Little-known quake, tsunami hazards lurk offshore of Southern California

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A satellite picture of the Channel Islands off the coast of Southern California. New research into the little known, fault-riddled, undersea landscape off of Southern California and northern Baja California has revealed more worrisome details about a tectonic train wreck in the Earth's crust with the potential for magnitude 7.9 to 8.0 earthquakes. Credit: NASA

While their attention may be inland on the San Andreas Fault, residents of coastal Southern California could be surprised by very large earthquakes - and even tsunamis - from several major faults that lie offshore, a new study finds.

The latest research into the little known, fault-riddled, undersea landscape off of Southern California and northern Baja California has revealed more worrisome details about a tectonic train wreck in the Earth's crust with the potential for magnitude 7.9 to 8.0 earthquakes. The new study supports the likelihood that these vertical fault zones have displaced the seafloor in the past, which means they could send out tsunami-generating pulses towards the nearby coastal mega-city of Los Angeles and neighboring San Diego.

"We're dealing with continental collision," said geologist Mark Legg of Legg Geophysical in Huntington Beach, California, regarding the cause of the offshore danger. "That's fundamental. That's why we have this mess of a complicated logjam."

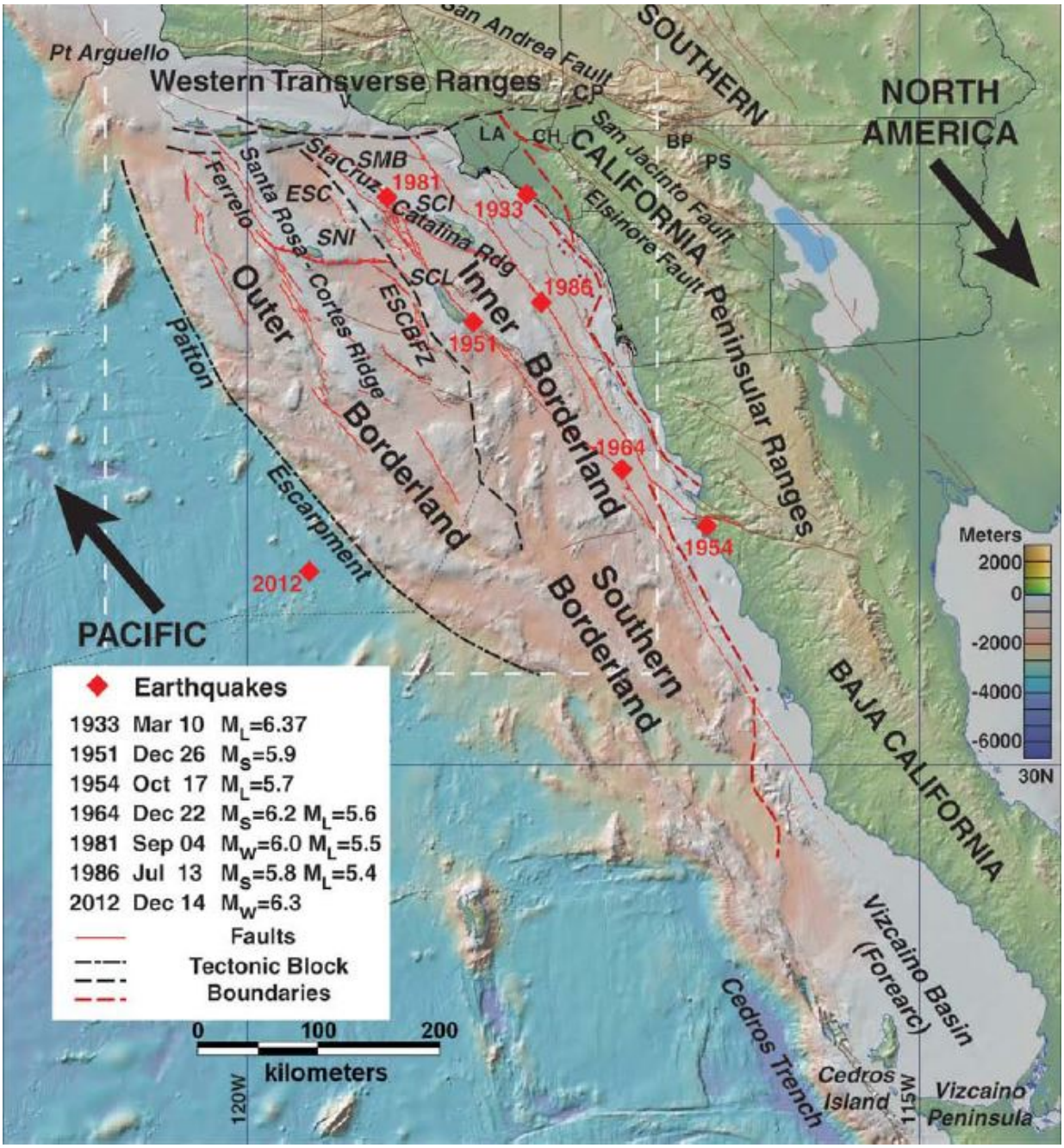
Legg is the lead author of the new analysis accepted for publication in the *Journal of Geophysical Research: Earth Surface*, a journal of the American Geophysical Union. He is also one of a handful of geologists who have been trying for decades to piece together the complicated picture of what lies beyond Southern California's famous beaches.

