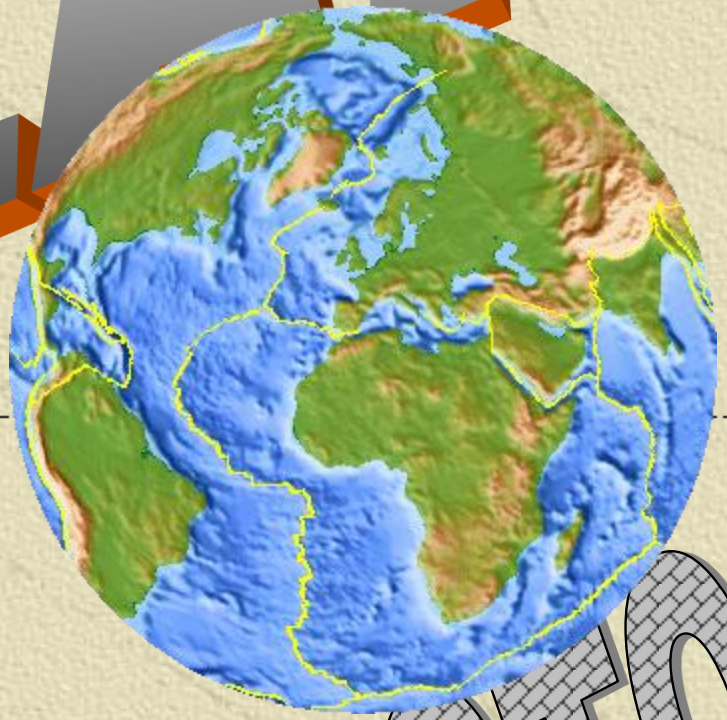
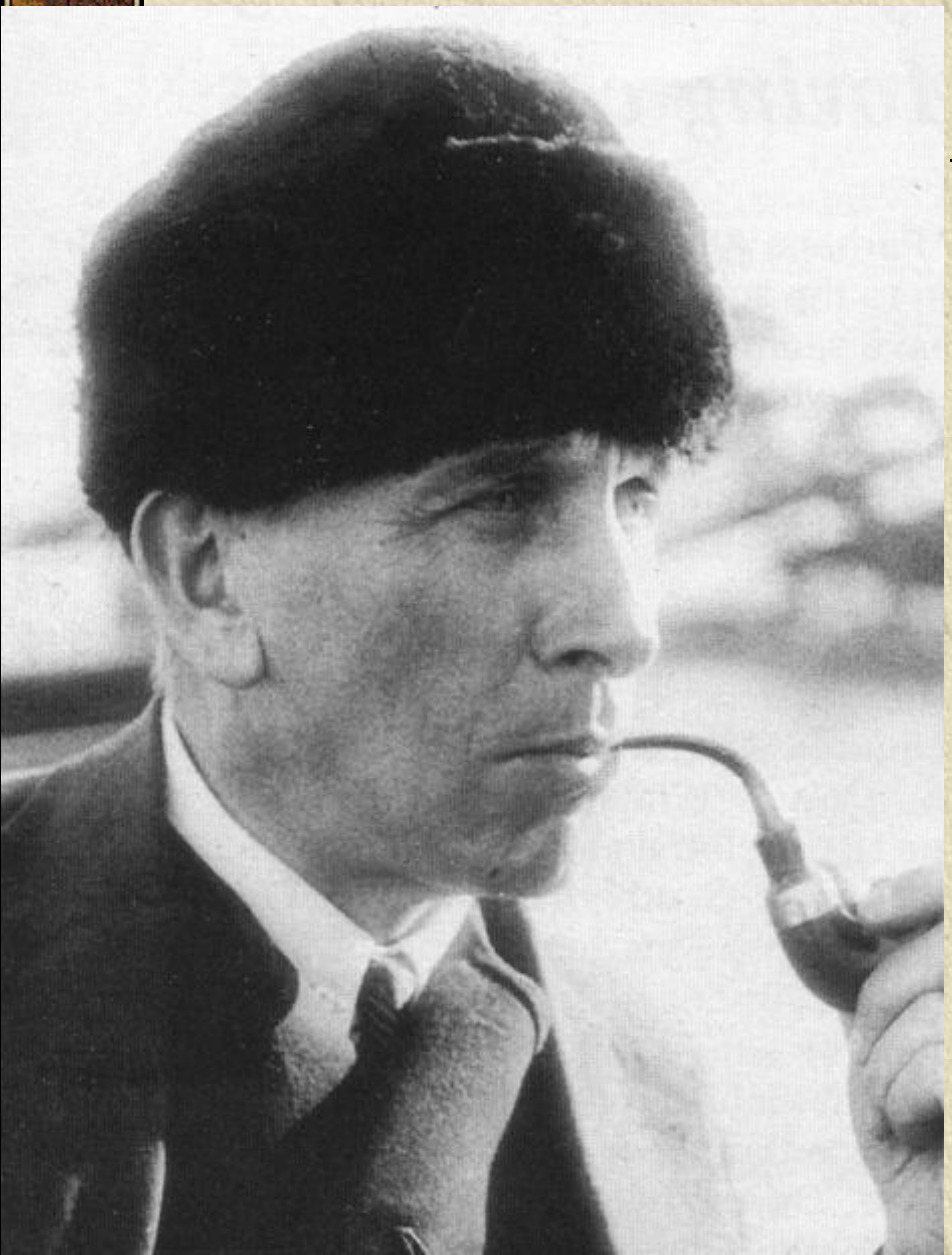
PLATE TECTONICS



Lithospheric Plates

- The Earth's rocky outer crust solidified billions of years ago, soon after the Earth formed. This crust is not a solid shell.
- It is broken up into huge, thick **plates** that drift atop the soft, underlying mantle.
- A number of rigid, but moving, pieces of the Earth’s surface.
- Also called **lithospheric plates**

Continental Drift:



Alfred Wegener:

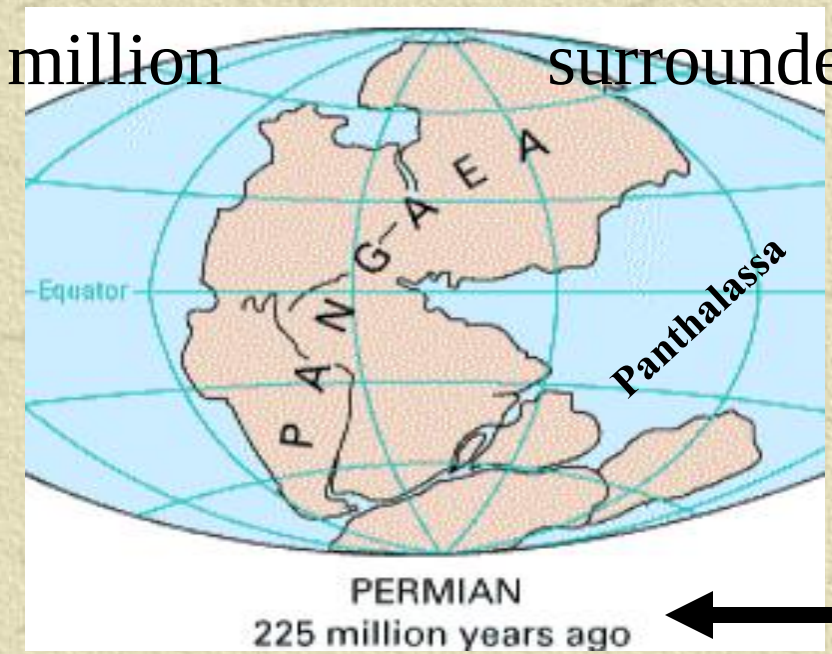
German Meteorologist

On **January 6, 1912** Wegener presented his Continental Drift theory/hypothesis after analyzing either side of the Atlantic Ocean for rock type, geological structures and fossils. However, it wasn't considered to be sufficient evidence by the scientific community.

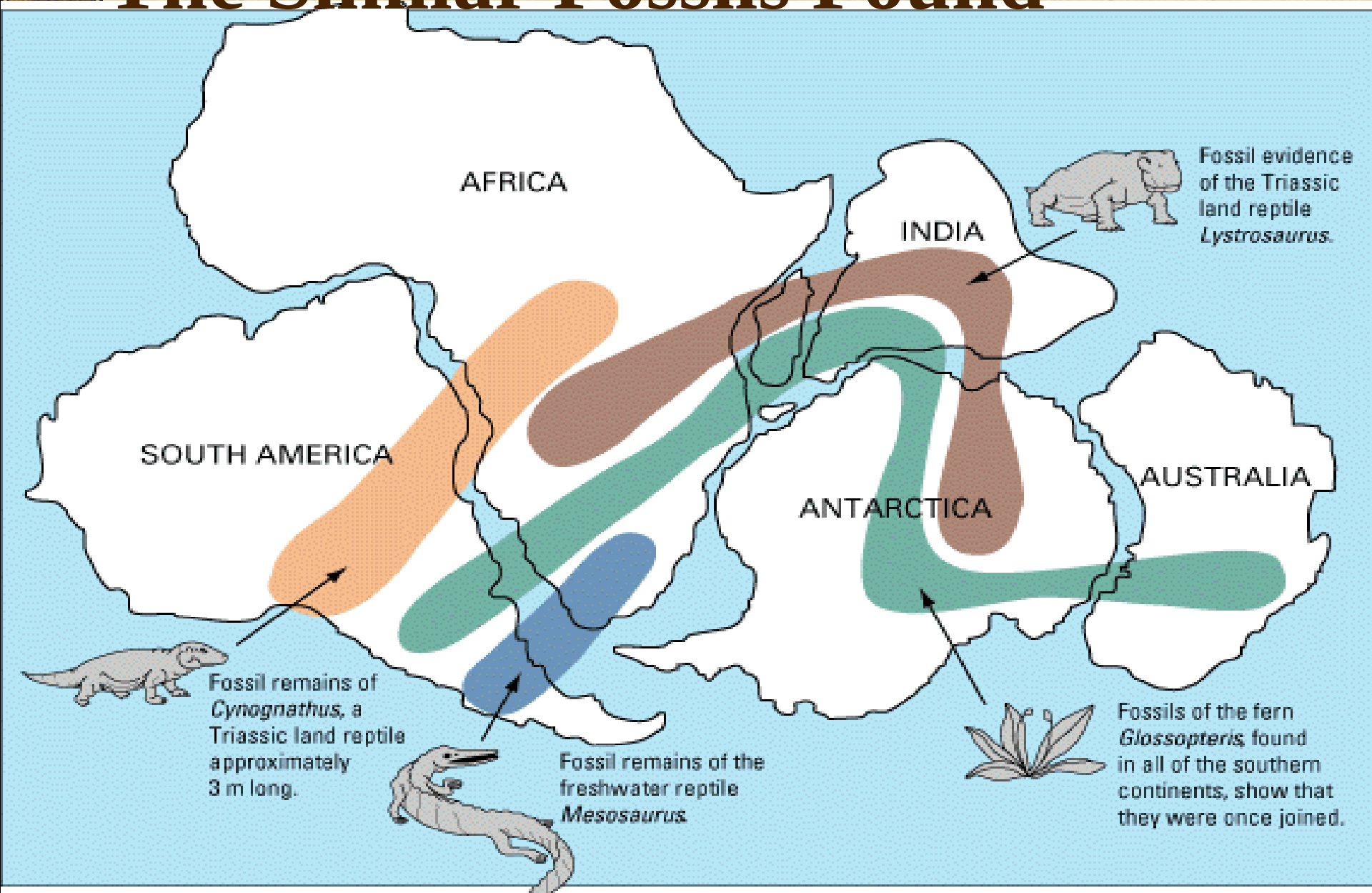
In Wegener's hypothesis he gave a name to the single landmass and it's ocean.

- **Pangaea:**
(means "All Land")
- -The single landmass that formed between 250 and 300 million years ago.

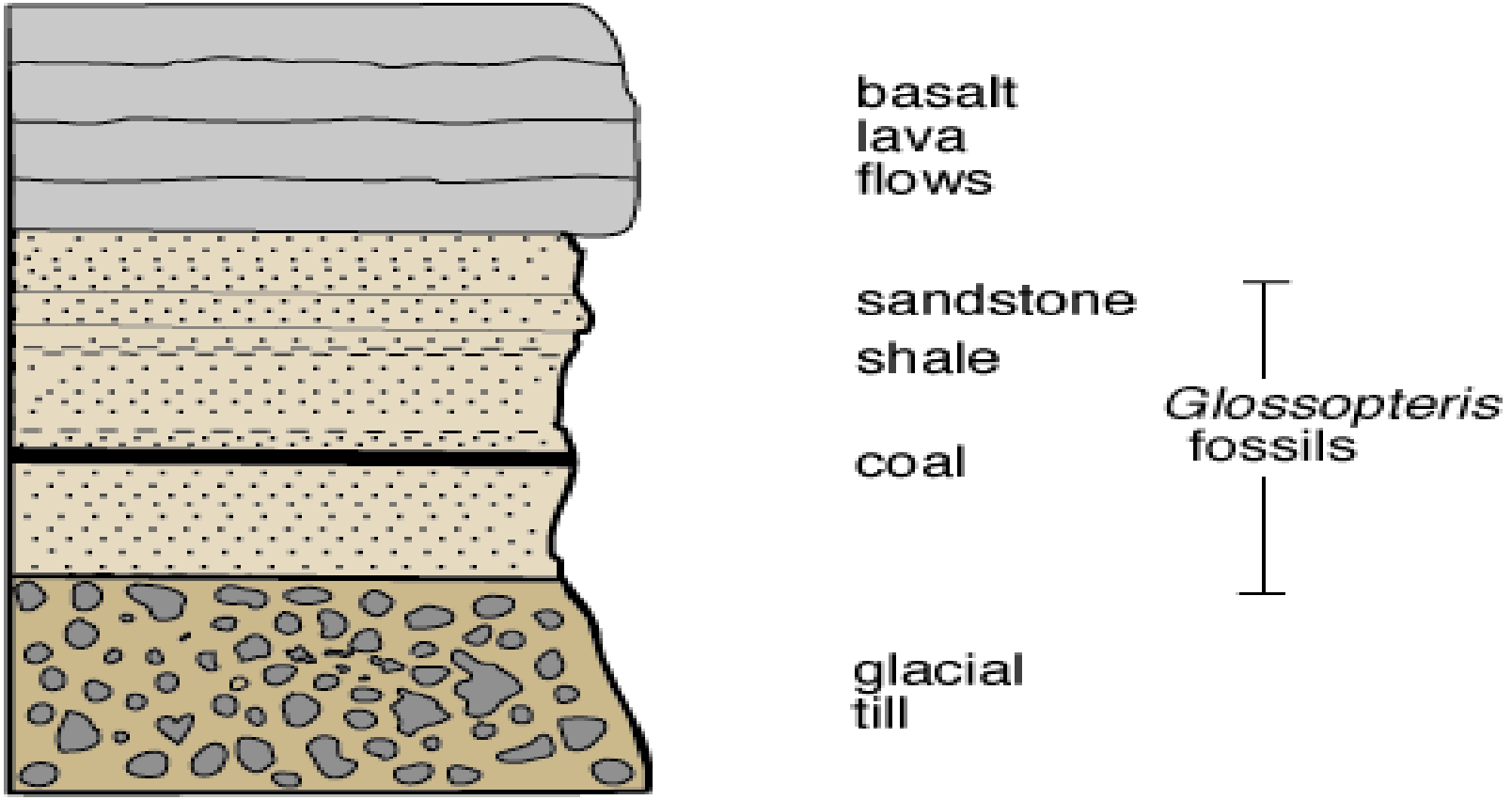
- **Panthalassa:**
(means "All Seas")
- -The name given to the vast ocean that surrounded Pangaea



The Similar Fossils Found

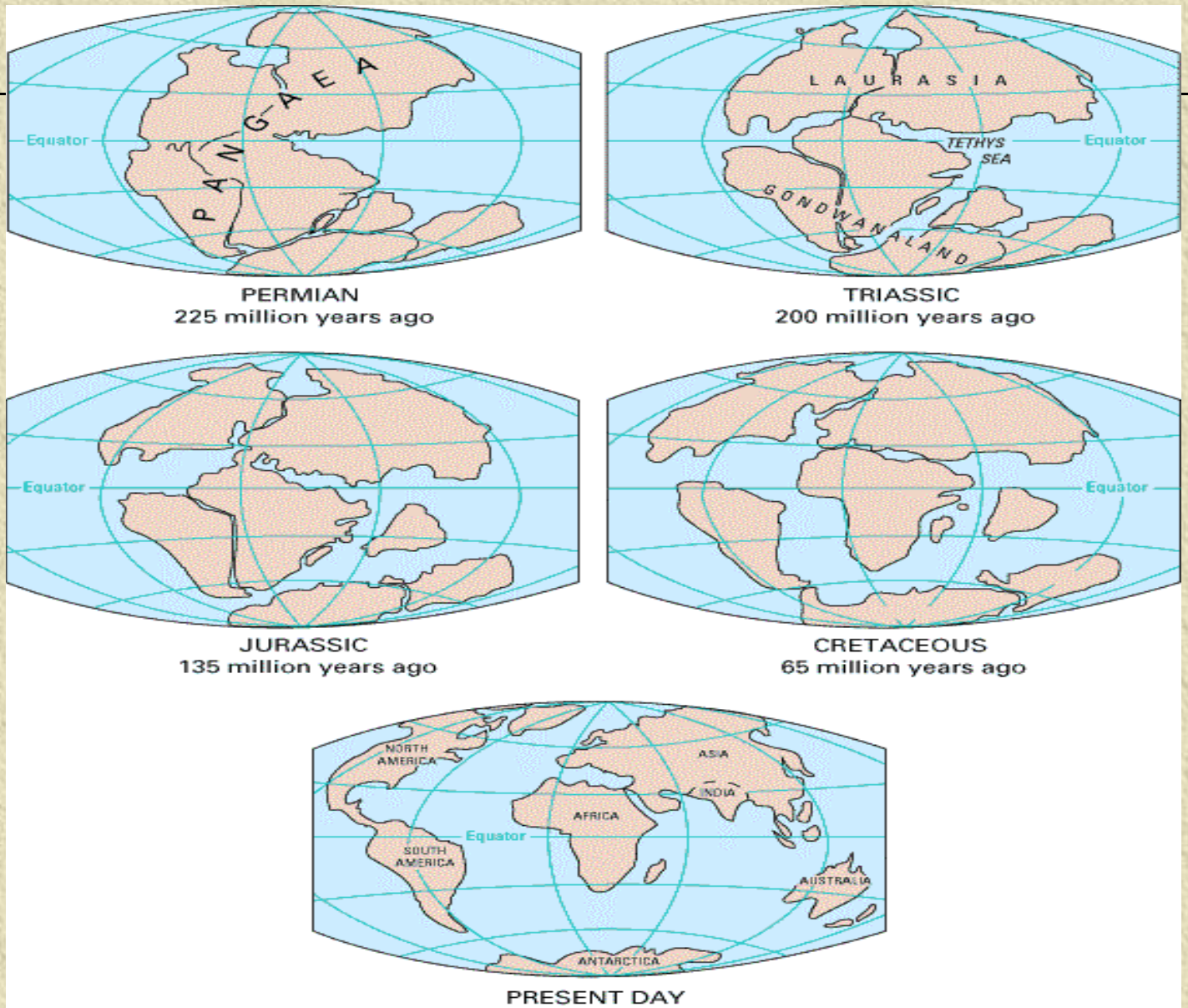


The Similar Rock Structures Found



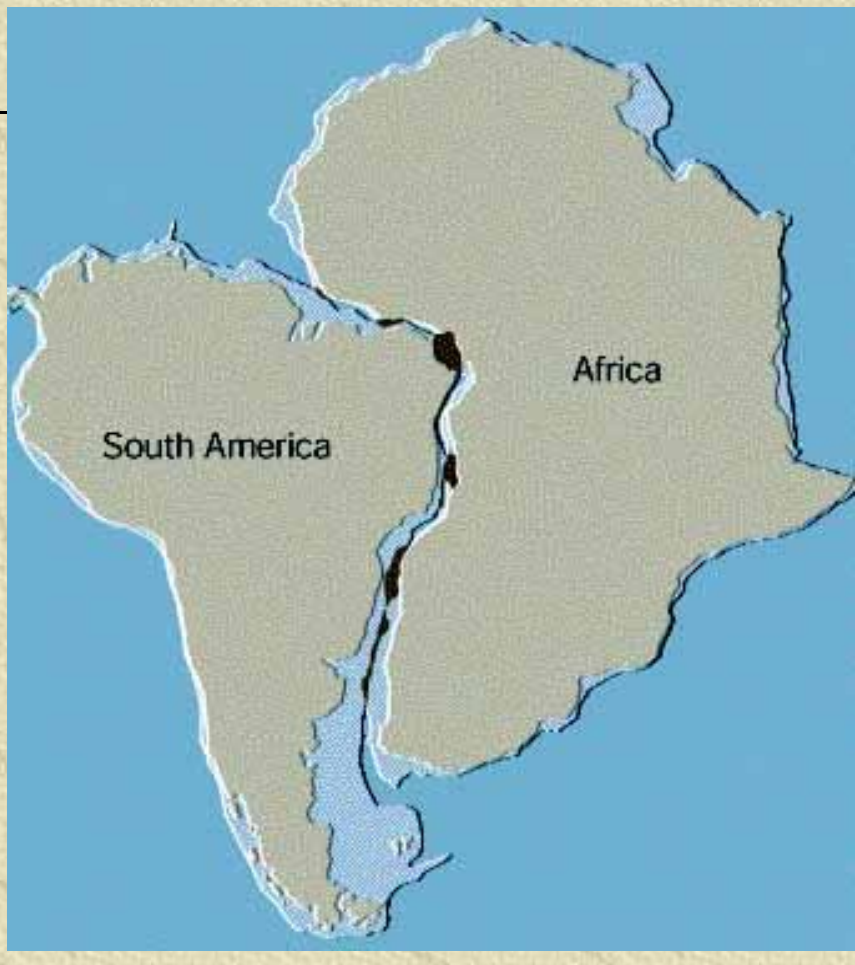
Similar layers of rock were formed in Antarctica, Australia, South America, Africa, and India before Pangea broke apart. Glossopteris fossils were found in the rocks on each continent.

Continental Drift



Evidence of Continental Drift:

- **1.)Coastline Similarities**
- **2.)Fossils of Plants & Reptiles were similar**
- **3.)Geologic Patterns of Rocks & Mountain Chains**
- Why then was his theory rejected by leading scientist?



Because it did not sufficiently **explain the forces causing Continental Drift-Wegener died in 1930 still trying to discover what made the continents move**

Wagener, poor and unable to support his family tries one last time…

In 1930 Wegener leaves for Greenland to find evidence for his hypothesis.

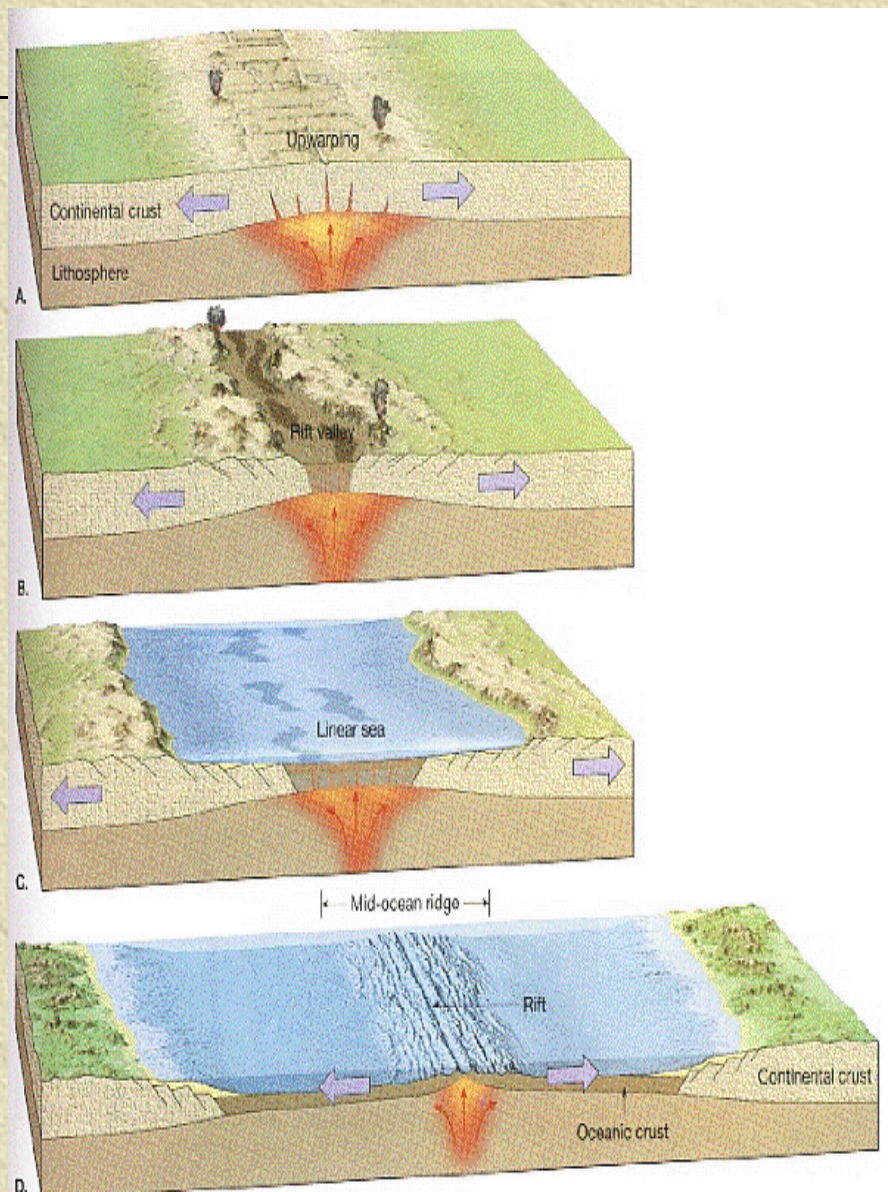
He is never seen again

This is last the photo taken of him before his death.

