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'Ultrasound' of Earth's crust reveals inner workings of a tsunami factory

May explain why seafloor near SW Japan generates devastating tsunamis, will help assess risk of giant tsunamis in other regions

AUSTIN, Texas—Research announced this week by a team of U.S. and Japanese geoscientists may help explain why part of the seafloor near the southwest coast of Japan is particularly good at generating devastating tsunamis, such as the 1944 Tonankai event, which killed at least 1,200 people. The findings will help scientists assess the risk of giant tsunamis in other regions of the world.

Geoscientists from The University of Texas at Austin and colleagues used a commercial ship to collect three-dimensional seismic data that reveals the structure of Earth's crust below a region of the Pacific seafloor known as the Nankai Trough. The resulting images are akin to ultrasounds of the human body.

The results, published this week in the journal Science, address a long standing mystery as to why earthquakes below some parts of the seafloor trigger large tsunamis while earthquakes in other regions do not.

The 3D seismic images allowed the researchers to reconstruct how layers of rock and sediment have cracked and shifted over time. They found two things that contribute to big tsunamis. First, they confirmed the existence of a major fault that runs from a region known to unleash earthquakes about 10 kilometers (6 miles) deep right up to the seafloor. When an earthquake happens, the fault allows it to reach up and move the seafloor up or down, carrying a column of water with it and setting up a series of tsunami waves that spread outward.

Second, and most surprising, the team discovered that the recent fault activity, probably including the slip that caused the 1944 event, has shifted to landward branches of the fault, becoming shallower and steeper than it was in the past.

"That leads to more direct displacement of the seafloor and a larger vertical component of seafloor displacement that is more effective in generating tsunamis," said Nathan Bangs, senior research scientist at the Institute for Geophysics at The University of Texas at Austin who was co-principal investigator on the research project and co-author on the Science article.

The Nankai Trough is in a subduction zone, an area where two tectonic plates are colliding, pushing one plate down below the other. The grinding of one plate over the other in subduction zones leads to some of the world's largest earthquakes.

In 2002, a team of researchers led by Jin-Oh Park at Japan Marine Science and Technology Center (JAMSTEC) had identified the fault, known as a megathrust or megasplay fault, using less detailed two-dimensional geophysical methods. Based on its location, they suggested a possible link to the 1944 event, but they were unable to determine where faulting has been recently active.

"What we can now say is that slip has very recently propagated up to or near to the seafloor, and slip along these thrusts most likely caused the large tsunami during the 1944 Tonankai 8.1 magnitude event," said Bangs.

The images produced in this project will be used by scientists in the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE), an international effort designed to, for the first time, "drill, sample and instrument the earthquake-causing, or seismogenic portion of Earth's crust, where violent, large-scale earthquakes have occurred repeatedly throughout history."

"The ultimate goal is to understand what's happening at different margins," said Bangs. "The 2004 Indonesian tsunami was a big surprise. It's still not clear why that earthquake created such a large tsunami. By understanding places like Nankai, we'll have more information and a better approach to looking at other places to determine whether they have potential. And we'll be less surprised in the future."

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Bangs' co-principal investigator was Gregory Moore at JAMSTEC in Yokohama and the University of Hawaii, Honolulu. The other co-authors are Emily Pangborn at the Institute for Geophysics at The University of Texas at Austin, Asahiko Taira and Shin'ichi Kuramoto at JAMSTEC and Harold Tobin at the University of Wisconsin, Madison. Funding for the project was provided by the National Science Foundation, Ocean Drilling Program and Japanese Ministry of Education, Culture, Sports and Technology.
