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Scientists Scramble to Analyze Haiti’s Seismic Risk

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Since the ground shook Port-Au-Prince, Haiti, on January 12 and sent the densely populated city into chaos, scientists have been harnessing every possible tool to quickly assemble a detailed picture of a region in which scientific research had already been difficult to conduct.

“The question we are trying to address right now is if there could be other faults nearby or perhaps other portions of the fault to the east or west that could go,” says Eric Calais, a geophysicist at Purdue University in West Lafayette, Ind., who has used GPS stations to monitor the area since 2003.

At 4:53 p.m. local time on the day of the quake, a magnitude-7.0 temblor struck just 15 miles west-southwest of Port-Au-Prince, according to the U.S. Geological Survey. The shallow quake occurred along the Enriquillo–Plantain Garden fault system, one of several major faults defining the boundary between the Caribbean and North America tectonic plates that move past each other in an east-west direction near Haiti. A section of fault approximately 31 miles long moved during the quake, says Gavin Hayes of the USGS National Earthquake Information Center. The largest amount the fault slipped was 15 feet.

The devastation has been extreme, with poor building construction and dense population making what, by seismic standards, is not a massive earthquake into a major disaster. As of January 15, tens of thousands of people were reported dead.

Now scientists are bracing for what might happen next. “Our folks and others are acquiring all the imagery they can in order to examine possible landslide-dammed drainages that could create subsequent flash flood hazard, identify surface rupture and look for the extent of … ground failure,” says David Applegate, senior science adviser for natural hazards with the U.S. Geological Survey.

Haiti’s political situation had made it a difficult place to do science, Calais says. “A lot of researchers who otherwise would have liked to work in Haiti decided not to…. There is very little science infrastructure.”

Satellites are proving a key tool to understanding the recent earthquake. It will be some time before teams can do crucial field work on the ground, Applegate says. Other plans include close investigations of lifelines; hopes to deploy ocean-bottom seismometers nearby; and strategies for using satellite radar images taken before and after the quake as a way to determine degrees of deformation.

Though the planet is littered with some 4,000 seismic stations that constantly detect waves produced as the Earth’s crust moves and shifts, not one station is in Haiti, the scientists note.

For measuring the big quake, that's not a problem. "Every sand grain on the planet dances to the music of those seismic waves," says Ross Stein of the USGS in Menlo Park, Calif., who is part of a team working to quickly model the possible aftereffects of the January 12 quake. But, Hayes says, "there are no local stations in the immediate vicinity of the epicenter from which we can obtain data to help constrain very detailed characteristics," he says, such as whether shaking was stronger, and damage even more severe, in some areas than others.

Seismic stations nearby, such as in the Dominican Republic, have allowed researchers to record and locate aftershocks as low as magnitude 3.0, Hayes says, but with a certain error.

Most aftershocks are smaller than the first rupture, and they become less frequent with time. But the strength of aftershocks doesn't necessarily decrease with time, Stein says. "A small percentage of them can be larger than the main shock." And a large aftershock could still hit a hundred days later, he says.

Researchers are hoping the quake won't be a repeat of the 1999 Izmit earthquake and subsequent aftershocks, when a magnitude-7.6 on the North Anatolian fault system struck western Turkey and resulted in the deaths of at least 17,118 people, according to the USGS. Three months later, Stein says, an adjacent portion of the fault ruptured in a magnitude-7.0 quake.

The Enriquillo–Plantain Garden fault system and North Anatolian fault system are similar, researchers say. Both are long faults, Stein says, with bumps and bends that can stop a rupture. When the rupture stops at those strong points, Calais adds, the change imparts large stresses that can make those areas of the fault more likely to experience quakes. That's what happened on the North Anatolian in 1999. "One earthquake tends to trigger the next one within a few years or a couple of decades," Calais says. "Hopefully this is not the case here."

For the Enriquillo–Plantain Garden fault system, the early data from other Caribbean seismic stations show aftershocks defining a western limit to the portion of fault that slipped, Hayes says.

It wasn't until 2003 that researchers were able to begin quantifying the movement along the Enriquillo–Plantain Garden fault system. Calais and fellow researchers began using portable GPS receivers to monitor the motion around the fault. In 2008, the team announced at a meeting of the Caribbean Geological Conference that the fault posed a major seismic hazard.

The team had measured plate motion of 7 millimeters a year, one-fifth of the motion along some portions of the San Andreas, which is a similar type of fault, Calais says. "The problem is the fault had been quiet for a long time." The last major earthquake on the Enriquillo–Plantain Garden fault system was in 1770, historical accounts show. By January 12, a large amount of stress had built up along the fault, Calais says. "This is the way most faults behave on the planet. Most faults are quiet for a long time."

The fault was behaving like most faults, but the quake hit a place unprepared for it. And also, Calais says, "it is only recently that we were able to quantify what's going on there.... The progress we've been able to make has been too slow. The earthquake happened too early.

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