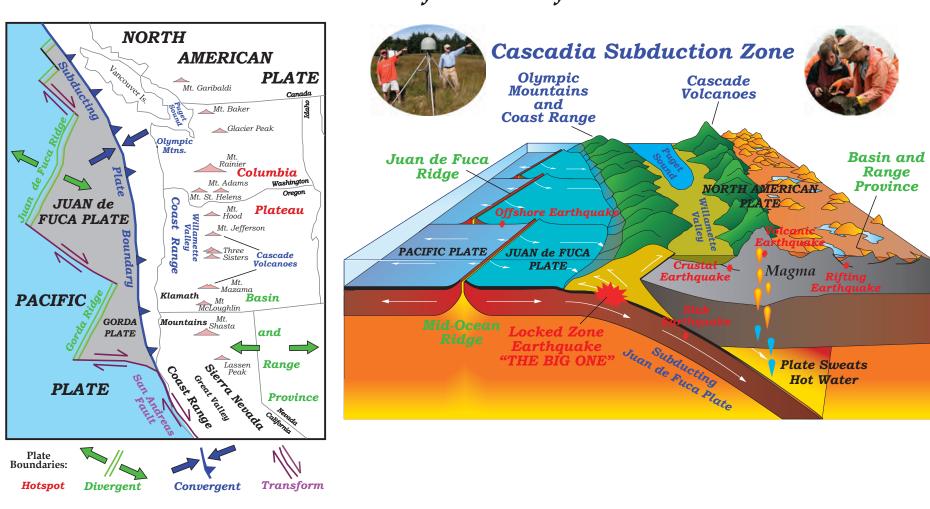
Beauty and the Beast

Plate Tectonics of the Pacific Northwest



Binder Foldout & CEETEP Poster



Beauty and the Beast



"The same geological processes that threaten our lives with earthquakes, tsunamis, and volcanic eruptions also nourish our spirits by creating the spectacular mountains, valleys, and coastlines of the Pacific Northwest."



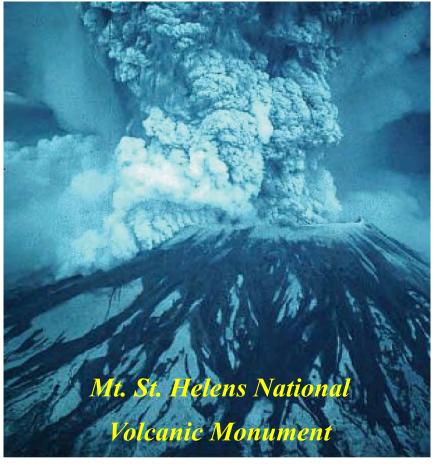
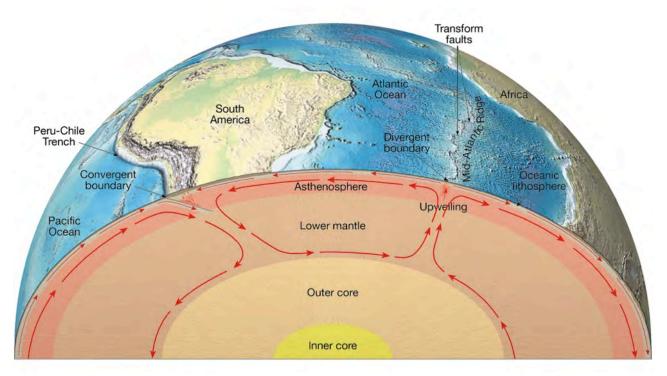
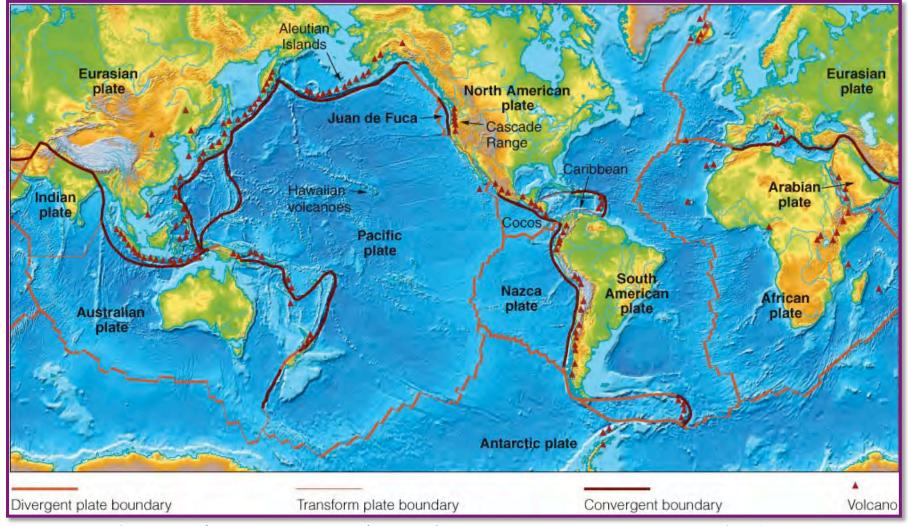


Plate Tectonics

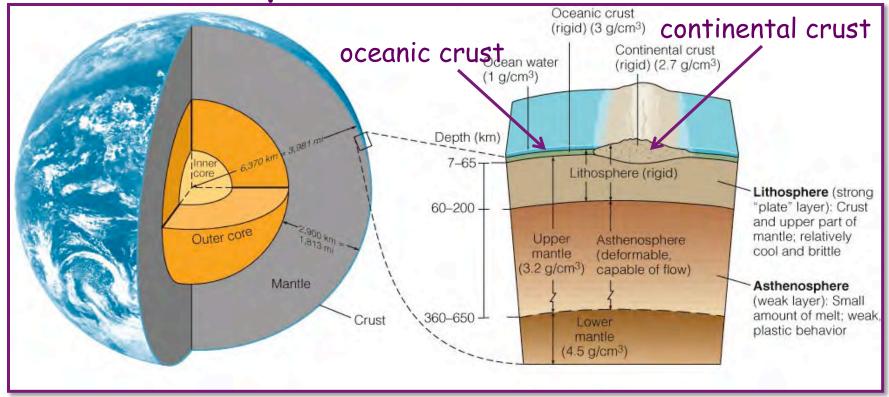


The Earth's interior is convecting. Plates are driven by cooling of Earth. Gravity provides the "ridge push" and "trench pull" forces to move plates.

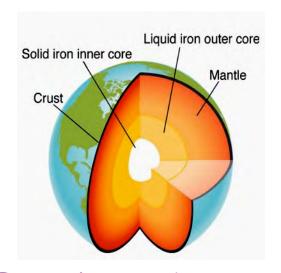


About a dozen plates; some plates have continents; some don't. Plates move a few centimeters per year (the rate of fingernail growth). Volcanoes and earthquakes are concentrated at plate boundaries.