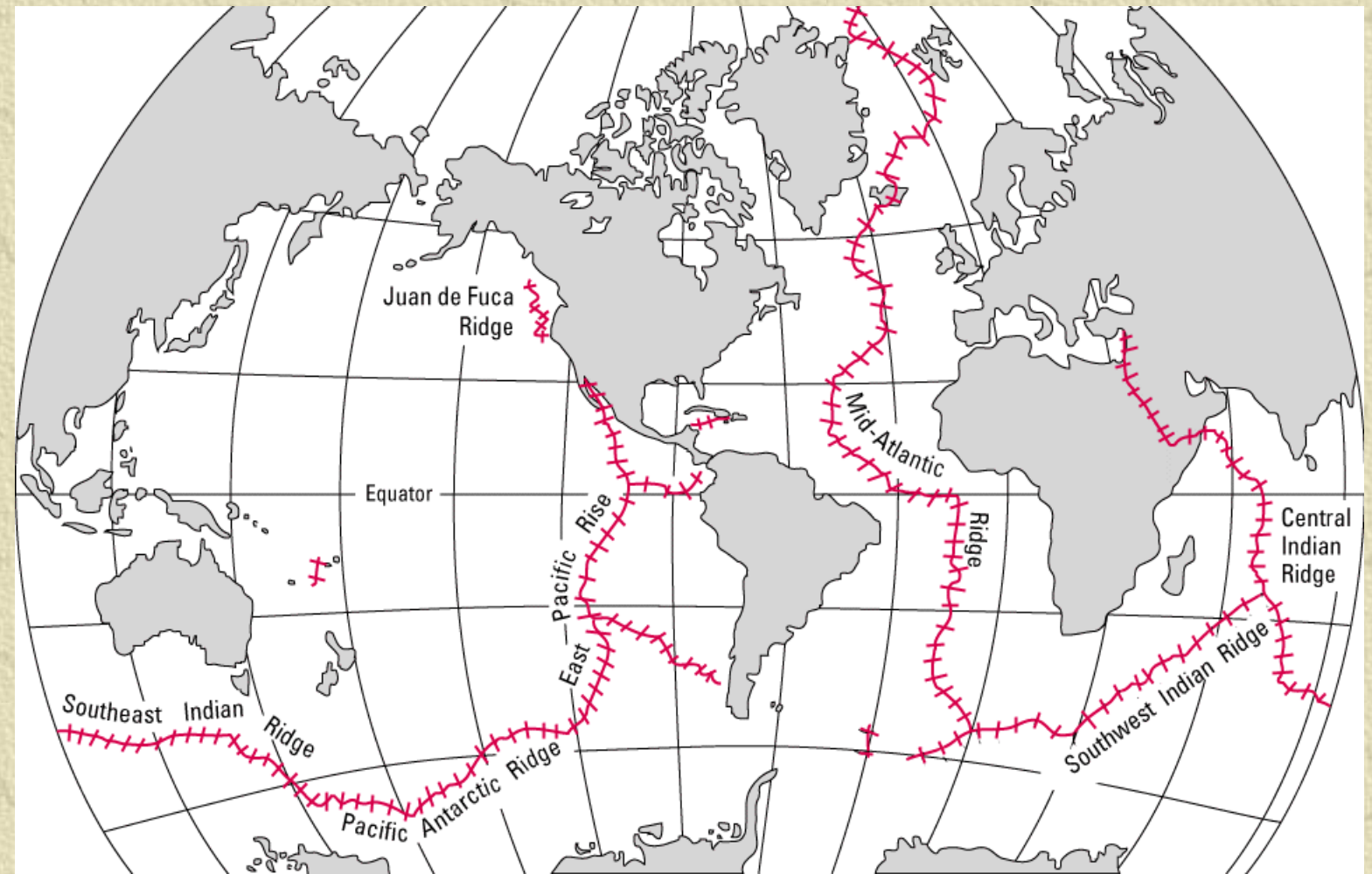
His theory is hotly debated for the next 30 years

The Evidence is Discovered:

- **-1947,** Scientists on the survey ship Atlantis begin mapping the ocean floor and found that the ocean floor was not flat like they thought.
- In the **1950's** a great mountain range on the ocean floor was discovered that virtually encircled the Earth. (**Global mid-ocean ridge**) It zigzags between the continents 65,000 km long with an average height of 4,500 m



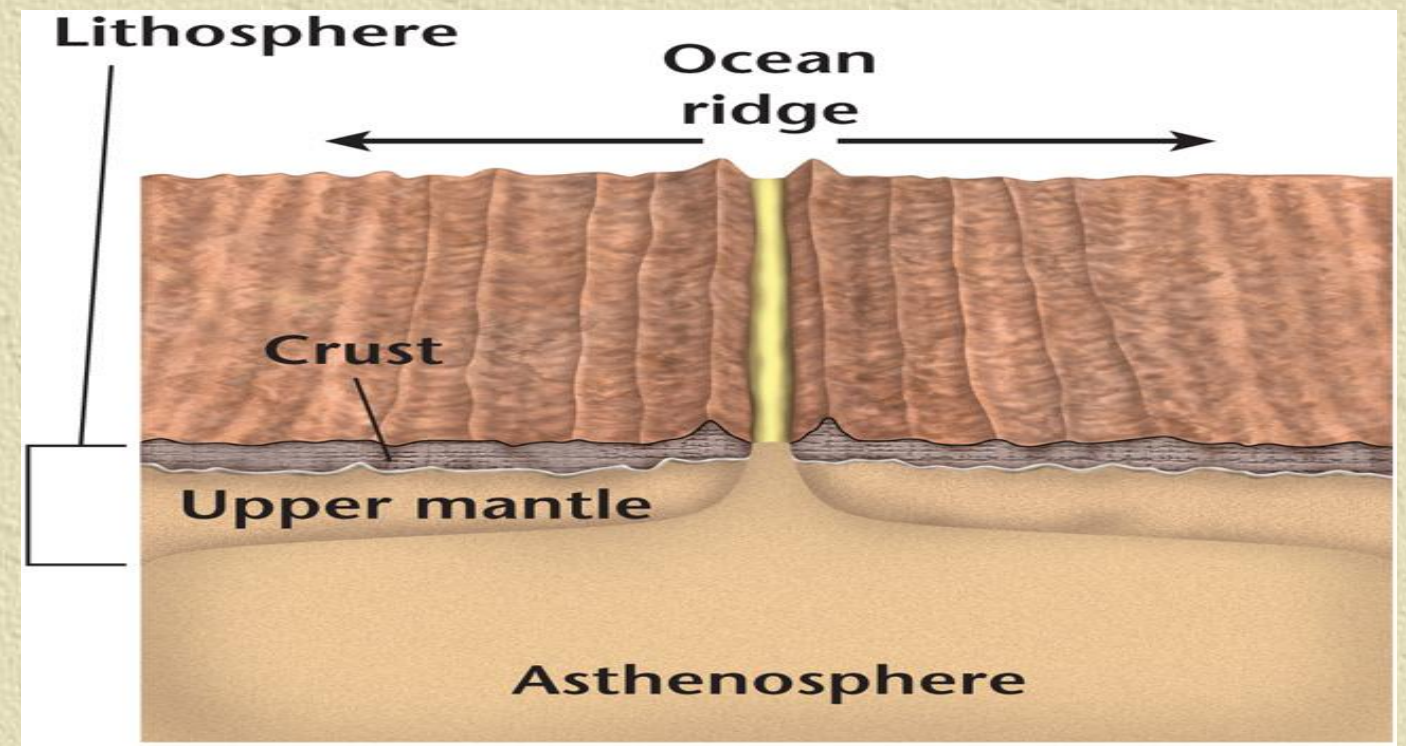
The Evidence is Discovered:



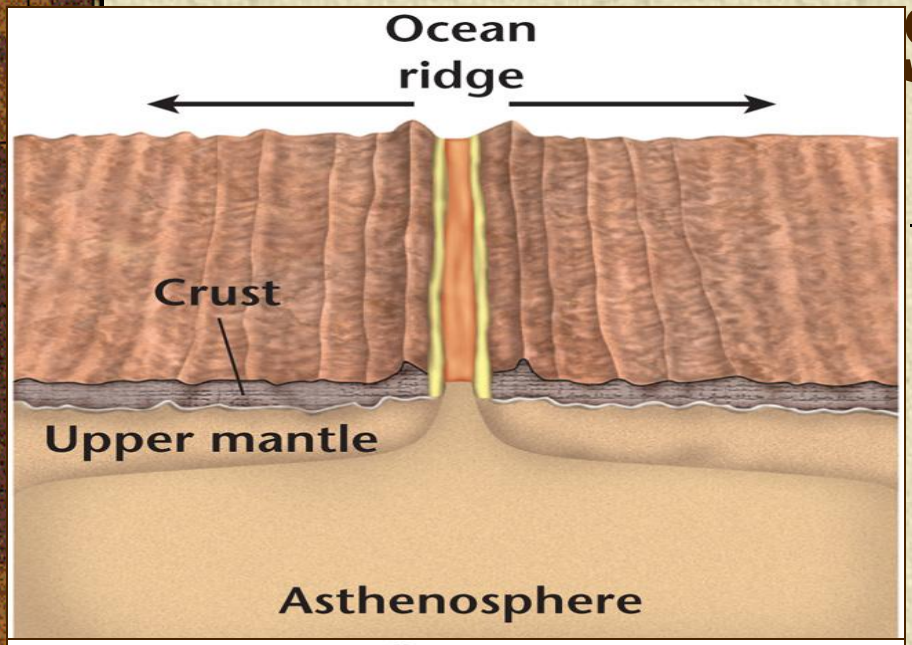
Seafloor Spreading, 1961

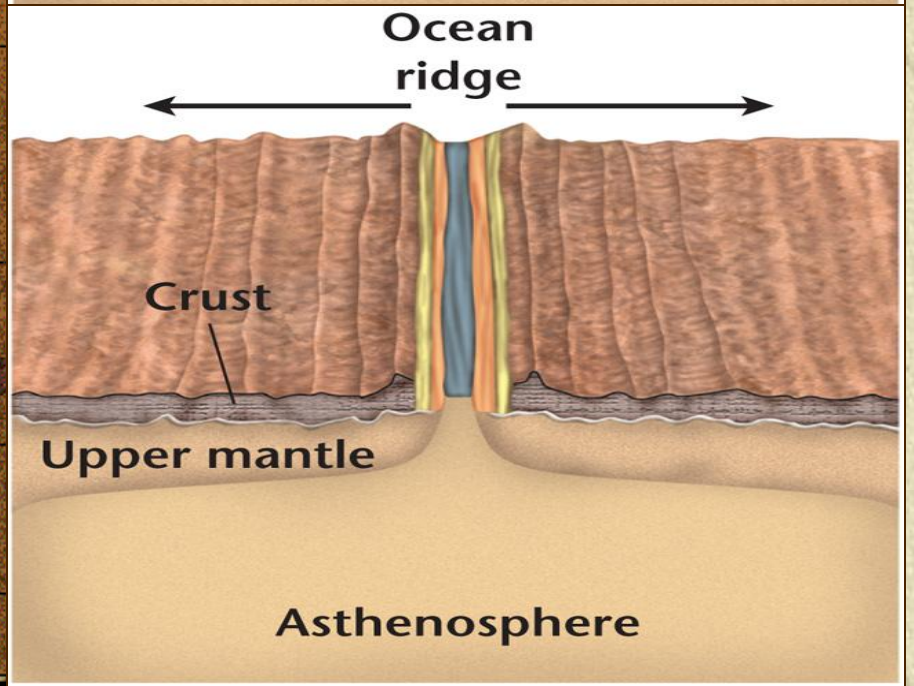
Seafloor spreading: states that new ocean crust is formed at ocean ridges and destroyed at deep-sea trenches.

- Magma is forced toward the crust along an ocean ridge and fills the gap that is created.



Seafloor Spreading





- When the magma hardens, a small amount of new ocean floor is added to Earth's surface.
- Each cycle of spreading and the intrusion of magma results in the formation of another small section of ocean floor, which slowly moves away from the ridge.

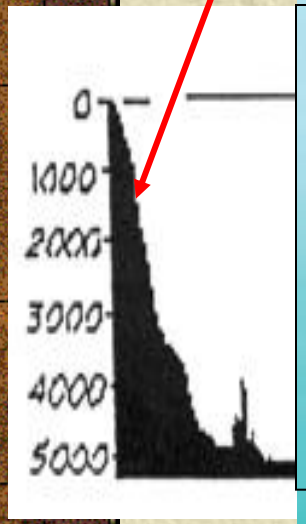
The Missing Link

- Seafloor spreading was the missing link needed by Wegener to complete his model of continental drift.
- Continents are not pushing through ocean crust, as Wegener proposed; they ride with ocean crust as it slowly moves away from ocean ridges.

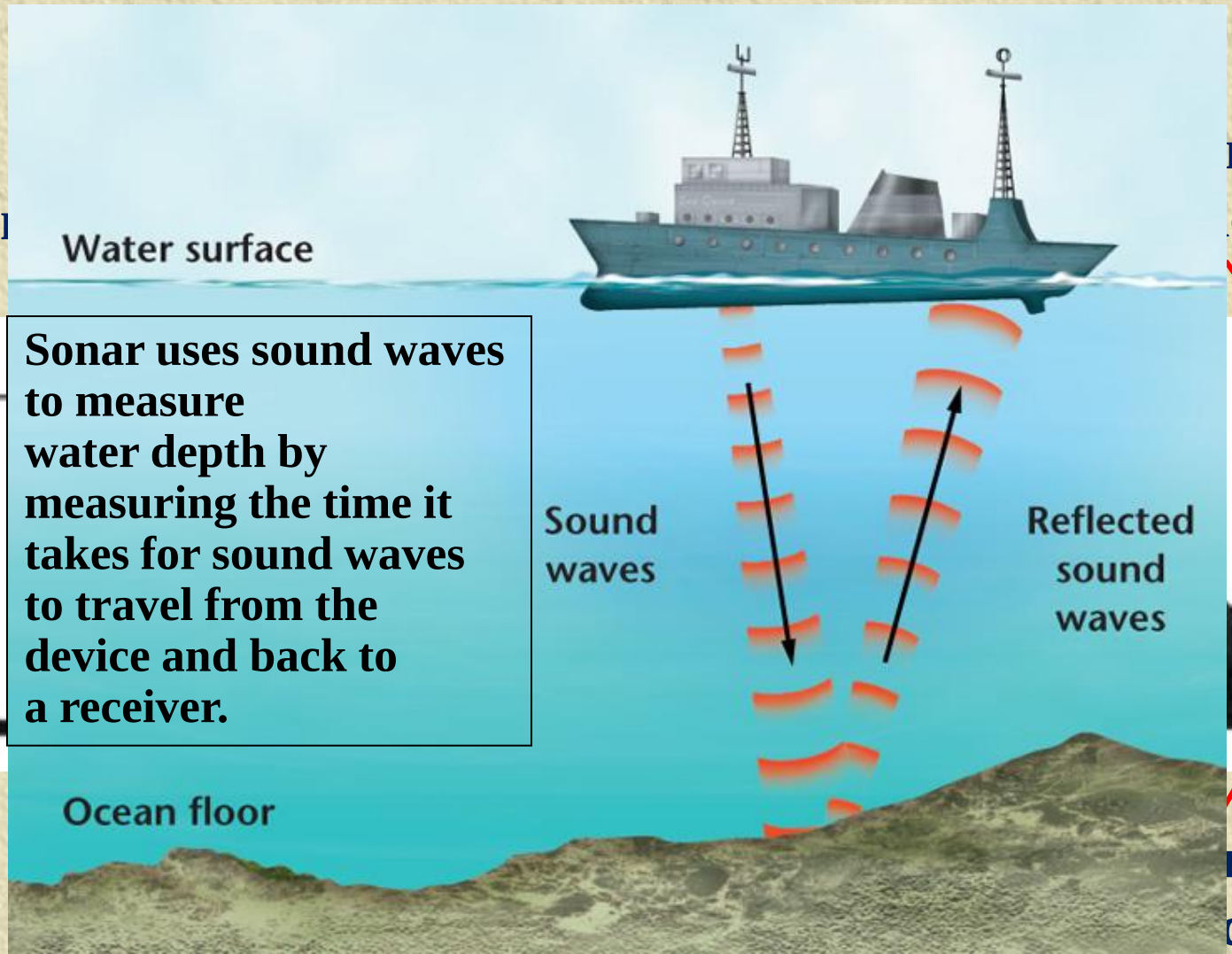

WORLD
OCEAN FLOOR

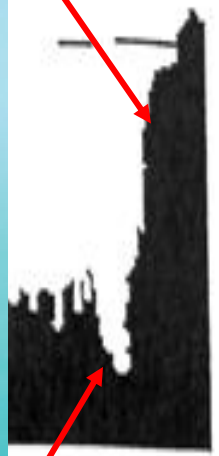
The Evidence is Discovered:

Scientists then used echo soundings hoping they would be able to build up a picture of the ocean floor.



Sonar uses sound waves to measure water depth by measuring the time it takes for sound waves to travel from the device and back to a receiver.





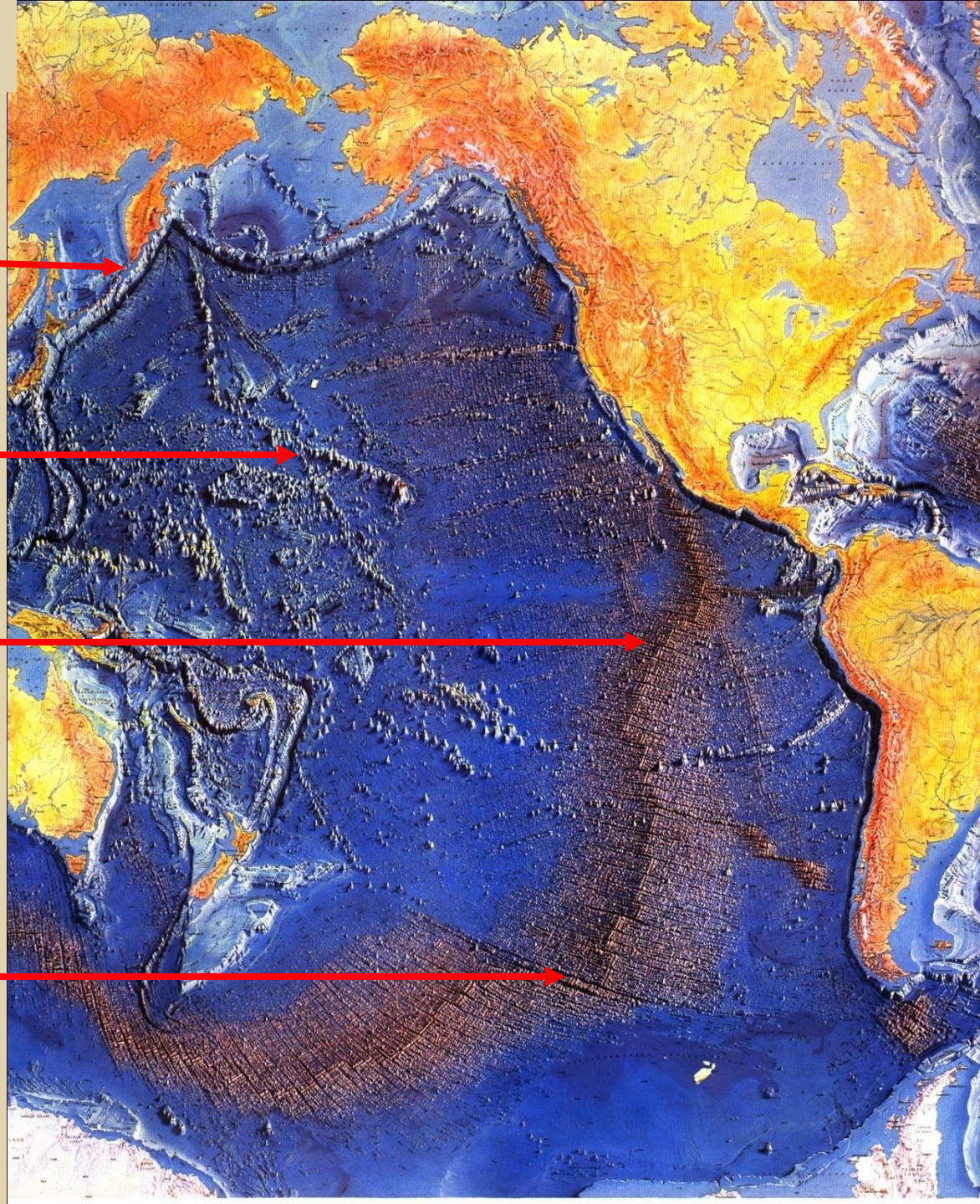
Ocean floor features:

Trenches

Sea mounts

Mountain chains

Fracture zones



The Evidence is Discovered:

The Geomagnetic Time Scale

- In **1963** scientist towed magnetometers behind ships to measure the magnetic field of the ocean floor… they soon revealed an interesting pattern.
  - In places where the magnetic readings of the ocean floor matched Earth's present field, a stronger-than-normal reading (+) was recorded.
  - In places where the magnetic data were reversed in relation to Earth's present magnetic field, a lower-than-normal reading (–) was recorded.

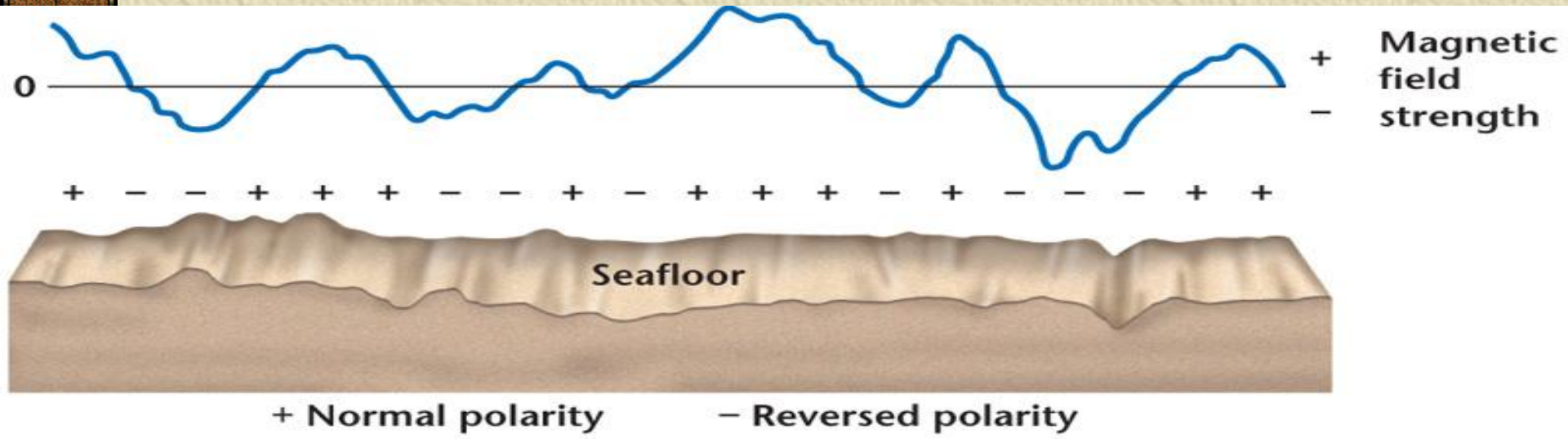
A **magnetic reversal** is a change in Earth's magnetic field.

