Earthquake Faults in the San Juan Islands

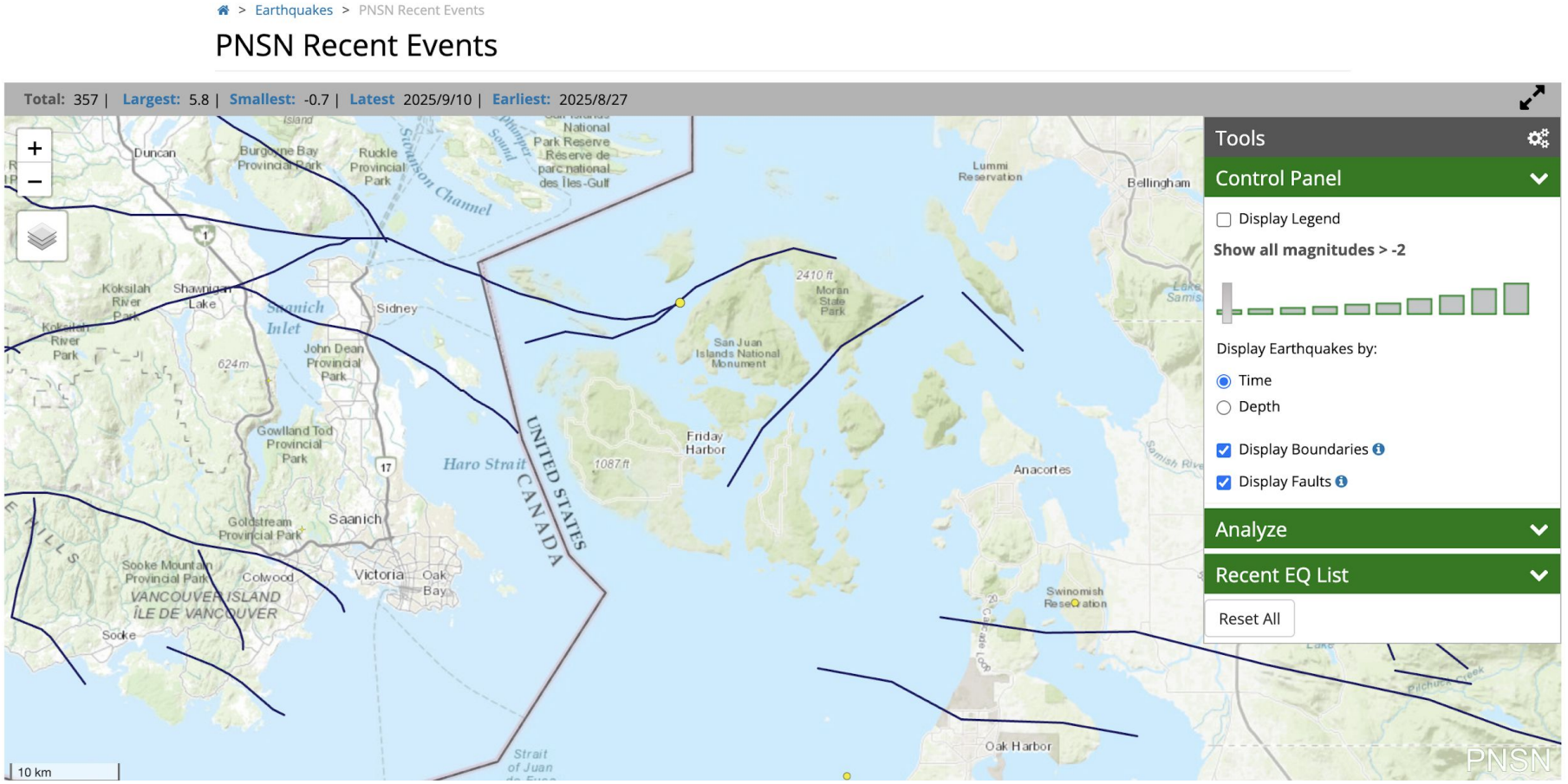


Photo credit: https://www.pnsn.org/earthquakes/recent

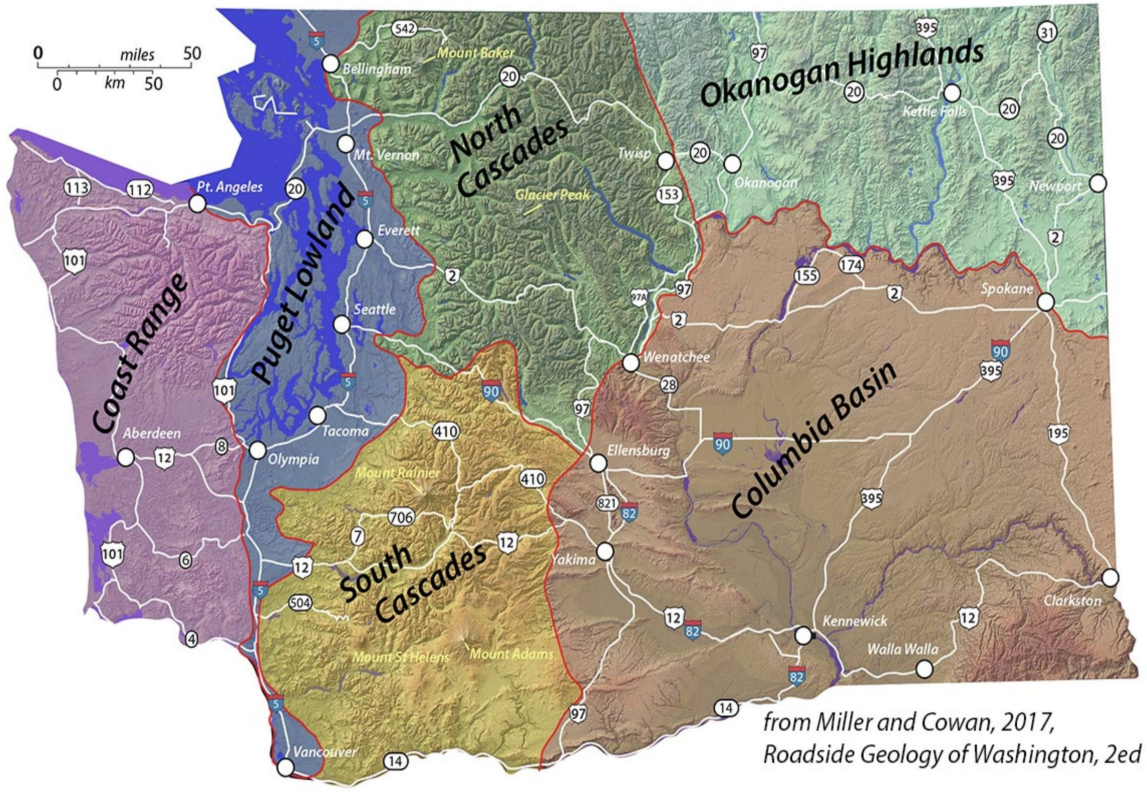
- Big Picture Geology
- Overview of SJI's Faults
- What to expect in an EQ in the islands
- How to Prepare

Who am I & why am I here?

