After Haiti, Worries About Other Big Quakes

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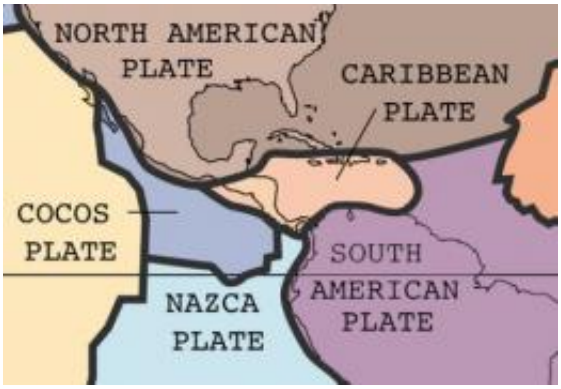

The Caribbean plate is wedged between four surrounding tectonic plates. Credit: ISNS

In the last several days, while the attention of the world has been focused on the human toll of Tuesday's earthquake in Haiti, scientists have begun to look at the quake's geological toll. What is the danger to populations living along other fault lines in the Caribbean, they are asking, and what other parts of the world are at risk?

Seismologists have just started the long process of analyzing the geological reverberations of the magnitude 7.0 quake. They are worried that this week's natural disaster could increase the chance of another temblor in Haiti, though their computer models may ease their minds after all of the data has been crunched.

"We're most concerned about the Haitian peninsula, the area west of this fault rupture" said seismologist Carol Prentice of the U.S. Geological Survey (USGS) in Menlo Park, Calif., who studies the Caribbean.

Pending a more detailed analysis -- which will take weeks and may be hampered by the lack of data-collecting equipment in Haiti -- Prentice said that the Haitian earthquake may have increased the chance of a future quake in the neighboring Dominican Republic as well. She added that the likelihood of the event having repercussions for other Caribbean nations such as Jamaica, Cuba and Puerto Rico is extremely low, however.

"Jamaica, Cuba, the whole area needs to worry about earthquakes for other reasons," said Prentice. "But this particular earthquake is unlikely to change the stress in faults that far away."

A History of Violence

Worldwide, earthquakes of magnitude 7.0 and larger are reported about 18 times each year, and at least a dozen of them occurred in the Caribbean over the last 500 years. In 1946 a magnitude 7.6 earthquake in the Dominican Republic left 20,000 homeless, and the 1843 earthquake in the Leeward Islands killed an estimated 5,000.

Connected to each other beneath the ocean, these island nations all sit on one large piece of the Earth's crust called the Caribbean Plate. This tectonic plate is slowly sliding eastwards relative to the neighboring North American plate. But the edges of the two plates do not glide past each other smoothly. Instead, they lock up and a stick together, forming cracks or "faults" in which strain builds up. When the strain becomes too great, the rocks on either side of the fault slip past each other suddenly and, in extreme cases, produce a large earthquake. Two of these "strike-slip" faults run through Haiti and the Dominican Republic.

In 2008 a team of geologists figured out how much strain had built up in the southern fault responsible for this week's quake, the Enriquillo-Plantain Garden fault, which stretches from Jamaica in the west through Haiti into the Dominican Republic. Using GPS tracking devices, they calculated that the plates had moved about 6 feet past each other since the last big earthquake in 1751, and they predicted that the fault had built up enough stress to produce a magnitude 7.2 earthquake.

Similar calculations have revealed other at-risk faults in other regions of the world.

The ancient Turkish city Istanbul, home to 12 million people, may be due for a massive earthquake in the coming decade. It lies only 12 miles from the North Anatolian fault, which has not ruptured since 1766 and has built up even more strain than the fault that caused the Haitian quake.

"We would expect an even larger earthquake than the one in Haiti -- the worst case scenario goes up to 7.6" said seismologist Oliver Heidbach of the Helmholtz Centre Potsdam in Germany, whose research appears this Sunday in the journal Nature Geoscience.

The southern portion of the San Andreas fault near Los Angeles, quiet for 300 years now, has also accumulated enough strain to produce a "big one" of magnitude 7.0 or greater, according to University of California-San Diego seismologist Yuri Fialko.

The USGS maintains hazard maps highlighting areas of the United States considered to be most at risk for big earthquakes. The strongest U.S. earthquake ever recorded, magnitude 9.2, was the Great Alaska Earthquake of 1964. Now regions in South Carolina and Washington state are considered at risk, and particular attention is being paid to the New Madrid fault -- which runs through Missouri and six other Southern

and Midwestern states. The last time this fault ruptured, in 1811, the vibrations were said to have caused church bells to ring as far away as Boston.

Quakes Beget Quakes

During the Haitian quake, only 30 to 60 miles of the 300-mile fault near Port-au-Prince ruptured and slid. The rest of it stayed stuck, still glued together by friction. The area that ruptured is likely to have increased the amount of strain -- and the risk of quake -- in other parts of the fault, especially in areas to the west of Port-au-Prince.

This happened in 2004 in Indonesia, after a magnitude 9.4 earthquake (more than 3000 times stronger than the one in Haiti) occurred off the coast of Sumatra. Data from computer models, published in the journal Science, warned that the gigantic tremors had increased the amount of stress on two other two areas of the fault and on another fault to the east. In March of 2005, this eastern fault experienced a magnitude 8.7 quake.

The smaller Haitian quake on the Enriquillo fault is unlikely to have such widespread consequences but could affect the nearby Septentrional fault in the north, which runs through Haiti and the Dominican Republic and has been quiet for more than 800 years, according to USGS scientist Prentice.

To determine how the strains in both of these faults have changed this week, seismologists like Ross Stein of the USGS are analyzing measurements that show where and how violently the earth shook on Tuesday and feeding this data into computer programs that model how stress in other regions of the fault has changed. But the scientists admit that the models cannot perfectly predict what will happen next.

"We have to be really humble as earth scientists," Stein said. "We have a

colossal record of failing to predict [earthquakes in advance]."

Haiti may be particularly challenging because seismologists like Stein would normally check local seismometers -- instruments that record data about earthquakes -- for smaller "aftershock" earthquakes in the stressed regions their models predicted. For Haiti, this may be impossible because the island has very few seismometers and a crude catalog of the aftershocks at best. Even the data that described the large original earthquake came largely from distant instruments in the United States.

"We have a poorer idea of how the fault slipped than we would if this were an earthquake in the United States or Japan, and we have a poorer record of the aftershocks that follow it," said Stein. "We have one or more hands tied behind our back."

No Time

It will be weeks before scientists know whether these models give us a better idea of new risks in the Caribbean. But Stein said that even when models do identify areas of risk -- whether in the Caribbean, Turkey or California -- they cannot predict when the next earthquake will come.

To predict when earthquakes will occur, some scientists try to examine the historical record of when and how often quakes have occurred in the past. This too poses challenges, said Stein, because only the very tiniest temblors -- of magnitude 1 or 2 -- tend to occur in regular, repeating intervals.

"There has been some progress in long-term earthquake forecasting where we estimate the likelihood in a period of years to decades of an earthquake occurring," said Michael Hamburger of Indiana University in Bloomington. "But that is not the same as short-term earthquake prediction -- to say that an earthquake is happening in the next few

weeks, and we can evacuate a town."