SCIENCE NEWS of the week

Cyclical Pattern Suspected for Quakes

Like modern movies and pop music, earthquakes of late just can't compare with those of yesteryear. Although large quakes strike every few years or so, a truly monstrous jolt has not hit since the mid-1960s, when megaquakes frequently set the entire planet ringing. Looking back over the record of past tremors, a seismologist has discerned an apparent pattern in the way Earth releases energy through great quakes — an intriguing discovery that could open new avenues for predicting seismic shocks and for studying the way Earth's plates move.

Barbara Romanowicz of the University of California, Berkeley, found that since the early part of this century, the largest earthquakes have followed a distinct progression, alternating every 20 to 30 years between two different types, known as thrust and strike-slip quakes. Huge thrust shocks develop where the leading edge of one plate dives beneath another plate at a subduction zone, forming a deep trench such as those that rim the Pacific Ocean. Conversely, great strike-slip quakes occur along the sides of plates, where they slide past one another horizontally, as along California's San Andreas fault.

In the June 25 SCIENCE, Romanowicz reports that Earth has traded off between times of thrust and strike-slip quakes. "It's basically an alternation. You have a period of a decade or two of large activity in subduction zones followed by quiet. And in that quiet, the strike-slip earthquakes are active."

For her study, Romanowicz culled the largest strike-slip events from earthquake records and compared their frequency with that of thrust earthquakes. She isolated the strike-slip quakes because even the largest of these jolts pales in comparison to great thrust quakes, which break the crust diagonally and involve more surface area than do strike-slip shocks.

"What people had done in the past is just look at big earthquakes," says Harvard University's Richard J. O'Connell. Because that method misses most strike-slip events and focuses almost exclusively on subduction quakes, previous researchers had not detected the alternating pattern, he says.

Seismologists have long recognized that the 1950s and 1960s marked an unusual period, punctuated by a string of the largest recorded earthquakes, including the 1960 Chilean megaquake (magnitude 9.5) and the 1964 Alaskan disaster (magnitude 9.2). Since the 1960s, Earth has not unleashed any giant subduction quakes.

Romanowicz found that during this well-known spell of thrust quakes, great strike-slip temblors were relatively rare. Conversely, strike-slip earthquakes were strongest during times when the largest thrust quakes were absent, both before and after that midcentury span. Most recently, the 1980s brought a substantial increase in the number of large strike-slip quakes, including a 1987 jolt southwest of New Zealand that measured magnitude 8.2, the strongest since 1979. A similar period of numerous strike-slip quakes spanned the 1930s and 1940s.

Aside from their temporal cycle, the earthquakes also show a spatial pattern, Romanowicz reports. The greatest number of midcentury thrust quakes hit along the leading edge of the Pacific plate, between Japan and Alaska. Since that time, strike-slip jolts have sprung up along the sides of the plate, southeast of Alaska and south of Japan. During times of increased strike-slip earthquakes, seismic unrest also spreads to other parts of the globe.

Such shifts could provide clues as to how plates move. For instance, seismic activity may concentrate along subduction zones when the forces pulling the plate into the Earth tug on the leading edge. Those stresses could then migrate to other parts of the plate — causing earthquakes along the sides — and even spread to other plates, Romanowicz hypothesizes. Alternatively, forces such as those arising from Earth's wobble or other factors could spur the shifts in seismicity.

If Romanowicz is right, the current spell of strike-slip jolts will soon die down, giving way to a renewed period of great thrust quakes. Combining that knowledge with information about shifting spatial patterns could help seismologists predict more accurately when and where great quakes will strike, she says.

At present, though, Romanowicz and other seismologists say it's unclear whether this cycle is real. The 80 years of available data cover only 1.5 cycles, not nearly long enough to tell whether the pattern will repeat itself.

Hiroo Kanamori of the California Institute of Technology in Pasadena also raises questions about the first few decades of data. He wonders whether quakes in the 1930s and 1940s were measured precisely enough to determine their size and type.

Still, Kanamori and others think Romanowicz has offered an intriguing model that could bear fruit if quakes follow her predictions over the next decade or two. "Without some picture in mind, studying seismicity is a fairly routine, unimaginative practice. I think we should take this paper as a kind of framework for interpreting patterns of seismicity," says Kanamori. *— R. Monastersky*

Enzymatic, my dear Watson

Among spotted hyenas, the females take charge. They are the bigger, more aggressive sex and exhibit male-like sex organs, presumably because their fetal ovaries made too much testosterone.

Endocrinologists have now shown that a mother hyena's ovaries and placenta may conspire to give developing daughters the upper hand, demonstrating how some traits get passed on by nongenetic means.

While at the University of California, San Francisco, School of Medicine, Tamer M. Yalcinkaya and his colleagues first discovered that ovarian tissue from hyenas does not produce much testosterone; instead, it releases lots of an inactive chemical, called androstenedione, that enzymes can convert to either testosterone or estrogen.

Then the scientists compared the activity of these enzymes in placental tissue from four humans and six spotted hyenas. The enzyme aromatase, which makes estrogen from androstenedione, is 20 times more active in humans. "The ability of hyenas to make estrogen is low," says Pentti K. Siiteri, who now works at a branch of the National Cancer Institute in Rockville, Md. In contrast, the activity of the enzyme that makes testosterone from this chemical is about the same in the two species, the researchers report in the June 25 SCIENCE.

Experiments in rodents show testosterone can reduce the number of ovarian follicles that develop in fetuses, which may explain why adult female hyenas have so much extra androstenedione in the first place, Siiteri says. Normally, cells in follicles use up androstenedione to make estrogen, so having fewer follicles means that more of this chemical is available for conversion to testosterone by placental enzymes, he explains.

"There are parallels in human pregnancy," he adds. Sometimes, abnormal fetal adrenal glands make too much of another chemical that can become excess testosterone in the placenta and lead to male features. In addition, hyenas' ovaries resemble the abnormal ovaries in women with polycystic ovarian syndrome, a disease that may begin in the fetus, Siiteri says. □