Geological Forces

Continental drift, plate tectonics, earthquakes, and volcanoes

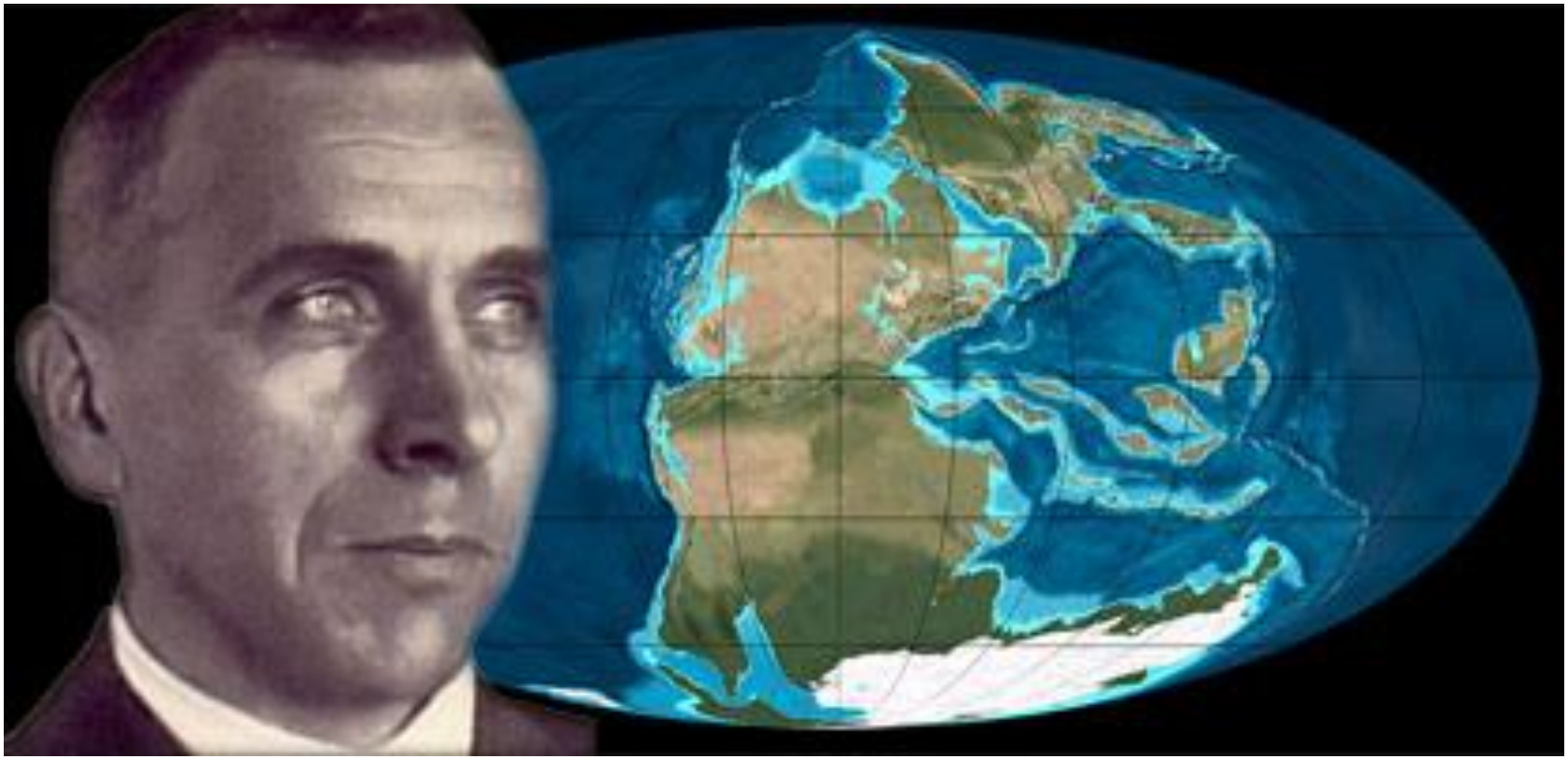
In 1912, a man named Alfred Wegener proposed that at one time the continents were joined together, but over time have moved slowly to their current locations.

His hypothesis is called Continental Drift.

Wegener called the once connected large landmass Pangaea.

Pangea Puzzle Time

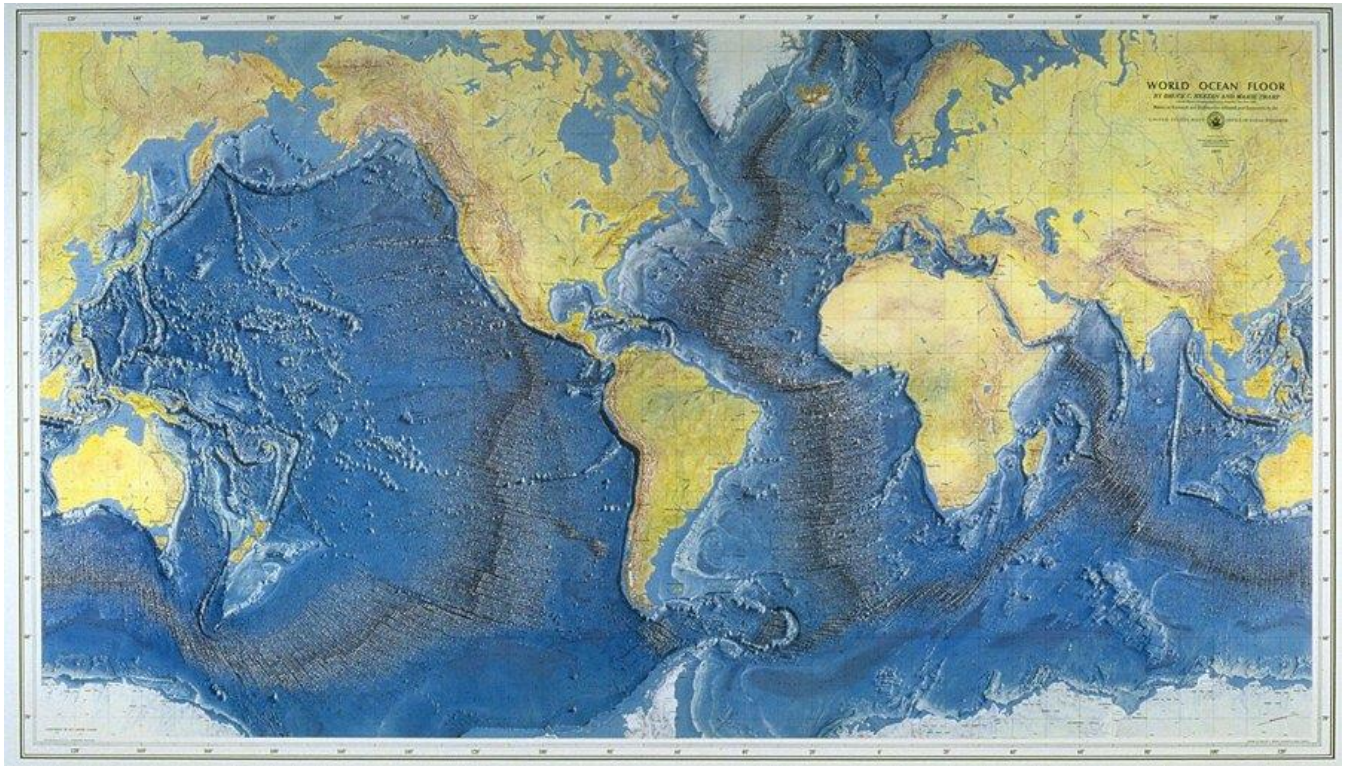
Wegener and Continental Drift Reading



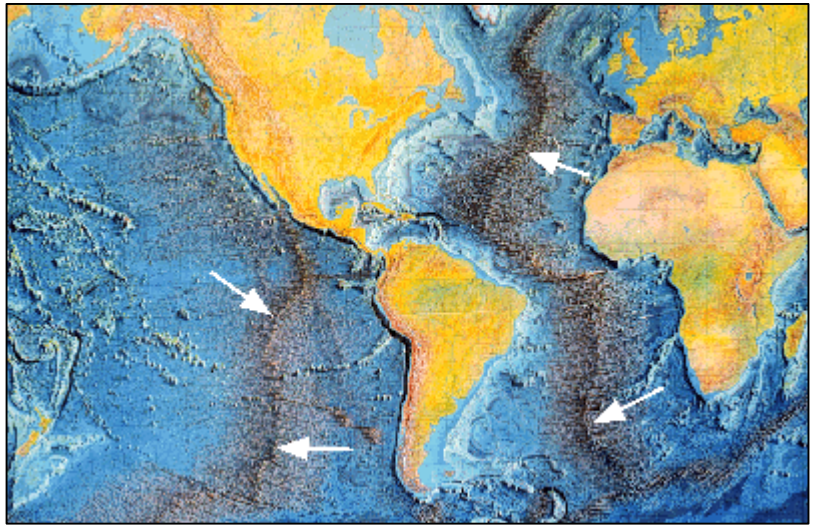
Other than the "puzzlelike" fit of the separated continents, what evidence was used to support the theory of continental drift?

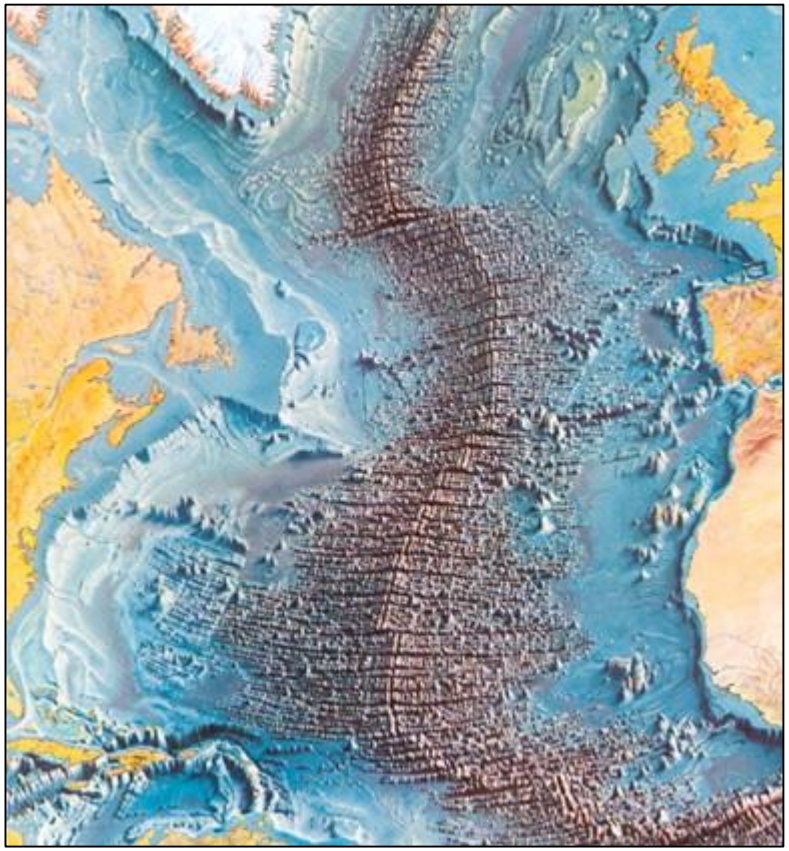
Rock, fossil, and climate clues were the main types of evidence for continental drift. Advances in technology have provided additional clues to help explain continental drift.

During the 1940s and 1950s, using technology developed during World War I, scientists began using sound waves to map the ocean floor.

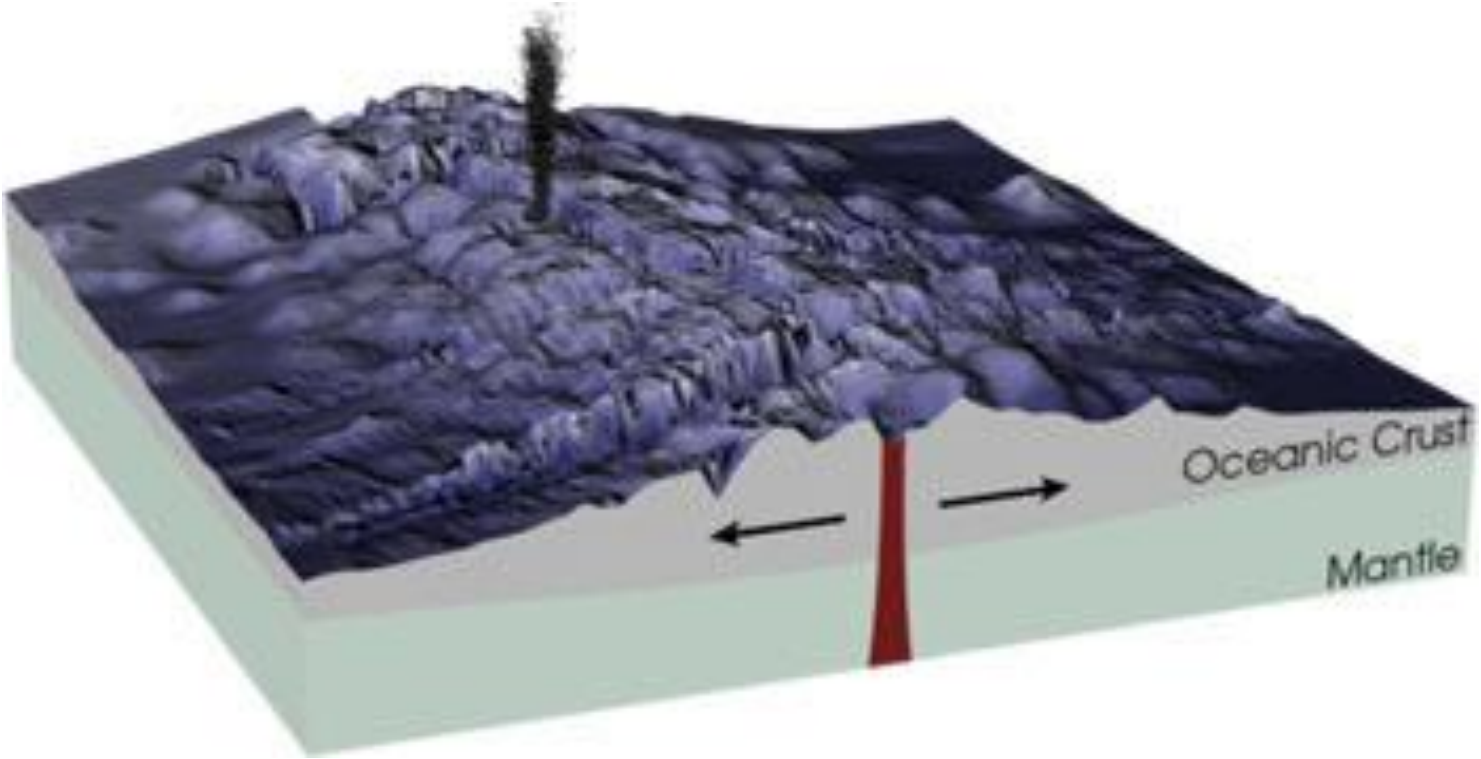


Researchers discovered an underwater system of ridges (mountains) and valleys like those found on the continents.

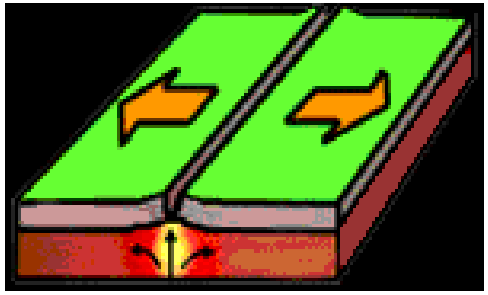




The theory of seafloor spreading explains the formation of the underwater mountain ranges.

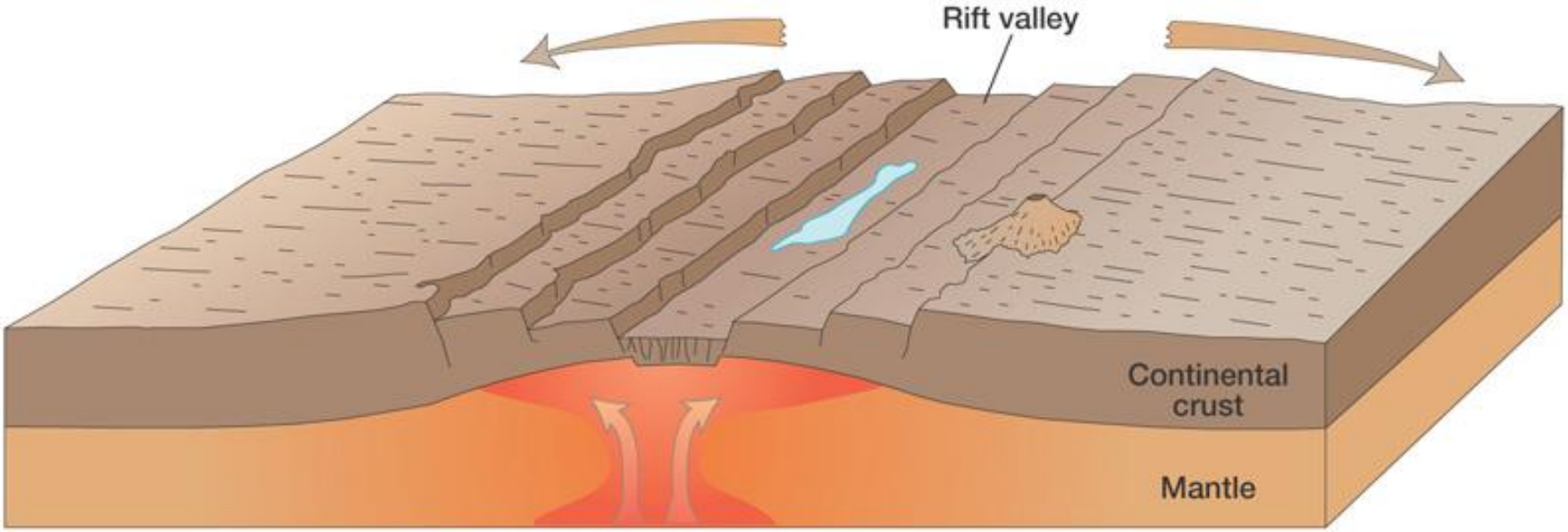


Seafloor Spreading



- Hot, less dense material below the Earth's crust rises toward the surface at the mid-ocean ridges.
- The seafloor spreads apart and magma is forced upward pushing the older seafloor away from the ridge in opposite directions.
- The magma becomes solid as it cools and sinks forming new seafloor.

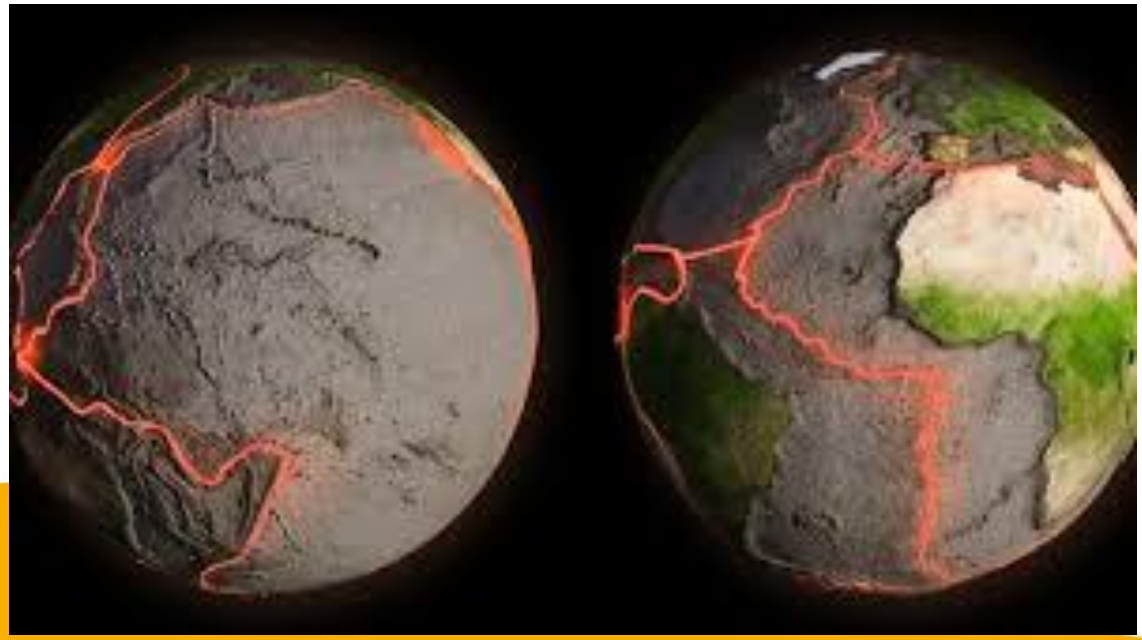
Seafloor Spreading



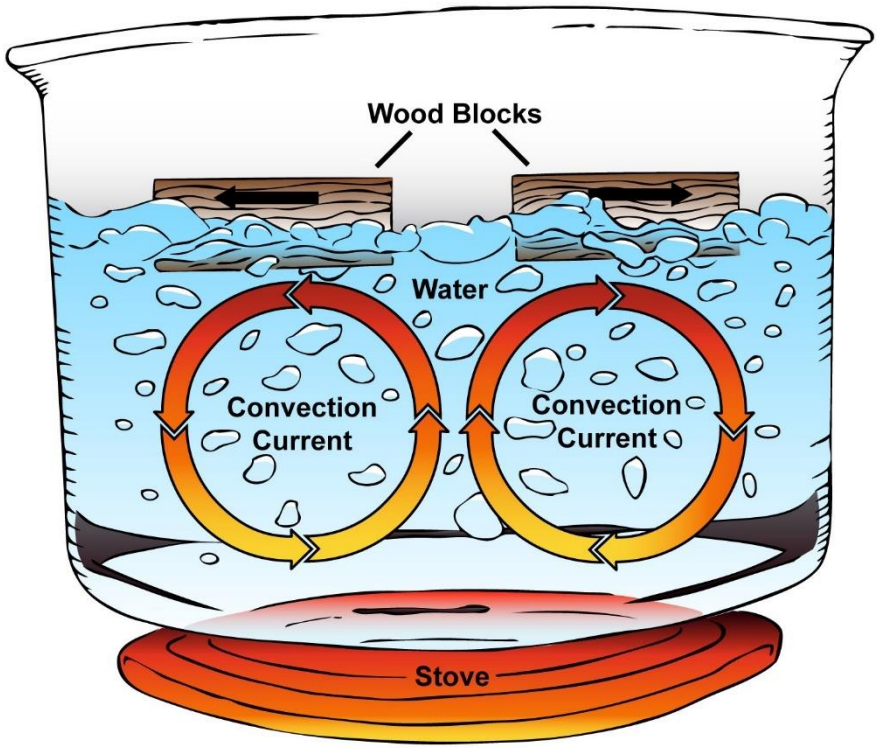
The idea of seafloor spreading showed that more than just the continents were moving, as continental drift had shown.

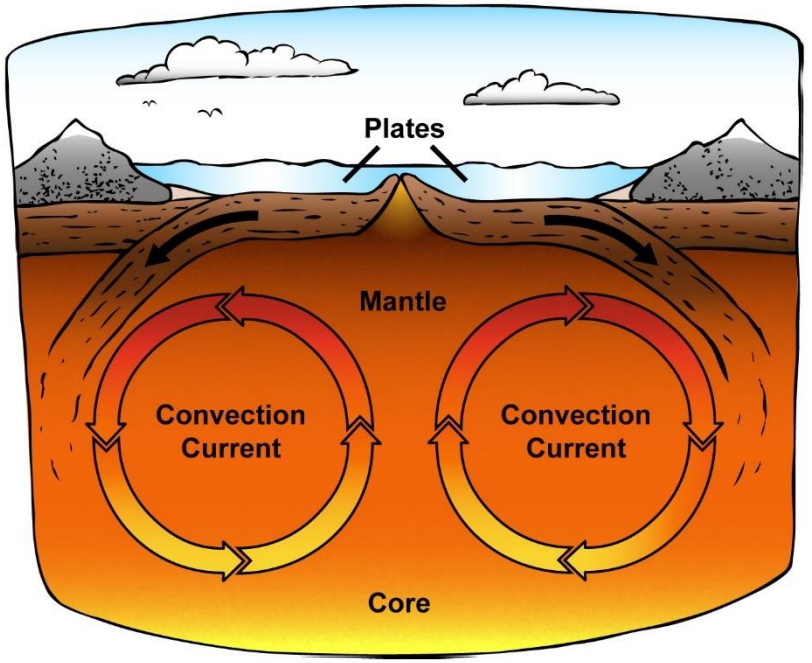
Scientists now believe that sections of the seafloor and continents move in relation to one another.

