Geoscientists find Pacific plate is scored by large undersea faults that are pulling it apart

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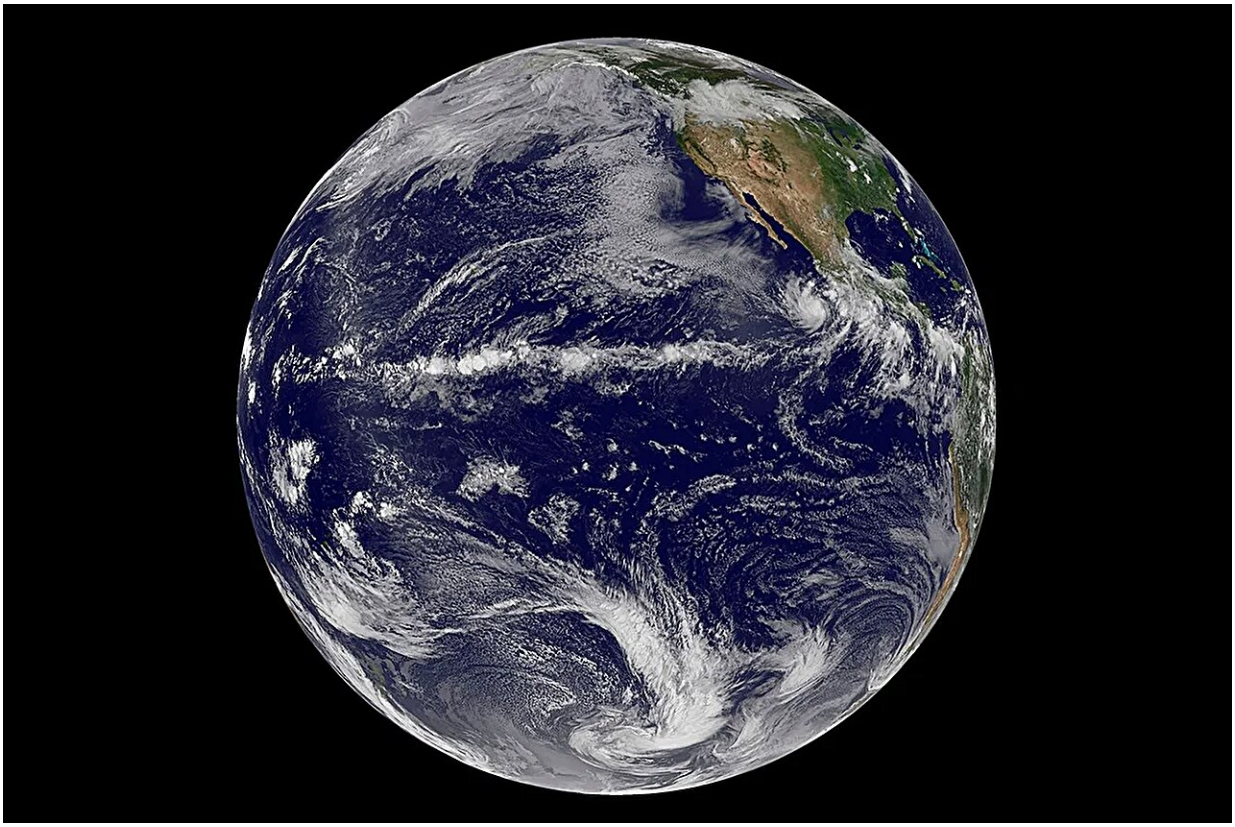

Researchers discovered new undersea faults on the Pacific plate, some of which are thousands of meters below the surface of the ocean and hundreds of kilometers long. Credit: NOAA/NASA GOES Project

A team of geoscientists from the University of Toronto is shedding new

light on the century-old model of plate tectonics, which suggests the plates covering the ocean floors are rigid as they move across the Earth's mantle.

The researchers found that the Pacific plate is scored by large undersea faults that are pulling it apart. The newly discovered faults, described in a paper published in the journal *Geophysical Research Letters*, are the result of enormous forces within the plate tugging it westward.

Some of the faults are thousands of meters deep and hundreds of kilometers long.

"We knew that geological deformations like faults happen on the continental plate interiors far from plate boundaries," says Erkan Gün, a post-doctoral researcher in the department of Earth Sciences in the Faculty of Arts & Sciences. "But we didn't know the same thing was happening to ocean plates."

Russell Pysklywec, a professor in the department of Earth sciences, adds that the research contributes to a fuller understanding of the field.

"What we're doing is refining plate tectonics—the theory that describes how our planet works—and showing those plates really aren't as pristine as we previously thought," says Pysklywec.

Other researchers involved in the study include Phil Heron, an assistant professor in the department of physical and environmental sciences at U of T Scarborough, as well as researchers from the Eurasia Institute of Earth Sciences at Istanbul Technical University.

For millions of years, the Pacific plate—which constitutes most of the Pacific Ocean floor—has drifted westward to plunge down into the Earth's mantle along undersea trenches or subduction zones that run

from Japan to New Zealand and Australia. As the western edge of the plate is pulled down into the mantle, it drags the rest of the plate with it like a tablecloth being pulled from a table.

The newly discovered plate damage at the faults occurs within extensive, sub-oceanic plateaus formed millions of years ago when molten rock from the Earth's mantle extruded onto the ocean floor; the faults tend to run parallel to the closest trench.

"It was thought that because the sub-oceanic plateaus are thicker, they should be stronger," says Gün. "But our models and seismic data show it's actually the opposite: the plateaus are weaker."

In other words, if the Pacific plate is like a tablecloth being pulled across a tabletop, the plateaus are patches of weaker cloth that are more prone to tearing.

The researchers studied four plateaus in the western Pacific Ocean—the Ontong Java, Shatsky, Hess and Manihiki—in a vast area roughly bounded by Hawaii, Japan, New Zealand and Australia. They made their discovery using supercomputer models and existing data—some collected in studies done in the 1970s and '80s.

"There is evidence that volcanism occurred at these sites in the past as a result of this type of plate damage—perhaps episodically or continuously—but it isn't clear if that's happening now," says Gün. "Still, we can't be certain because the plateaus are thousands of meters below the ocean surface and sending research vessels to collect data is a major effort. So, in fact, we're hopeful our paper brings some attention to the plateaus and more data will be collected."

The theory of plate tectonics has been refined over many decades by numerous Earth scientists, including U of T's John Tuzo Wilson, who

made significant contributions to it during his career.

"But the theory's not carved in stone and we're still finding new things," says Pysklywec. "Now we know this fault damage is tearing apart the center of an ocean plate—and this could be linked to seismic activity and volcanism.

"A new finding like this overturns what we've understood and taught about the active Earth," he says. "And it shows that there are still radical mysteries about even the grand operation of our evolving planet."

More information: Erkan Gün et al, Syn-Drift Plate Tectonics, *Geophysical Research Letters* (2024). DOI: 10.1029/2023GL105452

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