

Scientists say P.R. should expect major earthquake by 2035

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Any Puerto Rican under 85 has never experienced a major earthquake on the island, but scientists say the odds that they will before 2035 are overwhelming.

The fact that there has been no major earthquake since 1918 could make islanders complacent, say specialists who recently mapped the Puerto Rican trench to help predict when the next earthquake and other natural disasters will occur.

It could happen any time, and they recommend that residents be ready.

An earthquake, scientists say, is a series of vibrations in the earth's crust caused by the abrupt rupture and rebound of rocks in which elastic strain has been slowly accumulating.

A panel of leading ocean scientists, explorers and educators spent the past three weeks mapping the Puerto Rico Trench 37 kilometers north of Arecibo.

The group of U.S. Geological Survey scientists and National Oceanic and Atmospheric Administration explorers studied the geology of the region to map earthquakes, understand how they happen, and estimate where earthquakes and tsunamis (tidal waves) will erupt next.

U.S. Geological Survey Chief Scientist Uri ten Brink said many earthquakes and tsunamis have occurred in the northeastern Caribbean because the plate movements of the earth's surface are rapid and complicated.

"The Puerto Rico Trench on the north side of the island is the deepest part of the Atlantic Ocean and the fifth deepest body of water in the world, with maximum depth of 28,232 feet," he said.

Scientists say Puerto Rico trembles at least twice a day, or some 2,000 times a year. However, most residents never feel anything because they are just "slight micro-seismic events."

But scientists say there is no way to predict when a tremor will level a city. For years they have calculated the risk based on past seismic events, but that can only give an approximate prediction. Unlike hurricanes, any earthquake likely to strike Puerto Rico will come with little or no warning. Scientists attribute this phenomenon to the fact that tsunami sites are closer to the coast here than in many other areas.

"In Hawaii sites of tsunami generation are very distant from the coast and warnings can be broadcast hours in advance," said ten Brink.

He added that Puerto Rico and the Virgin Islands sit atop the Caribbean tectonic plate, a subterranean slab whose collision with the North American plate produces earthquakes and volcanoes. With plate movement of an inch a year, the Caribbean region produces an earthquake registering 8 or more on the

Richter scale approximately every 100 years. "Many earthquakes and tsunamis resulting from these plate-tectonic movements have occurred in the northeastern Caribbean," said ten Brink. "As Puerto Rico's population continues to grow, future events will pose serious hazards to its residents, mainly in the form of underwater faults and landslides."

Without saying when, scientists predict a "big one" will hit this generation in Puerto Rico, no later than 2035, and as soon as today.

The admonition is consistent with the fact that the island has suffered one major shock — 7.0 or more in magnitude — with almost clockwork precision every 50 to 117 years for the last four centuries. The island has escaped a major earthquake for 85 years.

The most violent tremor recorded in Puerto Rico was in Mayagüez on Oct. 11, 1918.

The 7.5 quake took place around 10:30 a.m. Moments later, a 20-foot tidal wave washed over cities on the northwest coast, killing 32 people and destroying more than 300 homes in Aguadilla alone.

In all, 116 people were killed and millions of dollars in damages were reported.

USGS scientists aboard the National Oceanic and Atmospheric Administration ship Ronald H. Brown spent over \$750,000 to learn more about these phenomena. They discovered several new submarine rockslides on the descending North American tectonic plate and a large fault system in very deep water near the trench.

The discoveries suggest this part of the plate boundary may be capable of generating only moderate earthquakes.

The cruise, funded by the NOAA Office of



These scientists spent three weeks studying underwater phenomena to help predict earthquakes. From left, chief scientist Uri ten Brink, Christopher Polloni and William Danforth from the USGS Woods Hole Field Center, Catalina Martínez, Taconya Piper and Toshi Uozumi from the National Oceanic and Atmospheric Administration, and Ramey High School science teacher Harold Roettger.

Ocean Exploration, took place Feb. 18 through March 7. Other participants were Christopher Polloni and William Danforth from the USGS Woods Hole Field Center. Gene Parker, Toshi Uozumi, Catalina Martínez and Taconya Piper from the NOAA Office of Ocean Exploration were also on board. Marine mammal observers from the Center of Coastal Studies Rebecca Lester and Amy Kennedy studied the migration of humpback whales. Ramey High School science teacher Herald Roettger helped gather data.

