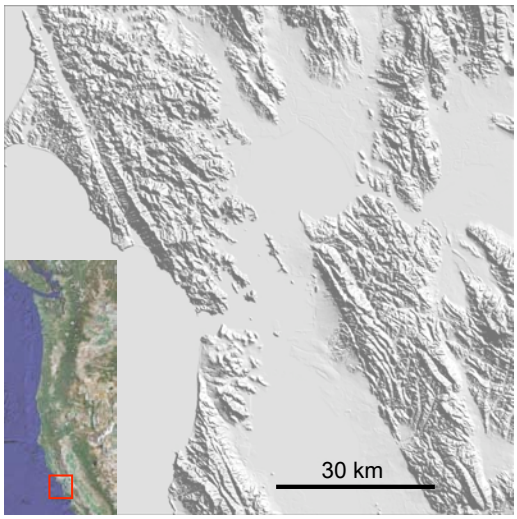
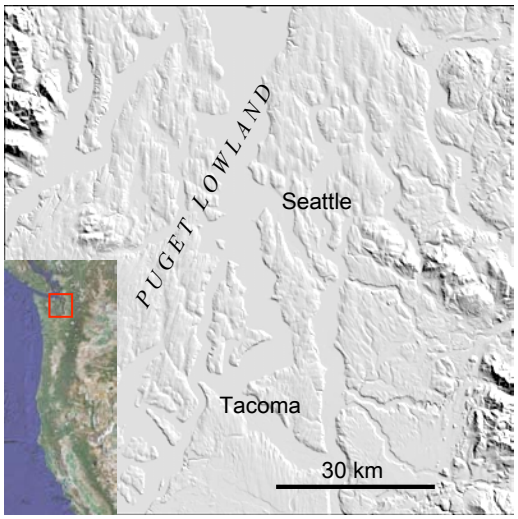


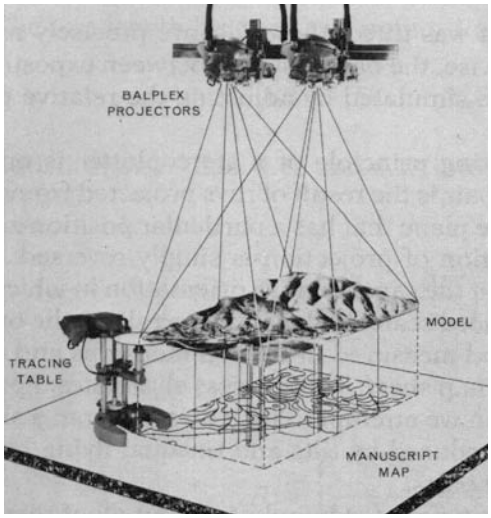
Every time I fly into San Francisco I map the San Andreas fault anew



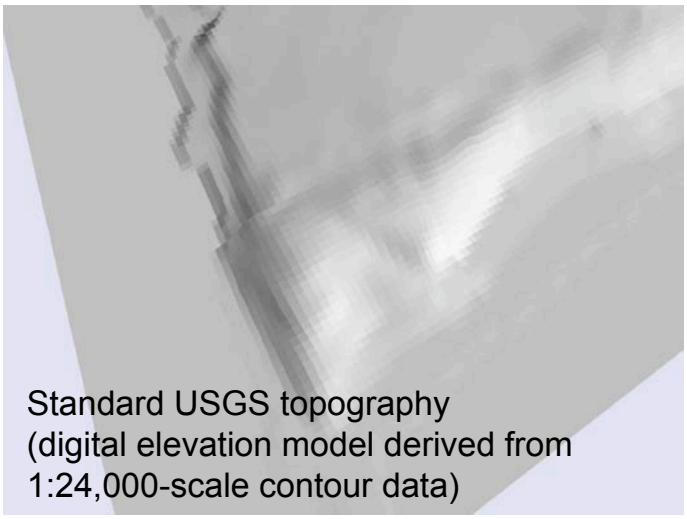
Where is the Seattle fault?

