



Plate Tectonic Theory

Evidence for
Plate Tectonics

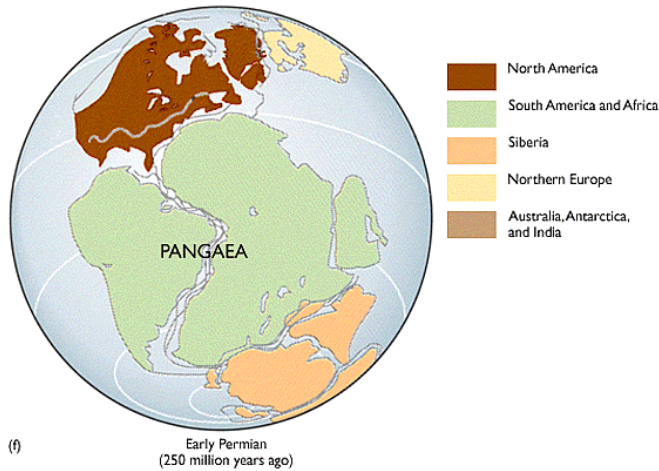
CONTINENTAL DRIFT



- Alfred Wegener in the early 1900's proposed the hypothesis that continents were once joined together in a single large land mass he called **Pangea** (meaning "all land" in Greek).
- He proposed that Pangea had split apart and the continents had moved gradually to their present positions - a process that became known as **continental drift**.



CONTINENTAL DRIFT



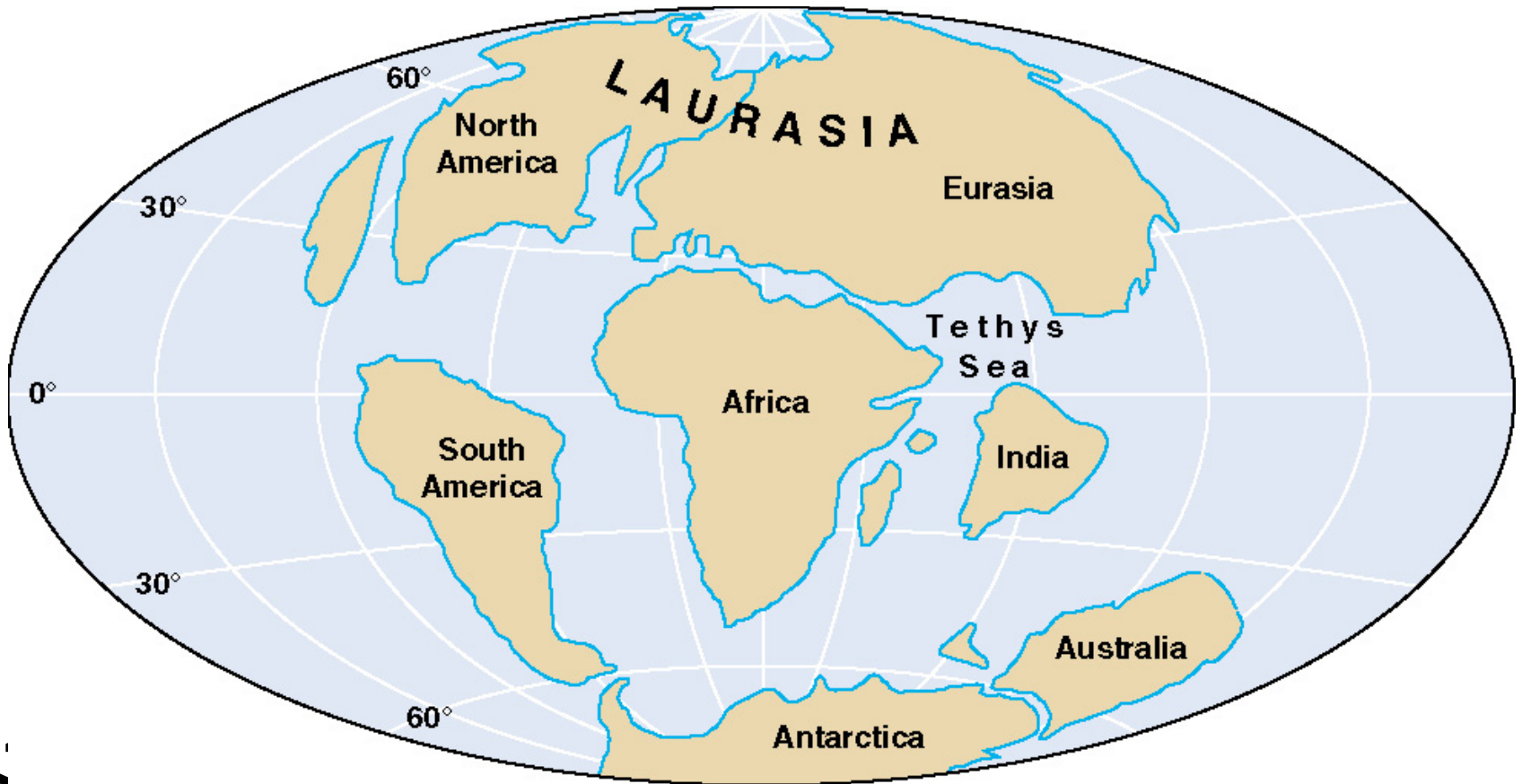
According to the hypothesis of **continental drift**, continents have moved slowly to their current locations.



Pangaea about 200 million years ago, before it began breaking up. Wegener named the southern portion of Pangaea **Gondwana**, and the northern portion **Laurasia**.



The continents about 70 million years ago. Notice that the breakup of Pangea formed the Atlantic Ocean. India's eventual collision with Eurasia would form the Himalayan Mountains.

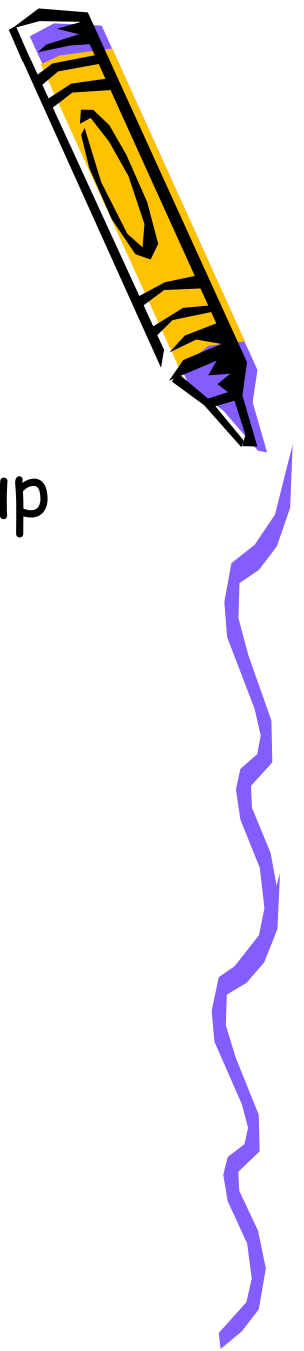


The position of the continents today. The continents are still slowly moving, at about the speed your fingernails grow. Satellite measurements have confirmed that every year the Atlantic Ocean gets a few inches wider!



