Overview of EarthScope: USArray and the Plate Boundary Observatory

Bob Lillie
EarthScope Education/Outreach Manager
EarthScope National Office
Oregon State University

EarthScope Cascadia Interpretive Workshop
Mt. Rainier National Park Education Center
Tahoma Woods, Washington
April 7-10, 2008

www.earthscope.org

Parks and Plates

- **Funded by the National Science Foundation**
- **A collaborative effort by the Incorporated Institutions for Seismology (IRIS), UNAVCO Inc., and Stanford University, with contributions from the U. S. Geological Survey, NASA, and other organizations**

USGS

NSF

NASA

UNAVCO

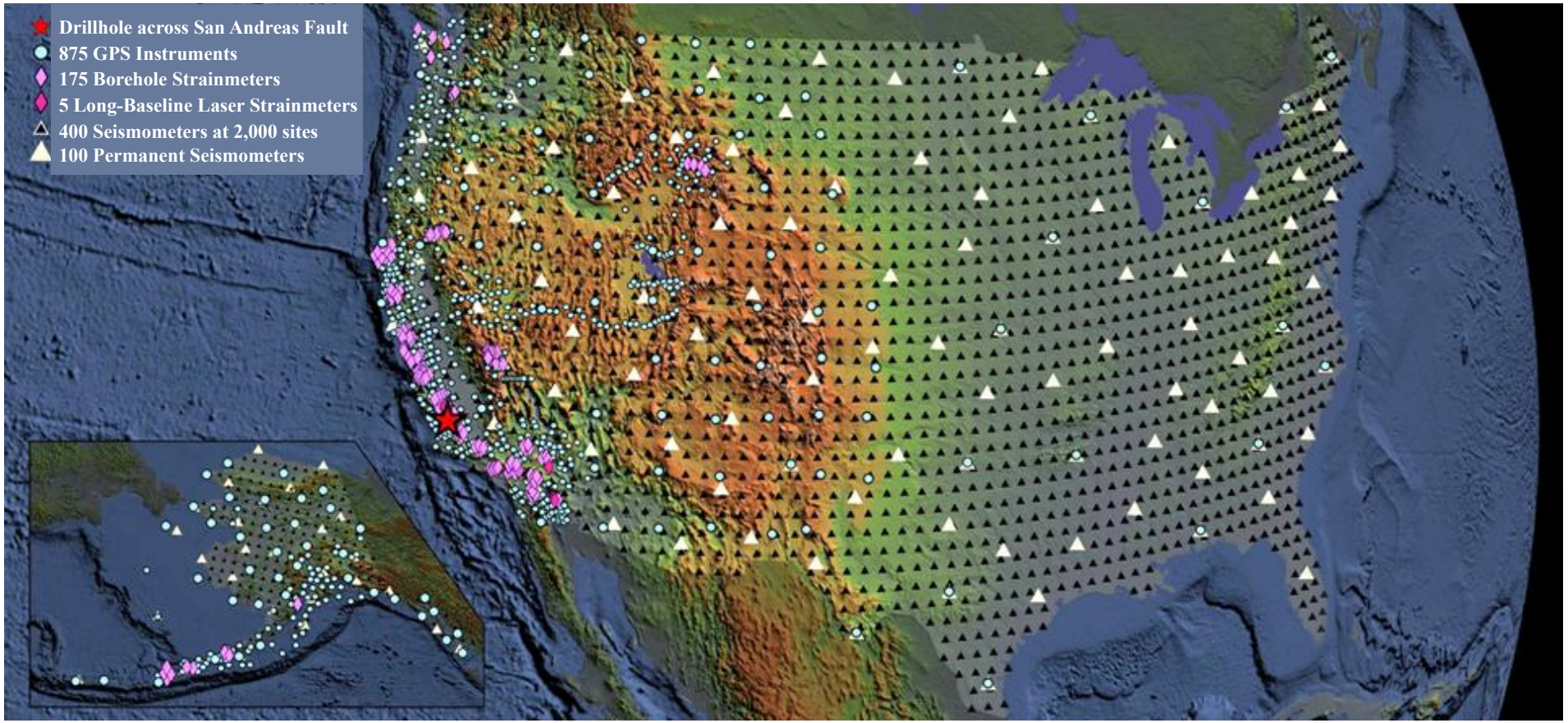
IRIS

Oregon State University | earthscope National Office

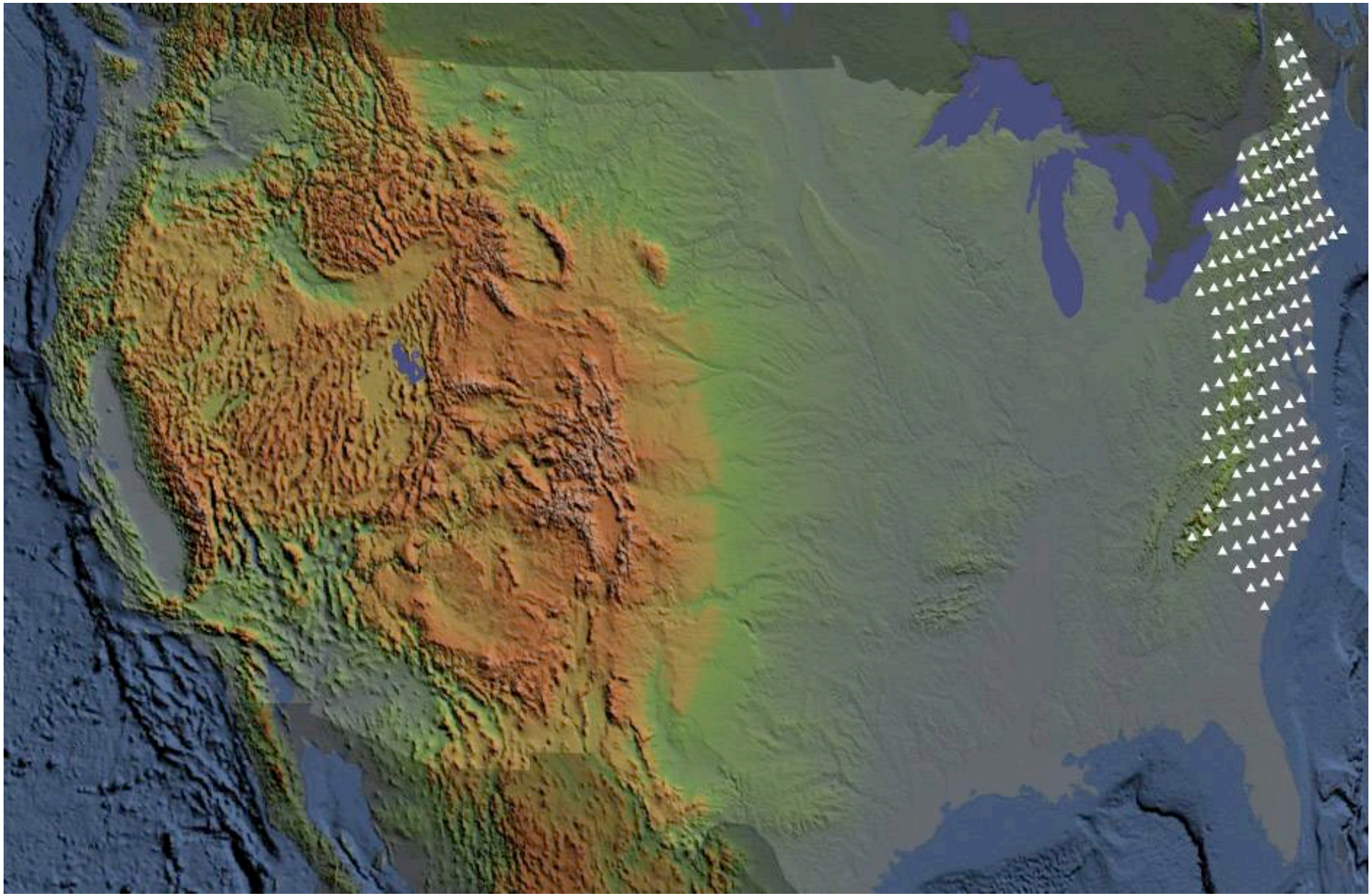
What is EarthScope?

A nationwide program to …..

- Explore the structure and evolution of the North American continent
- Understand processes that cause earthquakes and volcanic eruptions



USArray
(Includes 400 Transportable Seismometers)



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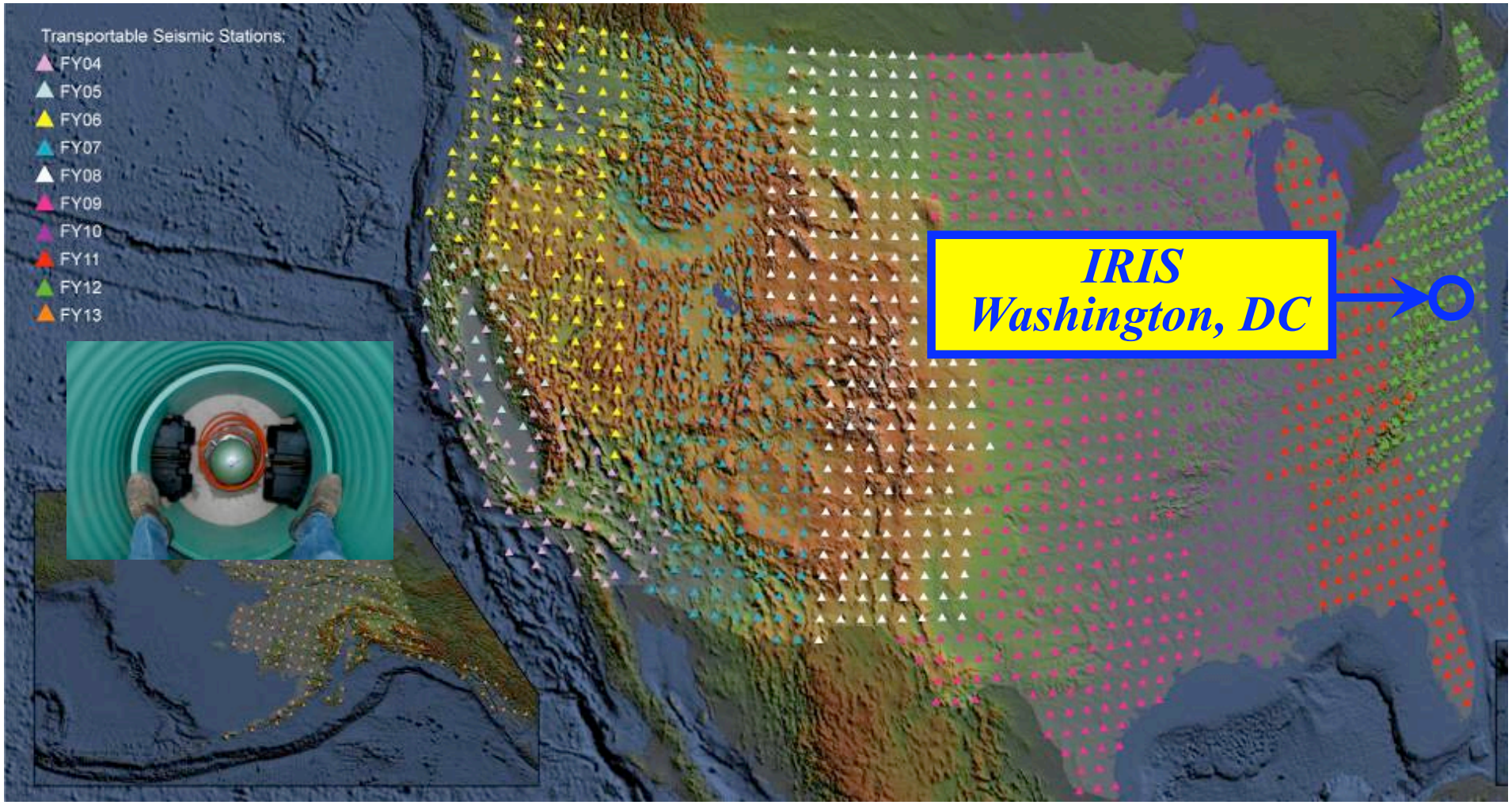
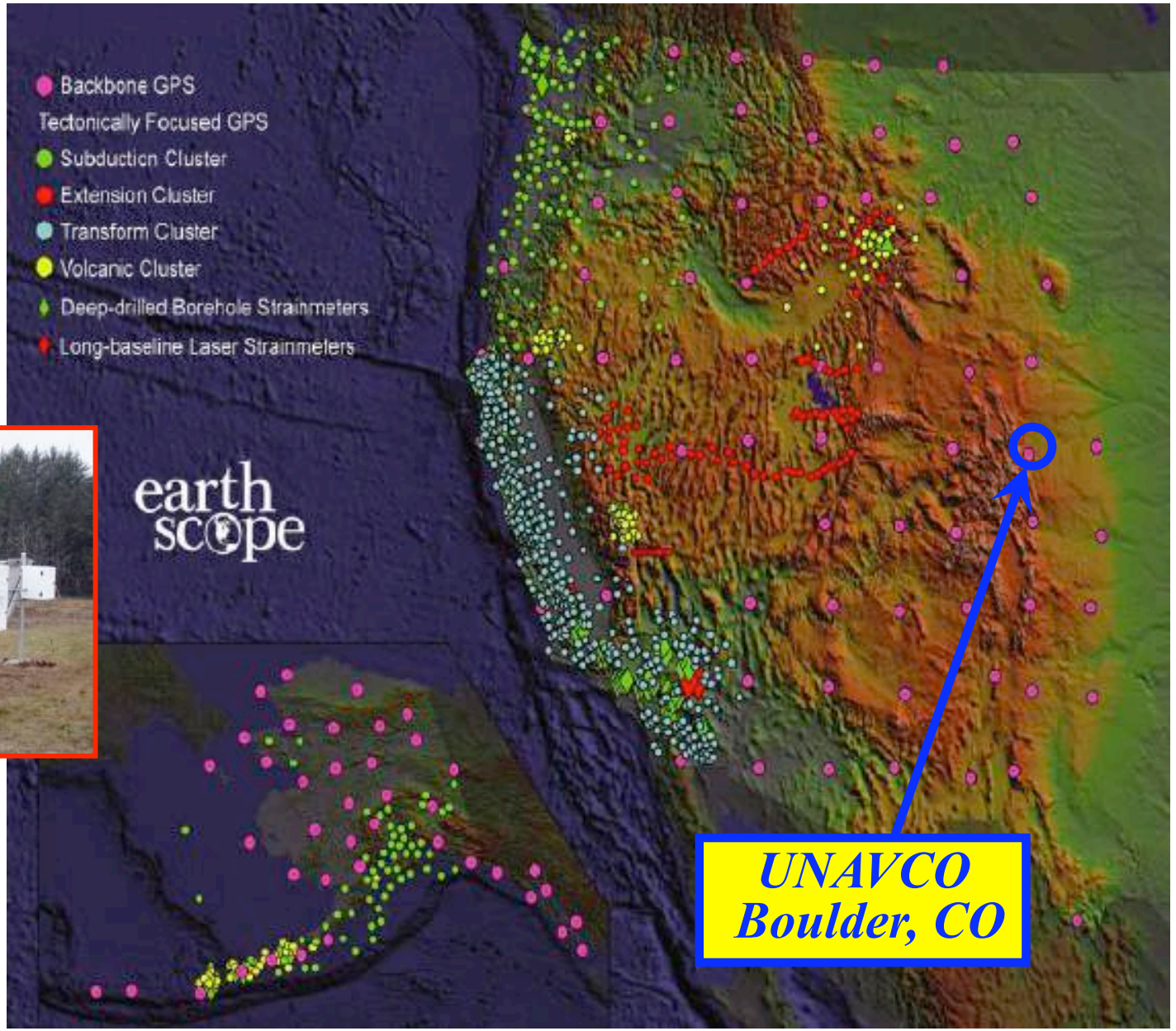


Station occupies a site for 1½ - 2 years
10 years to leap-frog array across the country

Plate Boundary Observatory (PBO)

