Our Ocean Backyard — *Santa Cruz Sentinel* columns by Gary Griggs, Director, Institute of Marine Sciences, UC Santa Cruz.

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Subduction zones, great earthquakes and tsunamis

On the evening of January 26, 1700, residents of several villages along the east coast of Japan recorded a series of tsunami waves washing up on their shoreline. Two hundred and sixty-five years later, as an oceanography graduate student, I made an interesting discovery that would take 20 more years to connect to the Japanese tsunami of 1700. I was studying sediment cores collected from an undersea canyon 150 miles off the Oregon Coast. This feature, Cascadia Channel, is much like Monterey Submarine Canyon and begins not far off the mouth of the Columbia River and extends for hundreds of miles across the deep ocean floor.

What struck me as I opened up these ancient sediment cores was the very regular appearance of 2o to 30 feet of submarine mudflows deposits that had been left behind in this undersea canyon. Underwater mudflows, called turbidity currents, are very fluid, are driven by their greater density than seawater, and can flow hundreds of miles across the ocean floor. We have found similar deposits in Monterey Submarine Canyon and in other similar canyons all over the world. They form when thick deposits of sand and mud brought to the ocean by rivers become unstable, begin to flow down slope, and are finally deposited many miles away.

By using carbon-14 to date the organic material contained in these 2 to 3 foot thick layers, as well as identifying volcanic glass in the sediments from the eruption of Mt. Mazama (now occupied by Crater Lake) about 6,600 years ago, I was able to determine that these massive mud flows happened about every 300-500 years. The question that plagued me at the time was what would initiate these huge underwater avalanches every several centuries? The two best ideas I could some up with at the time were either large storm waves or very large earthquakes. The year was 1966, however, and plate tectonics had not yet been born.

Within a few years, the global distribution of earthquakes, volcanoes, trenches and mountain ranges, as well as many other lines of evidence were recognized and assembled into a coherent picture of a mobile and fractured Earth. The Ring of Fire around the Pacific Basin was integrated into the concept of plate tectonics and we realized that the chains of volcanoes and trenches extending from New Zealand and Chile to the Aleutians were all part of a bigger picture of an Earth under stress.

The deep sea floor from Cape Mendocino to Vancouver Island was first recognized as a subduction zone where an offshore oceanic plate slides beneath the coast of northern California, Oregon and Washington. This feature was given a name, the Cascadia Subduction Zone. We now know that the same plate motion that generated the 9.3 Indian Ocean earthquake in December 2006 and the associated tsunami also occurs along the Cascadia Subduction Zone. Twenty years after my initial discovery and the birth of plate tectonics, evidence for historic tsunamis and periodic great earthquakes began to be recognized in a number of estuaries and bays along the coast of Washington, Oregon and northern California. What does all this mean for Monterey Bay?