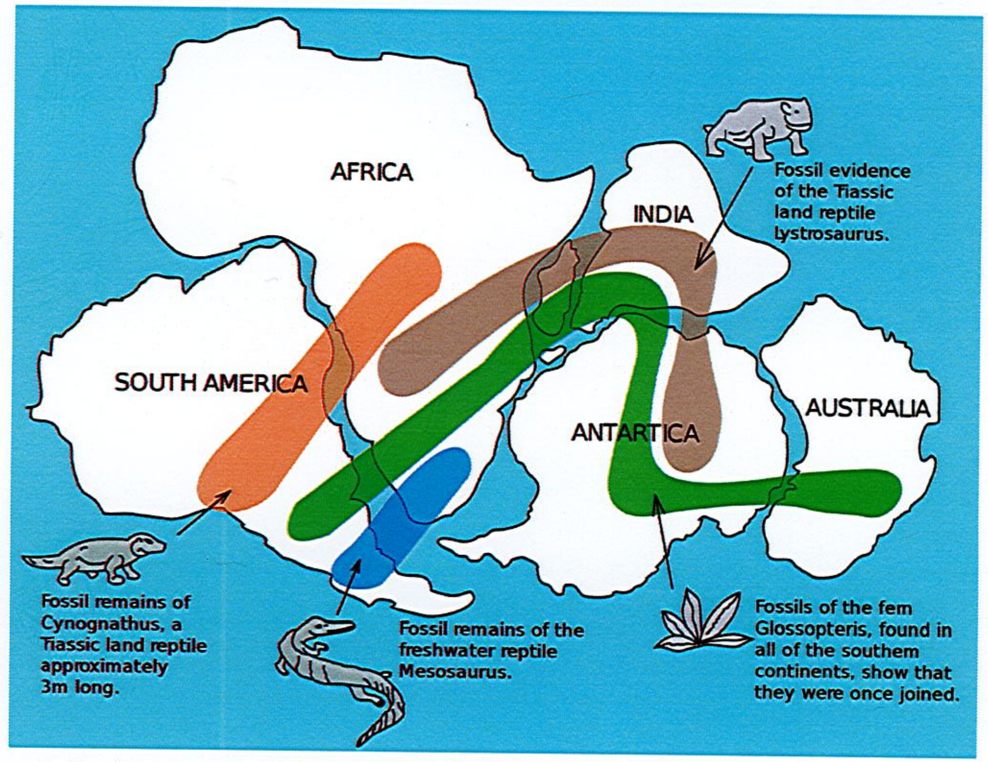
ANIMAL FOSSILS

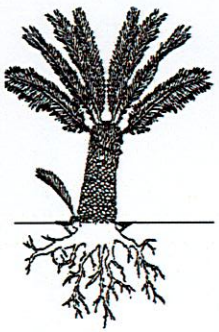
Alfred Wegener found evidence for continental drift from ancient **fossils**. He found fossils of the same species of extinct animals in rocks of the same age, but on continents that are now widely separated. Two possibilities can explain this: 1) animals evolved separately in separate locations during identical time and resulted in the same species, or that 2) the continents could not have been in their current positions because the organisms would not have been able to travel across the oceans.



