

Hazards in the Seattle Area



- Volcanoes
 - St. Helens
 - Adams, Rainier, Glacier, Baker
- Earthquakes
 - Outer coast
 - Puget Sound (Seattle Fault & others)
- Tsunami
 - Outer coast
 - Puget Sound (Seattle Fault & others)

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Disaster Questions



- What happened?
- Where & when did it happen?
- How big was it?
- How much damage occurred?
- What caused it?
- What does it tell us about the future?
- What does it have to do with the ocean?

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Where Were You?



- May 18, 1980
 - Probably not born yet.



© Associated Press / 1980



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<http://seattletimes.nwsourc.com/helens/gallery/>

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Where Were You?



- June 12, 1991 Mt. Pinatubo Philippines



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http://vulcan.wr.usgs.gov/Outreach/AboutVolcanoes/do_volcanoes_affect_weather.html

Where were you?



- February 28, 2001
- \$2 billion damage
- Alaskan Way viaduct



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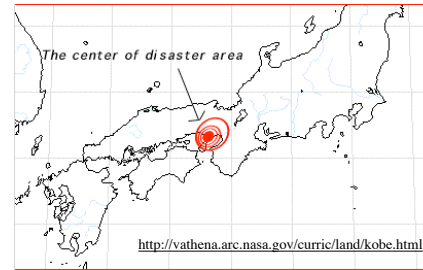


<http://seattletimes.nwsource.com/photogallery/quake/>

Where were you?



- January 17, 1995, 7.2 magnitude
 - Kobe Japan (pop. 1.5 million)
 - More than 5500 dead & \$200 billion damage



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http://www.nhk.or.jp/pr/english/annual/2004/images/ph21_2.gif

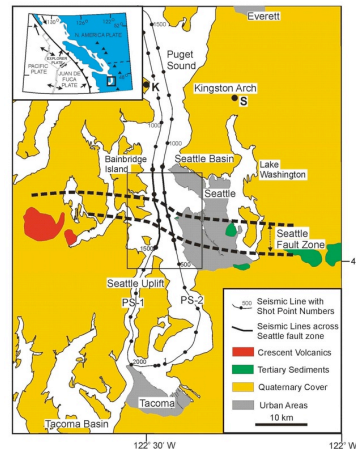
You Were Not Born



- Year 900 A.D.?
- Magnitude >7
- Puget Sound tsunami
- Landslides in Olympic Mts. & L. Washington



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<http://earthquake.usgs.gov/regional/pacnw/activefaults/sfz/>

Where were you?

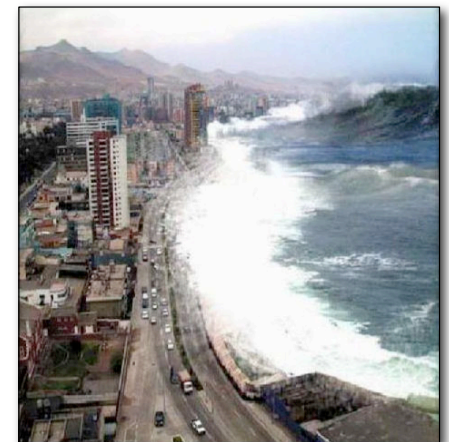


- December 26, 2004 www.kkr.sasebo.nagasaki.jp/contents/data/Phuket_Tsunami-copy.jpg
 - Magnitude 9.1 - 9.3
 - 230,000+ dead



<http://en.wikipedia.org/wiki/Image:2004-tsunami.jpg>

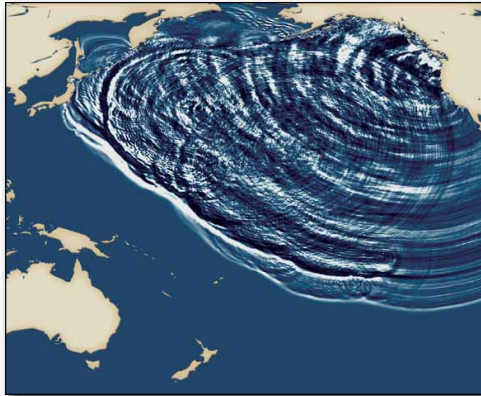
8



You Were Not Born



- January 26, 1700
- Magnitude 8.7 - 9.2
- “Orphan Tsunami” hit Japan
- Where did it start?



