UNIVERSITY OF ZAMBIA

Introduction to Earth Science, Earth's Structure and Plate Tectonics

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GEOLOGY DEPARTMENT

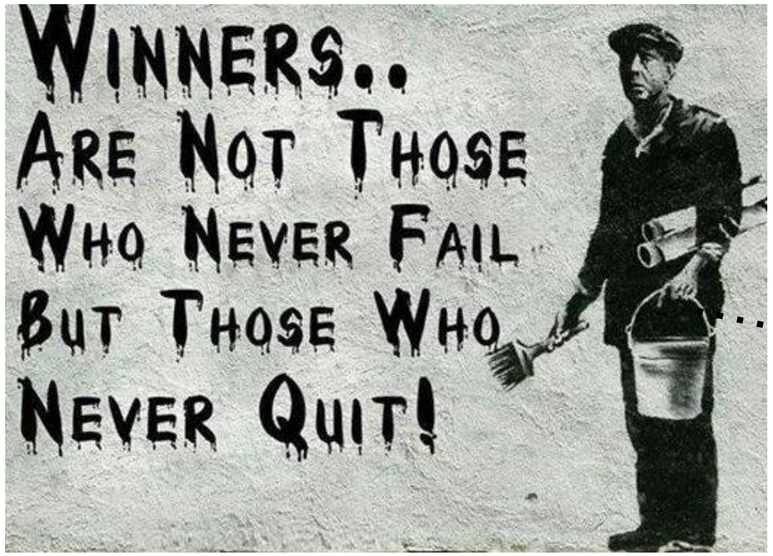
Presentation Outline

PART 1: Introduction to Earth Science

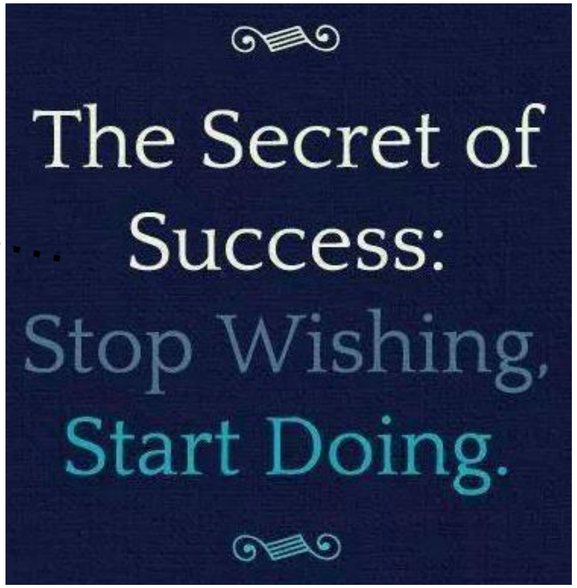
PART 2: Earth's Structure and Plate Tectonics

PART - I

1. INTRODUCTION TO EARTH SCIENCE



……and thus,……



Earth Science

- **Encompasses all sciences** that seek to understand:
  - Earth
  - Earth's neighbours in space.
- Includes;
  - **Geology** – study of Earth
  - **Oceanography** – study of oceans
  - **Meteorology** – study of atmosphere & processes that produce weather
  - **Astronomy** – study of universe

Earth Science.....contd.

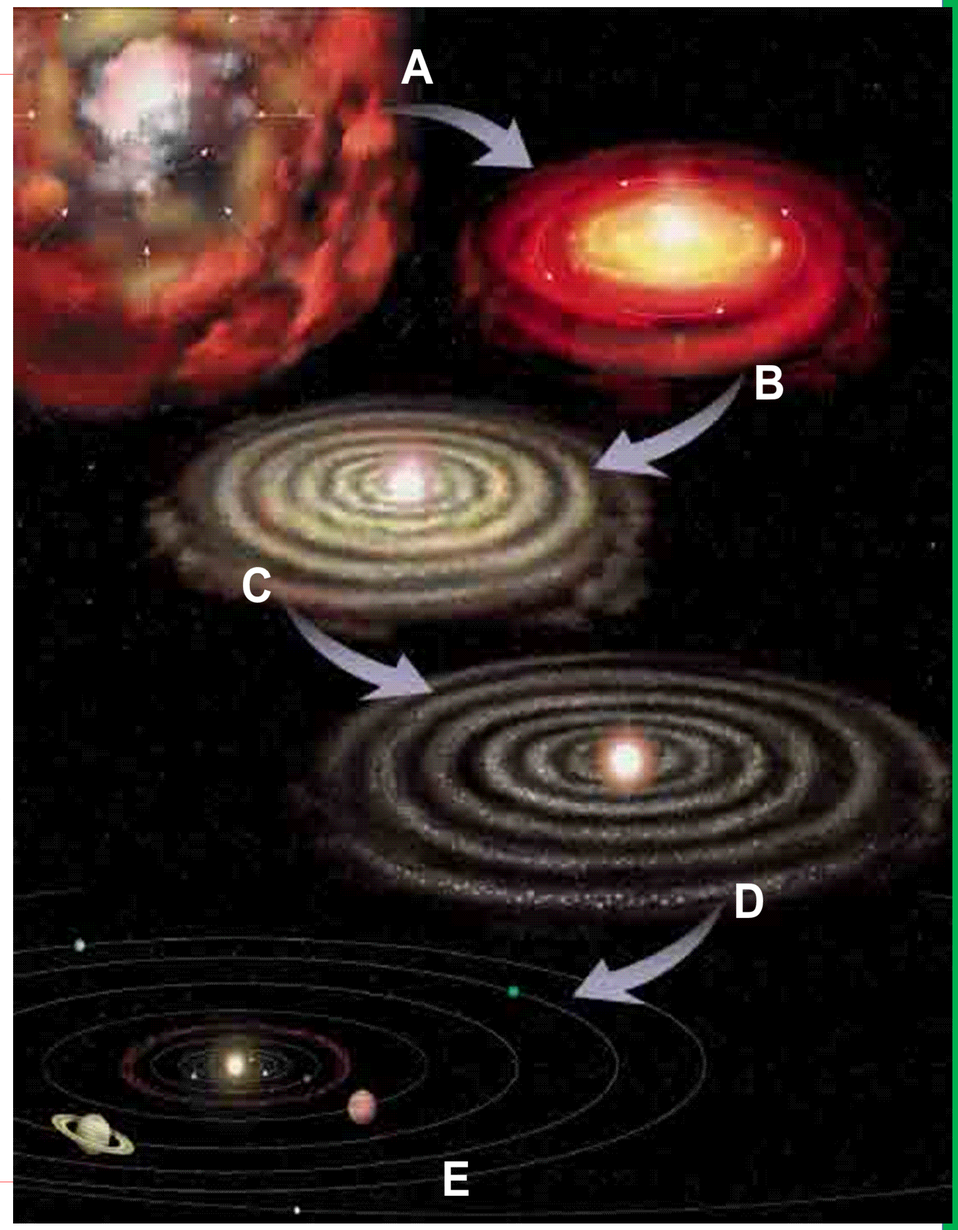
- In the formation of Earth, most researchers have concluded that
  - earth and other planets formed at essentially same time,

    but……

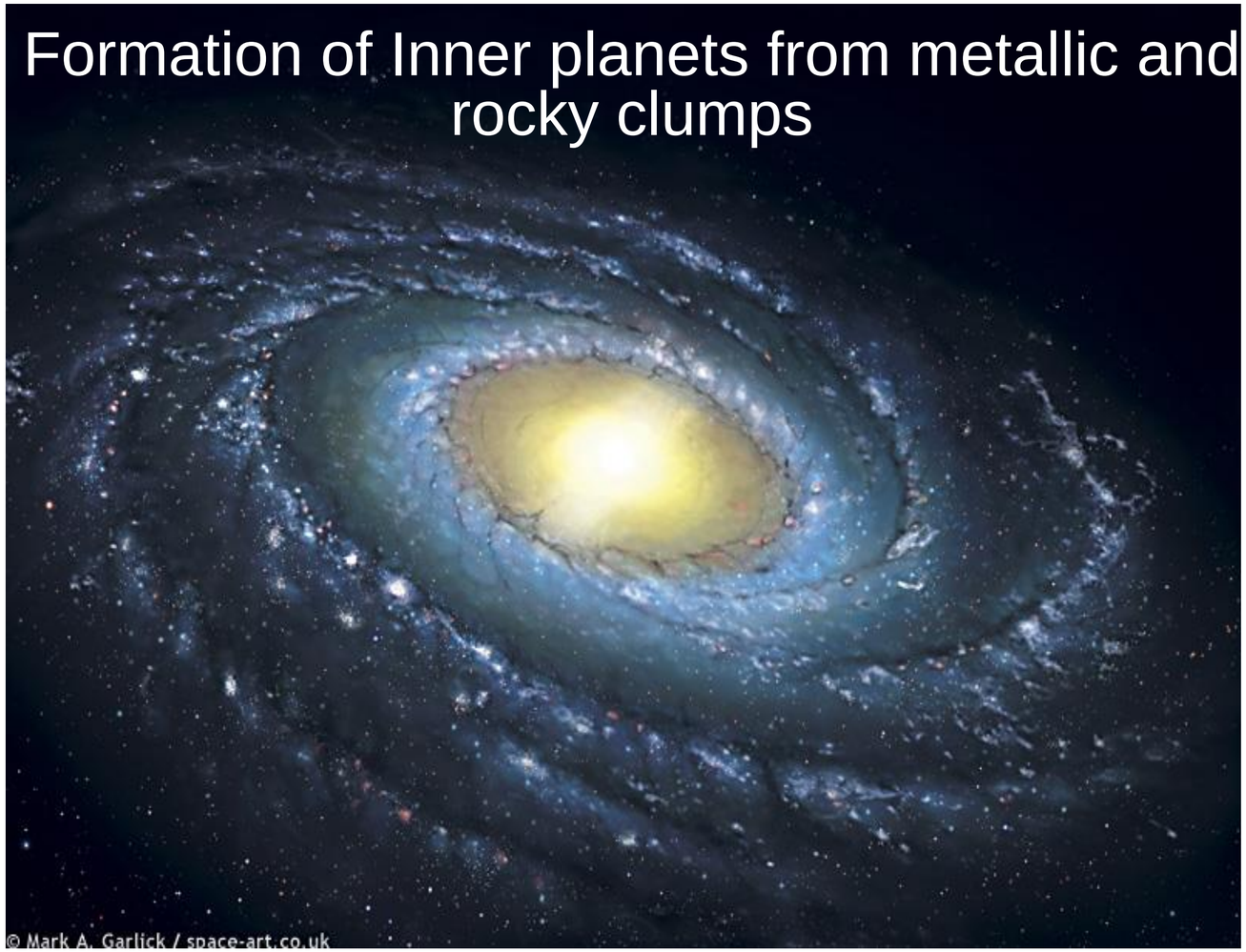
Formation of the Earth

….according to NEBULAR Hypothesis:

- Solar system evolved from an enormous rotating cloud called **solar nebula** – **composed** mostly **of hydrogen & helium**, and that;
  - About 5 billion years ago, nebula began to contract (**A**)
  - nebula assumed a flat, disk shape (B)
- Inner planets began to form from metallic and rocky clumps (**C & D**).
- Larger outer planets began forming from fragments with a high percentage of ice (**E**).



Formation of the Earth.....contd.

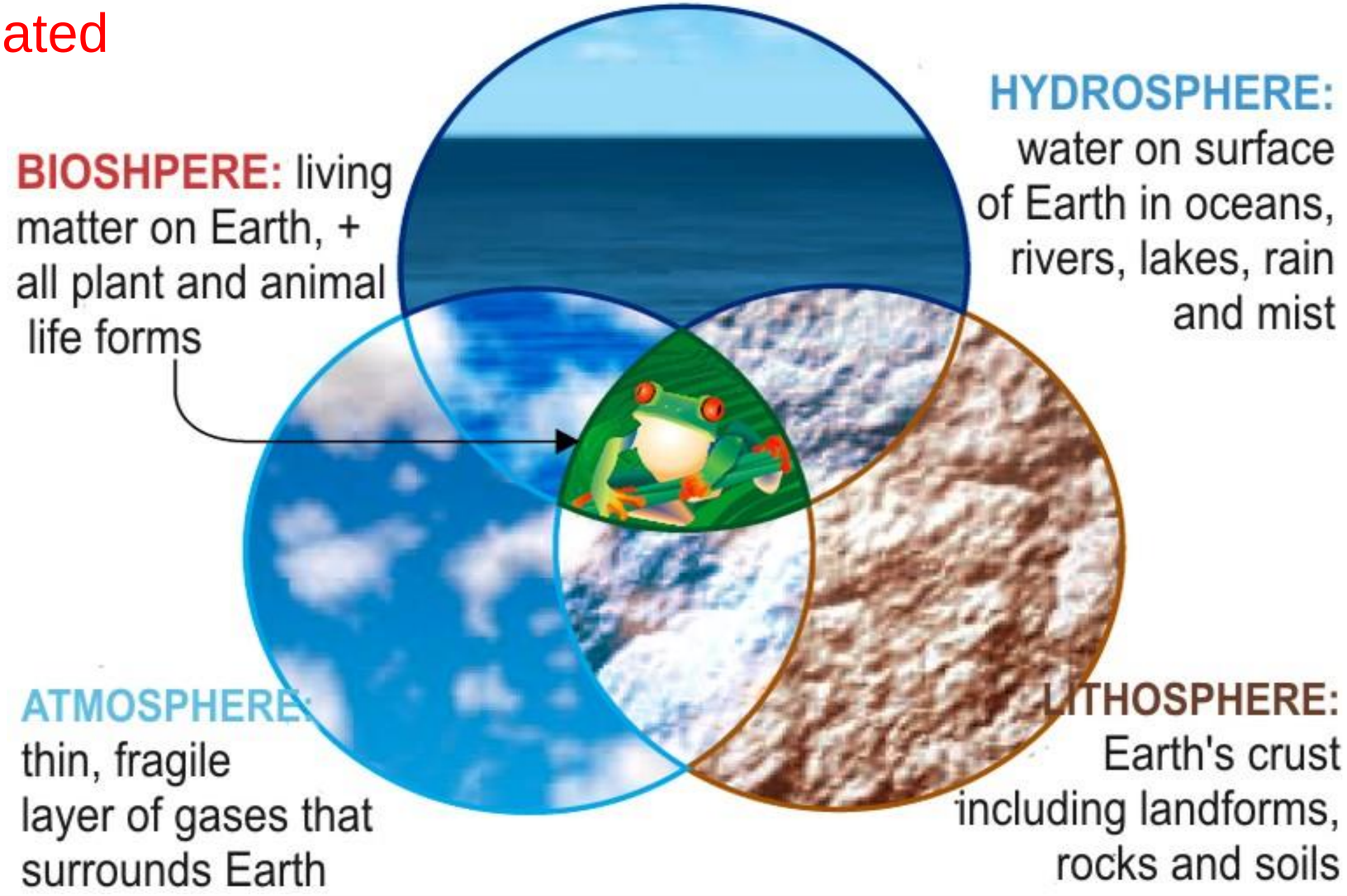


Formation of Earth Layers

- As **Earth formed**, decay of radioactive elements and heat from high-velocity impacts **caused temperature to increase**, resulting in:
  - **Lighter rocky components floating outward**, toward earth's surface.
  - **Gaseous material escaping from Earth's interior** to produce primitive atmosphere.