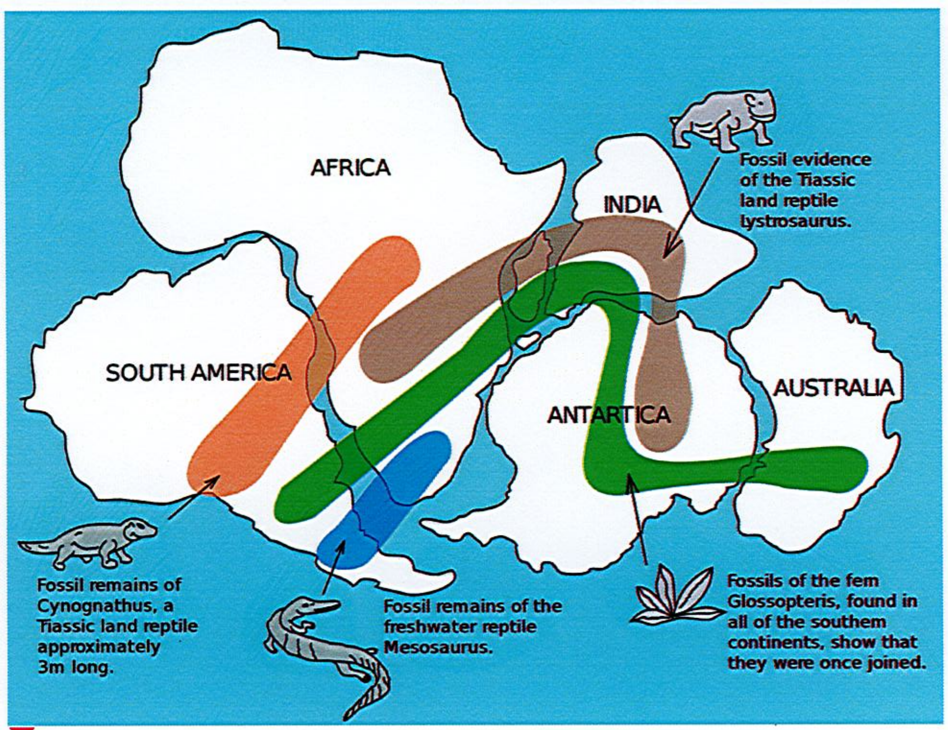
For example, Mesosaurus fossils are found in South America and South Africa, but the reptile could only swim in fresh water. Mesosaurus therefore could not have swam across the ocean, instead the continents of South America and South Africa must have been conjoined.

Another example, are the fossils of Cynognathus and Lystrosaurus. Cynognathus and Lystrosaurus were reptiles that lived on land. Both of these animals were unable to swim, let alone swim across wide seas! Their fossils have been found across South America, Africa, India and Antarctica. Wegener proposed that the organisms had lived side by side, but that the lands had moved apart after they were dead and fossilized.