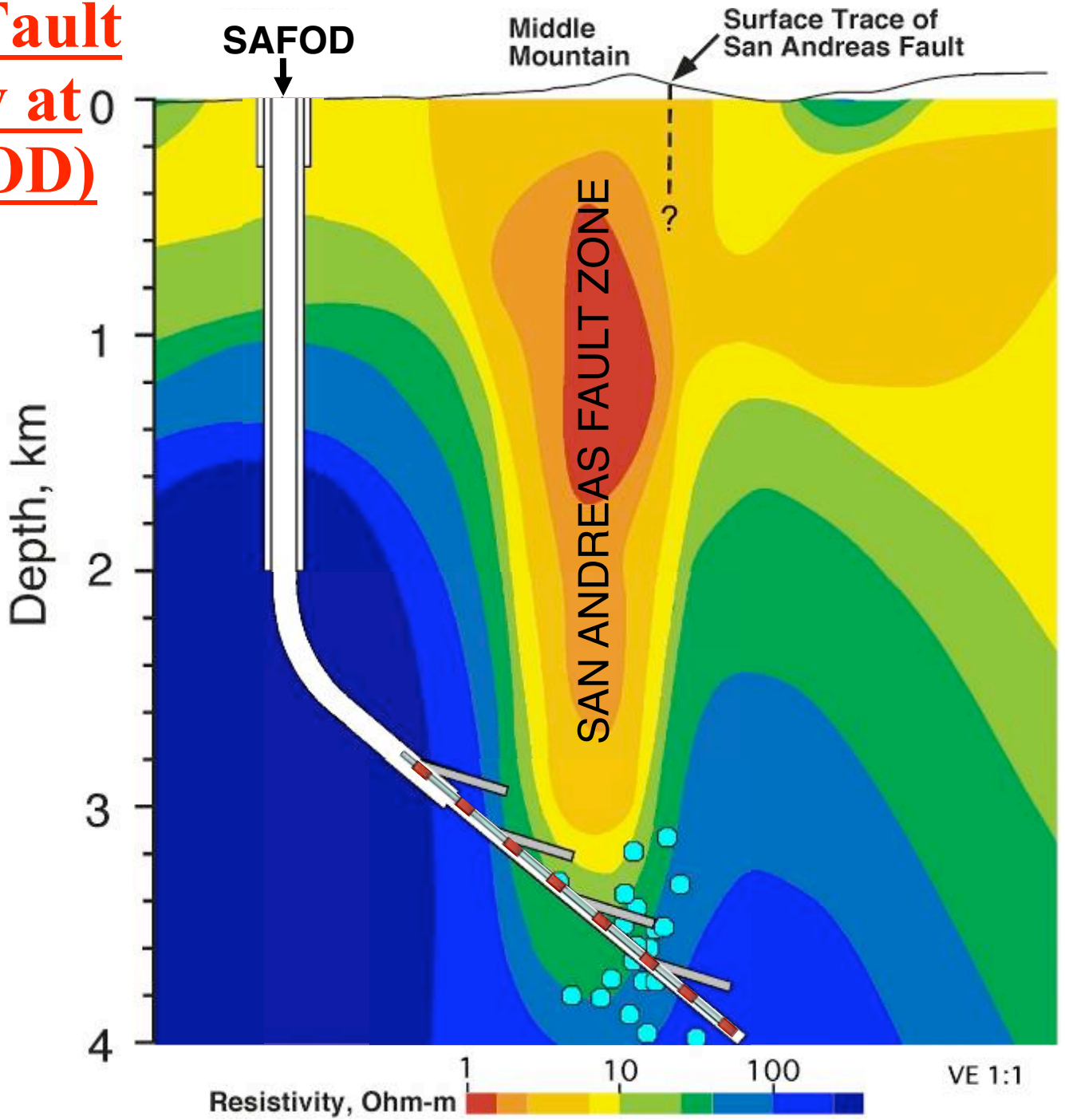
- **GPS Instruments**
- **Strainmeters**



San Andreas Fault Observatory at Depth (SAFOD)

Stanford University

earth scope SAFOD

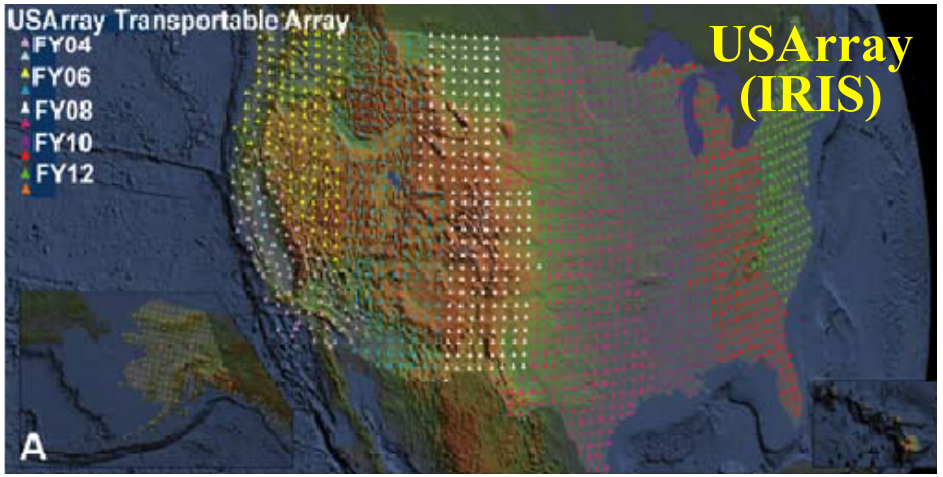


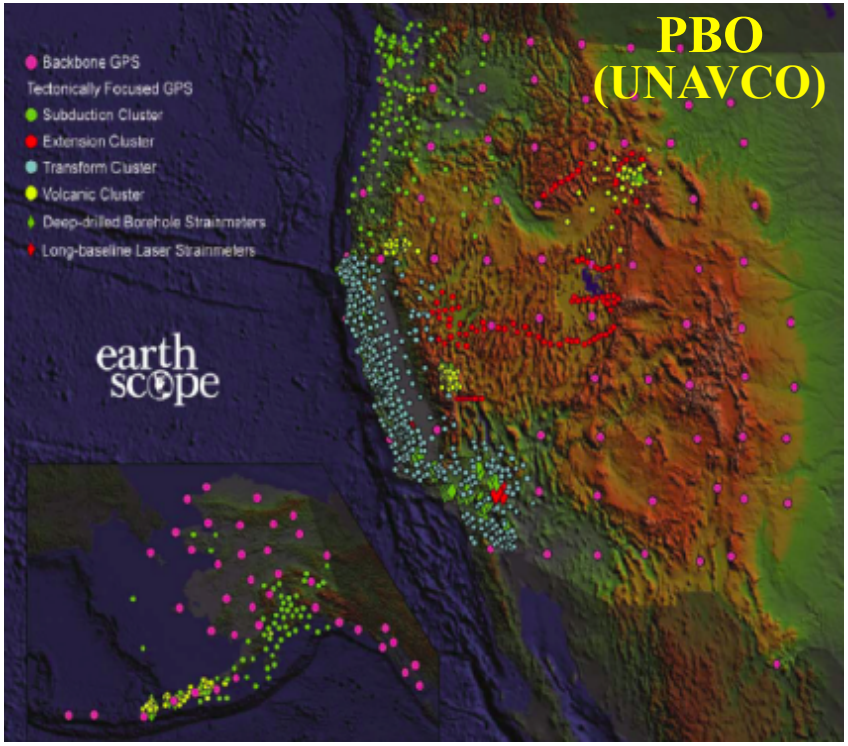
EarthScope National Office (ESNO)

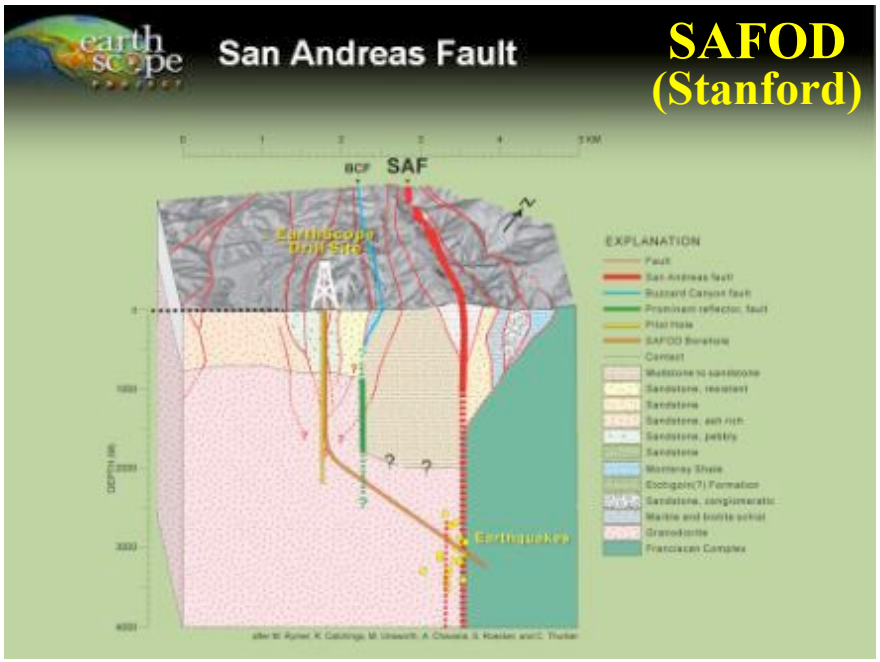
To assist the EarthScope community in products and training for science and outreach. For the next few years, EarthScope is focused on the west.

Oregon State University – 2007-2010

- Anne Trehu – ESNO Director
- Bob Lillie – EarthScope E/O Manager
- Chris LeBoeuf – Office Manager
- Jochen Braunmiller – Research Assoc.
- Charlotte Goddard – Research Assoc.

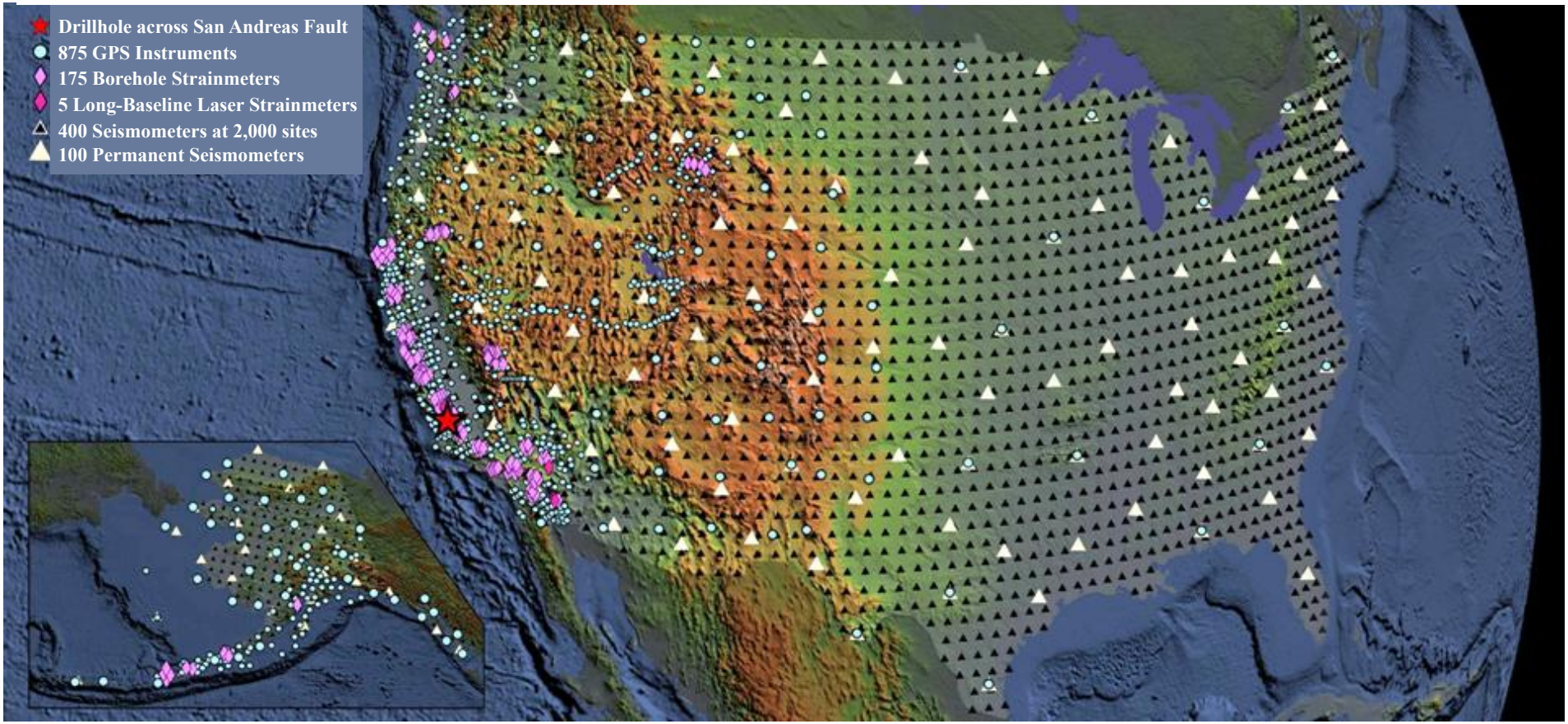






EarthScope:

Like a "Hubble Telescope" aimed into the Earth

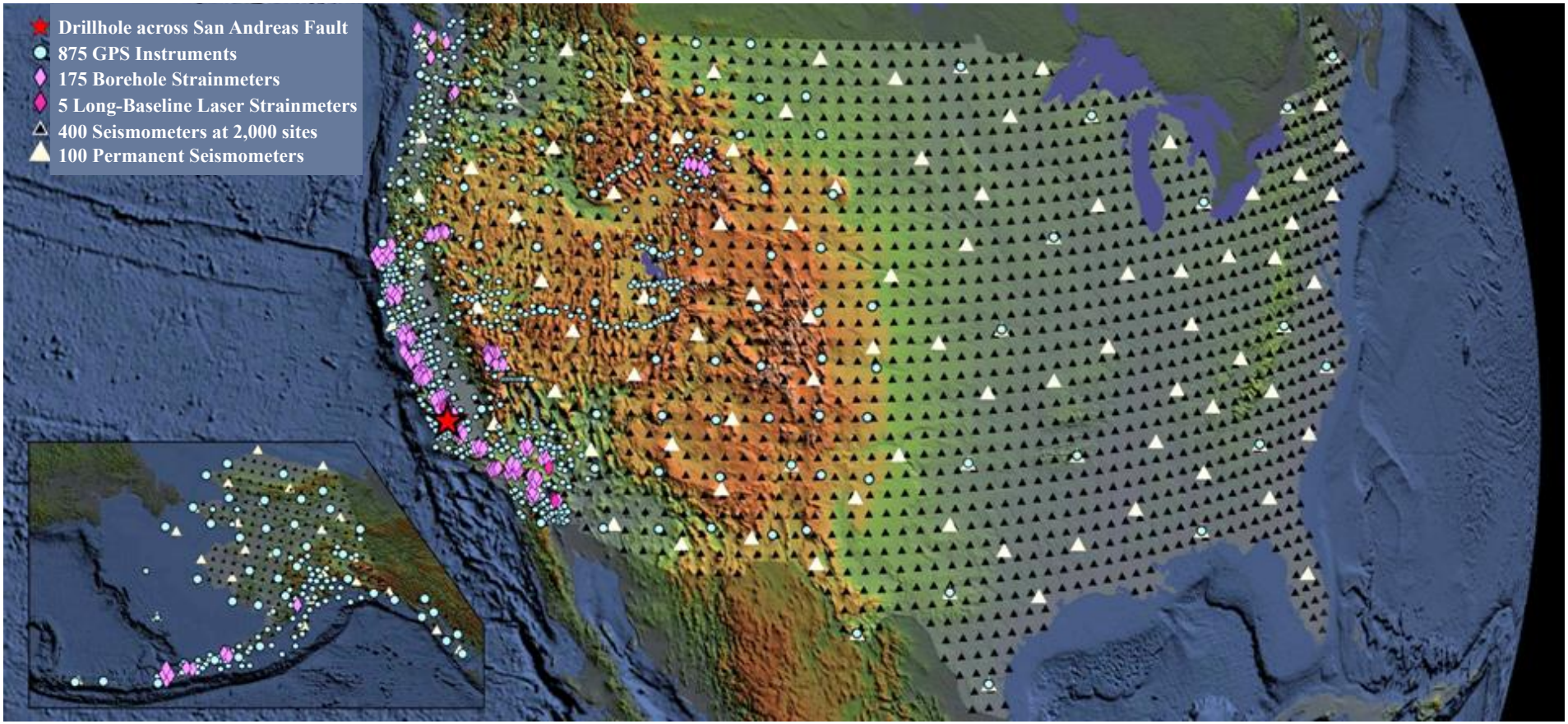


Scoping Our World:

- A microscope images the world smaller than us ……

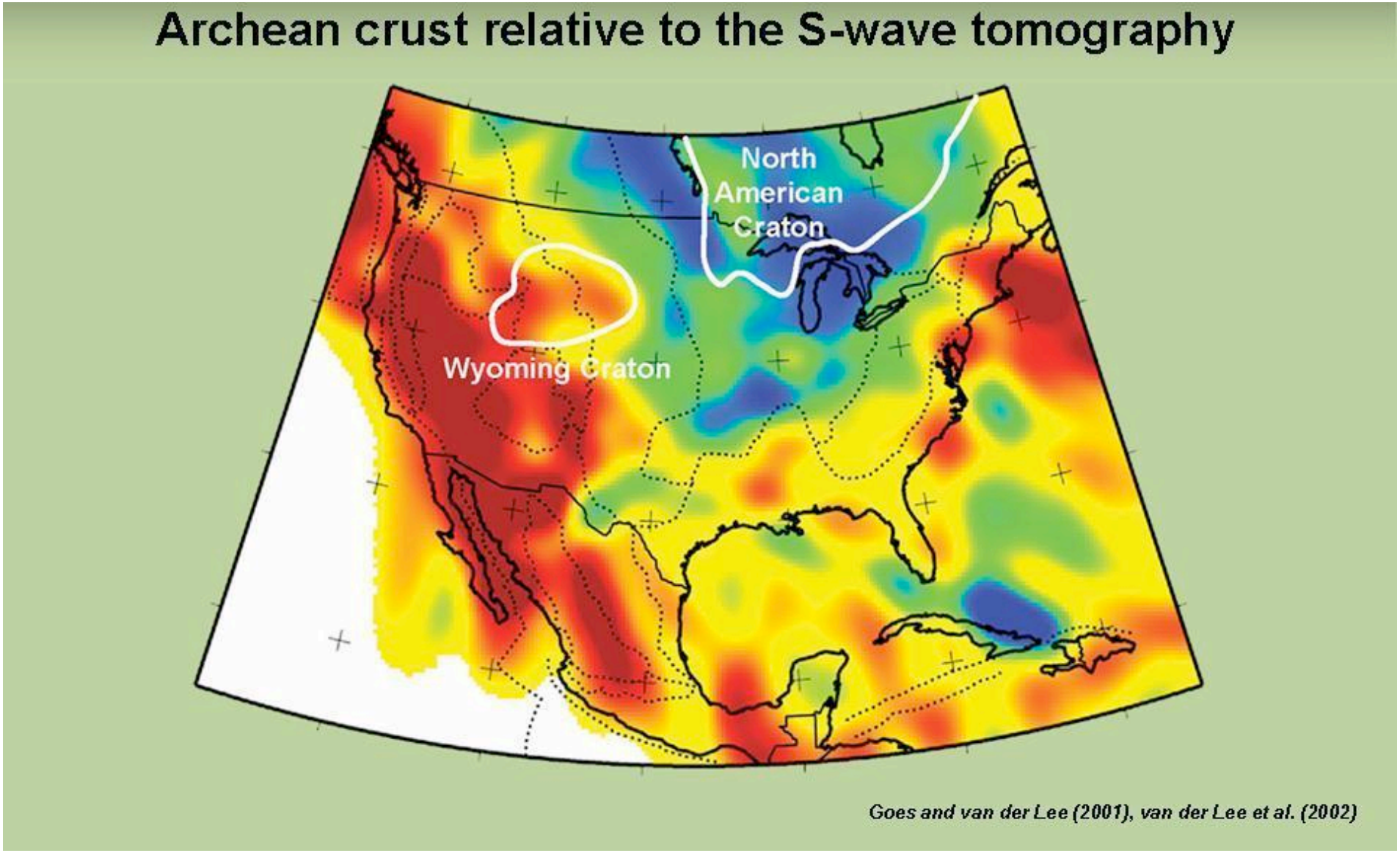
- EarthScope images the world we live on ……

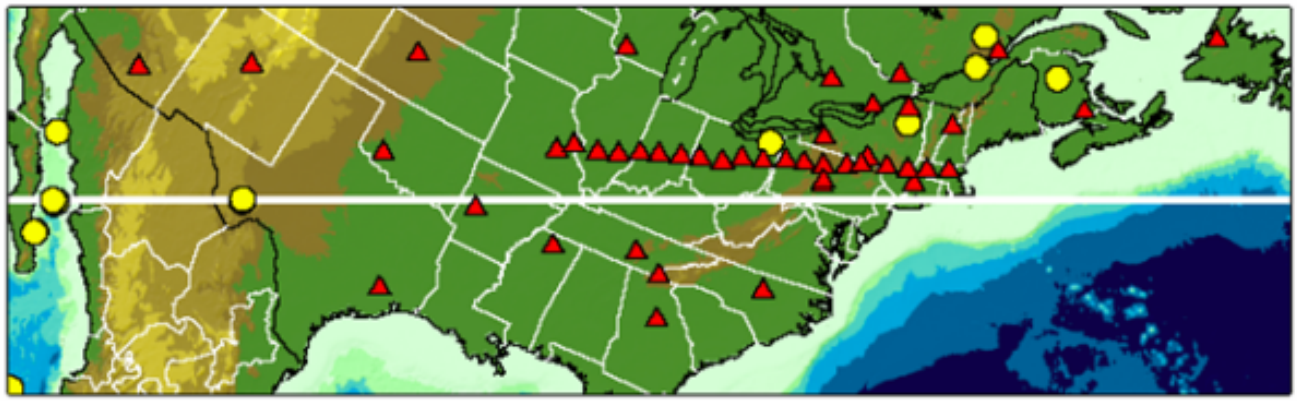
- A telescope images the world bigger than us ……



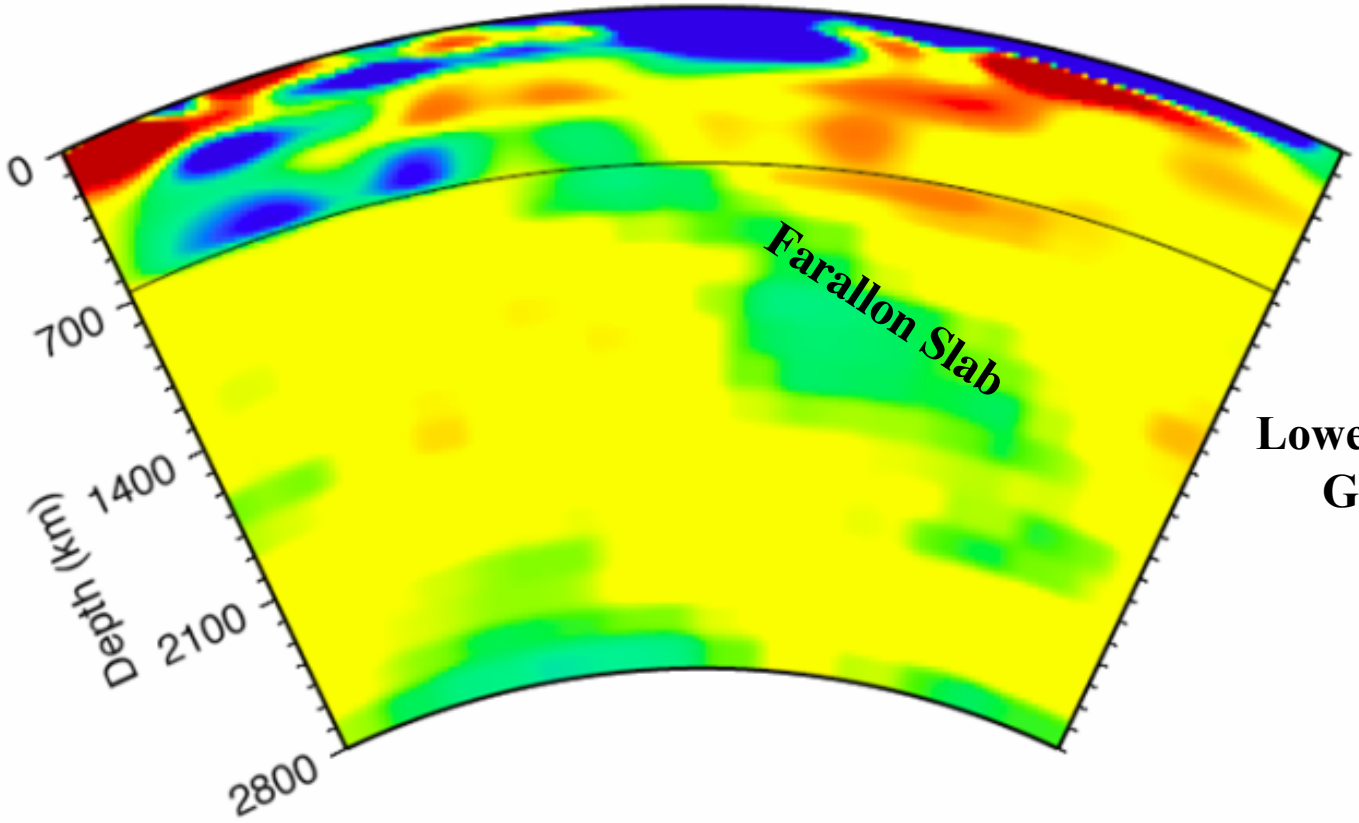
USArray:

Like taking CatScans or Ultrasounds of North America





Seismic Tomography



Upper mantle from Van der Lee and Frederiksen (2005)

Lower mantle from Grand (2002)

Accelerated Uplift and Magmatic Intrusion of the Yellowstone Caldera, 2004 to 2006

(Wu-Lung Chang, et. al., 2007)

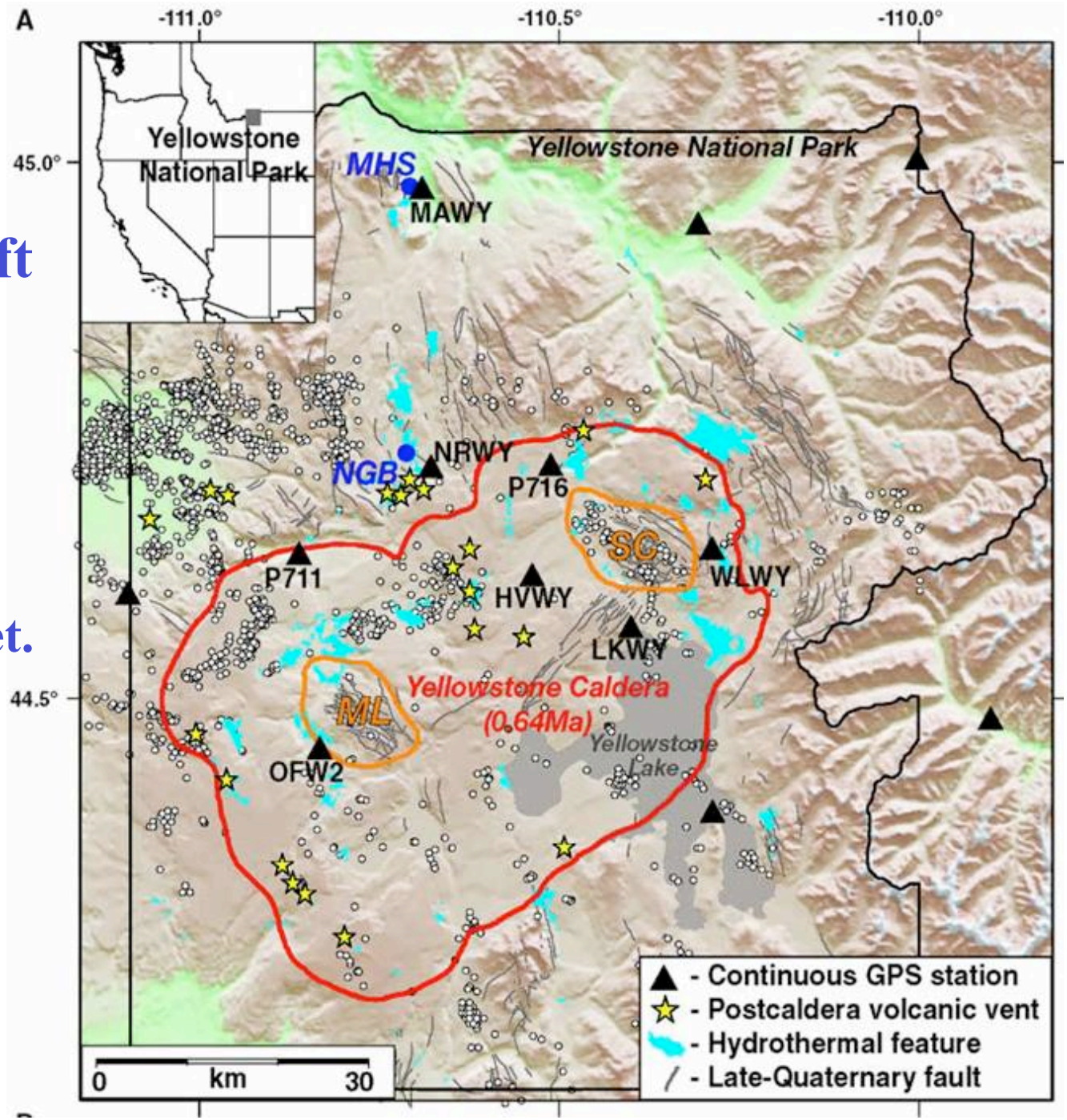
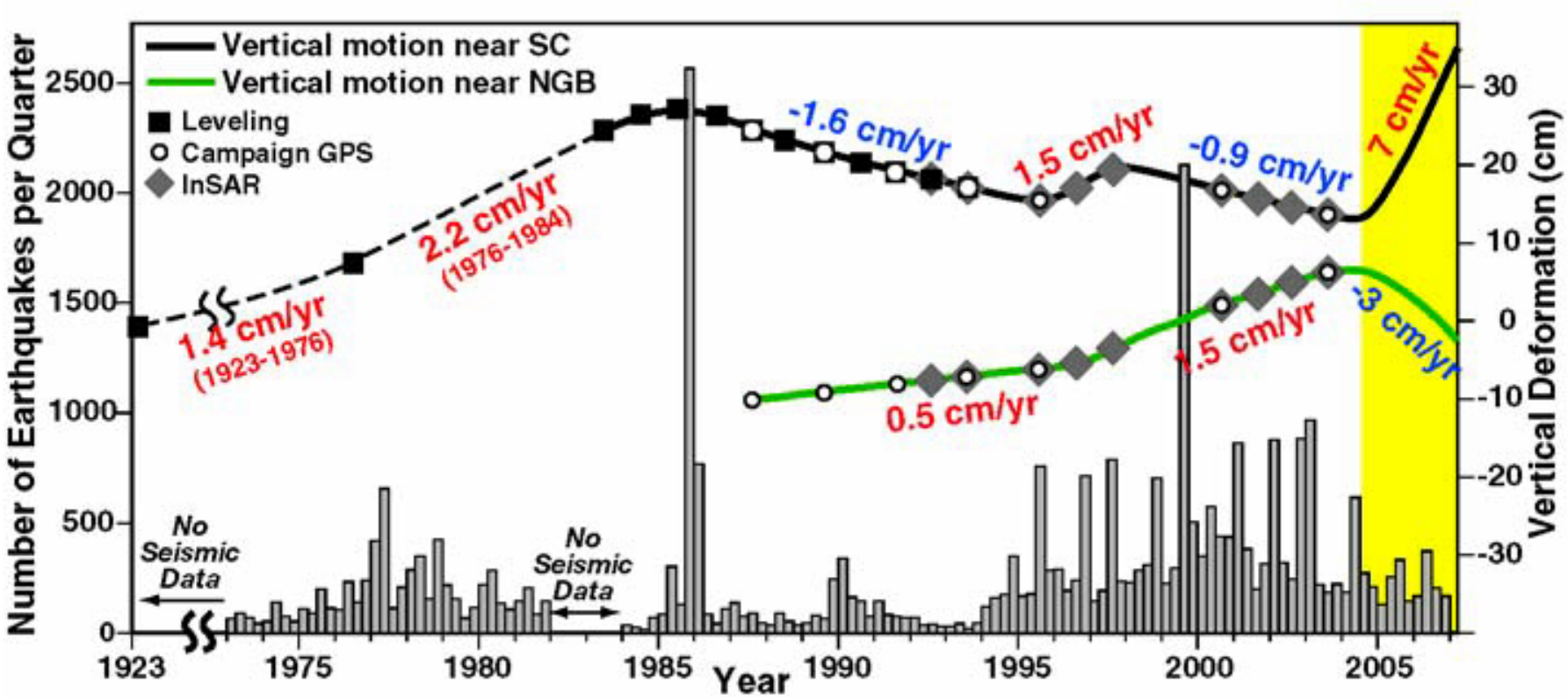


Plate Boundary Observatory (PBO):

Helps us monitor the living, throbing Earth ☺



Accelerated Uplift and Magmatic Intrusion of the Yellowstone Caldera, 2004 to 2006

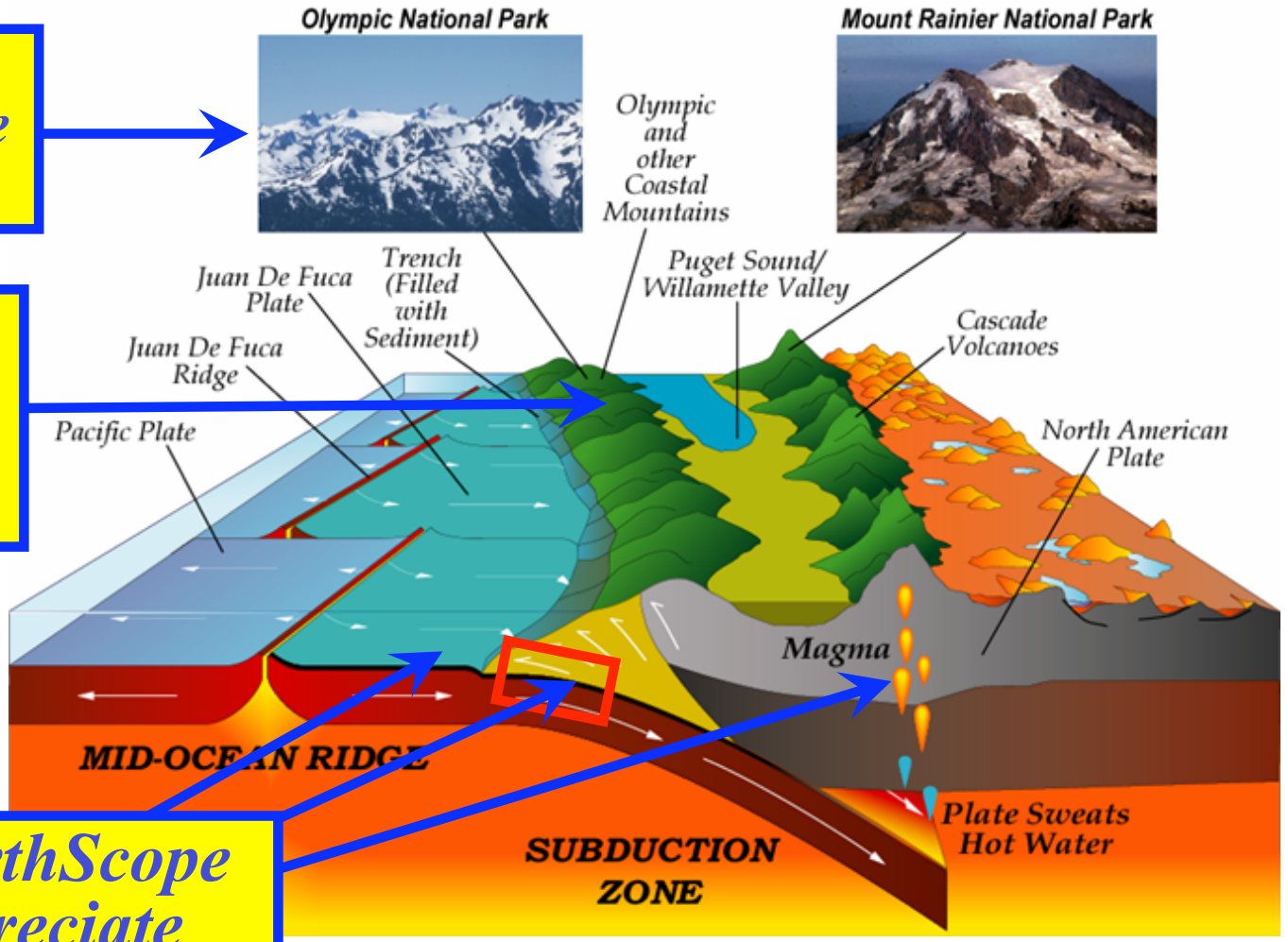
(Wu-Lung Chang, et. al., 2007)

Cascadia Subduction Zone

We can see what's on the surface.

