Digging up lessons from an ancient quake

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Beth Arcos picked her way through muck and pickleweed just west of the Bremerton waterfront, on the trail of an ancient earthquake and tsunami.

"Here's the first evidence," the former University of Washington doctoral student said, kneeling to pluck clam shells from what used to be a tidal mud flat - but now sits well above the waterline. More than 1,000 years ago, Arcos explained, the Seattle fault let loose, lifting the ground here nearly 10 feet.

In this quiet bay, Arcos also confirmed what scientists long have suspected: The tsunami triggered by that quake walloped the coastline that is now home to Naval Base Kitsap, with its shipyards and aircraft carriers, as well as hundreds of waterfront houses and businesses.

The ground warping that Arcos measured around Bremerton was bigger than expected. That means the earthquake probably affected a wider swath of Western Washington than previously thought - which, in turn, nudges it toward the upper end of its estimated magnitude 7-7.5 range.

"It's a reminder that this is a location where we can get these big earthquakes, and that we need to plan and prepare for them," Arcos said. The results from her research were published in the June issue of the Bulletin of the Seismological Society of America.

The Seattle fault isn't a single strand, but a zone of subterranean fractures that extends across Puget Sound, passing under Seattle and

reaching as far east as Issaquah. Arcos' work suggests the fault may extend farther west than previously thought, said Tim Walsh, chief hazards geologist for the Washington Department of Natural Resources.

The study also underscores the fact that a repeat of the most recent Seattle fault quake, dated at about 930 A.D., would be catastrophic for the cities and ports that have sprung up since then, Walsh said. Tsunami modeling suggests waves up to 16 feet high would swamp harbors and waterfront property from Olympia to Everett.

"The damage from the earthquake itself would be far worse," Walsh said. "Then the tsunami would add insult to injury."

U.S. Geological Survey scientist Uri ten Brink, who did some of the first computer modeling of the 930 A.D. quake, said Arcos' work is a valuable addition - but he would like to see similar results from a wider area before changing current assumptions about how big the quake might have been.

One scenario predicted that even a moderate Seattle fault quake of magnitude 6.7 would kill up to 1,600 people and cripple the region's economy.

There's comfort in the fact that quakes on the Seattle fault - and the dozen or so other shallow faults that crisscross Western Washington - don't strike often, said John Vidale, head of UW's Pacific Northwest Seismic Network.

Geologists found evidence for at least two other quakes on the Seattle fault in the past 2,500 years. But neither was nearly as big as the 930 A.D. event, Vidale said.

Earthquakes on shallow faults are particularly destructive, but they're

just one of the seismic hazards facing the Pacific Northwest. Deep quakes, such as the 2001 Nisqually quake, seem to rattle the Puget Sound region every few decades. Megaquakes and ocean tsunamis, like those that devastated Japan last year, strike off the coast every 500 years or so.

It wasn't until 1992 that geologists first discovered that the Seattle fault was active, linking it to terraces on Bainbridge Island and Alki Point in West Seattle that were lifted 20 feet or more in an instant. Submerged forests swept into Lake Washington helped pin down the date of the most recent quake. Geologists found sand layers deposited by tsunamis along the Seattle shoreline and as far north as Whidbey Island and the Snohomish River delta, confirming that the quake displaced a huge volume of water and sent giant waves ripping through Puget Sound.

Taking up the story almost two decades later, Arcos was the first to make a detailed examination of the creeks and marshes of Bremerton's Sinclair Inlet. The uplifted shellfish beds helped her estimate how much the ground was displaced during the quake, she explained on a recent sunny day.

"These are 1,000 years old," she said, prying an intact clam the size of a mango from the banks of Gorst Creek. The small waterway, which joins the inlet near its head, also proved the best tsunami recorder.

At low tide, Arcos dropped into the creek bed, standing ankle-deep in the rushing water. With an Army surplus trenching tool, she hacked at the cutbank, exposing layers of mud and sand.

"This is the tsunami deposit," she said, pointing out a 4-inch-thick band of sand. The wave swept through the low-lying area, leaving this layer behind. For her research, Arcos also used a core barrel to extract nearly 100 mud cylinders from the mash, and map out the tsunami's reach.

The waves 1,000 years ago were nothing like the walls of water that drowned Japanese communities last year, Walsh said. But they were big enough to wreak havoc with the type of waterfront facilities that line the shores around Bremerton today.

If that's not enough, Arcos also unearthed evidence of another hazard. Lying atop the tsunami layer in the stream bank is a much thicker layer of mud - the signature of a massive landslide, probably shaken loose by the quake.