OUTLINE

- How we map topography
- Landscape (the Earth's shape) = History
- The Seattle fault



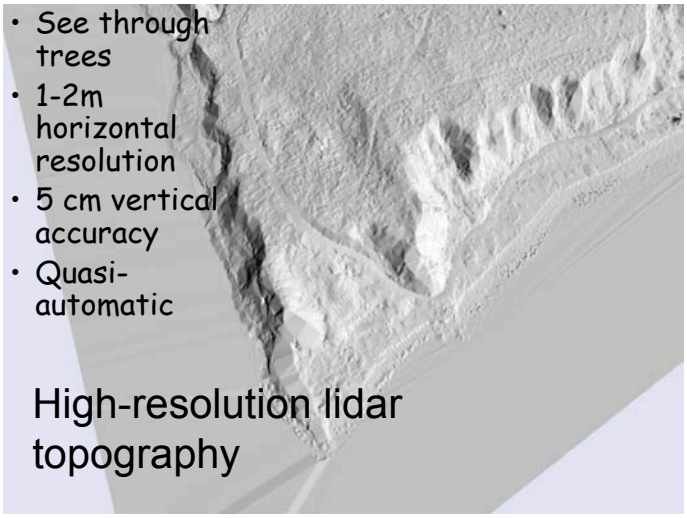
…via manual inter-pretation of stereo aerial photo-graphy



Standard USGS topography
(digital elevation model derived from 1:24,000-scale contour data)

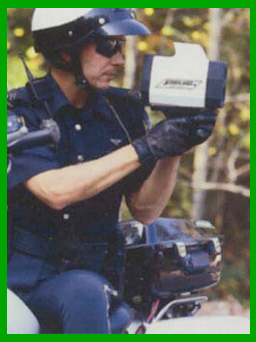
Some problems with contours drawn from stereo photos

- You can't see the ground through the trees
- Sparse sampling. 1:24,000-scale contours have, at best, ~30 meter horizontal resolution
- There is a person involved. Contour topography is subjective!



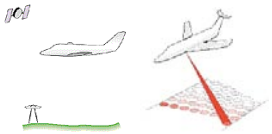
- See through trees
- 1-2m horizontal resolution
- 5 cm vertical accuracy
- Quasi-automatic

High-resolution lidar topography



A lidar (**li**ght **d**etection **a**nd **r**anging) instrument

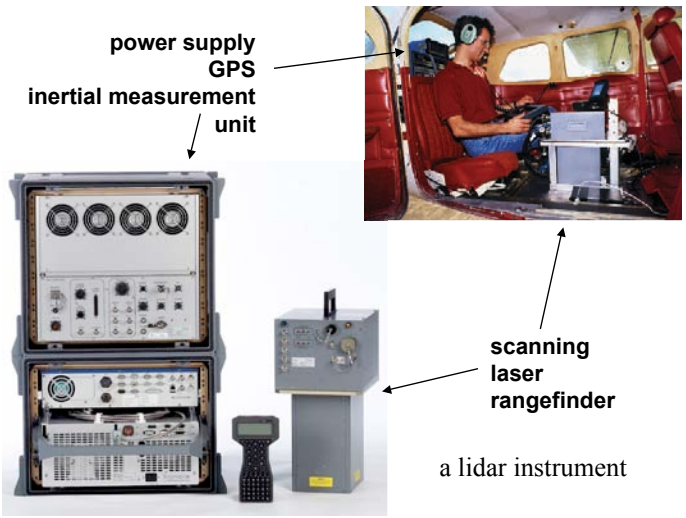
- measures distance by measuring the time-of-flight for a pulse of light



graphic courtesy Natural Resources Canada

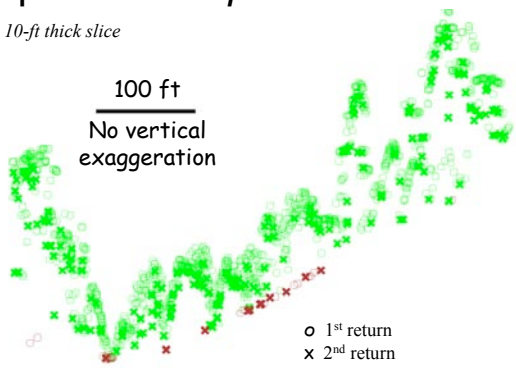
- Differential GPS
- Inertial measurement unit
- Laser rangefinder