Quick Check

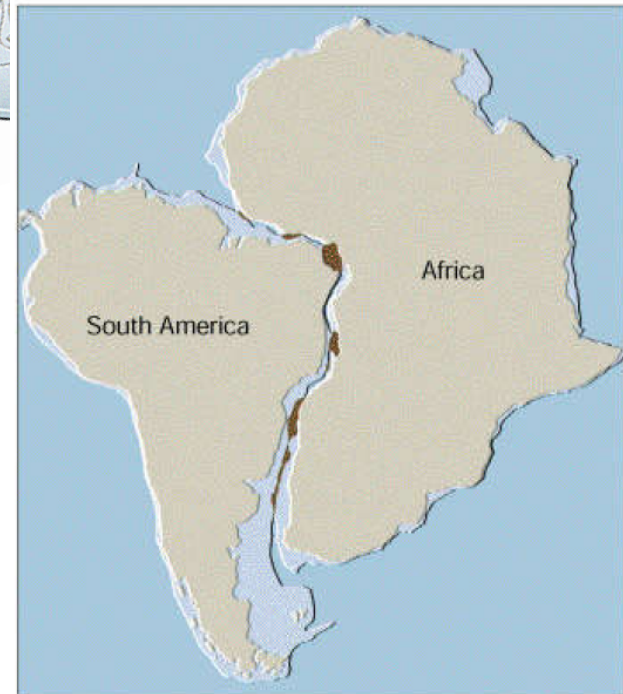
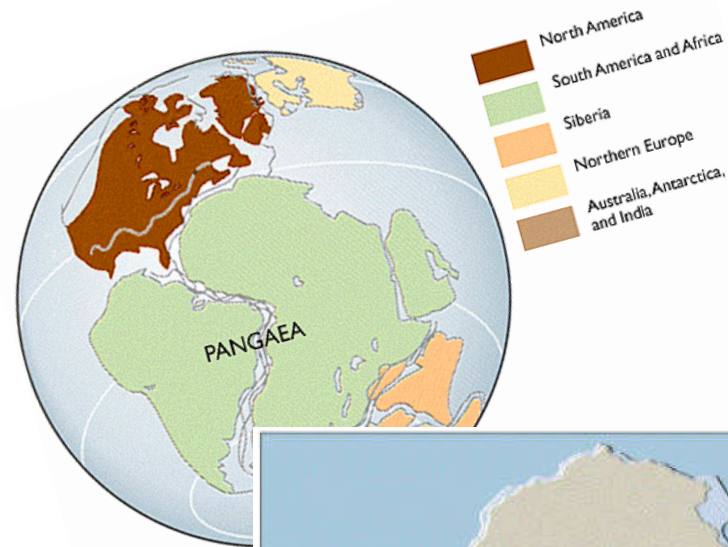
Turn and tell your neighbor who came up with the continental drift theory.



Wegener's Evidence for Continental Drift

Continents fit together like a puzzle....e.g. the Atlantic coastlines of Africa and South America.

The Best fit includes the continental shelves (the continental edges under water.) WHY?



Picture from

http://www.sci.csuhayward.edu/~lstrayer/geol2101/2101_Ch19_03.pdf

Wegener's Evidence for Continental Drift

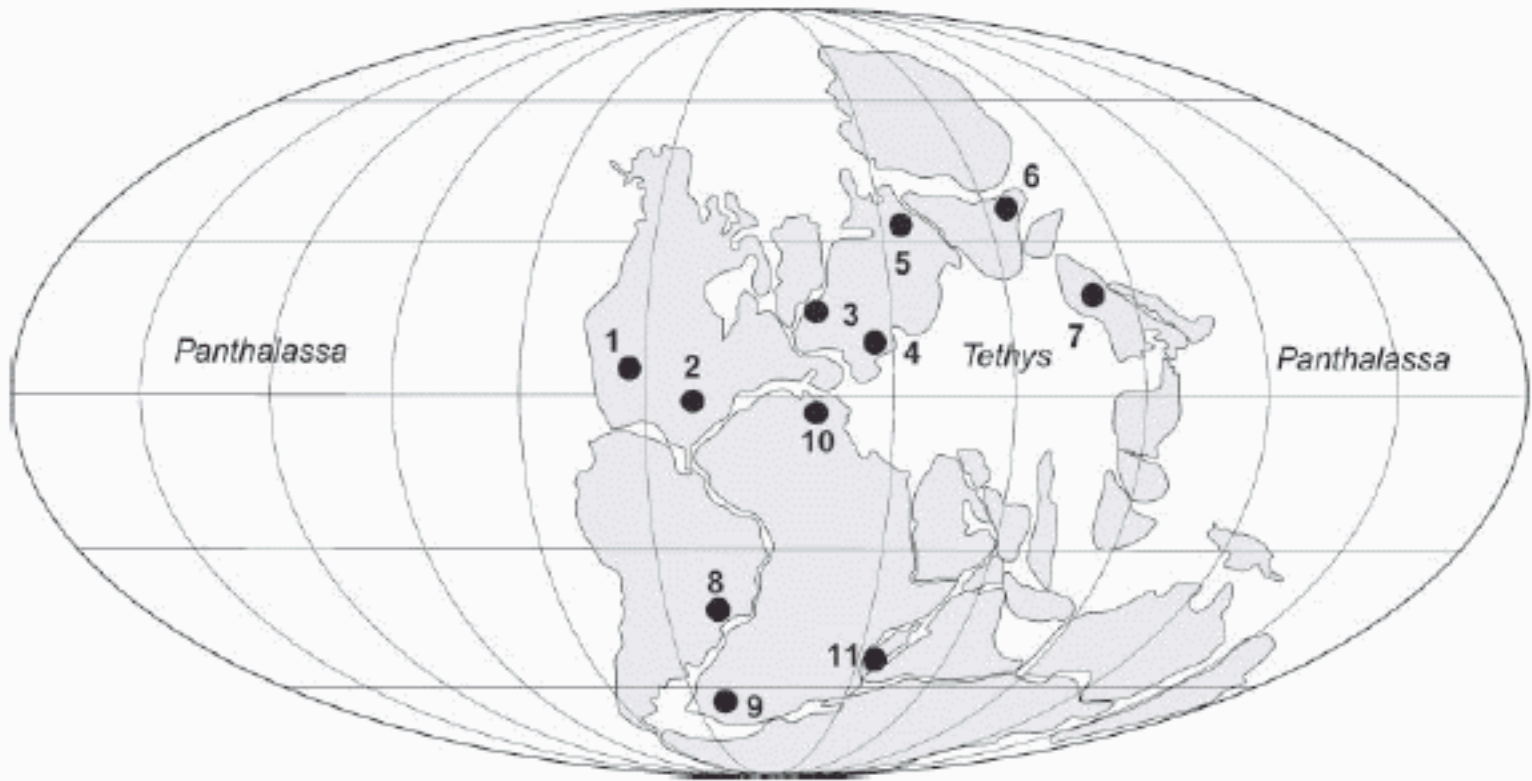
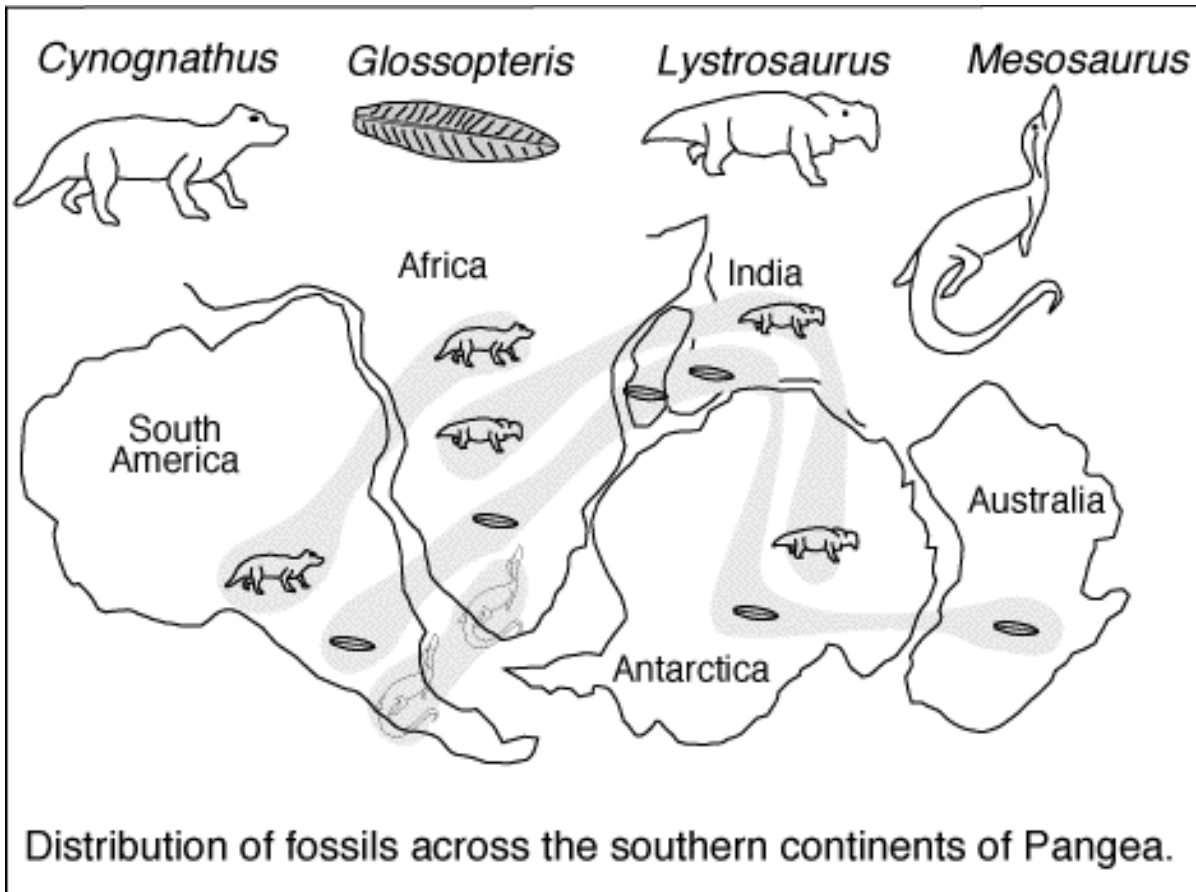


