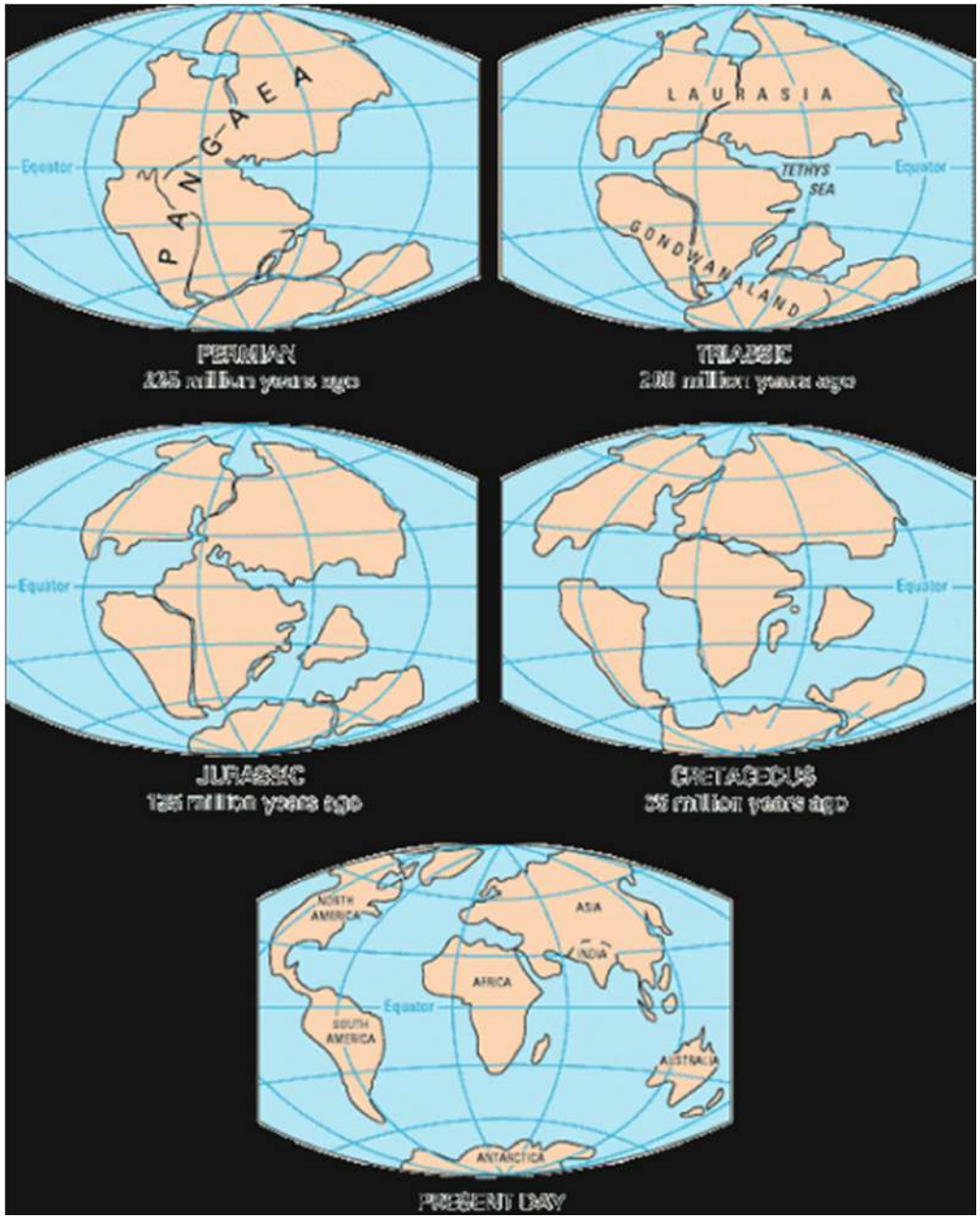
***Map Activity – Continental Drift

- Use the pieces that you have been provided to try to develop the same ideas as early explorers.

- **Observations:** Your job is to write down observations in your lab notebook about what you see when dealing with these different pieces.

Pangea

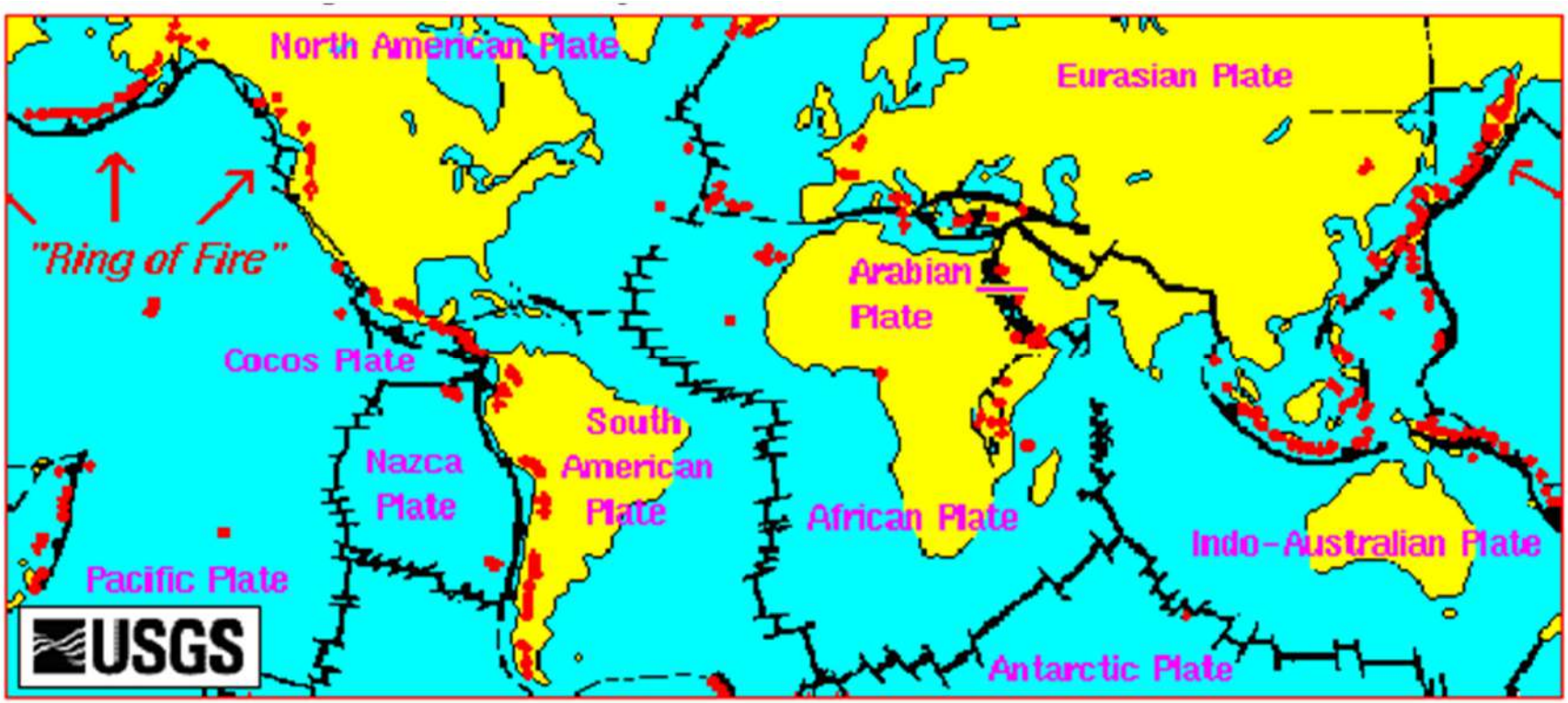

PANGAEA
Equator
LAURASIA
TETHYS SEA
GONDWANALAND
PERMIAN
225 million years ago
TRIASSIC
200 million years ago
JURASSIC
135 million years ago
CRETACEOUS
65 million years ago
NORTH AMERICA
ASIA
INDIA
AFRICA
SOUTH AMERICA
AUSTRALIA
ANTARCTICA
PRESENT DAY

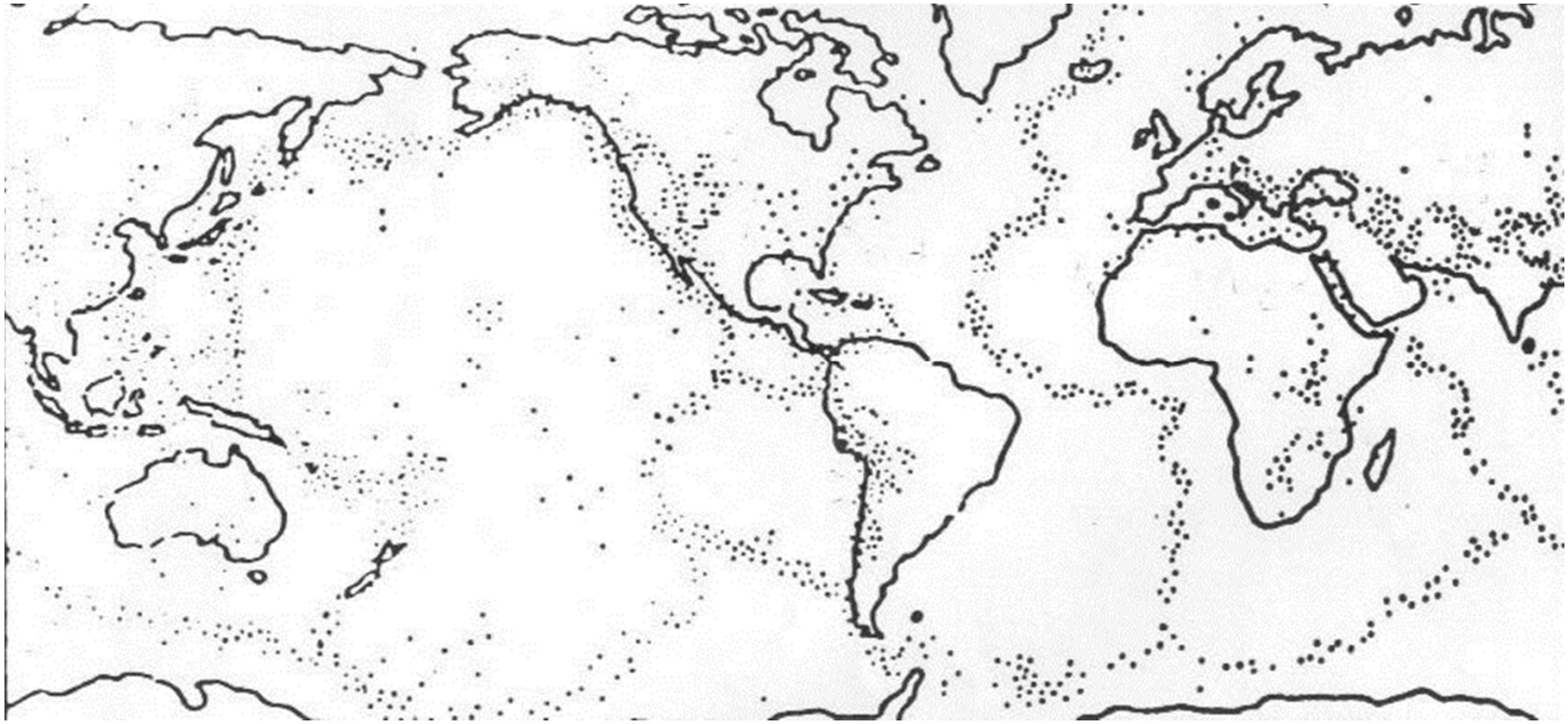
Theory of Continental Drift

- Early 1500s explorers noticed the fit between Africa and South America
- 1912 Alfred Wegener
- The idea that the continents used to form a super continent called Pangea
- The continents then slowly drifted apart over time to their current locations
- Used fossil evidence as well as the fact that the continents looked like puzzle pieces
  - Mesosaurus – reptile lived 270 million years ago, found only in parts of South America and Africa

Continental Drift

- Wegener's idea did not explain *how* the continents moved
  - He thought that maybe the continents float on top of deeper earthly fluid and that the internal heat of the planet helped move those continents, but he had no *evidence*


North American Plate
Eurasian Plate
"Ring of Fire"
Arabian Plate
Cocos Plate
South American Plate
Nazca Plate
African Plate
Indo-Australian Plate
Pacific Plate
USGS
Antarctic Plate



What do you notice about the map?
What can you predict based on this map?
What do the dots follow?

Plate Tectonics

- 1950s and 1960s
- Earthquakes, magnetism, and age of ocean floor rocks
  - Provided some support to Wegener's idea, but the motion paths did not match with the evidence
- The theory
  - Continents and ocean basins are adhered to lithospheric plates which cause the continents to move when the plates are moving; explains earthquakes and volcanoes

Plate Tectonics

Strain builds along boundaries creating fractures leading to an earthquake.

High heat flow where molten rock moves up to Earth's surface -- volcanoes

Evidence for Plate Tectonics comes from magnetic properties & age of igneous rock on ocean floor

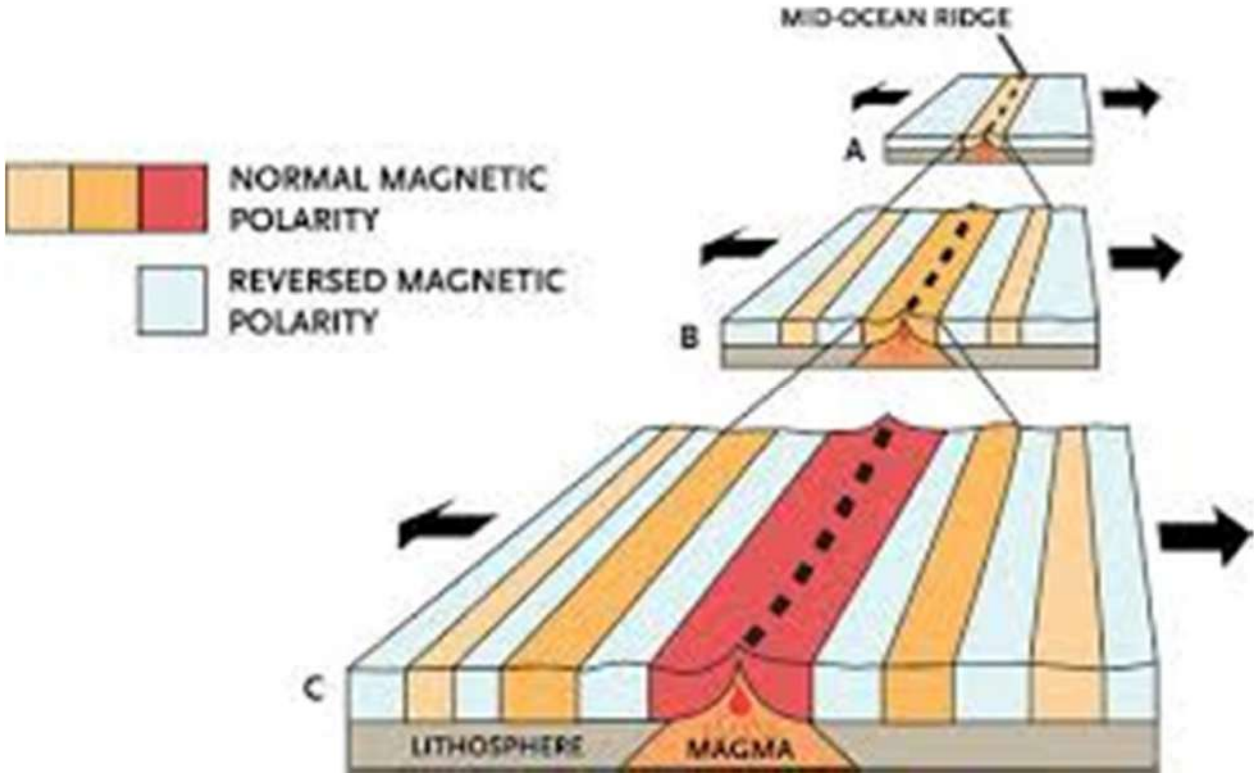
Provide record of direction of magnetic field and reversals.

Mid-Ocean Ridges

Mid-ocean ridges- long chain of volcanic mountain on ocean floor w/ deep central valley

- magnetic reversal recorded in rocks on either side of ridge
- rocks become increasingly older going out from ridge
- heat cools moving out from ridge
- ridges of lithospheric boundary where plates moving apart.

Magnetism of the Ocean Floor



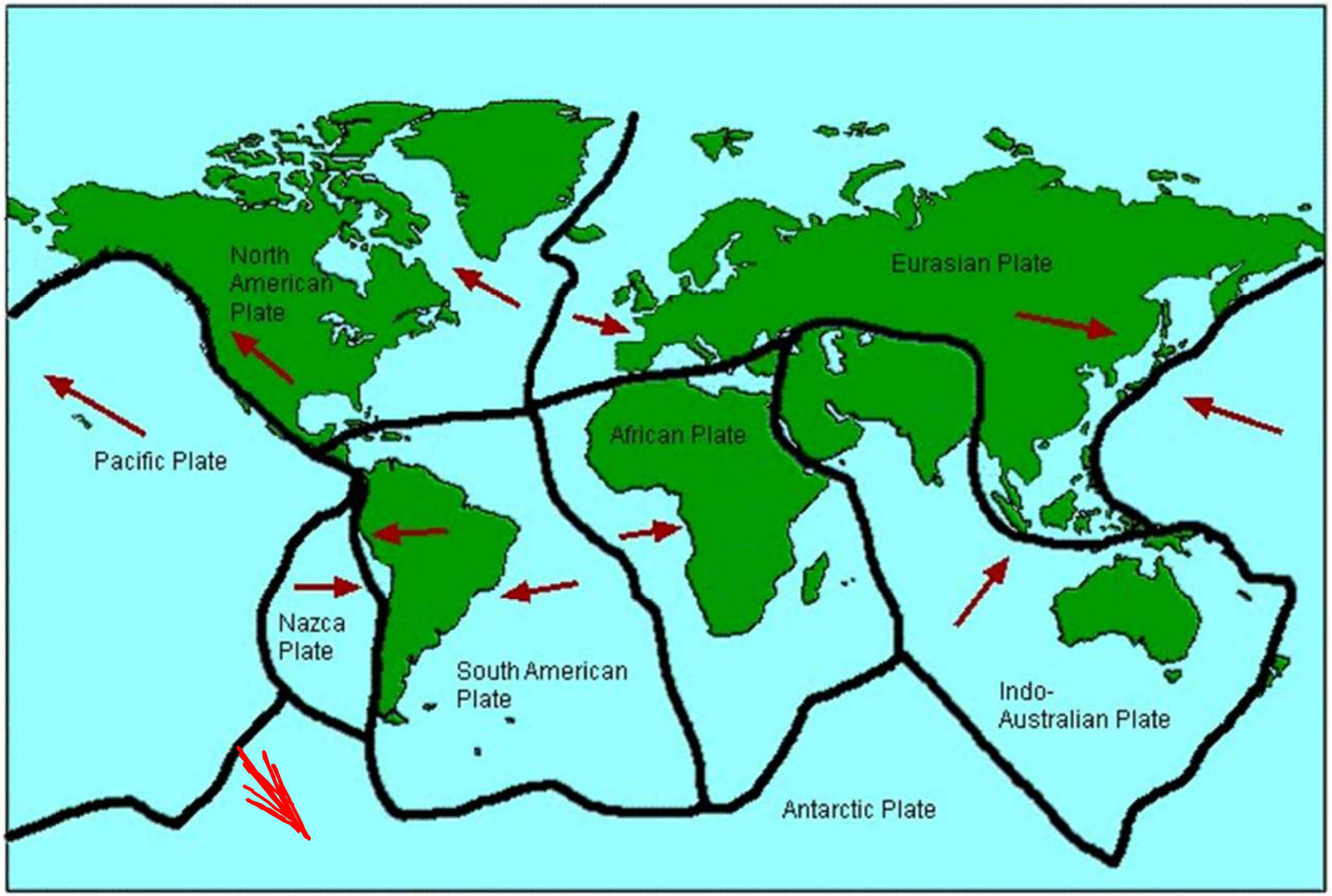

North American Plate
Eurasian Plate
Pacific Plate
African Plate
Nazca Plate
South American Plate
Indo-Australian Plate
Antarctic Plate

Plate Boundaries

Divergent

Plates are moving away from each other

new crust is created

Convergent (collision)

Plates are moving towards each other

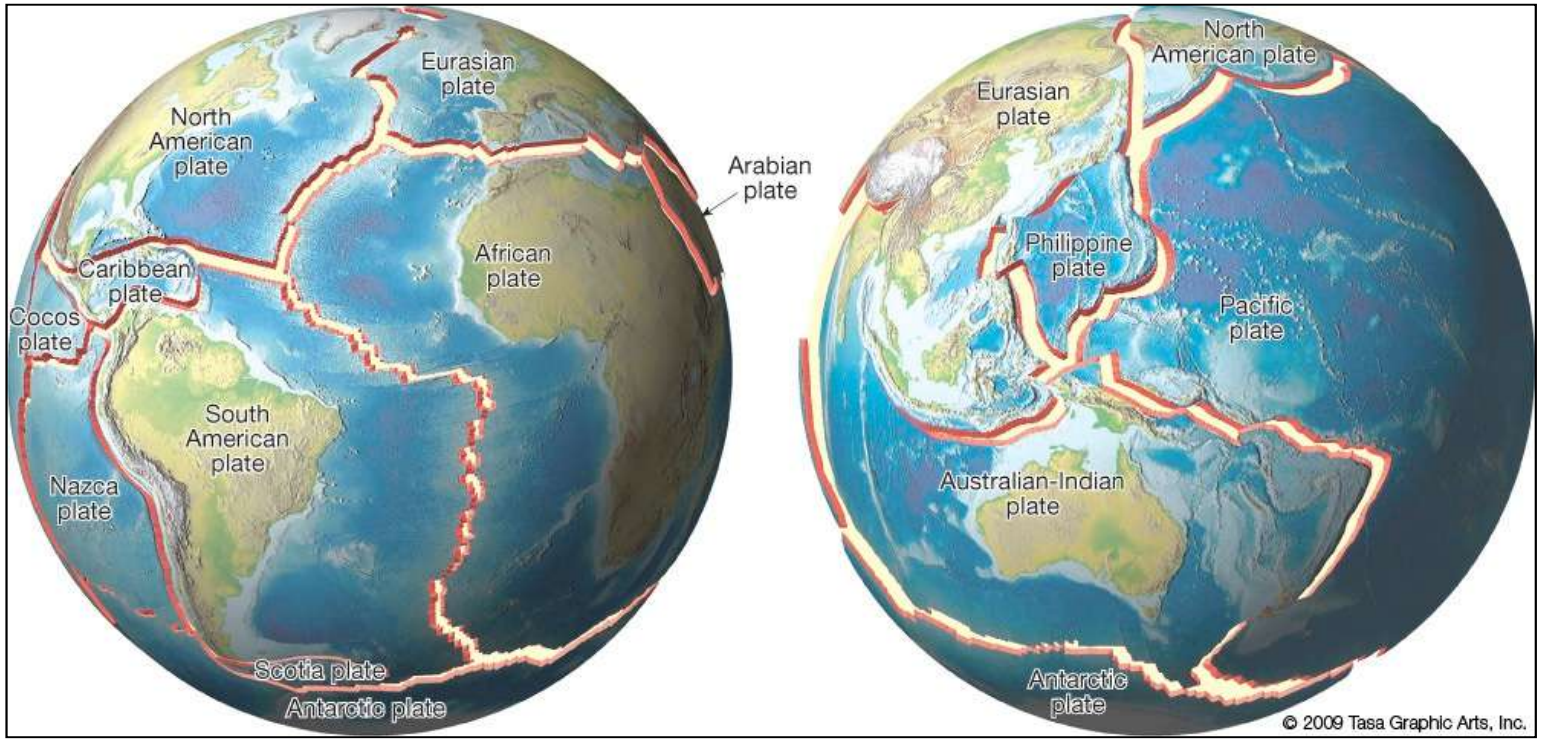
old crust is recycled

Transform

Plates are sliding past one another

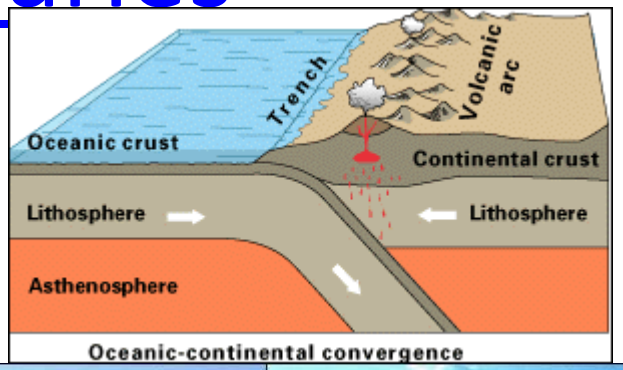
Plate tectonics

– theory that states that pieces of the lithosphere are in constant slow motion driven by convection currents in the mantle



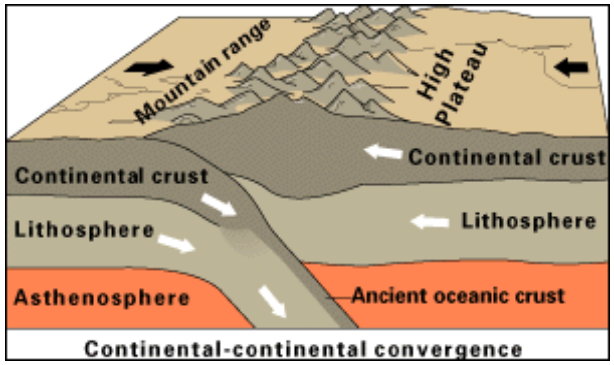
Convergent Boundaries

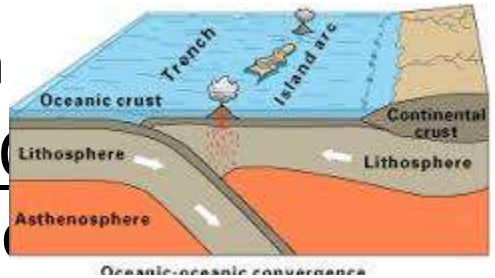
- Two plates collide
- The denser plate sinks below the more buoyant plate in a process called subduction.



Examples

- Ocean-Continent: Subduction and Volcanic arc
  - Cascade Mountains (Mt. St. Helens, Mt. Rainier), Andes Mountains
- Continent-Continent: M
  - Hima
- Ocean-
  Volcani





Divergent Boundaries

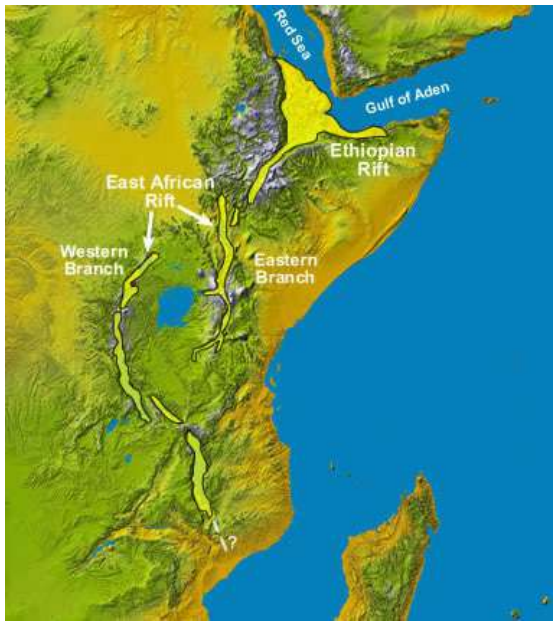
- Two plates separating

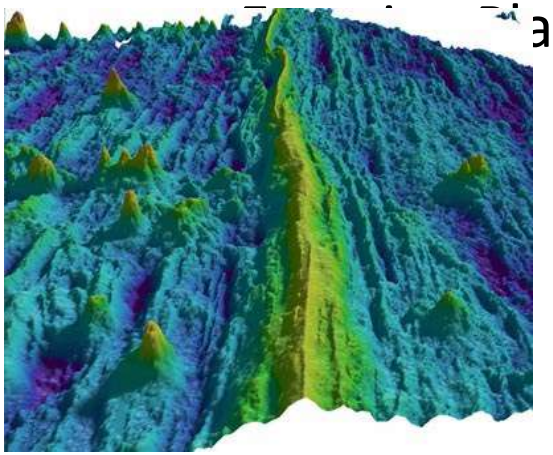
  Examples

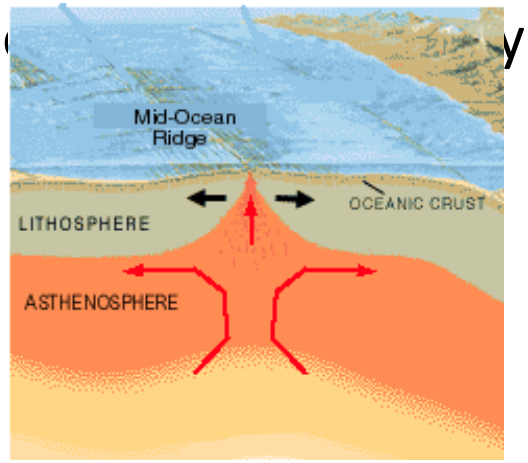
  – Ocean-Ocean: Seafloor spreading

    - Mid-Atlantic Ridge

  – Continent-Continent: Widening and separating of land







Transform Boundaries

- Two plates slide horizontally past one another

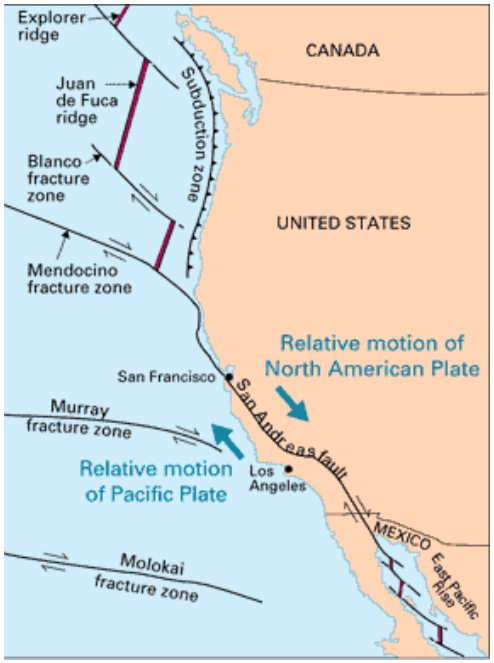
  Examples

  – Continent-Continent: Earthquakes

    - San Andres Fault

  – Ocean-Ocean: Earthquakes

    - East Pacific Rise



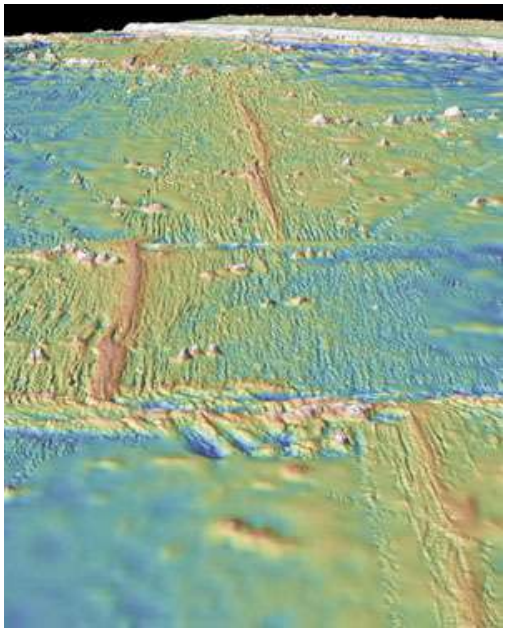
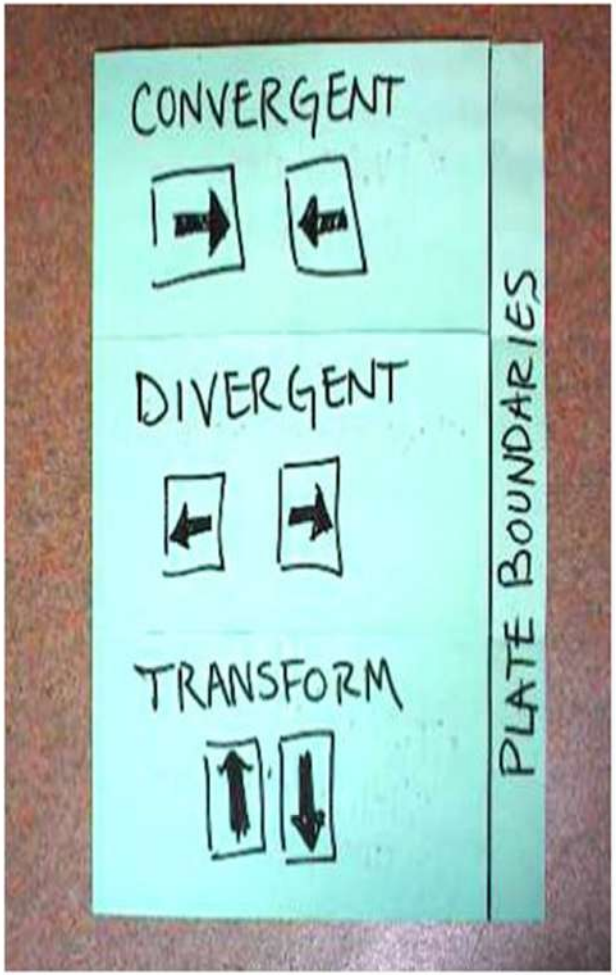
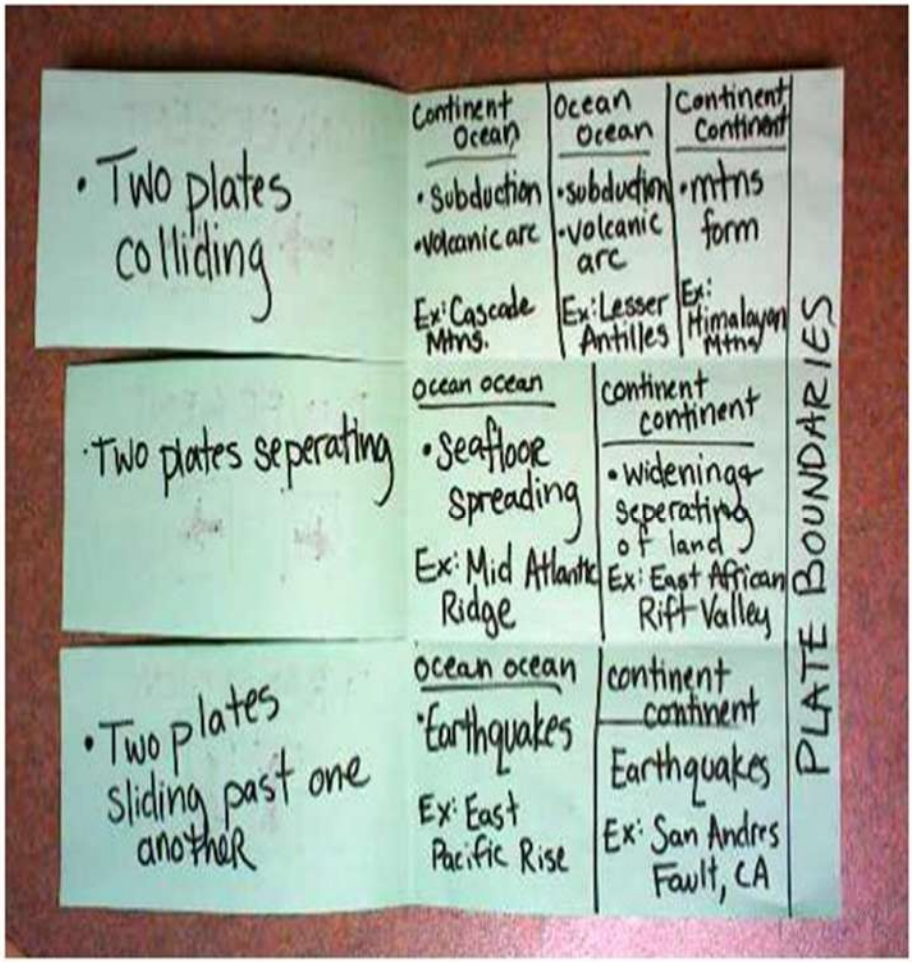


Plate Boundaries Foldable

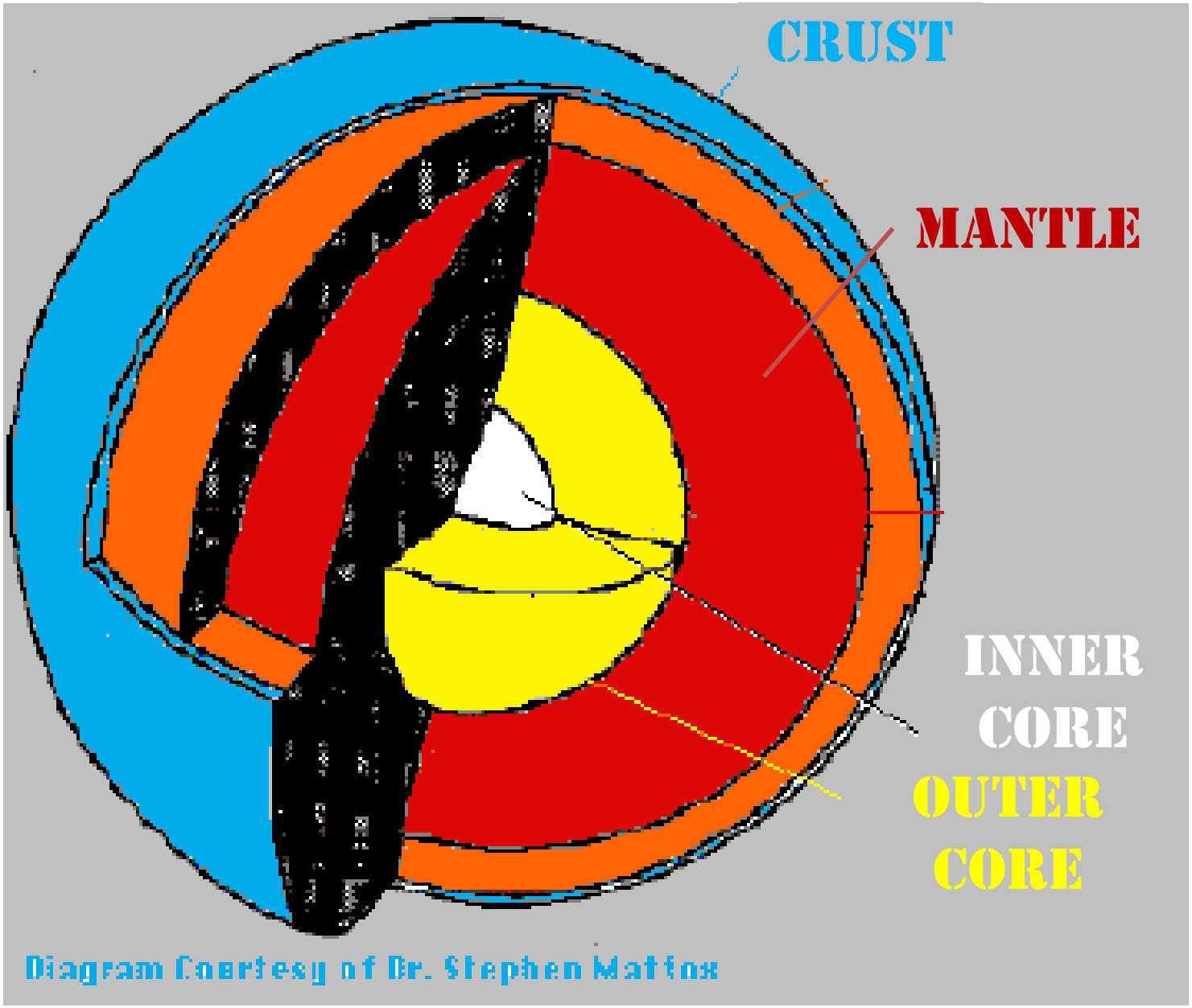




Type of Boundary	Process involved	Characteristic features	Current examples
Divergent			
Convergent			
Transform			

Type of Boundary	Process involved	Characteristic features	Current examples
Divergent	Sea floor spreading	• Mid-ocean ridges • Rift valleys • Earthquake activity at fracture zones along mid-ocean ridges • Volcanic activity	• Mid-Atlantic Ridge • East Pacific Rise
Convergent	Ocean-ocean subduction	• Deep-sea trenches • Volcanic island arcs • Earthquake activity	• Islands of Indonesia • Mariana Islands
	Ocean-continent subduction	• Deep-se4a trench bordering continent • Volcanoes along coast of continent • Earthquake activity	• Western coast of South Africa
	Continent-continent collision	• High continental mountain chains • Earthquake activity	• Himalayas
Transform	Plates sliding past each other	• Earthquake activity	• San Andreas Fault • North Anatolian Fault (Turkey) • Fracture zones along mid-ocean ridges

The Earth is divided into 4 layers.

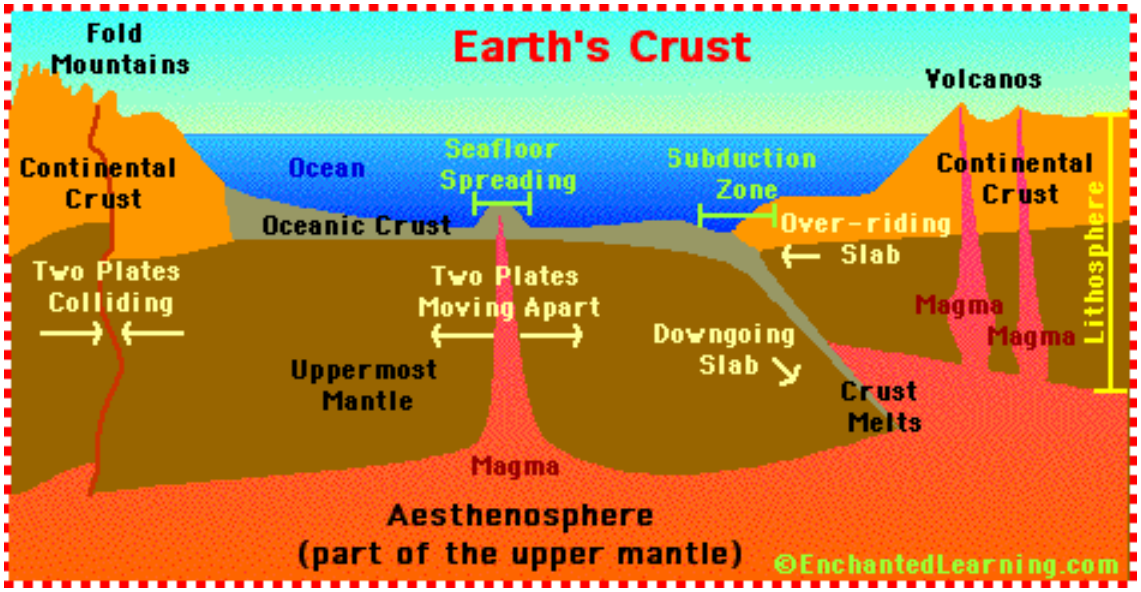

CRUST
MANTLE
INNER
CORE
OUTER
CORE
Diagram Courtesy of Dr. Stephen Mattox

The Crust

- Layer of rock that forms Earths outer skin
- **Solid** rock included both dry land and ocean floor (rocks, mountains, soils, water)
- Thin layer (similar to paper thin layer of an onion)
- Ranges from **5-40 km thick** (70km underneath mountains)
- **Composition: oxygen, silicon, aluminum, calcium, iron, sodium, potassium, magnesium**
  - Basalt = oceanic crust
  - Granite = continental crust
- **Temperature: whatever is on the surface**

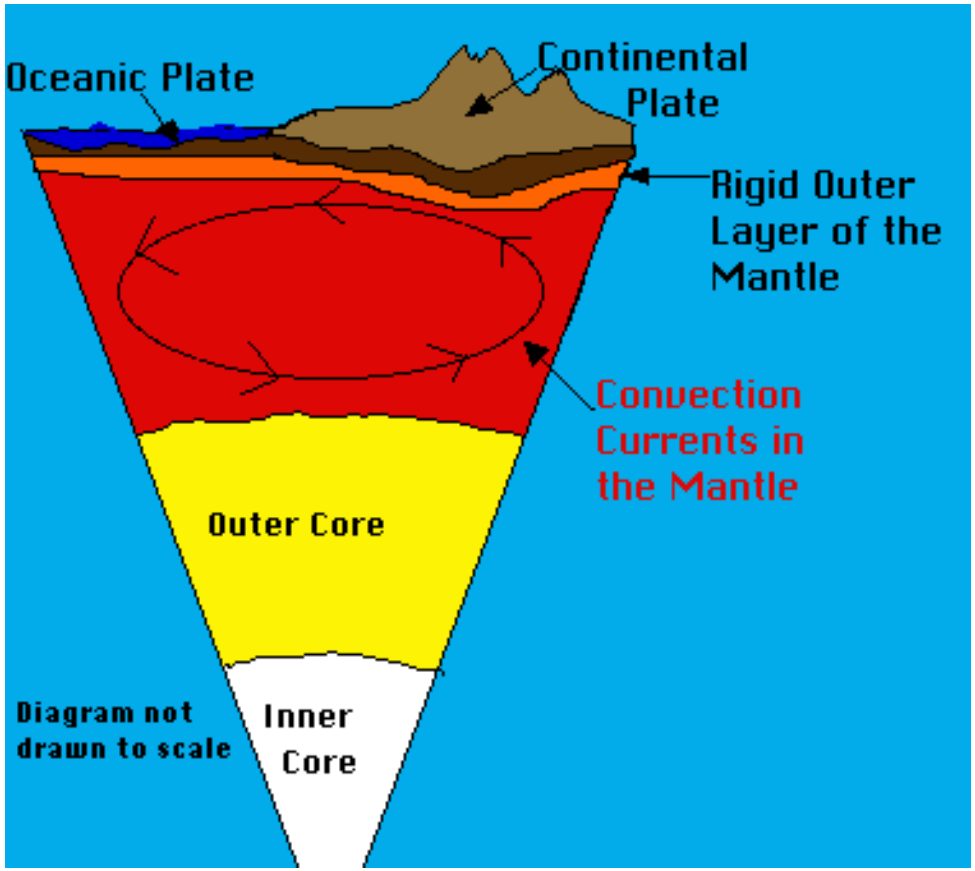
Crust

- The plates move along smoothly but sometimes they get stuck and pressure builds up.



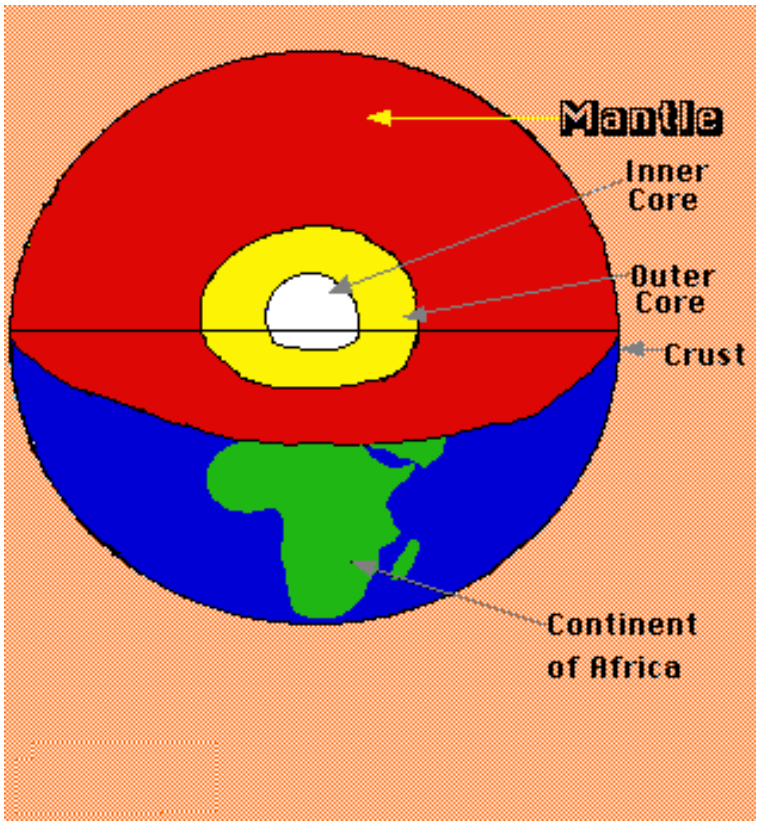
Mantle

- **Rock that is very hot and bendable but solid at the same time.**
- Solid upper mantle and crust = **lithosphere** (100km thick)
- Under lithosphere = **asthenosphere**
  - So hot that it behaves like a plastic material; it flows
- **2,900 km thick**
- **Temperature 870°C**
- **Composition: silicon, oxygen, iron, magnesium**



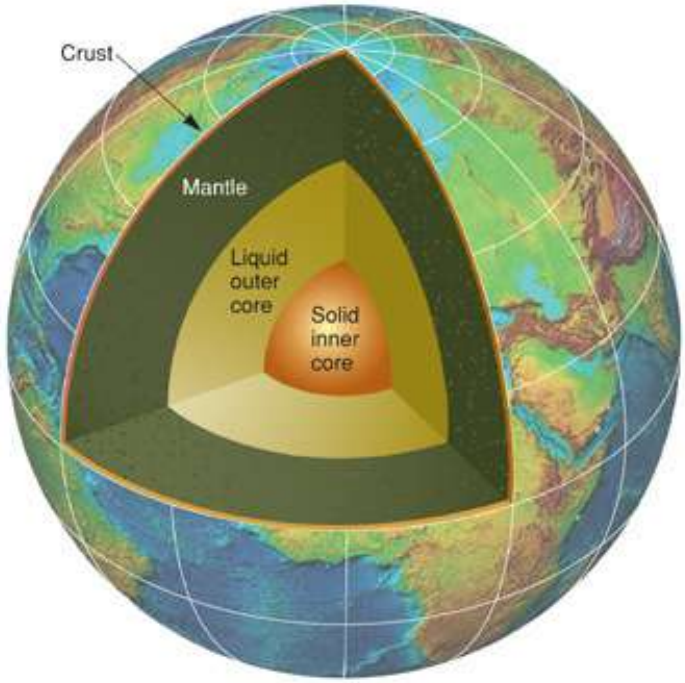
Mantle

- The movement of the mantle create the movement of the Earth's plates.



Outer Core

- **Composition: iron and nickel**
- **Temperature: 2200°C**
- **State of Matter: thick liquid (molten metal)**
  - LOTS of pressure
- **2,250 km thick**

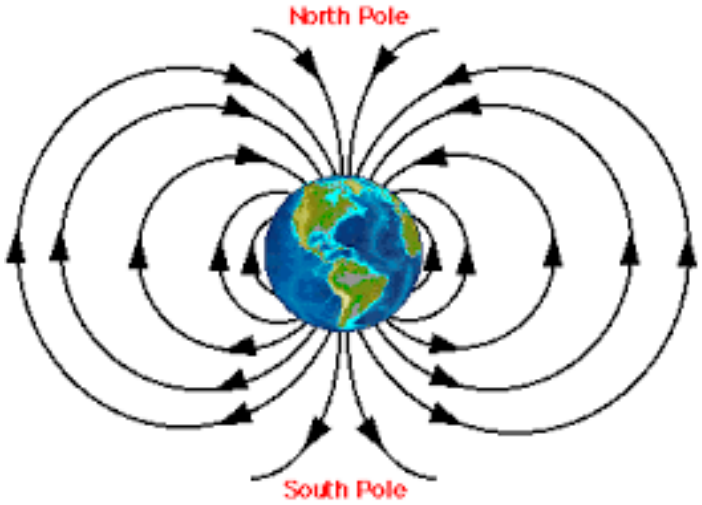


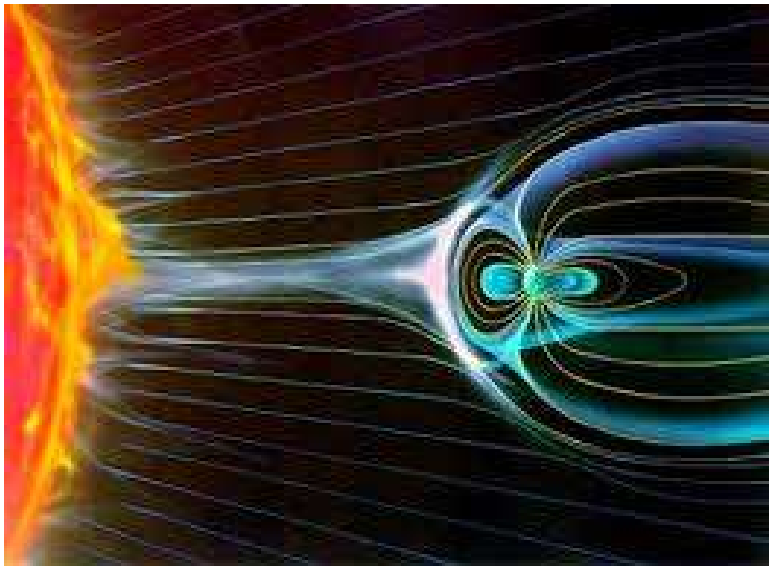
Inner Core

- **Composition: iron and nickel**
- **Temperature: 5000℃**
- **State of Matter: Dense solid metal**
  - Extreme pressure (squeezes that atoms of iron and nickel so much they can't spread out and become liquid)
- **1,200 km thick**

Earth's Magnetic Field

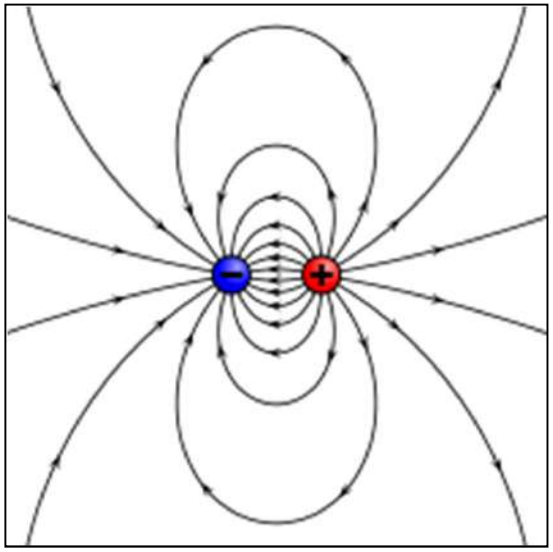
- Currents in the liquid outer core force the solid inner core to spin. The inner core spins at a slightly faster rate than the earth's rotation. Because of this movement, it causes Earth to act like a giant bar magnetic. The magnetic field protects us from the sun's damaging UV rays.





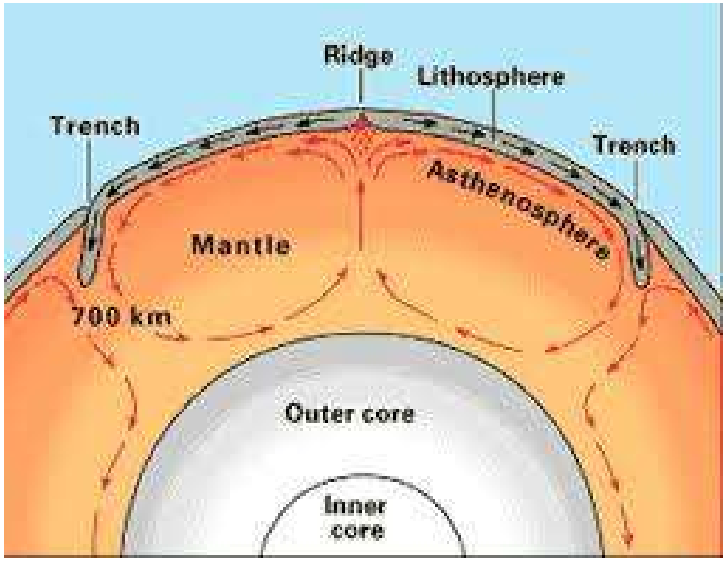
Earth's Magnetic Field

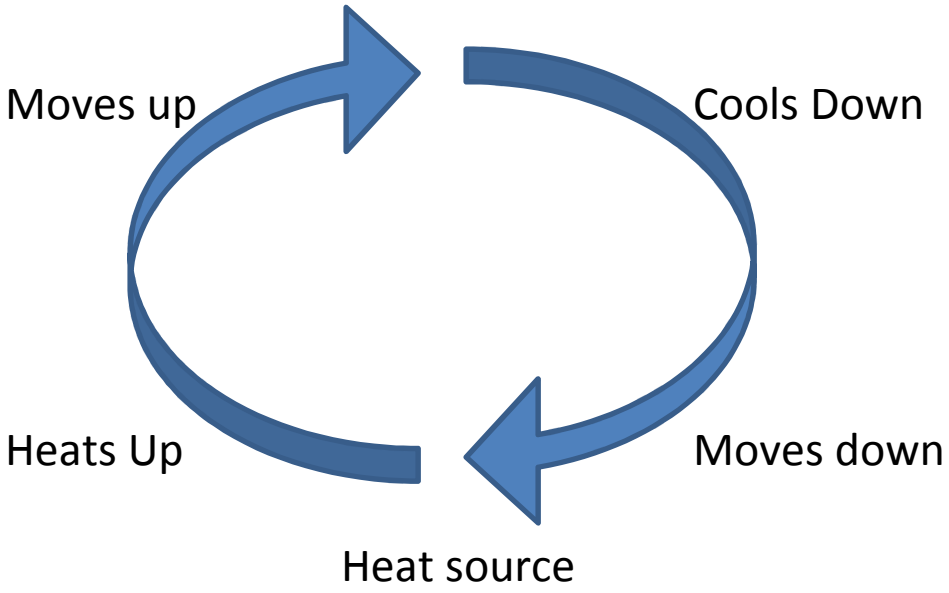
- Earth is a gigantic magnet surrounded by a magnetic field
- Dipole (bar magnet)
- Source is the liquid outer core
  - Molten iron in the liquid outer core flows around the solid inner core
- Unlike bar magnet the Earth's field changes

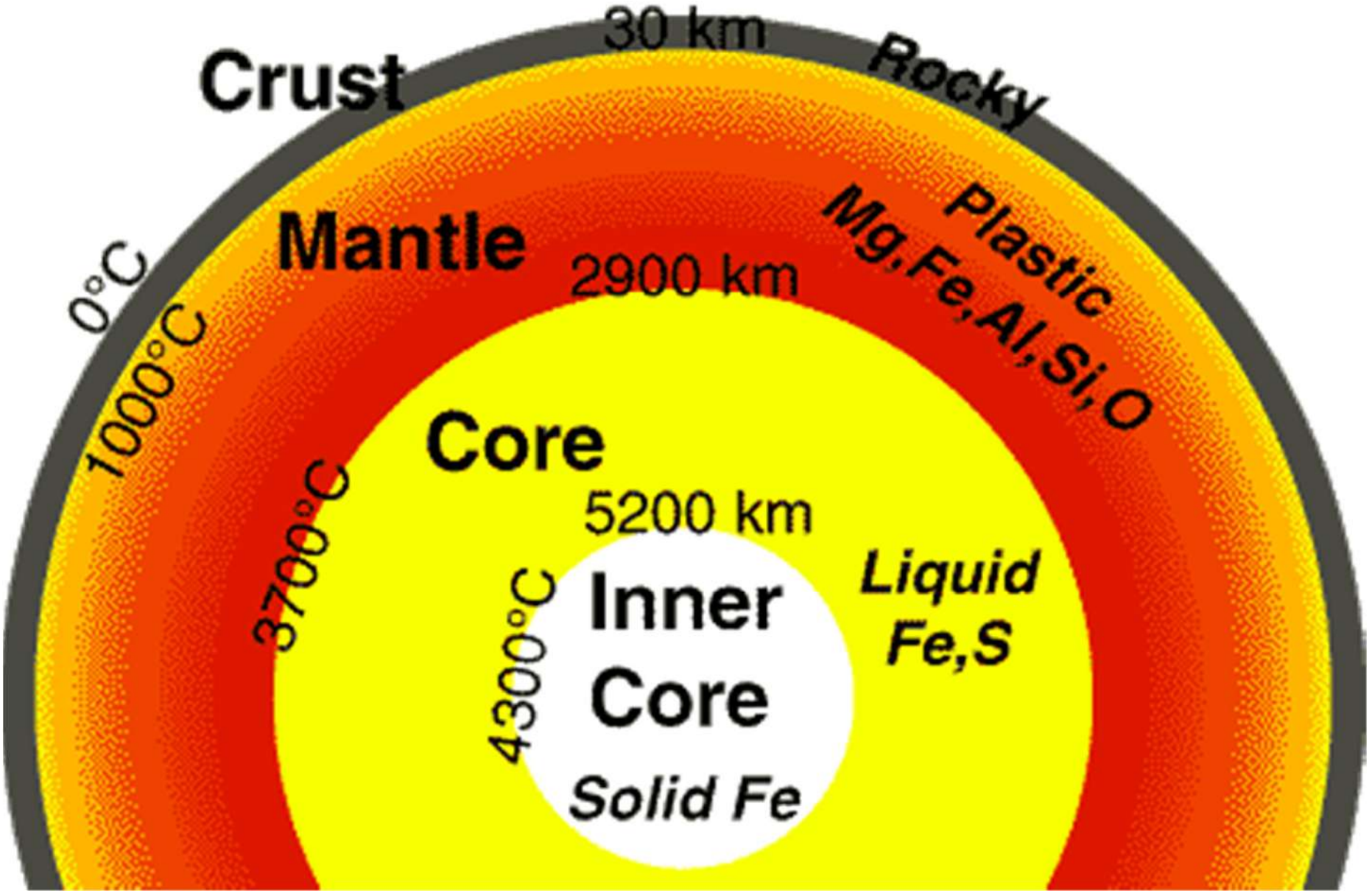


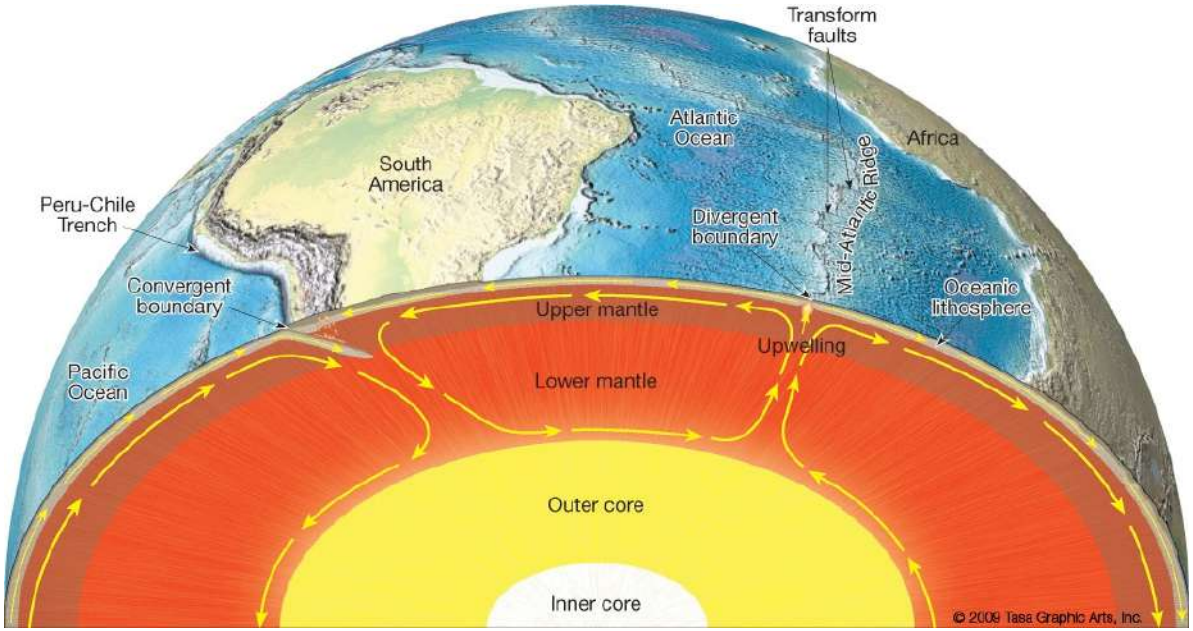
Convection Currents

- As liquid heats up, it becomes less dense and rises. When it is away from the heat source, it cools down and becomes more dense and sinks. Heat from the lower mantle and the cores (inner and outer) cause convection currents in the asthenosphere.






Crust
30 km
Rocky
Mantle
2900 km
Plastic
Mg, Fe, Al, Si, O
Core
5200 km
Liquid
Fe, S
Inner
Core
Solid Fe
0°C
1000°C
3700°C
4300°C


Transform faults
Atlantic Ocean
Africa
South America
Mid-Atlantic Ridge
Peru-Chile Trench
Divergent boundary
Convergent boundary
Oceanic lithosphere
Upper mantle
Upwelling
Pacific Ocean
Lower mantle
Outer core
Inner core
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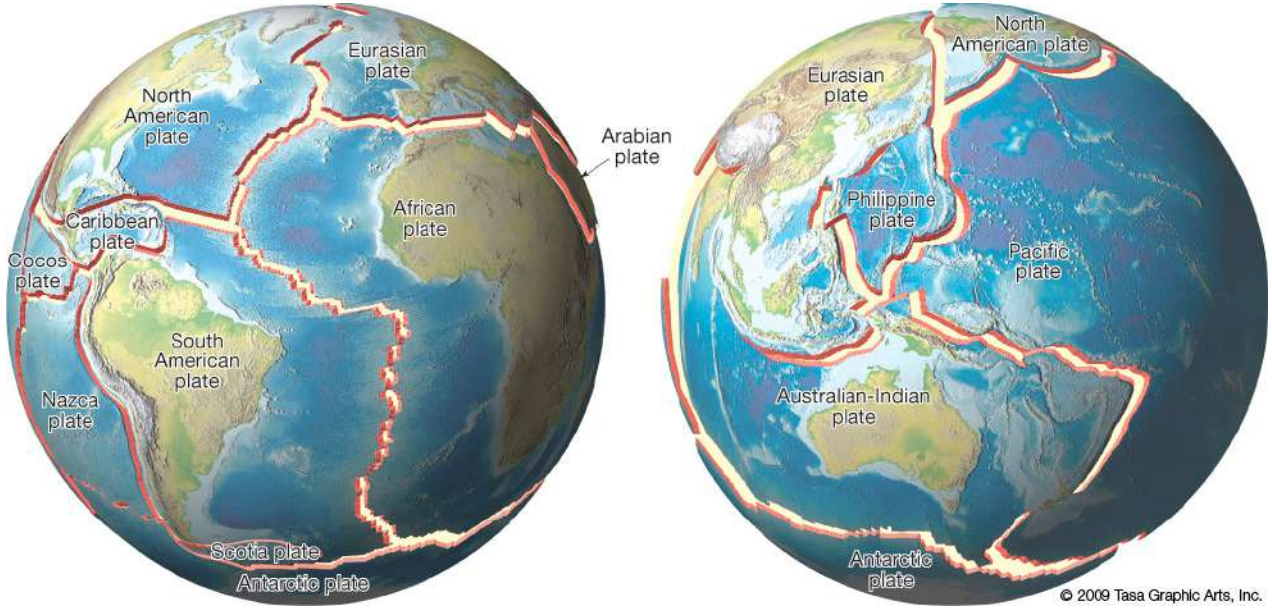
Eurasian plate
North American plate
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Cocos plate
South American plate
Nazca plate
Scotia plate
Antarctic plate
North American plate
Eurasian plate
Philippine plate
Pacific plate
Australian-Indian plate
Antarctic plate
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