Lithosphere in Earth Context



Thickness of lithosphere (= tectonic plates) ~ 100 km. Lithosphere is crust on top and mantle on bottom. Oceanic crust is basalt, thickness = 7 km. Continental crust is granite, average thickness = 40 km. Granite is less dense than basalt.



Earth - vs -Egg

Earth radius = 6370 km Lithosphere thickness = 100 km What % of Earth radius is lithosphere? 4.8%

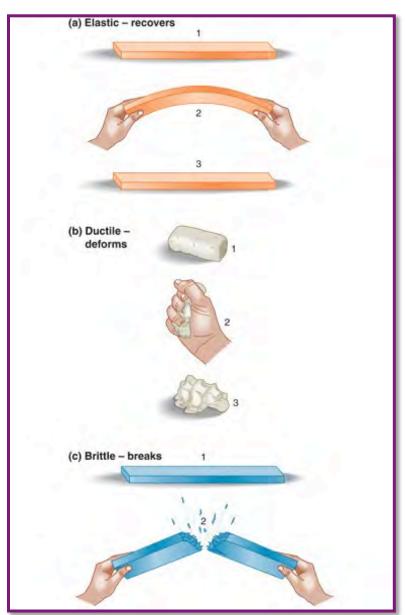
Egg radius = 0.75 inch Egg shell thickness = 0.015 inch What % of egg radius is shell?

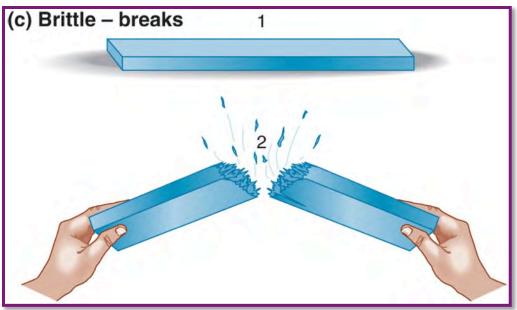
2%

How do these compare?

Lithosphere is to Earth as shell is to egg.

Mechanical Behaviors





Elastic: bends and recovers.

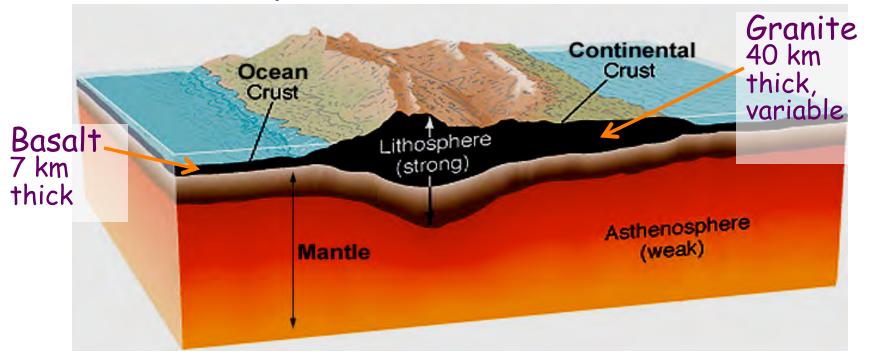
Brittle: elastic UP TO A LIMIT,

then BREAKS.

COLD rocks are brittle.

Ductile: permanent deformation. WARM rocks are ductile.

Lithosphere (= Tectonic Plate)



Lithosphere: outer ~100 km.

Contains crust + upper mantle.

Cold, rigid, and brittle; can fracture.

Asthenosphere: deeper, hotter mantle.

Can flow like silly putty.

A VISCOELASTIC SOLID. NOT LIQUID!!

"Oceanic Crust" "Continental Crust"

"Earth's Mantle"

Three Kinds of Plate Boundaries

Transform Divergent Convergent

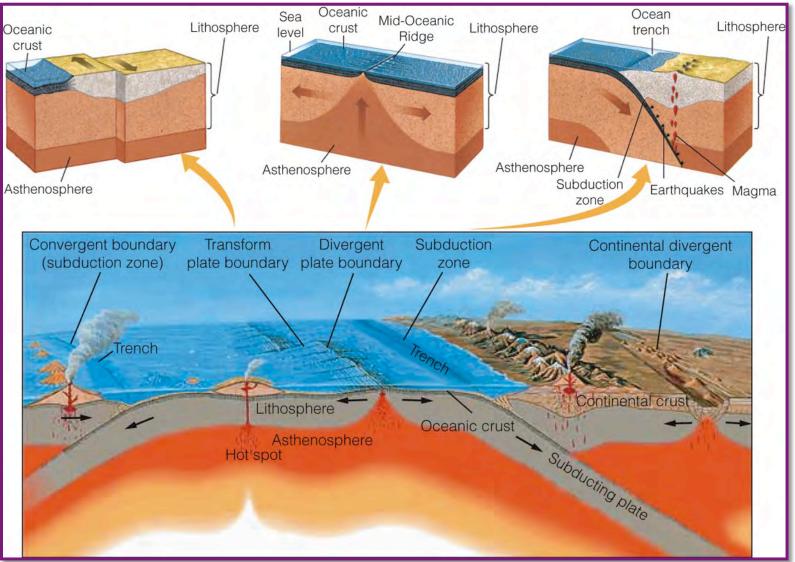
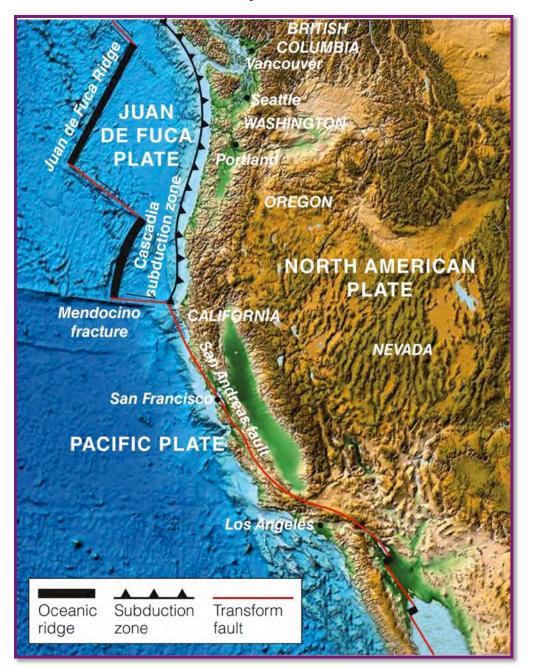
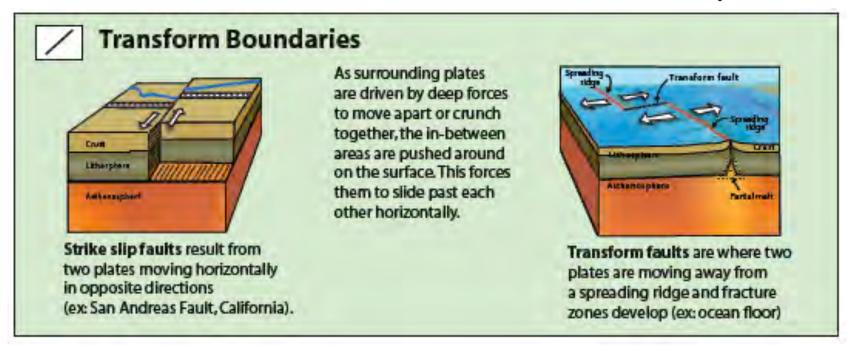


