TEACHERS ON THE LEADING EDGE

Understanding the Cascadia Subduction Zone - From Scientists to Teachers to Interpreters

OR

Translating Cascadia Geology and EarthScope for Novice Learners of Earth Science

Bob Butler
Department of Physics
University of Portland

TEACHERS ON THE LEADING EDGE

Teachers on the Leading Edge

Cascadia Tsunami Geology Curriculum Development

EarthScope in K-12 Earth Science

Collaborations with:

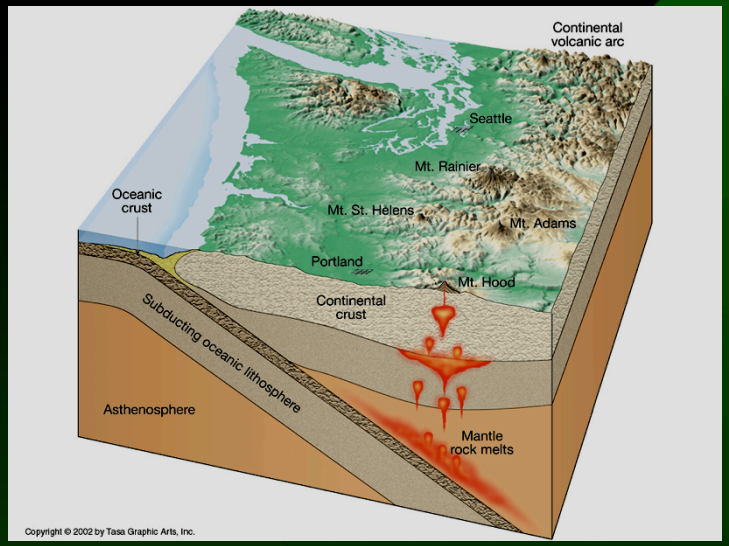
IRIS — Operates USArray

UNAVCO — Operates PBO

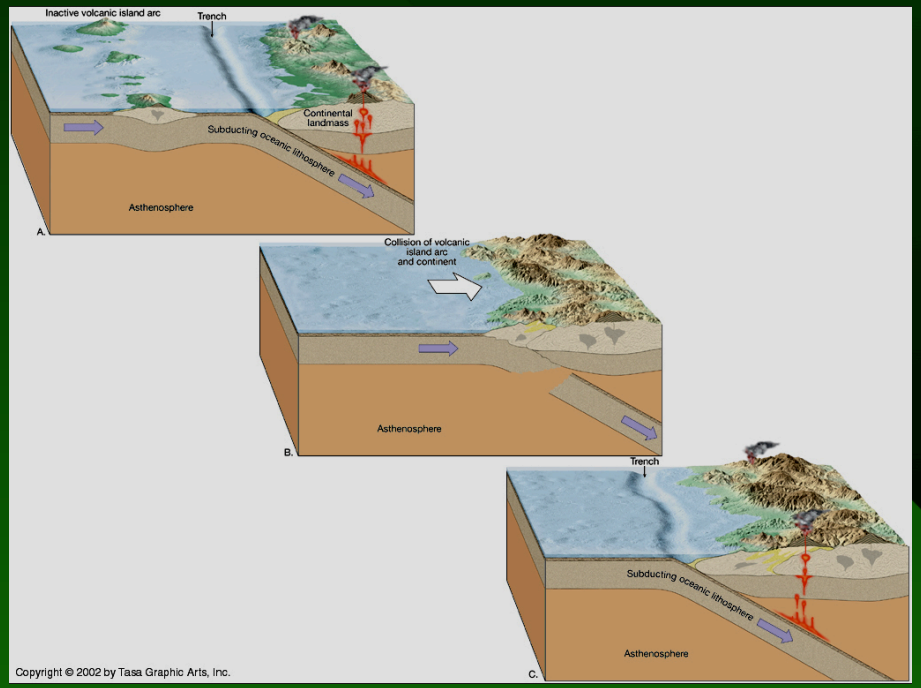
OSU Oregon State University — EarthScope National Office

O.H. Hinsdale Wave Research Laboratory

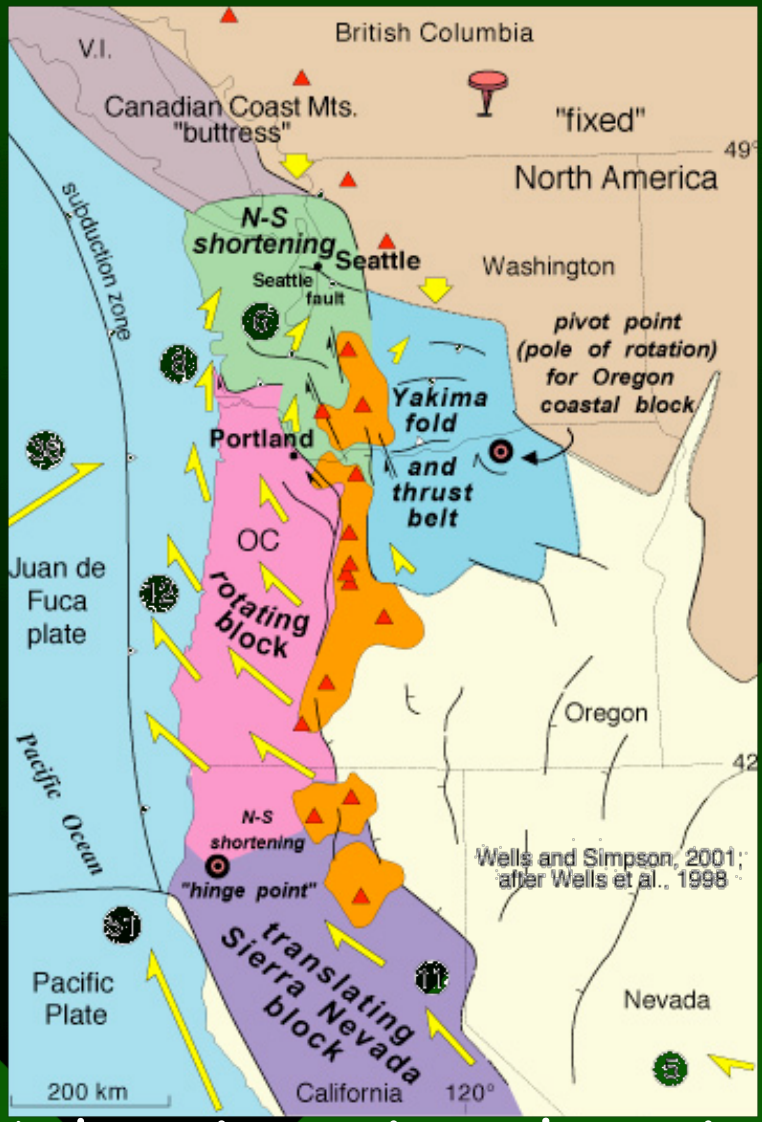
What a geologist sees



A subduction zone and magmatic arc

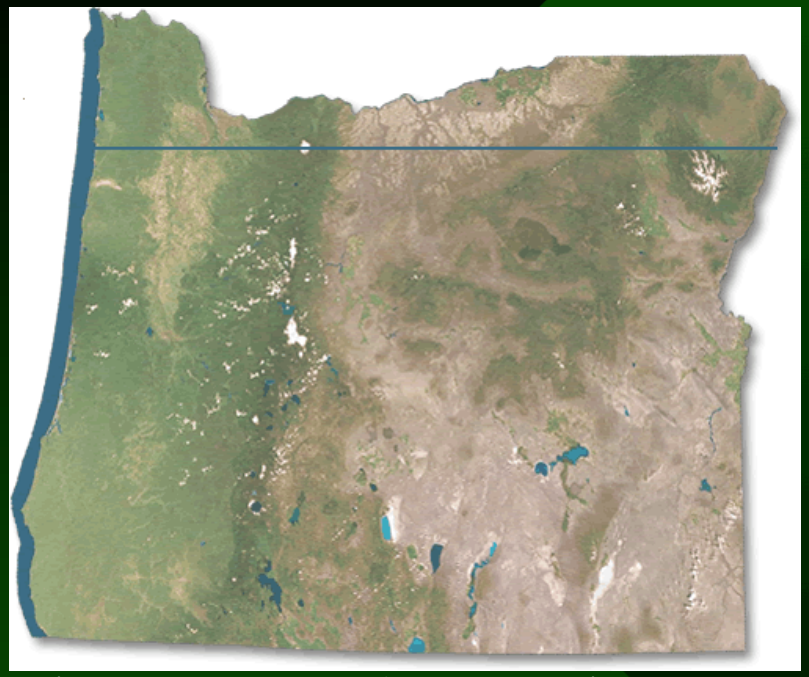


200 m.y. history of accreted terranes



A dynamic continental margin

Earth Science in K-12 & Informal Science Education



A landscape with no explanation?

Earth and Environmental Science is a main feature of middle school science. Only 1/3 of middle school Earth Science teachers ever took a geology course. So teachers must learn background and regional geology…on their own?

A similar situation for parks interpreters?

TEACHERS ON THE LEADING EDGE

What is Teachers on the Leading Edge (TOTLE)?

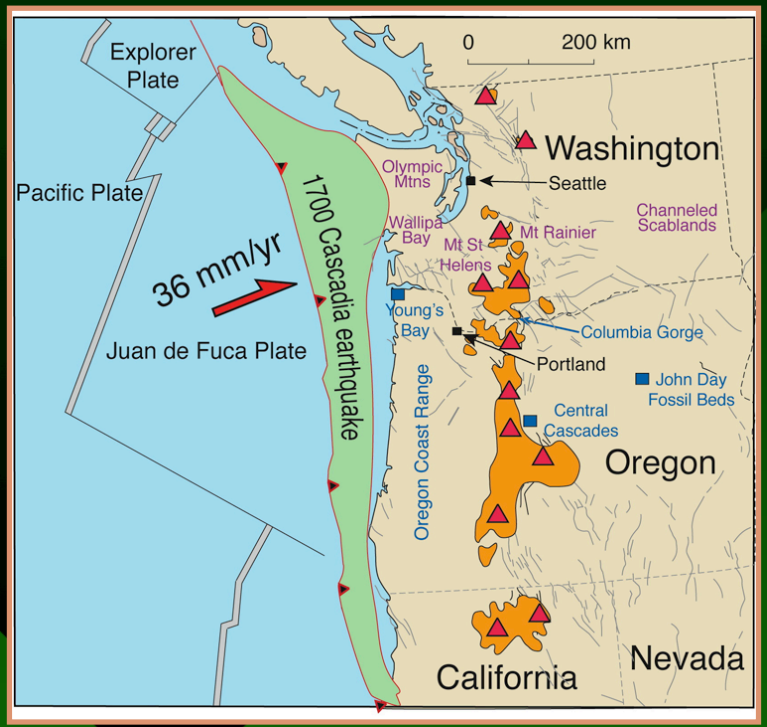
K-12 Earth Science teacher professional development program.
Emphasis on middle school teachers.
Teacher workshops during 2008 - 2010 funded by EarthScope.

Themes

Place-based teaching & learning.

Geophysics & EarthScope.

Geologic Hazards.



TEACHERS ON THE LEADING EDGE

Who is Teachers on the Leading Edge?

