Sea Floor Spreading

- EQ:What is seafloor spreading and how does it account for the movement of continents?

Breakup of Pangaea

245 Million Years Ago
Pangaea existed when some of the earliest dinosaurs were roaming the Earth. The continent was surrounded by a sea called *Panthalassa*, which means "all sea."

180 Million Years Ago
Gradually, Pangaea broke into two big pieces. The northern piece is called *Laurasia*. The southern piece is called *Gondwana*.

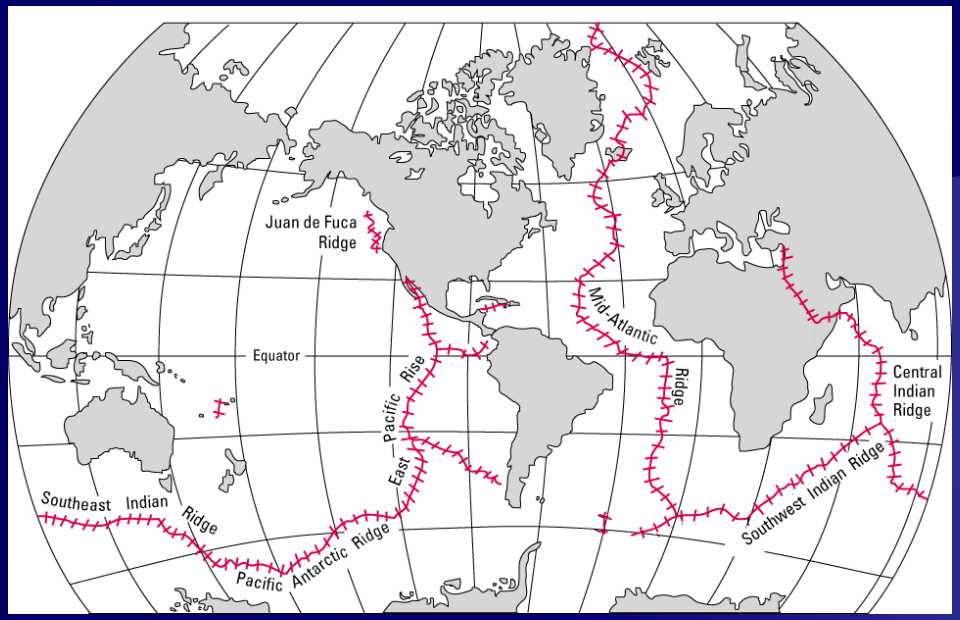
65 Million Years Ago
By the time the dinosaurs became extinct, Laurasia and Gondwana had split into smaller pieces.

Mid-Ocean Ridge

- Beginning in the 1950s, a wealth of new evidence emerged to revive the debate about Wegener's theories.

Specifically, oceanic exploration greatly expanded.

Data gathered led to the discovery that a great mountain range on the ocean floor virtually encircled the Earth.

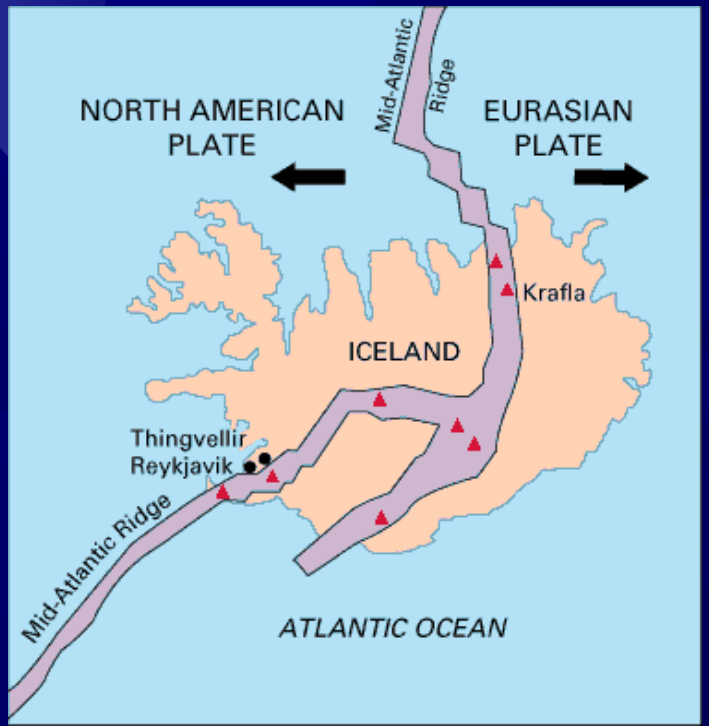


This underwater mountain chain is called the Mid-Ocean Ridge.

