Little afterslip in the April 2015 Nepal earthquake indicates buildup of strain: study

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Buildings in Kathmandu, Nepal damaged by the April 2015 Gorkha earthquake. Credit: Roger Bilham/CIRES

The Gorkha earthquake struck Nepal on April 25, 2015. It's a part of the world that is prone to earthquakes, as the Indian plate makes its incremental, sticky descent beneath the Eurasian plate. The magnitude 7.8 jolt, which was very shallow (only 15 km underground), caused a tremendous amount of damage in Kathmandu. But it didn't rupture the Earth's surface, signifying that only part of the fault had slipped, below-ground.

In the following days, even the afterslip—post-earthquake movement—produced little surface evidence of continued movement. That meant only one of two things could be happening: either the part of the fault that hadn't moved was experiencing a slow-slip event, a slow-motion earthquake, or it remained completely locked, accumulating further strain in that segment of the fault. A new research paper, out online from *Nature Geoscience*, finds it is likely the latter.

David Mencin, the lead author on that paper, is a graduate student with CIRES and the University of Colorado Boulder's Department of Geological Sciences and a project manager with the geoscience non-profit UNAVCO. Following the earthquake, an international team of scientists quickly deployed a series of GPS receivers to monitor any movements. They also relied on InSAR—interferometric synthetic aperture radar—to look for changes to the Earth's surface. They found there had been 70 mm (2.75 inches) of afterslip north of the rupture and about 25 mm (1 inch) of afterslip to the south of the rupture. But scientists estimate there's about 3.5 meters (11.5 feet) worth of strain built into this fault, which those post-earthquake movements did nothing to alleviate.

"There was a clear lack of afterslip," says Mencin. "That has implications for future great earthquakes, which can tap into this stored strain."

CIRES Fellow Roger Bilham, a co-author on the study and Professor of Geological Sciences, got an early look at the fault zone when he took a helicopter flight over the area following the quake.

"Roger went out there immediately to search for a surface rupture," says Mencin. "A newly formed 3.5 meter escarpment (upthrust) would have been obvious, even to the casual tourist."

Historical earthquakes in the region—in 1803, 1833, 1905 and 1947—also failed to rupture the surface of the Himalayan frontal faults and they, too, experienced a lack of afterslip or large subsequent earthquakes. That, according to the team's research, means there's significant strain throughout the region.

"There's no evidence that it will spontaneously rupture in another damaging earthquake," says Bilham. "But the strain may fuel a future earthquake starting nearby. The entire Himalayan arc may host dozens of pockets of strain energy awaiting release in future great earthquakes."

And this region remains vulnerable to earthquakes, not only because of its geography, but because of its architecture and development patterns. While this 2015 earthquake killed 8,000 people, left tens of thousands homeless and destroyed parts of Kathmandu, the amount of strain built up in the faults, if released suddenly, could do much more damage in this part of the world. That's why Mencin and his colleagues are already at work on their next paper, which they hope might help identify patterns across the entire Himalayan front.

"We're trying to understand the earthquake cycle in the Himalaya and understand how they happen," says Mencin.

More information: Gorkha earthquake hints at reservoir of mid-Himalayan strain pending release in future great ruptures, *Nature Geoscience*, DOI: 10.1038/ngeo2734

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