Fig. 1. Map of Permian Pangaea showing principal tetrapod localities. 1, western USA; 2, eastern USA (Dunkard); 3, Scotland; 4, western Europe (Rotliegend); 5, Russian Urals; 6, Junggur Basin, China; 7, Ordos Basin, China; 8, Paraná Basin, Brazil; 9, Karoo Basin, South Africa; 10, Morocco; 11, southern Madagascar.

Wegener's Evidence for Continental Drift

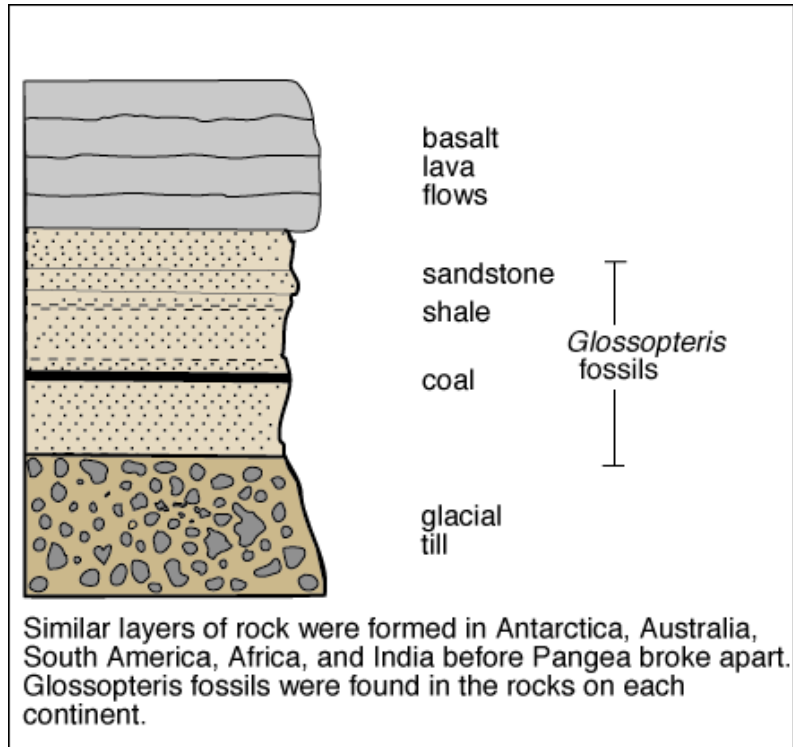


Picture from
[http://
volcano.und.edu/
vwdocs/vwlessons/
plate_tectonics/
part3.html](http://volcano.und.edu/vwdocs/vwlessons/plate_tectonics/part3.html)

Fossils of plants and animals of the same species found on different continents.

