

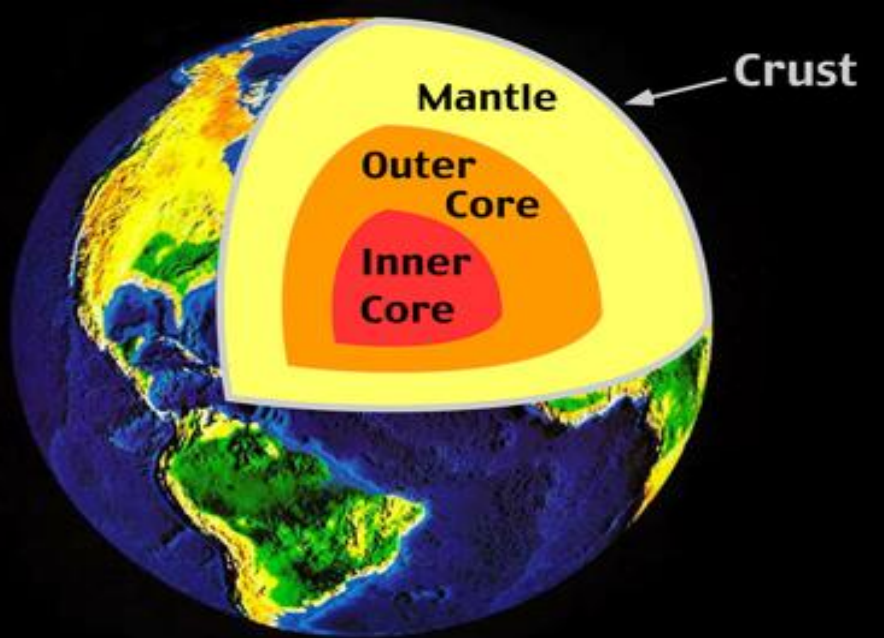
Earth/Environmental Science

Unit 4: Formation of Earth and Geology

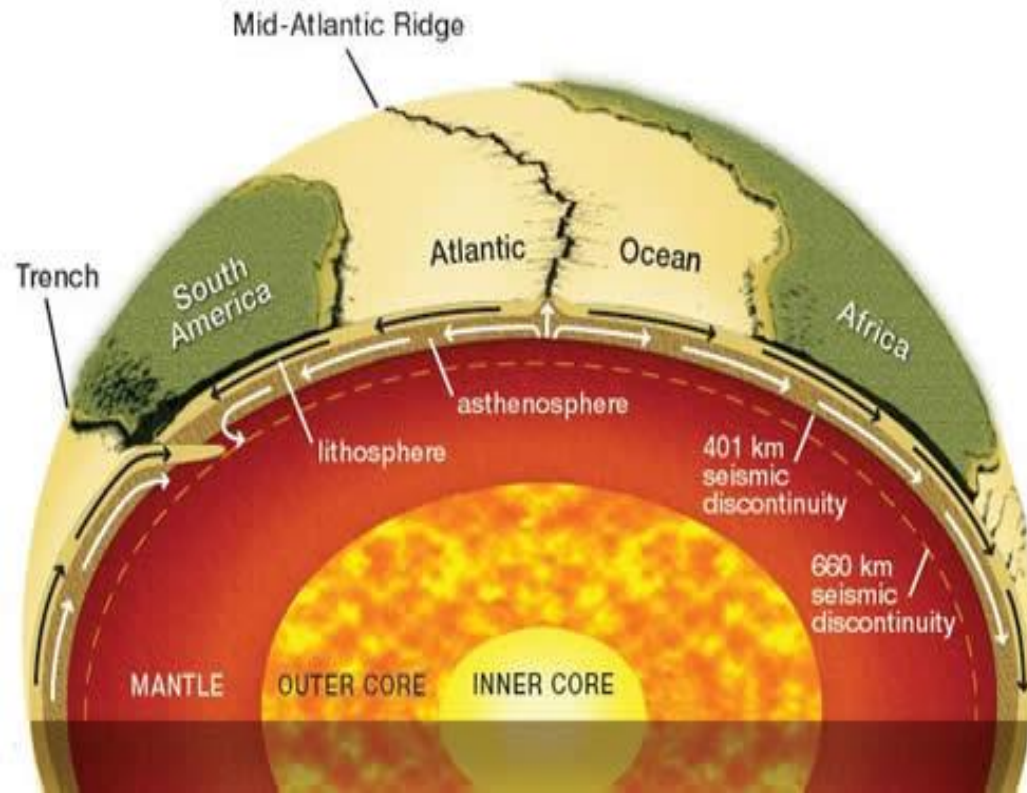
EEn.2.1.1

I can explain how the rock cycle, plate tectonics, volcanoes, and earthquakes impact the lithosphere.

Parts of the Earth

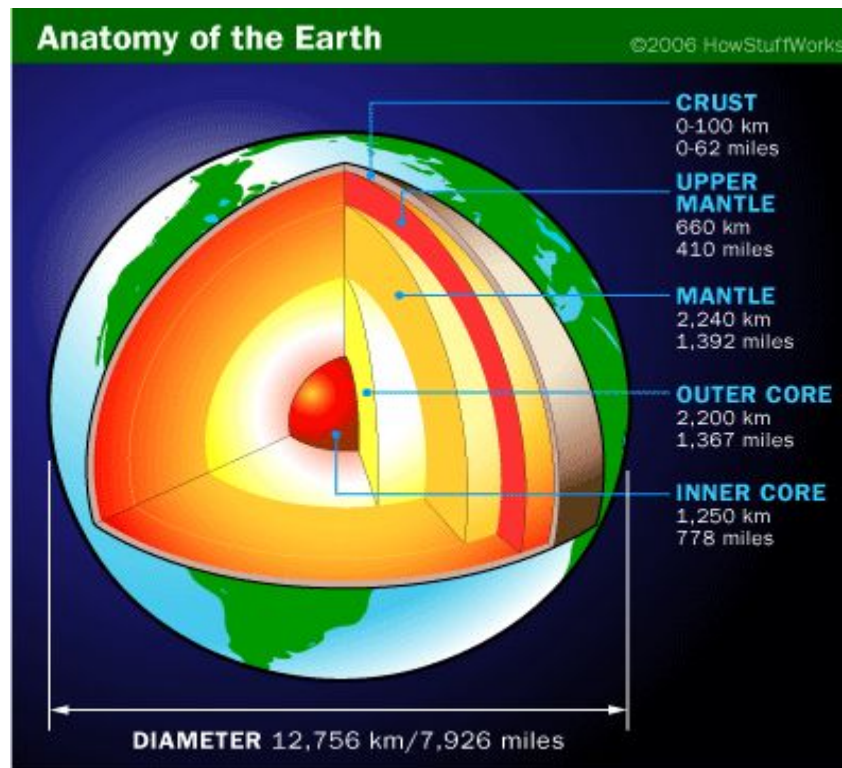


- Layers defined by composition
- Crust
 - Thin, rocky outer layer of Earth
 - Oceanic crust is 7 km thick which is thicker than continental plates



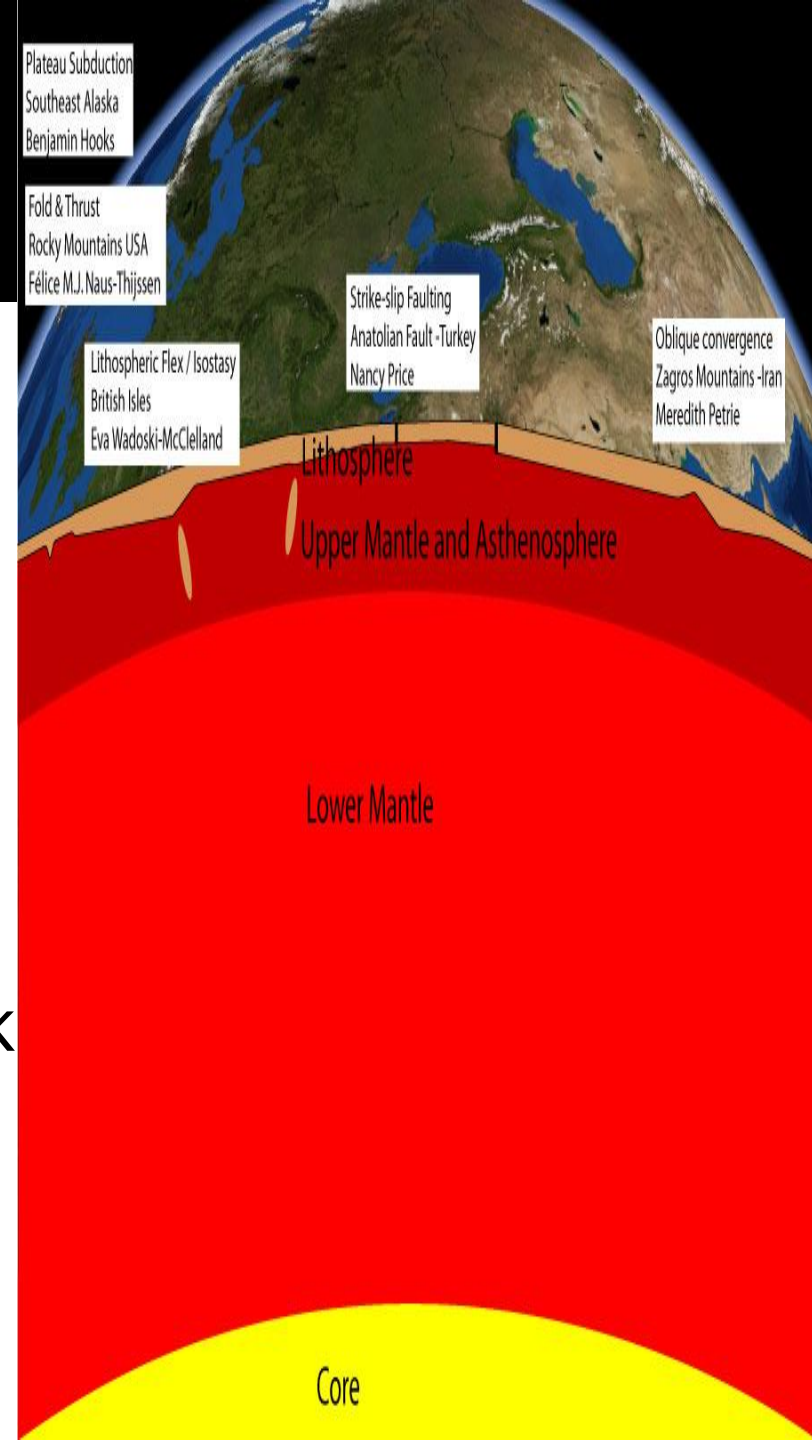
▪ Mantle

- 82% of the Earth's volume
- Solid rock at the top, liquid at the bottom



Layers defined by Physical Properties

- Lithosphere
 - The crust and uppermost mantle
 - Cool, rigid shell
 - 100 km thick
- Asthenosphere
 - **Soft**, comparatively weak layer
 - Below the lithosphere
 - Rock close to melting

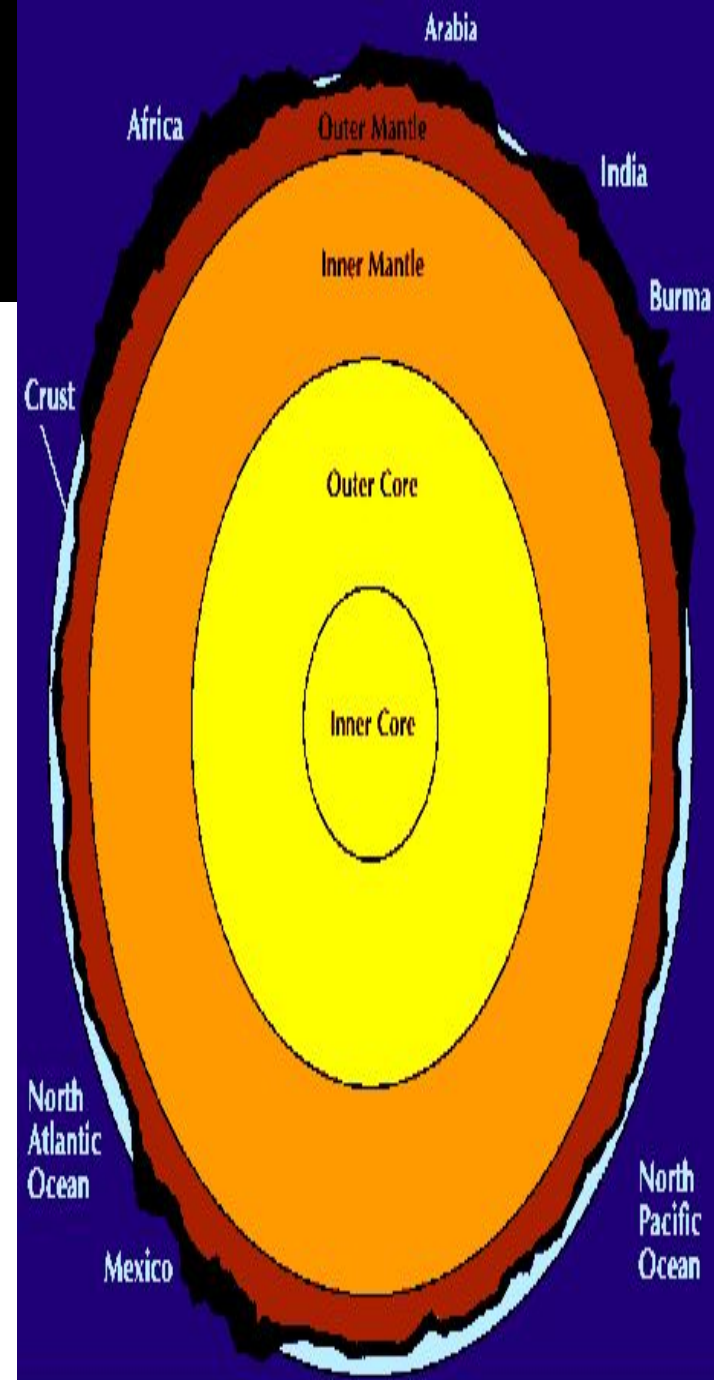


- **Outer Core**

- Liquid layer 2260 km thick
- Metallic iron generates Earth's magnetic field

- **Inner Core**

- Solid layer having a radius of 1220 km
- High temperatures and high pressure
- Nickel mostly



What is a Rock?