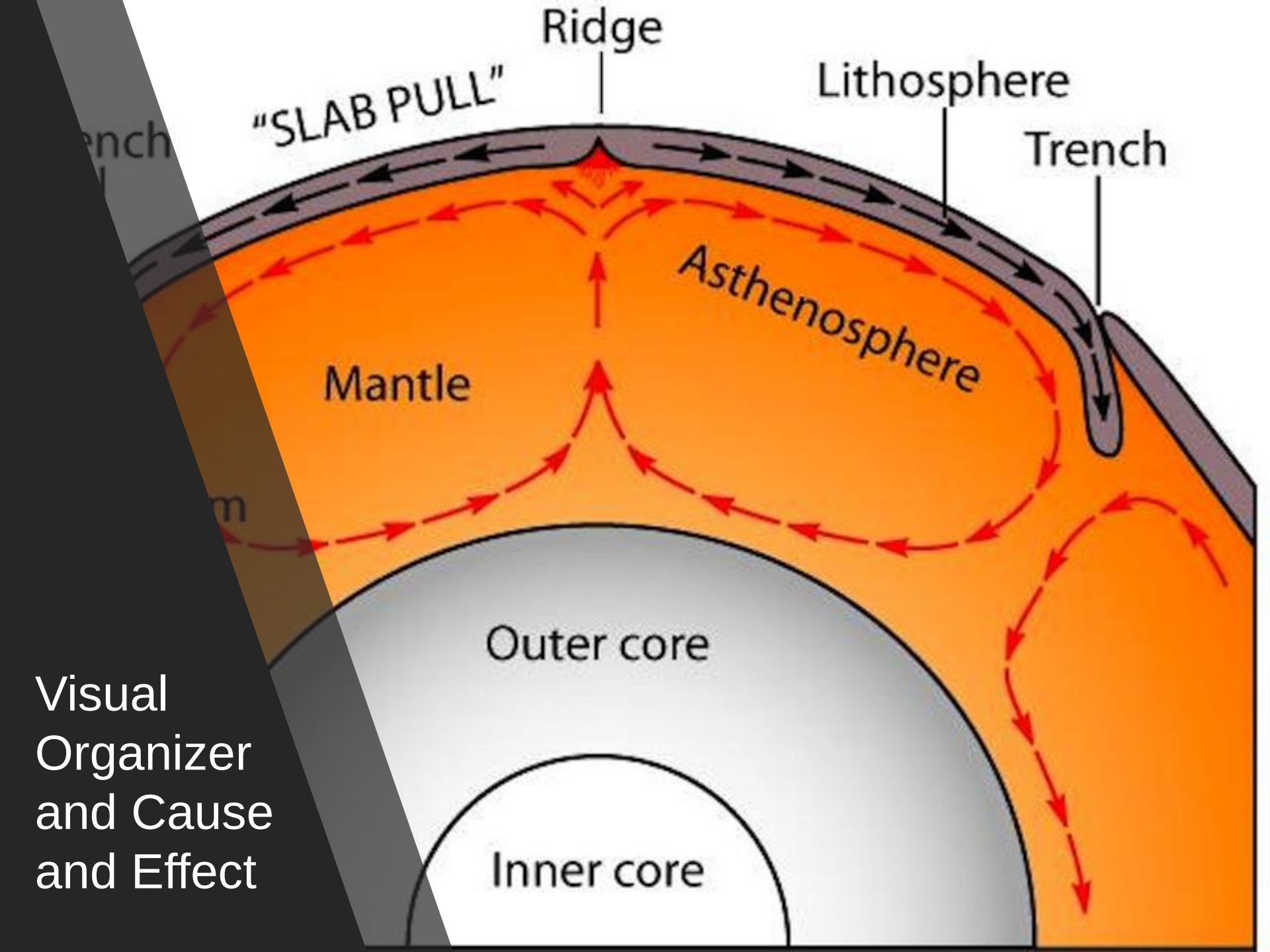
Plate Tectonics in Action Video and Vocabulary Activity



What is the mechanism driving continental drift and seafloor spreading?

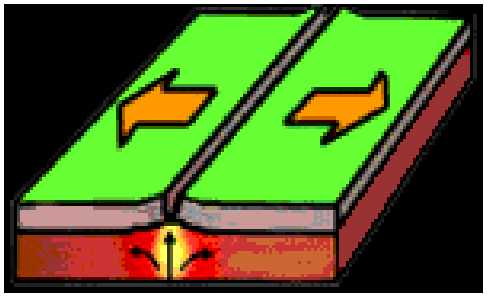






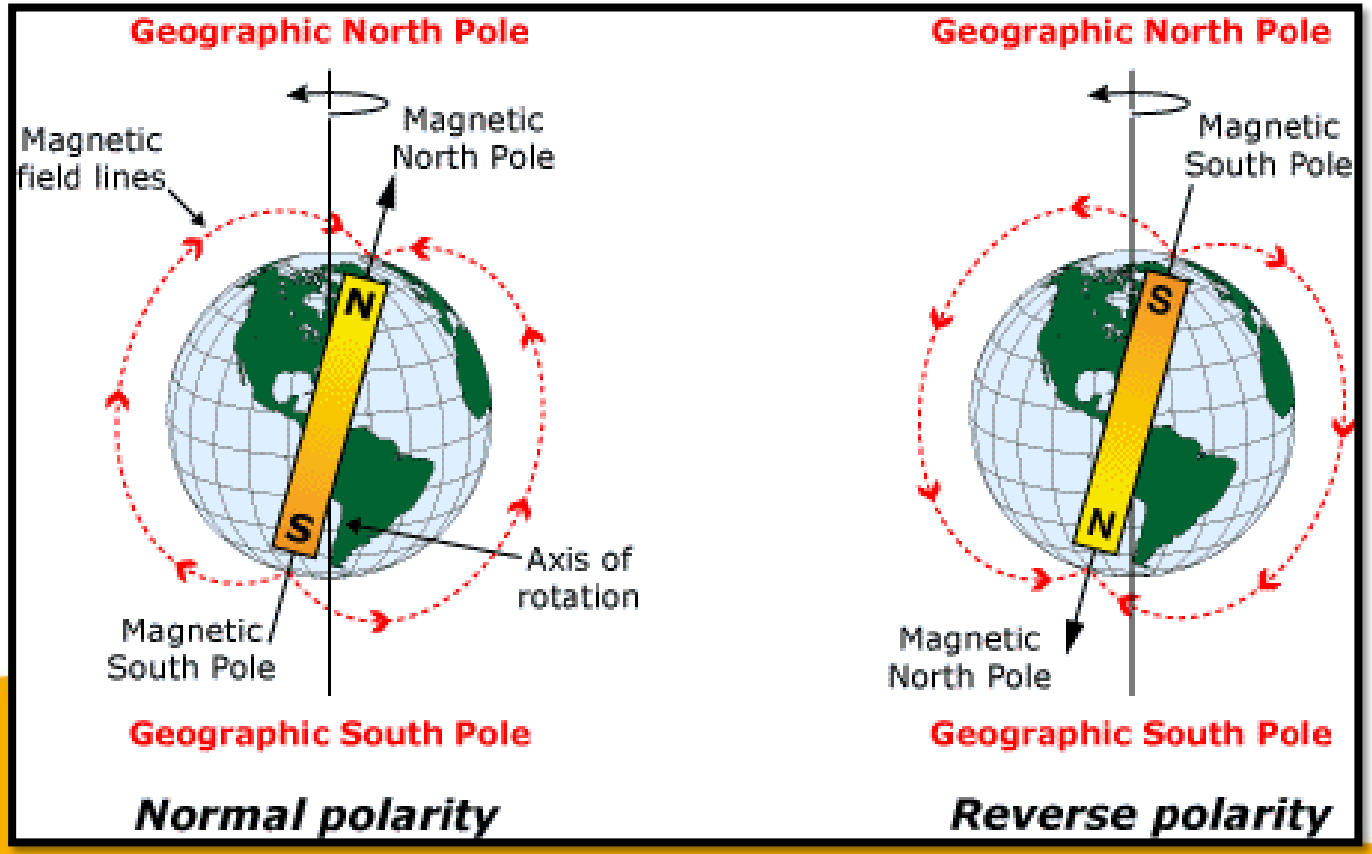
Visual Organizer and Cause and Effect

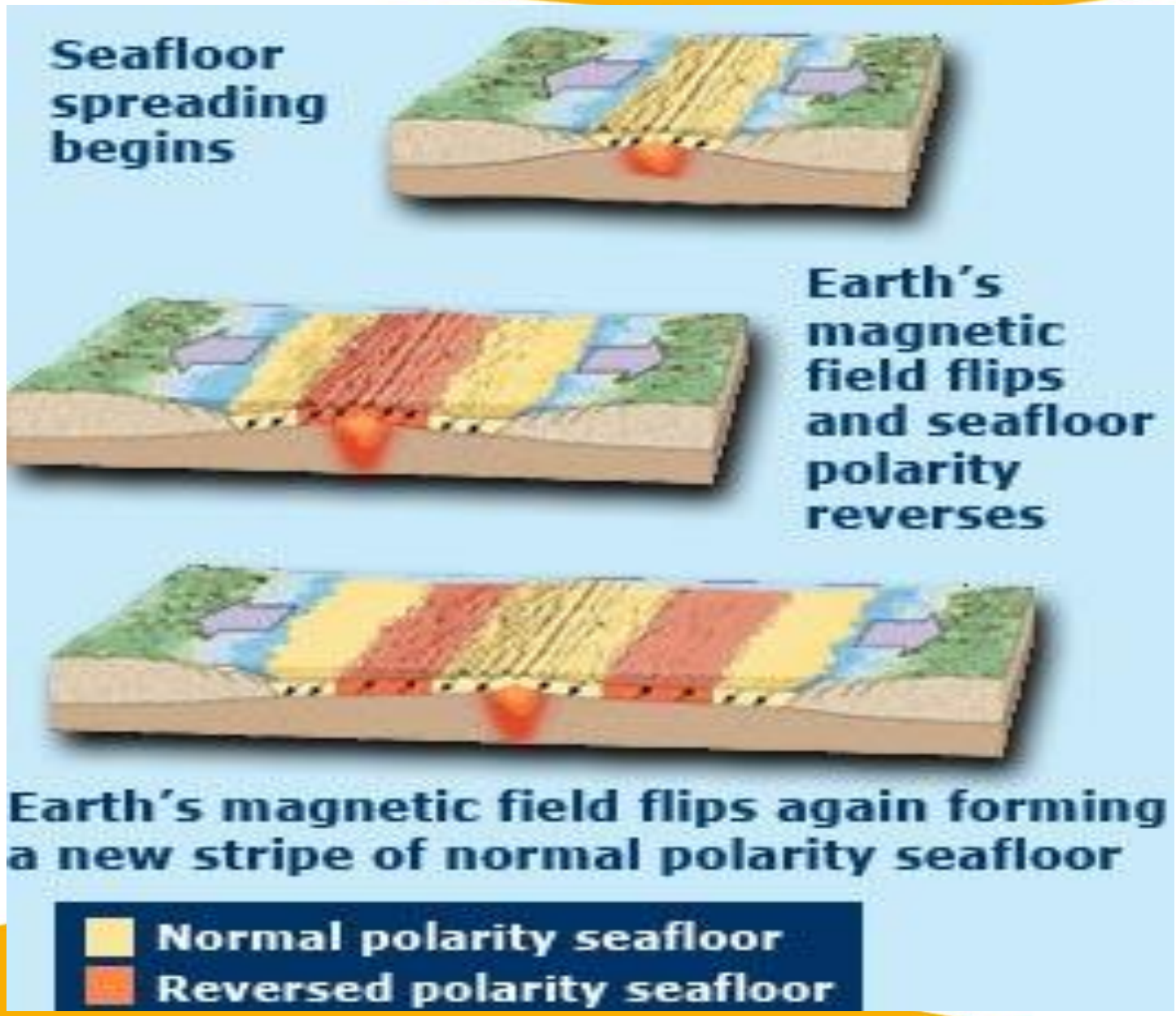
REMINDER…Seafloor Spreading

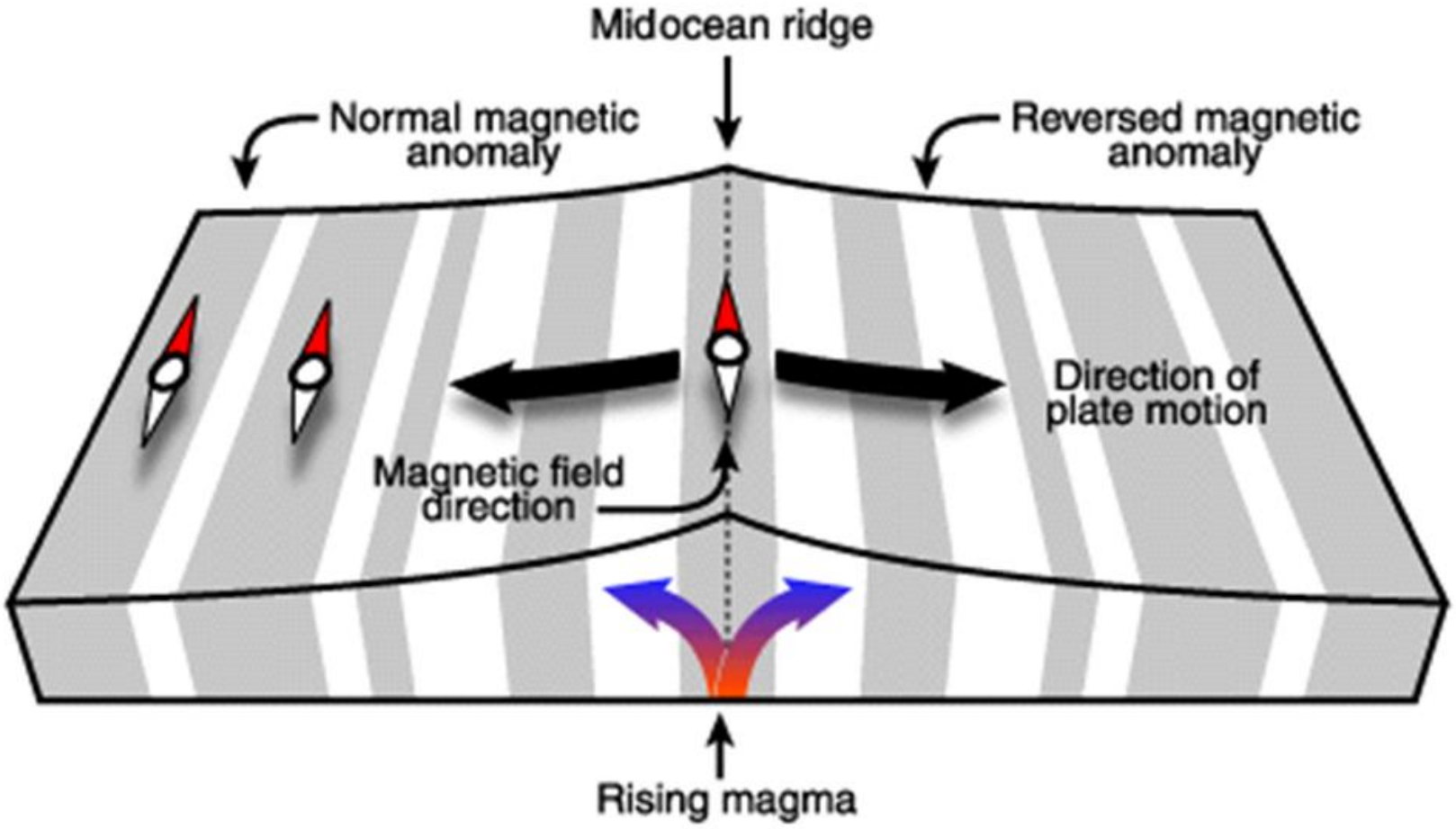


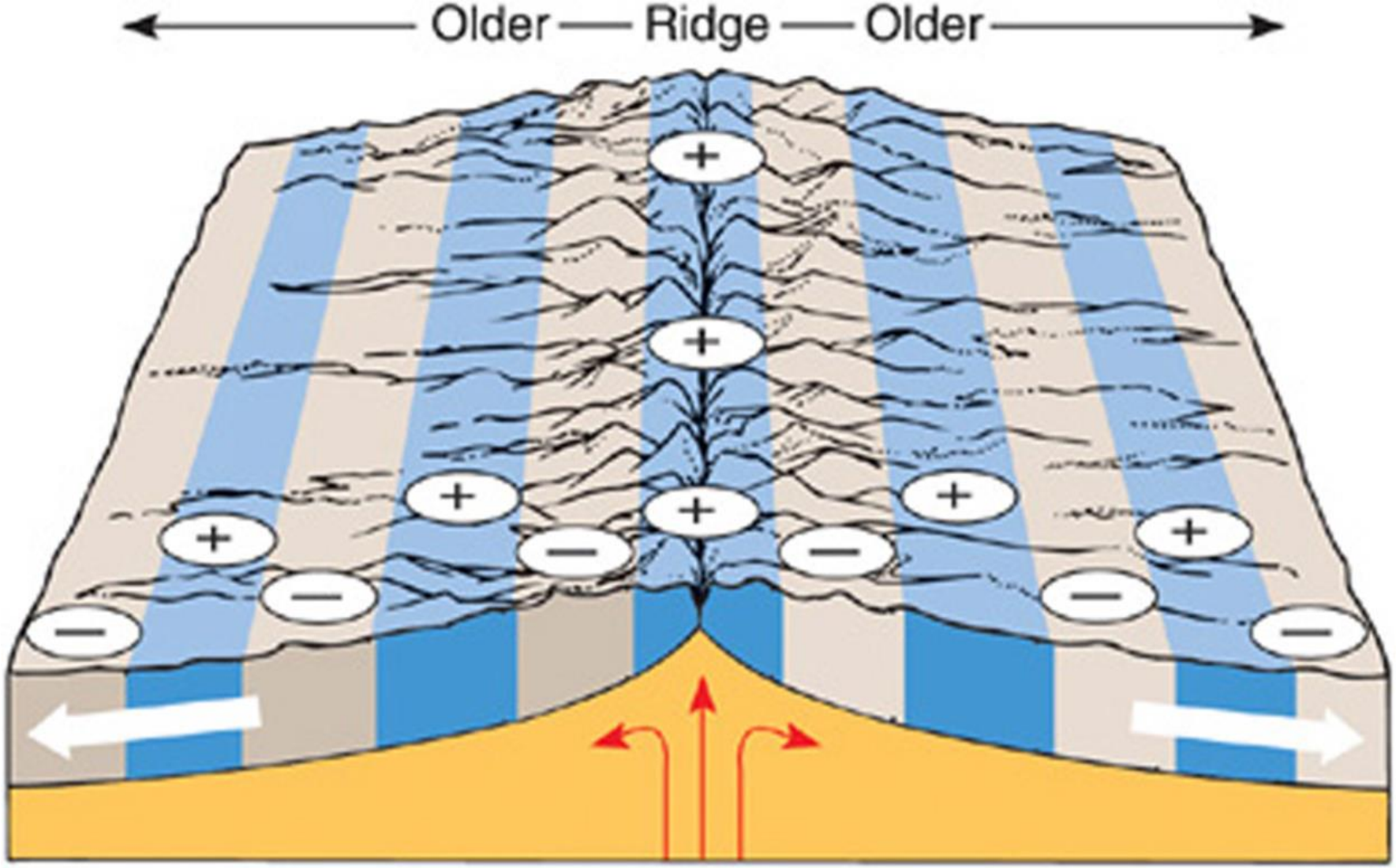
- Hot, less dense material below the Earth's crust rises toward the surface at the mid-ocean ridges.
- The seafloor spreads apart and magma is forced upward pushing the older seafloor away from the ridge in opposite directions.
- The magma becomes solid as it cools and sinks forming new seafloor.

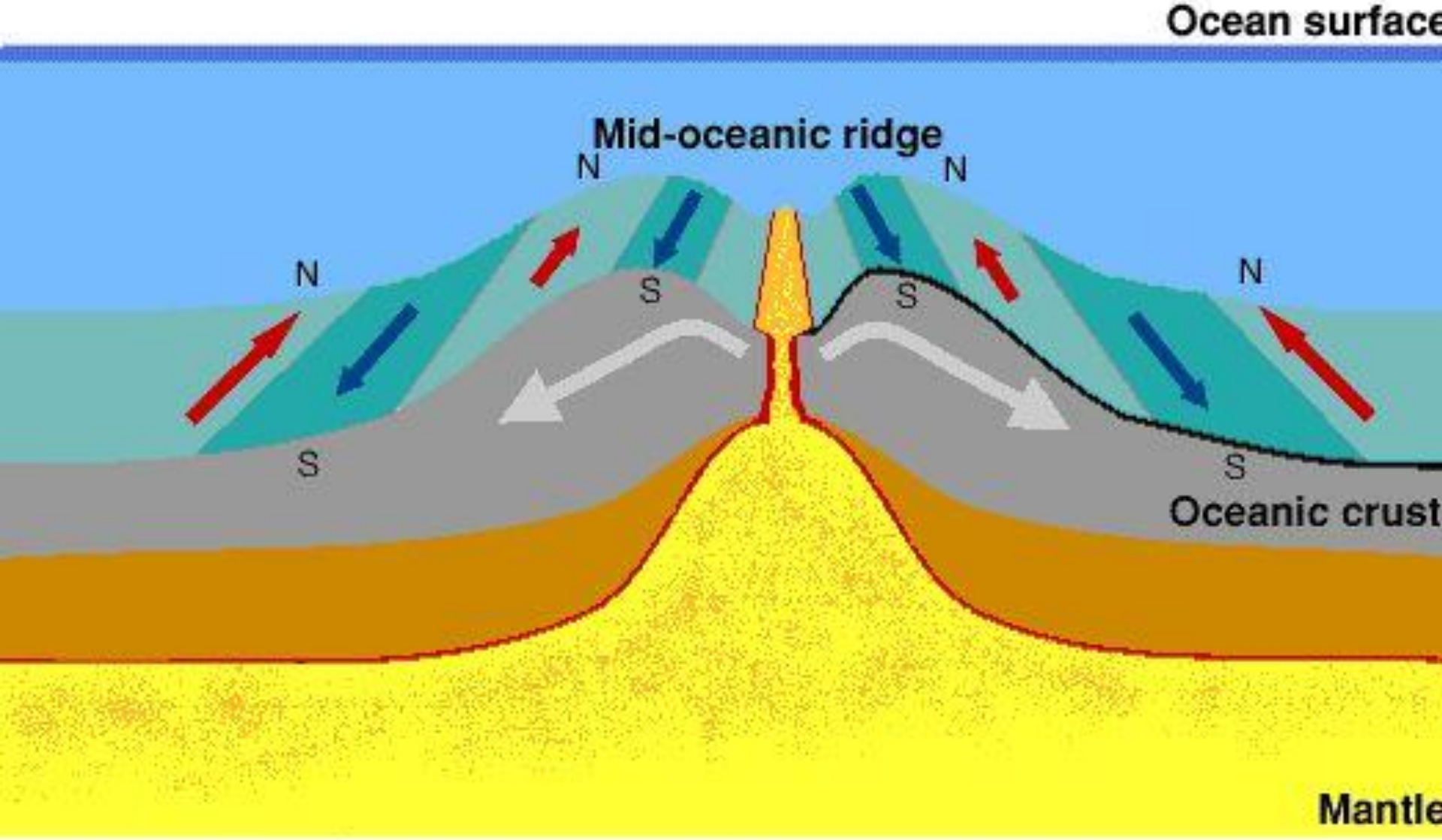
Seafloor spreading and convection currents cause the movement of the plates as well as the reversal of the Earth's magnetic poles. This is called reverse polarity.









