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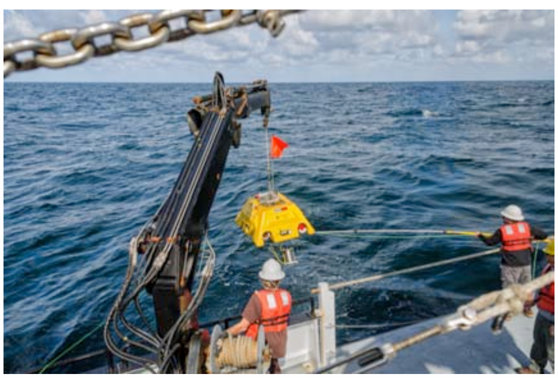
Seismological Research Letters: Special Focus Section on Cascadia Initiative to Monitor Northwest Pacific Seismic Risks

SAN FRANCISCO – Early data coming in from a massive, four-year deployment of seismometers onshore and offshore in the Pacific Northwest are giving scientists a clearer picture of the Cascadia subduction zone, a region with a past and potential future of devastating "megathrust" earthquakes.

The preliminary results from the Cascadia Initiative include a report of previously undetected, small earthquakes offshore, and seismic imaging that reveals new offshore structures at the subduction zone. The reports, published as a focus section in the September-October 2015 issue of *Seismological Research Letters* (SRL), also provide an update on how well the Initiative's instruments are operating, including a look at how seafloor pressure monitors can detect tsunamis in the region.



Researchers on the Research Vessel Oceanus retrieve an ocean-bottom seismometer during a 2014 expedition supporting the Cascadia Initiative.
Credit: Pat Kight via Flickr

The Cascadia subduction zone (CSZ) is a 1,100-kilometer (680-mile) Pacific fault that runs roughly from Cape Mendocino, California in the south to northern Vancouver Island, British Columbia. The zone marks the place where the Juan de Fuca and Gorda tectonic plates slip beneath the North American plate at a rate of about 2.3 to 4 centimeters (.9 to 1.6 inches) per year. At subduction zones like this throughout the globe, the tremendous strain built up in these crustal collisions has been released in the world's largest recorded earthquakes. These megathrust quakes include the 2004 magnitude 9.1 Sumatran Andaman earthquake that devastated parts of Indonesia, and the 2011 magnitude 9.0 Tohoku earthquake in Japan.

Although the CSZ has been relatively quiet in recent years, researchers have compiled a historical record of full and partial ruptures of the massive fault, with a magnitude 9.0 earthquake and tsunami last occurring in 1700. Scientists estimate that these megathrust quakes occur at 400 to 600-year intervals. Agencies such as the U.S. Federal Emergency Management Agency (FEMA) and others have warned of catastrophic damage along the U.S. Northwest coast in the wake of a megathrust quake.

Funded from 2011 to 2015 by the National Science Foundation, the Cascadia Initiative was designed in part to collect information on the potential seismic threat of the CSZ. The project includes 27 new inland seismic stations, upgrades to 232 other land stations, and the deployment of 60 new seismometers on the ocean bottom, spread across the tectonic plates. The data collected by the initiative is openly available to the full scientific community in a database managed by the Incorporated Research Institutions for Seismology (IRIS) Data Management Center.

The project "offers a unique opportunity to image the seismic structures associated with an entire plate, including its spreading center and subduction zone, within an easily accessible part of the continental and offshore United States," said University of Massachusetts Amherst researcher Haiying Gao, a guest editor of the *SRL* focus section.

"I don't think we can predict the time or location of the next megathrust earthquake in the CSZ based on the current research progress," Gao cautioned. "Nevertheless, the Cascadia Initiative significantly contributes to a better understanding of the structure of the downgoing oceanic plates and thus to the assessment and mitigation of potential seismic and tsunamic hazards."

For instance, a paper by New Mexico Tech researchers Emily Morton and Susan Bilek describes 96 small new earthquakes occurring in 2011 and 2012 that were detected with the help of the Initiative's ocean floor seismometers. These earthquakes occurred in the shallow, offshore "locked" part of the CSZ, where the fault is stuck in place, and had not been observed by land-based instruments. Detecting and locating these small seismic events can help researchers understand how strain on the megathrust fault may be changing, and to help predict how the megathrust might behave during a large rupture.

The seismic data collected by the Initiative has also helped Gao and her colleague Yang Shen at the University of Rhode Island, along with another study by Columbia University scientist Helen Janiszewski and Cornell University researcher Geoffrey Abers, to compile a picture of the CSZ structure that points to new places where the crushing pressure of subduction is squeezing water from and transforming rock at the trench where the Juan de Fuca plate is bending under the North American plate. The newly deployed seafloor seismometers, said Gao, have offered an unprecedented look at how released fluid can affect the fault's strength and behavior at the offshore trench.

Offshore instruments are important tools for observing and detecting tsunami risks in the region, according to a paper by Anne Sheehan of the University of Colorado Boulder and colleagues. They compared readings from several types of seafloor pressure gauges to study the tsunami caused by the 2012 Haida Gwaii earthquake, to evaluate how well the gauges could detect the timing and size of a tsunami.

Other papers in the issue examine how deep sea sediments may affect seismic wave readings, and evaluate how the Cascadia Initiative's data collection from ocean bottom seismometers has improved over the first three years of the study.

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