Purdue-led research team finds Haiti quake caused by unknown fault

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Eric Calais, a Purdue professor of geophysics, shows GPS equipment used to track movements of the Earth's surface as small as one millimeter. These tiny movements show the build up of stress that could lead to an earthquake and are used in evaluating the potential threat to an area. Credit: Purdue News Service file photo/David Umberger

Researchers found a previously unmapped fault was responsible for the devastating Jan. 12 earthquake in Haiti and that the originally blamed fault remains ready to produce a large earthquake.

Eric Calais, a Purdue University professor of earth and atmospheric sciences, led the team that was the first on the ground in Haiti after the magnitude 7.0 earthquake, which killed more than 200,000 people and left 1.5 million homeless.

The team determined the earthquake's origin is a previously unmapped fault, which they named the LÄogëne fault. The newly discovered fault runs almost parallel to the Enriquillo fault, which was originally thought to be the source of the earthquake, he said.

"This means that the Enriquillo fault is still capable of producing large earthquakes and that Haiti has to adapt to this seismic hazard," said Calais, who in September was appointed science adviser for the United Nations Development Program in Haiti. "The fault system is more complex than we originally thought, and we don't yet know how the January earthquake impacted the other faults. Preliminary measurements indicate that the Enriquillo fault did not release any accumulated seismic energy and, therefore, remains a significant threat for Haiti, and Port-au-Prince in particular. We need to investigate the fault system further to be able to determine where the next earthquakes might occur and how large they could be."

The shifting of the Earth's crust after a major earthquake can add to or reduce stresses building up in nearby faults and can apply pressures that effectively stop or release other earthquakes. Because of this, the earthquake along the Léogâne fault may have delayed or advanced the timing for the next earthquake on the Enriquillo fault, he said.

"For practical purposes, speculating on when the next earthquake might happen is not an effective strategy," Calais said. "We rather need to focus attention, energy and funds on proactive measures to help the country adapt to earthquake hazards and, eventually, reduce economic losses and save lives. Our finding raises many important scientific questions and we are working to find the answers, but we already know that the earthquake threat in Haiti is inexorable. The reconstruction process that is now starting in Haiti is an opportunity to build better, of course, but also to develop an effective prevention and mitigation strategy for the future."

The team analyzed data they recorded before the Jan. 12 earthquake and new measurements taken after the event. Their work is detailed in a paper that will be published in the November issue of *Nature Geosciences*.

Andrew Freed, paper co-author and a Purdue professor of earth and atmospheric sciences, said the absence of any surface rupture was the first clue that the earthquake did not happen along the Enriquillo fault.

"It was a big surprise that we couldn't find a surface rupture anywhere," Freed said. "We did find other physical changes that we expected after an earthquake of that magnitude, but in entirely the wrong location to have come from the Enriquillo fault."

For instance the team found that the epicenter area rose by a little more than half a meter and that the earthquake caused contraction of the Earth's crust opposite of what would be expected from the Enriquillo fault, he said.

The team used global positioning system equipment and radar interferometry to measure how the ground moved during the earthquake, which provides insight into what is happening as much as 20 kilometers below the surface. The team then used a computer model to determine what characteristics the source of the earthquake must have in order to produce the observed changes.

Through this work, the team discovered the previously unmapped Léogâne fault, which is located just to the north of the Enriquillo fault and dips by a 60-degree angle to the north. The fault is a blind thrust, meaning one side of the fault is being thrust over the other, but the fault does not reach the surface.

About 30 kilometers of the fault shifted during the January earthquake,

and the sides of the fault moved by as much as five meters relative to each other below the Earth's surface. The full length of the fault is not known, Freed said.

"Only portions of a fault are affected during any given earthquake, and the length of the portion affected is relative to the magnitude of the event," Freed said. "Because this is a blind fault, we don't have some of the clues at the surface, like scars from past ruptures, that show where the fault runs. On the Enriquillo fault you can almost walk the line of the fault because scars from many past events reveal the fault below. That isn't the case with the Léogâne fault."

The team plans to continue to take measurements of the postseismic processes that allow them to understand changing stresses within the Earth's crust over time that could help point to areas where seismic hazard is increasing. In addition they plan to create models to better understand the fault systems, their behavior and why they exist at these particular locations, Freed said.

In addition to Freed, co-authors include Glen Mattioli of the University of Arkansas; Falk Amelung, Sang-Hoon Hong and Timothy Dixon of the University of Miami; Sigurjùn Jùnsson of the King Abdullah University of Science and Technology in Saudi Arabia; Pamela Jansma of the University of Texas at Arlington; Claude PrÄpetit of the Bureau of Mines in Haiti; and Roberte Momplaisir of the State University of Haiti.

Calais has studied the Enriquillo and Septentrional faults on the island of Hispaniola, which includes Haiti and the Dominican Republic, since 1989. His research team has been measuring the build up of energy along these faults using global positioning system technology for 10 years. The team first reported the risk for a major earthquake there in 2008.

More information: Transpressional Rupture of an Unmapped Fault During the 2010 Haiti Earthquake, *Nature Geosciences*, Nov 2010.

Provided by Purdue University