Collaborators

Bob Butler, University of Portland
Frank Granshaw, Portland Community College
Beth Pratt-Sitaula, Central Washington University
Jill Whitman, Pacific Lutheran University
Jenda Johnson, IRIS Education Specialist

Collaborators on Previous Programs

Kip Ault, Lewis and Clark College
Ellen Morris Bishop, Oregon Paleolands Institute
Travis Southworth-Neumeyer, OMSI Science Camps

Master Teachers

Bonnie Magura:
Jackson Middle School
NSF Presidential Award winner

Roger Groom:
Mt Tabor Middle School
2006 UNAVCO Master Teacher

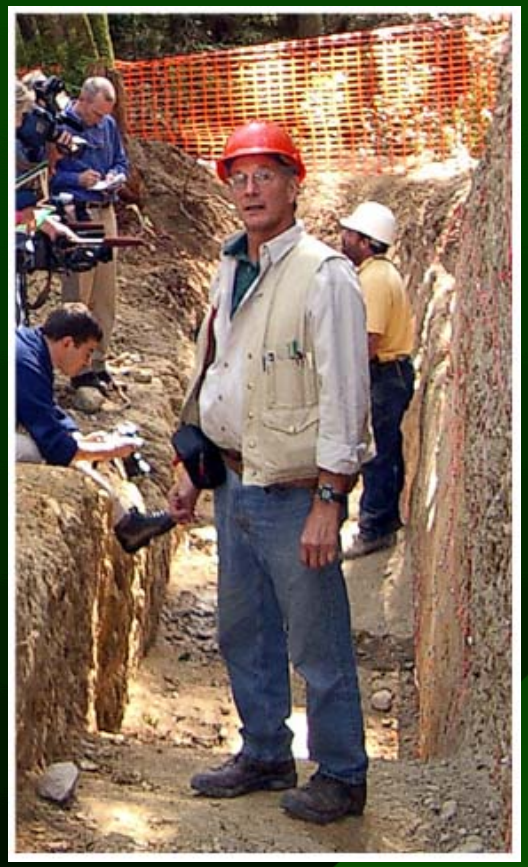
Chris Hedeen:
Oregon City High School
MS in Geology
MAT in Science Education

Parks Interpreters must supply their wisdom on what can work in their parks.

USGS partners

Rick Blakely: Geophysicist

Volcanologists:
Carolyn Driedger
Willie Scott



Ray Wells: Geologist
Geologic Hazards

Brian Atwater: Paleoseismologist
Cascadia great earthquakes and tsunamis

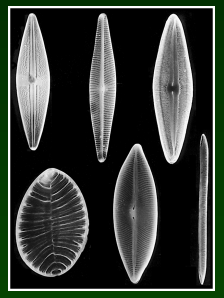
Cascadia Tsunami Geology Storyline

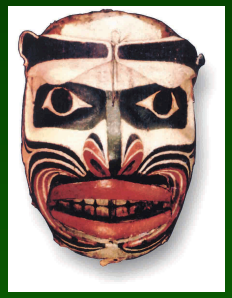
At Risk: Earthquakes and Tsunamis on the West Coast

The Orphan Tsunami of 1700

Do Great (Gianormous) Earthquakes Happen in Cascadia?

Evidence: Ghost forests, buried soils, diatoms, tsunami sand sheets, liquefaction, turbidites.





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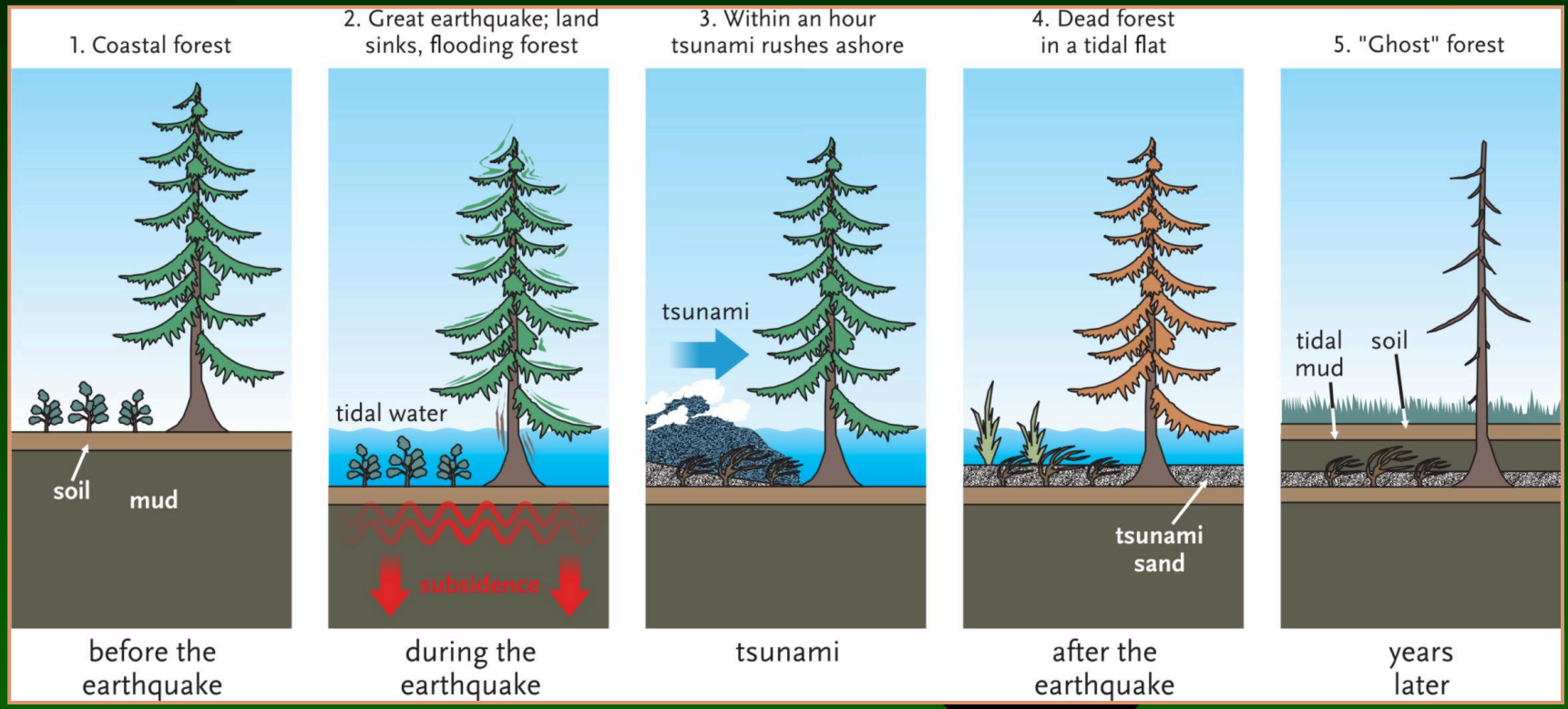
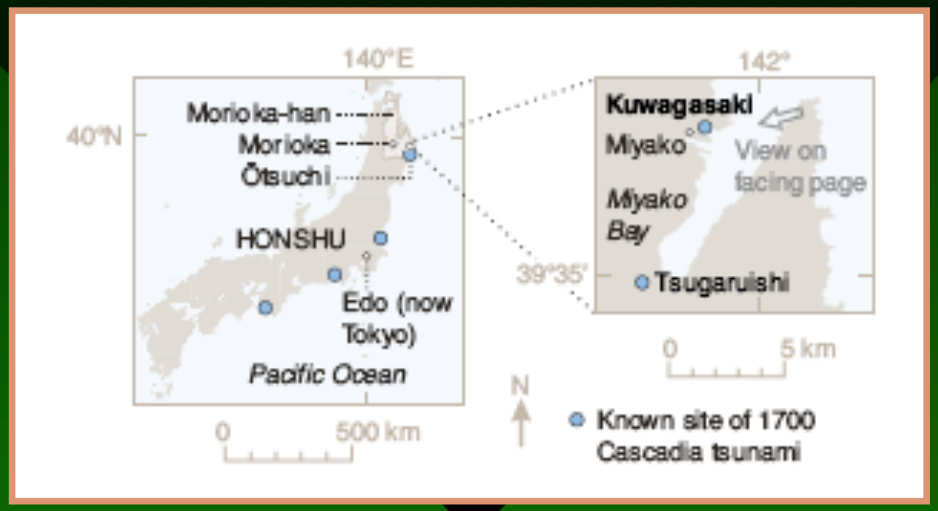


Cascadia Tsunami Geology Storyline

When Was Most Recent Earthquake?
Radiocarbon and Tree-Ring Dating.

How Gianormous Was It?
Rupture length tested by radiocarbon dating of turbidite deposits (a marine geology connection).
"Orphan Tsunami" size inferred from Japanese documents and linked to Cascadia Earthquake by tree ring dating.



Orphan Tsunami Crossing Pacific

**One winter's night in the year 1700,
a mysterious tsunami flooded fields
and washed away houses in Japan.
It arrived without the warning that
a nearby earthquake usually provides.
Samurai, merchants, and villagers
recorded the event,
but nearly three centuries would pass
before discoveries in North America
revealed the tsunami's source.**

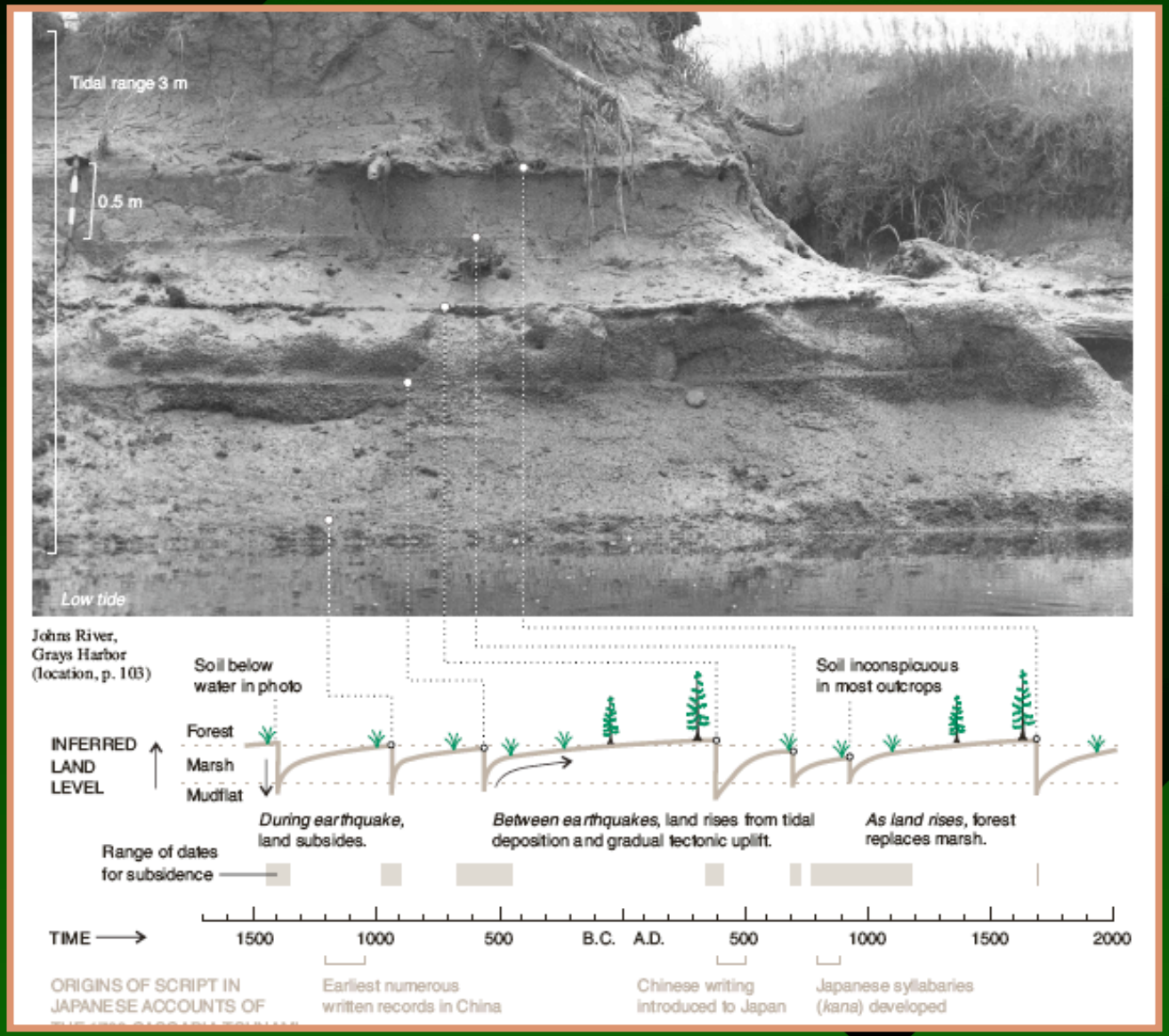
The Orphan Tsunami of 1700 (Atwater and others, 2005)

Cascadia Tsunami Geology Storyline

The great earthquake cycle.

