EarthScope Cascadia Interpretive Workshop

April 7-10, 2008

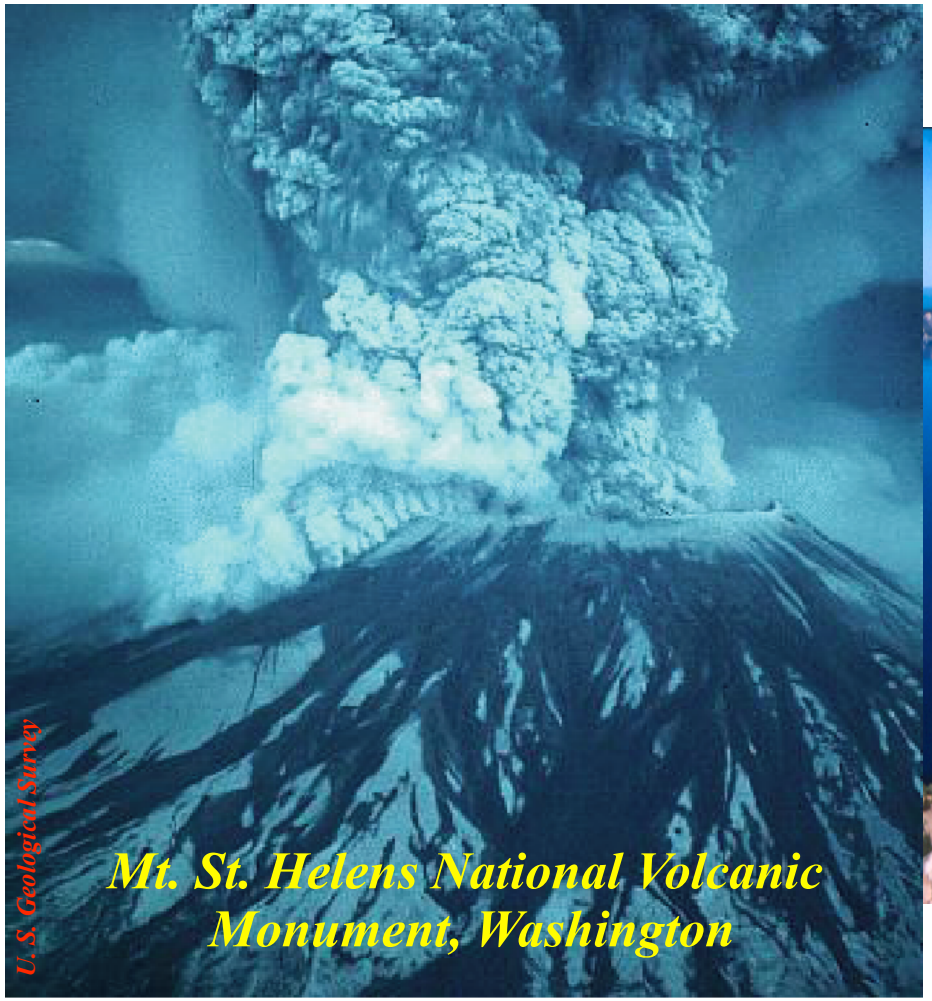
Mt. Rainier National Park Education Center

Supported by funds from the National Science Foundation to the EarthScope National Office

Robert J. Lillie

Beauty and the Beast:

"The same earthquake and volcanic activity that threatens our lives also nourishes our spirits by creating the tranquil mountains and coastlines of the Pacific Northwest."



Mt. St. Helens National Volcanic Monument, Washington

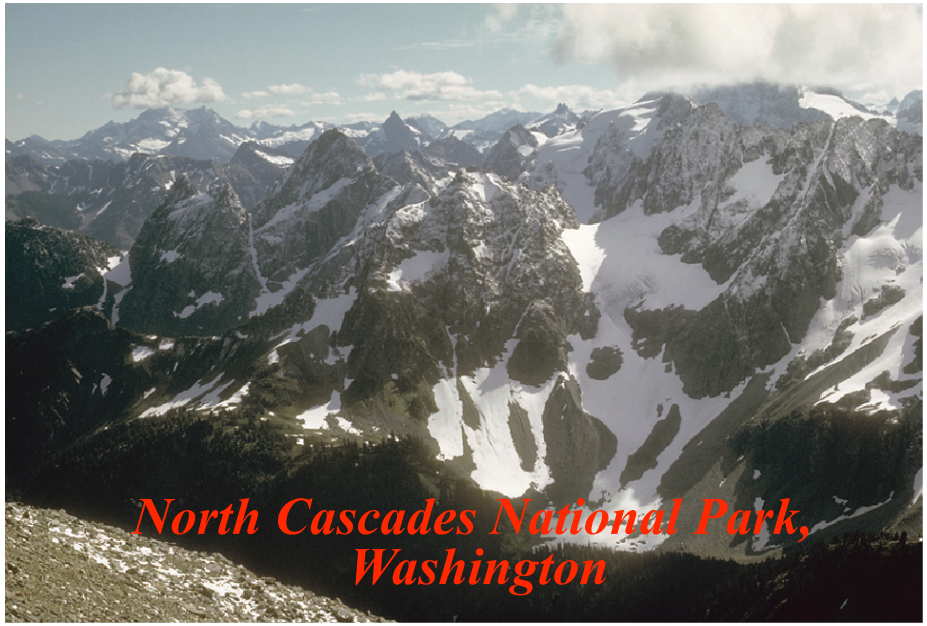
Crater Lake National Park, Oregon

Beauty and the Beast:

"The same earthquake and volcanic activity that threatens our lives also nourishes our spirits by creating the tranquil mountains and coastlines of the Pacific Northwest."

Nisqually Earthquake, Feb. 28, 2001

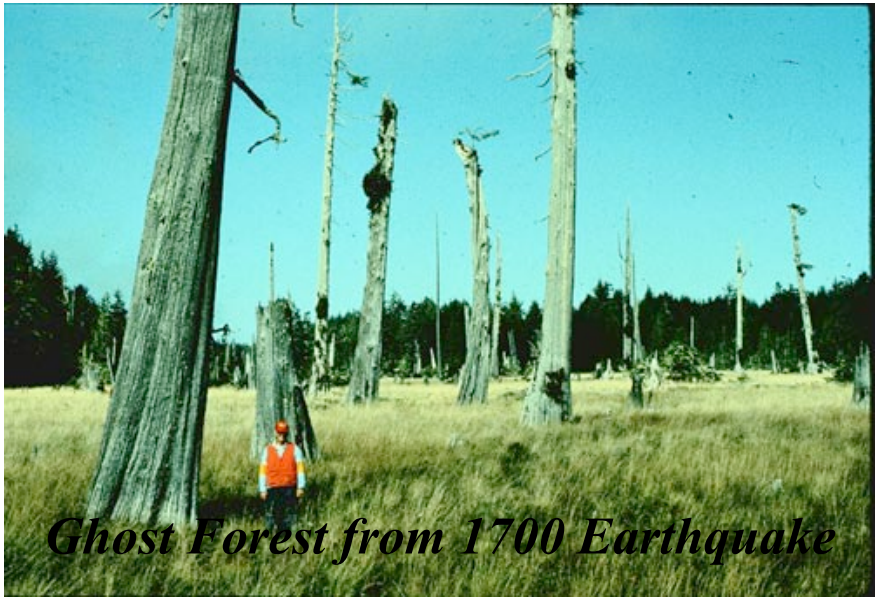
Robert D. Lawrence



North Cascades National Park, Washington

Beauty and the Beast:

"The same earthquake and volcanic activity that threatens our lives also nourishes our spirits by creating the tranquil mountains and coastlines of the Pacific Northwest."



Ghost Forest from 1700 Earthquake

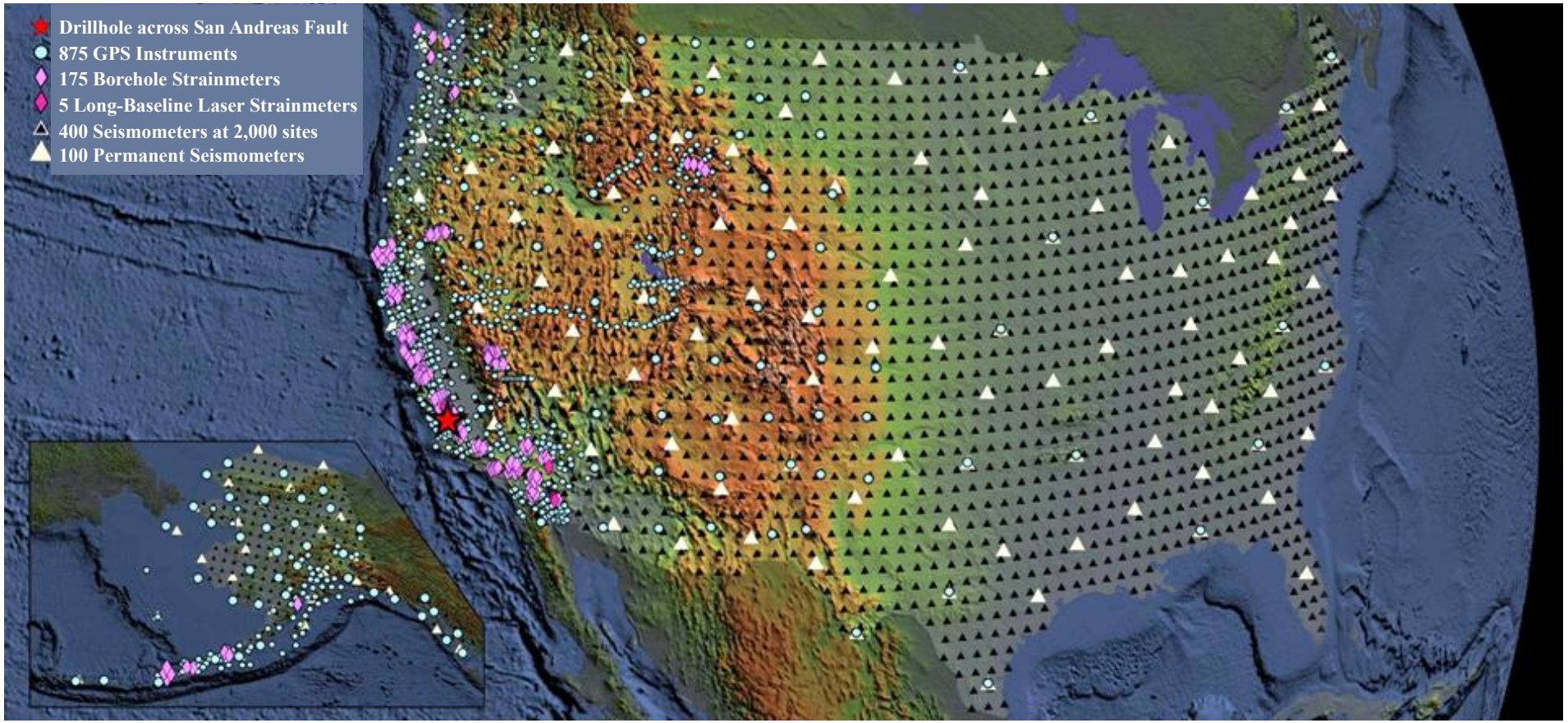
Cape Perpetua Scenic Area, Oregon

Matt Lovemark

EarthScope

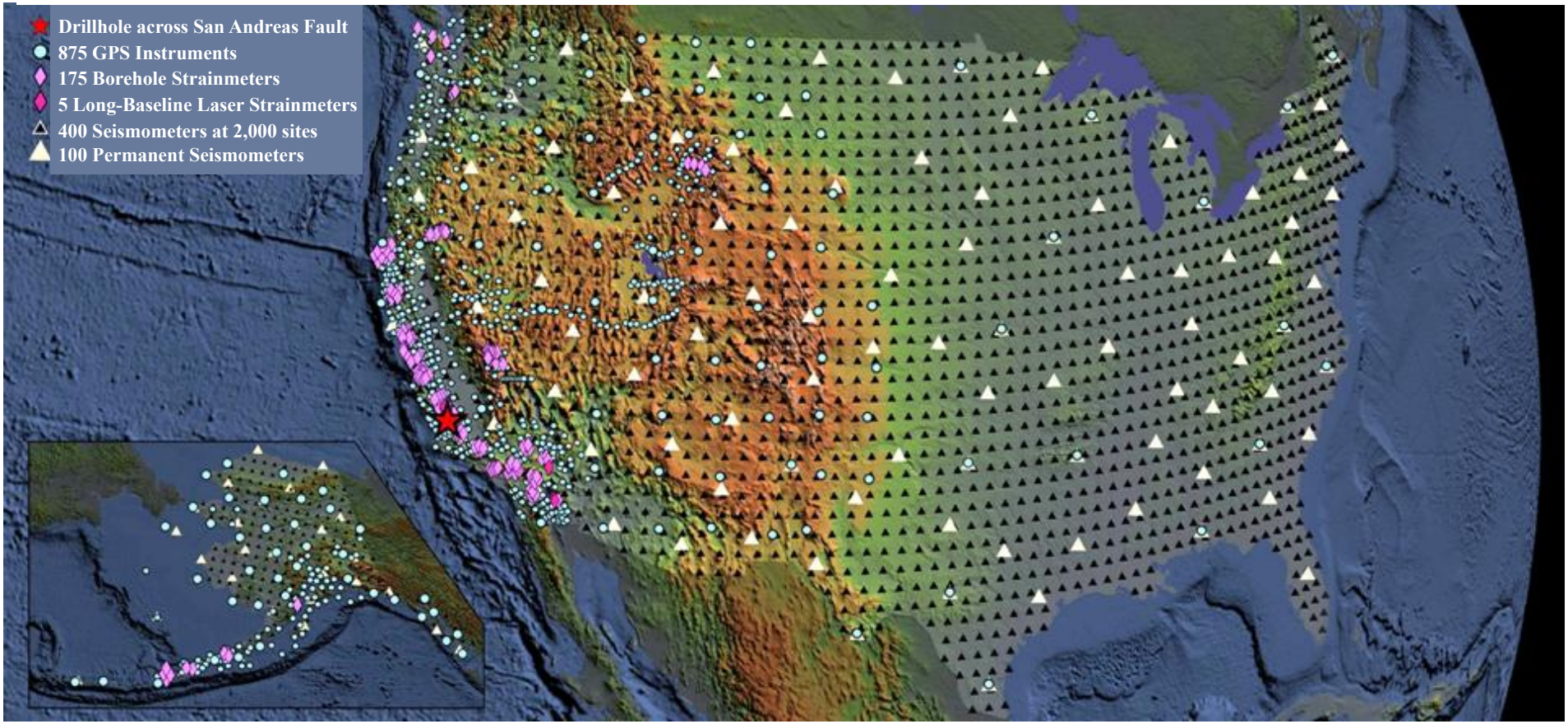
A nationwide program to …..

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



EarthScope

Like a "Hubble Telescope" aimed into the Earth



EarthScope Cascadia Interpretive Workshop

- **Science Content**
  - Basic geology: plate tectonics and the dynamic landscape
  - EarthScope: USArray, Plate Boundary Observatory (PBO), and other monitoring of the landscape
- **Interpretive Methods**
  - "Beauty and the Beast"
    - Inspiring landscapes formed by geological processes
    - Same processes result in earthquakes, tsunamis, and volcanic eruptions
  - Participants participate:
    - Work in groups to prepare and present interpretive programs that incorporate EarthScope
    - Field trip for landscape/instrumentation
    - IRIS Active Earth Kiosk
- **Questions for Each Speaker**
  - Form in folder
  - Write one question for each speaker
  - Turn in immediately after presentation
  - Speaker asked to answer questions
  - Answers sent to participants

Robert J. Lillie

EarthScope
Cascadia Interpretive Workshop

Co-Instructors and Facilitators:

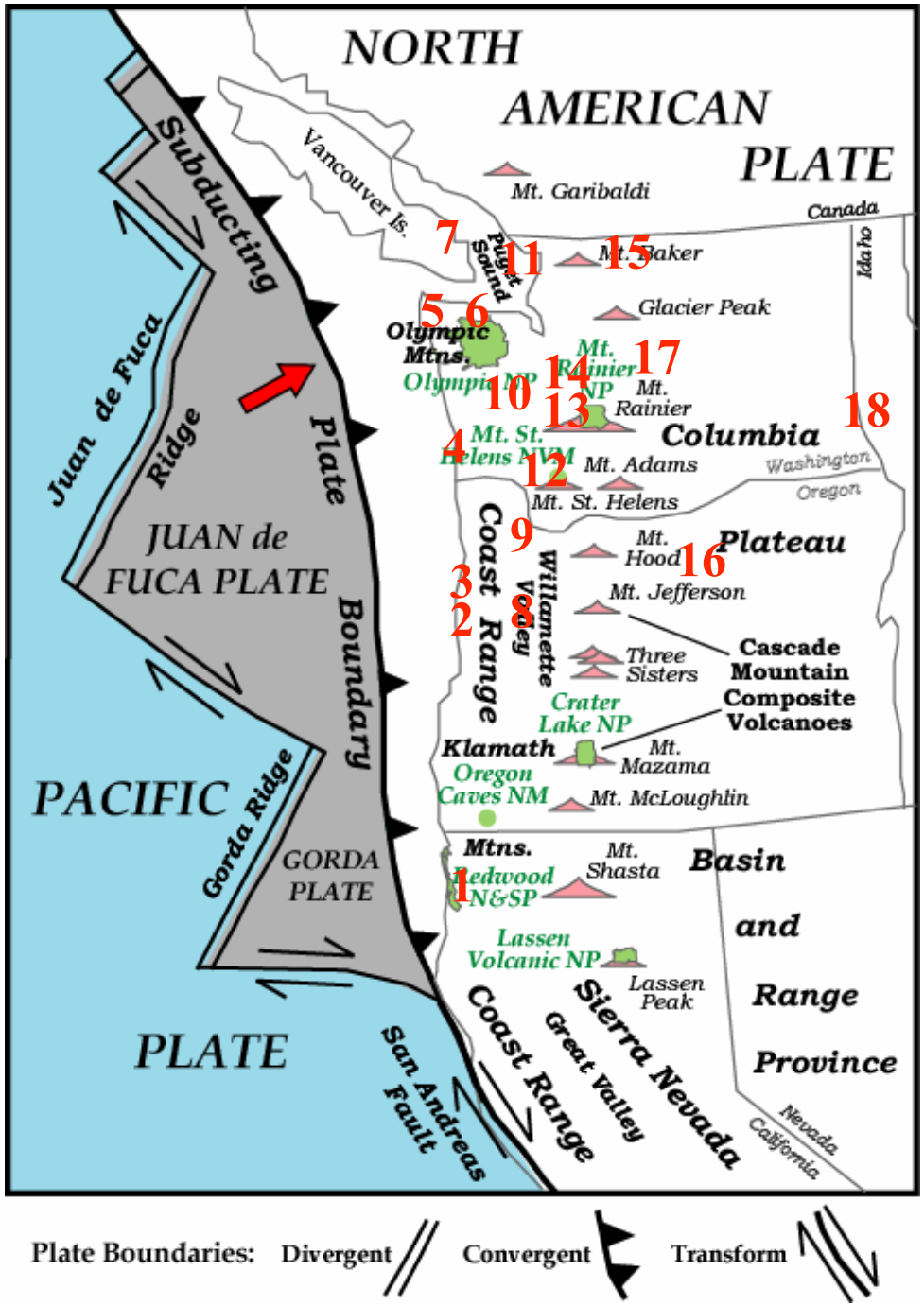
- Bob Butler (University of Portland)
- Anne Doherty (Mt. Rainier Nat Park)
- Carolyn Driedger (USGS-CVO)
- Susan Eriksson (UNAVCO)
- Charlotte Goddard (Oregon State Univ)
- Bob Lillie (Oregon State University)
- Steve Malone (Univ Washington)
- Tim Melbourne (Central Wash Univ)
- Seth Moran (USGS-CVO)
- Lynne Murdock (National Park Service)
- Kelly Reeves (IRIS)

Robert J. Lillie

Participant Organizations 20 19

1. Redwood N&SP
2. Hatfield Marine Science Center
3. Oregon State Parks, Depoe Bay
4. Wash State Parks & Rec, Ilwaco
5. Olympic NP (Forks)
6. Olympic Park Institute
7. Pacific Geoscience Centre
8. Oregon State University
9. Oregon Dept Geology & Mineral Industries
10. Washington Nat Res/Geological Survey
11. Wash State Parks & Rec, Oak Harbor
12. Mount St. Helens NVM
    Mount St. Helens Institute
    Wash State Parks - Mount St. Helens VC
13. Mt. Rainier NP
    Mt. Rainier NP Education Center
14. Orting High School
15. North Cascades NP
16. Oregon Paleo Lands Institute
17. Lake Wenatchee State Park
18. Nez Perce NHP
19. Lake Clark NP&Pres
20. Denali NP

Some Park Lands in the Cascadia Subduction Zone



Introductions

(About 5 at a time ☺)

1. Who? Where from? Why this workshop?
2. What's your favorite park - other than your own ☺ - and why?

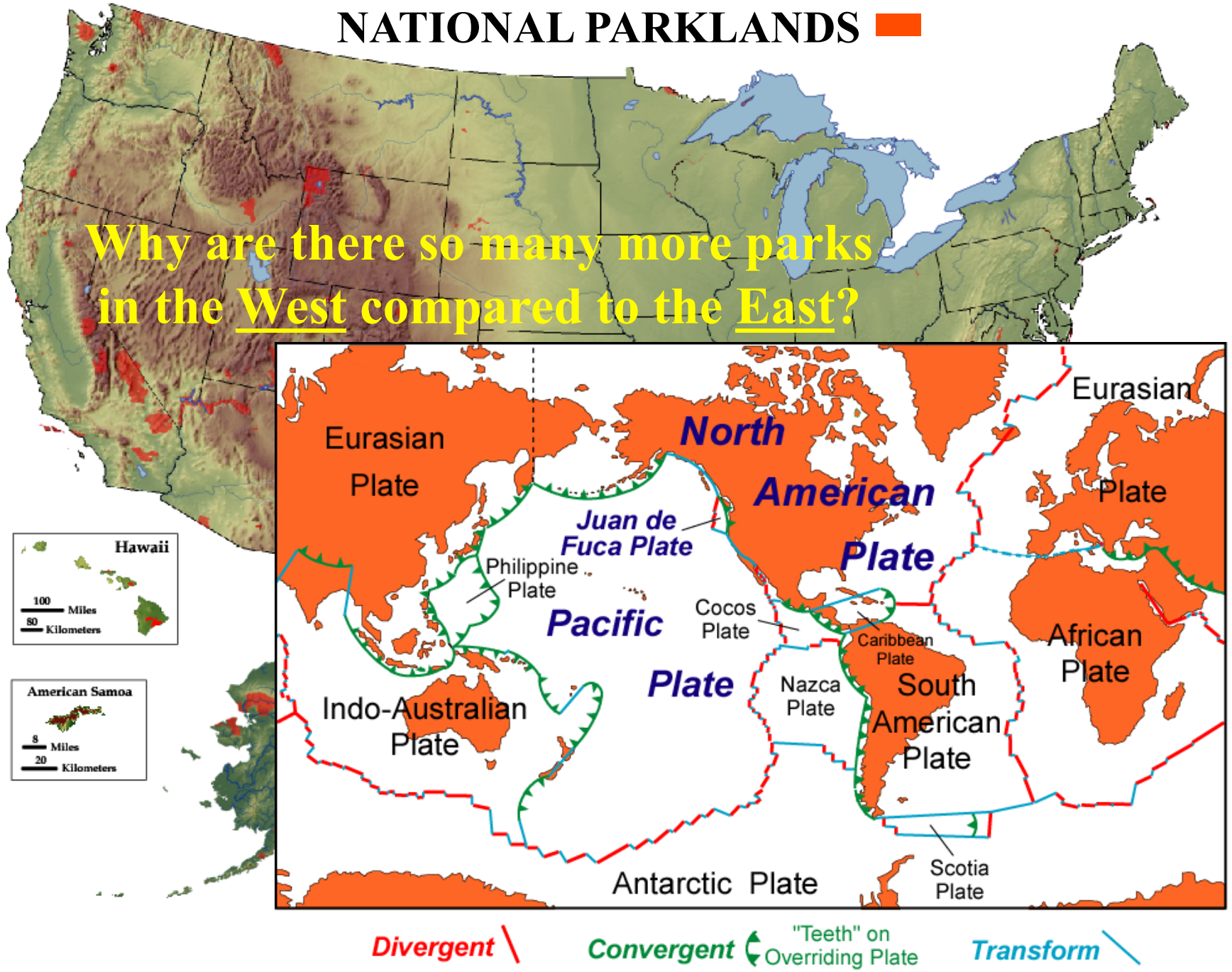
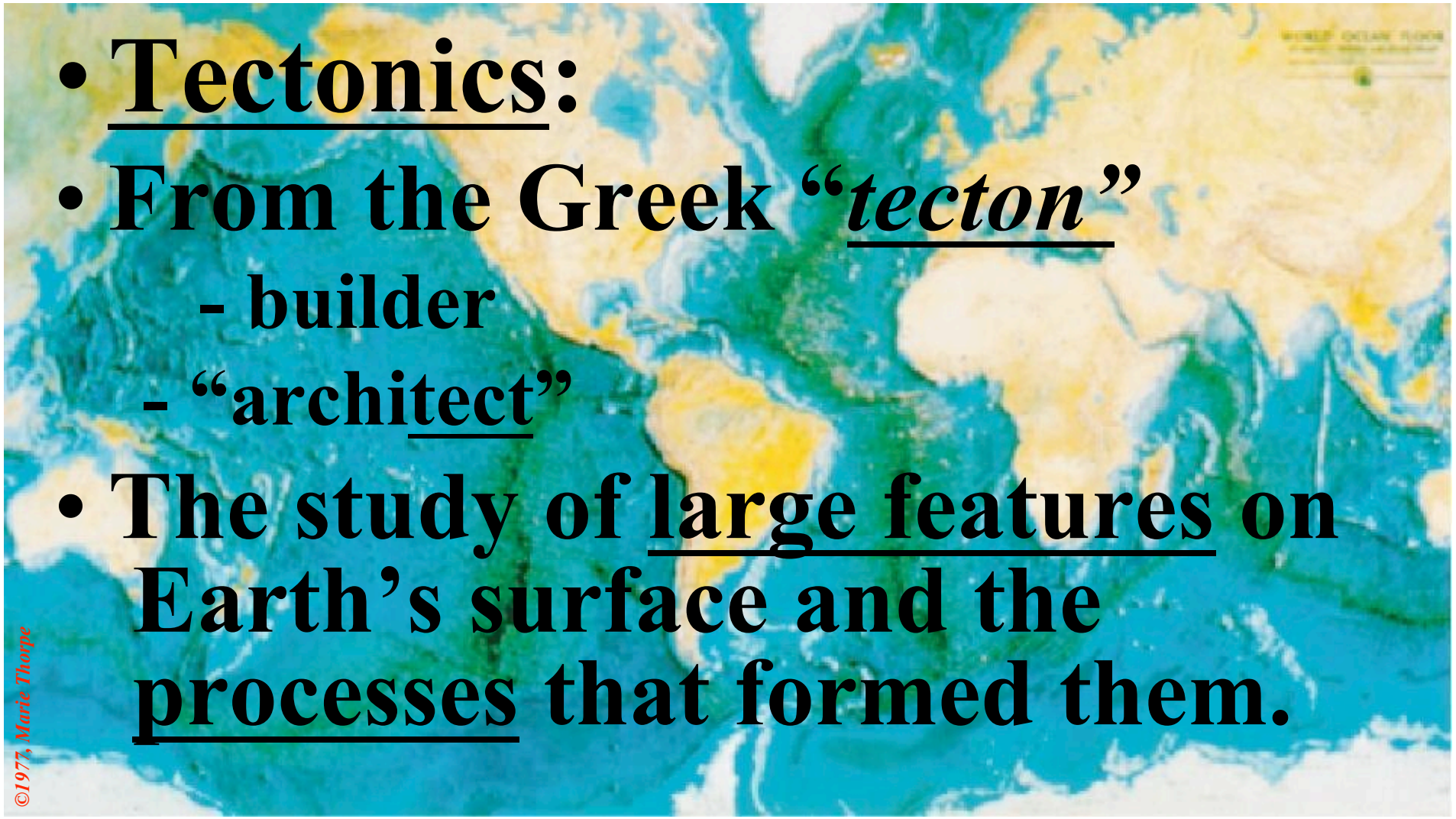
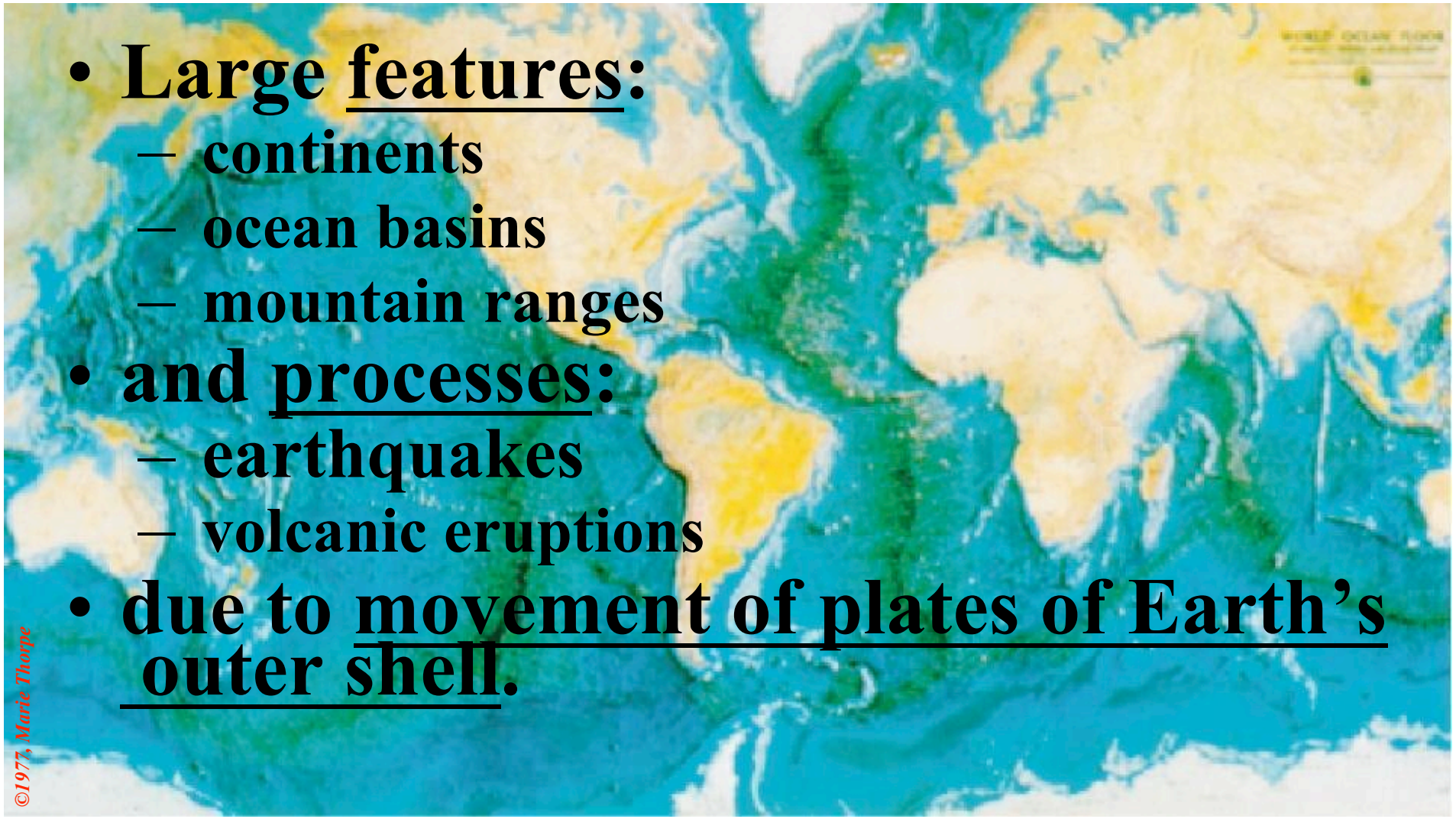

