Old evidence leads to new ideas about earthquake hazards in Pacific Northwest

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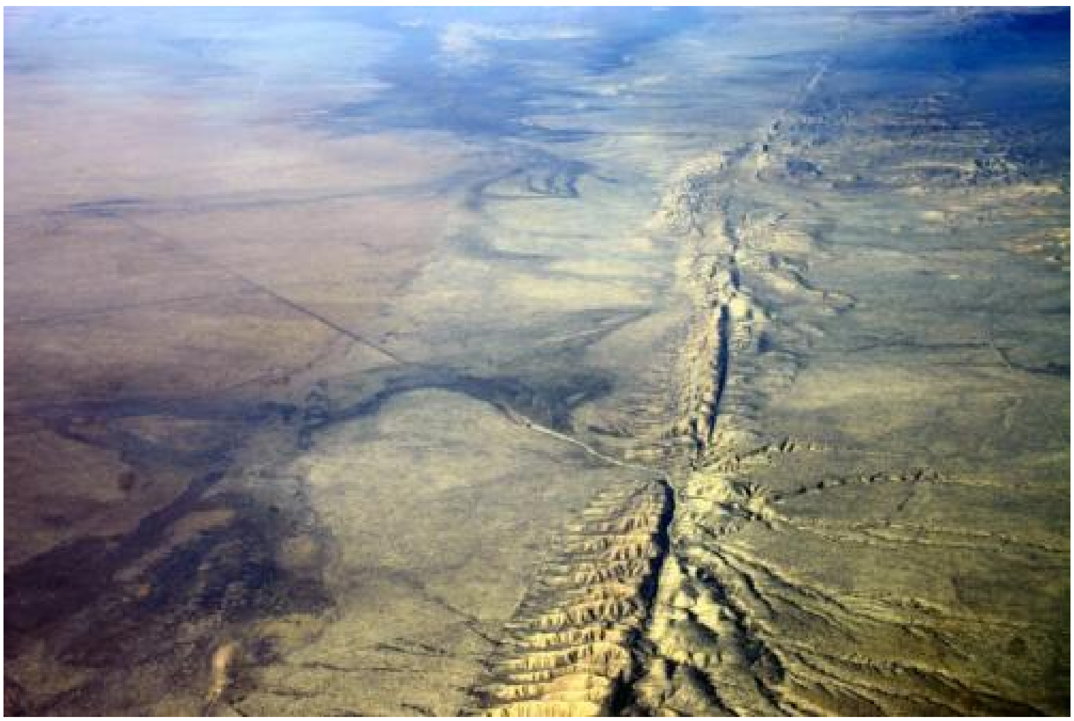

Aerial photo of the San Andreas Fault in the Carrizo Plain, northwest of Los Angeles. Credit: Wikipedia.

(Phys.org) —Gary Griggs began studying sediment deposits on the deep-sea floor off the Oregon coast in 1965 as a graduate student in oceanography at Oregon State University. Now, almost 50 years later, Griggs is a distinguished professor of Earth and planetary sciences and director of the Institute of Marine Sciences at UC Santa Cruz, and the sediment cores he collected as a grad student have led geologists to rethink their ideas about earthquake hazards in the Pacific Northwest.

It wasn't until 1990 that the distinctive sediment layers Griggs and his colleagues observed were recognized as evidence of massive earthquakes that occurred centuries ago. A new study published July 29 in *Geology* reexamines that evidence and its implications.

"Science has come a long way in the past half century. When I was a graduate student we didn't have the benefit of plate tectonics and no understanding of the potential for big earthquakes in that area," said Griggs, a coauthor of the new paper.

The report focuses on the Cascadia subduction zone—a giant active fault that slants eastward beneath the Pacific coast of southern British Columbia, Washington, Oregon, and northern California. The lead author is Brian Atwater of the U.S. Geological Survey, an expert on Cascadia earthquakes who contacted Griggs several years ago to learn more about the sediment cores he had collected as a graduate student.

Geologic studies in the past three decades have provided increasingly specific estimates of Cascadia earthquake sizes and repeat times. The estimates affect public safety through seismic provisions in building design and tsunami limits on evacuation maps. At issue is not whether the Cascadia subduction zone produces enormous earthquakes repeatedly. It is widely held, for instance, that the zone last ruptured along most of its 700-mile length in January 1700, in an earthquake of estimated magnitude 9. The new report does not question this consensus. What the report asks instead is how much geologists can say, with confidence, about Cascadia earthquake history before 1700.

"The question is whether we get magnitude 8 earthquakes every 300 years or magnitude 9 earthquakes every 500 years, and that's important because it's been over 300 years since the last very large quake and tsunami," Griggs said. "It may be more complicated than people once thought to determine exactly when those past earthquakes occurred."

The new report reappraises sediment cores that were collected near the foot of the continental slope offshore Washington. Several cores from this area underpin influential estimates of Cascadia earthquake size and recurrence that were published in 2012. The new report points to confounding evidence from a much larger suite of cores that were collected and first analyzed in the late 1960s and early 1970s, including those collected by Griggs.

At that time, plate tectonics was such a new idea that scientists were just beginning to recognize the Cascadia subduction zone as a tectonic plate boundary. The sediment cores were collected to learn about turbidites—beds of sand and mud laid down by bottom-hugging, sediment-driven currents that infrequently emerged from submarine canyons onto the deep ocean floor. Not until a 1990 report would turbidites be reinterpreted as clues to Cascadia earthquake history.

The new report asks how well geologists have managed to read this earthquake history. Which earthquakes represent long ruptures and which represent sequential, shorter breaks? Do earthquakes happen more often here than there? The report concludes that extracting such details from turbidites at Cascadia is more complicated than was previously thought.

For Griggs, the new developments show how important it is to keep good research records. "Even if you don't have the answer at the time, if you do careful work others can come along later and reevaluate the evidence in the light of new models and understanding," he said.