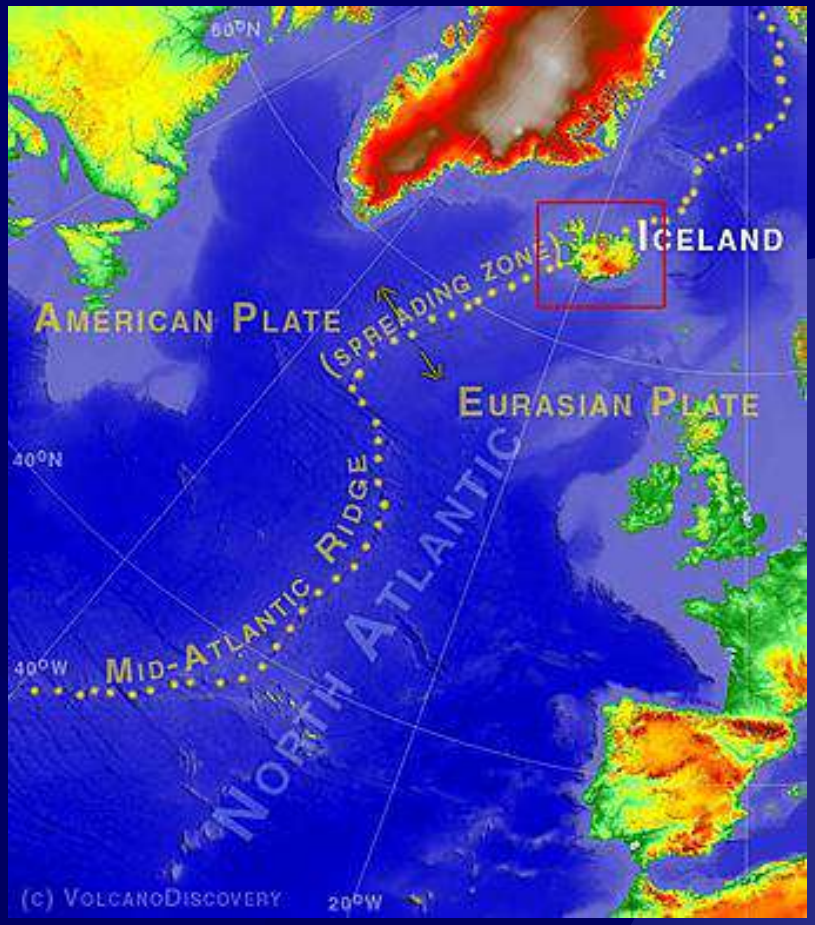
Mid-Ocean Ridge

It curves along the sea floor, extending into all of the Earth's oceans.

