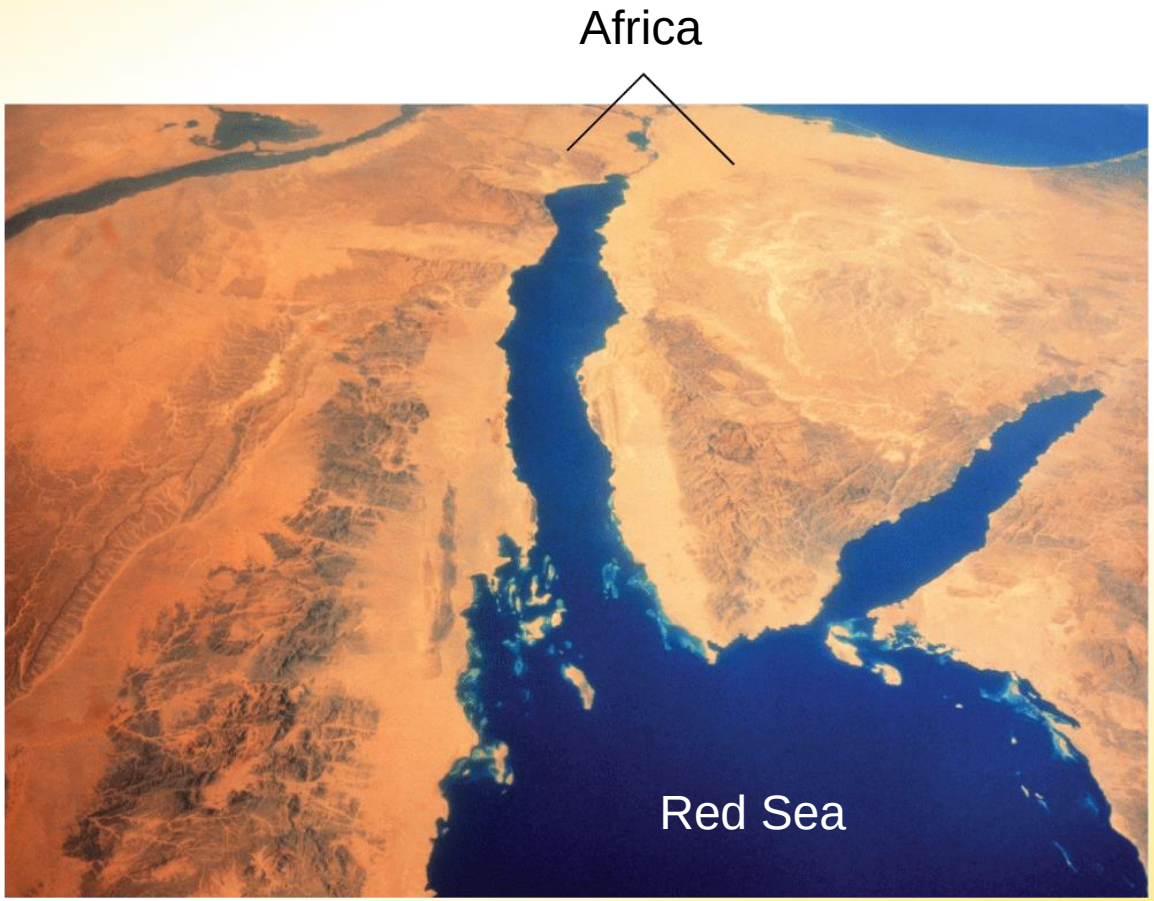
The Red Sea between Africa and the Arabian peninsula in Asia marks a region where two pieces of the lithosphere are slowly moving apart. Over the next 100 million years, the Red Sea could become an ocean.



Continental Drift

- What are plate tectonics and continental drift?
- The theory of plate tectonics explains the formation and movement of Earth's plates.
- Wegener hypothesized that the continents were once joined in a single supercontinent, which then broke into pieces that moved apart.

Continental Drift

Plate tectonics is the theory that pieces of Earth's lithosphere, called plates, move about slowly on top of the asthenosphere.