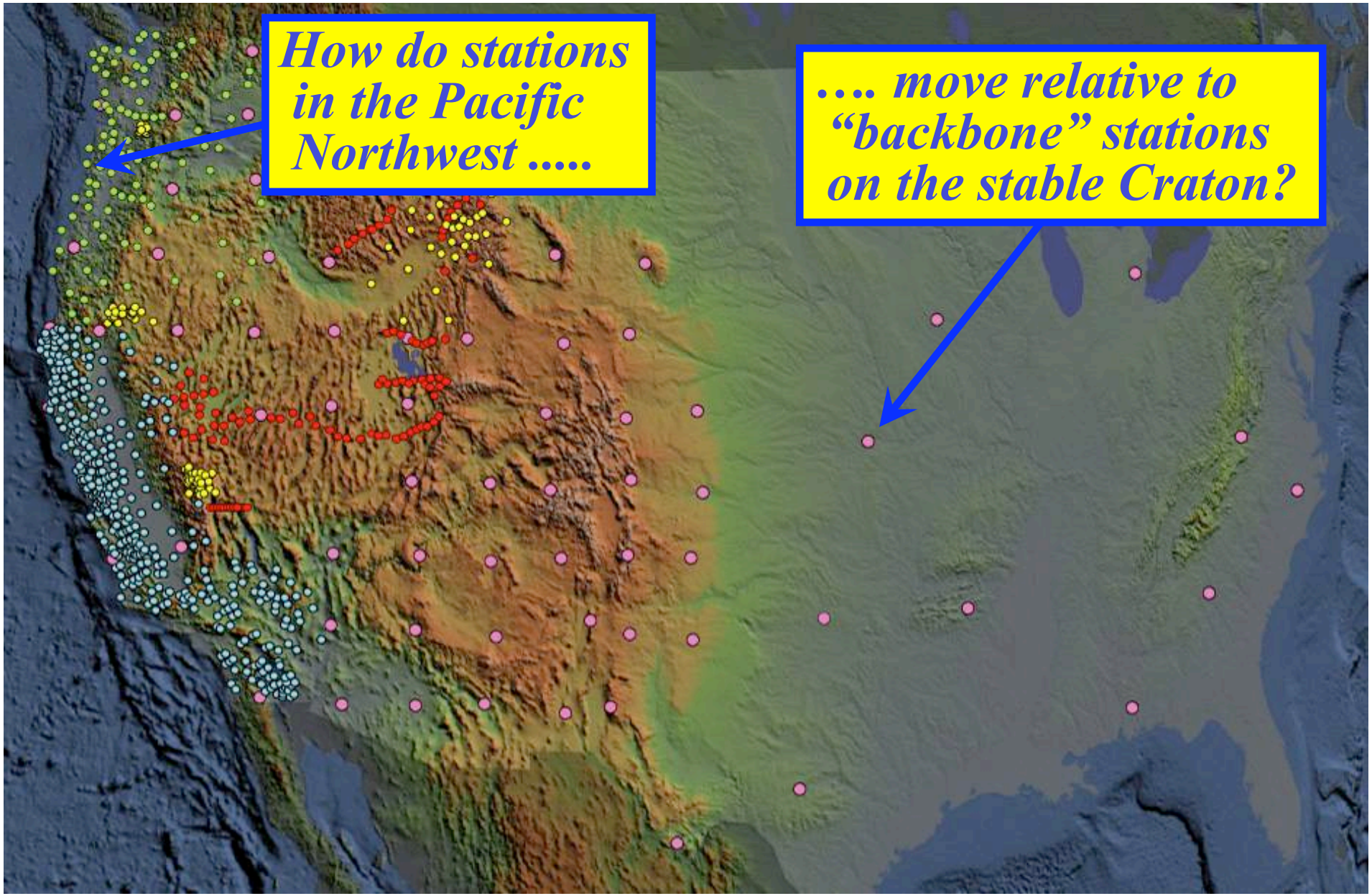
How does the surface change as a response to subduction?

How does EarthScope help us appreciate earthquakes, tsunamis, and volcanic eruptions?



EarthScope GPS Stations

Backbone Network
Subduction Cluster Volcanic Cluster
Transform Cluster Extension Cluster



Introduction to GPS

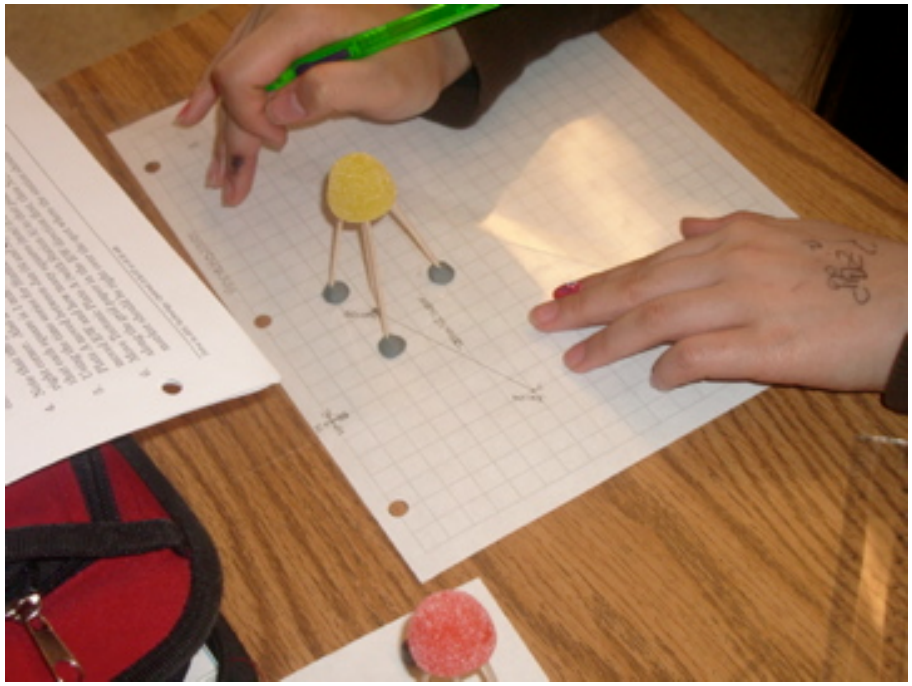
- Building a GPS Monument ☺

(From UNAVCO GPS Workshop)

Newport, Oregon GPS Station

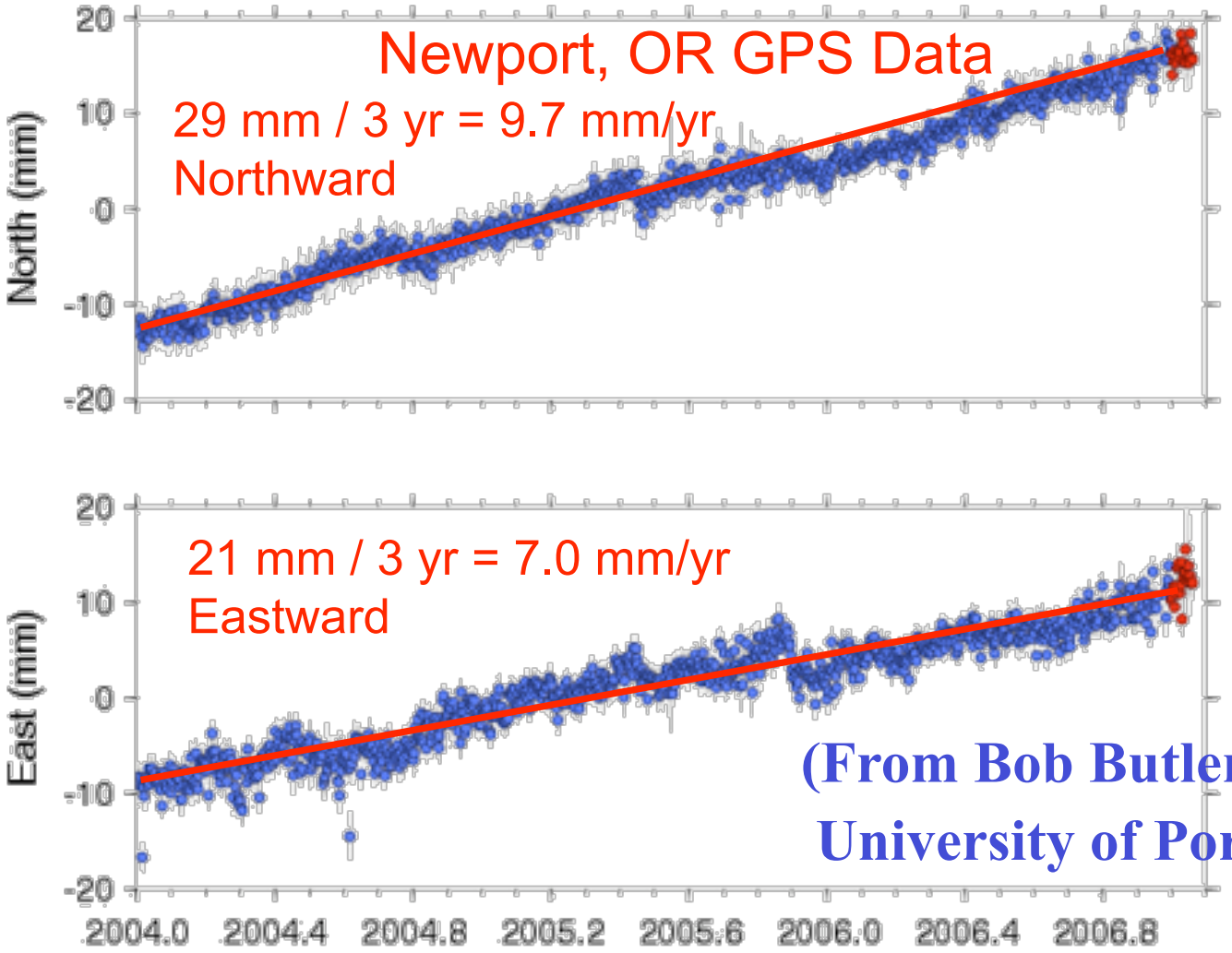
Introduction to GPS

- **Moving GPS Stations** ☺
  - **Using data from actual GPS Stations, move the GPS monuments using grid paper and transparencies**



(From UNAVCO GPS Workshop)

Newport, Oregon GPS Data



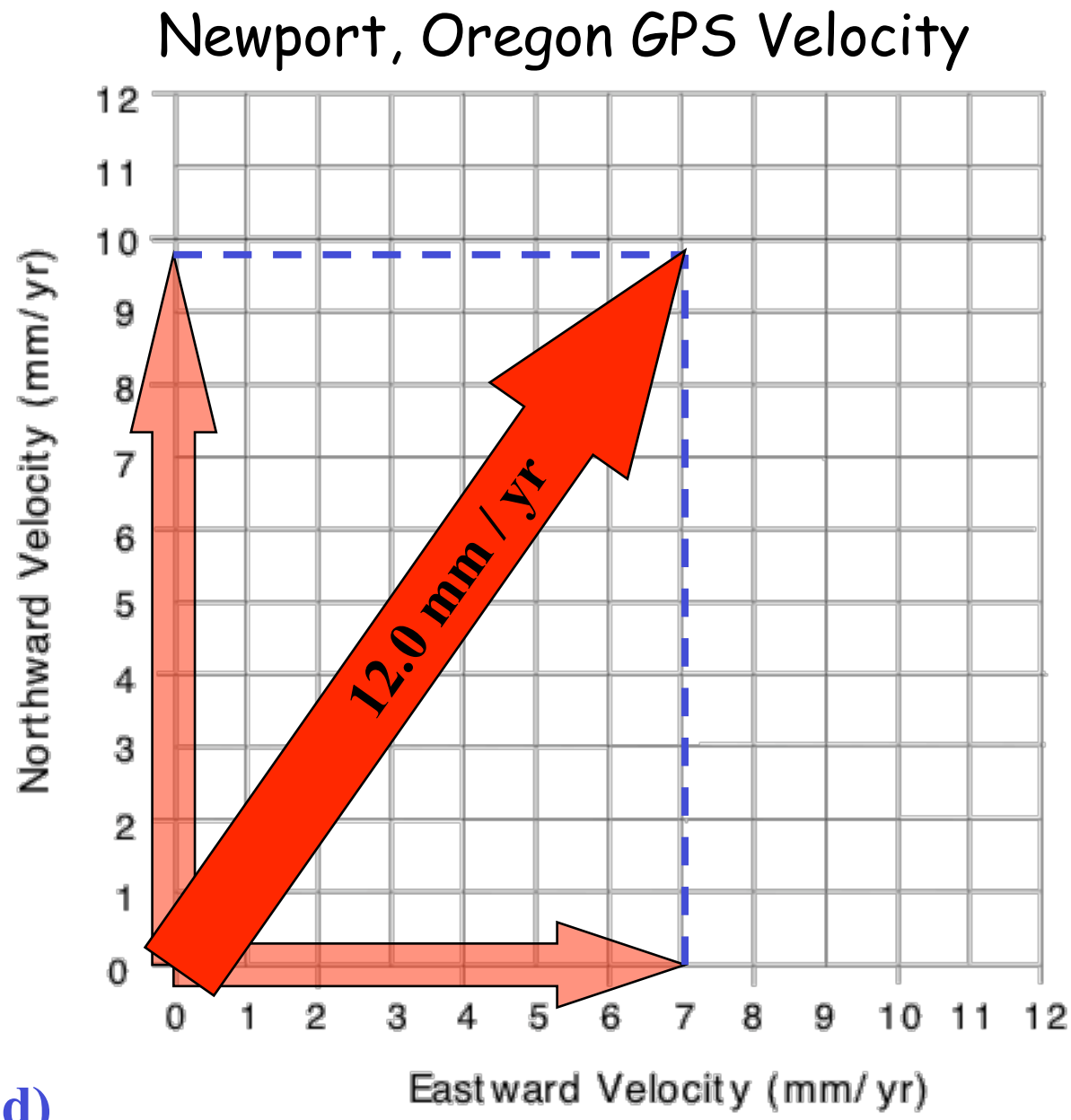
(From Bob Butler, University of Portland)

Can download data to spreadsheet and determine best-fit slopes = Rates of north and east motion

Graphically add the north and east velocities.