Plate Boundaries of the Western US

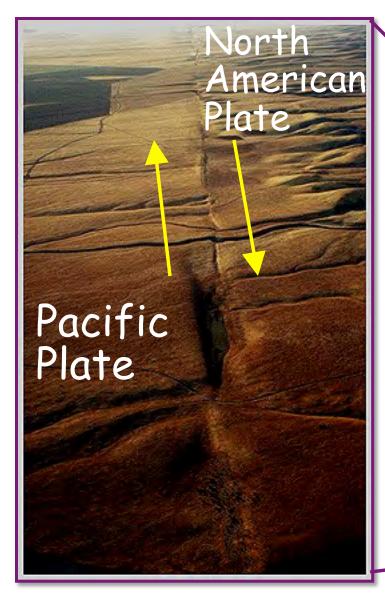


Transform Plate Boundary



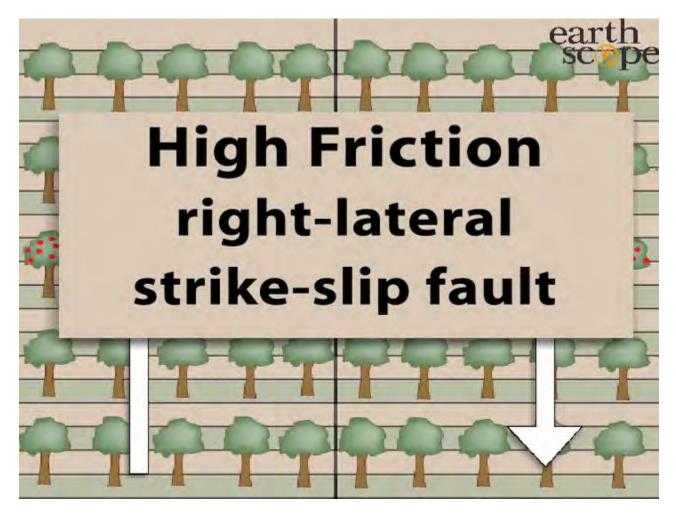
Strike-slip faulting

San Andreas Fault



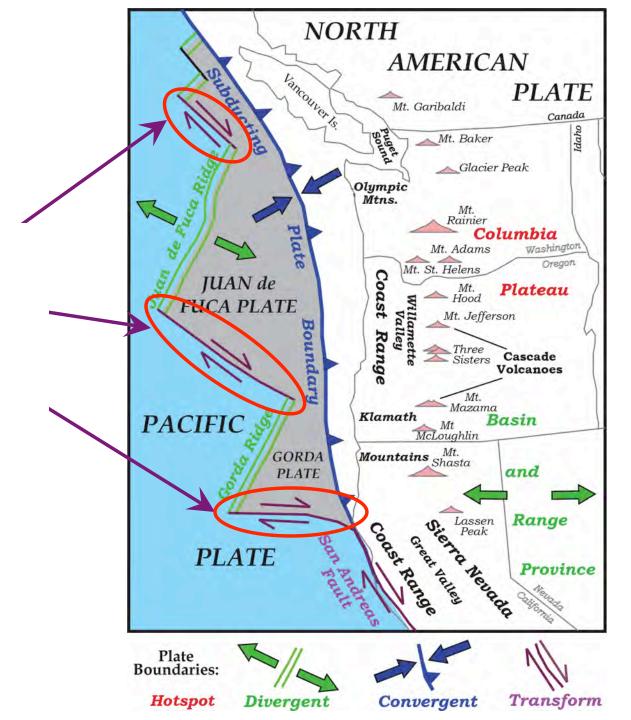


Strike-Slip Fault



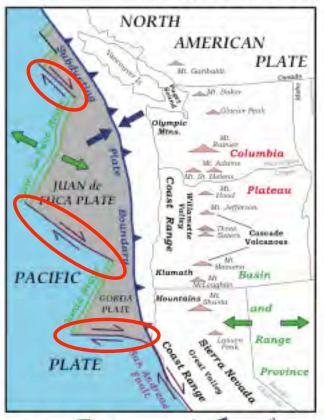
Produced by shearing forces.

Transform
Plate
Boundaries



Transform Plate Boundaries

PLATE TECTONICS OF THE PACIFIC NORTHWEST





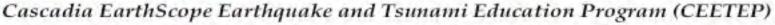












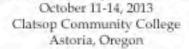
Workshop for K-12 Teachers, Park/Museum Interpreters, and Emergency Management Educators











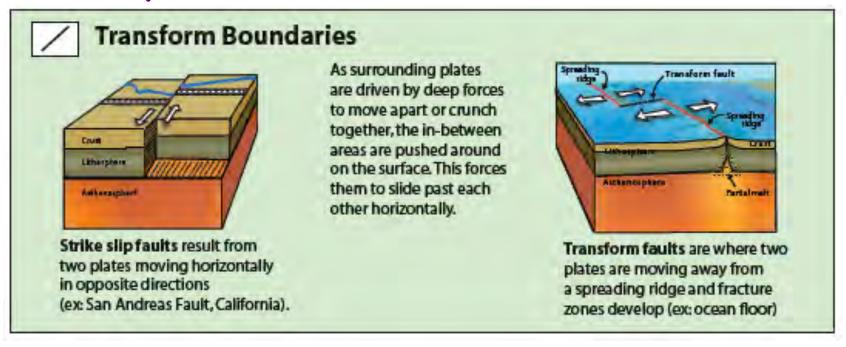








Earthquakes on Transform Boundaries



Strike-slip faulting with horizontal motion parallel to fault. Shallow depths, almost never deeper than 20 km. Why?