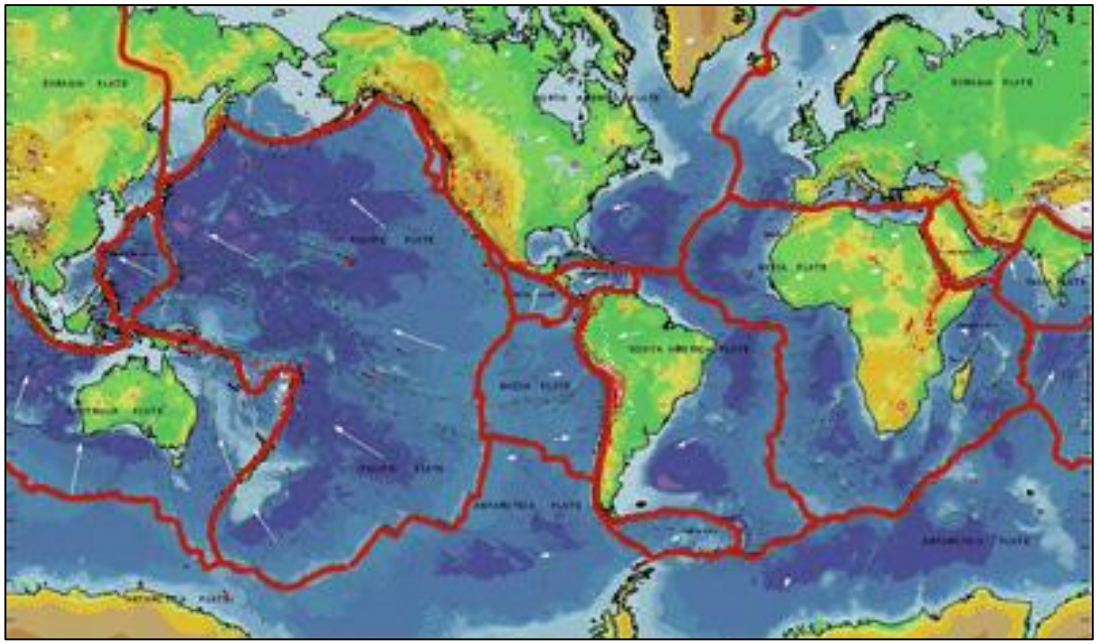


Sea floor spreading at the mid-oceanic ridge

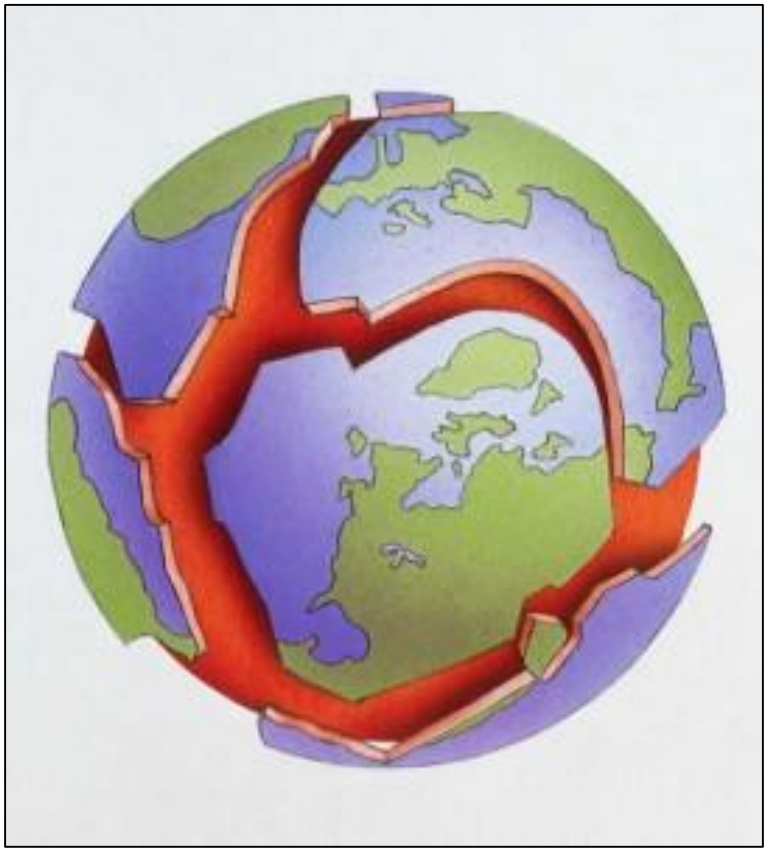
direction of Earth's magnetic field
(recorded in solidified lava)

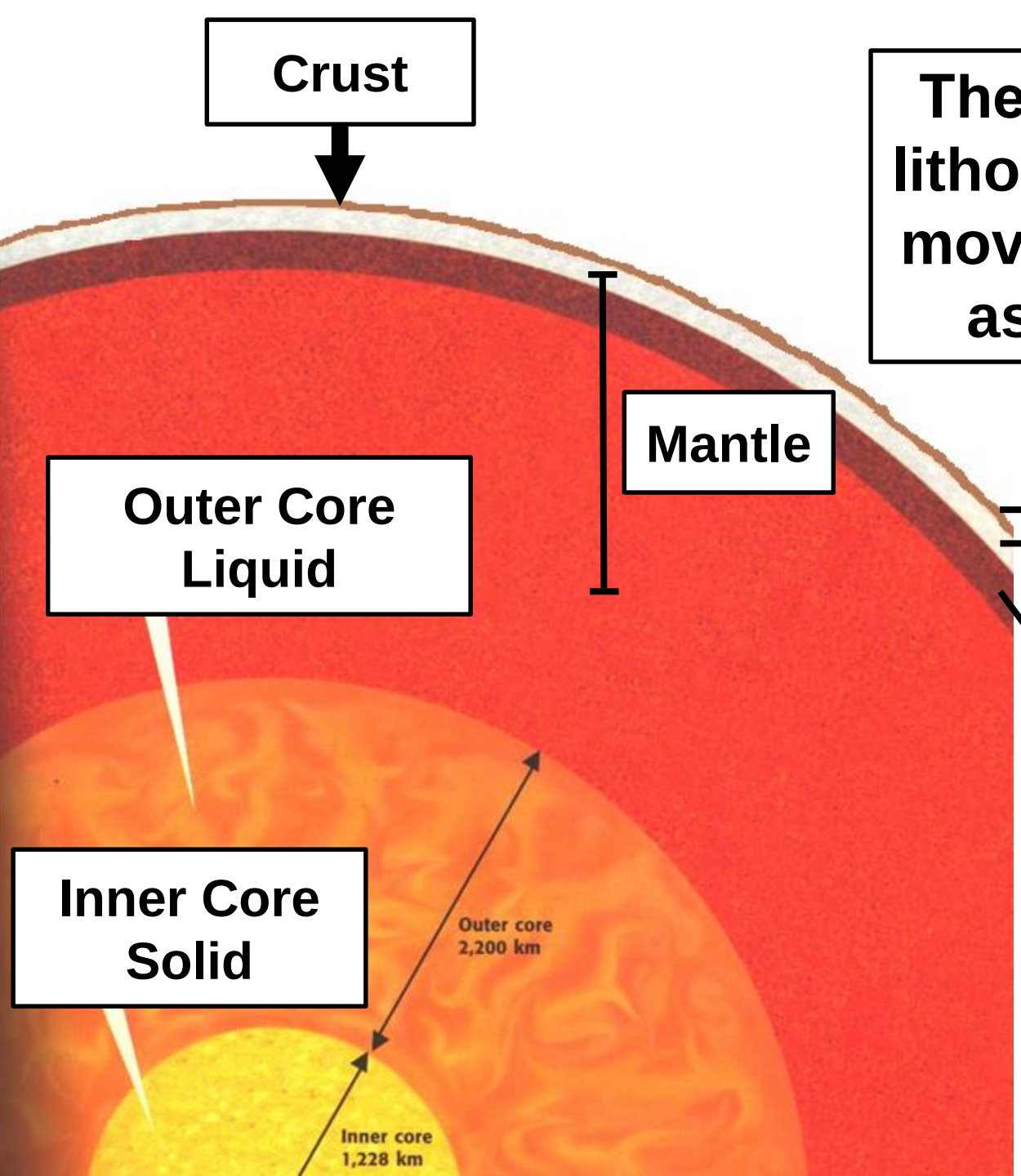
Seafloor Spreading Activity

A new theory that combined continental drift and seafloor spreading was developed known as the theory of Plate Tectonics.



The theory of Plate Tectonics states that the Earth's crust and part of the Upper Mantle are broken into plates (sections) that move.



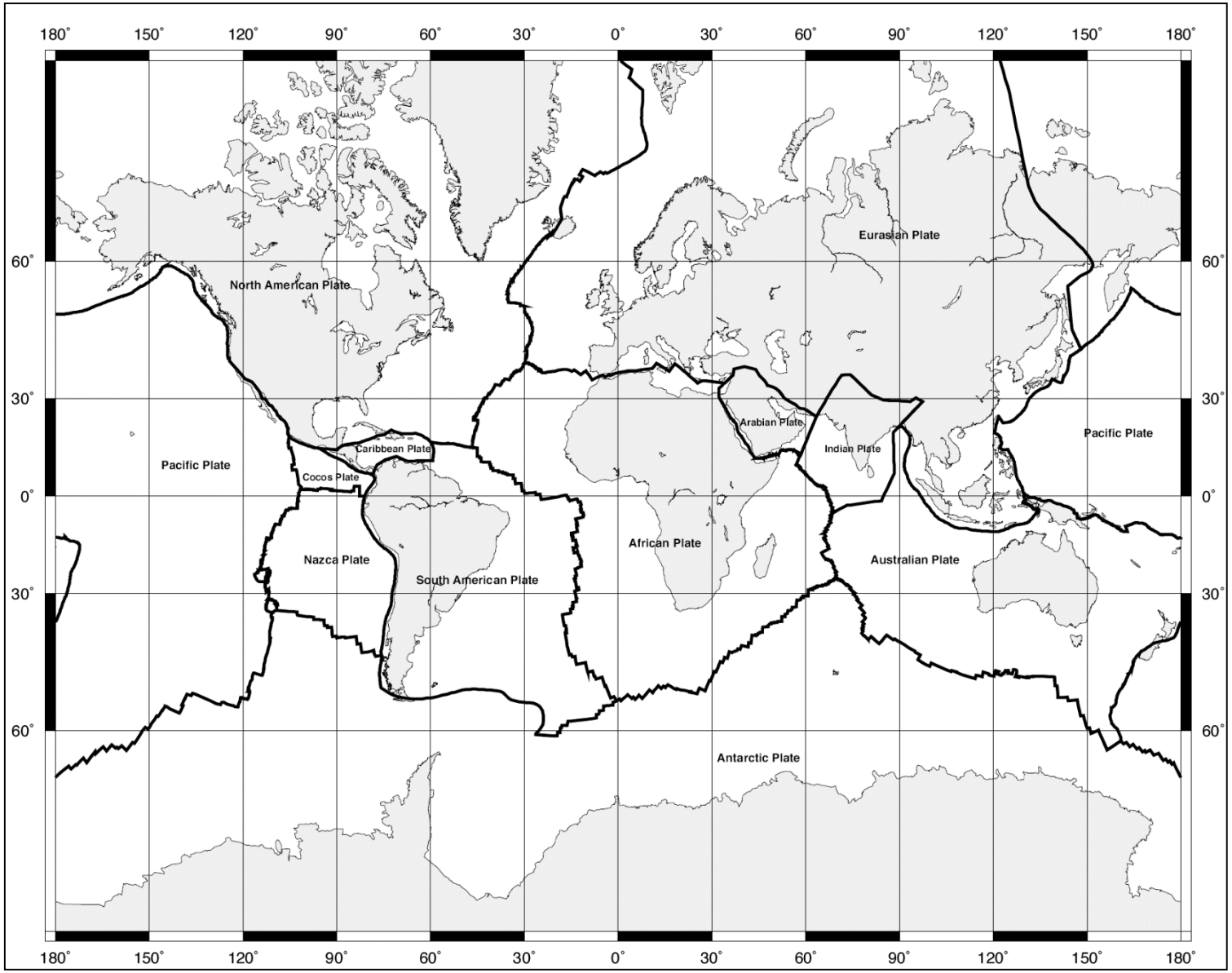


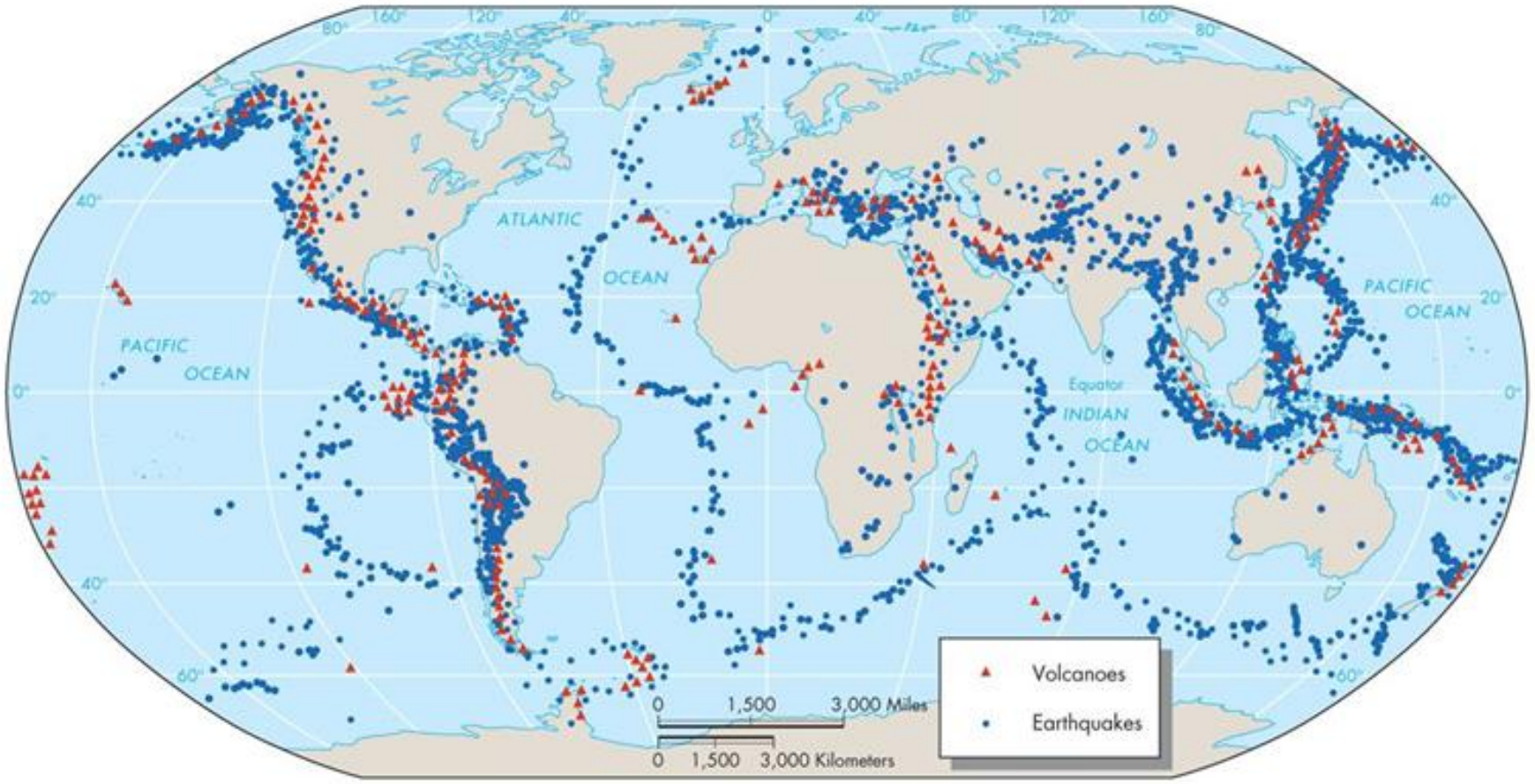
The "plates" of the lithosphere float and move around on the asthenosphere.

Lithosphere – Crust and Upper Layer of the Mantle

Layer of the Mantle (asthenosphere) that consists of hot rock of tar-like consistency, which slowly moves

Plate Boundary Map





Volcanoes and Earthquakes form along tectonic plate boundaries

Types of Plate Boundaries Reading/Organizer activity

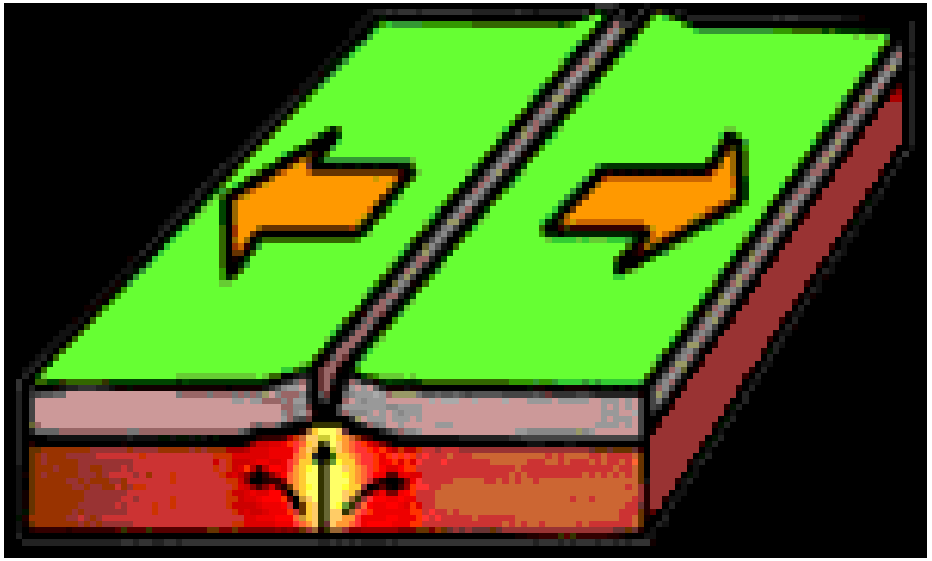
Boundary Type		Diagram	Seafloor Change	Events Observed	Examples
			N/A		

When plates move, they can interact in several ways:

- They can move toward each other
- They can pull apart from each other
- They can slide alongside one another

The result of plate movement can be seen at plate boundaries.

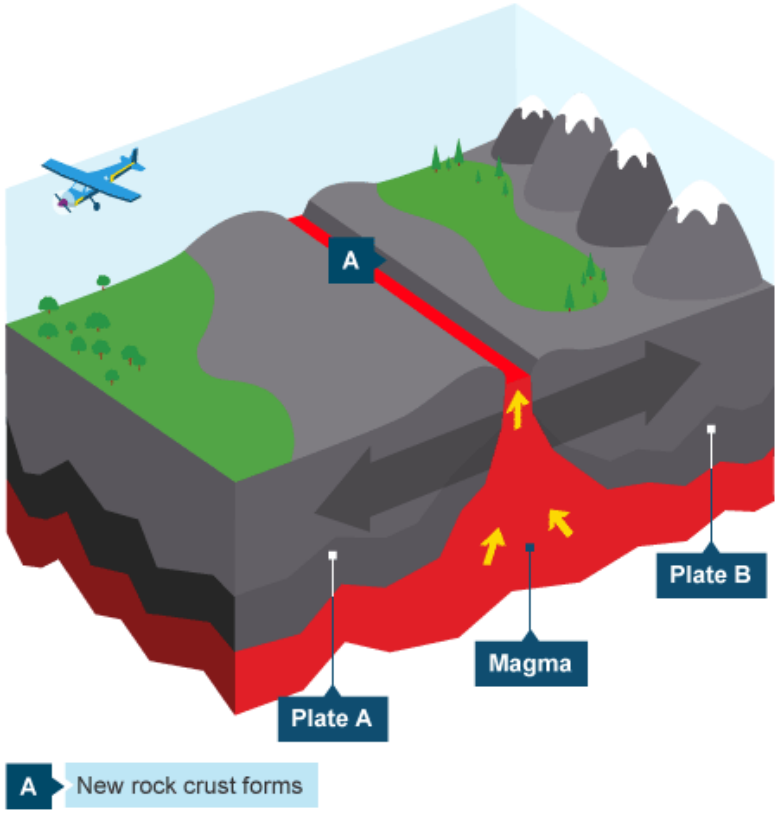
Divergent Plate Boundary: two plates are moving apart and new crust is created



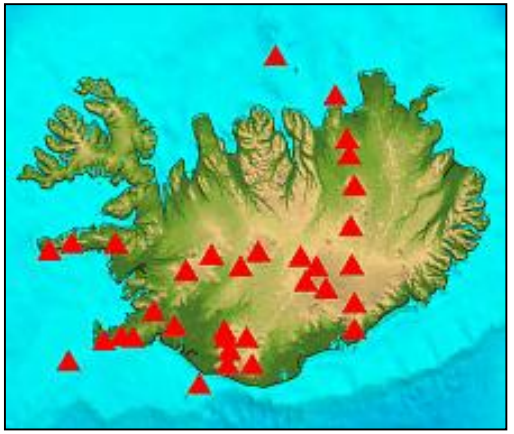
Divergent Plate Boundary:

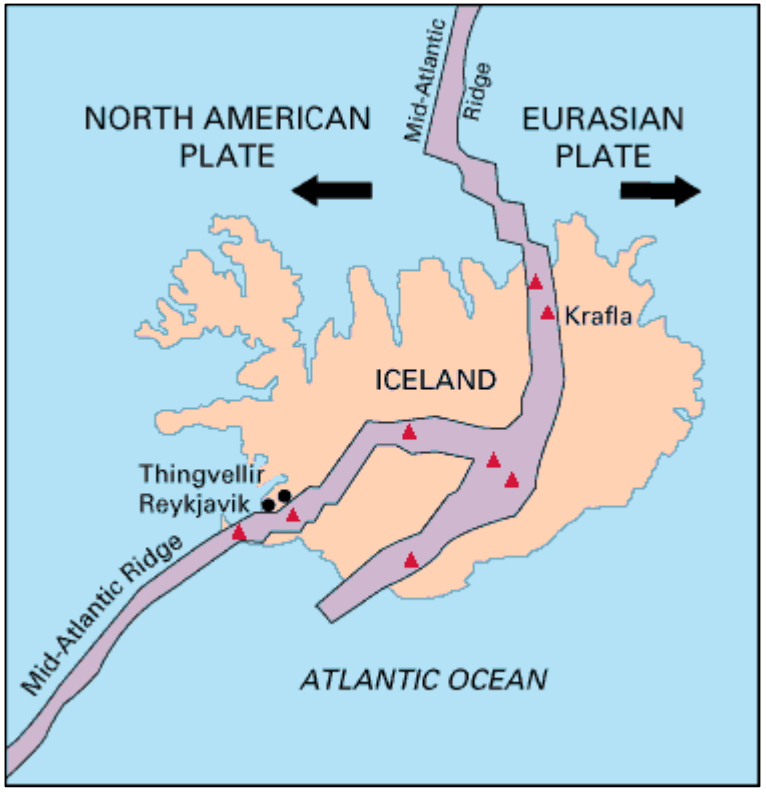
Continental Plate ⟵ ⟶ Continental Plate

When two continental plates spread apart rifts (cracks) begin. Magma can rise and squeeze between the cracks sometimes forming volcanoes.

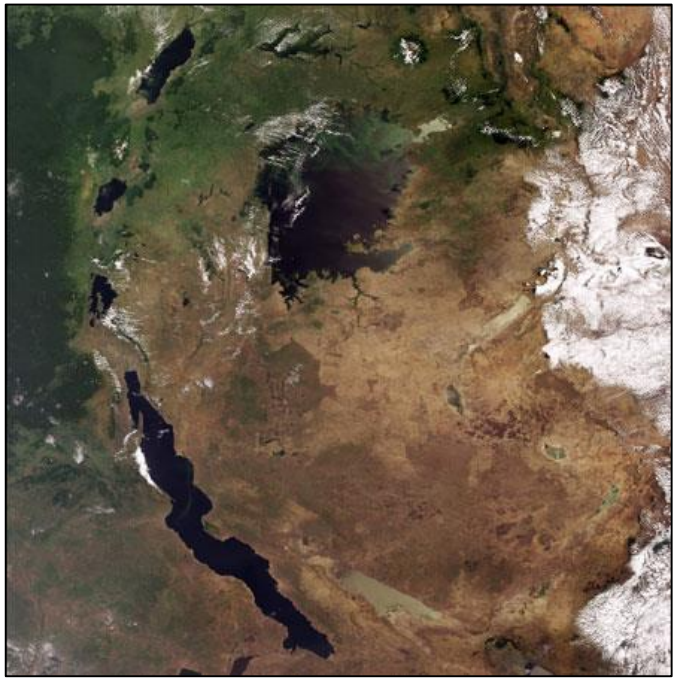


Divergent Boundary in Iceland

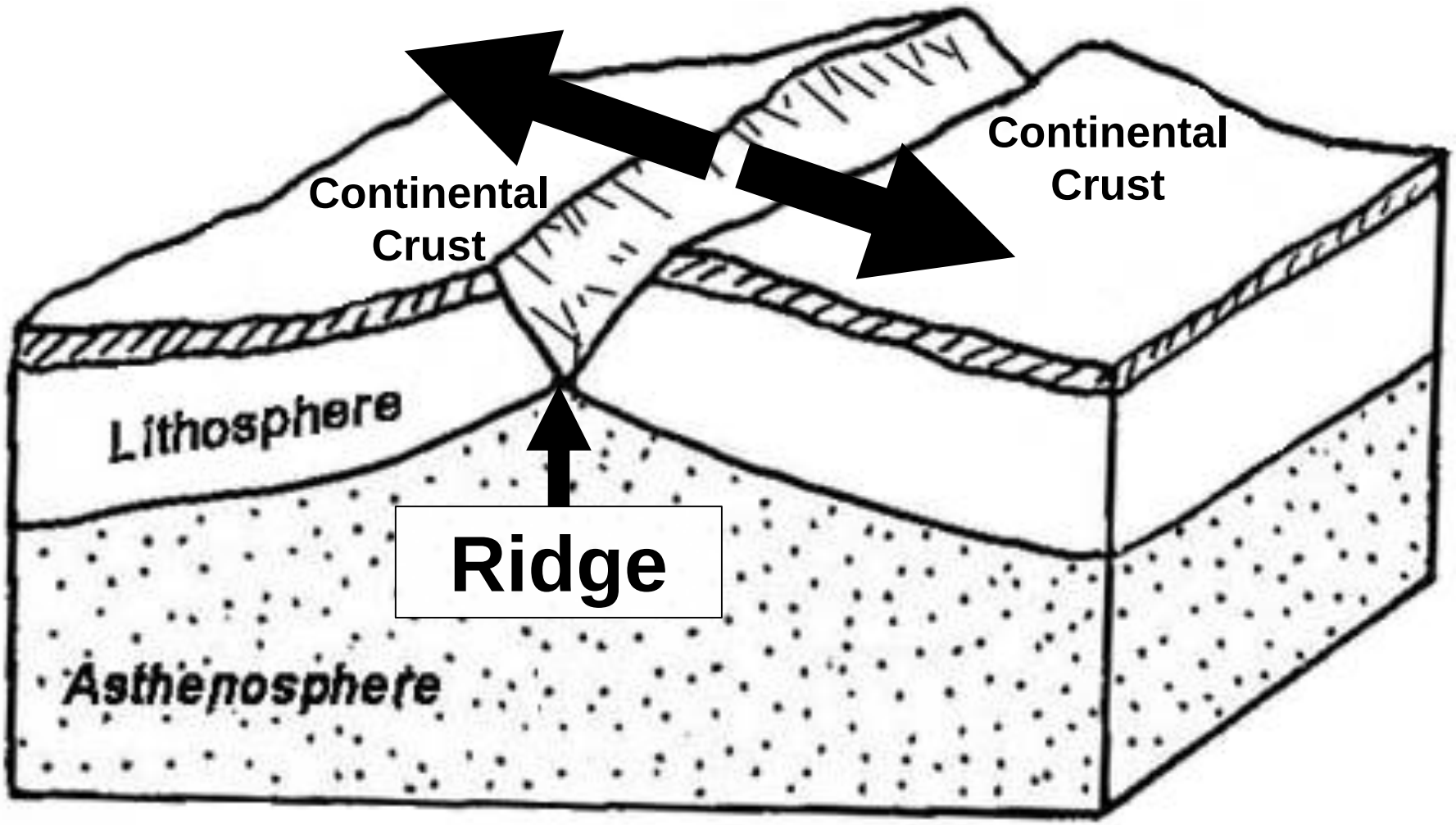




Divergent Boundary in Africa



Divergent Plate Boundary:
Continental Plate ← → Continental Plate



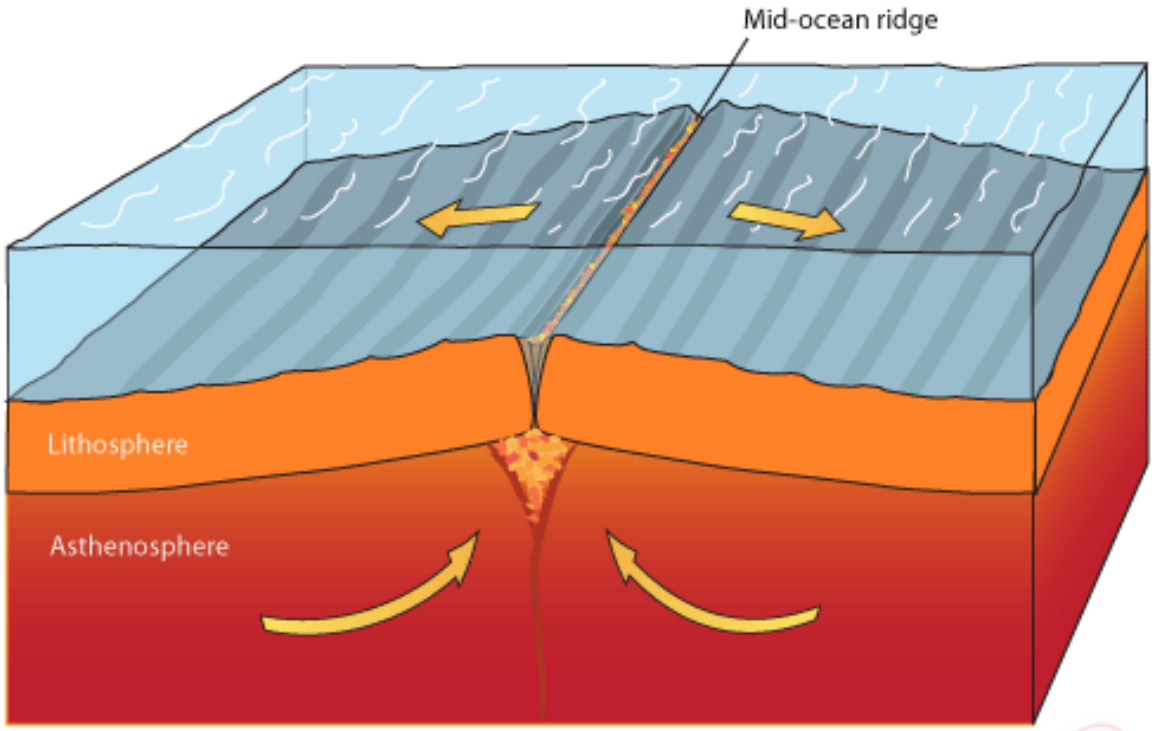
Divergent Plate Boundary:

Oceanic Plate ← → Oceanic Plate

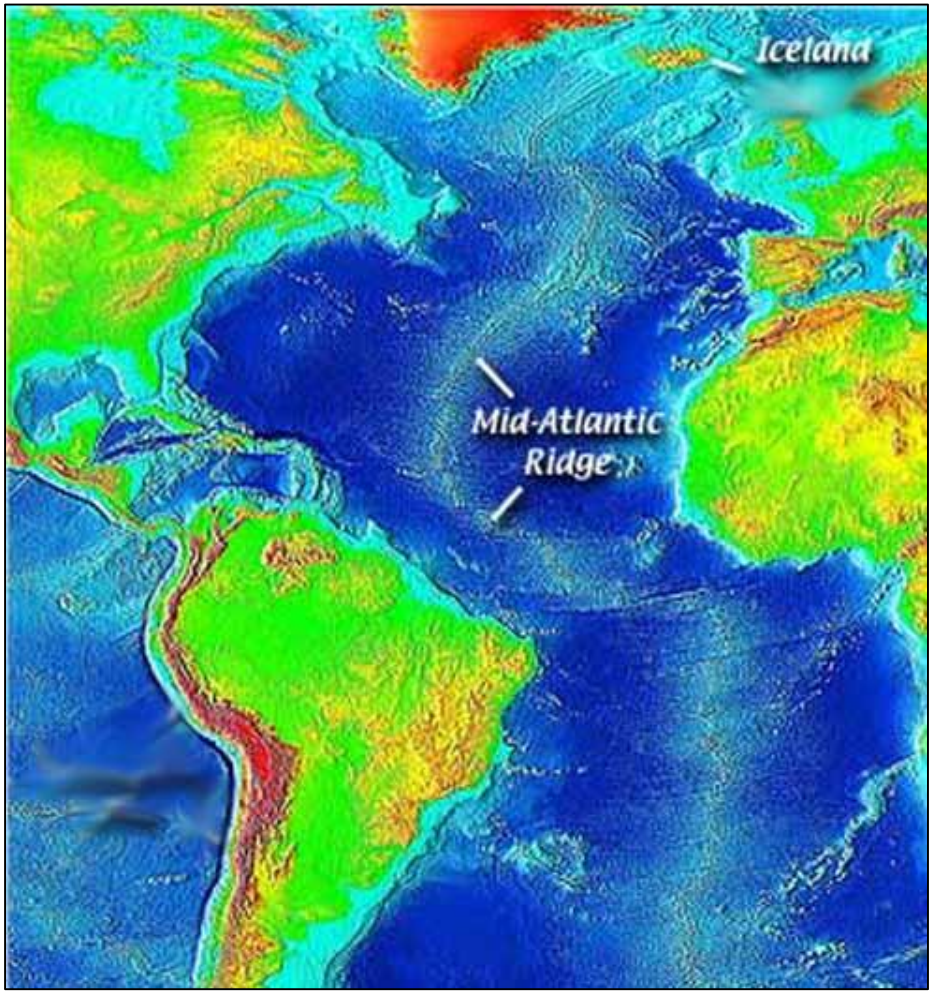
When two oceanic plates spread apart magma is forced upward pushing the older seafloor away in opposite directions forming a ridge.

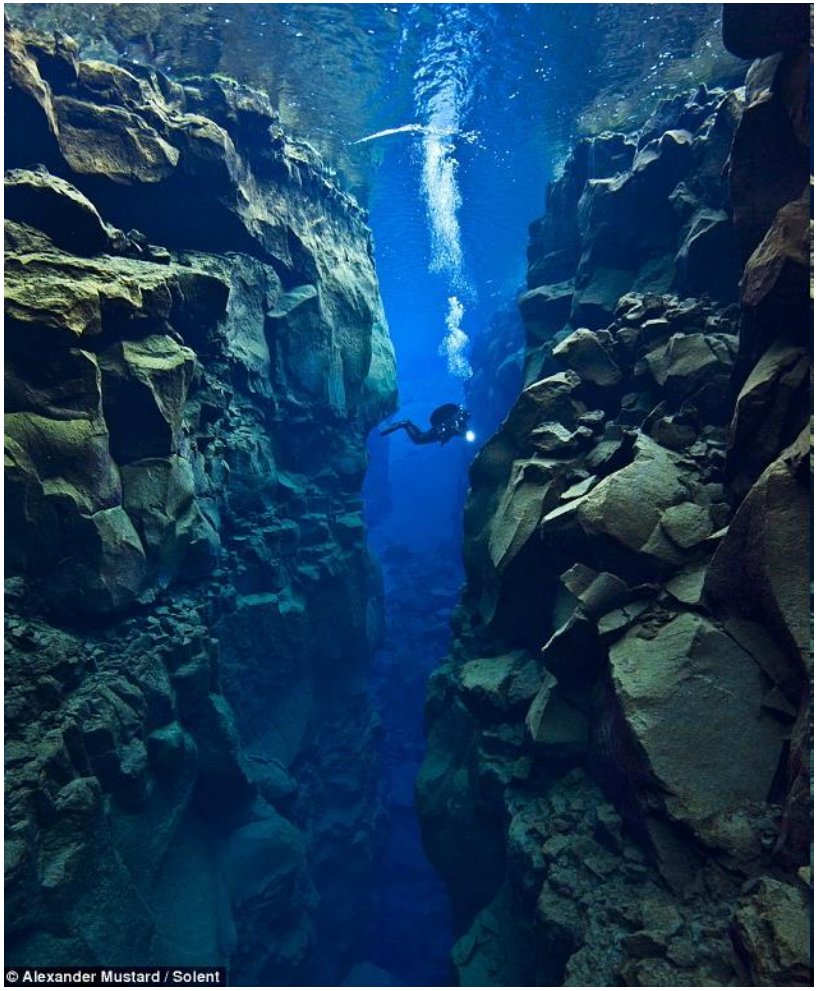
Divergent Plate Boundary:

Oceanic Plate ← → Oceanic Plate



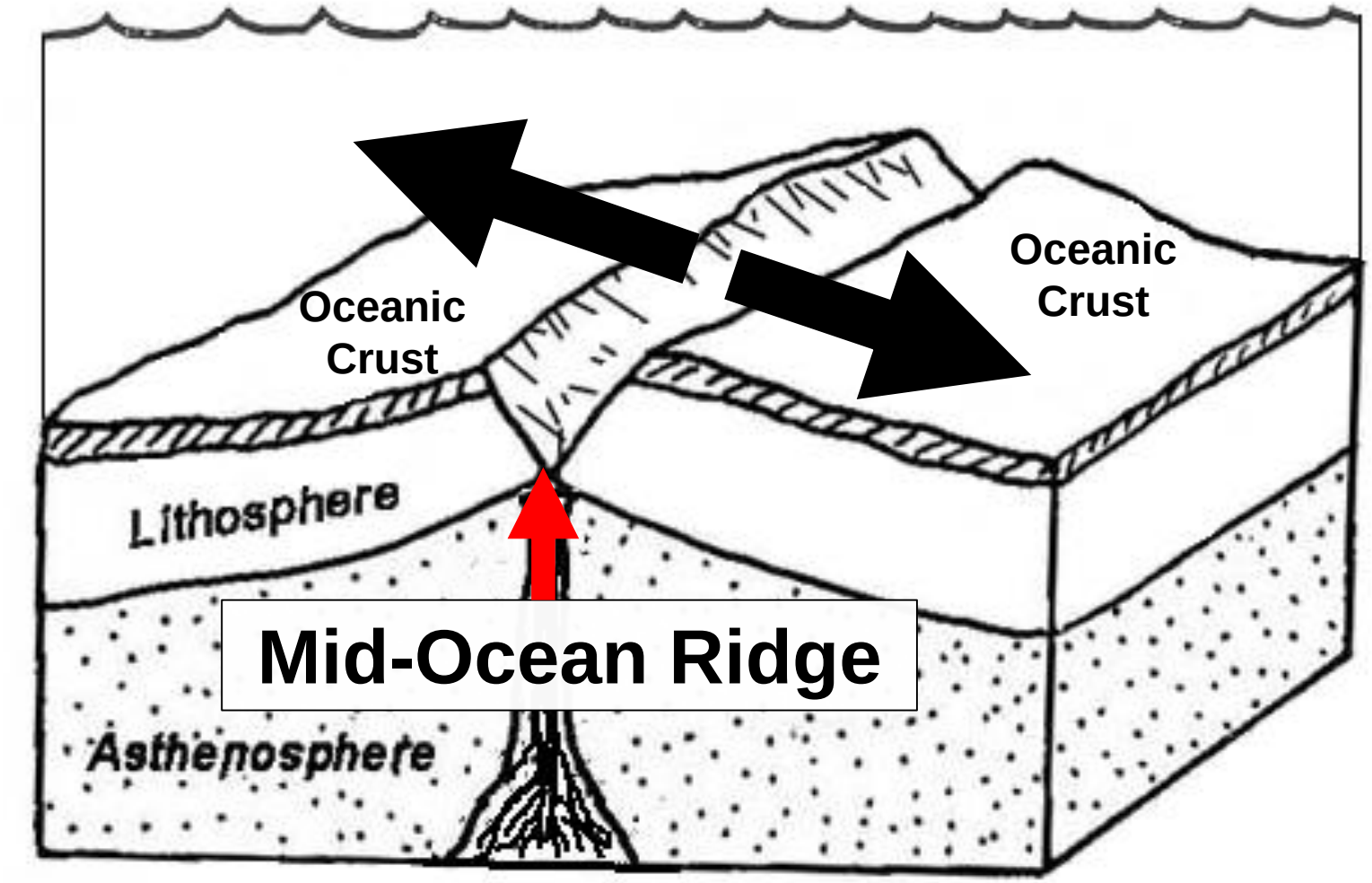
Divergent Boundary: Mid-Atlantic Ridge



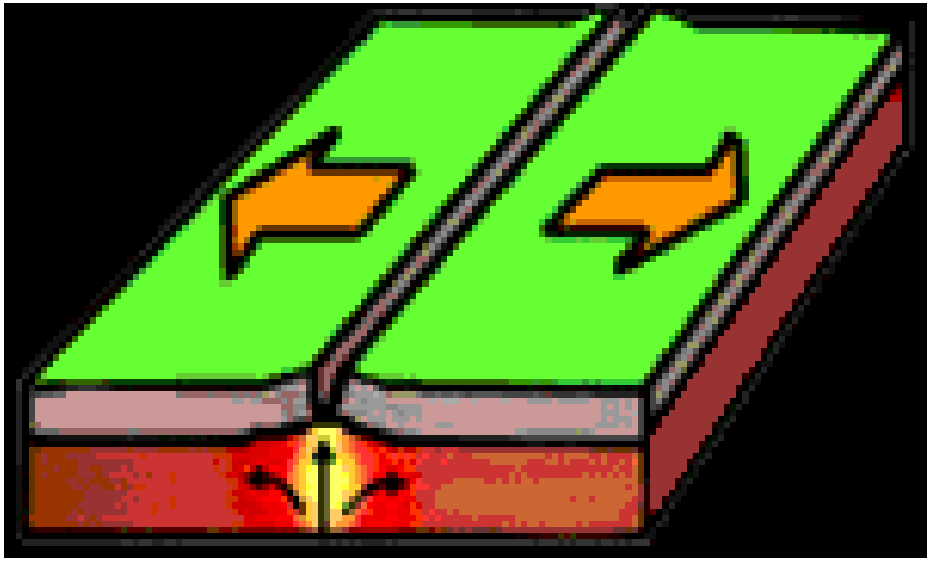


Divergent Plate Boundary:

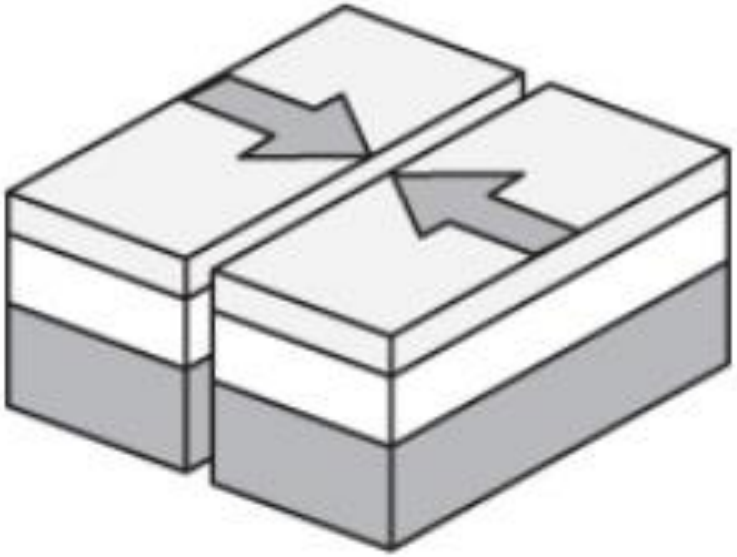
Oceanic Plate ← → Oceanic Plate



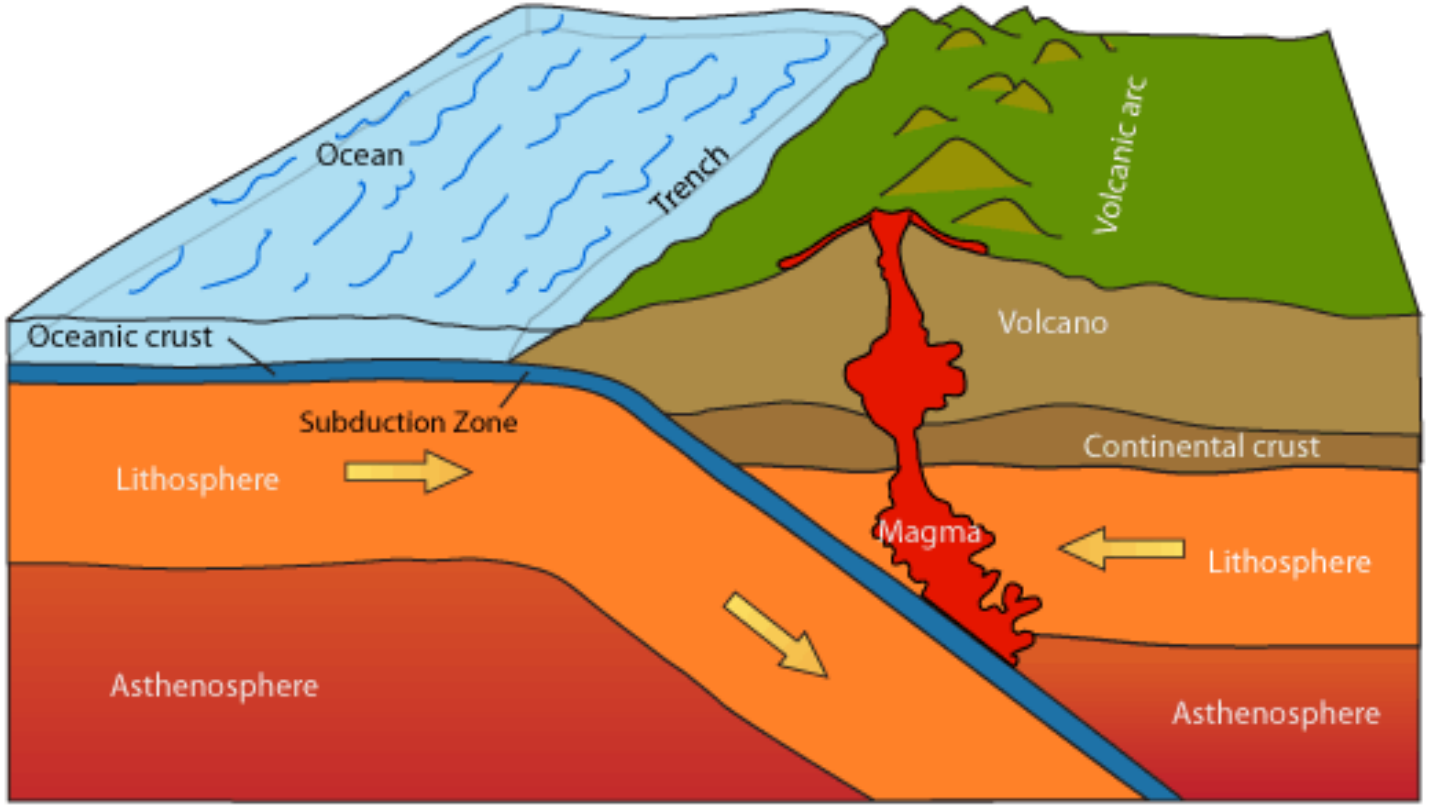
Turn to a seat partner and discuss the cause, effects, and importance of divergent boundaries.



Convergent Plate Boundary: two plates collide



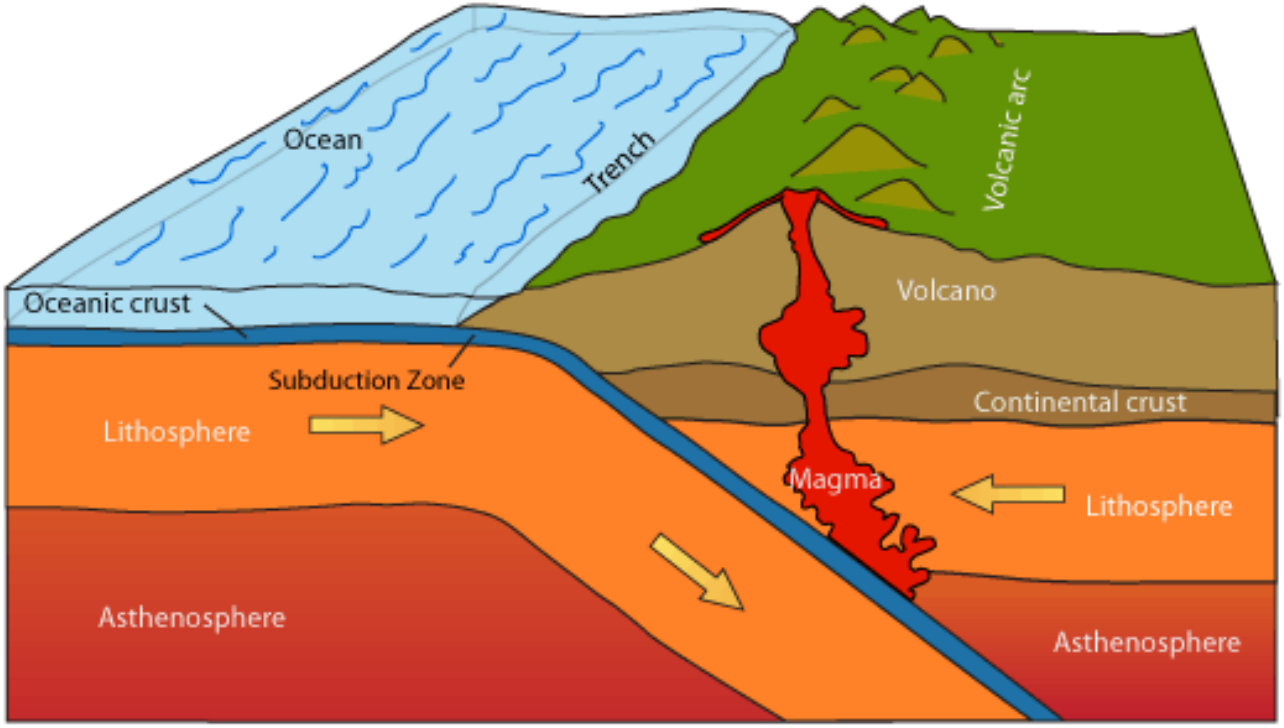
Convergent Plate Boundary: Oceanic → ← Continental



Convergent Plate Boundary: Oceanic → ← Continental

- The denser oceanic plate subducts (goes down), under the continental plate into the mantle.
- A deep sea trench is created where one plate bends and sinks.
- High temperatures cause rock to melt around the subducting plate as it goes under the other plate
- Newly formed magma is forced upward along these plate boundaries, forming volcanoes.

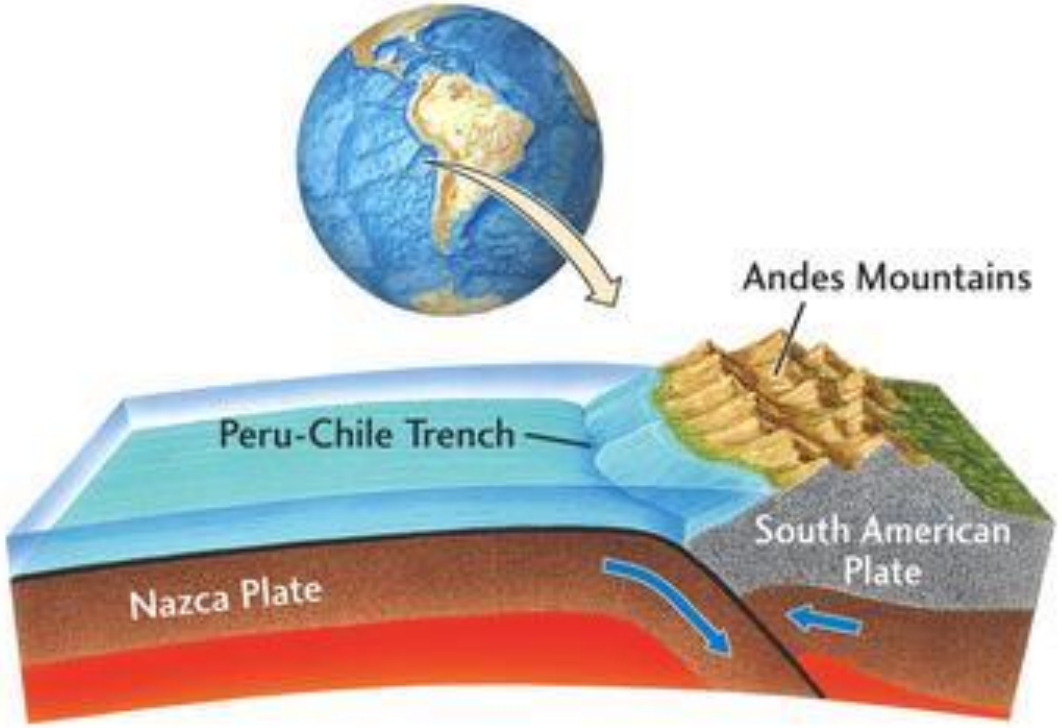
Convergent Plate Boundary: Oceanic → ← Continental



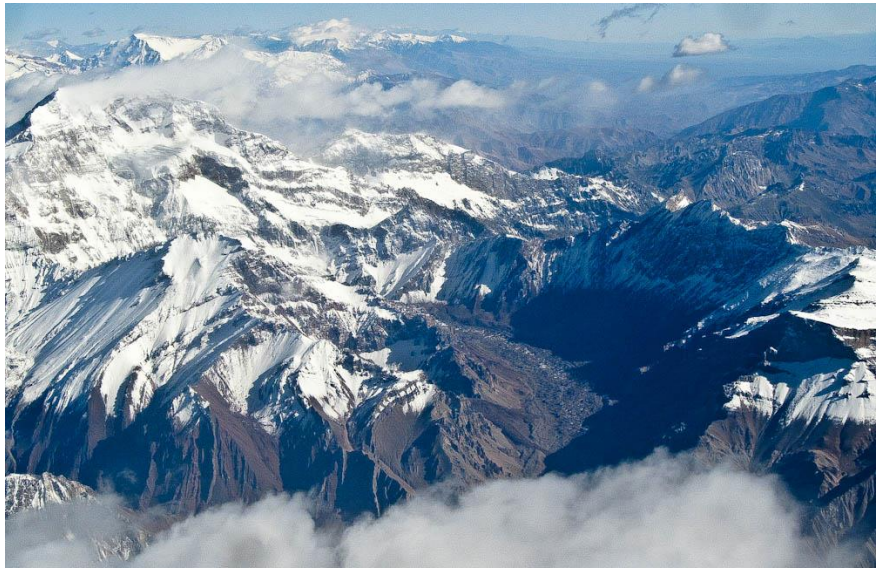
Model a Convergent Boundary with Subduction:

- Place your hands in front of you with your palms facing the floor as shown in the picture.
- Push your left hand slightly under your right hand.
- This motion demonstrates what happens when one plate slides under the other.