- 20,000 to 100,000 pulses per second
- 3-20 million returns per square mile
- 2+ GB per 7.5' quad
- In forested terrain, 4/5 of returns from canopy



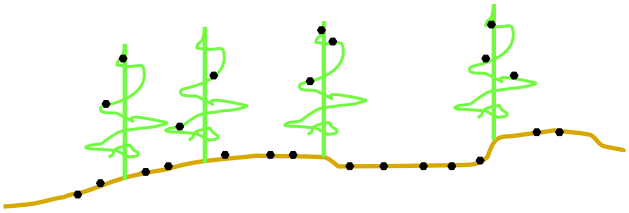
a lidar instrument

A lidar point cloud—pure XYZ position *in profile view*

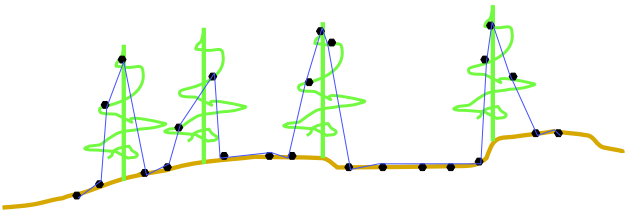


Despike algorithm

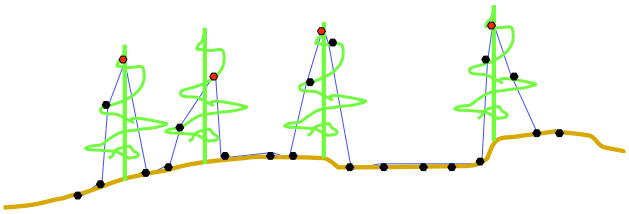
.



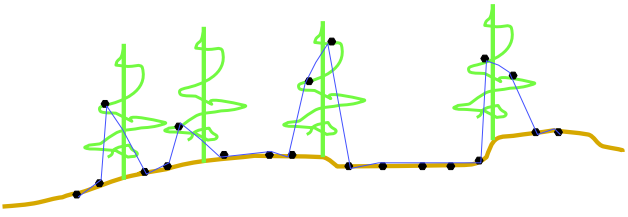
Start with mixed ground and canopy returns (e.g. last-return data), build TIN



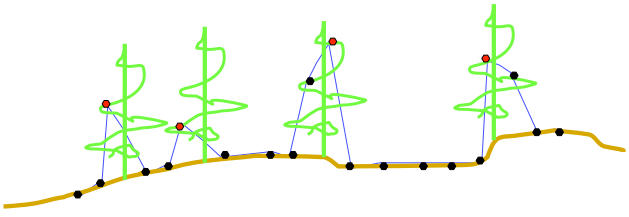
Flag points that define spikes (strong convexities)



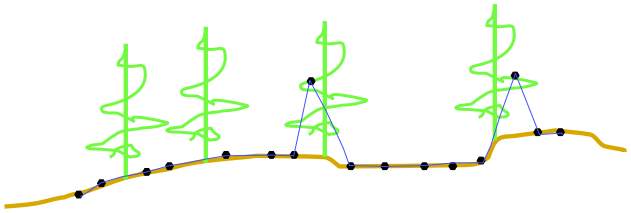
Rebuild TIN



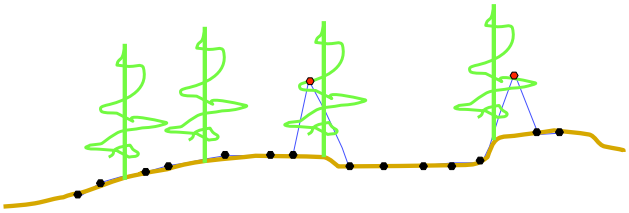
Flag points that define spikes (strong convexities)