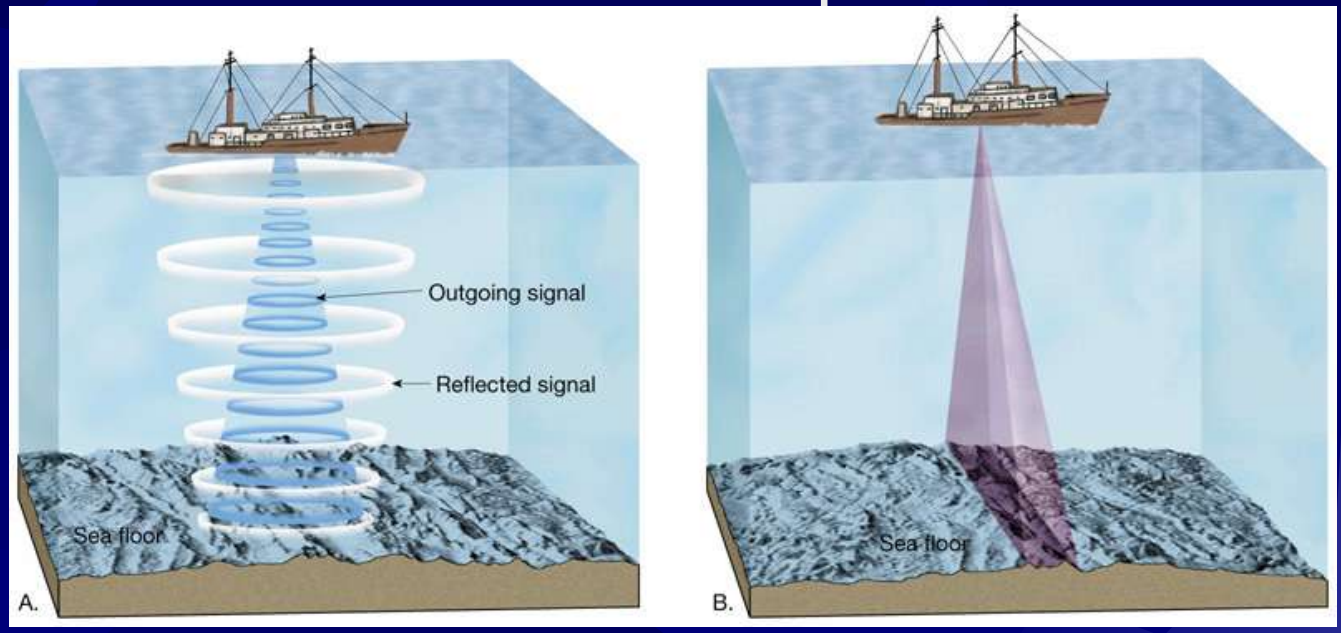
There are places where it pokes above the surface of the Earth, such as the island of Iceland.



- The Mid-Ocean Ridge is the longest mountain chain in the world.



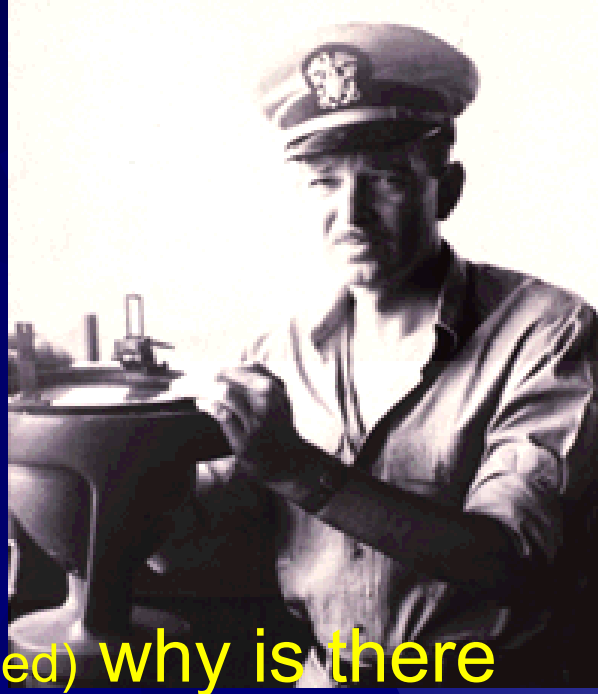
- Scientists have used sonar to map the Mid-Ocean Ridge.



Sonar is a device that bounces sound waves off underwater objects and records the echoes of these sound waves.

The time it takes for the echo to arrive indicates the distance to the object.

Harry Hess



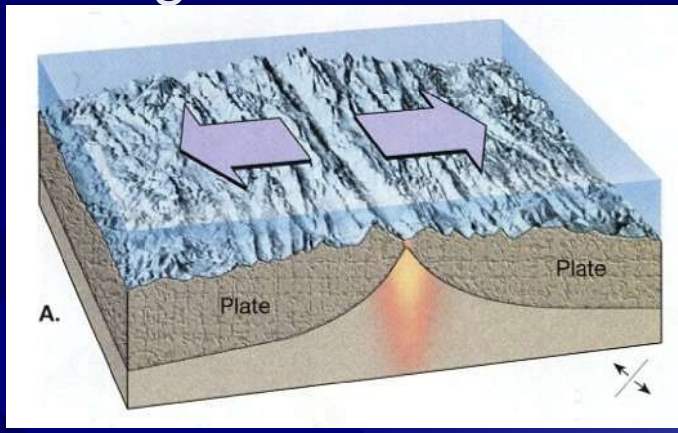
If the oceans have existed for at least four billion years (as most geologists believed) why is there so little sediment deposited on the ocean floor?