Paleomagnetism

The Geomagnetic Time Scale

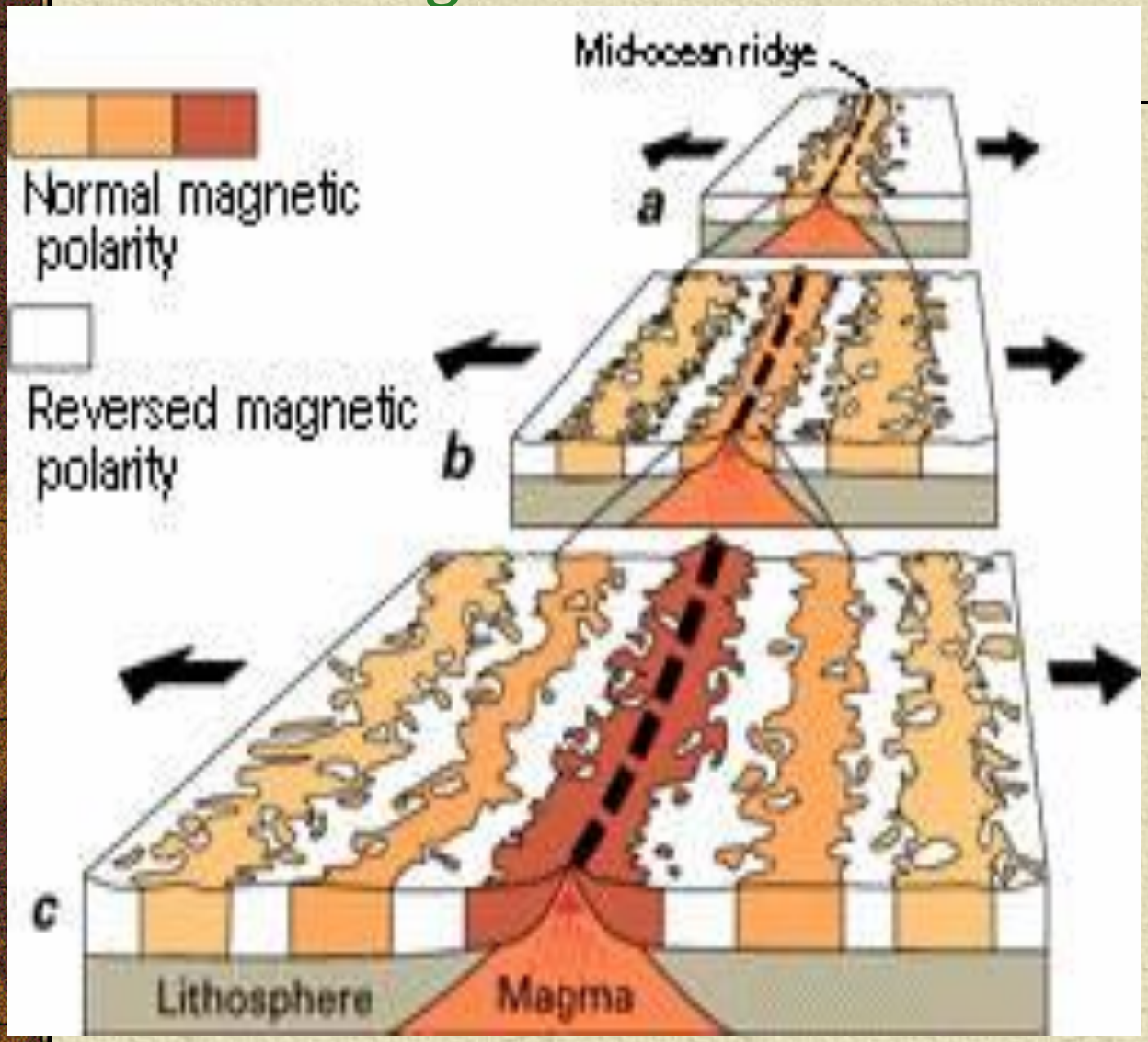
Paleomagnetism is the study of Earth's magnetic record.

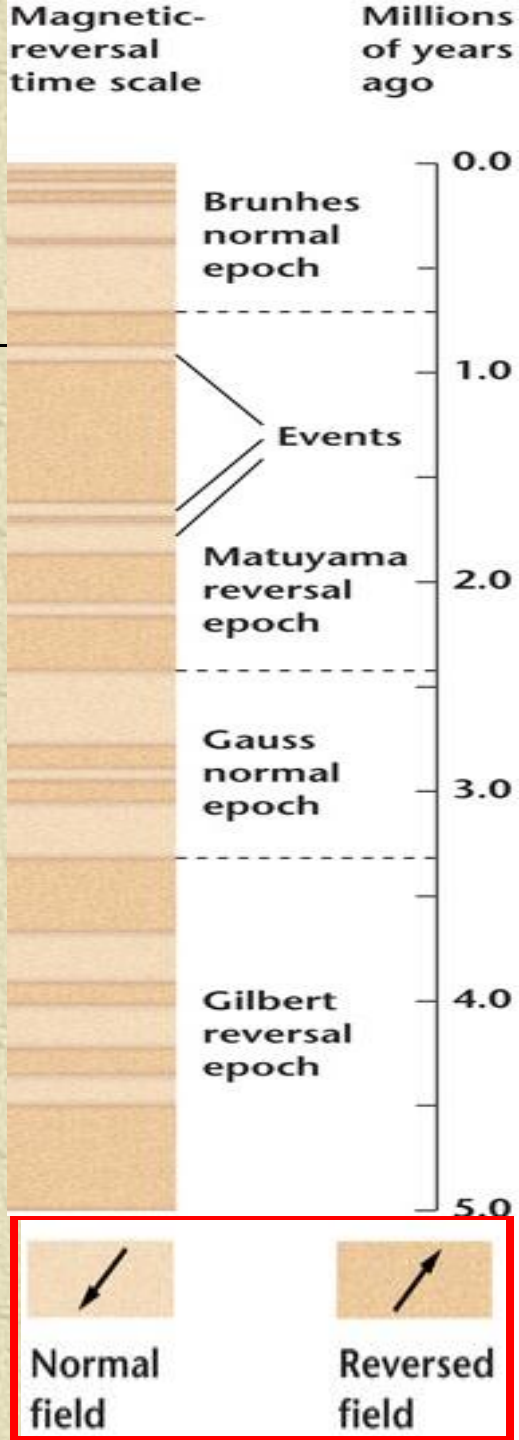
- Rocks containing iron-bearing minerals provide a record of Earth's magnetic field.
  - Basalt, because it is rich in iron-bearing minerals, provides an accurate record of ancient magnetism.



Paleomagnetism

The Geomagnetic Time Scale



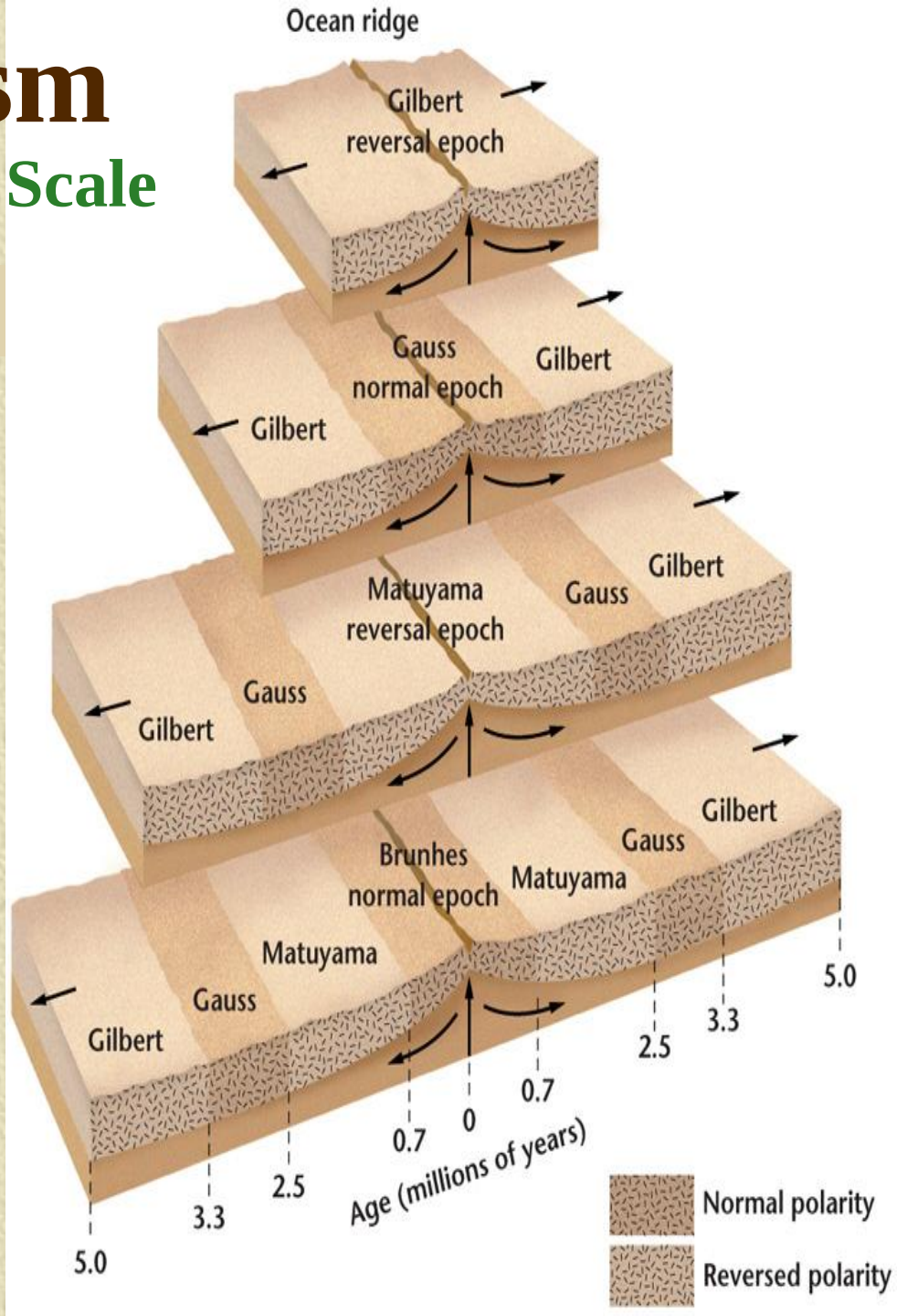


Paleomagnetism

The Geomagnetic Time Scale

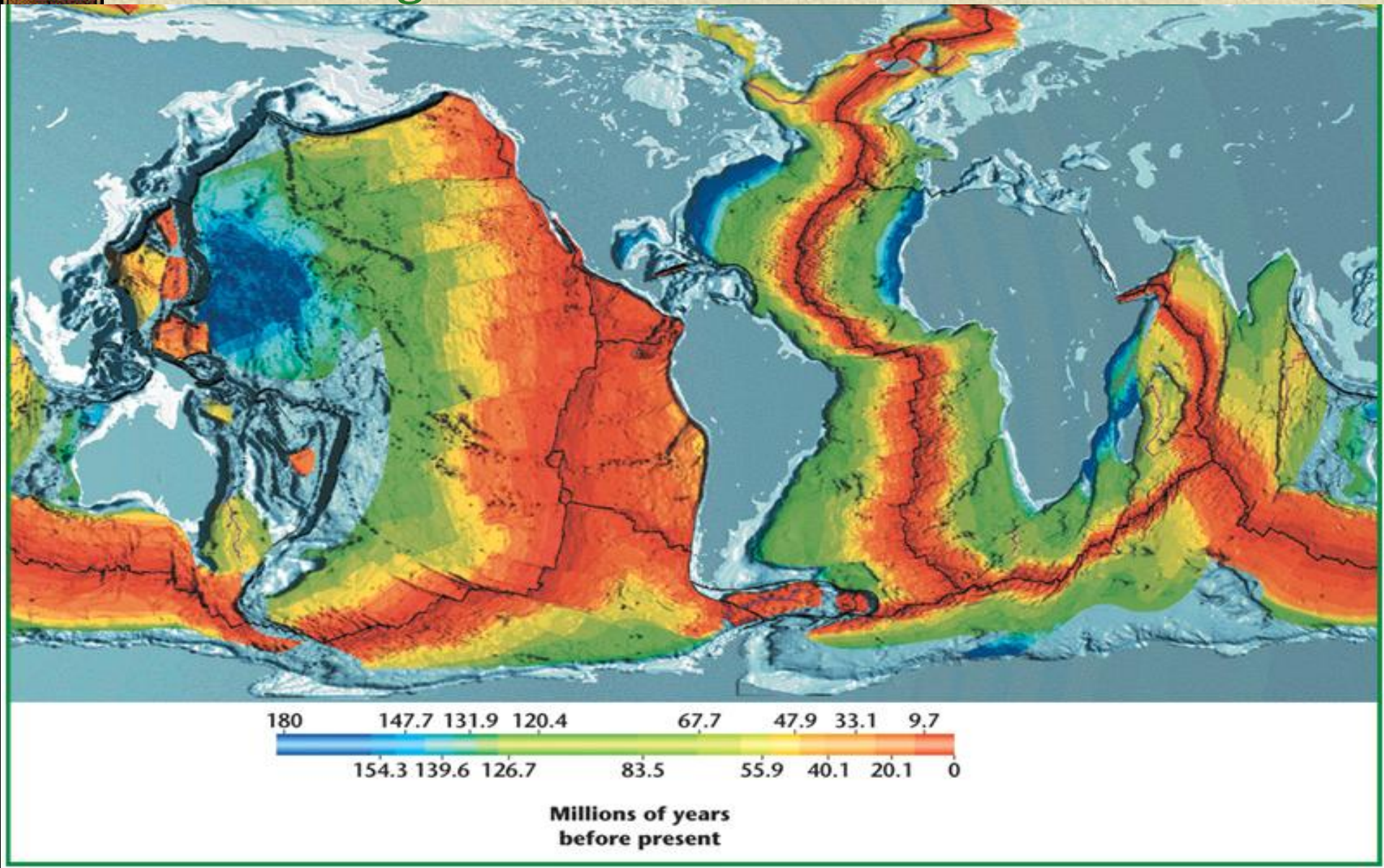
Magnetic Symmetry

- The positive and negative areas of the seafloor form a series of stripes that were parallel to ocean ridges.
- From this match, scientists were able to determine the age of the ocean floor from a magnetic recording and create geologic time maps of the ocean floor.



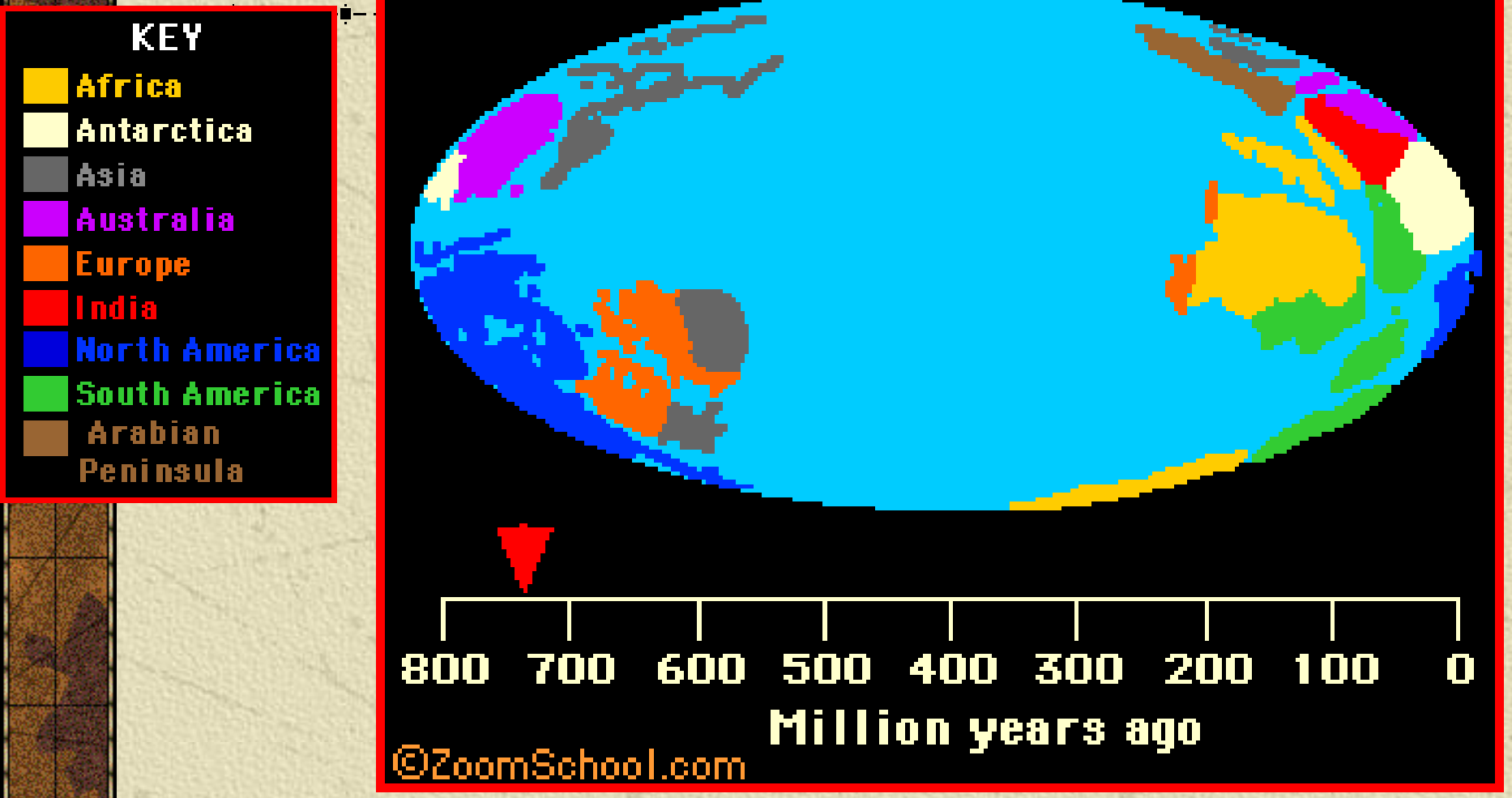
Paleomagnetism

The Geomagnetic Time Scale



Final Conclusion:

- The Seafloor is spreading apart at these mid-ocean ridges pushing the continents with them.
- The ocean floor rock is younger then the continental rock.
- The earth's magnetic poles switch sides and polarity of the rock can determine the time frame in which the rock was formed.



http://www.ucmp.berkeley.edu/geology/anim1.html

-Pop Quiz-

Continental Drift

Questions?

1.) What type of evidence supports Wegener's Hypothesis of Continental Drift?

2.)Describe the process of how seafloor spreading occurs.

3.) What observation first led to Wegner's hypothesis of continental drift

Answers!

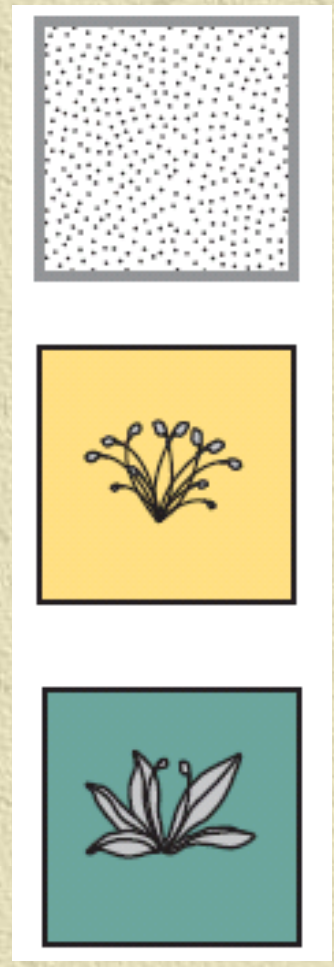
Similar Fossil, Geological, Mid-ocean ridges, Paleomagnetic bands.

Magma pushes up through the Mid-Ocean ridges, cools and forces The oceanic crust to separate.

The similarity of coastlines between continents on either side of the Atlantic Ocean.

DIRECTIONS:

- 1. Label the land masses on each sheet. Color the fossil areas to match the legend below.
- 2. Cut out each of the continents along the edge of the continental shelf (the outermost dark line). Alfred Wegener's evidence for continental drift is shown on the cut-outs. Wegener used this evidence to reconstruct the positions of the continents relative to each other in the distant past.
- 3. Try to logically piece the continents together so that they form a giant supercontinent.
- 4.When you are satisfied with the ‘fit' of the continents, discuss the evidence with your partners and decide if the evidence is compelling or not. Explain your decision and reasoning on the evidence.



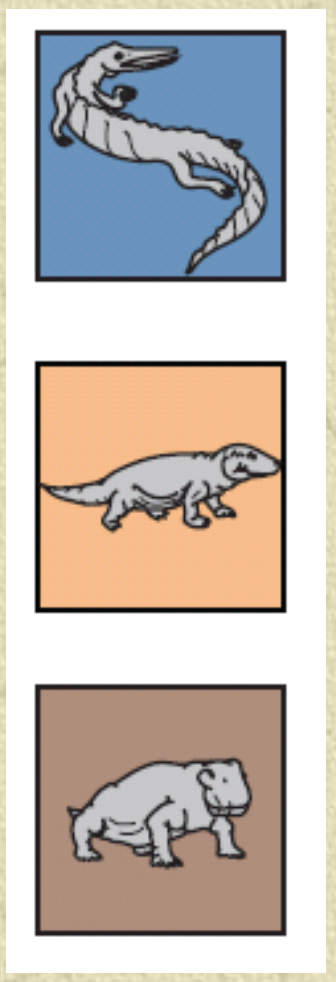


Plate Tectonics Emerges:

- **1968, The Theory of Plate Tectonics:**
  - **-**The **Lithosphere** is made up of plates that float on the **Asthenosphere** and the plates move by convection currents.
  - Lets take a closer look at both the Lithosphere and the Asthenosphere

The Lithosphere is made up of 3 parts

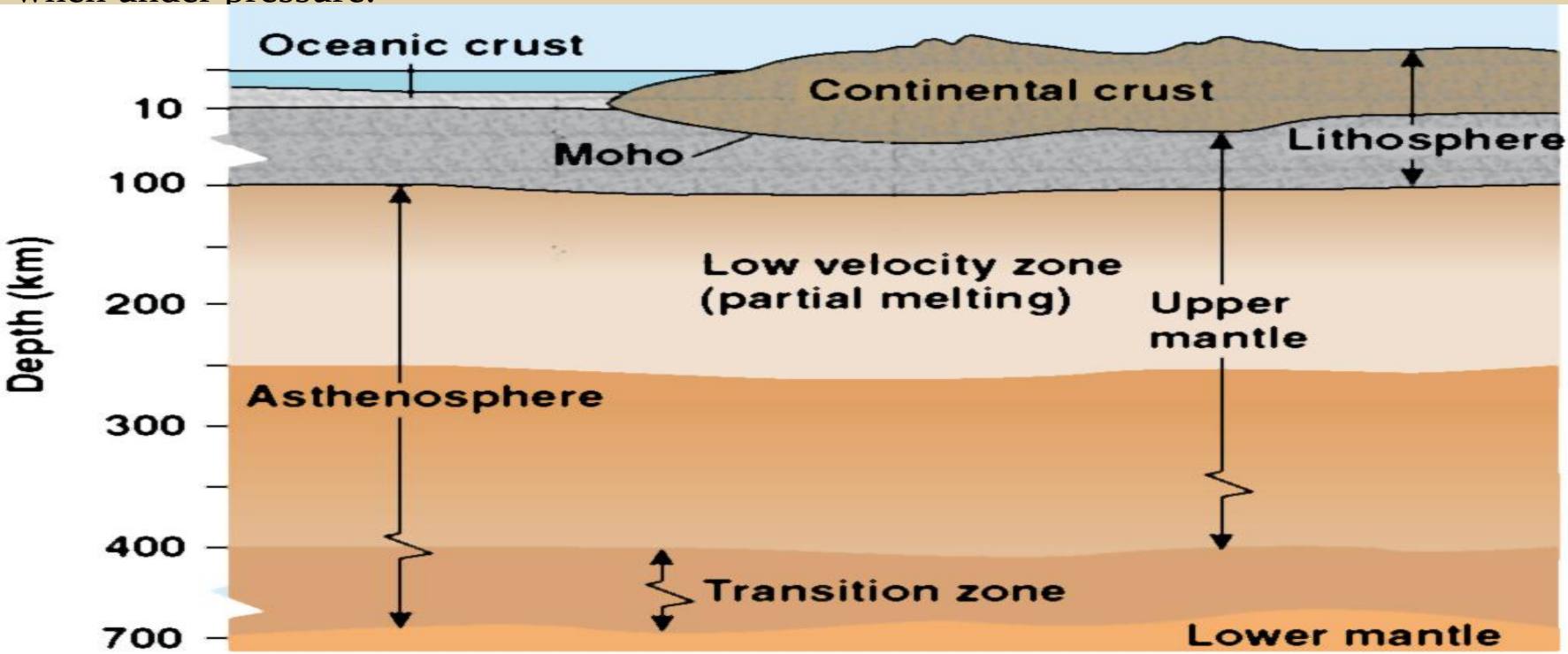
1.) Oceanic Crust: contains Very Dense ocean floor material

2.) Continental Crust: contains Less Dense continental material

3.) Rigid Upper Mantle: the thins outer shell of the earth that supports both oceanic and continental crusts

Asthenosphere:

The layer of solid plastic type rock under the Lithosphere that slowly flows (like putty) when under pressure.