The Earth's Major Spheres

Foregoing process created FOUR major Earth Spheres:



The Earth's Major Spheres.....contd.

The 'Spheres' are closely connected, such that:

- changes in one sphere often generate chain reactions, and;
  - results in changes in others

The Earth's Major Spheres.....contd.

Examples of interactions **between spheres**:

- Deforestation ⇒ rain ⇒ erosion *(Bio – Hydro – Geo);*
- Soil loading by erosion in water ⇒ increased turbidity *(Geo – Hydro);*
- Turbidity ⇒ impacts water plants/animals *(Hydro – Bio).*

Drivers of Earth Systems' Processes

Earth's System's processes are driven by:

- Sun's heat, which propels;
  - ALL Earth's **external processes** – weather, ocean circulation & erosional processes.
- Heat from Earth's interior, which powers;
  - **Earth's Internal processes,** including volcanoes, earthquakes and mountain building.

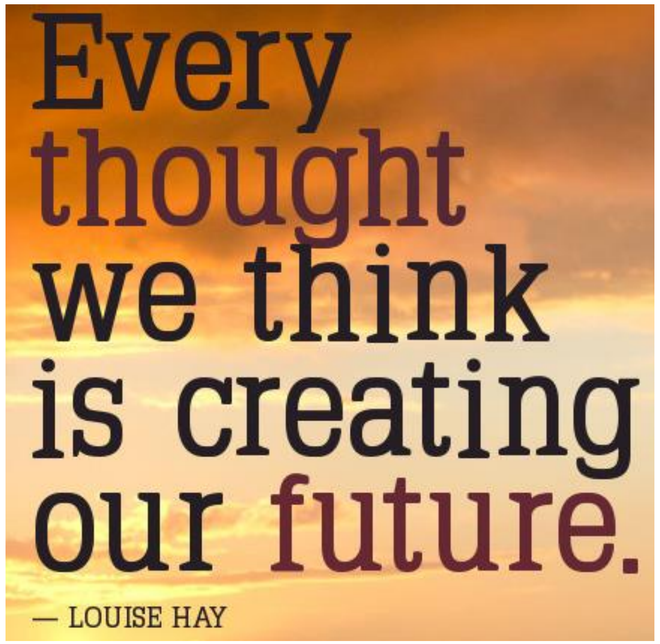
Drivers of Earth Systems' Processes…..contd.

So, the **scientific study** of the Earth's Systems Processes is called **GEOLOGY**, and it included:

- Origin of the Earth
- Materials of which the earth is made
- Processes acting upon the Earth's materials
- Structure of, and how **Earth's materials, processes** + **organisms** have changed over time.

PART - II

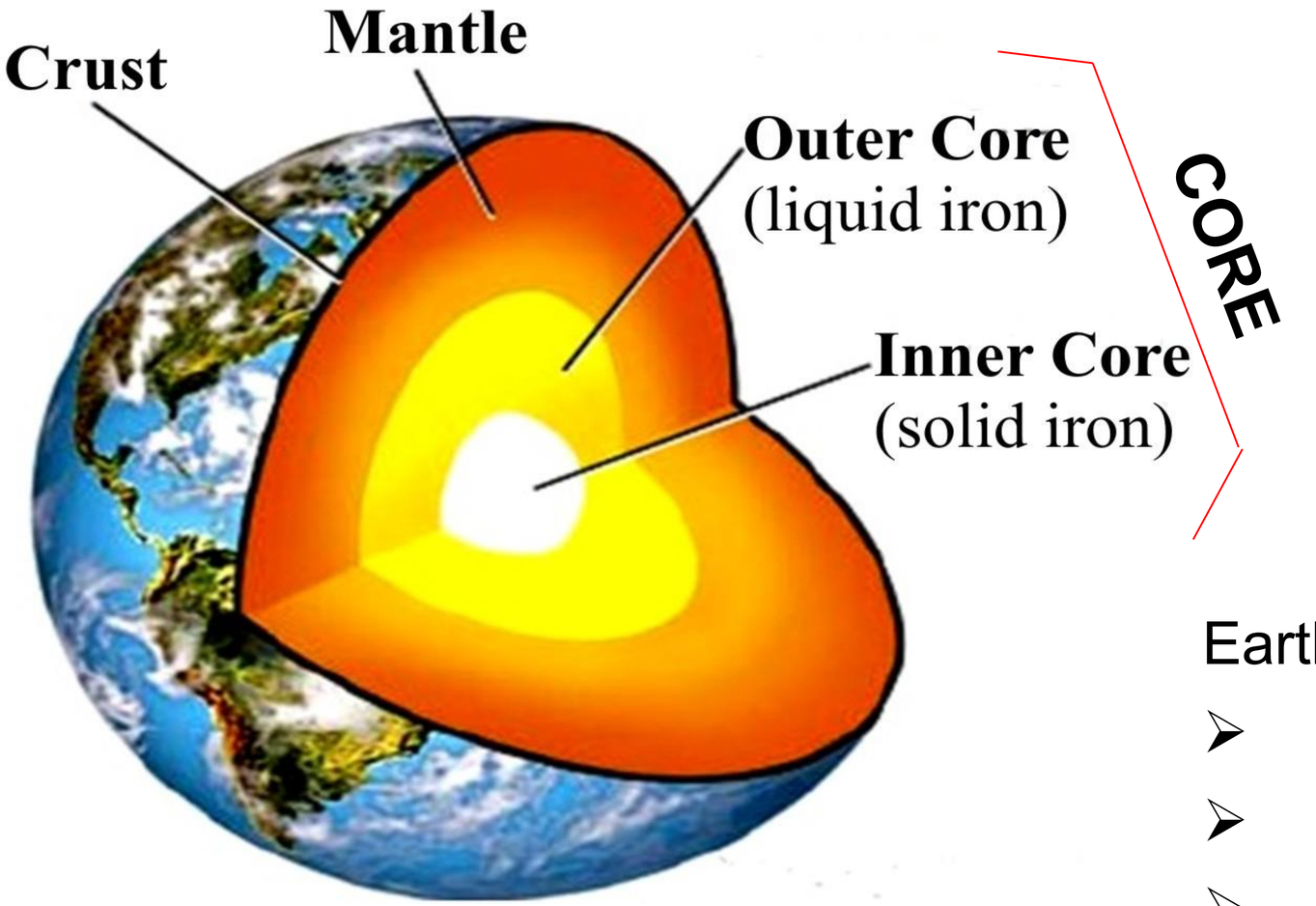
2. EARTH'S STRUCTURE AND PLATE TECTONICS



So, what other people think of you must be none of your business.

2.1 Earth's Structure

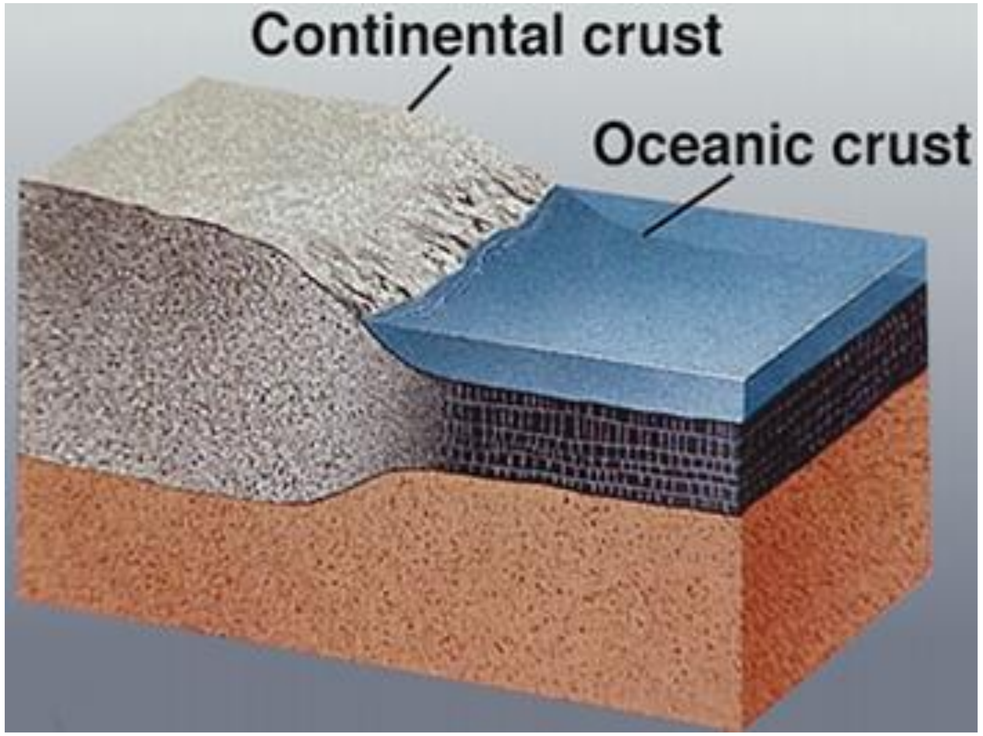
Earth is divided into 3 MAIN layers:

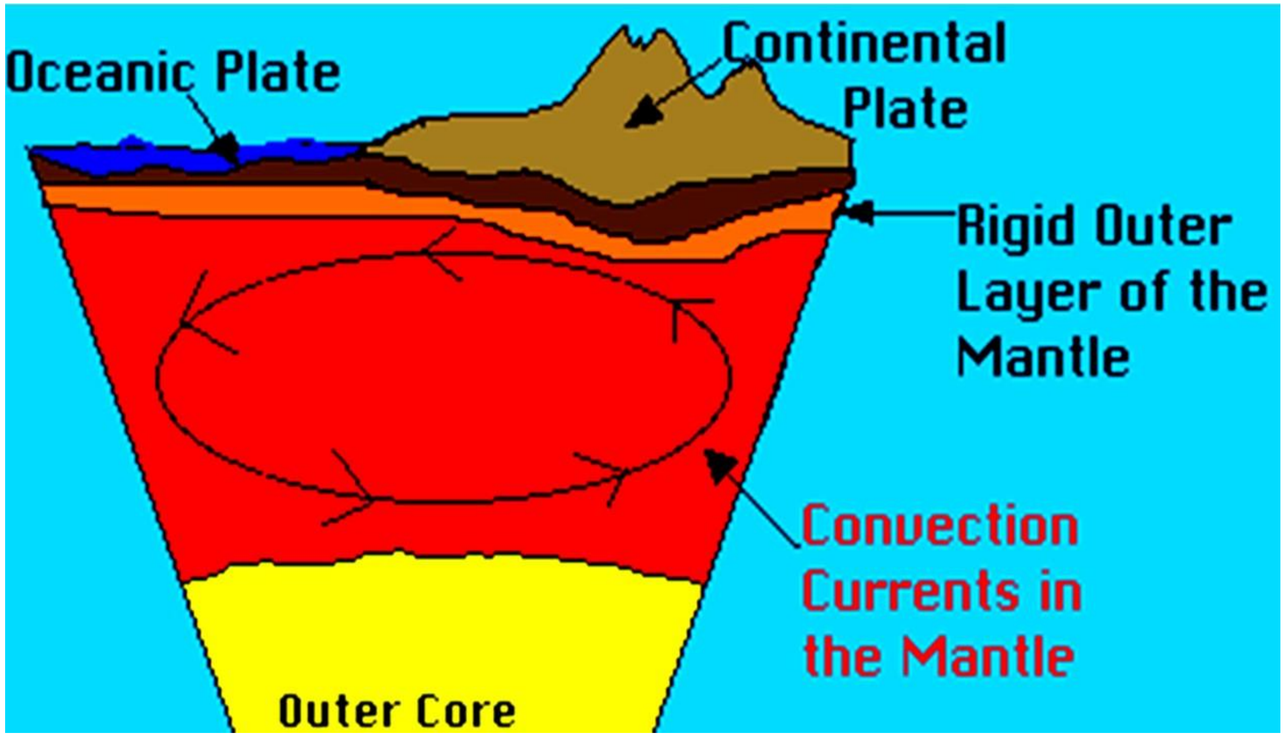


Earth's layers are similar to an egg's…..

