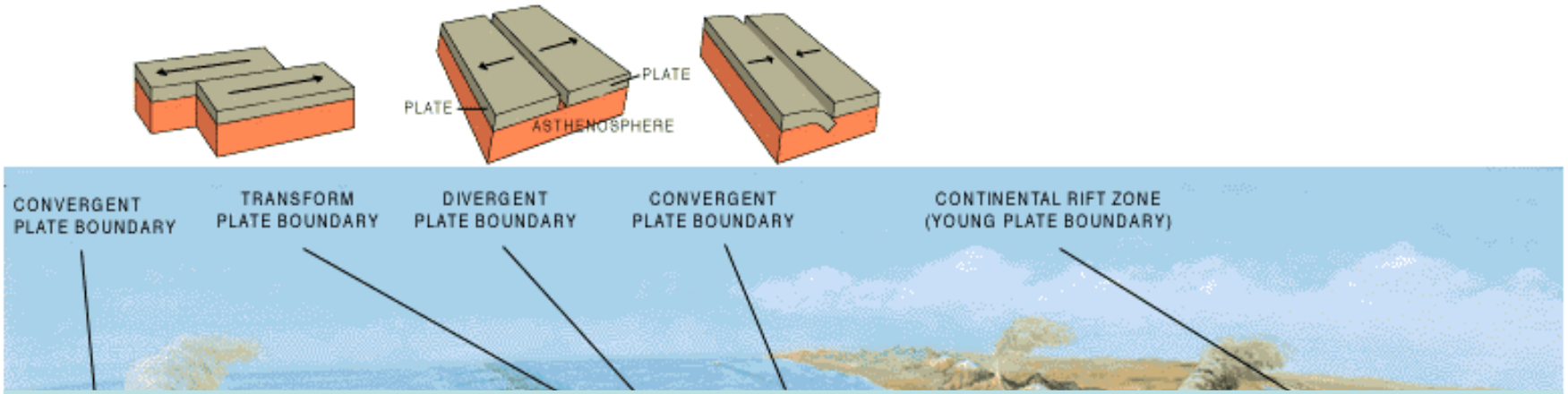
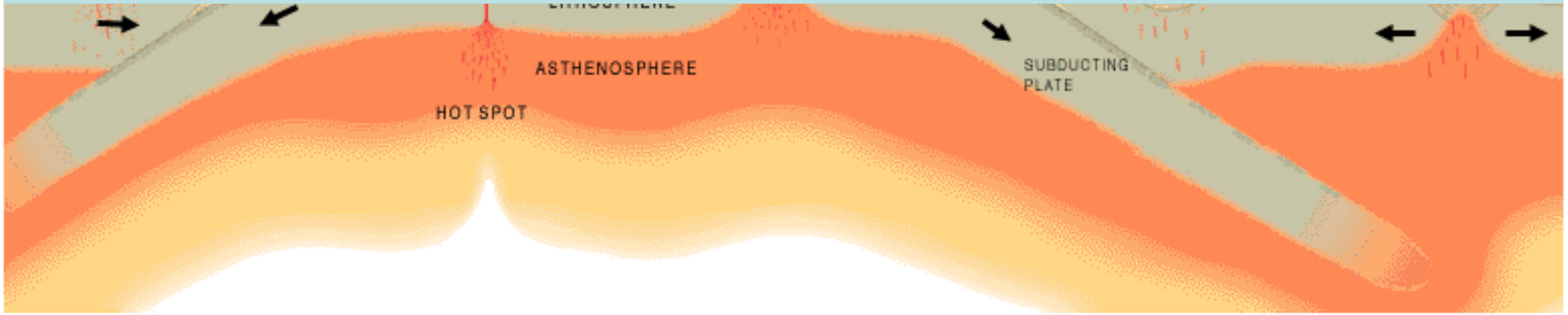
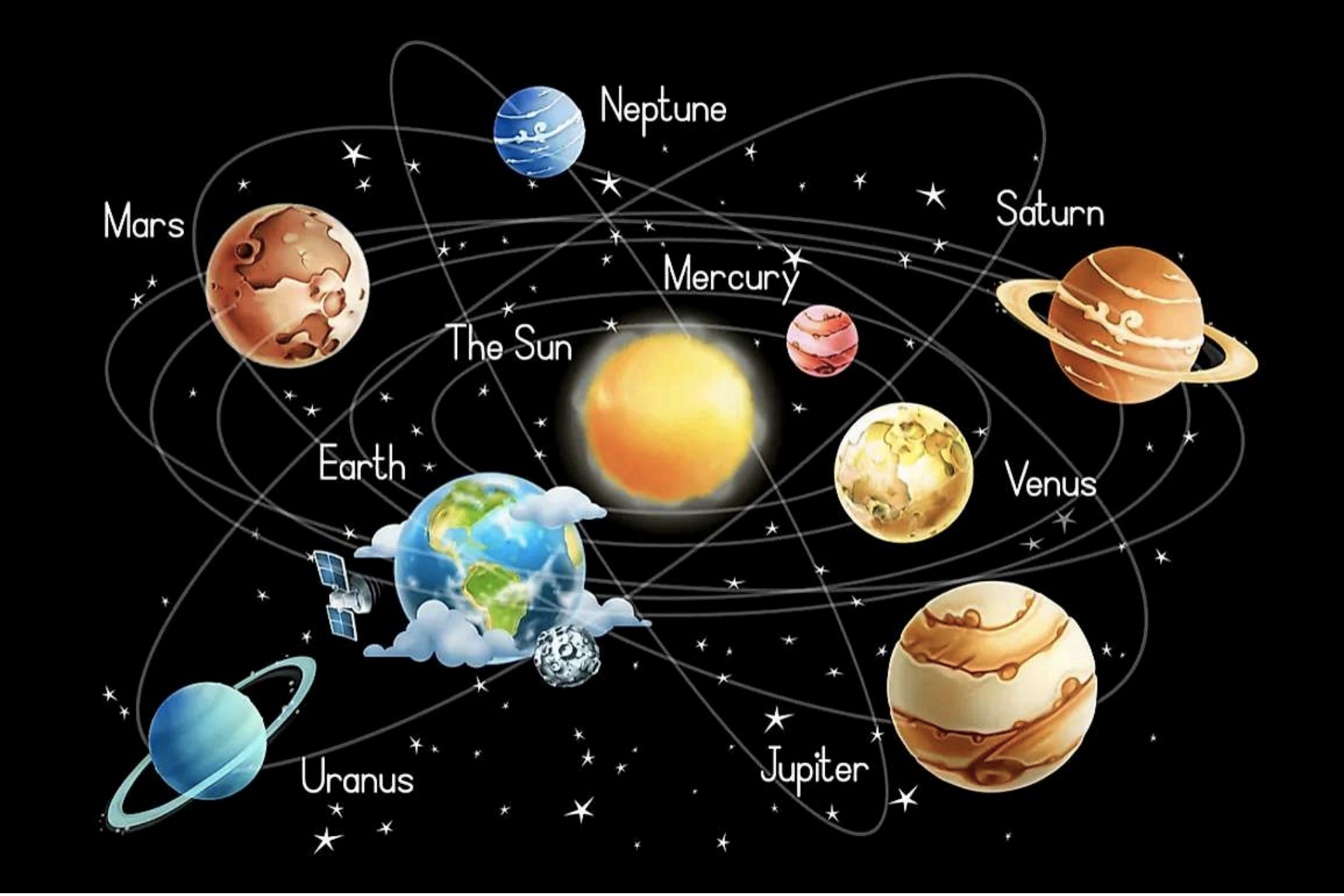
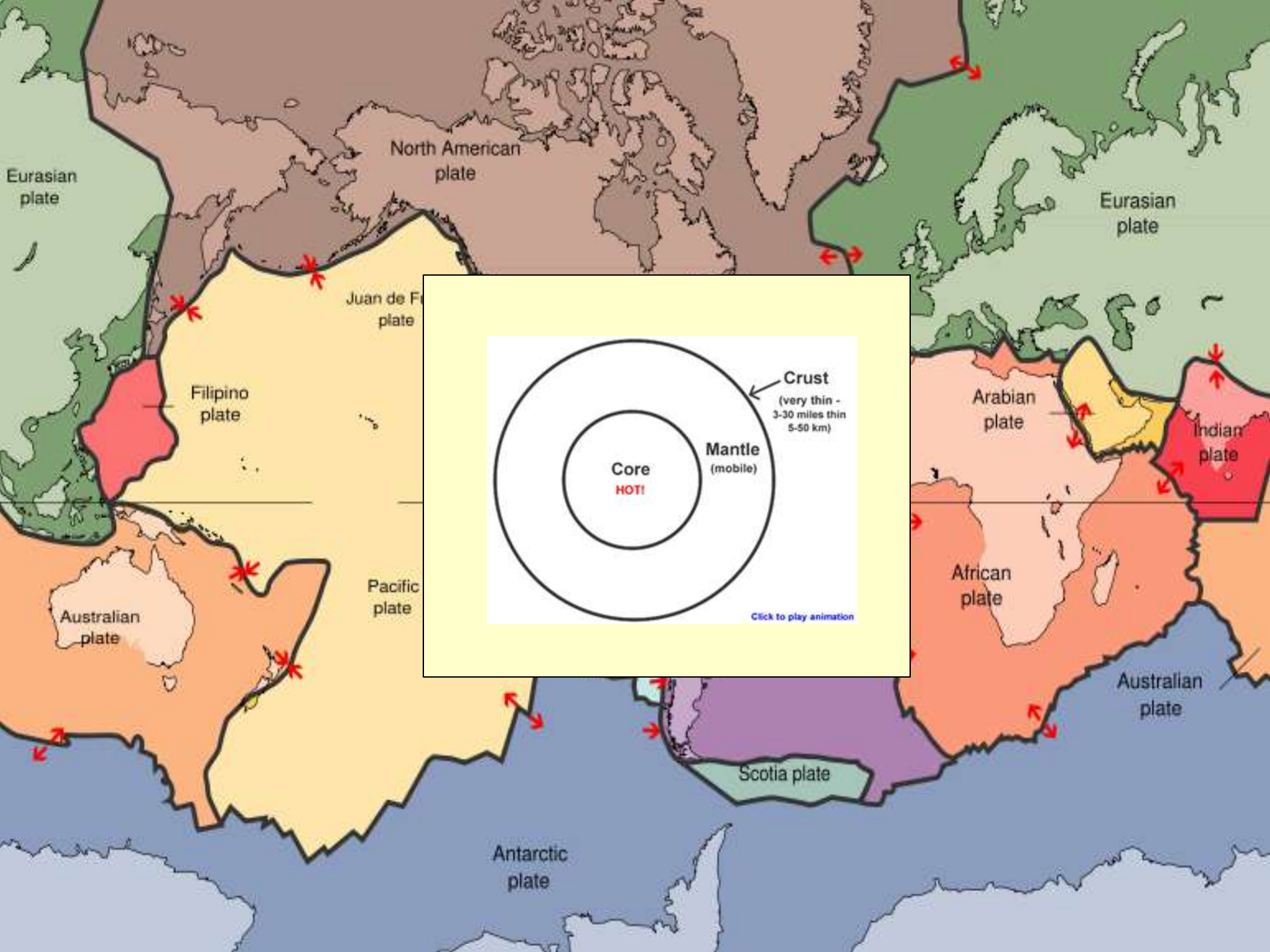