- Any solid mass of mineral or **mineral-like matter** that occurs naturally as part of our planet
- **3 types**
 - Igneous
 - Sedimentary
 - Metamorphic



G657



G663



G664



Zidingxiang



Taohuahong



G682



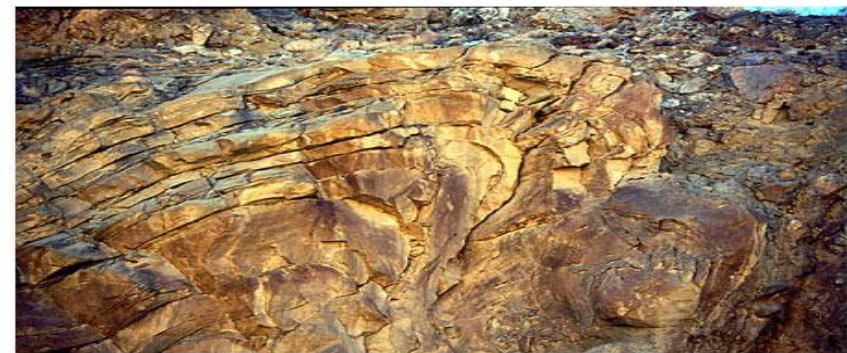
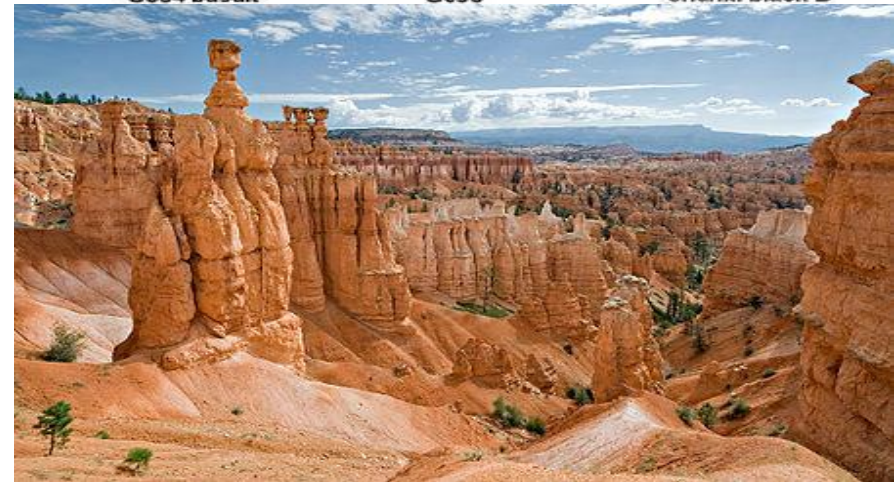
G684 basalt



G696



shanxi black B



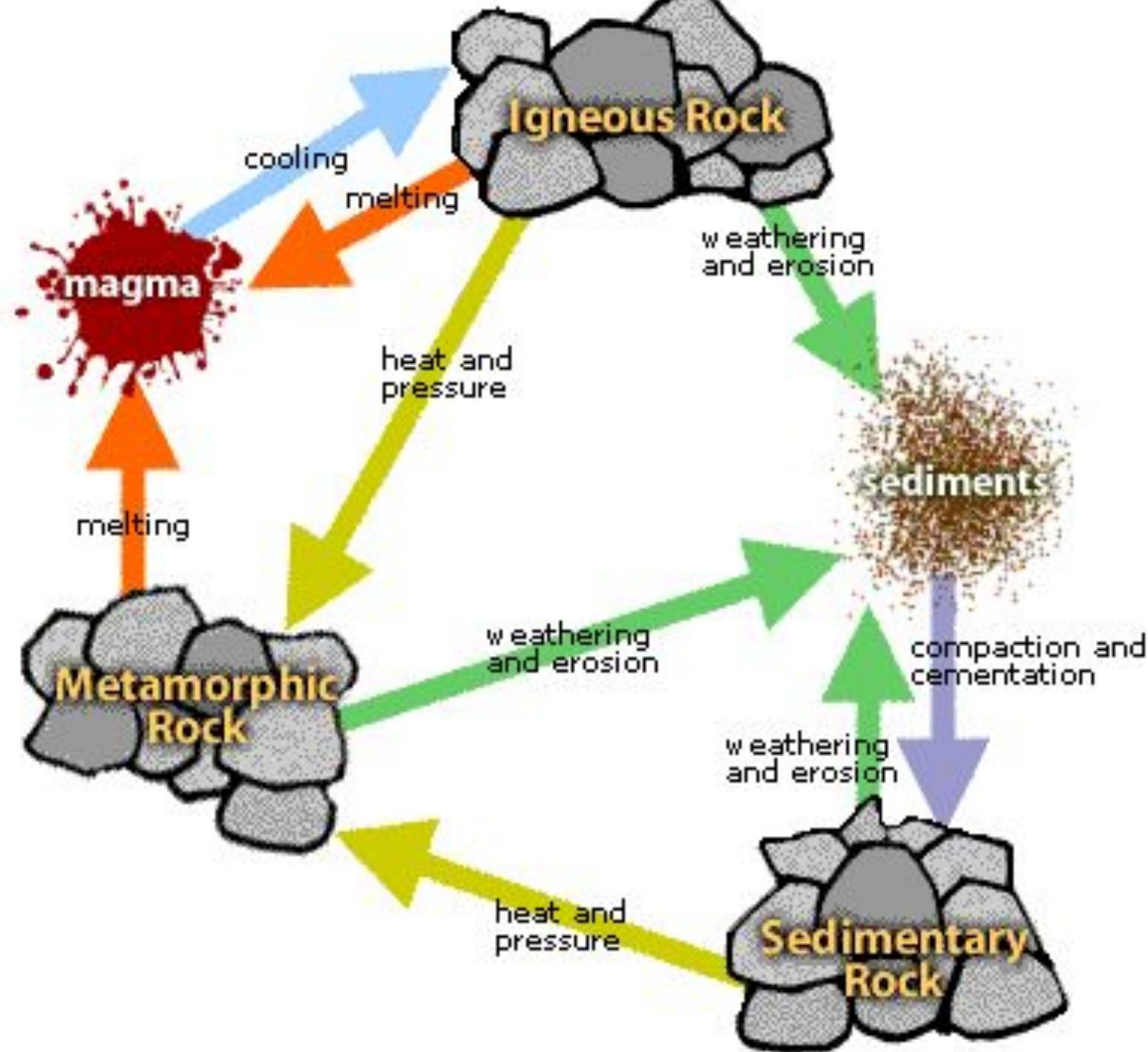
Define these terms

- **Weathering**
- **Compaction**
- **Melting**
- **Cementation**

The Rock Cycle

- Interactions among Earth's water, air, land, and living things can cause rocks to change from one type to another
- A continuous process
- **Driven by heat and mechanical energy**

Rock Cycle



The Rock Cycle

Igneous Rock -----> Sedimentary Rock

Sedimentary Rock -----> Metamorphic Rock

Metamorphic Rock -----> Igneous Rock

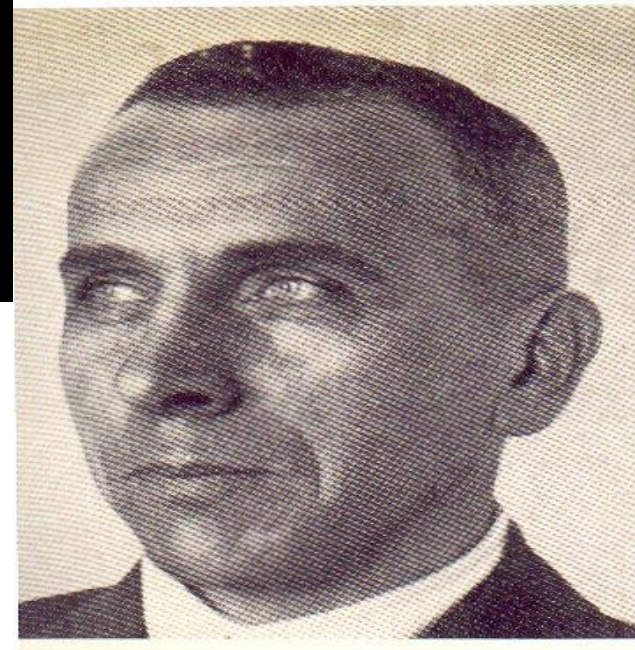
Metamorphic Rock -----> Sedimentary Rock



Plate Tectonics

What is Continental Drift

- Proposed by Alfred Wegener
- **Stated that the continents had once been joined to form a single supercontinent**
- Wegener's Theory
 - Pangaea broke apart 200 MY
 - Continents "drifted"
 - Continents "broke" through the oceans



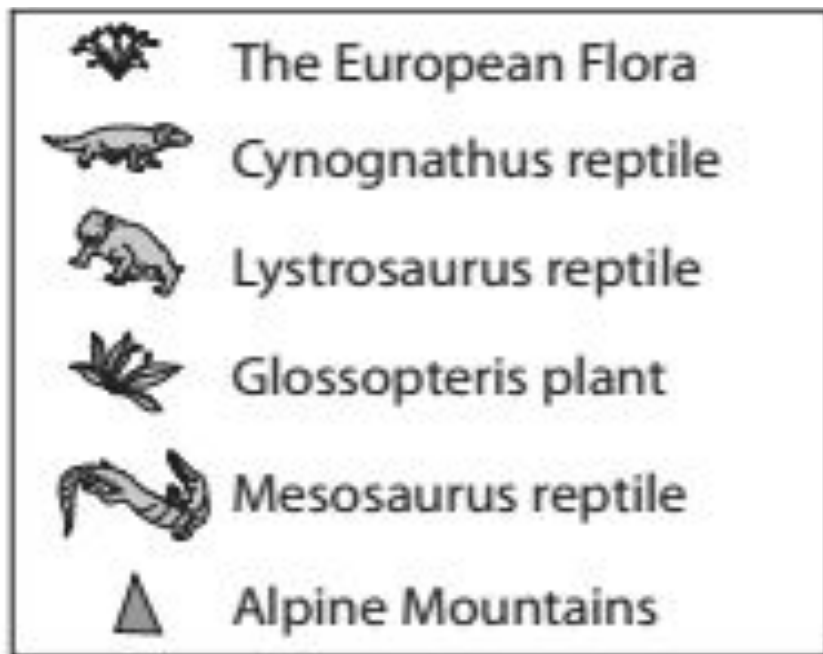
Pangaea

- Occurred 500 MY
- Continents breakup begins 200 MY
- North America and Africa split 135 MY



