Caribbean-South American plate boundary primed for major earthquake

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View of the Plaza Venezuela in Caracas, Venezuela. Credit: George Miquilena

Faults along the central portion of the Caribbean-South American

tectonic plate boundary are primed to produce a powerful earthquake, posing a potentially serious hazard to northern Venezuela, according to an international team of scientists.

"Most of the populated cities in this region happen to be on a plate boundary, so it's important to understand the seismic hazard," said Machel Higgins, who led the research as part of his doctorate at Penn State. "We found a significant portion of the Caribbean-South American plate boundary is locked and capable of producing up to a magnitude 8 earthquake."

The boundary is a roughly 550-mile stretch where two tectonic plates slide past each other from northern Venezuela and the Caribbean Sea in the west to Trinidad and Tobago in the east. Multiple faults extend along the boundary, and the region is prone to earthquakes.

"There have been many destructive earthquakes on this plate, particularly magnitude 7 and above around Venezuela's capital, Caracas, in 1812 and 1900," said Higgins, who graduated in spring 2021. "The elastic strain buildup we've calculated here could produce a similarly large earthquake that has seismic hazard implications for Caracas and surrounding urban areas in northern Venezuela."

The team, led by Penn State scientists, combined GPS and Interferometric Synthetic Aperture Radar (InSAR) data to observe small changes to the ground along the boundary and used that to model where strain is building along the faults, indicating where the potential for earthquakes exists.

"This is the first time this segment of the Caribbean—South American plate boundary has been investigated completely, and our results show where significant strain is accumulating," said Peter LaFemina, professor of geosciences and Higgin's adviser.

Faults on the eastern end of the boundary, with one exception, are creeping, which means the plates are sliding past each other smoothly. The western faults are locked, which means they are hung up and unable to move. When this happens, stress builds up until the plates release, triggering an earthquake, the scientists said.

"That strain is typically relieved by rupturing during an earthquake or freely slipping, which is called creeping," Higgins said. "We've found that where there have been large historical earthquakes there is a high magnitude of elastic strain build up. And where there have been many small magnitude earthquakes or few earthquakes, there was virtually no elastic strain buildup."

The Caribbean plate moves about 20 millimeters a year to the east relative to the South American plate, and the researchers found a single slipping fault on the island of Trinidad is responsible for accommodating 70% of the relative motion.

"We knew the Central Range Fault in Trinidad was creeping and accommodating roughly 70% of the relative plate motion; however, our new results show that the fault is creeping across the entire island," LaFemina said.

This is the first study to combine GPS and InSAR techniques to study the entire length of the plate boundary. The results, recently published in the journal *Tectonics*, could help guide future seismic hazard decisions in northern Venezuela and Trinidad and Tobago, the scientists said.

"It's very difficult to assess the dangers of a magnitude 8 earthquake; they include not only loss of life, but downstream economic damages," Higgins said. "Because this area is somewhat dependent on the production of petroleum, a large earthquake that damages that infrastructure could set their economies back."

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