centre National D'Etudes Spatiales, also has sensors on satellites to detect ionospheric changes.

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While not conclusive, the results raise eyebrows. QuakeFinder's sensor network revealed that changes in the electromagnetic field began to occur before the San Simeon quake of 2003 as well as nine hours before the Parkfield earthquake in September 2004. The network also detected magnetic field changes a few days before a quake near Anza, Calif. The data was significant, Bleier said, in that the Anza quake measured only 5.2 on the Richter scale, lower than the 6.0 threshold the company assumed would be needed to generate detectable signals.

Data from Demeter, a French satellite, show ionospheric changes occurring in conjunction with a number of earthquakes. NASA is also conducting experiments to determine whether minute surface movement detected by satellites can serve as earthquake precursors.

Doubt, though, abounds. A five-year program for studying electromagnetic precursors at Japan's RIKEN, a scientific institute, was killed off. QuakeFinder has landed grants from some agencies but not enough to conduct all of the experiments it would like. The U.S. Geological Survey has rejected grant applications from QuakeFinder a couple of times. Freund says that scientific prejudice is behind some of the doubt.

"I'm now actively targeting the people who are most opposed to these ideas, who generally are seismologists," he said. "Many of them are very limited in their scope."

Getting venture capitalists to invest in earthquake warning systems remains difficult, because the potential payout is almost nonexistent. QuakeFinder's private funding has come from satellite companies.

If anything, the parties at least agree on this: There's still a lot we don't know.

"We're learning new things about the earth all the time," Beroza said.