The interior of Planet Earth

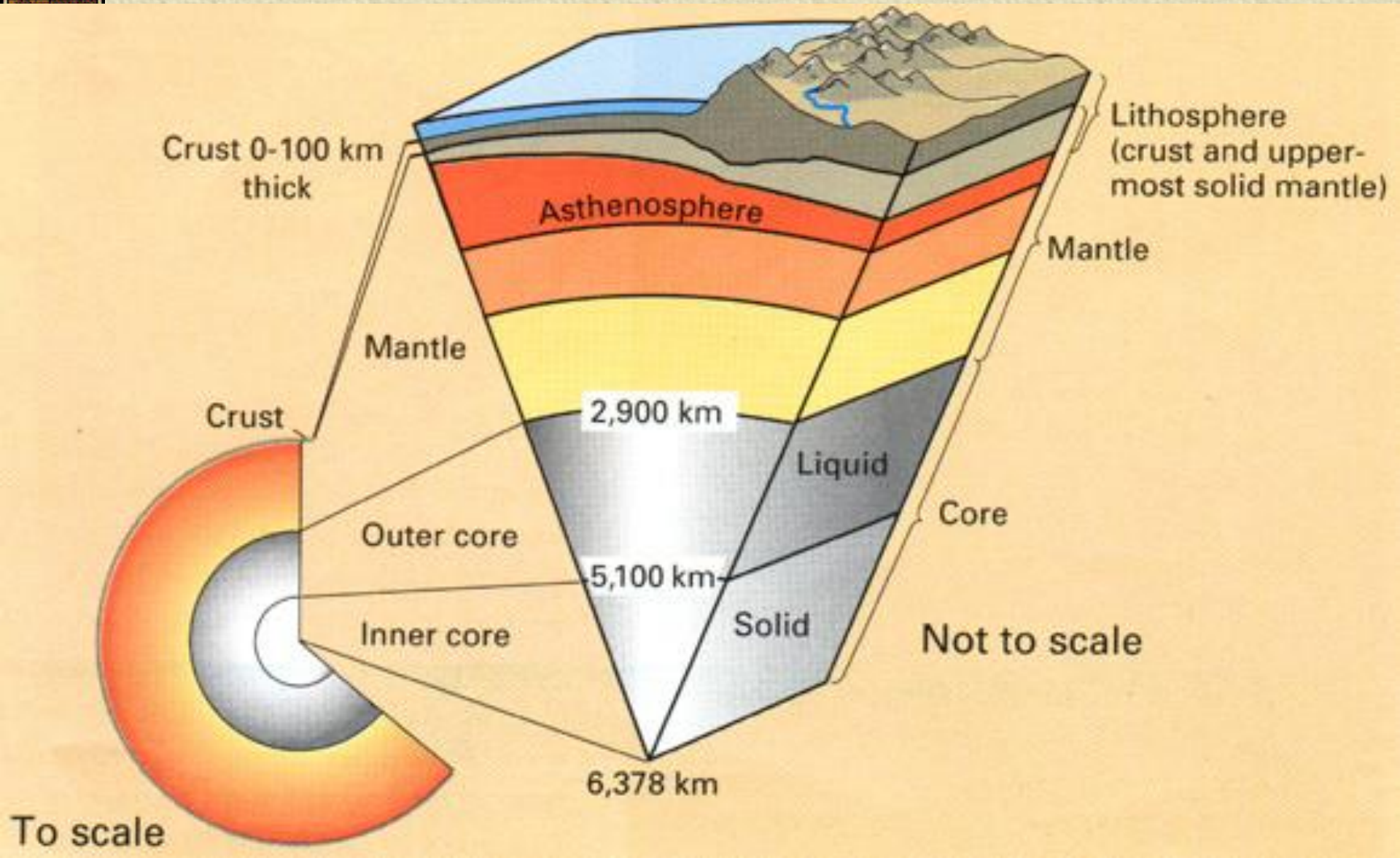
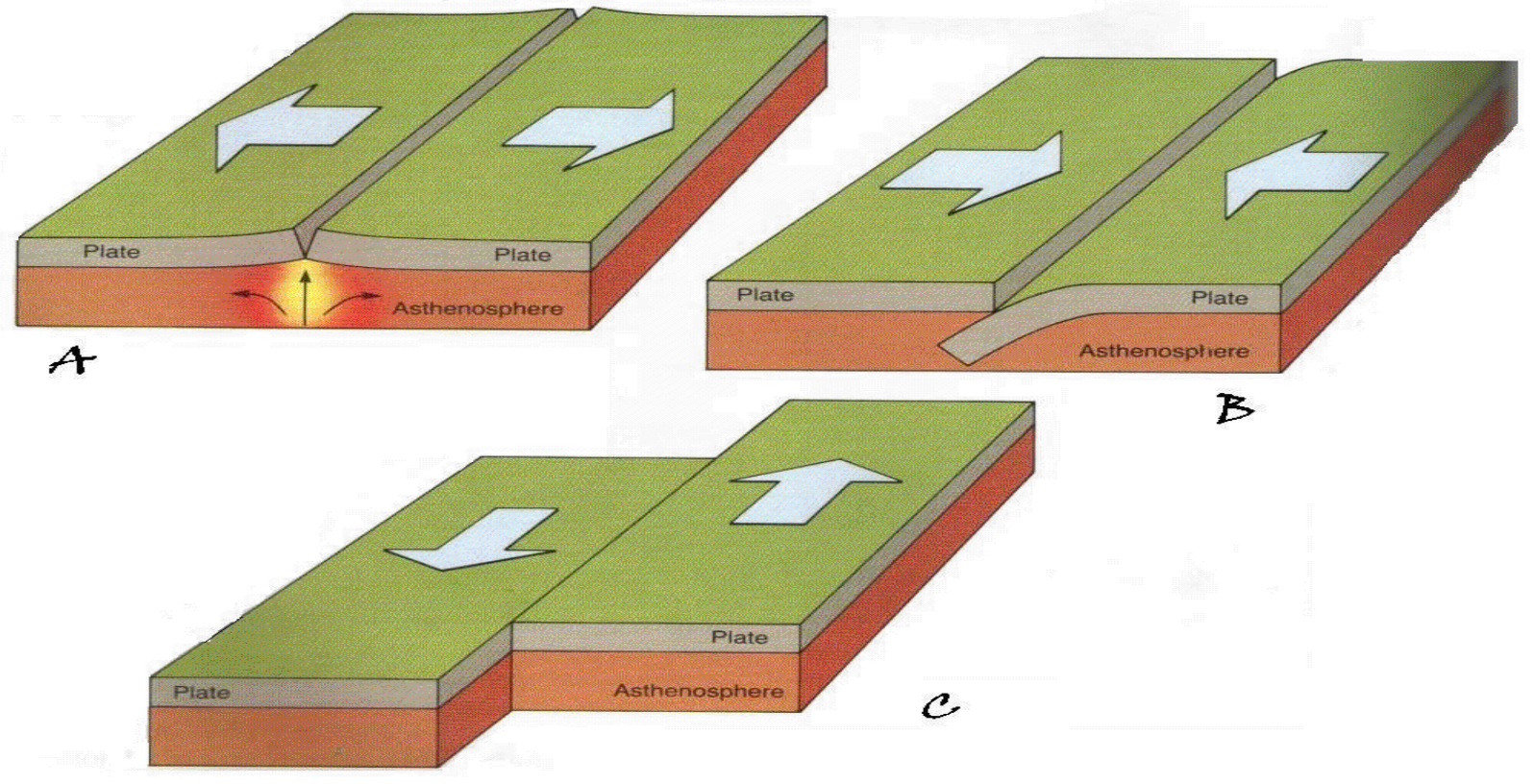
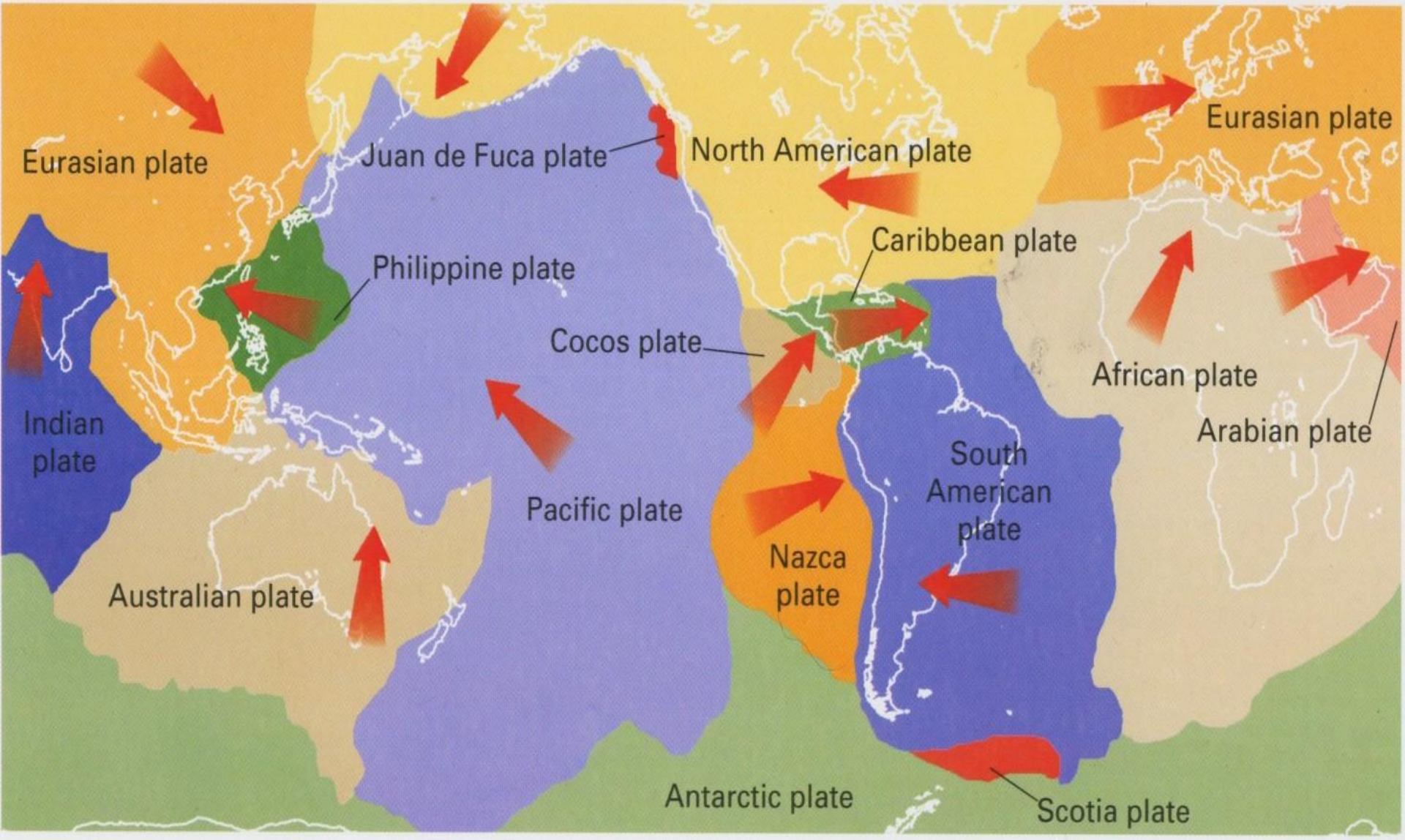


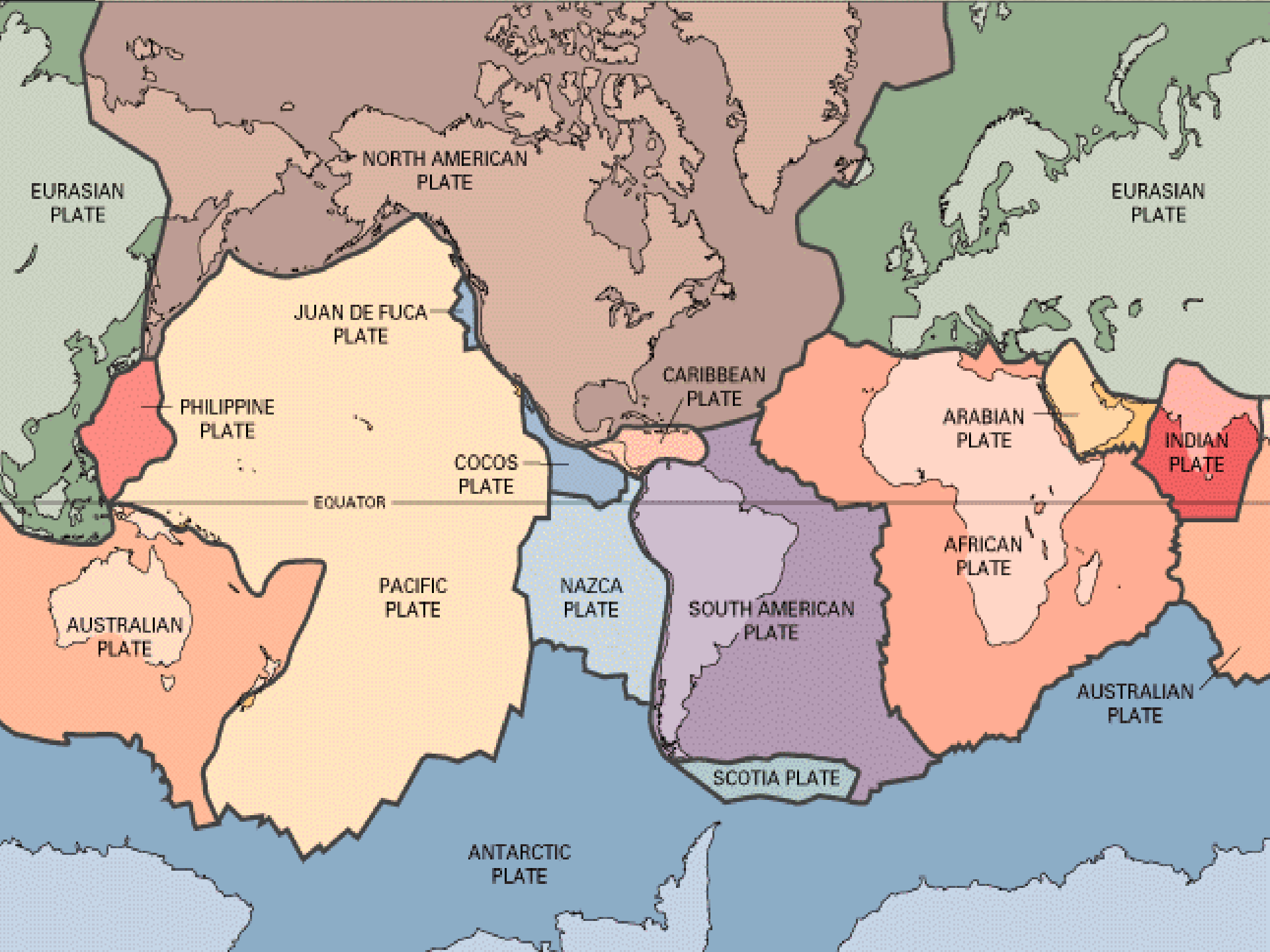
Plate Boundaries of the Earth:

-*30* moving plates have been identified to date. Some ***move away*** from each other, some ***collide*** with each other, and some ***grind*** past each other.



The Major Plate Boundaries




EURASIAN PLATE
NORTH AMERICAN PLATE
EURASIAN PLATE
JUAN DE FUCA PLATE
CARIBBEAN PLATE
PHILIPPINE PLATE
ARABIAN PLATE
INDIAN PLATE
COCOS PLATE
EQUATOR
AFRICAN PLATE
PACIFIC PLATE
NAZCA PLATE
SOUTH AMERICAN PLATE
AUSTRALIAN PLATE
AUSTRALIAN PLATE
SCOTIA PLATE
ANTARCTIC PLATE

The 3 types of Plate Boundaries:

1.)**DIVERGENT Boundary:** Created when two plates spread from each other.

Mid-Ocean Ridges & Rift Valleys:

(The Atlantic Ocean and The Red Sea)

2.)**CONVERGENT Boundary:** Created when two plates collide with each other

Volcanoes and Mountain Ranges form this way

***Subduction Zones:** The region along a boundary when oceanic plates moves under a continental plate.

***Ocean Trench:** **A deep trench that forms along subduction zones**.

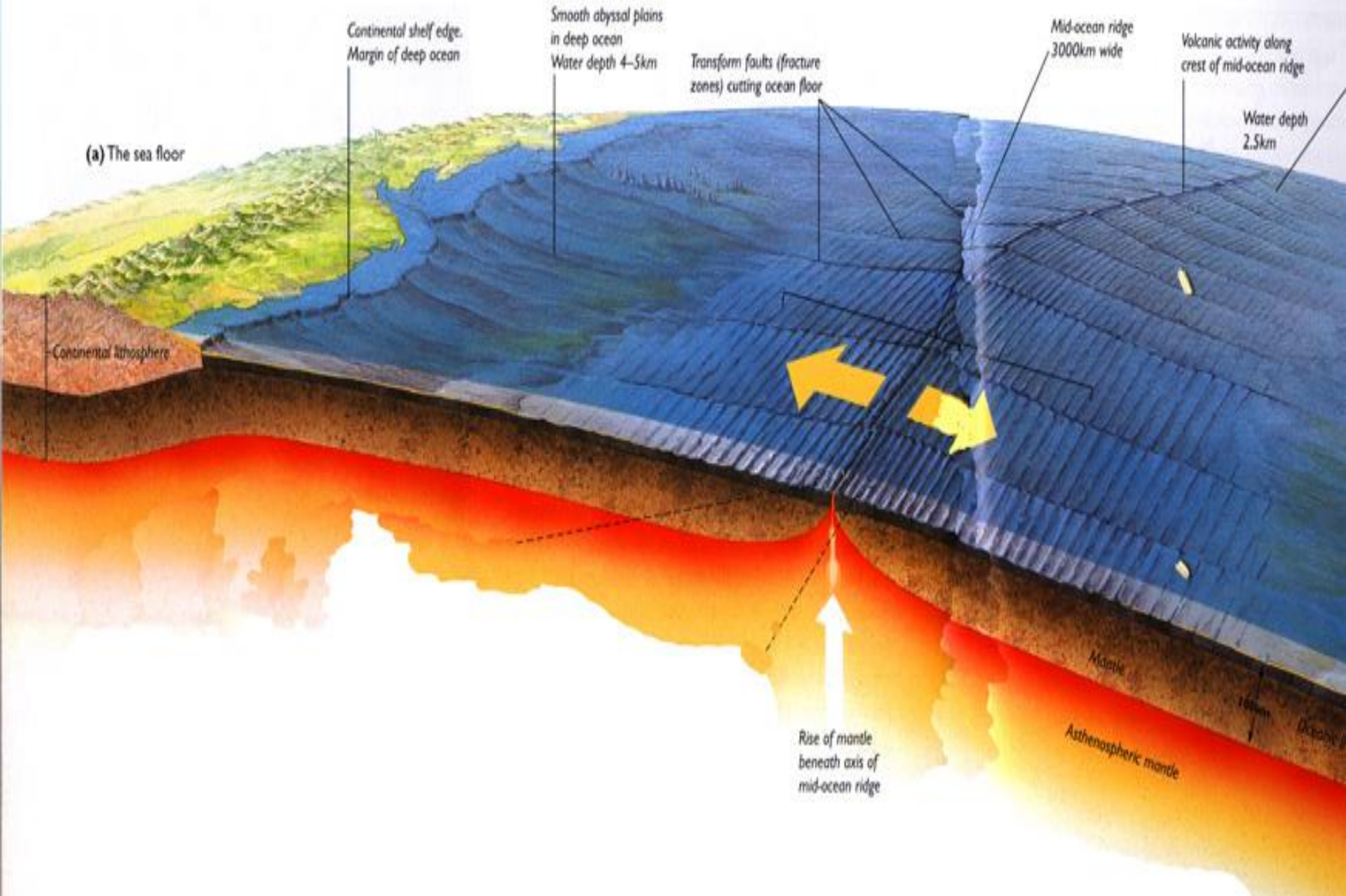
3.)**TRANSFORM FAULT Boundary:** Created when two plates grind past each other.

(San Andreas Fault: California)