NATIONAL PARKLANDS
Why are there so many more parks in the West compared to the East?
Hawaii
100 Miles
80 Kilometers
American Samoa
8 Miles
20 Kilometers
Eurasian Plate
North American Plate
Juan de Fuca Plate
Philippine Plate
Pacific Plate
Cocos Plate
Caribbean Plate
Nazca Plate
South American Plate
African Plate
Eurasian Plate
Indo-Australian Plate
Antarctic Plate
Scotia Plate
Divergent
Convergent
"Teeth" on Overriding Plate
Transform

PLATE TECTONICS

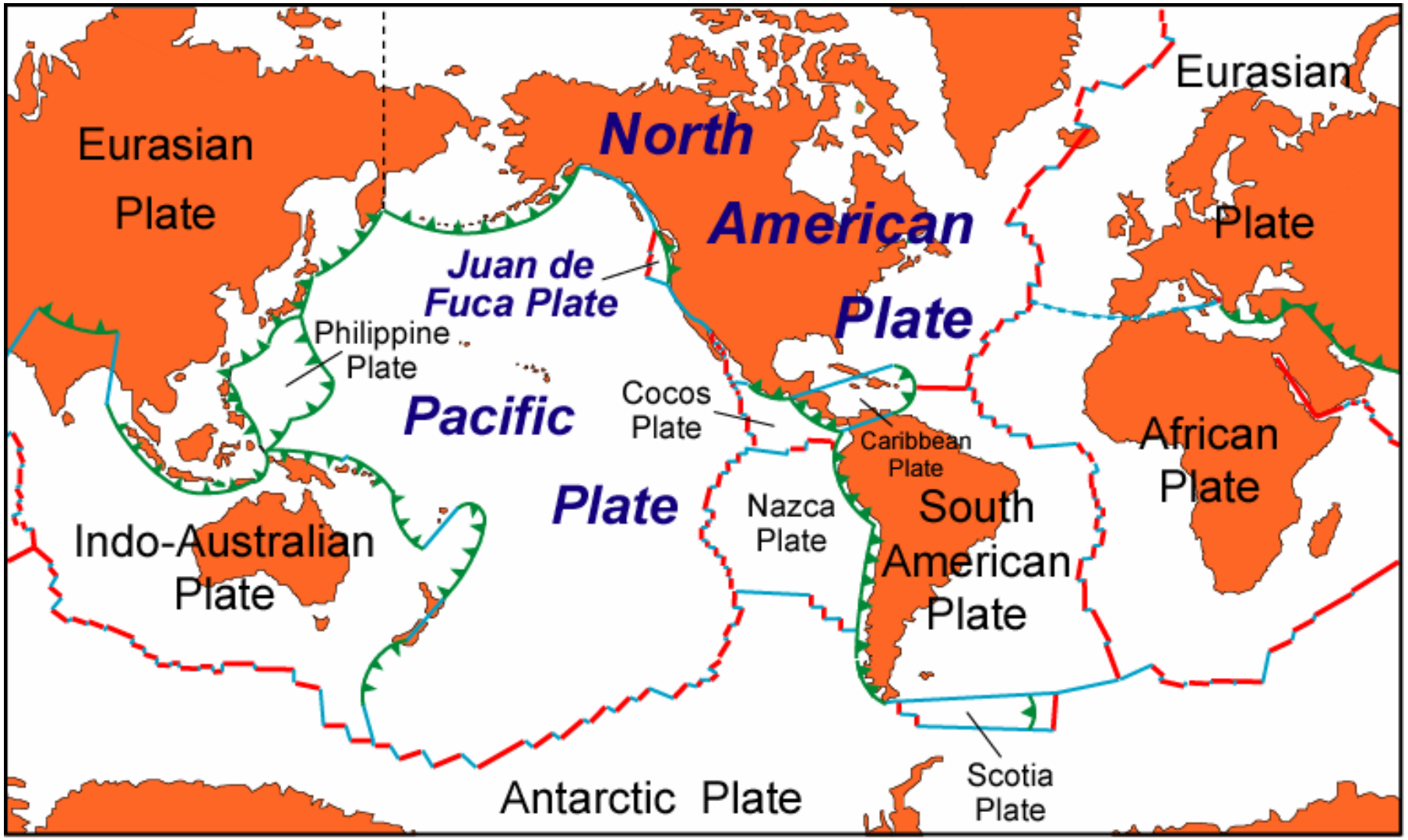


- **Tectonics:**
- **From the Greek "*tecton*"**
  - **builder**
  - **"architect"**
- **The study of large features on Earth's surface and the processes that formed them.**

"PLATE TECTONICS"



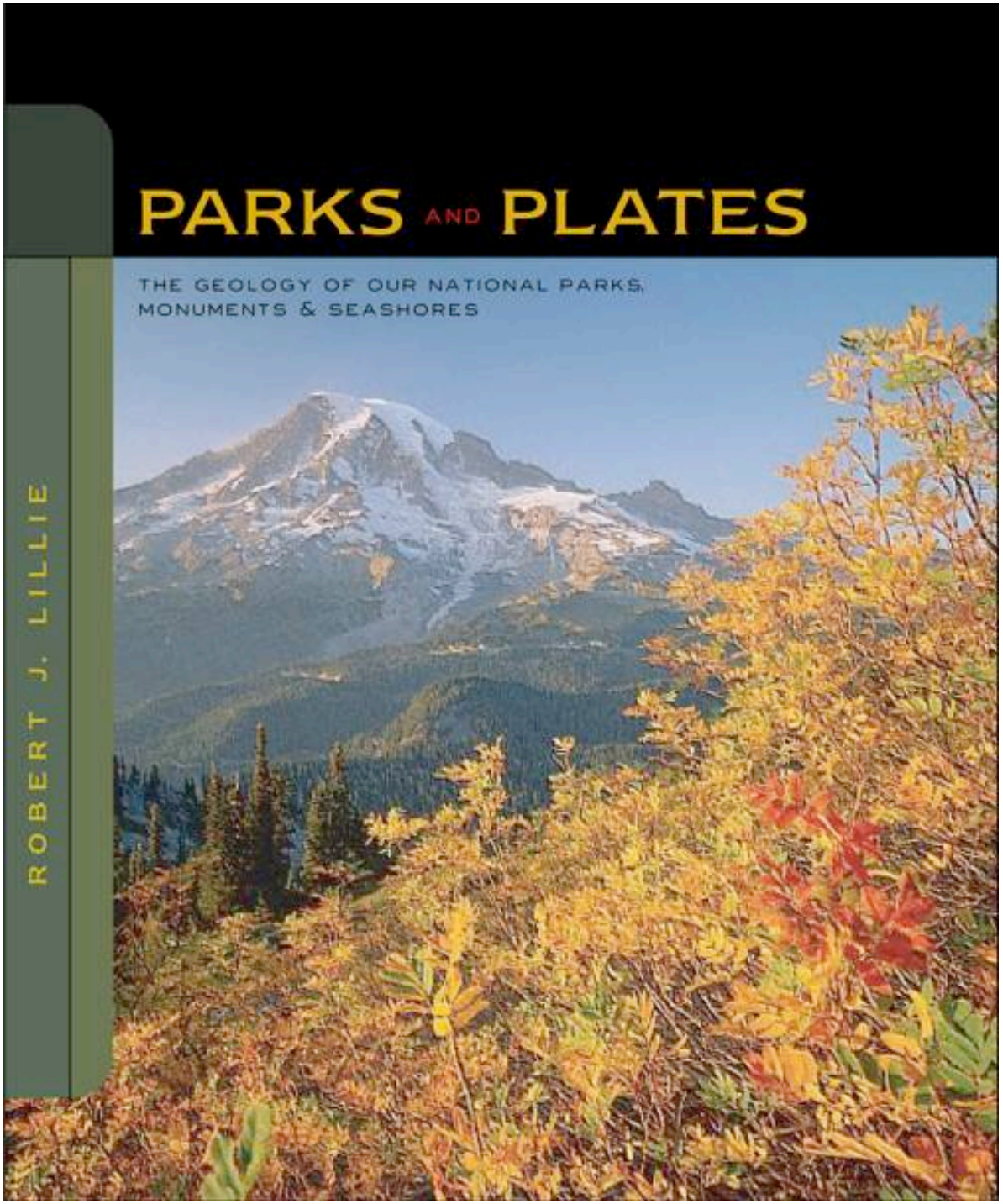
- **Large features:**
  - **continents**
  - **ocean basins**
  - **mountain ranges**
- **and processes:**
  - **earthquakes**
  - **volcanic eruptions**
- **due to movement of plates of Earth's outer shell.**

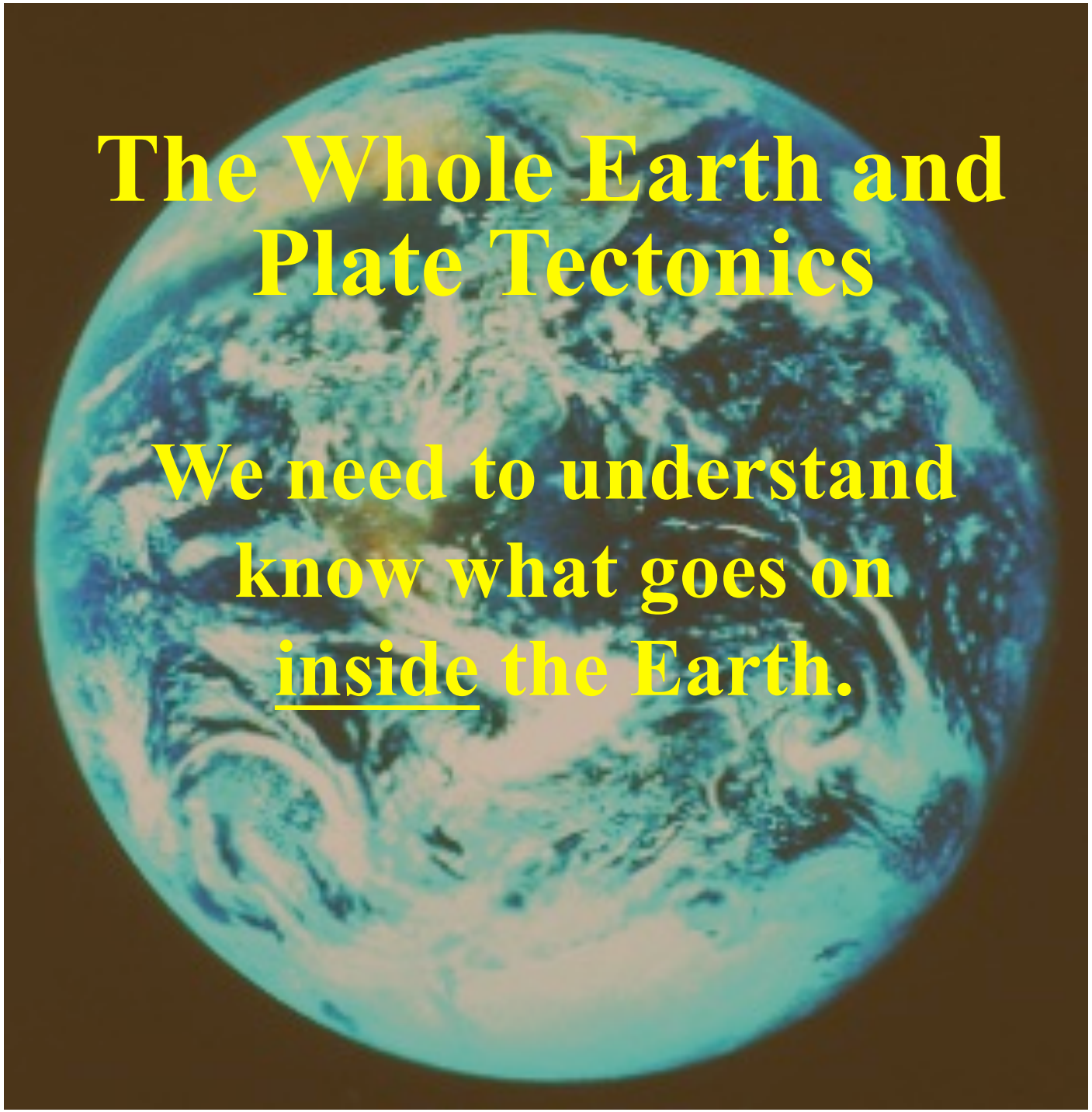


Cracked Egg Shell!

Landscapes of national parks due to processes:

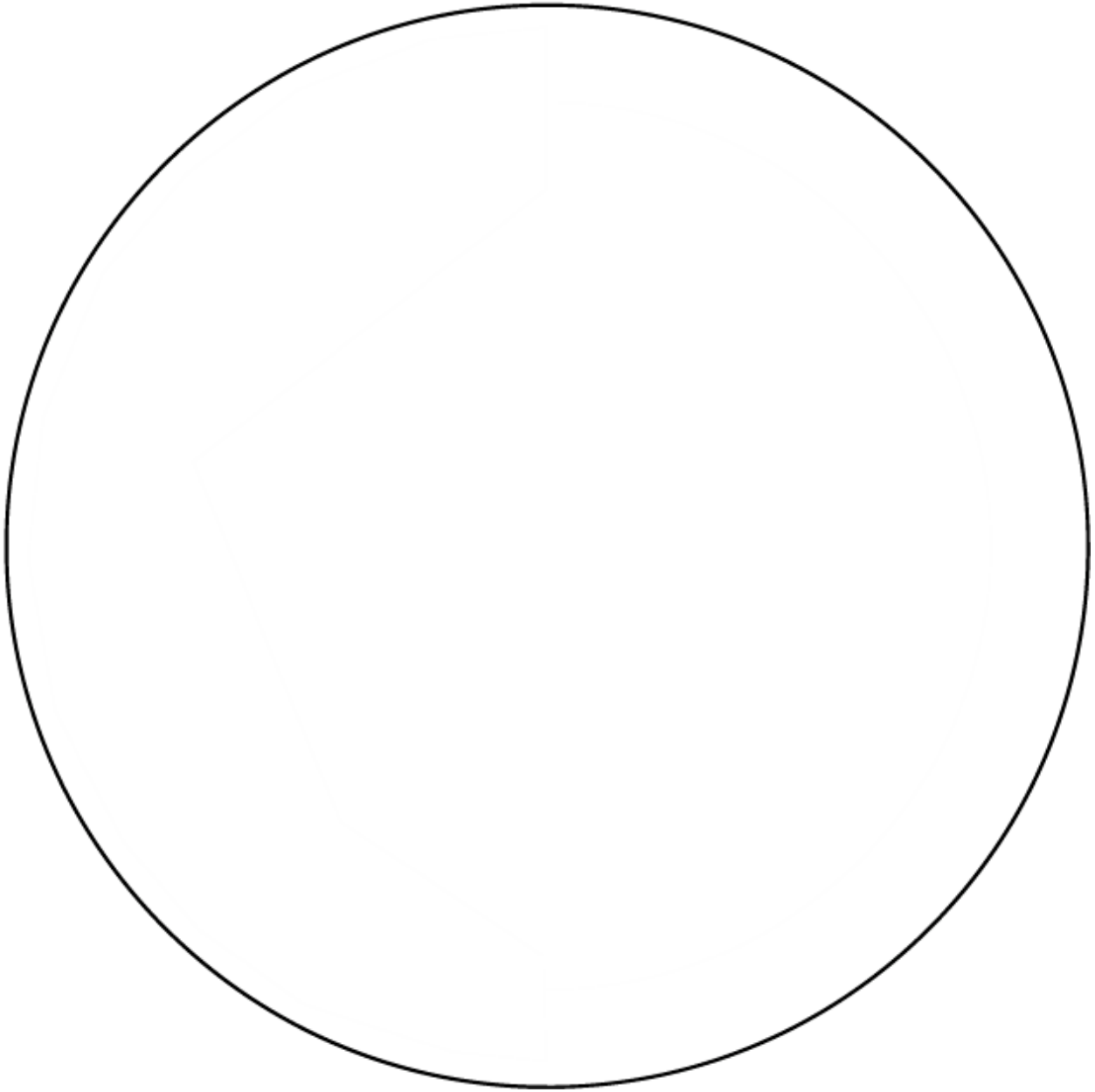
- **At plate boundaries**
  1. **Where they pull apart (divergent)**
  2. **Where they crash together (convergent)**
  3. **Where they slide past one another (transform)**



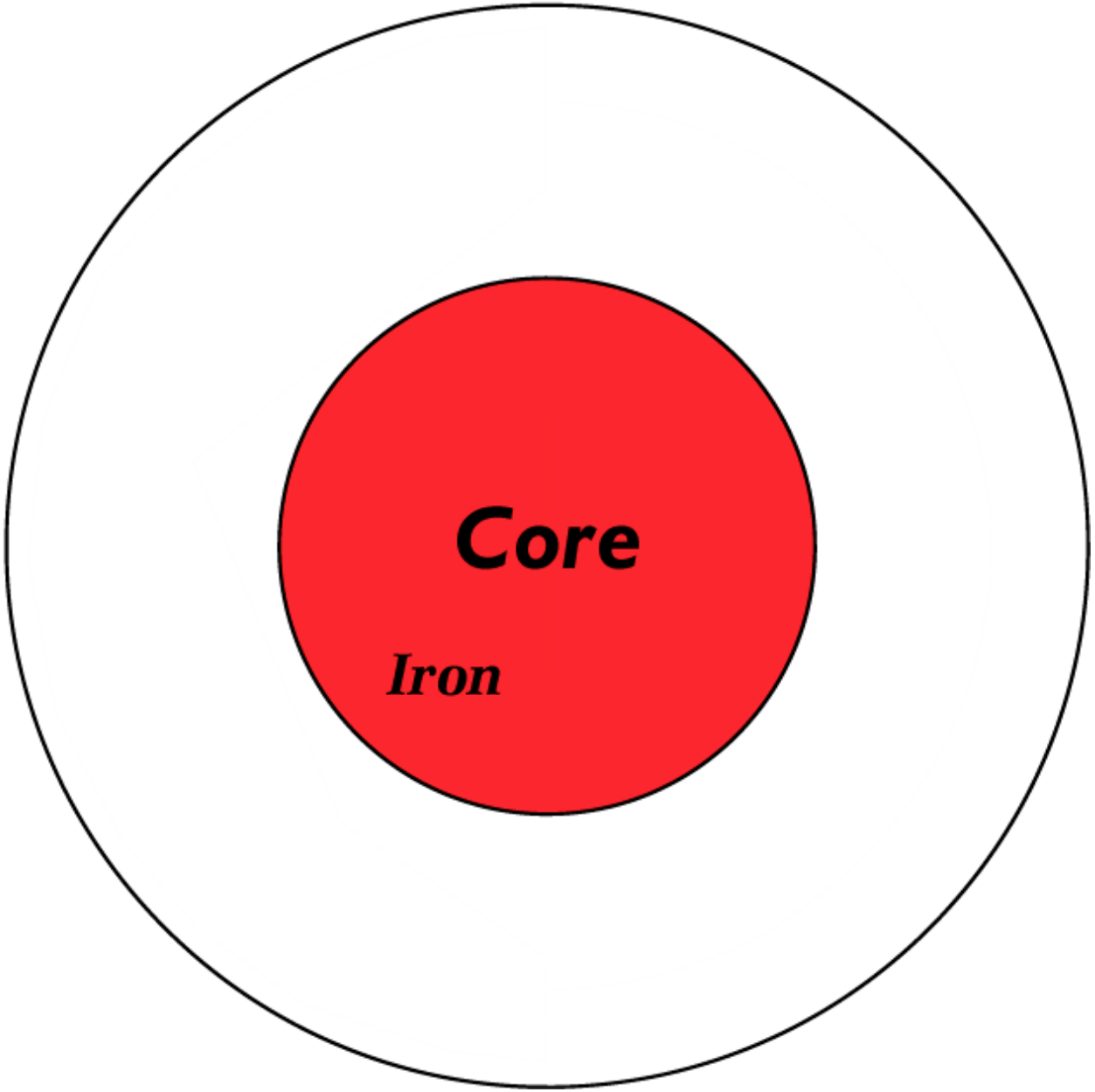


National Aeronautics and Space Administration

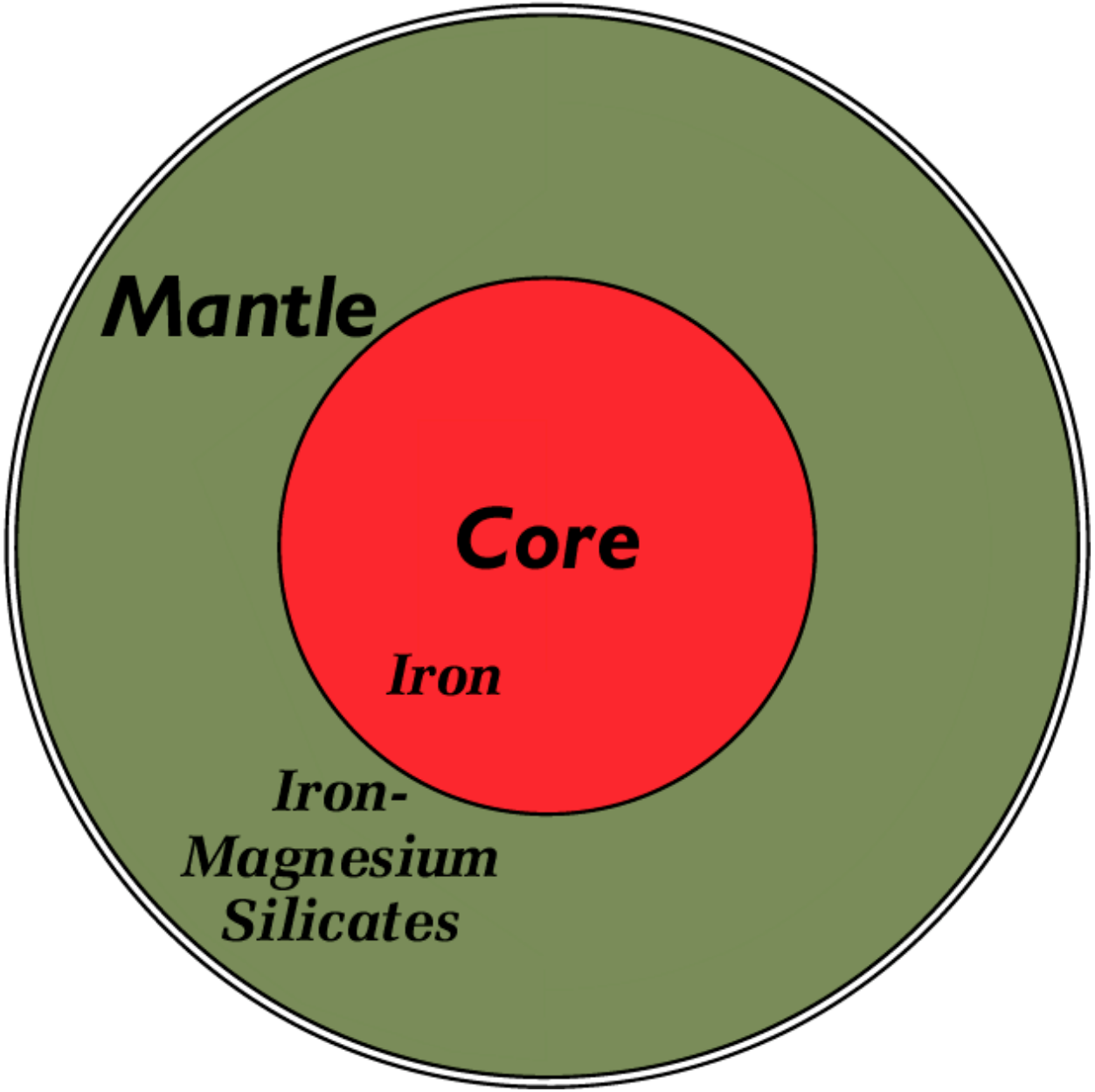
Classical Divisions of the Earth
(Chemical Composition)