Concept of Seismology and earth structure

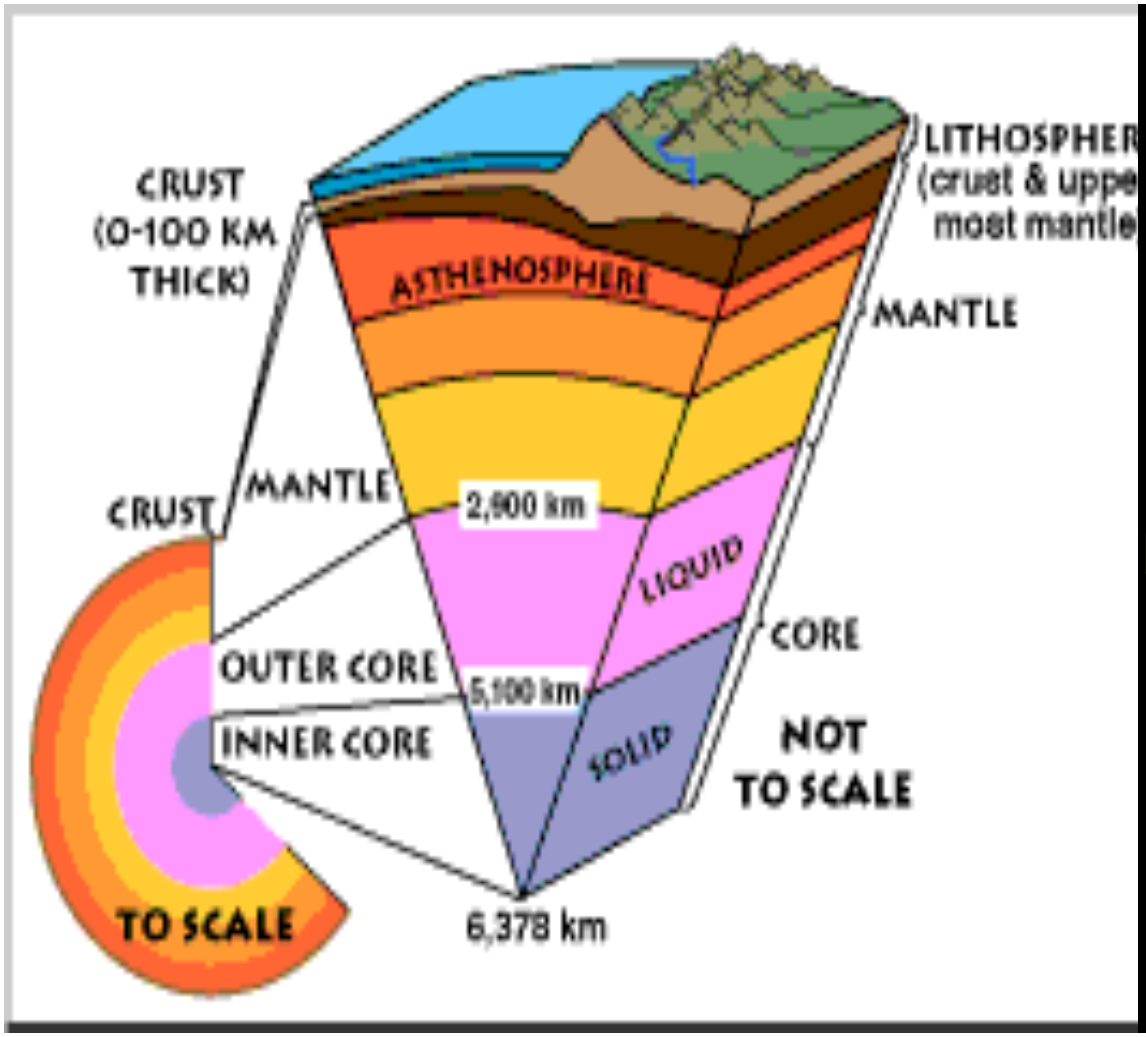


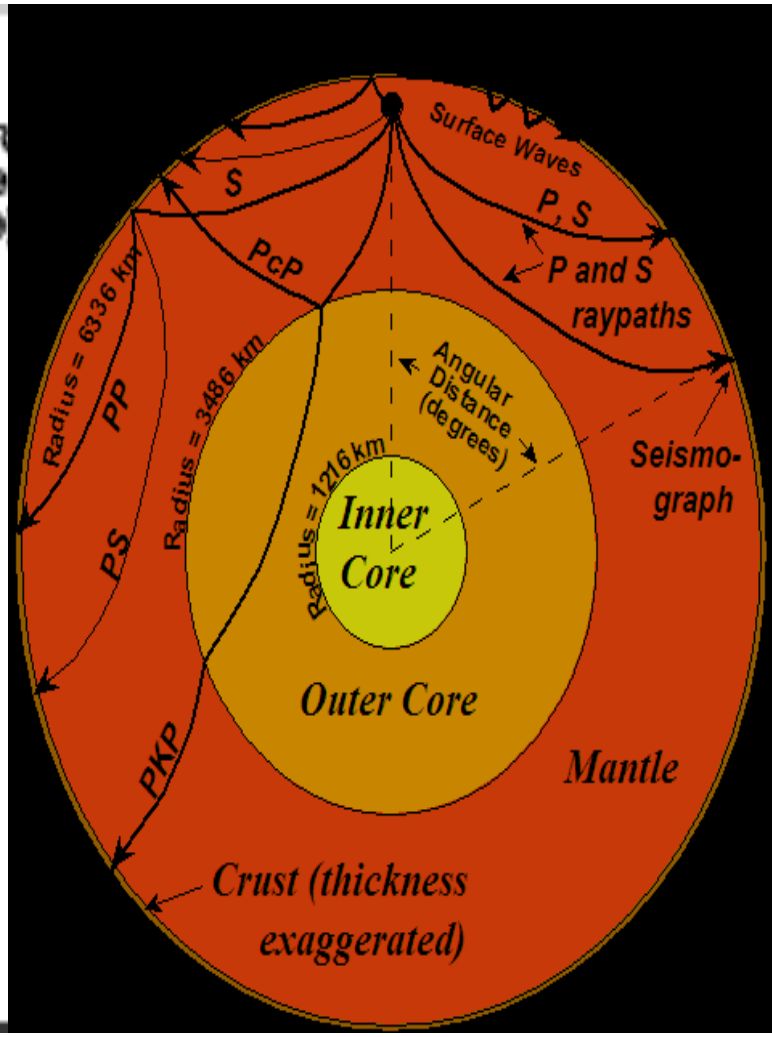
Raman Kumar Biswas, Ph.D.
Dept. of Disaster Resilience and Engineering, PSTU.


Neptune
Mars
Saturn
Mercury
The Sun
Earth
Venus
Uranus
Jupiter

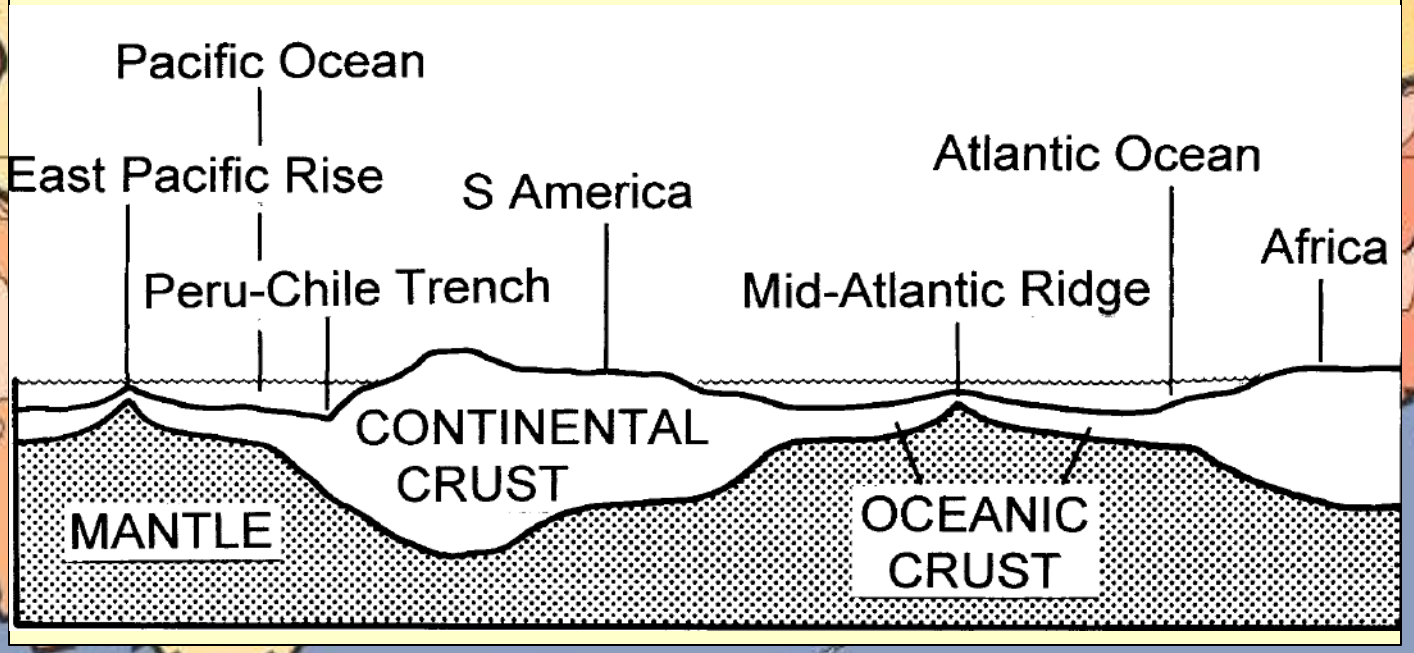

North American plate
Eurasian plate
Eurasian plate
Juan de Fuca plate
Filipino plate
Arabian plate
Indian plate
Pacific plate
African plate
Australian plate
Australian plate
Scotia plate
Antarctic plate
Crust
(very thin - 3-30 miles thin 5-50 km)
Mantle
(mobile)
Core
HOT!
Click to play animation