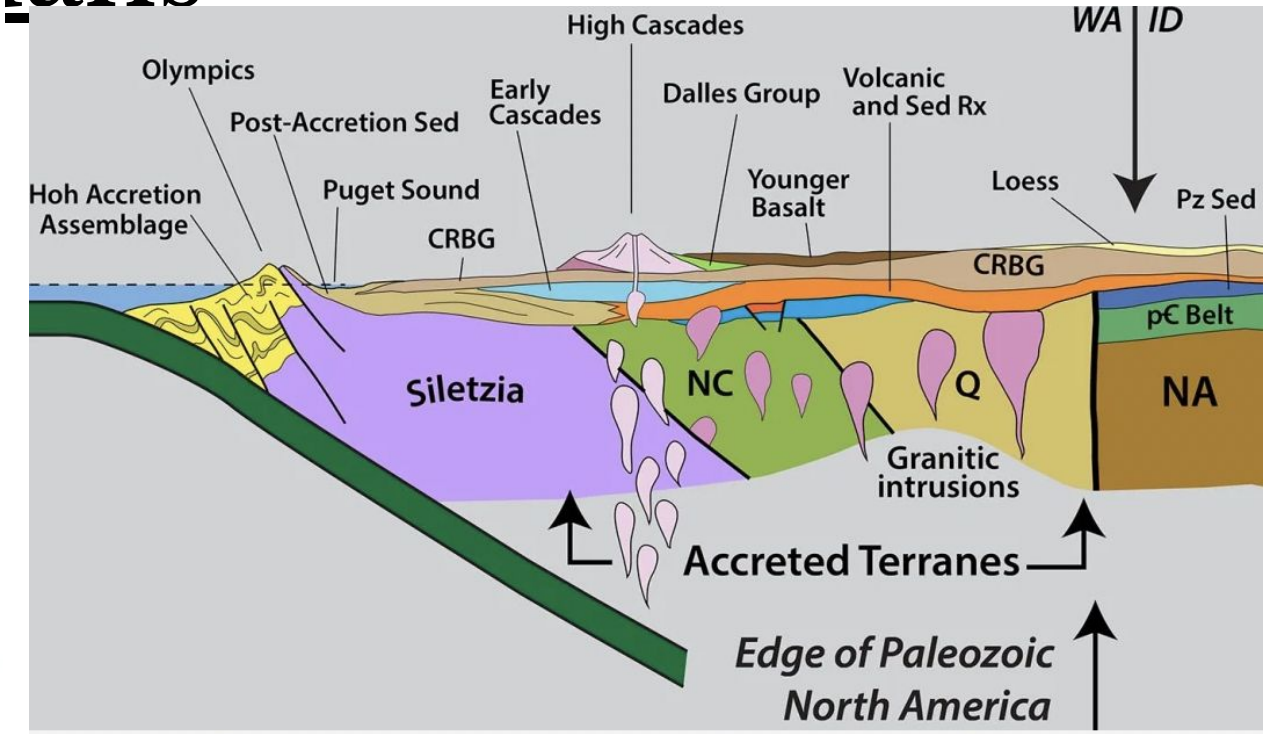
- B.S. Geology/Geophysics – WWU, Certified Permaculturist
- Youth/Outdoor Environmental Ed
- Wilderness Restoration
- Trails, Conservation, Natural Resource Management w/ Public Lands
- Former kayak guide, Whale Museum employee, canoe skipper
- Former Program Director SJICC
- Co-founder of On Sacred Ground
- Volunteer for SJIs Prepare

Photo Courtesy of Sarah Hanson

Big Picture Geological Story of the San Juans



from Miller and Cowan, 2017, Roadside Geology of Washington, 2ed



Generalized cross-section across Washington and Oregon.

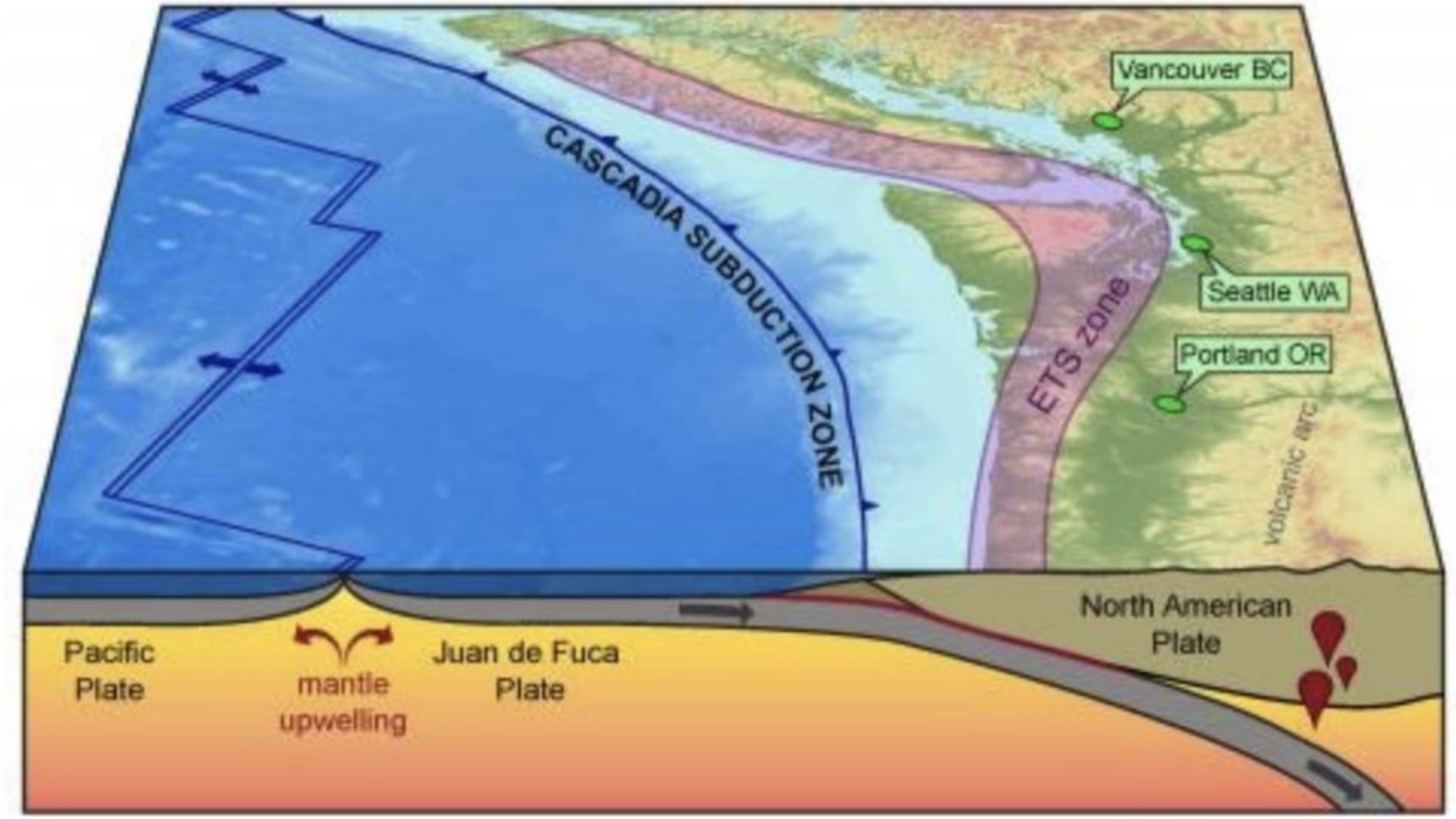
Underneath us:

- Subduction
- Accretionary wedges – mountain building Sound/Salish Sea, Straights