Continental Drift Activity

Paste activity in your notebook



Color Key

Flora - Red

C. Reptile - Yellow

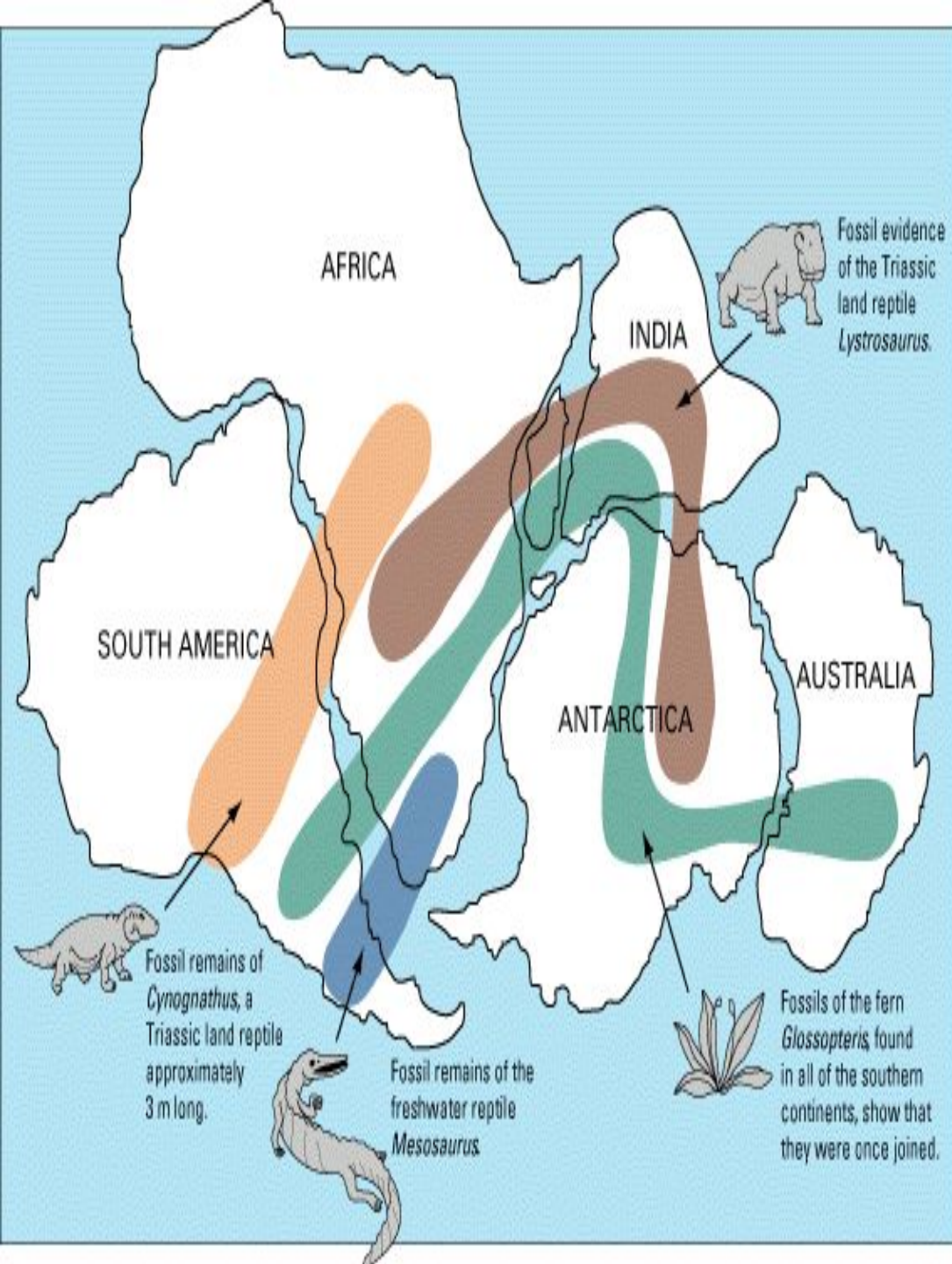
L. Reptile - Orange

G. Plant - Green

M. Reptile - Blue

Mountains - Purple

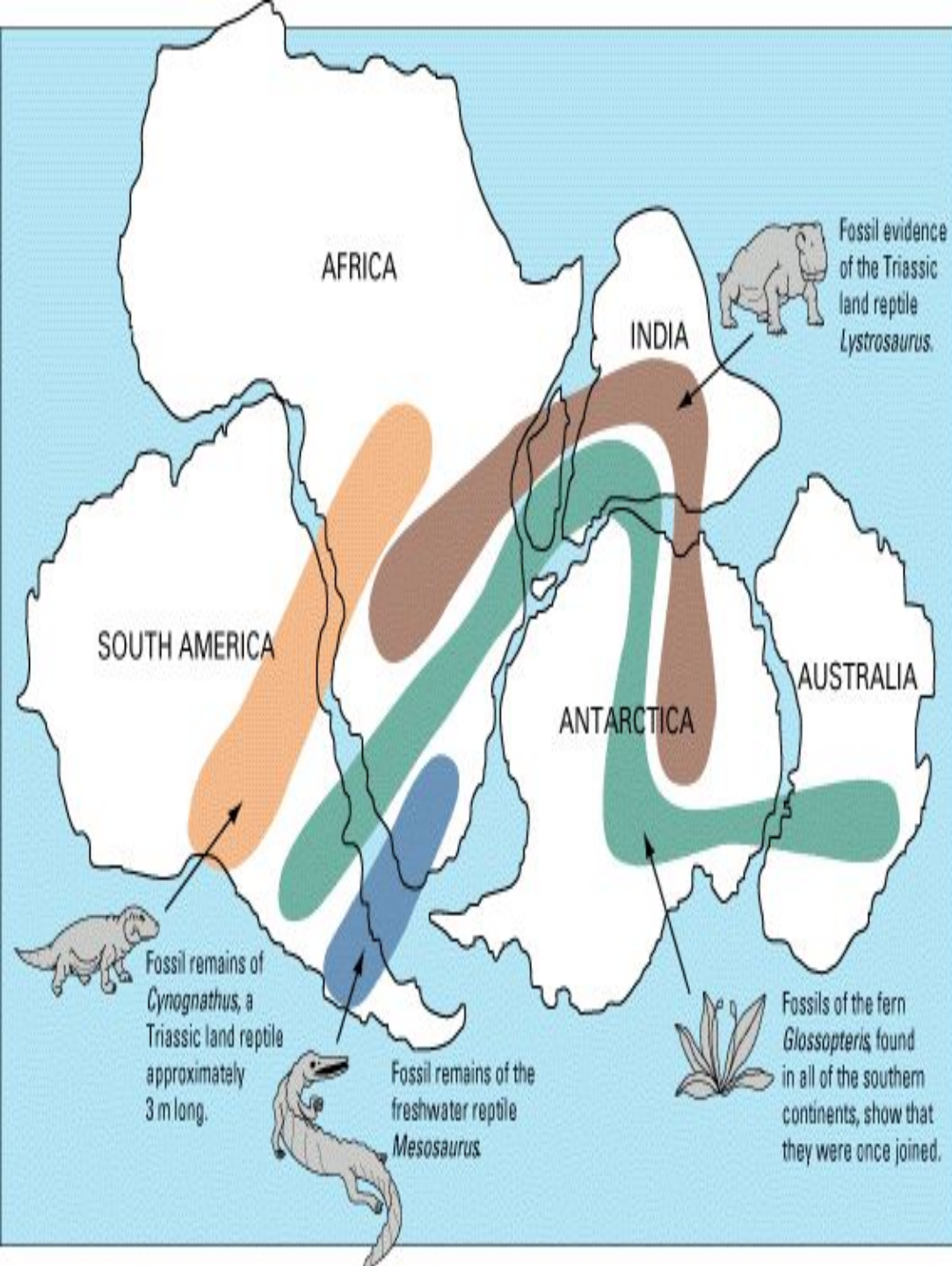
Evidence of Continental Drift



- Shorelines look like they **fit together**
- **Fossil organisms found on different landmasses**

Evidence of Continental Drift

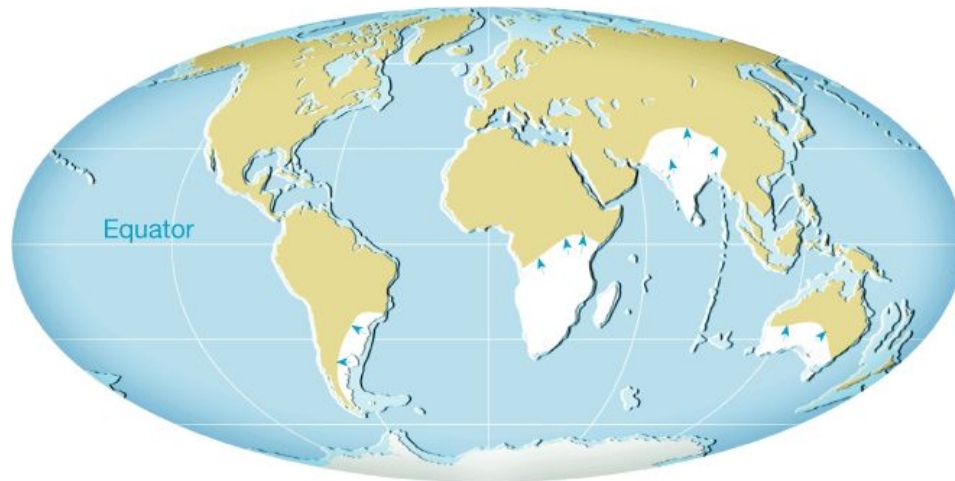
- Several mountain belts end at one coastline, **only to reappear on a landmass across the ocean**
- Ancient Climates

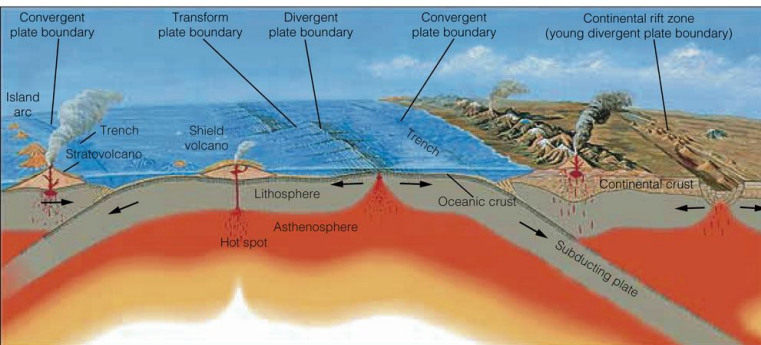
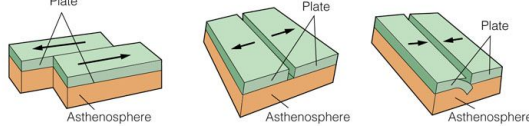


Matching Mountain Ranges



Glacier Evidence





© 2006 Brooks/Cole - Thomson

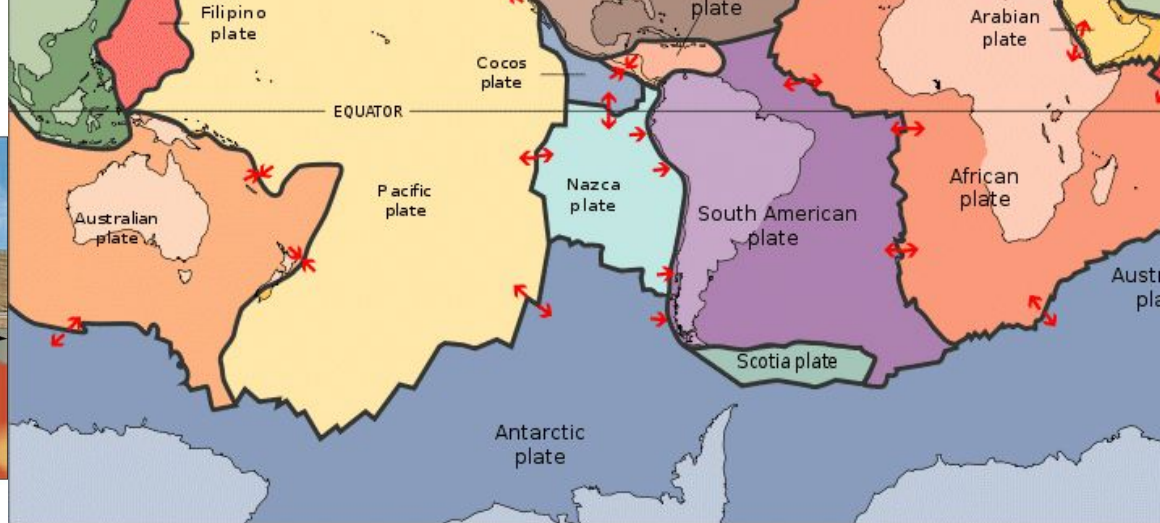
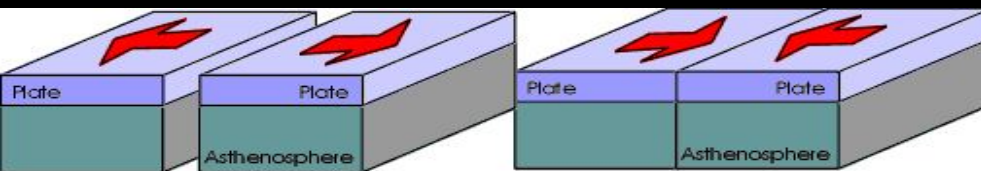
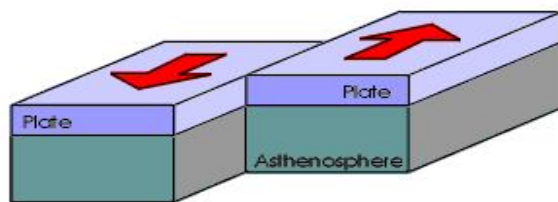