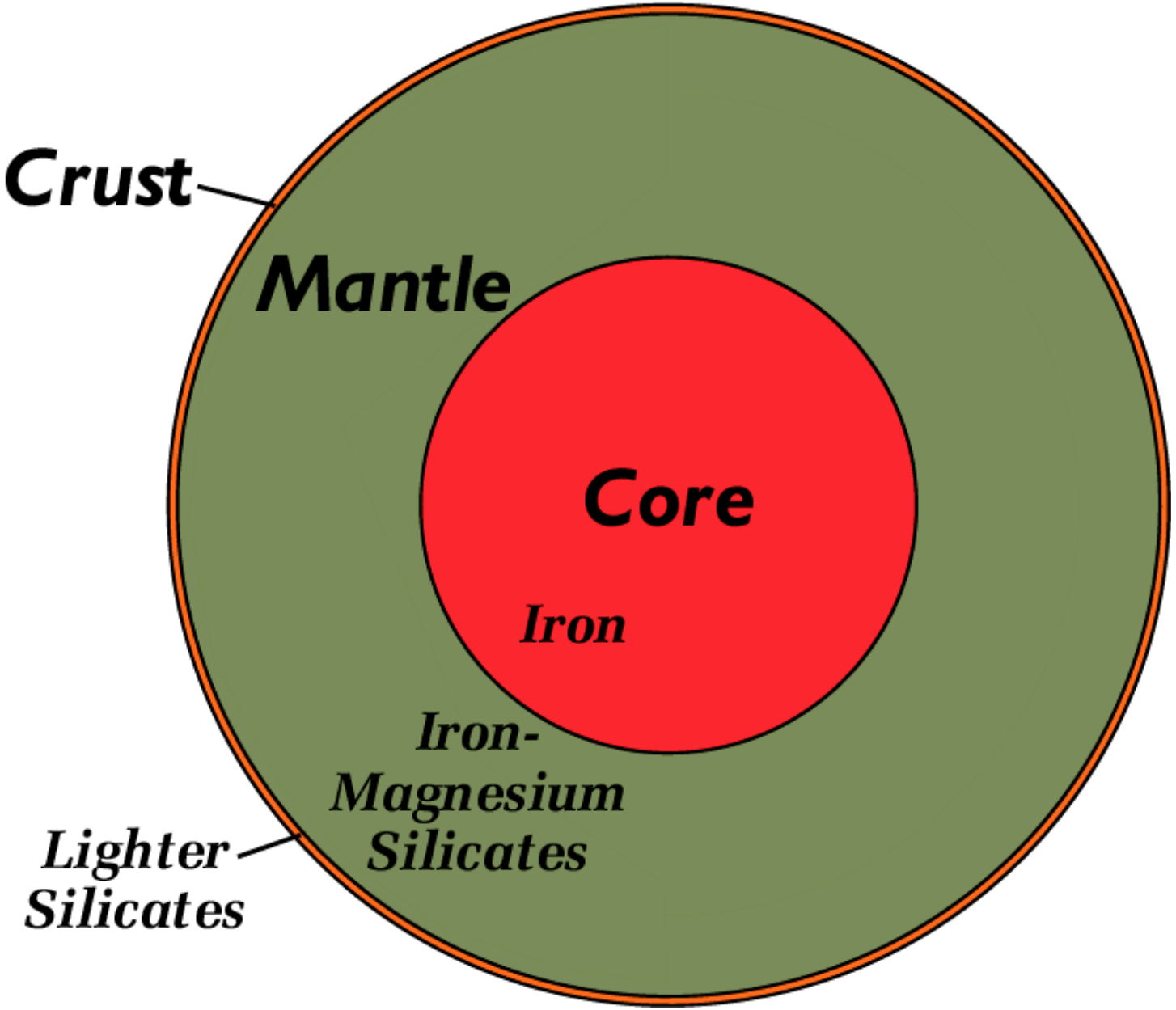
Classical Divisions of the Earth
(Chemical Composition)

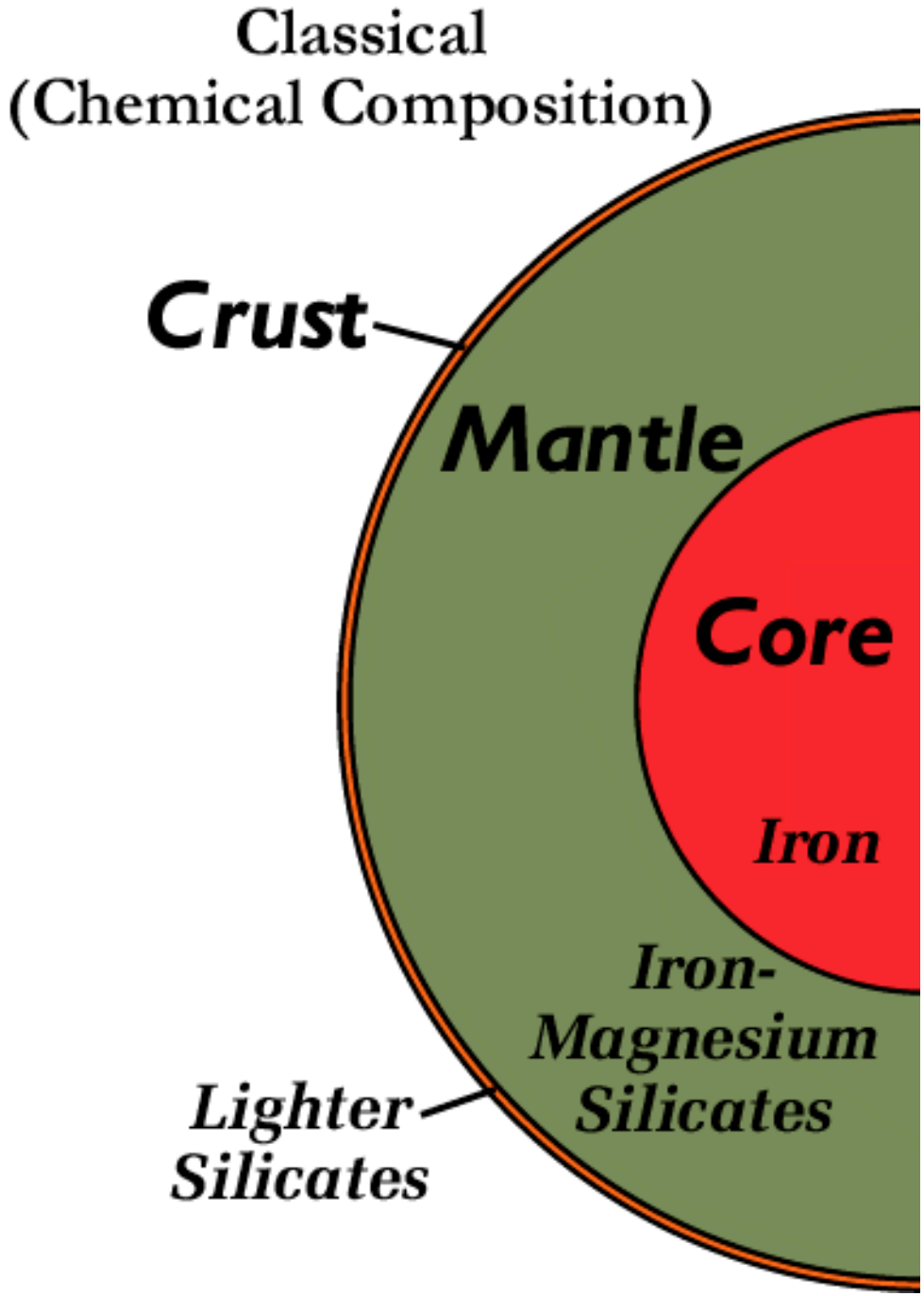


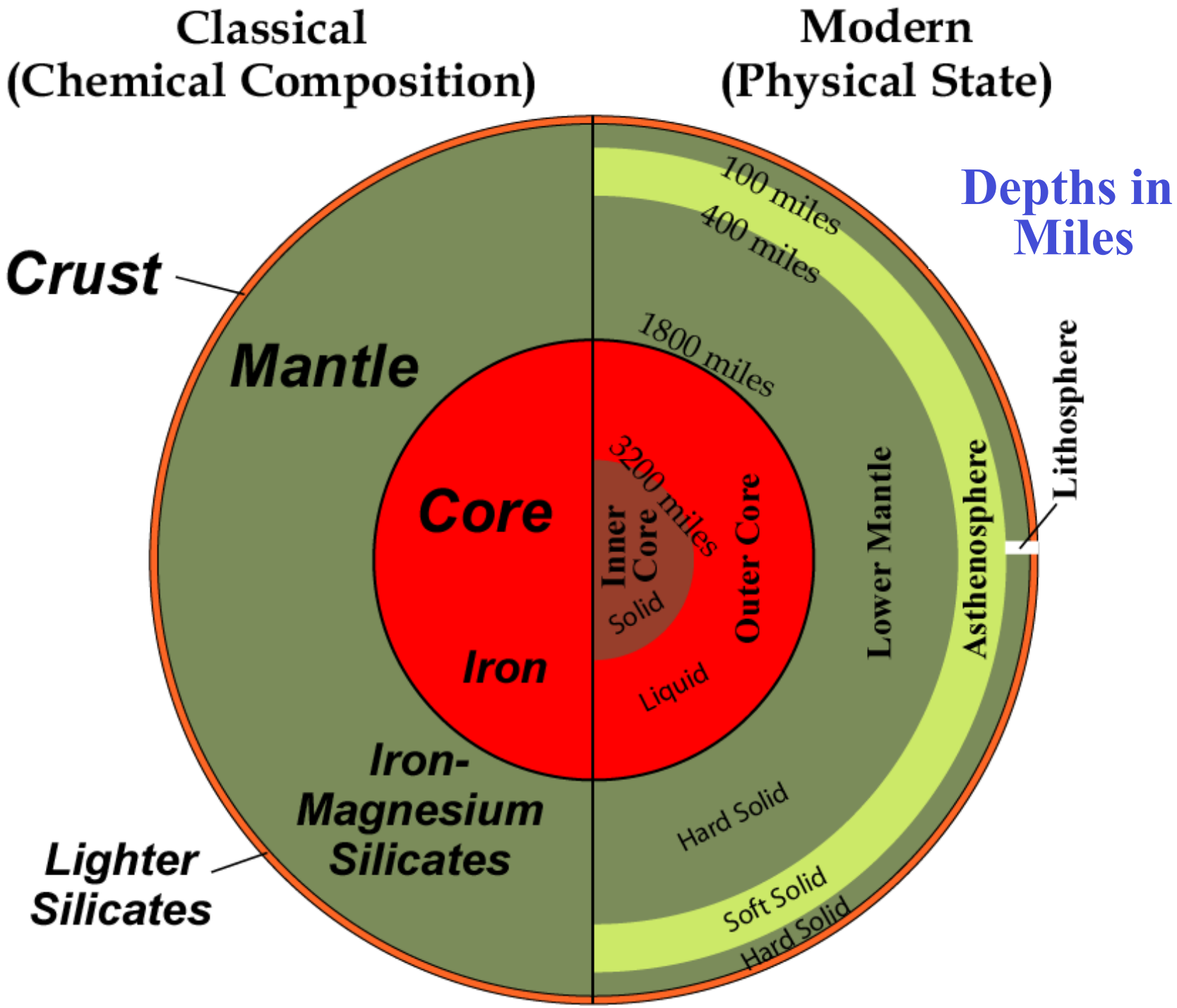
Classical Divisions of the Earth (Chemical Composition)

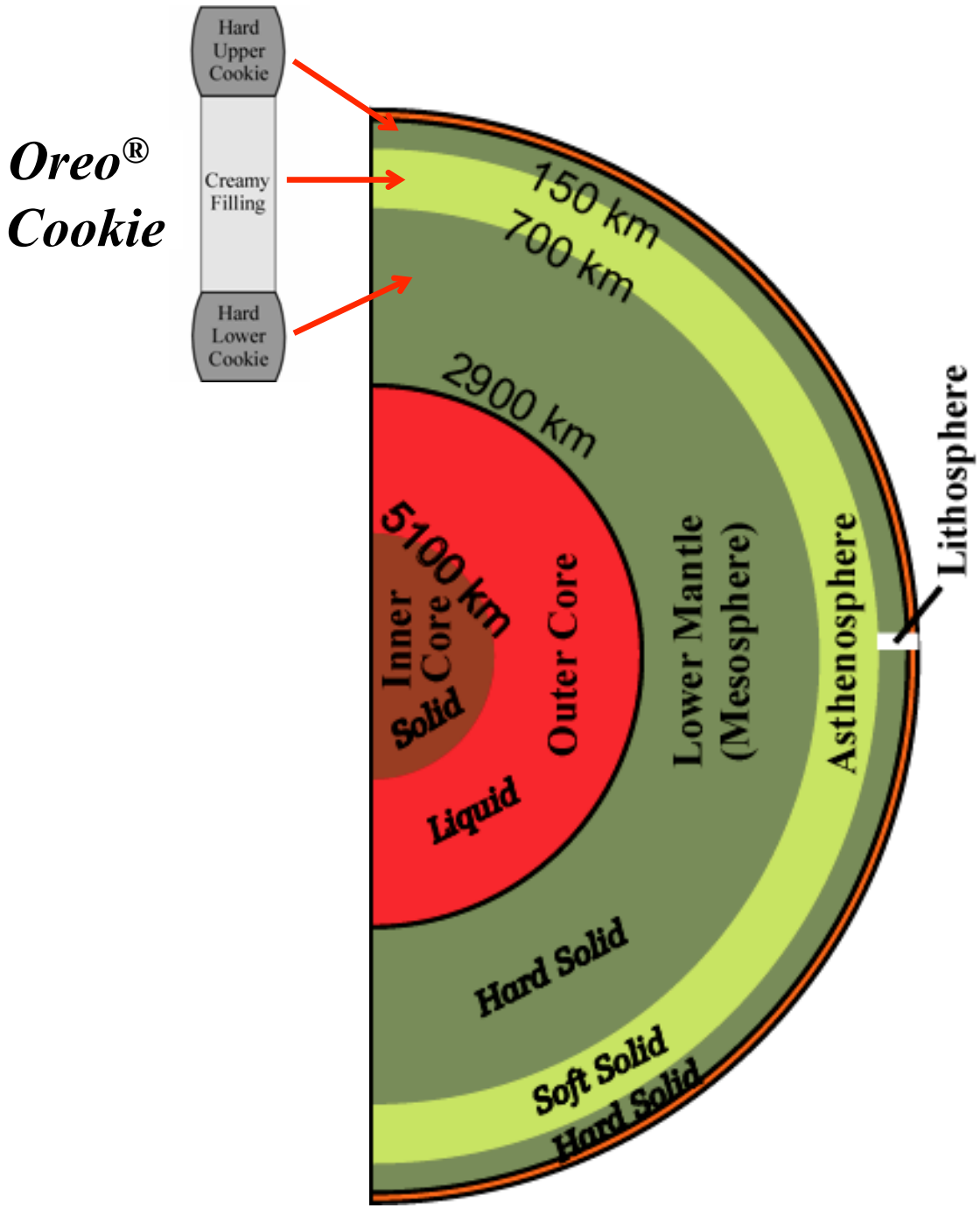


Classical Divisions of the Earth
(Chemical Composition)




Classical
(Chemical Composition)
Crust
Mantle
Core
Iron
Iron-
Magnesium
Silicates
Lighter
Silicates


Classical
(Chemical Composition)
Modern
(Physical State)
Depths in Miles
Crust
Mantle
Core
Iron
Iron-
Magnesium
Silicates
Lighter
Silicates
100 miles
400 miles
1800 miles
3200 miles
Inner Core
Solid
Outer Core
Liquid
Lower Mantle
Hard Solid
Asthenosphere
Soft Solid
Lithosphere
Hard Solid


Oreo®
Cookie
Hard Upper Cookie
Creamy Filling
Hard Lower Cookie
150 km
700 km
2900 km
5100 km
Inner Core
Solid
Liquid
Outer Core
Lower Mantle (Mesosphere)
Asthenosphere
Lithosphere
Hard Solid
Soft Solid
Hard Solid