Many small EQs (M<6). Some strong (M6) and major (M7) EQs.

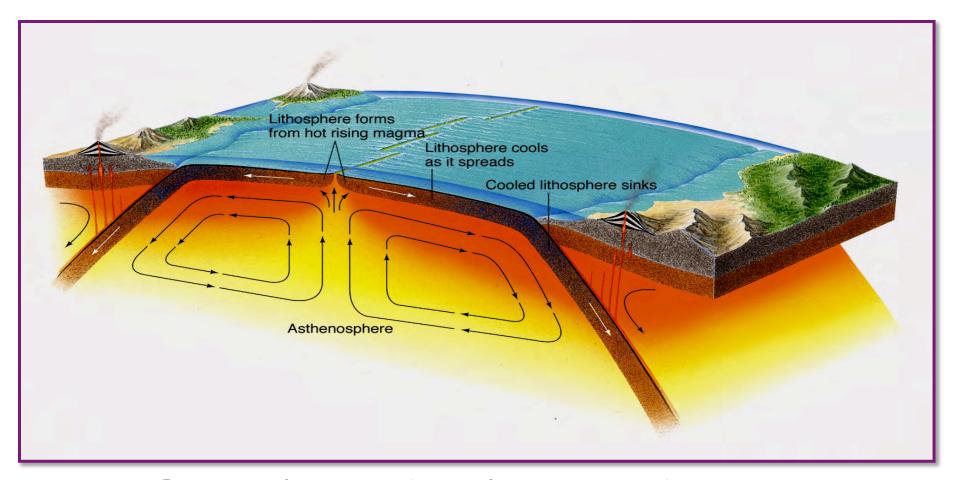
Divergent Plate Boundaries



Spreading ocean ridges

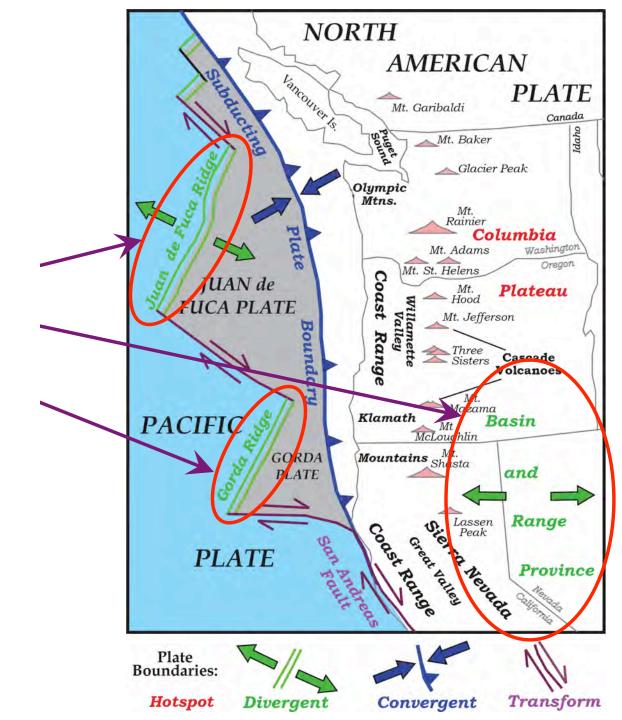
Continental rift zones

Divergent Boundaries in Oceans are Seafloor Spreading Centers



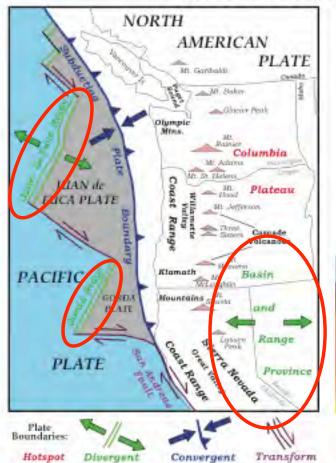
Example: Mid-Atlantic Ridge.

Divergent Plate Boundaries



Divergent Plate Boundaries

PLATE TECTONICS OF THE PACIFIC NORTHWEST





Cascadia EarthScope Earthquake and Tsunami Education Program (CEETEP)

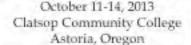
Workshop for K-12 Teachers, Park/Museum Interpreters, and Emergency Management Educators











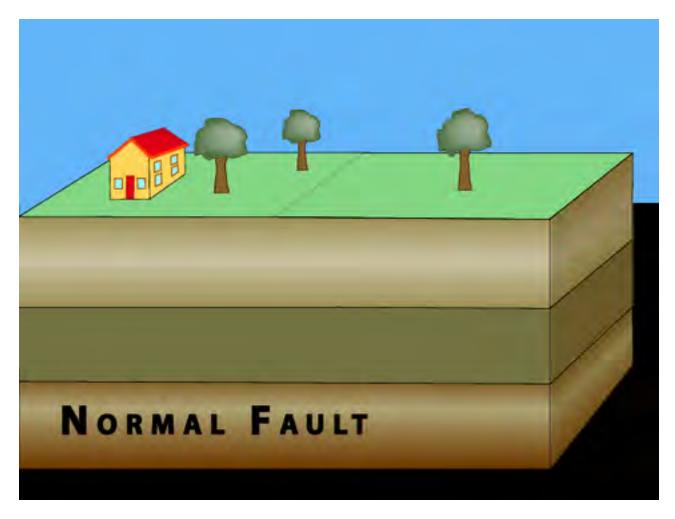








Normal Fault

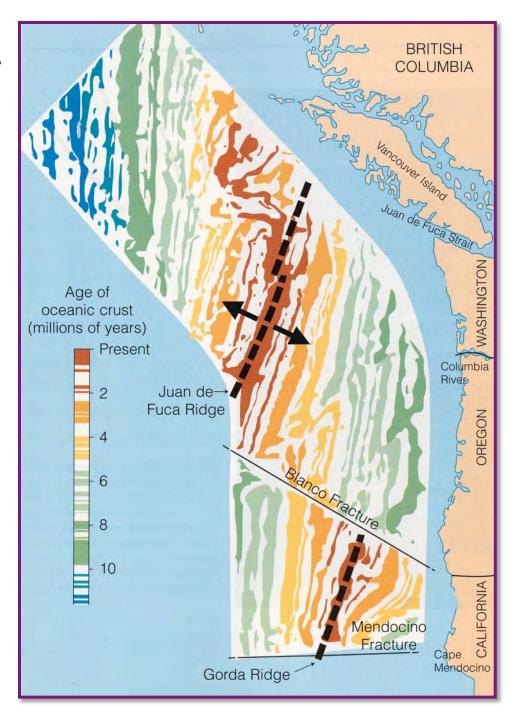


Produced by extensional forces.

