Cascadia subduction zone earthquake, tsunami, and sea-level hazards

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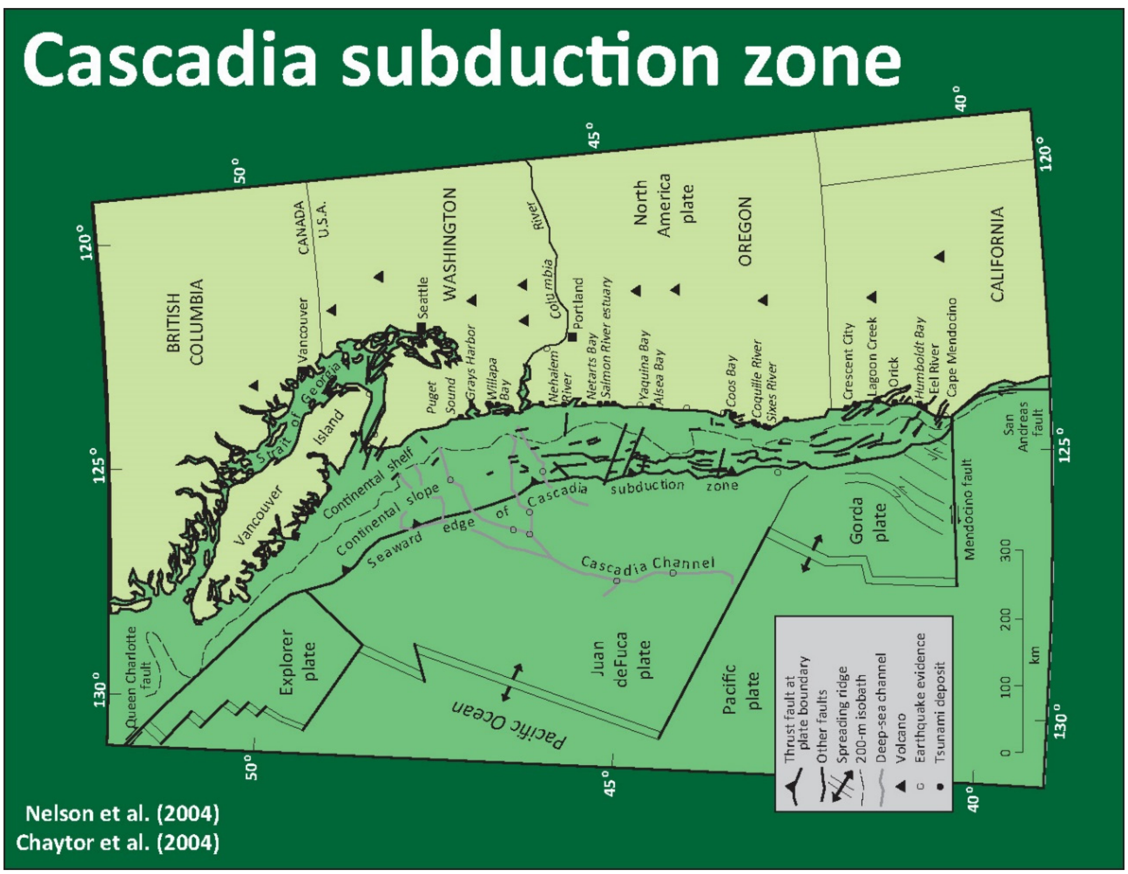
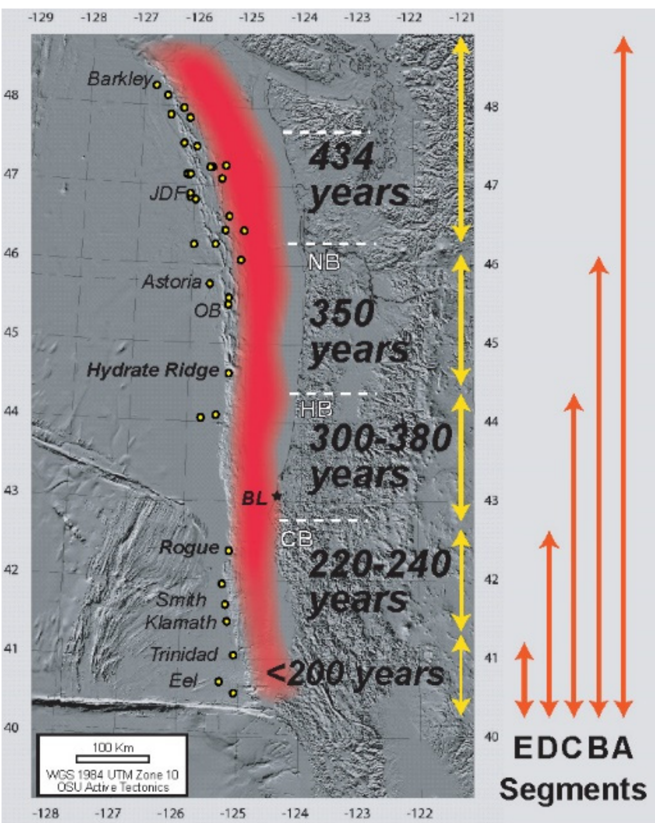
Dr. Jason "Jay" R. Patton will discuss the earthquake, tsunami, and other hazards associated with the Cascadia subduction zone (CSZ).