Wegener's Evidence for Continental Drift

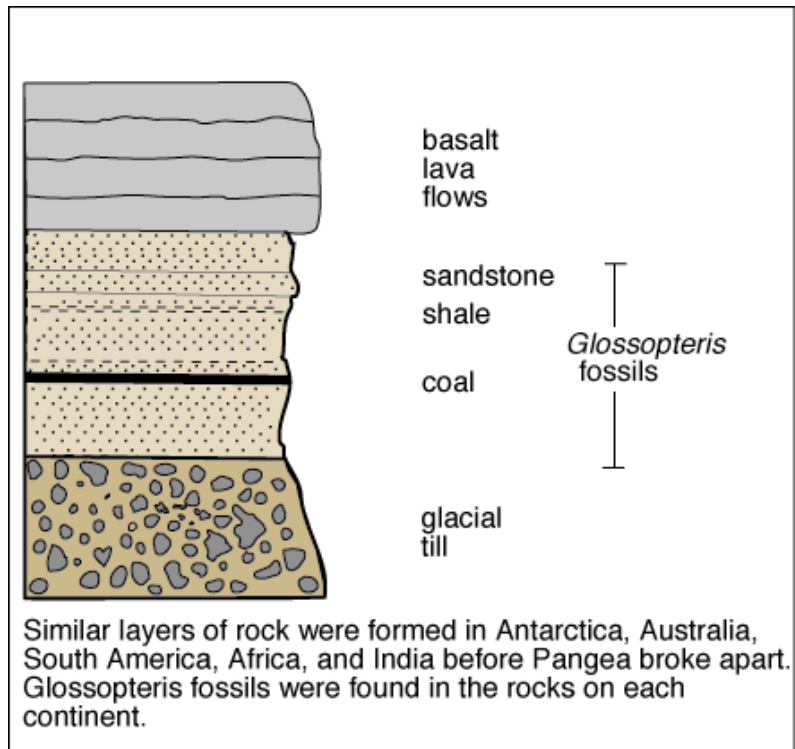
- Rock sequences (meaning he looked at the order of rock layers) in South America, Africa, India, Antarctica, and Australia show remarkable similarities.
- Wegener showed that the same three layers occur at each of these places.



Picture from
http://volcano.und.edu/vwdocs/vwlessons/plate_tectonics/part4.html

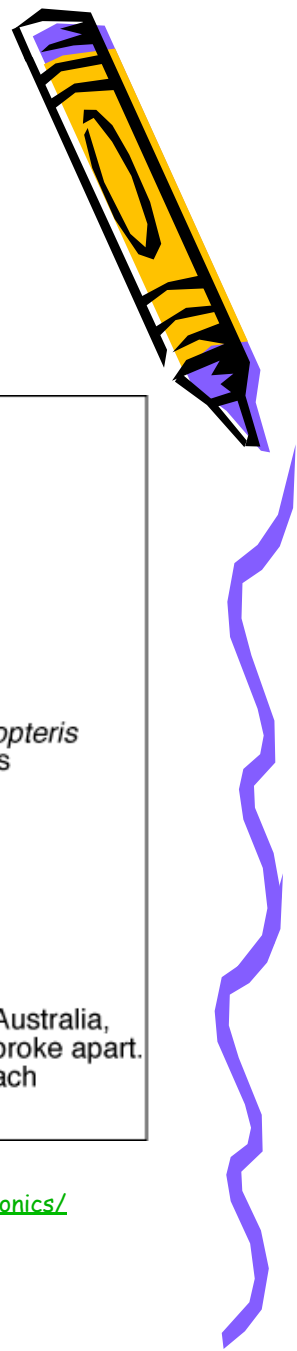
Wegener's Evidence for Continental Drift

- NOTICE: In all areas, including Africa, there are the same rock types... EVEN rocks from Glacier activity!
- This shows that not all continents were in their current positions in the past (Africa would have been somewhere colder)



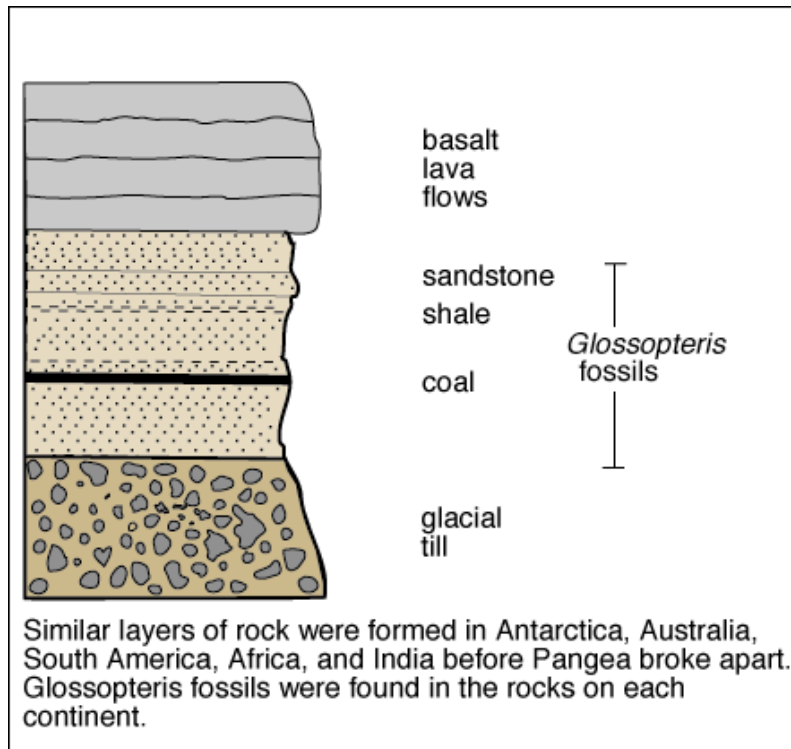
Picture from
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Wegener's Evidence for Continental Drift