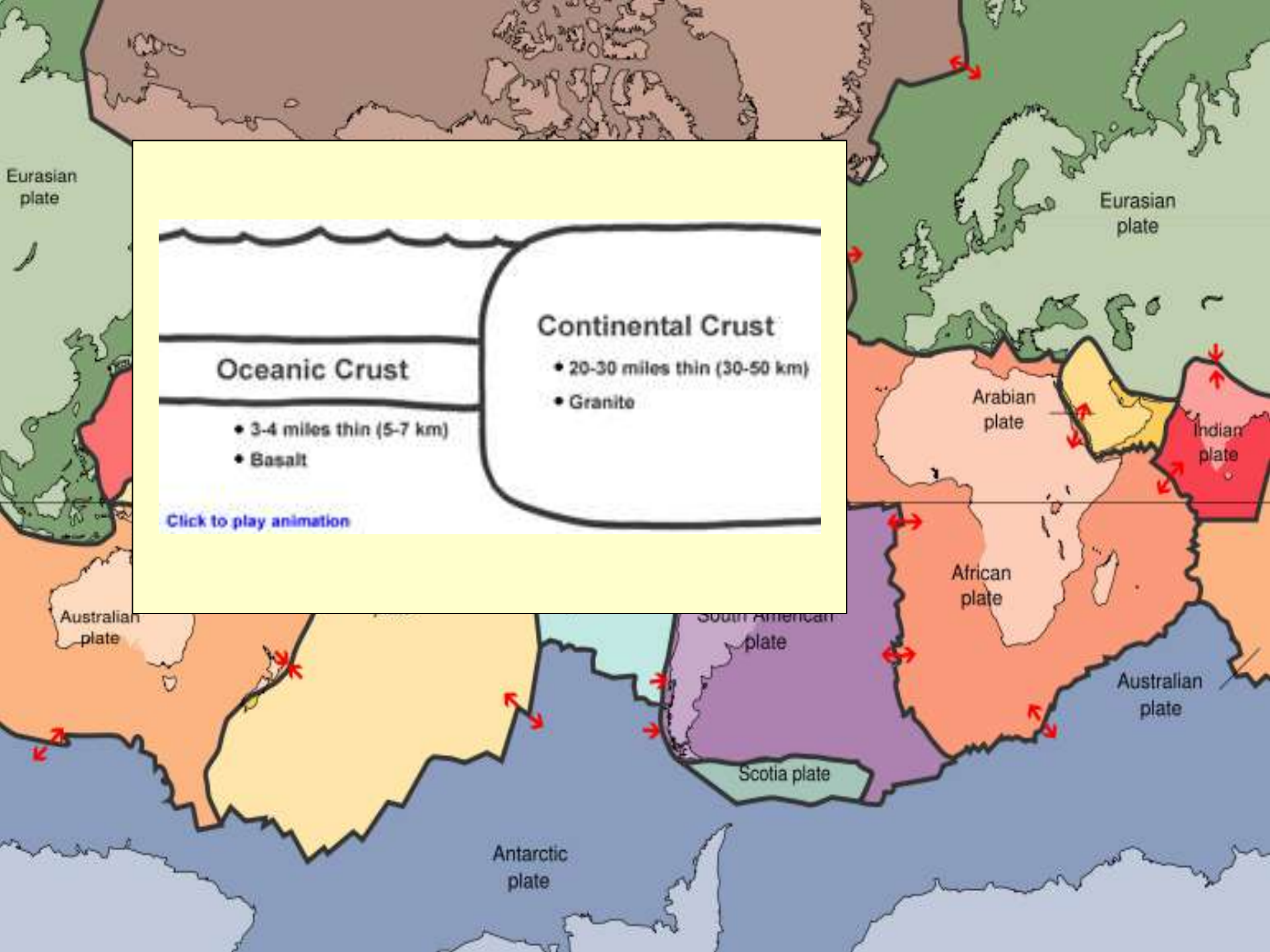
Cross Section of the Earth Interior

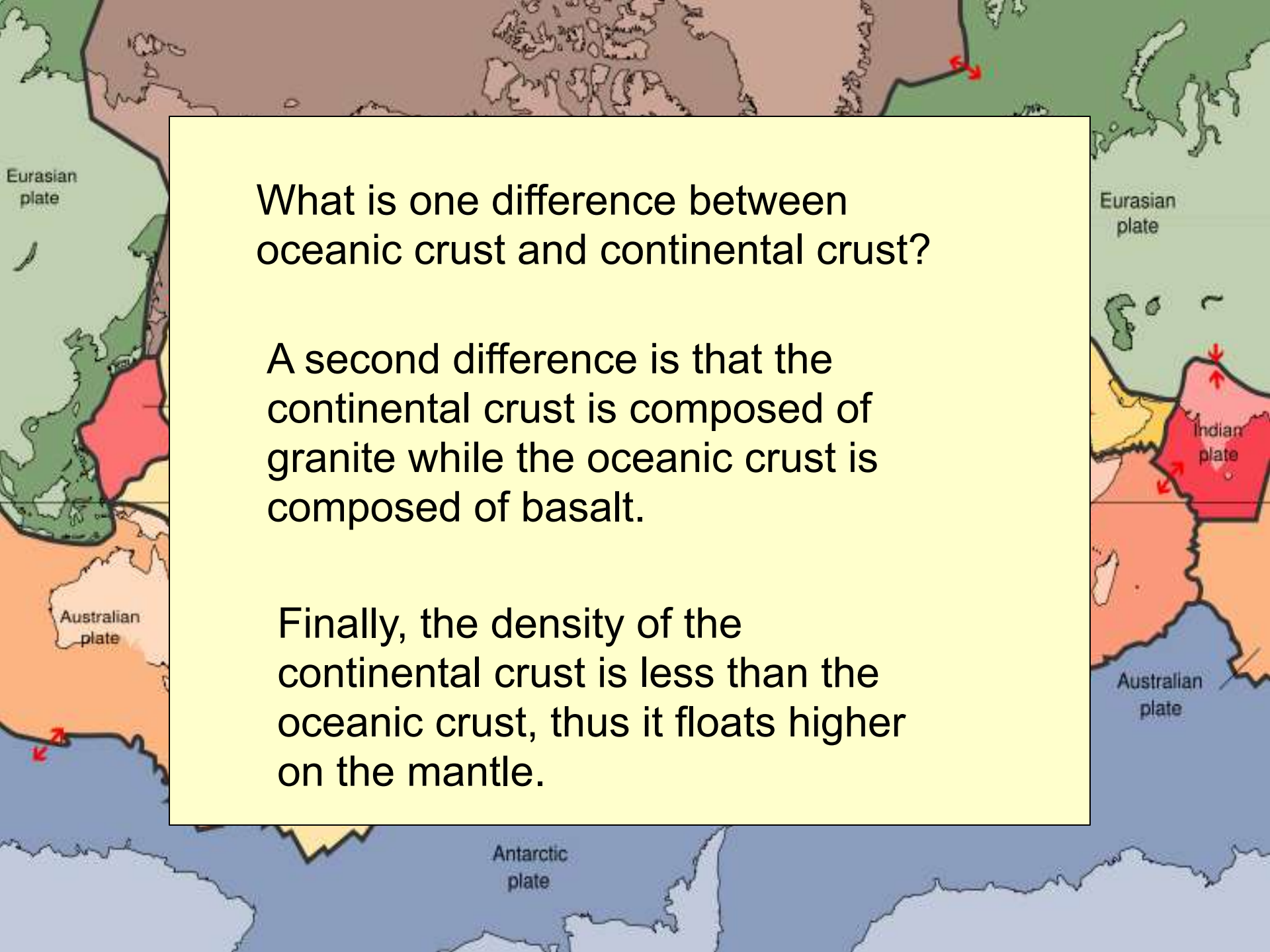




Two Types of Crust




Eurasian plate
Eurasian plate
Oceanic Crust
• 3-4 miles thin (5-7 km)
• Basalt
Continental Crust
• 20-30 miles thin (30-50 km)
• Granite
Click to play animation
Arabian plate
Indian plate
African plate
Australian plate
plate
Australian plate
Scotia plate
Antarctic plate

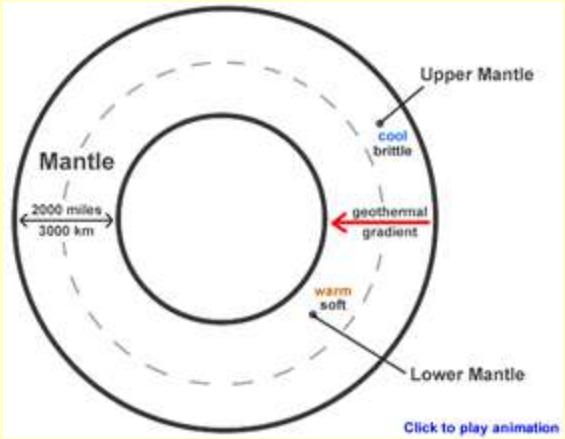


What is one difference between oceanic crust and continental crust?

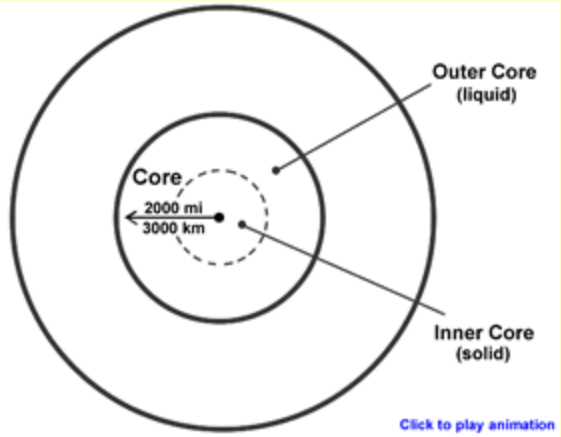
A second difference is that the continental crust is composed of granite while the oceanic crust is composed of basalt.

Finally, the density of the continental crust is less than the oceanic crust, thus it floats higher on the mantle.

The mantle increases in temperature depending on how close it is to the core. The rocks in the upper mantle are brittle and break while the rocks in the lower mantle are soft and flow instead of break.



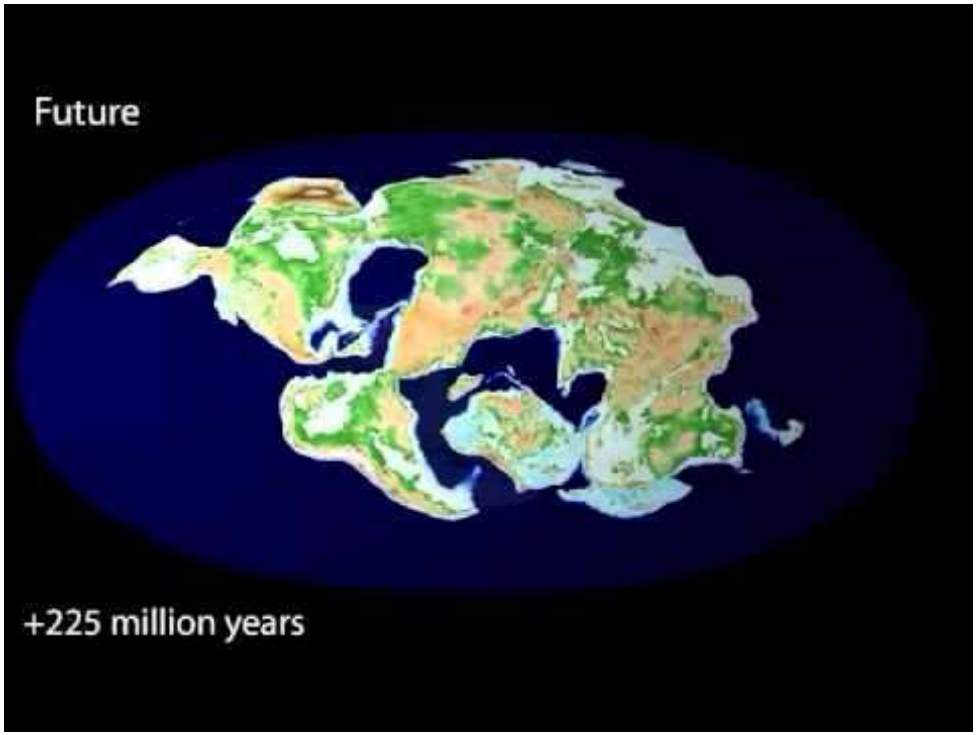
The core is thought to be composed of nickel and iron alloy. The outer core is liquid while the inner core is solid.



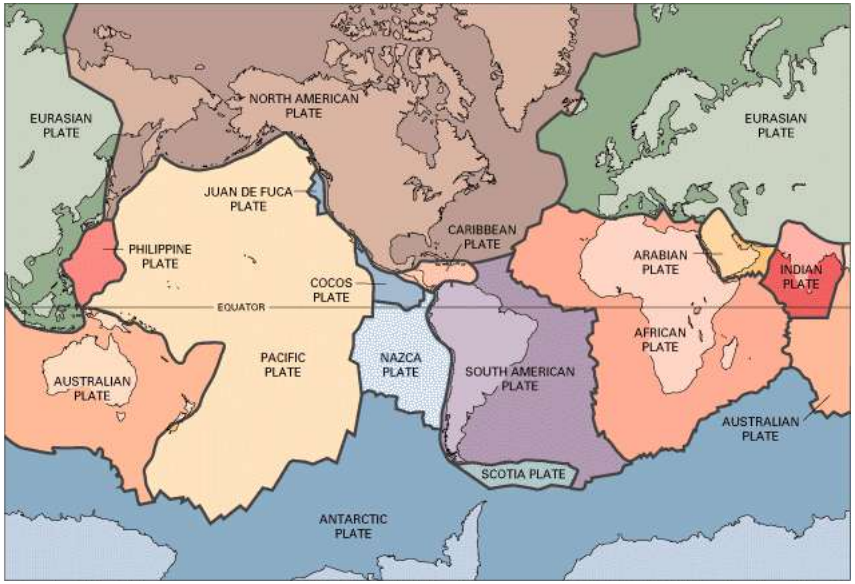
Tremendous pressure, produced by the weight of the overlying rocks is believed to crowd the atoms tightly together and prevent the liquid state.