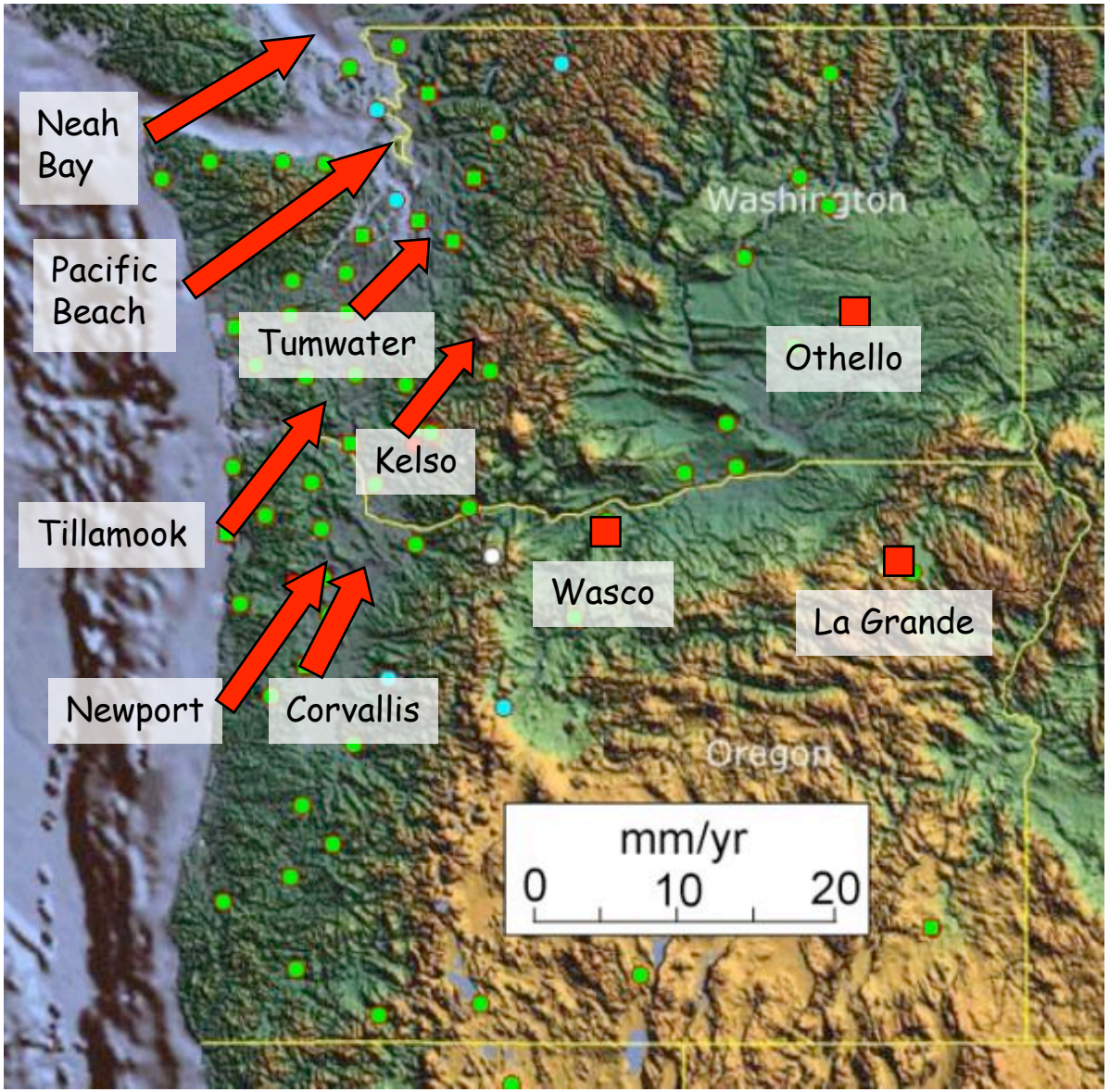
- Don't even THINK of using the word "vector" ☺

(From Bob Butler, University of Portland)



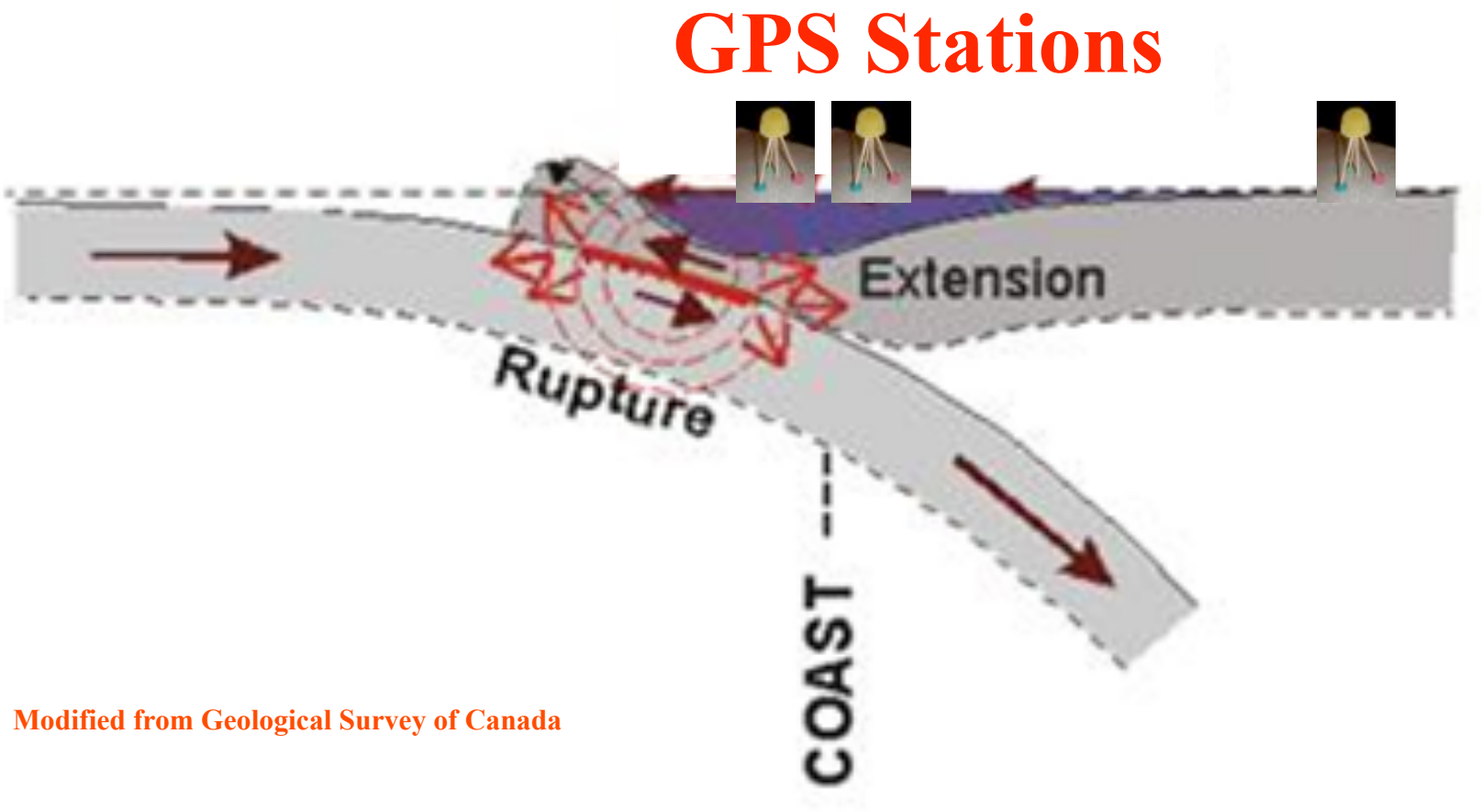
Compression of Pacific Northwest Continental Margin

- **Newport and other stations in western OR/WA moving NNE (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.**



(Modified from Bob Butler, University of Portland)

GPS Stations Monitor Ground Motion

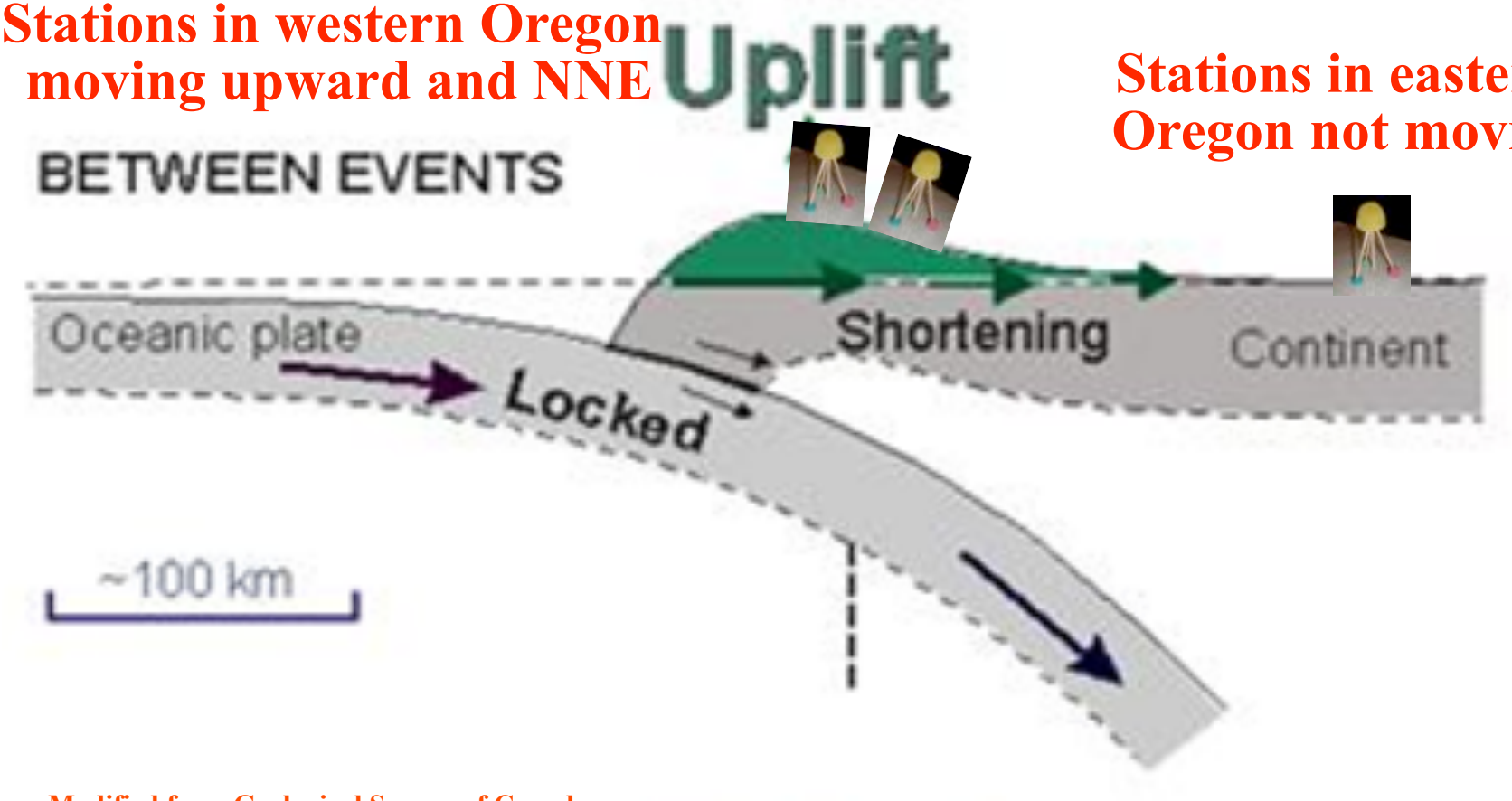


Modified from Geological Survey of Canada

"Locked" Subduction Zone

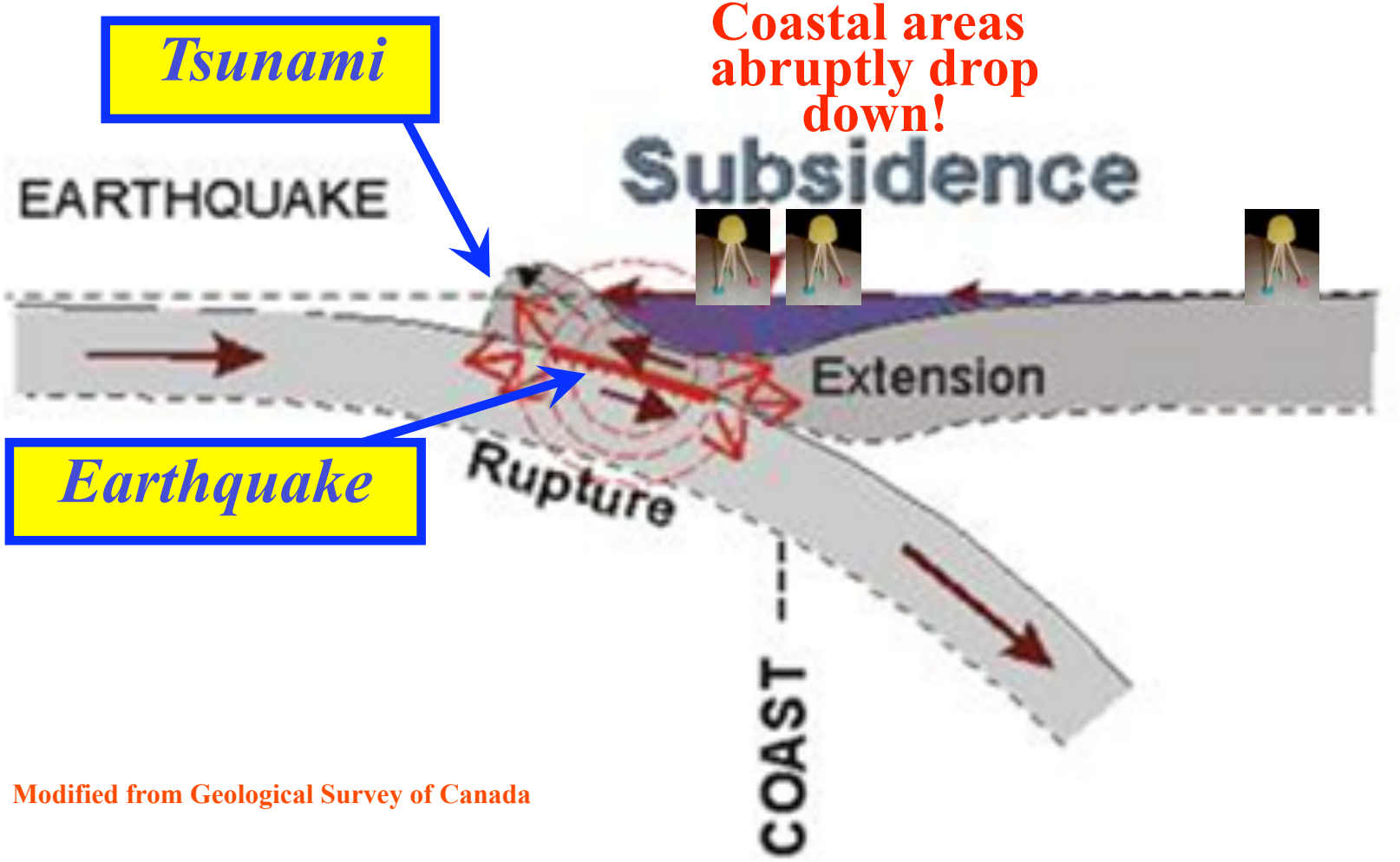
Stations in western Oregon moving upward and NNE

Stations in eastern Oregon not moving



Modified from Geological Survey of Canada

Suddenly Unlocks!!



Modified from Geological Survey of Canada

Teachers, park rangers, students, and the public "get it."