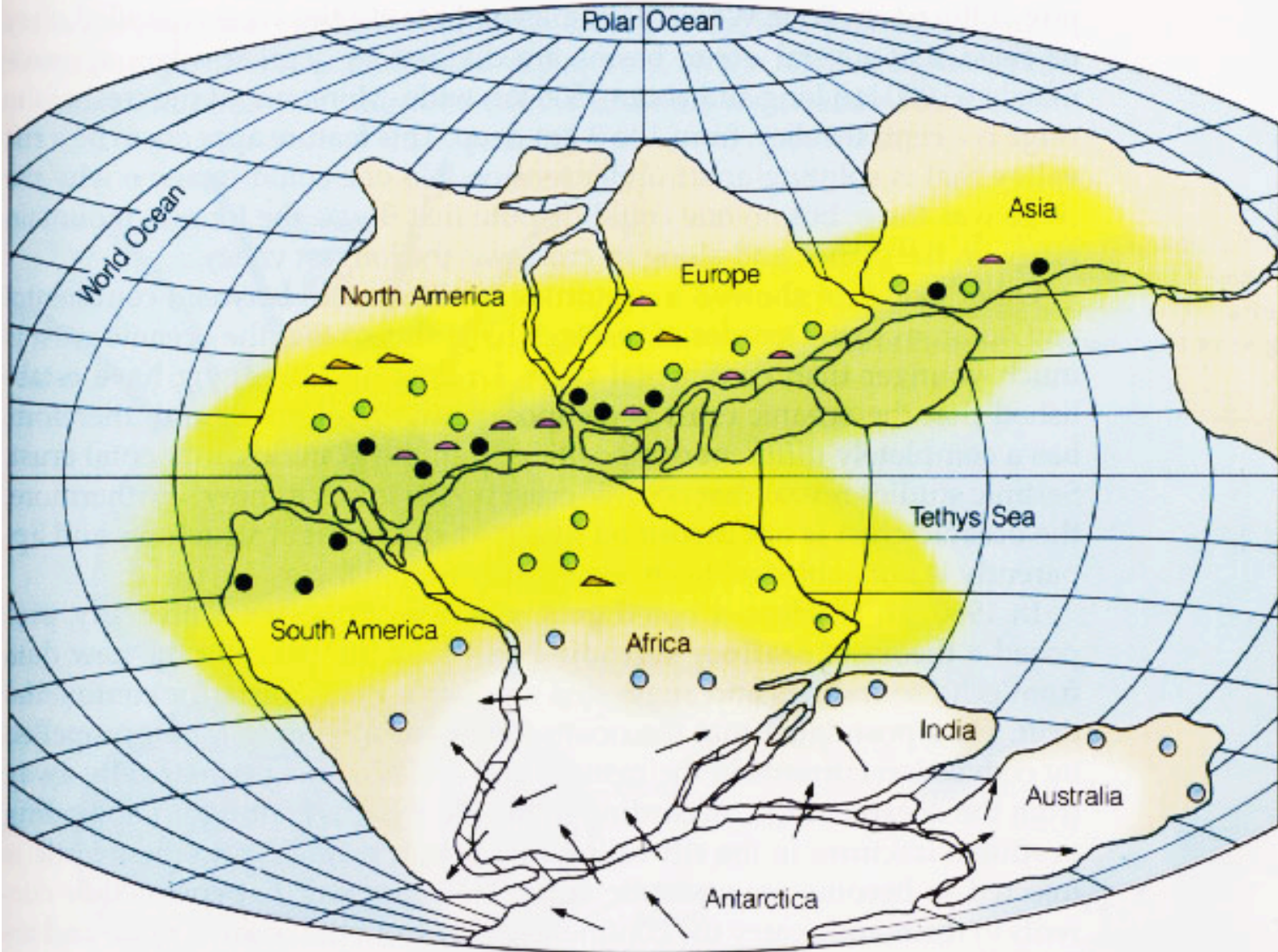
- The same three layers are in the same order in areas now separated by oceans.
- Wegener proposed that the rock layers were made when all the continents were part of Pangea.
- He proposed that they formed in a smaller small joined land mass that was later broken and drifted

apart



Picture from

http://volcano.und.edu/vwdocs/vwlessons/plate_tectonics/part4.html



● Ice-rafted boulders

● Coal

■ Low-latitude deserts

● Evaporite deposits

▲ Desert dune deposits

■ Tropics

◐ Coral reef

→ Direction of ice movement

□ Glacier

Bye, Alfred.

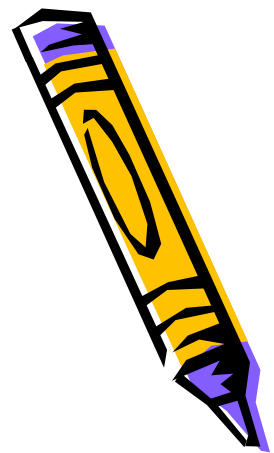


- Everyone agreed that Wegener's evidence was compelling. But wouldn't we feel the movement?
- Also, wouldn't there be evidence to show that the continents were still moving today?
- Wegener was a meteorologist and his theory was not well accepted. (He died on an expedition in Greenland collecting ice samples)



Continental Drift almost "Died"

- One reason scientists had a hard time with Wegener's theory is that there was no mechanism for the continents' motion.