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<http://pubs.usgs.gov/pp/pp1707/>

Mt. St. Helens



- 57 deaths (despite weeks of rumbling)
- Blast extended 19 miles (30 km)
- Devastated 229 mi² (596 km²)
- Atypical for its type of volcano

– www.ngdc.noaa.gov/seg/hazard/stratoguide/helenfeat.html



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Mt. St. Helens



- Key properties
 - Cool, viscous magma with dissolved gas
 - Causes explosive eruptions
 - Little lava flow, large ash cloud
- An atypical “stratovolcano”
 - Steep-sided
 - Most dangerous type



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www.ngdc.noaa.gov/seg/hazard/stratoguide/strato_home.html

Mt. Rainier



- An even more dangerous volcano
 - Lahar (mudslide)
 - Travel at high speed down river valleys
 - Warning system now in place



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<http://volcanoes.usgs.gov/Hazards/What/Landslides/RainierSlides.html>

Mt. Rainier



- Now-populated areas at risk
 - Built on ancient lahar deposits
 - Stump of tree buried by lahar 500 years ago



13 <http://volcanoes.usgs.gov/Hazards/What/Landslides/RainierSlides.html>



Contrast with Hawaii



- A “shield volcano”
 - Least dangerous type
 - <http://volcanoes.usgs.gov/Hazards/What/hazards.html>
- Key properties for our purposes
 - Less steep
 - Hot, fluid, low-gas lava flows
 - More continuous activity



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<http://hvo.wr.usgs.gov/maunaloa/>

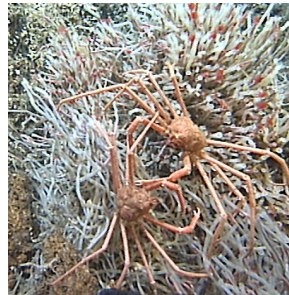
Lesser-Known Volcanoes



- Because they are 2+ miles underwater!
 - Volcanic vents in sea floor valleys
 - Support exotic life forms
 - Juan de Fuca Rift, WA coast



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www.neptune.washington.edu

What We Will Study



- How volcanoes are created
 - Hint: blame the sea floor
- Causes of different types of volcanoes
 - Different interactions of sea floor
 - Different source & composition of magma
 - Terrestrial, island & underwater volcanoes
- Relationship of volcanoes to global sea floor processes
 - “Plate tectonics”

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Washington Coastal Quakes

- Outer coast quakes the biggest
 - Up to magnitude 9
 - Each larger magnitude represents:
 - 10x increase in amplitude of seismic waves
 - 31x increase in energy released
 - <http://pubs.usgs.gov/gip/earthq4/severitygip.html>
- Poorly known until mid-1980's
 - Discovery of several types of evidence
 - Subsidence zones on land
 - Tsunami deposits
 - Native legend & Japanese history

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Evidence of Coastal Quakes

- Subsidence zones on land
 - Coast dropped 1+ meter – Soil buried by tide flats
 - Drowned trees – Tree rings: sudden death



Copalis River; very high fair-weather tide, December 1997

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<http://pubs.usgs.gov/pp/pp1707/> Chapter 2

Evidence of Coastal Quakes

- Tsunami deposits
 - “Sand sheet” atop terrestrial soil
 - Contains marine fossils
 - Tapers away from ocean
 - Follows stream beds inland
 - Carbon dated to 1700
 - Fits Japan date


<http://pubs.usgs.gov/pp/pp1707/> Chapter 2

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What We Will Study

- How coastal quakes are generated
 - Hint: blame the sea floor
- Causes of different types of submarine earthquakes
 - Different interactions of sea floor (and land masses)
 - Different magnitude depends on situation
- Relationship of earthquakes to global sea floor processes
 - “Plate tectonics”

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Puget Sound Quakes



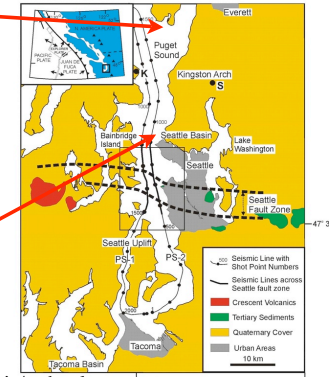
- Magnitude to about 7
 - But more dangerous to life & property
 - Closer to surface
 - Closer to more populated areas
- Poorly known until early-1990's
 - Discovery of several types of evidence
 - Surface fault zones
 - Pattern of quakes
 - Buried fault zones
 - Puget Sound tsunami deposits
 - Landslides in Olympic Mts. & L. Washington

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Puget Sound Quakes



- Discovery of several types of evidence
 - Puget Sound tsunami sands similar to coast
 - Cultus Bay, S. Whidbey I.



- West Pt., Seattle
- Animation

22 nctr.pmel.noaa.gov/pugetsound/pre2/movie/ps.html

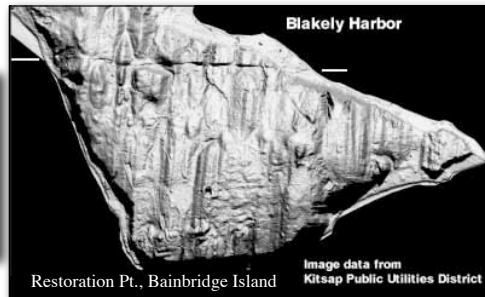
Puget Sound Quakes



- Discovery of several types of evidence
 - Surface fault zones
 - Airborne radar used to reveal terrain
 - Beach lifted ~7 meters



www.edu.gunma-u.ac.jp/~hayakawa/seminar/seacq.html



Restoration Pt., Bainbridge Island
Image data from Kitsap Public Utilities District