Hess reasoned that the sediment has been accumulating for about 300 million years at most and he looked for an explanation.

Seafloor Spreading

- Ocean floors move like conveyor belts, carrying the continents along with them.

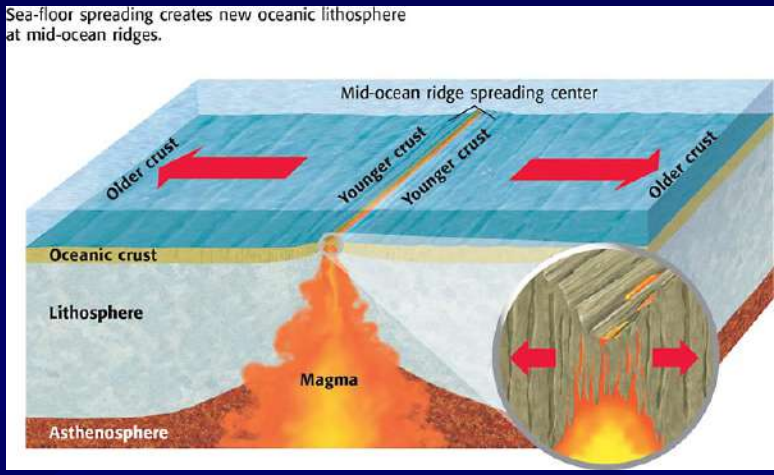
1. movement begins at the Mid-Ocean Ridge.
2. Molten material rises from the mantle and erupts along the ridge.
3. The molten material spreads out, pushing older rock to both sides of the ridge.



4. It cools to form a strip of solid rock in the center of the ridge.
5. molten material flows into the crack, splitting apart the solid rock, pushing it aside.

Hess called this process seafloor spreading.

Seafloor Spreading



- Several types of evidence from the oceans supported Hess's theory of seafloor spreading:
  - Evidence from molten material
  - Magnetic stripes
  - Drilling samples

This evidence also led scientists to look again at Wegener's theory of continental drift.

Evidence from Molten Material

This rock was shaped like pillows, or like toothpaste squeezed from a tube.

These strange formations could only have formed when molten material hardened quickly after erupting underwater.

Evidence from Magnetic Stripes

- Beginning in the 1950s, scientists, using magnetic instruments *(magnetometers)*, began recognizing odd magnetic variations across the ocean floor.

Basalt -- the iron-rich, volcanic rock making up the ocean floor-- contains a strongly magnetic mineral *(magnetite)* and can locally distort compass readings.

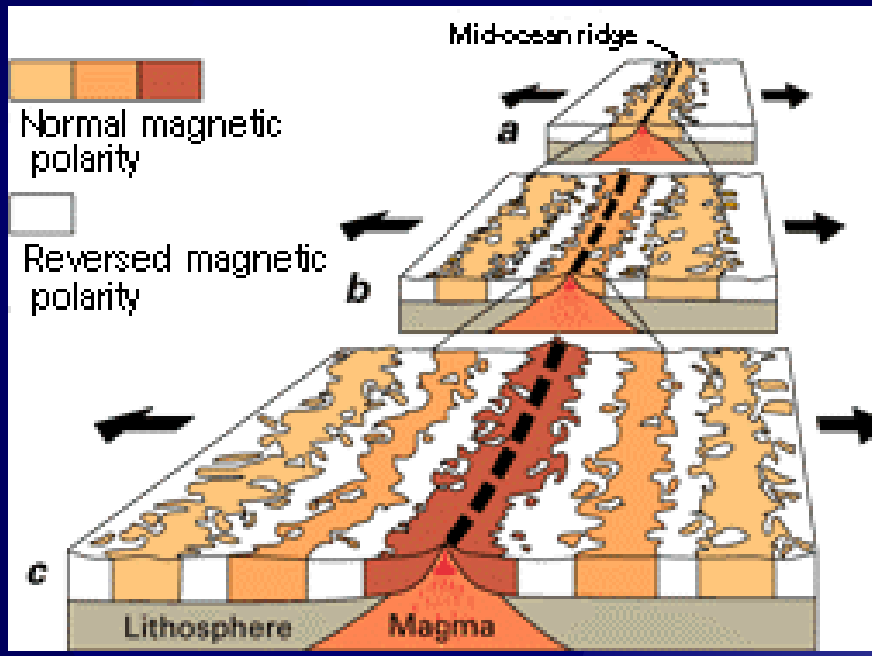
When material that erupted from the Mid-Ocean Ridge cooled, the iron in the rock lined up in the direction of Earth's magnetic poles.