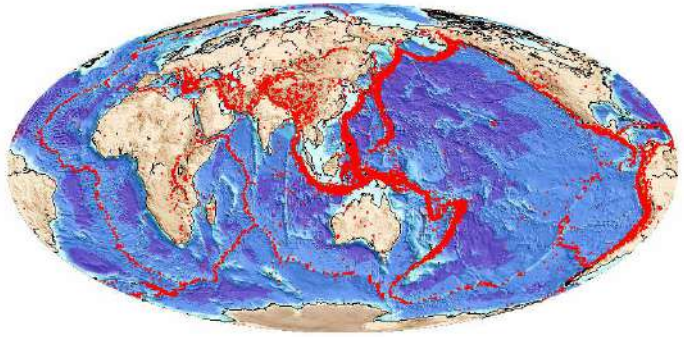
THE EARTH & EARTHQUAKE

Movement of the Earth

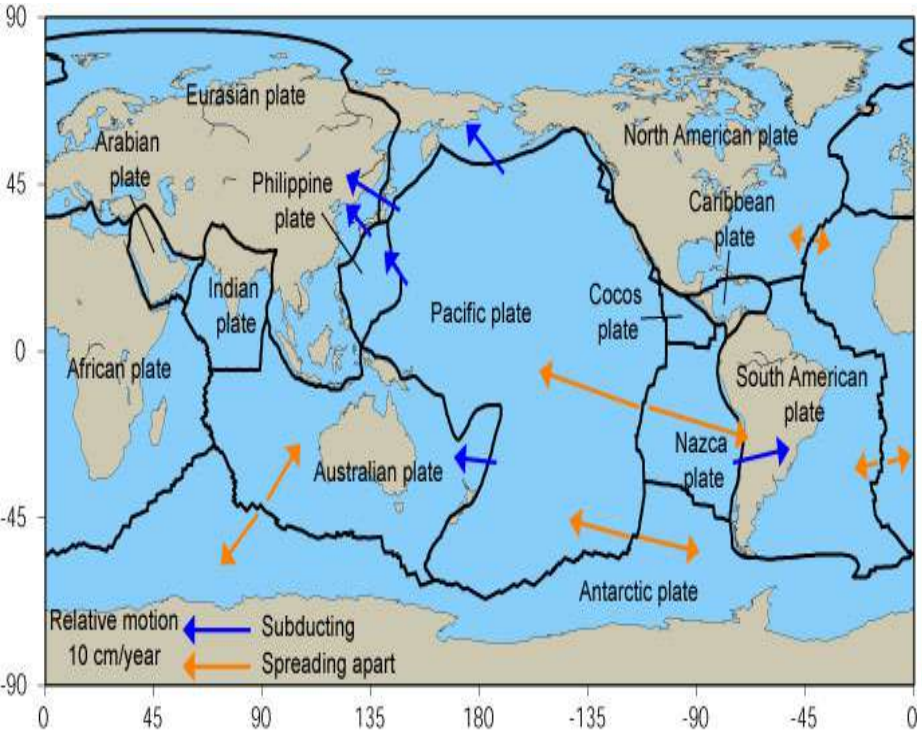


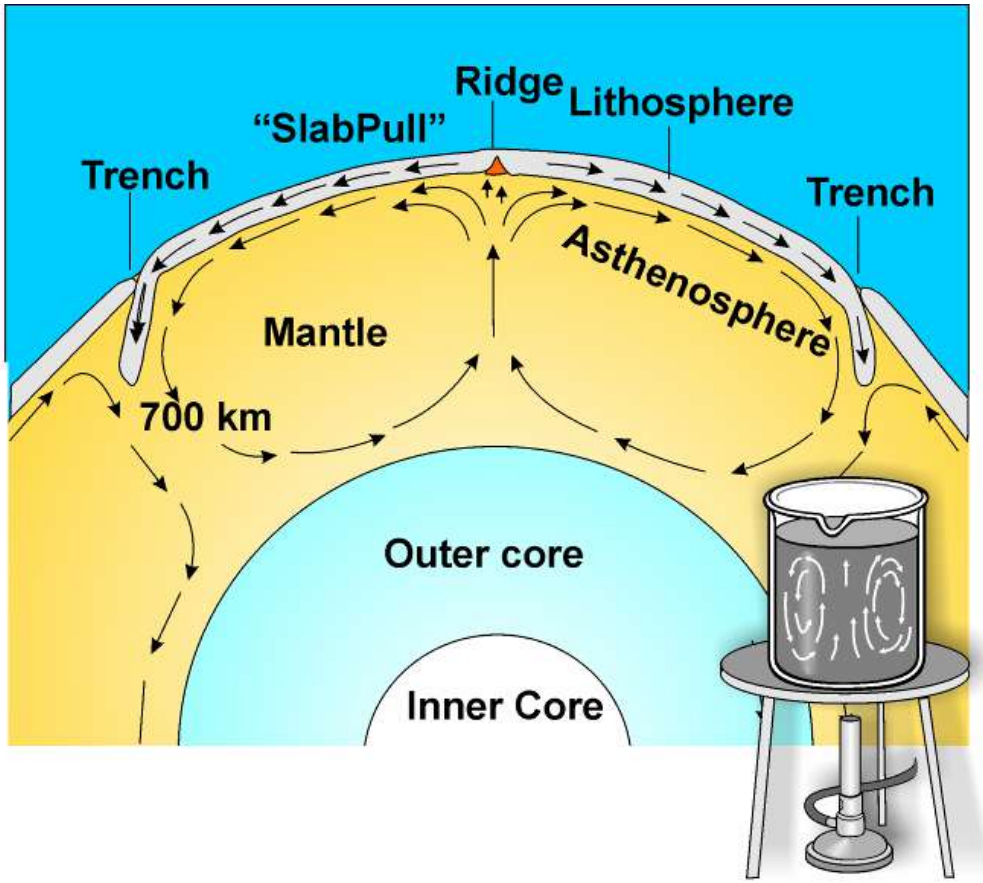
Tectonic Plates





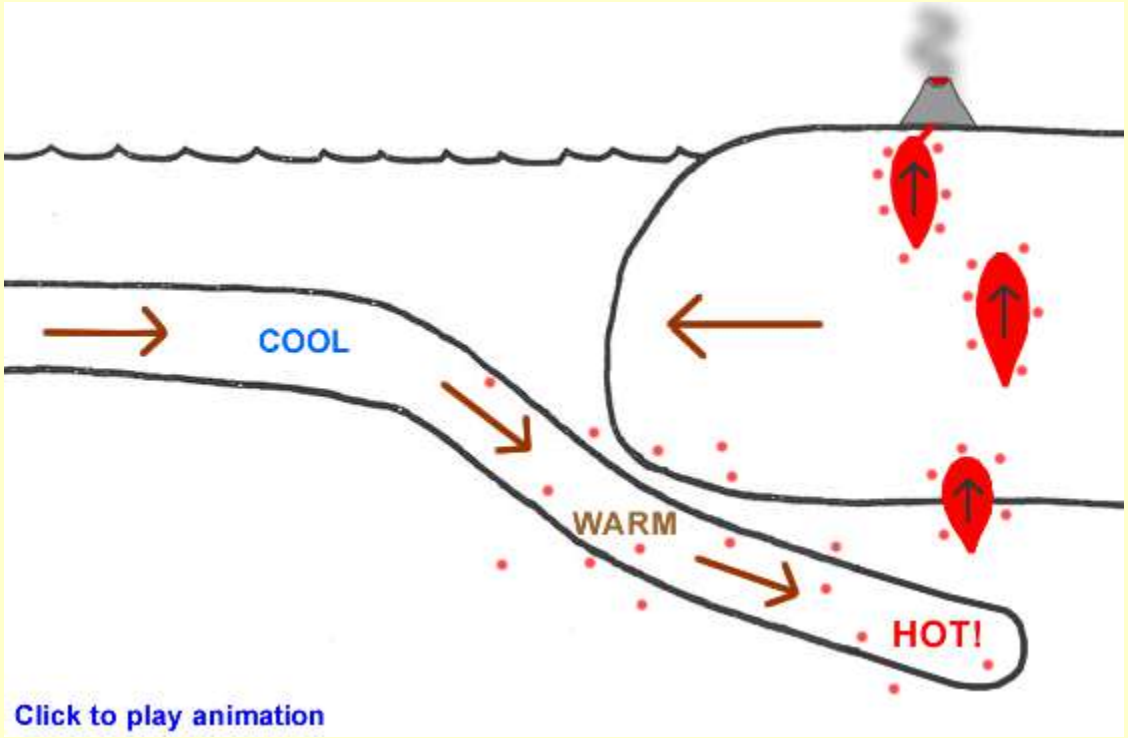
Tectonic Plates





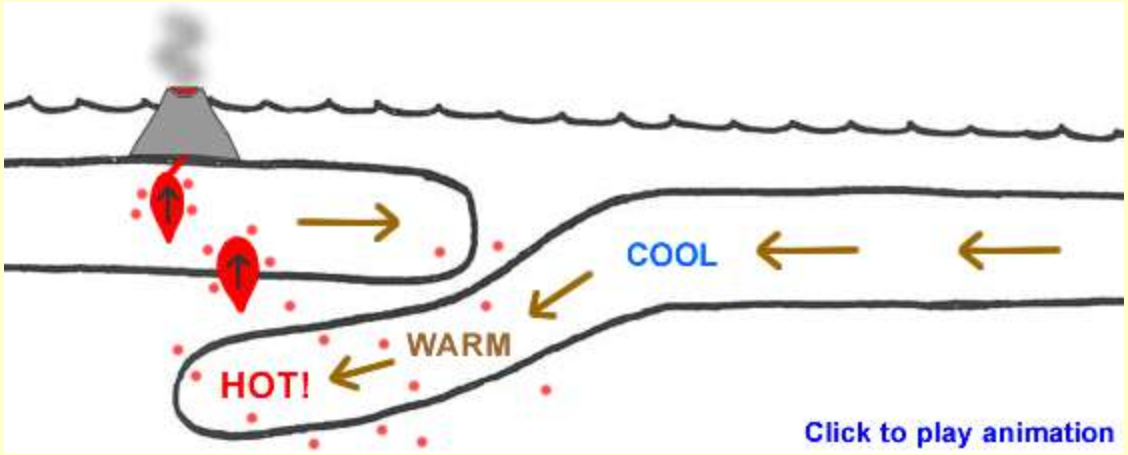
Types of Plate Boundary

Convergent Boundary
Continental/Oceanic



Convergent Boundary

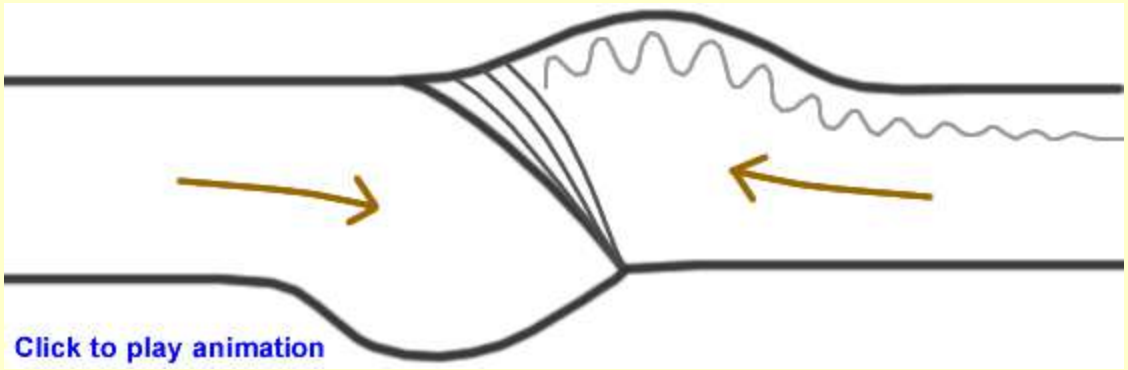
Oceanic/Oceanic



Eurasian plate
Eurasian plate
Indian plate
Australian plate
Australian plate
Antarctic plate