Plate Boundaries and Features

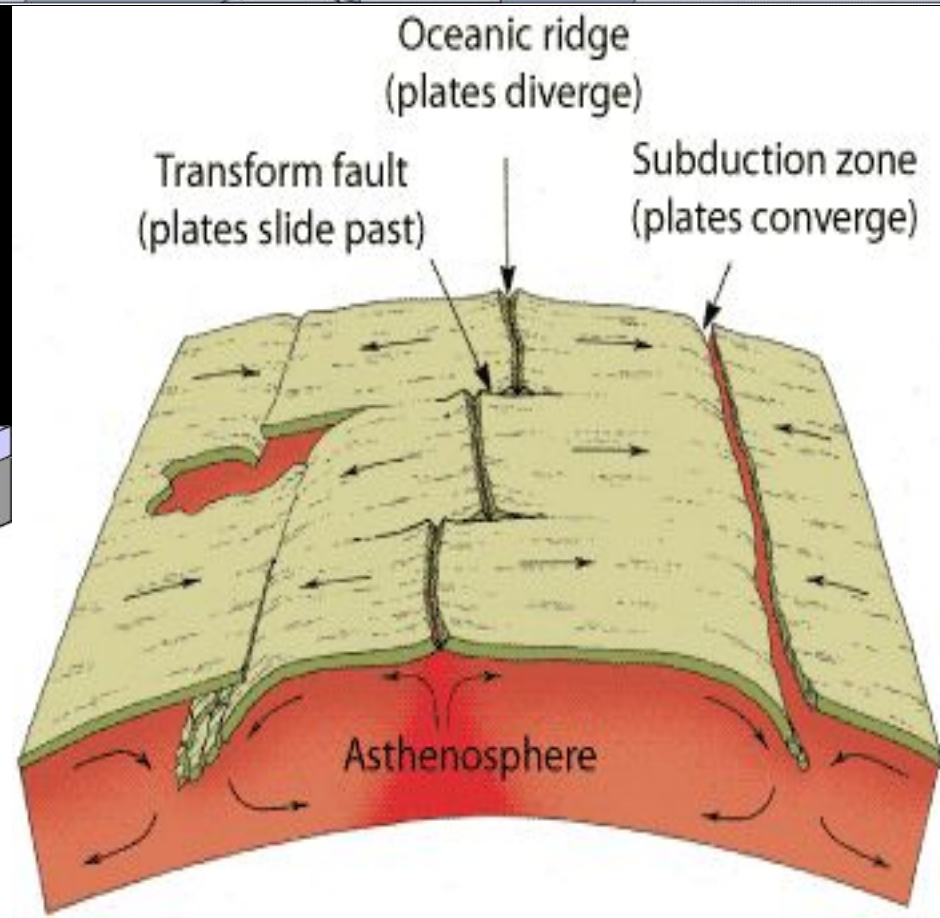


Divergent

Convergent

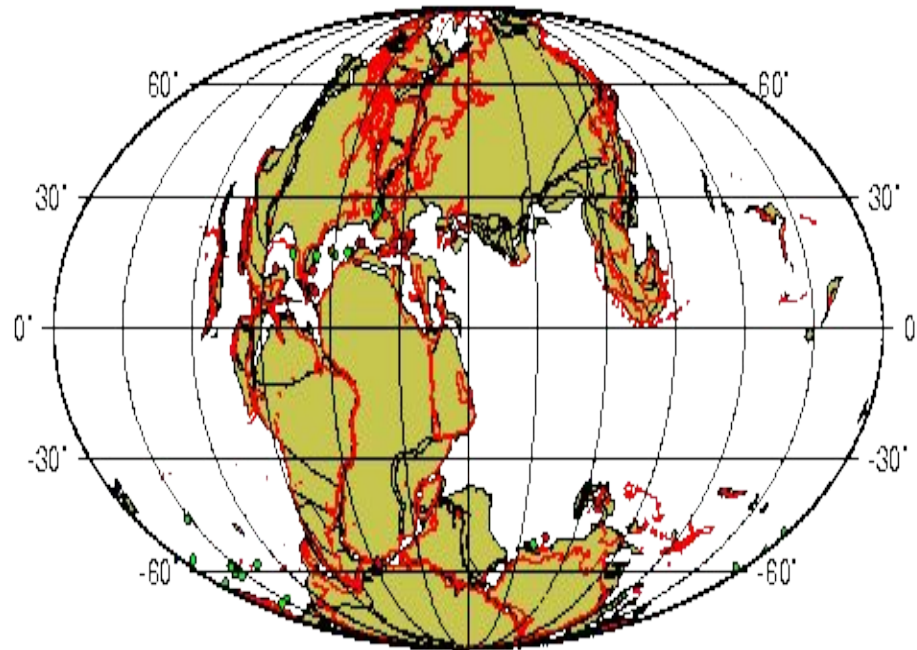


Transform



The Theory of Plate Tectonics

- Proposes that Earth's outer shell consist of **individual** plates that **interact** in various ways and thereby produce earthquakes, volcanoes, mountains, and the crust itself



150 My Reconstruction

Do the plates move?

- *Do the plates move? If so, why?*

Causes of Plate Motion

■ Mantle Convection

- Basic driving force for plate movement
- The unequal distribution of heat within Earth causes thermal convection the drives plate motion

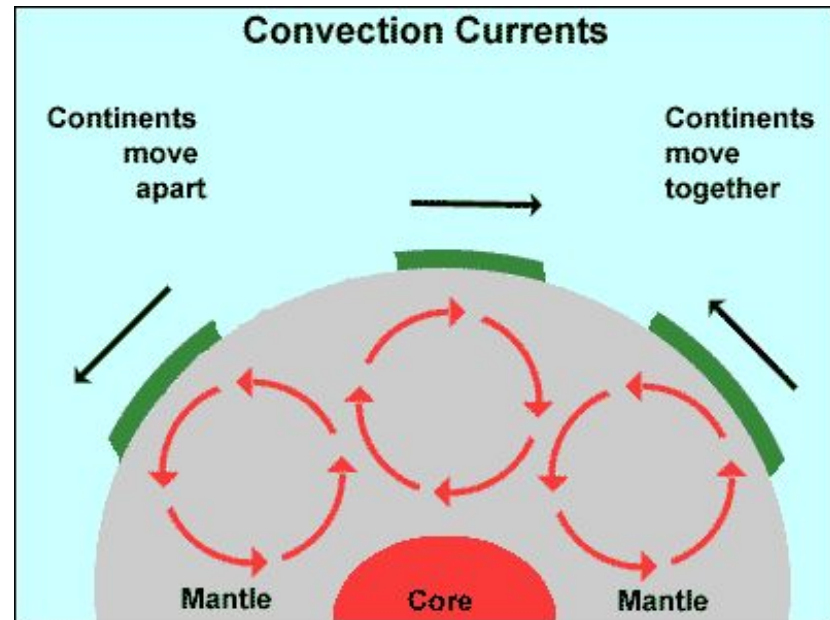
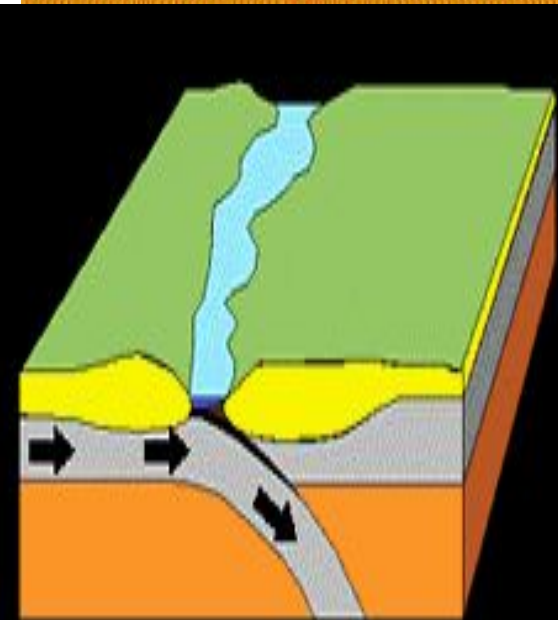
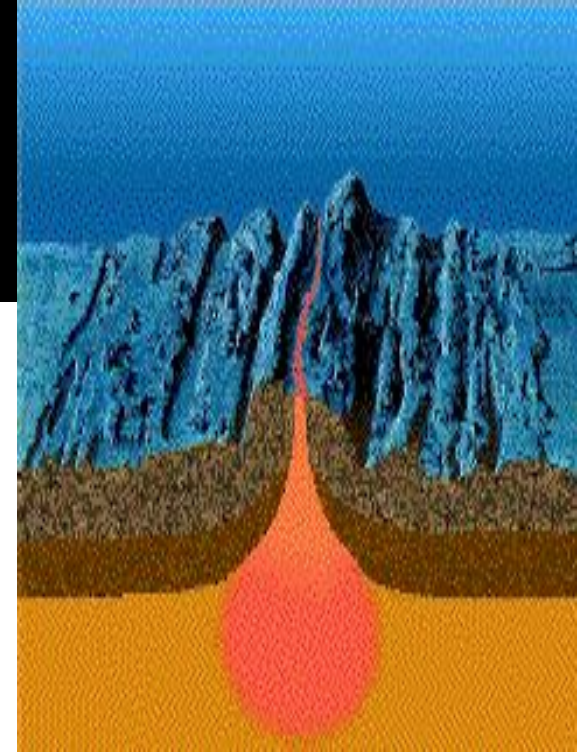


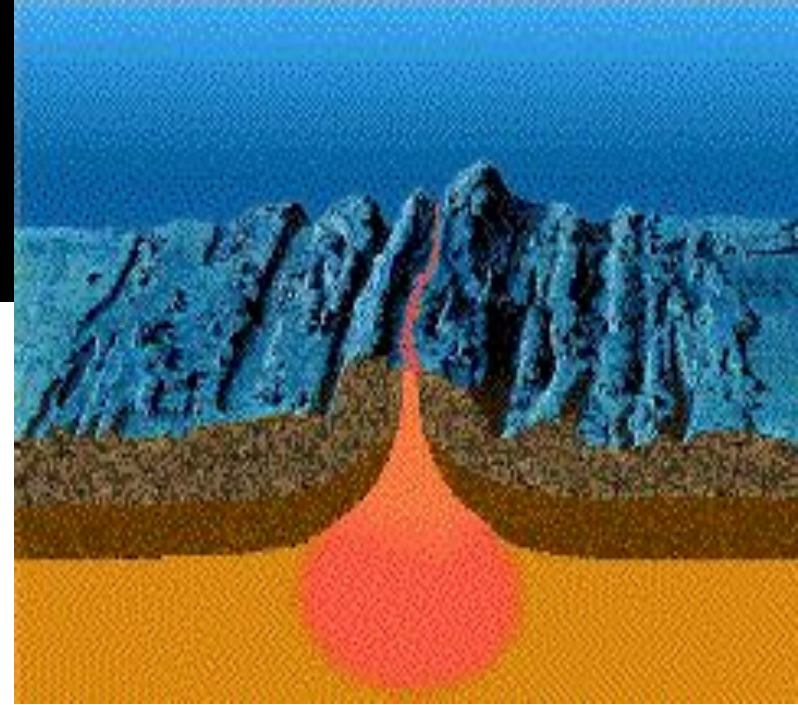
Plate Boundary Activities

- Seismic activity – Earthquakes!
- Volcanism
- Mountain Building
- Sea Floor Spreading