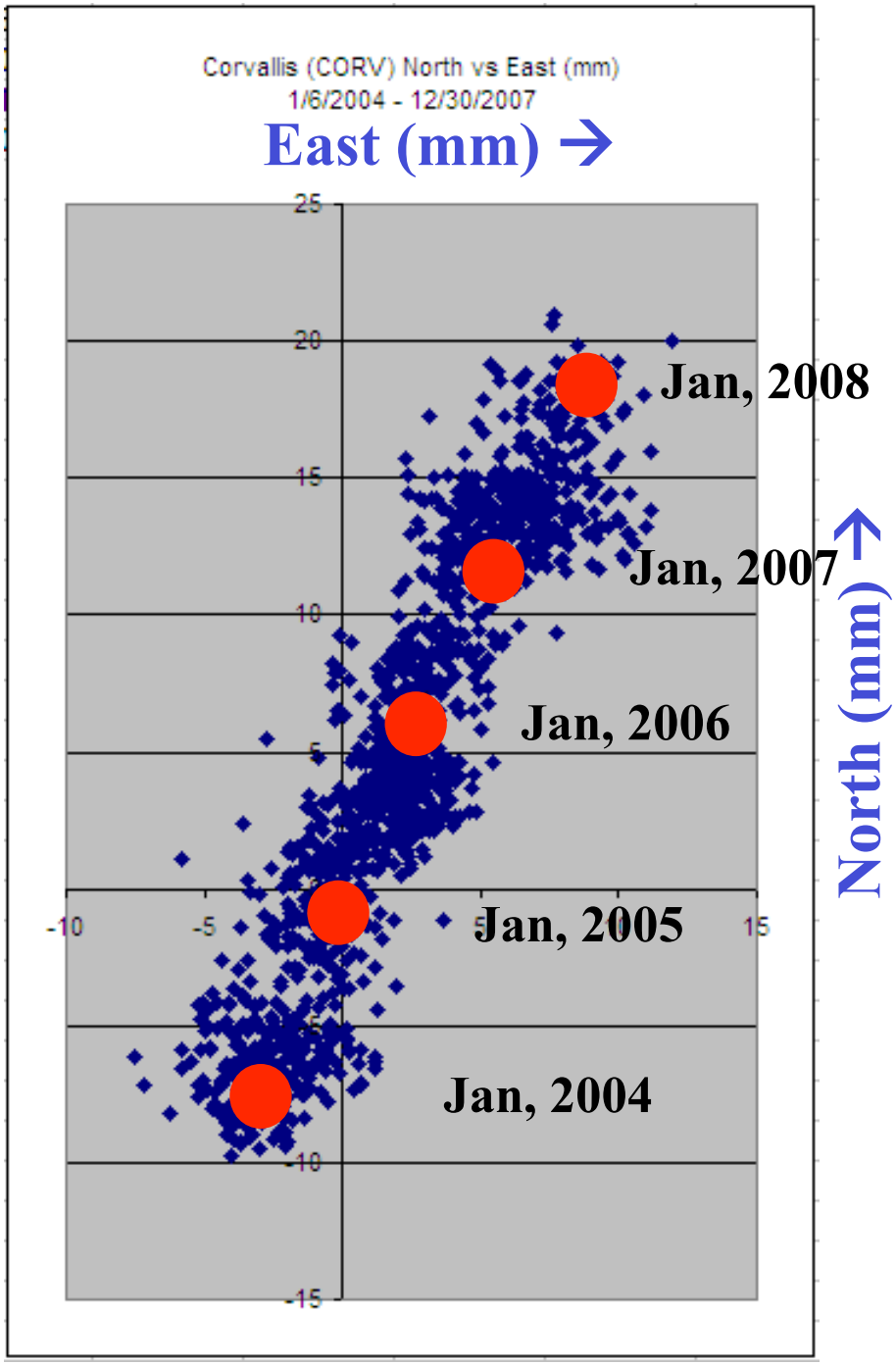
Corvallis, Oregon GPS Station

Northward and Eastward Motion January, 2004 – January, 2008

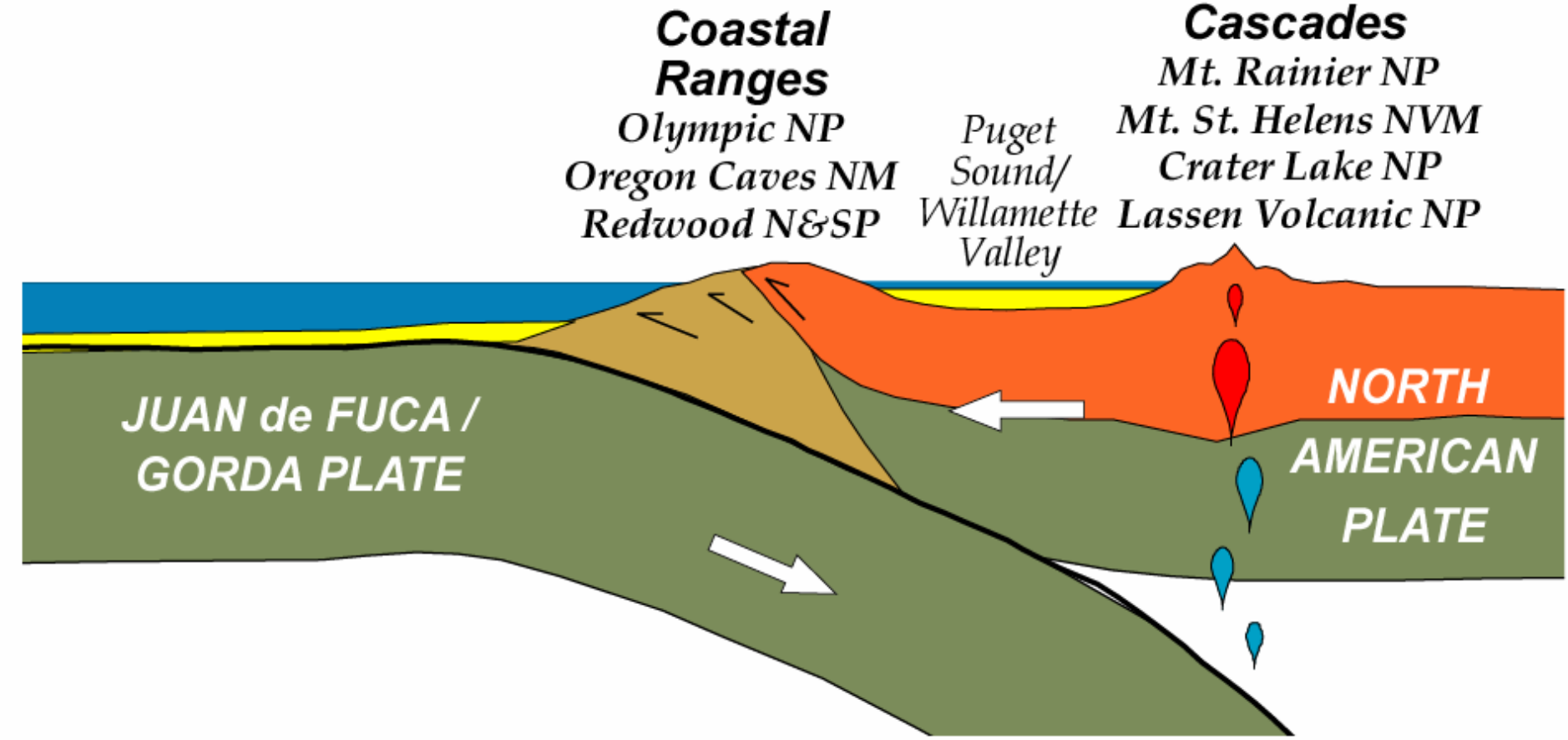
32 mm/4 years = 8 mm/year

How far has Corvallis moved northeastward since the last mega-thrust earthquake in AD 1700?

John Lahr Idea ☺



Four Types of Earthquakes in Cascadia Subduction Zone



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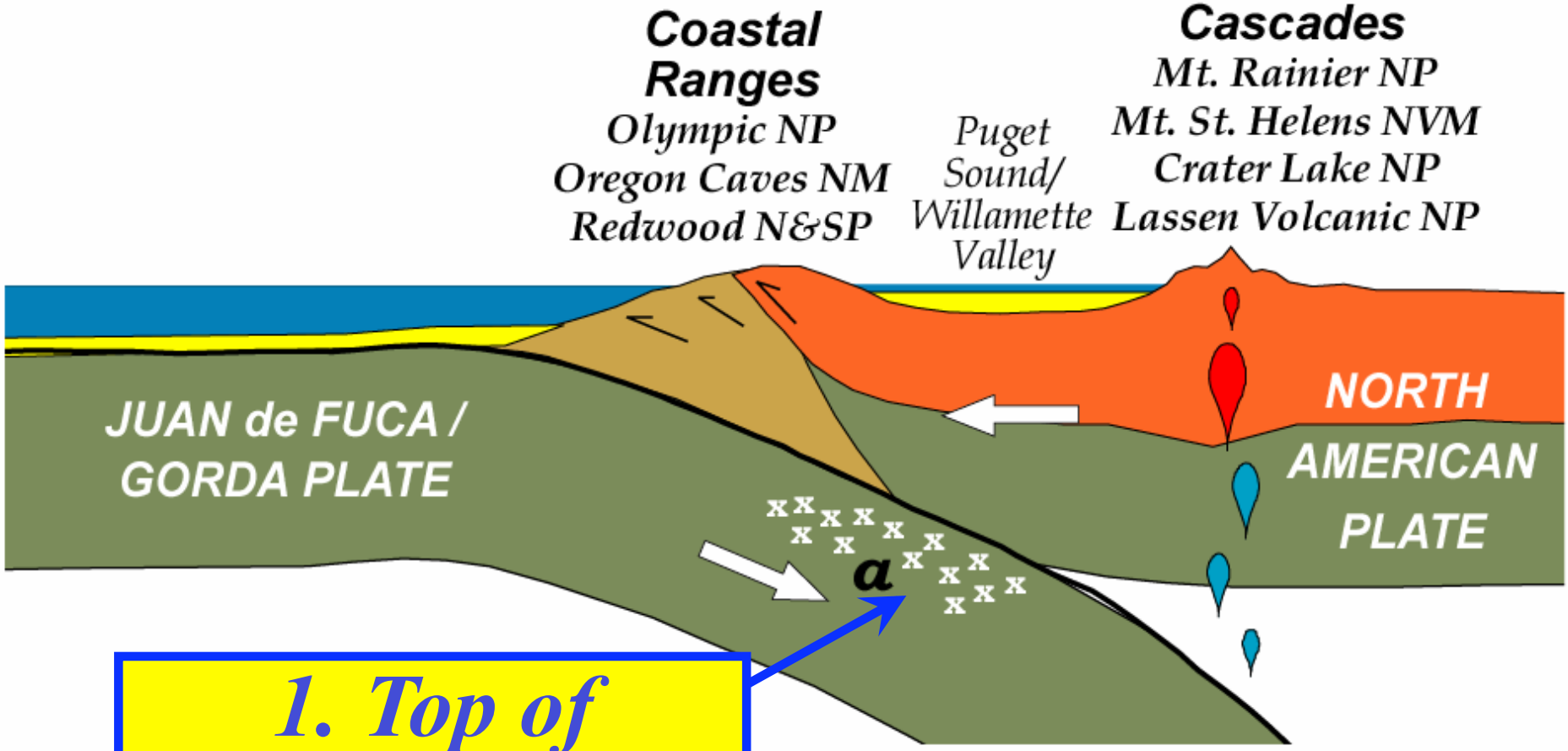
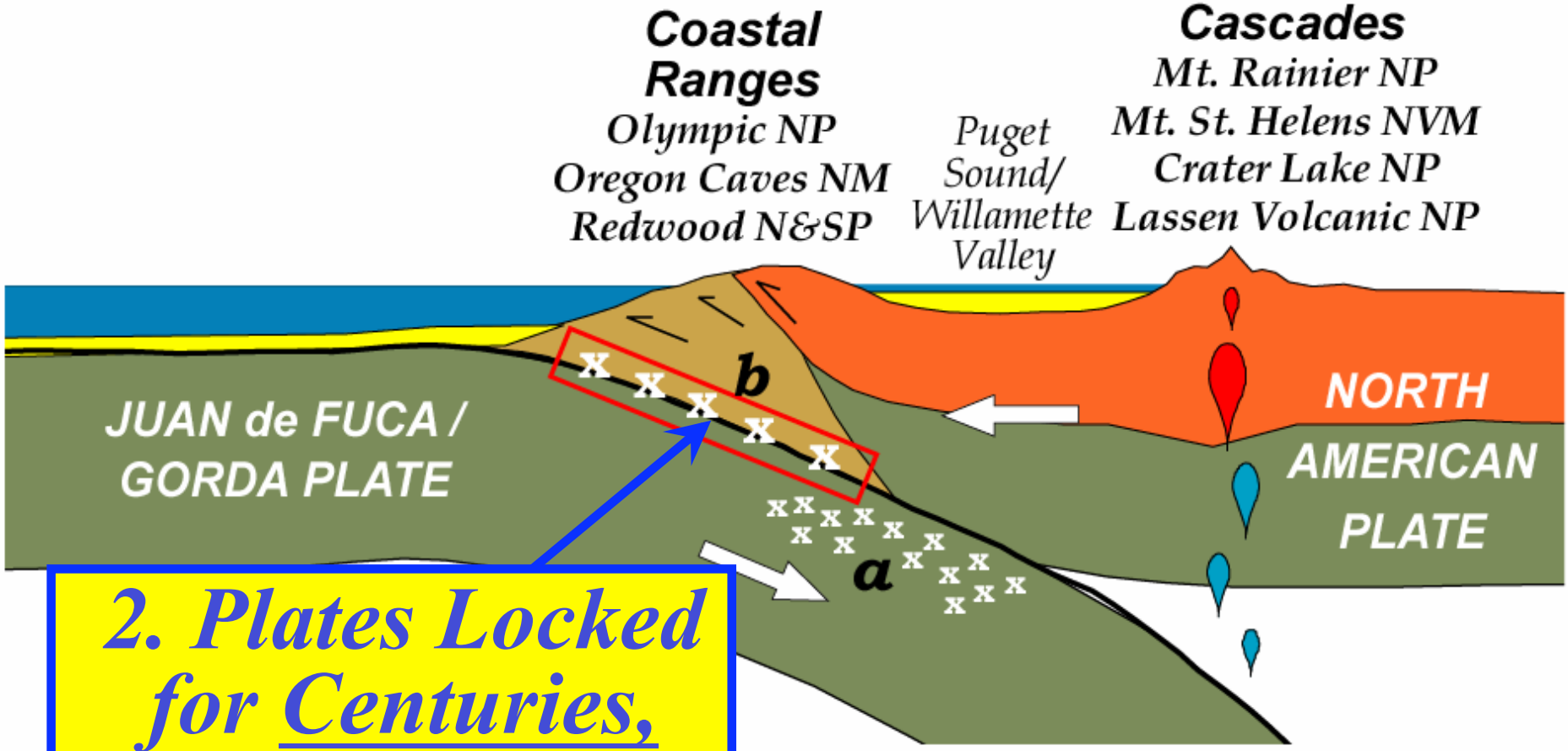
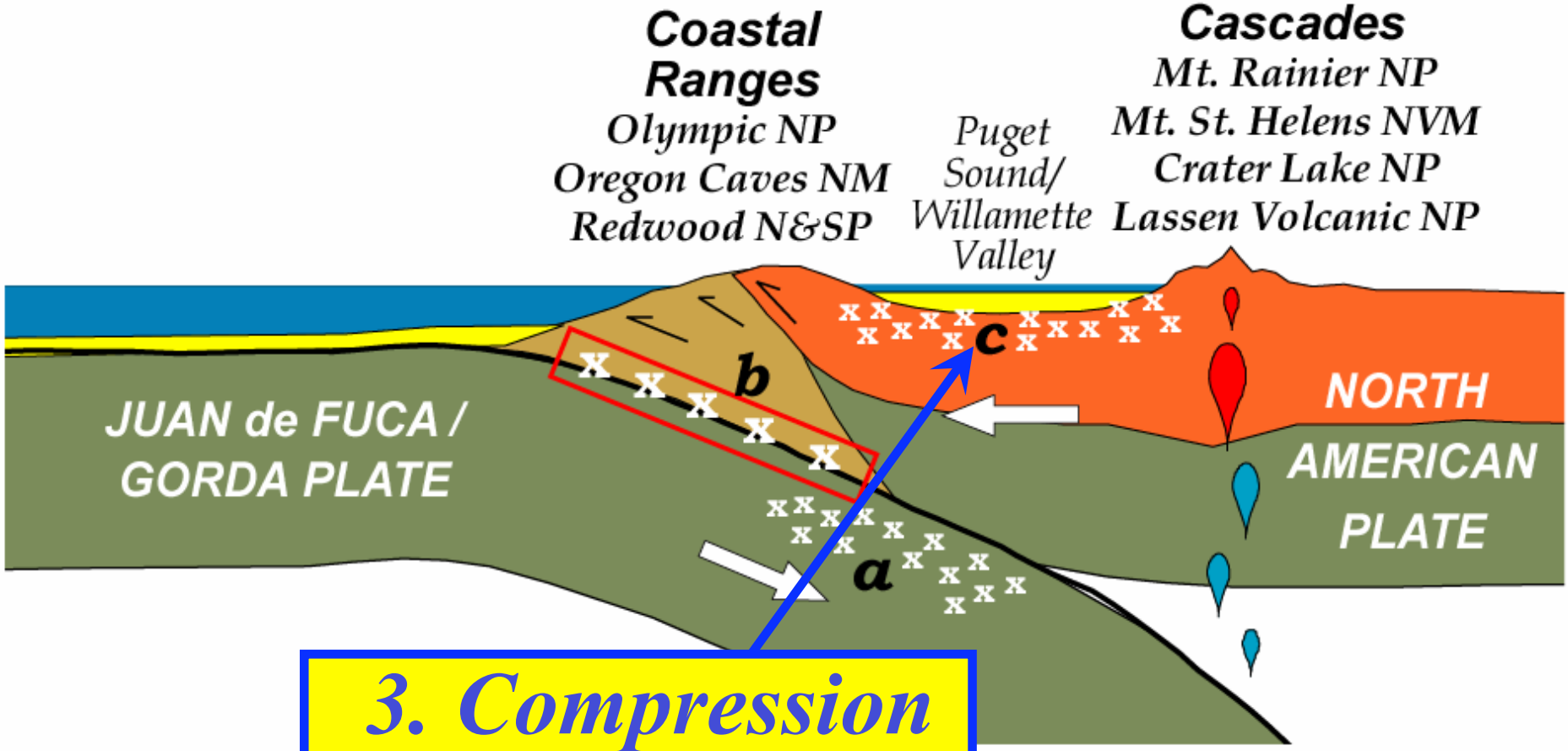


