'Clusters' of earthquakes yield an ominous scenario

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The newest studies on the Cascadia Subduction Zone off the coast of the Pacific Northwest have identified a "clustering" of great earthquakes of the type that would cause a major tsunami, yielding a historical record with two distinct implications - one that's good, the other not. According to scientists at Oregon State University, this subduction zone has just experienced a cluster of four massive earthquakes during the past 1600 years, and if historical trends continue, this cluster could be over and the zone may already have entered a long quiet period of 500 to 1,000 years, which appears to be common following a cluster of earthquake events.

Alternatively, the current cluster of earthquakes may have one or more events left in it – some clusters within the past 10,000 years have had clusters of up to five events – and within a cluster, the average time interval between earthquakes is 300 years. Since the last major Cascadia earthquake occurred in the year 1700, the next event may well be imminent.

"The Cascadia Subduction Zone has the longest recorded data about its earthquakes of any major fault in the world," said Chris Goldfinger, an associate professor of marine geology at OSU and one of the leading experts on this fault zone. "So we know quite a bit about the periodicity of this fault zone and what to expect. But the key point we don't know is whether the current cluster of earthquake activity is over yet, or does it have another event left in it."

The two most recent major earthquakes on this fault occurred in the year 1700 and approximately the year 1500, Goldfinger said. Those two events were only 200 years apart, and it's now been 305 years since the last one. From this perspective, there's some reason to believe the next major earthquake could happen soon.

As the death toll and catastrophic destruction from the East Asia earthquake of last Monday continues to mount, more and more attention is turning to the local version of that geologic setting – the Cascadia Subduction Zone.

According to Goldfinger, there are only two places in the United States with active subduction zones, or major areas where one of the Earth's great plates are being subducted, or forced underneath the other. One is in Alaska, the site of the great earthquake of 1964. The other is the Cascadia zone, a 600-mile long fault zone that runs from Cape Mendocino in California to Vancouver Island in southern British Columbia.

Major studies have been done on this fault zone, many of them at OSU, and they have identified 19-21 major earthquake events during the past 10,000 years. During at least 17 of these events, the entire fault zone appears to have ruptured at once, causing an earthquake around magnitude 9, and major tsunamis.

"There's some variation in intensity, the last event in 1700 appeared to be about average," Goldfinger said. "To track these events we use radiocarbon dating of deposits of sand called turbidites, which come from marine landslides. These deep-sea cores give us a pretty accurate picture of when and where an earthquake event happened."

According to Goldfinger, there are remarkable geologic parallels between what just happened in East Asia and what could happen in the

Pacific Northwest. The Asian event happened where the India plate was being subducted beneath the Burma microplate, and it ruptured – for the first time since 1833 - along a 600-mile front that is just about the same length as the Cascadia Subduction Zone.

That earthquake happened as the Indian plate moved towards the northeast beneath Asia, just like the Juan de Fuca plate is in the Pacific Northwest before it disappears beneath the North American plate.

What happened in Asia may give a vivid demonstration of the geologic future of the Pacific Northwest. For hundreds of years, these subduction zone plates remain locked, releasing little of their tension. The plate which is being subducted is forced down, while the plate above bulges upwards. Then, in a few minutes of violence every few centuries, the forces are released. The upper plate moves seaward, and a massive tsunami can be produced along with catastrophic destruction from earthquake shaking.

"In the case of the Cascadia Subduction Zone, you could have an area of ocean sea floor that's 50 miles wide and 500-600 miles long suddenly snap back up, causing a huge tsunami," Goldfinger said. "At the same time, we could expect some parts of the upper, or North American plate to sink one to two meters. These are massive tectonic events. Subduction zones produce the most powerful earthquakes and tsunamis in the world."

The question, Goldfinger says, is not whether or not the Cascadia Subduction Zone will break again. It's when. And that's where the study of past events may shed light on the present.

Following are the earthquake events on this fault zone during the past 9,800 years:

-- Oldest recorded earthquake, 9,800 years before present
-- 800 year gap with no major earthquakes
-- Three earthquake events, 8,300 to 9,000 years before present
-- 700 year gap with no major earthquakes
-- Five earthquake events, 5,700 to 7,600 years before present
-- 1000 year gap with no major earthquakes
-- Two earthquake events, 3,900 to 4,700 years before present
-- 500 year gap with no major earthquakes
-- Three earthquake events, 2,500 to 3,400 years before present
-- 700 to 900 year gap with no major earthquakes
-- Four earthquake events from 1600 years before present to today

"We're going to continue to study the geology of these events and identify the patterns and likelihood of future events as best we can," Goldfinger said. "A few things are clear. There are clusters of earthquake events on the Cascadia Subduction Zone, and there are big gaps. And we're either in a cluster right now or at the end of one."

"Whether the current cluster is over yet, we just don't know," he said. "One possibility is that we could be done with this cluster and looking at a period of many hundreds of years before the next earthquake."

"The other distinct possibility is we could still be in a cluster of events. If that's the case, the average time interval between earthquakes within a cluster is already up. We would be due just about any day."

Source: Oregon State University