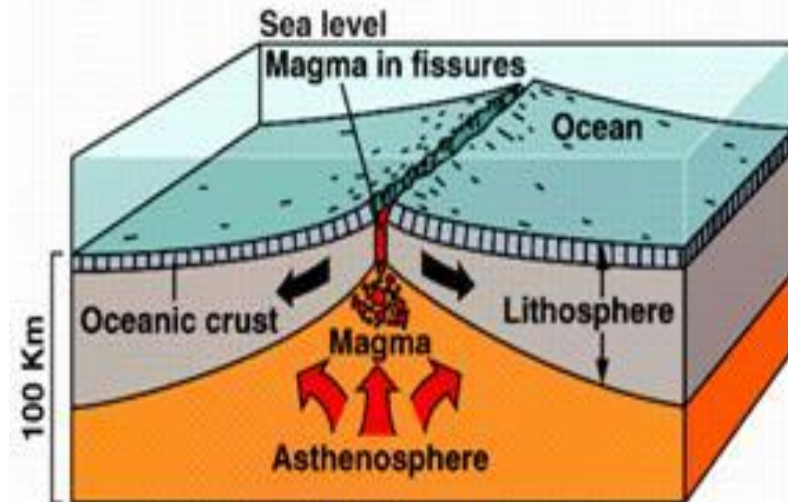
Divergent Boundaries

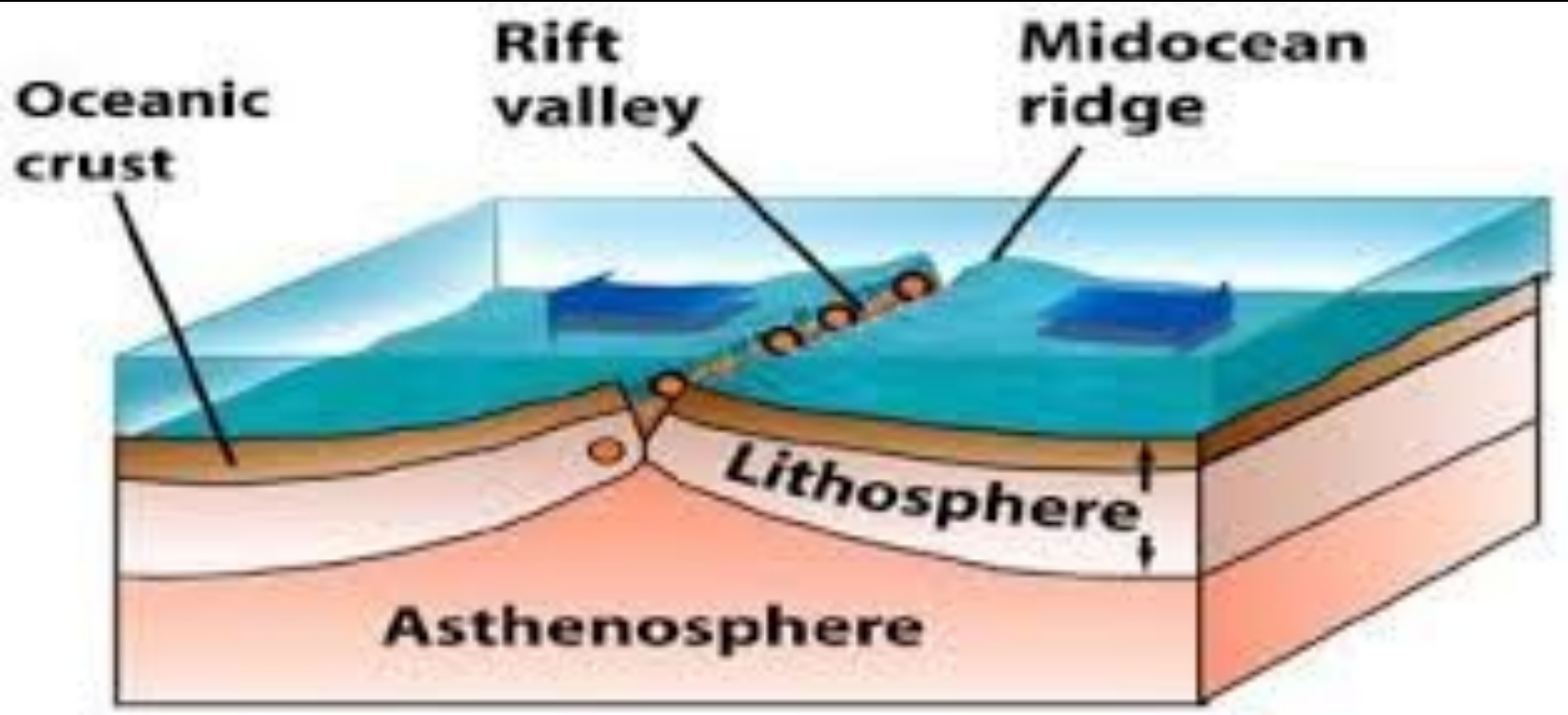
- Also called spreading centers
- When two plates move apart
- Creates new seafloor (seafloor spreading)
- Causes ocean ridges and rift valleys



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A Divergent Boundary





Oceanic crust

Rift valley

Midocean ridge

Lithosphere

Asthenosphere

DIVERGENT BOUNDARY

Convergent Boundaries

Oceanic-
Continental
boundaries

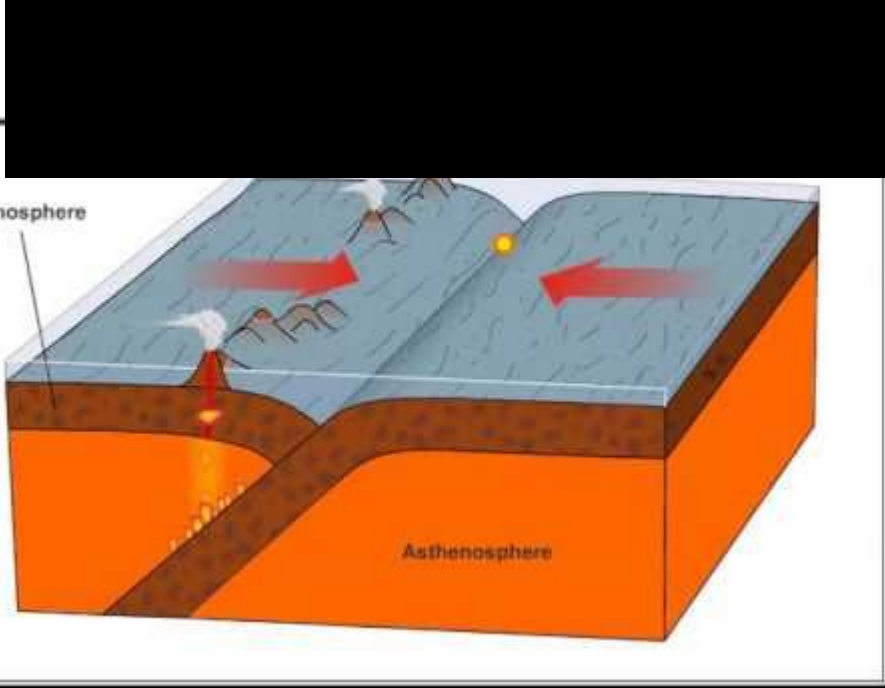
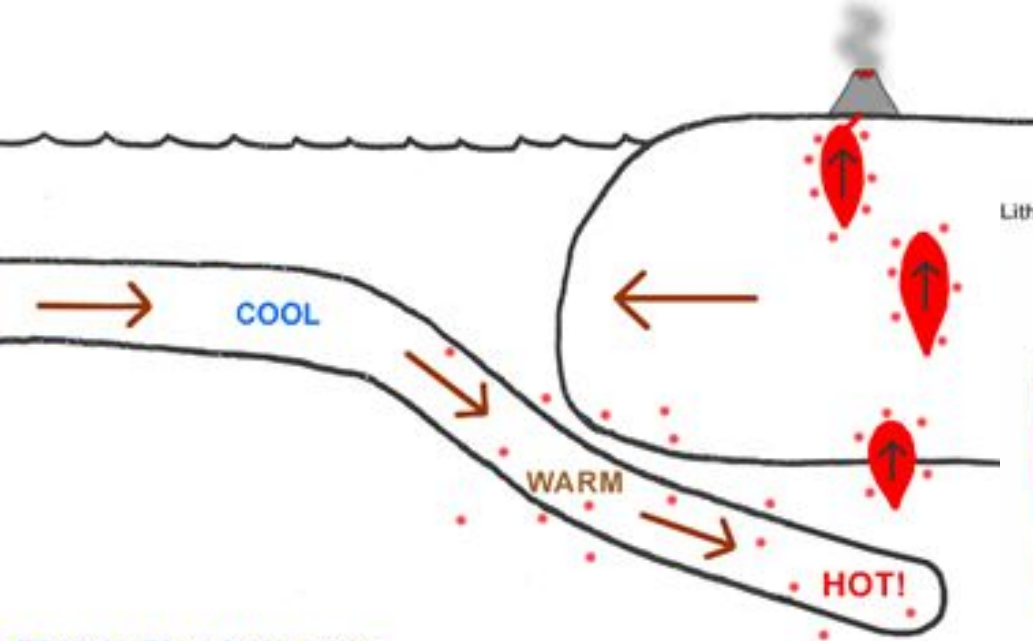
Causes
subduction zones,
trenches,
continental
volcanic arcs

Continental-
Continental
Boundaries

Two plates collide
- Forms
mountains

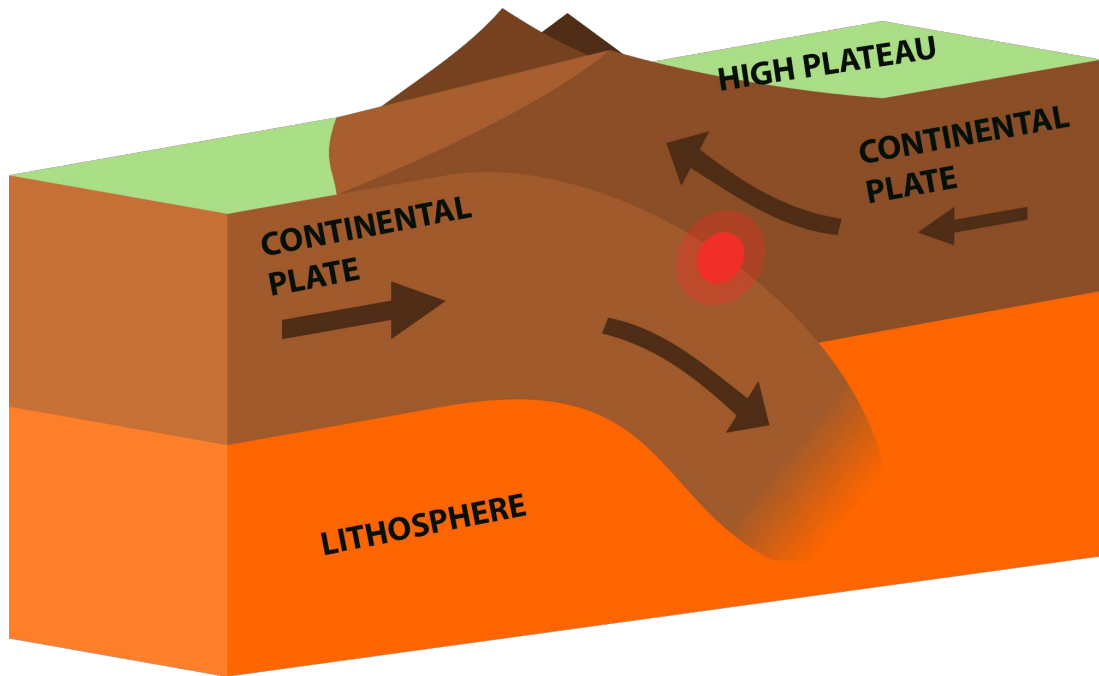
Oceanic-
Oceanic
boundaries

One oceanic plate
goes **beneath**
another oceanic plate
Creates volcanic
island arcs



[Click to Play Animation](#)

MOUNTAIN RANGE



What is a volcano?

- A mountain formed of lava and/or pyroclastic material



Volcanoes

- Magma vs. Lava
- Magma – molten rock within Earth
- Lava – molten rock on Earth's surface

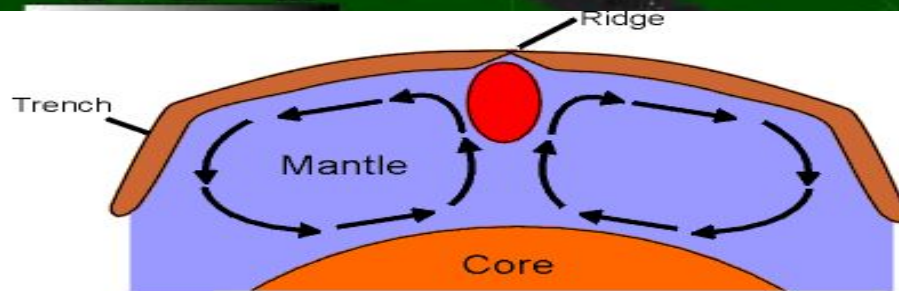
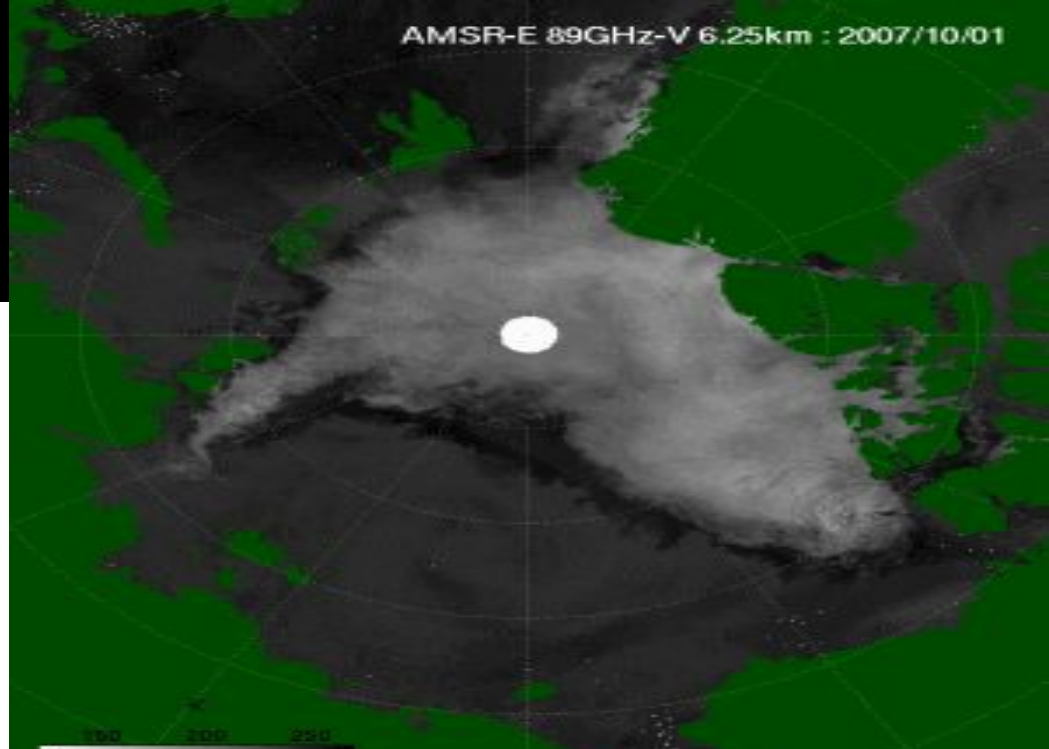
Pyroclastic flow on Augustine volcano
Photo by B. Yount, USGS, 1998