According to Wegener's hypothesis, the continents move slowly across Earth's surface in a process called **continental drift.**

Continental Drift

When the early explorers began to discover the shapes of the continents, mapmakers noticed how well the shapes of North and South America fit together with Europe and Africa.

Later on, geologists discovered fossils of species of land-based plants and animals on continents separated by large oceans.

Continental Drift

Fossils of *Glossopteris* and other plants and animals on widely separated land masses led Alfred Wegener to hypothesize that the continents had once been joined.

Continental Drift

In 1912, Alfred Wegener proposed a hypothesis of continental drift to explain these puzzling observations.

Wegener called the ancient supercontinent **Pangaea.**

Continental Drift

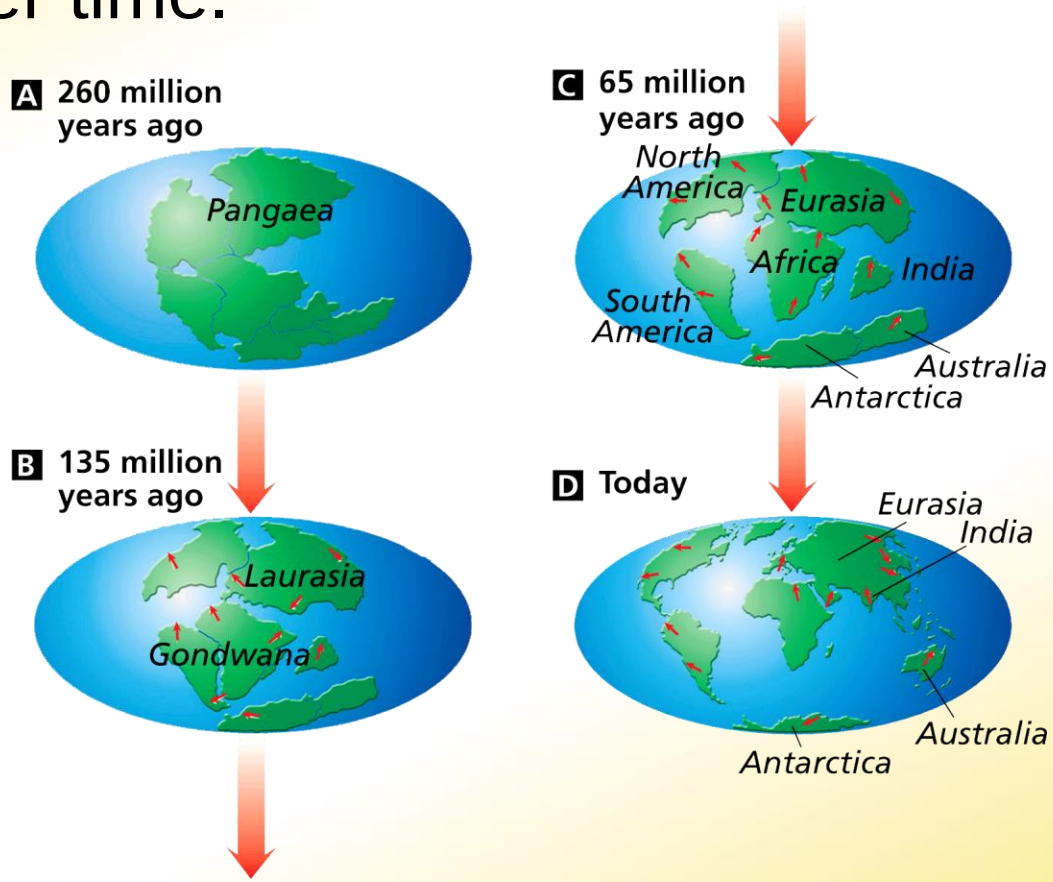
Continental drift explains why the continents seem to fit together. It also explains why the fossils from a single region appear across the globe.

Wegener was unable to explain how the continents could plow through the solid rock of the sea floor or what force could move entire continents.

As a result, most geologists rejected continental drift.

Continental Drift

The continents move slowly across Earth's surface over time.



Sea-floor Spreading

What are the roles of sea-floor spreading and subduction in plate tectonics?

Sea-floor spreading creates new oceanic crust at mid-ocean ridges. Subduction destroys old oceanic crust at subduction zones.

Sea-floor Spreading

Sea-floor spreading is the process by which new oceanic crust is created at mid-ocean ridges as older crust moves away.

As sea-floor spreading occurs, old oceanic plates sink into the mantle in the process of **subduction.**

Sea-floor Spreading

Several decades after Wegener proposed his hypothesis, new evidence led geologists to reconsider his ideas.

New evidence helped scientists propose the theory of plate tectonics.

Sea-floor Spreading

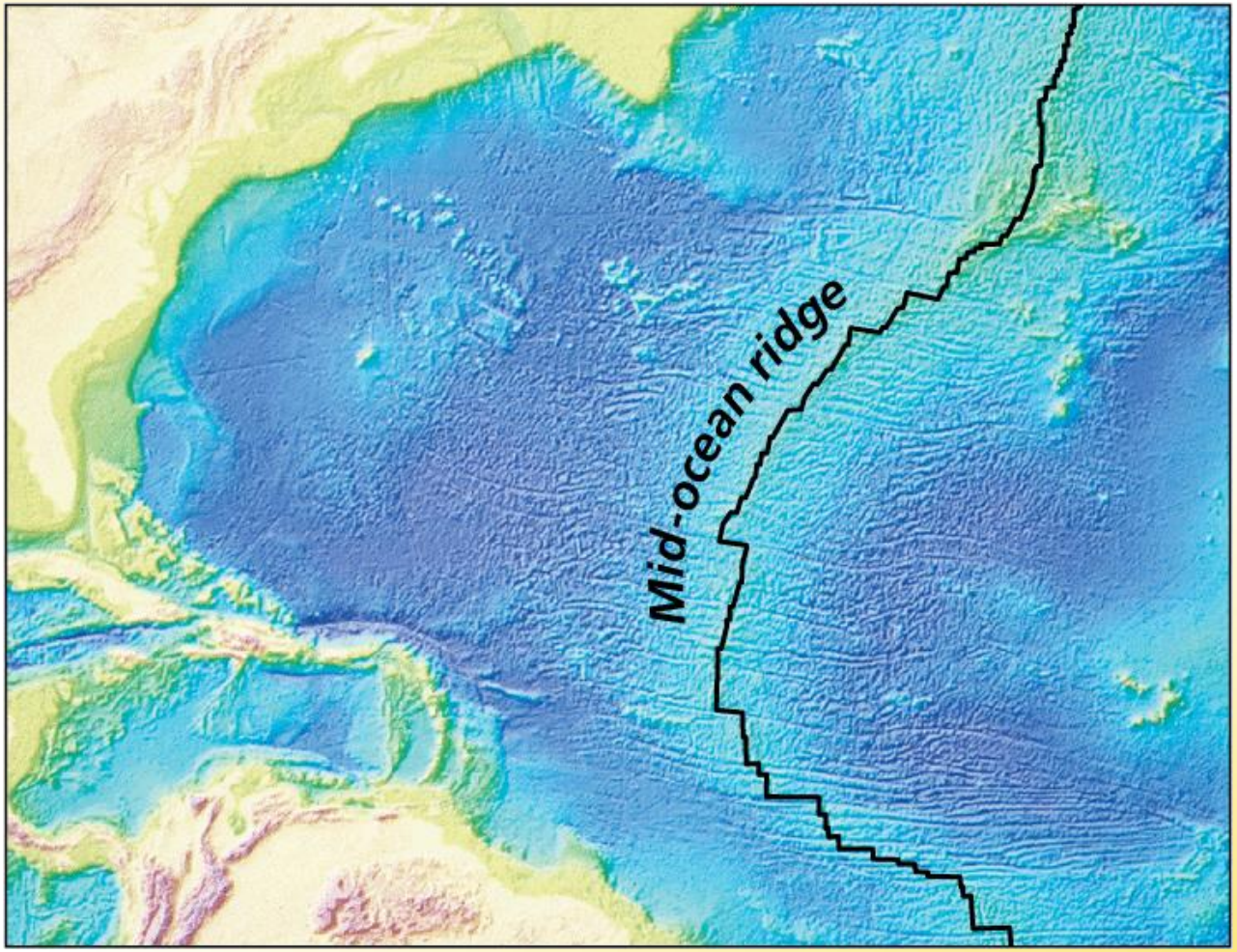
The Mid-Ocean Ridge

When scientists mapped the ocean floor, they found a chain of underwater mountains which they called the **mid-ocean ridge.**

It forms the world's longest mountain chain.

Sea-floor Spreading

This false-color satellite image shows a segment of the mid-ocean ridge in the Atlantic Ocean. The ridge system winds through all of Earth's oceans.



Sea-floor Spreading

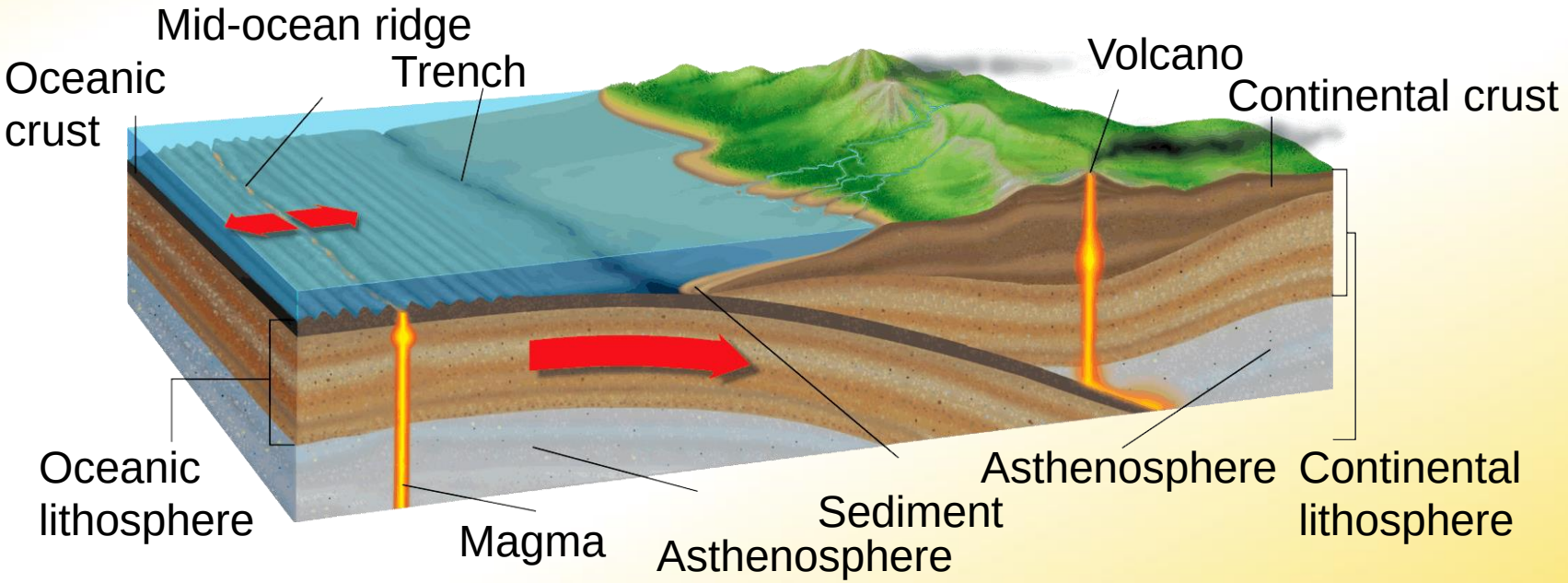
Formation of Oceanic Crust

Sea-floor spreading is the process by which new oceanic crust is created at mid-ocean ridges as older crust moves away.

- The mid-ocean ridge is a huge crack where magma pushes upward.
- The parts of the ocean floor on both sides of the central valley are moving apart.
- Magma from the mantle wells up and solidifies to form new oceanic crust.

Sea-floor Spreading

During sea-floor spreading, oceanic crust forms at the mid-ocean ridge. This crust gradually moves toward a subduction zone, where old crust sinks beneath a trench.



Sea-floor Spreading

Subduction of Oceanic Plates

As sea-floor spreading occurs, old oceanic plates sink into the mantle in the process of subduction.

Subduction zones are near the edges of oceanic plates.

As a plate sinks through a subduction zone, it bends, forming a depression in the ocean floor called a **trench.**

Sea-floor Spreading

Subduction occurs because, as an oceanic plate moves away from the mid-ocean ridge, it gradually cools and becomes more dense.

During subduction, the force of gravity slowly pulls the dense edges of oceanic plates into the mantle, destroying old ocean floor.

Sea-floor spreading and subduction together act like a giant conveyor belt.

Sea-floor Spreading

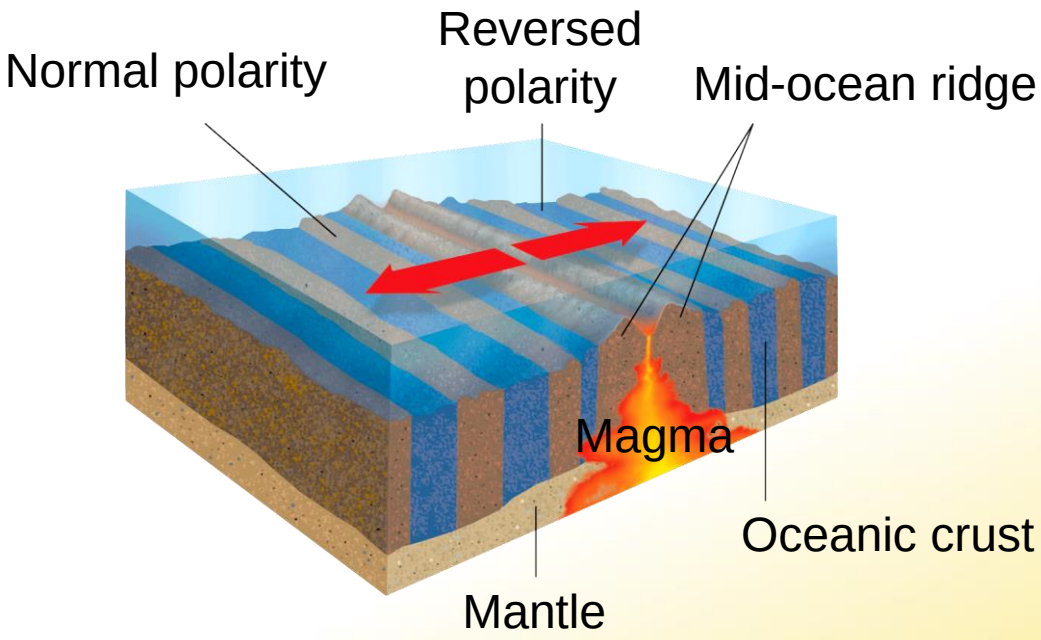
Evidence for Sea-floor Spreading

Scientists discovered patterns of parallel magnetic "stripes" that were identical on the two sides of the mid-ocean ridge.

- Earth's magnetic field has reversed itself many times.
- The magnetic field causes rock crystals to line up in a certain way before the rock solidifies.
- Stripes show that new ocean floor was added to both sides of the mid-ocean ridge.

Sea-floor Spreading

The pattern of magnetic stripes in the rock of the ocean floor is the same on both sides of the mid-ocean ridge.



Sea-floor Spreading

Geologists used radioactive dating to determine the ages of rock samples from the ocean floor.

They found that rocks nearer the mid-ocean ridge were younger, and rocks farther from the ridge were older.

The Theory of Plate Tectonics

- **Why do tectonic plates move?**
- **Plate motions are the visible part of the process of mantle convection.**

The Theory of Plate Tectonics

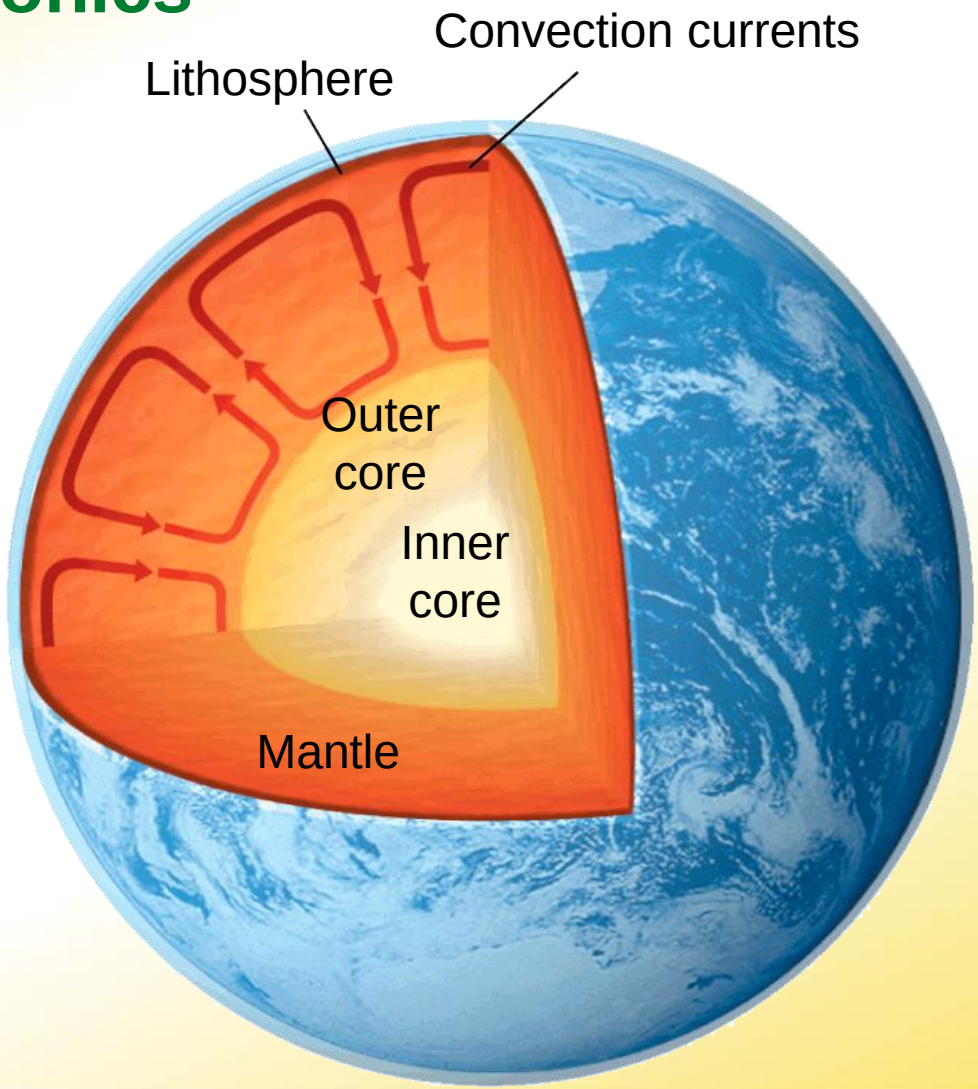
Convection currents form in the mantle as hot rock rises, cools and spreads out, and then sinks back into the mantle at subduction zones.

These sinking slabs of dense lithosphere and heat from within Earth drive the circulation of convection currents in the mantle.

The Theory of Plate Tectonics

Heat flows from Earth's hot interior toward the cooler surface mainly through large convection currents in the mantle.

Plates are the uppermost part of a global convection system.



The Theory of Plate Tectonics

The heat that drives convection in the mantle comes from two sources.

- Earth was very hot when it first formed, and some of the heat moving upward in convection currents is due to the gradual cooling of its interior.
- A second source of heat is the result of the decay of radioactive isotopes that are distributed throughout the mantle and crust.

Plate Boundaries

What are the types of plate boundaries and what are their characteristics?

There are three types of plate boundaries: divergent boundaries, convergent boundaries, and transform boundaries.

Plate Boundaries

There are about a dozen major tectonic plates.

Most major plates contain both continental and oceanic crust. The edges of plates meet at plate boundaries.

As the plates move apart, collide, or slide past each other, they cause changes in Earth's surface.

Plate Boundaries

The lithosphere is broken into about a dozen large plates, which move slowly over Earth's surface.

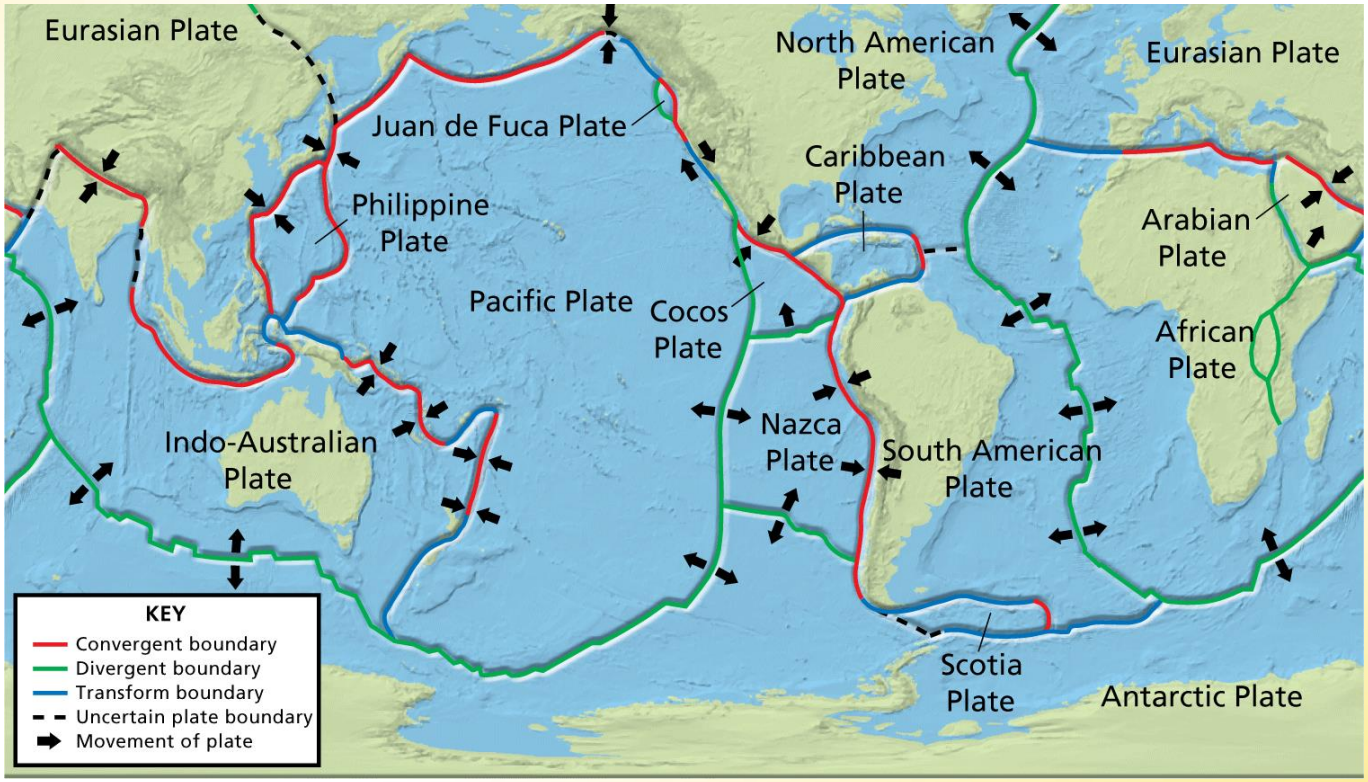


Plate Boundaries

The plates move very slowly, about 0.1 to 10 centimeters per year.