They discovered evidence of magnetic reversals in the rock on the ocean floor.

Sometimes the iron in the rocks pointed toward the North Pole and sometimes it pointed toward the South Pole.

Magnetic Reversals

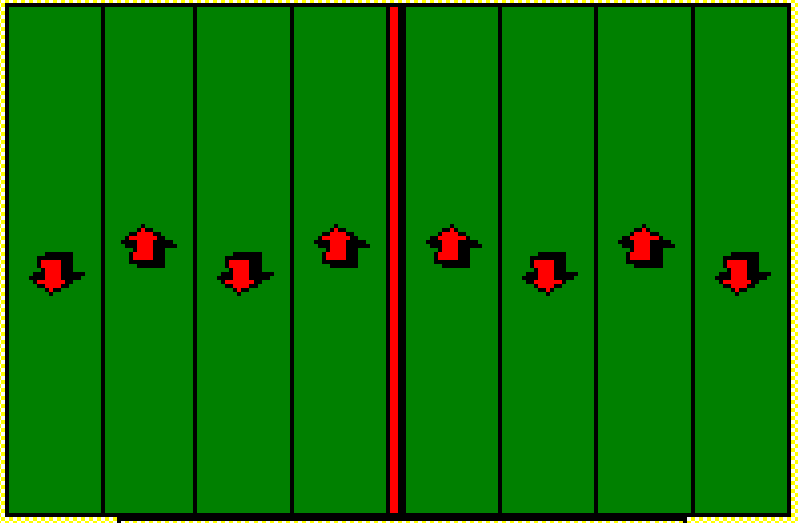
- When scientists recorded the magnetic memory of the rocks on both sides of the Mid-Ocean Ridge, they discovered that a stripe of rock that show's when Earth's magnetic field pointed north is followed by a parallel strip of rock that shows when the magnetic field pointed south.



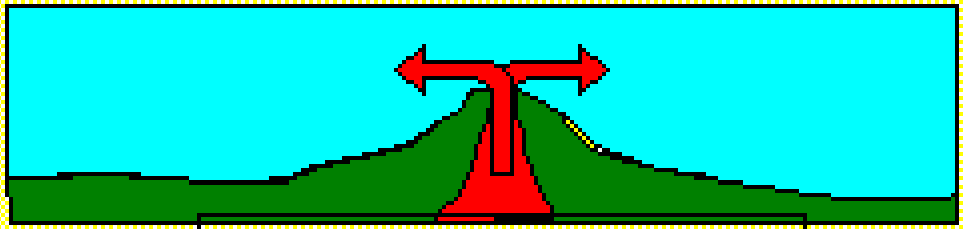
AND the pattern is the same on both sides of the ridge.

SEA FLOOR SPREADING AND MAGNETIC REVERSALS

Older ⬅ Youngest ➡ Older



Magnetic Stripes



Midoceanic Ridge

Evidence from Drilling Samples

When scientists determined the ages of the rocks they found that the farther away from the ridge the samples were taken, the older the rocks were.

The youngest rocks were always in the center of the ridges.