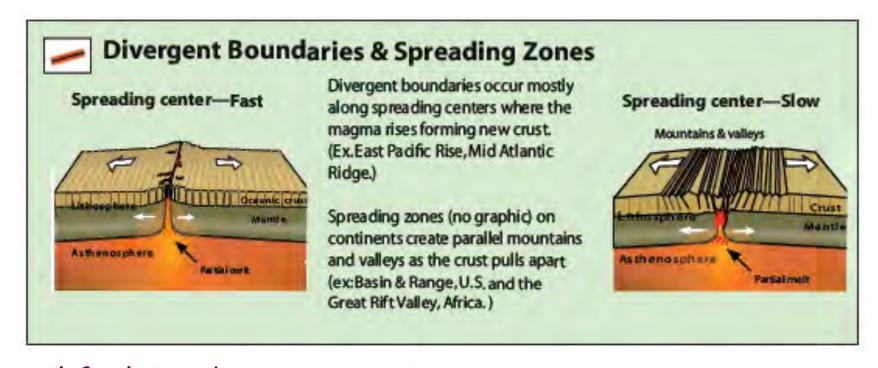
Age of Juan de Fuca and Gorda Plates

New oceanic plate formed at the spreading ridge. Plate is young at the ridge and gets older with distance away from the ridge.

Juan de Fuca Plate is "only" 10 million years old when it subducts.



Earthquakes on Divergent Boundaries



Normal faulting due to extension.

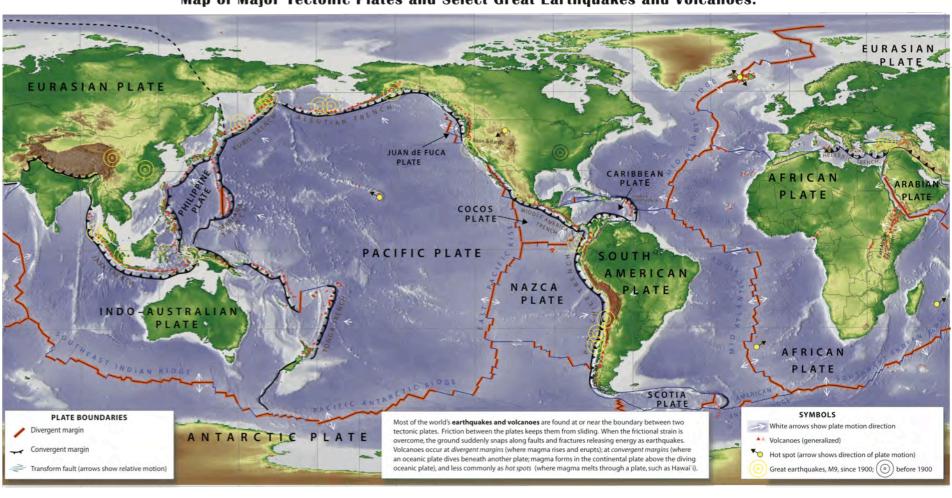
Shallow depths, rarely deeper than 10 km. Why?

Many small EQs (M<6). Some strong (M6) and major (M7) EQs.

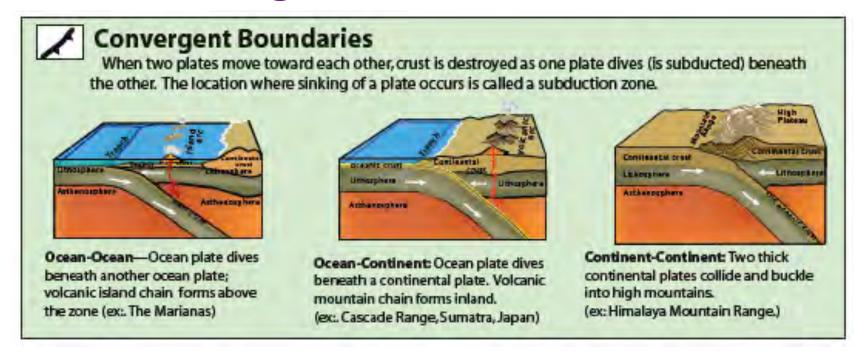
World Map of Plates

Explore Spreading Ocean Ridges and Transform Plate Boundaries

Map of Major Tectonic Plates and Select Great Earthquakes and Volcanoes.



Convergent Plate Boundaries



Ocean - Ocean subduction zone, Marianas Ocean - Continent subduction zone, Cascadia Continent - Continent collision zone, Himalayas

Why does an oceanic plate subduct beneath a continental plate?

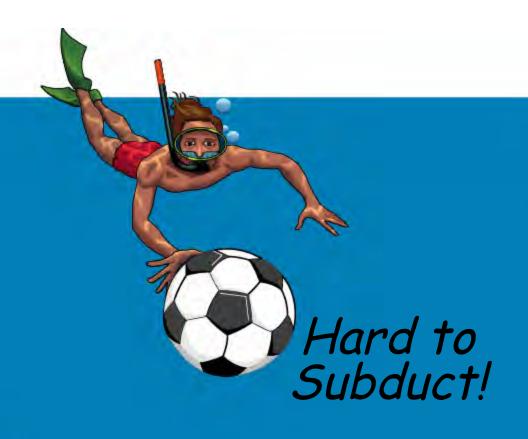
Swimming Pool "Earth's Mantle" "Oceanic "Continental Crust"

"Earth's Mantle"





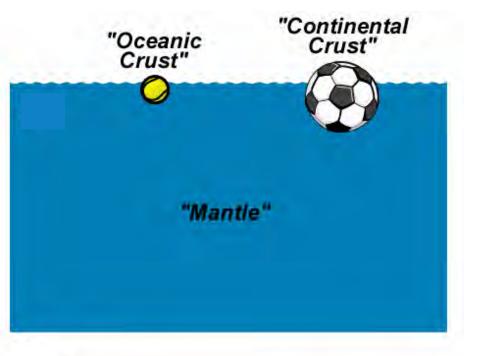
Parks and Plates
© 2005 Robert J. Lillie