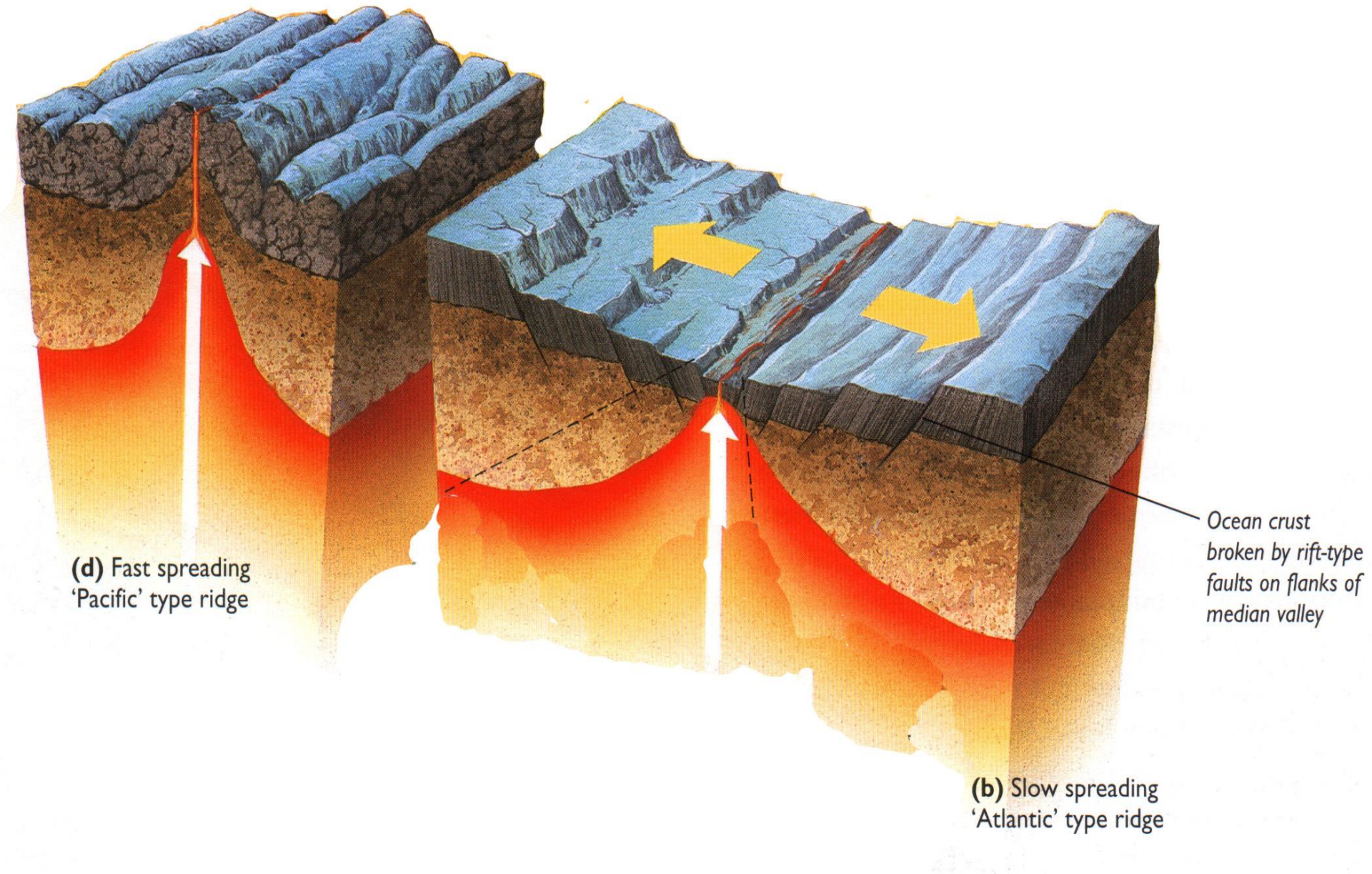
Divergent

plate boundaries

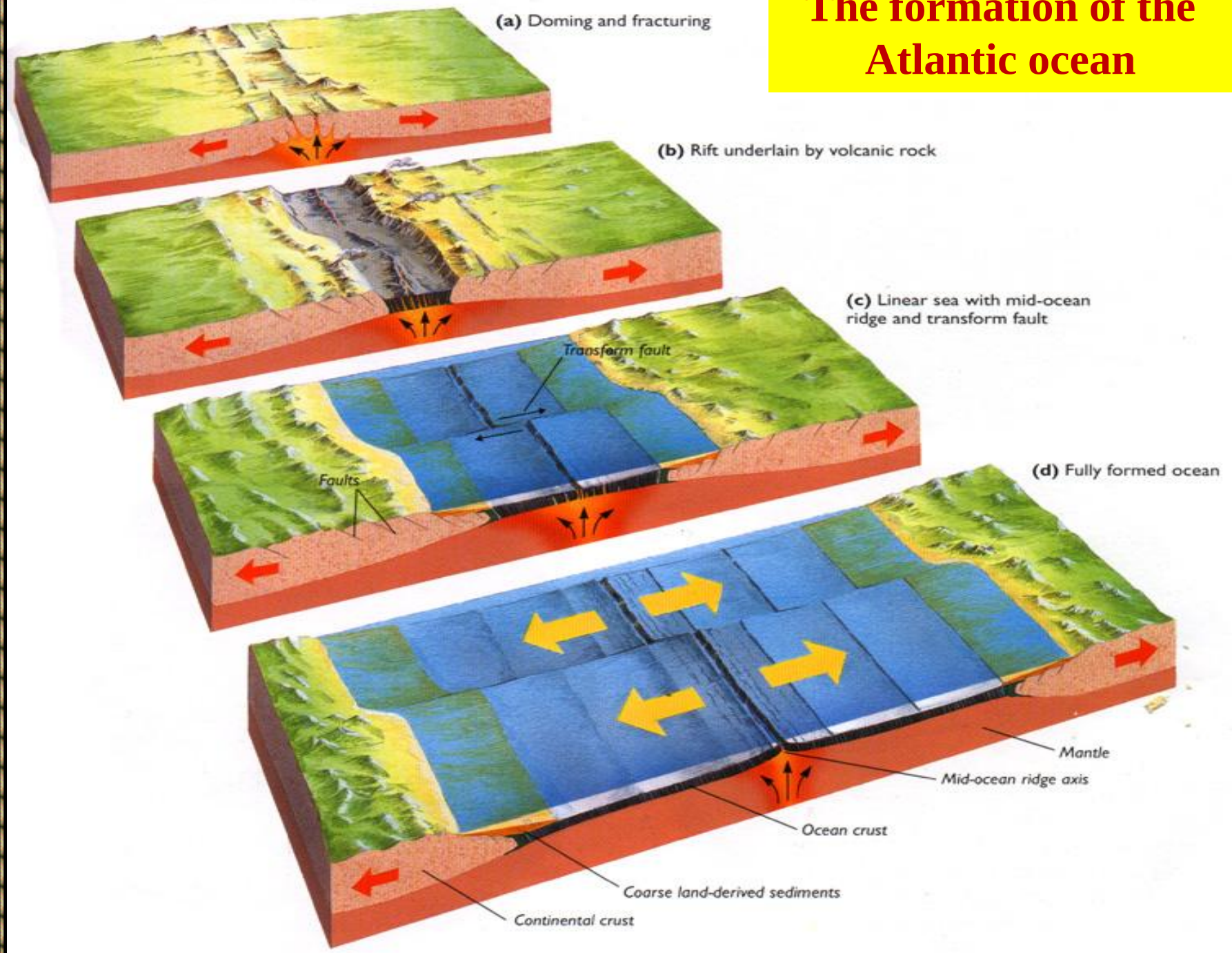
The ocean crust



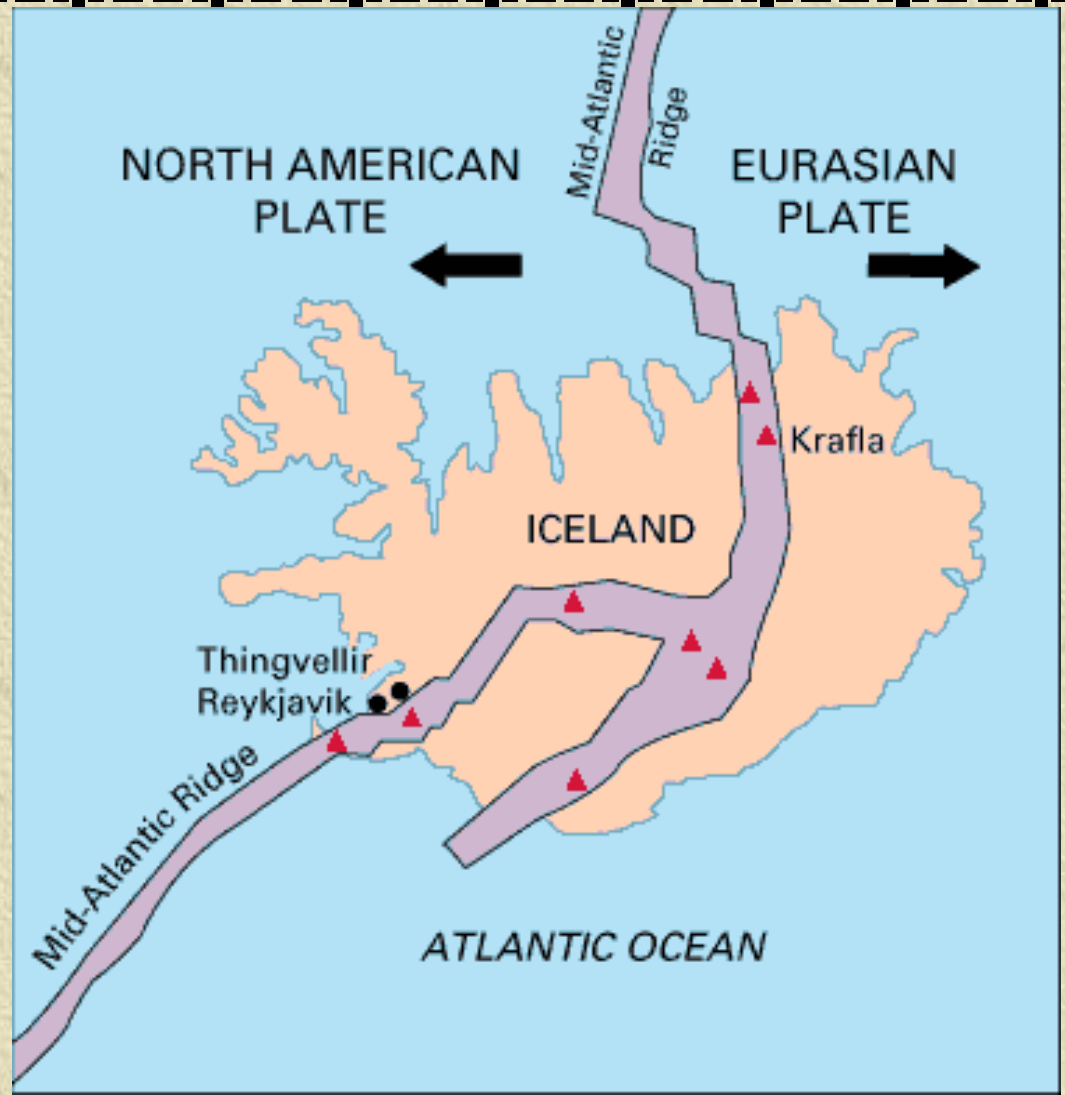
New basaltic magma rises to the surface along the ridge forming new oceanic crust



The formation of the Atlantic ocean



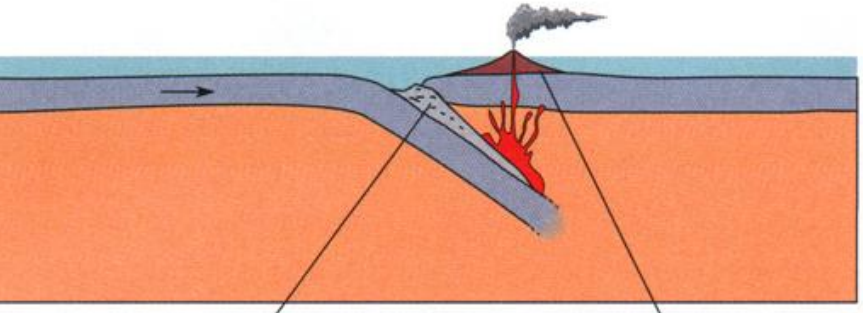
ICELAND Lies in the Middle of a Divergent Boundary Zone



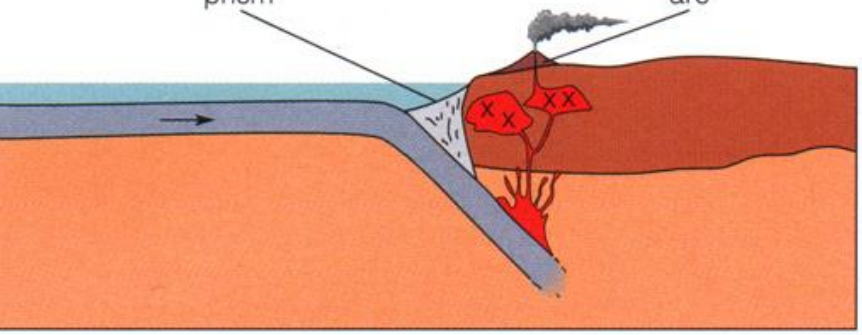
Convergent

plate boundaries

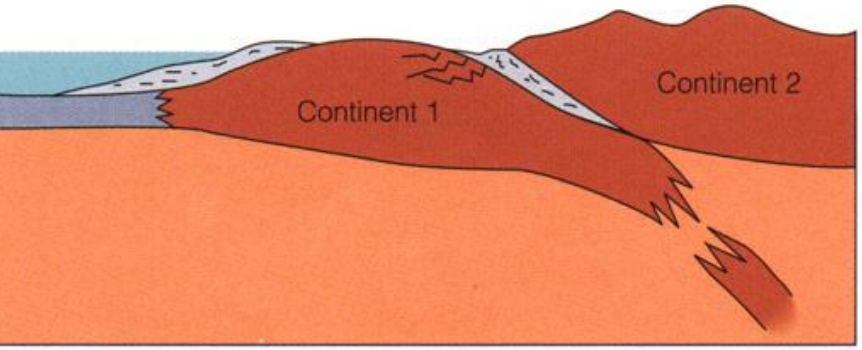
3 Types of Convergent plate boundaries



(a)



(b)



(c)

Oceanic-Oceanic

E.g. Japan, New Zealand

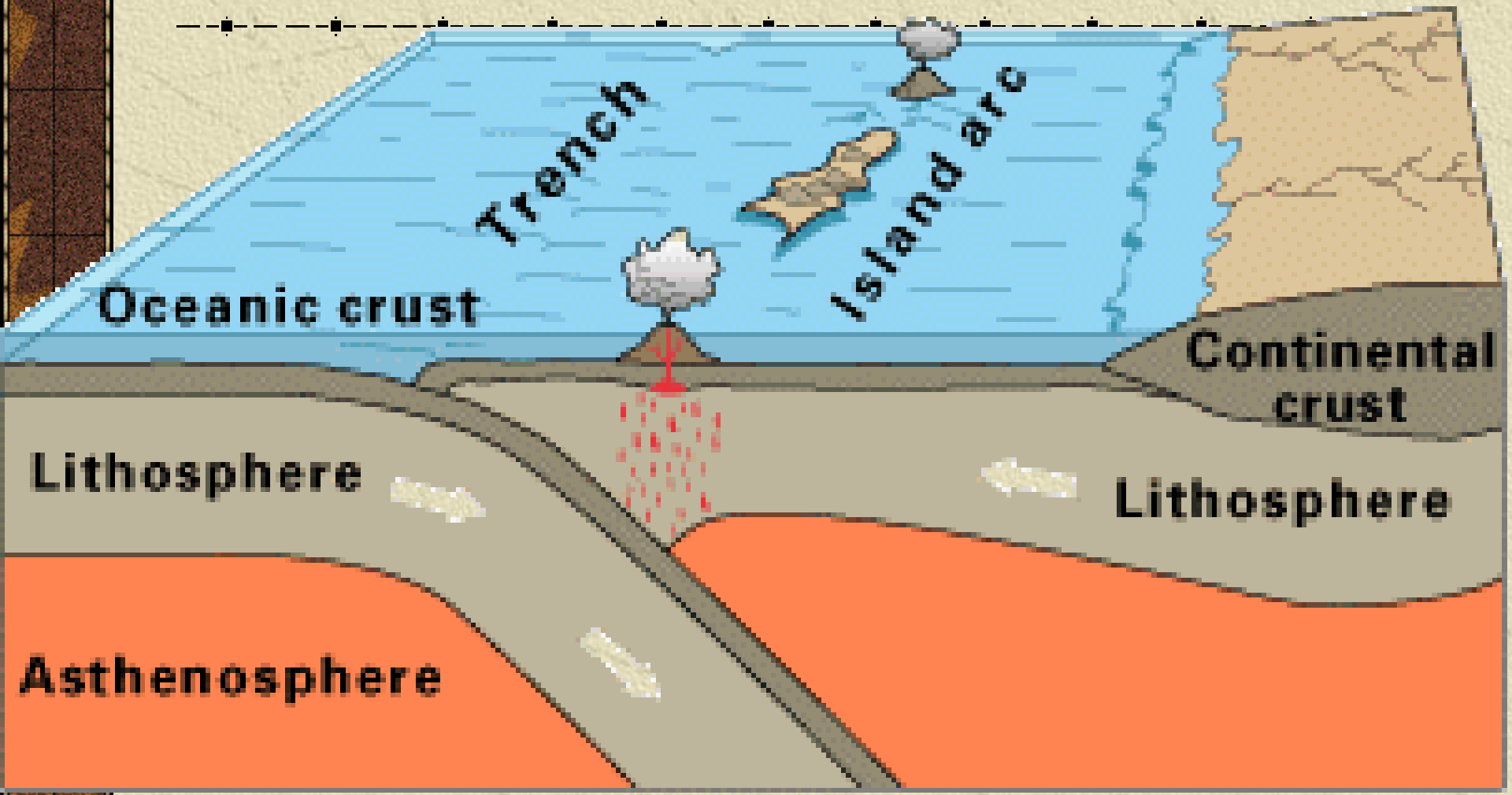
Oceanic-Continental

E.g. Andes, Sierra Nevada's

Continental-Continental

E.g. Himalayas

Oceanic-Oceanic convergence

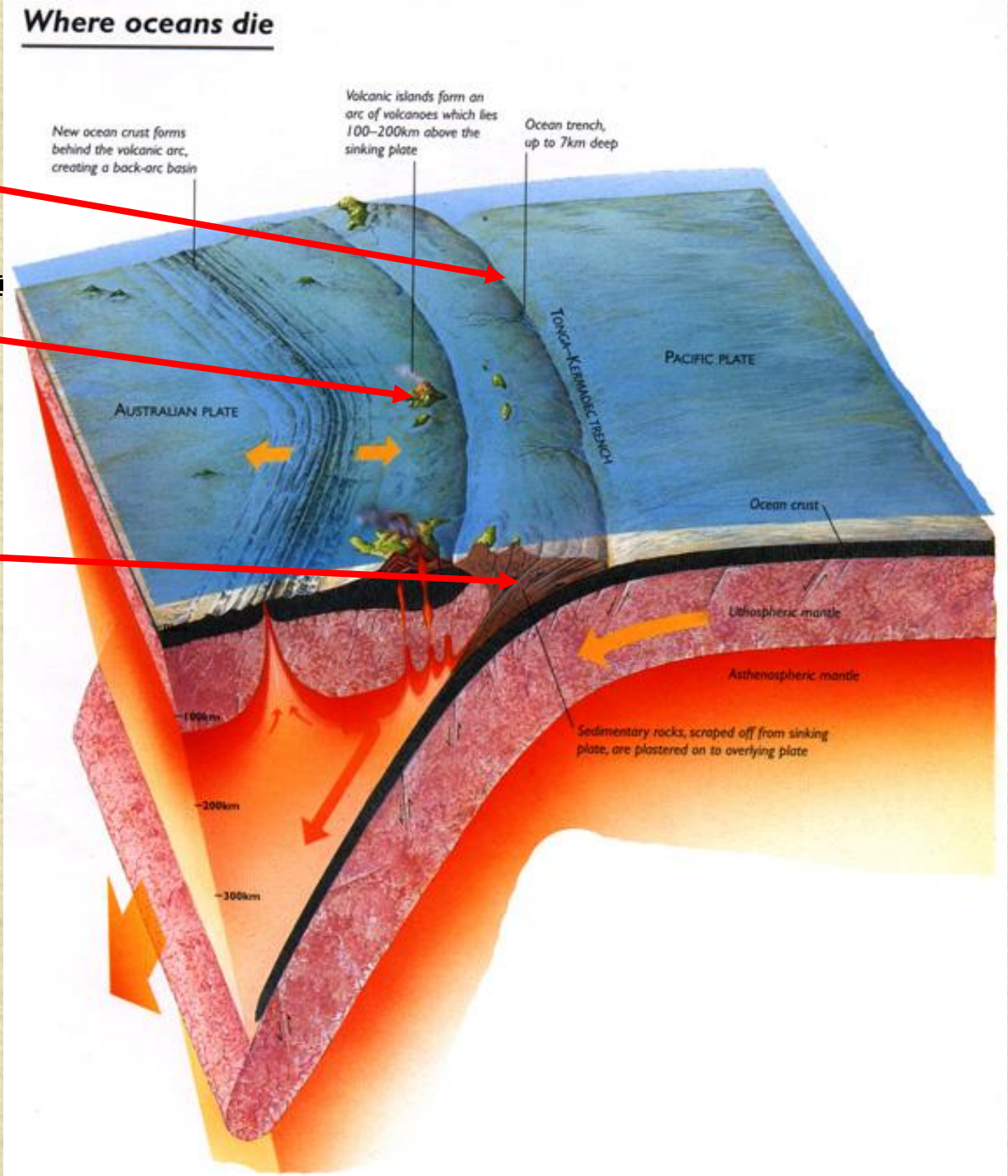


Oceanic-oceanic convergence

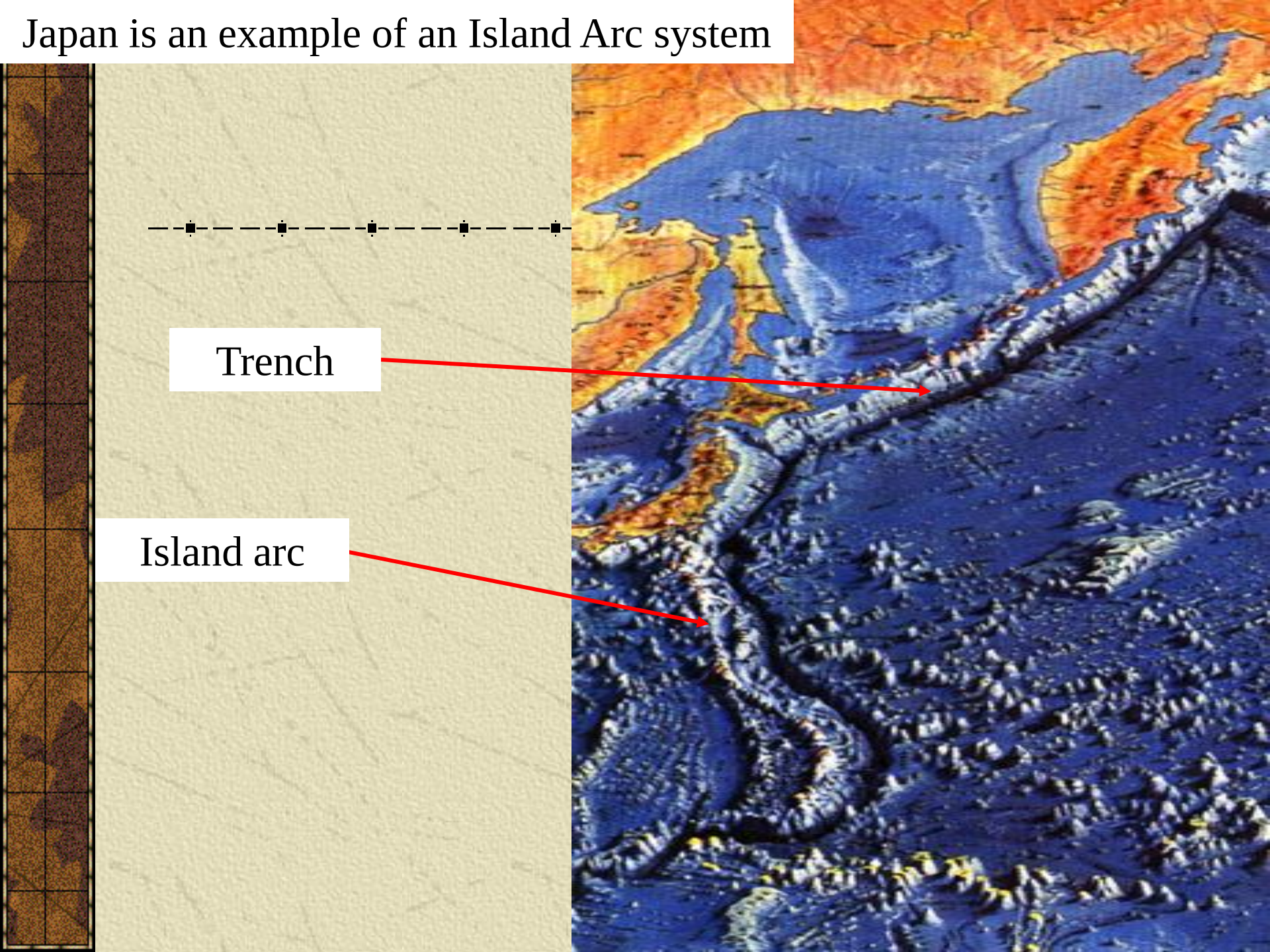
Trench

Island arc

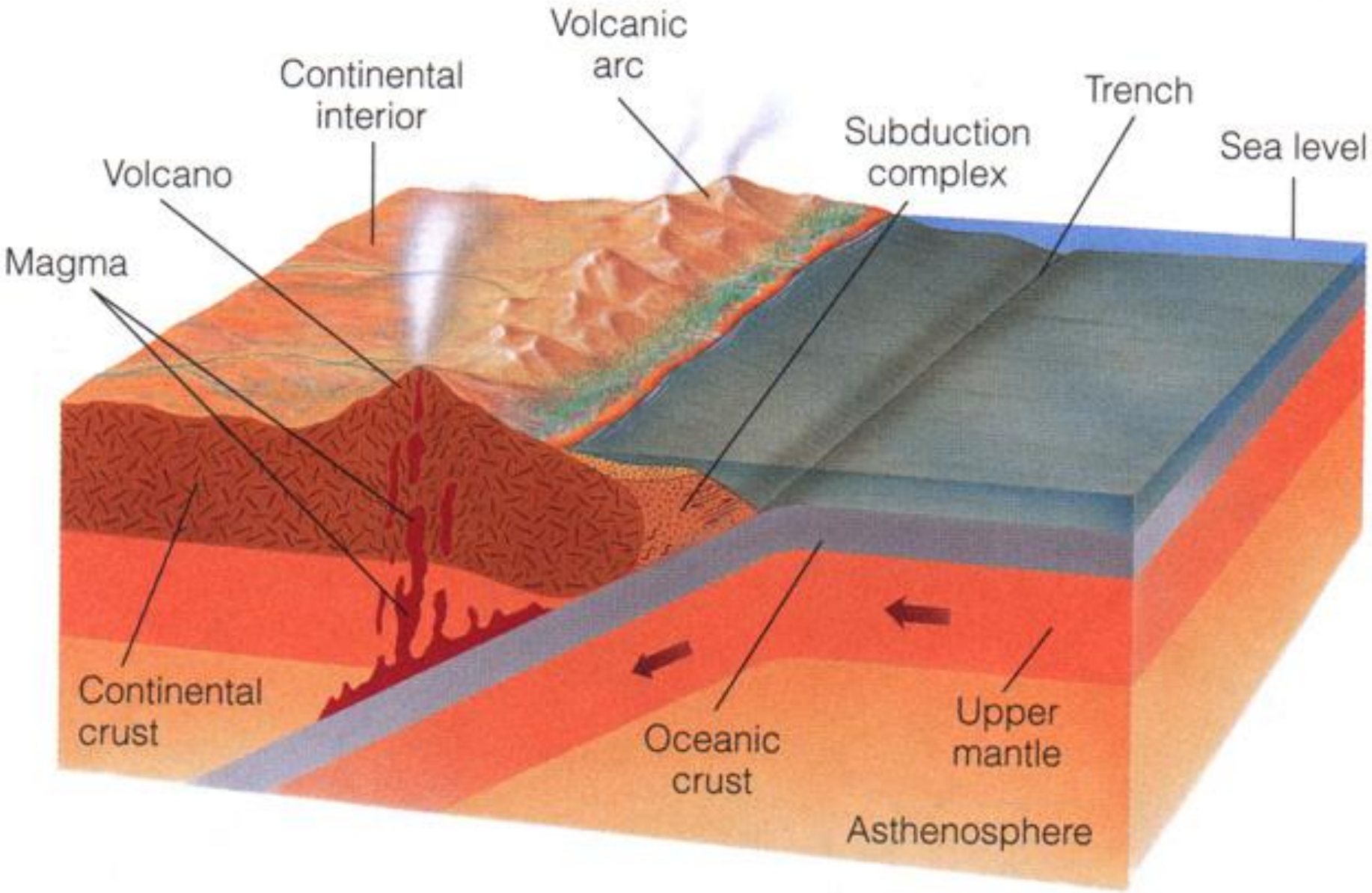
Piled up sedimentary rock



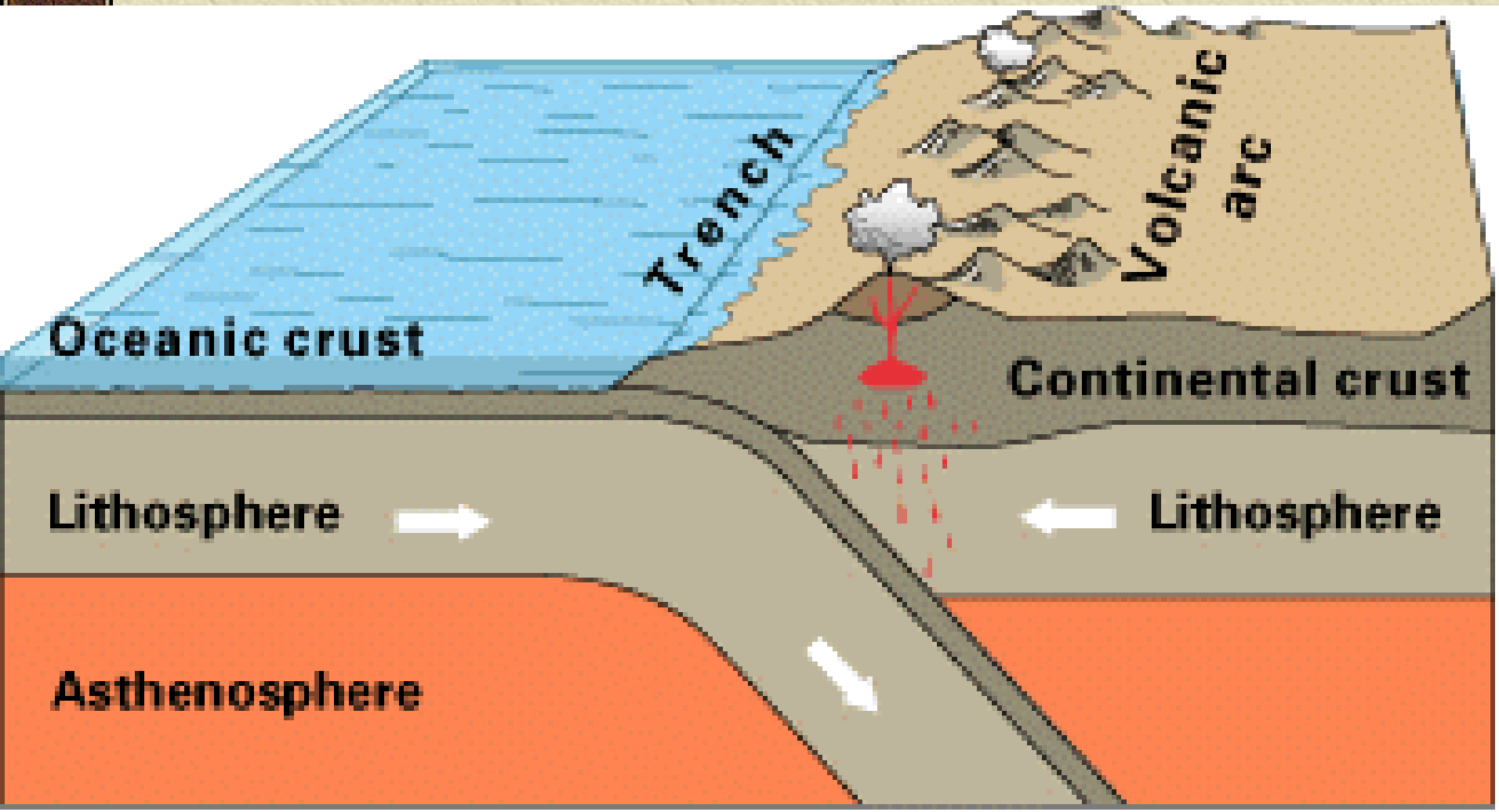
Japan is an example of an Island Arc system