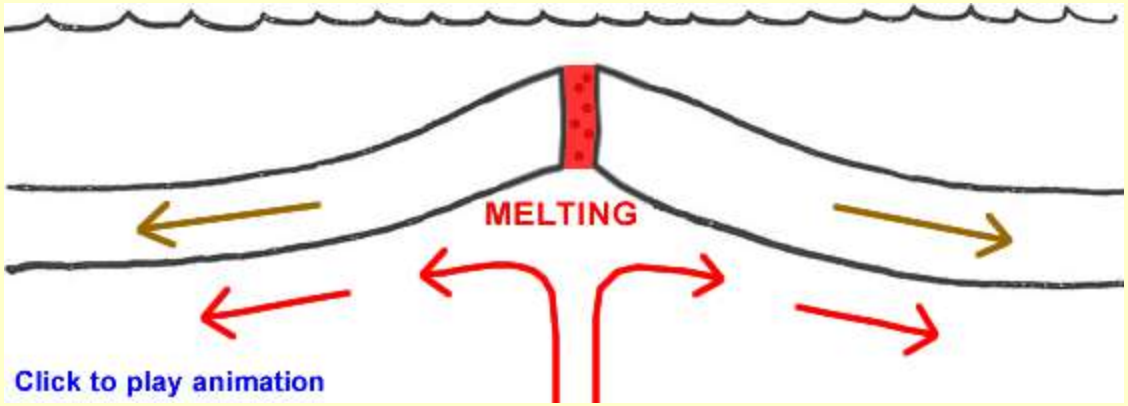
Convergent Boundary

Continental/Continental



Divergent Boundary

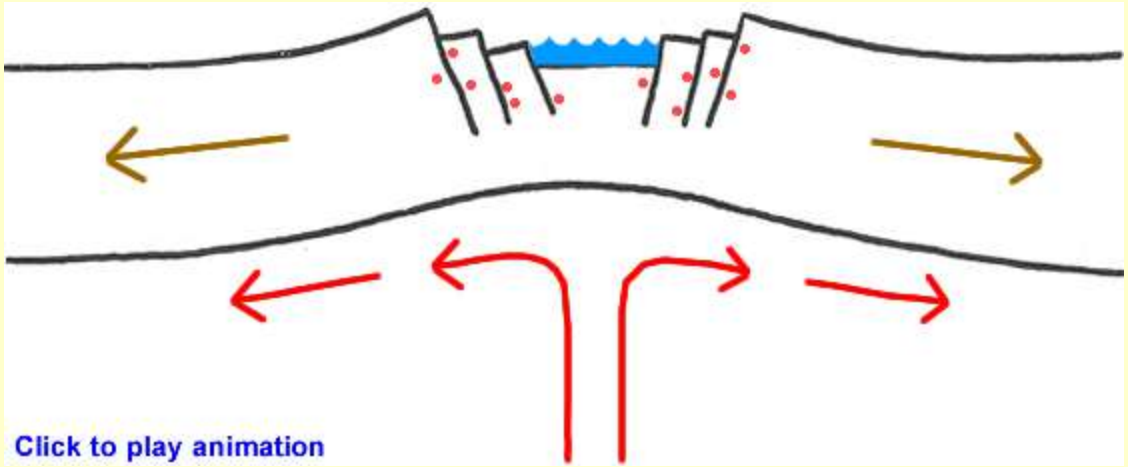
Oceanic



Eurasian plate
Eurasian plate
Indian plate
Australian plate
Australian plate
Antarctic plate