The Cascadia subduction zone (CSZ) is a convergent plate boundary fault system located offshore of northern California, Oregon, Washington, and British Columbia. The oceanic Explorer, Juan de Fuca, and Gorda plates subduct eastwards beneath the continental North America plate. Between earthquakes (a.k.a. the interseismic period) the fault is seismogenically locked and the lithosphere accumulates elastic strain. This causes the ground overlying and adjacent to the locked zone to deform vertically and horizontally. One can measure rates of interseismic ground motion using GPS, high precision bench mark surveys, and tide gages. The vertical ground motion has an effect on the local sea-level. In Humboldt Bay we have measured and observe the highest rates of downward ground motion along the west coast of the continental USA. When combined with eustatic sea-level rise measurements, we observe the largest rates of sea-level rise in the northeast Pacific.



When the fault slips during an earthquake (a.k.a. the coseismic period) the ground surface often tends to move with the opposite sense of motion than for between earthquakes. There exists sedimentary geological evidence for past CSZ earthquakes on land, along the coast in California, Oregon, Washington, and Canada. There also exists evidence for these earthquakes in the marine sedimentary record offshore in the northeast Pacific. Tsunami accompany these earthquakes and there is also sedimentary evidence for these past tsunami. Prehistoric earthquakes have been found to have variation spatially (not all CSZ earthquakes rupture in the same location) and temporally. Numerical ages derived from radioactive isotopes collected from the coastal and offshore sediments provide temporal constraints for this prehistoric record of earthquakes and tsunamis. We can make estimates of recurrence of CSZ megathrust earthquakes from this spatiotemporal history.

Holocene (<12 thousand years) recurrence of earthquakes along the Cascadia subduction zone (CSZ) is characterized by secondary geologic evidence in the form of buried marsh deposits, seismoturbidites, and tsunami deposits. Buried intertidal and supratidal deposits have been reported as evidence for pre-historic coseismic subsidence using modern litho- and bio-stratigraphic analogues (Atwater, 1987; Atwater and Hemphill-Haley, 1997; Nelson et al., 2006). Submarine landslide deposits, known as turbidites, deposited in the deep sea offshore the northeast Pacific provide evidence for strong ground shaking from CSZ earthquakes (Adams, 1990; Goldfinger et al., 2003; Goldfinger et al., 2012). When turbidites are demonstrated to likely be the result of ground shaking from earthquakes, we call them "seismoturbidites." Sediments have been interpreted as evidence for local tsunamis triggered by slip on the CSZ megathrust; in some cases, these paleotsunami deposits are associated with the buried marsh deposits (Nelson et al., 1996; Atwater and Hemphill-Haley, 1997). These paleoseismic, paleotsunami, and paleodeformation records provide evidence for spatio-temporal variation of these pre-historic earthquakes, resulting in estimates of recurrence that vary along strike. The seismoturbidite record provides a segmented record of paleoearthquakes, with segments that are of increasing length (from south to north) and decreasing recurrence intervals (north to south). The Holocene recurrence of earthquakes along these segments, each segment reaching the southernmost CSZ and extending sequentially further north, is 220-240, 300-380, 410-500, and 500-530 years (Goldfinger et al., 2012).



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