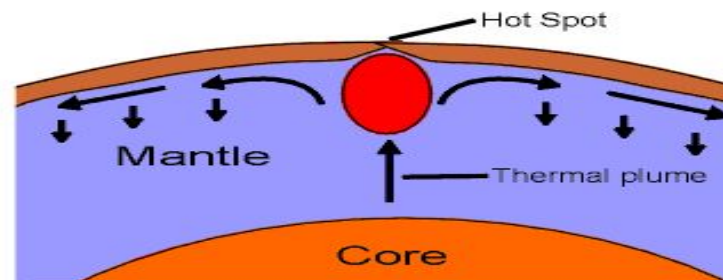
- **Gases**
 - 70% water vapor
 - 15% carbon dioxide
 - 5% nitrogen
 - 5% sulfur
- **Pyroclastic material**
 - Fragments **ejected** during eruptions
 - Varies in size from very fine and volcanic ash to pieces that weigh several tons

Hot Spots

- Small volcanic region a few hundred kilometers across within a plate
- Ex: Hawaiian Island



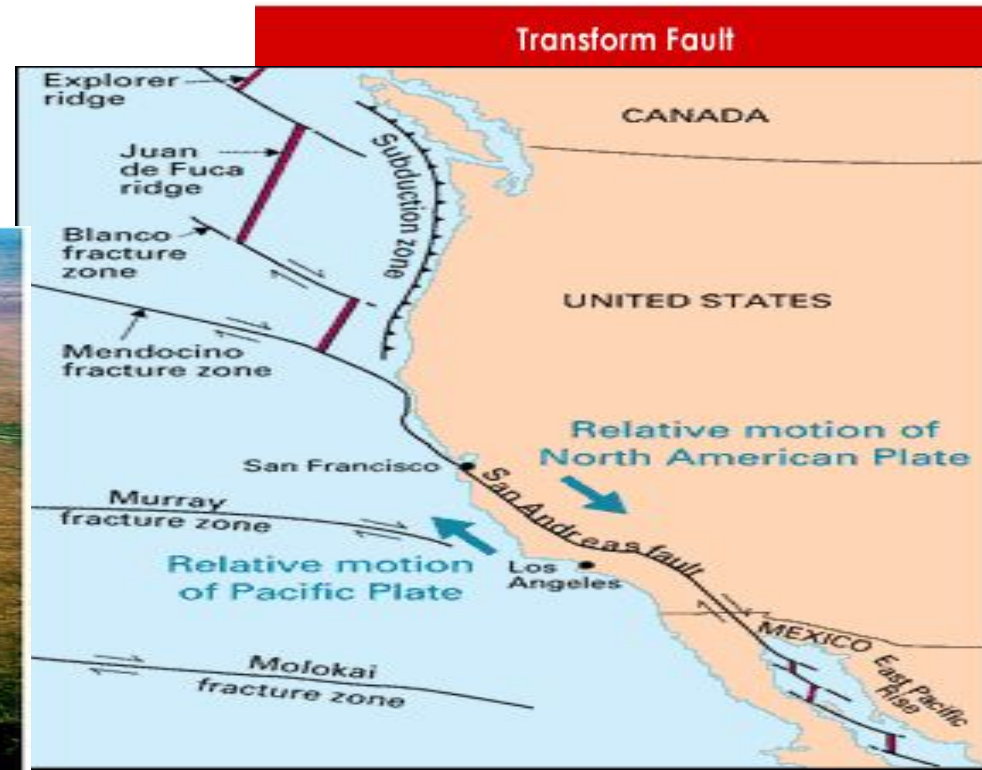
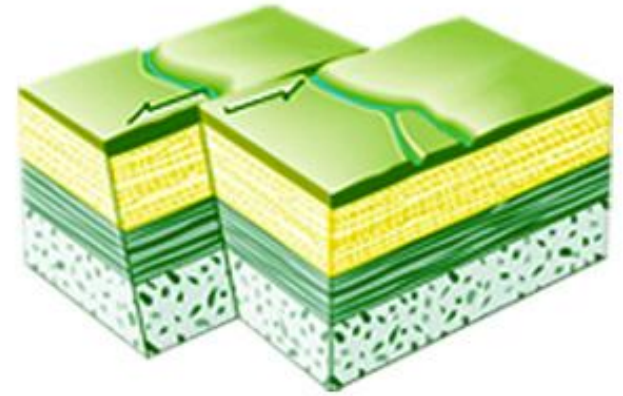
Convection Model

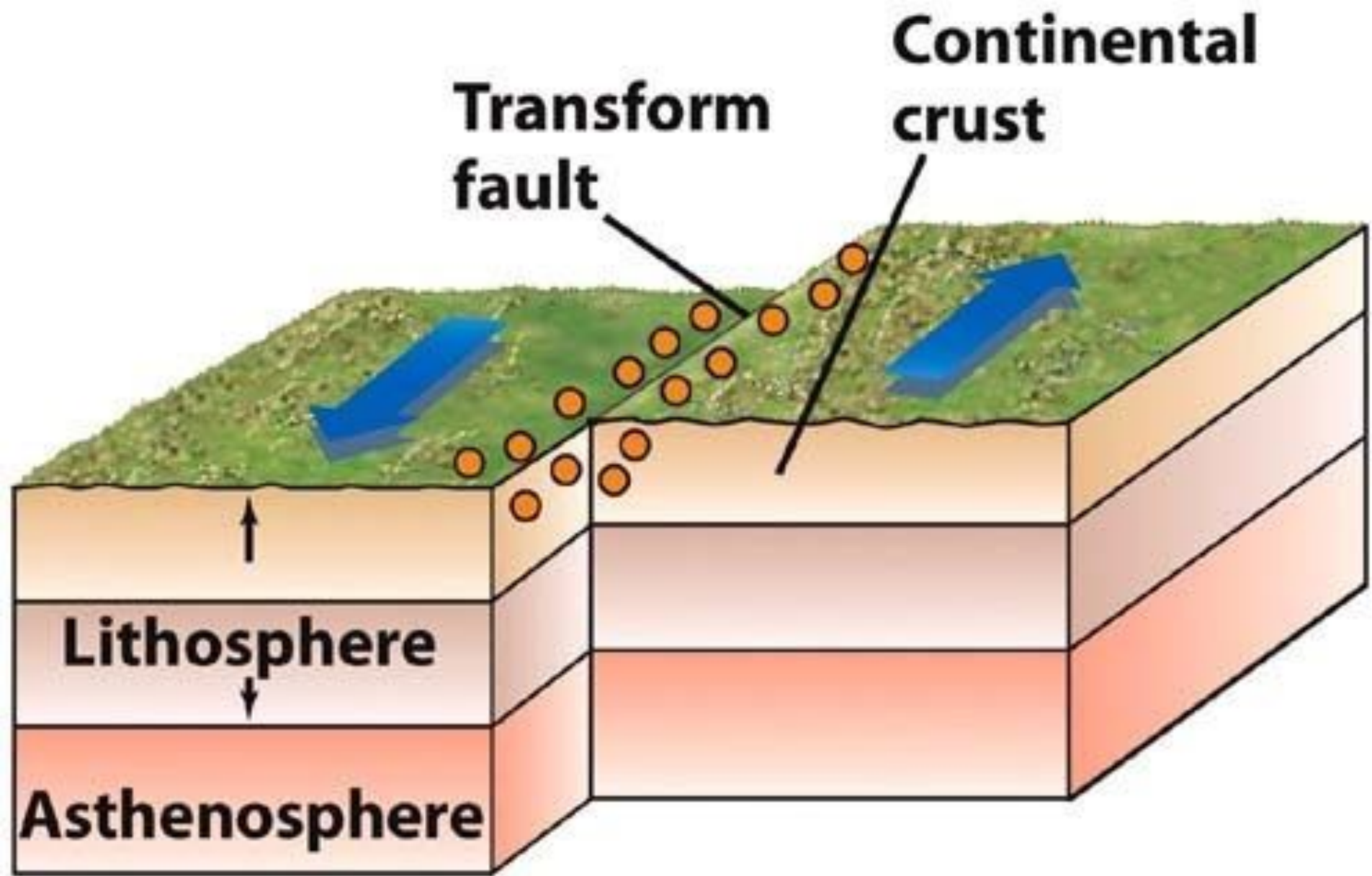


Hot Spot Model

• Transform Boundaries

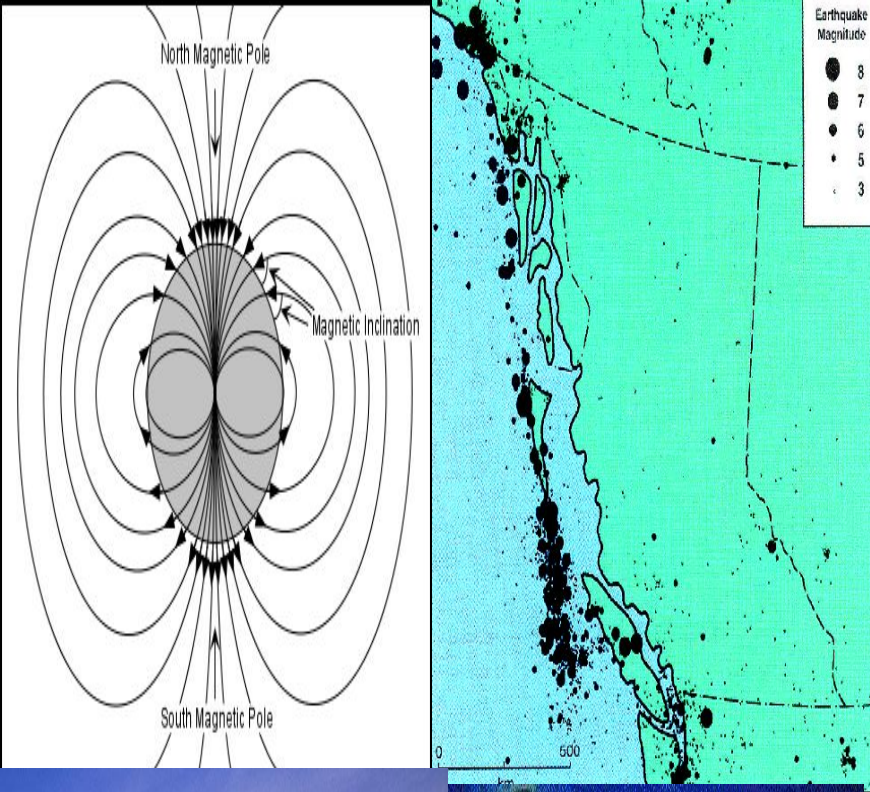
- Two plates grind past each other without production and destruction of lithosphere
- Ex: San Andreas Fault in California
- Plate Boundary Rap





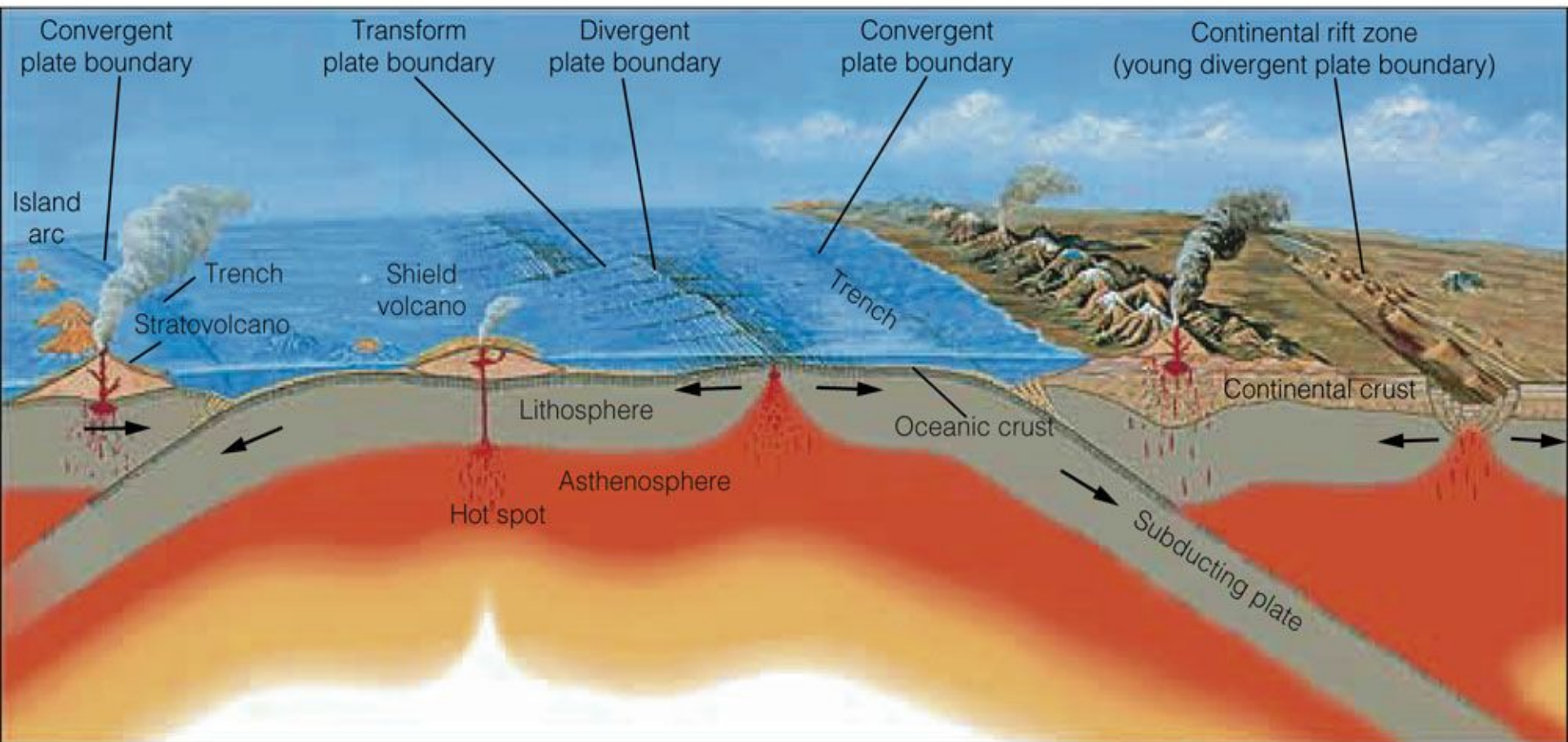
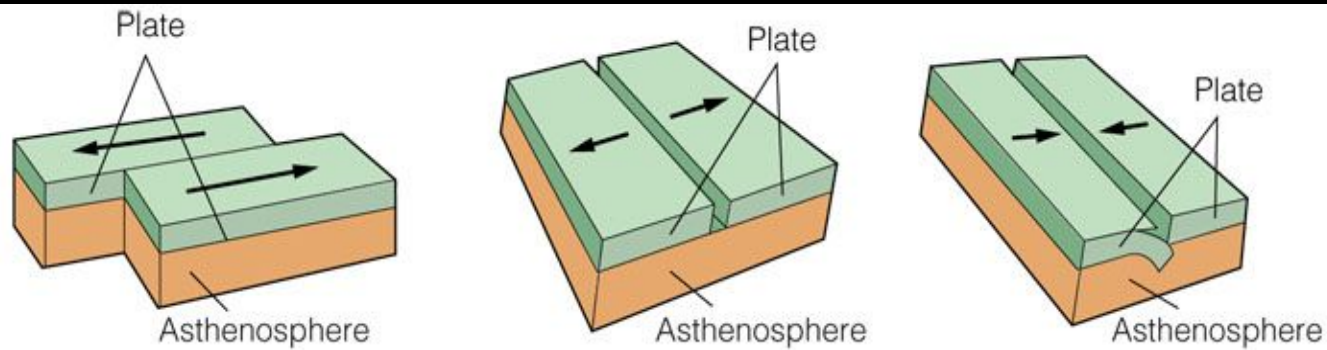
TRANSFORM FAULT BOUNDARY

