Chapter Nineteen: Changing Earth

- 19.1 Inside Earth
- 19.2 Plate Tectonics
- 19.3 Plate Boundaries
- 19.4 Metamorphic Rocks

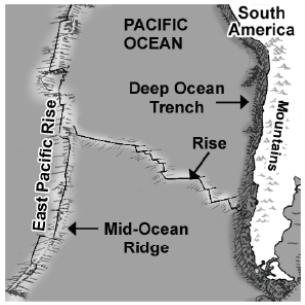
19.2 Learning Goals

- Discuss hypotheses which ultimately led to plate tectonics theory.
- Explain the relationship between magnetic reversal patterns an scientists' understanding about plate movement.
- Use plate tectonics theory to make predictions about Earth's future.

Investigation 19B

Plate Tectonics

- **Key Question:**
  - What is plate tectonics?



19.2 Pangaea

- Alfred Wegener was a German climatologist and arctic explorer who suggested the concept of continental drift.

- Continental drift is the idea that the continents move around on Earth's surface.

19.2 Movement of continents

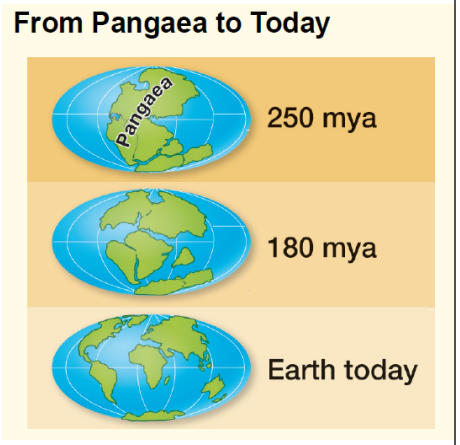
- Wegener thought that the continents we know today had once been part of an earlier supercontinent.
- He called this great landmass Pangaea.

19.2 Movement of continents

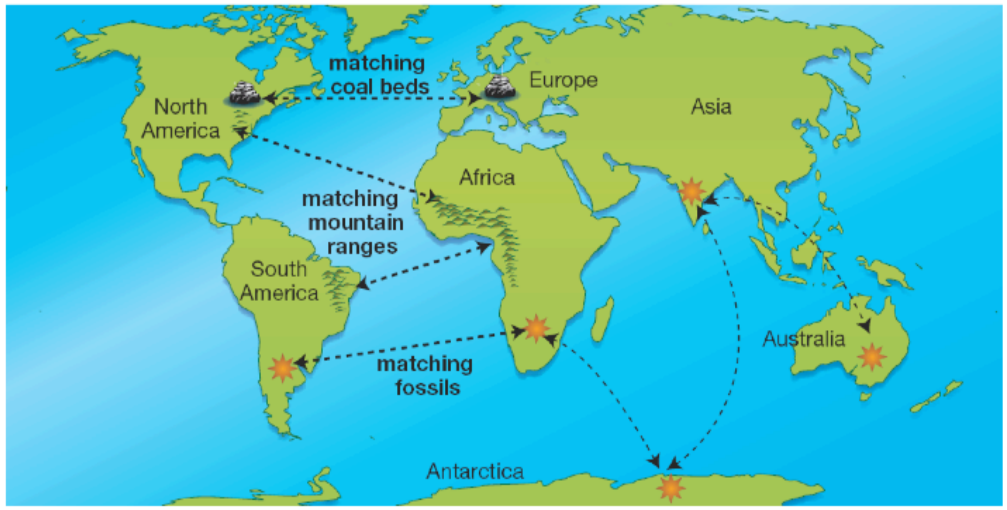
- The surface of Earth is broken into many pieces like a giant jigsaw puzzle.
- Plate tectonics describes how these pieces move on Earth's surface.

19.2 Evidence for continental drift

- Wegener's belief was a scientific hypothesis based on observations.
- Continental drift was accepted by all scientists because there was no evidence at the time to explain how continents could move.



Evidence for Continental Drift

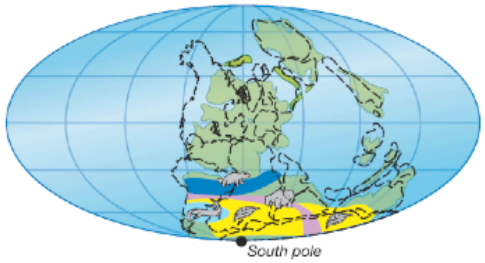


19.2 Evidence for continental drift

- Coal beds stretch across the eastern U.S. and continue across southern Europe.
- Matching plant fossils are found in South America, Africa, India, Australia, and Antarctica.
- Matching reptile fossils are found in South America and Africa.
- Matching early mammal fossils are found in South America and Africa.
- Fossils in South America and Africa are found in rocks of identical age and type.
- Matching rock types and mountain belts occur in North America and the British Isles, and Africa and South America.
- Evidence of glaciers is present in regions with warm, dry climates. Continents that are close to the equator today were once closer to the South Pole in the distant past.