* Glacial carving runs north & south
    * Forms soils, inland sea – Puget

Photo Courtesy of

Cascadia Subduction Zone 3D View



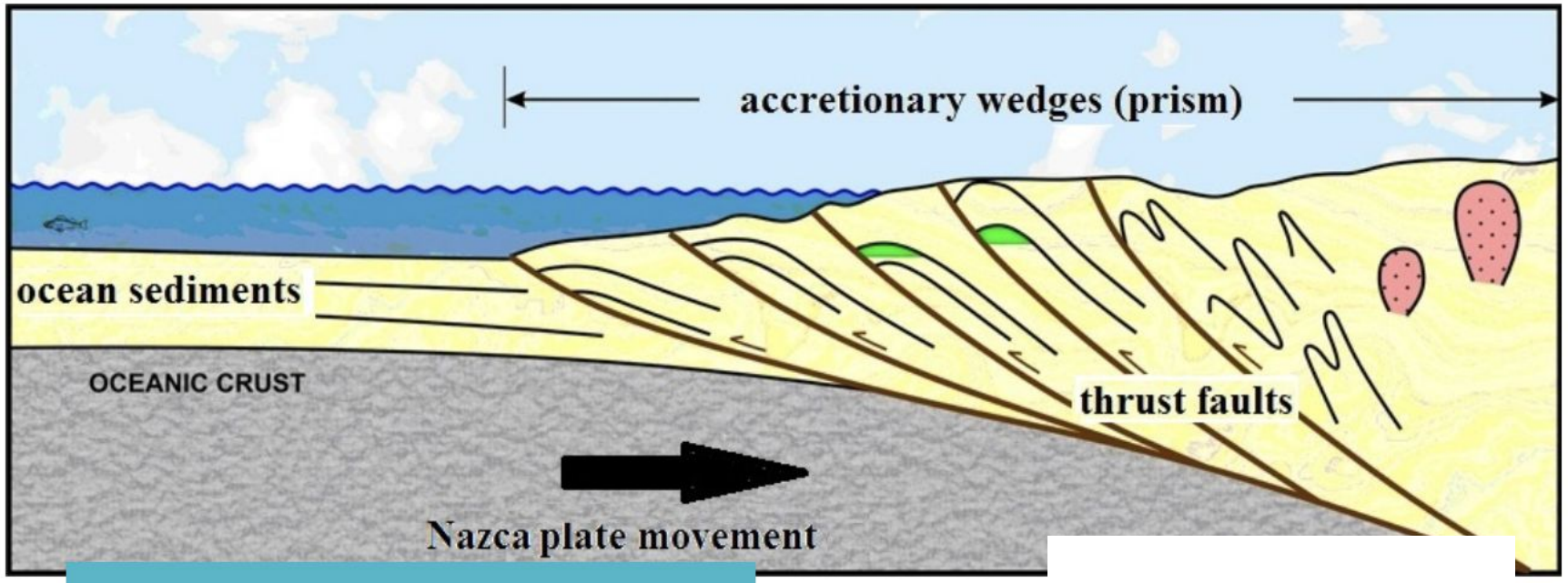
In the Pacific Northwest, the Juan de Fuca plate is colliding into the North American plate known as the Cascadia Subduction Zone.

- 3 plate boundary types
- ”Big One” offshore

Source:

https://blog.jumpstartinsurance.com/are-oregon-and-washington-due-for-a-big-one-of-their-own/

Accretionary Wedges Zoomed In

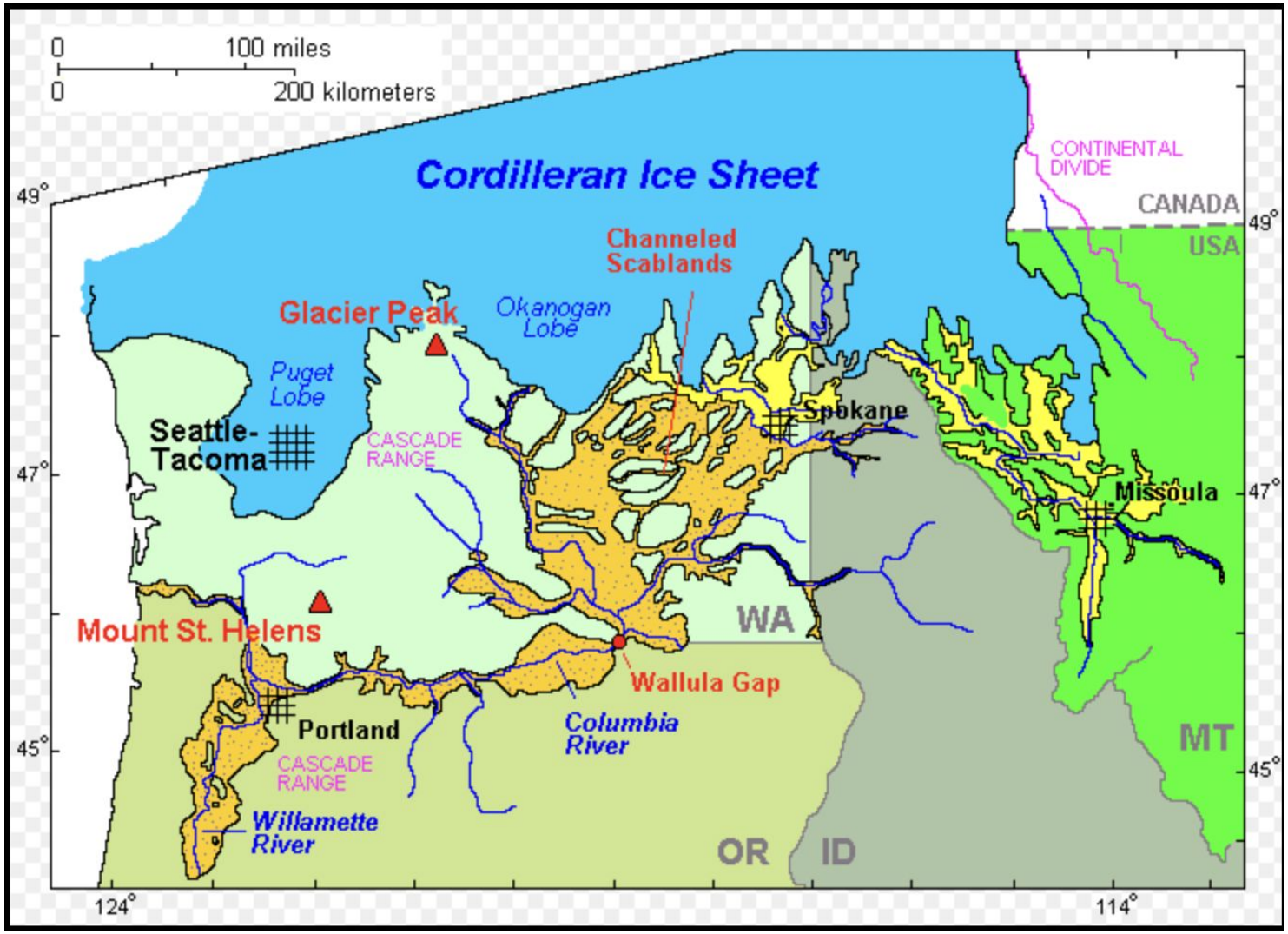


Cross section of an accretionary wedge

Source:

https://www.geolsoc.org.uk/Plate-Tectonics/Chap3-Plate-Margins/Convergent/Oceanic-continental.html