Divergent Boundary

Continental



Eurasian plate

Eurasian plate

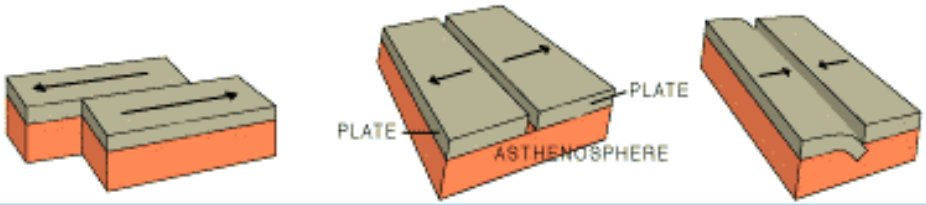
Indian plate

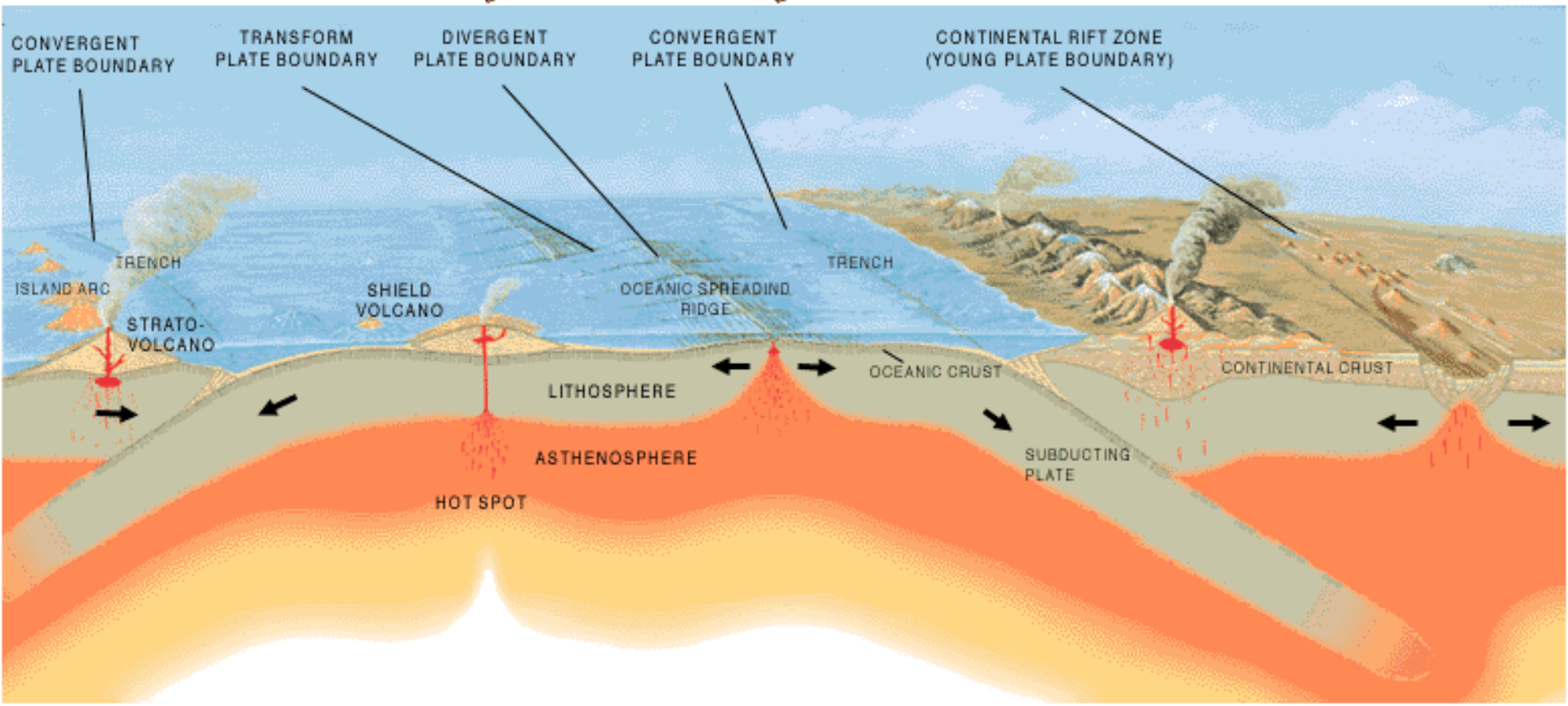
Australian plate

Australian plate

Antarctic plate

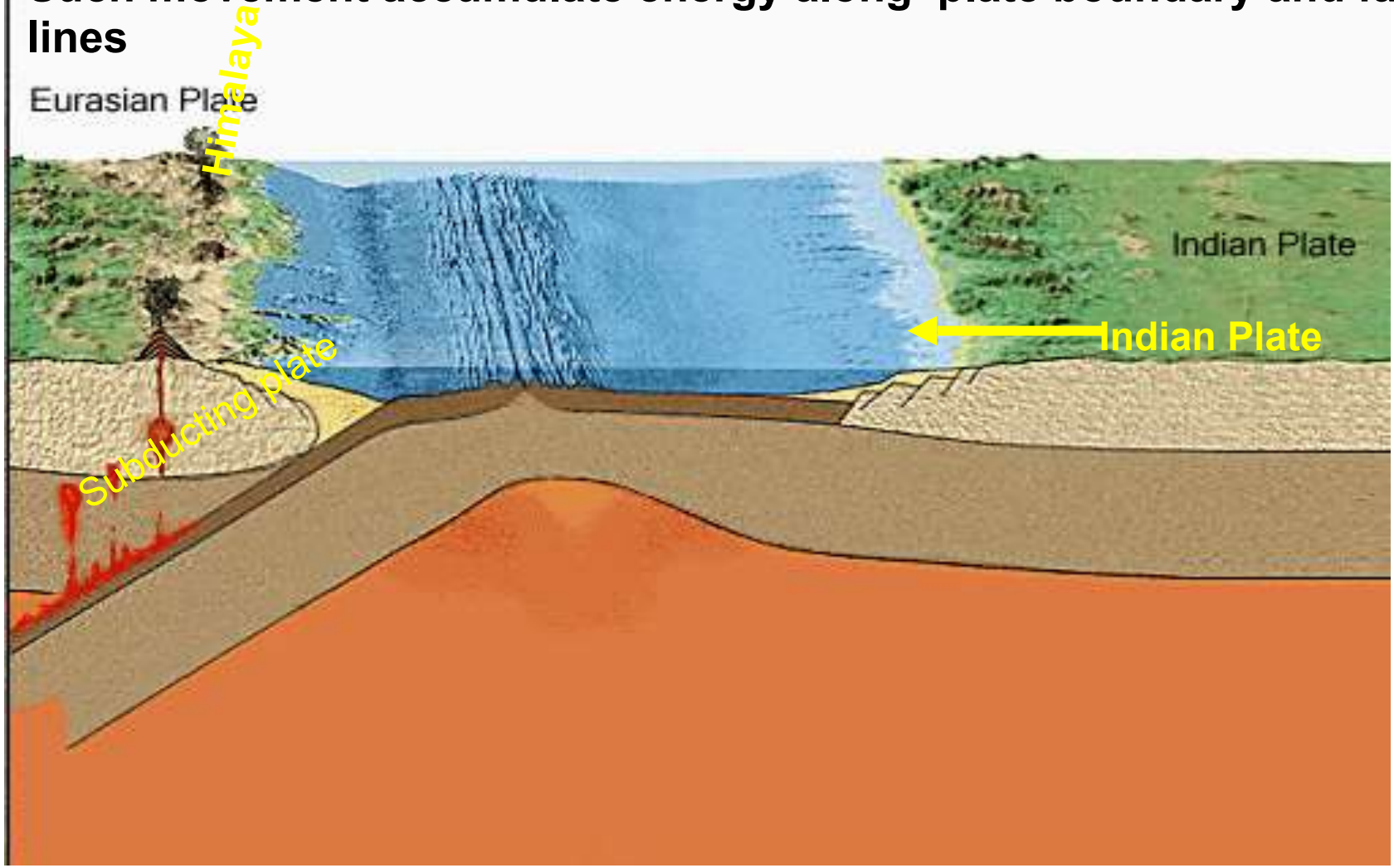
Plate Boundaries

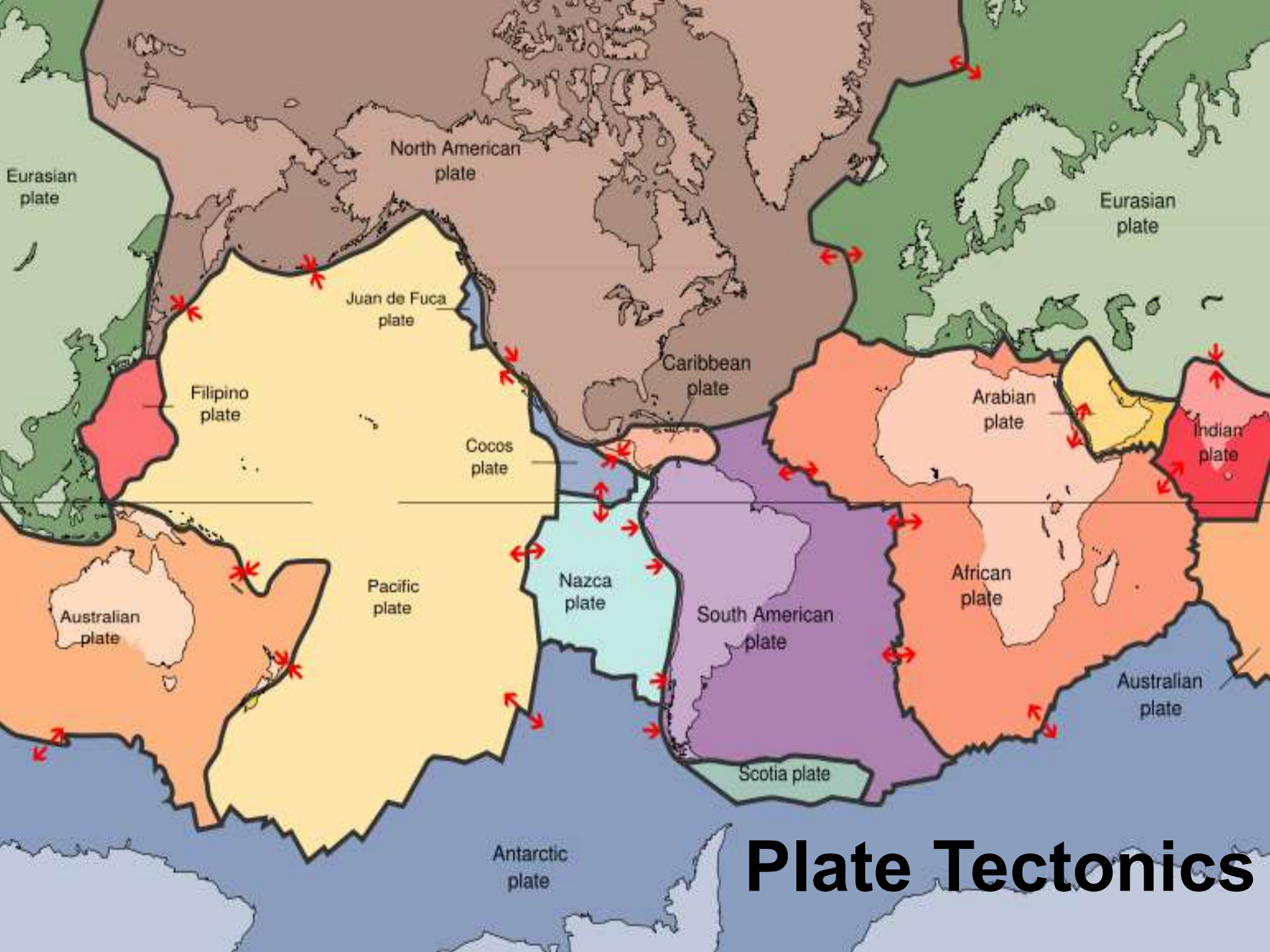




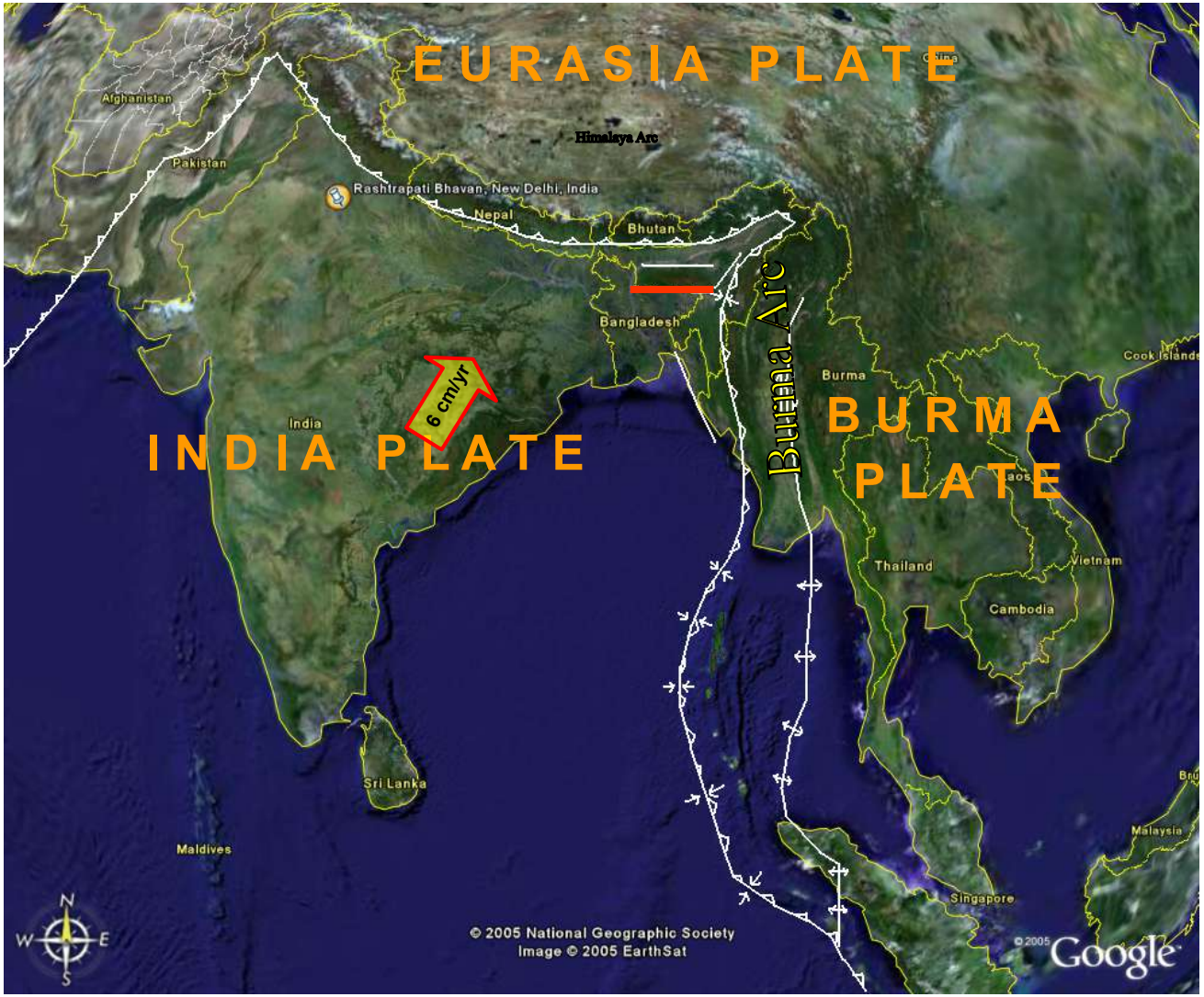
ORIGINATION OF HIMALAYAS AND EARTHQUAKES IN THE REGION

- Himalaya is the young mountainous terrain
- The region is still active in term of vertical and horizontal movement
- Such movement accumulate energy along plate boundary and fault lines




Eurasian plate
North American plate
Eurasian plate
Juan de Fuca plate
Caribbean plate
Filipino plate
Arabian plate
Indian plate
Cocos plate
Pacific plate
Nazca plate
African plate
South American plate
Australian plate
Australian plate
Scotia plate
Antarctic plate
Plate Tectonics

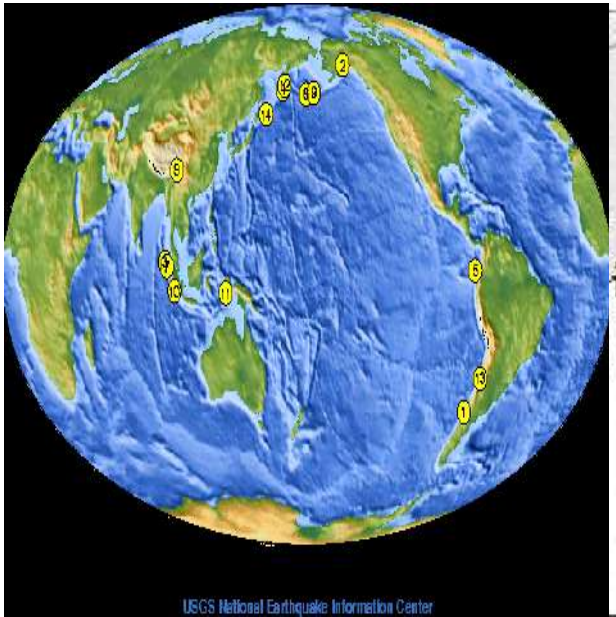
Tectonic setup of Bangladesh

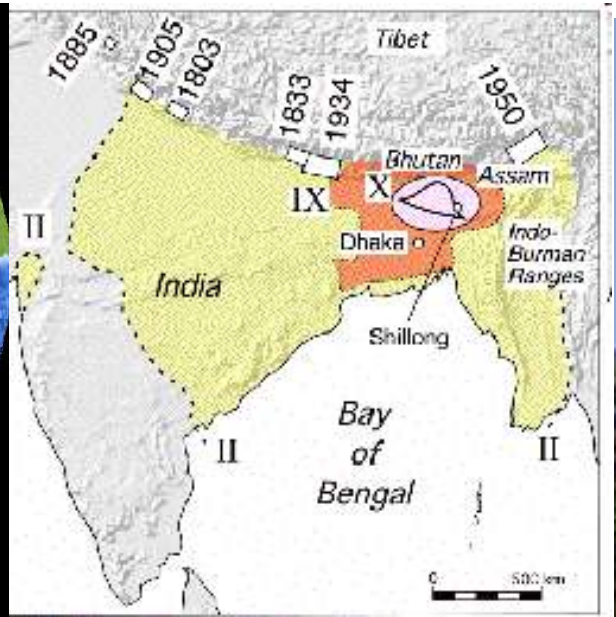


What is Earthquake

A sudden movement of the earth's crust caused by the release of stress accumulated along *plate boundary, geologic faults or by volcanic activity*

Chile 1960 plate boundary EQ, Tohoku earthquake, 2011





What is an Earthquake ?