Oceanic - Continental convergence

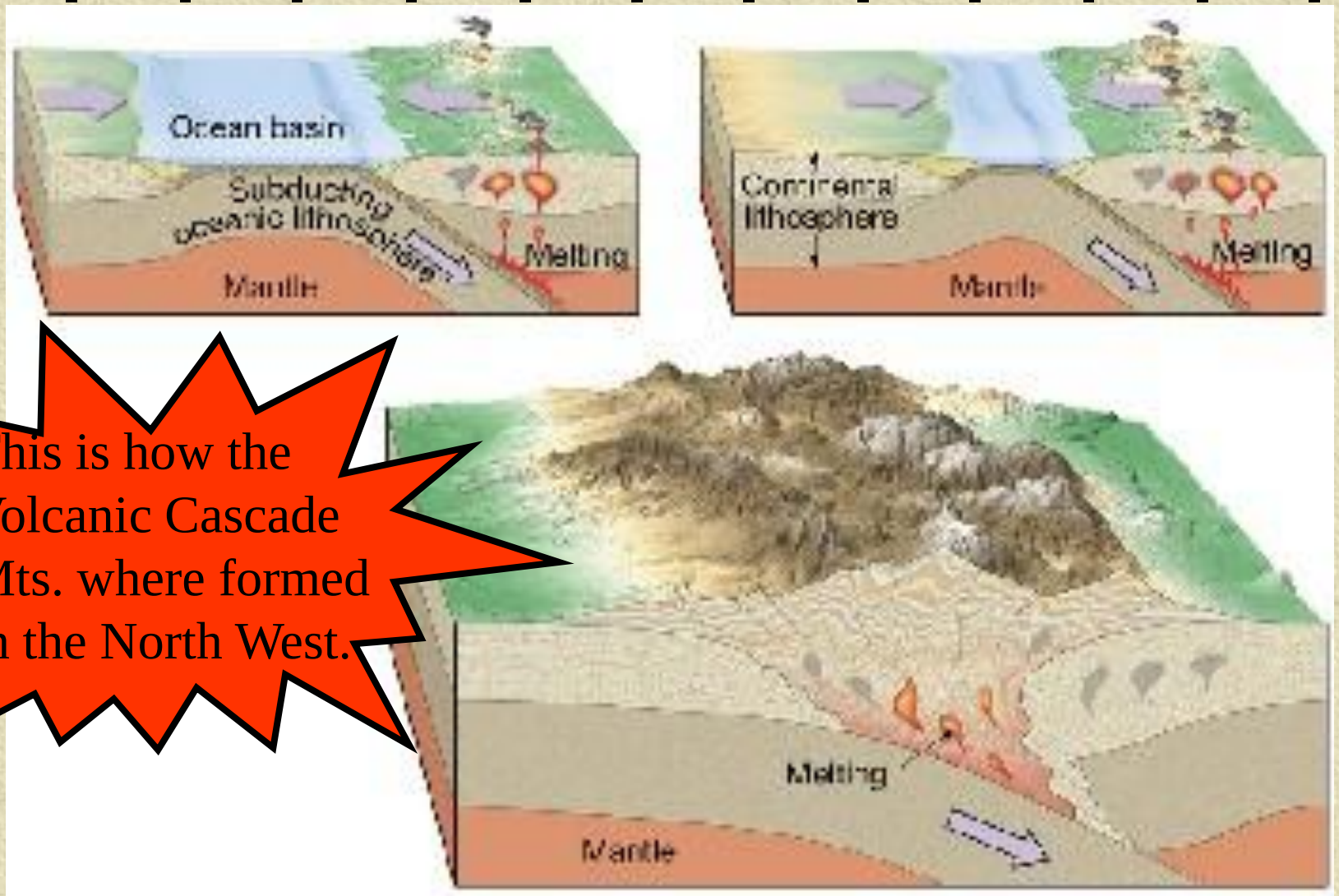


Subduction Zone:



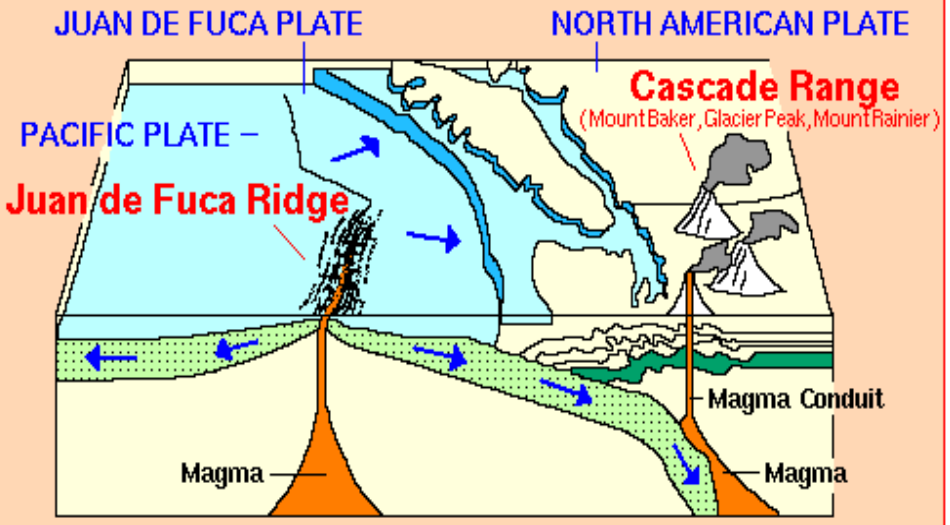
Oceanic-continental convergence

Oceanic & Continental Convergent Boundary Zone



This is how the Volcanic Cascade Mts. where formed in the North West.

Juan de Fuca Ridge – Cascade Range



Juan de Fuca Ridge

The boundary between the Pacific and Juan de Fuca Plates is marked by a broad submarine mountain chain about 500 kilometers long (300 miles), known as the Juan de Fuca Ridge. Young volcanoes, lava flows, and hot springs were discovered in a broad valley less than 8 kilometers wide (5 miles) along the crest of the ridge in the 1970's. The ocean floor is spreading apart and forming new ocean crust along this valley or "rift" as hot magma from the Earth's interior is injected into the ridge and erupted at its top.

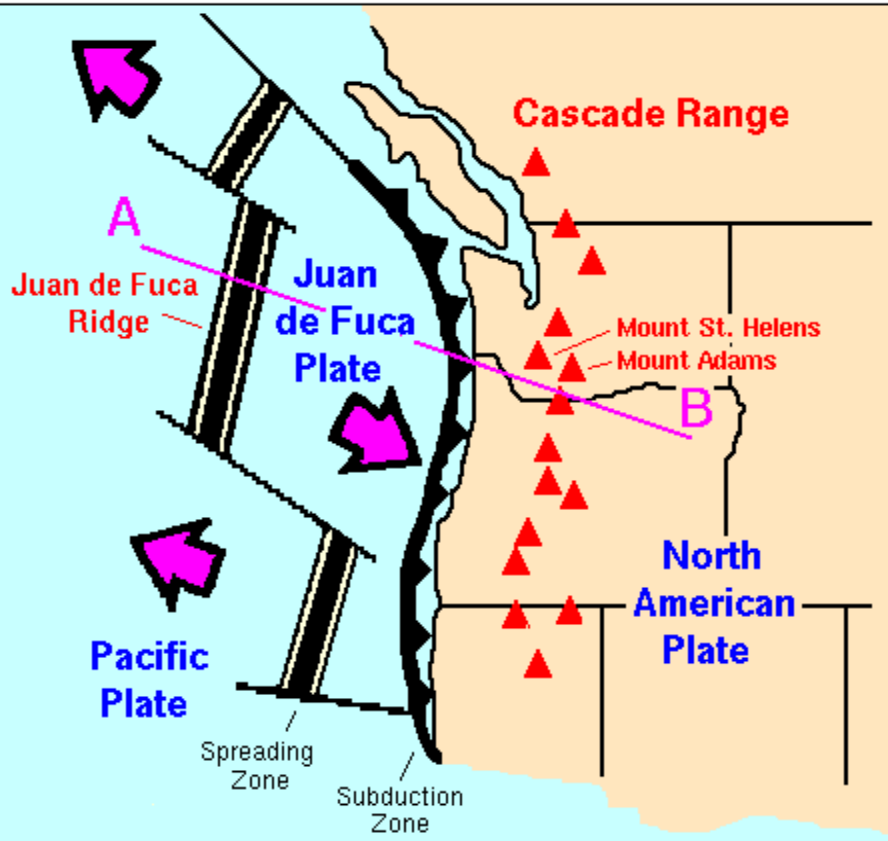
Cascade Range

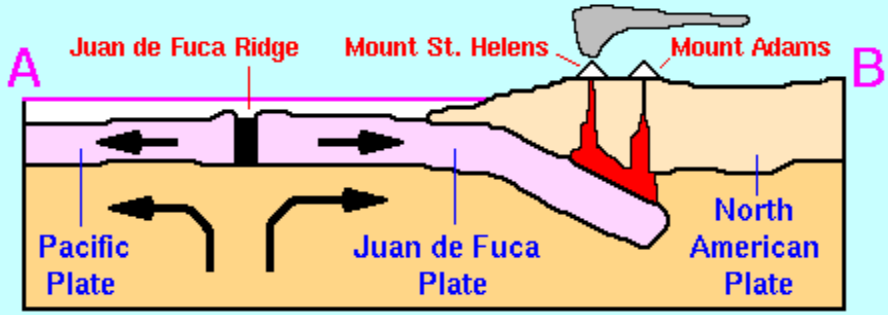
In the Pacific Northwest, the Juan de Fuca Plate plunges beneath the North American Plate. As the denser plate of oceanic crust is forced deep into the Earth's interior beneath the continental plate, a process known as "subduction", it encounters high temperatures and pressures that partially melt solid rock. Some of this newly formed magma rises toward the Earth's surface to erupt, forming a chain of volcanoes above the subduction zone.

USGS

Topinka, USGS/CVO, 1999, Modified from: Brantley, 1994, Volcanoes of the United States, USGS General Interest Publication 376-846

Plate Tectonics – Cascade Range





USGS

Topinka, USGS/CVO, 1999, Modified from: Tilling, 1985, Volcanoes: USGS General Interest Publication

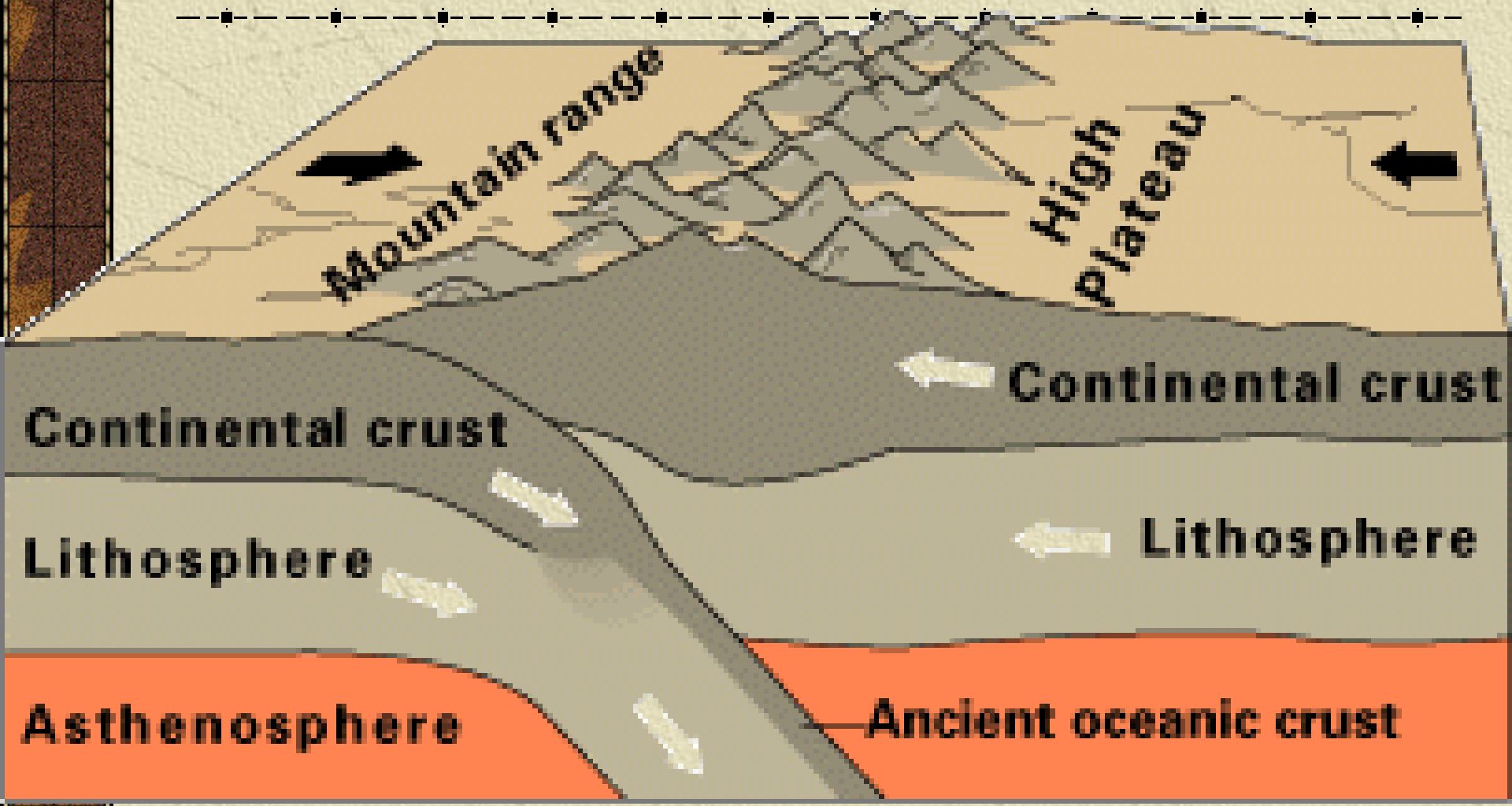
Mount Rainier the highest peak in the Cascade Range, which runs through southwestern Canada and the northwestern United States. The dormant, glacier-capped volcano rises to a height of (14,410 ft) in western Washington. The mountain's slopes support 25 named glaciers, the thickest of which is the Carbon Glacier, at (705 ft).

The History of the Bathyscaph

Finding the Deepest place on Earth!

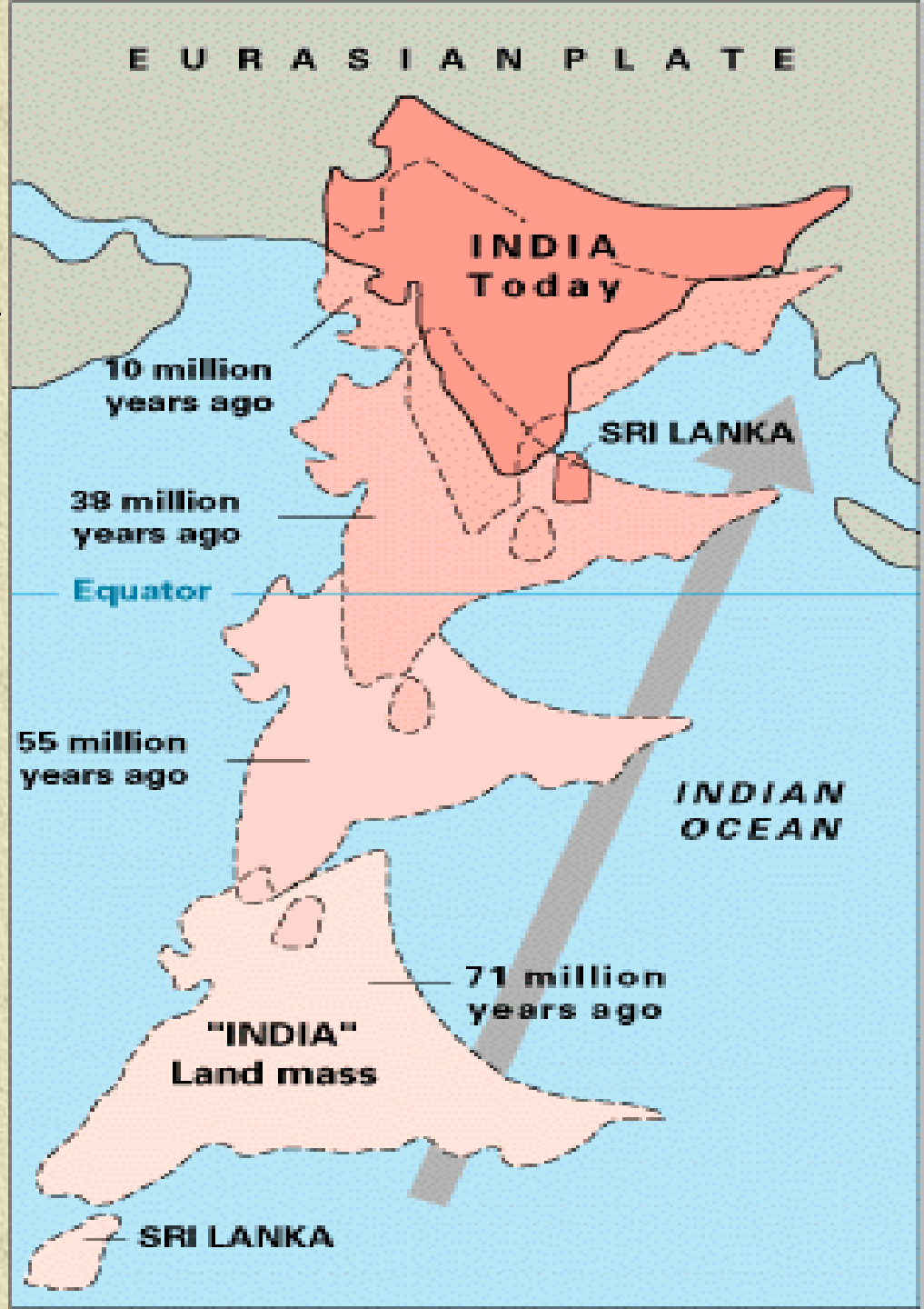
The bathyscaph, designed by Belgian scientist Auguste Piccard (1884-1962), was not suspended from a surface vessel but rather attached to a free-floating tank. (The tank was filled with petroleum liquid, which is lighter than water and hence buoyant.) Piccard's first bathyscaph, the FNRS-2, was referred to as the "submarine balloon" because its heavy-metal ballast, attached by electromagnets, allowed it to sink to a desired depth when engaged and rise to the surface when released. It had greater maneuverability than the bathysphere, though it did not fare well in tests. Piccard and his son Jacques later designed and built a new bathyscaph, the Trieste. In 1953, they descended in it to a depth of 10,330 feet in the Mediterranean. The Piccards sold the Trieste to the U.S. Navy in 1958. **On January 23, 1960, the Trieste set a new world record of 35,800 feet when it touched bottom in the Marianas Trench near Guam.**