- Shell → CRUST
- Egg white → MANTLE
- Yolk → CORE

2.1 Earth's Structure…..contd.





Crust:

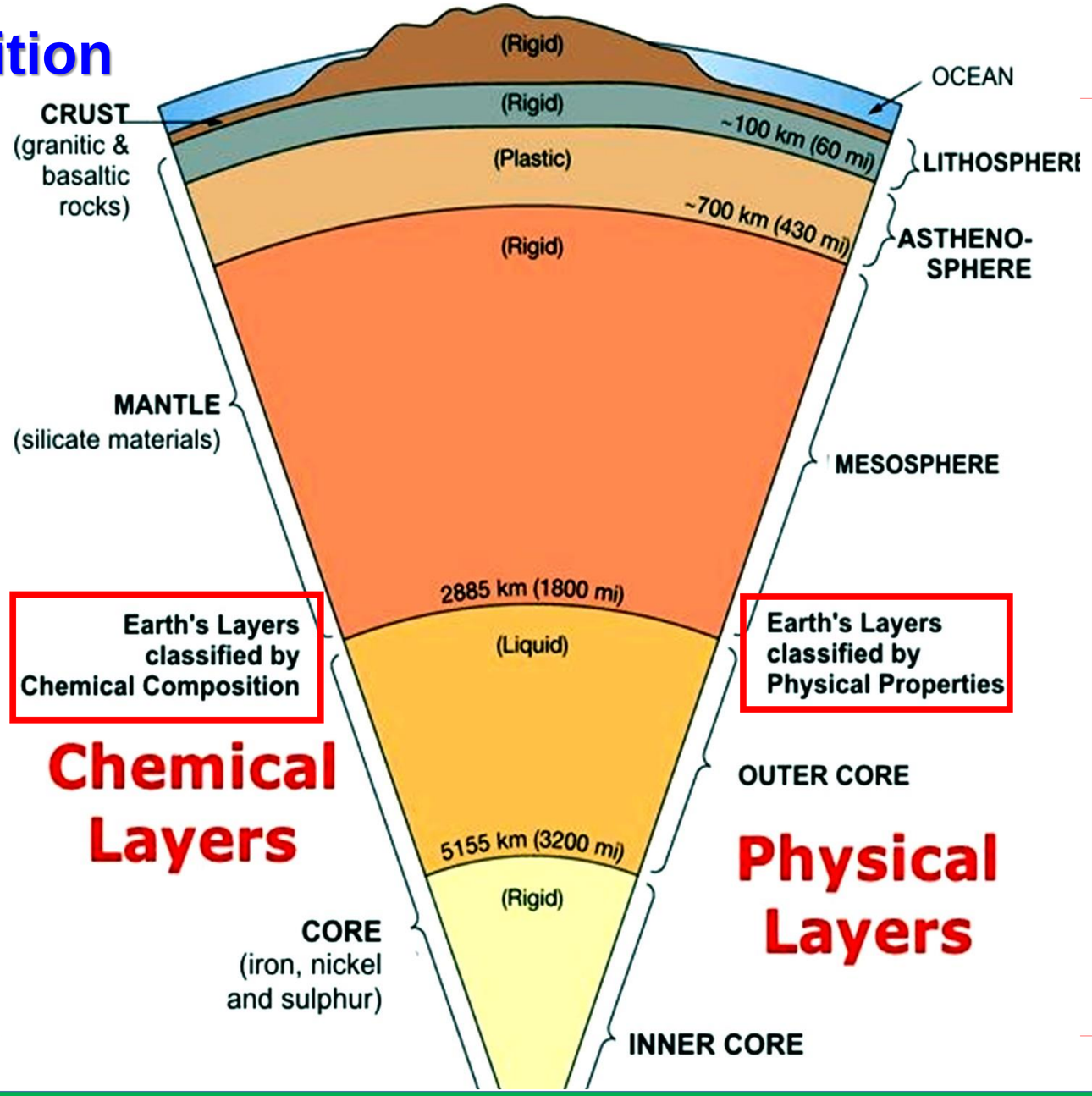
- The lightest of three layers
- extends 5-8 km beneath oceans, & 20-70 km beneath continents.

Mantle:

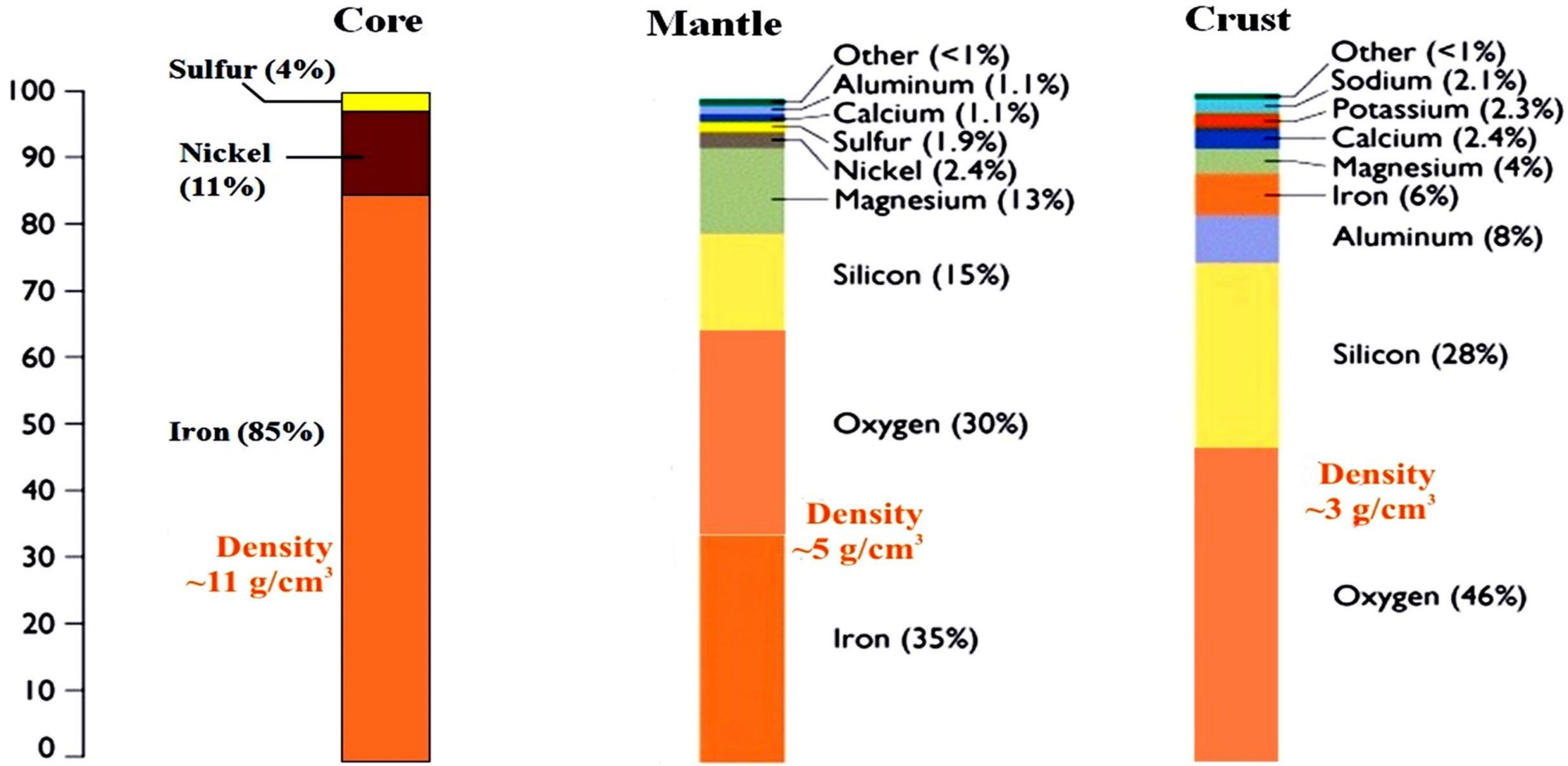
- Layer above Core
- is nearly 2900 km thick
- has convection currents….

2.1 Earth's Structure – Composition

Earth consists of a series of concentric layers, which differ in **CHEMICAL** & **PHYSICAL** Properties:

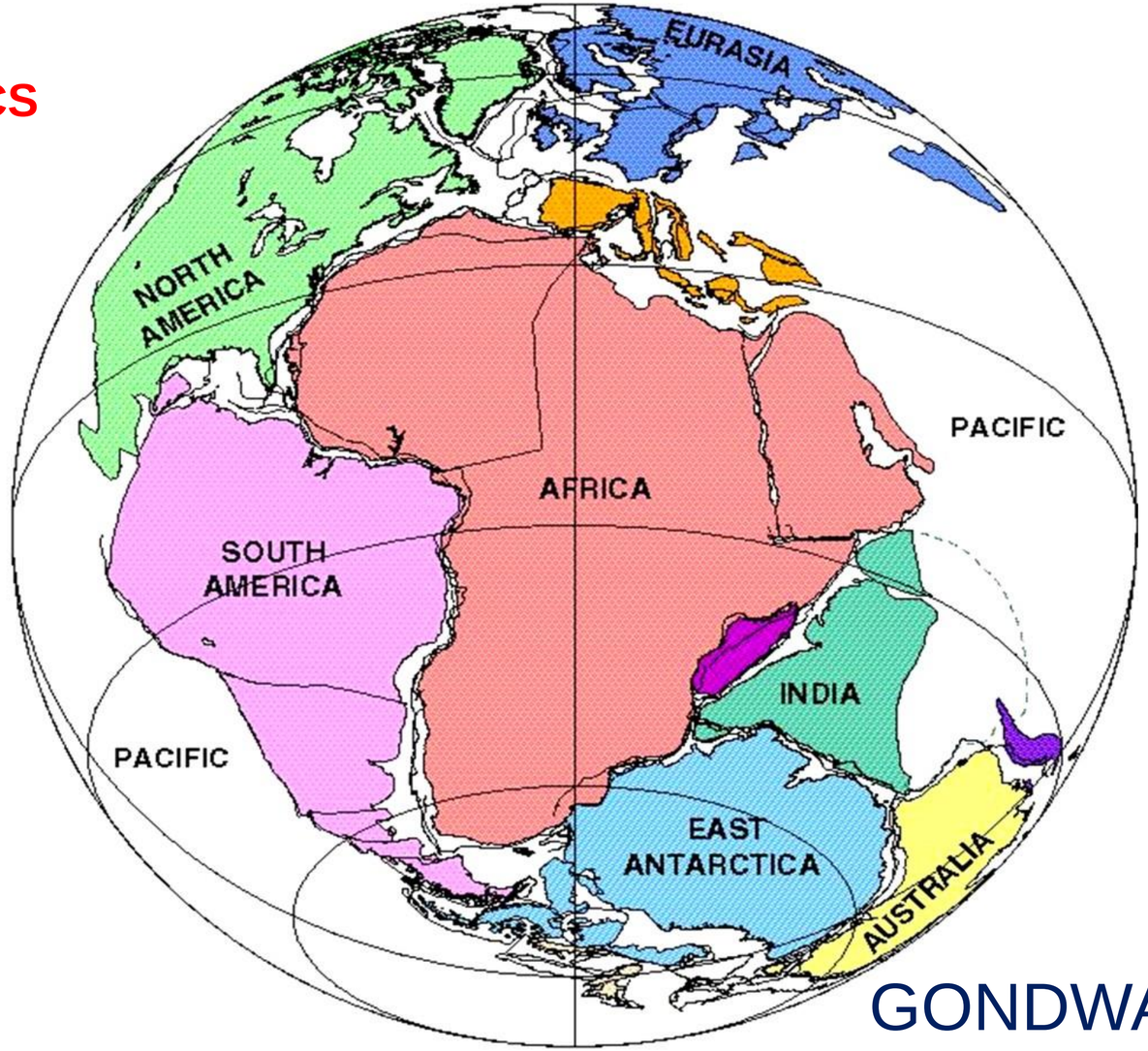


2.1 Earth's Structure – Composition…..contd.



2.2 Plate Tectonics

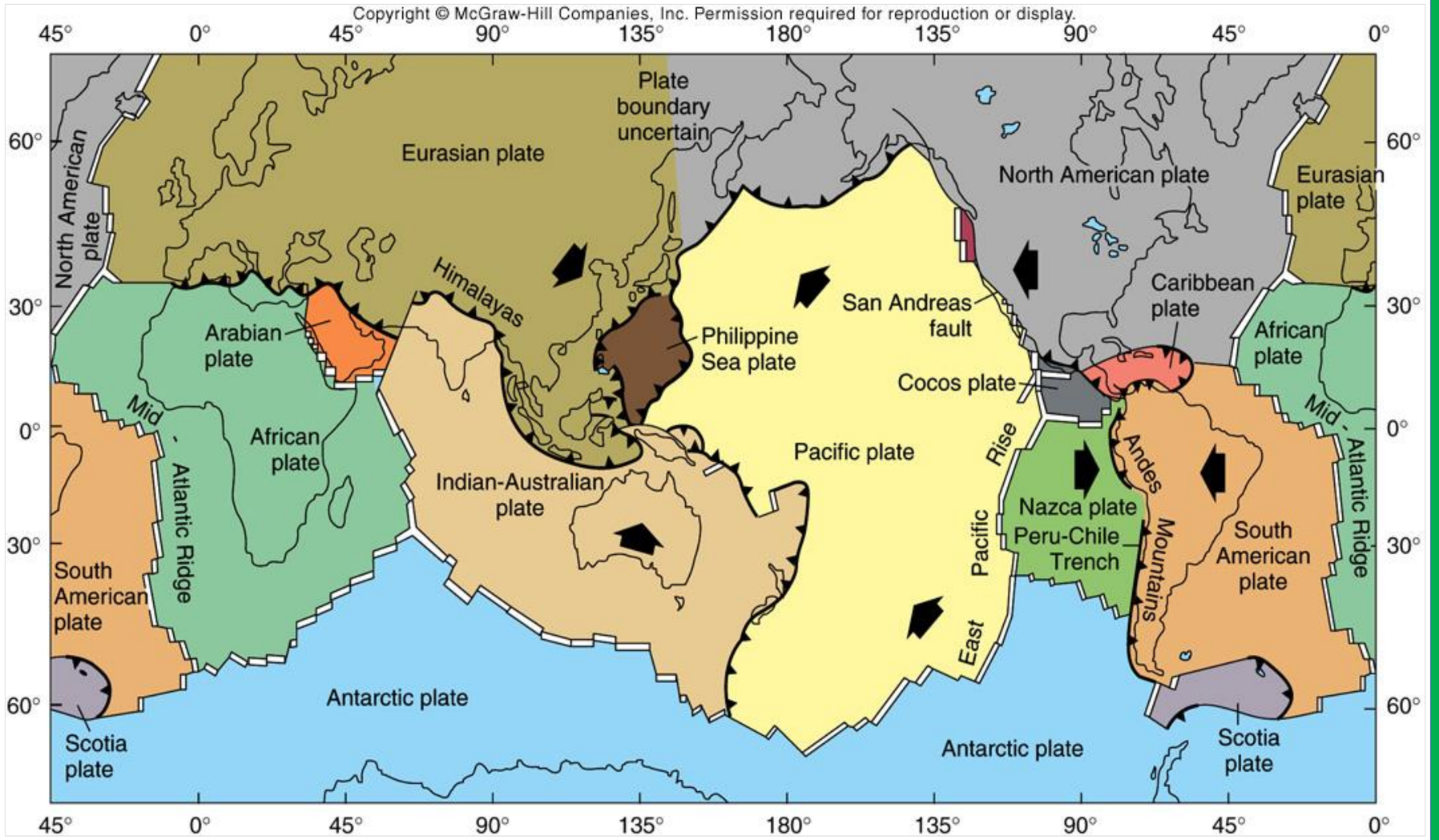
PLATE TECTONICS



GONDWANA – Super Continent

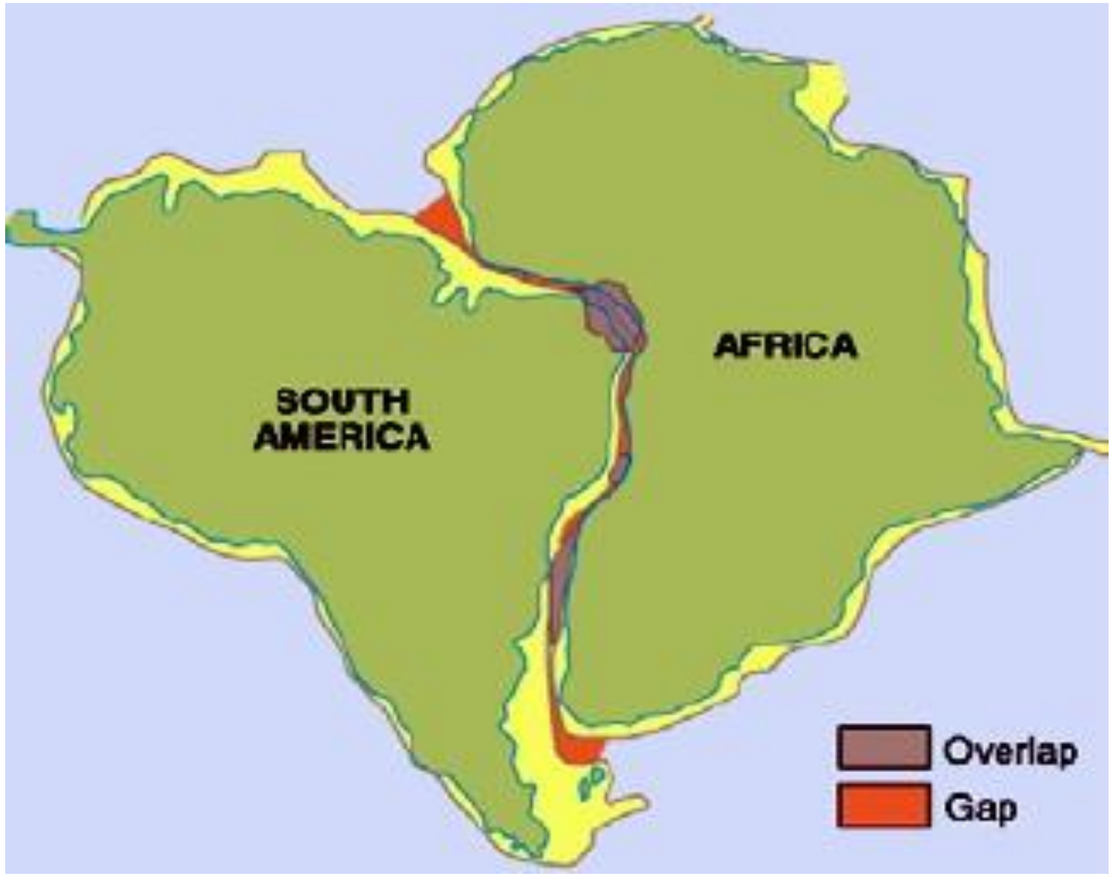
2.2 Plate Tectonics…..contd.

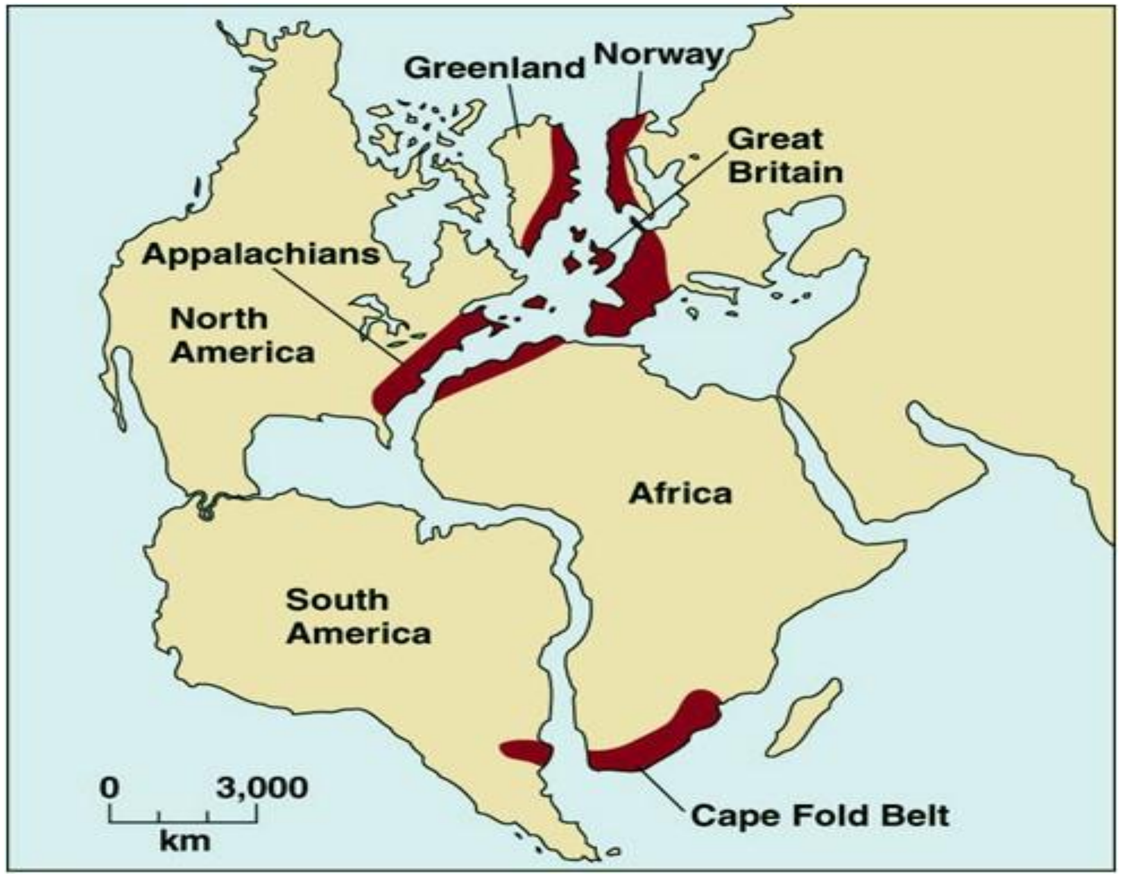
Gondwana break-up resulted in several large plates in Earth's crust that now fit together like a jigsaw puzzle.



2.2.1 Evidence for Gondwana's Break-up

Evidence for:

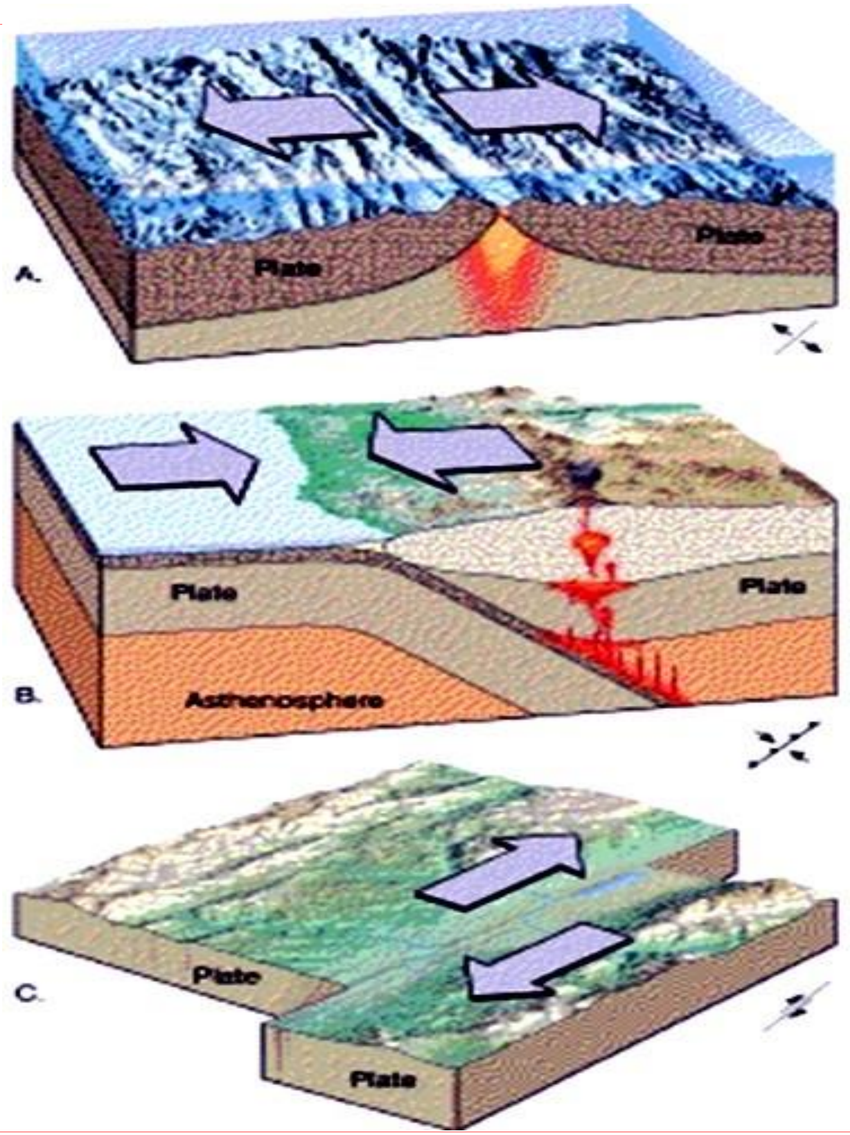




2.2.2 Tectonic Plate Boundaries

There are 3 major types of plate boundaries:

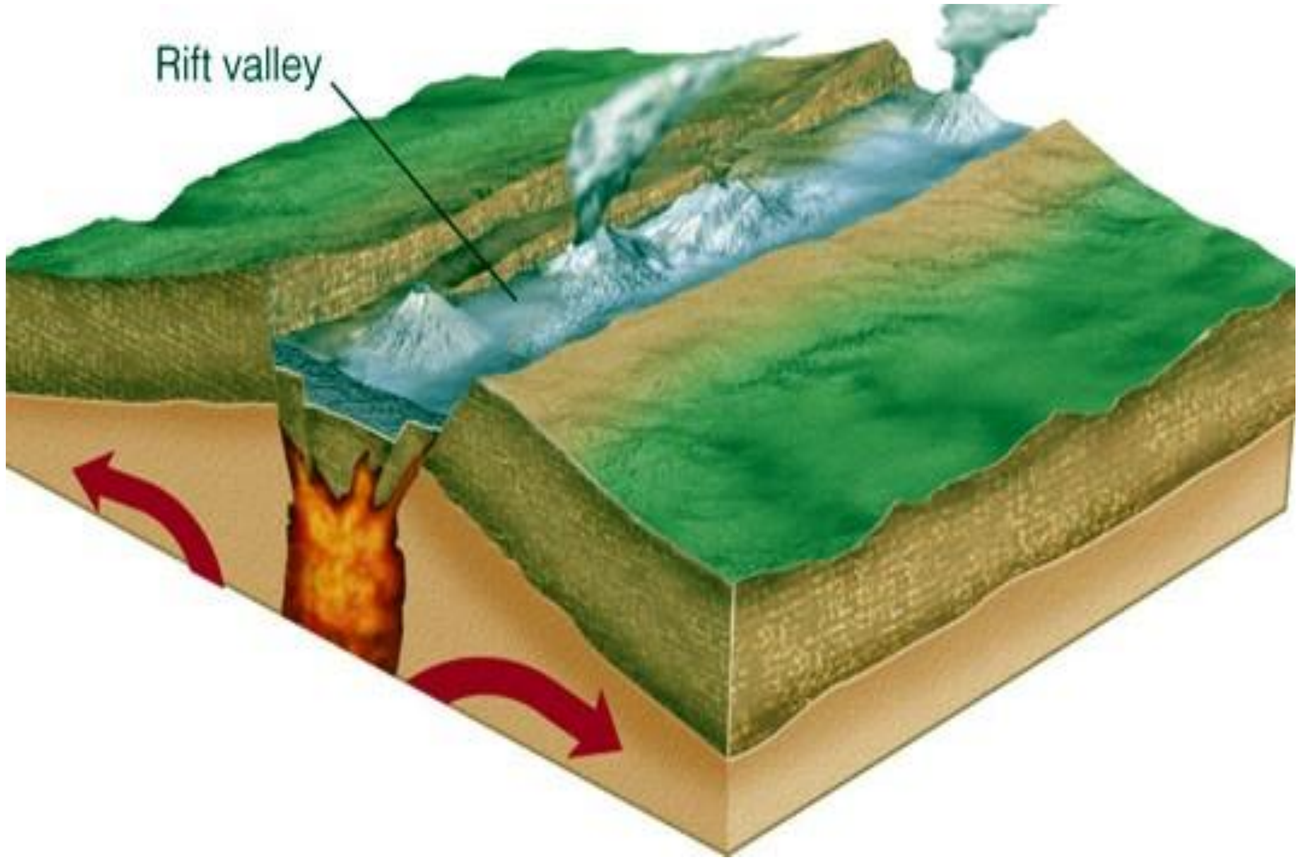
1. ***Divergent*** **–** plates move away from each other (tension)
2. ***Convergent*** – plates move towards each other (compression)
3. ***Transform*** **–** plates grind horizontally against one another (strike-slip motion)



2.2.2.1 Divergent (Extensional) Boundaries

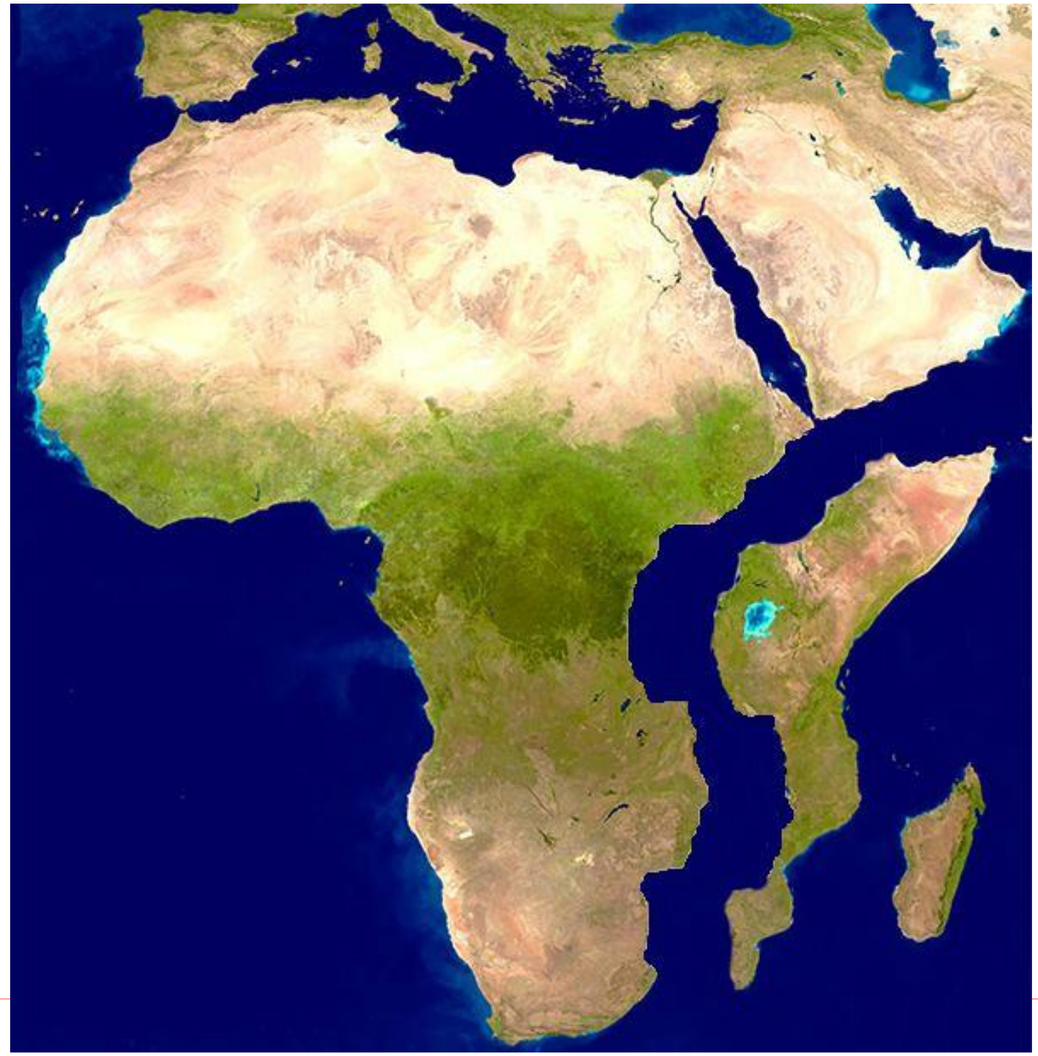
Resulted in formation of such features as Rift Valleys, where:

- magma typically intrudes into the fractures & flows onto valley floor….

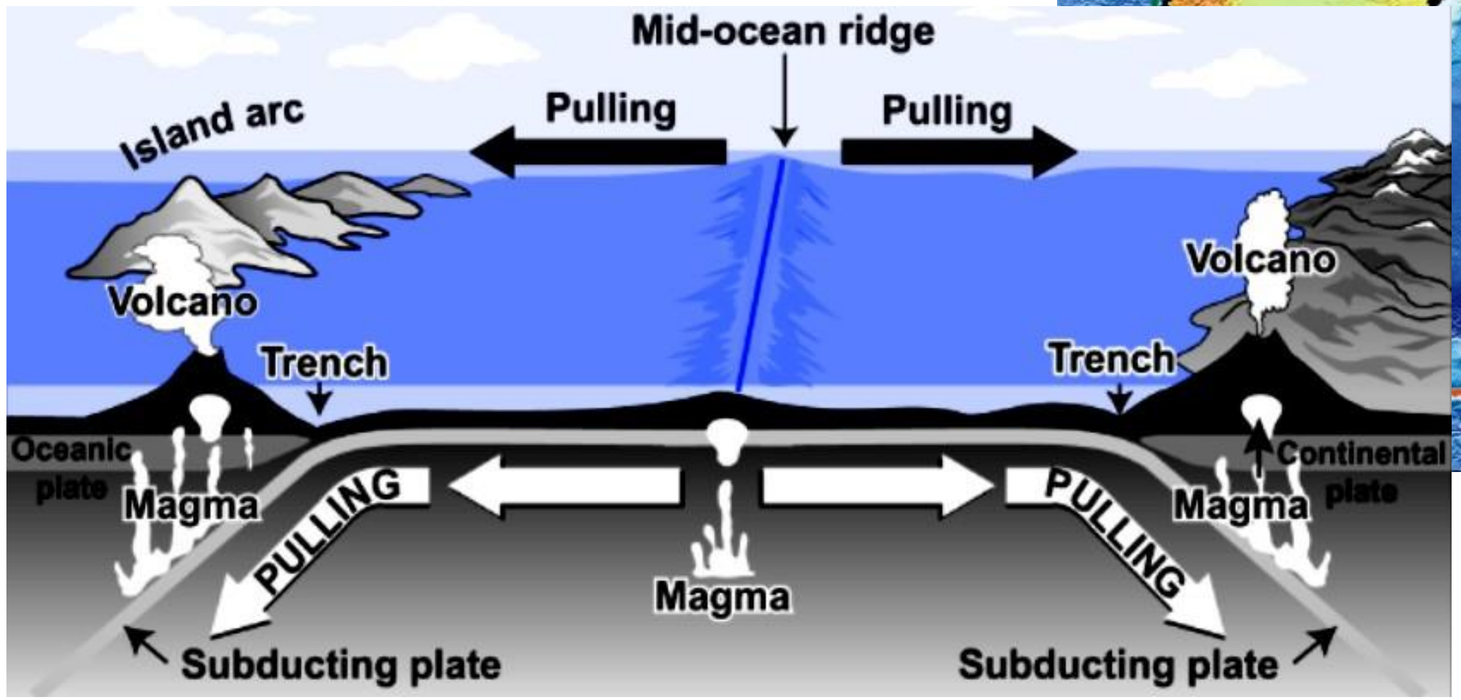


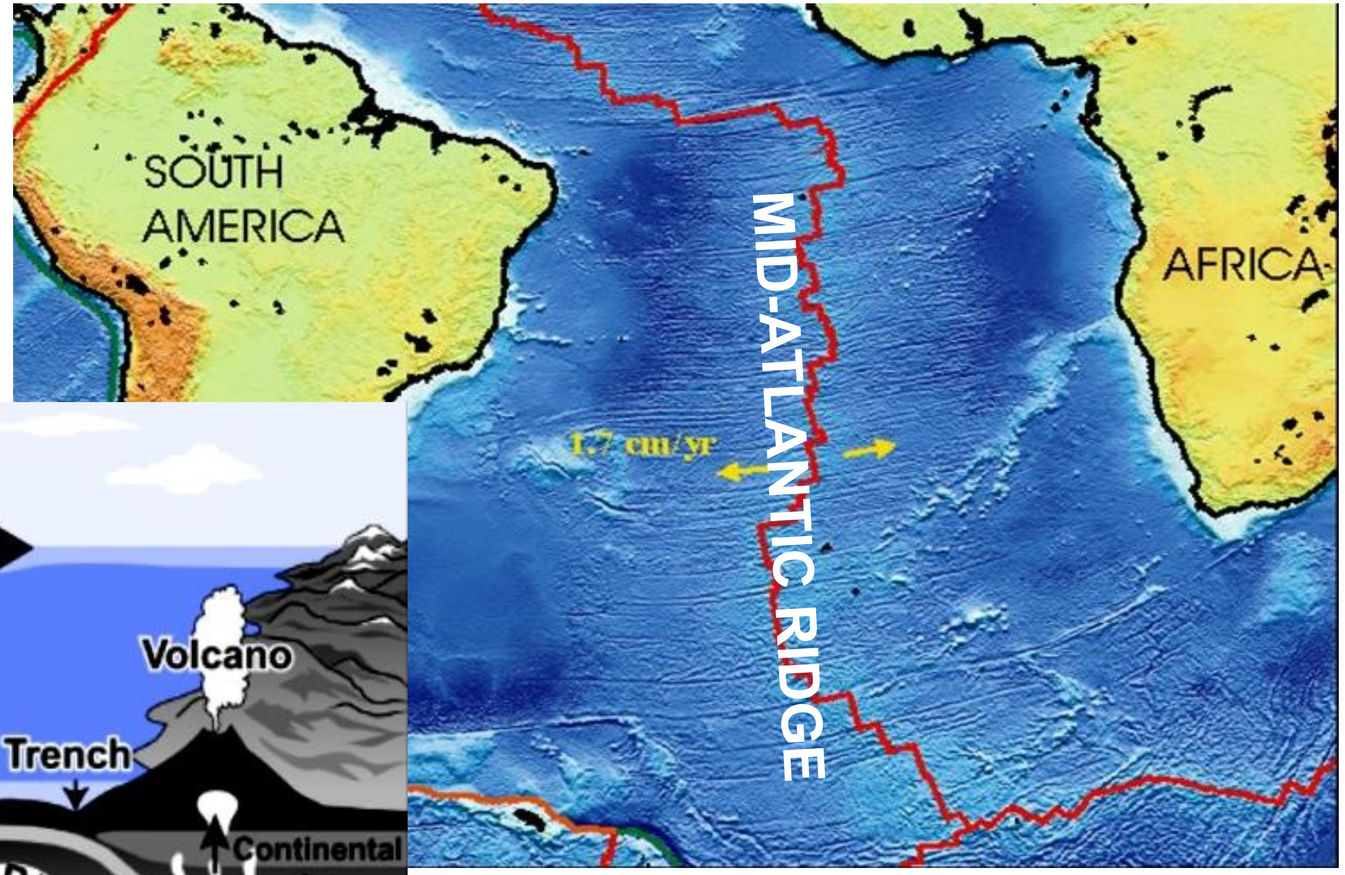
2.2.2.1 Divergent (Extensional) Boundaries…..contd.