Convergent Boundary

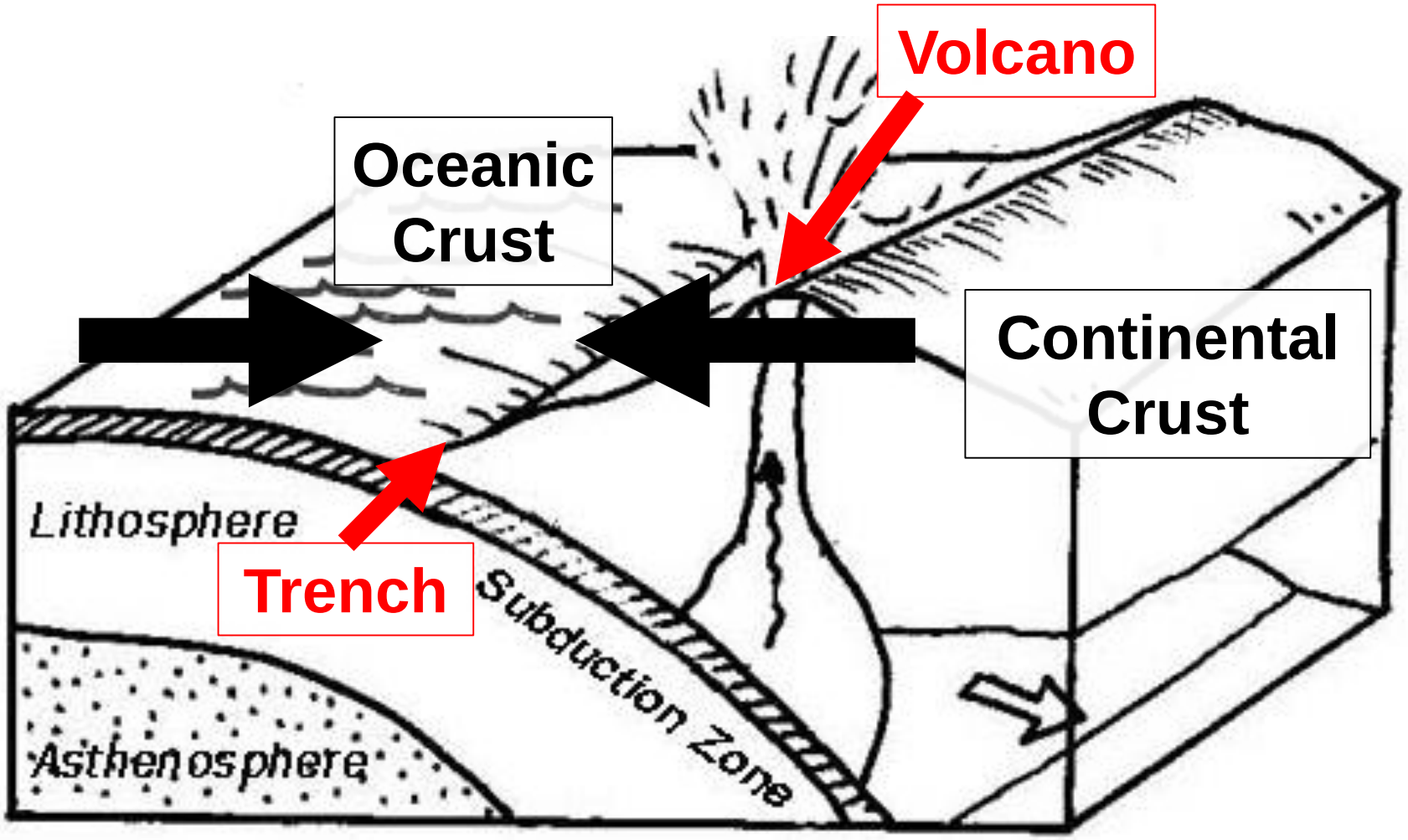


Andes Mountains



New crust is added at divergent boundaries while it disappears below the surface at the subduction zones of convergent boundaries.

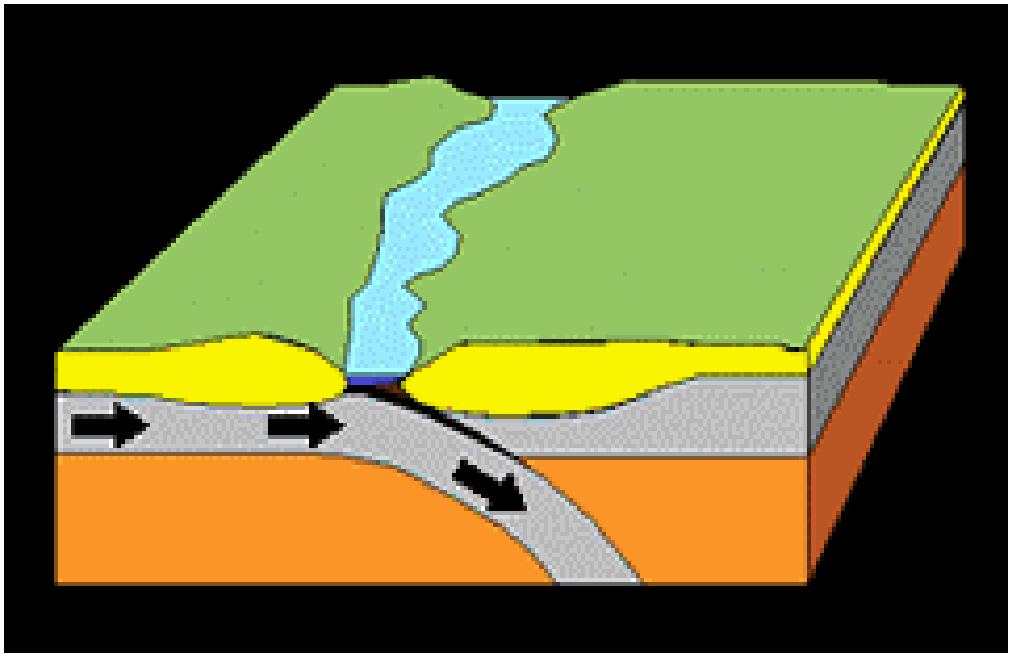
Convergent Plate Boundary: Oceanic → ← Continental



Convergent Plate Boundary:

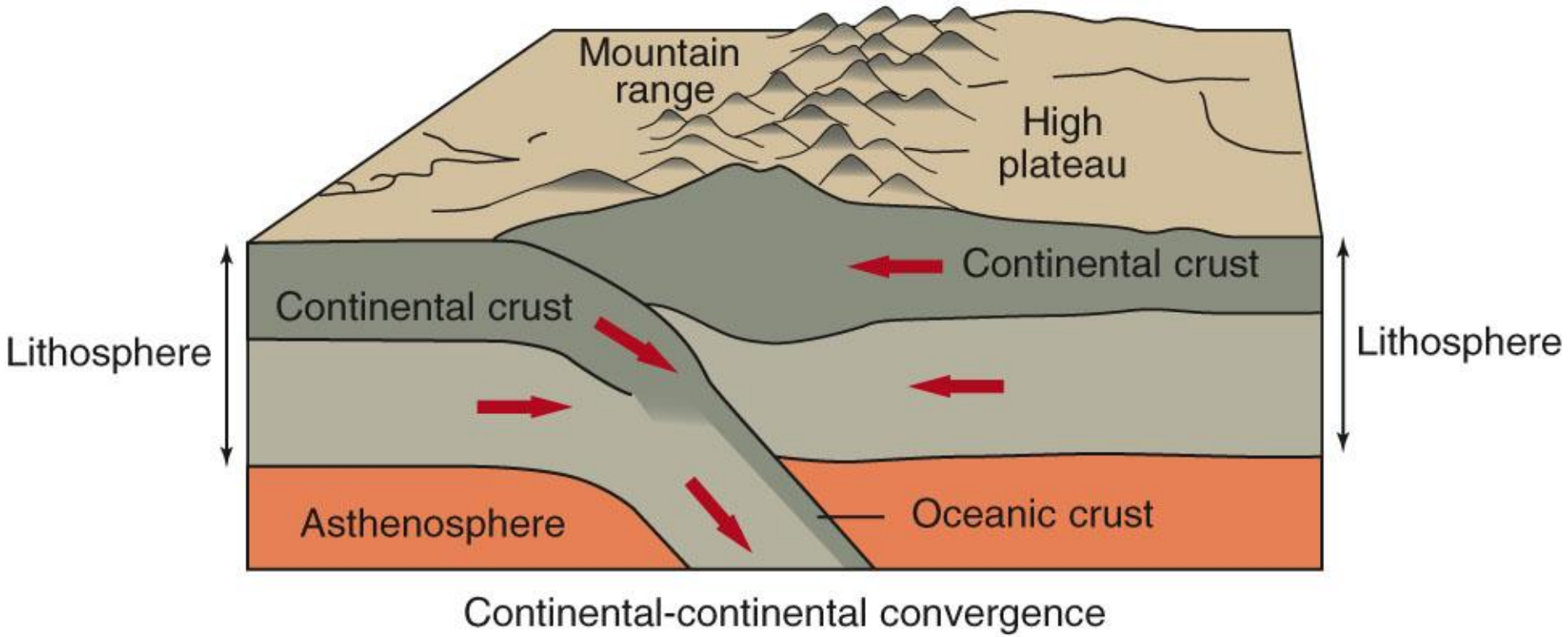
Continental Plate → ← Continental Plate

the crust buckles and pushes upward forming mountains



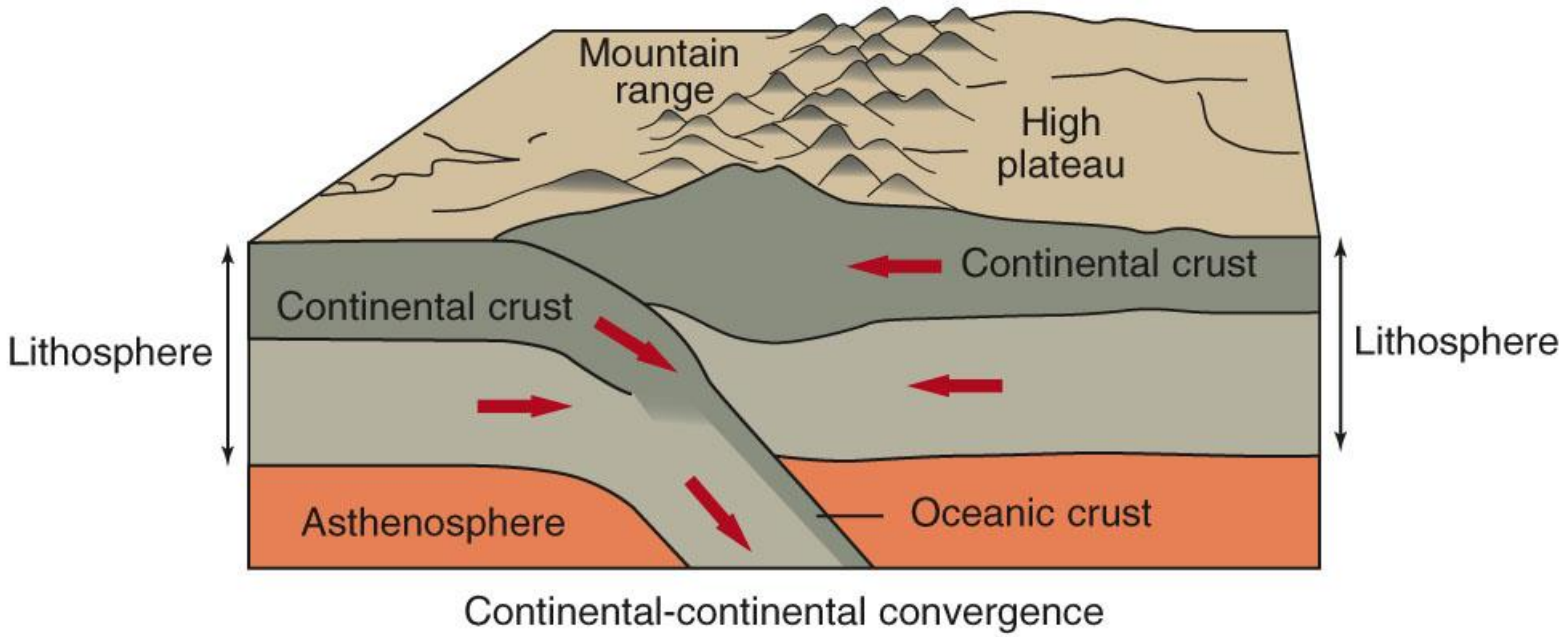
Convergent Plate Boundary

Continental → ← Continental



Convergent Plate Boundary

Continental → ← Continental



Continental-continental convergence

Earthquakes are common at these convergent boundaries, but volcanoes do not form because there is no, or little, subduction.

Convergent Plate Boundary

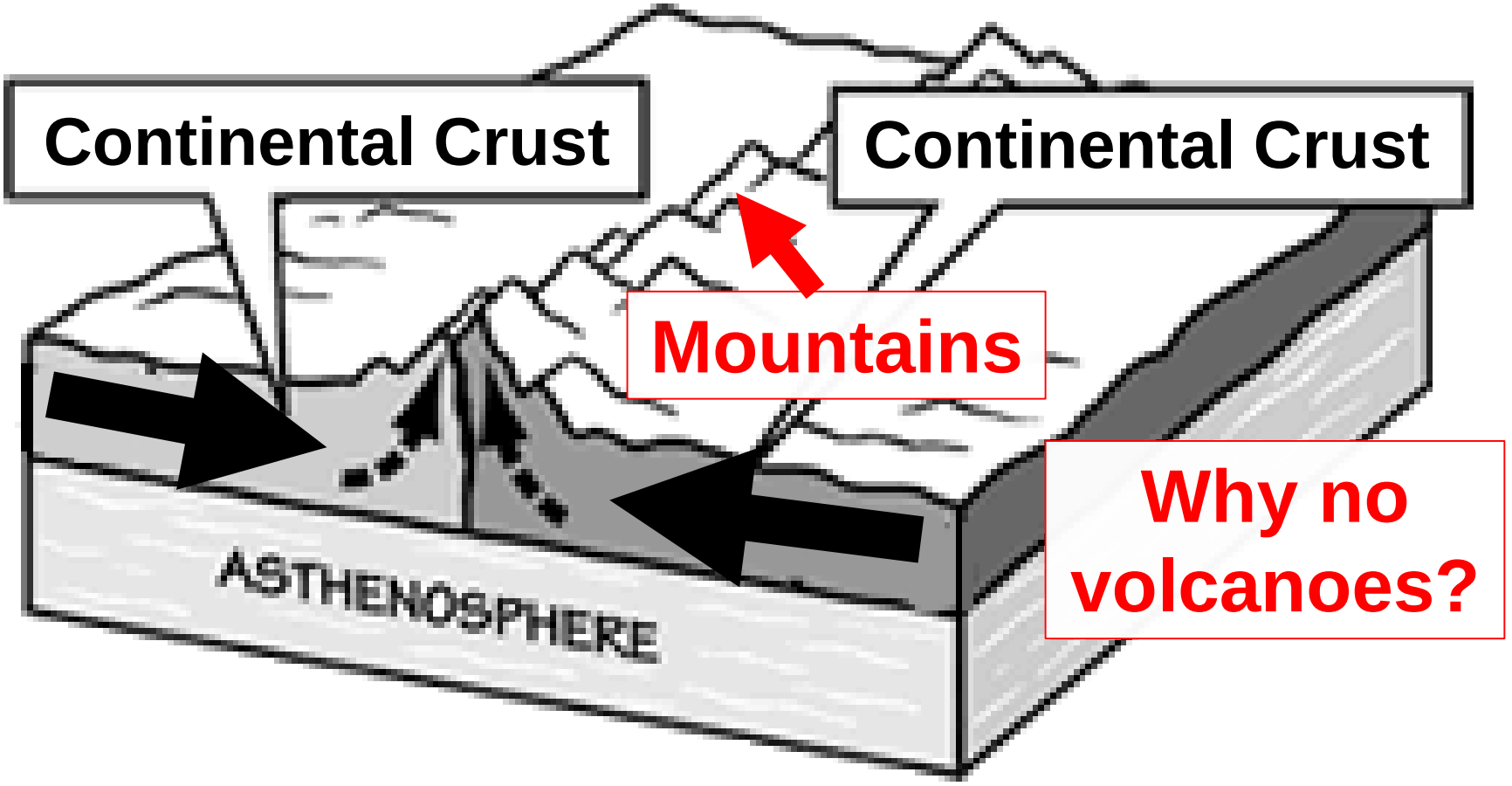
Continental → ← Continental

Himalayan Mountains

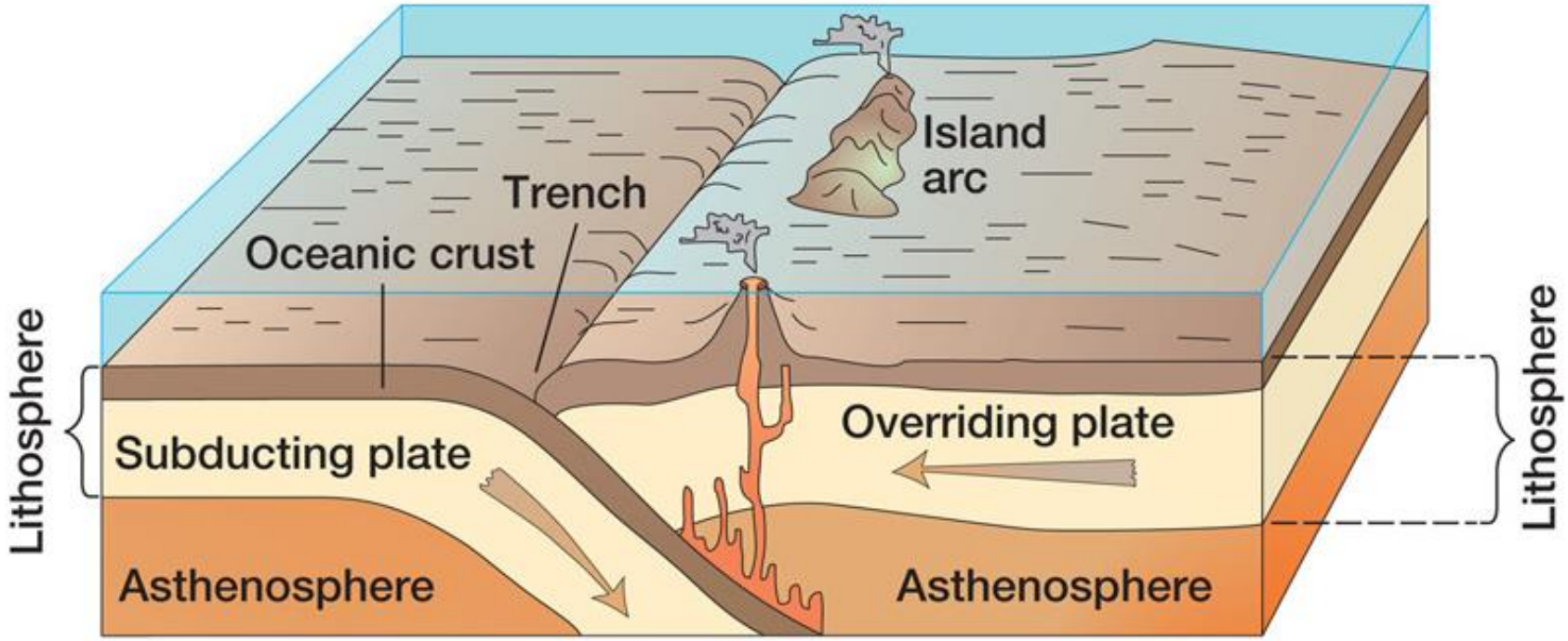
http://www.classzone.com/books/earth_science/terc/content/visualizations/es1105/es1105page01.cfm?chapter_no=visualization

Convergent Plate Boundary

Continental → ← Continental



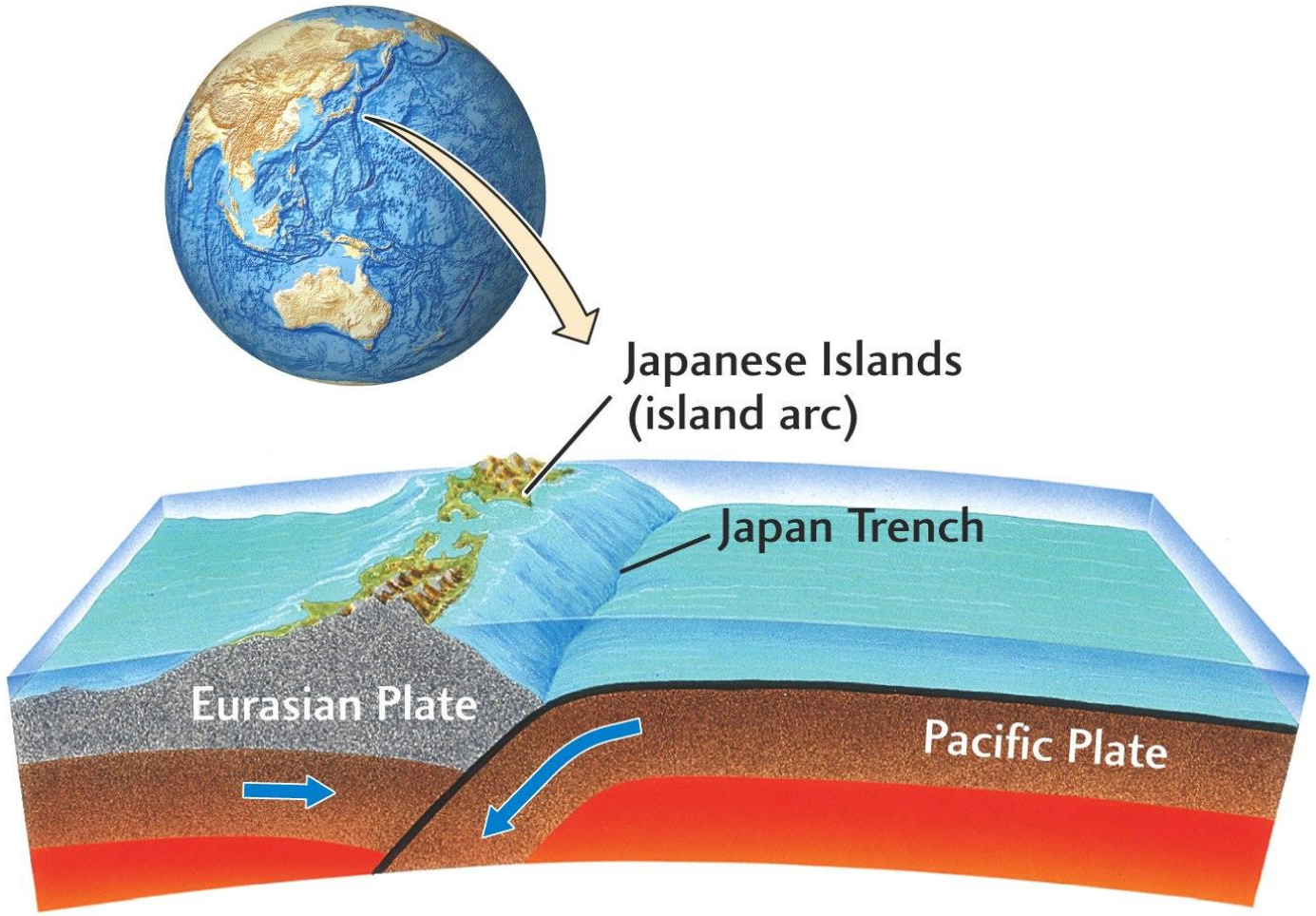
Convergent Plate Boundary: Oceanic → ← Oceanic



Convergent Plate Boundary: Oceanic → ← Oceanic

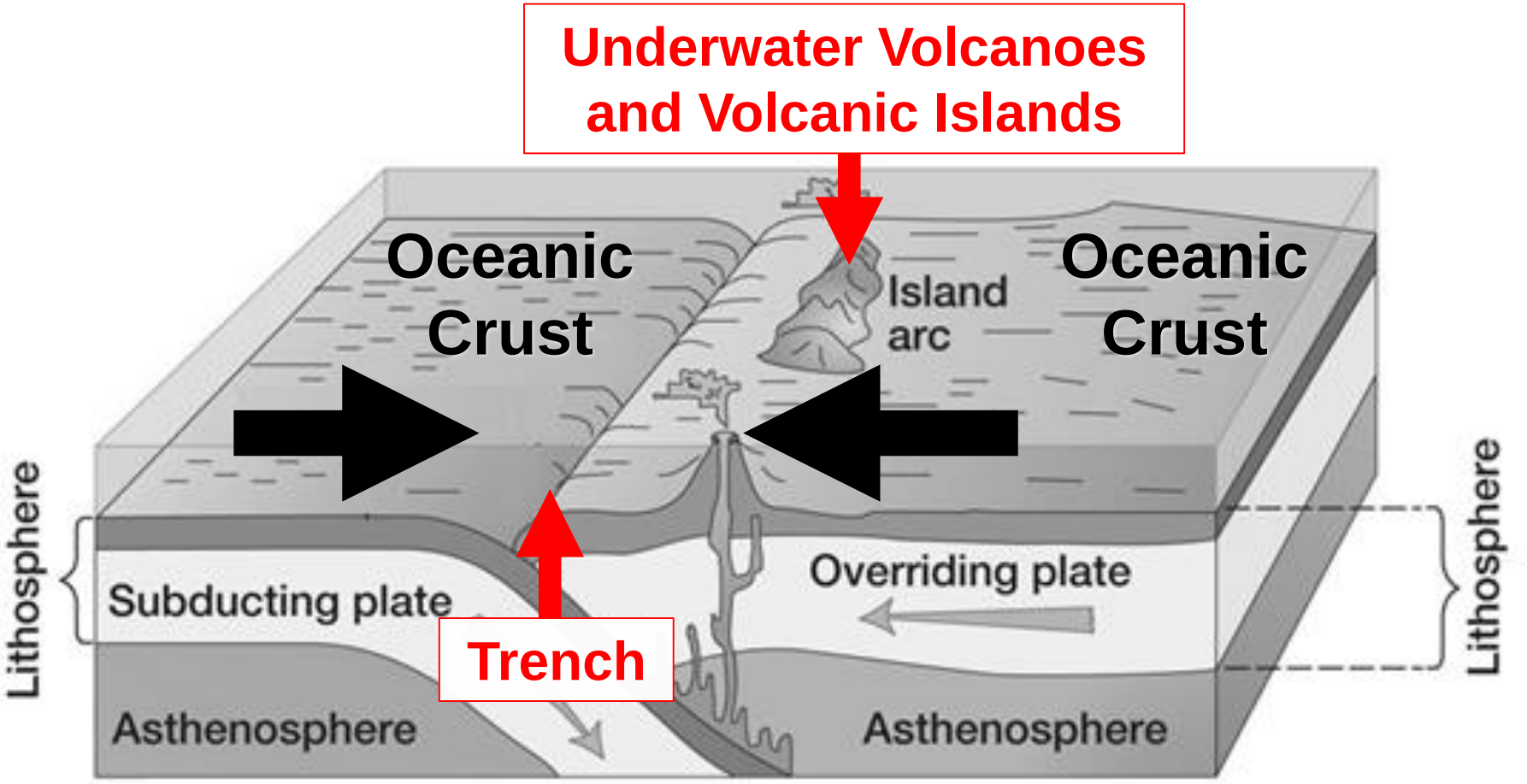
- A colder, older, denser oceanic plate subducts (goes down), under another oceanic plate into the mantle.
- A deep sea trench is created where one plate bends and sinks.
- High temperatures cause rock to melt around the subducting plate as it goes under the other plate
- Newly formed magma is forced upward along these plate boundaries, forming volcanoes.
- Over millions of years, erupted lava piles up until it rises above sea level to form volcanic islands.