Relatively Recent Geologic History of the San Juan Islands



Cordilleran Ice Sheet

- Carved landscapes & created ecosystems

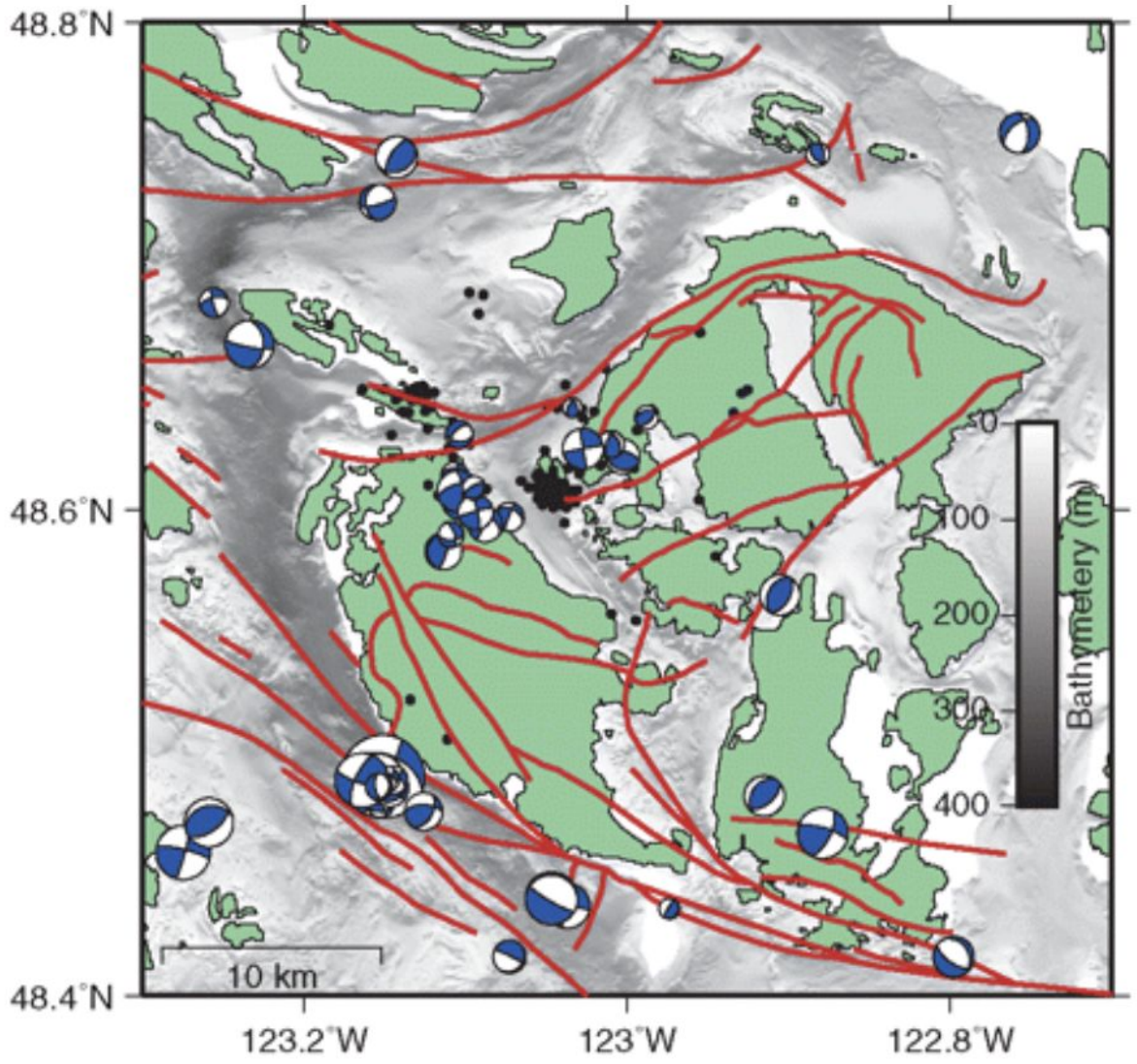
- Soil Deposition – glacial moraines on top of bedrock/faults

- Isostatic Rebound

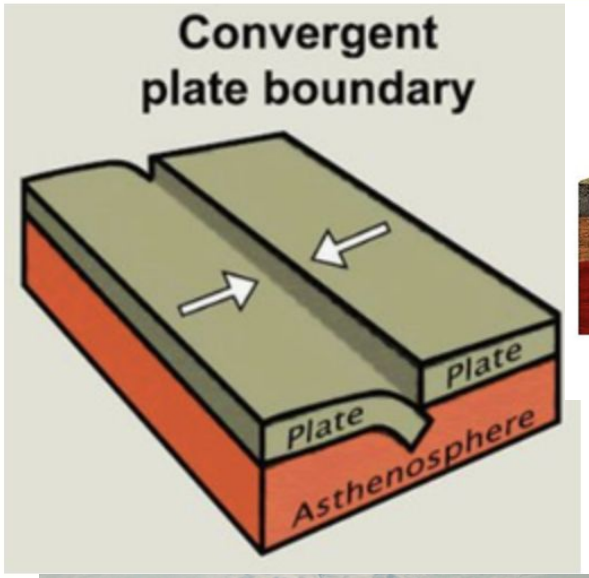
Photo credit: Wikipedia ”Cordilleran Ice Sheet”

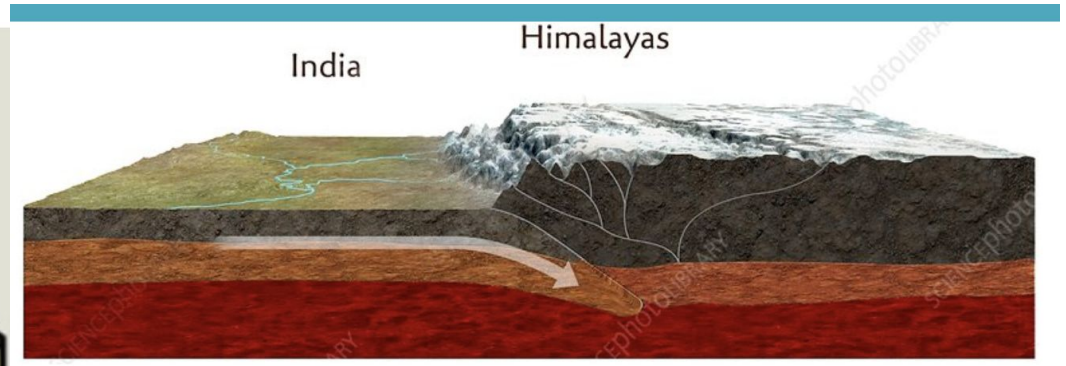
Seismotectonics in the San Juan Islands

- Graph depicts hypocenters (point of origin below ground), fault lines & focal mechanisms (shows type of slip on the fault during EQ)
- Faults run in multiple directions:
  - East/West & North/South, etc
- Study published in 2012
- Photo courtesy of https://pnsn.org/blog/2012/06/04/seismotectonics-near-the-san-jua



Types of Tectonic Plate Boundaries:





