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The devastation created by Haiti's magnitude-7 earthquake left 1.3 million survivors homeless.

EARTH SCIENCE

Quake threat looms over Haiti

Tectonic strain remains in key fault line, researchers find.

BY QUIRIN SCHIERMEIER

The half-minute of tremors that shook Haiti in January left death and destruction — and lingering questions about when and where another such quake might strike. Some 230,000 people died in the magnitude-7.0 quake, more than twice as many as in any recorded earthquake of similar strength. As the disaster drew aid workers from around the globe, scientists also flocked to the impoverished country to try to understand the quake.

What they found was unexpected. After ten months of intense field research, geologists are questioning conventional wisdom about what happened to Earth's crust during the fateful 30 seconds that set back Haiti's development by years. The research, summarized in a package of papers in the November issue of *Nature Geoscience*, has two common conclusions: the Haitian earthquake was more complex than initially believed, and may not have fully released the tectonic strain that had accumulated in the

region. If so, Haiti is at serious risk of similar devastation in the future.

"The 12 January earthquake only unloaded a fraction of the seismic energy that has built up over time in Haiti," says Eric Calais, a geophysicist at Purdue University in West Lafayette, Indiana, and science adviser for the United Nations Development Programme in Haiti. "Other earthquakes are therefore inevitable."

The Haiti quake occurred in a Caribbean fault system called the Enriquillo–Plantain Garden, at the interface of the Caribbean and North American plates, where seismic strain gradually accumulates as the two plates slide past each other (see 'Anatomy of a quake'). Strong earthquakes originating from this fault have twice destroyed Port-au-Prince, in 1751 and 1770. Using computer models alongside satellite and field observations, Calais and other scientists have tried to establish which parts of the fault system ruptured this time around, and in which direction.

The results suggest that the quake may not

have originated from the main fault in the system, as geologists had initially assumed. For example, there is a puzzling absence of the geological evidence normally left by tectonic slips that rupture the surface. A team led by Carol Prentice of the US Geological Survey (USGS) in Menlo Park, California, spent months searching the land along the plate boundary fault south of Port-au-Prince for such traces. Although they found stream channels that had been wrenched sideways during historic quakes, they failed to find any fresh signs of surface rupture around the main fault¹.

"This is pretty bizarre," says Roger Bilham, a geologist at the University of Colorado, Boulder, who was not involved in the recent studies. "It might mean that the main fault is a geological fossil. But more likely its surface part has been clamped shut by a complex sequence of nearby slips in January. If so, another strong quake could happen any time soon right above the January epicentre."

The findings also mean that the January quake must have been triggered along another fault. To pinpoint it, two teams of scientists have created different fault models based on ground deformation, seismic waves recorded at the time, and the little that is known about local geology. Unsurprisingly, given the uncertainties in the data, the models differ considerably.

Calais' team says that the quake occurred on a previously unknown subsidiary fault in the Enriquillo–Plantain Garden.

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Dubbed Léogâne, after a nearby town, it lies to the north of and parallel to the main fault².

The second team, led by Gavin Hayes, a seismologist with the USGS in Golden, Colorado, reckons that the quake involved at least three faults, which mutually triggered each others' slipping. The slip started on either the main Enriquillo fault or the Léogâne subsidiary fault, they conclude³.

To assess the hazard of future quakes in the region, scientists need to know how much additional seismic stress was transferred to nearby faults by January's disaster. But that assessment would vary depending on the model used — an uncertainty that offers little comfort for planners and engineers in Haiti, or for the 1.3 million survivors living in camps after their homes were destroyed. As *Nature* went to press, those people were facing the growing threat of a rapidly spreading cholera outbreak.

The January quake also had unexpected effects at the surface. Scientists led by Susan Hough of the USGS in Pasadena, California, have found that the strongest ground motion did not occur in the soft sedimentary rock that underlies most of Port-au-Prince, as would be expected. Instead, the greatest movement was seen in a foothill ridge south of the capital, where the ground consists of relatively solid rock⁴. The team believes that seismic waves were amplified by local geological conditions

and topographic features such as valleys and hills.

“What we know now hasn’t brought us any closer to understanding Haiti’s seismic future,” says Bilham. “As things stand, we can only recommend engineers rebuild Port-au-Prince as safely as money allows.” An array of seismic instruments installed across Haiti since the quake may soon provide some of the missing information about the fault’s origin, and the amount of strain remaining in the system, he adds. The array is recording frequent tiny quakes, of magnitudes 1–2, which will help scientists to map the region’s subsurface geometry and improve their models.

“We know enough already to recommend

proactive measures to adapt the country to earthquake hazard and, eventually, reduce economic losses and save lives,” says Calais. “But research must continue to better characterize seismic hazard. A dedicated effort is key to identifying all potential sources of earthquakes and producing the hazard maps that are badly needed for planning and engineering purposes.” ■

1. Prentice, C. *et al.* *Nature Geosci.* doi:10.1038/ngeo991 (2010).
2. Calais, E. *et al.* *Nature Geosci.* doi:10.1038/ngeo992 (2010).
3. Hayes, G. P. *et al.* *Nature Geosci.* doi:10.1038/ngeo977 (2010).
4. Hough, S. E. *et al.* *Nature Geosci.* doi:10.1038/ngeo988 (2010).