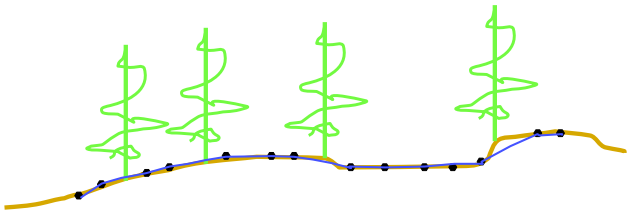
Rebuild TIN

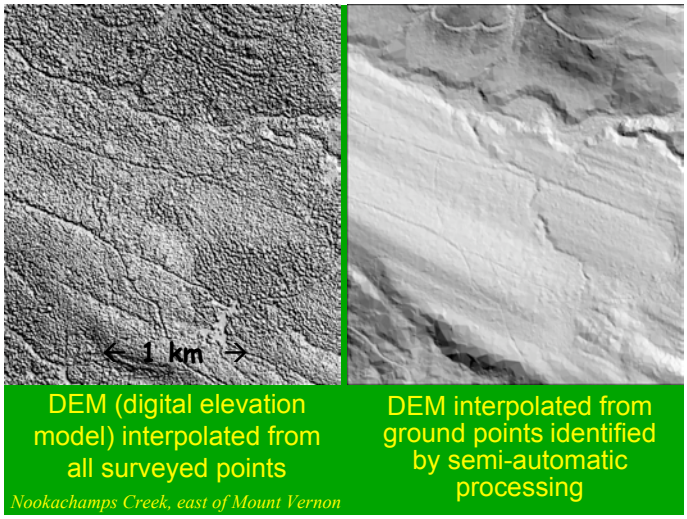


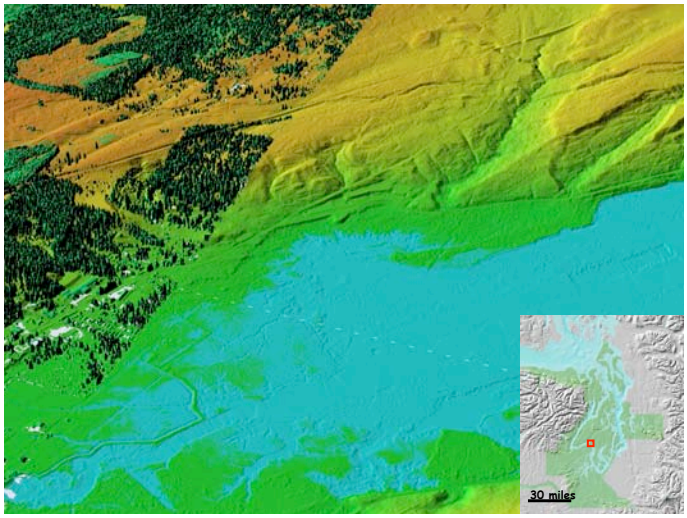
Flag points that define spikes
(strong convexities)