Formation of the Himalayas, illustration

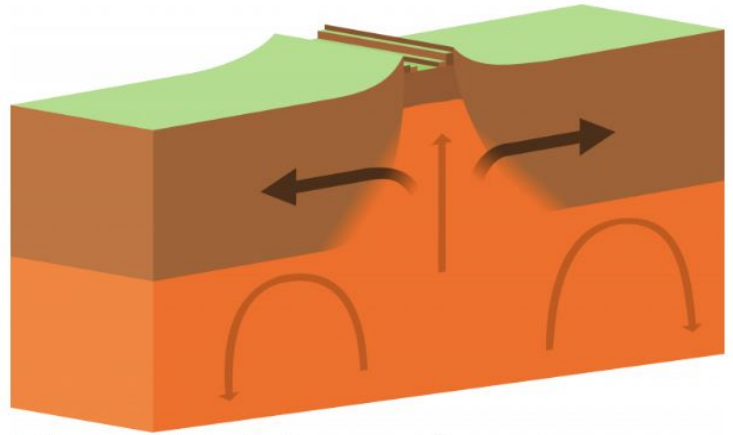


Figure 2.5.1. A divergent boundary may

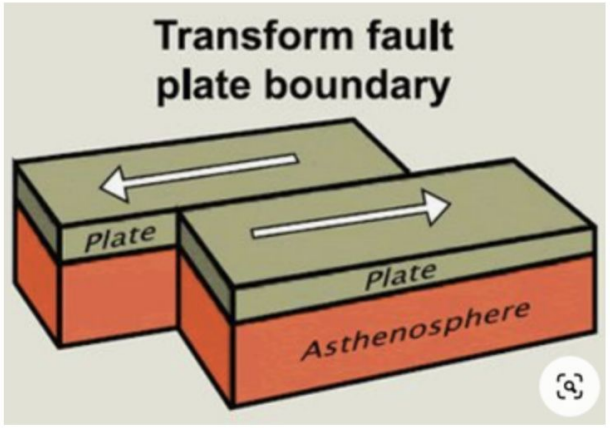
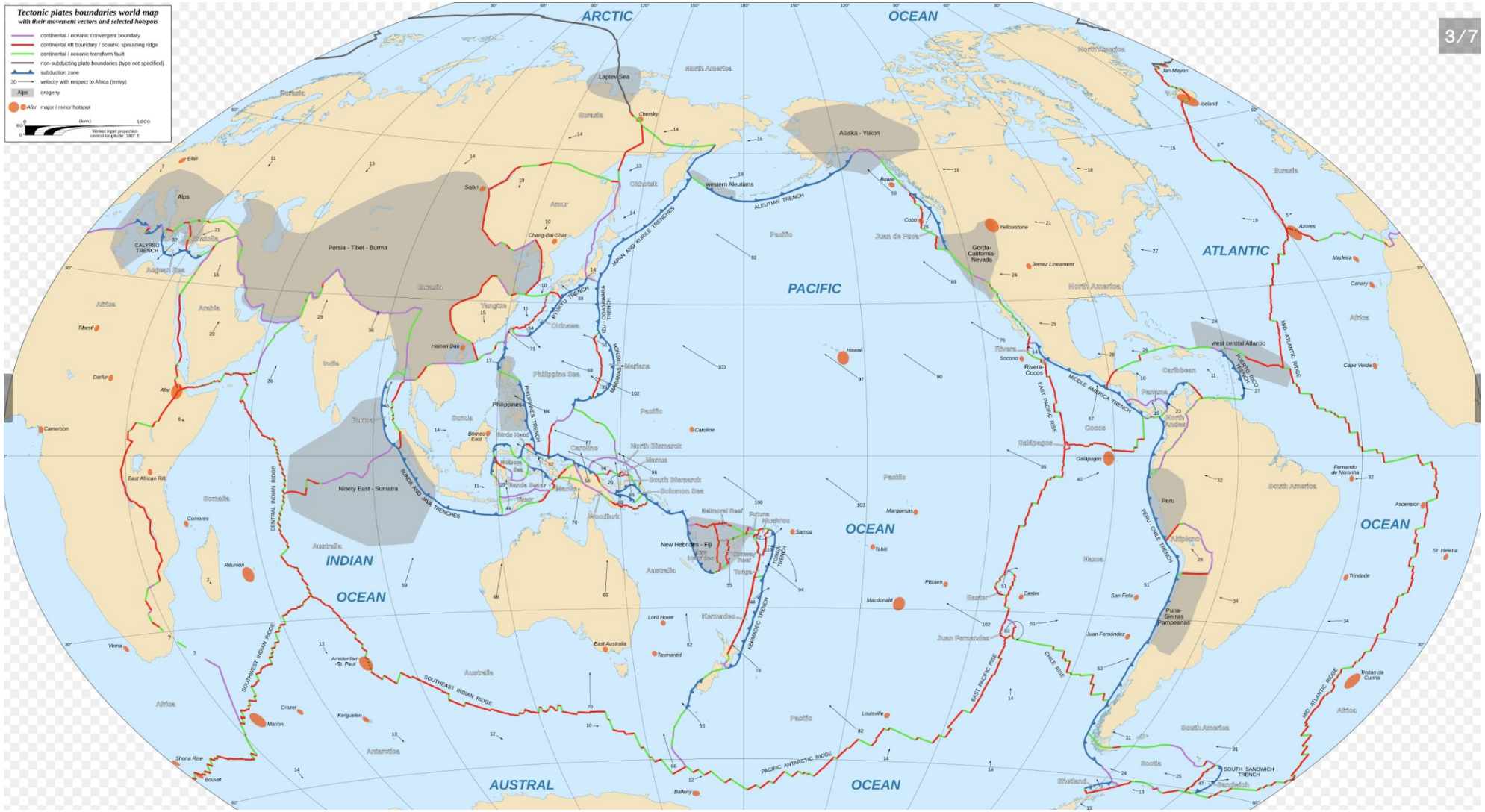


Plate Tectonics of the World Map



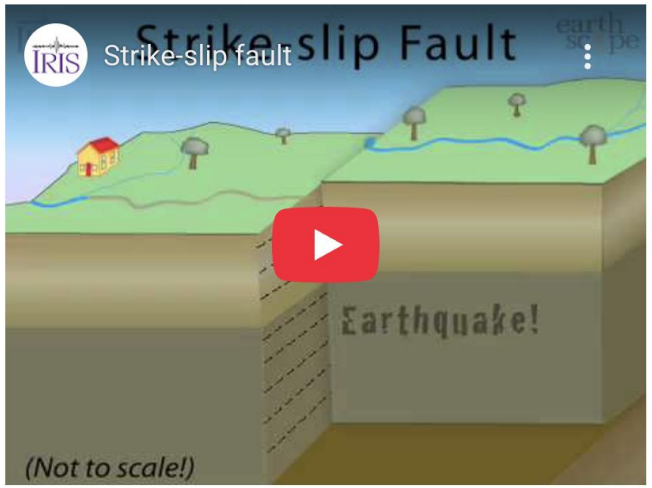
- Detail – shows the general movement of the plates

Photo Courtesy of: https://en.wikipedia.org/wiki/List_of_tectonic_plates#/media/File:Tectonic_plates_boundaries_World_map_

Types of Faults (Different than Plate Boundaries)

Strike-slip faults

A **strike-slip fault** occurs when two blocks move past each other. The Straight Creek fault in the Cascade Range is an example of this kind of fault and has ~50–60 miles of movement across it. The San Andreas fault in California is a good example of a very active strike-slip fault.

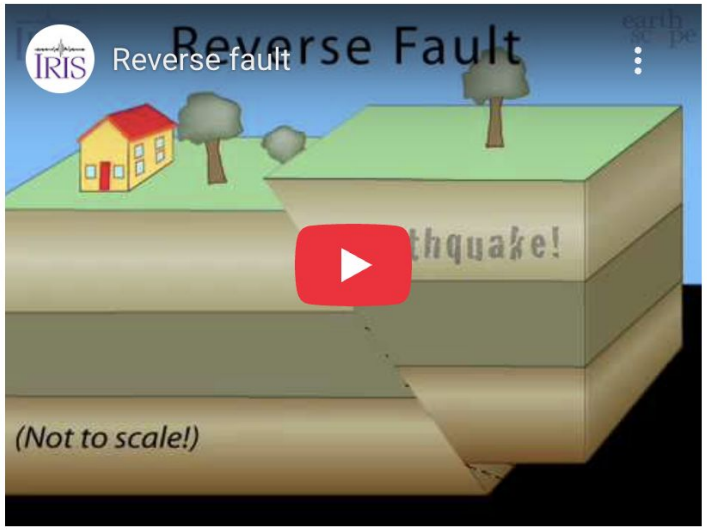


Thrust faults

A **thrust fault** is a special kind of reverse fault that has a shallow dip. The Cascadia subduction zone along the Washington and Oregon coast is one of the biggest hazards to our state and is a good examples of this kind of fault.

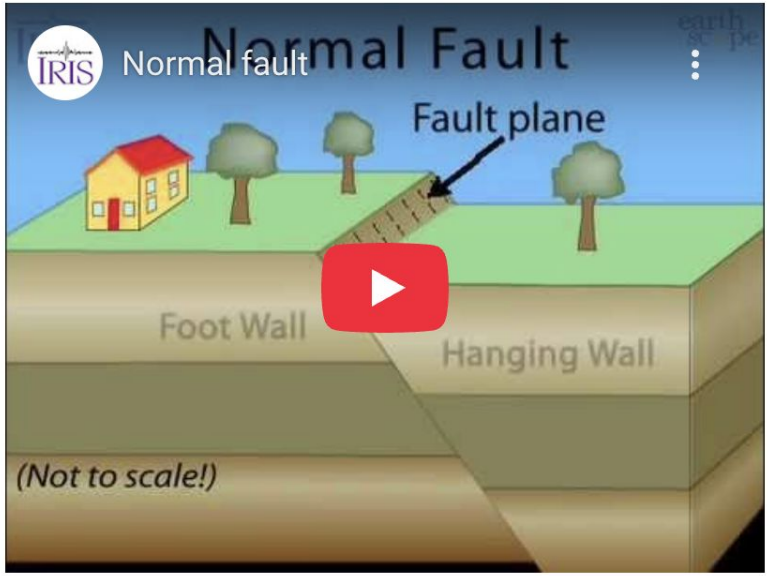
Reverse faults

A **reverse fault** occurs when two blocks are pushed together and one moves up and over the other. Reverse faults are usually steep and occur in regions of compression. The Seattle fault is a good example of a fault that is mostly reverse. This means that when the Seattle fault ruptures the south side of the fault moves up relative to the north side.