The Source

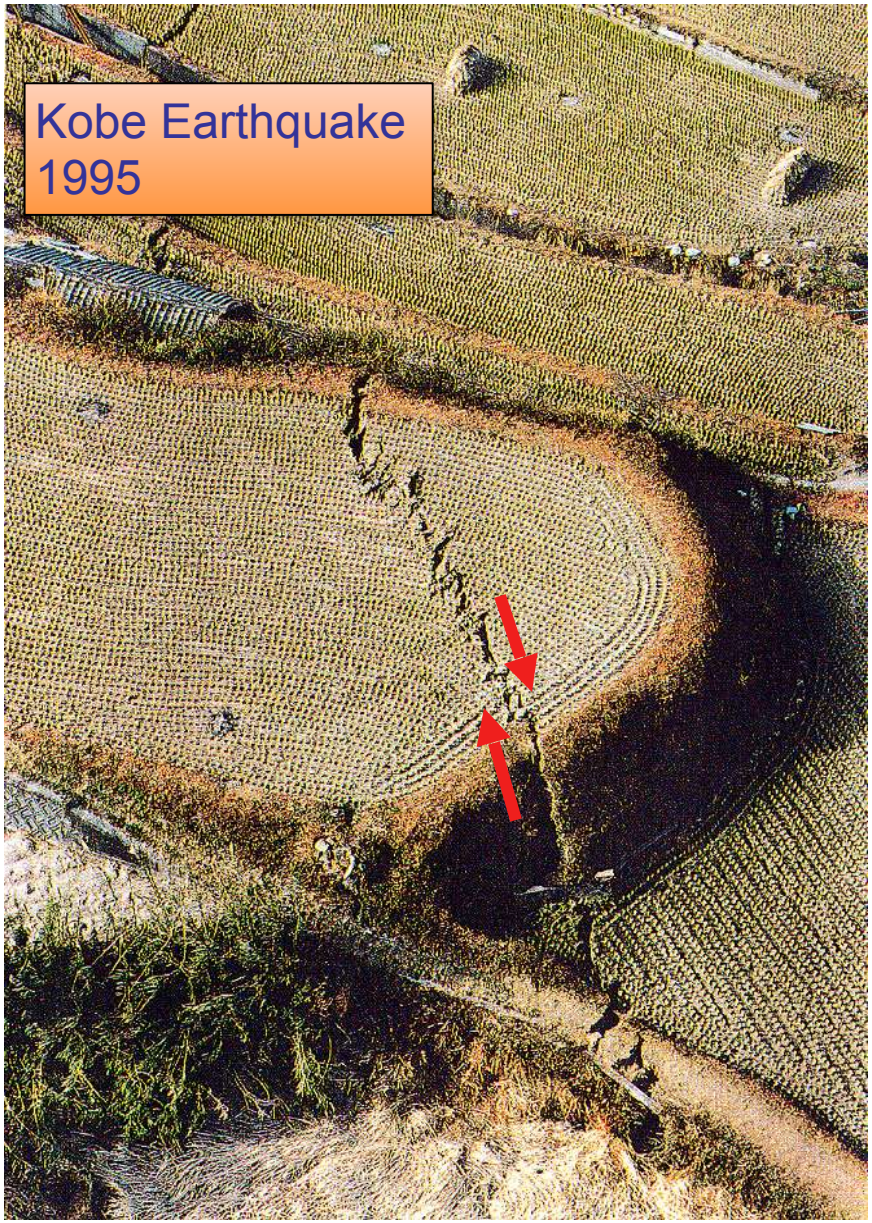
Fault and Plate mechanisms

The Shaking

Wave propagation

Structures

FAULT



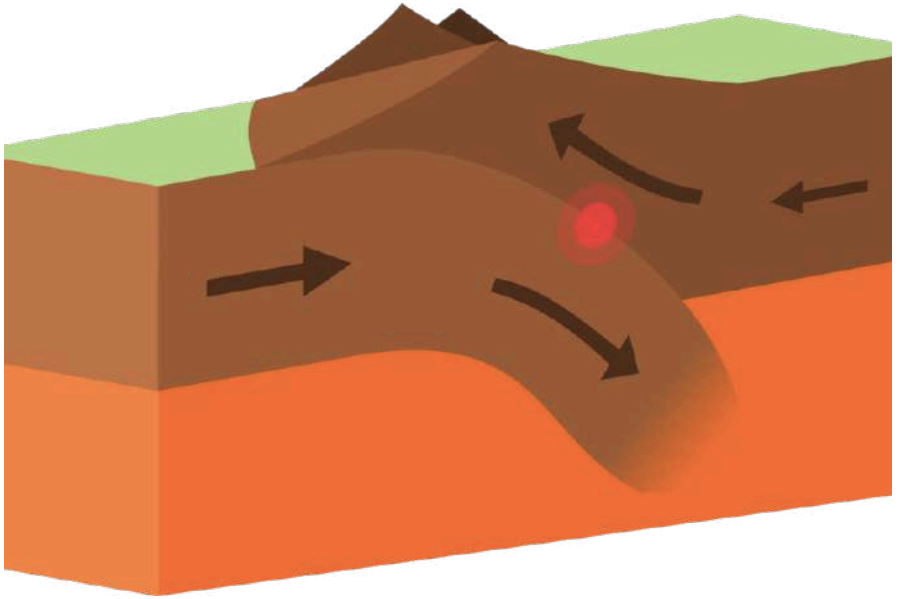
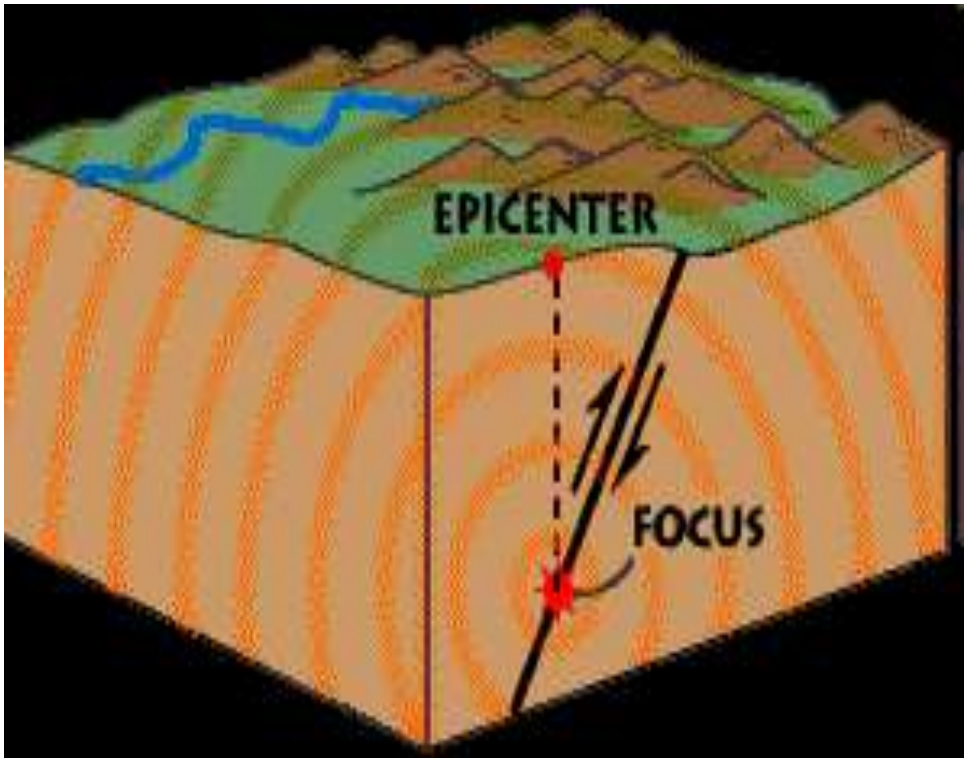


Plate Tectonics

Focus and Epicentre

- The point within the earth where seismic waves originate is called the focus of the Earthquakes.
- The point on the earth's surface directly above the focus is the epicenter



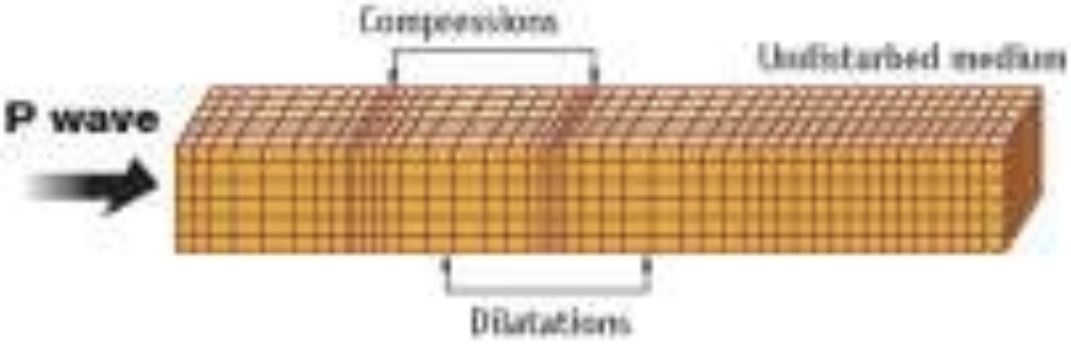
Seismic waves: P and S

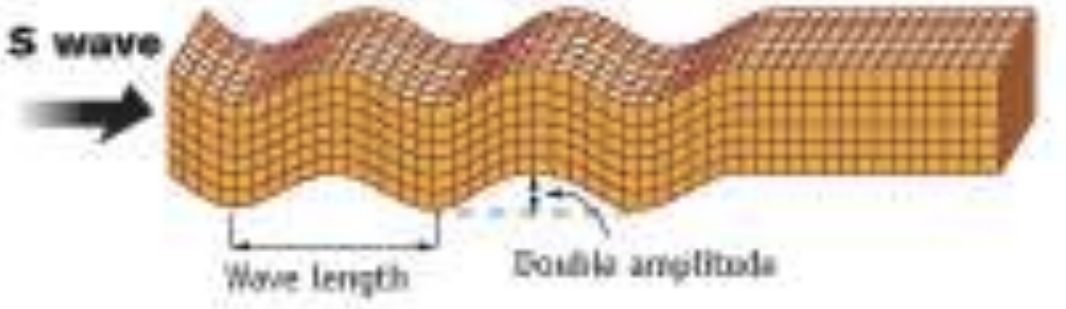
Seismic

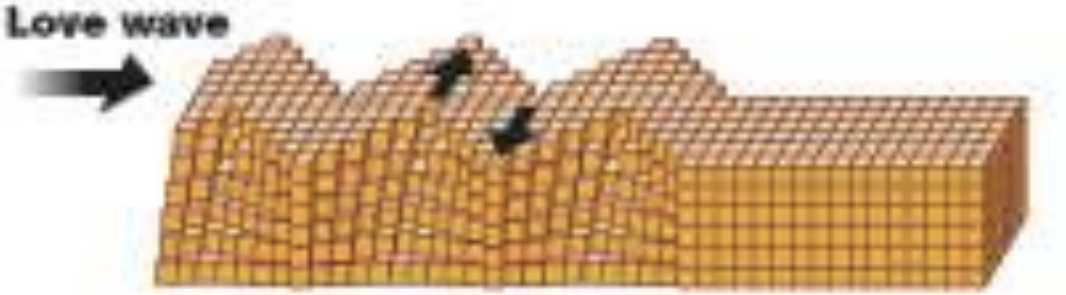
- Body waves

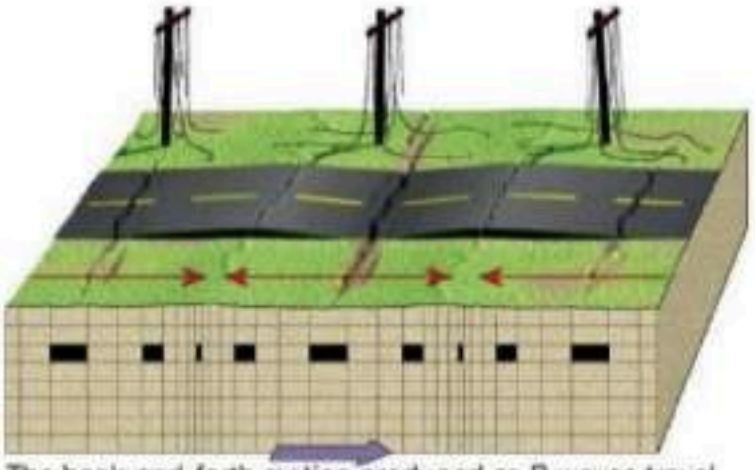
– P-Waves
  - Primary, Compression
  - Particle motion consis
    compression and dilat

– S-Wave
  - Secondary, Shear, Trar
  - Particle motion consists
    transverse motion.

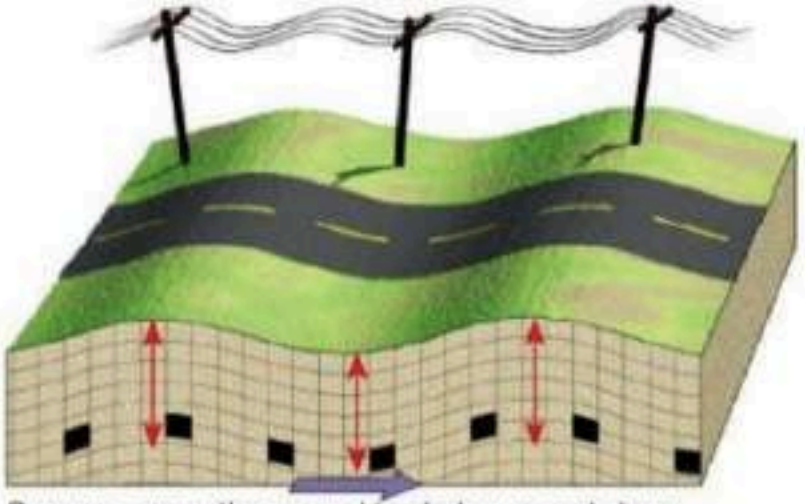




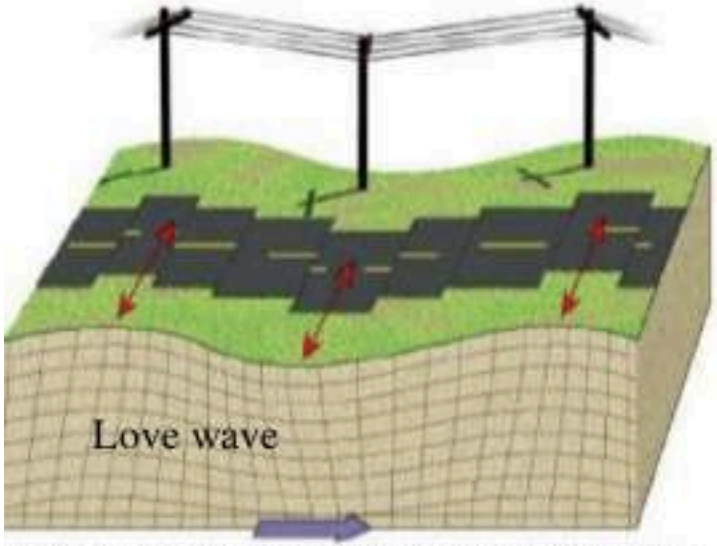




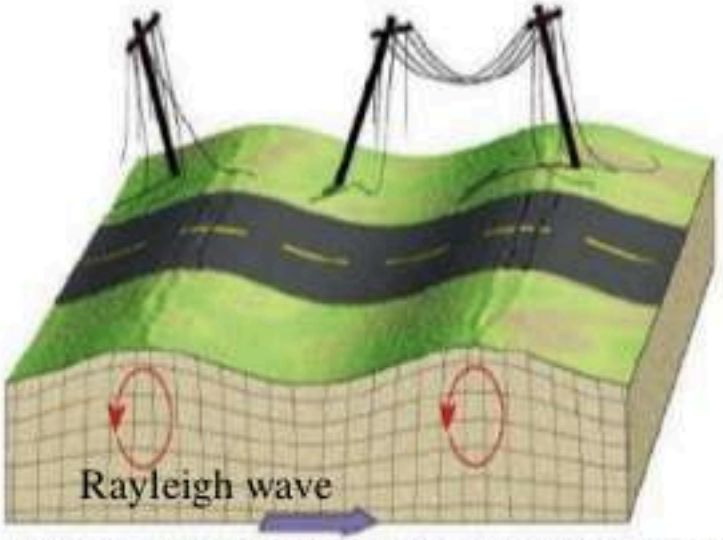
The back-and-forth motion produced as P waves travel along the surface can cause the ground to buckle and fracture.