Oreo® Cookie

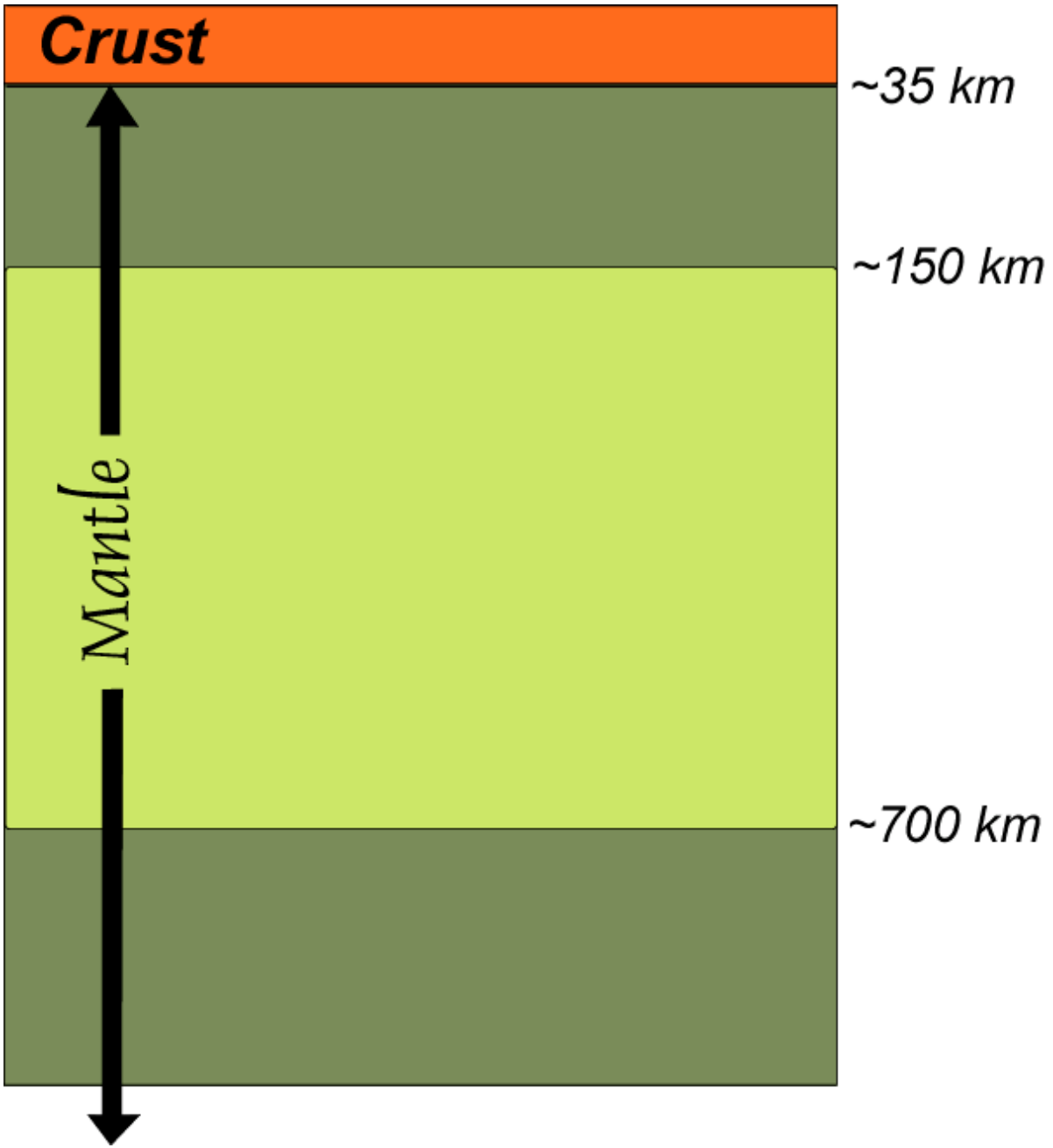
Oreo® Cookie


Hard
Upper
Cookie
Creamy
Filling
Hard
Lower
Cookie


Crust
~35 km

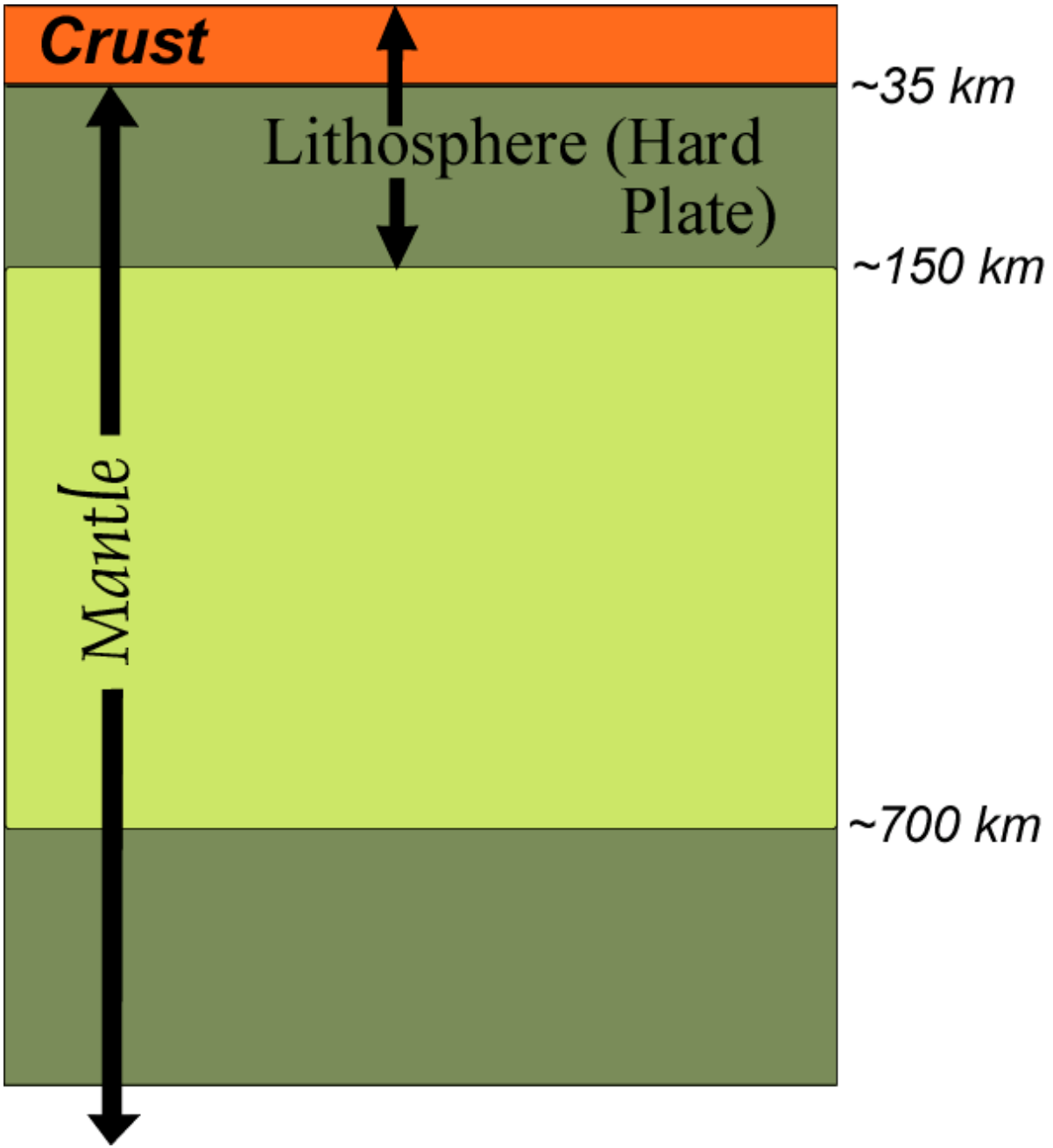
Oreo® Cookie


Hard
Upper
Cookie
Creamy
Filling
Hard
Lower
Cookie


Crust
~35 km
~150 km
Mantle
~700 km

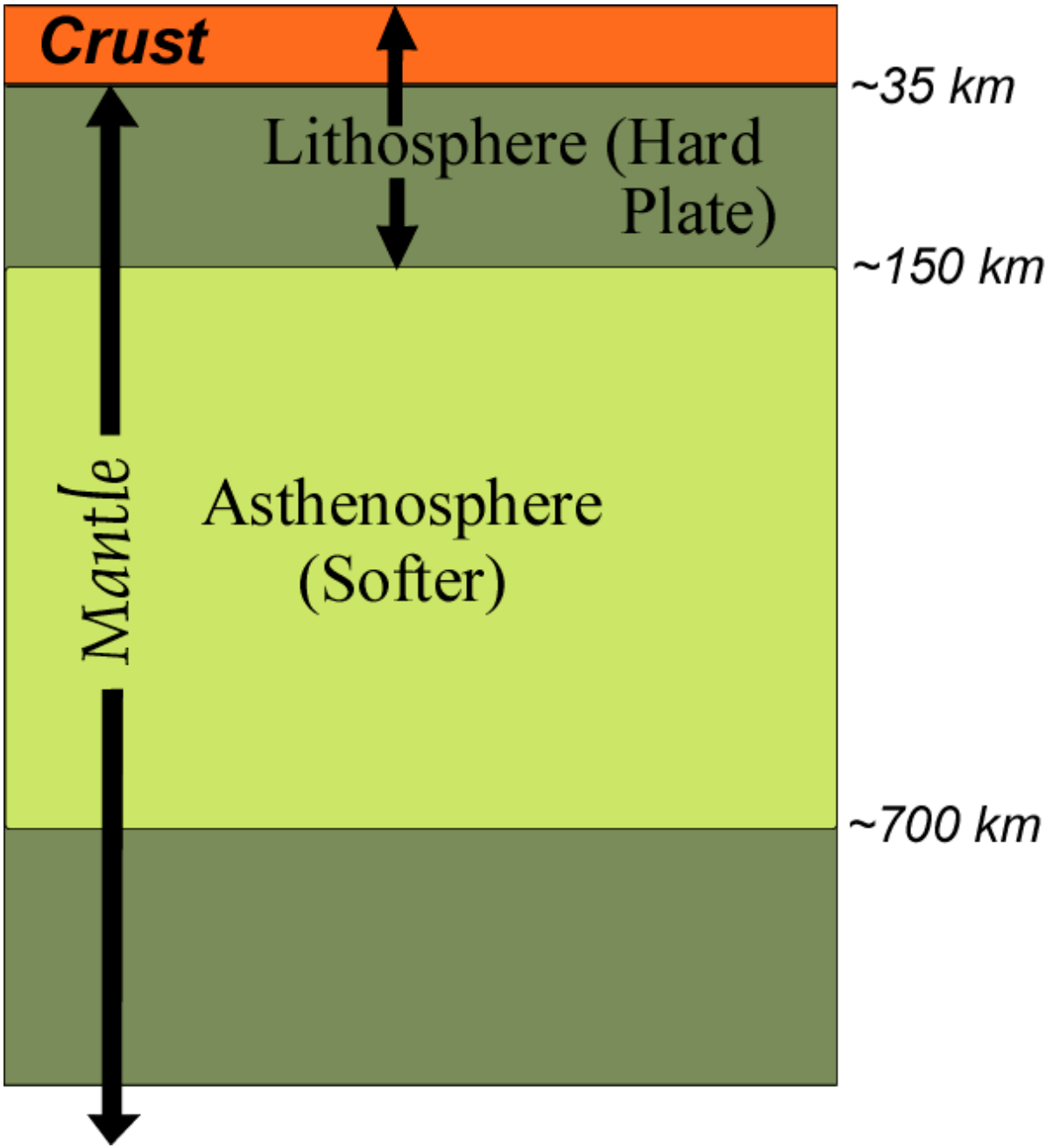
Oreo® Cookie


Hard Upper Cookie
Creamy Filling
Hard Lower Cookie


Crust
Lithosphere (Hard Plate)
Mantle
~35 km
~150 km
~700 km

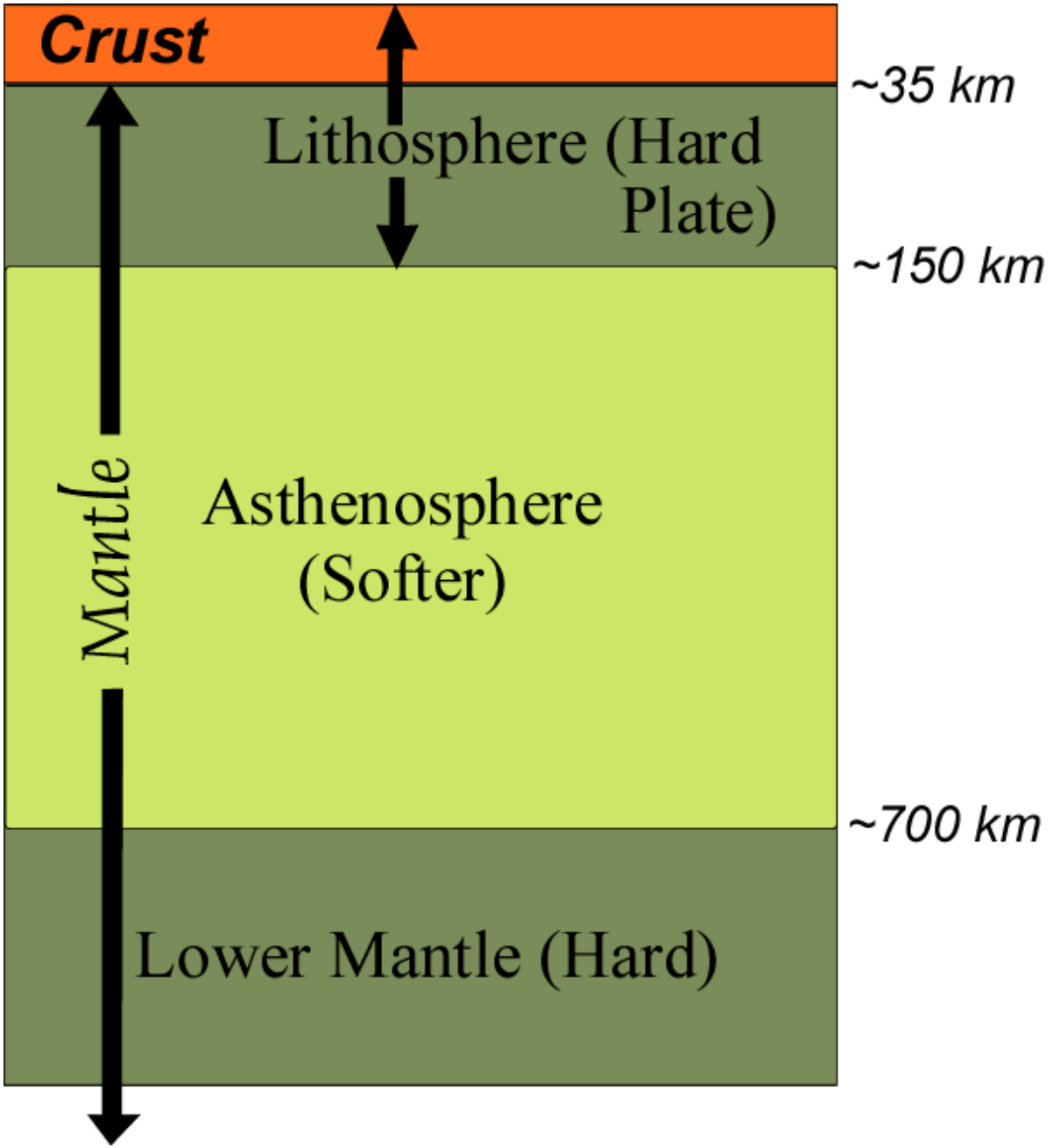
Oreo® Cookie


Hard
Upper
Cookie
Creamy
Filling
Hard
Lower
Cookie


Crust
~35 km
Lithosphere (Hard
Plate)
~150 km
Mantle
Asthenosphere
(Softer)
~700 km

Oreo® Cookie


Hard Upper Cookie
Creamy Filling
Hard Lower Cookie


Crust
Lithosphere (Hard Plate)
Mantle
Asthenosphere (Softer)
Lower Mantle (Hard)
~35 km
~150 km
~700 km


Robert J. Lillie

Oreo® Psycho-Personality Test

www.superkids.com/aweb/pages/humor/050199.sht

- **Psychologists have discovered that the manner in which people eat Oreo® cookies provides great insight into their personalities. Choose which method best describes your favorite method of eating Oreos:**
- **1. The whole thing at once.**
  2. One bite at a time.
  3. Slow and methodical nibbles examining the results of each bite afterwards.
  4. In little feverous nibbles.
  5. Dunked in some liquid (milk, coffee …..)
  6. Twisted apart, the inside, then the cookie.
  7. Twisted apart, the inside, and toss the cookie.
  8. Just the cookie, not the inside.
  9. I just like to lick them, not eat them.
  10. I don't have a favorite way because I don't like Oreos.

6. Twisted apart, the inside, then the cookie.

- You have a highly curious nature.
- You take pleasure in breaking things apart to find out how they work, though you're not always able to put them back together, so you destroy all the evidence of your activities.
- You deny your involvement when things go wrong.
- You are a compulsive liar and exhibit deviant, if not criminal, behavior.

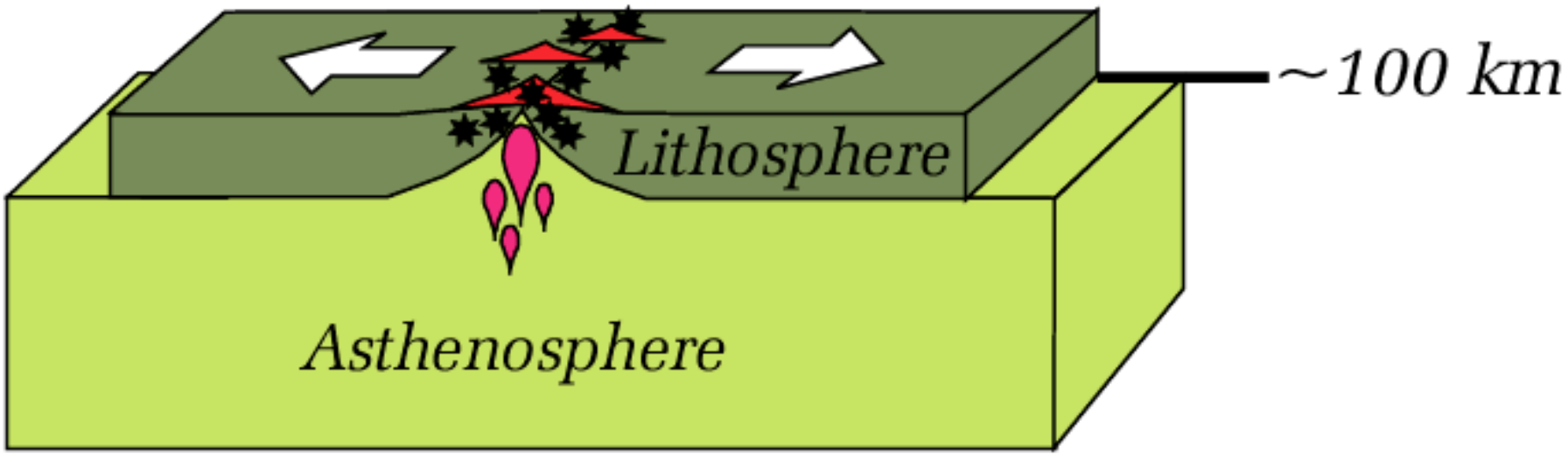
Sliding Plate over Asthenosphere

Robert J. Lillie

Divergent Plate Boundary


Mid-Atlantic
Ridge

Divergent Plate Boundary

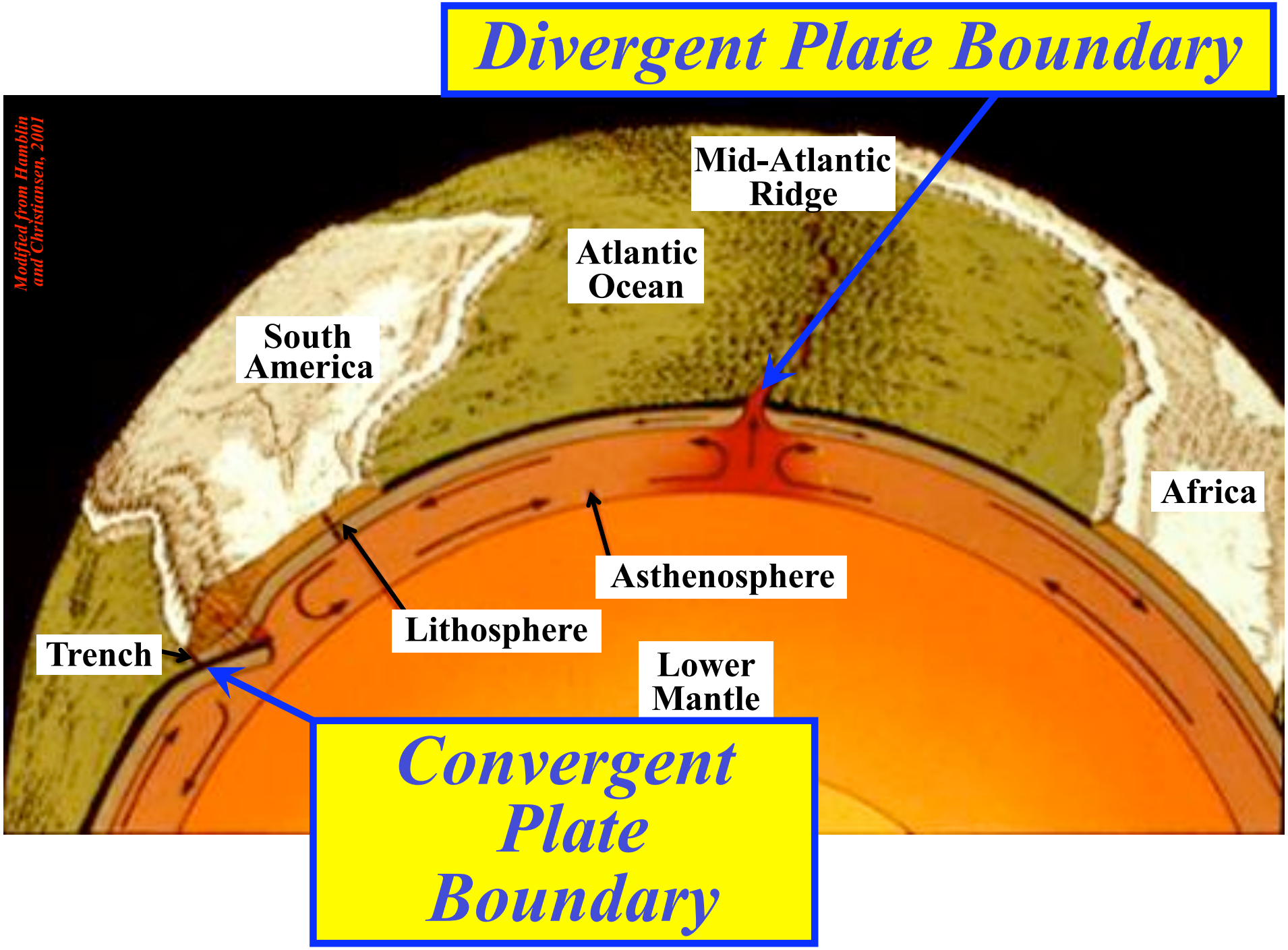


Volcanoes

Earthquakes

- Small to Moderate Size
- Very Large

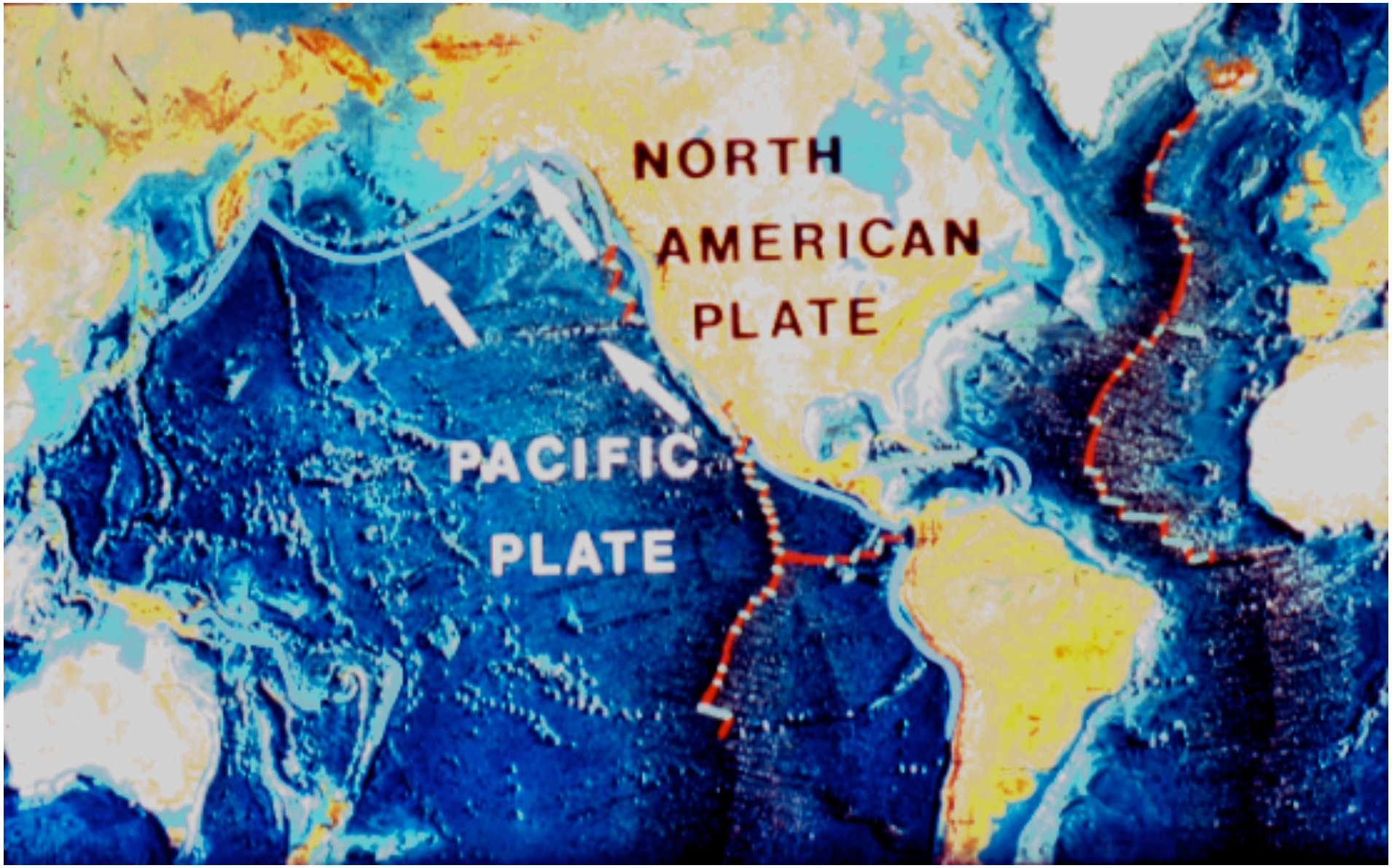
Convergent Plate Boundary


Divergent Plate Boundary
Modified from Hamblin and Christiansen, 2001
Mid-Atlantic Ridge
Atlantic Ocean
South America
Africa
Asthenosphere
Lithosphere
Trench
Lower Mantle
Convergent Plate Boundary


Andes
Mountains

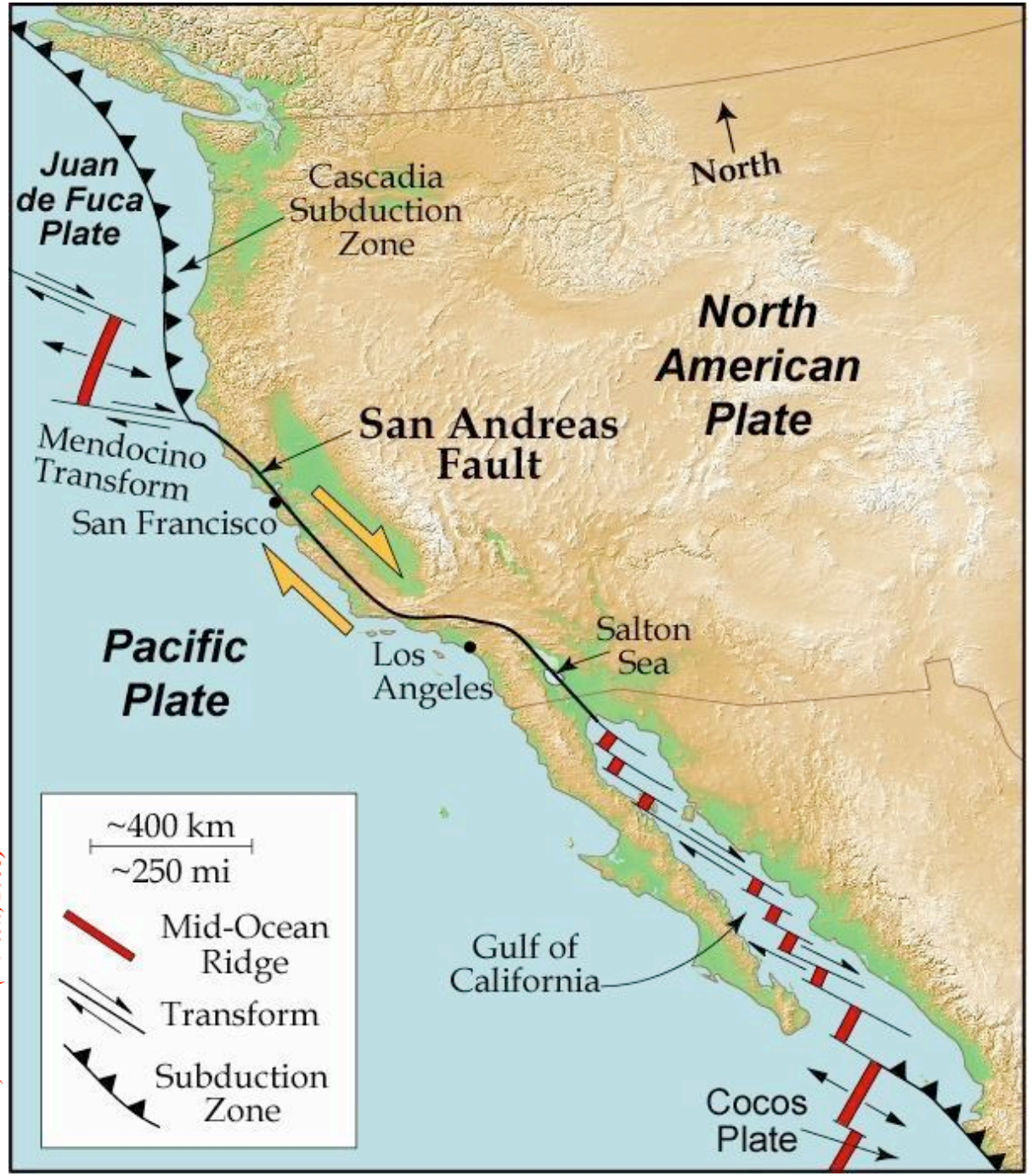
Robert J. Lillie

Transform Plate Boundary

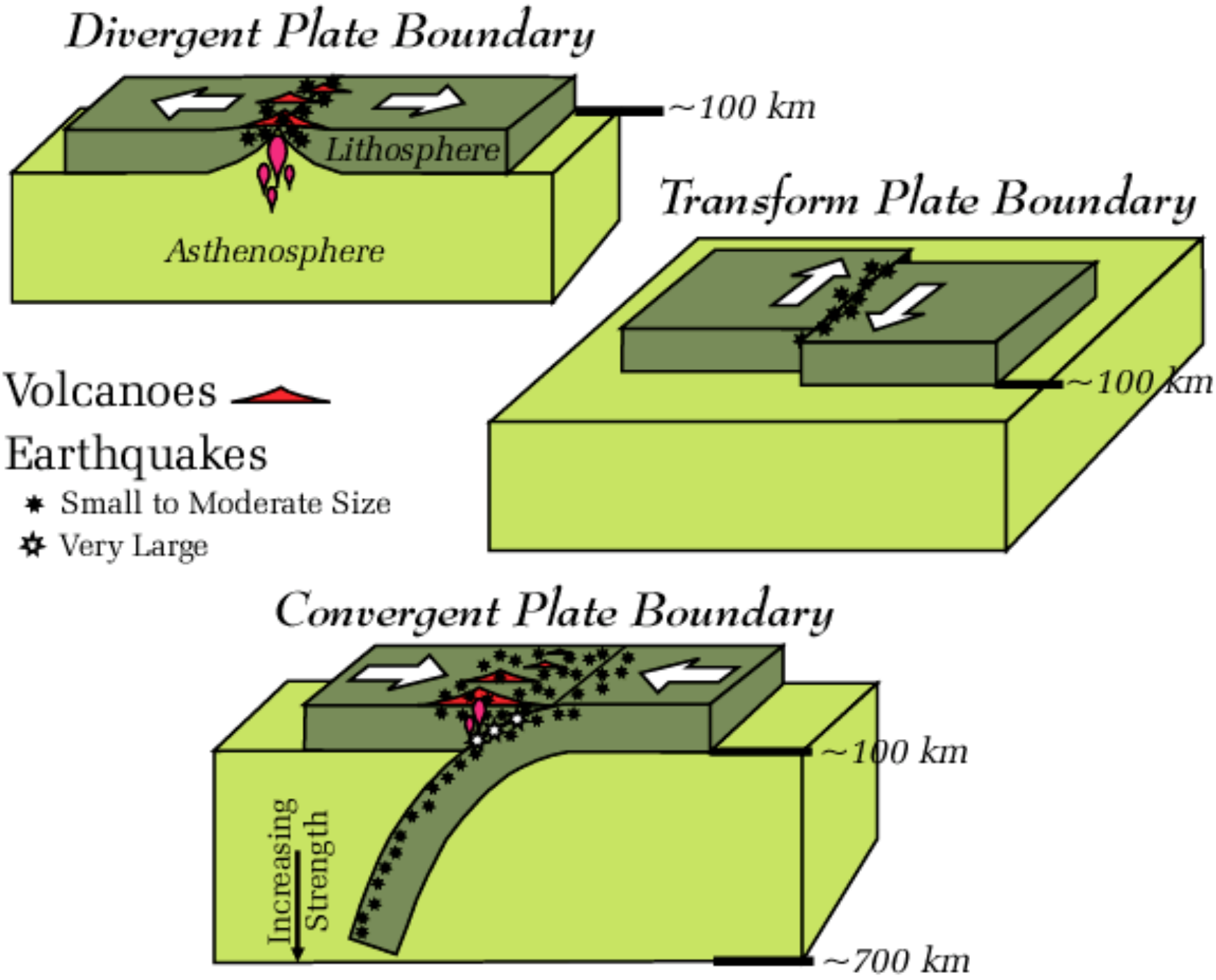

NORTH
AMERICAN
PLATE
PACIFIC
PLATE

Transform Plate Boundary

The Pacific Plate slides past the North American Plate along the <u>San Andreas Fault</u> in California.