Map with Fossil Locations

Where animals lived on ancient continents



Ancient continents Modern continents

Range of animals

Cynognathus Lystrosaurus

Glossopteris Mesosaurus

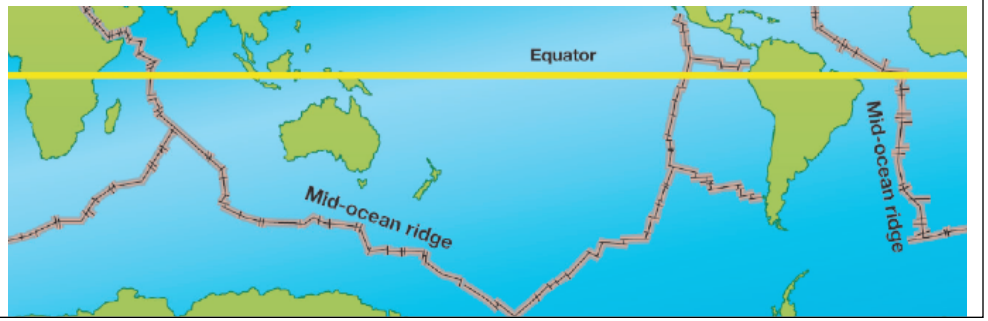
Where fossils are found today

Glacial limit Cynognathus Lystrosaurus

Glossopteris Mesosaurus

19.2 Sea Floor Spreading

- American geophysicist Harry Hess helped develop the theory of plate tectonics.
- While a Navy officer, Hess helped map the ocean floor.



19.2 Sea Floor Spreading

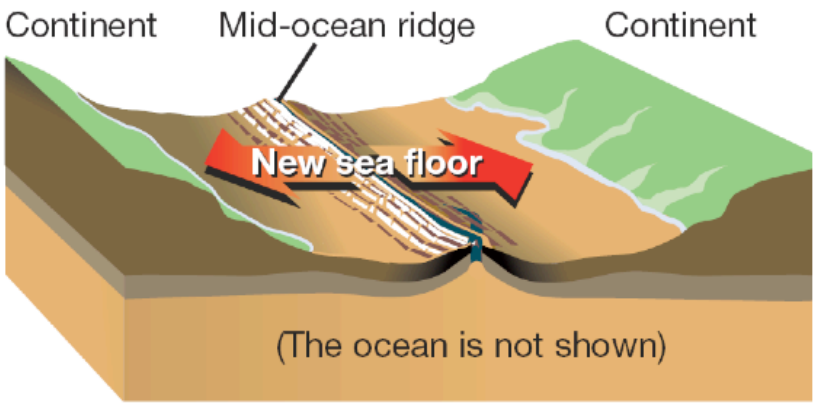
- Naval maps showed undersea mountain chains that formed a continuous chain down the centers of the ocean floors.
- Hess wondered if new ocean floor was created at these mid-ocean ridges.

19.2 Sea floor spreading

- Hess called his hypothesis sea-floor spreading.
- The key was the discovery that there are “magnetic patterns” in the rocks on either side of the mid-ocean ridges.
- Matching magnetic patterns and the age of rocks on either side of mid-ocean ridges provided strong evidence for sea-floor spreading.

Harry Hess' Idea

As new sea floor is made at mid-ocean ridges, the continents are pushed away.

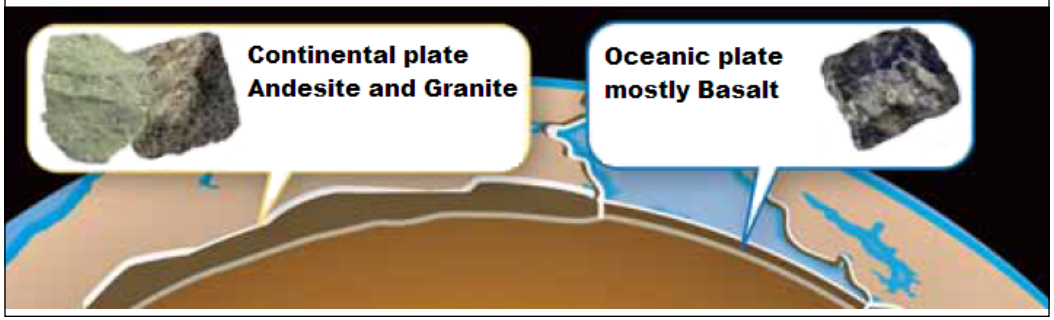


19.2 Moving pieces of the lithosphere

- Scientists realized that large pieces of Earth's surface moved about like rafts on a river.
- These "rafts" are pieces of lithosphere called lithospheric plates.
- Plate tectonics is the study of these lithospheric plates.

19.2 Moving pieces of the lithosphere

- There are two kinds of lithospheric plates: oceanic plates and continental plates.