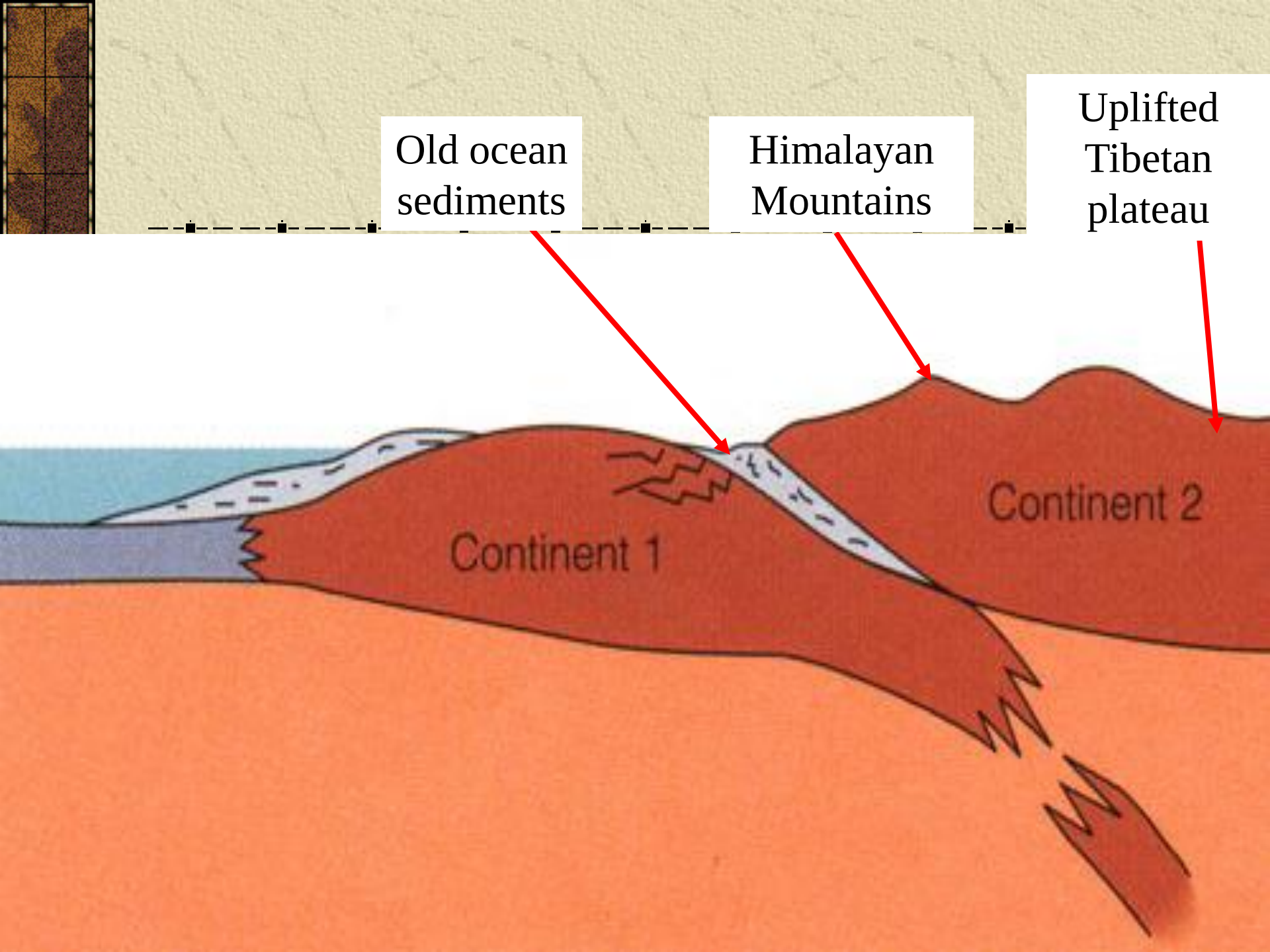
Continental-Continental convergence



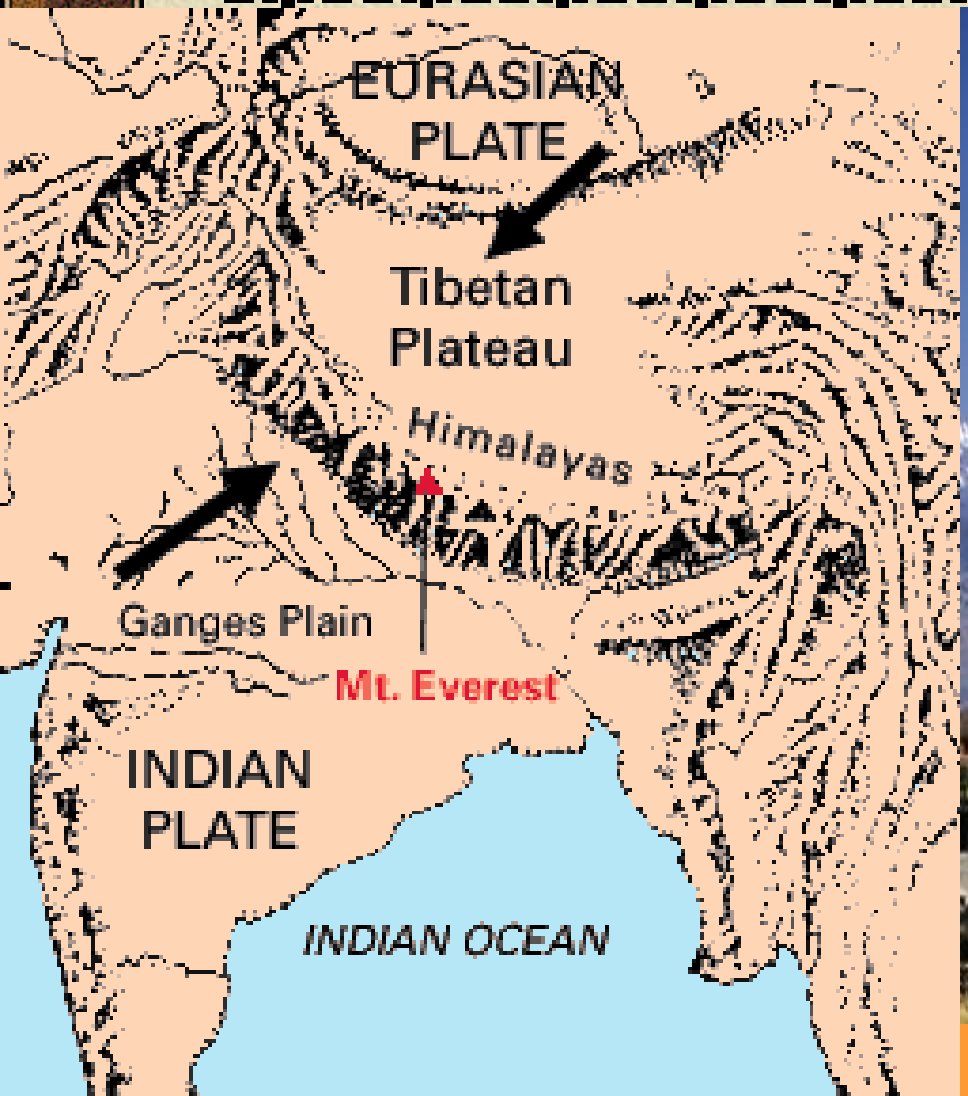
Continental-continental convergence

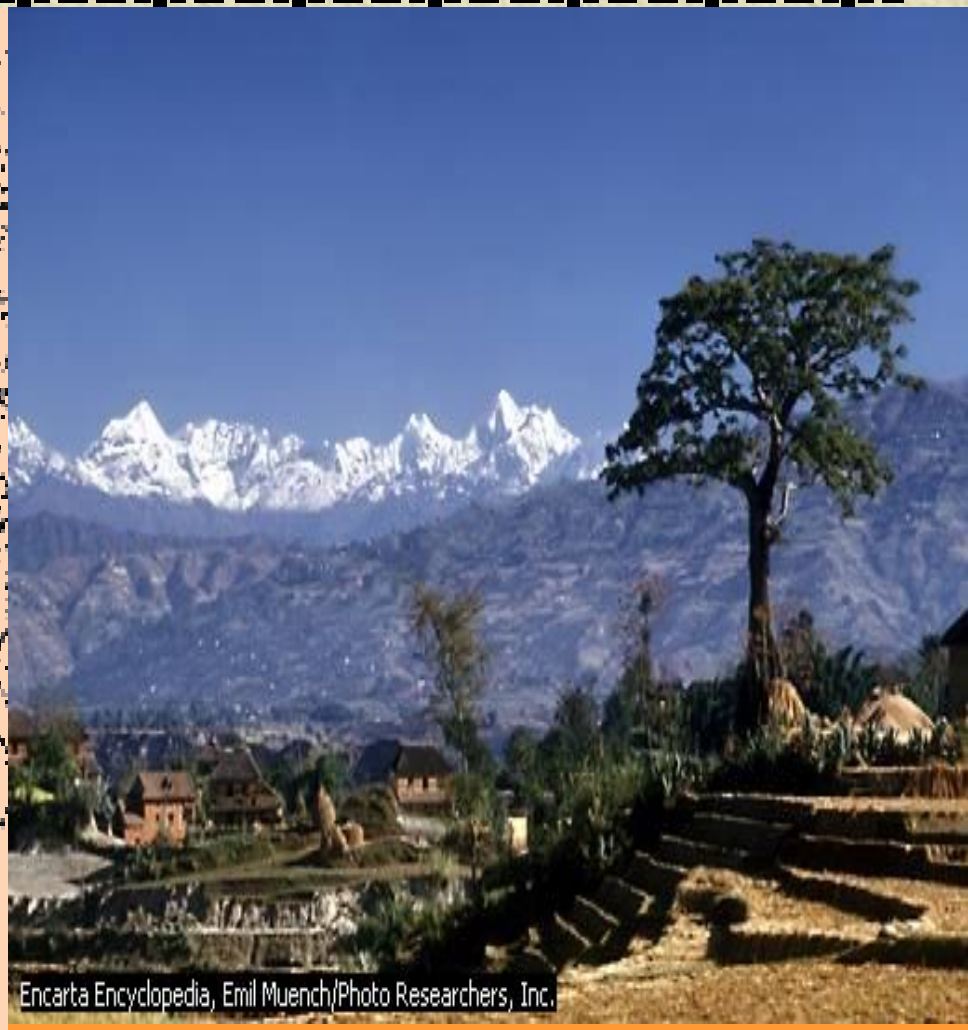
The sub-continent of India has collided with the Eurasian continent to form the Himalayas




Old ocean sediments
Himalayan Mountains
Uplifted Tibetan plateau
Continent 1
Continent 2

The Himalayan Mountain Range
Convergent Boundary Zone

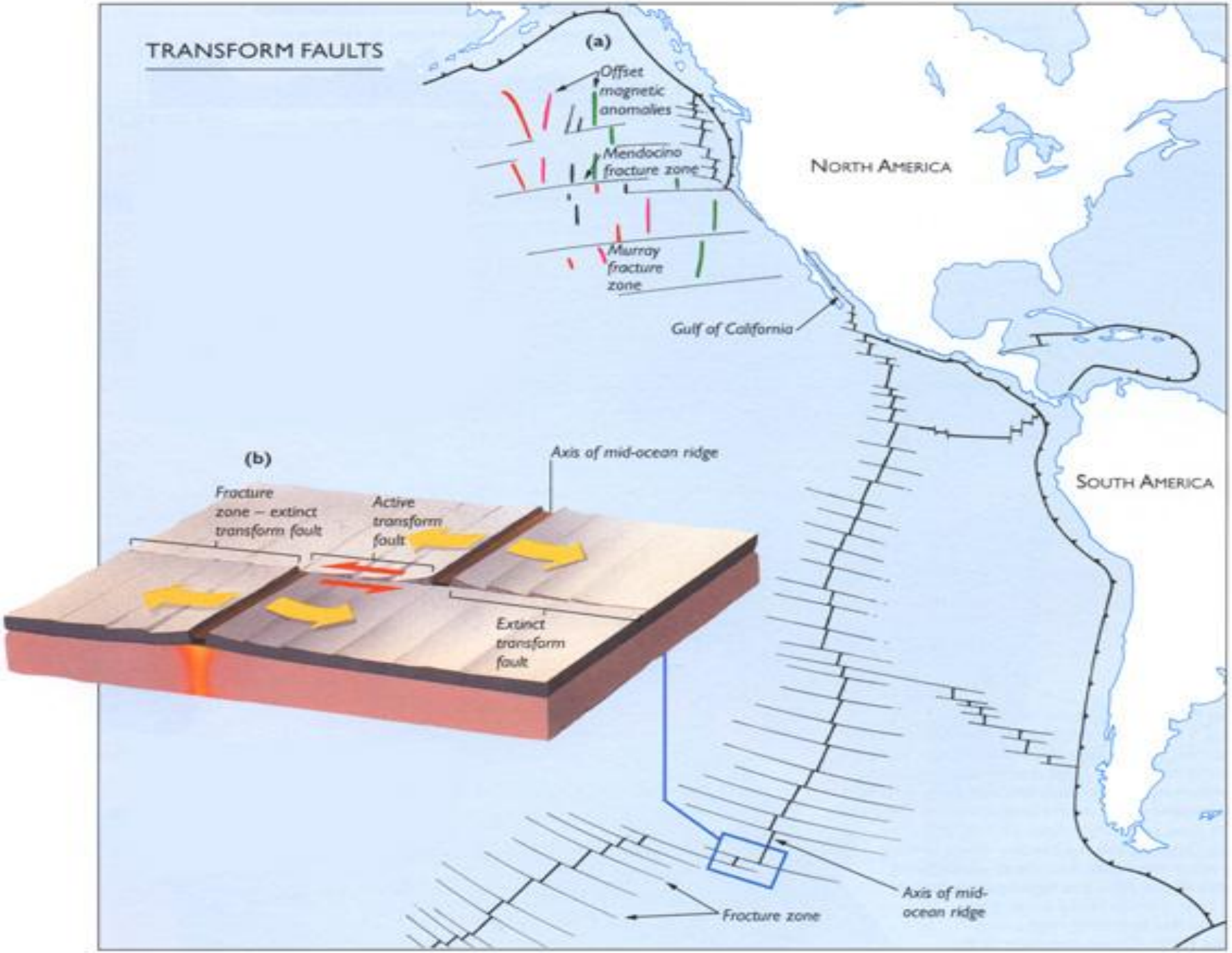




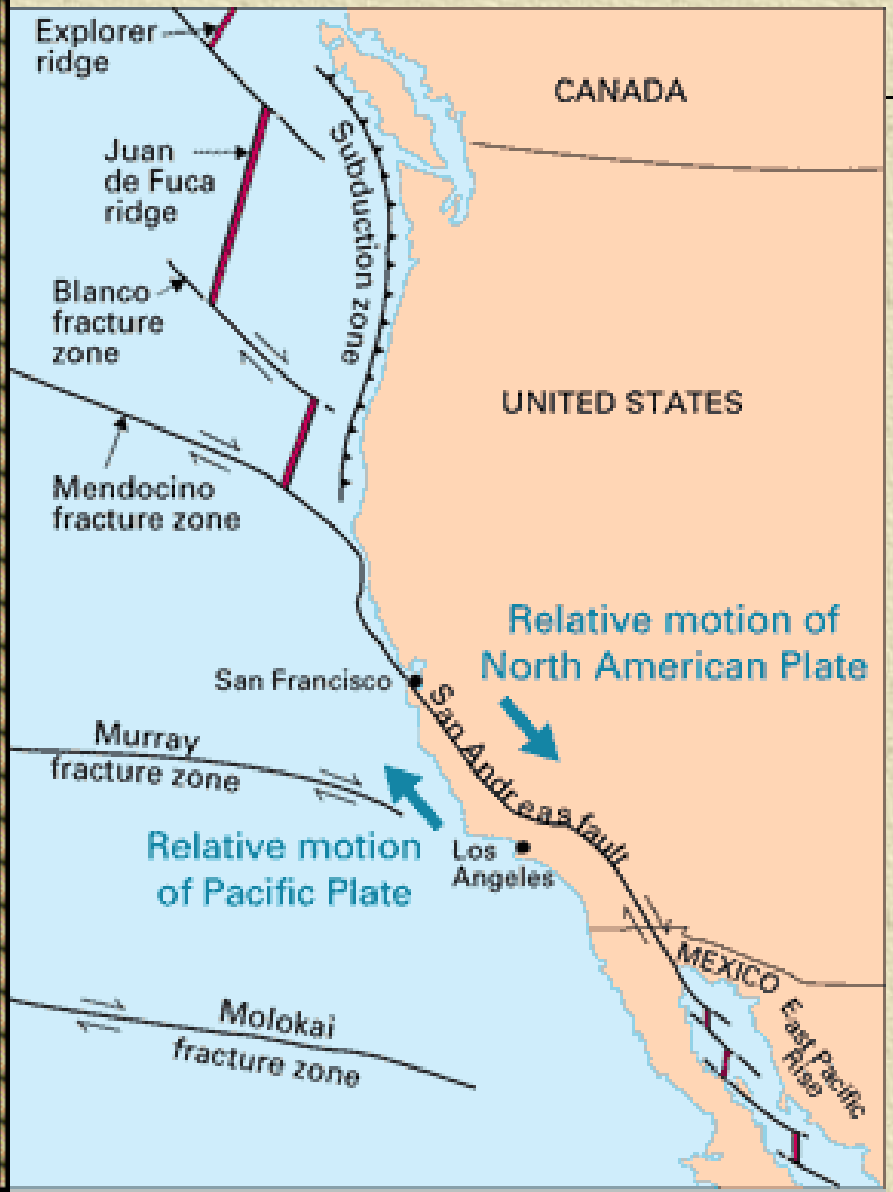
Himalayan Mountain Range- Highest Mountain Range in the World- includes 8 of the 10 highest Mt.

Transform

plate boundaries


TRANSFORM FAULTS
(a)
Offset magnetic anomalies
Mendocino fracture zone
Murray fracture zone
Gulf of California
NORTH AMERICA
SOUTH AMERICA
(b)
Axis of mid-ocean ridge
Fracture zone – extinct transform fault
Active transform fault
Extinct transform fault
Fracture zone
Axis of mid-ocean ridge

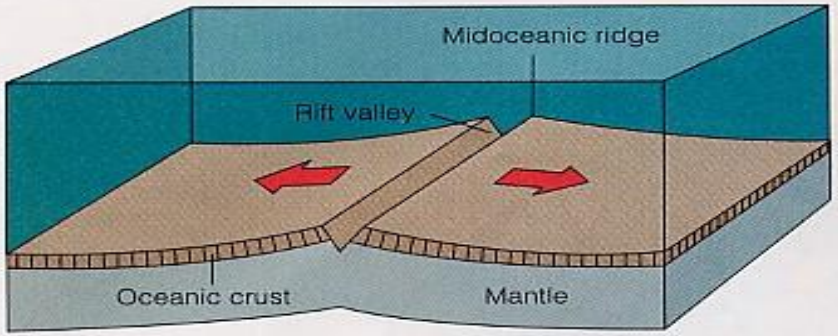
Transform Fault- San Andreas Fault in CA.



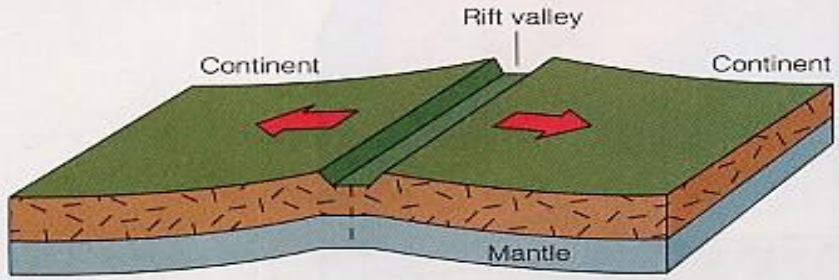
North American plate

Pacific plate

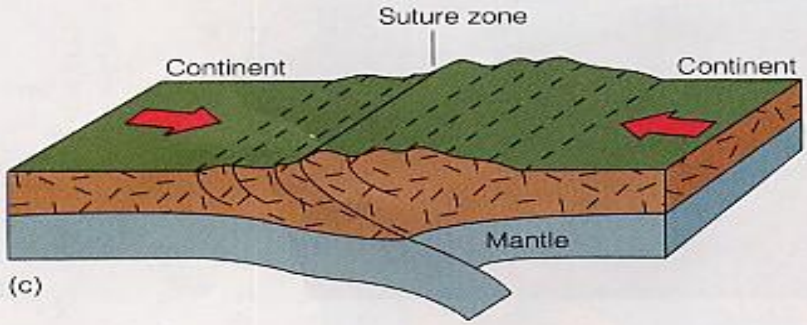
Can you name the Boundary???



(a)



(b)



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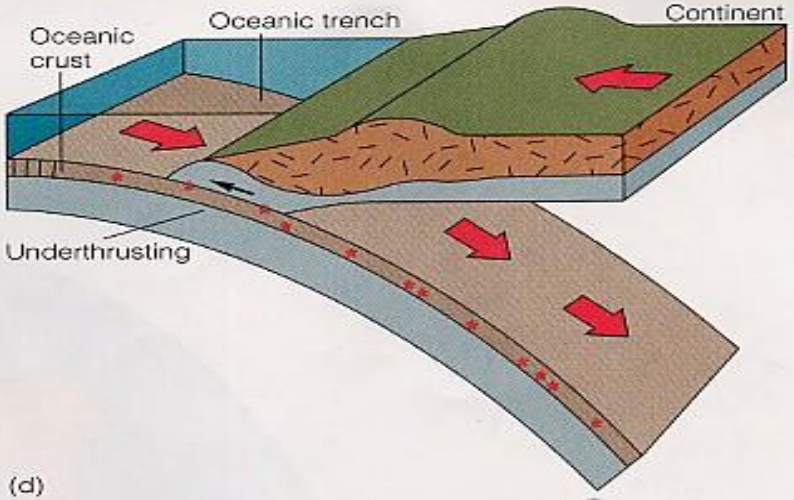
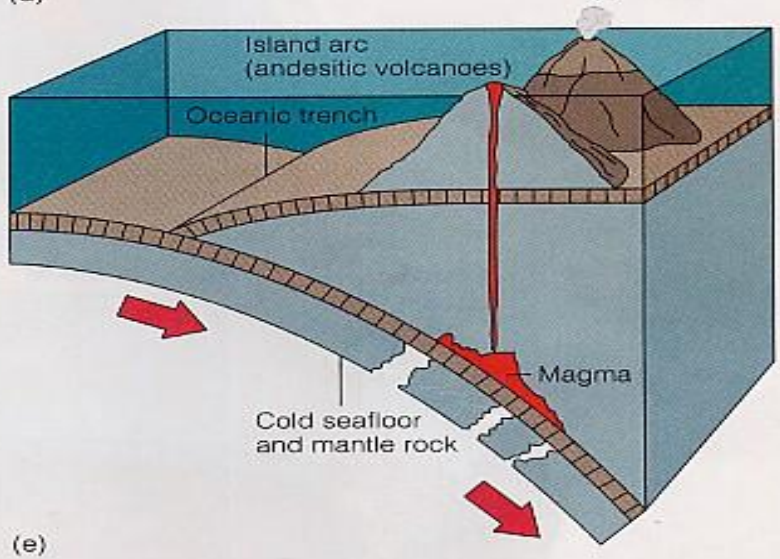
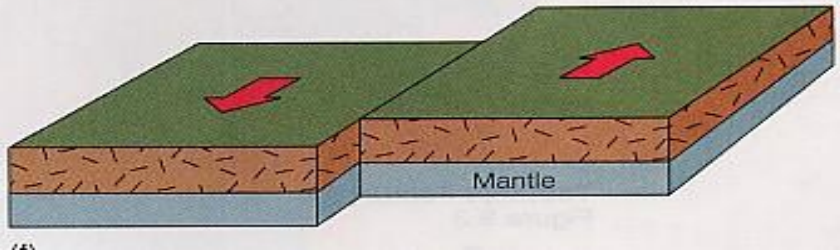


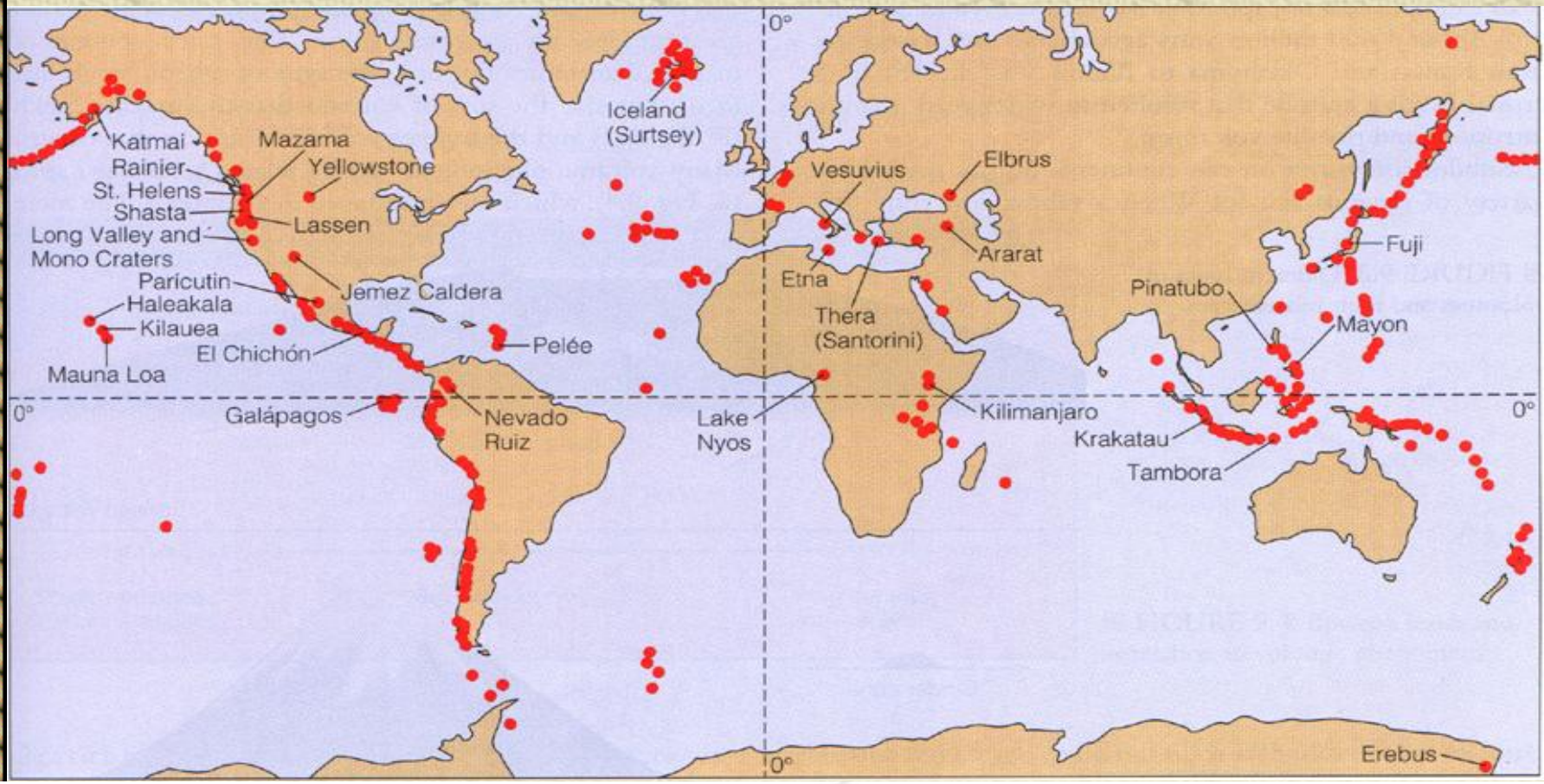
(d)

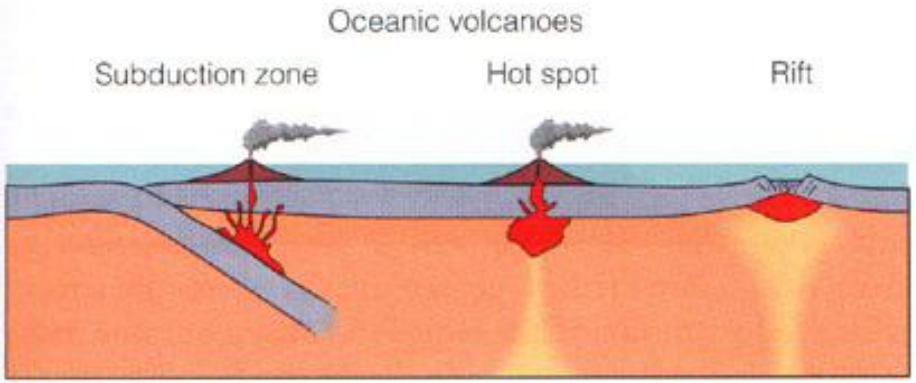


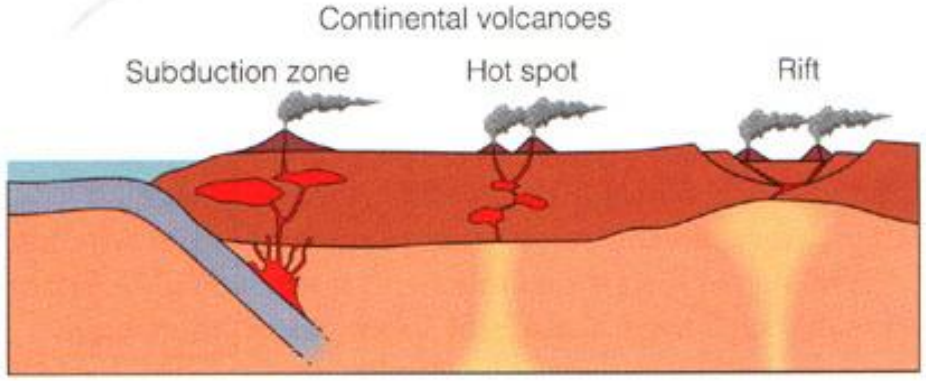
(e)