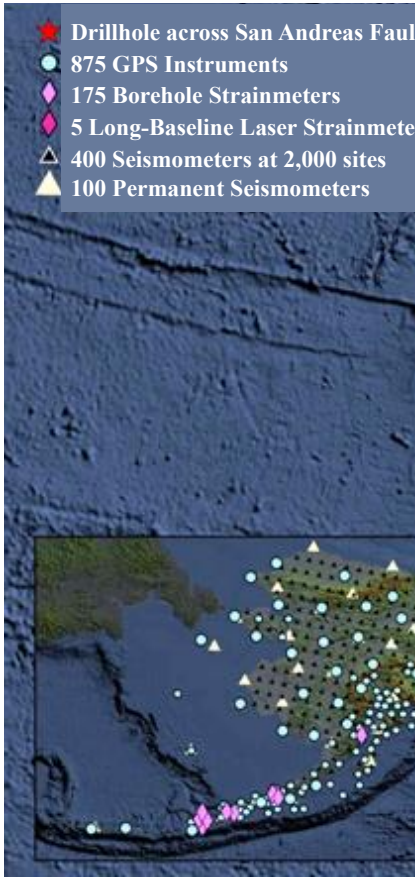
Marshak, EARTH (Norton, 2005)

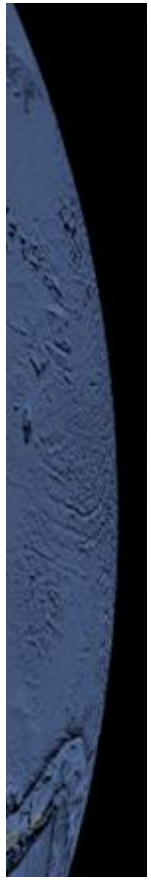

Divergent Plate Boundary
~100 km
Lithosphere
Asthenosphere
Transform Plate Boundary
~100 km
Volcanoes
Earthquakes
Small to Moderate Size
Very Large
Convergent Plate Boundary
~100 km
Increasing Strength
~700 km

OSU Oregon State University

EarthScope National Office

Workshops for Interpretive Professionals in Parks and Museums

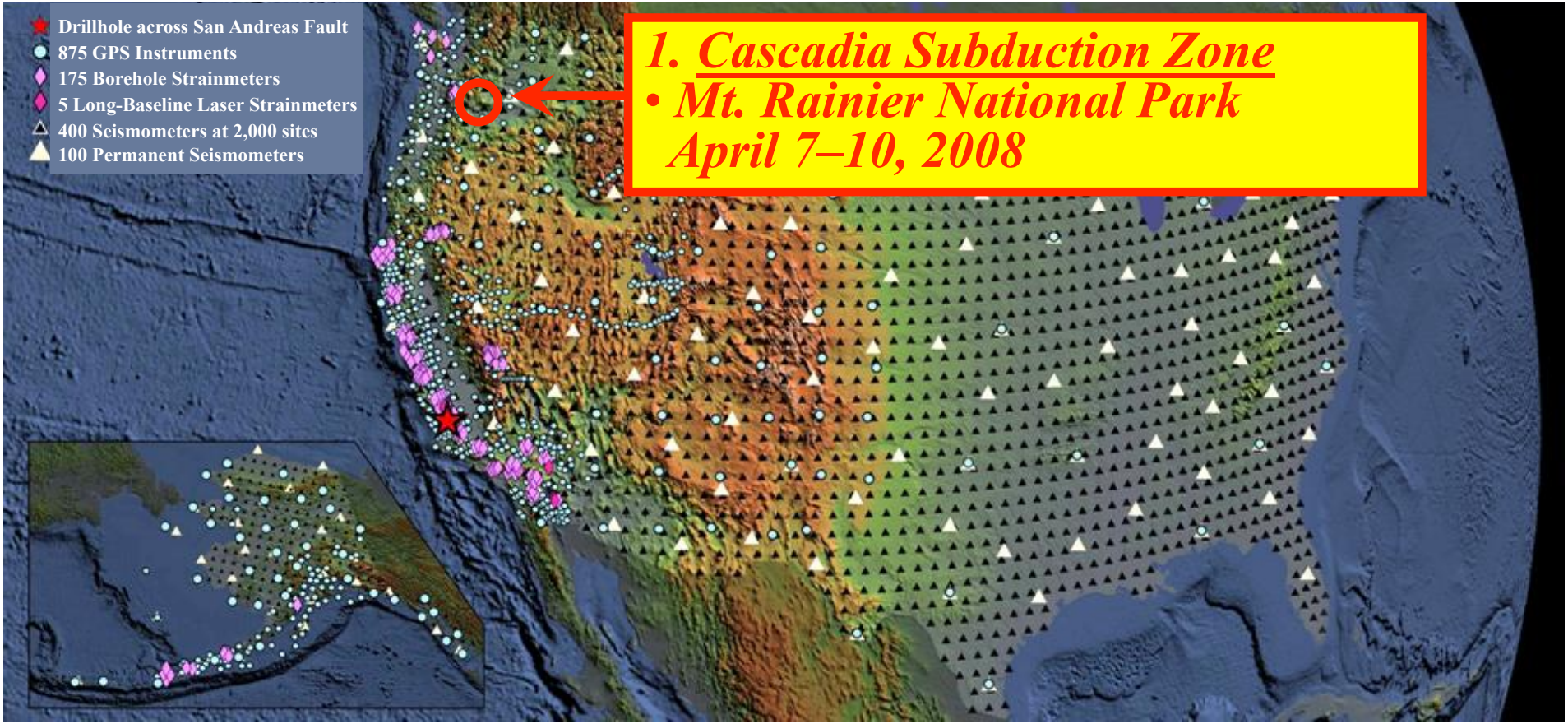




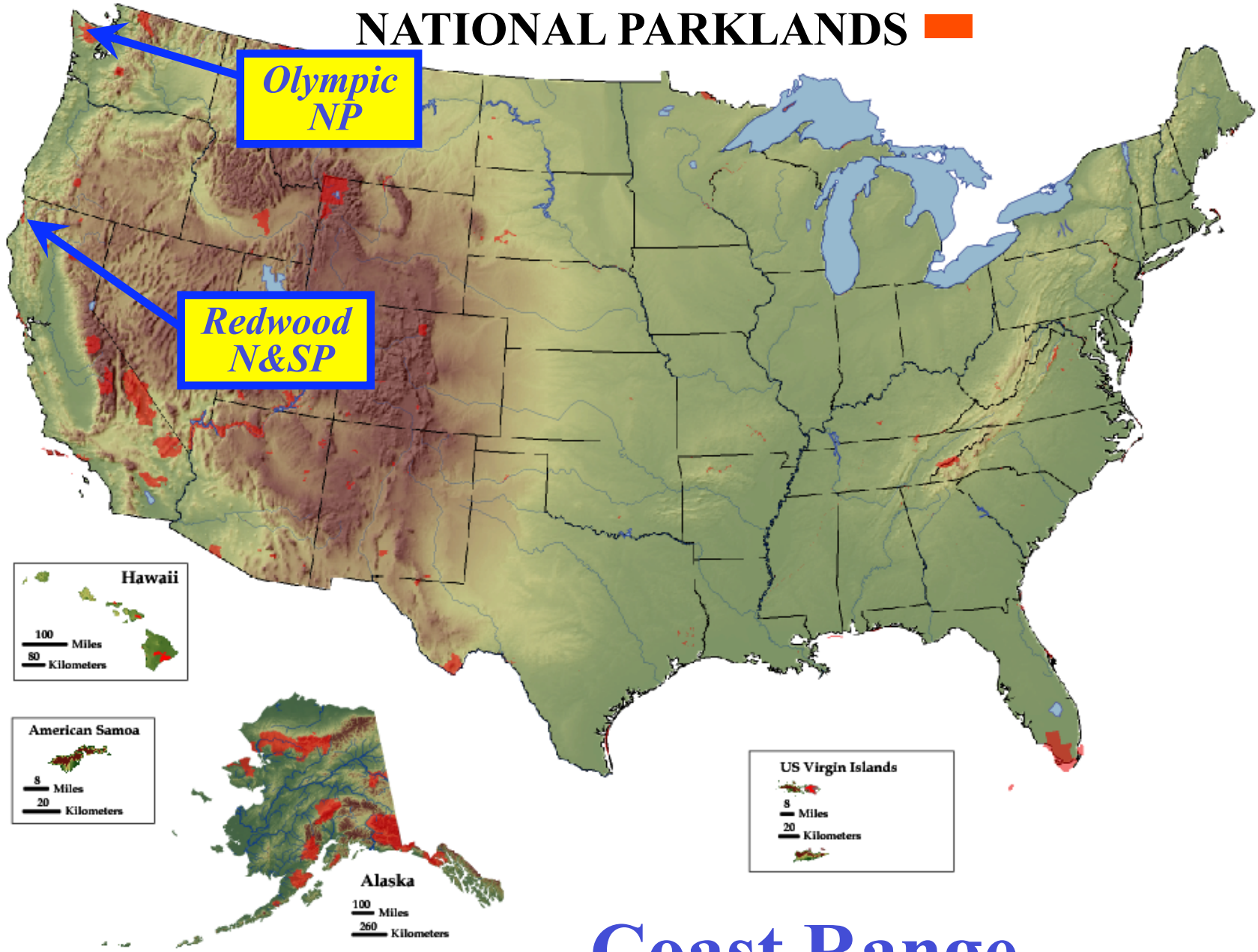
OSU Oregon State University

EarthScope National Office

Workshops for Interpretive Professionals in Parks and Museums



Parks and Plates

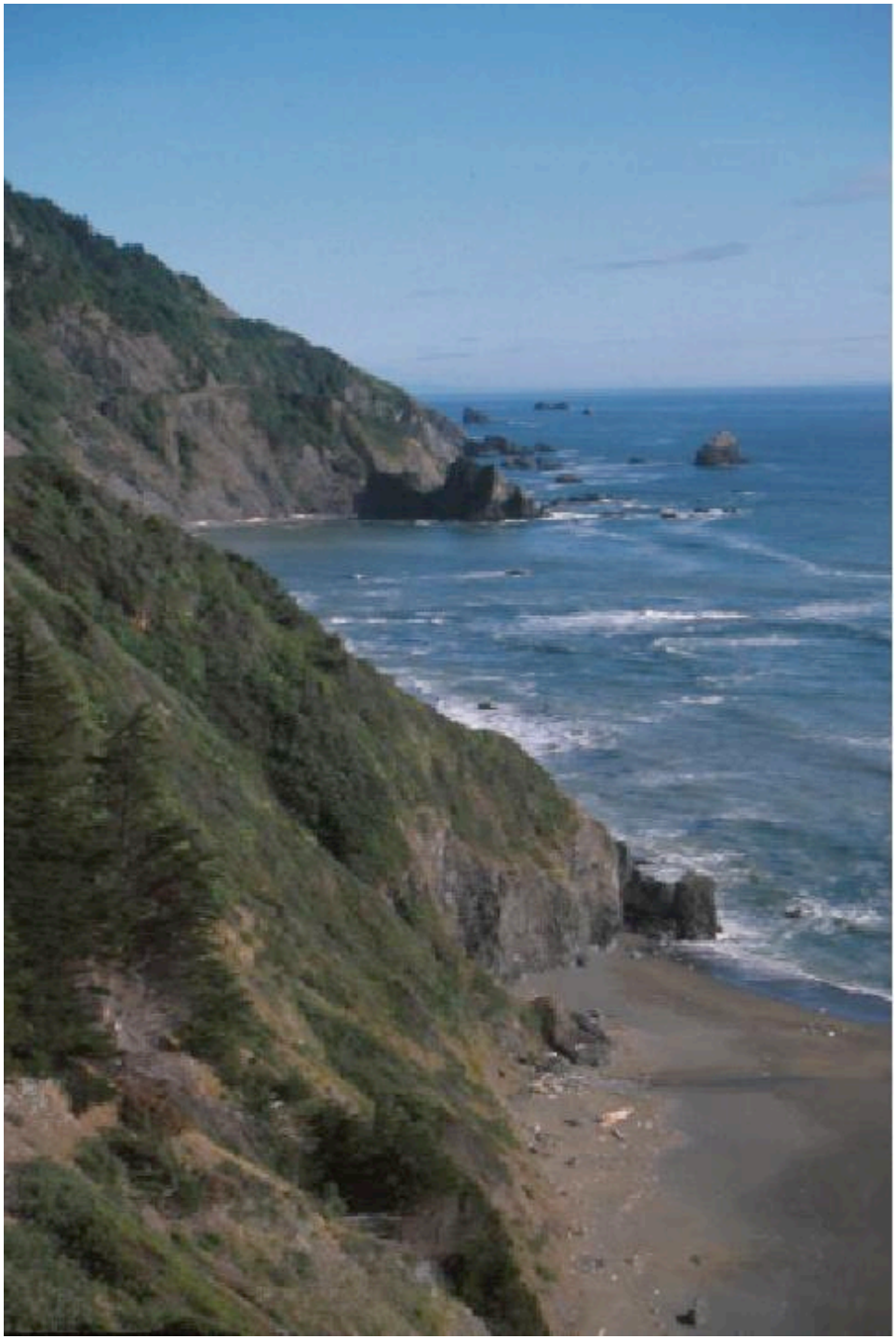

NATIONAL PARKLANDS
Olympic NP
Redwood N&SP
Hawaii
100 Miles
80 Kilometers
American Samoa
8 Miles
20 Kilometers
Alaska
100 Miles
260 Kilometers
US Virgin Islands
8 Miles
20 Kilometers

Coast Range

Olympic National Park, Washington

Robert J. Lillie

Redwood National and State Parks, California



Robert J. Lillie


NATIONAL PARKLANDS
Mount Rainier NP
Mt. St. Helens NVM
Crater Lake NP
Lassen Volcanic NP
Hawaii
100 Miles
80 Kilometers
American Samoa
8 Miles
20 Kilometers
Alaska
100 Miles
260 Kilometers
US Virgin Islands
8 Miles
20 Kilometers

Cascades

Mount Rainier National Park, Washington

Robert J. Lillie

Mt. St. Helens National Volcanic Monument, Washington

U. S. Geological Survey

Crater Lake National Park, Oregon

Lassen Volcanic National Park, California

Coastal Ranges

Cascade Volcanoes

Why are there Two Parallel Mountain Ranges in the Pacific Northwest?

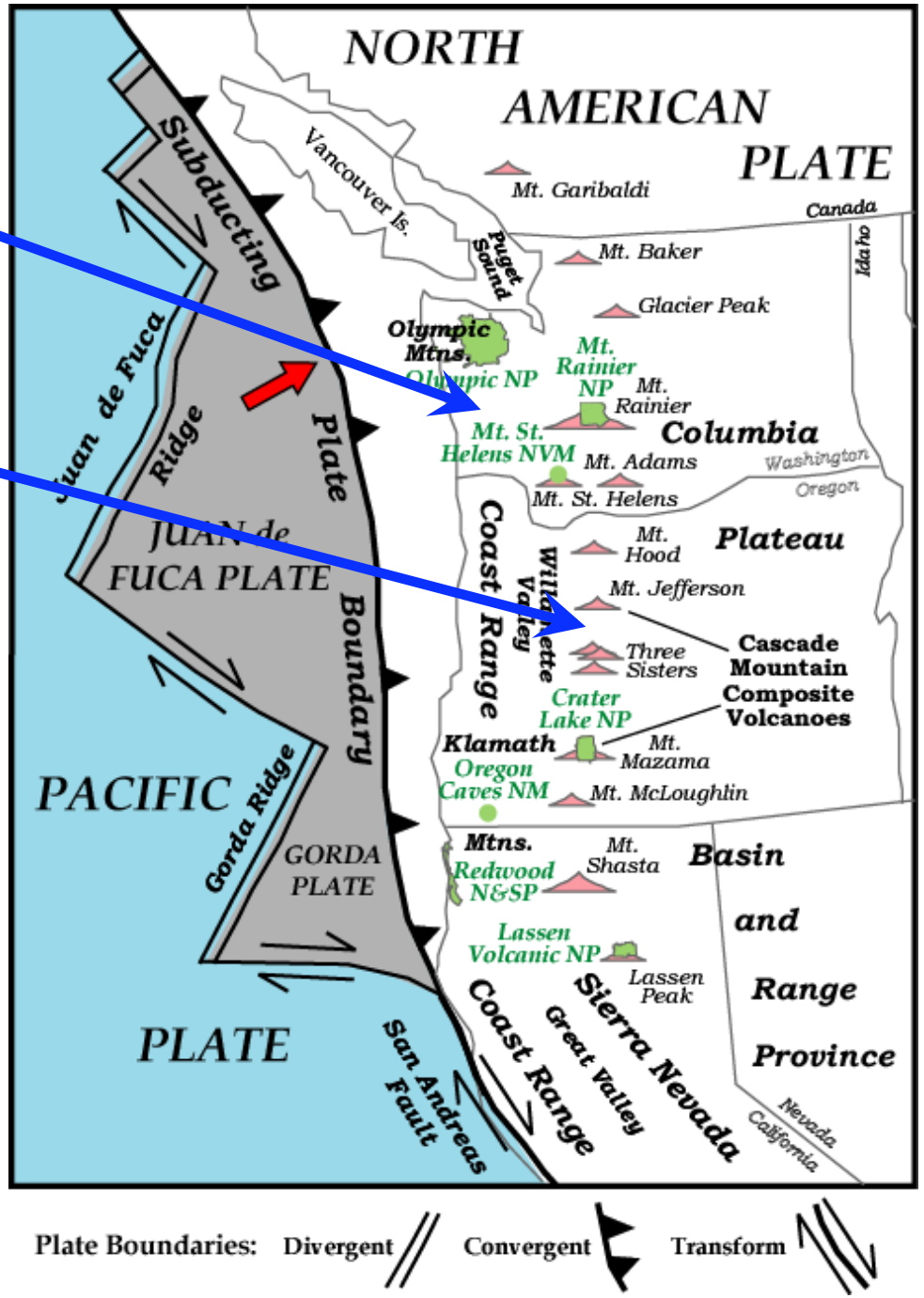
National Park Lands in the Pacific Northwest

Coastal Ranges

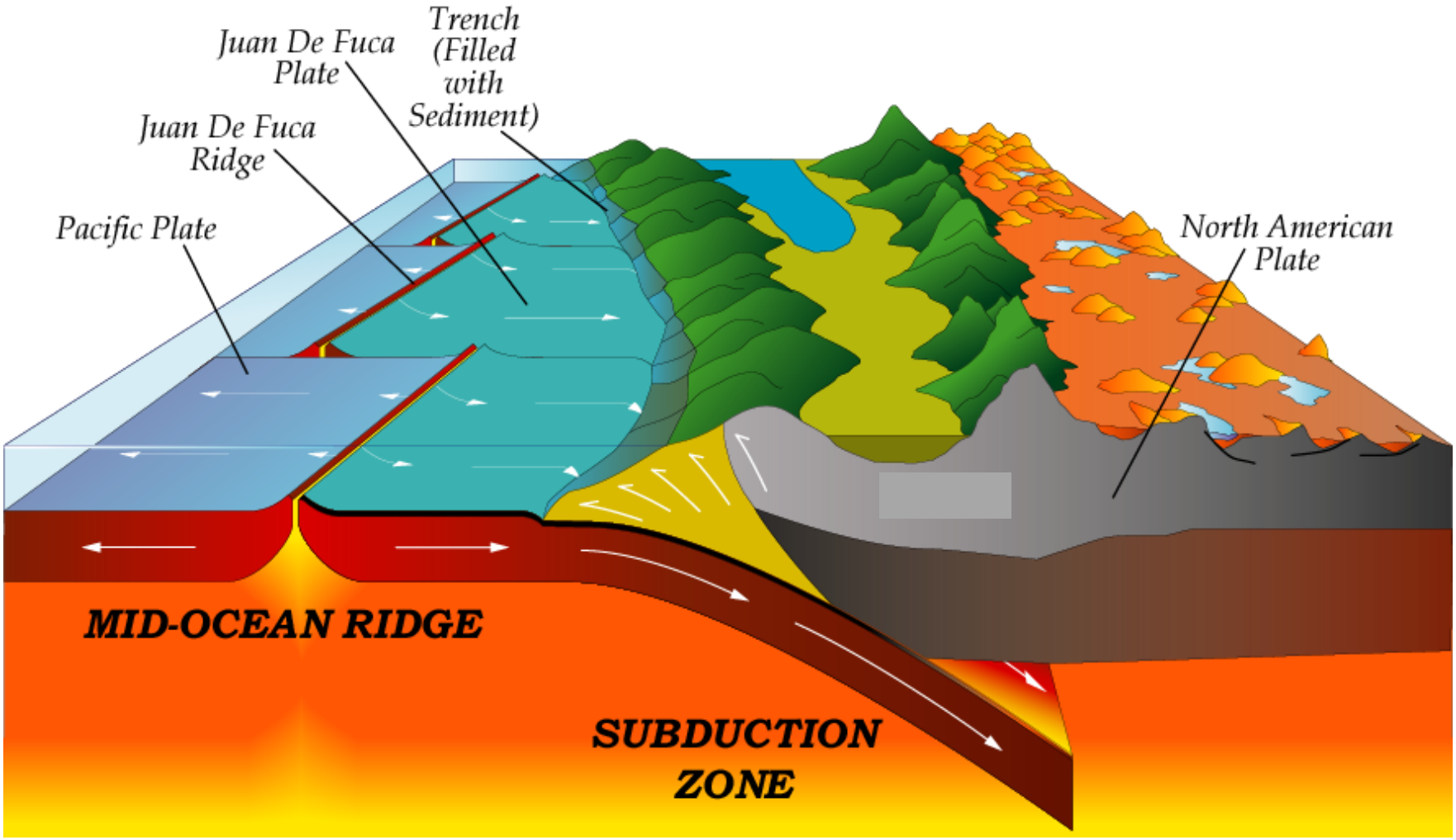
Cascade Volcanoes

Subduction of the Juan de Fuca Plate forms the Coastal Ranges and Cascade Volcanoes

National Park Lands in the Pacific Northwest

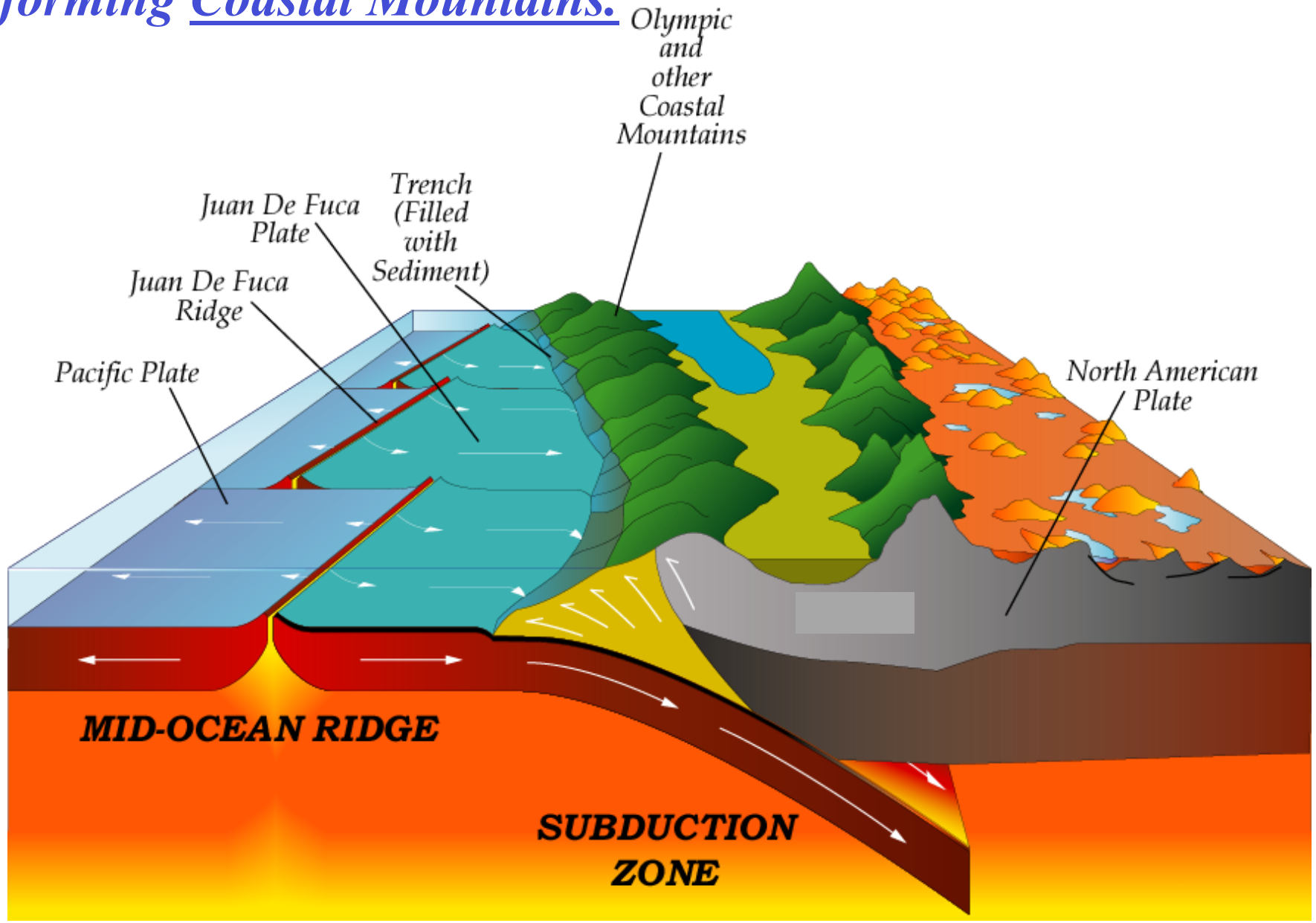


Subducting Juan de Fuca Plate forms two parallel mountain ranges in the Pacific Northwest.



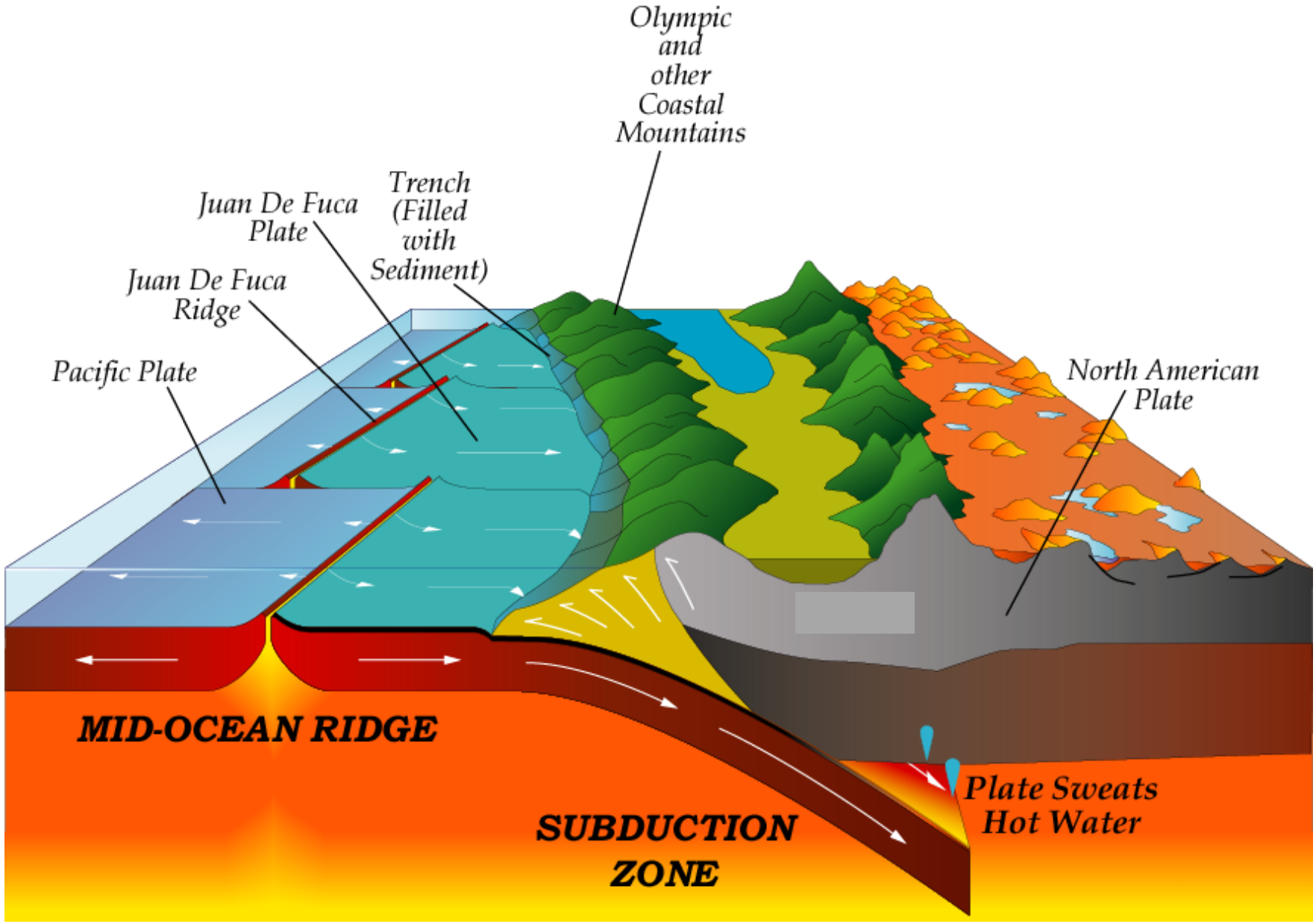
Robert J. Lillie
Bernard Garcia

Oceanic sediment and basalt scraped off subducting plate, forming Coastal Mountains.



