

Heaton, T.H. and Snavely, P.D. Jr. (1985). Possible Tsunami Along the Northwestern Coast of the United States Inferred from Indian Traditions. *Bulletin of the Seismological Society of America*. **75(5)**, 1455 – 1460.

- Before subduction of the Juan de Fuca and Gorda plates was officially confirmed
- Beginning to compile direct geological and historical evidence to affirm that great shallow subduction earthquakes have occurred along the coast of British Columbia, Washington, Oregon, California.
- Reports describing Indian legends of great sea-level disturbances that may be related to large nearby earthquakes
- Evidence provided by Judge James Swan who reported curious Indian traditions that suggests that there may have been great shallow subduction earthquakes
- Makah (Cape Flattery), Nootka, Clayoquot, Yurok
- Speak of whale bones left behind by T'hlukloots (Thunderbird) and fossil remains at a lake near Clayoquot

Heaton, T.H. and Kanamori, H. (1984). Seismic Potential Associated with Subduction in the Northwestern United States. *Bulletin of the Seismology Society of America*. **74(3)**, 983 – 941.

- Noting systematic difference between subduction zones that are capable of great earthquakes and those that are not (seismic coupling and earthquake size: depth of oceanic trench, seismic quiescence, etc.)
- The Juan de Fuca subduction zone has been ignored in the studies that established these differences, because of virtually no shallow thrust seismicity of the type we usually associate with active subduction zones
- Juan de Fuca plate is young between 10 -15 years old and that strong coupling is associated with every subduction zone where their subducted plate is less than 40 million years old
- The subduction rate of 3 – 4 cm/yr
- Juan de Fuca plate is topographically characterized as a smooth, featureless plain and these features further corroborate the interpretation that the Juan de Fuca subduction zone is strongly coupled and capable of large, shallow, thrust earthquakes
- Striking feature of the zone is its present-day very low level of seismicity
- No historical record of a large shallow thrust earthquake anywhere along the subduction zone within the past 150 years
- Although little present-day seismicity and no significant historical activity, there is sufficient evidence to warrant further study of the possibility of a great subduction zone earthquake in the Pacific Northwest

Atwater, B. F. (1987). Evidence for Great Holocene Earthquakes Along the Outer Coast of Washington State. *Science*. **236**, 942 – 236.

- No earthquake of the past 150 to 200 years in the states of Washington or Oregon has exceeded magnitude of 7.5 and Indian legends seem too ambiguous to indicate whether great Northwest earthquakes occurred during that time.
- Only geological evidence is likely to reveal whether great earthquakes from the Cascadia subduction zone have occurred
- Evidence in Chile (1960) and Alaska (1964) of rhythmic alternation between estuarine mud and buried lowland soils is cited as evidence of ancient subduction earthquakes

- A cycle of co-seismic submergence and post-seismic shoaling
- Peaty layers representing well-vegetated lowlands alternate rhythmically with muddy intertidal deposits
- Washington's outer coast has undergone submergence and shoaling in cycles that resemble the known and inferred cycles of co-seismic submergence and post-seismic shoaling
- 6 earthquakes have occurred since sea level approached its present position (7000 years ago)
- The earthquakes were of a magnitude of 8 or greater and buried lowlands for coast wide distances of 100 km

Clague, J.J. and Bobrowsky, P.T. (1994). Evidence for a Large Earthquake and Tsunami 100 – 400 Years Ago on Western Vancouver Island, British Columbia. *Quaternary Research*. **41**, 176 – 184.

- Evidence that most recent sudden submergence and tsunami along the coasts of Washington, Oregon, and northern California occurred about 300 yr ago
- High-precision and accelerator mass spectrometry radiocarbon dating and ring-width matching of trees rooted in the uppermost buried soil
- New stratigraphic evidence and radiocarbon ages, show that zone of subsidence associated with earthquakes in the Cascadia subduction zone may extend north to central Vancouver Island, BC
- Found evidence for sudden subsidence and a coincident tsunami at tidal marshes near Tofino and Ucluelet
- Sediments in the Tofino and Ucluelet tidal marshes provide evidence for co-seismic subsidence and a tsunami 100 – 400 years ago
- Evidence similar stratigraphy in many estuaries in Washington, Oregon, and northern California
- The earthquake most likely occurred in the Cascadia subduction zone, although a source within the North America or Juan de Fuca plates also is possible
- It is possible that hundreds of kilometres of the boundary between the Juan de Fuca and North America plates ruptured during one or a series of large earthquakes less than 400 years ago
- Consistent with geophysical data that suggest a section of the Cascadia subduction zone is locked and accumulating strain