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.

Seismic waves

- Surface waves

  – Love wave
    - Similar to S-waves

  – Rayleigh wave
    - Surface ripples
    - Particle motion consists of elliptical motions (generally retrograde elliptical as shown in the figure) in the vertical plane and parallel to the direction of propagation.

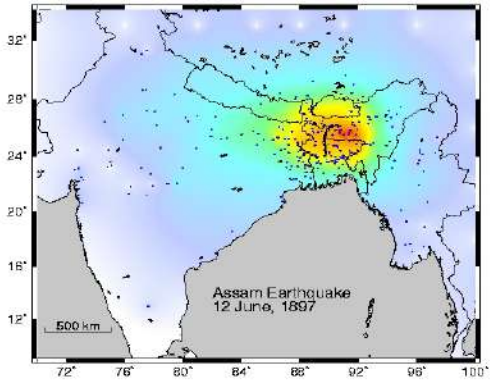
Size of an Earthquake

- 2 ways of measuring size of an earthquake:
  - Magnitude: amount of energy released - "Small earthquakes make small waves, big earthquakes make big waves"
  - Intensity: amount of damage, reaction of people

Intensity of an Earthquake

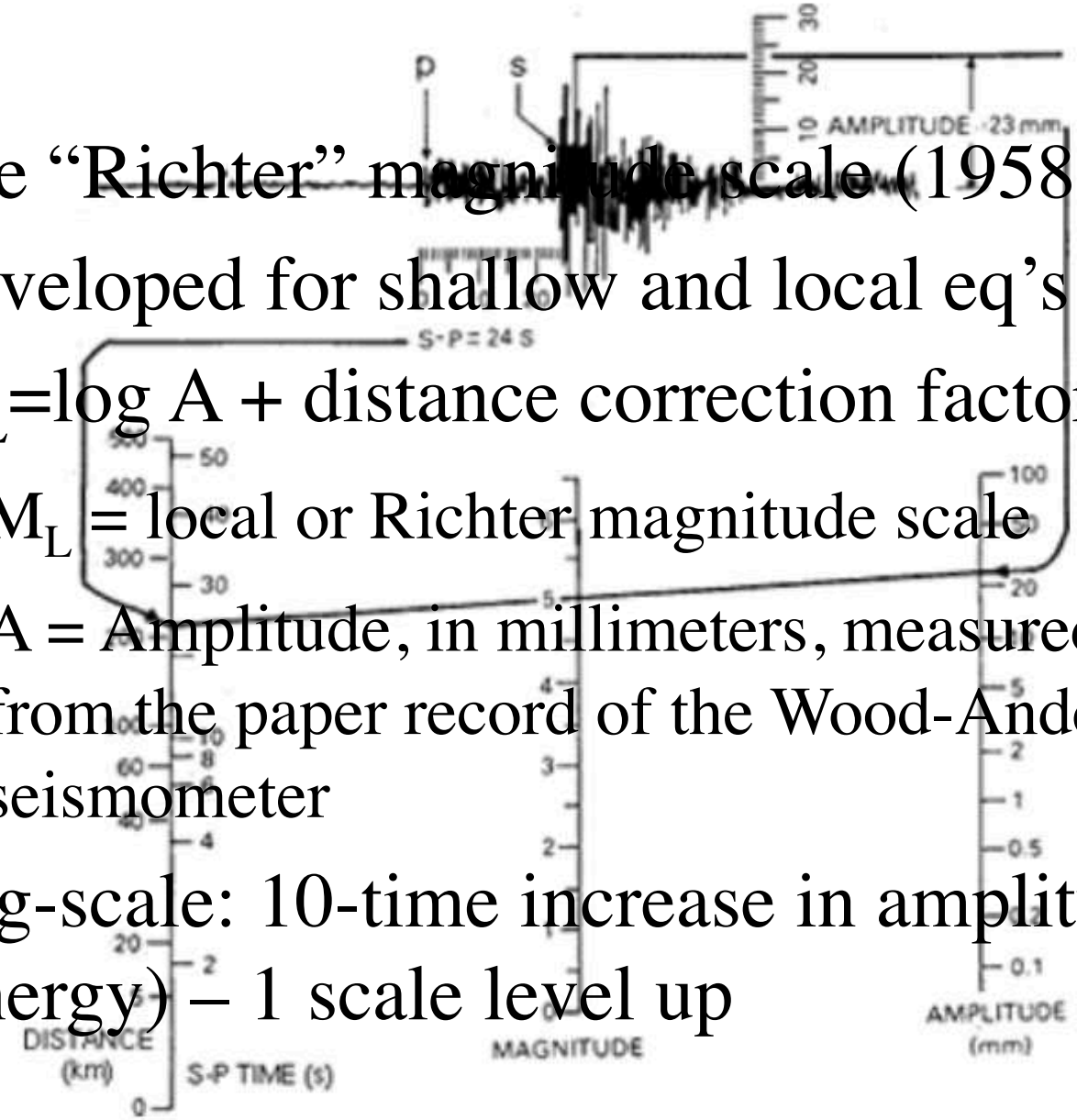
- **Based on:**
  - **Observations of damaged structures**
  - **Presence of secondary effects**
  - **Degree to which quake was felt by individuals**

- **Easy to determine in urban area, difficult in rural area**



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	I-II	IV	V	VI	VII	VIII	IX	X+

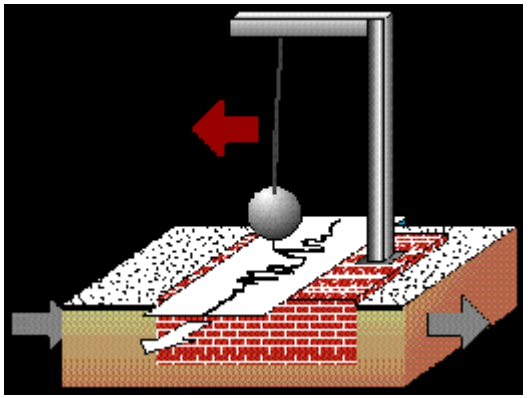
Local Magnitude (ML)



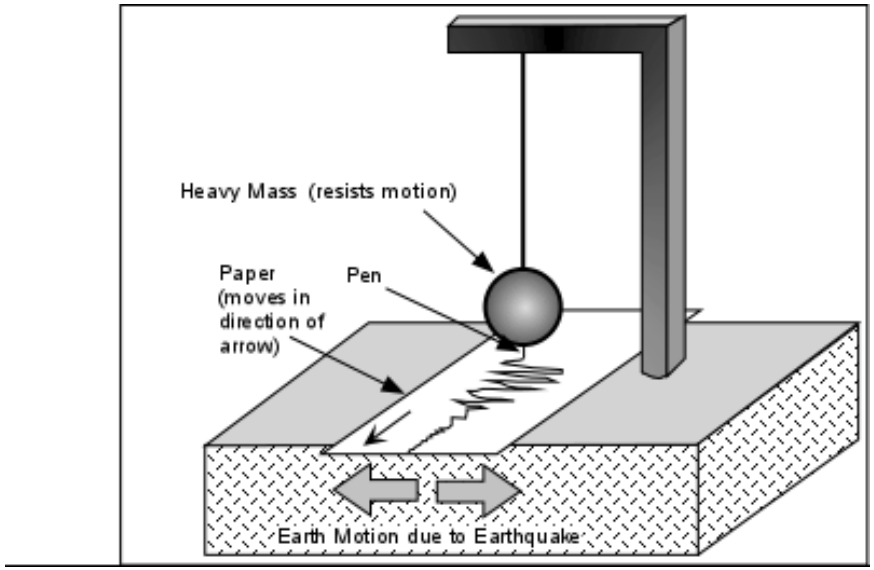
- The "Richter" magnitude scale (1958)
- Developed for shallow and local eq's
- M_L=log A + distance correction factor
  - M_L = local or Richter magnitude scale
  - A = Amplitude, in millimeters, measured directly from the paper record of the Wood-Anderson seismometer
- Log-scale: 10-time increase in amplitude (energy) – 1 scale level up

Seismograph

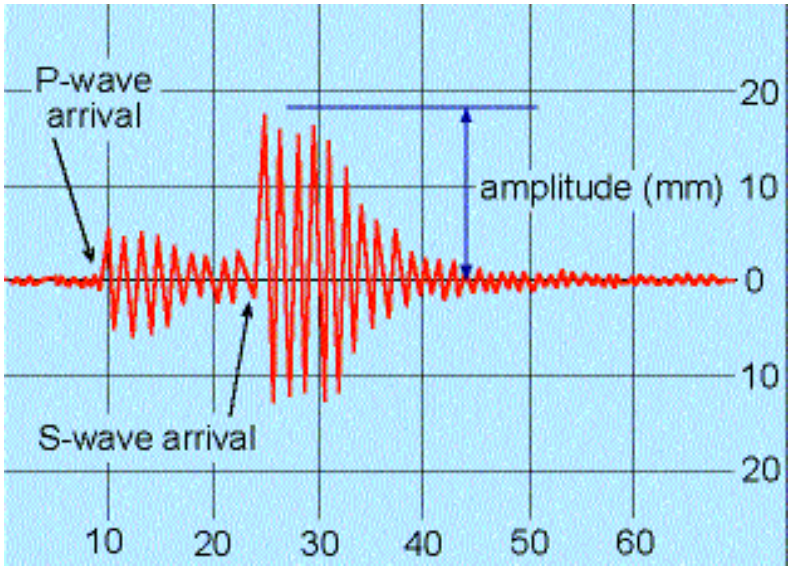
- **Records as a function of time, the motion of the earth's surface**
- **Actual record is called: Seismogram**



Seismograph



Seismogram

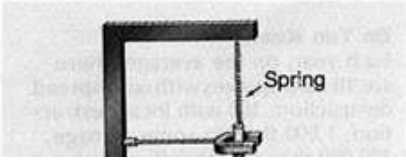


Earthquake Glossary

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z
All Terms
« seismogram
seismology »

seismograph

A seismograph, or seismometer, is an instrument used to detect and record earthquakes. Generally, it consists of a mass attached to a fixed base. During an earthquake, the base moves and the mass does not. The motion of the base with respect to the mass is commonly transformed into an electrical voltage. The electrical voltage is recorded on paper, magnetic tape, or another recording medium. This record is proportional to the motion of the seismometer mass relative to the earth, but it can be mathematically converted to a record of the absolute motion of the ground. **Seismograph** generally refers to the seismometer and its recording device as a single unit.



https://earthquake.usgs.gov/learn/glossary/?term=seismograph

Thank You Very Much