

New quake evidence

Experts say bigger tremors are possibility for area

By Bill Falk
Staff Writer

Scientists studying seismic activity on the East Coast — including a controversial finding of a “mind-boggling” ground shift under New York — now say it’s possible the metropolitan area could someday suffer a major, destructive earthquake.

No one can predict when such a quake could occur, scientists say. In fact, it might not happen for decades or centuries — if at all. But geologists and seismologists studying the New York area say bits and pieces of recently unearthed evidence point to one clear conclusion: It’s time to abandon the long-standing assumption that New York is immune to California-sized quakes.

“The entire East Coast was considered basically seismically inactive, but now that view is being re-evaluated,” said Charles Merguerian, a professor of geology at Hofstra University and a specialist in the New York City area.

“The evidence is still vague,” said Leonardo Seeber, a research scientist at Columbia University’s Lamont-Doherty Geological Observatory in Palisades in Rockland County, “but I think the possibility is there for a large earthquake.”

Seeber said he and other scientists plan to make public officials “aware of our shift in thinking.”

The evidence prompting that shift includes several recent developments:

- The two dozen small-to-moderate sized quakes (most of them too small to be felt) that shook the bedrock under southern Westchester in 1985. The tremors — including an Oct. 19 quake measuring 4.0 on the Richter scale — occurred in an area with little previous seismic activity and with no previously identified faults.

Seeber said the frequency of the quakes suggested they could be occurring on “a



SHEAR SPECULATION — One theory for possible major earthquake activity in the future is an undiscovered “shear zone,” or fault, somewhere under New York, perhaps miles under the Hudson River. Such a fault might be an eons-old remnant of a time when two tectonic plates, or giant slabs of rock that make up the Earth’s crust, met under what is now New York.

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creeping fault" — a geological formation previously associated only with areas of strong underlying stress.

• A study by three Stanford geophysicists that indicated the ground in the New York metropolitan area was being distorted out of shape by tremendous subterranean forces. The study was published in the British scientific journal "Nature," almost simultaneously with Westchester's strongest quakes in October.

In the study, the scientists revealed evidence that the Earth was moving along an unseen, deeply buried fault at the rate of approximately one-half inch a year.

That's a huge amount by geological standards, equivalent to the movement along the San Andreas fault in California.

The study's findings have been greeted with astonishment and skepticism. John Armbruster, a Lamont-Doherty seismologist, called the results of the Stanford study "mind-boggling" and "paradoxical."

"You'd have to conclude that if what they're saying is true," Armbruster said, "a spring is coiling underneath us, and eventually you'd have to have a large earthquake."

Mark Zoback, one of the study's authors, conceded it was hard to explain his findings. One possible explanation, he said, is that there is an undiscovered, major "shear zone," or fault, somewhere under New York, perhaps miles under the Hudson River. Such a fault might be an eons-old remnant of a time when two tectonic plates, or giant slabs of rock that make up the Earth's crust, met under what is now New York, he said.

• Earthquakes in areas that, like New York, have no apparent geological structure or mechanism to explain them. The most recent of these was a 5.0 quake that rattled Cleveland on Jan. 31.

The quake occurred in an area considered seismically more stable than New York City. It strongly shook the earth under a new nuclear plant about to go into operation — a plant built, like the two reactors at Indian Point in Buchanan, under the assumption they would not have to withstand violent earthquakes. There had never been a 5.0 quake recorded near Cleveland.

"To us, this is all evidence that you can't take the simple-minded view that the quakes of the past few centuries are the ways things are — that history over that short a period of time will repeat itself," Armbruster said. "It's pretty clear now that we don't understand all the quakes that can happen in an area like New York."

For decades, scientists, public officials and engineers have operated on the assumption that major earthquakes do not occur in New York City and its suburbs. That assumption was based on scientists' understanding of how earthquakes occur and on the record of the past three centuries.

During that time, the largest quake to strike the New York area, in 1884, measured approximately 5.0 on the Richter scale. A quake of that size — 10 times more powerful than the 4.0 quake that rumbled through Westchester on Oct. 19 — can inflict some damage to buildings.

Elsewhere on the East Coast, however, one major quake has occurred in relatively recent history. In 1886, a quake estimated at almost 7.0 caused tremendous damage in Charleston, S.C. That quake unleashed 1,000 times more power than the Oct. 19 quake in Westchester.