So...if the sea floor is getting wider…

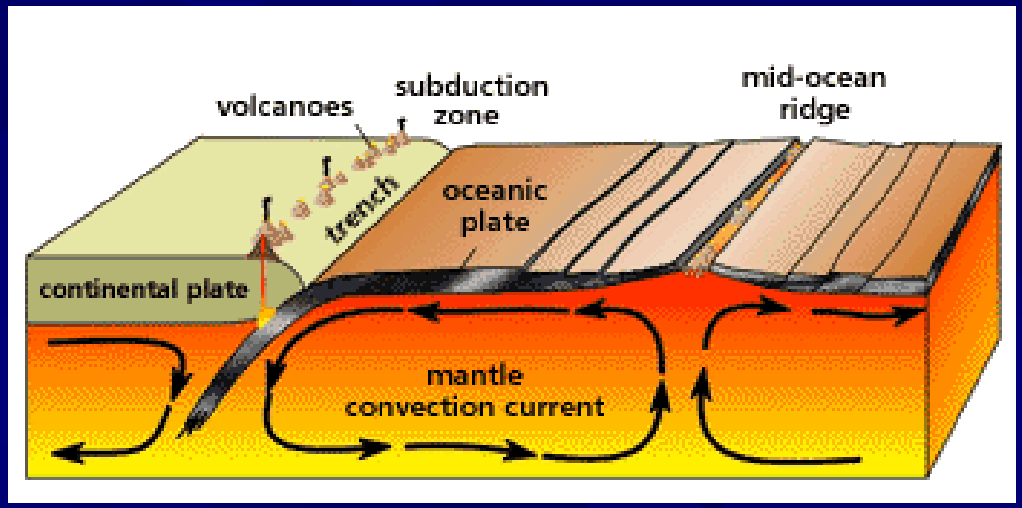
- Actually, the ocean floor doesn't keep spreading out.

Eventually, the ocean plunges deep into deep underwater canyons called deep ocean trenches.

These trenches form where the oceanic crust bends downward.

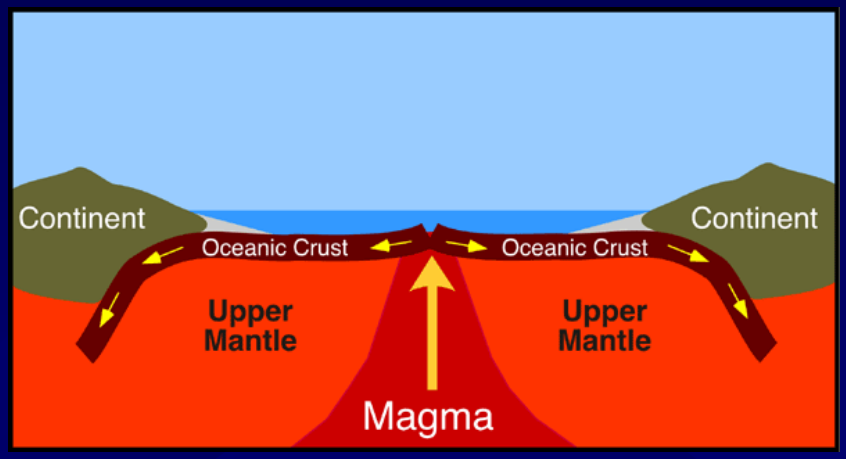
Subduction at Deep-Ocean Trenches

- Subduction is the process by which the ocean floor sinks beneath a deep-ocean trench and back into the mantle.



Convection currents under the lithosphere push new oceanic crust that forms at the mid-ocean ridge away from the ridge and toward a deep ocean trench.

- New oceanic crust is hot. As it moves away from the mid-ocean ridge, it cools and becomes more dense.



The farther away the rock is from the mid-ocean ridge, the denser the rock is.

Eventually, gravity pulls this dense oceanic crust back into the mantle.

The time it takes for new rock to form at the mid-ocean ridge, move across the ocean, and sink into a trench is approximately 200 million years.

- The Pacific Ocean is getting smaller. More ocean crust is being subducted into deep ocean trenches in the Pacific than can be created at the mid-ocean ridge.

On the other hand, the Atlantic Ocean is expanding. The Atlantic Ocean only has a few short trenches, so the expanding sea-floor has nowhere to go.

Since the continents are attached to the continental crust, which is attached to the oceanic crust, the continents move apart as the Atlantic Ocean spreads.