Volcanoes and Plate boundaries



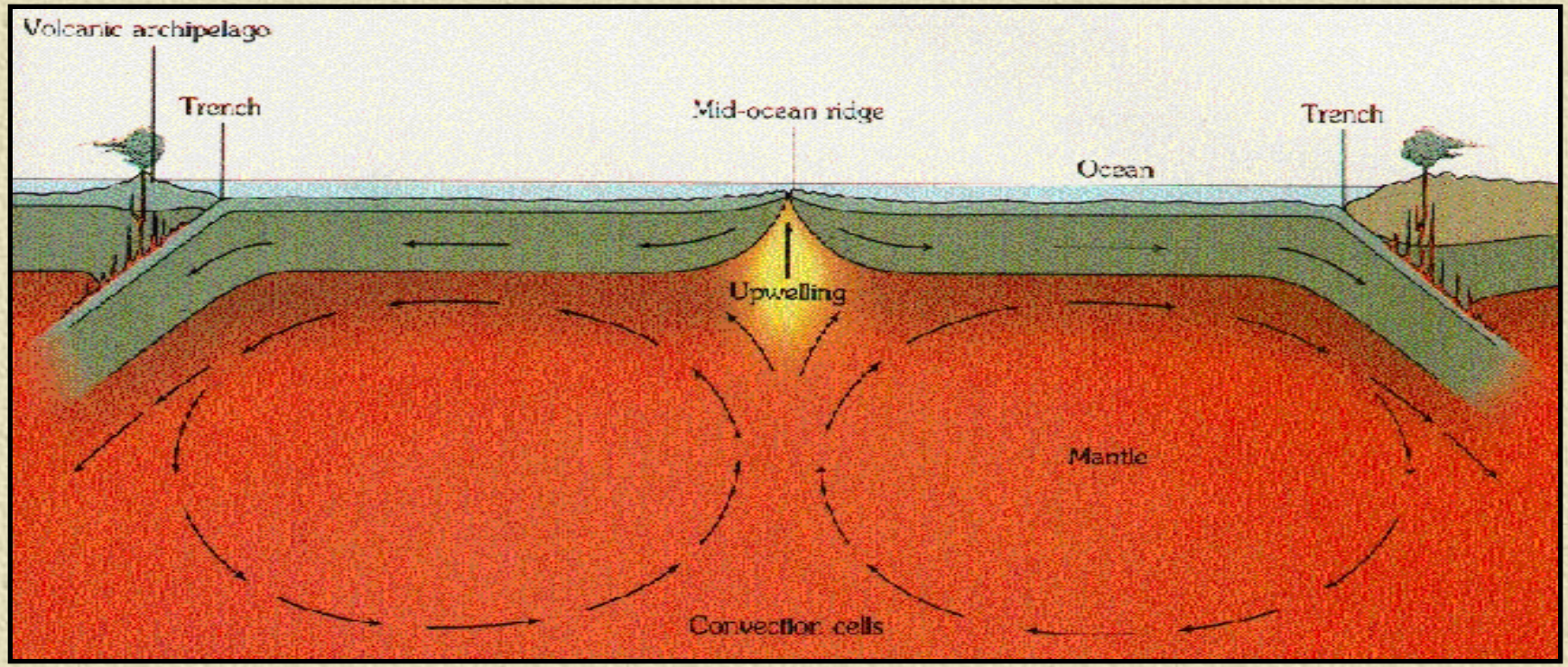




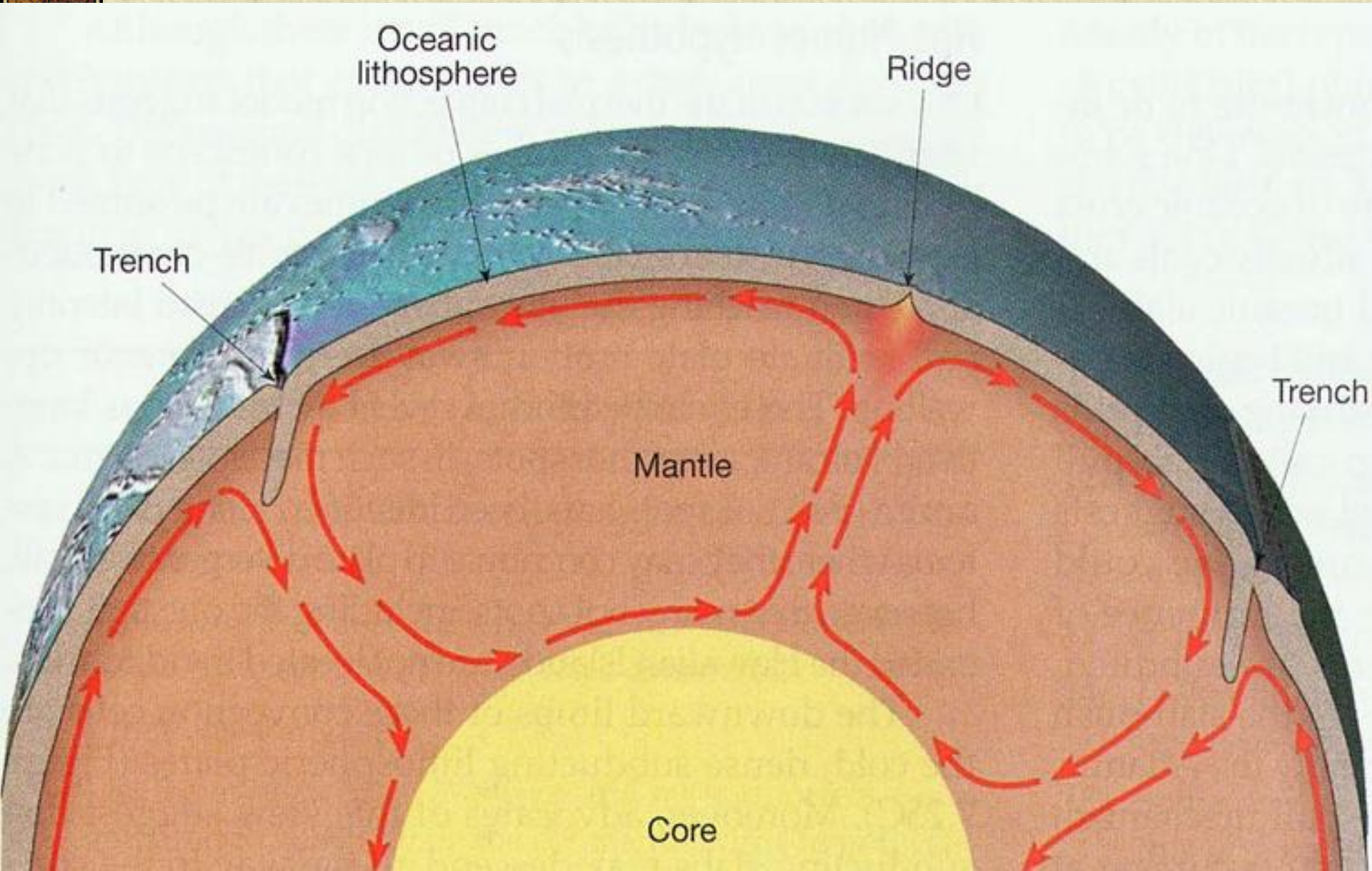
Cause of Plate Movement:

Convection Current:

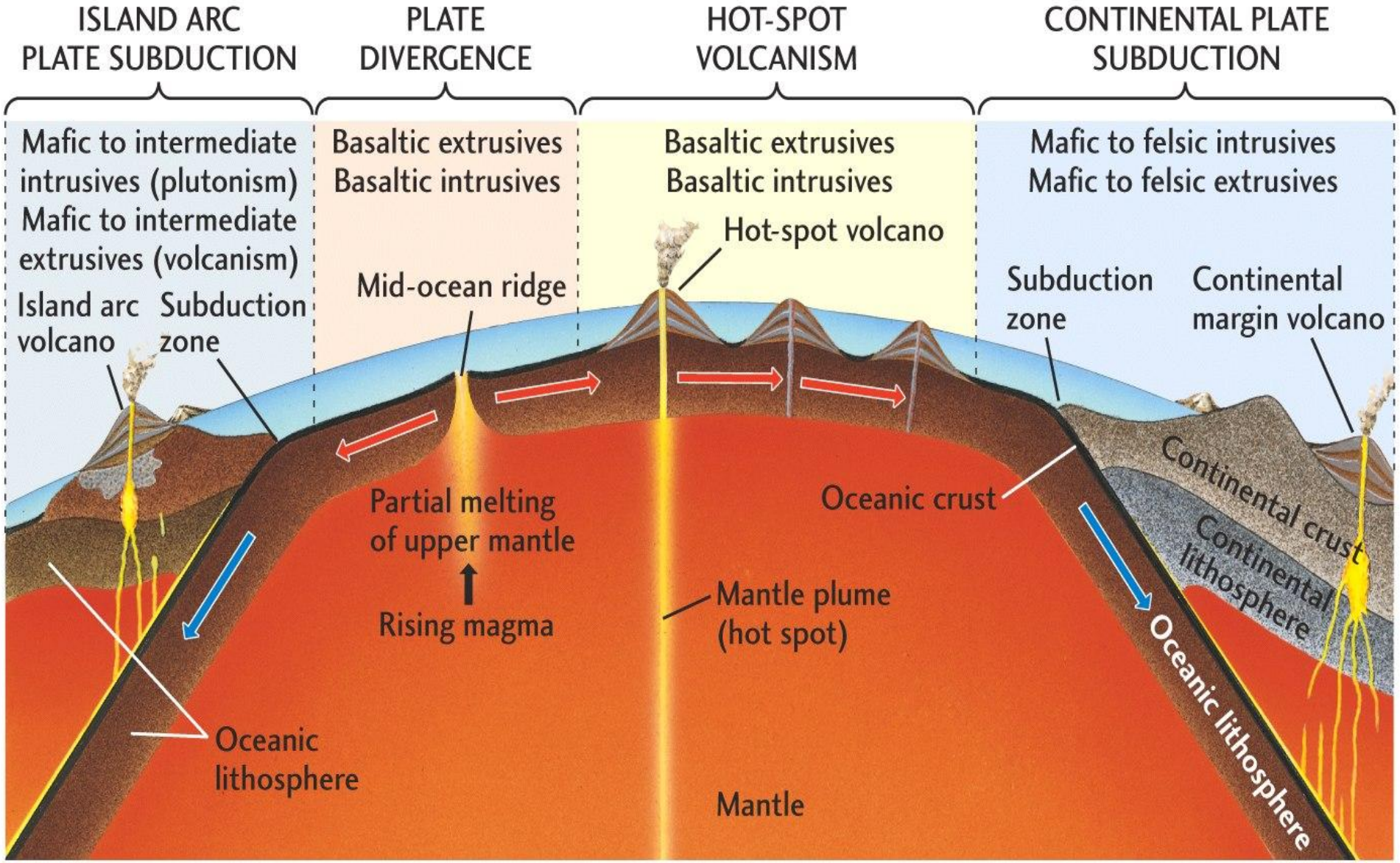
-Much like hot air rising and cool air sinking. The molten rock or the asthenosphere rises and sinks forcing the plates to move.



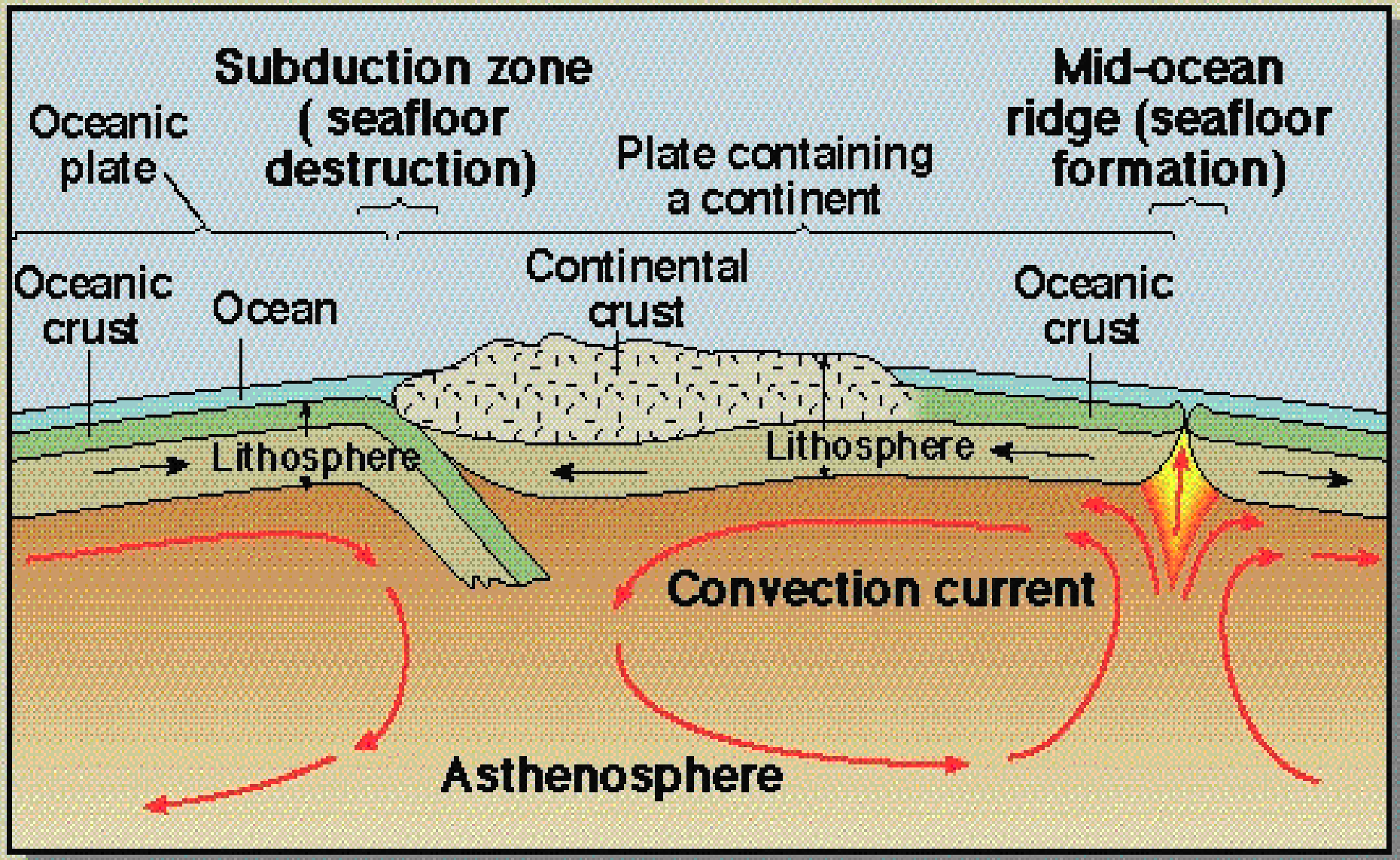
Convection Current Theory:



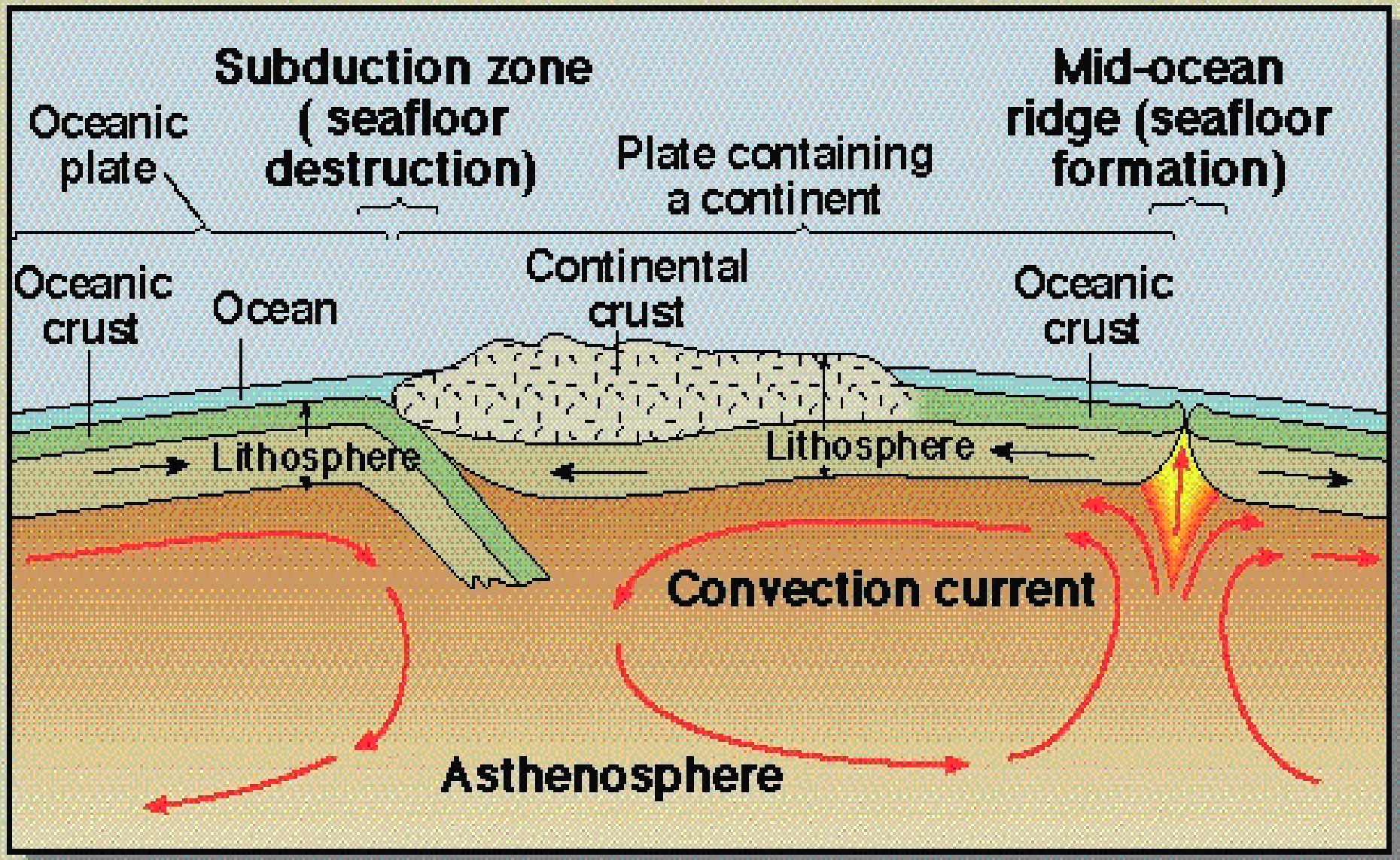
Overview of Plate Tectonics



Overview of Plate Tectonics



Overview of Plate Tectonics



http://www.ucmp.berkeley.edu/geology/tecall1_4.mov

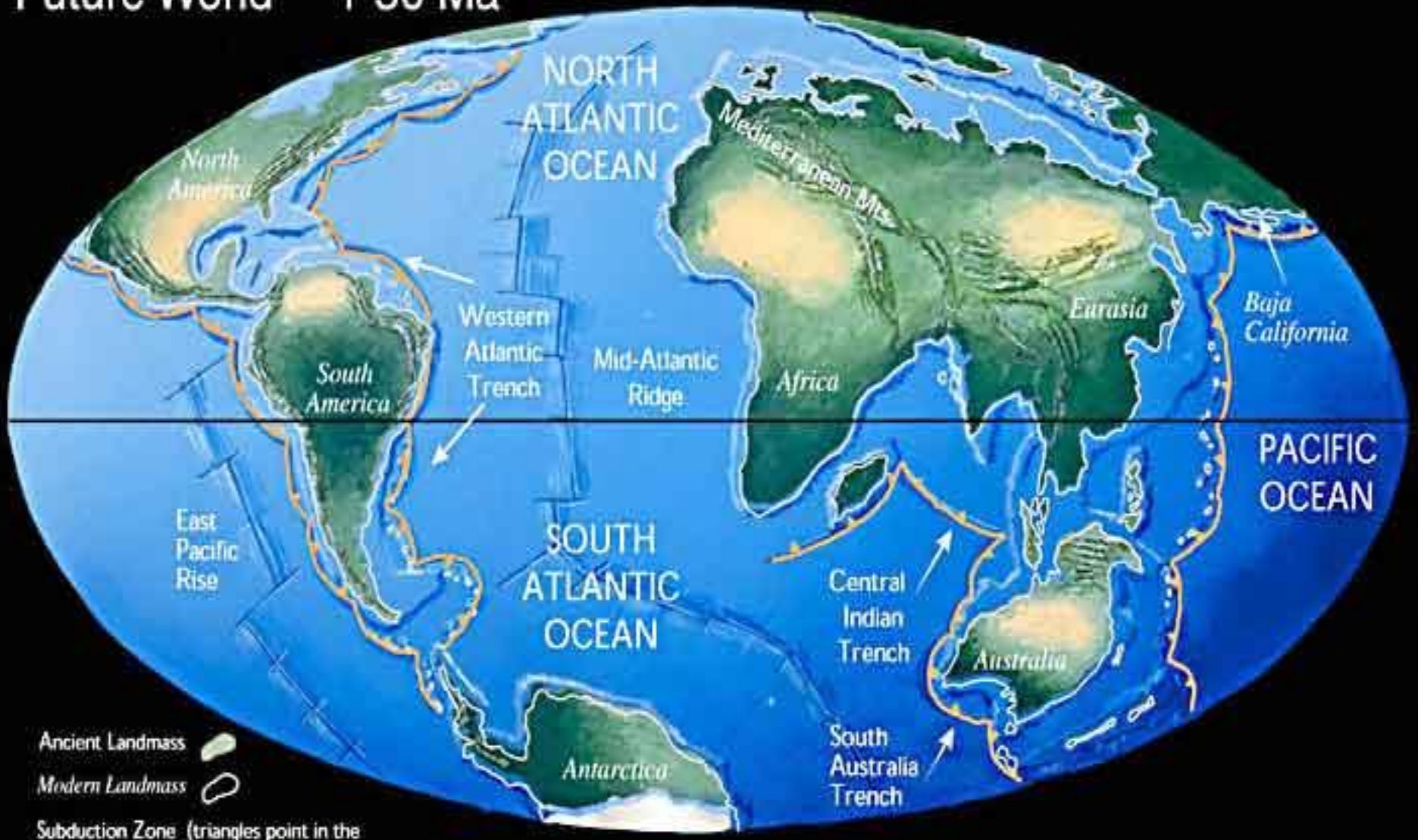
http://www.ucmp.berkeley.edu/geology/anim3.html

Are the Plates Still Moving?

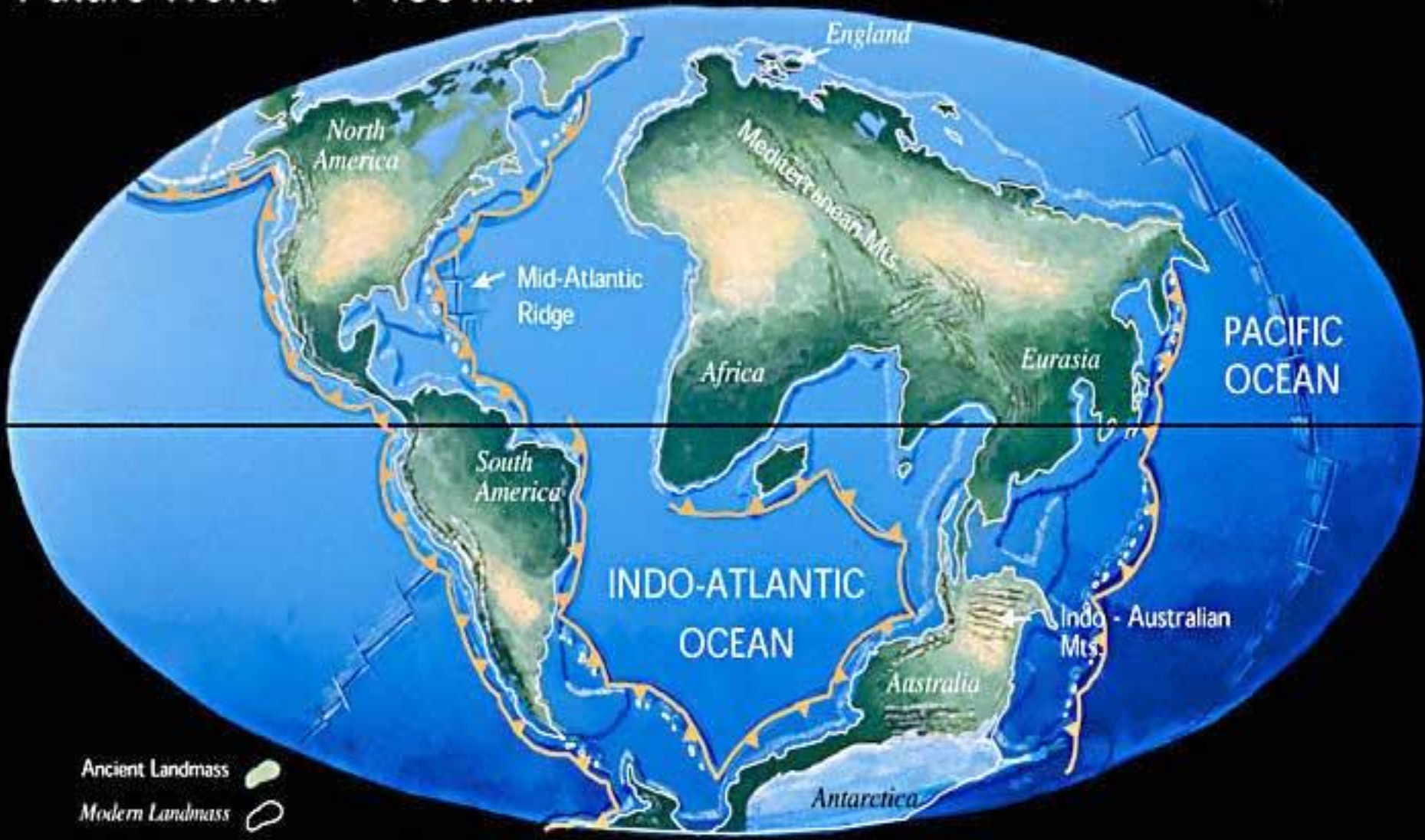
Lets take a look as to what the Future may hold.

Modern World

Future World + 50 Ma



Future World + 150 Ma



Future World + 250 Ma