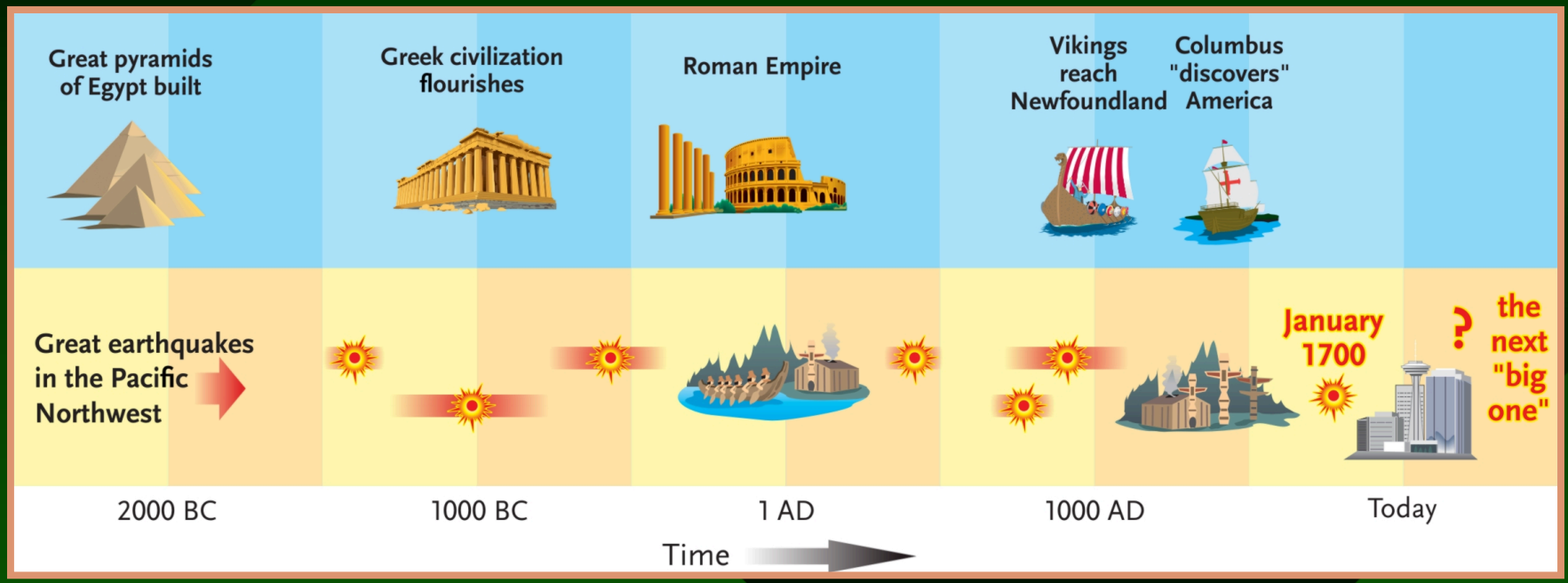
Cascadia Tsunami Geology Storyline

The great earthquake cycle.



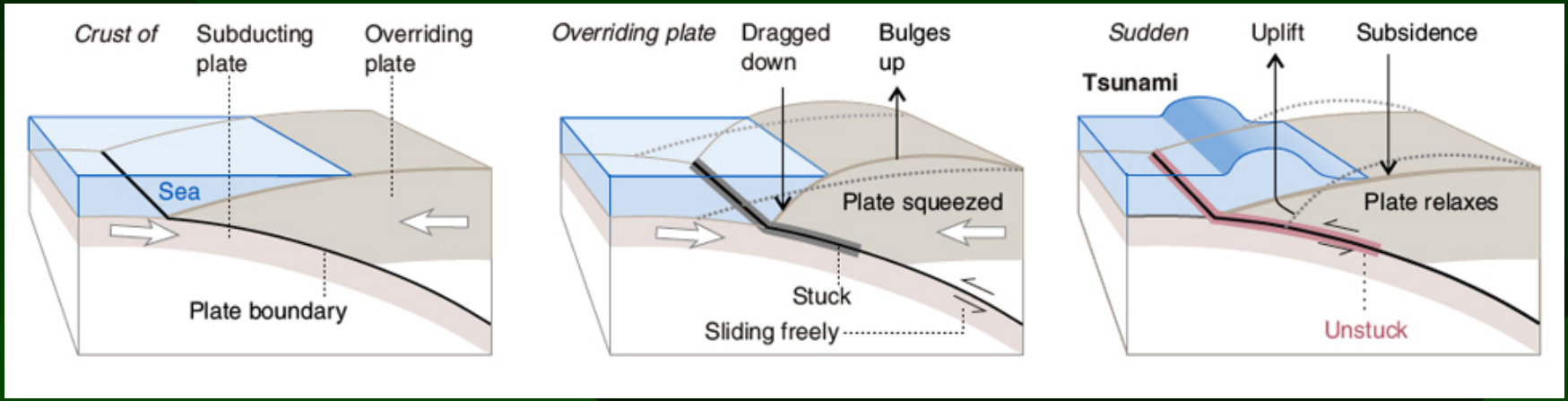
Cascadia Tsunami Geology Storyline

The great earthquake cycle.



Cascadia Tsunami Geology Storyline

The great earthquake cycle and tsunami generation.



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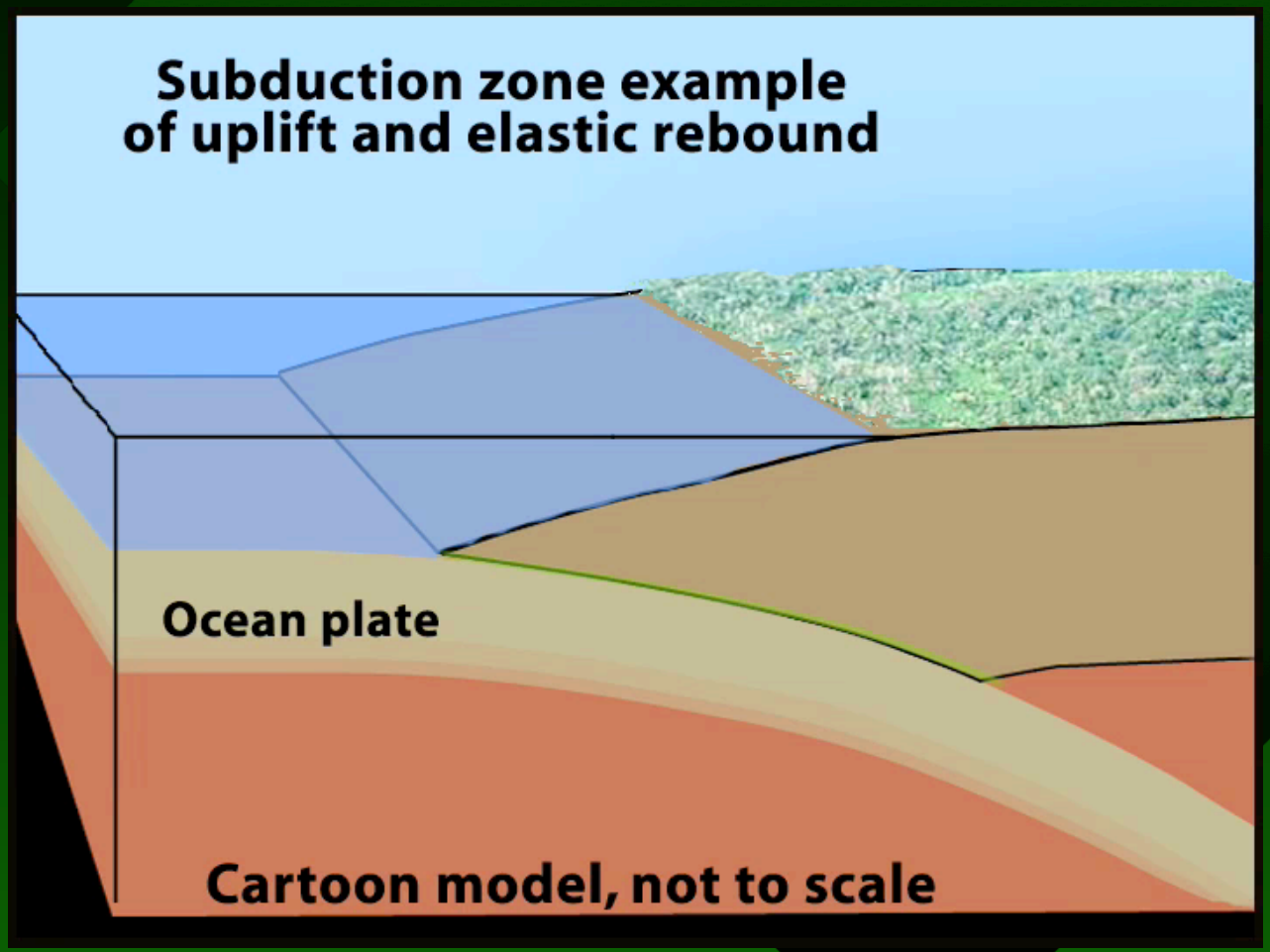


Computer animation by Jenda Johnson

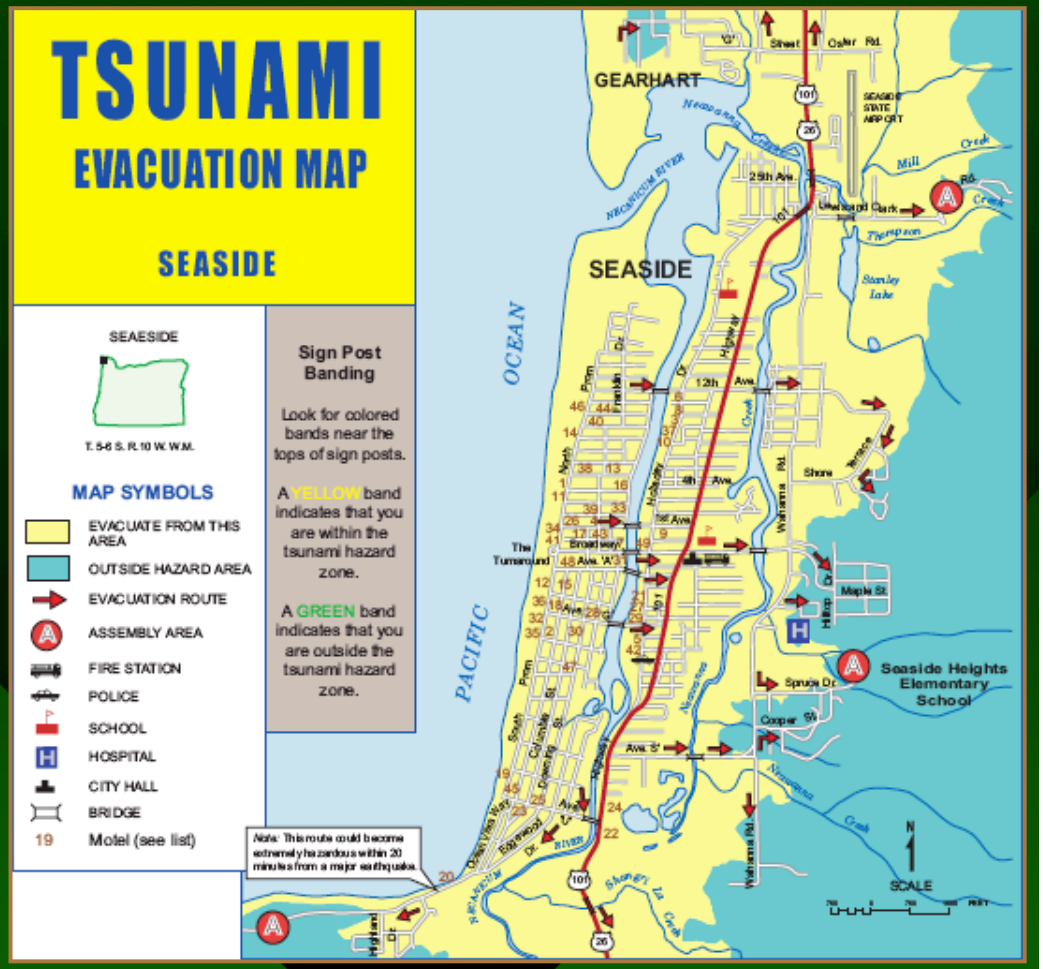
Cascadia Tsunami Geology Storyline

What Do We Do About It?

Tsunami Preparedness.

OSU Wave Research Laboratory.

Sunnyside Environmental School Tsunami Hotline.