Normal faults

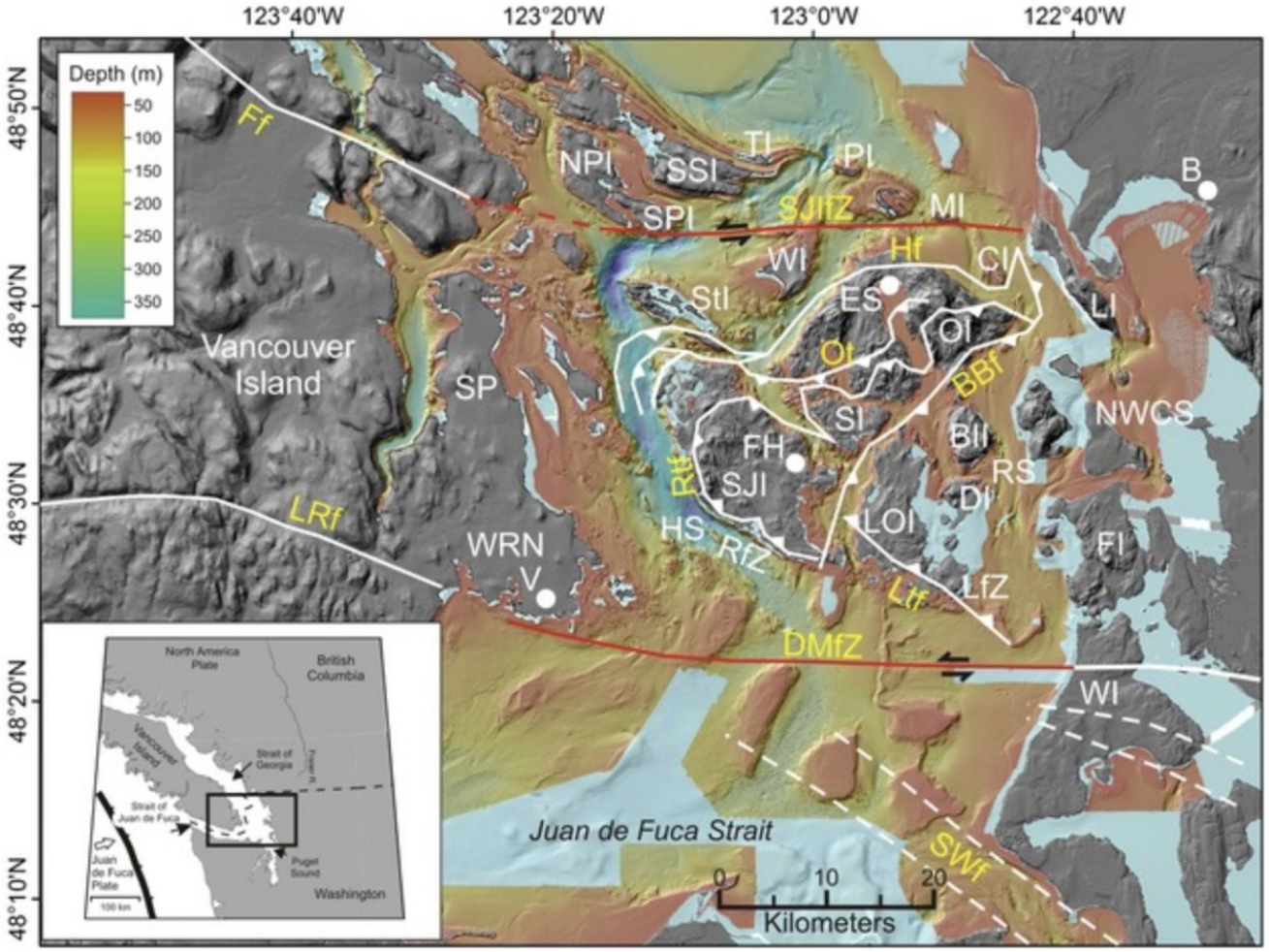
A **normal fault** occurs when two blocks are pulled away from each other. Washington has few large normal faults because it is mostly in a region of compression. Small normal faults are found along the top of folds in eastern Washington in the Saddle Mountain graben. The Eastern Sierra fault along the east side of the Sierra Nevada mountains in California is a good example of an active normal fault.



Source:

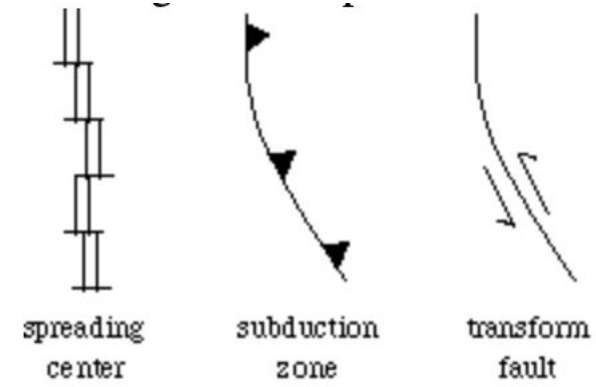
https://dnr.wa.gov/washington-geological-survey/geologic-hazards-and-environment/earthquakes-and-faults

Going Back to the Islands.....



Source: https://orcascurrents.com/the-cracked-and-broken-plate-on-which-our-islands-rest/

Symbols of plate boundaries & faults:



Symbol	Explanation	Symbol	Explanation
25	Strike and dip		Syncline
	Vertical strata		Anticline
	Horizontal strata		Plunging anticline
	Strike-slip fault		Plunging syncline
	Thrust fault		Normal fault

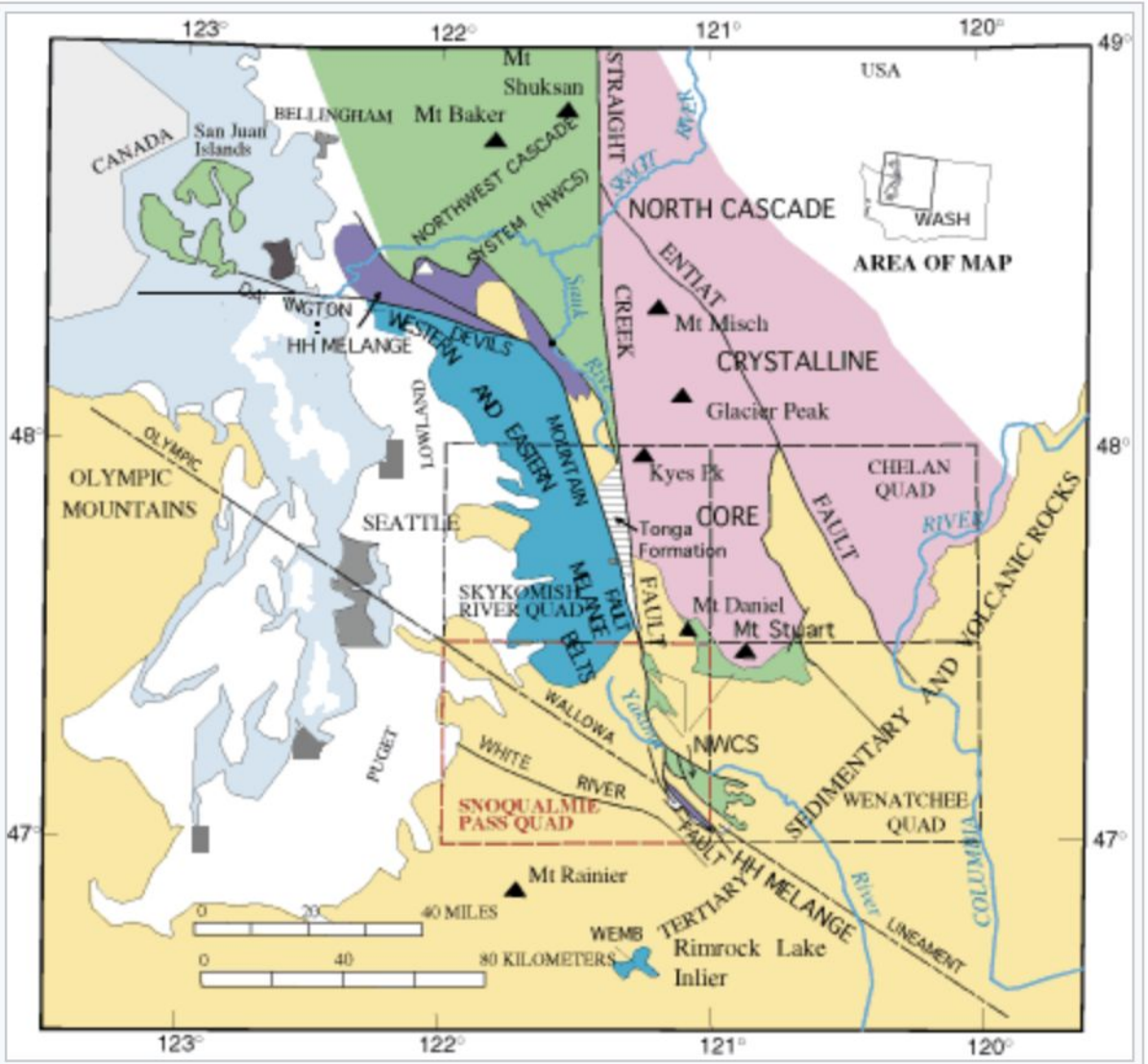
Oblique Faults! & Devils Mountain Fault Zone