An example of rift valley is the East African Rift Valley

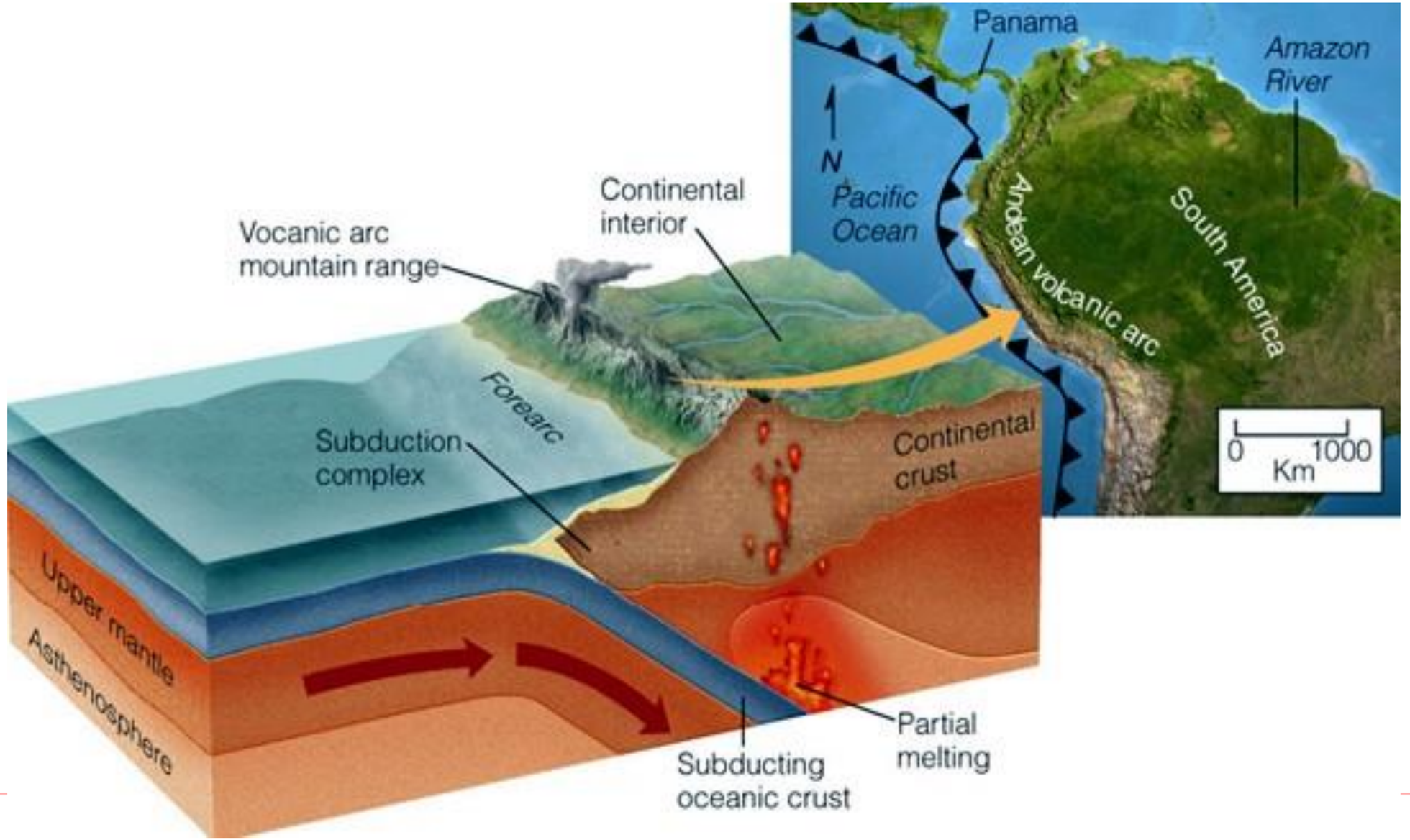


2.2.2.1 Divergent (Extensional) Boundaries.....contd.

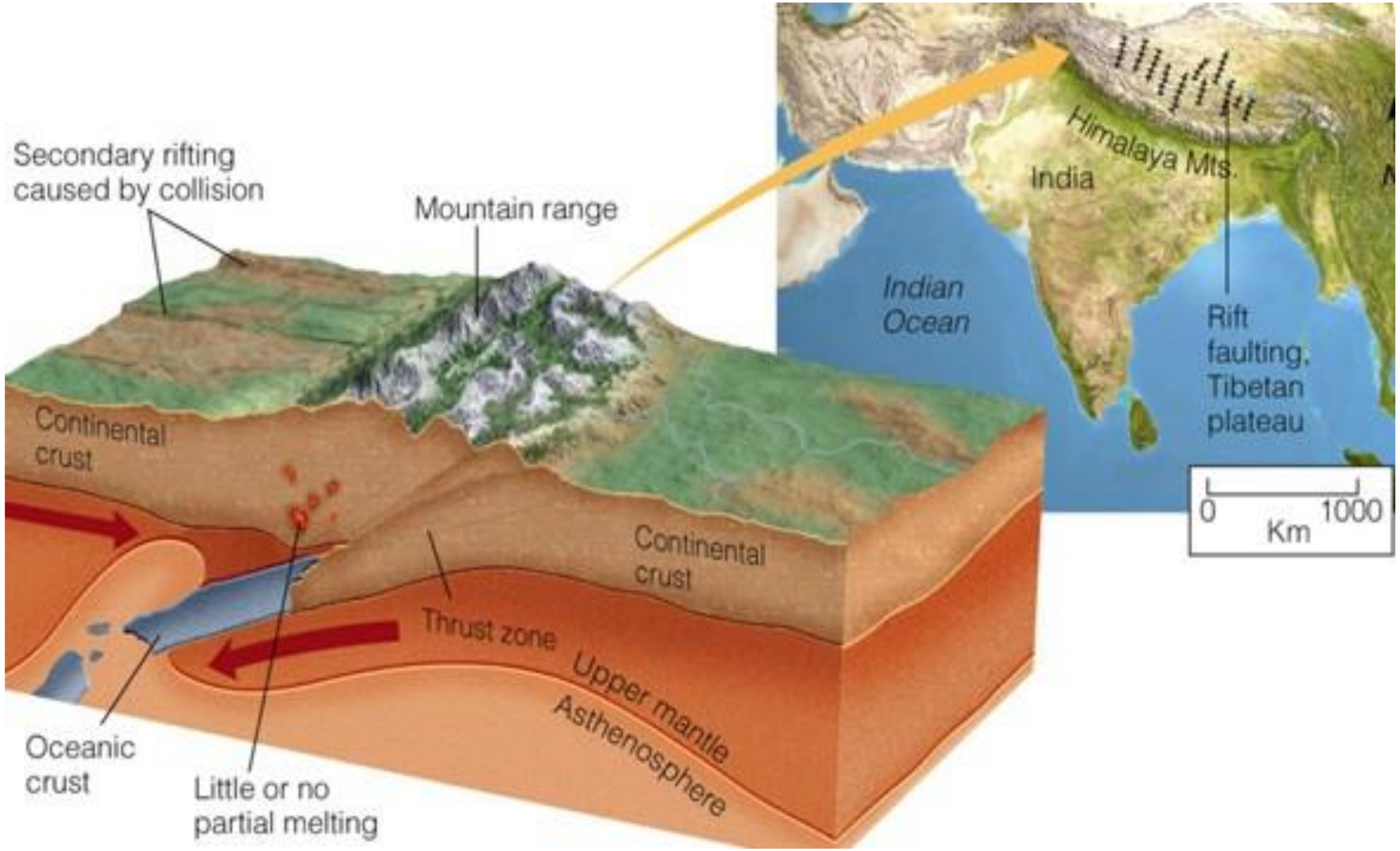




2.2.2.2 Convergent (Compressional) Boundaries

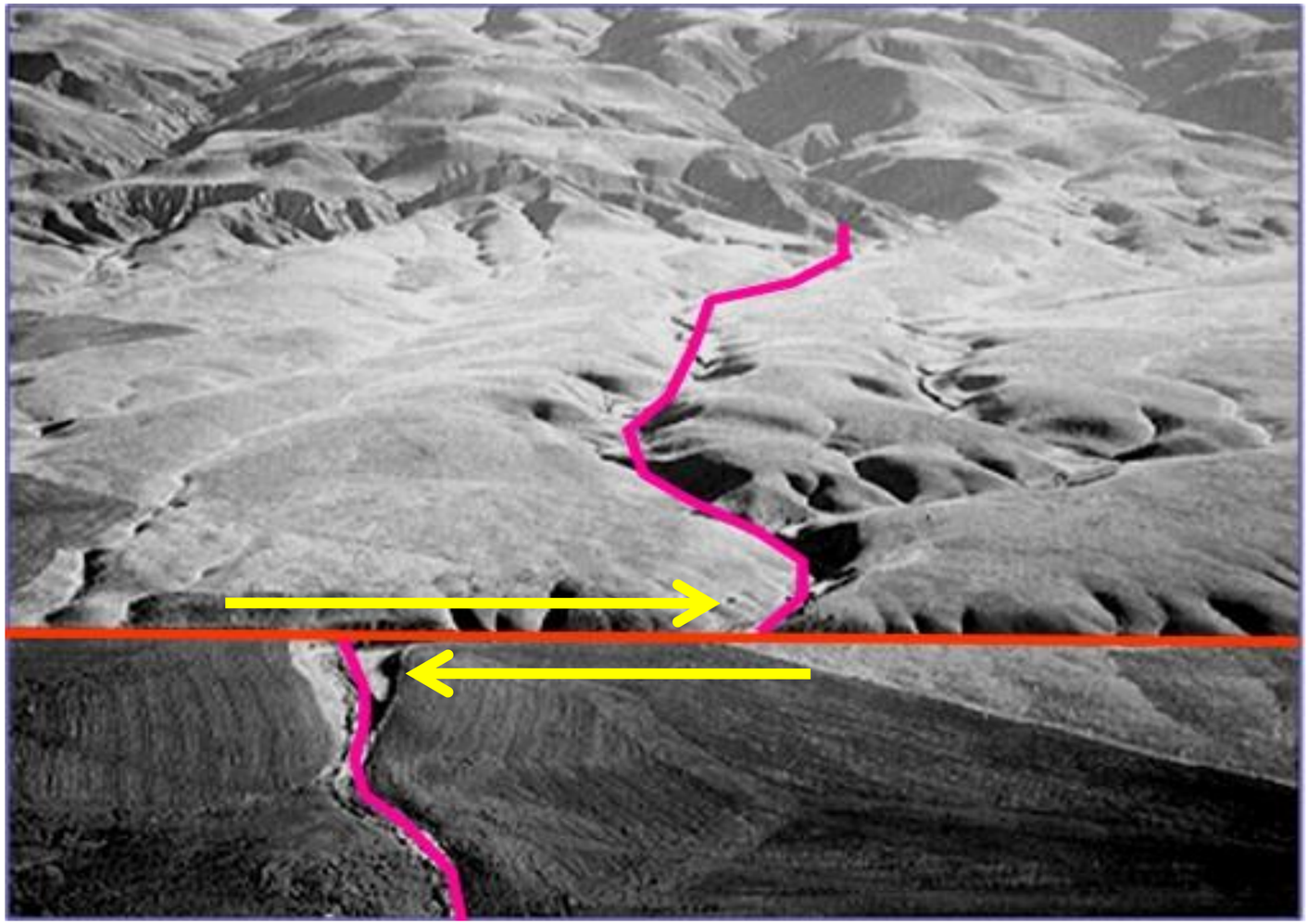


2.2.2.2 Convergent (Compressional) Boundaries…..contd.



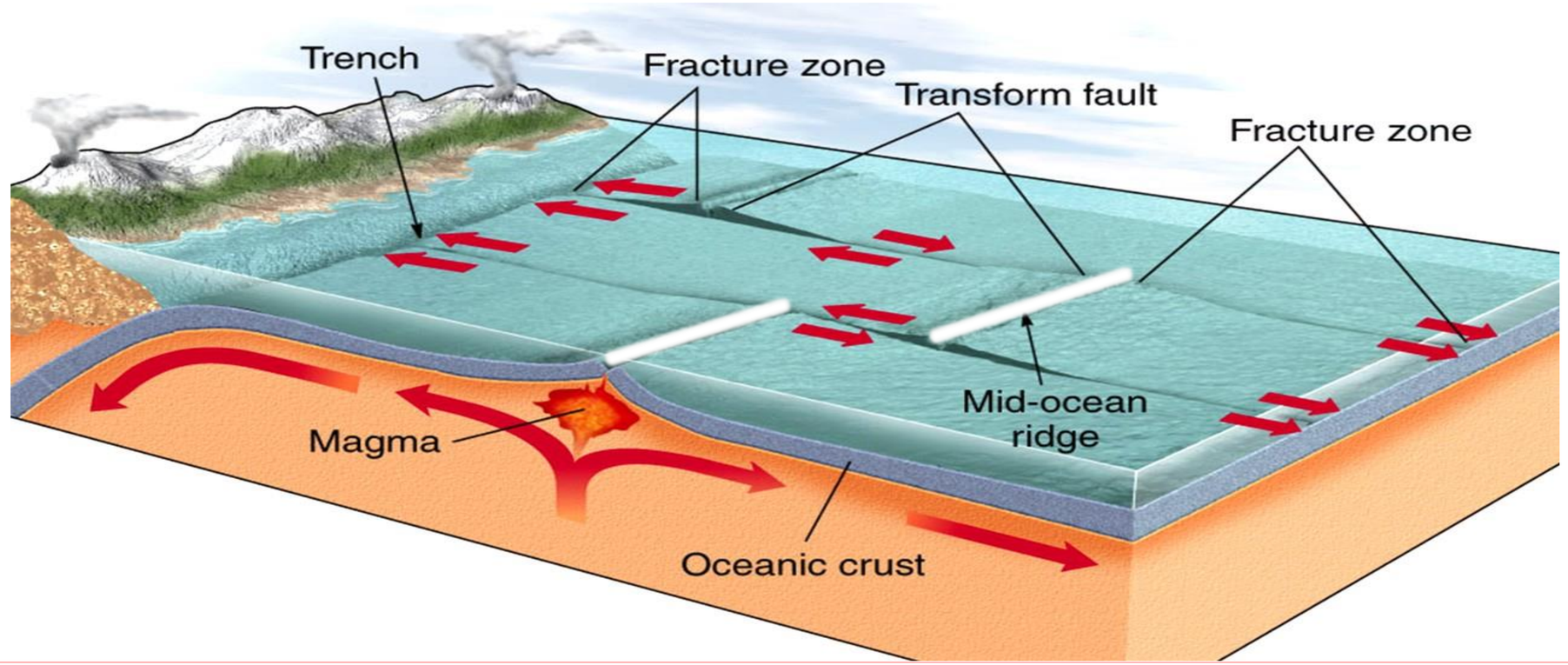
2.2.2.3 Transform Boundaries

where/when plates slide laterally past each other; roughly parallel to the direction of plate movement.