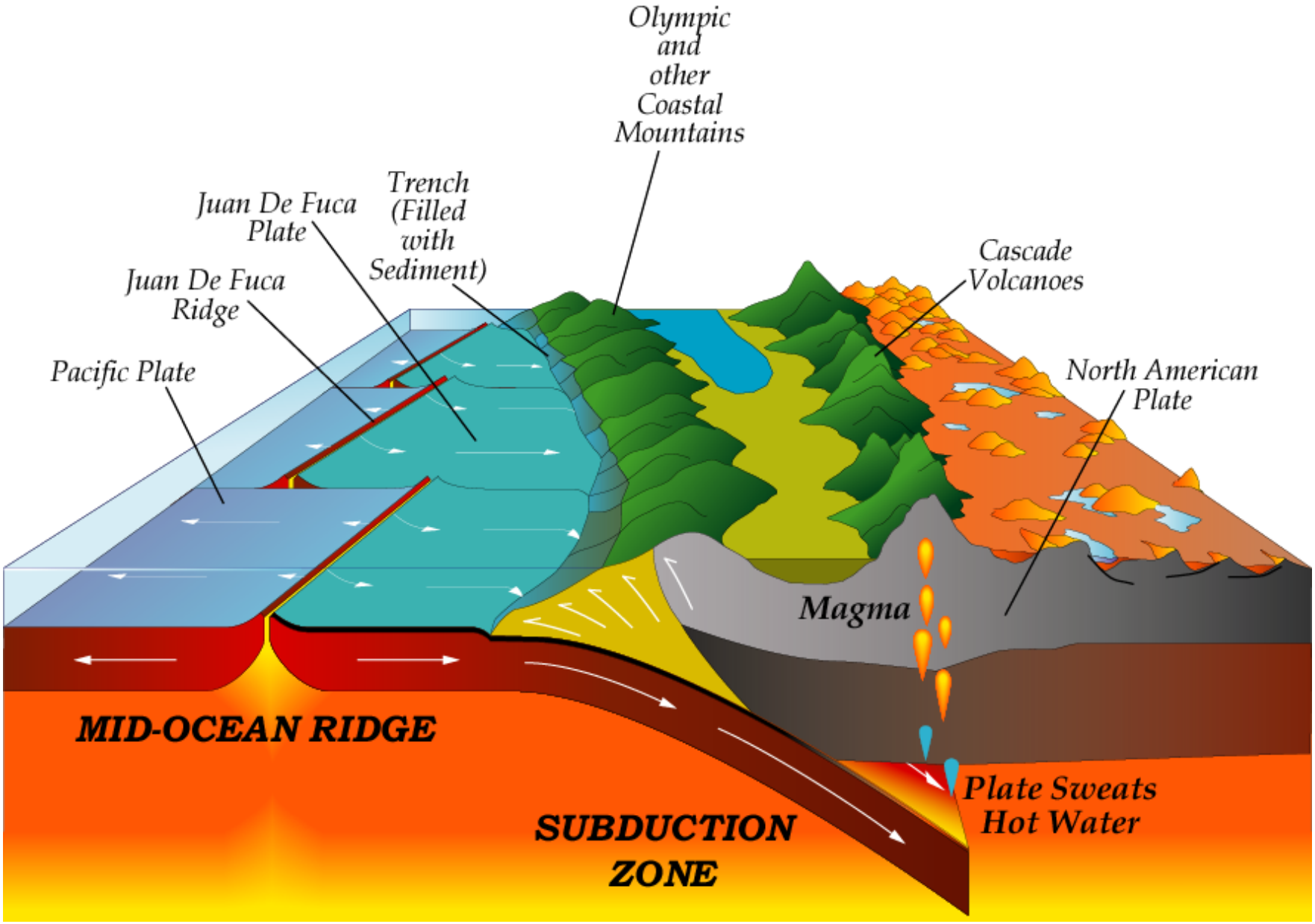
Robert J. Lillie
Bernard Garcia

Subducting plate dehydrates, forming Cascade Volcanoes.



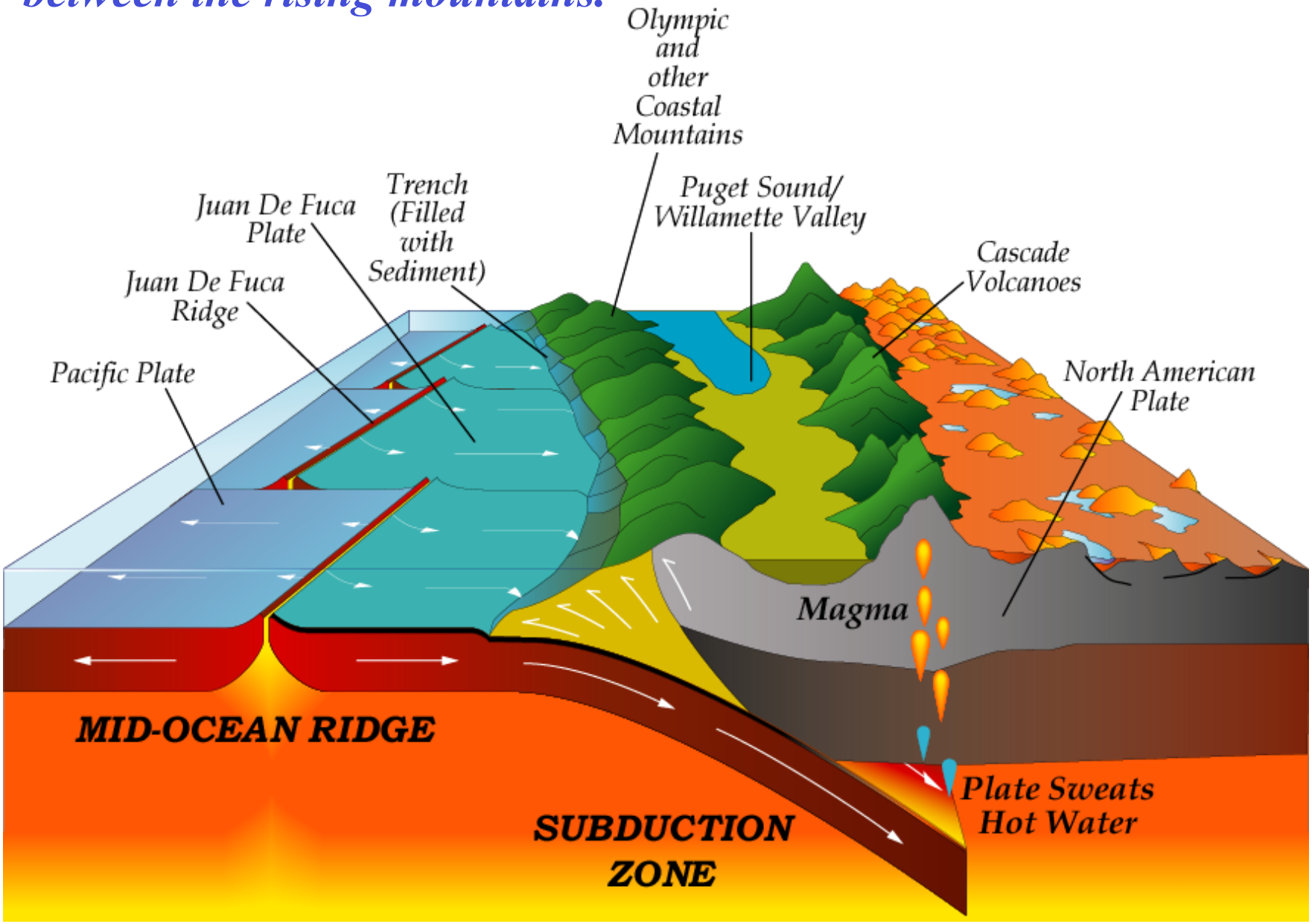
Robert J. Lillie
Bernard Garcia

Subducting plate dehydrates, forming Cascade Volcanoes.



Robert J. Lillie
Bernard Garcia

Puget Sound and the Willamette Valley are low-lying regions between the rising mountains.



Robert J. Lillie
Bernard Garcia

National Parks represent the two different mountain ranges.

Olympic and other Coastal Mountains

Trench (Filled with Sediment)

Juan De Fuca Plate

Puget Sound/ Willamette Valley

Cascade Volcanoes

Juan De Fuca Ridge

Pacific Plate

North American Plate

Magma

MID-OCEAN RIDGE

Plate Sweats Hot Water

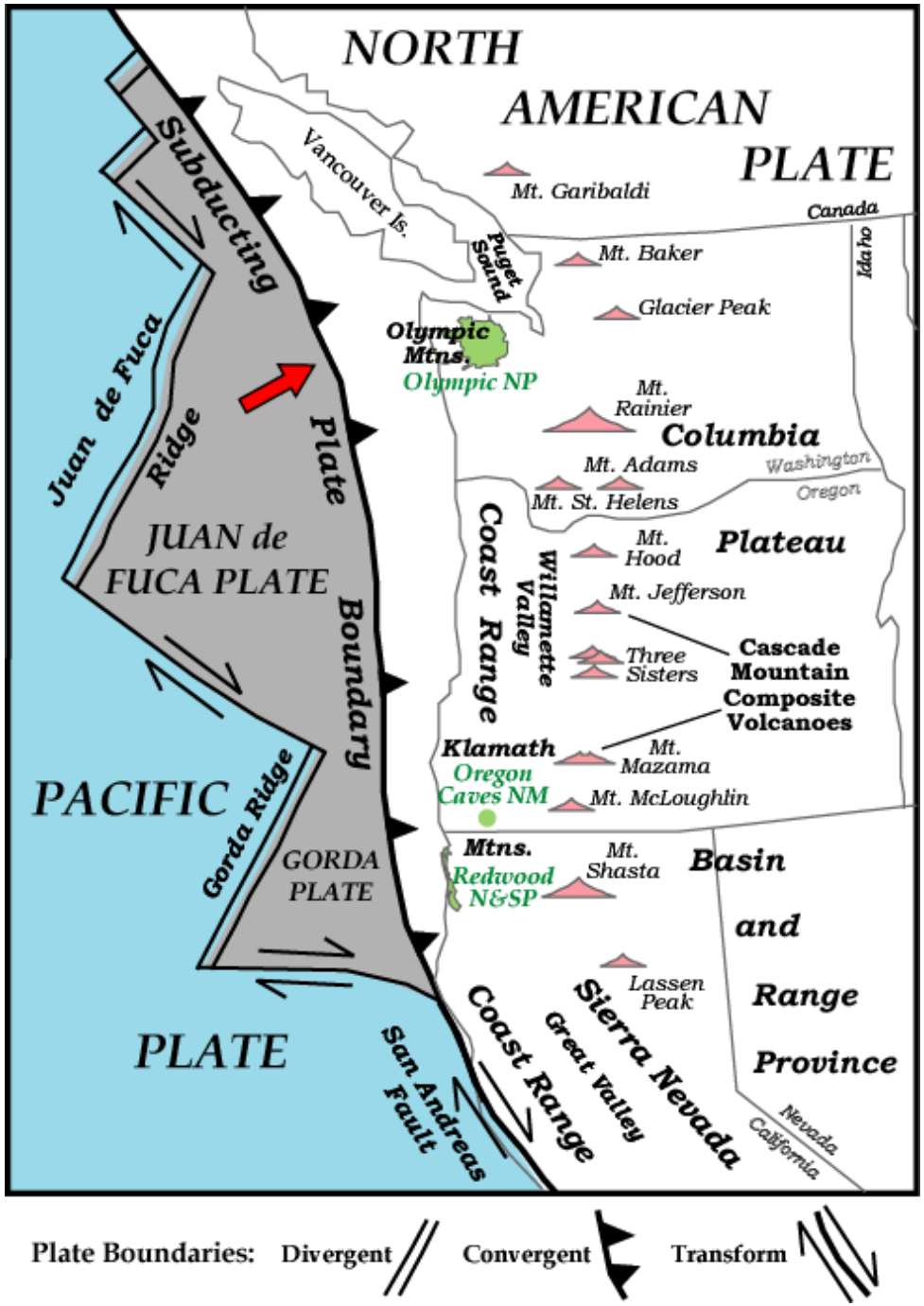
SUBDUCTION ZONE

Robert J. Lillie
Bernard Garcia

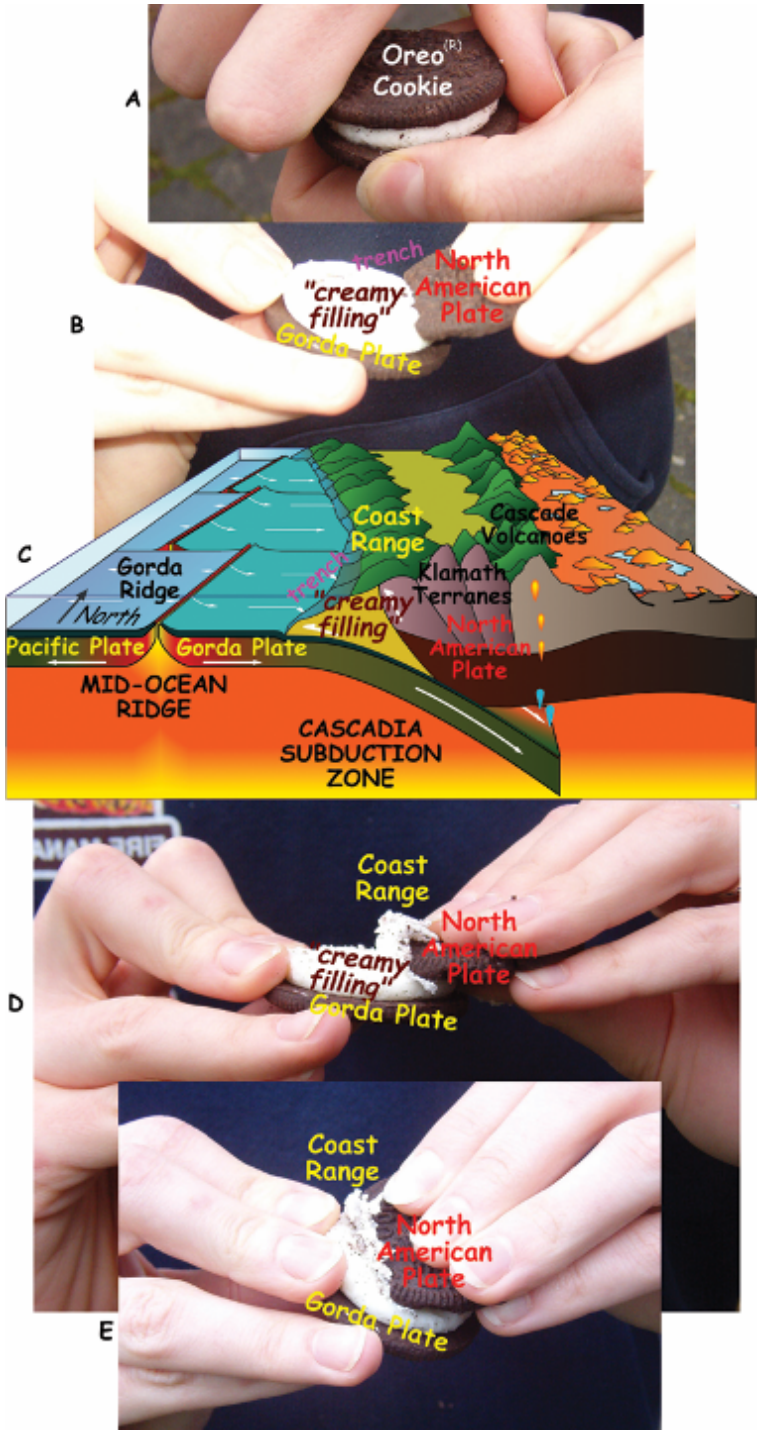
Convergent Plate Boundary

Parks in the Coastal Ranges contain materials that were manufactured in the sea, then scrapped off the subducting Juan de Fuca Plate.

National Park Lands in the Coastal Ranges



Jen Natoli's version of Oreo® demo ☺



Coastal Ranges

Layers Lifted out of the Sea

Robert J. Lillie

Cascades (Volcanic Arc)

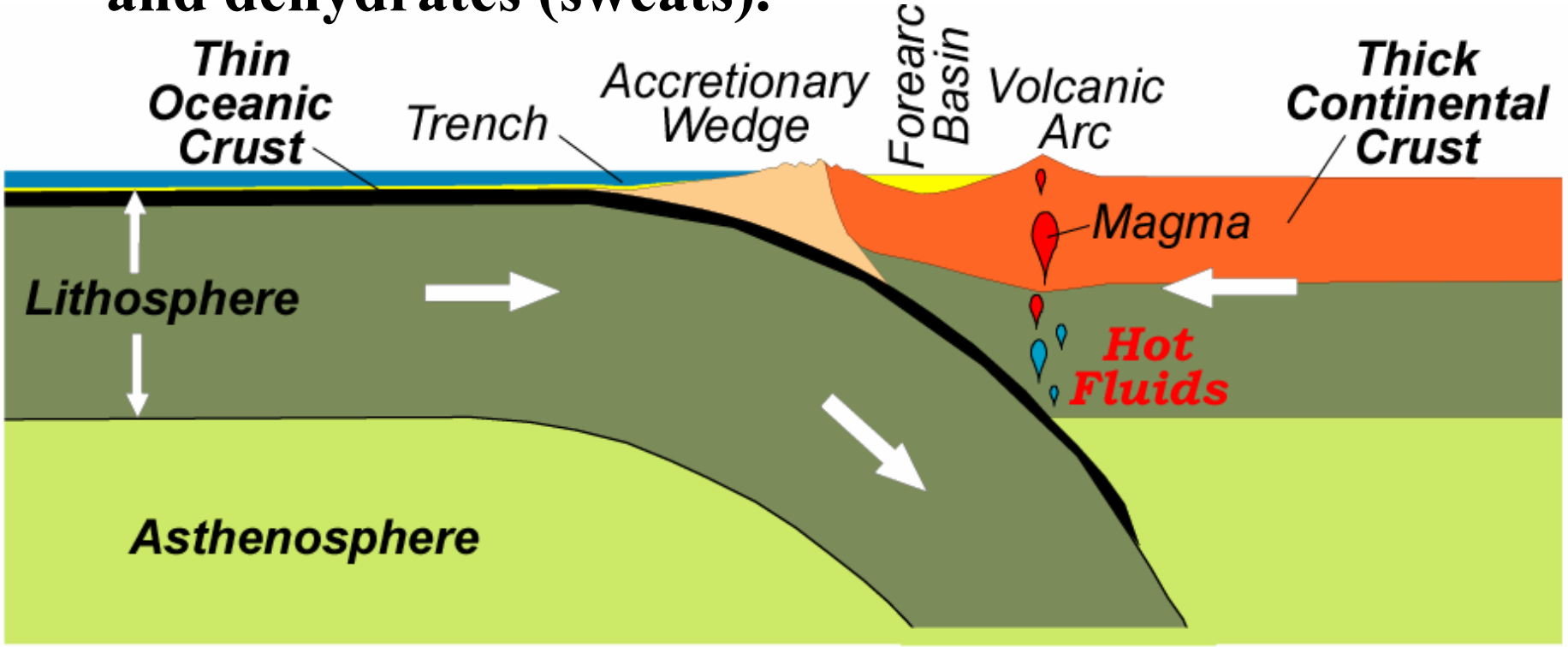
Why are the Cascade volcanoes in such a straight line?

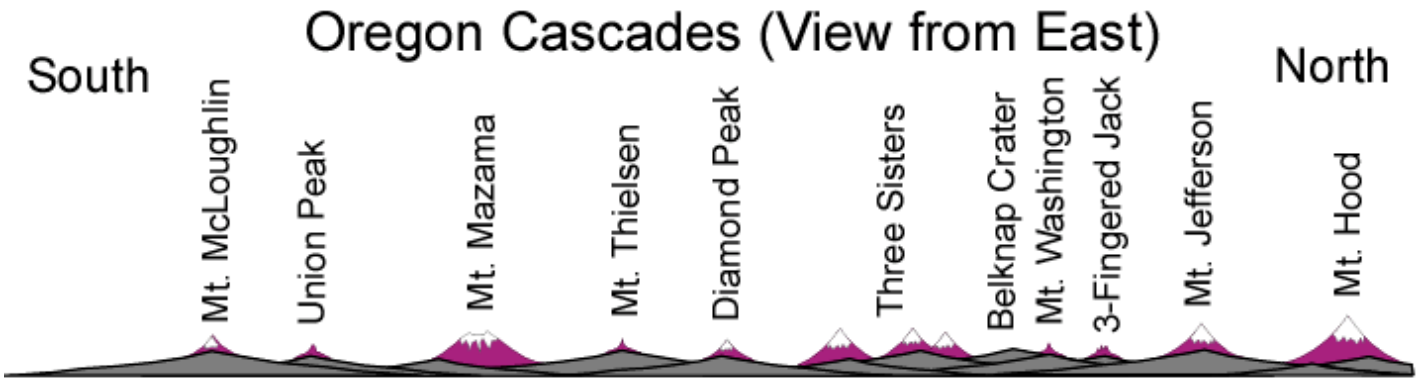
National Park Lands in the Pacific Northwest

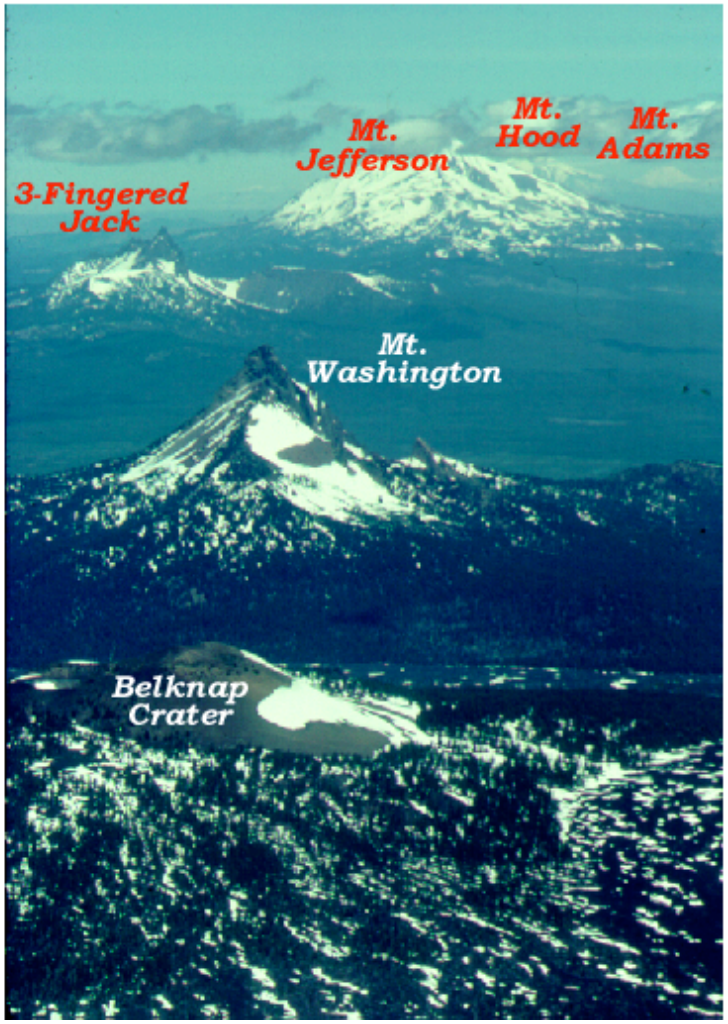
Cascadia Subduction Zone

Parks in the Cascades showcase volcanoes formed where the top of the Juan de Fuca plate reaches about 50 miles depth and dehydrates (sweats).