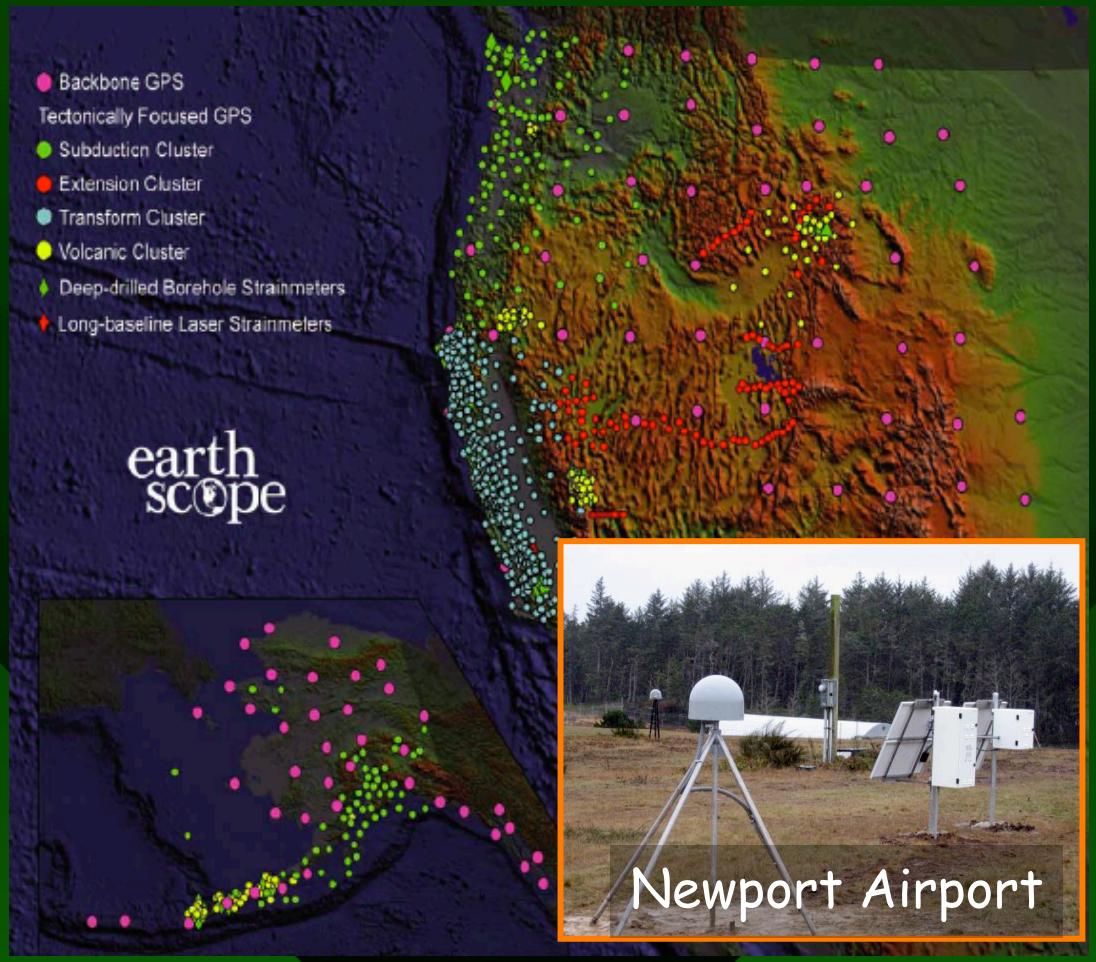


Cascadia Tsunami Geology Storyline

The link to EarthScope's Plate Boundary Observatory.

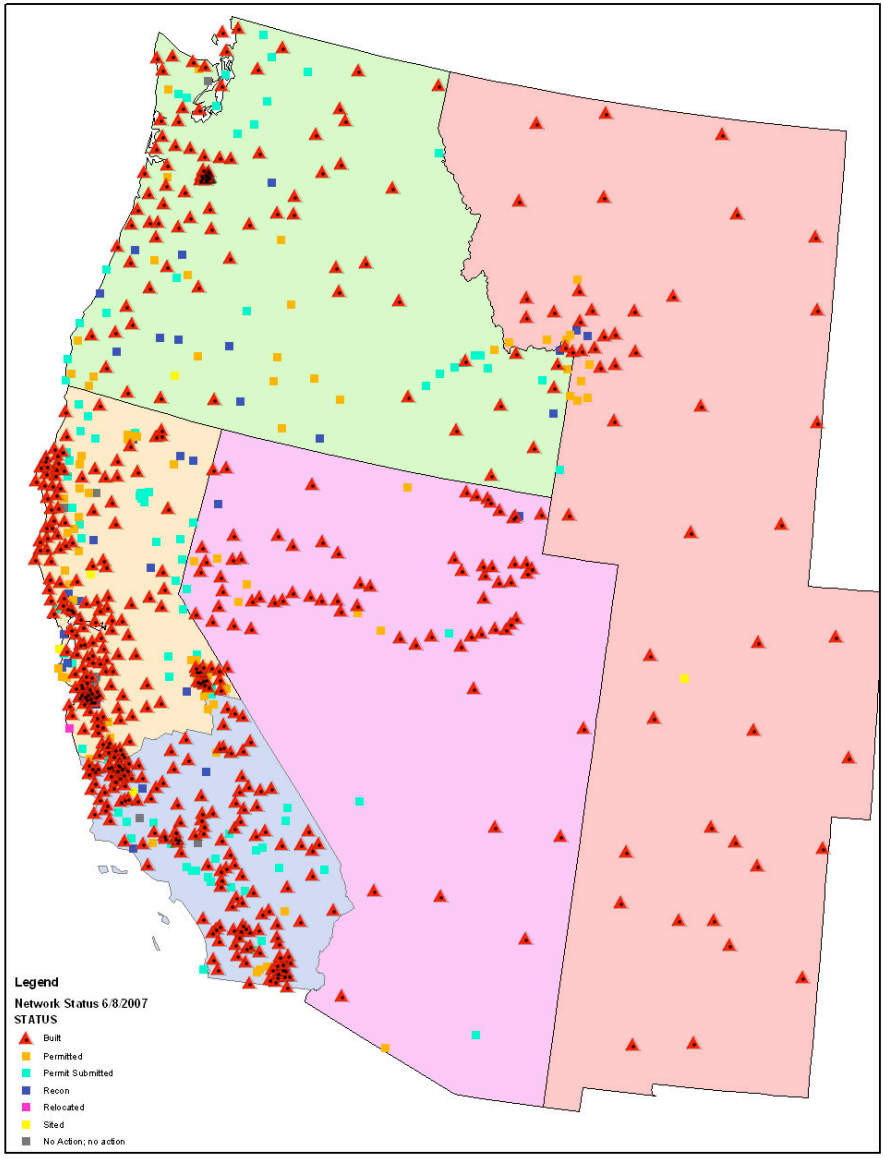
Arrays of GPS receivers across the Pacific Northwest.

Measure active tectonics at mm precision on time scales of weeks, months, and years.



PBO Stations in Pacific Northwest

Draw attention to your local PBO station(s).



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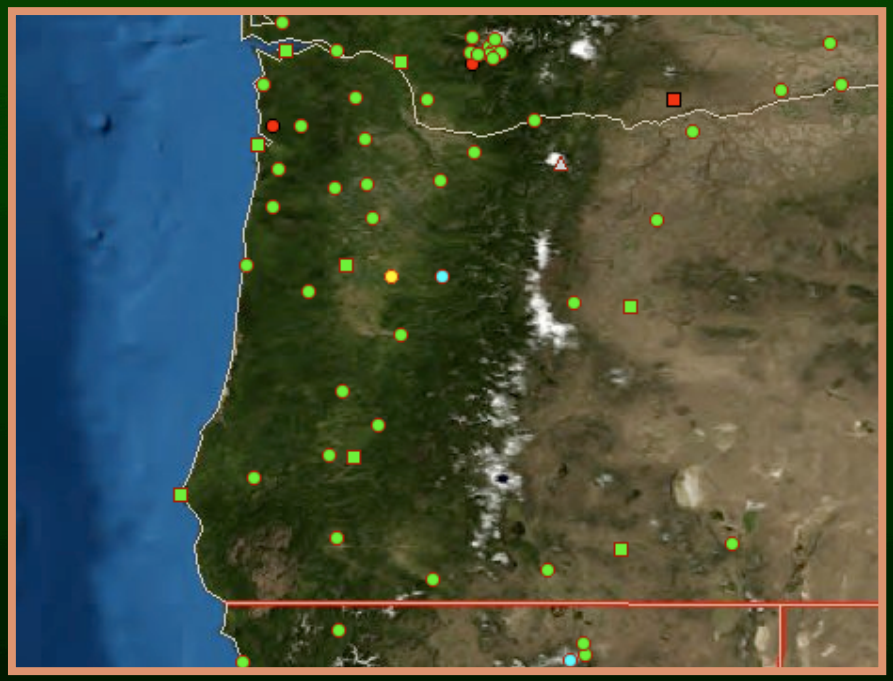


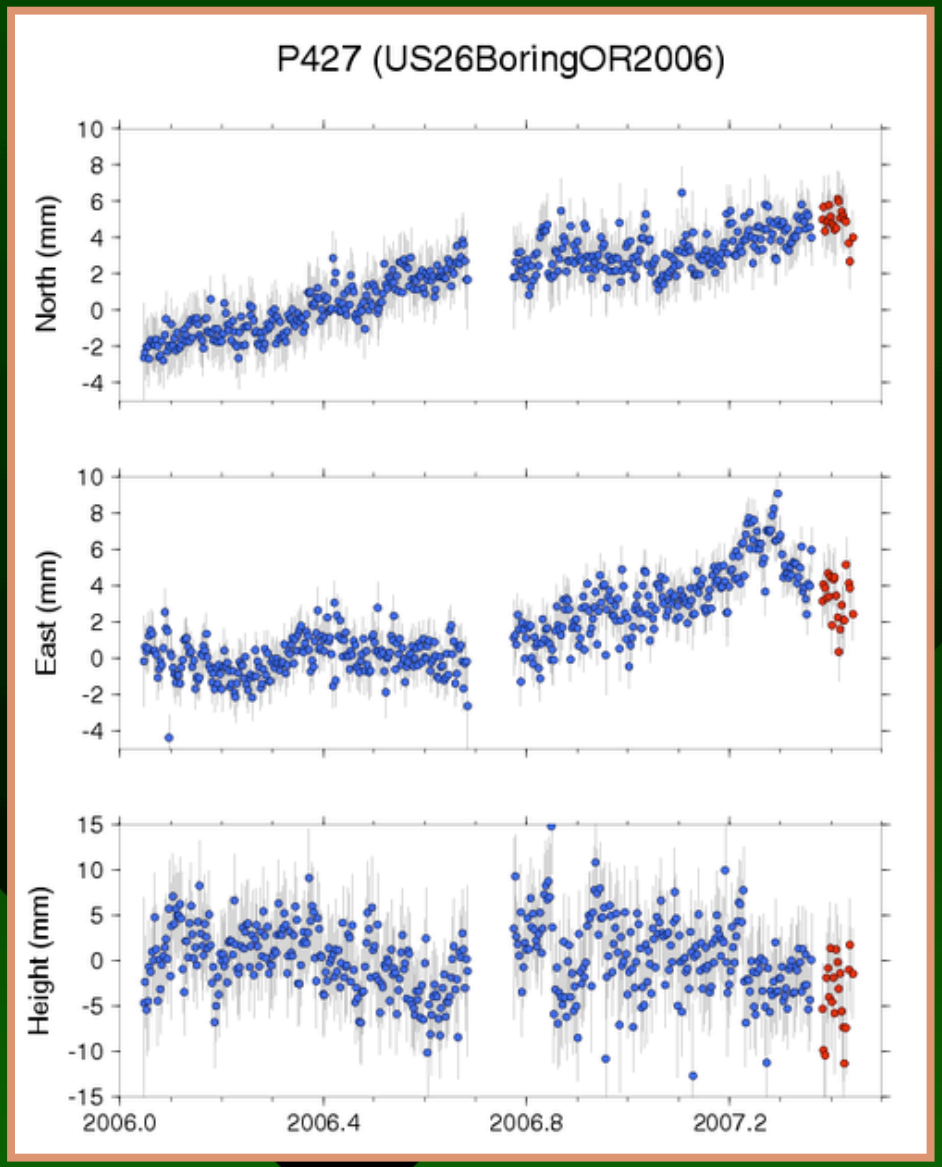
PBO Stations in Pacific Northwest

Draw attention to your local PBO station(s).