Scientists initially assumed the Charleston quake was caused by some geologic structure peculiar to that area, but a 10-year study completed several years ago uncovered no explanation for the quake — no fault, no quirk of geology.

This fact has led scientists to wonder if the Charleston quake might be an example of the kind of earthquake activity that occurs regularly on the East Coast over intervals of 500, 700 or 1,000 years.

"If it's true that Charleston isn't unique," Armbruster said, "then maybe within 100 years we'll see another magnitude-7 quake along the coast."

Such a quake, scientists agree, would cause enormous destruction in New York City or other major urban areas on the East Coast, all built under the assumption that huge quakes only occur in California.

"As far as I'm aware, no public officials in New York have yet considered what happens in a major earthquake," said Hofstra geologist Merguerian. "That's the scary part."

The current scientific model for how earthquakes occur offers no explanation for the Charleston quake, or even for the small quakes that occurred in Westchester.

Over the past two decades, scientists have come to understand that the Earth's outer crust consists of tectonic plates that creep along a semi-molten interior. These plates meet, collide and slide under each other at moving boundaries, or faults, such as the San Andreas in California.

This slow, tortuous movement — sometimes giving way to sudden, fitful slippage along the faults — is what produces earthquakes.

Although this model explains very well 95 percent of the 800,000 earthquakes that occur throughout the world each year, it provides no mechanism for those that occur away from the plate boundaries, in so-called "intraplate" areas.

New York sits on one of these intraplate areas. The entire East Coast is situated almost midway on the North American plate, which is bounded to the west by the Pacific coast and on the east by the mid-Atlantic ridge. In theory, interplate areas should be subjected to little seismic strain and should exhibit little deformation, or movement. That's what makes the Stanford study so hard for scientists to accept. Even the study's authors confess to astonishment at their findings.

"We were really immensely surprised," said Zoback, one of the geophysicists who carried out the study. "It doesn't seem to make sense."

A review by another group of scientists suggested the Stanford group overestimated the rate of the Earth's deformation by one-third. Still, that would represent an enormous amount of motion for New York and would leave the study's basic conclusions intact.

The Stanford study involved a computer analysis of measurements taken by the National Geodetic Survey between 1872 and 1973. The survey periodically takes sightings between "benchmarks," or markers, anchored in the Earth throughout the New York metropolitan area.

By measuring the change in angles between these benchmarks, the Stanford scientists were able to gauge how much movement had occurred in the underlying earth.

The scientists found virtually no movement in Pennsylvania, New Jersey or eastern Long Island. In the metropolitan area itself, extending north and east to Connecticut, and west into Putnam County and across the Hudson River to Rockland County, the analysis showed what by geological standards is a huge amount of movement.

Since this movement deep within the Earth's surface doesn't have an immediate outlet in a fault running to the surface, Zoback said, it could pose a large earthquake threat.

Miles down, the tremendous weight of the rock above creates heat and pressure which make the Earth's interior partially molten and elastic, like heated plastic. At that depth, the rock can respond to strong seismic stress without fracturing. Closer to the surface, however, rock does not easily bend and change shape in response to pressure. If there's no large, surface fault on which the land can creep, the strain generated from below bends and slowly distorts the crust. This is the kind of distortion Zoback believes he sees in the New York area.

Eventually, the stress builds to the point where the upper crust can no longer bend — and then it snaps, like a plank of wood bent too far.

When the Earth's crust snaps suddenly along miles-long fault lines, tremendous energy is released in the form of an earthquake.

"Movement of a few centimeters a year isn't very big," Zoback said. "But if that accumulates over 100 years, that's enough strain to produce a large earthquake."

He said the recent Westchester quakes probably were expressions of the stress he detected. "It's all part of the same process," Zoback said. "There's obviously a relationship."

Lamont scientists weren't so sure, pointing out that while Zoback's evidence points to a fault line heading north, the Westchester quakes appear to run on a buried fault pointing west-northwest.

Zoback conceded his study suggests a major earthquake as only one of several possibilities.

"It's something to think about, and it's a cause for concern," Zoback said. "But it's not something people should be staying up nights worrying about."

Lamont seismologist Armbruster said he and most of his colleagues remain skeptical about the Stanford study.

"But because we can't explain Zoback's results doesn't mean they should be thrown away," Armbruster said. "The Westchester quakes, the Zoback results, the Cleveland quakes all highlight how ignorant we are. We need to keep on trying to collect information so that one day, we will understand what we don't understand today."