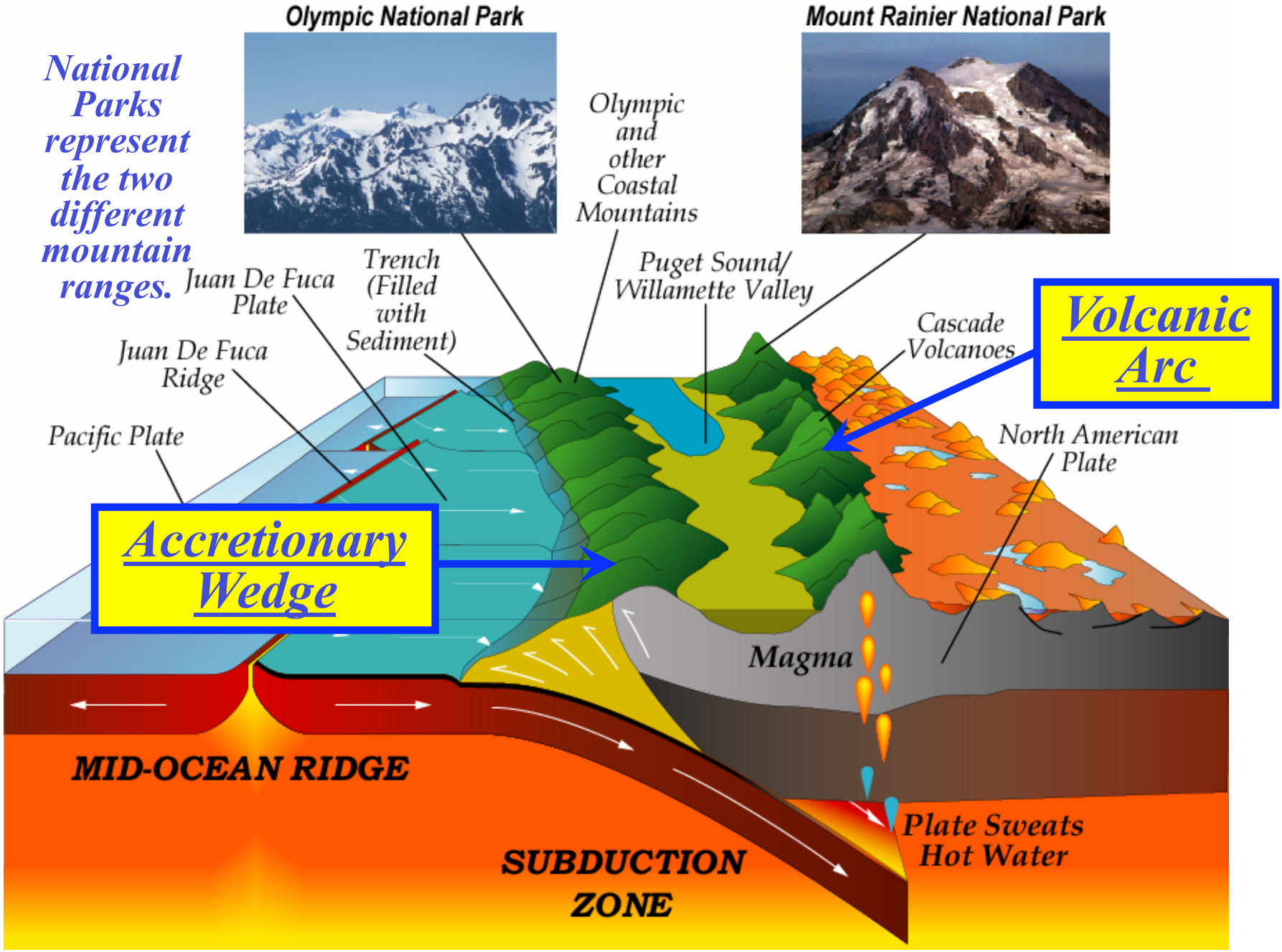
Mt. Rainier NP
Mt. St. Helens NVM
Crater Lake NP
Lassen Volcanic NP




Oregon Cascades (View from East)
South
North
Mt. McLoughlin
Union Peak
Mt. Mazama
Mt. Thielsen
Diamond Peak
Three Sisters
Belknap Crater
Mt. Washington
3-Fingered Jack
Mt. Jefferson
Mt. Hood


Mt. Jefferson
Mt. Hood
Mt. Adams
3-Fingered Jack
Mt. Washington
Belknap Crater

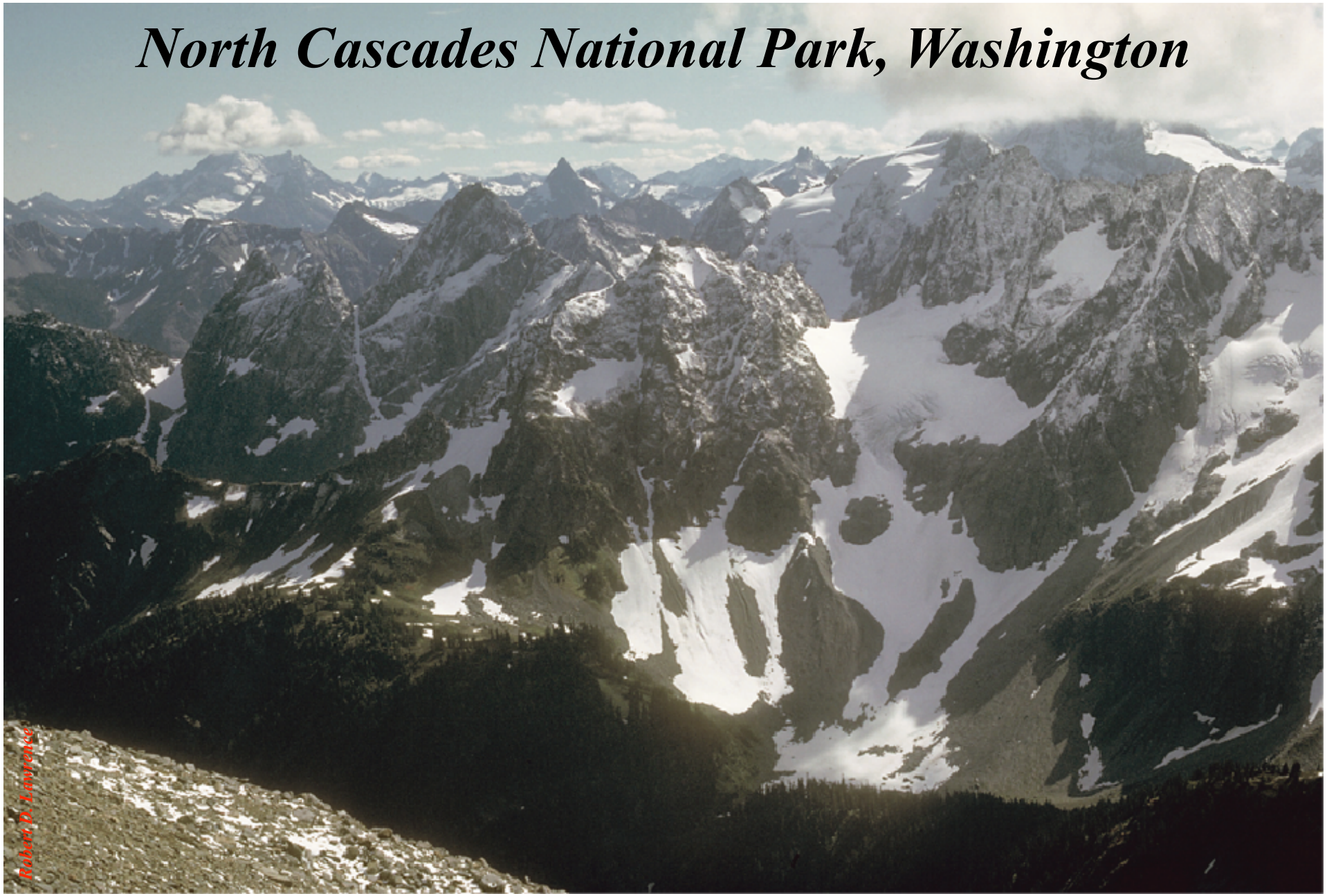
Features in Parks at Subduction Zones



Robert J. Lillie
Bernard Garcia

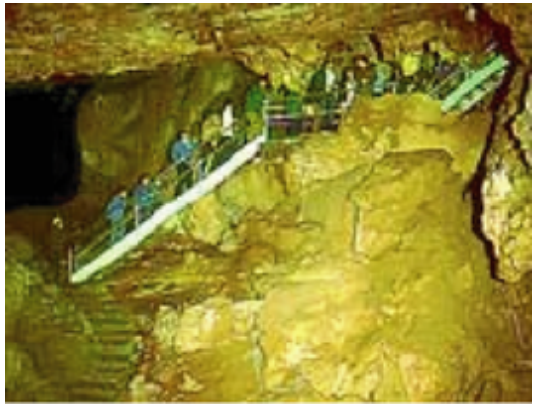
North Cascades/ Klamath Mountains

North Cascades National Park, Washington



Oregon Caves National Monument, Oregon

National Park Service

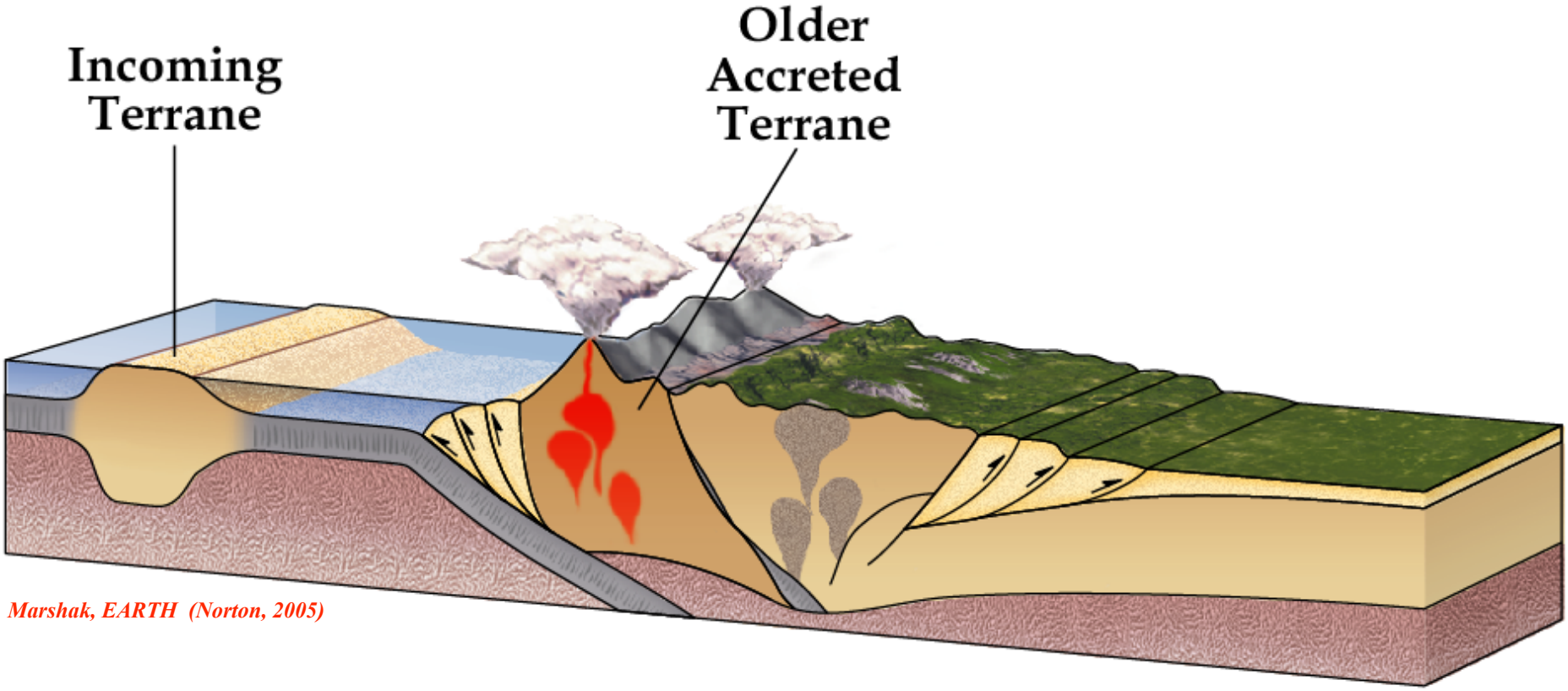


National Park Service

Contains <u>limestone</u> that was deposited in a warmer climate farther south, was carried northward by plate motion, where it crashed into North America.

Terrane Accretion

A TERRANE consists of crust that is too thick and buoyant to subduct. The continent grows outward as terranes come crashing in.



Marshak, EARTH (Norton, 2005)


Safeway Terrane Accretion ☺
Forth Terrane
Third Terrane
Second Terrane
Ocean Plate
First Terrane
North American Plate
Robert J. Lillie


Second Terrane
First Terrane
Double Stuf
OREO
Chocolate Sandwich Cookies
Diet
UP
7
Tastes Great
Splenda
Ocean Plate
Robert J. Lillie

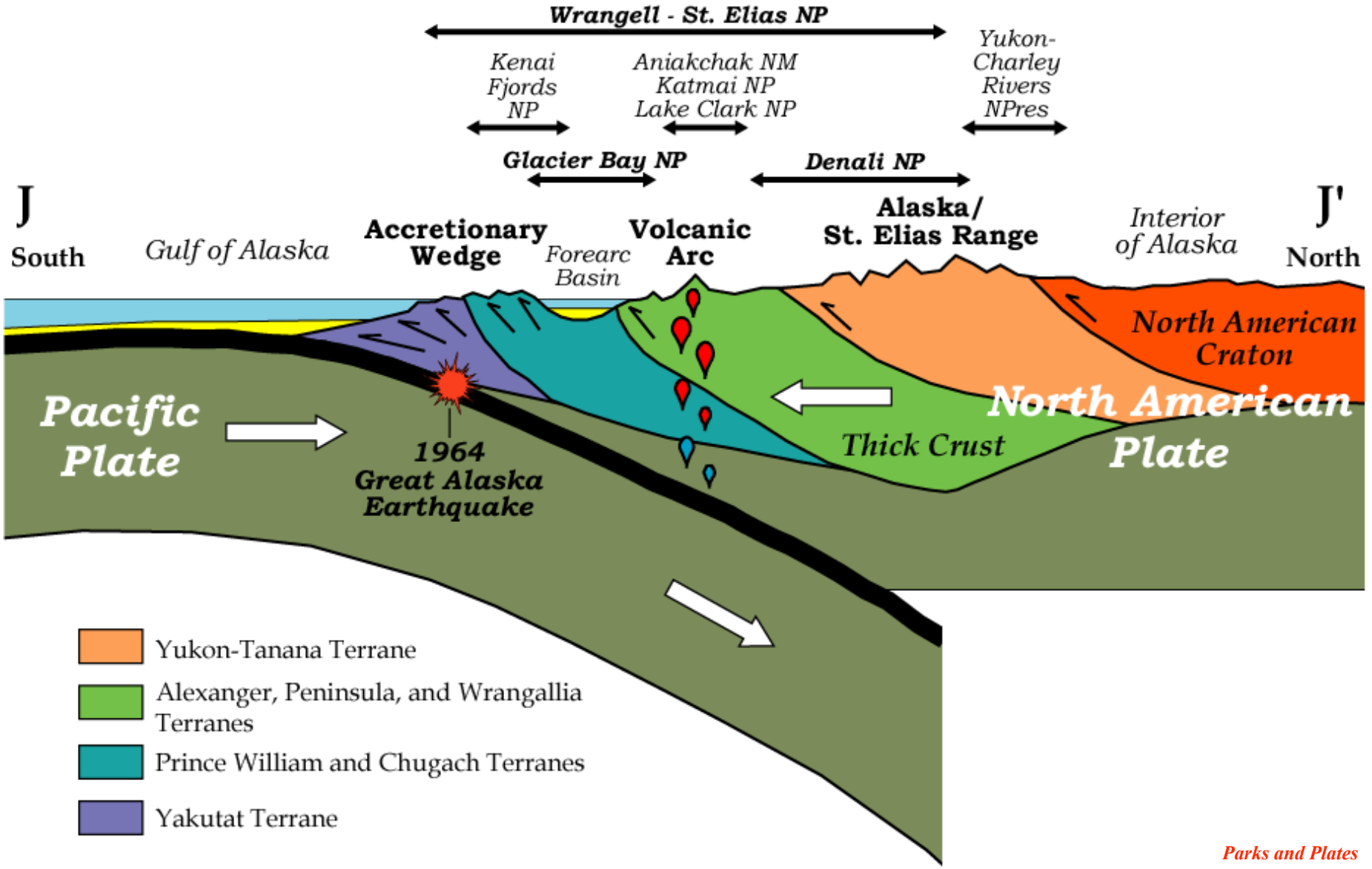
Ocean Plate


Third Terrane
Ocean Plate
Charmin
4 Giant Rolls!
10 REGULAR ROLLS
OREO
Robert J. Lillie


Fourth
Terrane
Fat Free
Fig
Newtons
4 Giant Rolls!
10 REGULAR ROLLS
Charmin
Charmin
4 Giant Rolls
Rollos Gigantes
Double Stuf
OREO
Ocean Plate
Robert J. Lillie

North American Plate
First Terrane
Second Terrane
Third Terrane
Forth Terrane
Ocean Plate
Robert J. Lillie

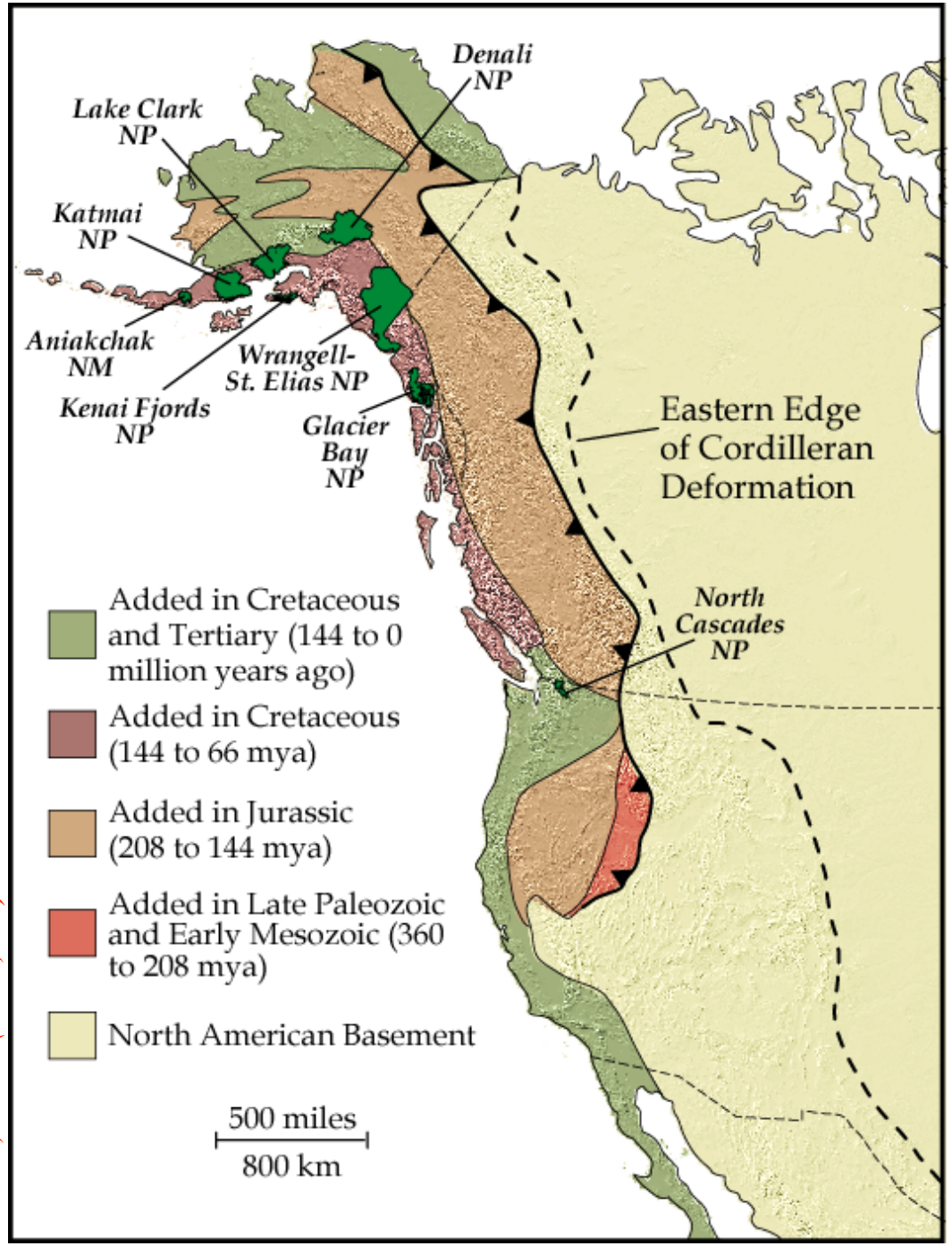
Terrane Accretion – Southern Alaska



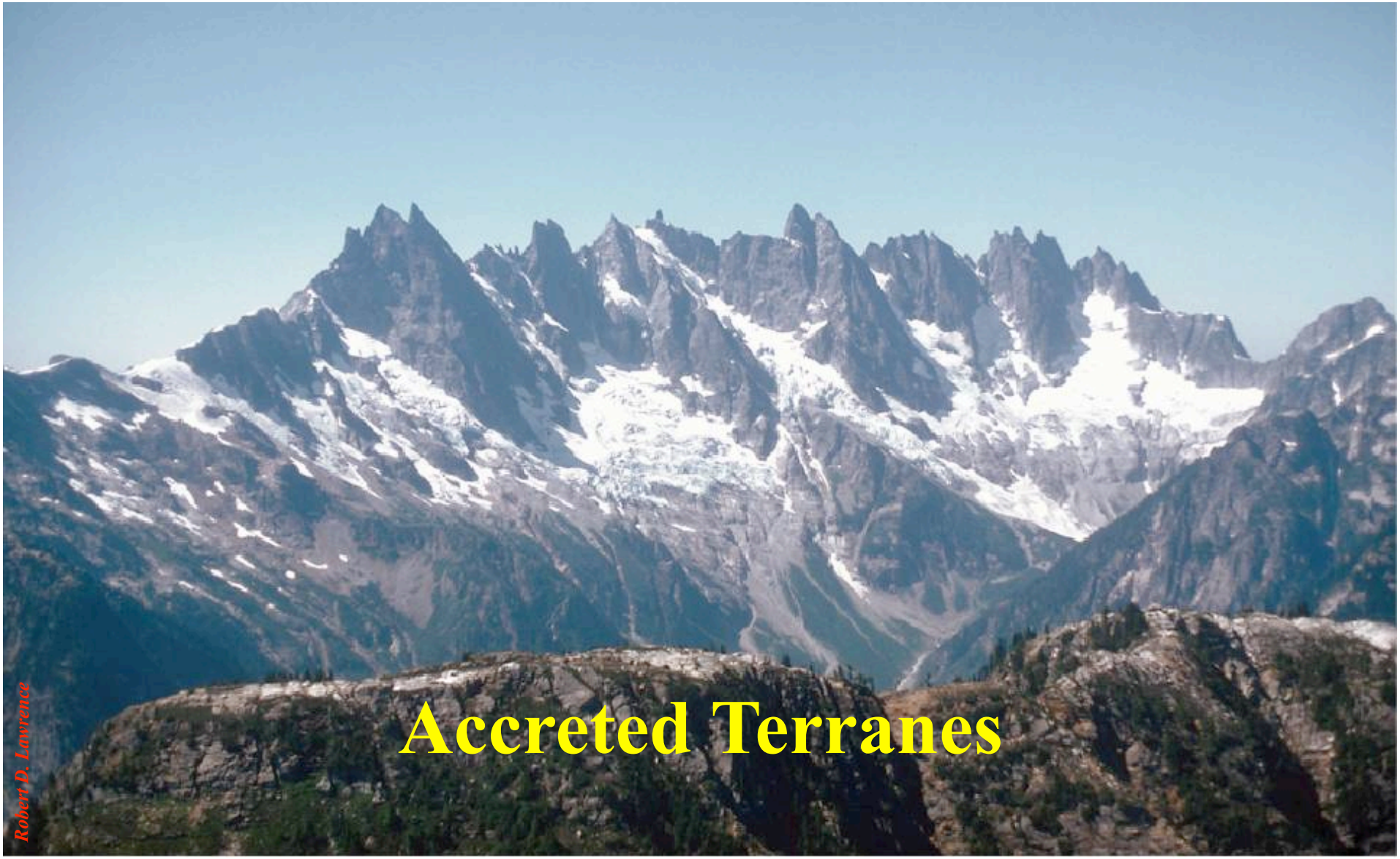
Accreted Terranes

North Cascades National Park in Washington state also displays the effects of terrane accretion.

NATIONAL PARKLANDS

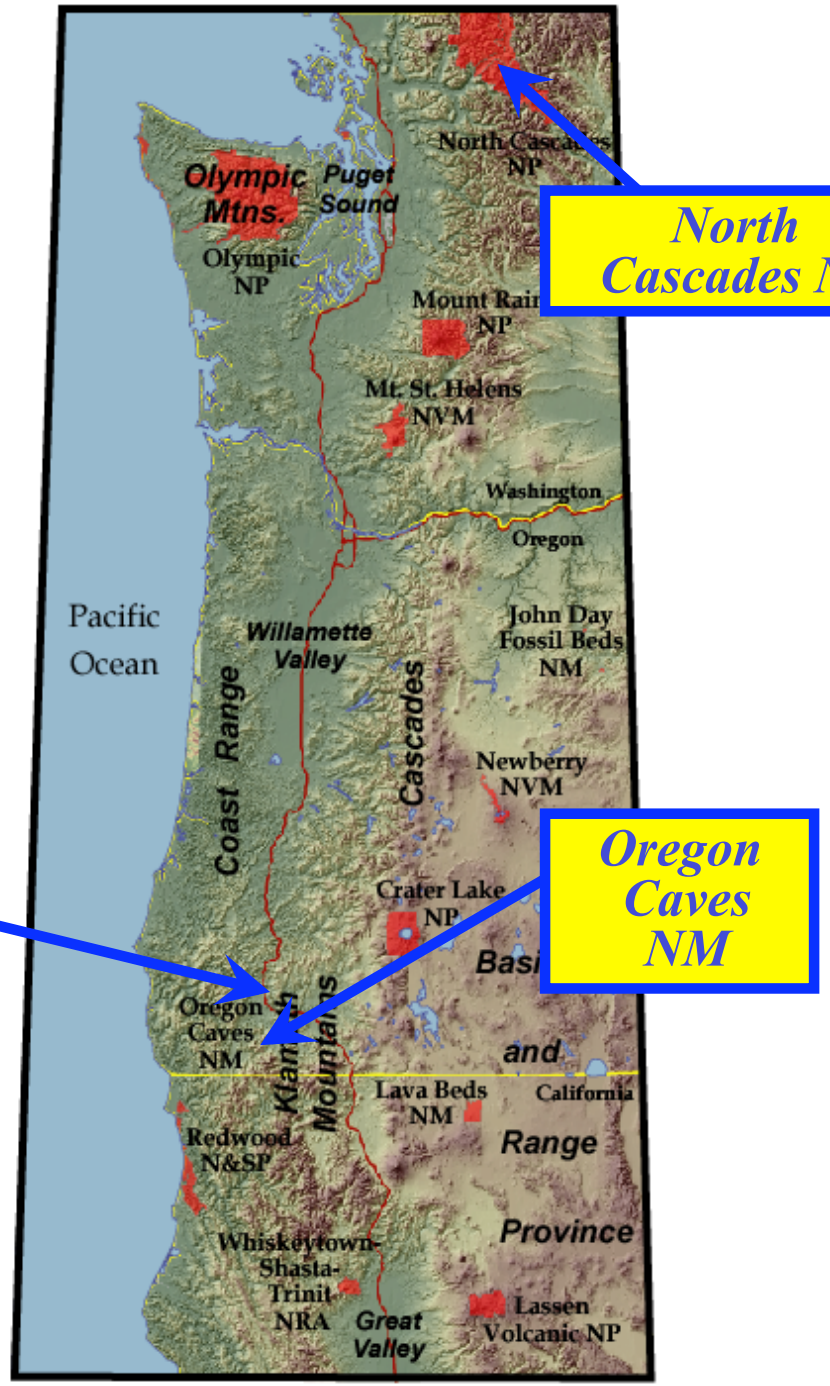


North Cascades National Park, Washington

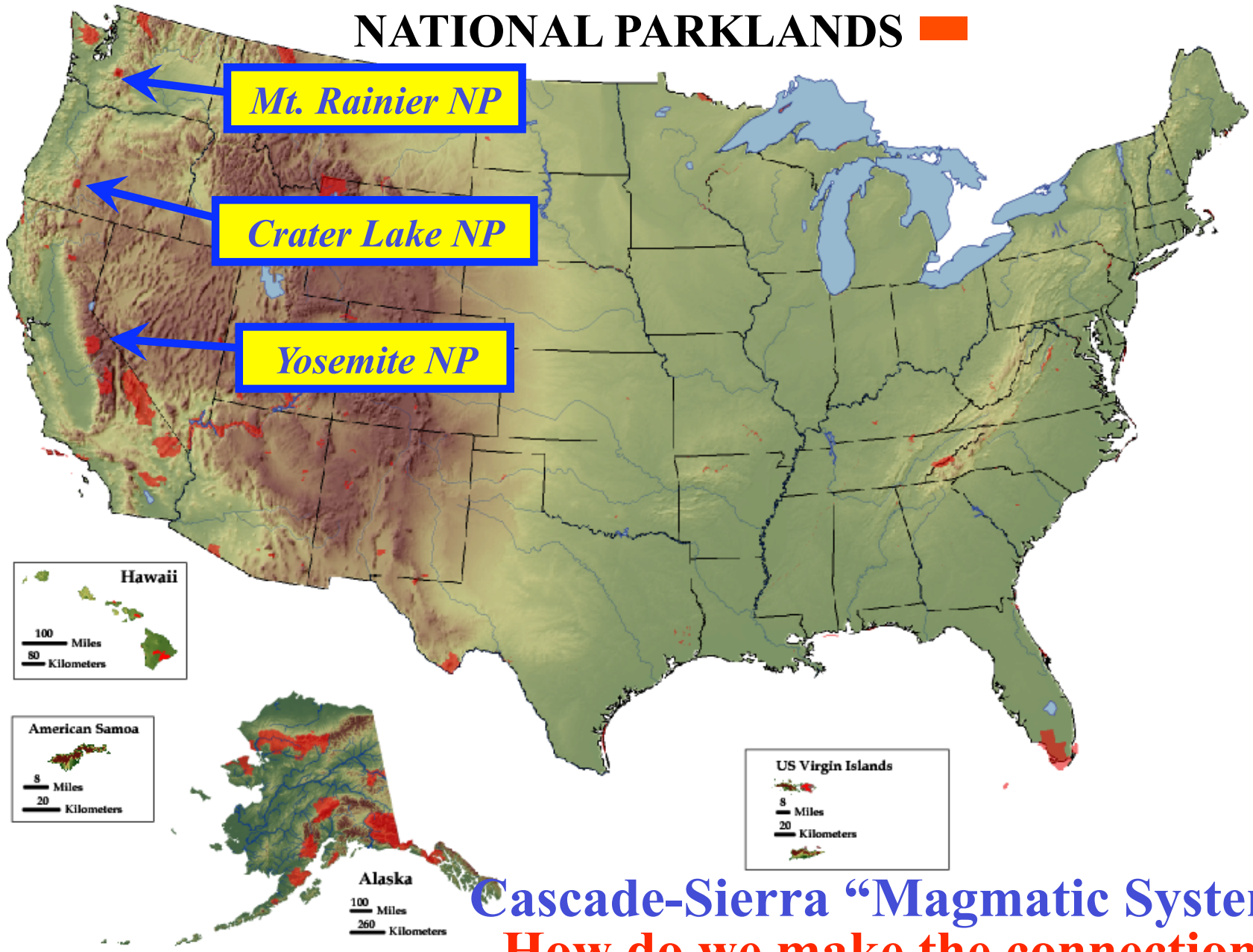


The <u>KLAMATH MOUNTAINS</u> disrupt the natural depression (Puget Sound/ Willamette Valley/ Great Valley) between the Coastal Ranges and Cascades.