4-Char:	P427
Station Name:	US26BoringOR2006
Station Installation Date:	2006-01-17 00:00:00
Monument Installation Date:	2006-01-17 00:00:00
Station Status:	Station Built
Project:	PBO
Region:	PNW
Latitude, Longitude:	45.430, -122.341
Elevation:	150 m / 492 ft
Monument Type:	Deep
Location (City, State):	Boring, OR
Group(s):	GPS-PBO
Co-Located Station(s):	No Colocated Station Found.
Station Log:	IGS Site Log

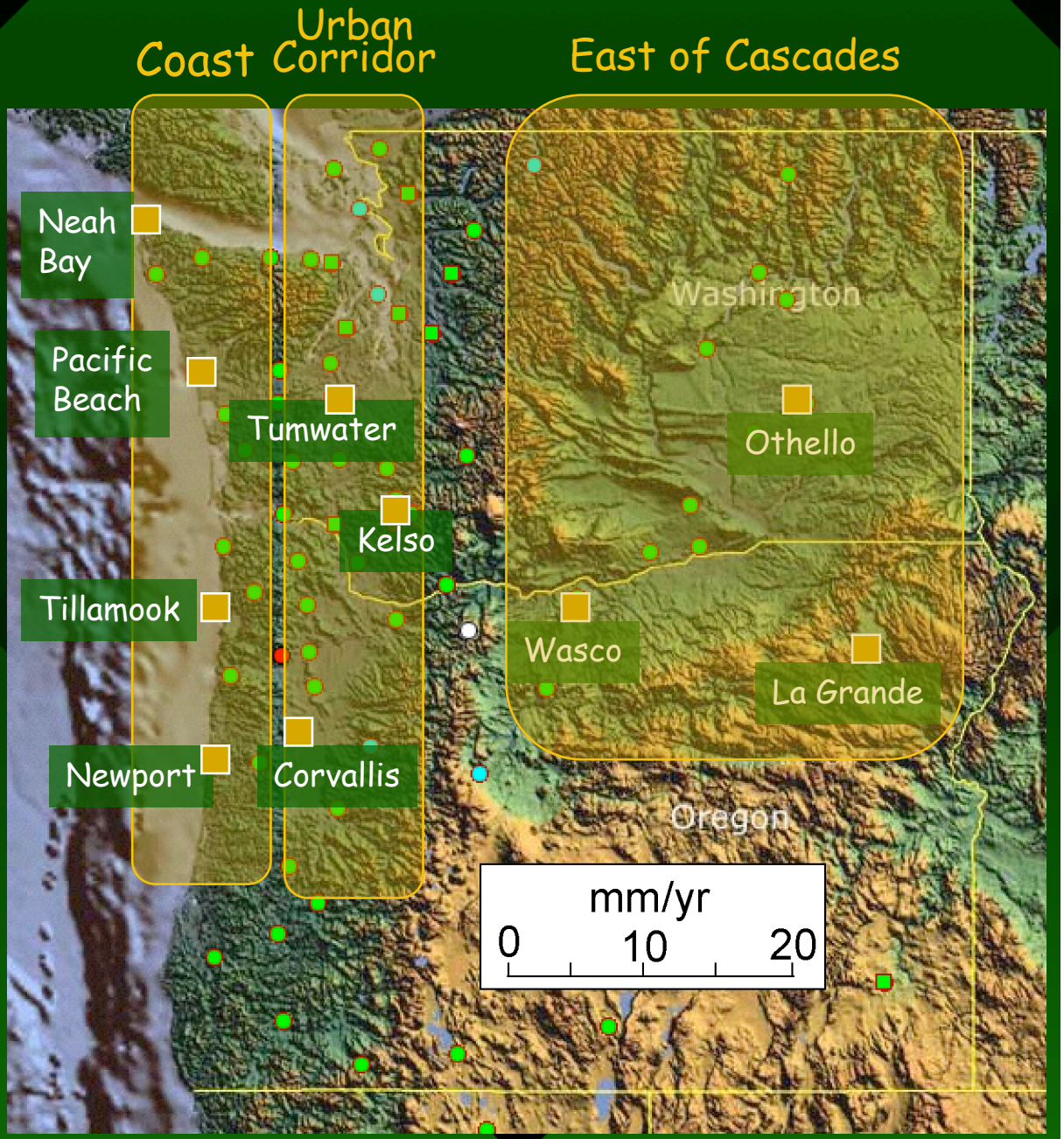
PBO Stations in Pacific Northwest

Draw attention to your local PBO station(s).

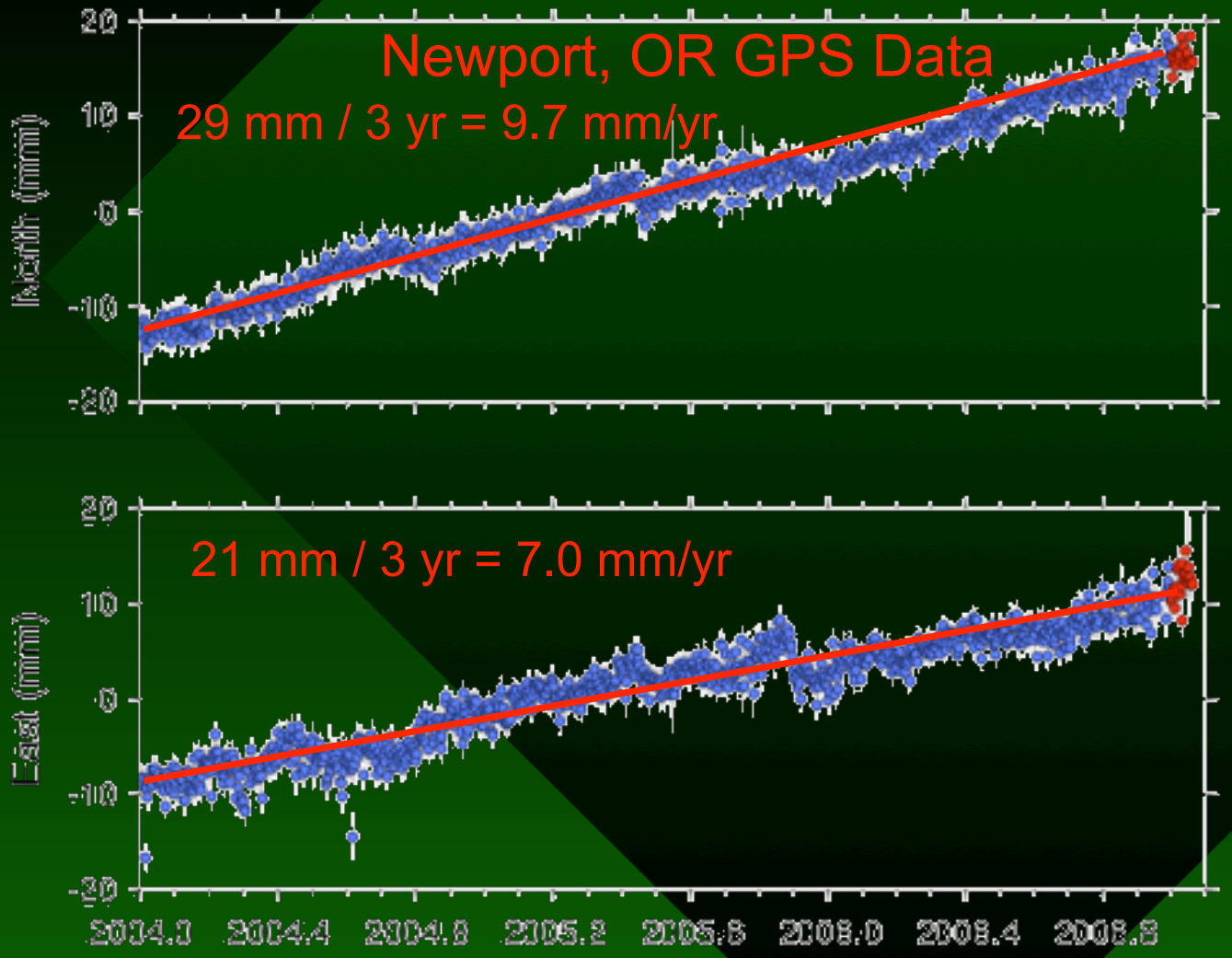


Compression of Pacific Northwest Continental Margin

A classroom exercise: Motions of GPS stations at different distances from Juan de Fuca - North America plate boundary.



Newport, OR GPS Data

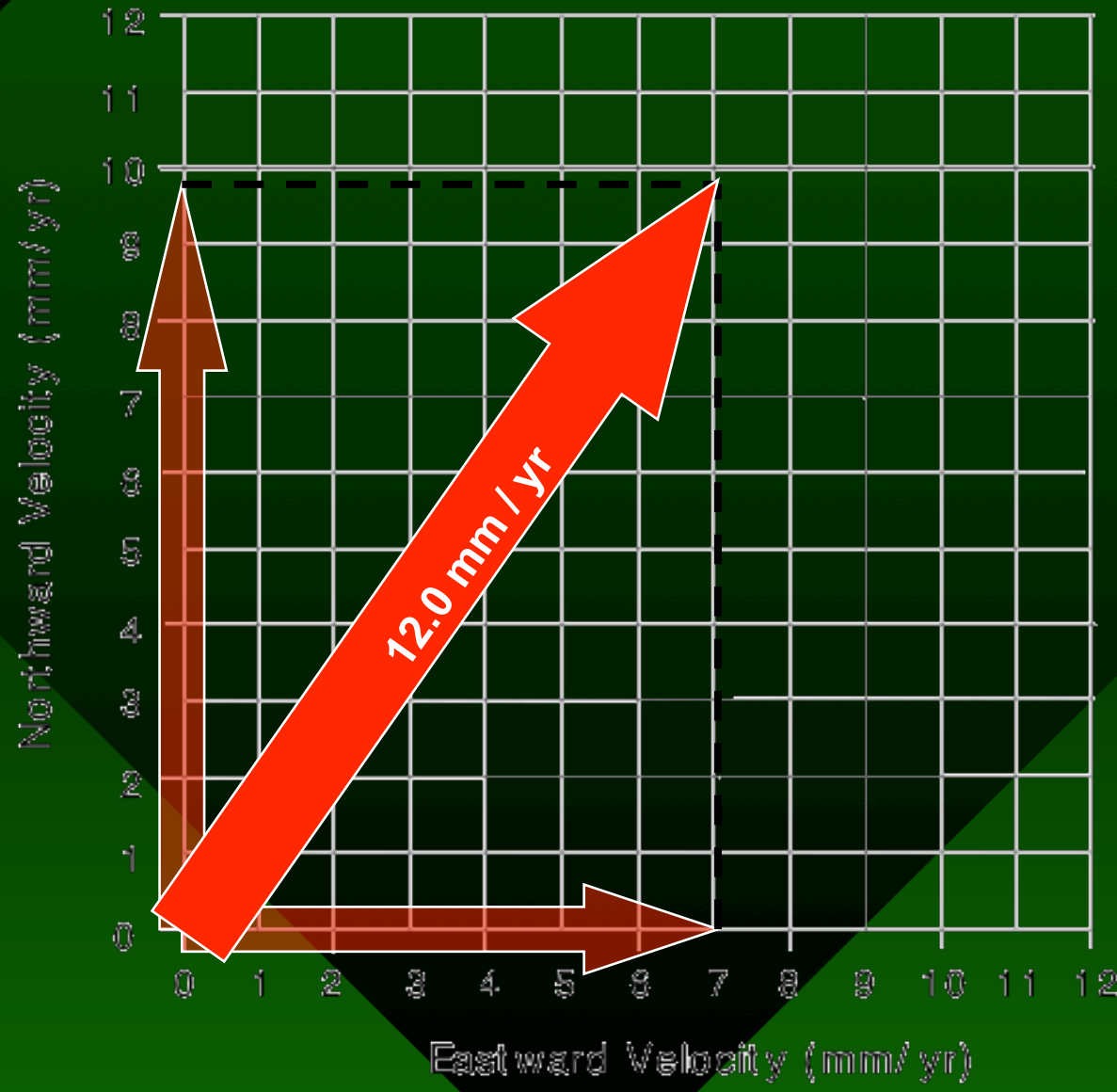


Can download data to spreadsheet and determine best-fit slope = rate.