Four Types of Earthquakes in Cascadia Subduction Zone



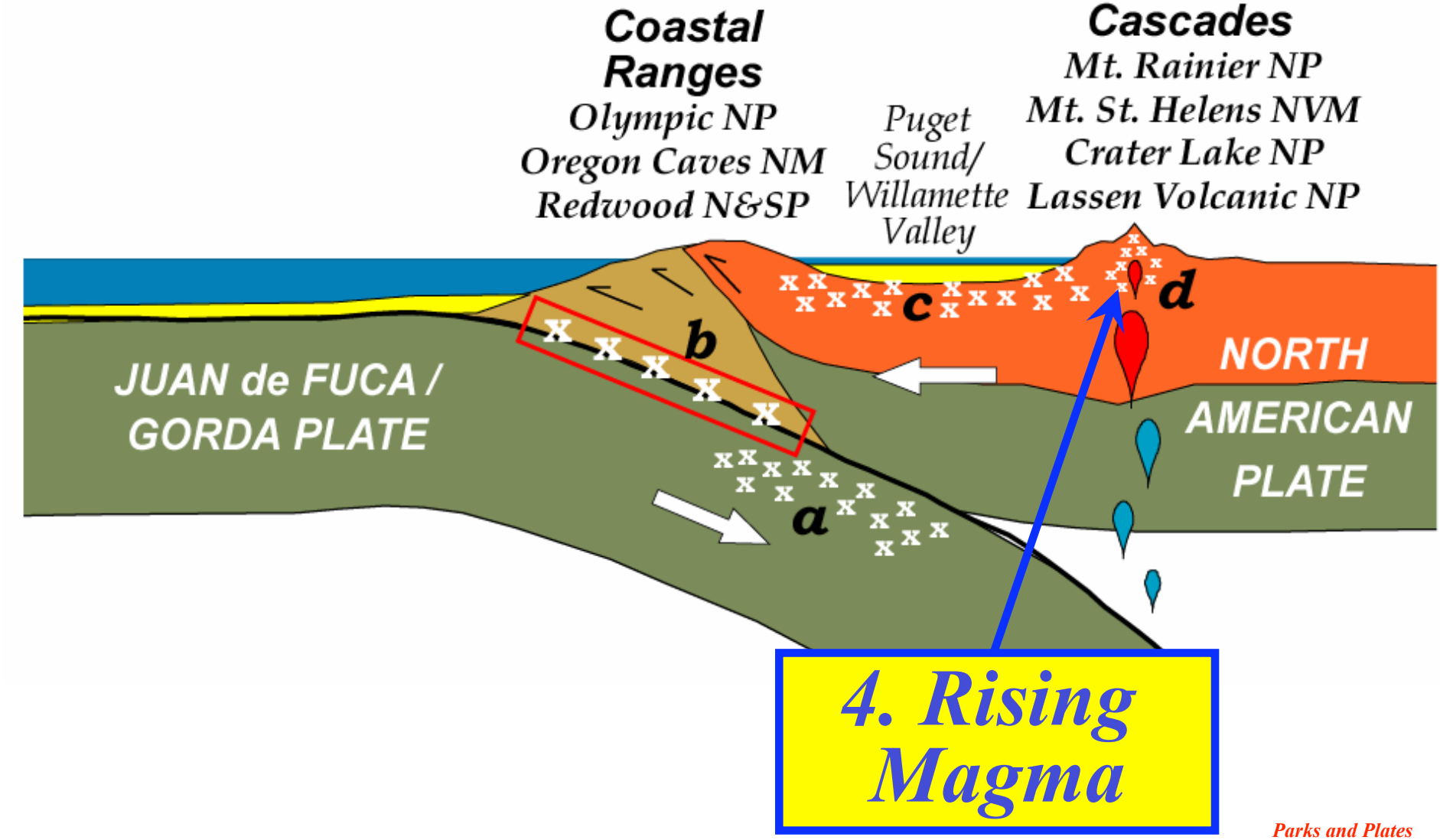
2. Plates Locked for Centuries, then Suddenly Let Go!

Four Types of Earthquakes in Cascadia Subduction Zone

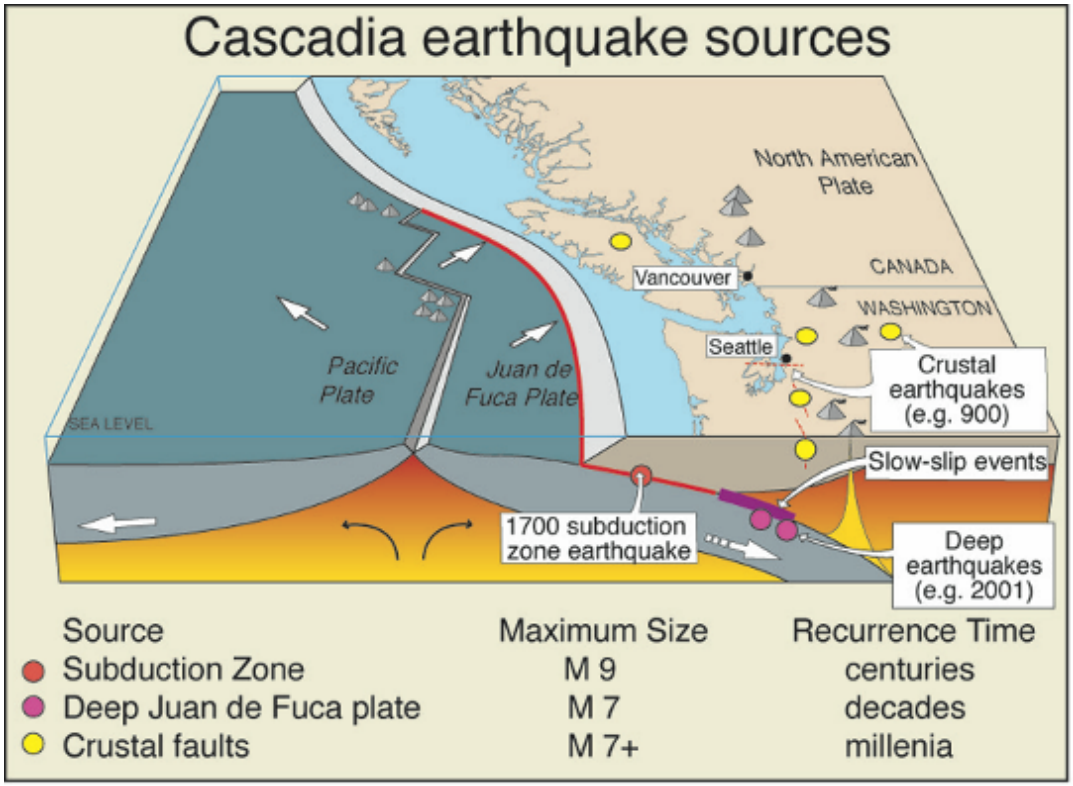


3. Compression of Overriding Plate

Four Types of Earthquakes in Cascadia Subduction Zone

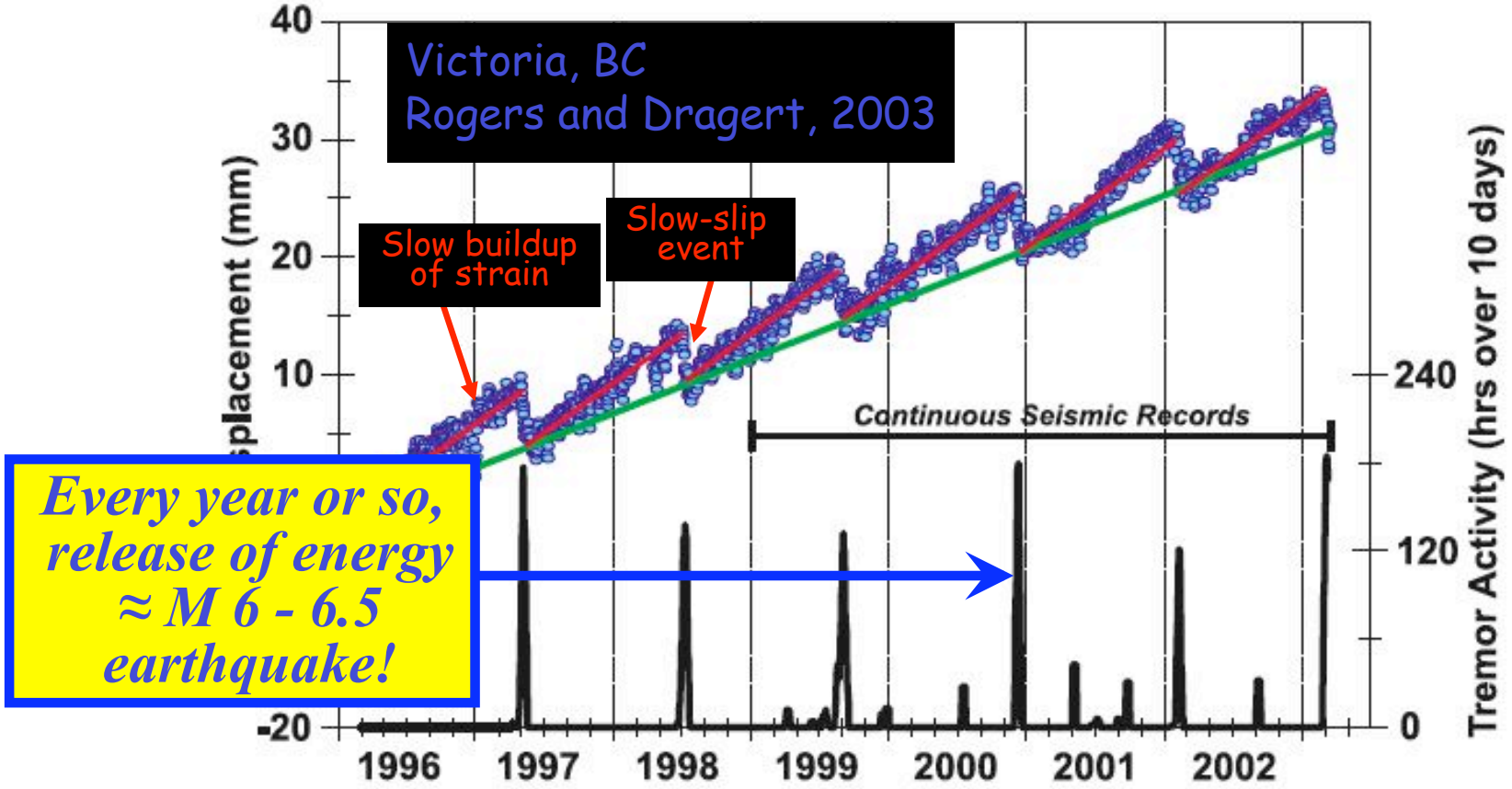


But what about Episodic Tremor and Slip ("Slow Earthquakes)?



- Probably slow slip between North American and Juan de Fuca plates at depths below locked zone.
- May increase stress on shallower, locked portion of subduction zone.

But what about Episodic Tremor and Slip ("Slow Earthquakes)?



What are the intellectual and emotional connections?

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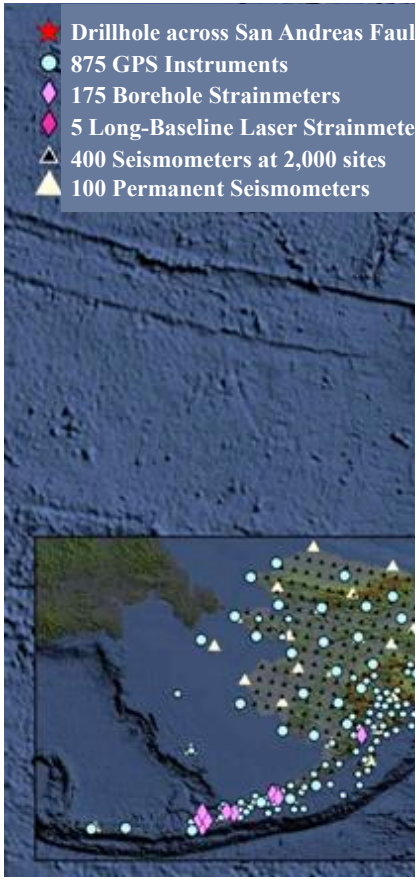
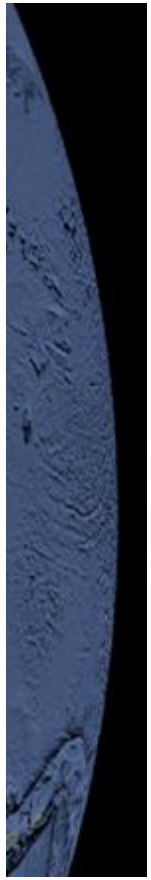
EarthScope National Office

Workshops for Interpretive Professionals in Parks and Museums





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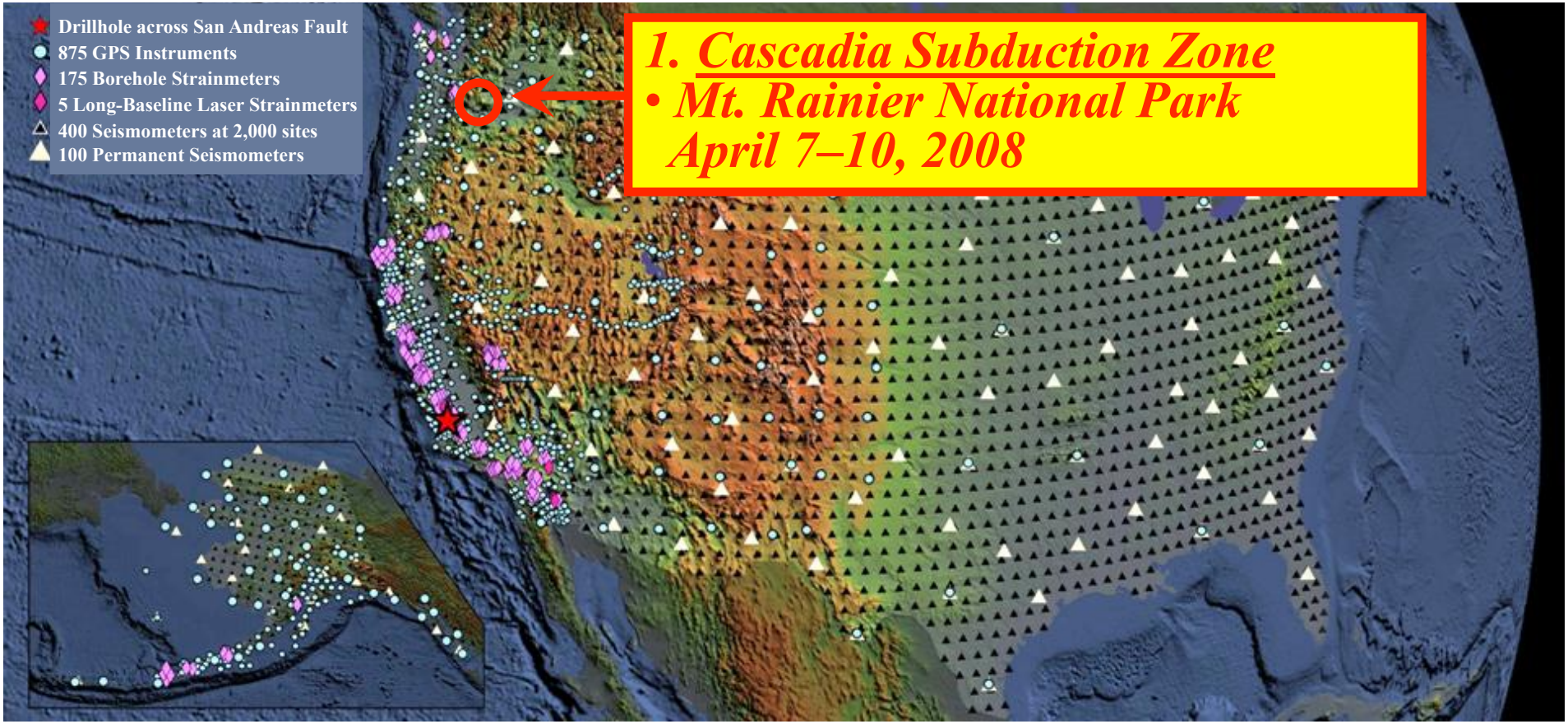

