

# the earth moves

## explaining earthquakes an occupation as old as man himself

By Bill Falk  
Staff Writer

When the ground under their feet heaved and rolled, the people of ancient Japan blamed it on the thrashing of the namazu, a giant catfish believed to have carried the earth on its back.

The Greek mathematician and philosopher Pythagoras thought earthquakes were caused by fighting among the buried dead.

Today, seismologists attribute earthquakes to an equally fantastic, if less poetic, process: the creeping of 3,000-mile wide, 50-mile thick slabs of rock, or "plates," across the earth's semimolten interior, like stone rafts on an ocean of boiling rock.

Yet modern scientists concede this theory of plate tectonics does not explain some kinds of earthquakes, such as the Westchester-based tremors that shook the New York metropolitan area last week.

In fact, experts studying last week's quake and aftershocks concede they have no clear idea of why the earthquake occurred, or why the town of Greenburgh just south of Ardsley has been the center of 14 tiny to moderate tremors in the last nine months.

The first of these tremors struck in January and was followed by another in May. Then on Oct. 19, a foreshock and the main quake roused millions of people from their sleep in the metropolitan area. Seismologists at Columbia University's Lamont-Doherty Geological Observatory in Palisades said as many as 10 aftershocks followed, including one Saturday afternoon felt by residents of the Yonkers area.

Scientists also do not know whether the sudden spurt of seismic activity in the Ardsley area marks the end of earthquake activity there for decades to come or is merely the prelude to a more powerful and possibly destructive earthquake in the near future.

Charles Merguerian, a professor of geology at Hofstra University, said a quake measuring 5 or 6 on the Richter scale — 10 times or 100 times more powerful than the Oct. 19 quake, respectively — could be brewing slowly in the bedrock below the metropolitan area.

"Not to be an alarmist, but it's possible," said Merguerian, one of a few geologists in the world to specialize in the New York City area. "But I think (last Saturday's) quake was a good thing. It's good to have smaller earthquakes like that one because it releases strain."

Charles Baskerville, a research geologist for the U.S. Geological Survey who also specializes in the New York area, said he thought the small quakes could be building to a larger one — perhaps as large as the 5.0 quake that rocked the metropolitan area in 1884. A 5.0 earthquake generally causes minor damage to buildings, breaks windows and causes objects to fall.

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Other scientists, including the seismologist Alan Kafka of the Western Observatory in Boston, another specialist in the geology of the metropolitan area, said such speculation was totally without scientific foundation.

"We really don't know what causes earthquakes in the Northeast," Kafka said.

Merguerian readily conceded he and other geologists could only guess the meaning of the recent tremors.

"We can all speculate on this, but in the end it really doesn't mean a damn," Merguerian said. "What's going to happen is going to happen."

The problem is not that geologists and seismologists know nothing about what causes earthquakes. They know quite a bit — but not about the kind of earthquake that struck the New York area.

The reigning theory of plate tectonics has enabled scientists to explain 95 percent of the 800,000 earthquakes that rumble through the earth's crust each year.

Seismologists know that most quakes occur at the boundaries of the 12 moving plates that make up the earth's crust. As the massive plates inch toward each other, enormous pressure builds on either side of the fault between them, contorting and twisting solid bedrock like so much soft wood.

Finally, the rock can no longer withstand the mounting strain, and it fractures like a ruler that's been bent too far. The two facing slabs, or plates, are then free to lurch under or alongside each other to a new position of reduced stress.

The most powerful earthquake on record, a 9.2 quake that struck Chile in May 1960, moved the earth on either side of the fault line 60 feet. In contrast, the Ardsley quake resulted from a side-to-side movement of about a half-inch along a buried fault line, scientists at Lamont-Doherty estimate.

After a quake on a major fault line releases the strain between plates, the process begins anew. The continental plates resume their slow, constant movement against each other until the day — years, decades or centuries later — that the pressure builds to an explosion within the earth.

But while the vast majority of earthquakes, especially powerful

ones, occur along or near the faults dividing the world's major plates, about 5 percent do not. They occur in the middle of the giant plates, away from obvious sources of stress, and away from the active, visible boundaries that have excited scientists.

"Almost all the attention and work and funding has gone to the study of the plate boundaries," said Dr. Leonardo Seeber, a seismologist at Lamont-Doherty. "Now, with this earthquake, we're seeing some attention to interplate areas like New York."

New York and Westchester are close to the middle of the North American plate, which extends from the middle of the Atlantic Ocean to California. Major quakes within this plate are much rarer than they are along the boundaries, but they are not unknown.

A series of powerful earthquakes measuring about 7.5 on the Richter scale struck New Madrid, Mo., in 1811 and 1812, causing huge fissures in the earth, churning the Mississippi River into such a froth that it temporarily flowed backward and destroying the homes of the settlers who lived there.

Though 20 million people live in the metropolitan area, its underlying bedrock has been the subject of less study recently than the remote areas of Antarctica and Alaska. Most scientists at Lamont-Doherty, which lies almost directly across the Hudson River from the area where the Oct. 19 quake occurred, specialize in distant areas of the world.

Craig Nicholson, a seismologist at Lamont-Doherty, said one reason for the general lack of interest in the New York City area is that much of the earth is covered by buildings and roads.

Merguerian said the presence of buildings was not the only reason.

"Most geologists are afraid to work in the city," he said. "I live in the city, so it doesn't bother me."

Merguerian has studied the city's geology in subway tunnels, excavations and the massive water tunnel now being constructed beneath Manhattan. He said "a wealth of information" about the area was available to any geologist willing to look for it.

The city's underlying layers of metamorphic rock, Merguerian said, are veined with hundreds of small faults, or cracks. But he said he could not pinpoint a single fault

line that would account for the Ardsley quake.

Lamont-Doherty scientists are still trying to identify a fault line along which the quake occurred. They believe the fault is buried under the surface, running either northeast or northwest through the Ardsley area.

Seismologists attempting to account for a buildup of pressure along the small, intraplate faults have looked to the overall theory of plate tectonics for an explanation. One possible explanation is that the North American plate's pressing up against the Pacific plate causes a compression of the entire plate — a form of strain that is transmitted through the rock until it finds an area of weakness on an old fault. An earthquake like the Ardsley quake then occurs.

Kafka, a self-described "renegade" who was once on the staff at Lamont-Doherty, scoffs at this hypothesis.

"I've heard that," Kafka said. "But whether that has anything to do with the quakes in the Eastern U.S. is another question. There isn't any evidence to support it."

Kafka said many of his colleagues in seismology made the mistake of thinking of intraplate quakes as smaller versions of quakes that occur at plate boundaries.

In truth, Kafka said, the quakes that occur within plates "are an entirely different animal." These quakes may occur on faults, he said, but not because of faults.

And locating a fault under Ardsley, he said, will do nothing to reveal why the earthquakes occurred and whether more are coming.

"People get mad at me when I say that," Kafka said. "People want to blame earthquakes on faults. It makes everyone's life easier."

"People don't like the answer. 'I don't know,'" he said. "But I think that's the only answer we've got right now."