2.2.2.3 Transform Boundaries…..contd.

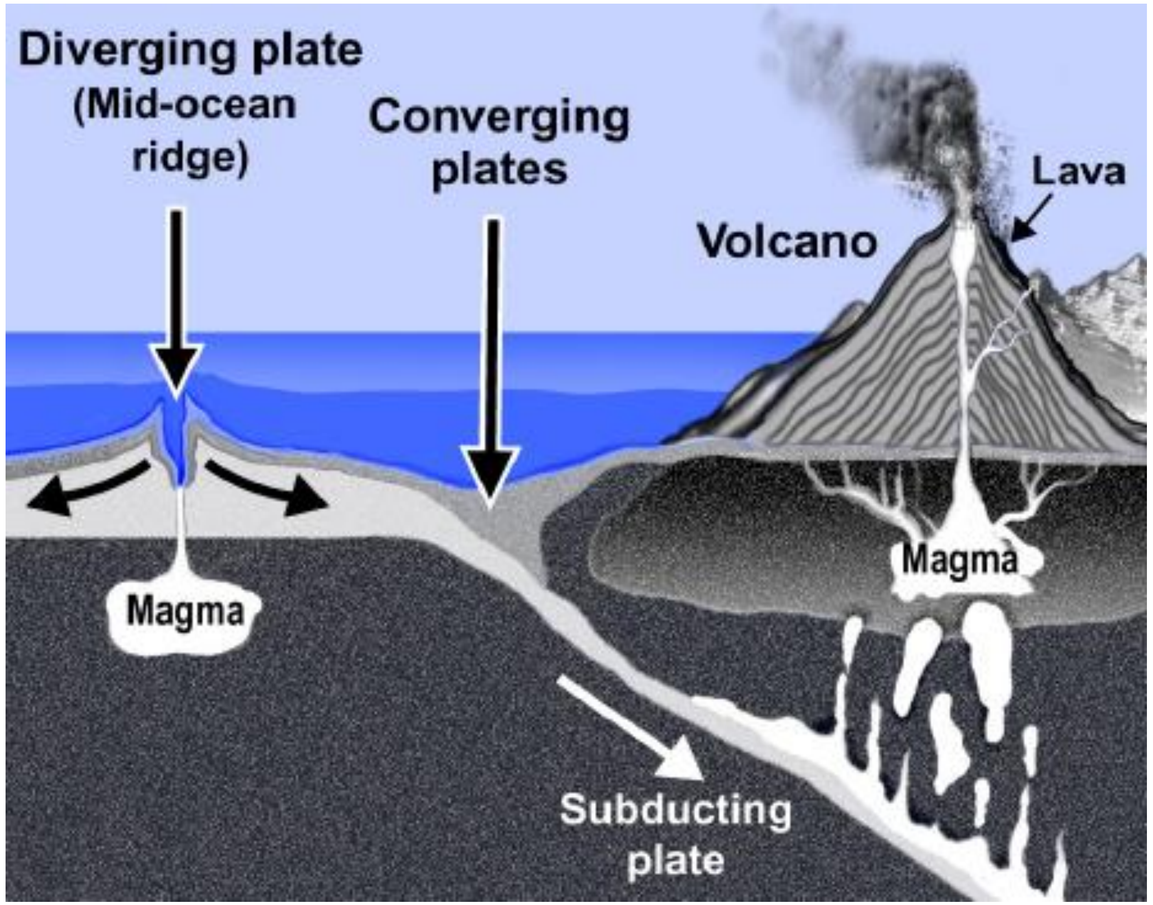
- Majority of transform faults connect two oceanic ridge segments, and
  - are marked by fracture zones



2.2.2.4 Volcanoes and Earthquakes

Most volcanoes and earthquakes are found at edges of tectonic plates, namely at:

- *divergent* and *convergent plate boundaries*

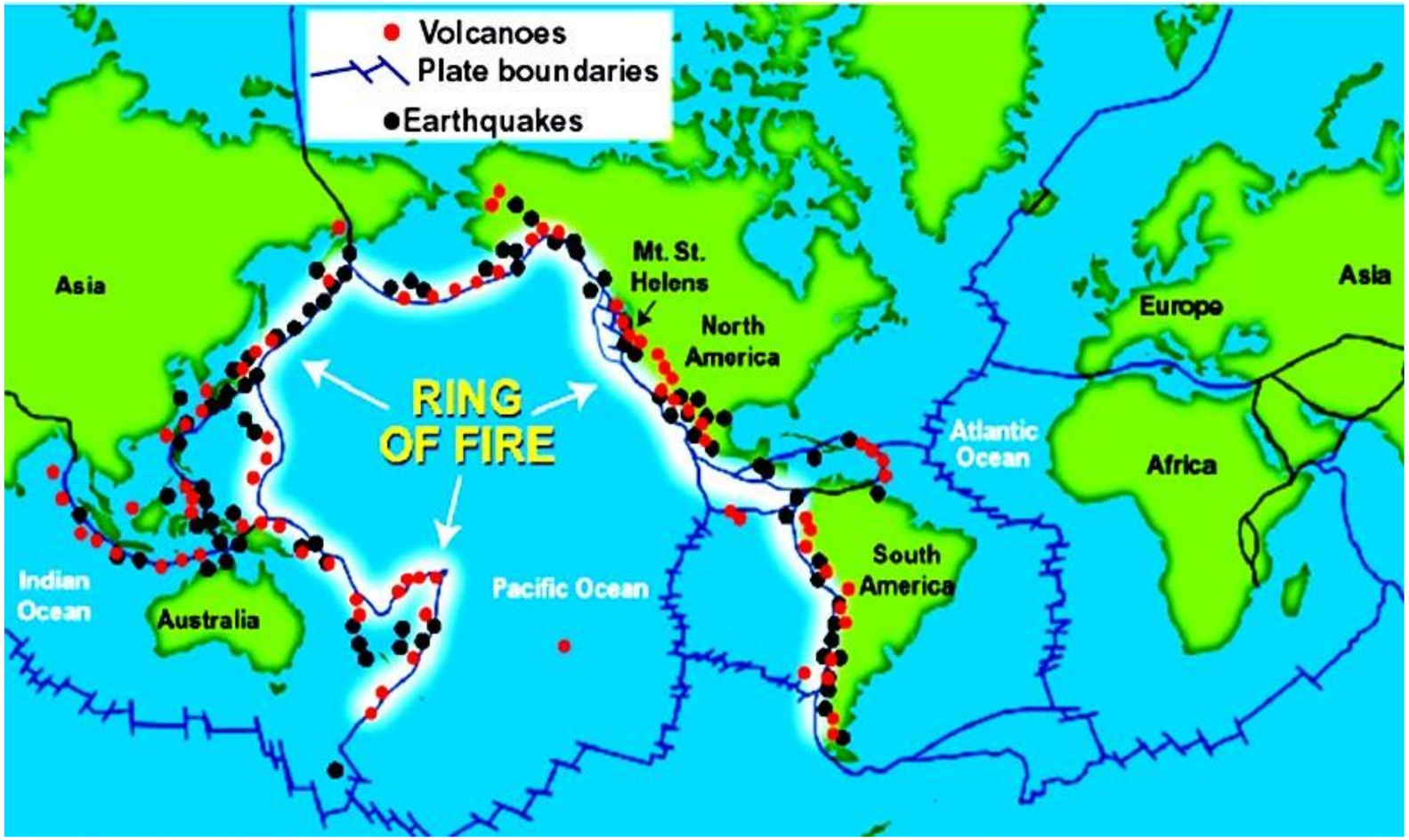


2.2.2.4 Volcanoes and Earthquakes…..contd.

The Ring of Fire is:

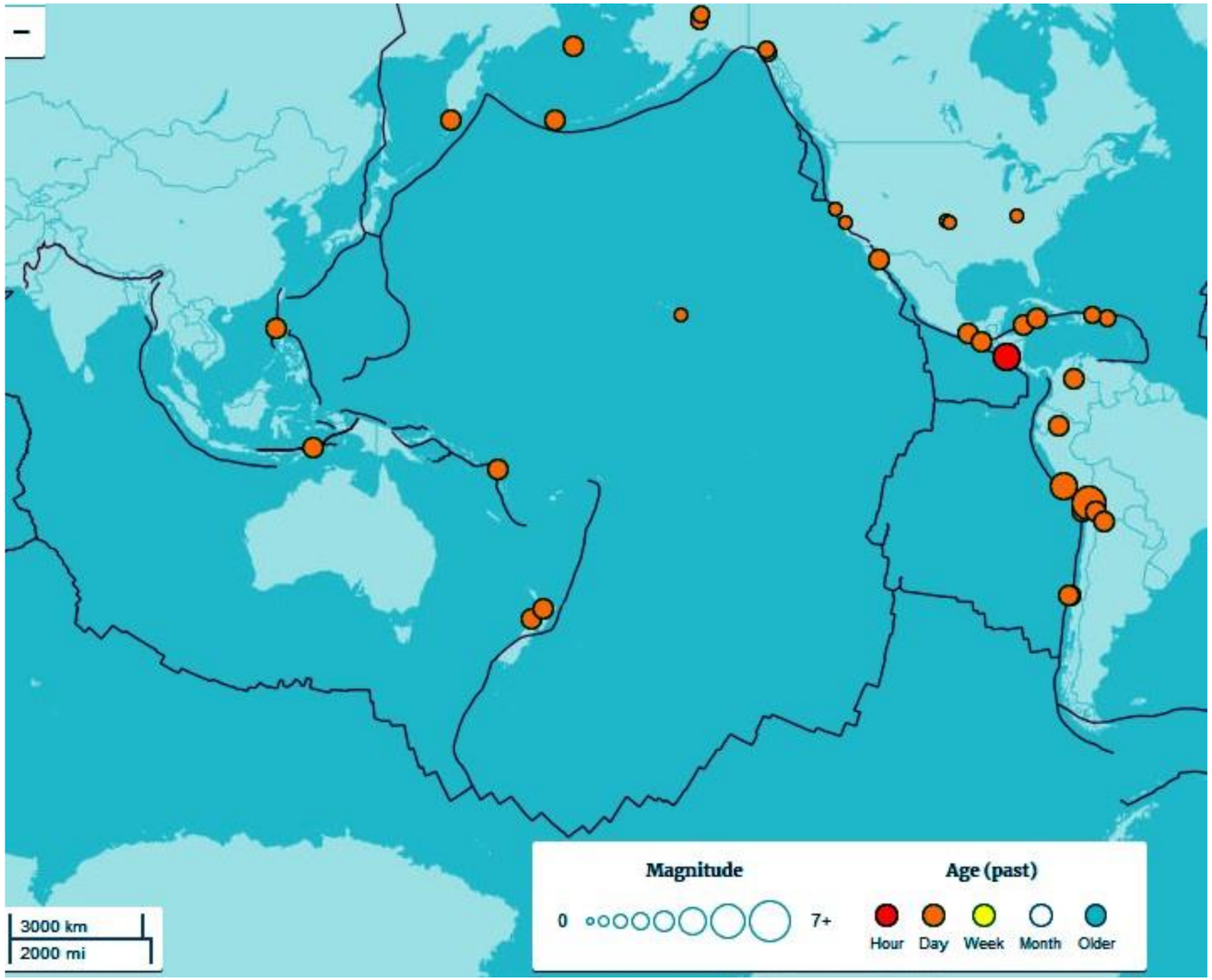
- a string of volcanoes & sites of seismic activity, or earthquakes
- around the edges of the Pacific Ocean.

Roughly 90% of all earth-quakes occur along the Ring of Fire.



