Holocene History of Great Earthquakes in the Cascadia Subduction Zone Based on the Turbidite Event Stratigraphy

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Abstract

Submarine channels along the Cascadia convergent margin have recorded a Holocene history of turbidity currents, in the form of turbidites, most likely triggered by great earthquakes. Turbidite systems from four regional sites, the Rogue, Astoria, Juan de Fuca, and Cascadia Channels, contain 13 correlative post Mazama turbidites (T1-13) based on the first occurrence of Mazama Ash (MA) at 7344 /- 130 cal. yr BP below T 13 and another T18 datum of 9744 /- 70 cal. yr BP. Based on these datums and tests of synchronicity, turbidity currents appear to have been triggered synchronously by great earthquakes along 660 km of the Cascadia Subduction Zone on average every 587 yr from T1-13 and every 480 yr from T13-18. Based on semi-independent methods of AMS radiocarbon ages and hemipelagic sediment thickness plus sedimentation rate beneath each turbidite, the average recurrence intervals of great earthquakes in Cascadia Basin are 530 years and 524 years respectively for the past 4000 yr, compared to coastal paleoseismic events of 533 yr at Willapa Bay, WA and 529 yr at the Sixes River,OR. The most complete and reliable hemipelagic record of recurrence intervals and ages for the 18 great earthquakes during the Holocene (past 9,744 years) has been determined at the Cascadia Channel site. Hemipelagic thicknesses and time intervals based on sedimentation

rates have been calculated for every turbidite event from 8 replicate cores. When there has been some erosion of the hemipelagic sediment interval in one core, it is evident because the thicknesses in the other cores at the site are greater and usually equal. In general, there is a trend towards thicker hemipelagic sediment and longer recurrence times (hemipelagic average interval = 324 yr and radiocarbon average interval = 400 yr) toward the later Holocene. The maximum recurrence time, based on radiocarbon ages (1477 yr), occurs between T10 and T11 and coincides with the maximum interval (922 yr) and thickness of hemipelagic sediment. From T1 to T9 events, the variance of recurrence times is least, based on hemipelagic sediment thickness in Cascadia Channel, while radiocarbon results indicate a high variability for the same interval, consistently showing the intervals prior to T7 and T4 as long intervals > 1000 years. The T1 to T9 events for the past 4620 cal yr BP have a minimum recurrence time of 409 yr and maximum of 644 yr in Cascadia Channel using hemipelagic thickness, but a range of 321 to 1077 years (120) with radiocarbon alone. The differences in the two methods appear to be the result of uniform hemipelagic thickness data following T8 and T5, whereas multiple radiocarbon ages at two sites suggest very long, > 1000 year intervals. These results also point out the need for further refinement of both methods, since the events can be correlated well without age information. When complete, the corrected age table should reveal an earthquake history ~ 10,000 years in length. This record can then be compared to the land record to identify differences that may reveal upper-plate, slab, or other events that did not trigger turbidity currents.

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