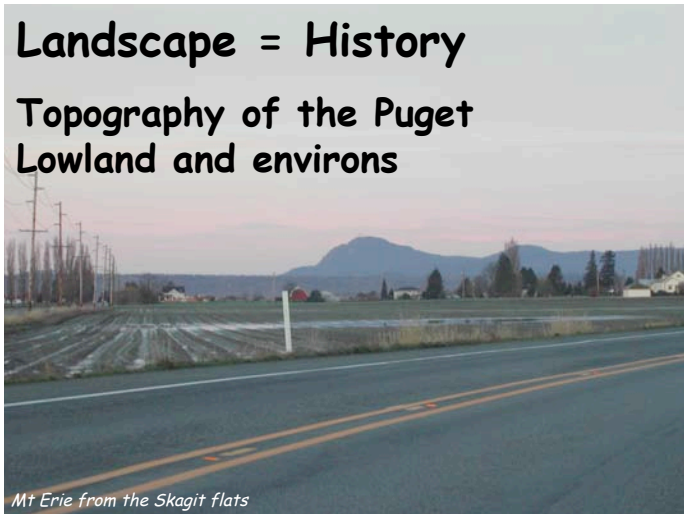


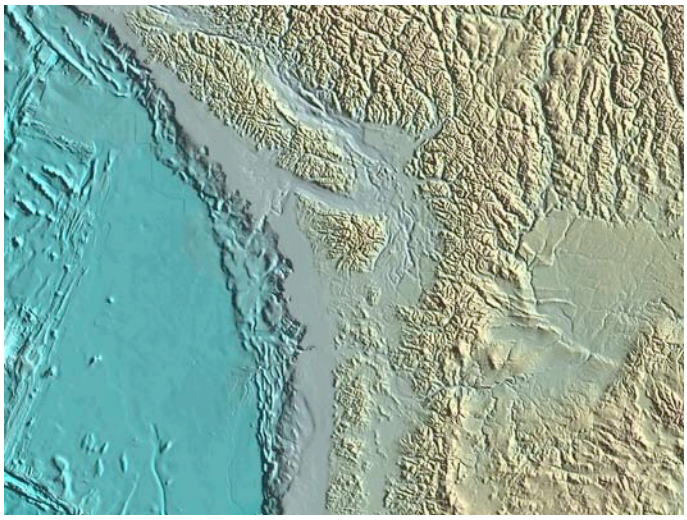
Rebuild TIN

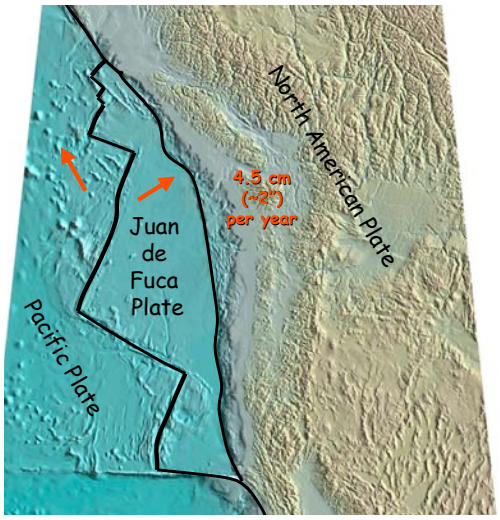


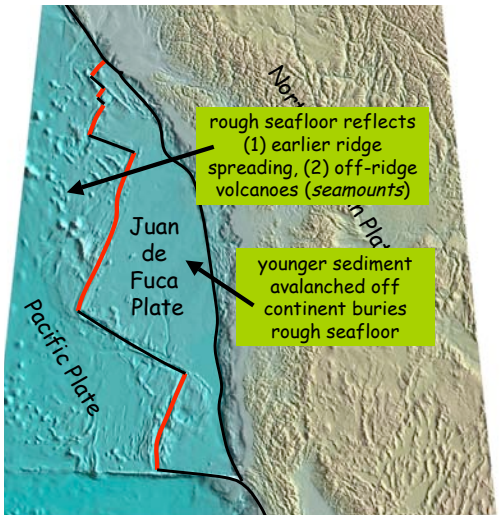


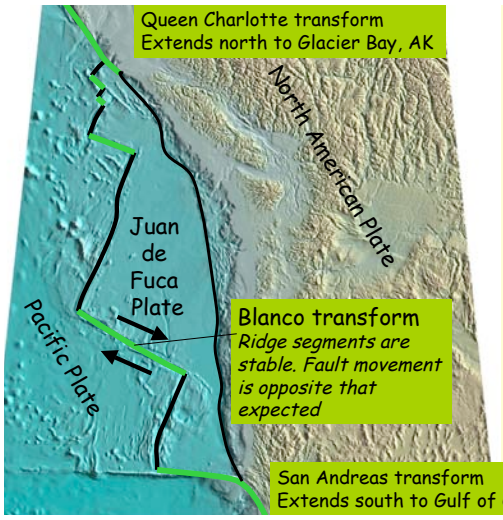


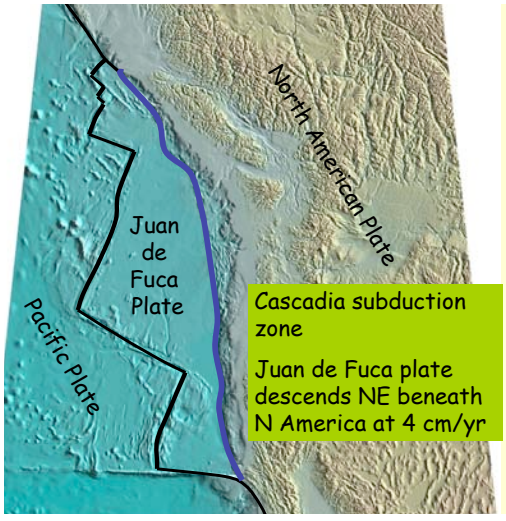


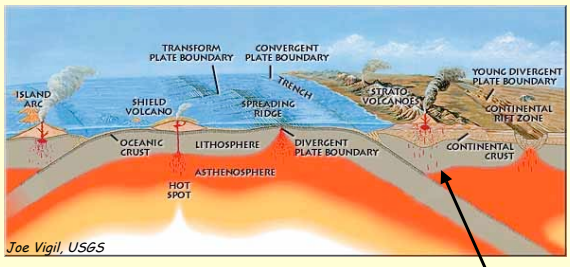




