Contorted oceanic plate caused complex quake off New Zealand's East Cape

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Subduction zones, where a slab of oceanic plate is pushed beneath another tectonic plate down into the mantle, cause the world's largest and most destructive earthquakes. Reconstructing the geometry and stress conditions of the subducted slabs at subduction zones is crucial to understanding and preparing for major earthquakes. However, the tremendous depths of these slabs make this challenging—seismologists rely mainly on the rare windows into these deeply buried slabs provided by the infrequent but strong earthquakes, termed intraslab earthquakes, that occur within them.

In a new study published in *Geophysical Research Letters*, a research team led by the University of Tsukuba used seismic data generated by a magnitude 7.3 earthquake that occurred off the northeasternmost tip of New Zealand's North Island on March 4, 2021, detected by seismometers around the world, to investigate the particularly unusual geometry and stress states of the subducted slab deep below the surface in this region.

"The 2021 East Cape earthquake showed a complex rupture process, likely because of its location at the boundary between the Kermadec Trench to the north and the Hikurangi Margin to the south," lead author of the study Assistant Professor Ryo Okuwaki explains. "To investigate the geometry of the stress field and earthquake rupture process, we used a novel finite-fault inversion technique that required no pre-existing knowledge of the area's faults."

This investigation revealed multiple episodes of rupture, generated by both compression and extension in the subsurface at different depths. These episodes included shallow (~30 km) rupture due to extension perpendicular to the trench as would typically be expected in a subduction zone. Unexpectedly, however, the deep (~70 km) rupture occurred with compression parallel to the subduction trench.

"Two alternative or inter-related factors may explain the unique rupture geometry of the 2021 East Cape earthquake," senior author Professor Yuji Yagi explains. "First, subduction of a seamount or multiple seamounts along with the subducted slab could contort the slab and create local changes in the stress field. Second, the transition from the Kermadec Trench to the Hikurangi Margin, where the subducted oceanic crust is considerably thicker, could create the local conditions responsible for the unusual faulting pattern."

Because of the rarity of deep intraslab earthquakes in this region, distinguishing between these two possibilities is currently challenging, and indeed both factors might play significant roles in creating the complex stress field revealed by the East Cape earthquake. Additional earthquakes off the northeast coast of New Zealand in the future may shed further light on this deep tectonic mystery.

More information: Ryo Okuwaki et al, Illuminating a Contorted Slab With a Complex Intraslab Rupture Evolution During the 2021 Mw 7.3 East Cape, New Zealand Earthquake, *Geophysical Research Letters* (2021). DOI: 10.1029/2021GL095117

Provided by University of Tsukuba

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