Klamath Mountains



National Park Lands in the Pacific Northwest



Cascade-Sierra "Magmatic System"

How do we make the connection?

NATIONAL PARK LANDS

The Sierra Nevada appear to be a continuation of the Cascade Volcanic Mountain Range

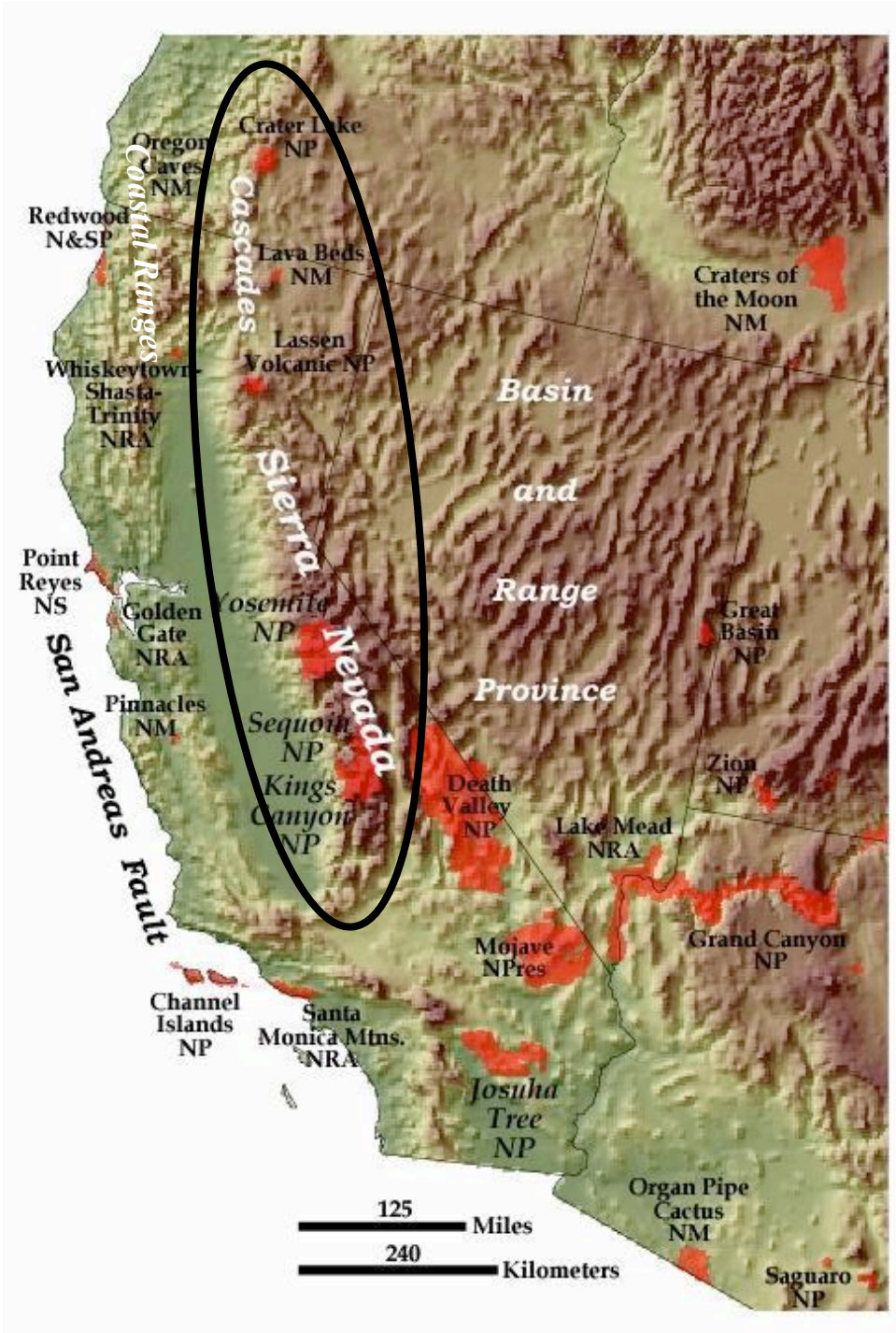


PLATE TECTONIC

DEVELOPMENT OF THE WESTERN UNITED STATES

In the past the entire West Coast was a subducting plate boundary. A volcanic arc extended all the way from Alaska to Mexico.

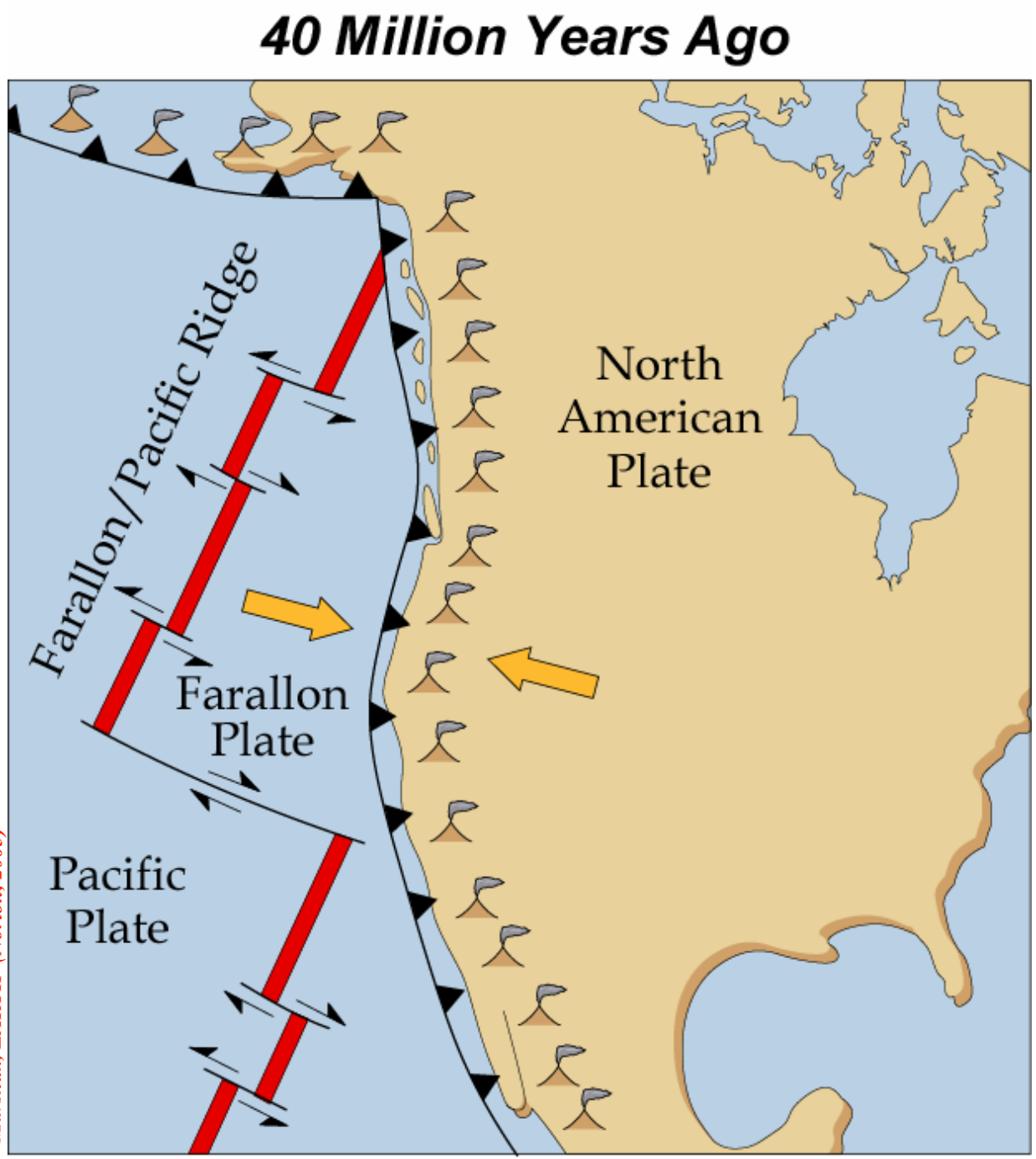
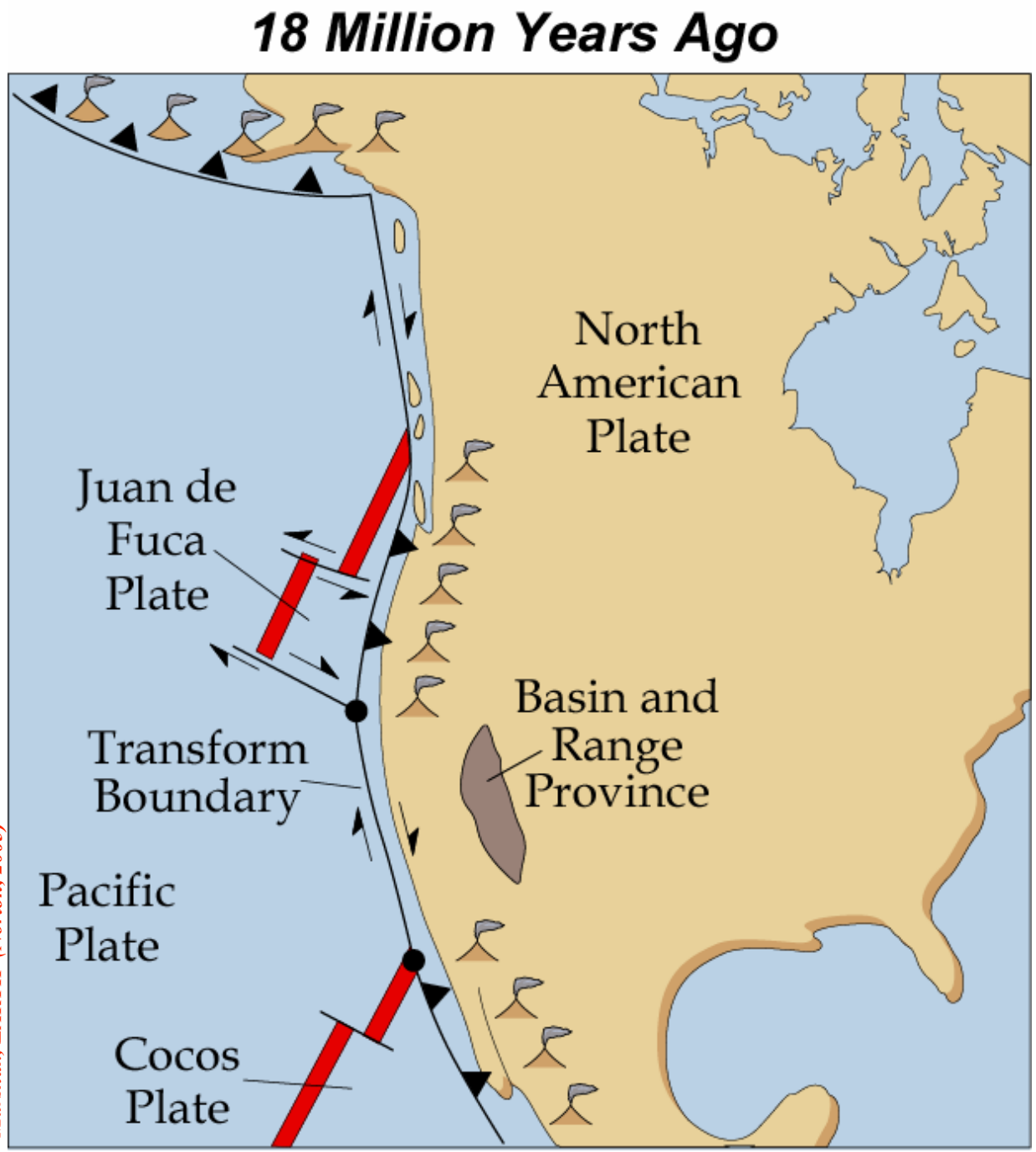


PLATE TECTONIC

DEVELOPMENT OF THE WESTERN UNITED STATES

The Farallon Plate was completely subducted in the California region, leaving only fragments know as the Juan de Fuca and Cocos plates. Where the Pacific and North American plates touched, subduction ceased and a transform boundary developed.

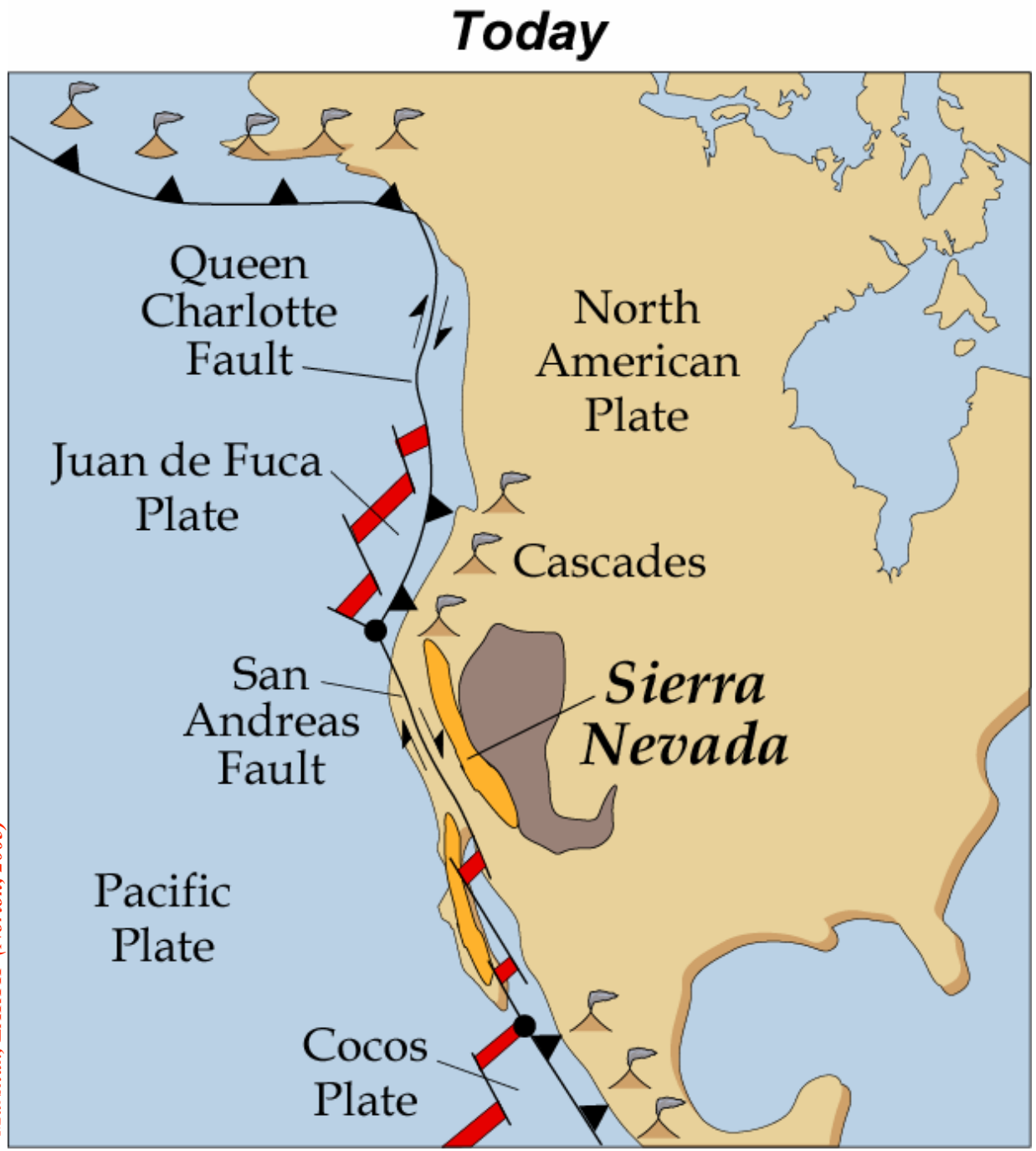


Marshak, EARTH (Norton, 2005)

PLATE TECTONIC

DEVELOPMENT OF THE WESTERN UNITED STATES

The Sierra Nevada are the eroded remnants of the once-extensive volcanic arc.



Cascade – Sierra "Magmatic System"

Making the connection ☺

Mount Rainier National Park

Cascade – Sierra "Magmatic System"

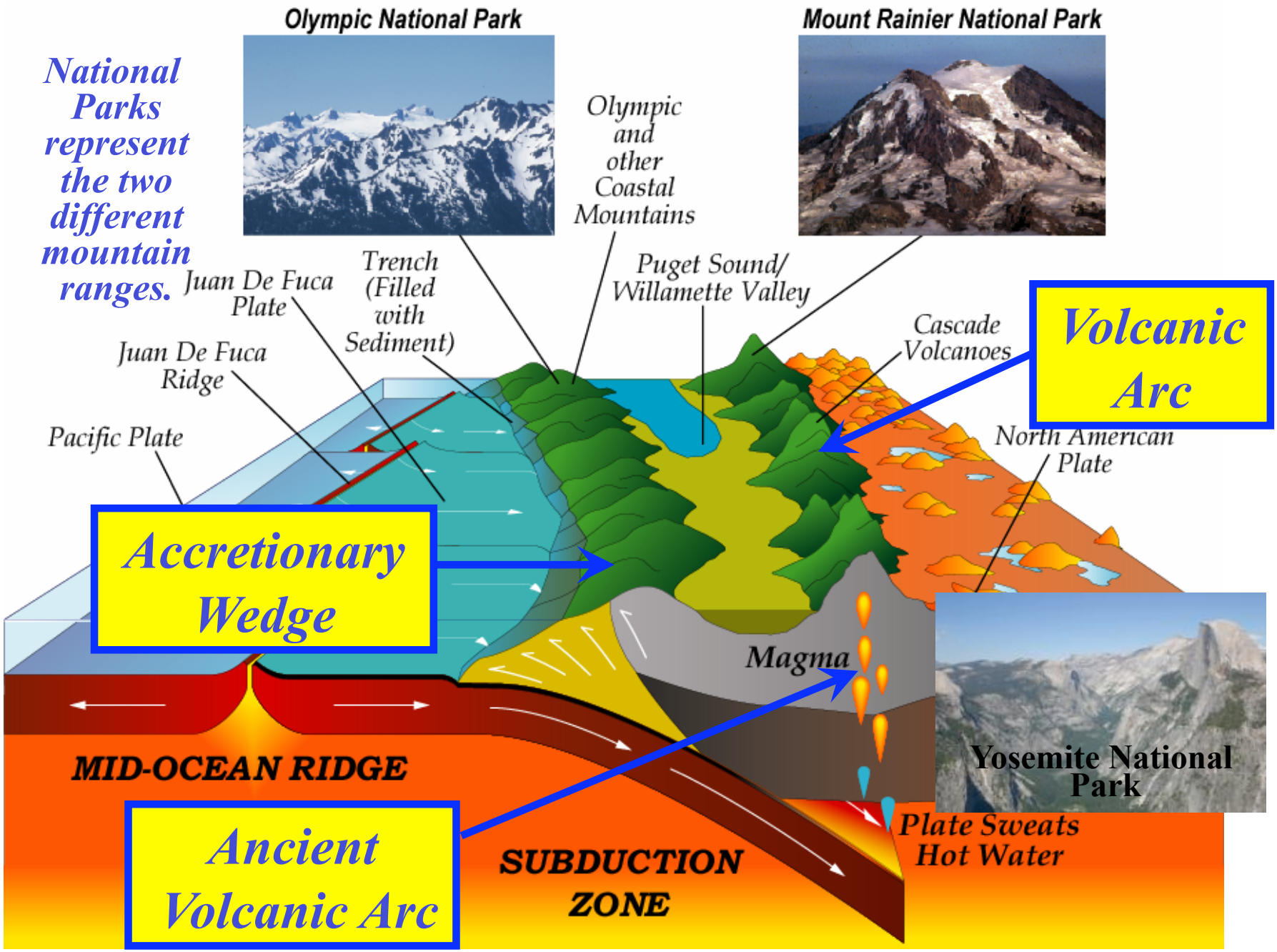
Making the connection ☺

Crater Lake National Park

Cascade – Sierra "Magmatic System"

Making the connection ☺

Yosemite National Park


National Parks represent the two different mountain ranges.
Olympic National Park
Mount Rainier National Park
Olympic and other Coastal Mountains
Juan De Fuca Plate
Trench (Filled with Sediment)
Puget Sound/ Willamette Valley
Juan De Fuca Ridge
Cascade Volcanoes
Volcanic Arc
Pacific Plate
North American Plate
Accretionary Wedge
Magma
Yosemite National Park
MID-OCEAN RIDGE
Plate Sweats Hot Water
Ancient Volcanic Arc
SUBDUCTION ZONE
Robert J. Lillie
Bernard Garcia

The Edge of the Sea

(Rachel Carson, © 1955, Houghton Mifflin, Company)

- *"Now I hear the sea sounds about me;*
- *the night high tide is rising, swirling with a confused rush of waters against the rocks below ….*
- *Once this rocky coast beneath me was a plain of sand;*
- *then the sea rose and found a new shore line.*
- *And again in some shadowy future the surf will have ground these rocks to sand and will have returned the coast to its earlier state.*
- *And so in my mind's eye these coastal forms merge and blend in a shifting, kaleidoscopic pattern in which there is no finality, no ultimate and fixed reality - Earth becoming fluid as the sea itself."*

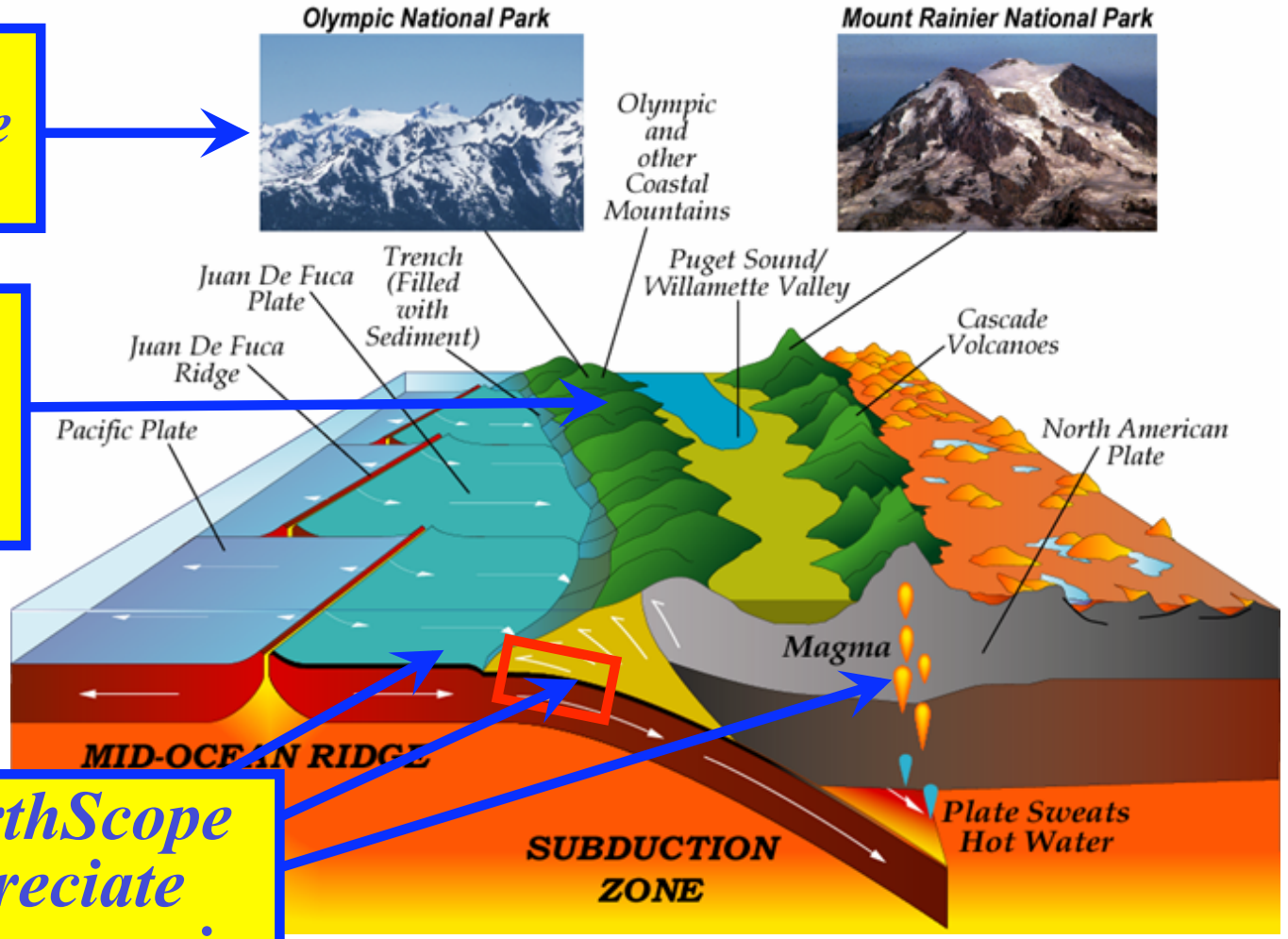
Cascadia Subduction Zone –

Earth becoming fluid as the sea itself …….

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?



OSU Oregon State University

EarthScope National Office

Workshops for Interpretive Professionals in Parks and Museums