Seafloor Spreading

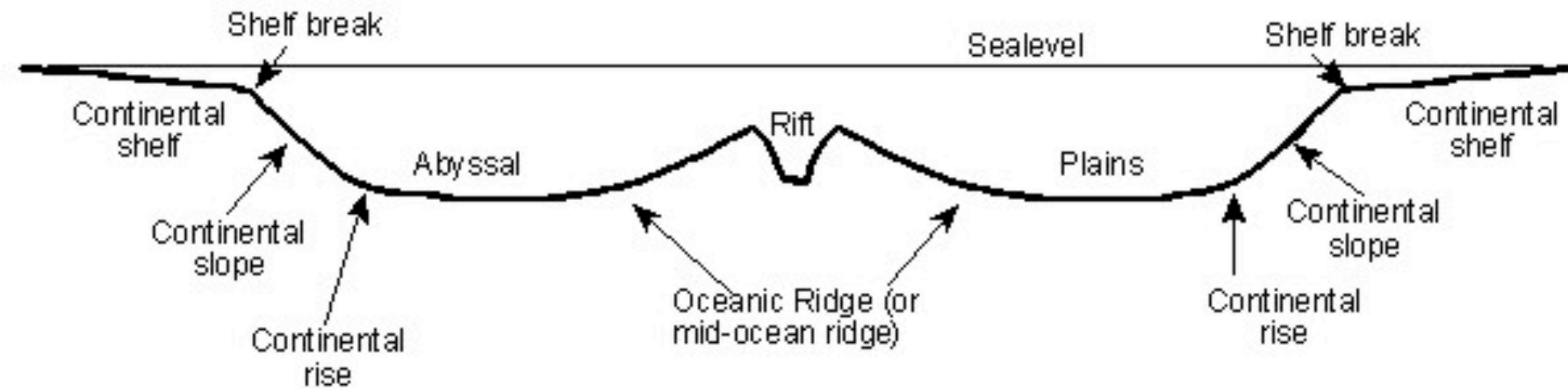


Picture from USGS
<http://pubs.usgs.gov/gip/dynamic/HHH.html>

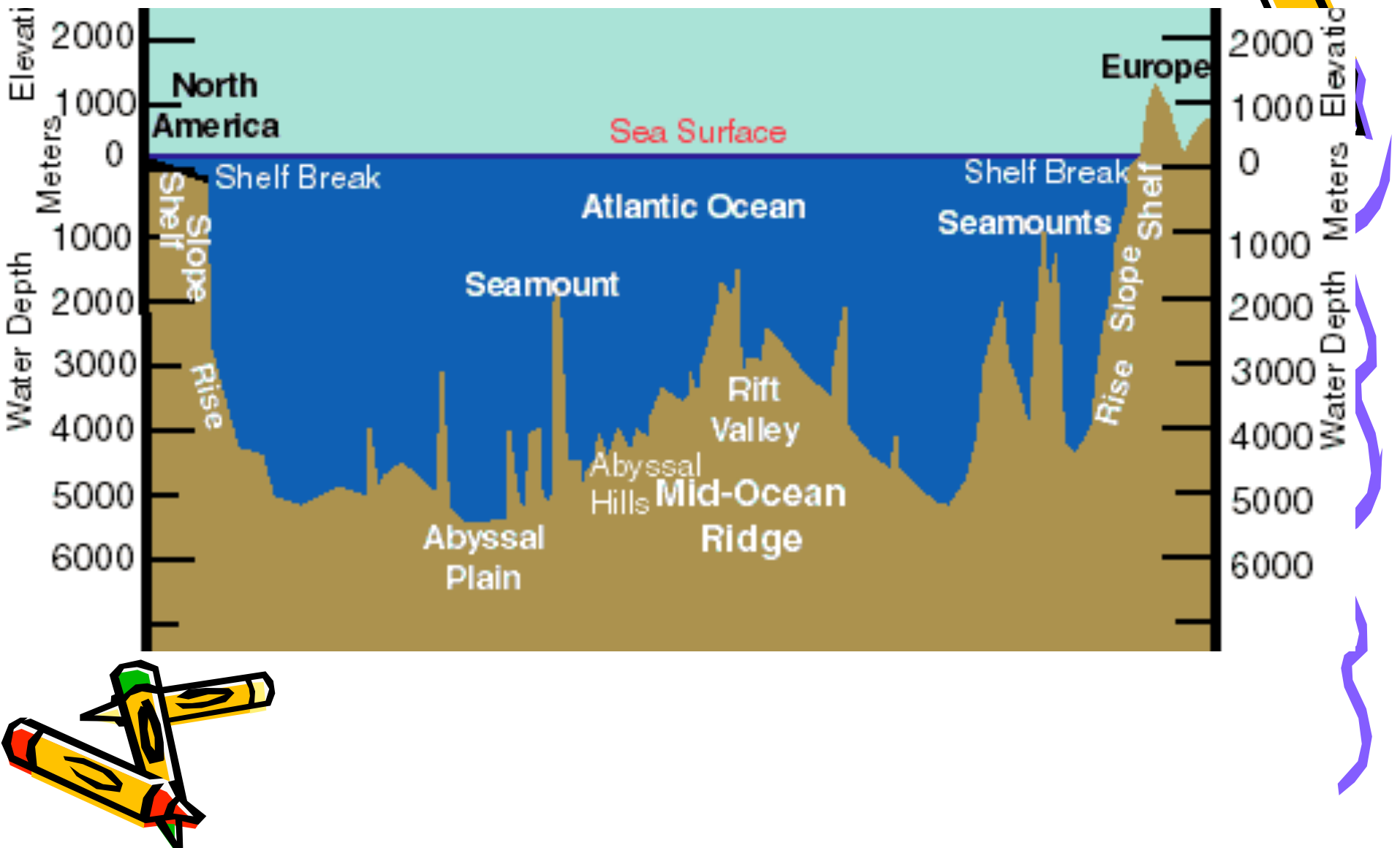
- In the 1960's, a scientist named Henry Hess made a discovery that would vindicate Wegner.
- Using new technology, radar, he discovered that the seafloor has both trenches and mid-ocean ridges. (Cold War)
- Henry Hess proposed the seafloor spreading theory.



Cross-section of the Atlantic Ocean (great vertical exaggeration, not to scale)



The ocean basin is very symmetric across the Atlantic Ocean, and the continental edges on both sides are called "Atlantic-type continental margins".

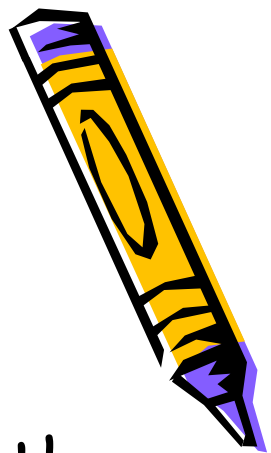


Seafloor Spreading



Picture from USGS
<http://pubs.usgs.gov/gip/dynamic/HHH.html>

- Undersea Mountains, with a rift in the middle. Volcanic activity was also recorded.

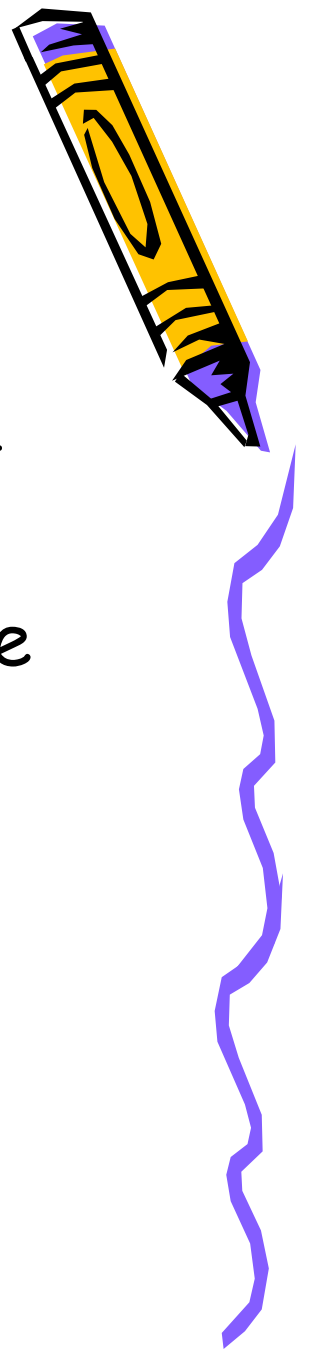


Seafloor Spreading

- Hess proposed that hot, less dense material below Earth's crust rises toward the surface at the mid-ocean ridges.
- Then, it flows sideways, carrying the seafloor away from the ridge in both directions.



Seafloor Spreading



- As the seafloor spreads apart at a mid-ocean ridge, new seafloor is created.
- The older seafloor moves away from the ridge in opposite directions.
- This helped explain how the crust could move—something that the continental drift hypothesis could not do.

