Earth Science

Waves in the night: Clues to a quake

Are some of the world's greatest earthquakes lurking in the future for the Pacific Northwest? Geologic evidence tells scientists that large tremors have struck the region repeatedly, most recently about 300 years ago. But the lack of written records before 1800 makes it difficult to judge whether such shocks measured magnitude 8 or magnitude 9 in size. That's a profound difference, since the larger quake packs 30 times the energy of the smaller and would shake the entire region from northern California to southern British Columbia.

Japanese seismologists can help resolve the question, they claimed last month at a meeting of the Seismological Society of America in El Paso, Texas. Kenji Satake of the University of Michigan in Ann Arbor and his colleagues at the University of Tokyo reasoned that great quakes on the west coast of North America would have spawned large tsunamis that crossed the Pacific. Any mention of damage from such waves in Japan's long historical records could then shed some light on the timing and magnitude of North American quakes.

The researchers found that a tsunami did indeed buffet Japan's coast in A.D. 1700, about the time geologists give for the last Pacific Northwest quake. Satake and his colleagues like the match. Although earthquakes in many parts of the Pacific can trigger tsunamis that reach Japan, the scientists ruled out these other sites. Written records in South America and Kamchatka do not mention any great jolts in 1700. And although Alaska lacks records that far back, geologic evidence in the region shows no sign of a giant tremor in that year.

According to Satake, the timing of the tsunami also points to an origin in the Pacific Northwest. The wave hit Japan between midnight and dawn on Jan. 28, which means it would have started its 10-hour journey across the ocean after 9:00 p.m. in the Pacific Northwest. That fits with local tales that describe a great shaking in the middle of a winter night.

From the size of the tsunami, the quake must have been a whopper. Satake calculates that a tremor along the Pacific Northwest coast would have had to reach magnitude 9 to produce the 2-meter- to 3-meter-high waves that pounded Japanese shores. A magnitude 8 quake would generate a tsunami there only about 40 centimeters in height.

The new report has intrigued researchers because it offers information otherwise unavailable about ancient quakes. But they wonder how well Satake and his colleagues can rule out other parts of the Pacific as the source for the tsunami of 1700. If the Japanese scientists are right, then residents across the Pacific Northwest have to face the prospect of a megaquake sometime in their future.

A test of tiny tremors

Thirteen quakes should strike the town of Parkfield, Calif., by the end of 1996, according to Robert Nadeau of the University of California, Berkeley. His prediction, made in December 1994, won't mean much to town residents because the expected quakes will reach only magnitude 1 in size. But the test can help scientists assess methods for predicting larger quakes.

Seismologists forecast quakes by looking at the average interval between jolts in a particular place. While shocks do not recur like clockwork, they often follow a rough pattern. Nadeau used this method to predict time windows for microquakes in 13 spots around Parkfield. If the technique works, it should catch at least two-thirds of the quakes. The advantage of working with microquakes is that they recur much more frequently than larger shocks, so Nadeau can easily test the predictions. But so far, two windows have closed without any quakes, he reported at a meeting of the Seismological Society of America.

Physics

Ivars Peterson reports from San Jose, Calif., at an American Physical Society meeting

Dipping into liquid imaging

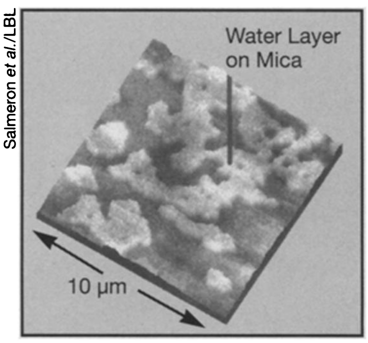
By dragging the tip of a microscopic needle back and forth across a solid surface, an atomic force microscope can detect and image surface features as small as individual atoms. However, applying the same technique to liquid surfaces merely wets the tip and disturbs the material.

Now, Miquel Salmeron and his coworkers at the Lawrence Berkeley (Calif.) Laboratory have developed a novel technique for surveying the microscopic structure of liquid films. Called scanning polarization force microscopy, the method depends on detecting slight variations in the attractive electric force between the microscope's electrically charged needle and a liquid's molecules.

Normally, it's hard to image liquids, and their structures are largely unknown, Salmeron says. This technique offers a way of obtaining information about such processes as corrosion and the evaporation and condensation of thin films of water on solid surfaces.

The researchers coat a conventional silicon nitride cantilever and needle with a thin layer of platinum, then connect the unit to a battery. This produces an intense electric field at the needle's sharp tip. Brought no closer than about 200 angstroms from a liquid's surface, the needle induces changes in the distribution of electric charge and orientation of the liquid's molecules, creating an attractive force. By scanning a surface without touching it, the researchers can create a map showing variations in the electric force, which generally correspond to surface topography. The method can detect features larger than about 200 angstroms across.

Salmeron and his colleagues have used the technique to monitor the wetting of an extremely smooth mica surface. Freshly cleaved in a humid environment, mica readily acquires a one-molecule-thick layer of water. As the humidity increases, a second layer begins to form, creating distinctively shaped patches, or islands, of water atop the first layer (see illustration). The researchers find a strong correlation between the straight edges of these water islands and the geometry of the underlying mica crystal structure.



Salmeron et al./LBL

"Islands" of water on a mica surface.

This type of microscopy may prove useful for contamination and environmental chemistry studies, Salmeron says. His team has already examined the microscopic details of how tiny droplets of sulfuric acid attack aluminum. "It tells you *where* things are happening," he says.

Currents in mercury superconductors

The addition of mercury to copper oxide superconductors has allowed researchers to create materials that lose all resistance to the flow of electric current at temperatures as high as 130 kelvins (-143°C). Now, Arunava Gupta and his colleagues at the IBM Thomas J. Watson Research Center in Yorktown Heights, N.Y., have produced thin films of these superconductors capable of sustaining current densities at least 10 times greater than those possible in bismuth- or thallium-based copper oxide superconductors.

Because high currents tend to destroy superconductivity in these materials, this achievement enhances the potential of using mercury-based superconductors for making SQUID magnetometers and other devices. The experiments, involving a compound of mercury, barium, calcium, copper, and oxygen, were done at 110 kelvins in a weak magnetic field.