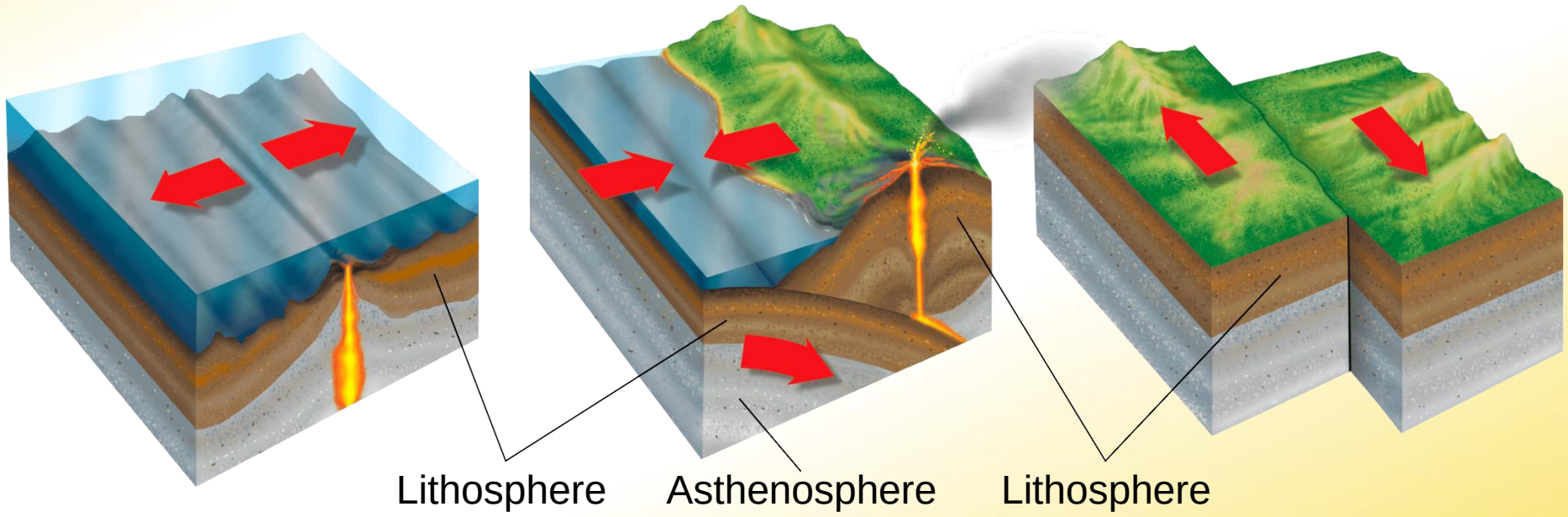
- Plates move away from each other along a **divergent boundary.** The mid-ocean ridge forms a divergent boundary. Divergent boundaries can also be found on land, for instance, in Africa.
- When plates move apart, magma rises to fill the gap and form new rock at the edge of each plate.

Plate Boundaries

- Plates come together, or collide, at a **convergent boundary.** The most common convergent boundary is one where an oceanic plate is subducted beneath a trench.
- At a **transform boundary,** plates slide past each other, moving in opposite directions. Rock is neither created nor destroyed at a transform boundary.

Plate Boundaries

Plates meet at three types of boundaries: divergent boundaries, convergent boundaries, and transform boundaries.



Mountain Building

- **Where do most mountains form?**
- **Geologists found that most mountains form along plate boundaries.**

Mountain Building

Some mountains form when two plates with continental crust at their edges collide along a convergent boundary.

- Neither plate is subducted during such collisions.
- The crust buckles, folds, and thickens, pushing up tall mountains.

Mountain Building

Mountains can also form along diverging plate boundaries.

- The mid-ocean ridge system forms one long chain of mountains on the ocean floor.
- In places, the mountains of the mid-ocean ridge rise above sea level. One example is the island of Iceland in the North Atlantic Ocean.

Mountain Building

The Andes, which extend along the western side of the South American plate, have risen as a result of a collision between that plate and the Nazca Plate

Assessment Questions

1. According to Wegener's hypothesis of continental drift, what is Pangaea?
   a. Africa and South America before they drifted apart
   b. a tectonic plate located in the Pacific Ocean
   c. the process by which continents move
   d. an ancient supercontinent formed 260 million years ago

Assessment Questions

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   ANS: D

Assessment Questions

2. What type of plate boundary causes mountain chains, such as the Himalayas, to form?
   a. divergent
   b. convection
   c. convergent
   d. transform

Assessment Questions

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Assessment Questions

3. What causes Earth's plates to move?
   a. gravitational force between continents
   b. magnetic forces in the lithosphere
   c. global winds pushing continents
   d. convection currents in Earth's mantle

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