Newport, OR GPS Velocity

Graphically add the north and east velocities.

(Don't even THINK of using the word "vector"!)

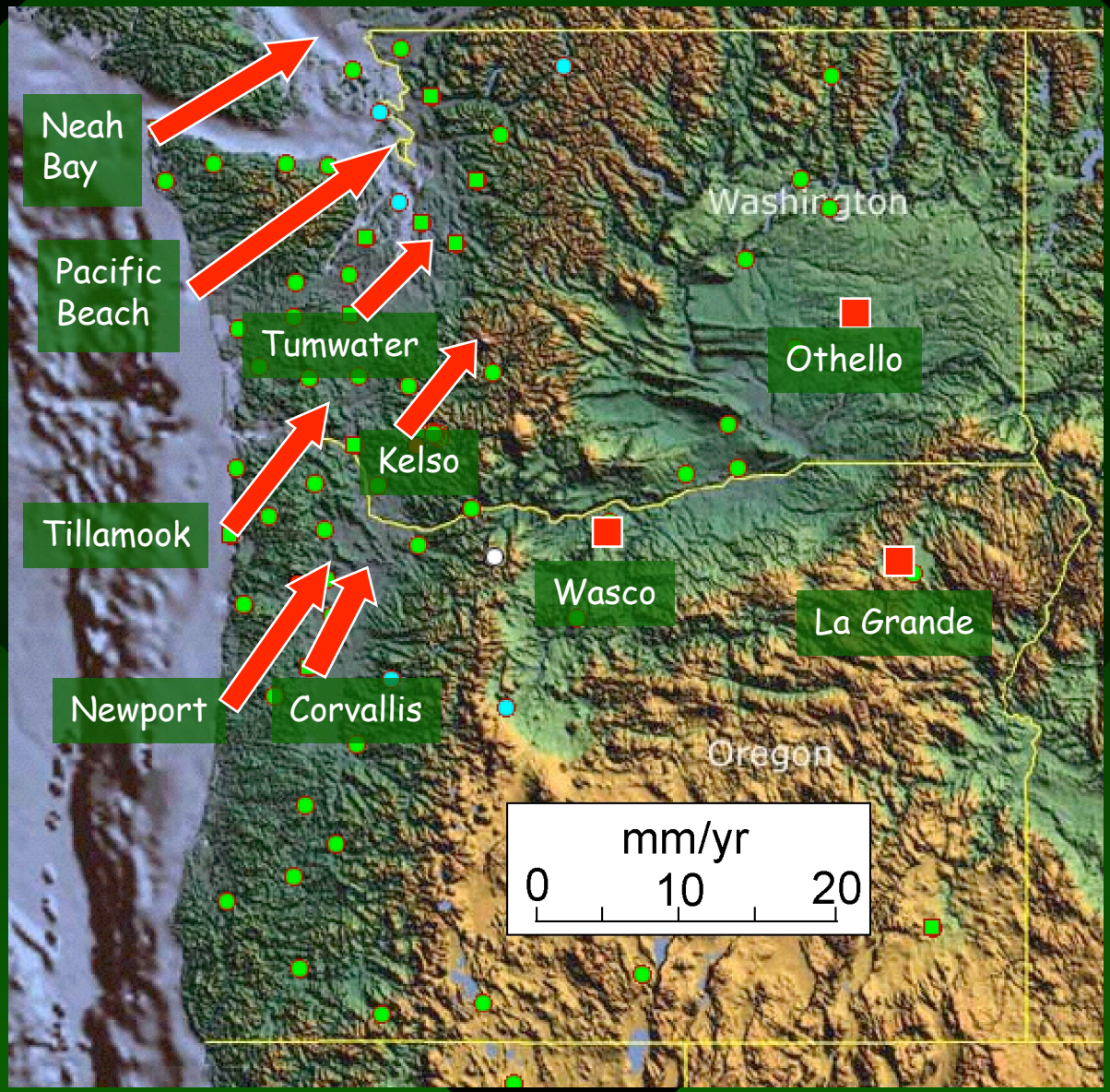


Compression of Pacific Northwest Continental Margin

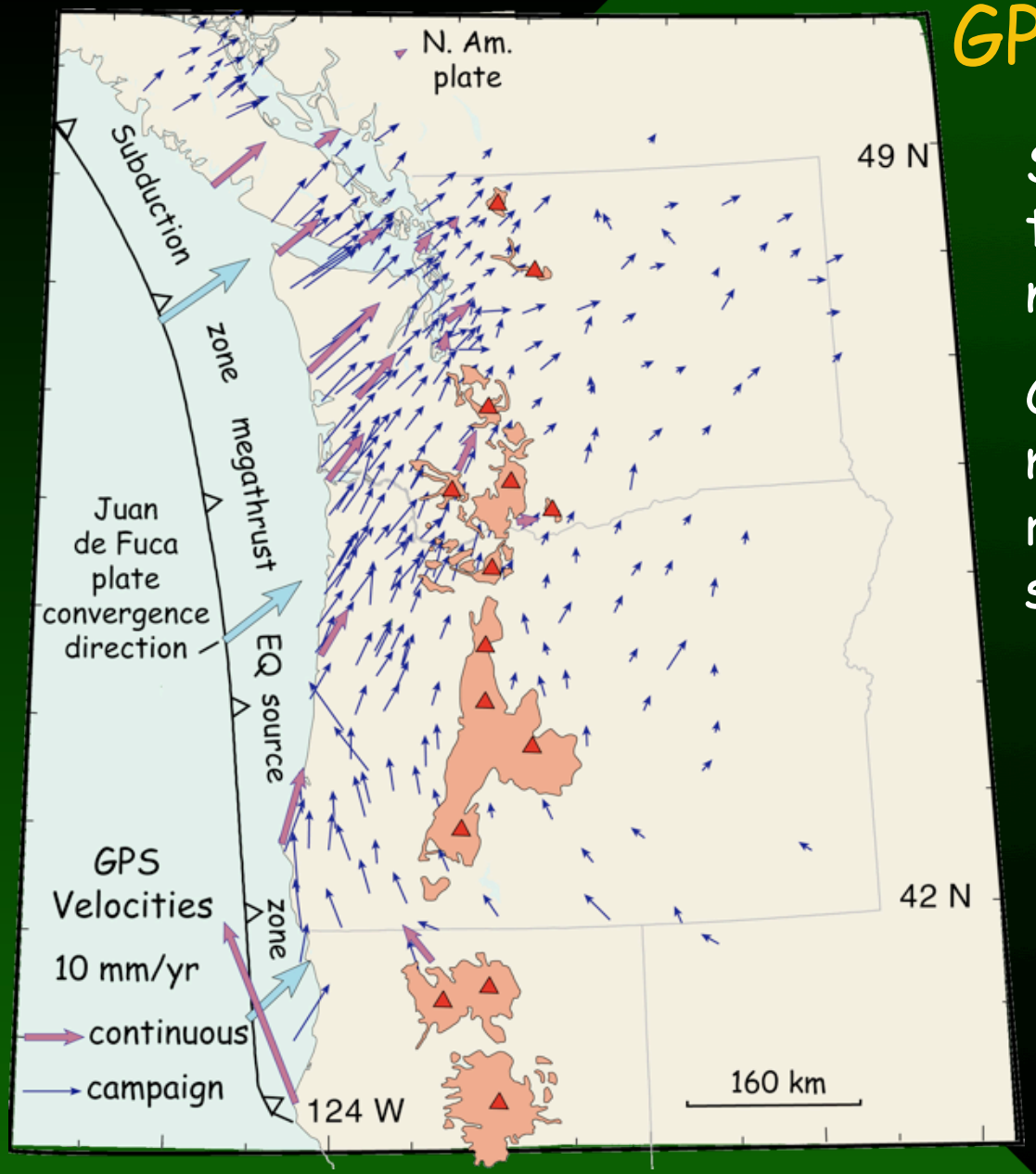
Stations on coast are moving NE faster than stations in urban corridor.

Stations east of Cascades are not moving (with respect to "stable North America").

Cascadia subduction zone boundary is "locked and loading" as it stores elastic energy that will be released in the next great Cascadia megathrust earthquake.



GPS velocity field

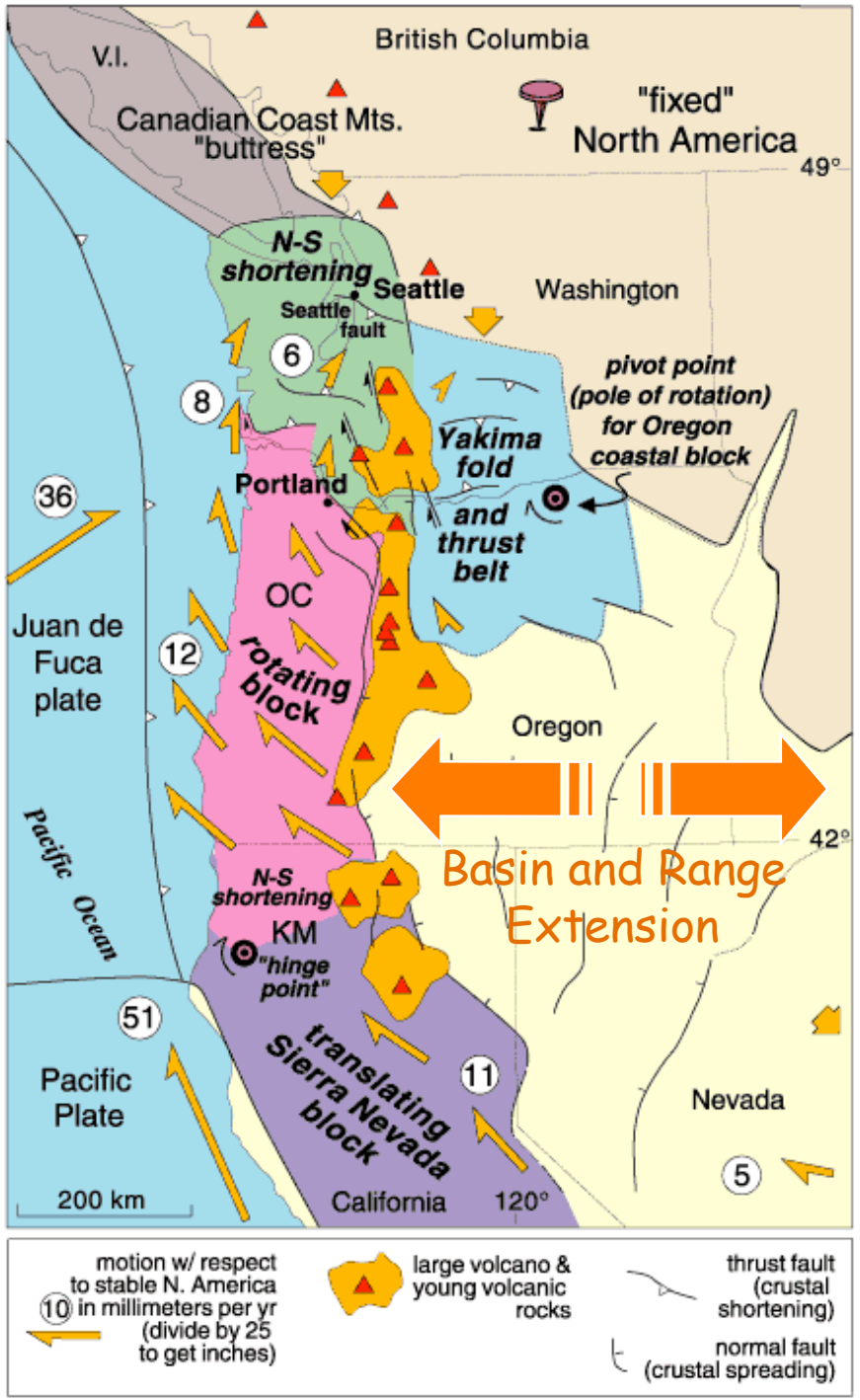


Simple compression of the continental margin is not the whole story.