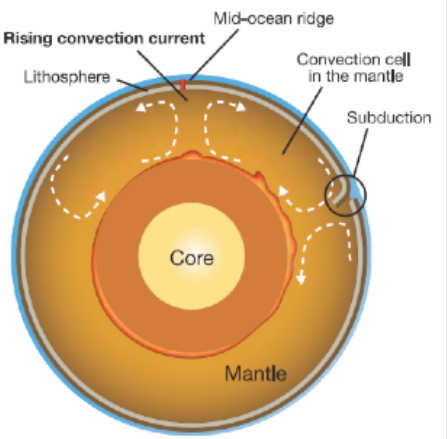


19.2 Moving pieces of the lithosphere

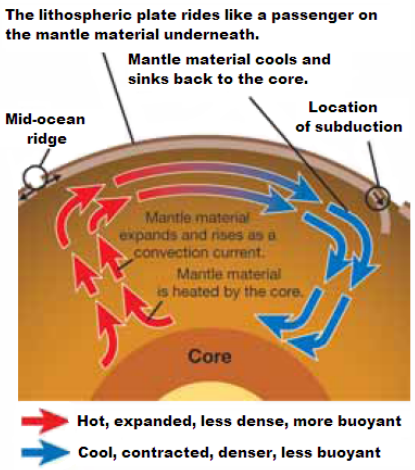
- The theory of how these lithospheric plates move on Earth's surface is called plate tectonics.
- The word tectonics is derived from the Greek word for "builder."

19.2 What drives lithospheric plates?

- Convection cells in Earth's lower mantle drive the lithospheric plates on the surface.
- Heated lower mantle material rises toward Earth's surface.

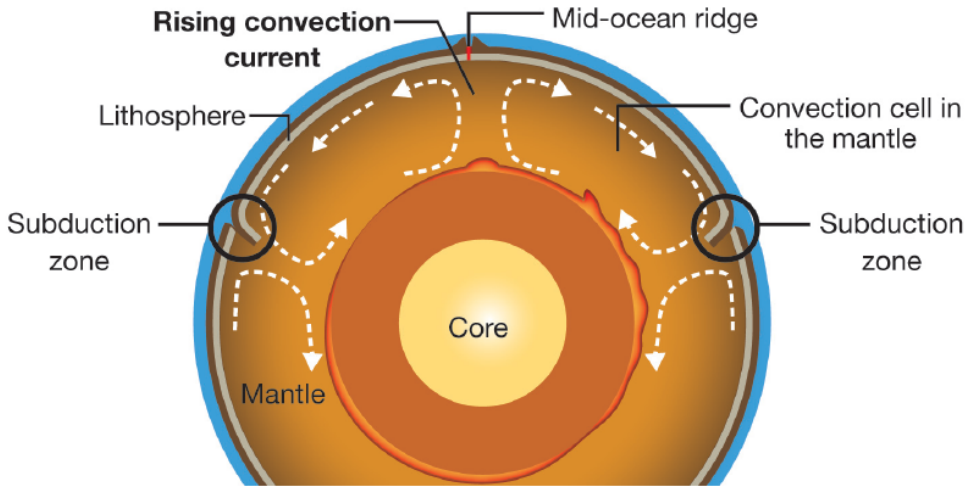


19.2 What drives lithospheric plates?

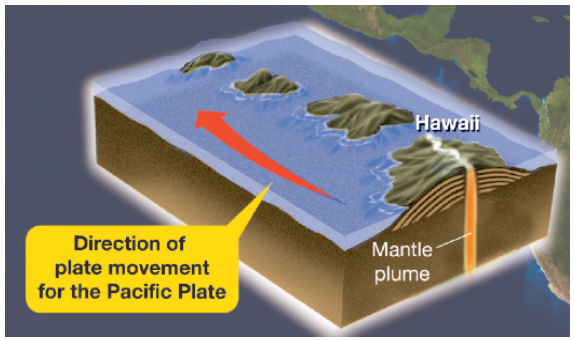


- Cooling makes the nearby material denser and it sinks deeper into the lower mantle.
- This sinking process is called subduction.

Convection and Subduction



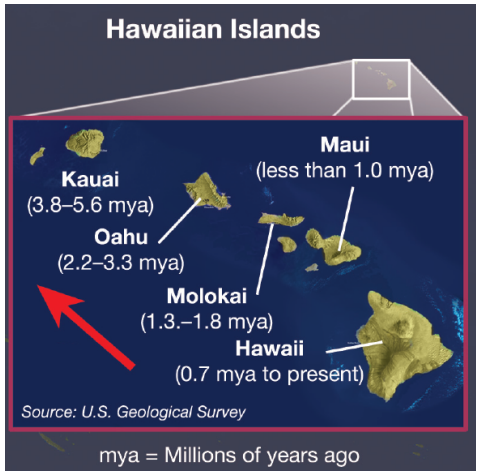
19.2 How do scientists measure the motion of plates?



- A single hot rising plume, called a mantle plume, can cause a volcanic eruption in the plate above it.
- If the eruption is strong and lasts long enough, the volcanic eruption may form an island on the plate.

19.2 How do scientists measure the motion of plates?

- After the island forms, the movement of the plate carries it away from the mantle plume.
- Scientists determine the direction and speed of plate movement by measuring these island chains.



Investigation 19C

Evidence for Plate Boundaries

- **Key Question:**

  How are fossils useful evidence for continental drift?