Types of faults

Faults are features in the Earth's crust where rock periodically breaks and moves, releasing seismic energy and creating earthquakes. Faults can be grouped based on their relative movement into three types. Each type has different kinds of earthquakes. Most faults in Washington are a mix of a strike-slip fault and a thrust or reverse fault. These combination faults are called oblique faults and include the Seattle fault, southern Whidbey Island fault zone, and Darrington-Devils Mountain fault zone.

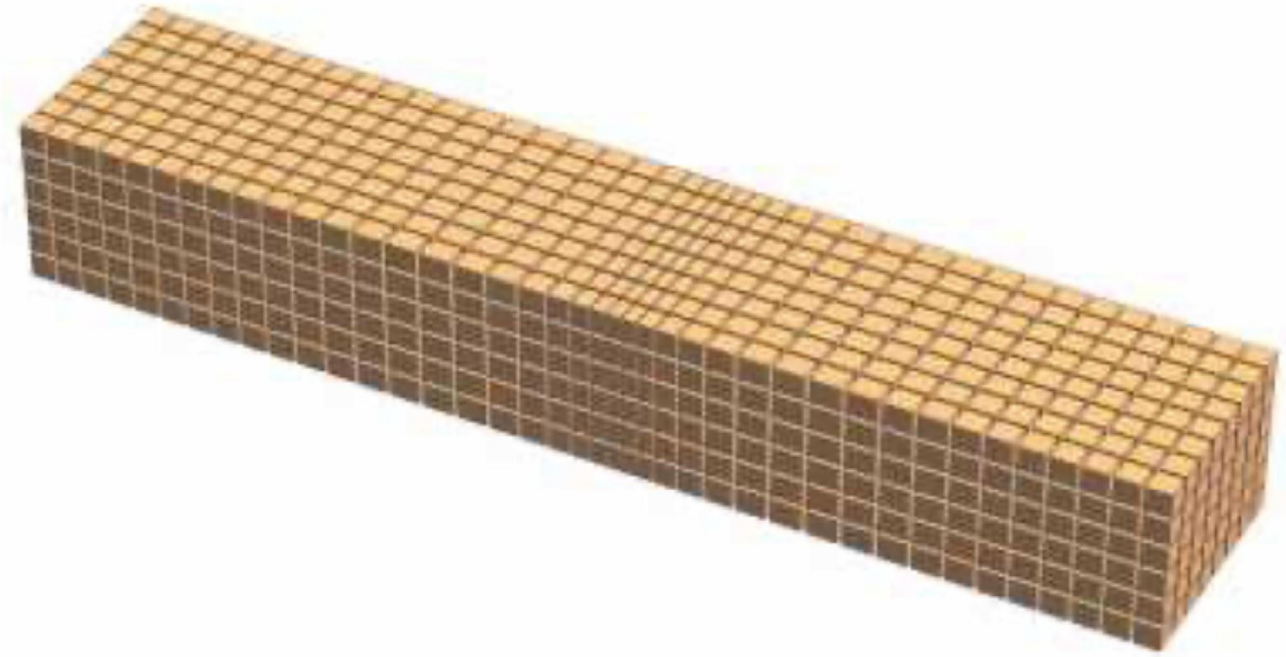
Source:

https://en.wikipedia.org/wiki/Puget_Sound_faults#DMF



Puget Lowland and other areas divided from the "North Cascade Crystalline Core" by the Straight Creek Fault. The green colored area on the left has been pushed north, the purple area ("HH Melange") on the Darrington—Devils Mountain Fault originally being at or southwest of the Olympic Wallowa Lineament. (Fig. 1 from USGS I-2538, modified.)

Types of EQ Seismic Waves

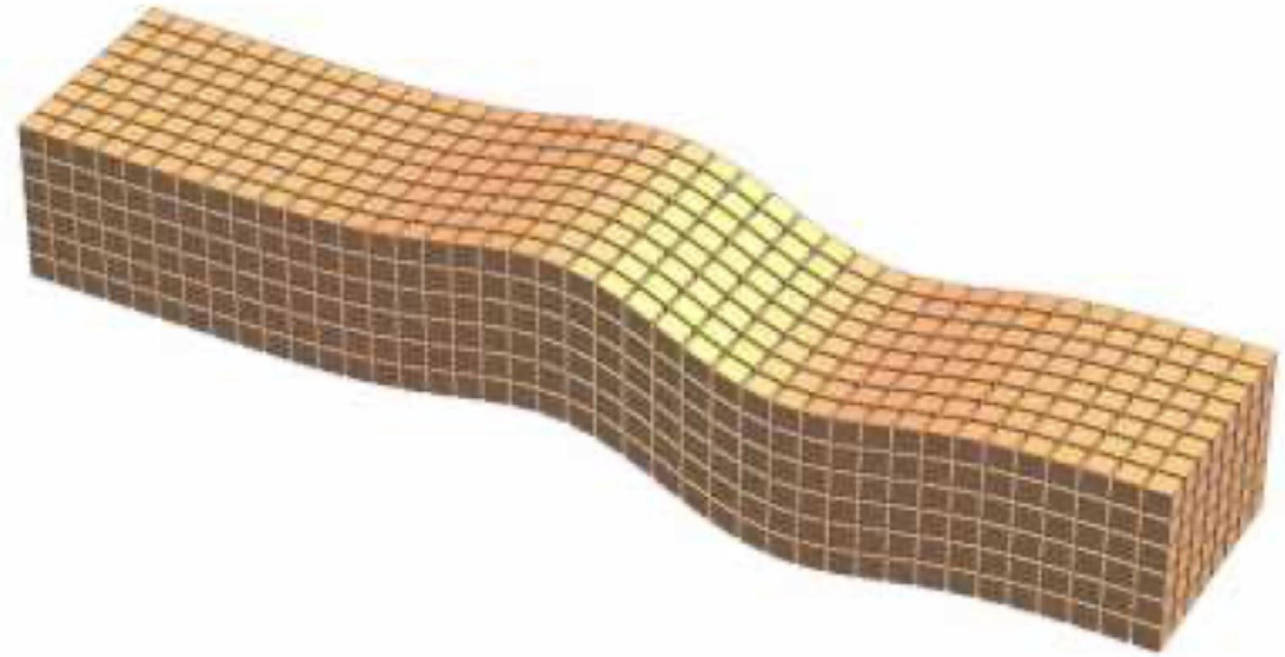


- P- Waves
  - Compression wave
  - 1st wave you'll feel
  - Not a lot of damage
  - Travels fast & thru liquids, solids & gases (air)
  - Often has a sound
  - Moves like train cars running into each other

Source: https://www.pnsn.org/out

Types of EQ Seismic Waves Cont'd:

- S Waves
  - Shear waves – deform ground perpendicular to direction of travel
  - Travel is slower
  - Shaking – back & forth movement on structures
  - Can't pass through water, magma or air (only solids)
  - Energy for both waves dissipates



