Earthquakes: The deadly side of geometry

In a discovery bound to raise the ire of real estate agents, a seismologist has discovered that living near certain faults poses significantly more danger than previously thought. Other faults, however, may not be as fearsome to their neighbors as they had once seemed.

Earthquakes often appear to strike capriciously, sparing some regions while devastating others nearby. By studying foam rubber models of faults and computer simulations of quakes, James N. Brune of the University of Nevada in Reno found that the geometry of faults may explain some differences among earthquakes. He reported on his research at last month's meeting of the American Geophysical Union in San Francisco.

Brune focused on two types of earthquakes, both stemming from faults that dive into the ground at an angle. In thrust fault earthquakes, land on one side of a fault gets driven up and over land on the other side, much like a block pushed up an inclined ramp. The contrasting situation is a normal fault earthquake, during which rock on one side of the fault gets pulled away from and down relative to the rock on the other side, like a block sliding down a ramp.

According to standard seismological theory, it should make little difference whether a house sits next to a thrust fault or a normal fault. Brune's simulations, however, revealed much stronger shaking near thrust faults, especially on the so-called hanging wall, the land that rises during a quake.

"If this model applies to the real earth, it's very dangerous for people living on the hanging wall of the thrust," says Brune.

The reason stems from differences in the seismic waves generated when a fracture develops and starts to grow. During a thrust earthquake, the fracture sends out a pulse of compression, which squeezes rock. When this pulse reaches Earth's surface, it reflects downward as a pulse of dilatation, which reduces stress on the rock. As these reflected waves intersect the fault, they relieve frictional pressure on the growing quake, allowing the rock on either side of the fault to slide more freely.

This amplification enhances shaking when the fracture reaches the surface. Normal fault quakes have the opposite geometry, which weakens the tremors.

Seismologists lack the critical measurements needed to test Brune's hypothesis for actual quakes. But circumstantial evidence of unusual damage patterns exists, Brune says. For instance, after the 1971 thrust fault earthquake in California's San Fernando Valley, geologists found signs of shattered ground—soil overturned by intense shaking—only on the hanging wall side of the fault.

In contrast, a strong normal fault earthquake in Nevada in 1954 failed to knock over ketchup bottles in a shack, even though the quake ruptured the ground only a few meters from the building. What's more, Brune has also discovered many precariously balanced rocks near normal faults, suggesting that the shaking immediately next to these faults is less intense than expected.

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In 1954, a quake ruptured a fault beside this house in Nevada, producing a prominent scarp but leaving ketchup bottles upright and unharmed inside.

Thomas H. Heaton of the California Institute of Technology in Pasadena says that Brune's findings could explain the mysterious case of a strong earthquake that hit Japan in 1945. "The thrust fault went right through town. The story was that the houses on the hanging wall were demolished, while houses on the foot wall were much less damaged," says Heaton.

"There is little doubt that the phenomenon happens," says Heaton. "But it's not yet clear what its widespread importance is yet."

The reflected waves that Brune studied would have little effect on earthquakes that fail to reach the surface, like the 1994 Northridge, Calif., earthquake. What's more, the amplified shaking only threatens regions close to thrust faults. At this point, however, seismologists cannot tell how close is too close. The affected regions could extend just a kilometer from the fault or much farther. *—R. Monastersky*

Can selenium ward off deadly cancers?

Doctors from several medical centers teamed up to discover whether a diet enriched with the element selenium would prevent skin cancer. It did not. Had this been their sole interest, they might have declared the effort a flop. But the researchers also tallied the other cancers that subsequently afflicted their volunteers—and drew a surprising conclusion.

A group that swallowed daily selenium supplements had lower rates of several other cancers, including cancer of the lung, colon, rectum, and prostate, compared to a group that did not take the supplements. Moreover, selenium cut the combined death rate from these fearsome cancers by 50 percent.

"This is the first study to show that nutritional supplements in a Western population reduce the incidence and death rate from cancer," says team member Larry C. Clark of the University of Arizona College of Medicine in Tucson. "It opens a new era in cancer prevention research."

The research was prompted by two smaller studies showing that people with low blood concentrations of selenium are more likely than average to develop skin cancer. A third study found that U.S. counties where diets are naturally rich in selenium report lower death rates from a variety of cancers than those where dietary selenium is scarce.

Intrigued by these findings, the team examined the effect of adding 200 micrograms of selenium daily—triple the U.S. recommended allowance but well below the toxic dose—to the diets of people with skin cancer.

The 1,312 volunteers were patients sometime between 1983 and 1991 at seven dermatology clinics in low-selenium areas of the United States. For 4.5 years, one group took selenium and the other was given a placebo. Clark and his colleagues tracked the groups' progress for an additional 6 years.

By last January, approximately the same number of new skin cancers had emerged in the two groups. The nearly 200 other new cancers, however, followed a strikingly different pattern. The selenium group had 63 percent fewer prostate cancers, 58 percent fewer colorectal cancers, and 46 percent fewer lung cancers than the placebo group.

The results, reported in the Dec. 25 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION (JAMA), convinced the researchers to urge people in the placebo group to take selenium.

"We were surprised that we weren't able to affect the incidence of skin cancer," Clark says. He observes that the study may not have lasted long enough to see a change.

Often skin cancers develop only after many years from premalignant growths triggered by prior ultraviolet exposure. Volunteers in the study may have begun taking selenium too late to prevent the consequences of this early damage, he argues.

Graham A. Colditz of Harvard Medical School cautions in a JAMA editorial—and Clark agrees—that doctors should confirm the results in further studies before urging widespread use of selenium supplements. *—S. Sternberg*