PLANT FOSSILS

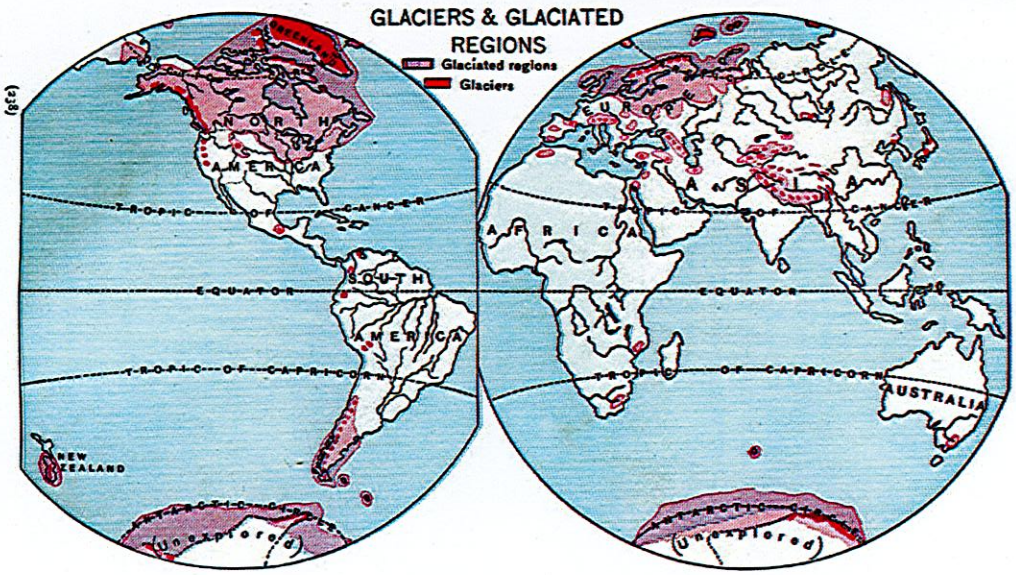


The widespread distribution of certain plant groups correlates rather nicely with theory of continental drift. For example, there are **cycads**, a plant similar to a palm tree, are widely distributed throughout tropical and temperate continents of the world. Prior to the theory of continental drift, the widely scattered distribution of present-day cycads in Australia, South Africa, Malaysia and the Americas was an enigma. The large, rounded seeds are typically dispersed short distances by gravity and their ability to roll downhill. This movement is undoubtedly enhanced by animals feeding on the disintegrating seed cones, particularly species with large, colorful seeds.



Another plant offers further evidence for continental drift. **Glossopteris** was a woody, seed-bearing shrub or tree, named after the Greek description of 'tongue' - a description of the shape of the leaves. Some reached 30m tall. It evolved during the Early Permian (299 million years ago) and went on to become the dominant species throughout the period, not becoming extinct until the end of the Permian. Fossils of glossopteris are found in Australia, South Africa, South America, India and Antarctica.

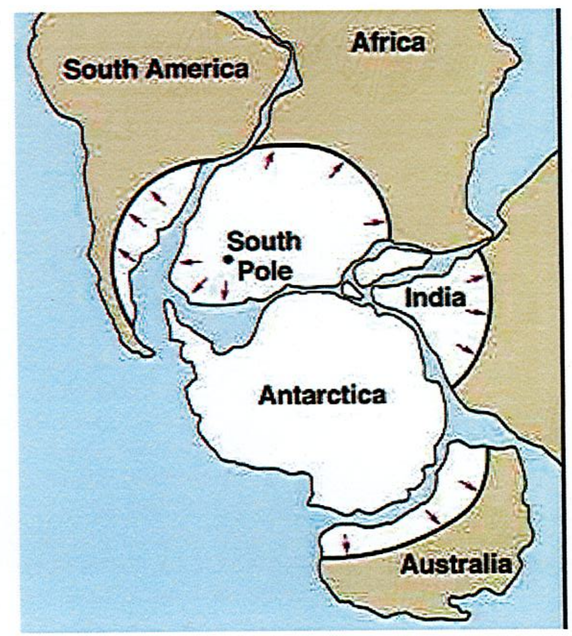
GLACIAL EVIDENCE



Today, **glaciers** cover a small fraction of landmass of those continents located closest to the Northern and Southern poles. Antarctica located on the Southern pole is entirely covered by glaciers. While North America, Greenland and Eurasia are only partially covered. Counties of Greenland, Canada and Russia have glaciers on their northernmost extends. The third place where glaciers can exist is at the top of mountain ranges where the temperatures are typically lower.

However, if we dig into the past things were quite a bit different. Continents of South America, Africa, India, and Australia all show evidence of past glaciation. This evidence comes in the form of **glacial striations**, which are scratches on rock left when large boulders are dragged beneath glaciers. As they drag along they scratch the underlying surface creating grooves parallel to the direction of travel of the glacier. H

Using the directions of glacial striations scientists showed that although glacial striations in South America, South Africa, India, and Australia do indeed indicate that all experienced glaciation at about the same time, in their current positions the striation point to continental glaciers originating in different locations. However, by aligning the continents the striations point to one continental glacier originating at the South Pole. So this is how these four currently warm continents, were able to be cold enough to form glaciers.