Parks and Plates
© 2005 Robert J. Lillie

Continental Crust is THICKER, and therefore MORE BOUYANT than Oceanic Crust



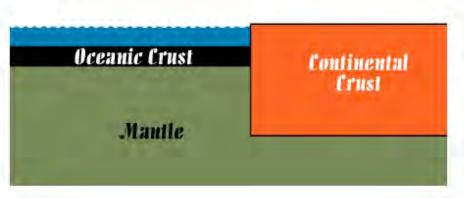
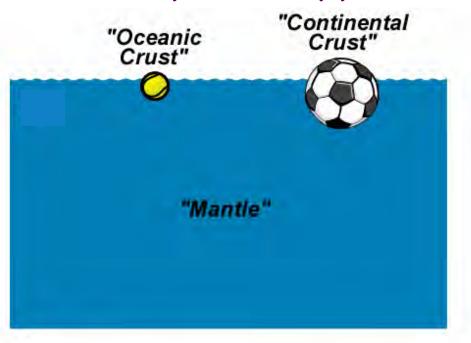
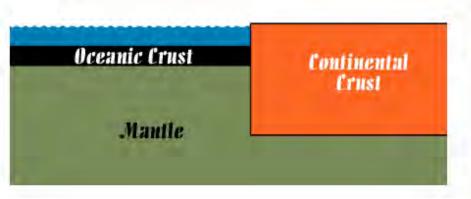
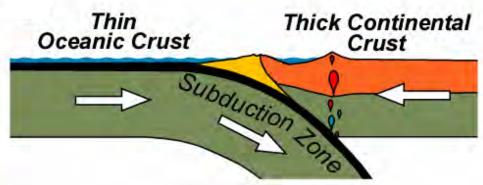


Plate capped with thin Oceanic Crust subducts beneath plate capped with thick Continental Crust





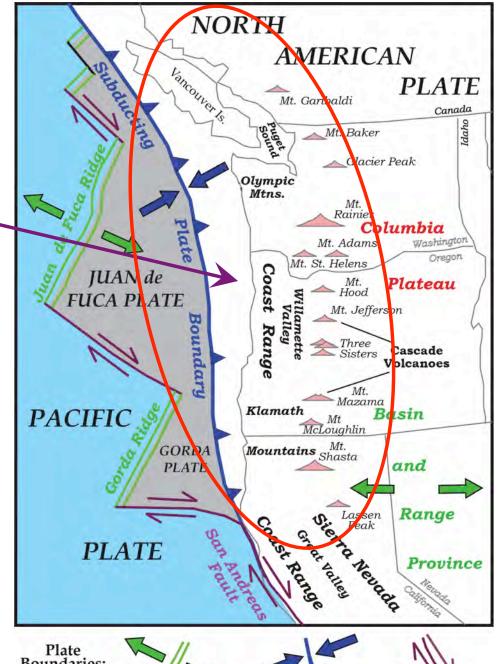




Parks and Plates ©2005 Robert J. Lillie

Convergent Plate Boundary

Entire region is the "Cascadia Subduction Zone"





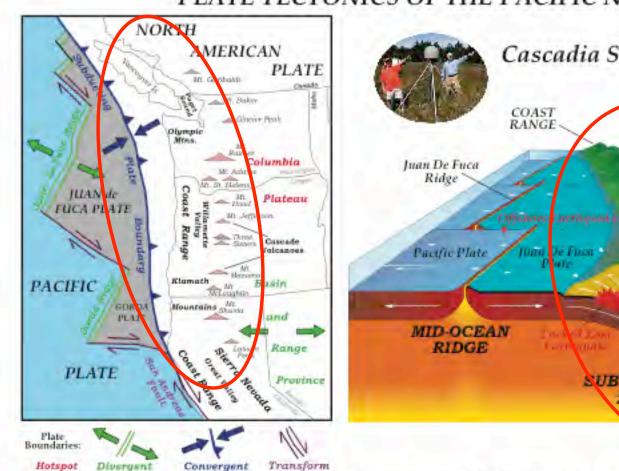


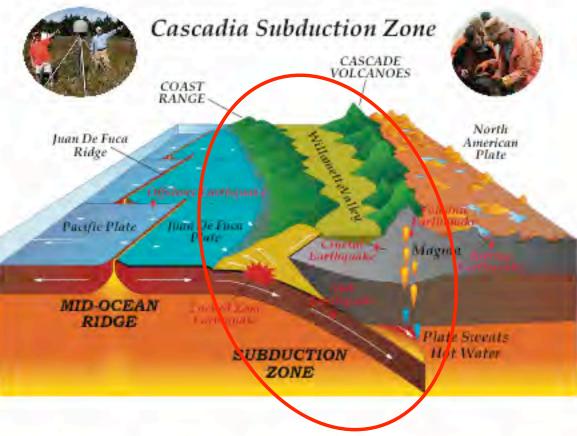




Cascadia Subduction Zone

PLATE TECTONICS OF THE PACIFIC NORTHWEST





Cascadia EarthScope Earthquake and Tsunami Education Program (CEETEP)

Workshop for K-12 Teachers, Park/Museum Interpreters, and Emergency Management Educators









October 11-14, 2013 Clatsop Community College Astoria, Oregon



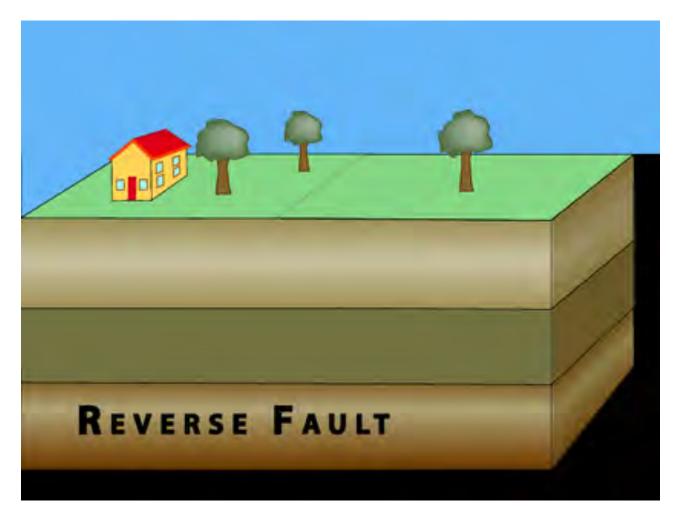






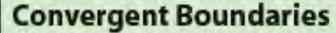
Foam Faults

Reverse (Thrust) Fault



Produced by compressional forces.

Earthquakes on Convergent Boundaries



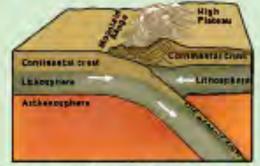
When two plates move toward each other, crust is destroyed as one plate dives (is subducted) beneath the other. The location where sinking of a plate occurs is called a subduction zone.



Ocean-Ocean—Ocean plate dives beneath another ocean plate; volcanic island chain forms above the zone (ex:. The Marianas)



Ocean-Continent: Ocean plate dives beneath a continental plate. Volcanic mountain chain forms inland. (ex. Cascade Range, Sumatra, Japan)



Continent-Continent: Two thick continental plates collide and buckle into high mountains. (ex: Himalaya Mountain Range.)