Convergent Plate Boundary: Oceanic → ← Oceanic

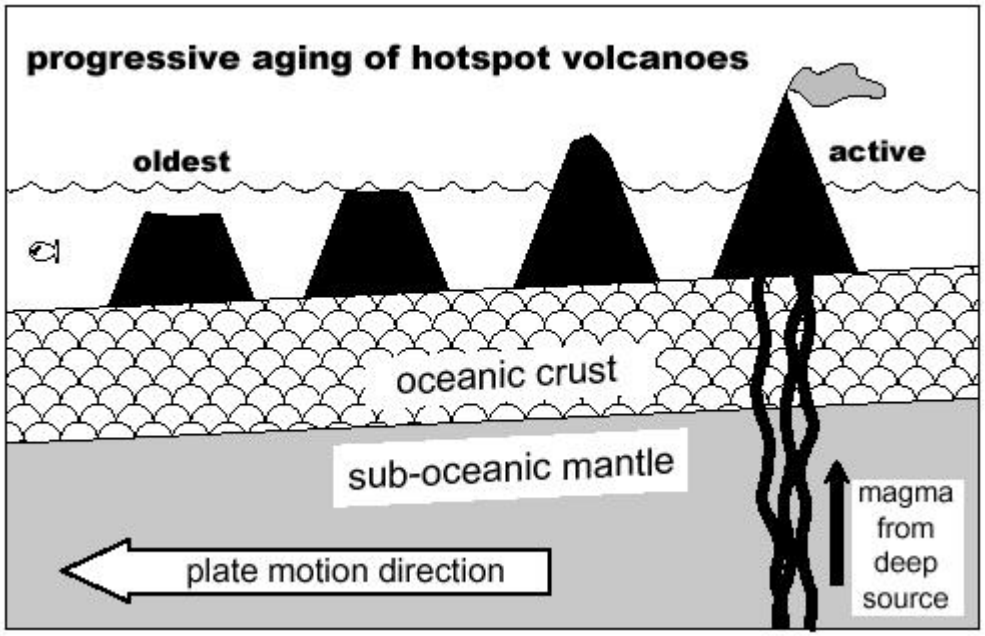


Convergent Plate Boundary:

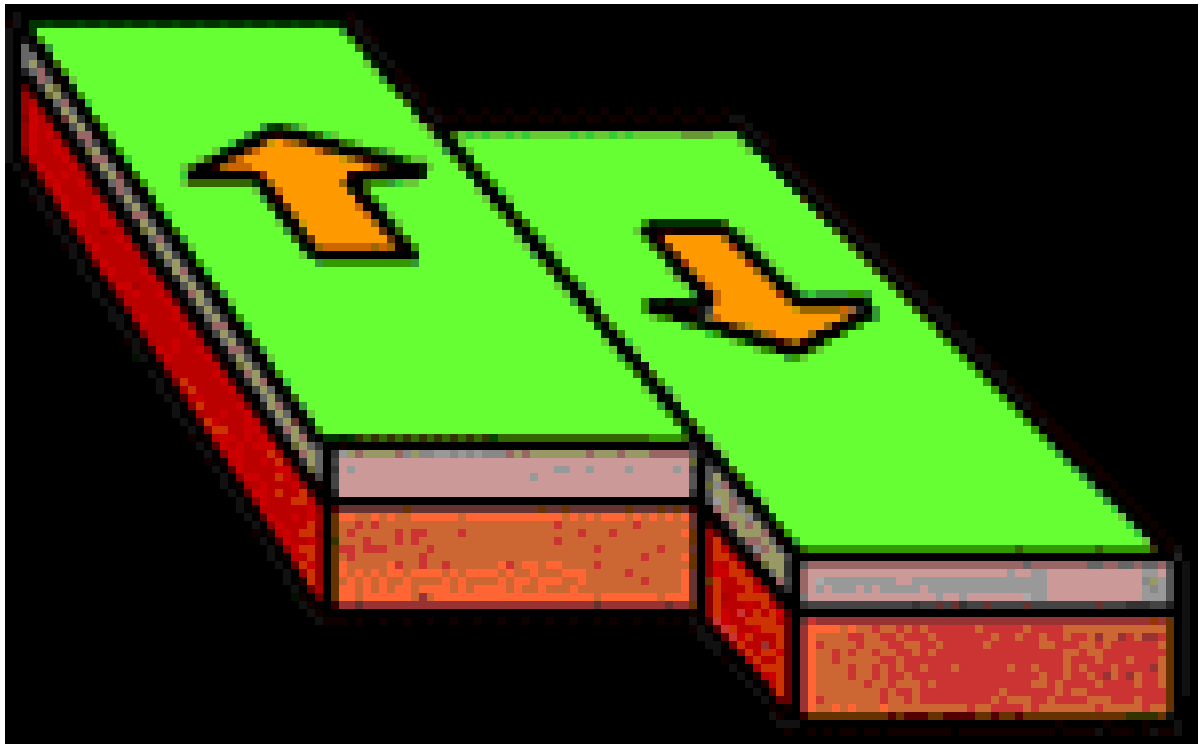
Oceanic → ← Oceanic



Sometimes volcanic islands form due to the movement of lithospheric plates over hot spots.

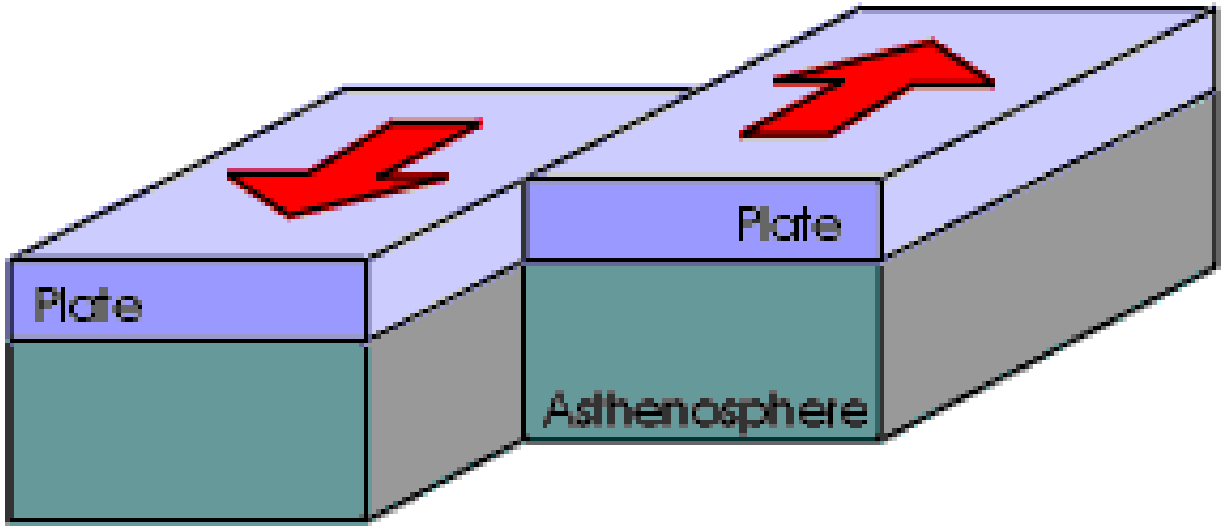


Transform Plate Boundary: Plates Slide Past Each Other

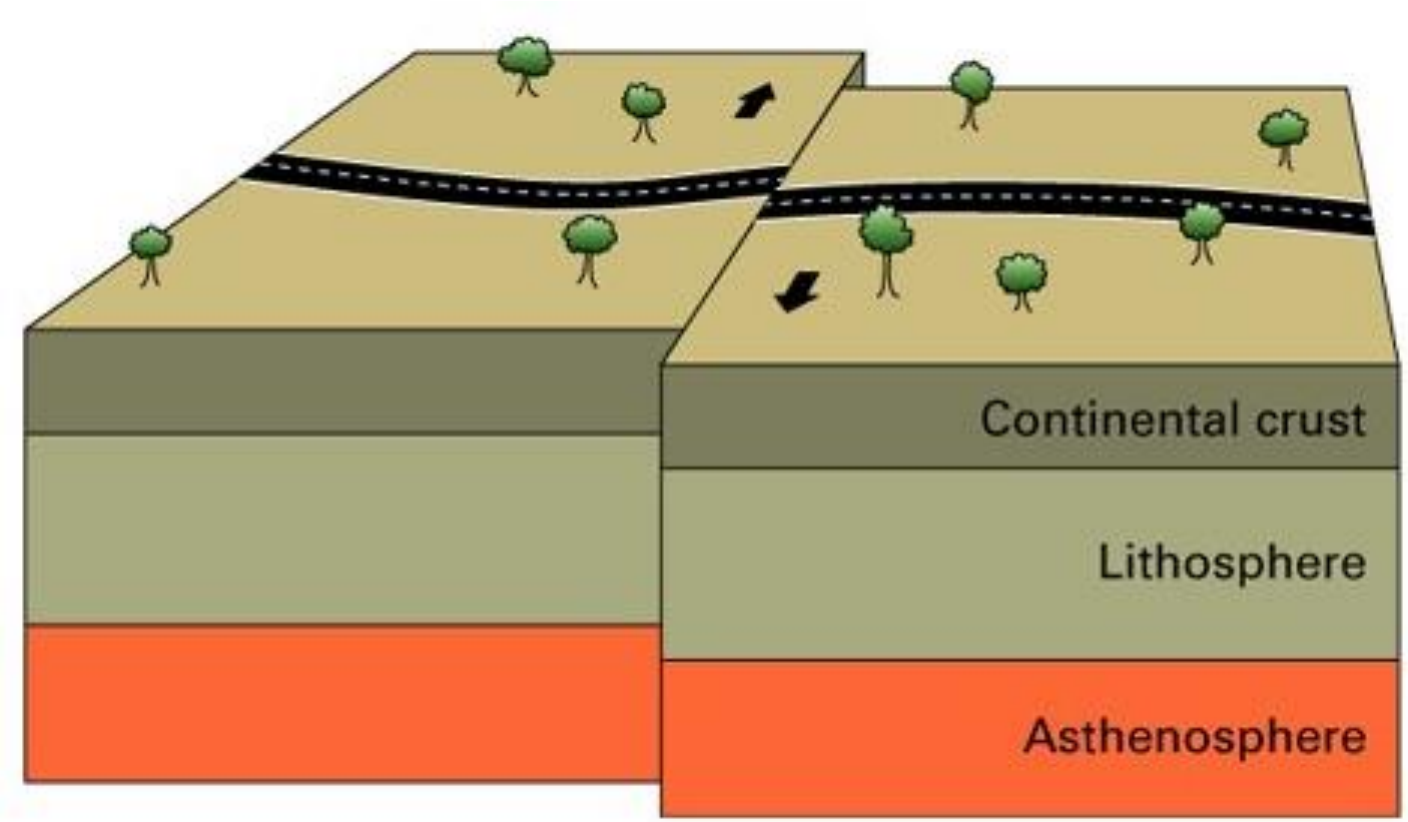


Transform Boundary

- **Plates move in opposite directions or in the same direction at different rates**
- **When one plate slips past another plate suddenly, earthquakes occur**
- **These plate boundaries do not destroy or build up Earth's crust.**



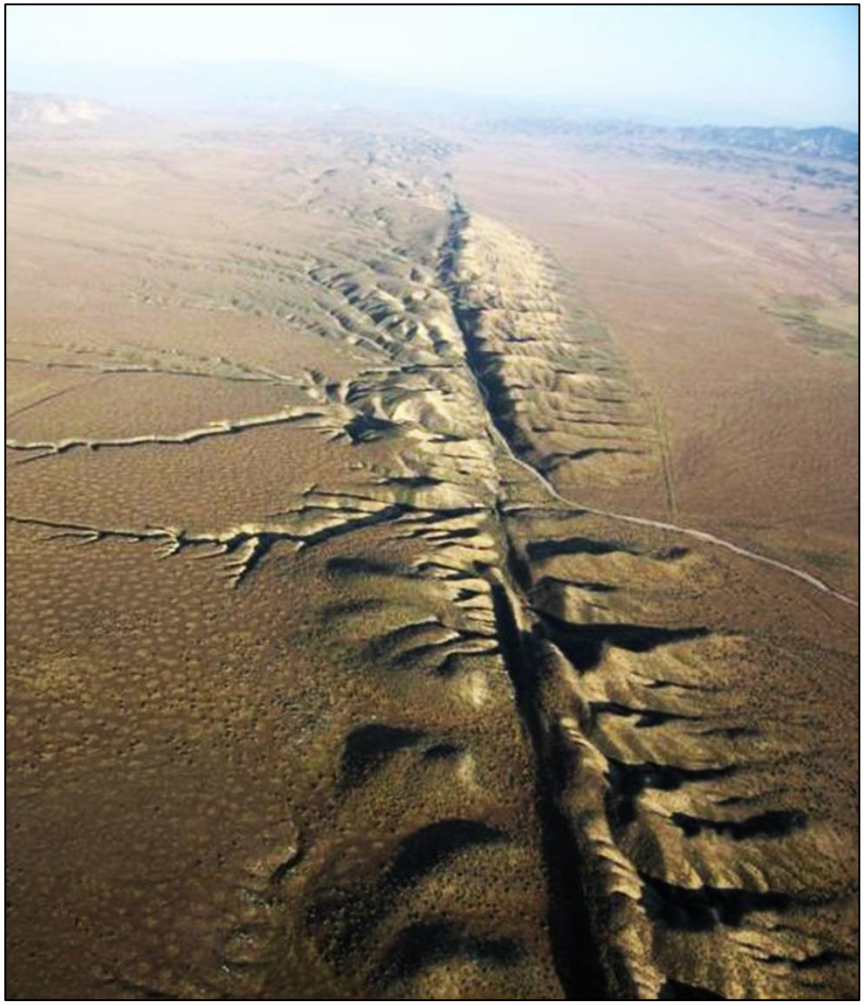
Transform Boundary



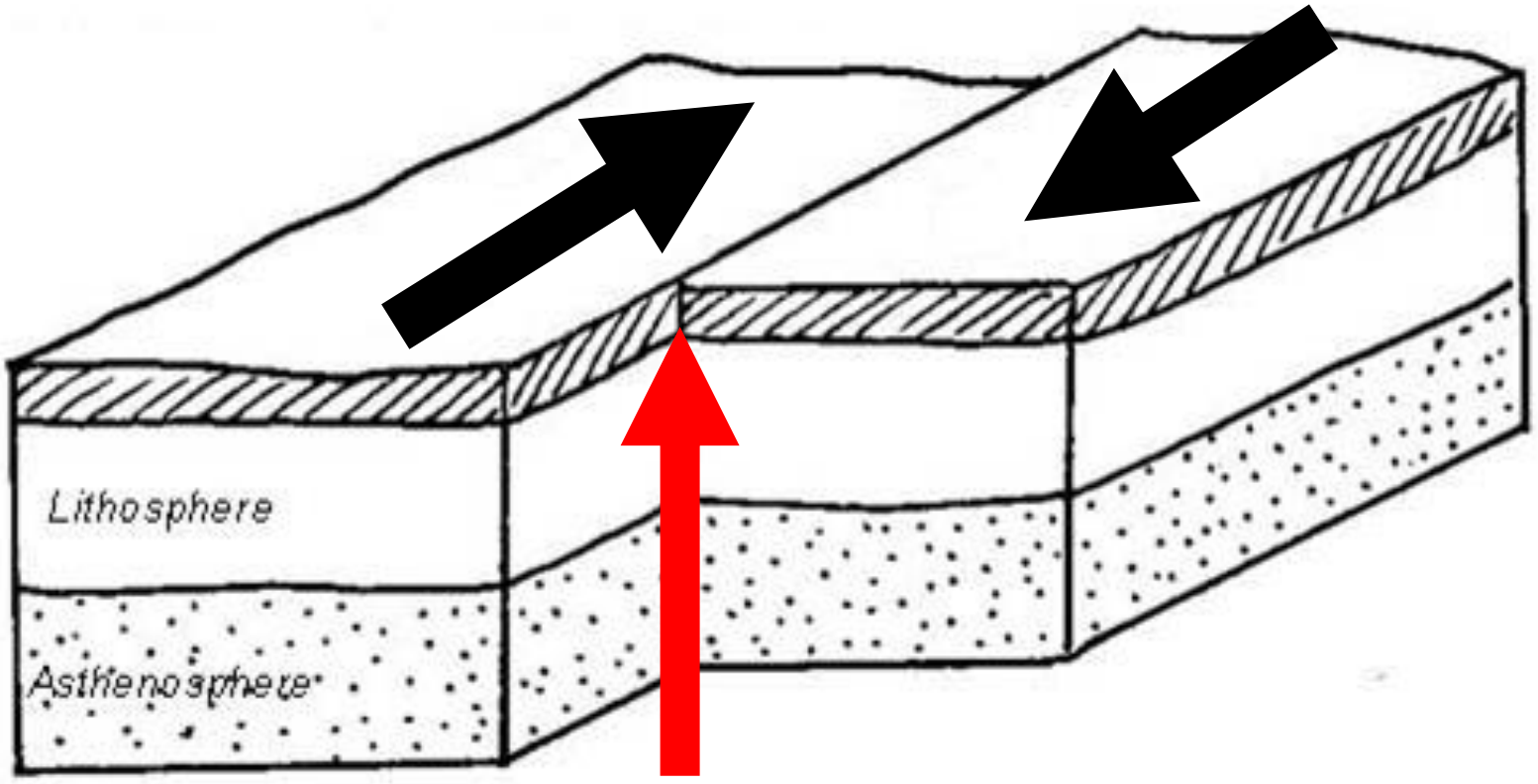
Model a Transform Boundary:

- Place your hands in front of you, side by side, with your palms facing the floor as shown in the picture.
- Move your right hand forward and your left hand backward.
- This type of movement occurs along the California coast at a transform boundary.

Transform Boundary: San Andreas Fault in California



Transform Boundary



Earthquakes

Plate Tectonics and Plate Boundaries

Based on what you have learned, what causes the lithospheric plates to move?

Convection Currents in the Mantle

Plate movement along the boundaries causes earthquakes and other geological forces.

What are the three types of plate boundaries?

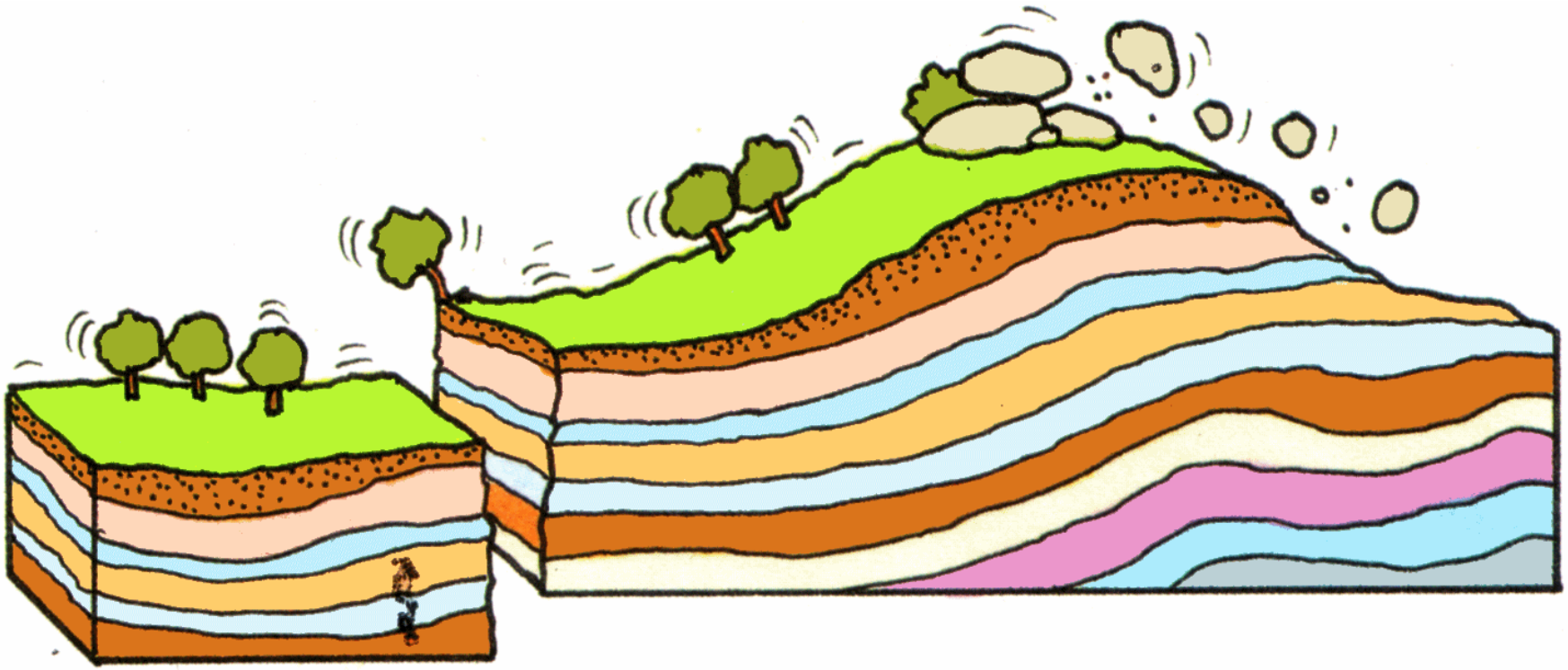
Convection Currents in the Mantle cause lithospheric plates to move. As the plates move, they interact. These interactions produce many geological features and events.

Movement of the lithospheric plates puts stress on the rocks near the plate edges.

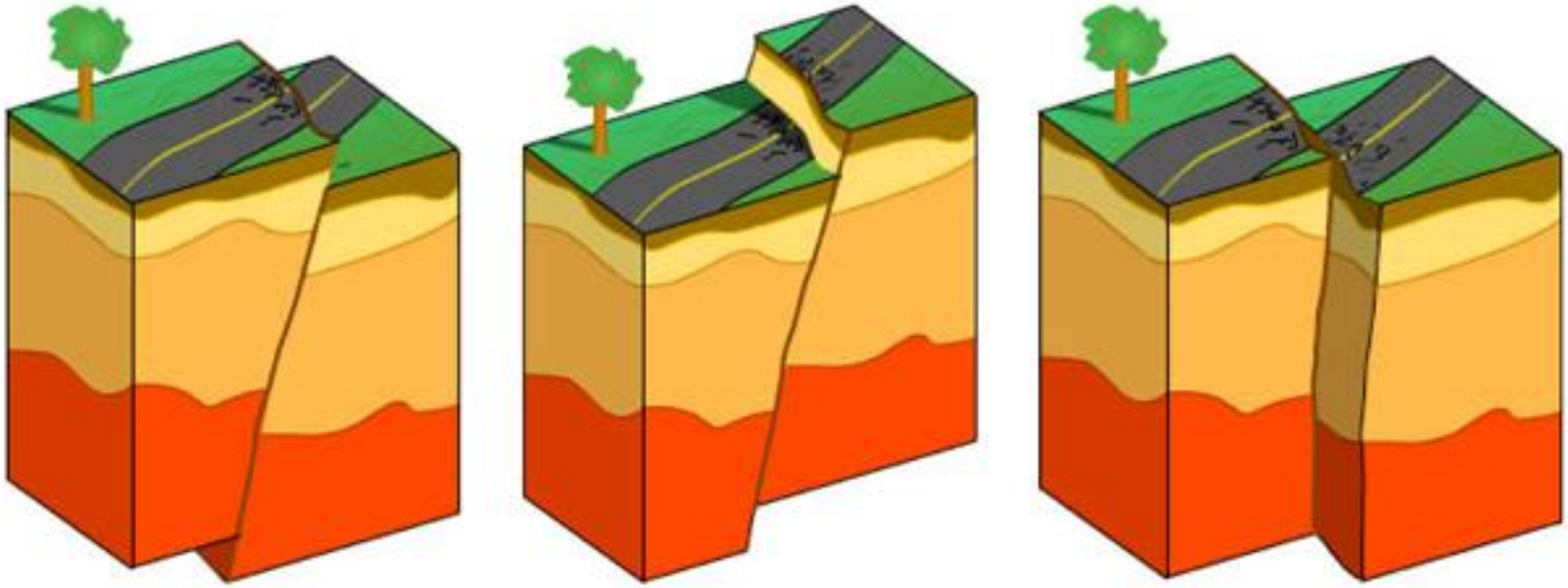
To relieve this stress, rocks tend to bend, compress, or stretch.

If the stress is great enough, the rocks will break.

Earthquakes are sudden breaks in crust continuously stressed by plate movement.

