Pacific Northwest tectonic plates are moving

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The three major tectonic plates off the Pacific Northwest coast are undergoing a gradual shift, and the area in which they converge – popularly known as the "Triple Junction" – appears to be migrating in a southeasterly direction.

The change isn't a cause for alarm, researchers say; in fact, it has been slowly taking place over millions of years. But advances in technology, and data provided in part by formerly classified U.S. Navy hydrophones, are giving scientists a new perspective on the underlying geology of the region – an understanding that may change previous accepted models of seafloor spreading, undersea volcanism and, ultimately, seismic hazards.

Findings of the research, conducted by Robert Dziak of Oregon State University, were just published in the journal *Geology*.

This "reorganization" of the Triple Junction may indicate that the subduction of the northern portion of the Juan de Fuca plate beneath the North American plate may be slowing and eventually cease, Dziak said.

"It appears that it is turning into a transform boundary, where the plates slide past each other instead of 'colliding,'" said Dziak, an associate professor at OSU whose lab is at the university's Hatfield Marine Science Center in Newport. "In many ways, it is becoming more like the San Andreas Fault to the south, where the earthquake danger comes from strike-slip events, rather than a subduction quake.

"If that is the case, it's possible that the new fault line may not rupture all

the way through, limiting the potential for a huge earthquake of magnitude 9.0 or higher," Dziak added. "That doesn't mean the Northwest isn't susceptible to a major earthquake. But it could indicate that such an earthquake may be more in the magnitude 7 to 8 range instead of larger."

Dziak compared the present fault lines with ancient fault lines using sonar data collected during 16 different research cruises over the past 23 years. Slight changes in the overall motion of the plates influence how they interact, he says, and are leading to the shift.

The Triple Junction is where the Juan de Fuca plate, the North American plate and the Pacific plate converge in an area off the Pacific Northwest coast from Oregon to Vancouver Island. Seafloor spreading associated with the tectonic action created two major ridges, the Juan de Fuca Ridge to the south and the Explorer Ridge to the north.

Over long periods of time – literally millions of years – these ridges have gradually reoriented themselves and formed an independent plate called the Explorer plate, which sheared off the Juan de Fuca plate and slowly has been subducting beneath Vancouver Island. The plate, about 200 kilometers in length, is subducting beneath the North American plate at the rate of about 4.3 centimeters a year.

Eventually, Dziak said, the Explorer plate will disappear.

"It is a small plate, caught between the two larger plates," he explained. "It's an example of the segmentation that is taking place that may be changing the seismic hazard profile of the entire region."

To evaluate that seismic hazard, Dziak and his colleagues at OSU's Hatfield Marine Science Center have used a hydrophone system called the Sound Surveillance System to "listen" for subtle earthquakes

offshore. SOSUS, as it is known, was used by the U.S. Navy during the Cold War to monitor submarine activity in the northern Pacific Ocean. As the Cold War ebbed, these and other unique military assets were offered to civilian researchers performing environmental studies.

When they first started using SOSUS, the researchers discovered that there were literally thousands of earthquakes taking place off the coast that had never been monitored. The frequency of these quakes – most falling in the magnitude 2 to 4 range – initially stunned researchers because they weren't being detected on land, even by the most sensitive seismometers. These small quakes occurred daily, but every so often there would be a "swarm" of as many as a thousand quakes in a three-week period.

"In the last 10 years, I've seen seven of these swarms," Dziak said. "The plate doesn't move in a continuous manner and some parts move faster than others. When it gets caught up and meets resistance, these swarms occur and when they do, lava breaks through onto the seafloor.

"Usually, the plate moves at about the rate a fingernail might grow – say three or four centimeters a year," he added. "But when these swarms take place, the movement may be more like a meter in a two-week period."

The SOSUS data are only 15 years old, so it is difficult to determine how the long-term effects of changes in the tectonic plates affect shorter-term seismic activity. There is no indication how these swarms of small quakes may be related, if at all, to the possibility of a major earthquake. Compared to the Indian Ocean, for example, the Northwest's Cascadia Subduction Zone is seismically "quiet" on a year-to-year basis, though there are indications the region may have had several large earthquakes in the past.

"We still have a lot to learn," Dziak said. "The Juan de Fuca is one of the most actively monitored tectonic plates on the planet, yet we are learning new things about it every day. And we still have a lot more to learn before we can pinpoint exactly what our hazard situation really is."

Source: Oregon State University, by Mark Floyd