Crustal blocks are moving northward and rotating with respect to stable North America.

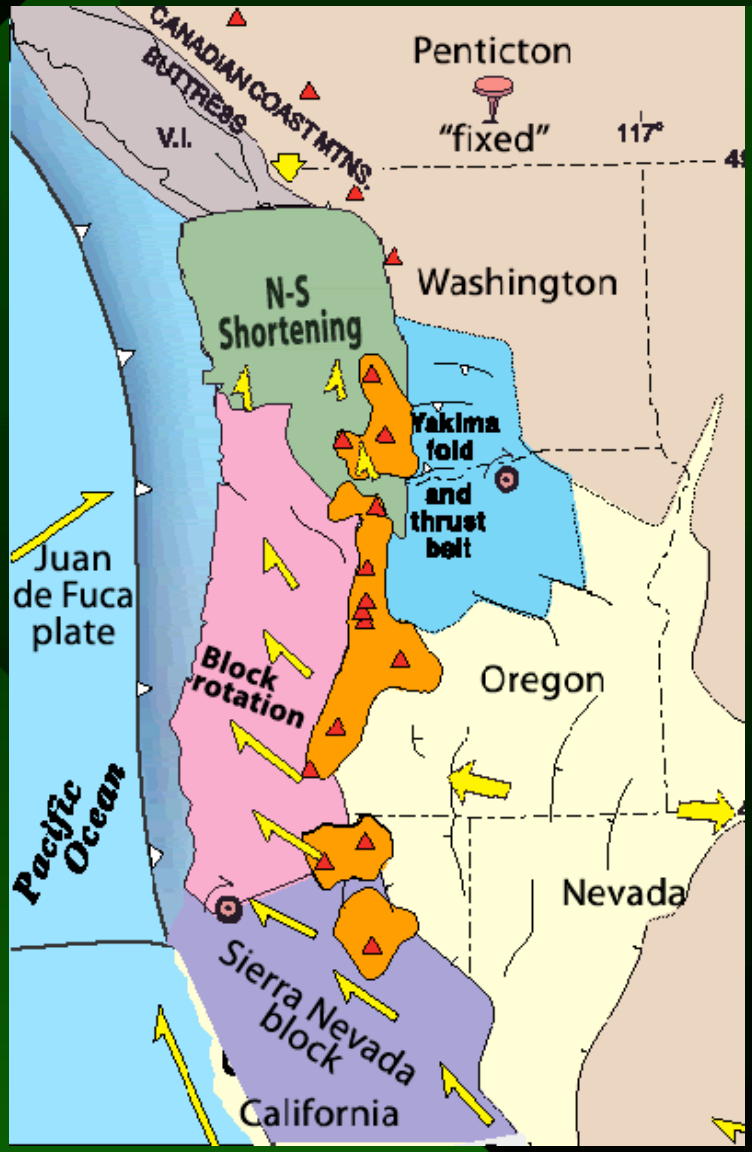
PNW Crustal blocks

- SE Oregon extending.
- Sierra Nevada block moving north into Oregon!
- Coast Ranges rotating and sliding north.
- Seattle getting squeezed.
- PBO is rapidly advancing our understanding of these motions and the associated earthquake hazards.
- Computer animation and manipulative model can help novices visualize block motions.



PNW Crustal Blocks

M6.7 on Seattle Fault



Computer animation by Jenda Johnson

M6.7 on Seattle Fault

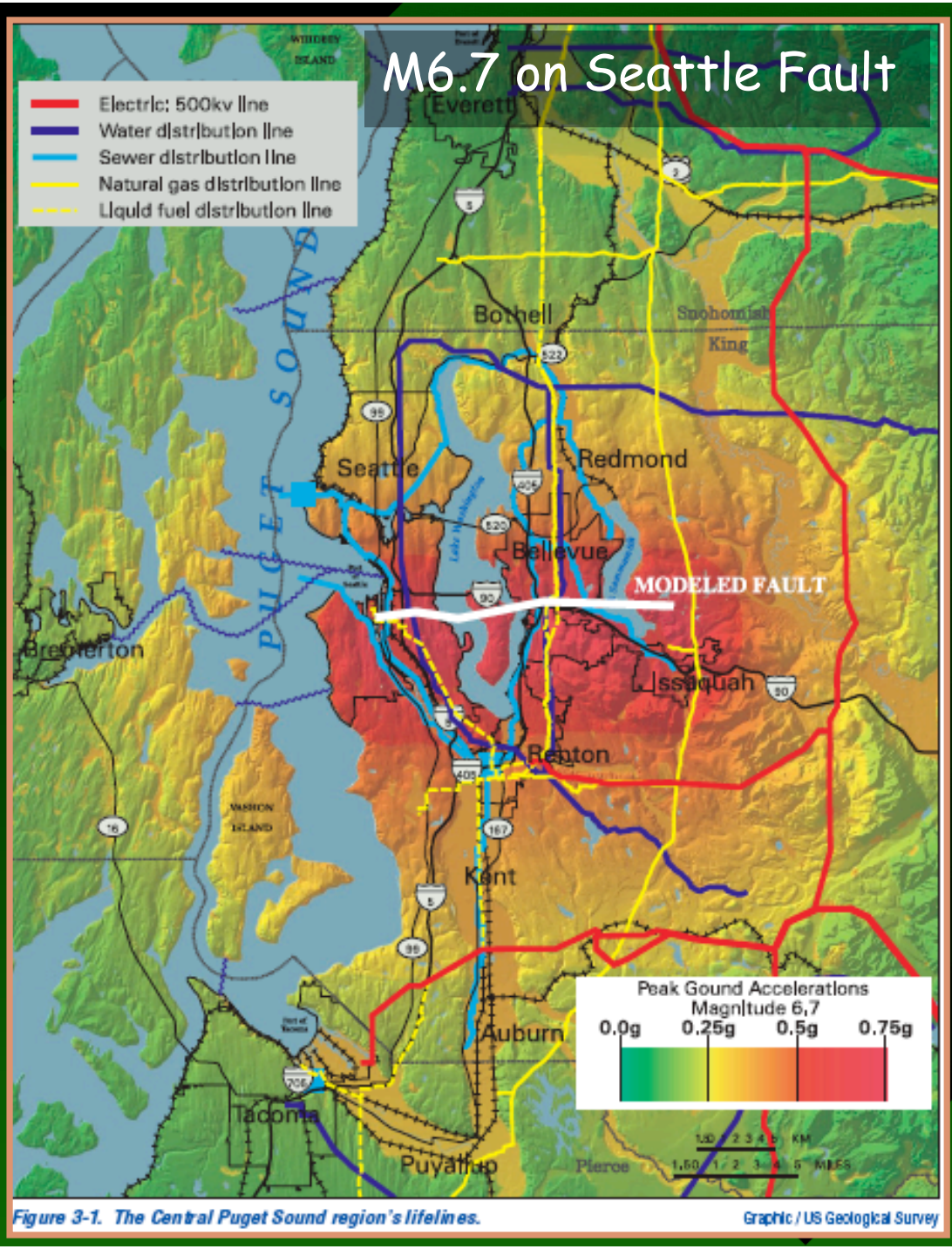
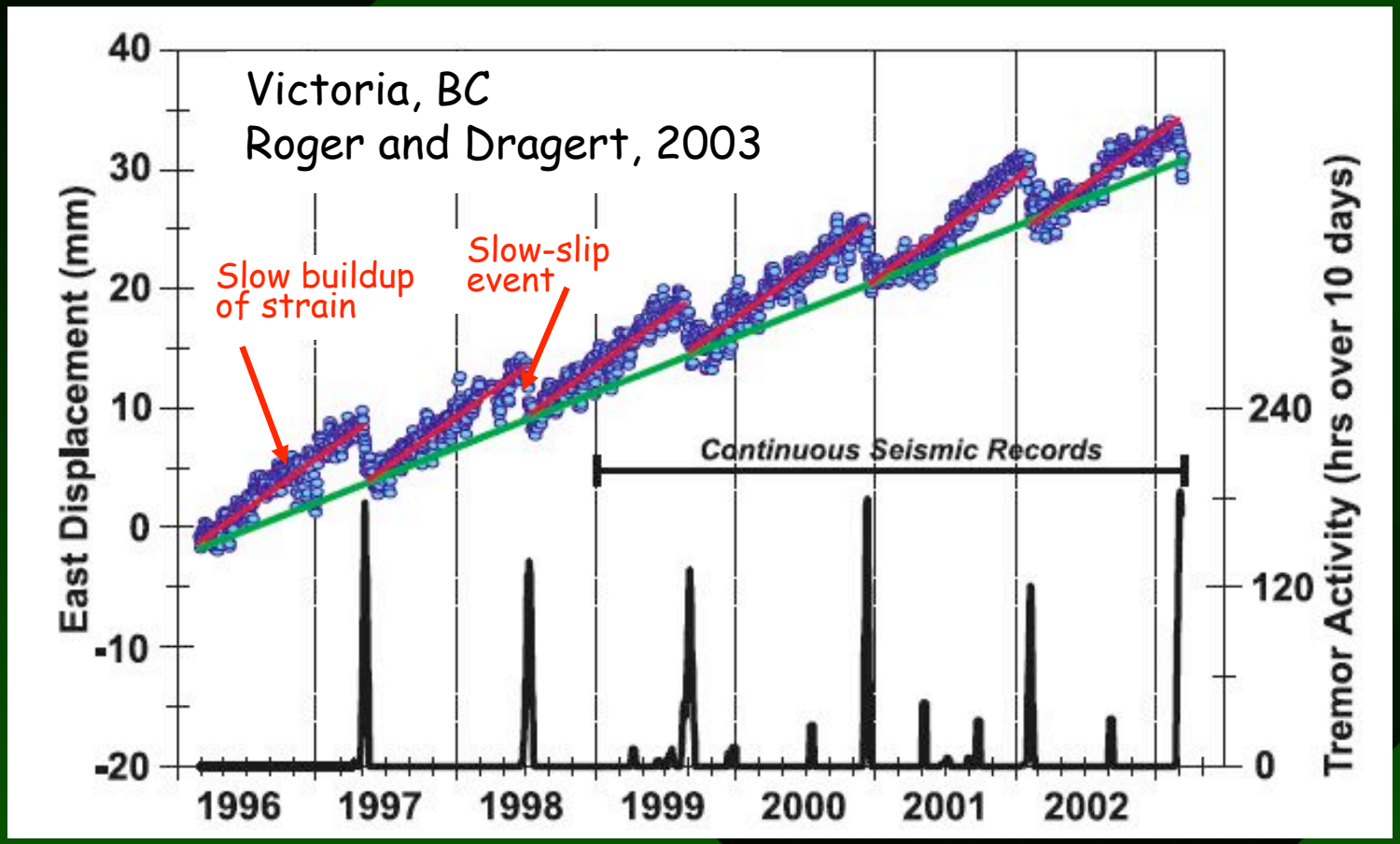


Figure 3-1. The Central Puget Sound region's lifelines.