Thrust faulting due to compression.

EQs to 100 km depth on plate boundary megathrust AND within the converging plates.

EQs to greater depths occur within subducting oceanic plate. Wide range of magnitudes. Most M8 & M9 great EQs are shallow megathrust events in subduction zones.

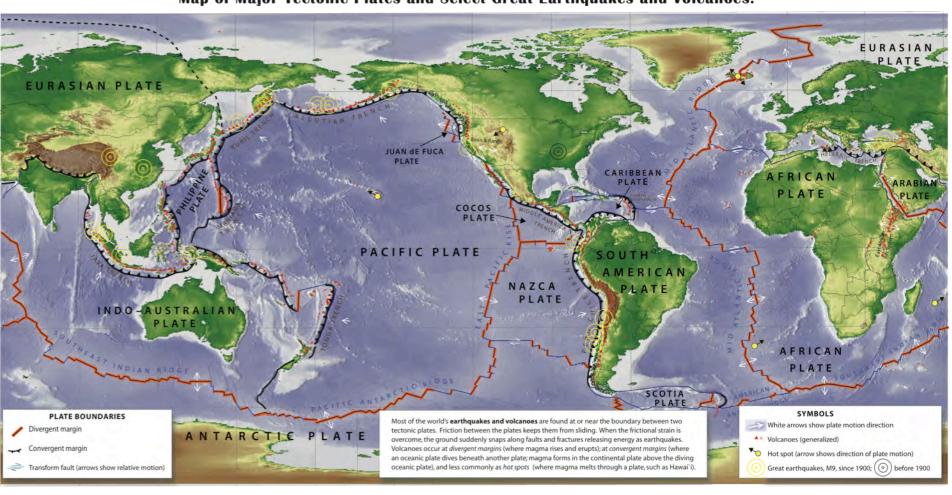
Cascadia Animation

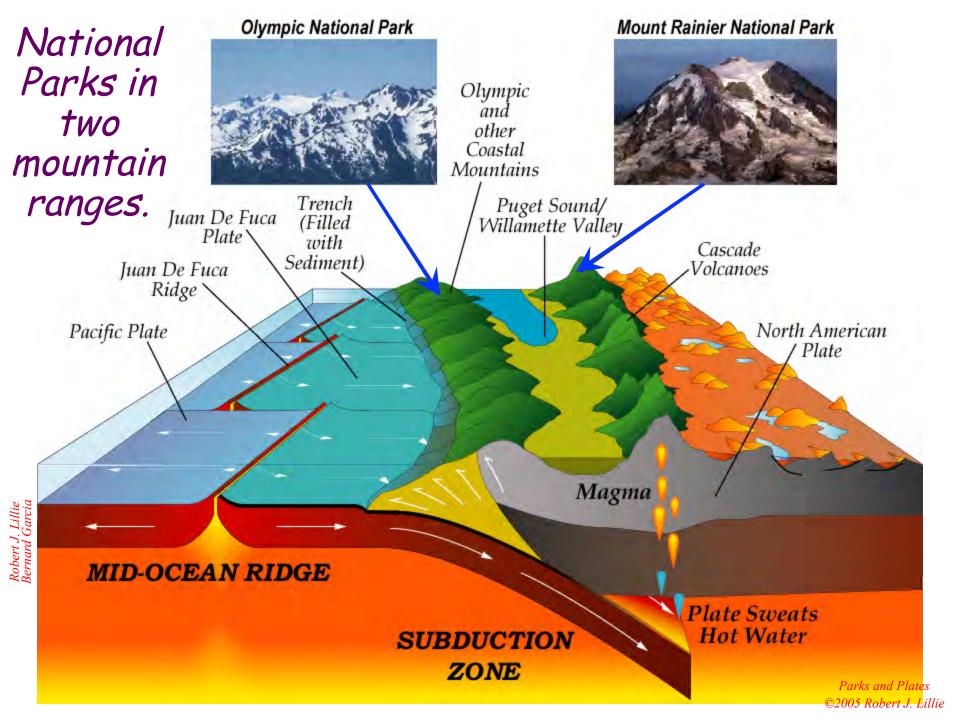


World Map of Plates

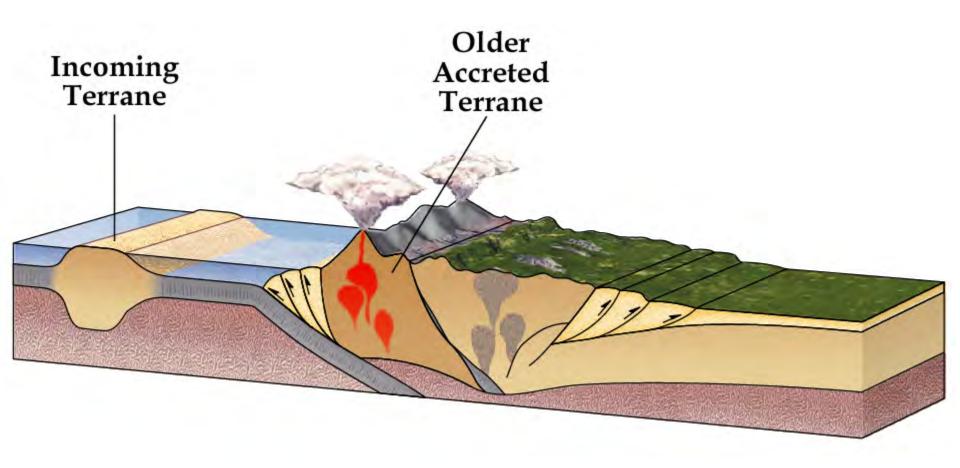
Explore Convergent Plate Boundaries

Map of Major Tectonic Plates and Select Great Earthquakes and Volcanoes.





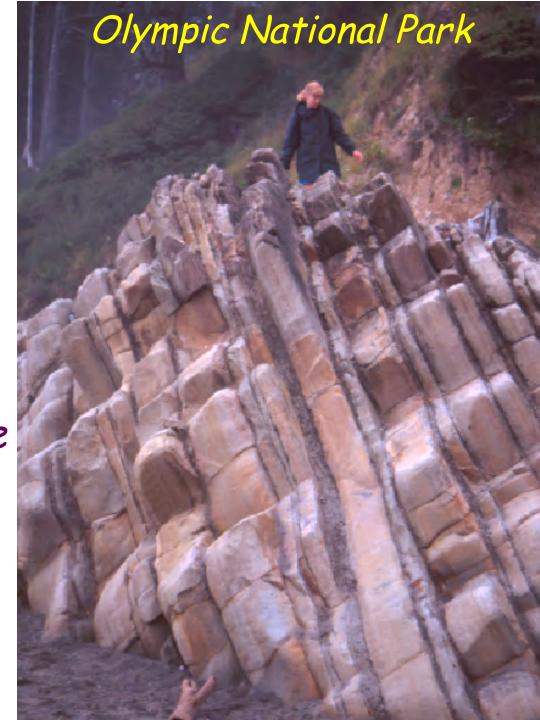
Terrane Accretion



A <u>TERRANE</u> consists of crust that is too thick and buoyant to subduct. The continent grows outward as terranes are added to the margin.