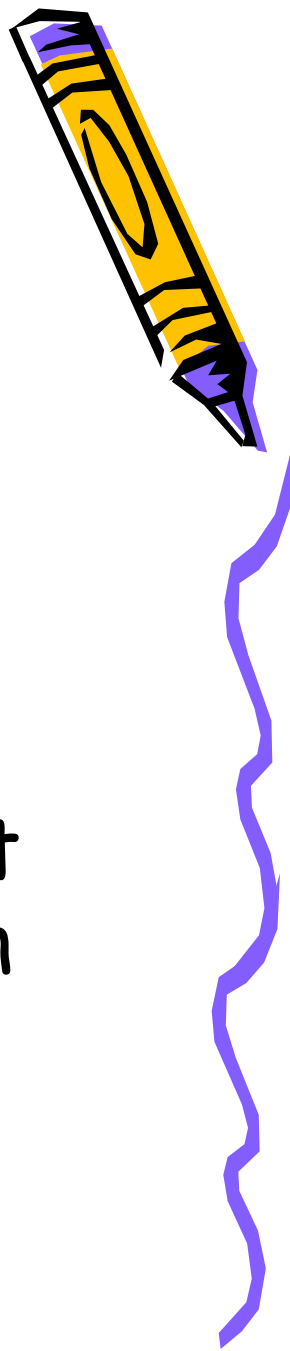


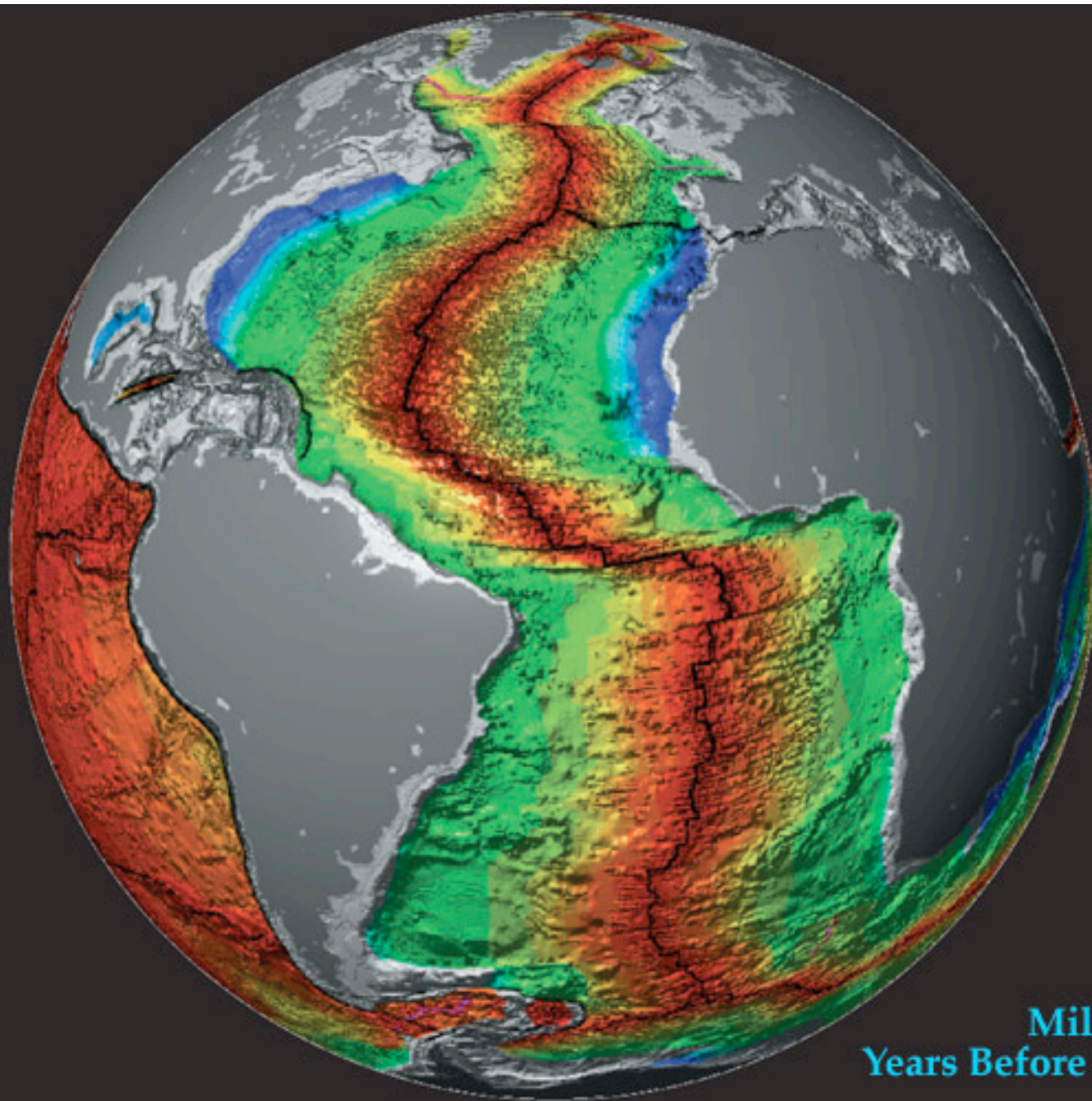
Picture from
<http://www.pbs.org/wgbh/aso/tryit/tectonics/divergent.html>



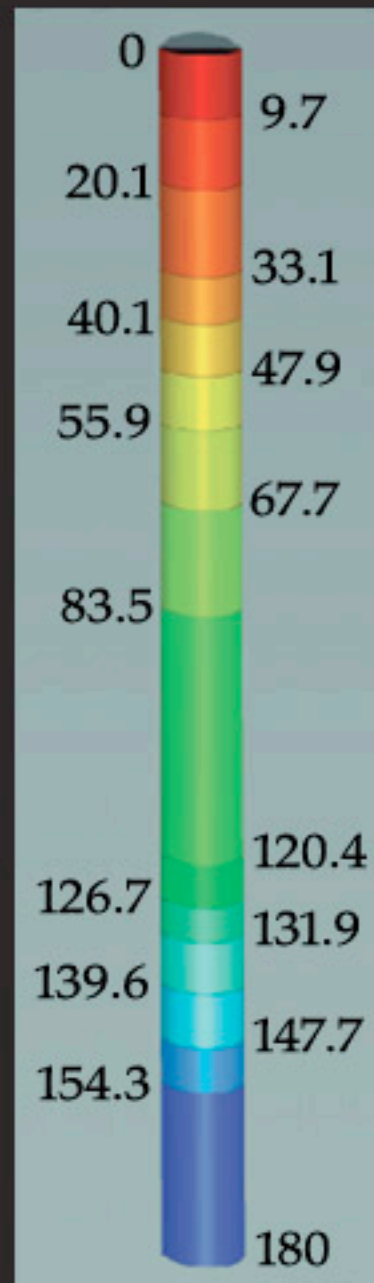
Evidence for Spreading

- In 1968, scientists aboard the research ship *Glomar Challenger* began gathering information about the rocks on the seafloor.
- Scientists found that the youngest rocks are located at the mid-ocean ridges. Ages are "Mirrored"