The logjam Legg referred to is composed of blocks of the Earth's crust caught in the ongoing tectonic battle between the North American tectonic plate and the Pacific plate. The blocks are wedged together all the way from the San Andreas Fault on the east, to the edge of the continental shelf on the west, from 150 to 200 kilometers (90 to 125 miles) offshore. These chunks of crust get squeezed and rotated as the Pacific plate slides northwest, away from California, relative to the North American plate. The mostly underwater part of this region is

called the California Continental Borderland, and includes the Channel Islands.

By combining older seafloor data and digital seismic data from earthquakes along with 4,500 kilometers (2,796 miles) of new seafloor depth measurements, or bathymetry, collected in 2010, Legg and his colleagues were able to take a closer look at the structure of two of the larger seafloor faults in the Borderland: the Santa Cruz-Catalina Ridge Fault and the Ferrelo Fault. What they were searching for are signs, like those seen along the San Andreas, that indicate how much the faults have slipped over time and whether some of that slippage caused some of the seafloor to thrust upwards.

What they found along the Santa Cruz-Catalina Ridge Fault are ridges, valleys and other clear signs that the fragmented, blocky crust has been lifted upward, while also slipping sideways like the plates along the San Andreas Fault do. Further out to sea, the Ferrelo Fault zone showed thrust faulting - which is an upwards movement of one side of the fault. The vertical movement means that blocks of crust are being compressed as well as sliding horizontally relative to each other-what Legg describes as "transpression."



This map shows the California Borderland and its major tectonic features, as well as the locations of earthquakes greater than Magnitude 5.5. The dashed box shows the area of the new study. Large arrows show relative plate motion for the Pacific-North America fault boundary. The abbreviations stand for the following: BP = Banning Pass, CH = Chino Hills, CP = Cajon Pass, LA = Los Angeles, PS = Palm Springs, V = Ventura; ESC = Santa Cruz Basin; ESCBZ = East Santa Cruz Basin Fault Zone; SCI = Santa Catalina Island; SCL = San

Clemente Island; SMB = Santa Monica Basin; SNI = San Nicolas Island. Credit: Mark Legg

Compression comes from the blocks of the Borderland being dragged northwest, but then slamming into the roots of the Transverse Ranges - which are east-west running mountains north and west of Los Angeles. In fact, the logjam has helped build the Transverse Ranges, Legg explained.

"The Transverse Ranges rose quickly, like a mini Himalaya," Legg said.

The real Himalaya arose from a tectonic-plate collision in which the crumpled crust on both sides piled up into fast-growing, steep mountains rather than getting pushed down into Earth's mantle as happens at some plate boundaries.

As Southern California's pile-up continues, the plate movements that build up seismic stress on the San Andreas are also putting stress on the long Santa Cruz-Catalina Ridge and Ferrelo Faults. And there is no reason to believe that those faults and others in the Borderlands can't rupture in the same manner as the San Andreas, said Legg.

"Such large faults could even have the potential of a magnitude 8 quake," said geologist Christopher Sorlien of the University of California at Santa Barbara, who is not a co-author on the new paper.

"This continental shelf off California is not like other continental shelves - like in the Eastern U.S.," said Sorlien.

Whereas most continental shelves are about twice as wide and inactive, like that off the U.S. Atlantic coast, the California continental shelf is

very narrow and is dominated by active faults and tectonics. In fact, it's unlike most continental shelves in the world, he said. It's also one of the least well mapped and understood. "It's essentially terra incognita."

"This is one of the only parts of the continental shelf of the 48 contiguous states that didn't have complete ... high-resolution bathymetry years ago," Sorlien said.

And that's why getting a better handle on the hazards posed by the Borderland's undersea faults has been long in coming and slow to catch on, even among earth scientists, he said.

NOAA was working on complete high-resolution bathymetry of the U.S. Exclusive Economic Zone - the waters within 200 miles of shore - until the budget was cut, said Legg. That left out Southern California and left researchers like himself using whatever bits and pieces of smaller surveys to assemble a picture of what's going on in the Borderland, he explained.

"We've got high resolution maps of the surface of Mars," Legg said, "yet we still don't have decent bathymetry for our own backyard."

More information: *Journal of Geophysical Research: Earth Surface*, onlinelibrary.wiley.com/doi/10 … ytk-41855.5282060185

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