Coastal Ranges

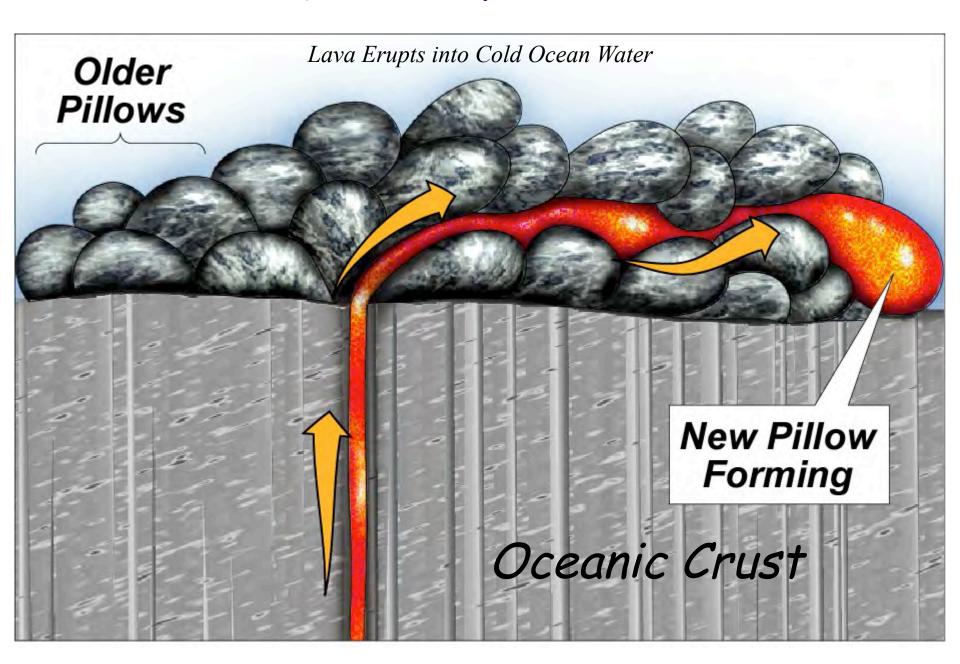
Marine sedimentary layers deposited on the seafloor then scraped off onto the continental margin.



Olympic National Park



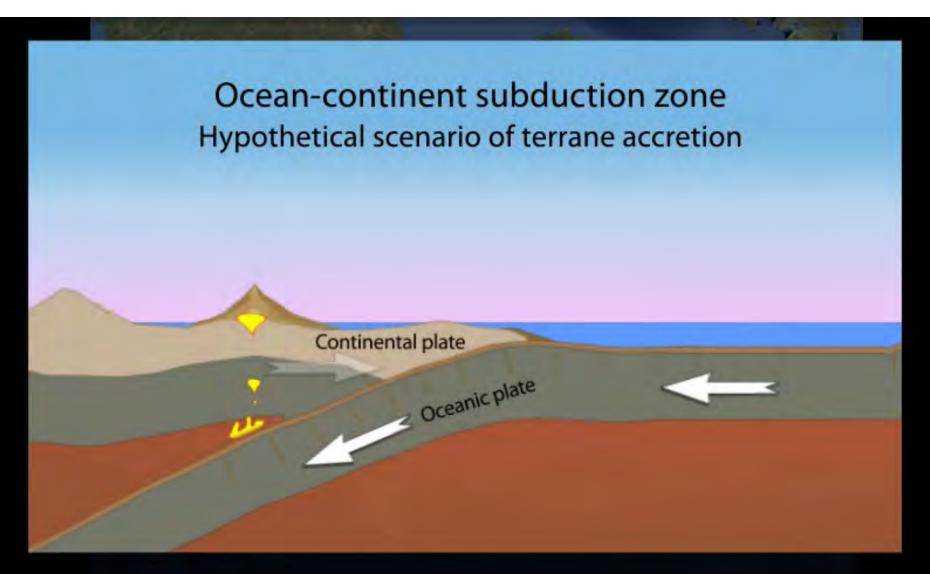
Formation of Pillow Lava



Video of Pillow Lava

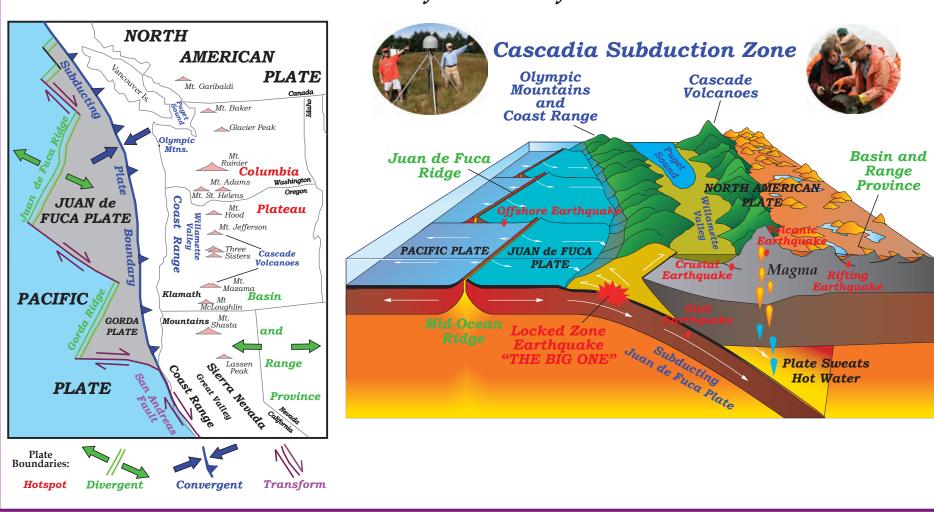


Terrane Accretion



Beauty and the Beast

Plate Tectonics of the Pacific Northwest

















Heceta Head Lighthouse State Scenic Viewpoint, Oregon



Beauty and the Beast

"The same geological processes that threaten our lives with earthquakes, tsunamis, and volcanic eruptions also nourish our spirits by creating the spectacular mountains, valleys, and coastlines of the Pacific Northwest."