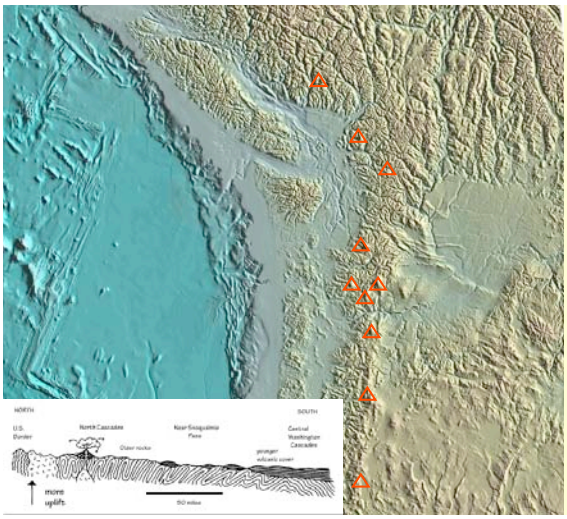






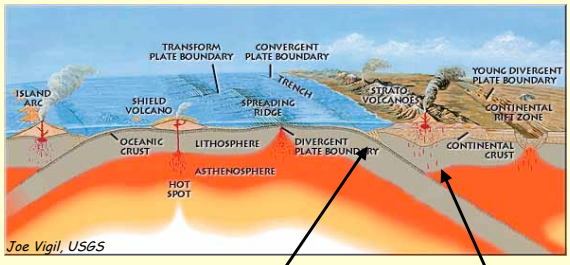


Descending plate gives off water, triggers melting in overlying plate, forms row of volcanoes



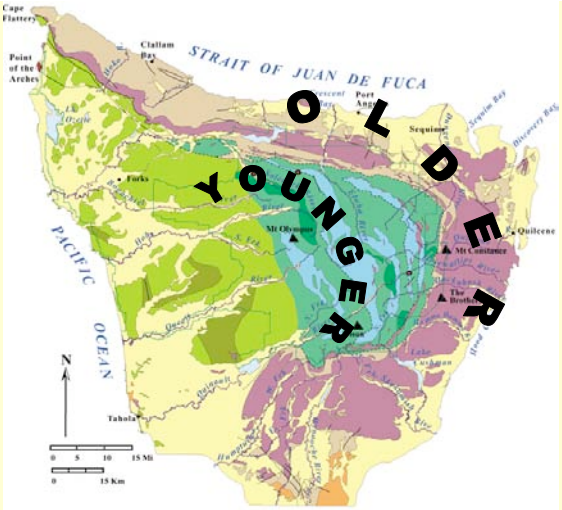
Cascade Range

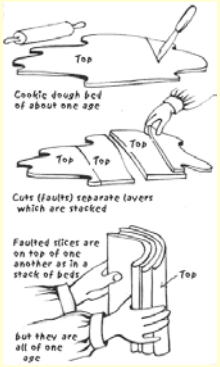
40 million years of volcanoes and their magmatic roots