EQ Impact – Site Effects

Impact Variables:

- Distance from EQ hypocenter
- Magnitude of EQ
- Soil/Rock Substrate
- Type of Building Material (wood vs. brick)

- Seismic waves get bigger in amplitude when transition from hard to soft earth (similar to tsunami transitioning from deep seafloor to shallow shore

Source: https://www.pbs.org/newshour/world/6-dead-76-missing-after-strong

National Earthquake Hazards Reduction Program

Source:

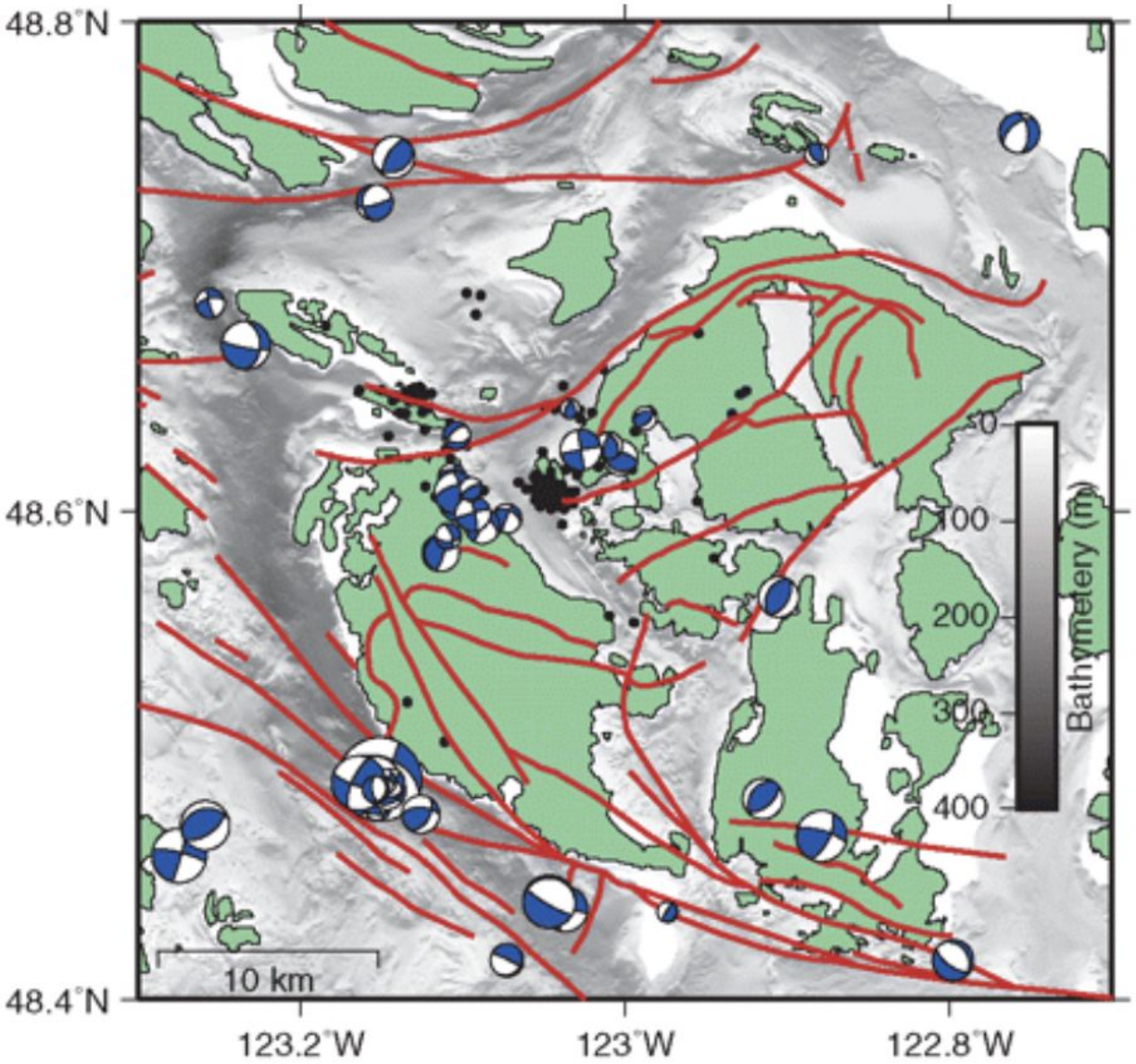
https://dnr.wa.gov/washington-geological-survey/geologic-hazards-and-environment/geologic-hazard-maps

EXPLANATION

- Site class F — Requires site-specific investigation
- Site class E
- Site class D to E
- Site class D
- Site class C to D
- Site class C
- Site class B to C
- Site class B
- Water
- Ice

Increasing amplification of ground shaking

Side by Side Comparisons

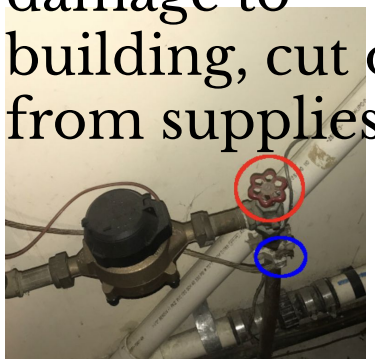


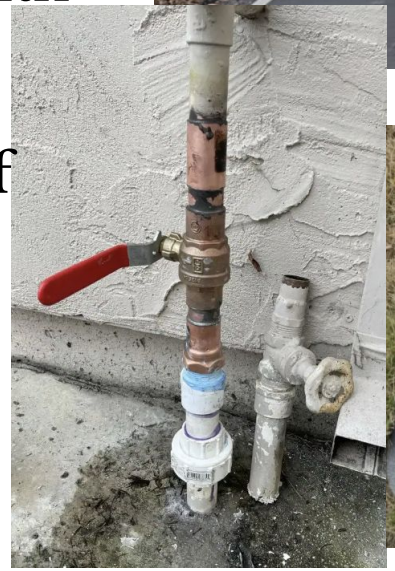
Building Materials & How They Handle EQ's

- Wood & Steel give more than unreinforced concrete, stucco & masonry
- Taller buildings built w/ engineering specs & flexibility handle eq's well – think tall person on subway w/ flex in body & not stiffness
- Anchorage into bedrock is great, soil not
- Liquefaction in saturated, sandy soils
- Building sway can match seismic waves = resonance & do big damage
- Can retrofit homes

Utilities and Water in EQ's

- Gas/propane, water & sewer lines susceptible to damage (smell, hiss, visibly broken)
- All can lead to major issues – fire, explosions, health hazard, further damage to building, cut off from supplies



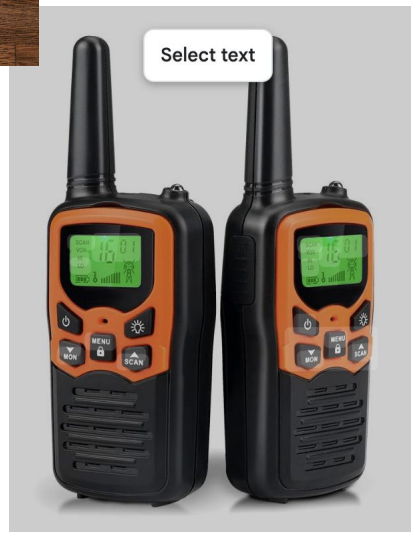


Retrofitting & Preparedness

- EQ Bracing for Water Heaters & Propane Tanks
- Install seismic bracing for pipes (i.e. in garage)
- Upgrade older piping (cast iron) to more modern, flexible materials (PVC)
- Install plumbing backflow prevention devices on water pipes
- Know where all your shut-off valves are & test

How to Prepare?

- 2 week supply?
  - Maybe longer – island?
  - Water: 1gal/person/day
  - Food – how prepare?
    - High calorie/nutrition
  - Meds – 1st aid kit, prescriptions
  - Tools – basics
  - Communications – back-up, family plans
  - Power – back-up
  - Pets
  - Safety gear – masks, etc
  - Resources to share



Resources: