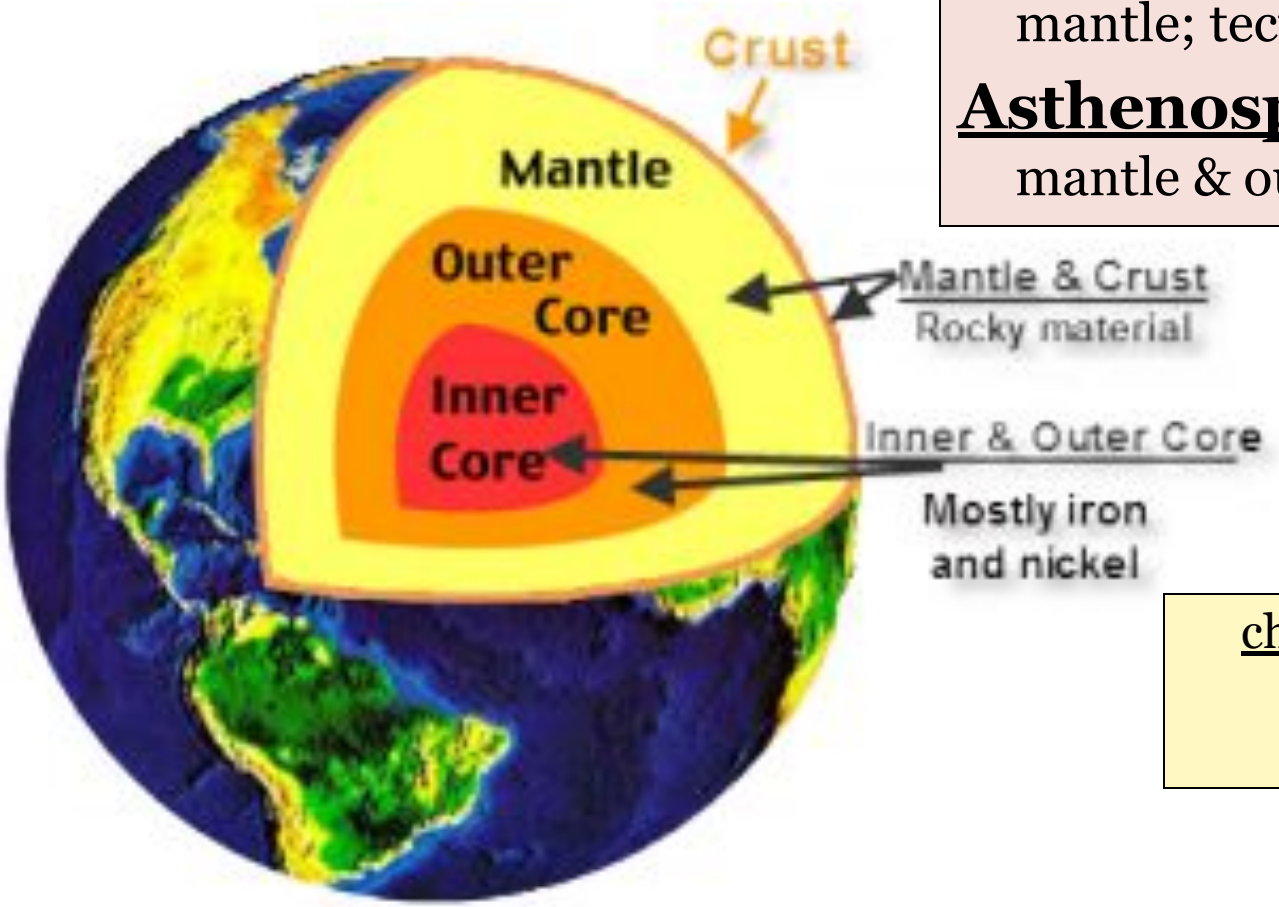
Warm-up #15

How does magma move throughout the mantle? What is another example of this movement in nature?

Earth's Structure



<u>Lithosphere</u> = crust & upper mantle; tectonic plates

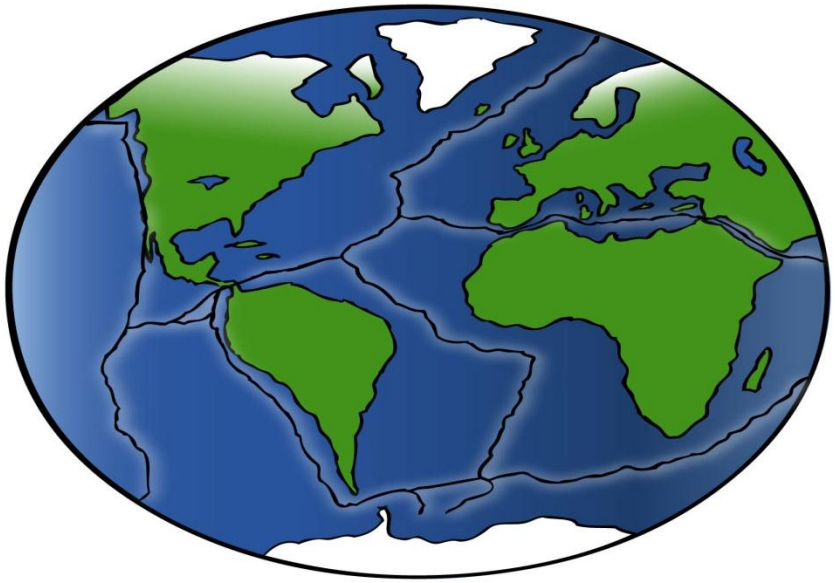
<u>Asthenosphere</u> = lower mantle & outer core

<u>chemical symbols</u>:
Fe = Iron
Ni = Nickel

Plate Tectonics

IDEA THAT EARTH'S SURFACE IS BROKEN INTO "<u>PLATES</u>" THAT MOVE AROUND

<u>Fault</u> = fracture in the crust where the movement has occurred



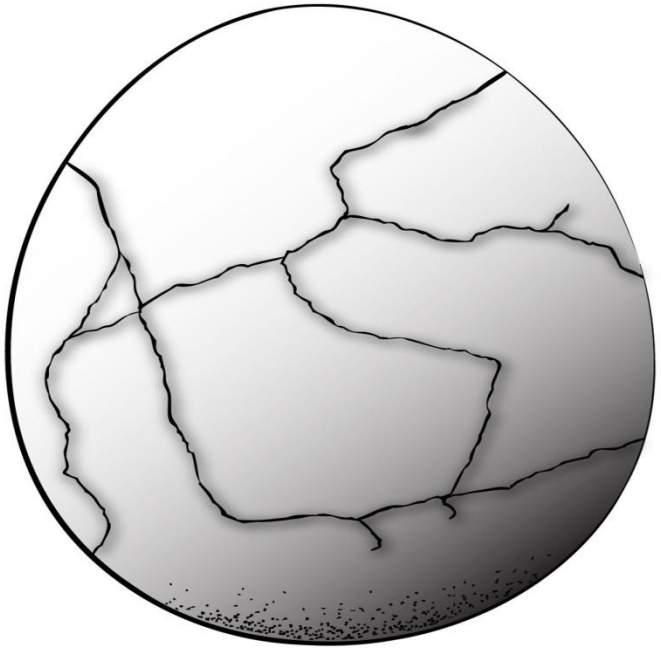
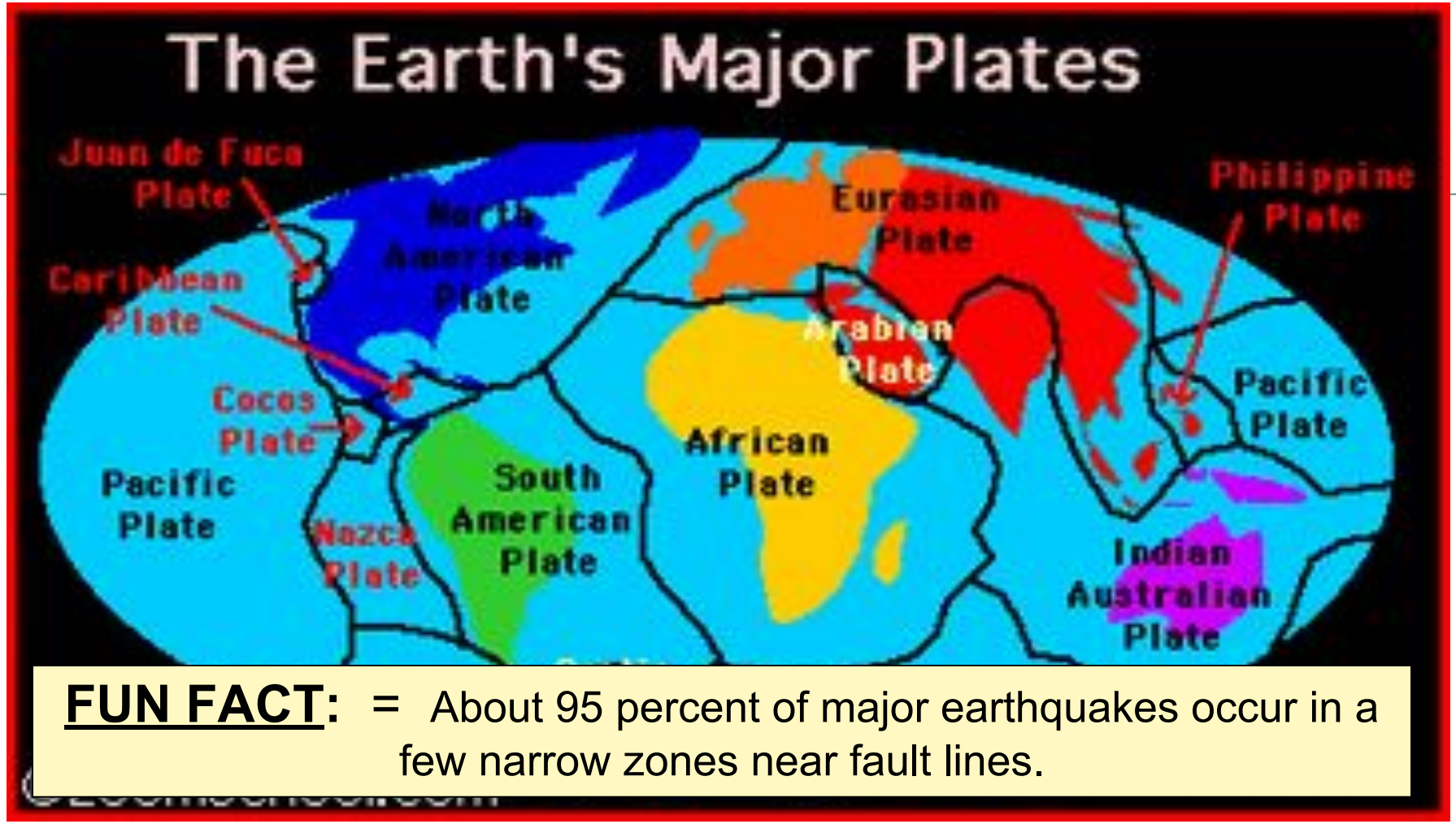


Plate Tectonics Theory

describes the formation, movements, & interactions of plates

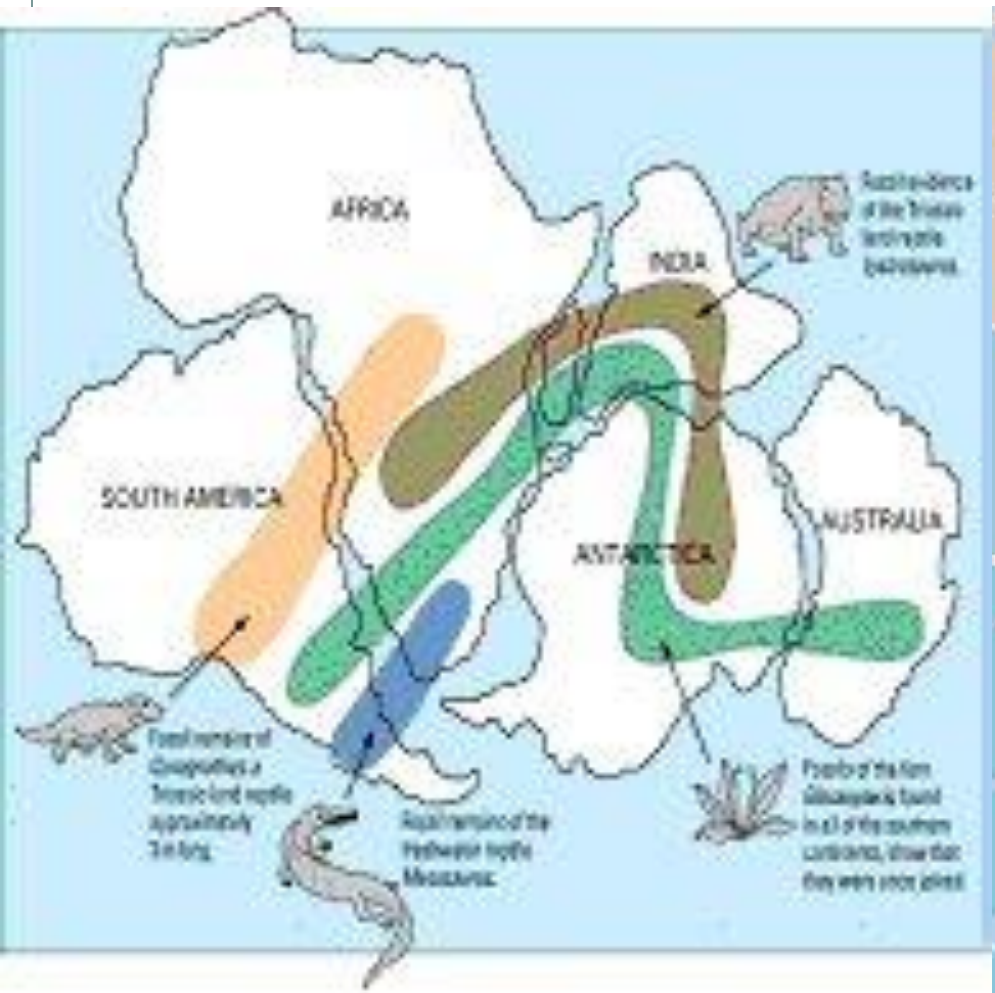


FUN FACT: = About 95 percent of major earthquakes occur in a few narrow zones near fault lines.

Alfred Wegener

- Considered the **father of plate tectonics**
- Proposed ***continental drift*** = Hypothesis that all the continents fit together as one mass, & around 200 million years ago, began to break apart from each other.
- Evidence for **Continental Drift**:
  - Continental Puzzle (Pangaea)
  - Matching fossils on different continents
  - Matching rock types & mountains on different continents
  - Ancient climates

Matching fossils:



Matching rock types:

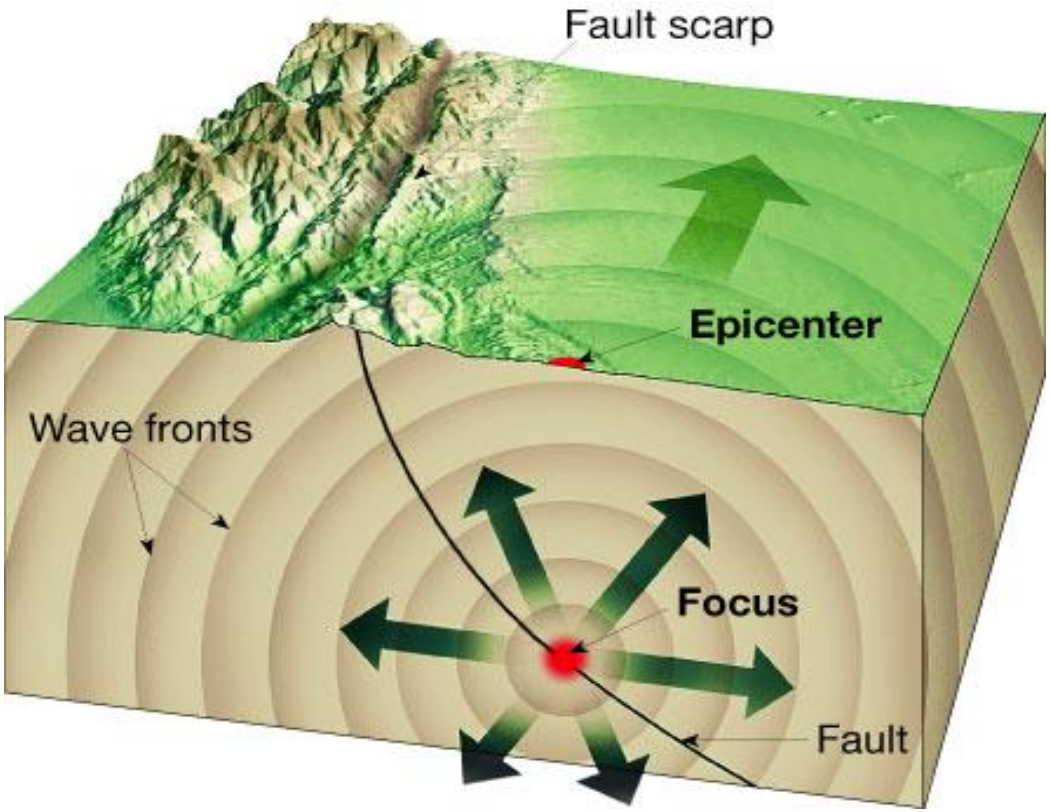
There are more than 30,000 earthquakes worldwide each year!

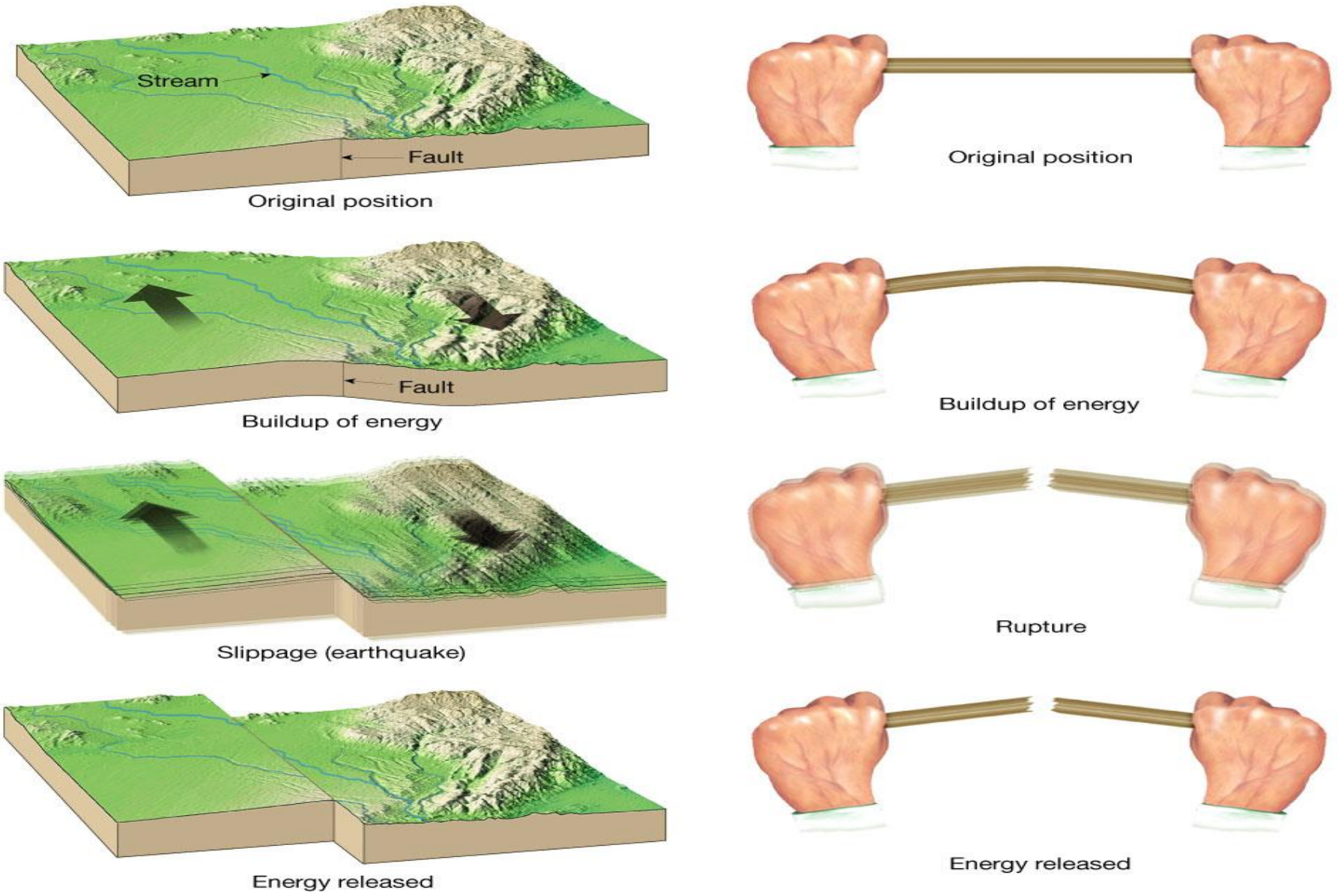
- **Earthquakes** = shaking of Earth because of a rapid release of energy
  usually because of movement of tectonic plates
  *Most earthquakes last for **less than a minute**.*

- **Foreshocks** = small earthquakes **before** an earthquake
- **Aftershocks** = small earthquakes **after** an earthquake

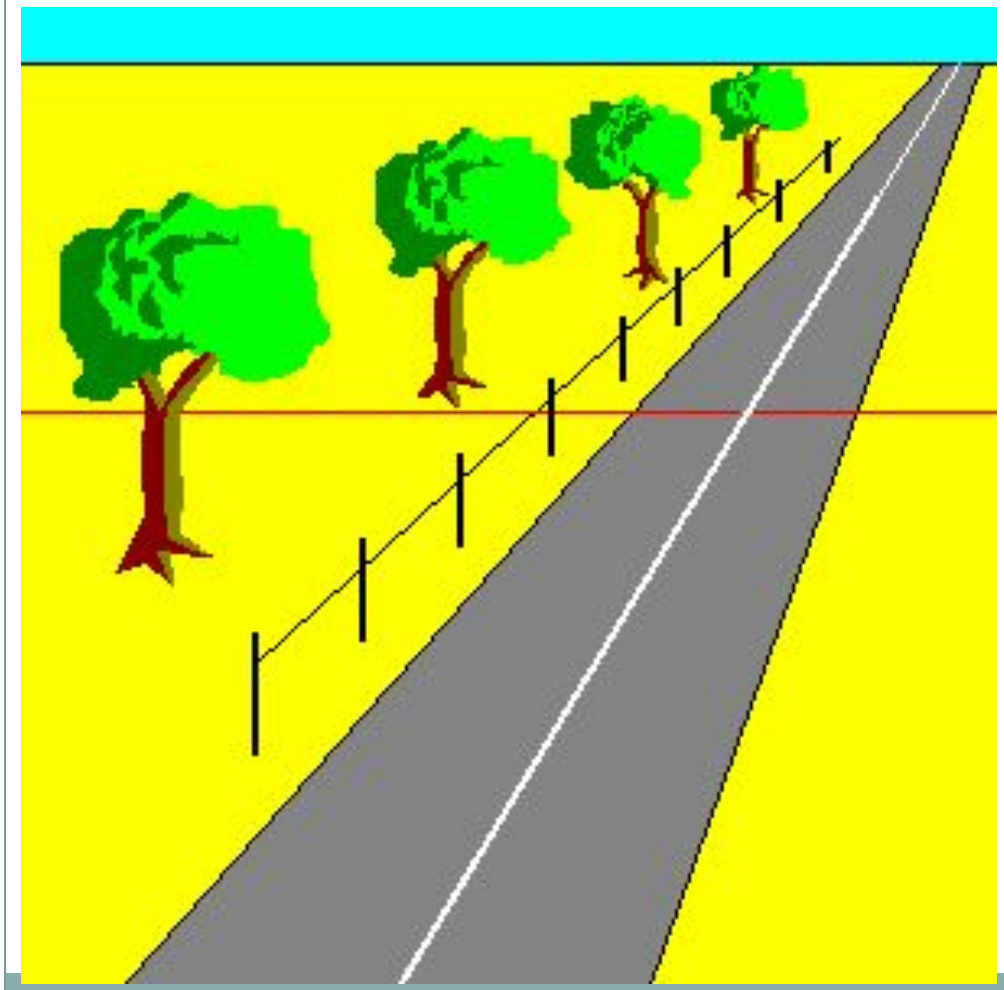
Earthquakes *(cont'd)*

- **Focus** = starting point of the earthquake
  - below surface
- **Epicenter** = point directly above the focus
  - on surface




Deformation of rocks
Stream
Fault
Original position
Fault
Buildup of energy
Slippage (earthquake)
Energy released
Deformation of a limber stick
Original position
Buildup of energy
Rupture
Energy released

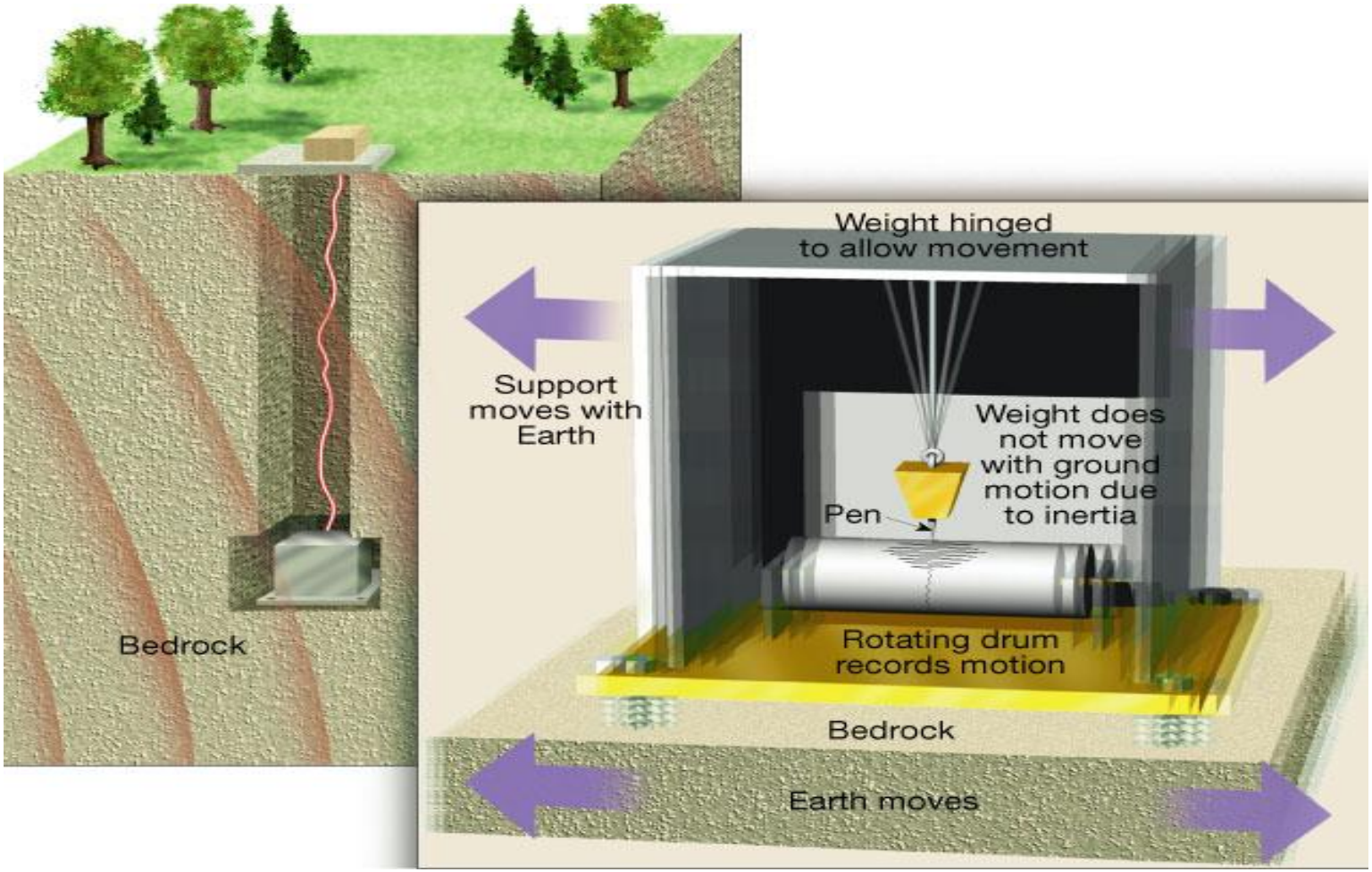
Elastic Rebound Hypothesis



1. Rocks are stretched
2. Energy accumulates
3. Rocks are bent to their breaking point and vibrate (earthquake)
4. Rocks return to their shape

Seismograph

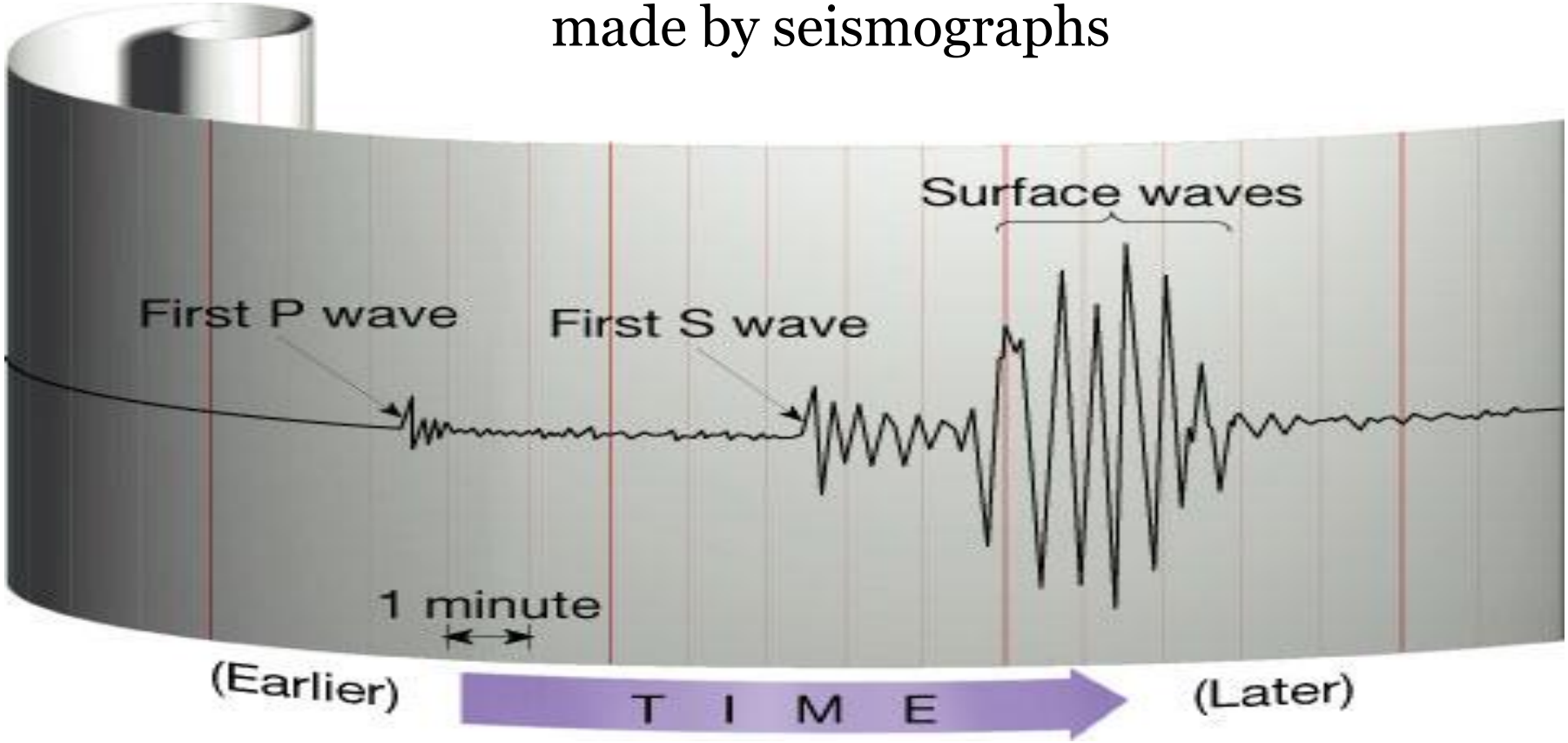
instrument that records earthquake waves.



Seismogram

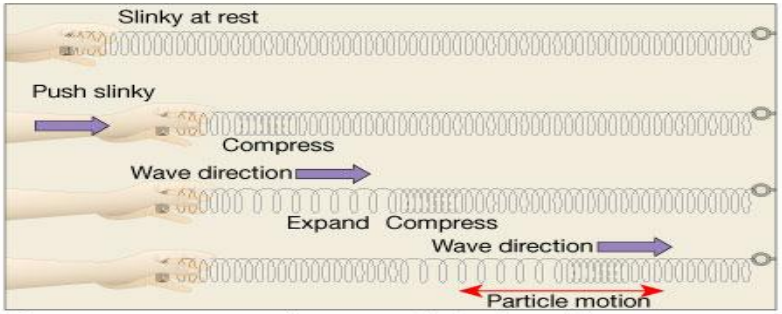
printout of seismic waves

traces of amplified, electronically recorded ground motion made by seismographs

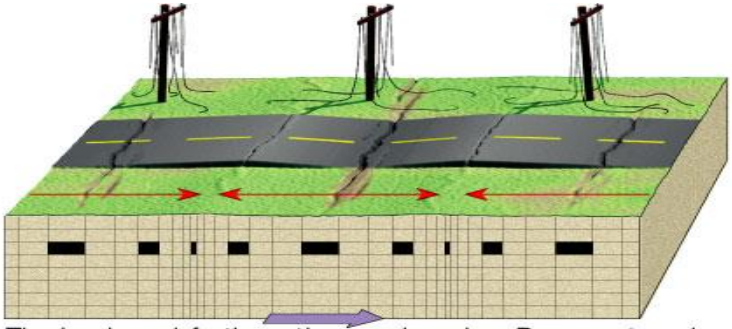


Seismic Waves

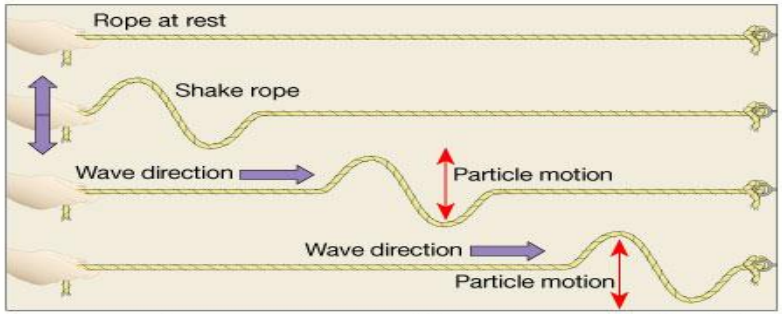
body waves	**P – waves** (primary)	-Push-pull waves (*longitudinal*) -Travel through **solids, liquids, & gases** -**Greatest velocity** (speed) of all seismic waves -Lowest intensity
body waves	**S – waves** (secondary)	-Waves shake particles at right angles (*transverse*) -Travel **only through solid**s -Slower velocity, **half the speed of P-waves** -Low intensity
surface waves		-Travel along Earth's outer layer -**Most intense** seismic waves, **do the <u>most damage</u>** -**Slowest velocity** (speed) / last to arrive



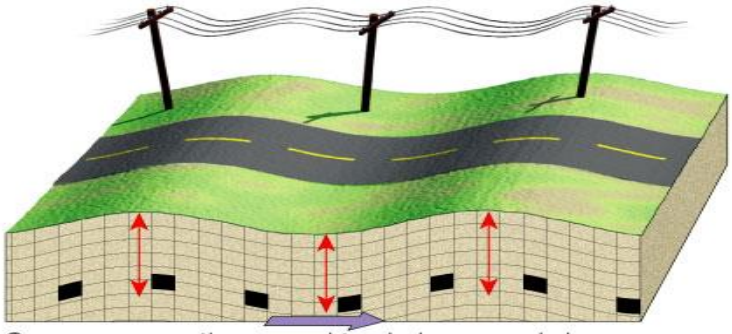
P waves are compression waves that alternately compress and expand the material through which they pass.



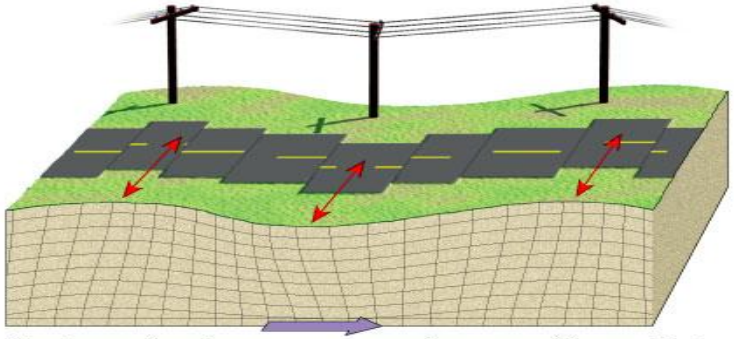
The back-and-forth motion produced as P waves travel along the surface can cause the ground to buckle and fracture.



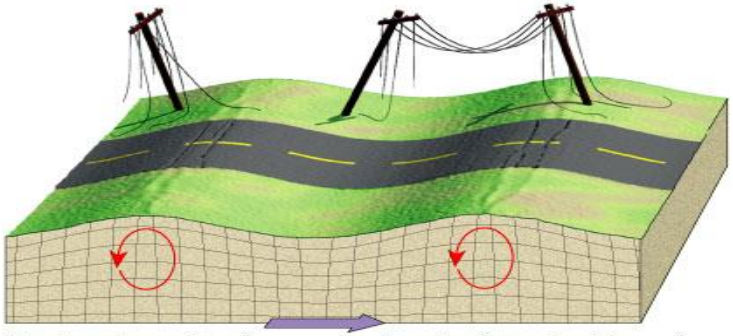
S waves are transverse waves which cause material to shake at right angles to the direction of wave motion. The length of the red arrow is the displacement, or amplitude, of the S wave.



S waves cause the ground to shake up-and-down and sideways.



One type of surface wave moves the ground from side to side and can damage the foundations of buildings.



Another type of surface wave travels along Earth's surface much like rolling ocean waves. The arrows show the movement of rock as the wave passes. The motion follows the shape of an ellipse.

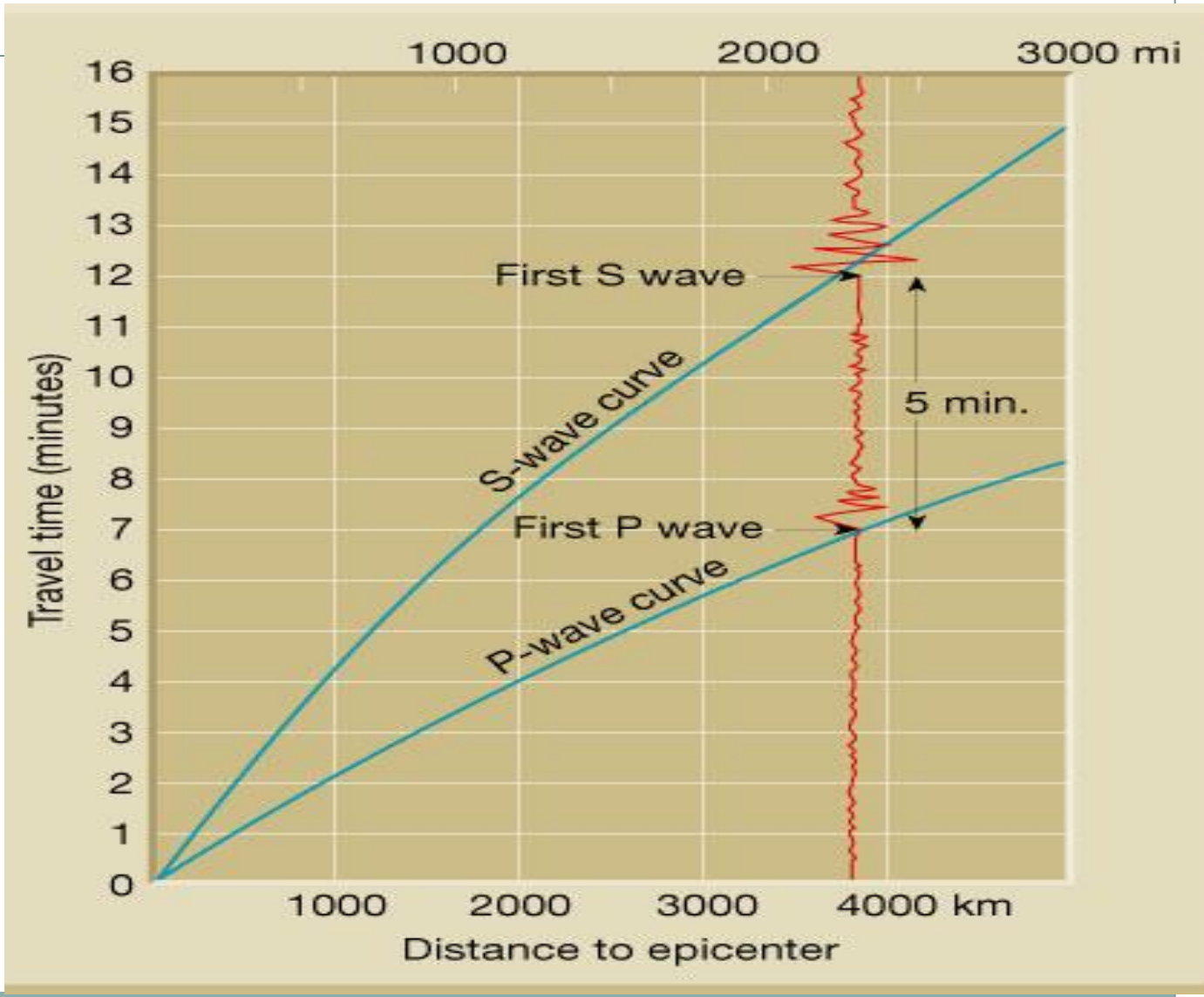
END OF 9/26

Locating the Epicenter

Distance to the epicenter:

1. Use the **difference** in the arrival times **between P & S wave** recordings (*in minutes*).

2. Then use the time-travel chart to find the **distance** (*miles or km*).



Locating the Epicenter

Direction of the epicenter:

Triangulation:

Once you know the **distance** to the epicenter, you would need **3 or more seismographs** to find the exact location of an earthquake.

Momentum Magnitude

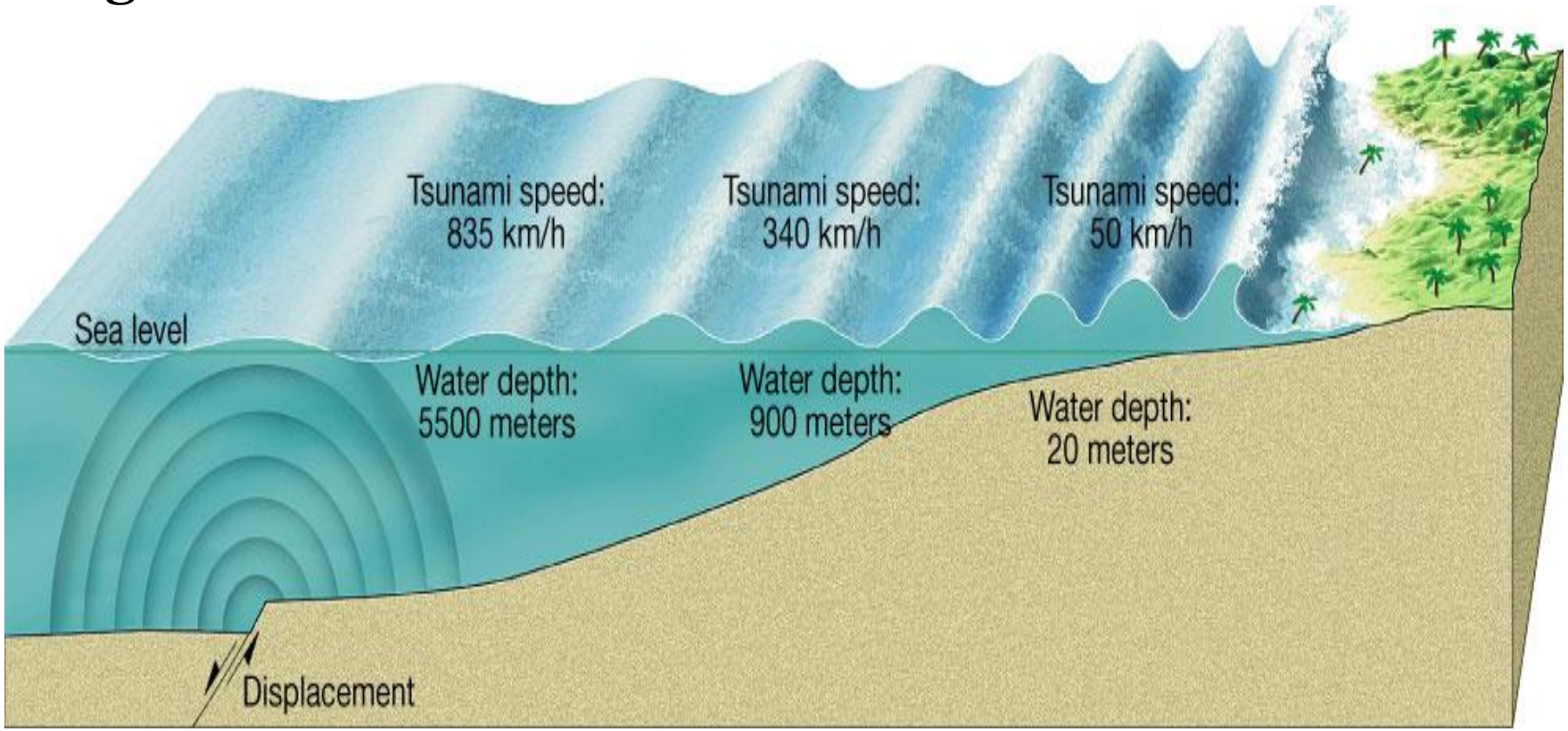
Derived from the amount of displacement that occurs along the fault zone

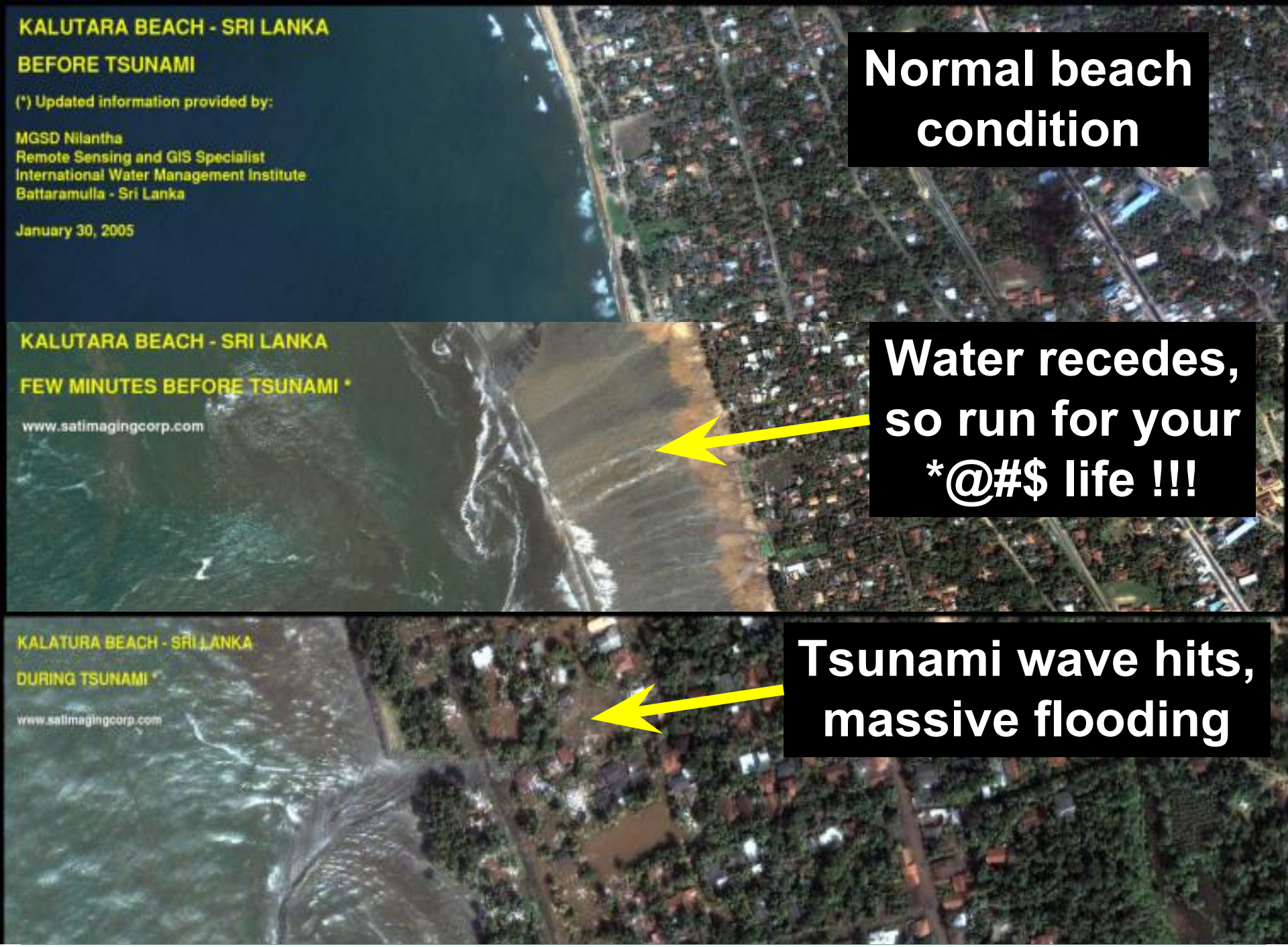
Table 1 Earthquake Magnitudes and Expected World Incidence

Moment Magnitudes	Effects Near Epicenter	Estimated Number per Year
< 2.0	Generally not felt, but can be recorded	> 600,000
2.0–2.9	Potentially perceptible	> 300,000
3.0–3.9	Rarely felt	> 100,000
4.0–4.9	Can be strongly felt	13,500
5.0–5.9	Can be damaging shocks	1,400
6.0–6.9	Destructive in populous regions	110
7.0–7.9	Major earthquakes; inflict serious damage	12
8.0 and above	Great earthquakes; destroy communities near epicenter	0–1

Tsunamis

Large sea wave caused when the ocean floor is moves.




KALUTARA BEACH - SRI LANKA
BEFORE TSUNAMI
(*) Updated information provided by:
MGSD Nilantha
Remote Sensing and GIS Specialist
International Water Management Institute
Battaramulla - Sri Lanka
January 30, 2005
Normal beach condition
KALUTARA BEACH - SRI LANKA
FEW MINUTES BEFORE TSUNAMI *
www.satimagingcorp.com
Water recedes, so run for your *@#$ life !!!
KALATURA BEACH - SRI LANKA
DURING TSUNAMI *
www.satimagingcorp.com
Tsunami wave hits, massive flooding

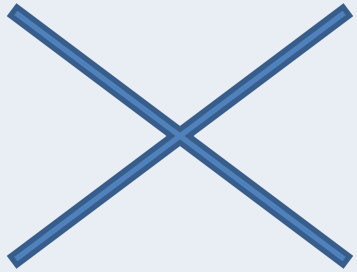
- ***Landslides*** = created when the ground moves downhill from the vibrations.

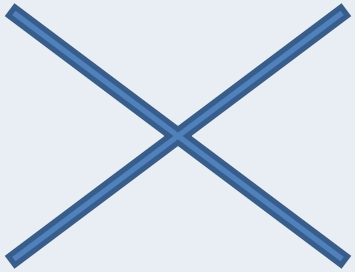
- ***Fires*** = often created from broken gas & electrical lines under the city which start a fire.

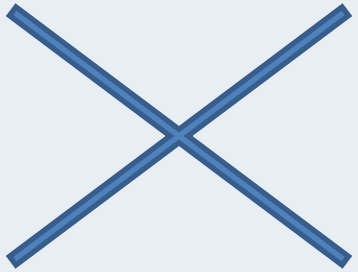
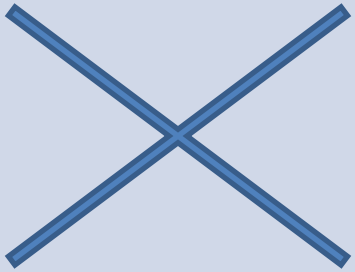
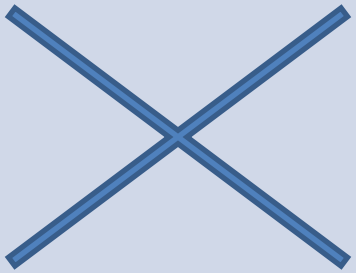
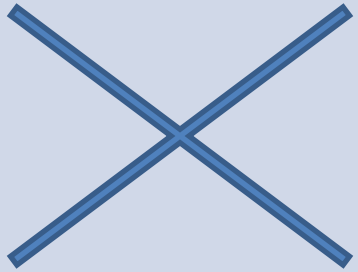
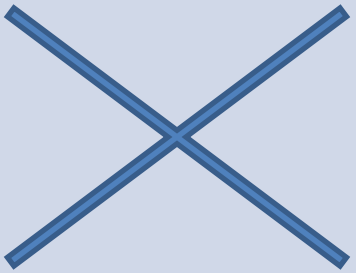
Lahar: volcanic mudflow of water & ash

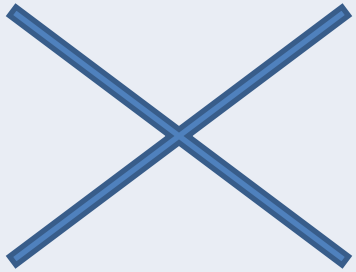
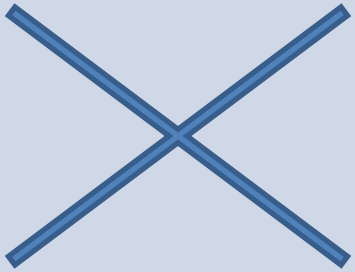
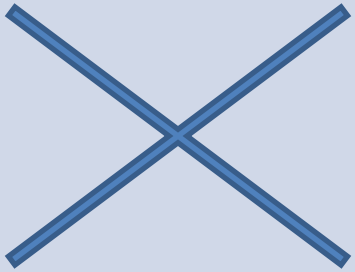
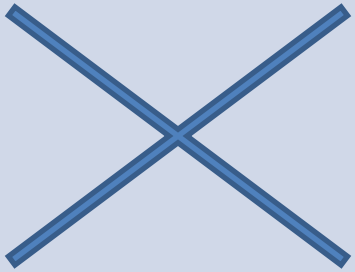
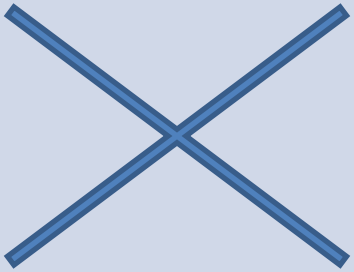
Liquefaction: when sandy soil becomes saturated with water and cannot support buildings

San Francisco is built on sandy soil or fill. Many structures built on this type of “soft” soil were badly damaged during the 1989 Loma Prieta earthquake.

Boundary *Sec 9.2*	**Divergent**	**Convergent**	**Transform**
Movement:			
Structures:			
Examples:			

Boundary *Sec 9.2*	**Divergent**	**Convergent**	**Transform**
Movement:	Moving apart New crust created	Coming together Crust destroyed	Plates grind past each other Crust neither created or destroyed
Structures:	• Oceanic ridge • Rift valleys • Seafloor spreading	• Subduction zone • Deep Trench • Volcanic activity	
Examples:	**Mid-Atlantic Ridge**	**Andes Mountains**	**San Andreas Fault**

Action *Sec 9.3*	**Ocean – Ocean**	**Ocean – Continent**	**Continent - Continent**
Convergent: *p. 261*			
Divergent: *p. 258*			
			

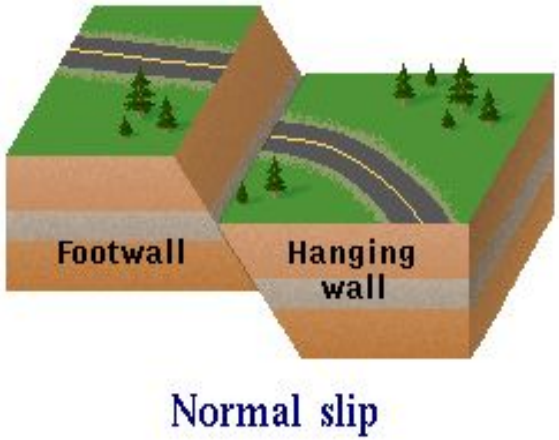
Action *Sec 9.3*	**Ocean – Ocean**	**Ocean – Continent**	**Continent - Continent**
Convergent: *p. 261*	Subduction zone, ocean trench, volcanic island arc	Subduction zone, ocean trench, volcanoes on continent	mountains
Divergent: *p. 258*	oceanic ridge		rift valley
			

Types of Faults

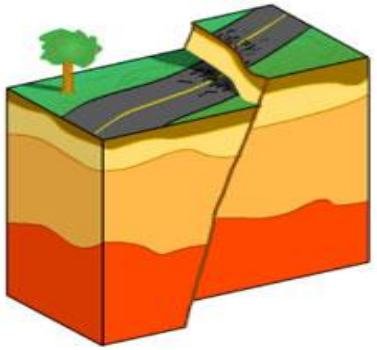
Normal = Hanging Wall moves down & Foot Wall moves up

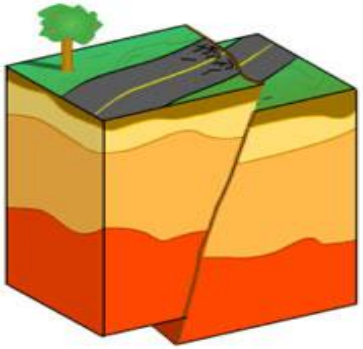
Reverse = Foot Wall moves down & Hanging Wall moves up

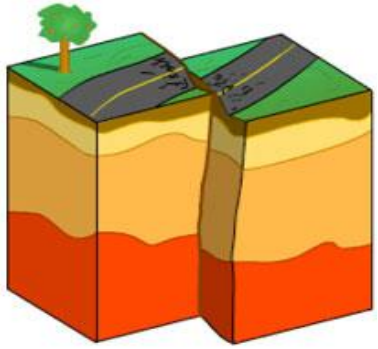
Strike-slip = two parts are moving past one another



Normal slip


Normal fault


Reverse fault


Strike-slip fault


0 %
Loading

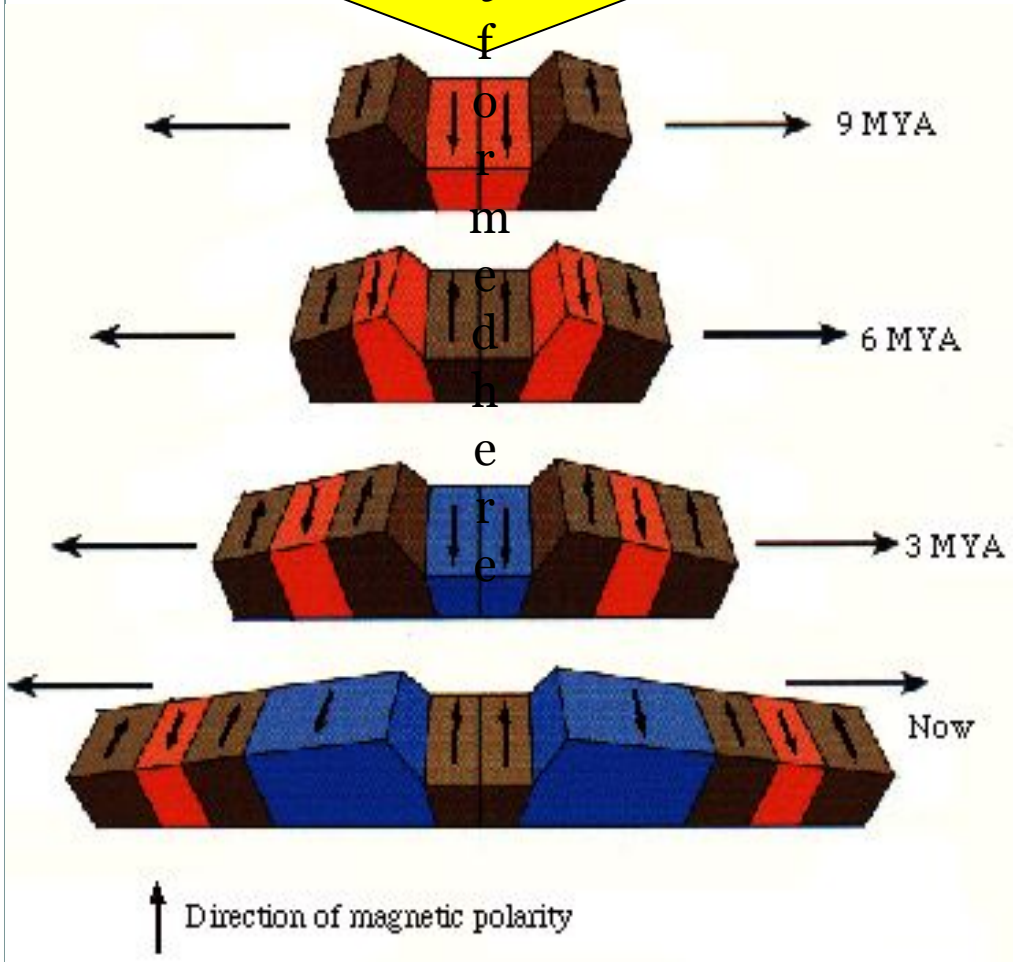
Evidence

- Evidence for **Continental Drift**:
  - Continental Puzzle (Pangaea)
  - Matching fossils on different continents
  - Matching rock types & mountains on different continents
  - Ancient climates

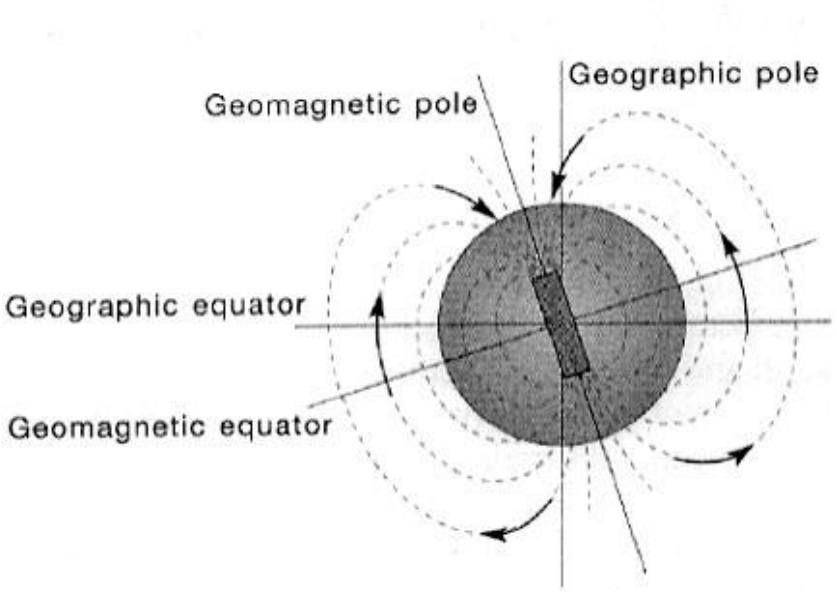
- Evidence for **Plate Tectonics:**
  - **Paleomagnetism** preserved in seafloor rock layers
  - Distribution of earthquakes/ volcanoes along **fault lines**
  - Age of the **sea floor rocks**/ocean drilling
  - **Hot spots**

Paleomagnetism

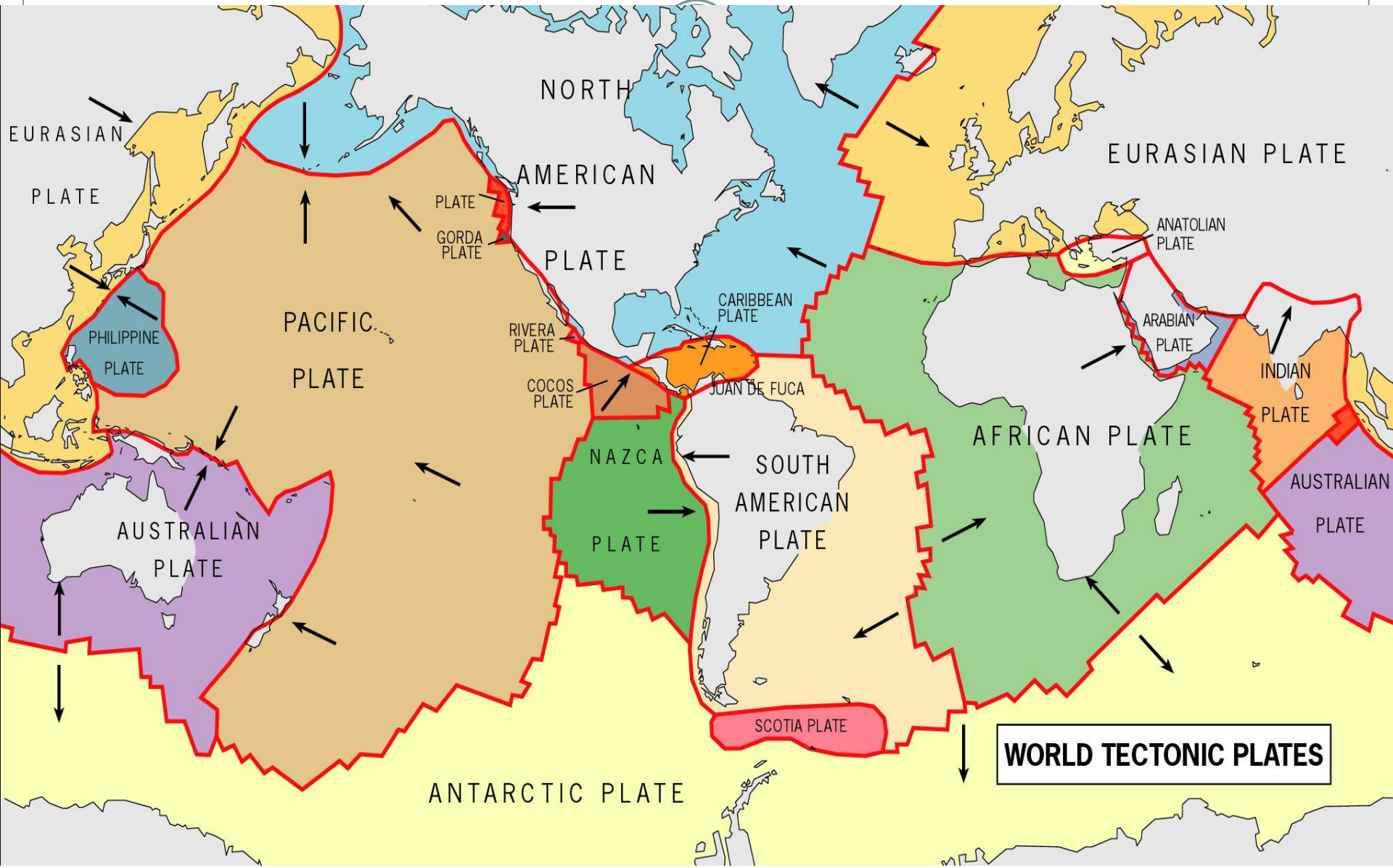
new crust formed here



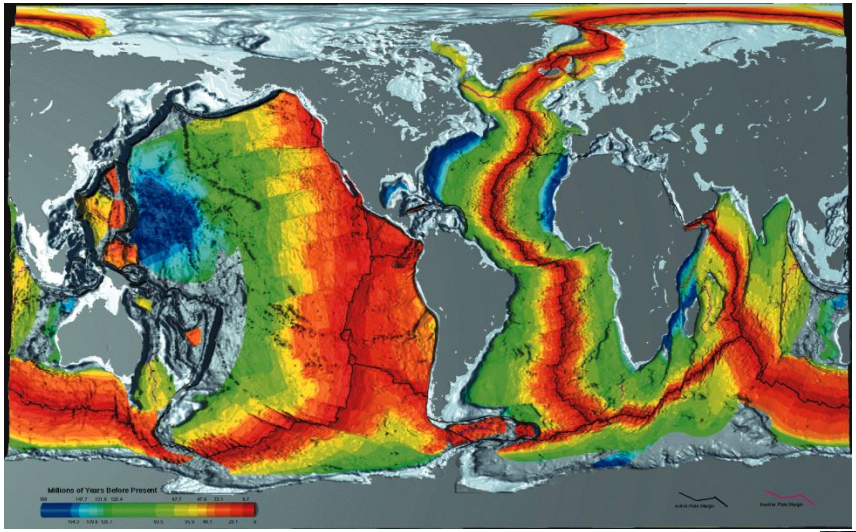
- Earth's magnetic poles switch periodically
- Rocks formed are magnetic → point to magnetic North
- Rocks are found with reverse polarities



Map of Plate Boundaries



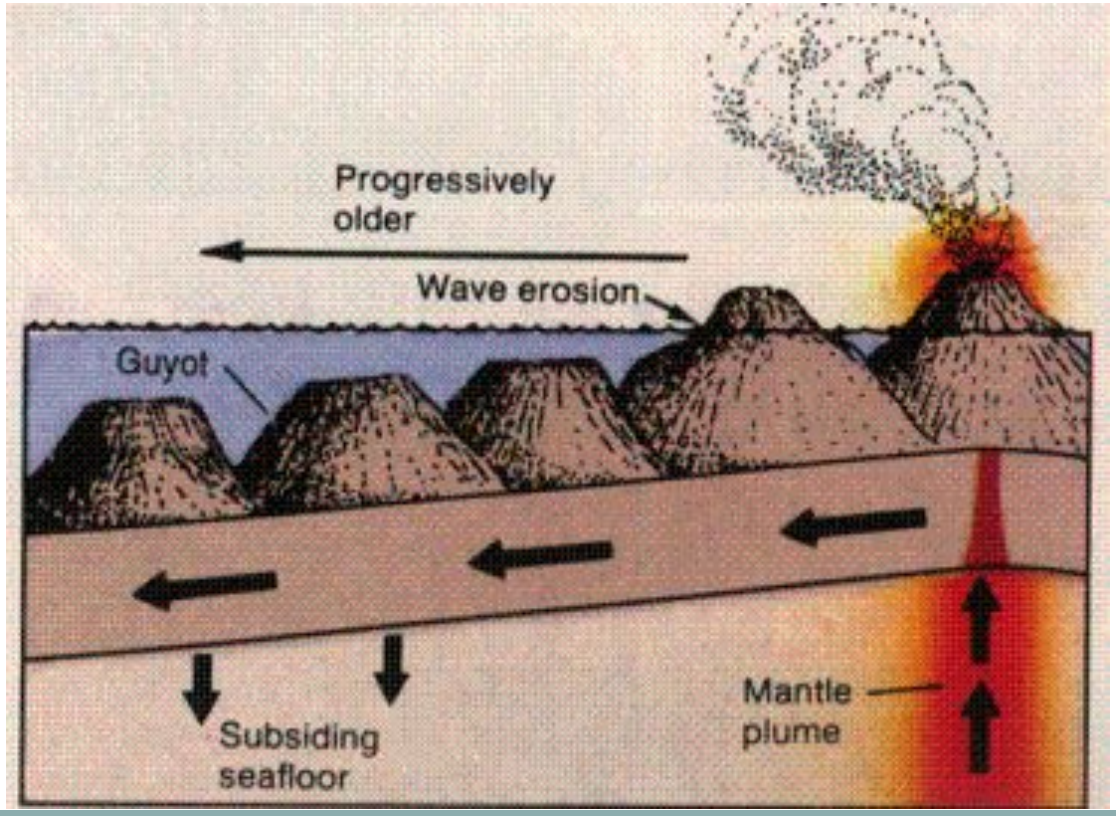
Age of the Sea Floor/Ocean Drilling



- As we move away from ridges, rocks get older
- Radiometric dating of ocean cores

Hot Spots

- Plume of magma in the middle of a plate
- Hot spot stays when the plate moves & creates islands



examples:

- Hawaii
- Iceland
- Yellowstone

Mechanisms of Plate Movement

1. **Mantle convection:** movement of heat in the mantle
2. **Slab-pull:** gravity pulling down on the subducting plate or "slab" & pulling the plate with it
3. **Ridge-push:** pushing of the plate because of creation of crust at the ridge