Hutchinson, I. and McMillian, A. D. (1997). Archaeological Evidence for Village Abandonment Associated with Late Holocene Earthquakes at the Northern Cascadia Subduction Zone. *Quaternary Research*. **48**, 79 -87.

- Depositional breaks and culturally sterile strata in the middens indicate partial or complete abandonment
- Evidence comes from native oral traditions and correlations between the archaeological record and a chronology of great earthquakes in Cascadia
- Analysis is restricted to the past 3000 yr due to the limited evidence for human occupation and paleoseismic events prior to this period
- Although the seismic hazard of the Cascadia subduction zone has been recognized only recently by the scientific community, oral traditions make it clear that they were familiar with earthquakes and associated hazards
- While they were a familiar phenomenon they provide no timing or magnitude of such events
- Traditions of floods that caused village abandonment and population dispersal, collected along the Nuuchahnulth, Makah, and Quileute may refer to ancient tsunamis

- Tsunamis may have damaged canoes and food supplies and eroded or buried intertidal shallfish beds. Re-deposition of eroded material may have choked the lower channels of salmon-spawning streams
- Contacts between cultural deposits (in midden) and “sterile” units (sand or gravel layers, forest soils, and landslide deposits) were used to determine periods of occupation and phases of abandonment
- Nootka area sites were most affected

McMillian, A.D. (2002). When the Mountain Dwarfs Danced: Aboriginal Traditions of Paleoseismic Events along the Cascadia Subduction Zone of Western North America. *Ethnohistory*. **49(1)**, 41 – 68.

- Oral traditions recount details of the past natural catastrophes (earthquakes and tsunamis)
- Oral stories do not meet the modern standards of scientific rigor for the study of such phenomena, they reflect the experiences and perceptions of aboriginal peoples
- They provide along with the archaeological record of the Native past and are the only insights into the impact of past seismic events on human populations in this region prior to two hundred years ago
- Recurrent great earthquakes and tsunamis generated at the Cascadia subduction zone had been a major cause of village abandonment throughout this region during the past three thousand years
- They examine the oral traditions of Native occupants of Vancouver Island
- Little ethnographic research was conducted in this area prior to the early twentieth century, by which time many traditions disappeared
- Early anthropologists and folklorists viewed stories as discrete things that could be collected, much like artefacts, thus the oral traditions generally lack the rich contextual detail that once made them meaningful
- Few academic researchers have given the evidence of past seismic events contained in oral histories credibility (Thomas Heaton and Parke Snavely, 1985, and John Clague, 1995, Rick Minor and Wendy Grant, 1996)
- Oral traditions may have multiple levels of meaning, rather than describing a single set of historical events and points out that oral traditions are cultural forms that organize perceptions of the world and are not merely vehicles for historical facts
- Cascadia subduction zone has an average recurrence interval of about five hundred years, with successive events separated by as little as two hundred years to more than a thousand years
- Mountain dwarfs, in Nuu-chah-nulth belief were responsible for the earth shaking, dwarfs have houses inside the mountains where they entice the unwary to dance with them around and around a great wooden drum. Sooner or later the guest stumbles against the drum and becomes afflicted with a peculiar disease called “earthquake foot” and everytime he takes a step the ground shakes
- Nuu-chah-nulth individual named Yahlua followed a group of supernatural beings into a cave near the village of Yuquot in Nootka Sound. Yahlua kicked a large box drum and felt the earth shake, for “these spirits were those who cause earthquakes by means of their drum”. Yahlua was then an “earthquake man” and “whenever he walked the earth trembled”.
- Earthquakes are also featured in the major Nuu-chah-nulth ceremony, the wolf ritual. Costumed participants used bull-roarers to imitate its sound.
- Many stories from this paper... write them out??