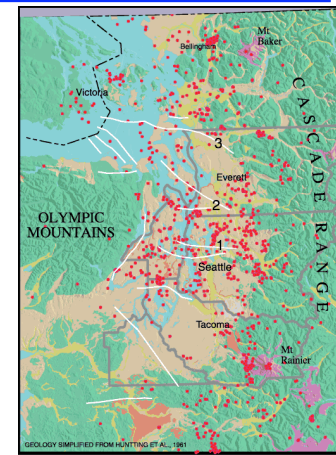
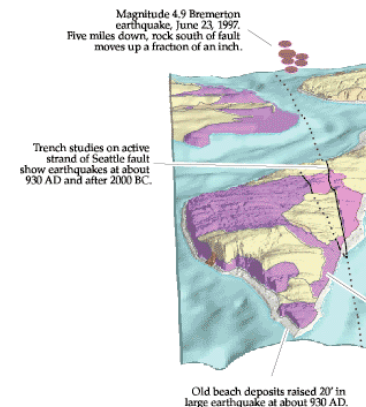
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<http://earthquake.usgs.gov/regional/pacnw/paleo/bainisl/sfhistory.html>

Puget Sound Quakes



- Pattern of quakes



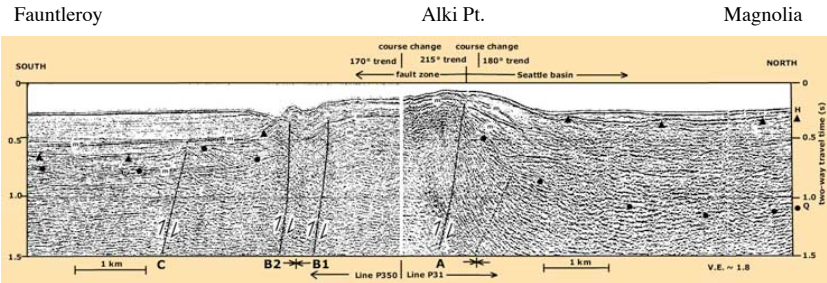
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<http://geomaps.wr.usgs.gov/pacnw/rescape1.html>

Puget Sound Quakes



- Discovery of several types of evidence
 - Buried fault zones under the Sound
 - High-intensity sound waves used to reveal subsurface structure

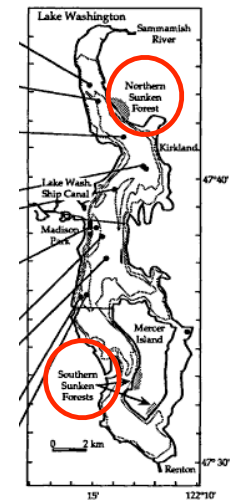


25 <http://earthquake.usgs.gov/regional/pacnw/activefaults/sfz/sfzfig5c.html>

Puget Sound Quakes



- Discovery of several types of evidence
 - Landslides in L. Washington
 - Trees slid to lake bottom
 - Ring- & carbon-dated ~900 AD
 - Preserved by cold, low O₂ water
 - Landslides in Olympic Mts
 - Blocked creeks to dam lakes
 - Stumps of drowned trees
 - Ring- & carbon-dated ~900 AD



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Science 258: 4 December 1992

Puget Sound Quakes



- Another large quake **WILL** occur!
 - About every 750 years—Overdue?
- What kinds of damage are predicted?
 - 1600 dead, 24,000 injured, 10,000's homeless
 - Destruction of buildings, roads, power & water
 - \$33 billion damage (not counting Alaskan Way)
- What can you do to prepare
 - Know hazard-prone areas
 - Have an emergency kit & plan

• www.cityofseattle.net/emergency_mgt/gettingPrepared/gettingPrepared.htm

27 seattletimes.nwsources.com/html/localnews/2002185299_earthquake20m.html

What We Will Study



- How Puget Sound quakes are generated
 - Hint: blame the sea floor (& the continent)
- Relationship of Puget Sound & coastal quakes
 - Shallow crustal quakes vs. deeper quakes
- Relationship of regional earthquakes to global sea floor processes
 - Washington vs. California
 - “Plate tectonics”

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Today's Key Online Reading

- “Orphan Tsunami” by Brian Atwater (UW & USGS) and others (free PDF)
 - Chapter 2 (30 mb)
 - Skim for material referred to in lecture
 - Link posted on syllabus
 - <http://pubs.usgs.gov/pp/pp1707/>
- “Paleoseisomology: A Search for Ancient Earthquakes on Puget Sound” J. Adams *Science* 258: 1592-1593 (1992)
 - PDF posted via link from syllabus
- “Pinpointing Devastation if Seattle Fault Ruptures” Sandi Doughton *Seattle Times* 2/20/05
 - http://seattletimes.nwsource.com/html/localnews/2002185299_earthquake20m.html