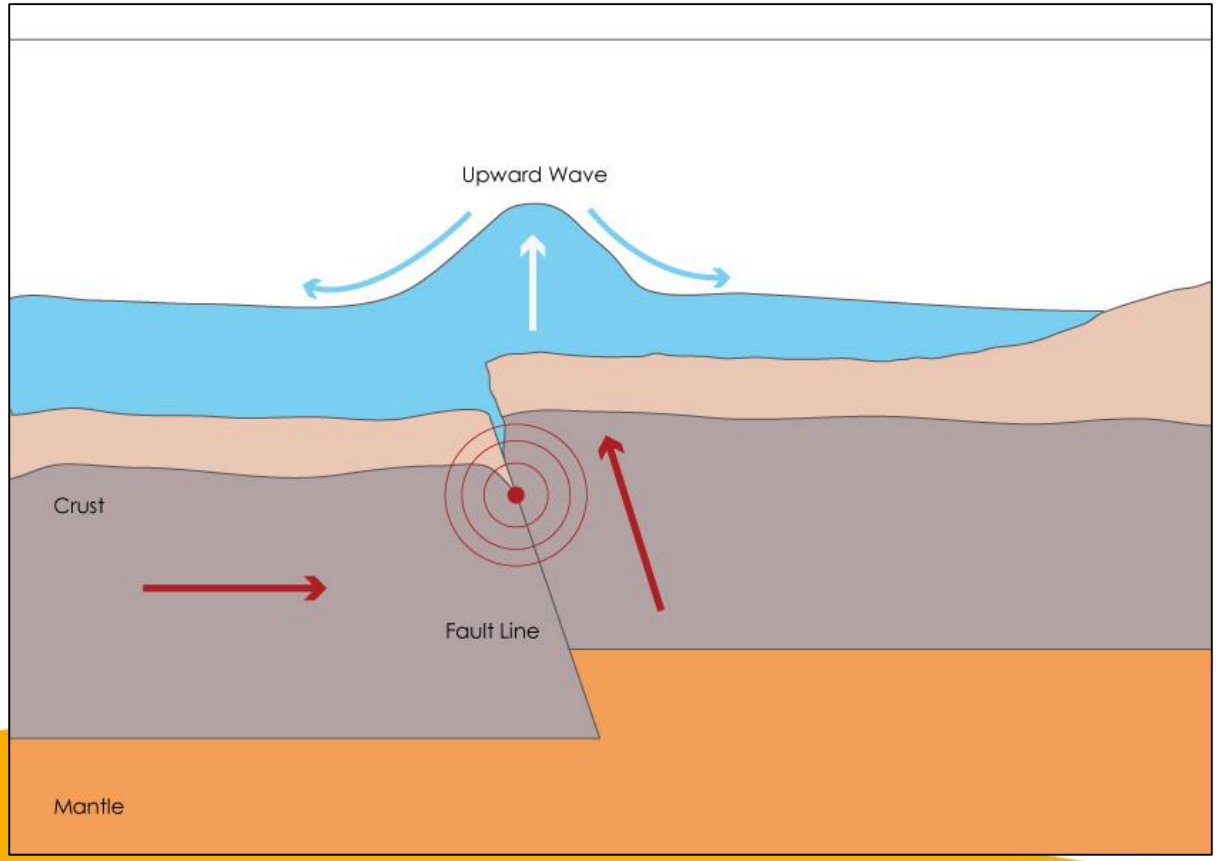


Along plate boundaries, the Earth's lithosphere fractures along faults. As plates move, blocks of crust shift along the faults. There are different kinds of faults.

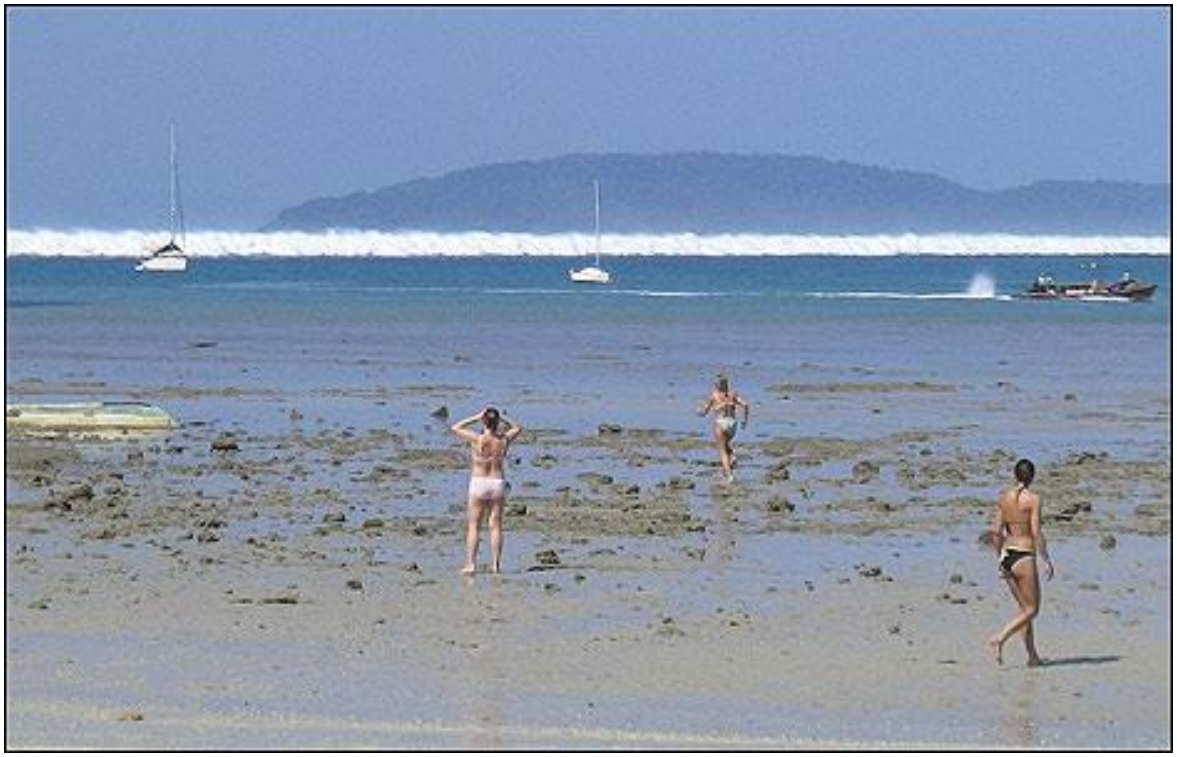


When rocks move suddenly along the fault, releasing stress, seismic waves travel through the earth's crust in the form of waves.

Tsunamis are ocean waves caused by earthquakes and landslides that occur near or under the ocean in oceanic crust.



The lowest point of a tsunami wave hits inland first and creates a vacuum that sucks up the coastal water near the shoreline away from the land, exposing the sea floor. This is the first indicator that the destructive part of the wave is on its way.



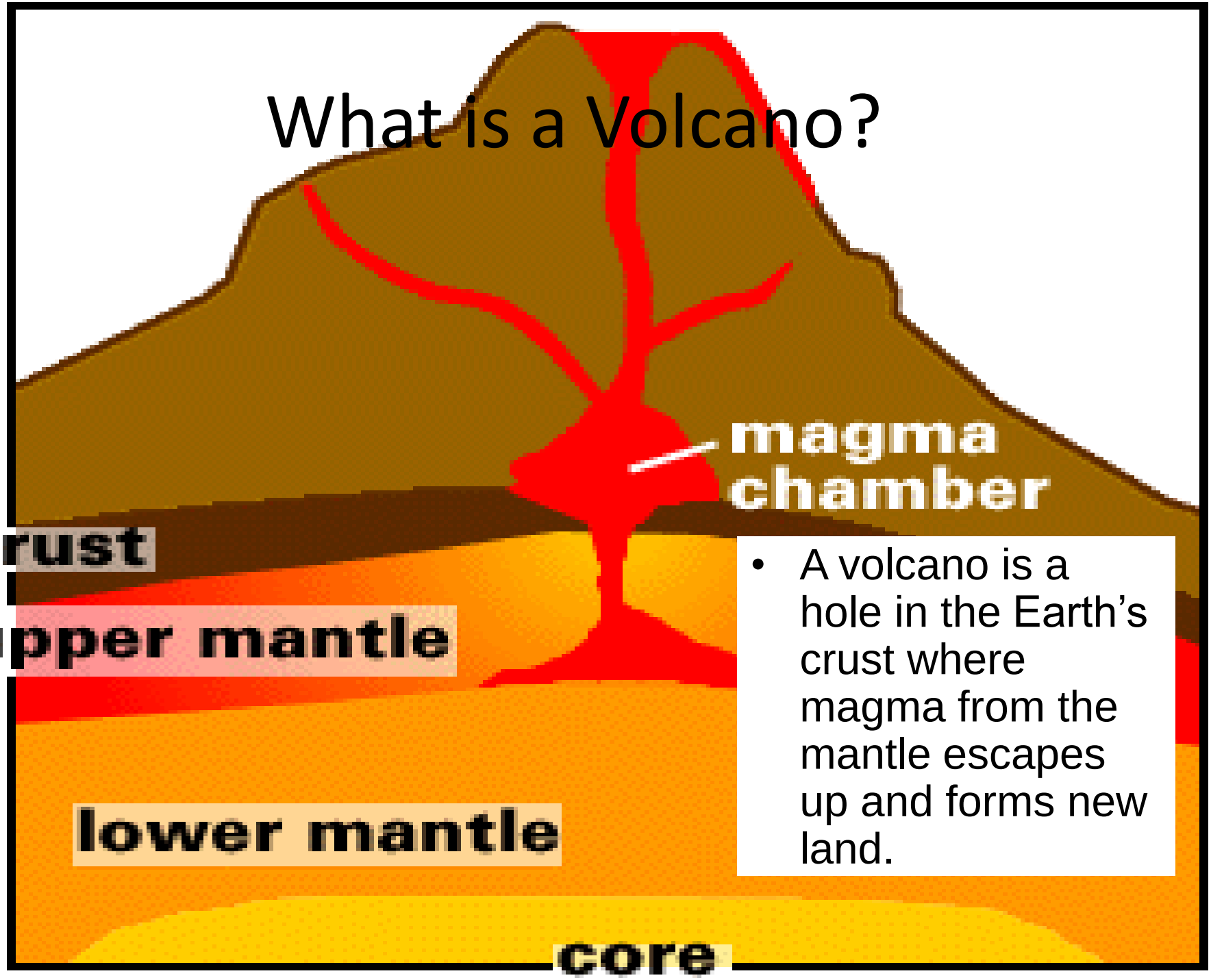
As a tsunami's waves travel across deep water they may be only a foot or so high and hard to detect. Once it reaches inland the surge can reach heights of 100 feet or more.

It is a massive wall of water that reaches land and can cause incredible destruction and loss of life.

Modeling Plate Movements


Volcanoes

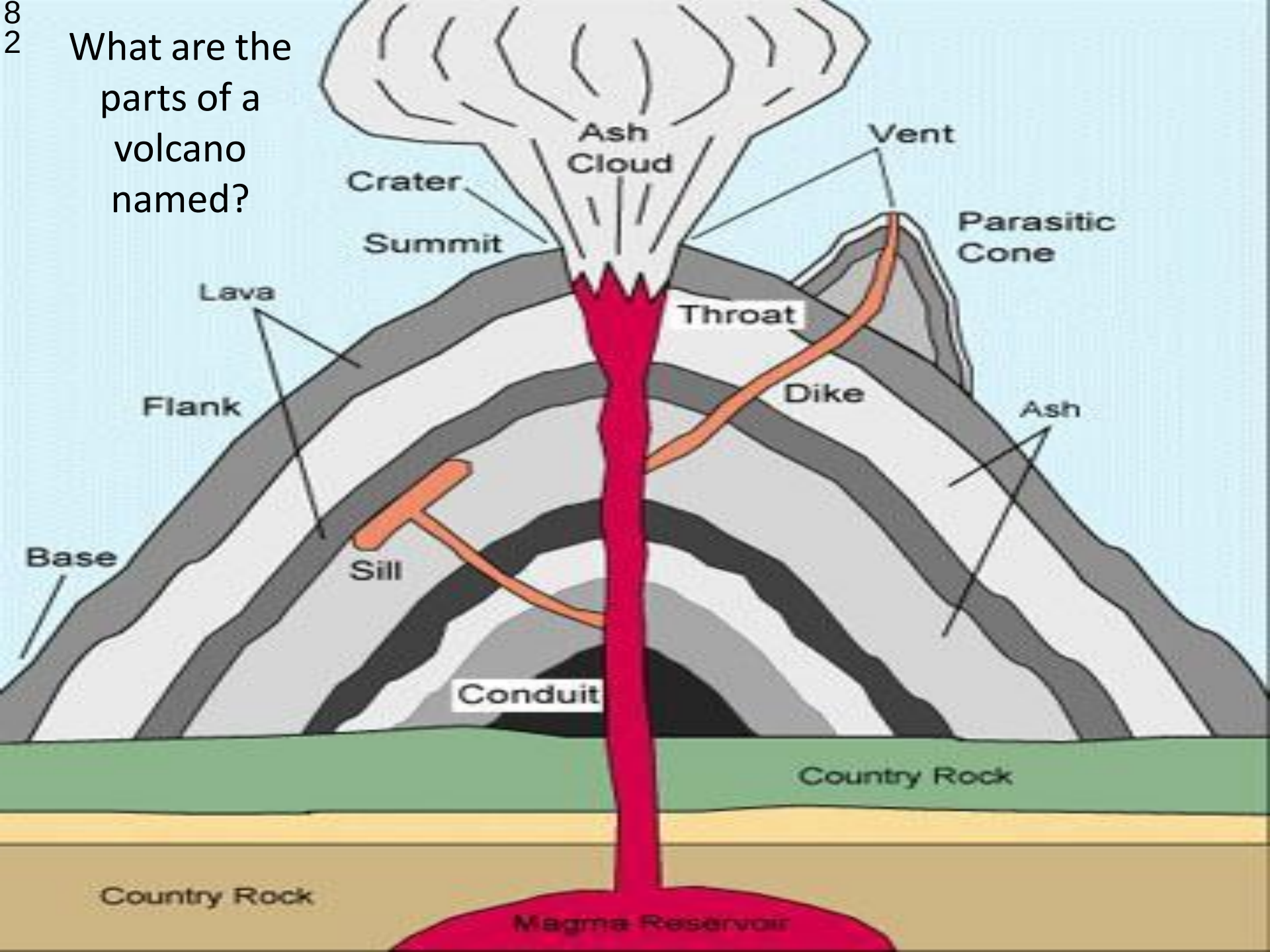
What is a Volcano?



- A volcano is a hole in the Earth's crust where magma from the mantle escapes up and forms new land.

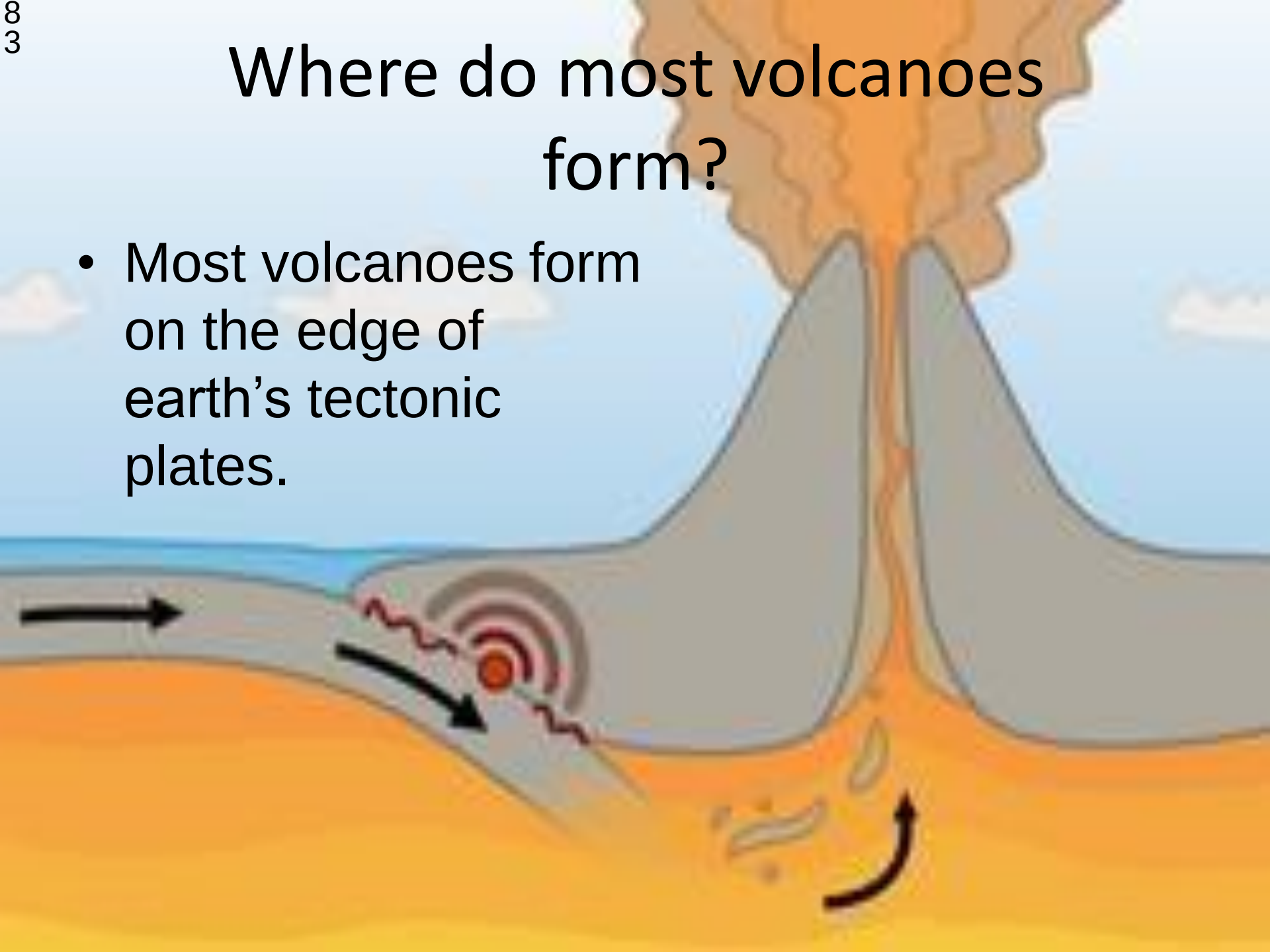
8
2

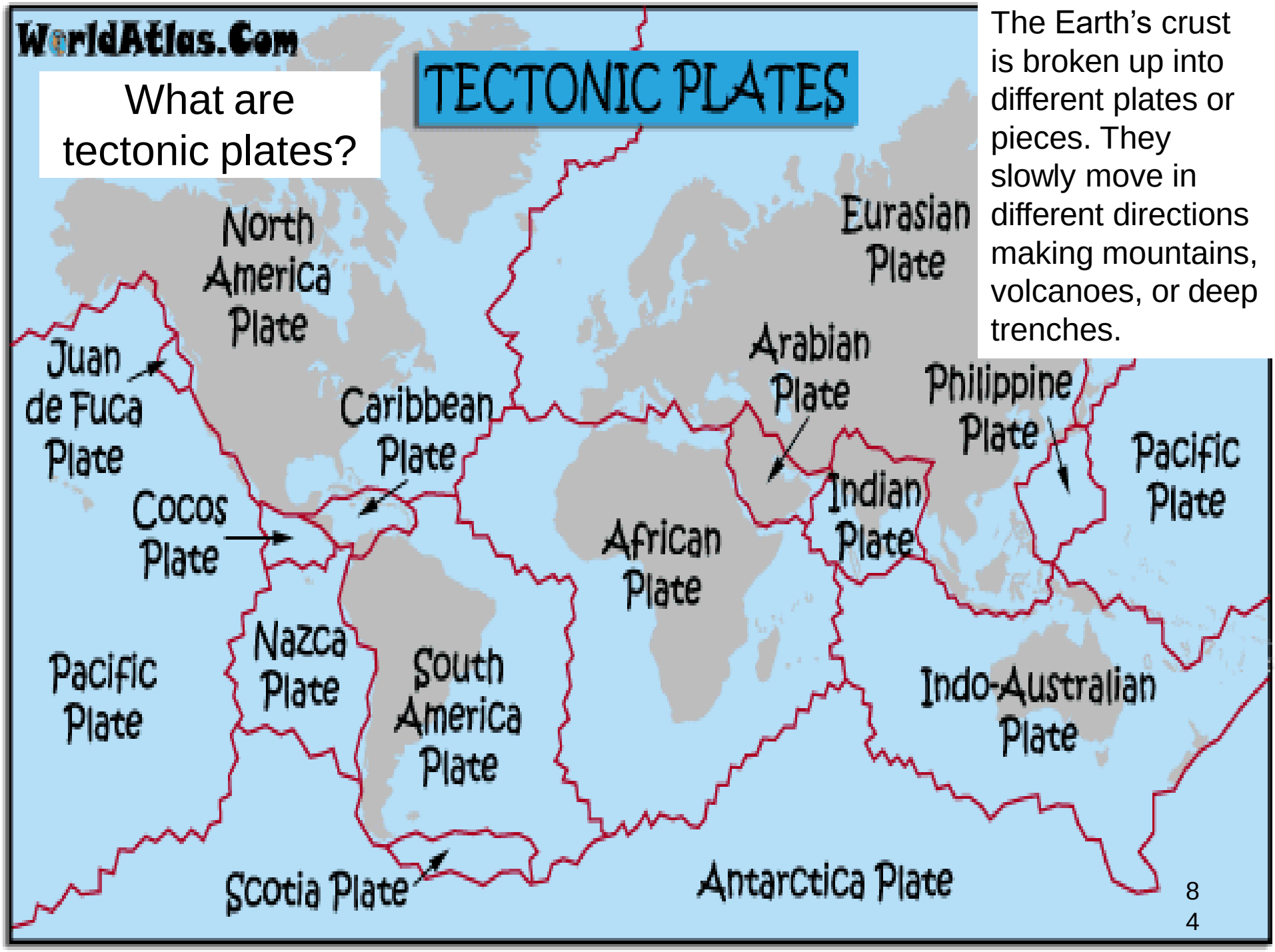
What are the parts of a volcano named?



Where do most volcanoes form?

- Most volcanoes form on the edge of earth's tectonic plates.

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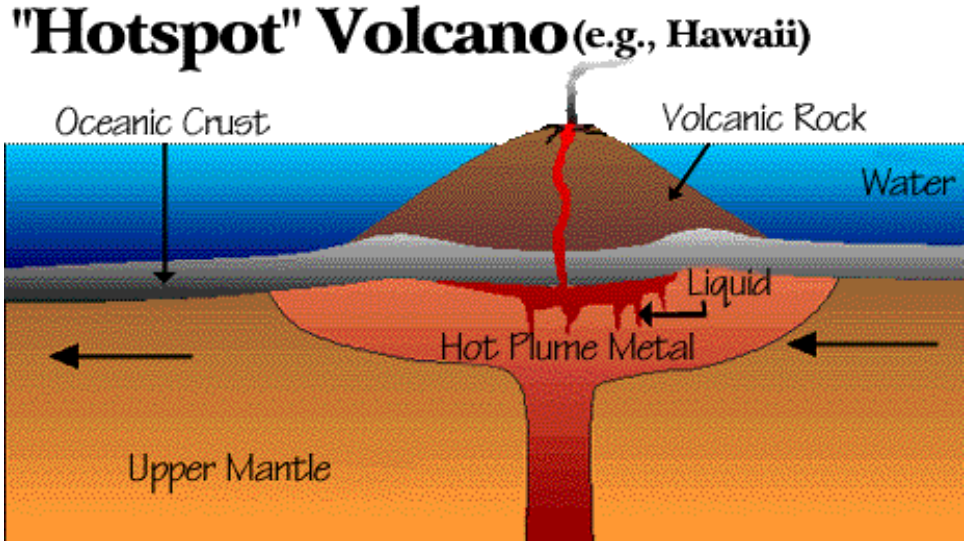
TECTONIC PLATES
What are tectonic plates?
The Earth's crust is broken up into different plates or pieces. They slowly move in different directions making mountains, volcanoes, or deep trenches.
North America Plate
Eurasian Plate
Juan de Fuca Plate
Caribbean Plate
Arabian Plate
Philippine Plate
Pacific Plate
Cocos Plate
Indian Plate
African Plate
Nazca Plate
Pacific Plate
South America Plate
Indo-Australian Plate
Scotia Plate
Antarctica Plate

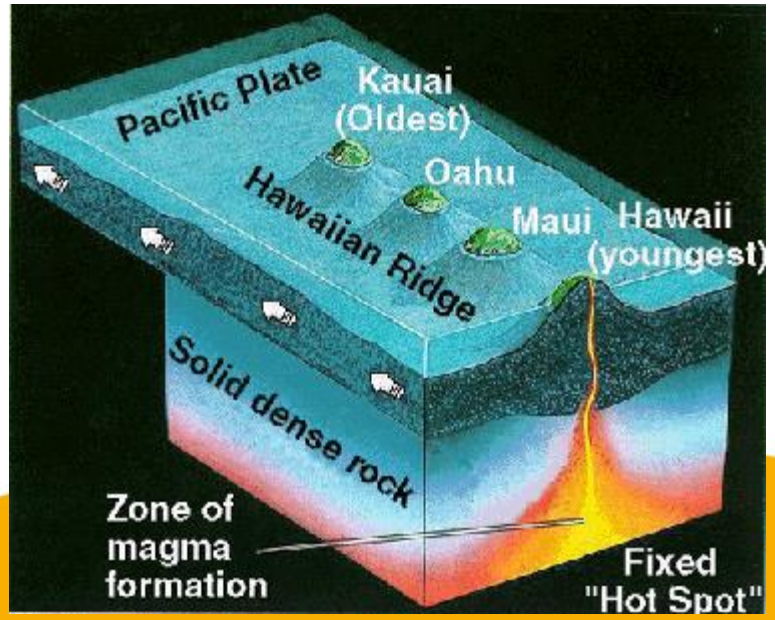
What is the Ring of Fire?

- The Ring of Fire is the ring of volcanoes that formed at the edge of the Pacific Plate

What is a hot spot volcano?