Evidence of Plate Tectonics



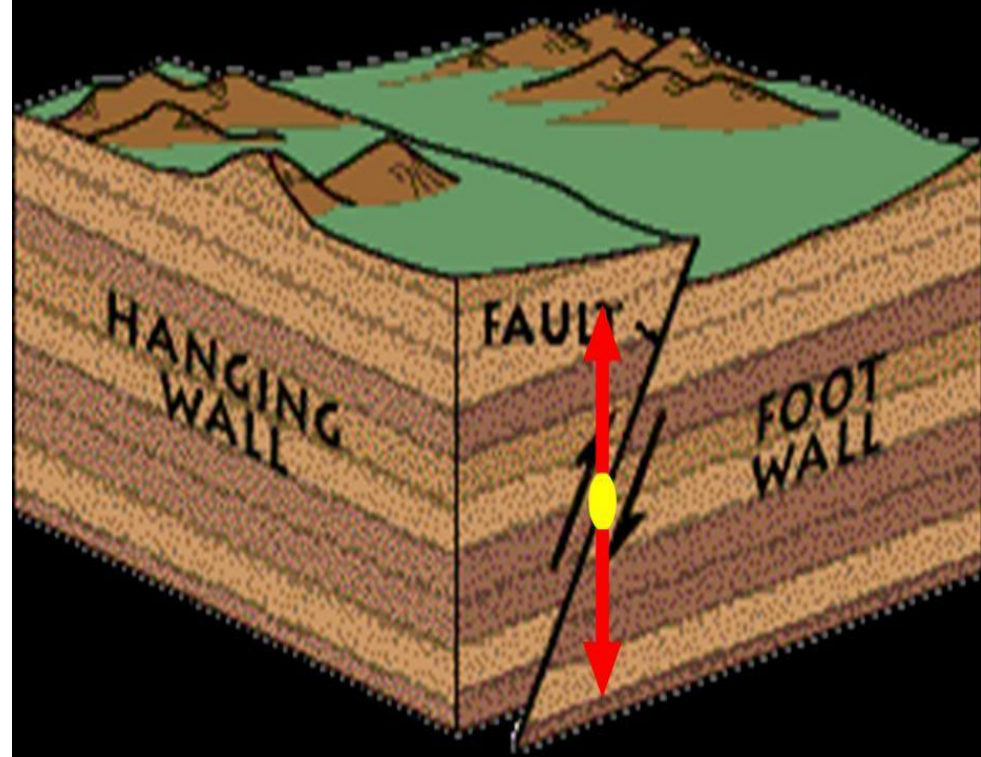
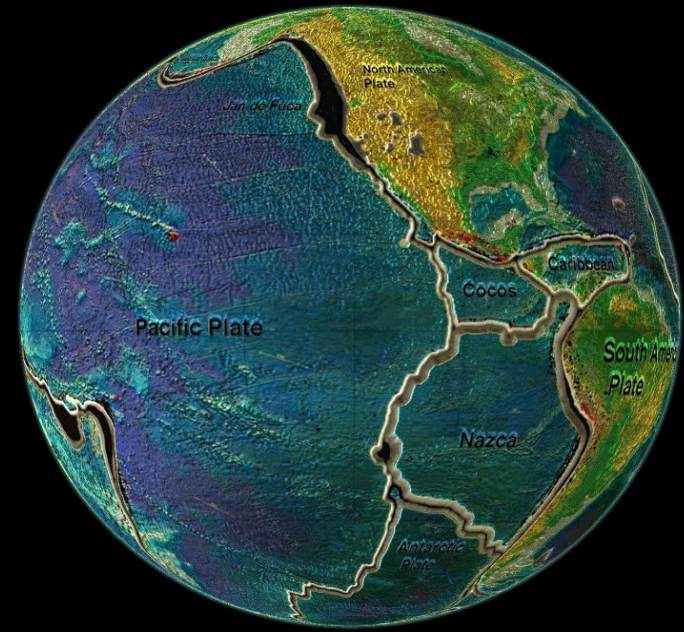
- **Paleomagnetism**
- **Earthquake patterns**
- **Ocean Drilling:**
- **Hot Spots:** supports that the plates move over Earth's surface





Faults

- Faults are formed by **fractures** in rocks
- Parts of a Fault
 - **Hanging wall:** rock above the fault line
 - **Foot Wall:** rock below the fault line



Earthquakes

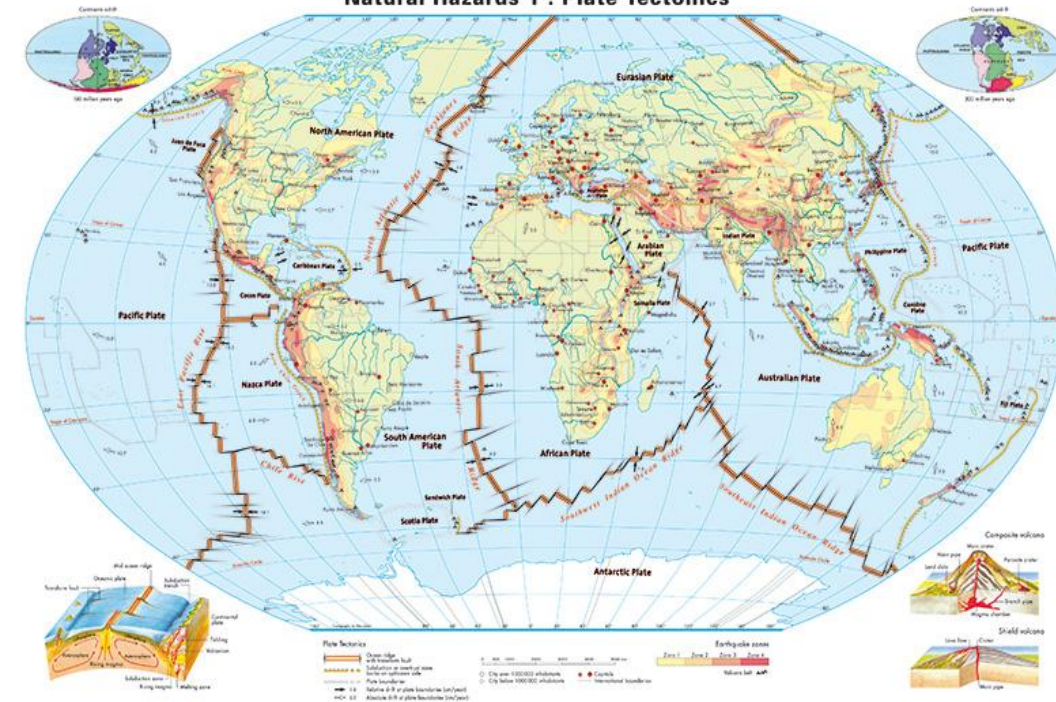


What is an earthquake?

- Vibration of Earth produced by a sudden release of energy
- **Movements along the fault line.**

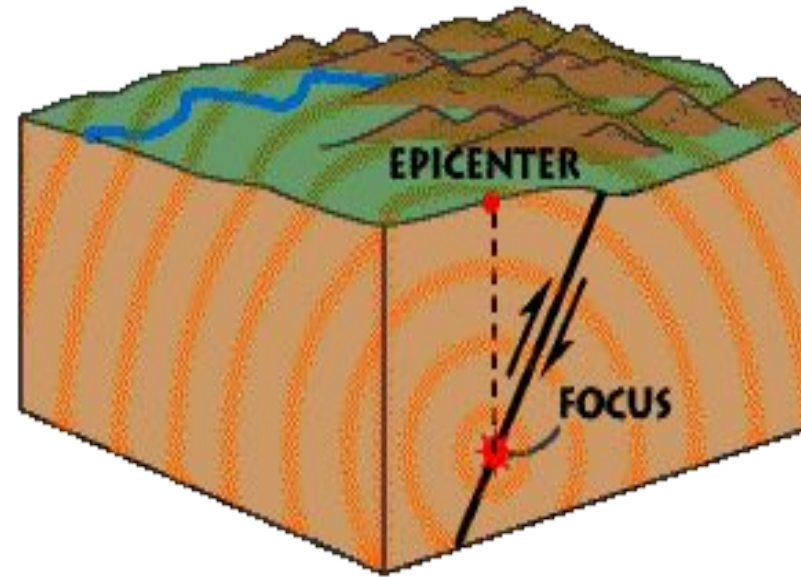
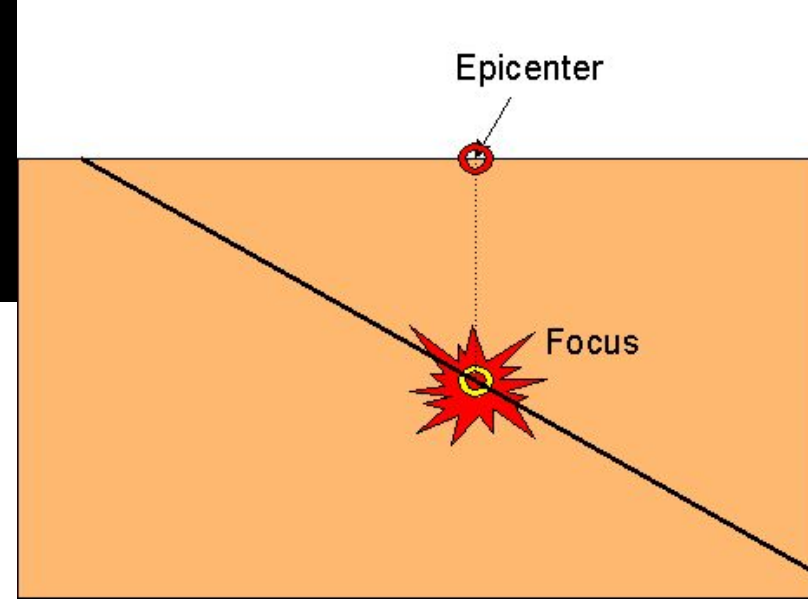


Natural Hazards 1 : Plate Tectonics



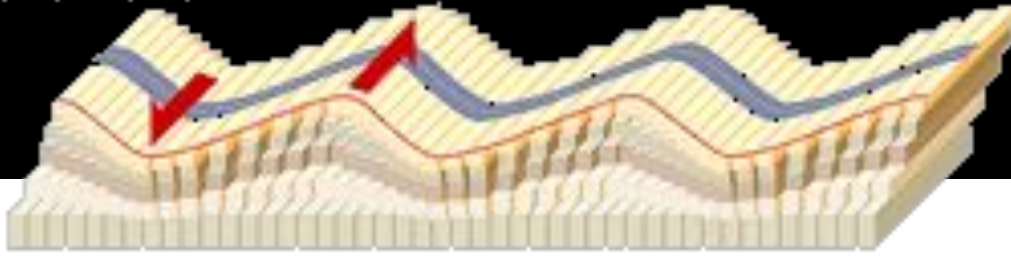
Focus, Epicenter and Faults

- **Focus** – point within the Earth where the Earthquake starts
- **Epicenter** – location on the surface of Earth **directly above the focus**
- **Fault**– associated with earthquake activity where movement has occurred