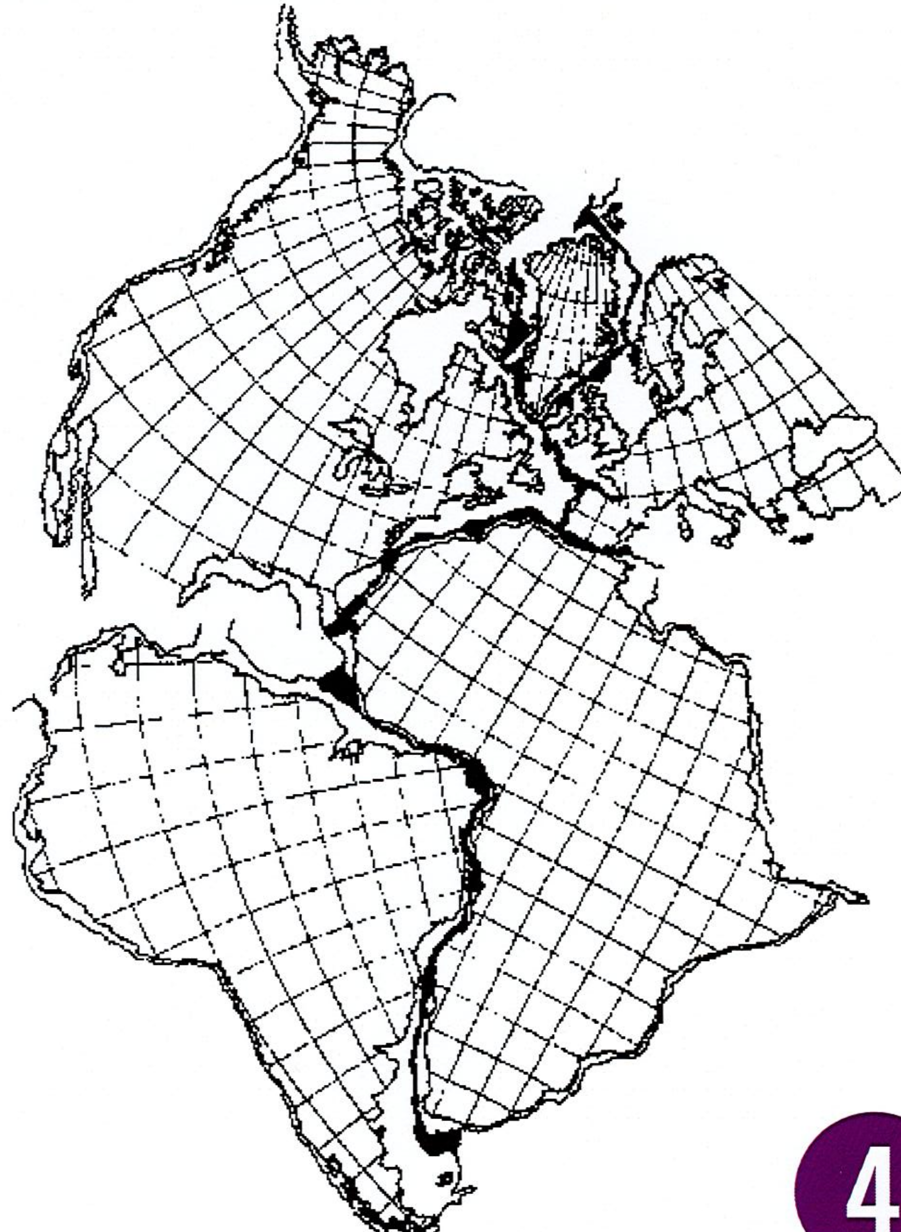


FIT OF CONTINENTS

Looking at a map of the world have you ever noticed that Africa and South America look like they could fit along their edges like pieces of a jig-saw puzzle? Well, you would not be the first person to make this observation. Alfred Wegener noticed this in 1960s. The chances of two continents fitting together so well randomly are very low. The explanation other than then is that South America and Africa were once part of a larger prehistoric continent that split apart into two.

This fit of Africa and South America becomes even better if we define the edges of continents by their **continental shelves**. The continental shelf is defined as the area of seabed around a large landmass where the sea is relatively shallow compared with the open ocean. The continental shelf is geologically part of the continental crust.

The only question that remains to be answered is how two giant continents were able to move so far as to form the Atlantic Ocean between them.