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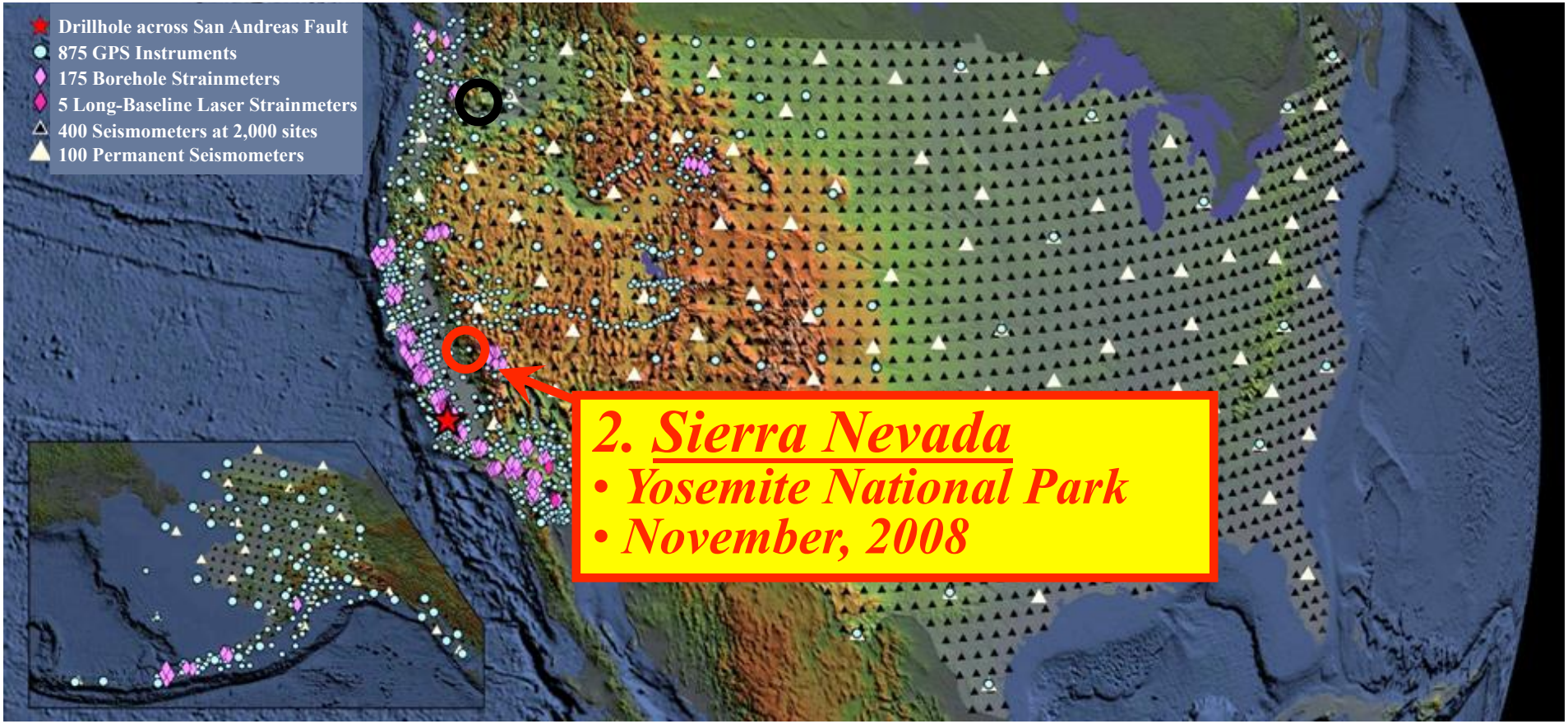

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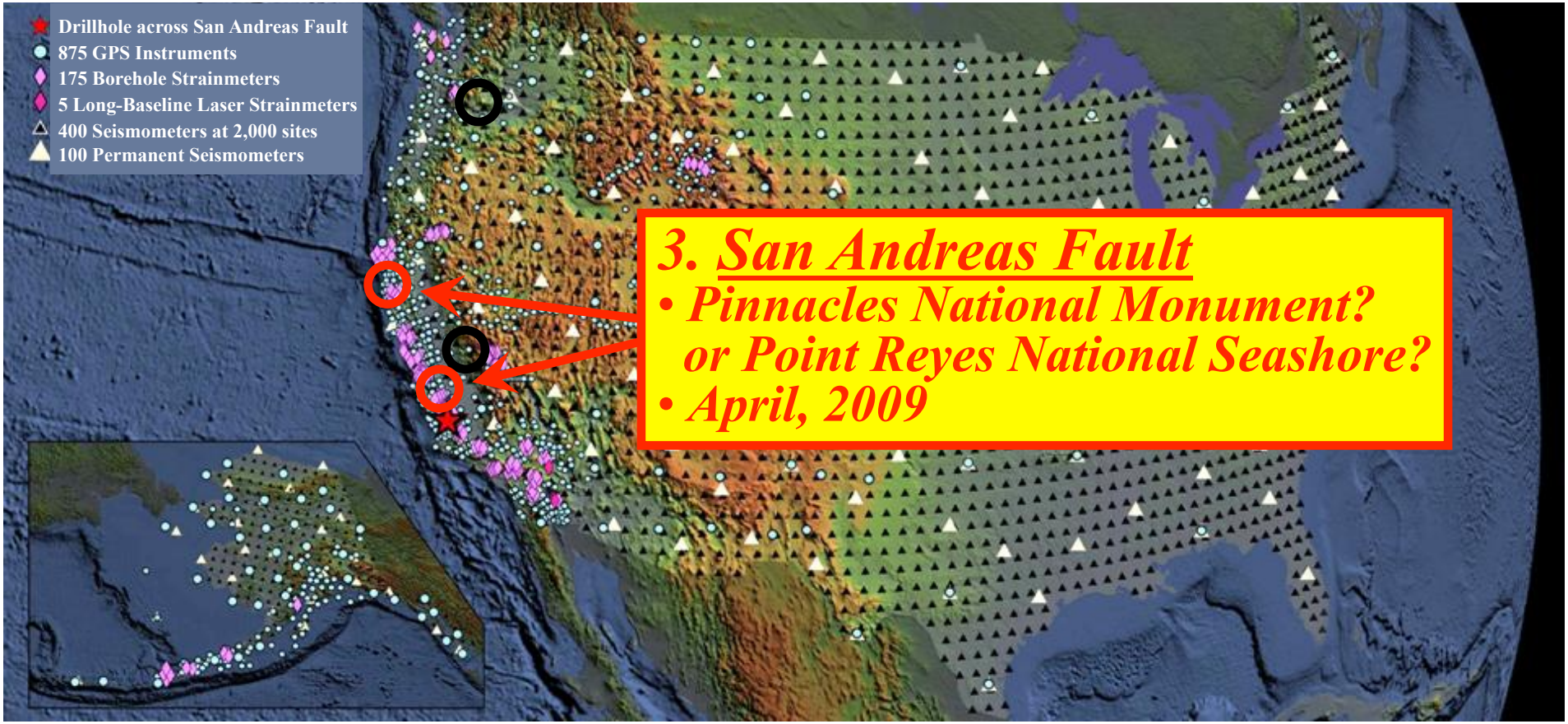

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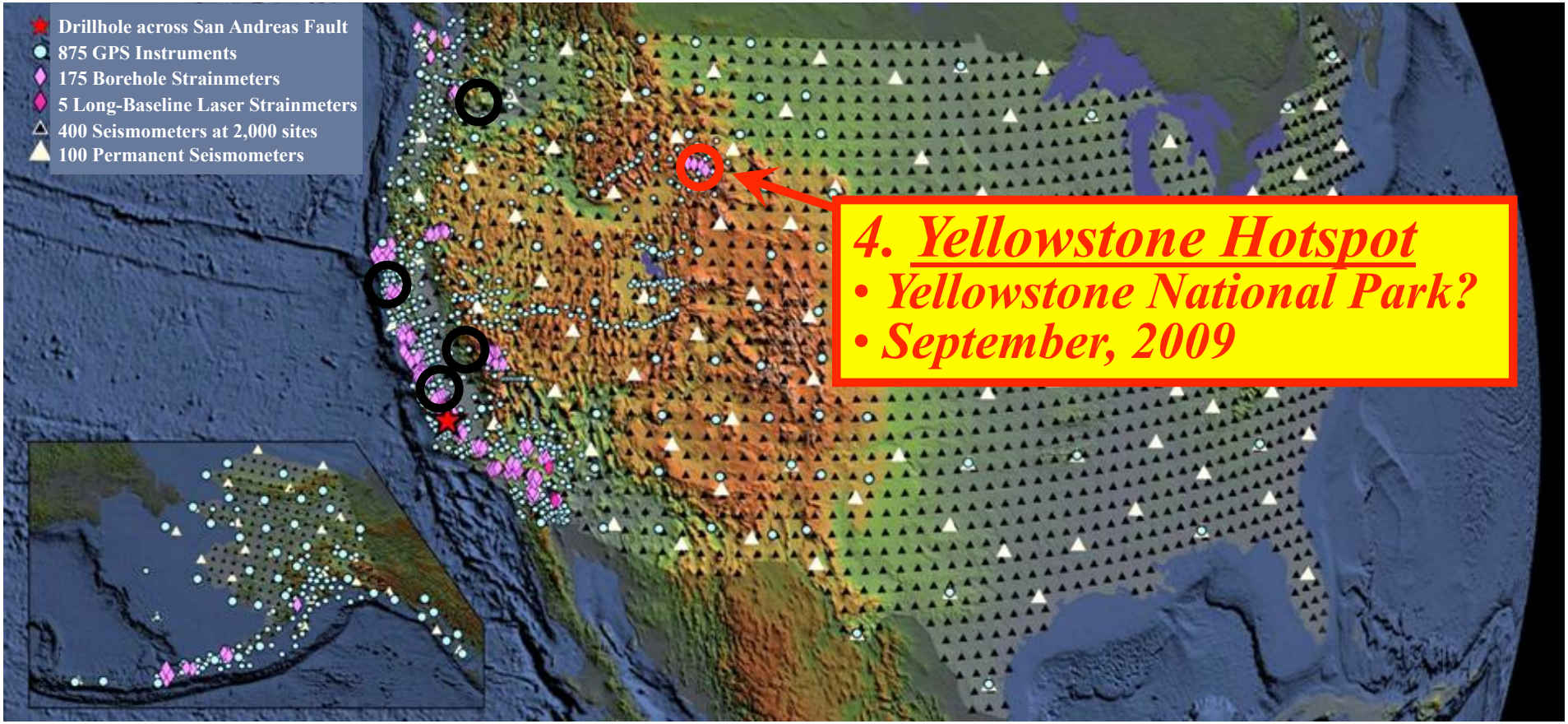

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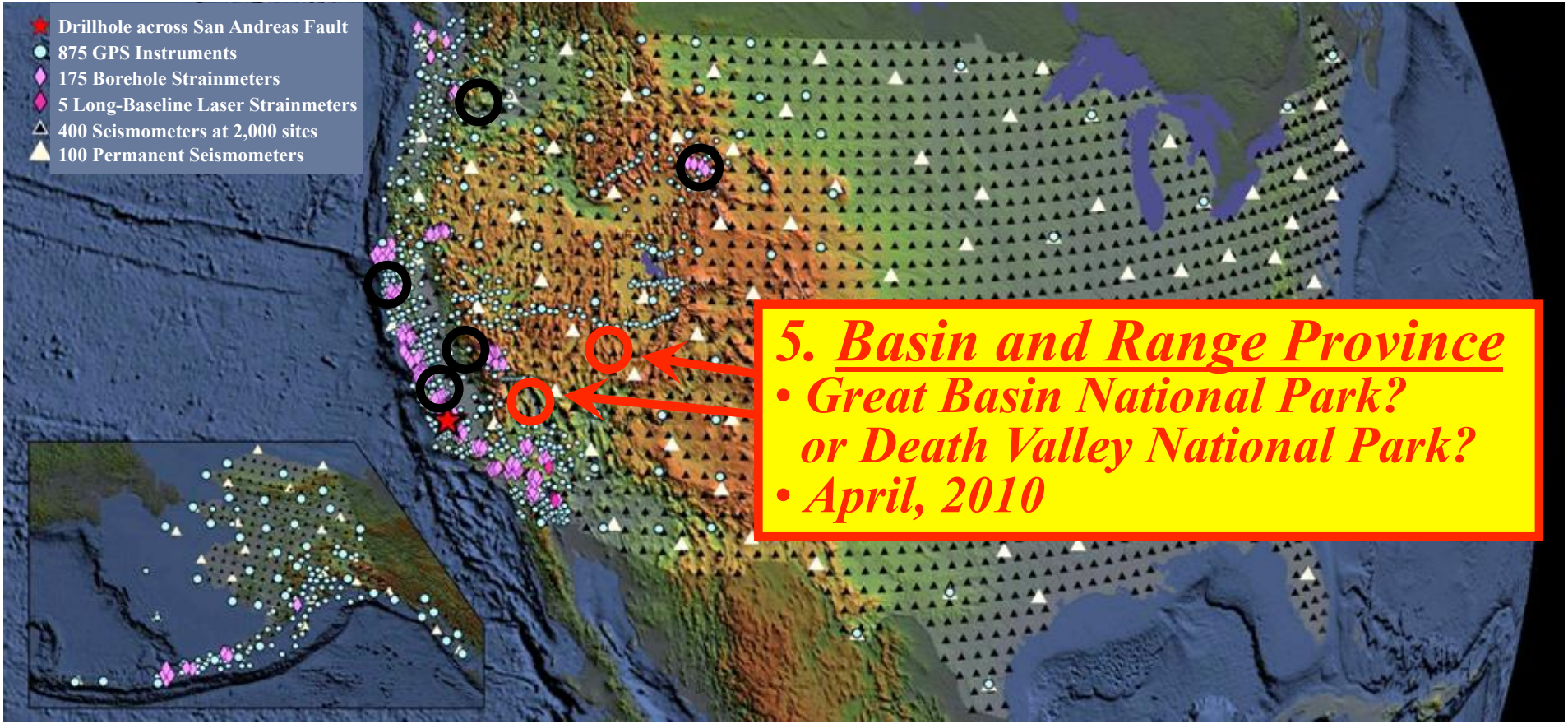

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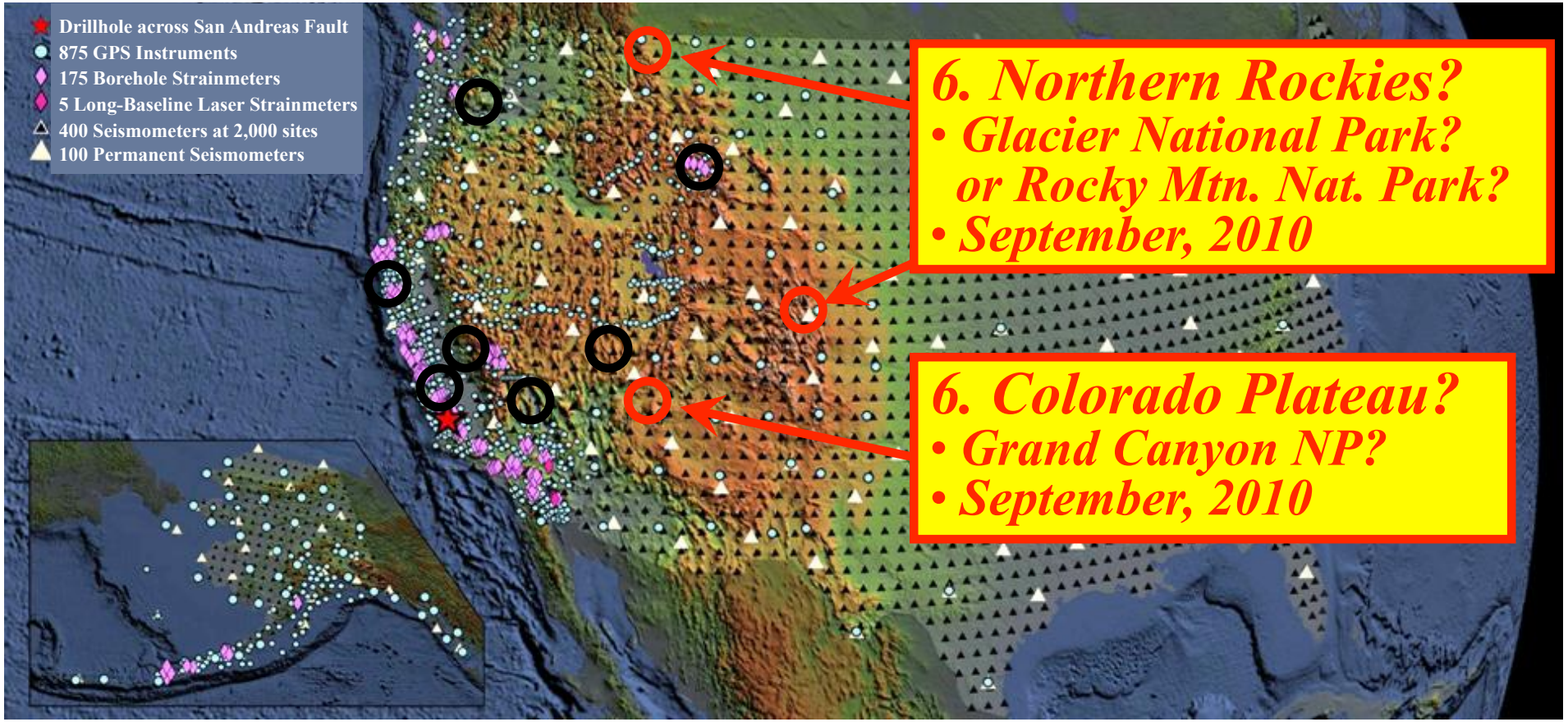

Formal Educators (Teachers!) ☺ will be participants in these workshops, too.