Turbidite Event Stratigraphy: Implications for Holocene Paleoseismicity of the Cascadia Subduction Zone and Northern San Andreas Faults

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Abstract

Numerous Holocene turbidite events have been found in Cascadia Basin channels from Vancouver Island to Cape Mendocino, and in Noyo Channel near the northern San Andreas Fault. The consistent pattern of events from multiple canyon sources along 1100 km of the continental margin has several implications for the Cascadia and San Andreas paleoseismic records. Correlation of events is based on the first occurrence of Mazama Ash in turbidites and on the approximate onset of Holocene sediment deposition as determined by a dominance of radiolarian fauna in hemipelagic sediment. The Holocene onset is estimated to be about 12,300 calendar yr BP (cal yr) near the base of the continental slope. The first post-Mazama turbidite event (MA) occurred about 7500 cal yr ago or about 100 yr after the Mt. Mazama eruption forming Crater Lake, Oregon. Thirteen post-MA events are found in the Cascadia, Astoria and Rogue channel systems that drain 700 km of the Cascadia Subduction Zone margin. Assuming event 13 took place 7500 cal yr and event 1 took place 1700 AD (Satake et al., 1996), 12 turbidite events have occurred during 7200 years or on average every 600 years. Where Mazama Ash stratigraphy is not present south of the Rogue Canyon, the number of evenly-spaced Holocene turbidite events in channel systems progressively increases toward the Mendocino Triple

Junction at the southern end of Cascadia Basin (Gorda Plate). Based on AMS ages: in Trinidad 25 turbidite events or l per 492 yr occur; in Eel 50 or 1 per 246 yr are present; in Mendocino 1 per 40-65 yr are found. The synchroneity of turbidite events in the northern two thirds of Cascadia Basin (1 per 600 yr) and the progressively increasing frequency of events toward the triple junction are best explained by seismic triggering. Most important, the Cascadia Basin evidence verifys this new paleoseismic technique utilizing turbidite event stratigraphy. This technique can be applied in other specific settings worldwide where an extensive fault traverses a continental margin with several active turbitite systems. Noyo and other channels along the northern California continental margin, which are associated with the single fault strand of the San Andreas, appear to provide another location to apply this paleoseismic technique. Preliminary data from Noyo Channel shows that 30 turbidite events have occurred approximately every 300 years since the Holocene onset. The AMS ages and hemipelagic sediment thickness suggest that the youngest and penultimate events occurred about 100 years ago and 1660 AD respectively, which is in agreement with the coastal paleoseismic record for the San Andreas fault. Also, intriguing is the observation that the 20 Cascadia and 30 San Andreas events may be additive to account for the 50 Holocene events observed in Eel Channel. The Eel is the best monitor for both fault systems since the Trinidad Canyon is too distant a monitor for the San Andreas and the Mendocino Channel is too close to other local triple junction earthquakes. Turbidite event stratigraphy implies that whole-plate earthquakes occur about every 600 yr along the northern 700 km of the Cascadia Subduction Zone. Confirmation of the Gorda Plate and San Andreas paleoseismic record, however, will require establishing a correlative turbidite event record in multiple channel systems for the entire north-central California margin.

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