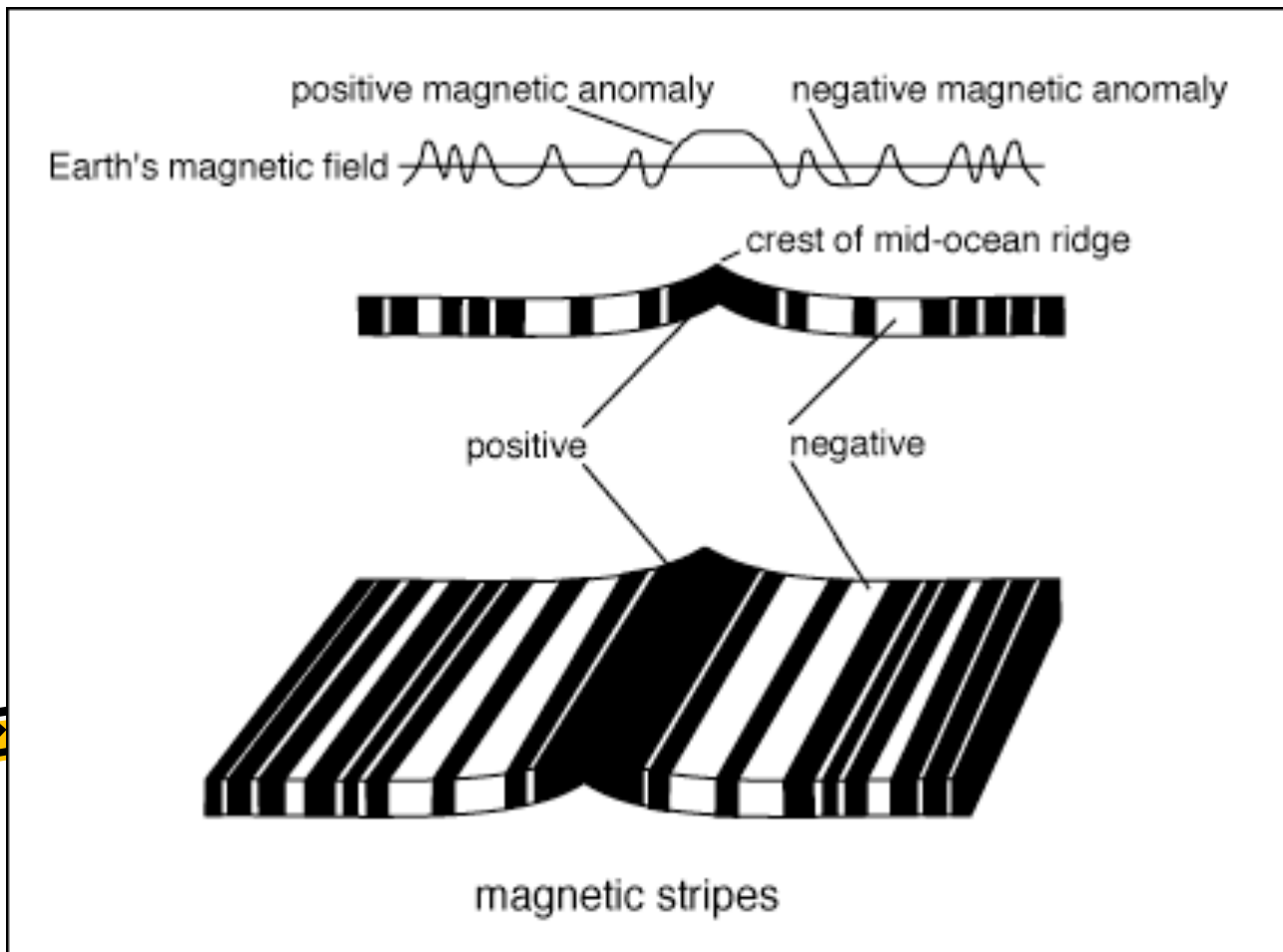


Millions of
Years Before Present



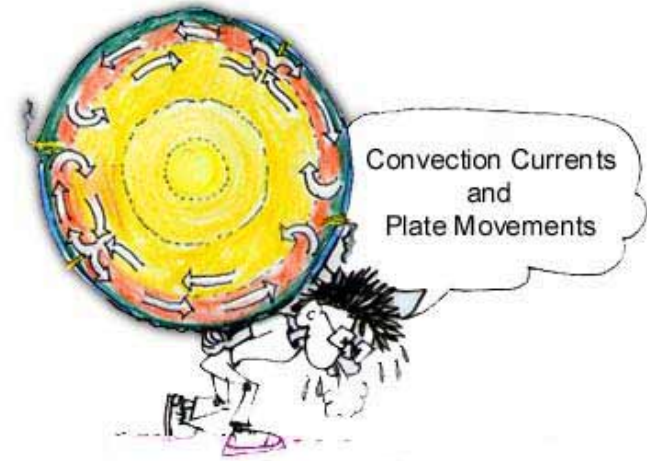
Evidence for Spreading

- Paleomagnetism- magnetic profile of the rocks also mirrored on seafloor



Mechanism for Plate Tectonics

- Seafloor Spreading provided insight to the mechanism for how the continents moved.
- The magma which pushes up at the mid-ocean ridge provides the new land pushing the plates, and the subduction zones (We'll cover later) gobble up the land on the the other side of the plates.



Picture from
<http://library.thinkquest.org/17457/platetectonics/2.php>

The mechanism
was convection
currents!



Plate Tectonic Theory

- Both Hess's discovery and Wegner's continental drift theory combined into what scientists now call the Plate Tectonic Theory.
- Theory of **plate tectonics**:
 - The Earth's crust and part of the upper mantle are broken into sections, called plates which move on a plastic-like layer of the mantle

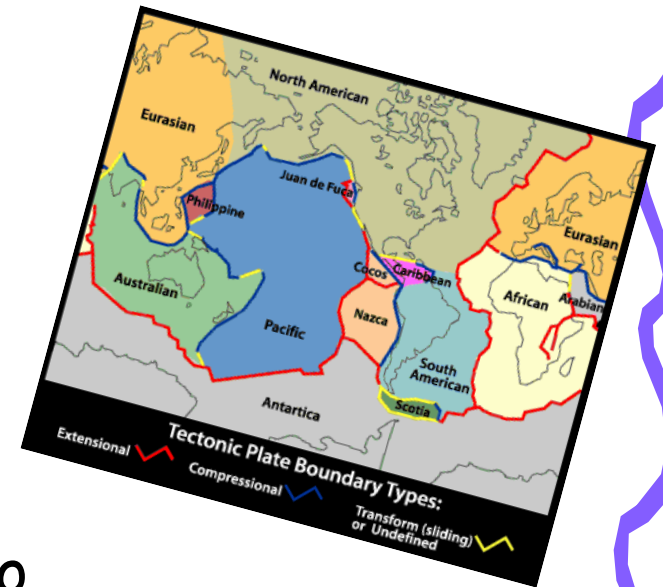
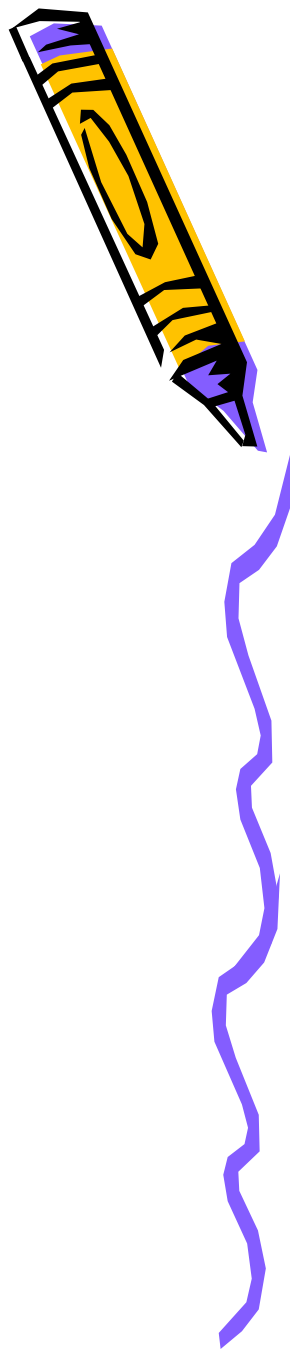


Plate Tectonic Theory

- Plate Tectonics explains
 - Earthquakes
 - Mountains
 - Volcanoes



Where are these plates?

- We can use patterns to find where plates are
 - Earthquakes
 - Volcanoes
 - Geologic features (like mountains)

Rock age and paleomagnetism