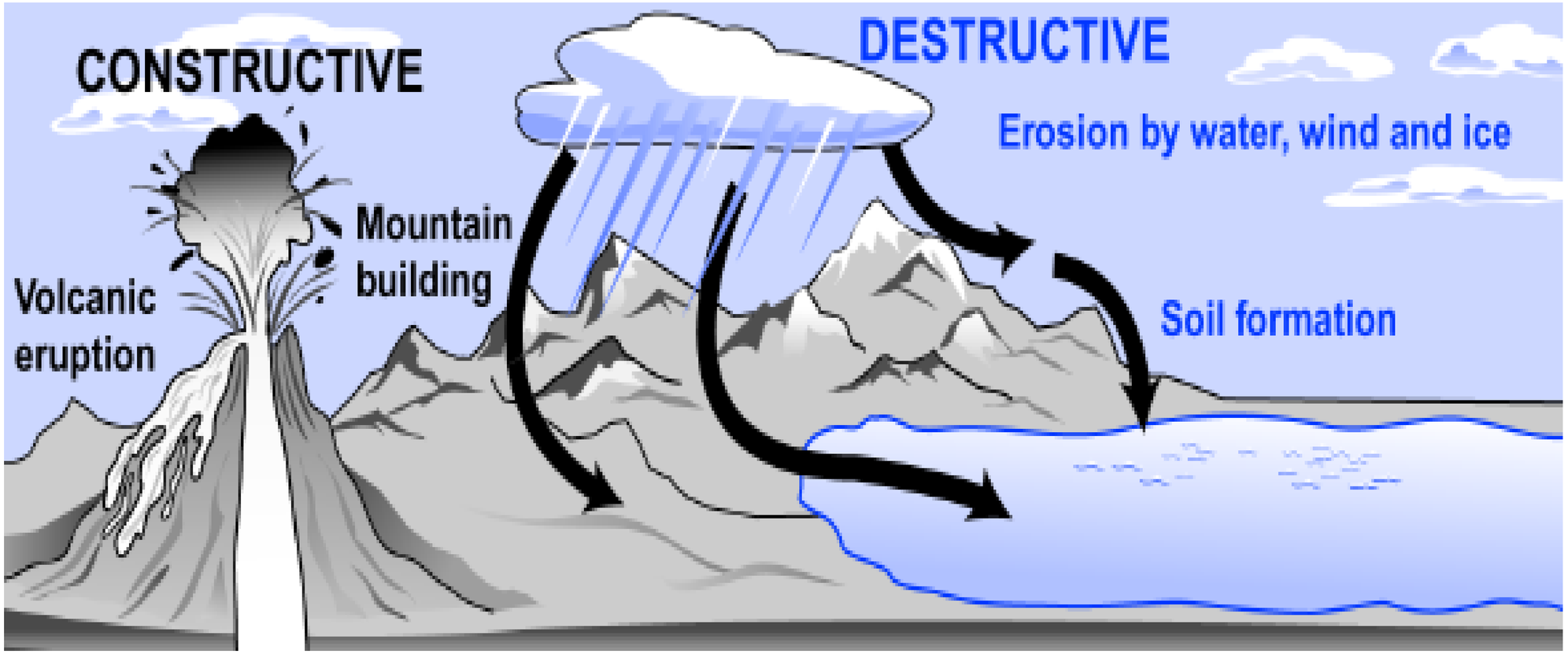
2.2.2.4 Volcanoes and Earthquakes…..contd.

Distribution and magnitude of earthquakes on 21:01:2018 at about 2030 hours in the Asia region.



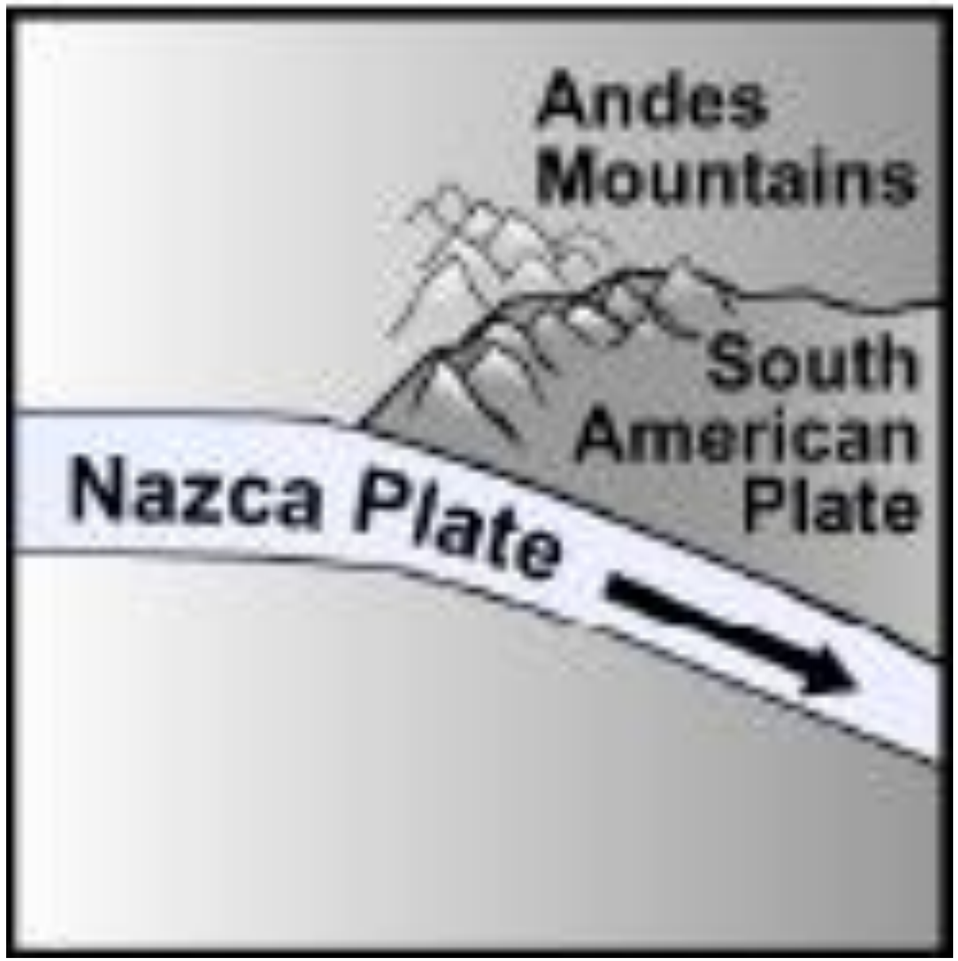
2.2.3 Earth's Surface

Features we see on Earth's surface represent a **dynamic balance** between CONSTRUCTIVE PROCESSES and DESTRUCTIVE PROCESSES.



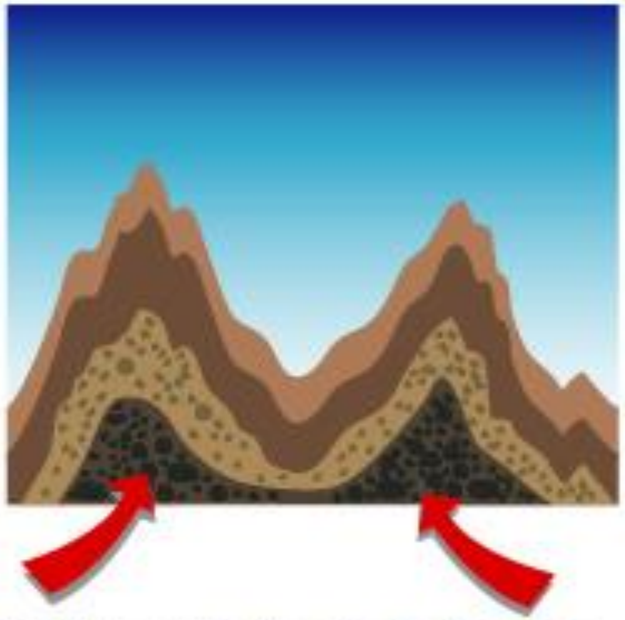
2.2.3.1 Mountain Building

- is a major **constructive** process.
- is promoted by <u>three major processes</u>:
  - **Folding** at convergent plate boundaries
  - movement of chunks of land at **Faults**
  - **Volcanic** activity



2.2.3.1 Mountain Building…..contd.

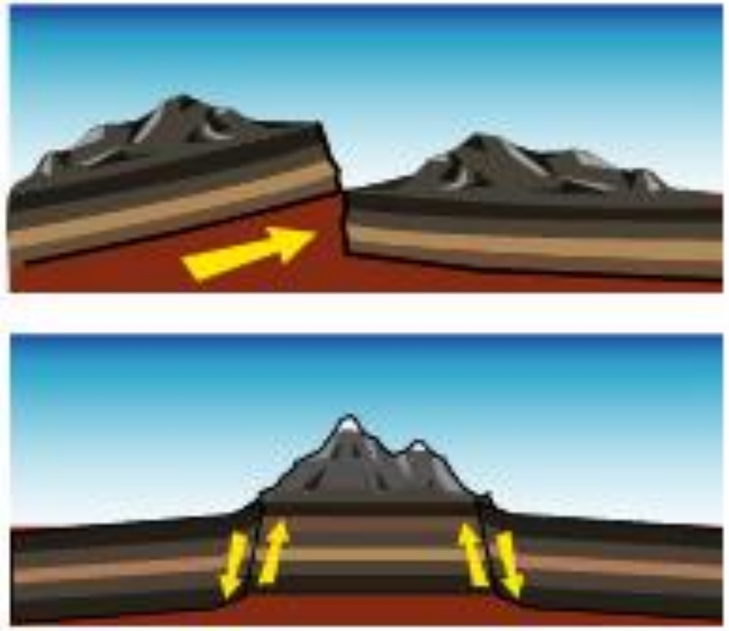
Fold mountains



Fold mountains include the Andes and Himalayan Mountains.

Fold mountains occur at convergent plate boundaries.

Fault-block mountains



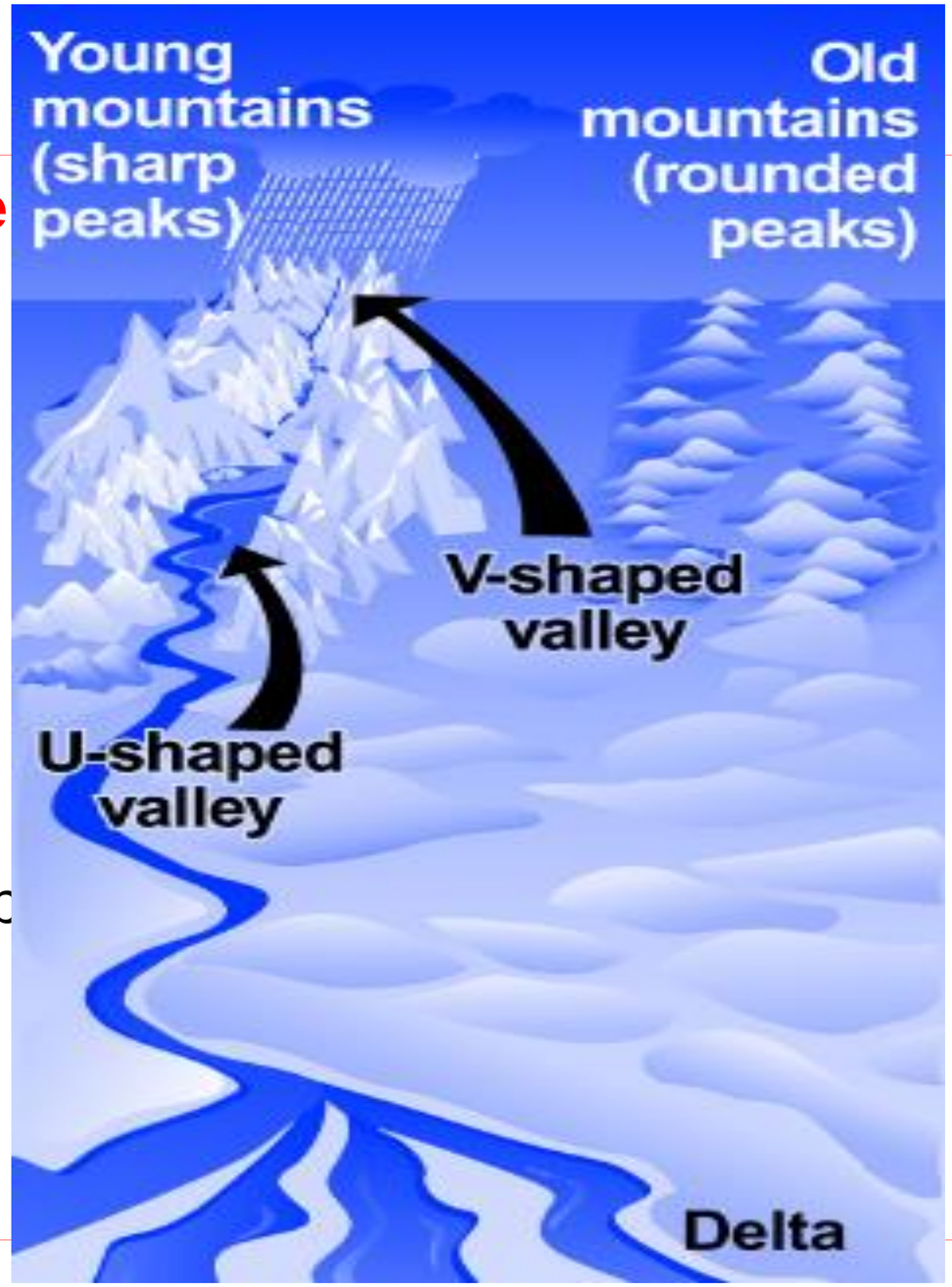
Mountains along the San Andreas fault are examples of fault-block mountains.

Volcanic Mountains

There are numerous volcanic mountains along the Ring of Fire. An example of a dome mountain is Mount Rushmore.

2.2.3.2 Erosion

- also known as *weathering*, is a major **destructive** process.
- describes continuous physical & chemical events that <u>cause land and rock to wear down.</u>
- its rate is related to
  - *height* and *steepness* of the mountain – the steeper the mountain, the faster it erodes because it is easier to push material down steep slope than a gradual slope.



Summary

- Earth's System's processes are driven by Sun's heat, which propels ALL Earth's **external processes** – weather, ocean circulation & erosional processes
- Heat from Earth's interior powers **Earth's Internal processes –** volcanoes, earthquakes, mountain building.
- Earth consists of a series of concentric layers, which differ in **CHEMICAL** & **PHYSICAL** Properties.
- **Plate tectonics** deals with the structure of the **earth's crust** and many associated phenomena, which have resulted from interaction of rigid lithospheric plates that move slowly over the underlying mantle.
- *Weathering*, is a major **destructive** process, which is promoted by continuous physical & chemical events that cause land and rock to wear down

End of Lecture