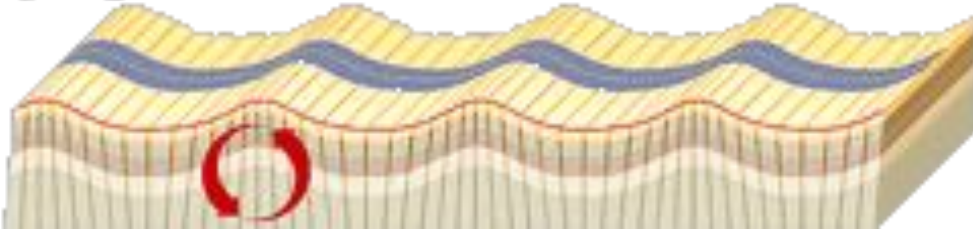
Earthquake waves

Love wave



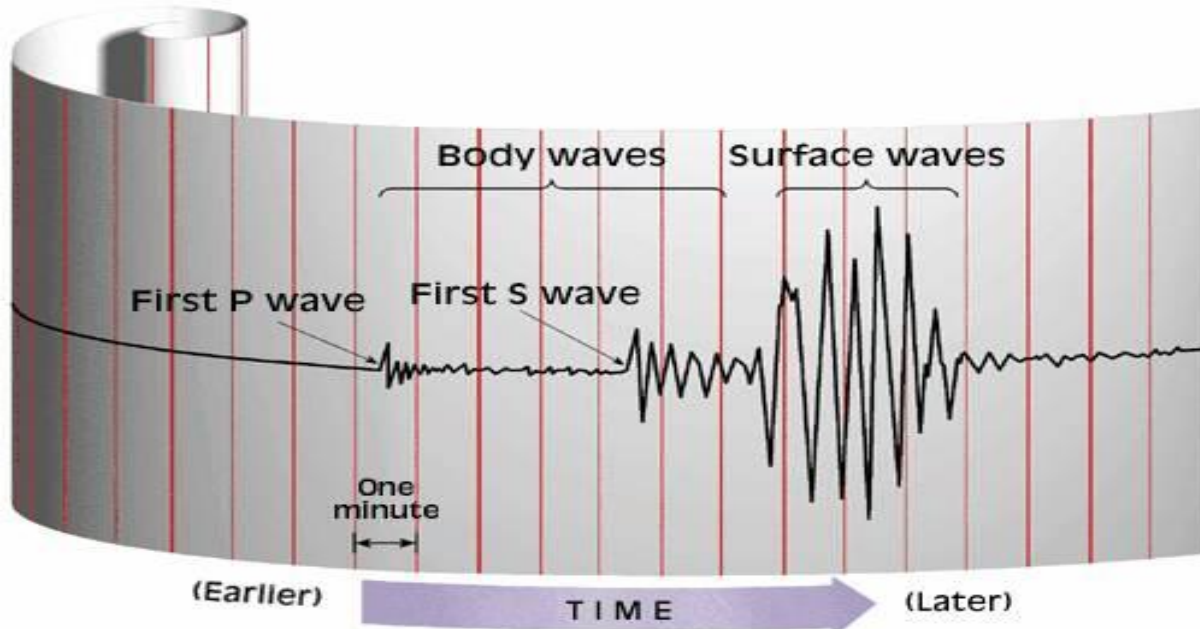
wave direction

Rayleigh wave

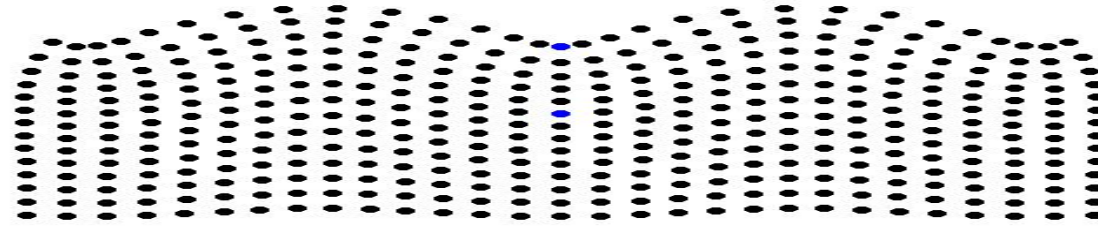


Surface

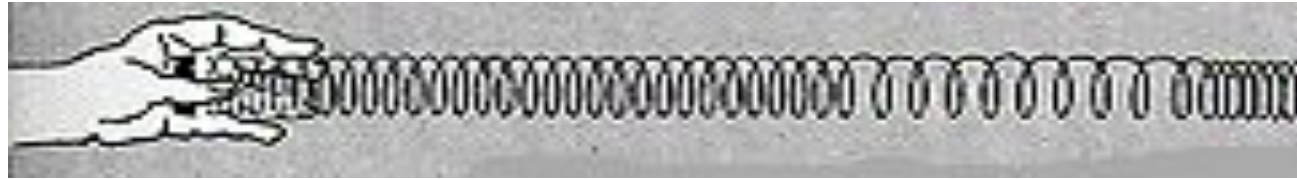
- Seismic waves that travel along Earth's outer layer
- **Most destructive earthquake waves**
- **Last to arrive at the seismograph**



Earthquake waves



- **P waves**
 - Can travel through solid, liquid, and gas
 - Fastest waves



- **S waves**
 - Can only travel through solids
 - Slower than P waves but faster than surface waves



Intensity and Magnitude of Earthquakes

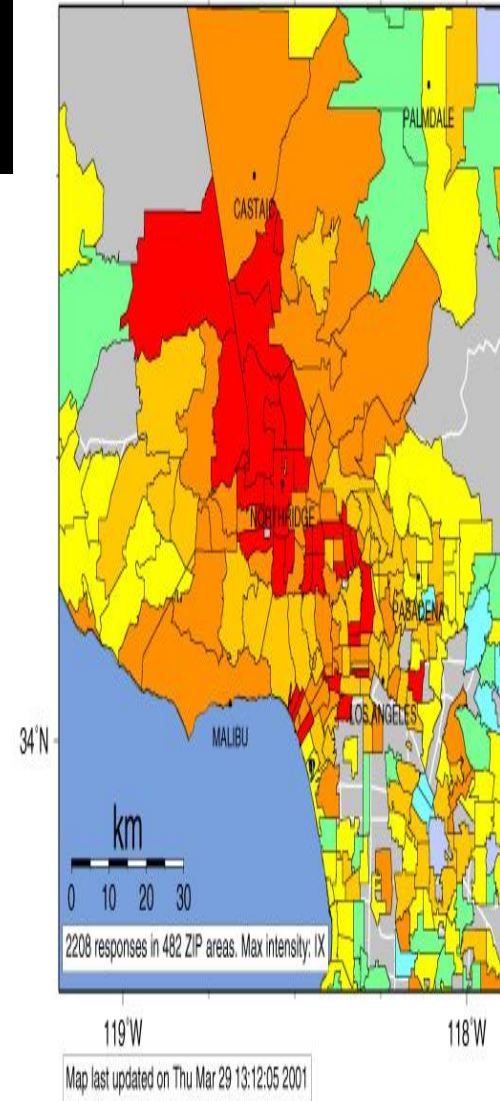
Intensity - A measure of the amount of earthquake shaking at a given location

Magnitude

the amount of energy released at the source of an earthquake

Scale 0–10, 2.5 is the weakest damage

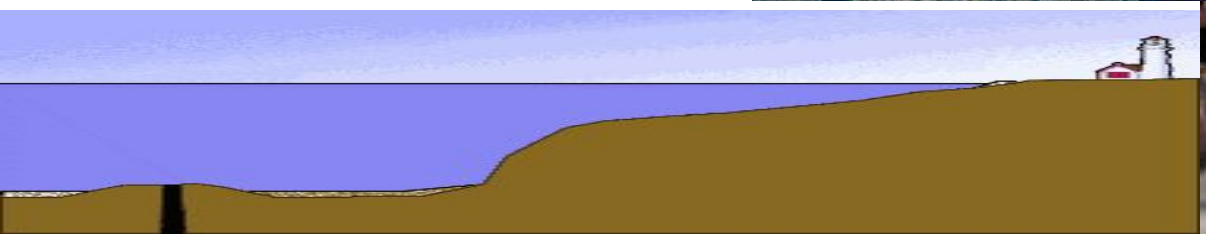
Community Internet Intensity Map for Northridge (Jan 17 1994)
04:30:55 PST Mag=6.7 Latitude=N34.21 Longitude=W118.54

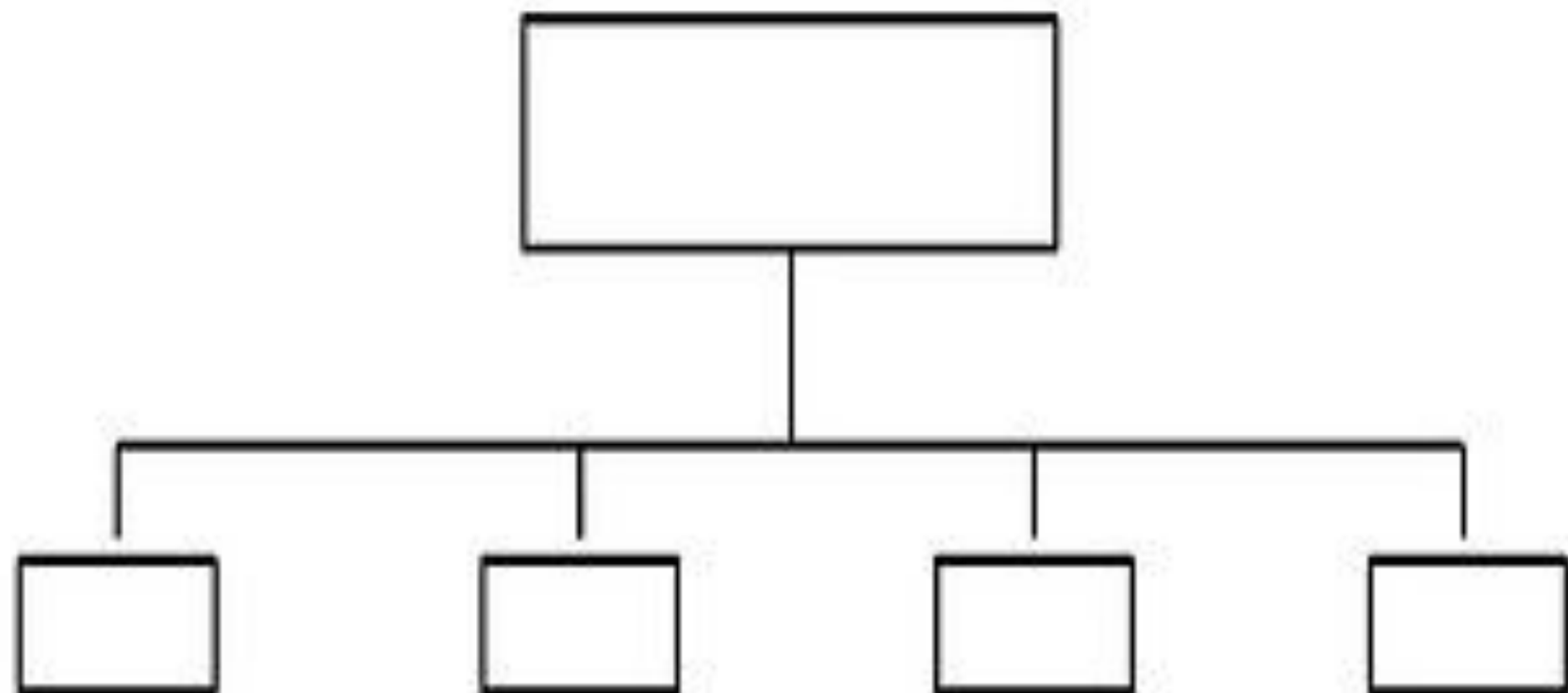


INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

Tsunami

- Seismic sea waves
- Triggered by an earthquake occurring where a slab of the ocean floor is displaced vertically along a fault





Other Dangers

- Landslides
 - Sinking of the ground triggered by the vibration
 - Greatest damage to structures
- Fires
 - Caused by ruptured gas lines



Predicting Earthquakes

- Short range
 - Methods for short range predictions of earthquakes have not been successful
- Long range
 - Based on the idea that earthquakes are repetitive
 - Seismic gap: an area along a fault where there has not been any earthquake for a



Aftermath of an earthquake in Japan, 2004
Photograph by Kimimasa Mayama/Reuters

Virtual Earthquake

- <http://www.sciencecourseware.com/eec/Earthquake/>
- Main Activities: Time travel Graph
 - Recommended: Tutorials (top right)
 - Tasks – use different tools to gather and record in journal at bottom of screen
 - Show teacher after you verify your answers
- Main Activities: Epicenter and Magnitude

Plate Tectonics and Igneous Activity

- The basic connections between plate tectonics and volcanism is that plate motion provide the mechanisms by which mantle rock melt to generate magma
- **Ring of Fire:** area around the Pacific ocean with extreme volcanic activity



Intraplate Activity

- Occurs within a plate, not plate boundary
- Most intraplate volcanism occurs where a mass of hotter than normal mantle material called mantle plumes rise toward the surface