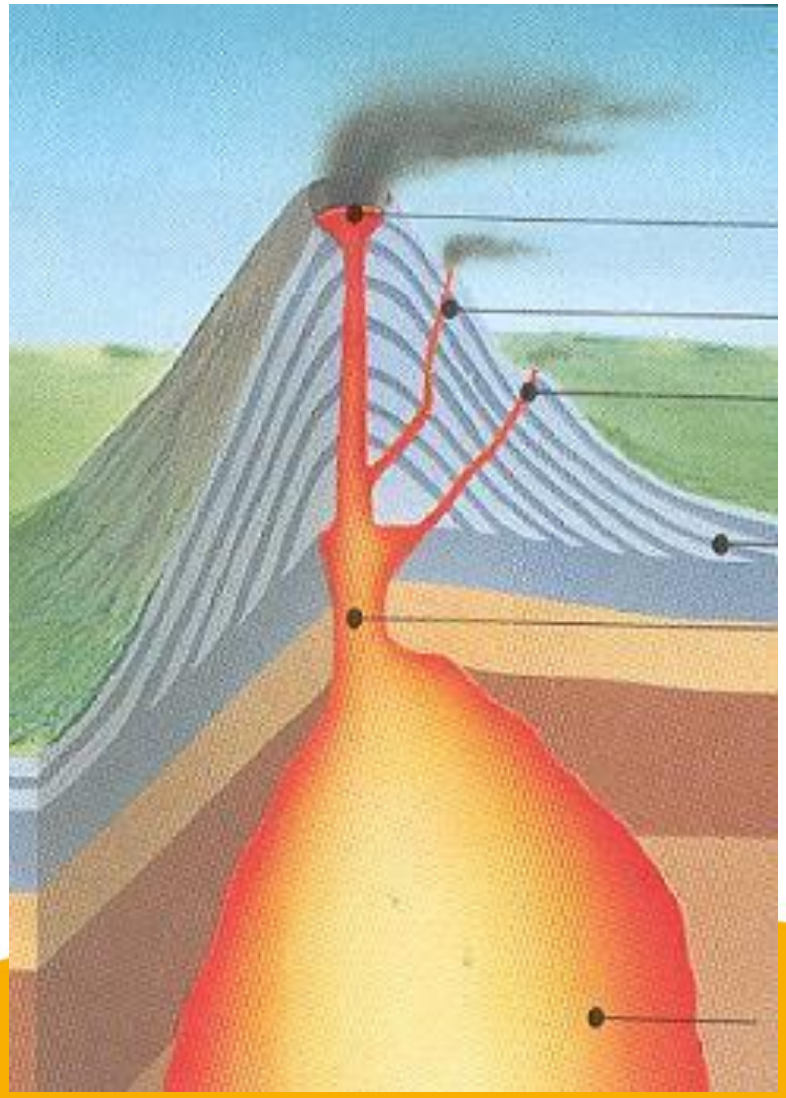
- A few volcanoes are formed by hot spots. Hot spots are incredibly hot places in the mantle where it has melted a hole through the crust.





•When the plates move over the hot spot it can form new volcanoes like the Hawaiian Islands.

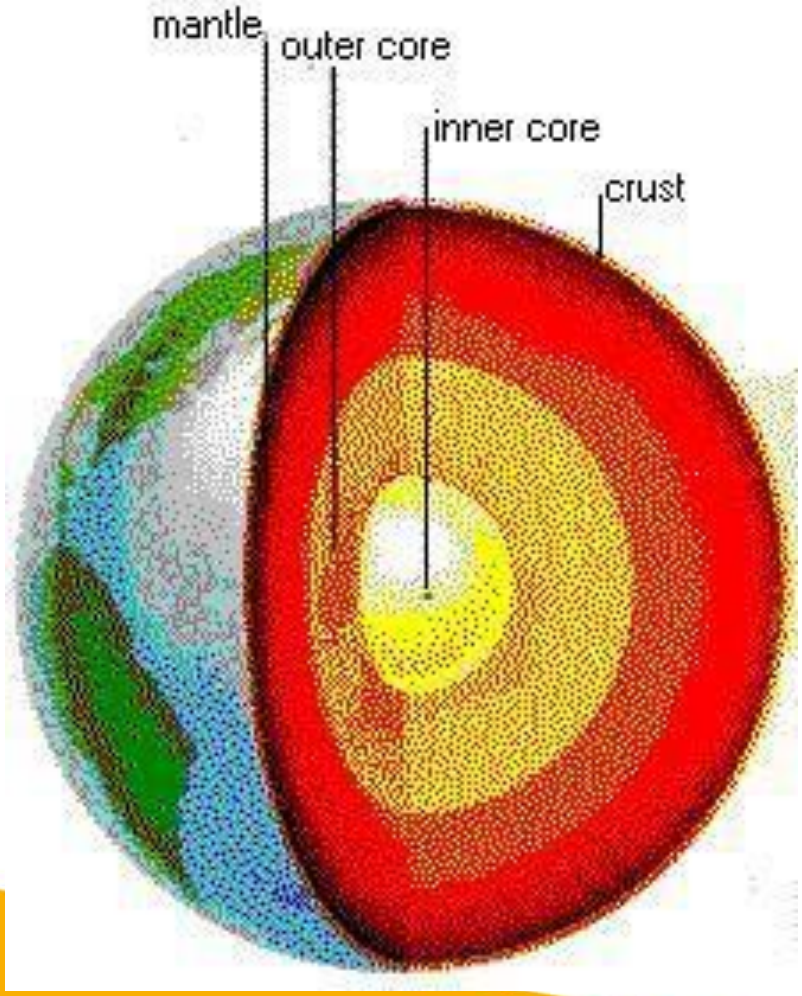
What is magma and lava?



- Magma is the hot molten rock
- coming from the mantle.
- When magma escapes to the surface it is called lava.

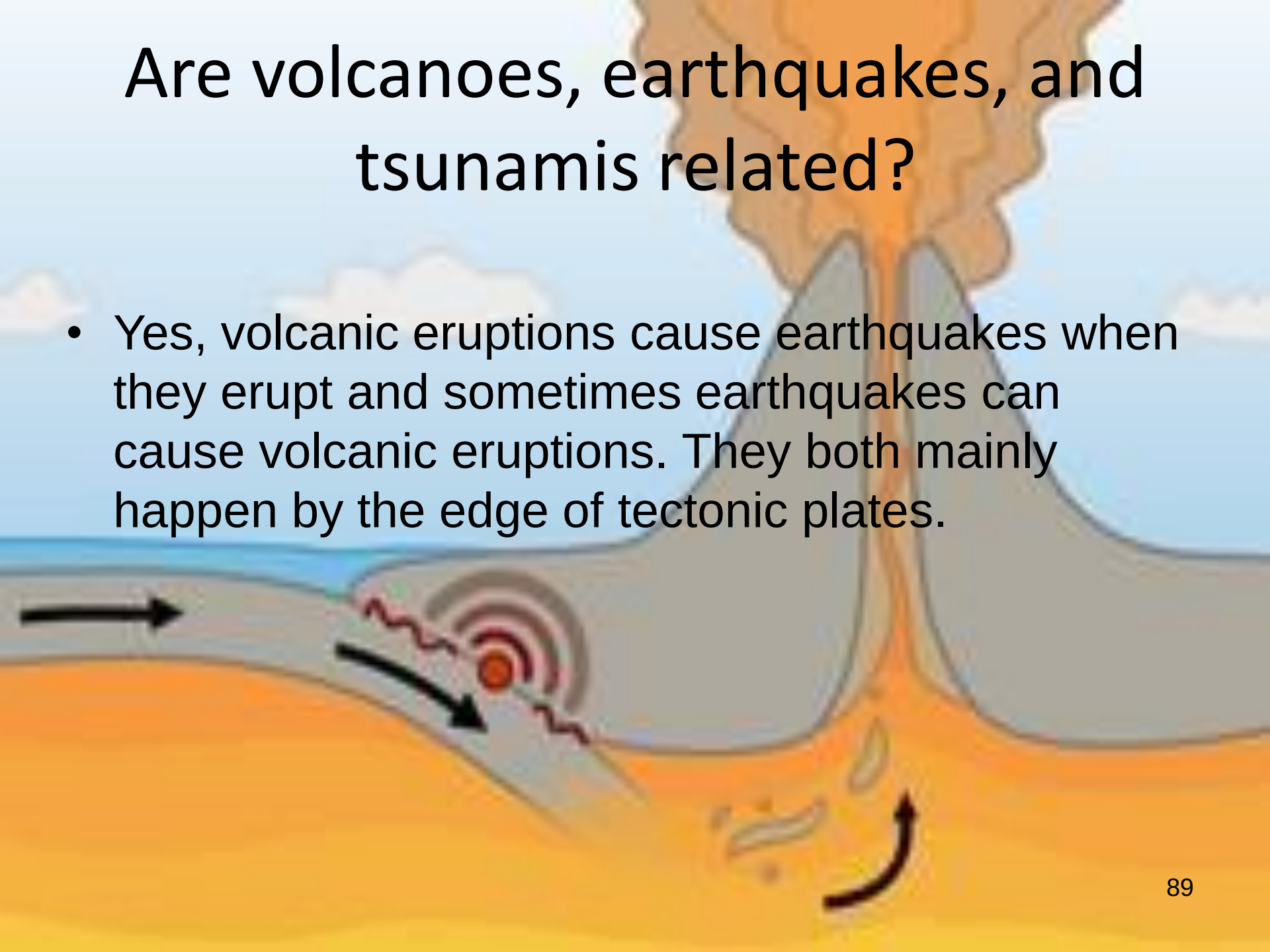
Why do volcanoes erupt?

- The heat from the inside of the earth creates pressure and pushes up through weak spots in the crust like at the edge of plates or in hot spots and causes volcanoes to erupt.



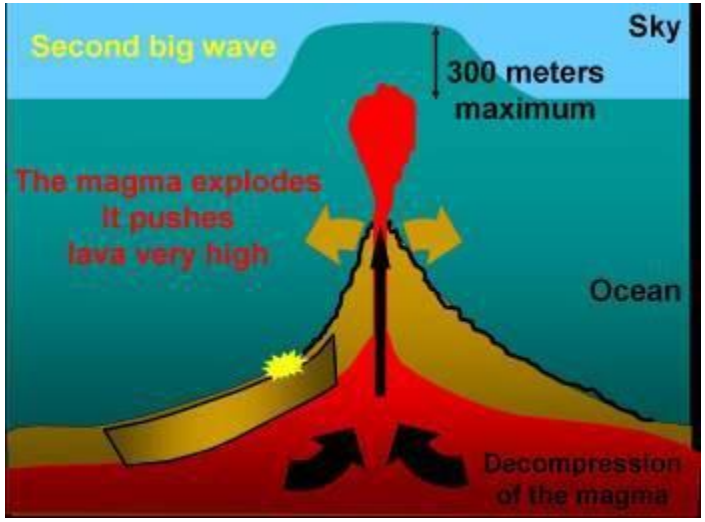
Are volcanoes, earthquakes, and tsunamis related?

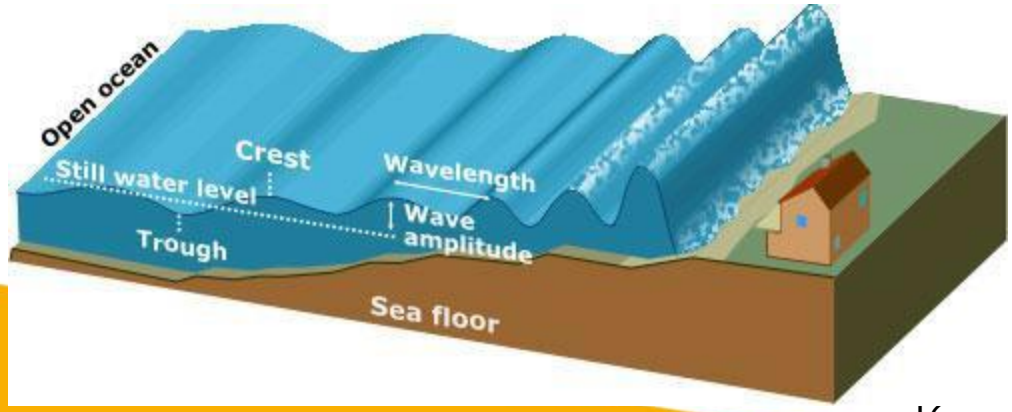
- Yes, volcanic eruptions cause earthquakes when they erupt and sometimes earthquakes can cause volcanic eruptions. They both mainly happen by the edge of tectonic plates.



Are volcanoes, earthquakes, and tsunamis related?

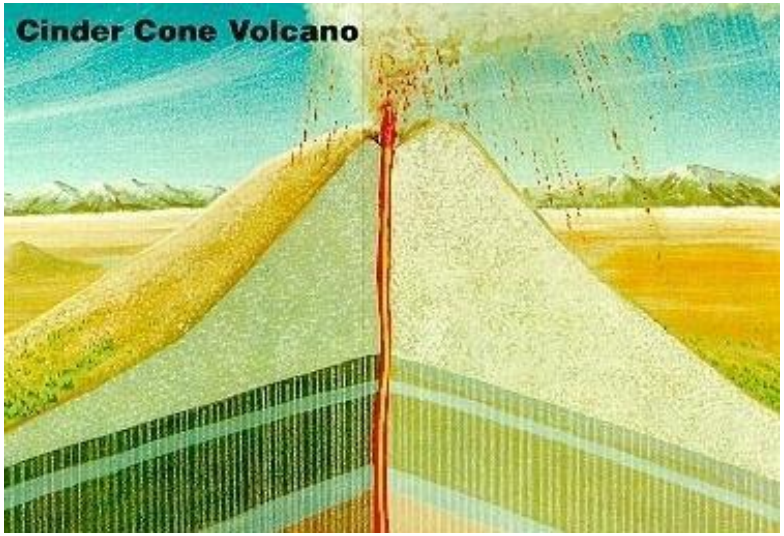
- Volcanoes and earthquakes release a lot of energy and can cause the ocean to create monster waves called tsunamis. They can be dangerous if you live right by the ocean.

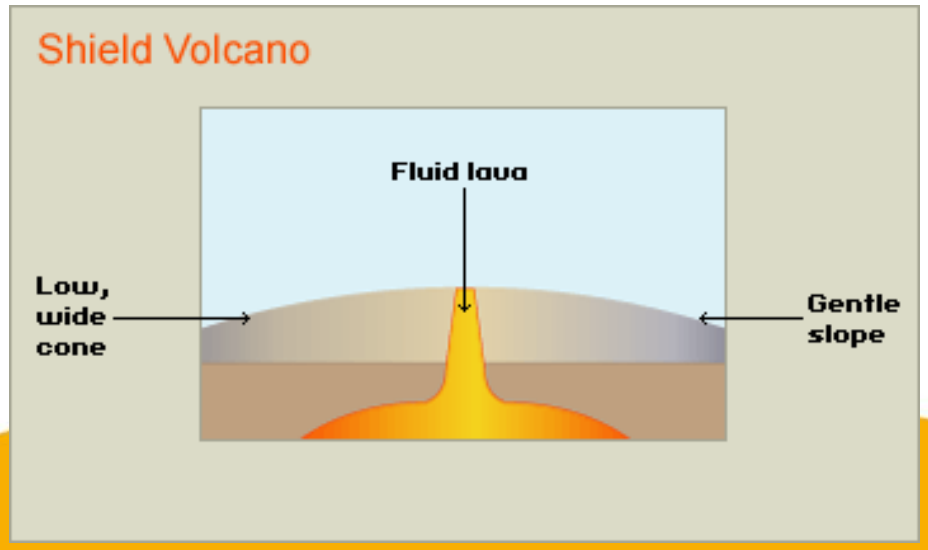


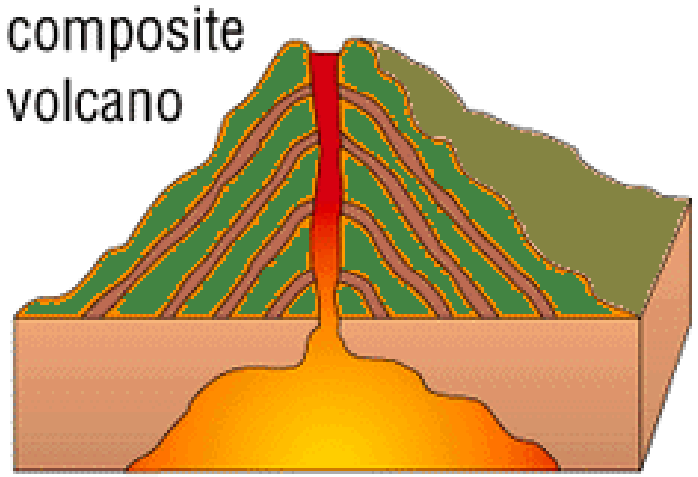


What are 3 types of volcanoes?

- The 3 types of volcanoes are cinder cone, shield, and composite.



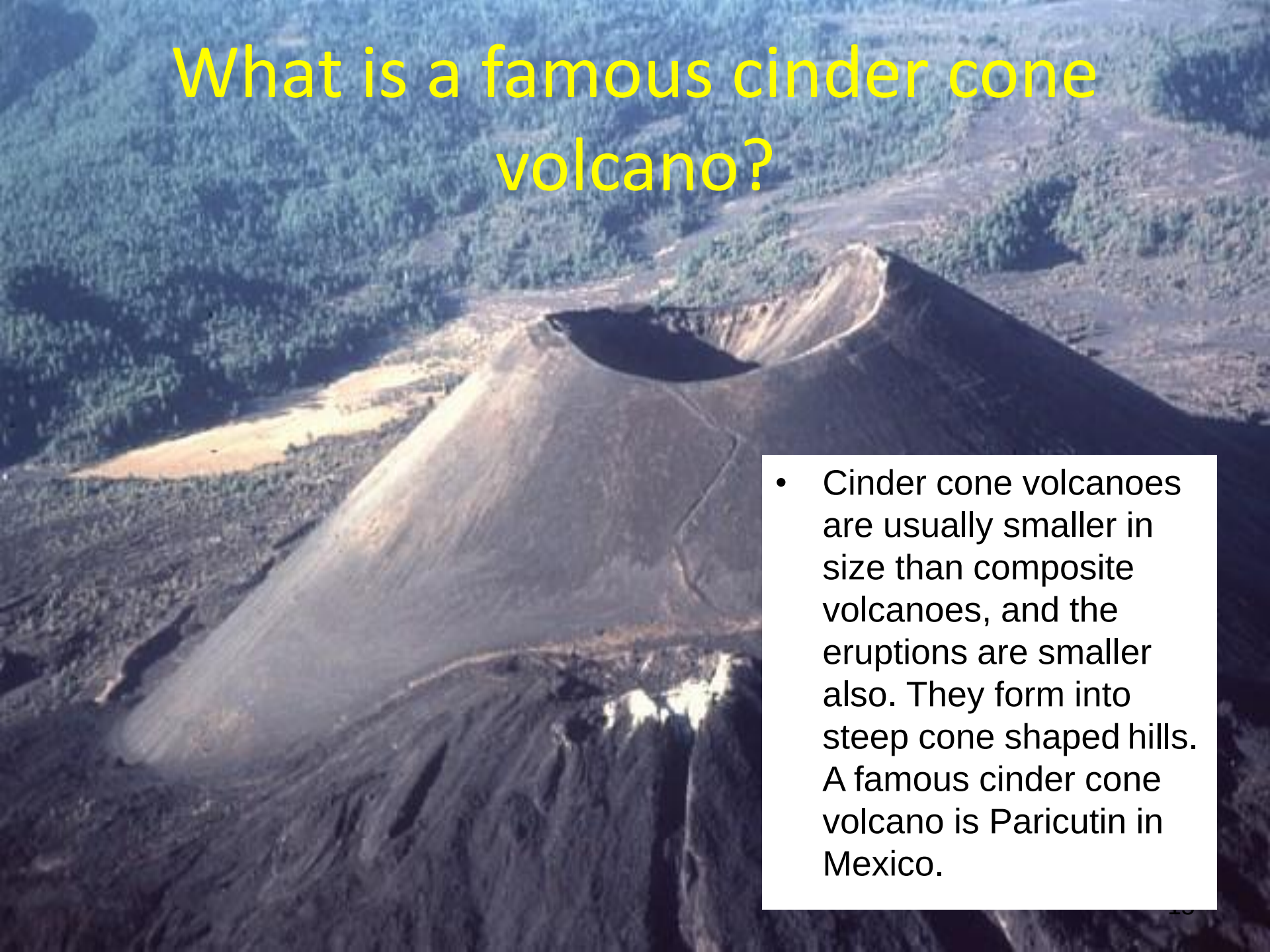




What is a famous composite volcano?

- **Composite volcanoes often form the largest and tallest volcanoes. They are the most explosive and dangerous of the types of volcanoes. A famous composite volcano is Mt. Saint Helens in Washington state. In 1980, it erupted destroying most of the life around it and sending ash across much of the western United States.**

What is a famous cinder cone volcano?



- Cinder cone volcanoes are usually smaller in size than composite volcanoes, and the eruptions are smaller also. They form into steep cone shaped hills. A famous cinder cone volcano is Paricutin in Mexico.

What is a famous shield volcano?

- Shield volcanoes do not erupt or explode like composite or cinder cone volcanoes. Shield volcanoes have much smaller eruptions producing less ash. However they pour out a lot more lava over a long period of time. One of the most famous shield volcanoes is Muana Loa in Hawaii.

What is so dangerous about volcanoes?

- Ash: when you breath it in, it will clog your lungs and make it so you can't breath.

- Flying Rocks: large rocks may be thrown through the air in a big explosion

- Poisonous Gases: Many dangerous gases to humans escape from volcanoes like sulfur and carbon dioxide.

Lava: It is incredibly hot and will melt you if you touch it.

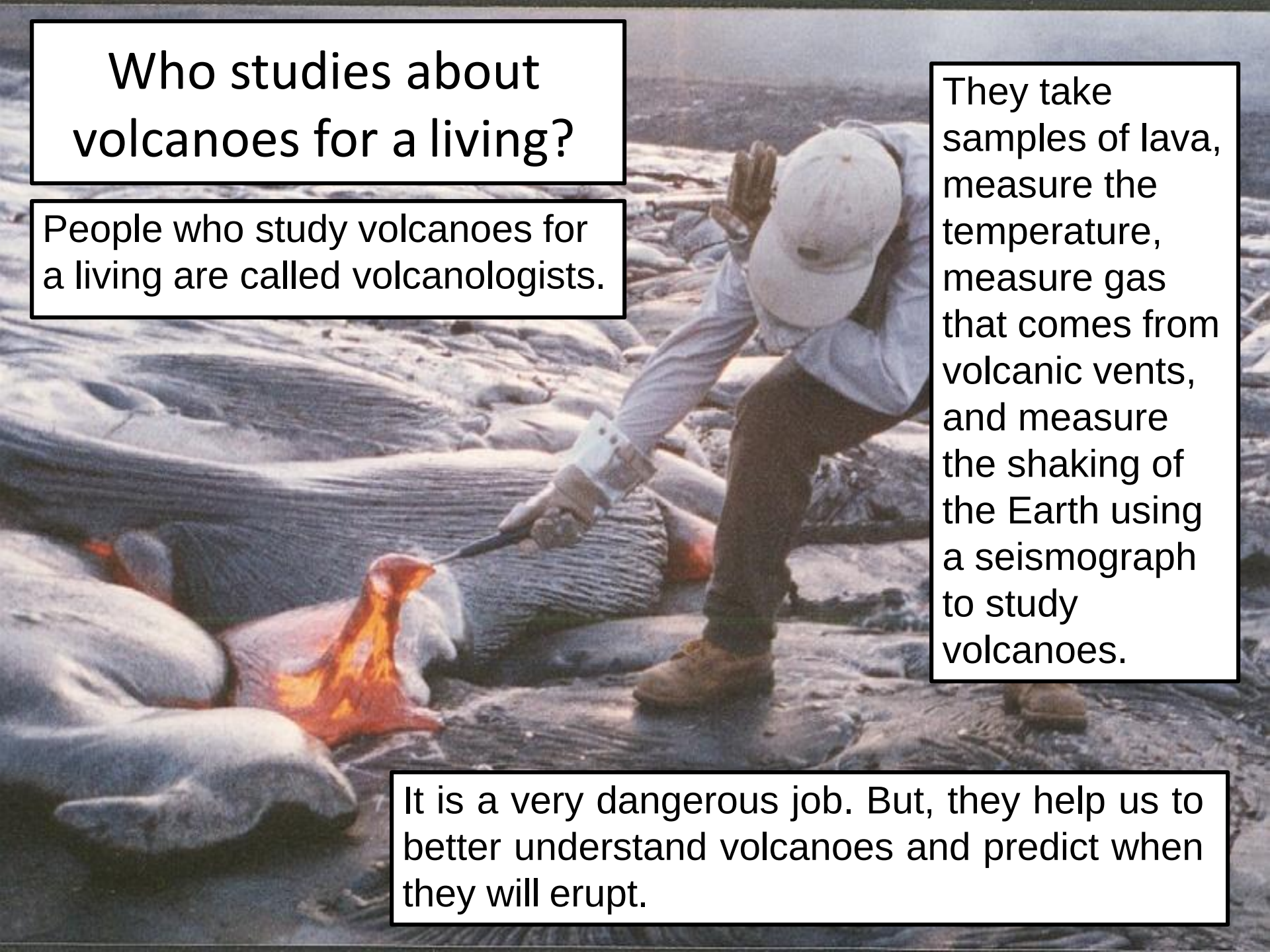
What is so dangerous about volcanoes?

- Pyroclastic flows: when a large volcano erupts, it can produce a super fast and hot wave of ash and small rocks that sweeps down the volcano.
- Floods & Mudslides: Some volcanoes have lots of snow on them. When the volcano erupts, it quickly melts the snow causing a large flood of water and mud to flow down hill wiping out everything in its path.

Are volcanoes always active?

- No, sometimes volcanoes are dormant or inactive. They do not erupt for a long periods of time (hundreds or thousands of years).

•However some volcanoes like Mauna Loa stay active and erupt much more often.



Who studies about volcanoes for a living?

People who study volcanoes for a living are called volcanologists.

They take samples of lava, measure the temperature, measure gas that comes from volcanic vents, and measure the shaking of the Earth using a seismograph to study volcanoes.

It is a very dangerous job. But, they help us to better understand volcanoes and predict when they will erupt.