- Mythic and ceremonial references to earthquakes seem deeply rooted in Northwest Coast cultures, presumably reflecting repeated experiences with such destructive phenomena
- Different examples of oral traditions: earthquake in Cowichan and rock slide in Squamish
- Story of Pachena Bay
- Only in the Nuuchahnulth story of how the Pachena Bay village was destroyed does an earthquake specifically precede the tsunami.
- Good comparative study of different nations and the similar stories they share
- Numerous common features run through the flood traditions, from the central British Columbia coast to southern Oregon: Nuuchahnulth, Makah, Quileute, Nuxalk, Heiltsuk, Oweekeno, Kwakwaka'wakw, and various Coast Salish groups of BC and Washington. Also Tillamook, Coos, Alsea.
- In these stories canoes become separated and the people are drifted apart, accounting for the dispersal of related groups today
- This is a good paper for a reference if students are interested
- Although the widespread flood stories almost certainly stem from a variety of factors, the repeated occurrence of major seismic events suggest that at least some of the oral traditions reflect the impact of tsunamis
- They argue that some oral traditions (Pachena Bay) are so specific in their details that they can be interpreted as historical narratives of catastrophic events
- Gitksan example (pg 61) being the best example of correlations between aboriginal oral traditions and geological evidence in BC (land claims stuff)
- Some modern scholars reject any separation of “science” and “myth” stressing the Native traditional knowledge offers a valid approach to understanding past and present phenomena in their environments

Questions to ponder: what difference does it make (in terms of dated geological sequence) whether or not earthquake dates were dated exactly? How could they have done this anyway? What if they had a different way of determining time? What about the fact that the “real data” they used also cannot determine an exact time? (soil samples, etc.) all of these methods gave a window but not an exact time? How might it make a culture feel when their knowledge is disregarded?

Ludwin, R. S., Dennis, R., Carver, D. McMillan, A.D., Losey, R. Clague, J., Jonientz-Trisler, C., Bowe chop, J., Wray, J., and James, K. (2005). Dating the 1700 Cascadia Earthquake: Great Coastal Earthquakes in Native Stories. *Seismological Research Letters*. **76(2)**, 140 – 148.

- Great summary of the events
- This paper speaks of the different stories told along the coast
- Recording of native stories began in the 1860's more than 350 years after first the European contacts in North America, almost 100 years after initial contact in Cascadia, and nearly 50 years after European settlement began
- The estimate is that 95% of native oral traditions may have been lost
- 40 native stories from 32 independent sources. These stories represent less than a third of the known stories that refer to shaking or marine flooding and were selected on the basis of clarity, descriptions of phenomena notable in megathrust earthquakes, and geographic distribution
- 3 broad categories: stories from which dates can be estimated, stories that are clearly historical but impossible to date, and apparently mythic stories without any clear timeframes

- Southern end: stories explicitly mention both earthquakes and tsunamis. Northern end: explicit earthquake stories and explicit flood stories, few including both phenomena. Middle portion of CSZ, along the coast of Oregon and Washington direct mention of earthquakes is rare and stories of marine floods are common
- Swai'xwe mask
- Chief Councillor of the Huu-ay-aht First Nation and grandson of Chief Louis Nookmis, working with a new translation of the recordings does include dates.
- Includes stories of Whale and Thunderbird; these stories appear from Vancouver Island to Northern Oregon. From central Oregon south, thunder or whale figures appear individually in stories and central figures are variously identified as Thunder, Thunderbird, or bird and Whale, fish, or sea monster, double-headed eagle and a water-monster.
- Comparative story from Africa

Ludwin, R. S., Thrush, C.P., James, K. Buerge, D., Jonientz-Trisler, C. , Rasmussen, J., Troost, K., And de los Angeles, A. (2005). Serpent Spirit-power Stories along the Seattle Fault. *Seismological Research Letters*. **76(4)**, 426 – 431.

- Comparative Seattle story

Thrush, C. P. & Ludwin, R. S. (2007). Finding Fault: Indigenous Seismology, Colonial Science, and the Rediscovery of Earthquakes and Tsunamis of Cascadia. *American Indian Culture and Research Journal*. **31(4)**, 1 – 24.