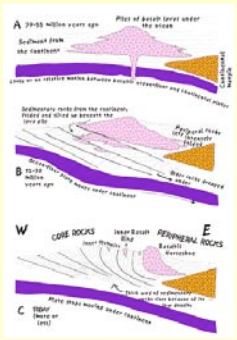


Off-scraped sediments accumulate in accretionary prism

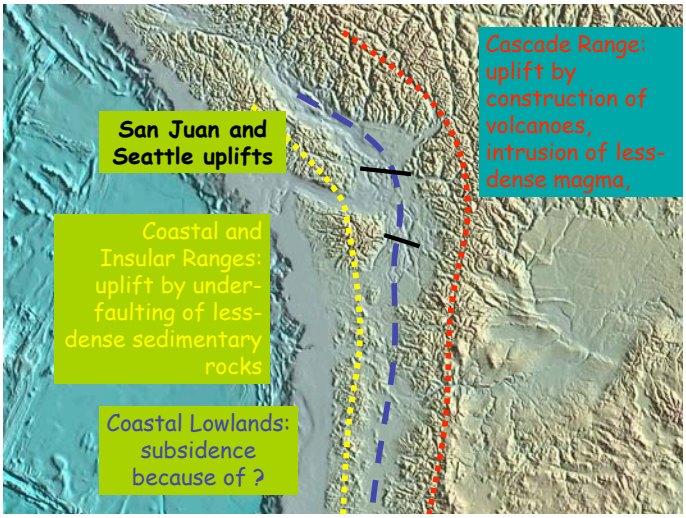
Descending plate gives off water, triggers melting in overlying plate, forms row of volcanoes



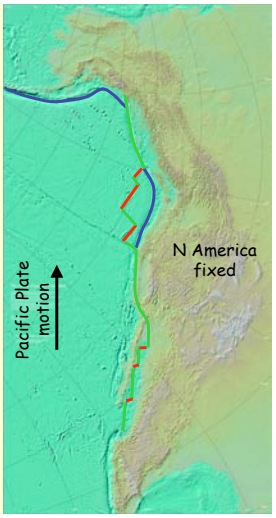




http://wrgis.wr.usgs.gov/parks/olym/



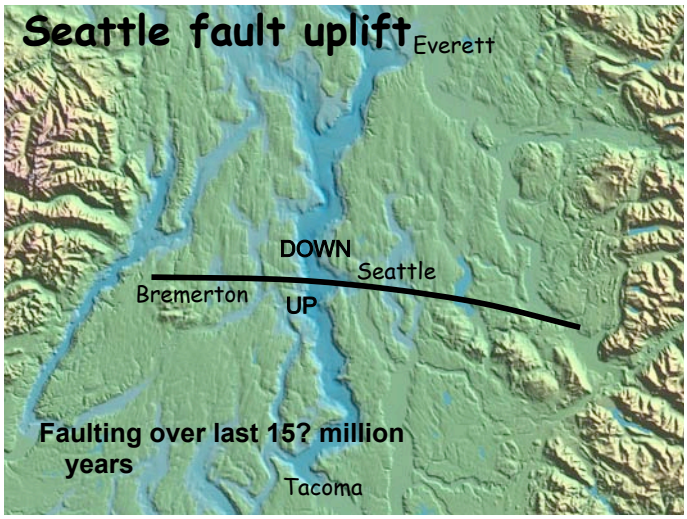
Western margin of North America is dominated by interaction with the Pacific Plate



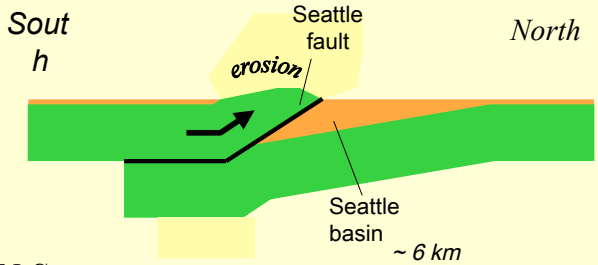
Relative to fixed North America:

- Pacific plate moves NW along San Andreas fault
- Sierra Nevada block translates NW
- Basin and Range spreads
- Oregon Coast Range rotates clockwise and translates N
- Washington is squished N-S