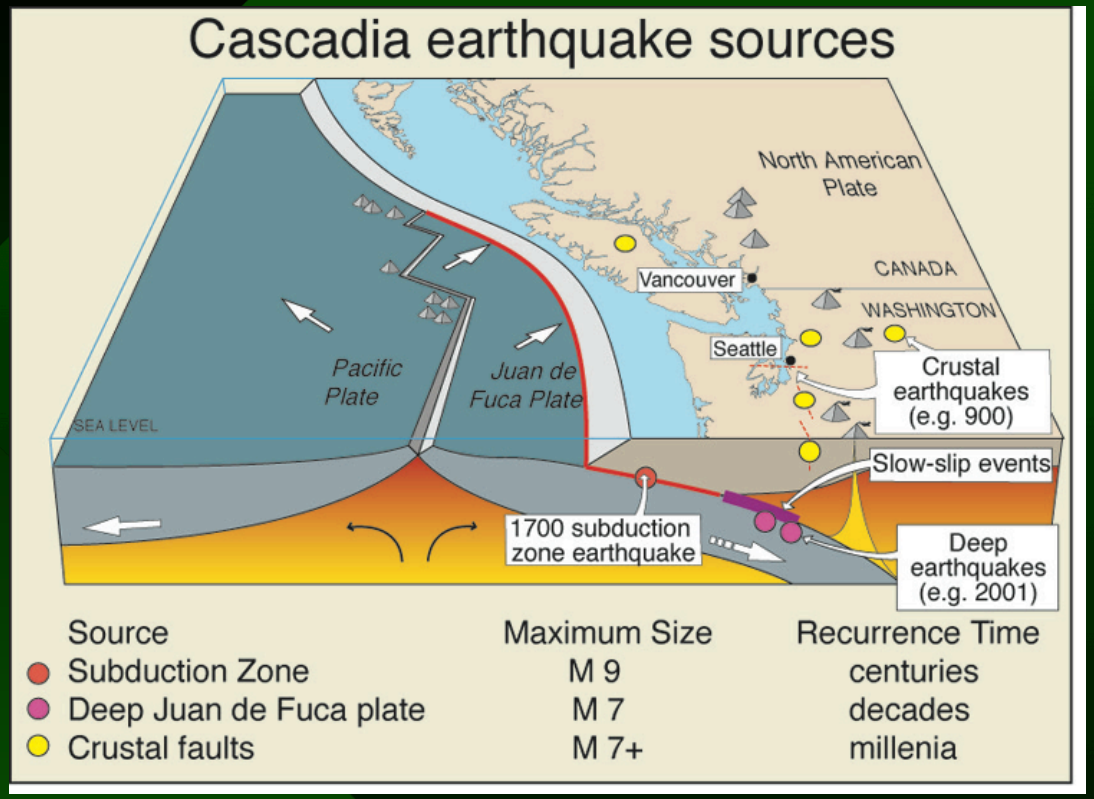
Graphic / US Geological Survey

Episodic Tremor and Slip
Slow but not quite silent "earthquakes"



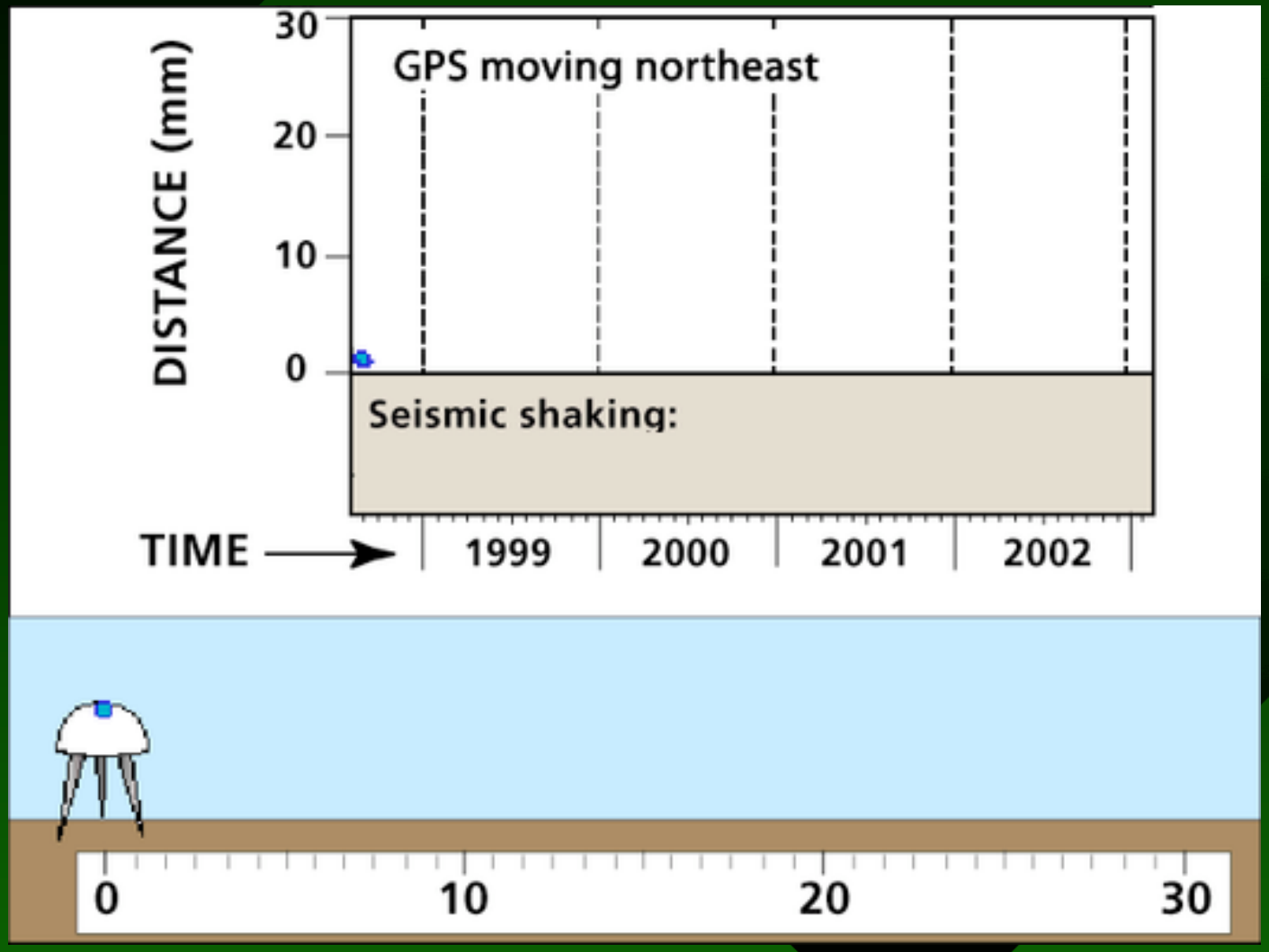
"Tremor activity" correlates with slow-slip events.

What is episodic tremor and slip?



Probably slow slip between North American and Juan de Fuca plates at depths below locked zone.
May increase stress on locked portion of subduction zone thereby increasing the probability of a great earthquake.

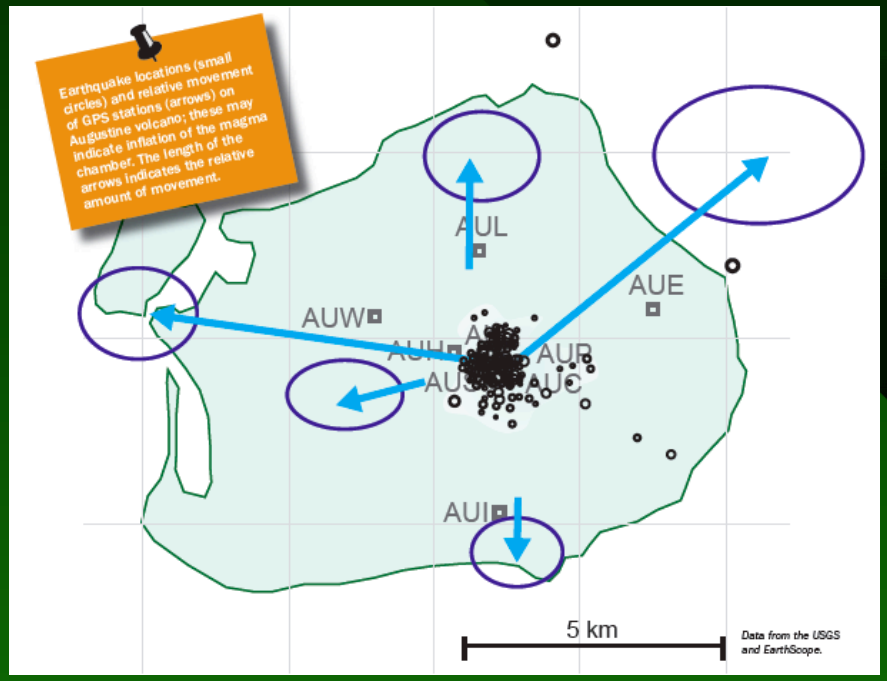
Can We Translate ETS for Novice Learners of Earth Science?



A physical model may help.

GPS Applied to Volcano Monitoring

- Denise Thompson
UNAVCO Master Teacher.
GPS observations of ground deformation at Yellowstone.



- GPS observations of deformation preceding and during 2005 eruption of Augustine Volcano in Alaska.

Peter Cervelli at AVO,
Jenda Johnson,
Bob Butler

USArray

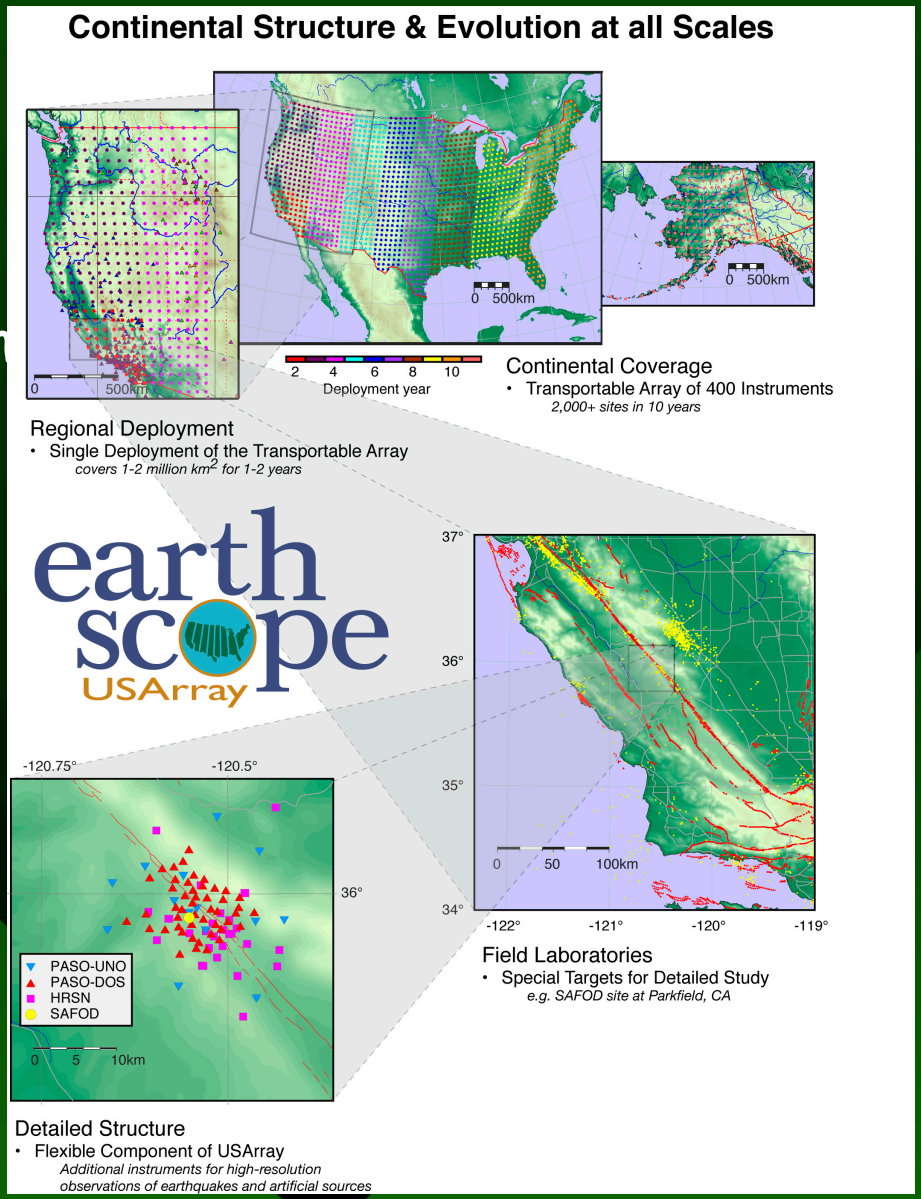
USArray consists of:

Seismometer arrays deployed in 49 states in a rolling grid.

Seismometer arrays focused on special targets.

Research objectives and data analyses are difficult to translate for novice learners.

BUT we do need to explain the rationale for USArray and how research results may impact seismic risk assessment.



TEACHERS ON THE LEADING EDGE

Earthquake Education in Middle School and in parks across Pacific Northwest.

IRIS

- Build instructors' science content knowledge of earthquake seismology and confidence in teaching about earthquakes.
- Provide pedagogical content knowledge and teaching materials to improve teaching about earthquakes.
- Combined with knowledge of Pacific Northwest geology, instructors can help citizens appreciate the wonder of our geology and understand the associated geologic hazards.