Variable Rupture Scenarios for Tsunami Simulations Inferred From a 10,000-Year History of Cascadia Megathrust Earthquakes

Robert C Witter, Oregon Dept of Geology & Mineral Industries, Newport, OR (rob.witter@state.or.us); **Chris Goldfinger**, Oregon State Univ, Corvallis, OR; **Kelin Wang**, Geological Survey of Canada, Sidney, BC, Canada; **George R Priest**, Oregon Dept of Geology & Mineral Industries, Newport, OR; **Yinglong J Zhang**, Oregon Health & Science Univ, Beaverton, OR

Differences in earthquake rupture scenarios for the Cascadia subduction zone contribute large uncertainties for simulations of tsunami inundation used to mitigate risk along the U.S. Pacific Northwest coast. Marine and coastal paleoseismic evidence now offer rare insight into rupture variability over multiple Cascadia earthquake cycles. To explore an array of geologically reasonable Cascadia tsunami scenarios, we 1) characterize earthquake sources consistent with paleoseismology and forearc structure, 2) use elastic models of vertical coseismic deformation as inputs to simulate tsunami inundation at Bandon, Oregon, and 3) compare simulation results with tsunami deposits in Bradley Lake, ~10 km south of Bandon. Maps will delineate inundation as percentile lines that reflect scenario rank and express the confidence level (percentage) that flooding from a Cascadia tsunami will not exceed the line.

We define 19 scenarios that cover a range of earthquake magnitudes, rupture lengths, fault geometries and coseismic slips inferred from marine turbidite paleoseismology spanning 10,000 years. 41 turbidites from submarine channels along the entire length of the plate boundary define a mean Holocene recurrence interval of ~530 yr for ruptures ≥800-km-long and ~240 yr for southern Cascadia earthquakes that ruptured 3 shorter segments. Maximum slip in each scenario varies with latitude as the product of selected recurrence intervals and the convergence rate. Rupture models involve either: a) regional rupture with slip distribution symmetrically tapering to zero up and down dip; or b) regional rupture diverting slip onto an offshore splay fault, evident in seismic data, that dips 30 degrees and merges with the megathrust. Alternative scenarios terminate slip beneath the Pliocene accretionary outer wedge or allow slip to continue seaward beneath the Pleistocene wedge where seismic coupling may be near zero. Maximum coseismic slip varies from 7-34 m at the latitude of Bandon for earthquakes varying from M_w ~8.3->9. A logic tree ranks each scenario by weights reflecting the relative strength of supporting data.

Tsunami simulations using the hydrodynamic model SELFE are compared to evidence for 13 tsunami deposits at Bradley Lake. Deposits of the 1700 tsunami require minimum slip of 13 m using the regional symmetric slip model. Augmenting uplift with a splay fault reduces slip by ~1 m. Earlier tsunamis, likely smaller than the 1700 wave, probably reached the lake when coastal erosion shifted the shoreline farther landward. Simulations with these conditions

require minimum slip of ~9 m accrued over 280 yr—still longer than the shortest intervals between turbidites (~130-260 yr) that correlate with tsunami deposits in the lake. Disparities between the shortest turbidite recurrence intervals and tsunami evidence implying larger coseismic slip may indicate release of stored strain from previous earthquake cycles or underestimation of tsunami size by the simulations.