Wells and others, 1998



Seattle fault uplift



~ 6 km subsidence in 15 million years

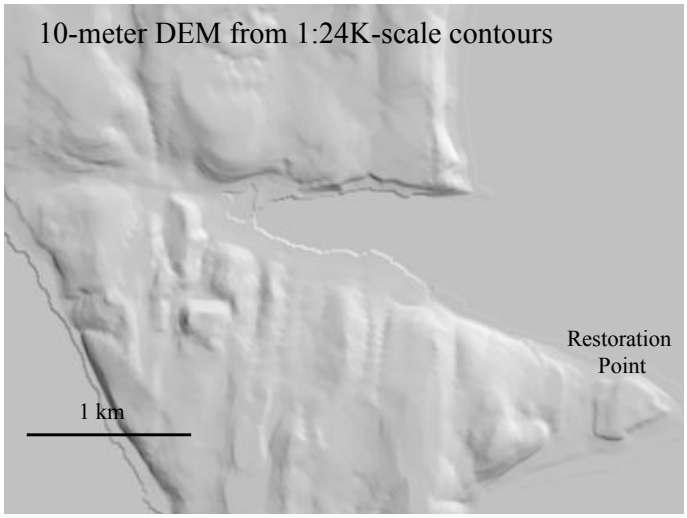
N-S contraction drives uplift and basin formation

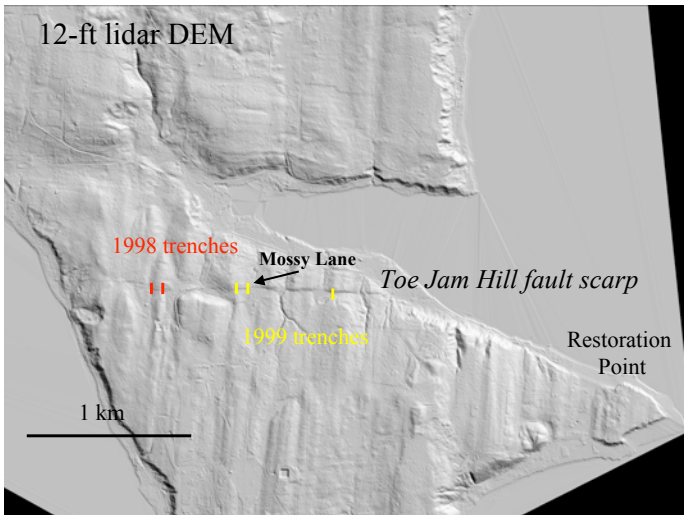
Vancouver's ship *Discovery* at Restoration Point, May 1792

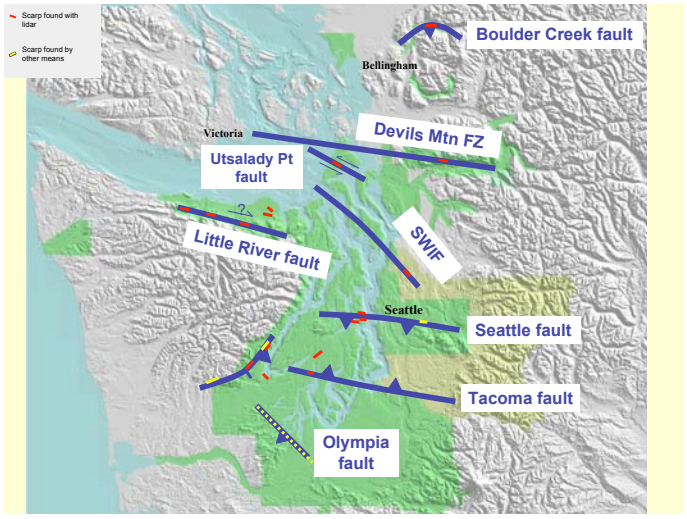
Mountains *active tectonics!*
History began 215 years ago
Low foreground plateau
glacial infillling 17,000 years ago
Dense forest hides landscape
Anomalous grassy nearshore bench

(partial view)
acrylic on canvas, 5' x 30'
Bill Holm, 1966

200 years later, we figured out that Restoration Point is a fossil beach uplifted 7 m in a single large earthquake 1,100 years ago




12-ft lidar DEM
1998 trenches
Mossy Lane
Toe Jam Hill fault scarp
1999 trenches
Restoration Point
1 km


Scarp found with lidar
Scarp found by other means
Boulder Creek fault
Bellingham
Victoria
Devils Mtn FZ
Utsalady Pt fault
Little River fault
SWIF
Seattle
Seattle fault
Tacoma fault
Olympia fault