Putting technology to use

The Ronald H. Brown, equipped with advanced instruments and sensors, carries 20 crew members and can accommodate up to 33 scientists.

A C-Band Doppler radar allows scientists to study precipitation patterns and storm dynamics. A radio sonde attached to a weather balloon measures atmospheric pressure, temperature, humidity and ozone concentra-

tions.

Echo sounders develop broad-based profiles of the sea bottom. Through the use of acoustic waves, surface features of the ocean floor can be determined in very deep water.

The scientists used the SeaBeam 2112 multi-beam underwater topography system to map the trench. This advanced radar system creates underwater topography charts, as well as detailed 3-D images of the sea floor.

Nearly all the ship's scientific devices are integrated into an on-board oceanographic system dubbed the Scientific Computing System.

S.J., Mayagüez are temblor targets

Particularly vulnerable are the San Juan urban corridor and the city of Mayagüez.

"Lack of understanding of the tectonic movements in this part of the Caribbean has hampered our ability to assess the seismic and tsunami hazards," said ten Brink.

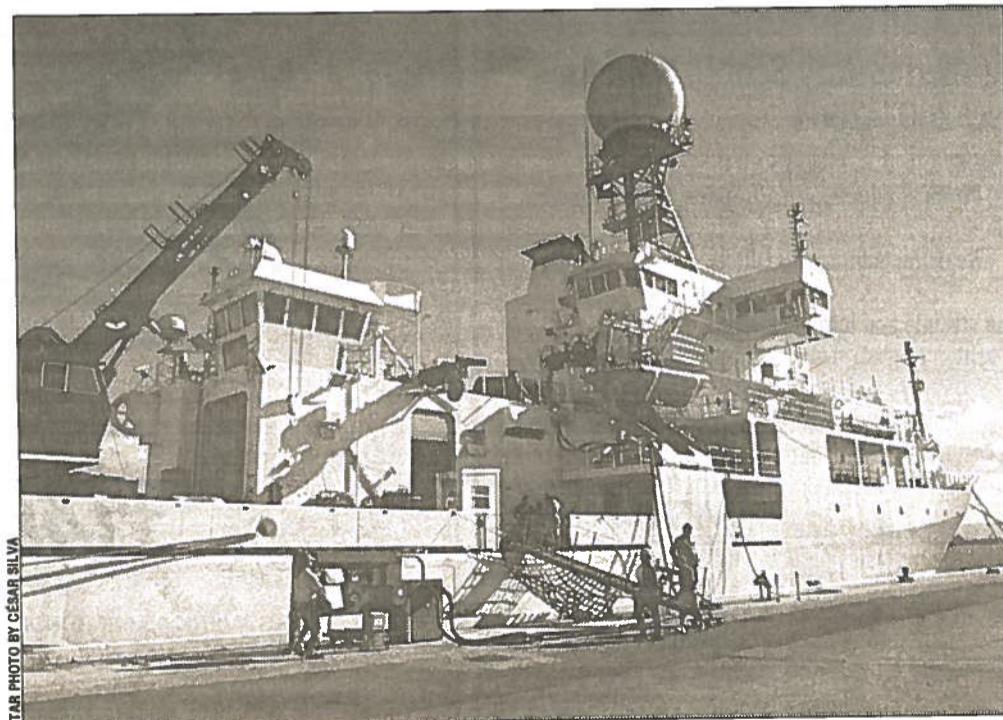
He said a temporary array of land and ocean-bottom seismometers was deployed last summer in and around western Puerto Rico for 45 days to record local and regional earthquakes.

The data collected will be augmented by data stored by the permanent stations of the Puerto Rico Seismic Network. This combined data will help to locate earthquakes more accurately than possible at present.

A seismic network was established in Puerto Rico in 1979 and was operated by the Lamont-Doherty Earth Observatory of Columbia University for the first five years. The network is now operated by the University of Puerto Rico in Mayagüez. In 1995, the network was modernized to include more sites, in rural and urban settings.

The Puerto Rico Building Code was amended in 1987 and again in 1990 to include stricter quake-resistant construction procedures. Special attention was given to primary urban infrastructure such as hospitals, bridges, docks, thermoelectric and water treatment plants, airports and schools.

The code mandates engineering guidelines to keep buildings from collapsing in the event of a major earthquake.



The Ronald H. Brown, carrying scientists mapping the Puerto Rican Trench, was in Puerto Rico for three weeks.