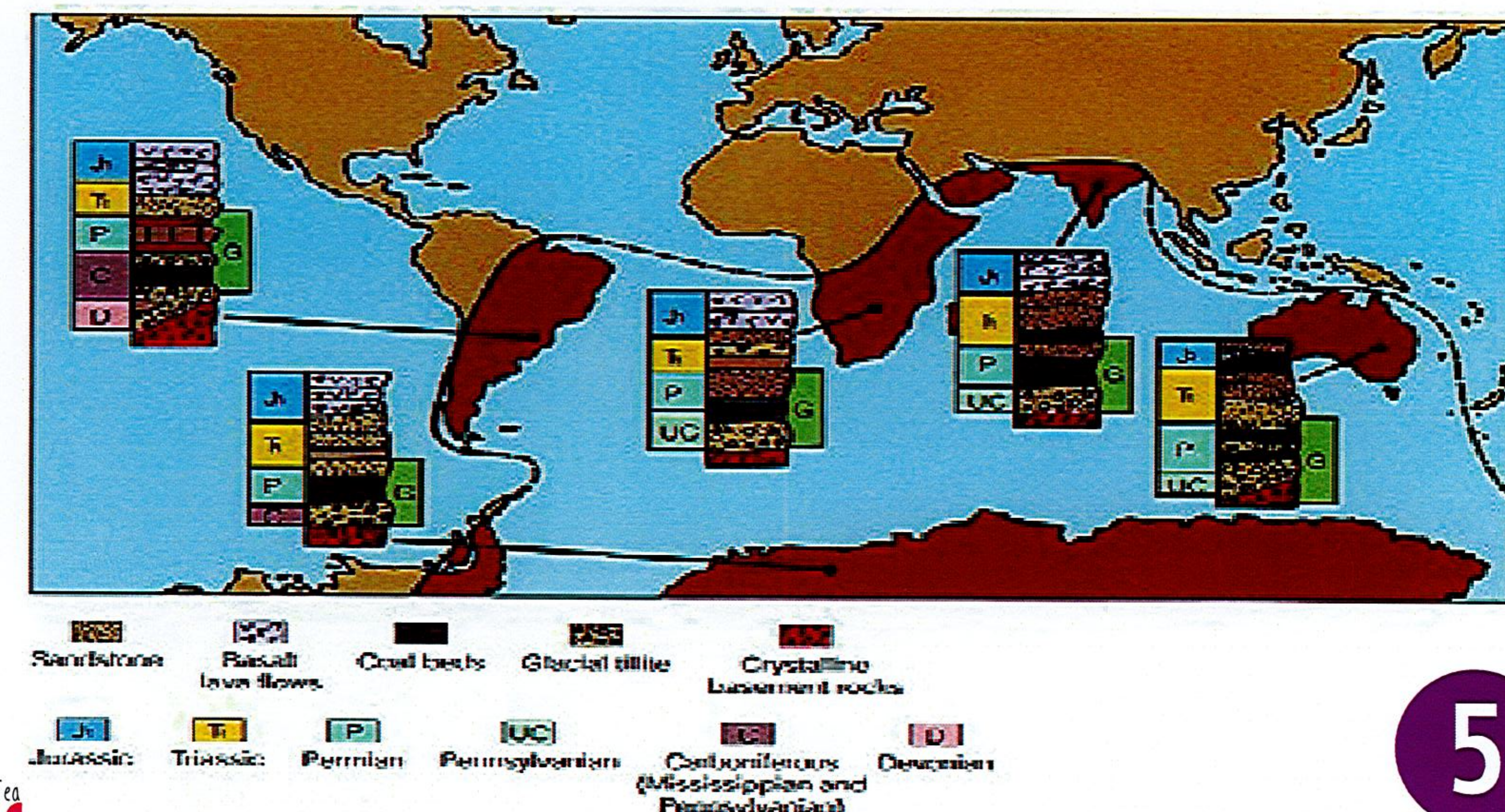


ROCK SEQUENCES

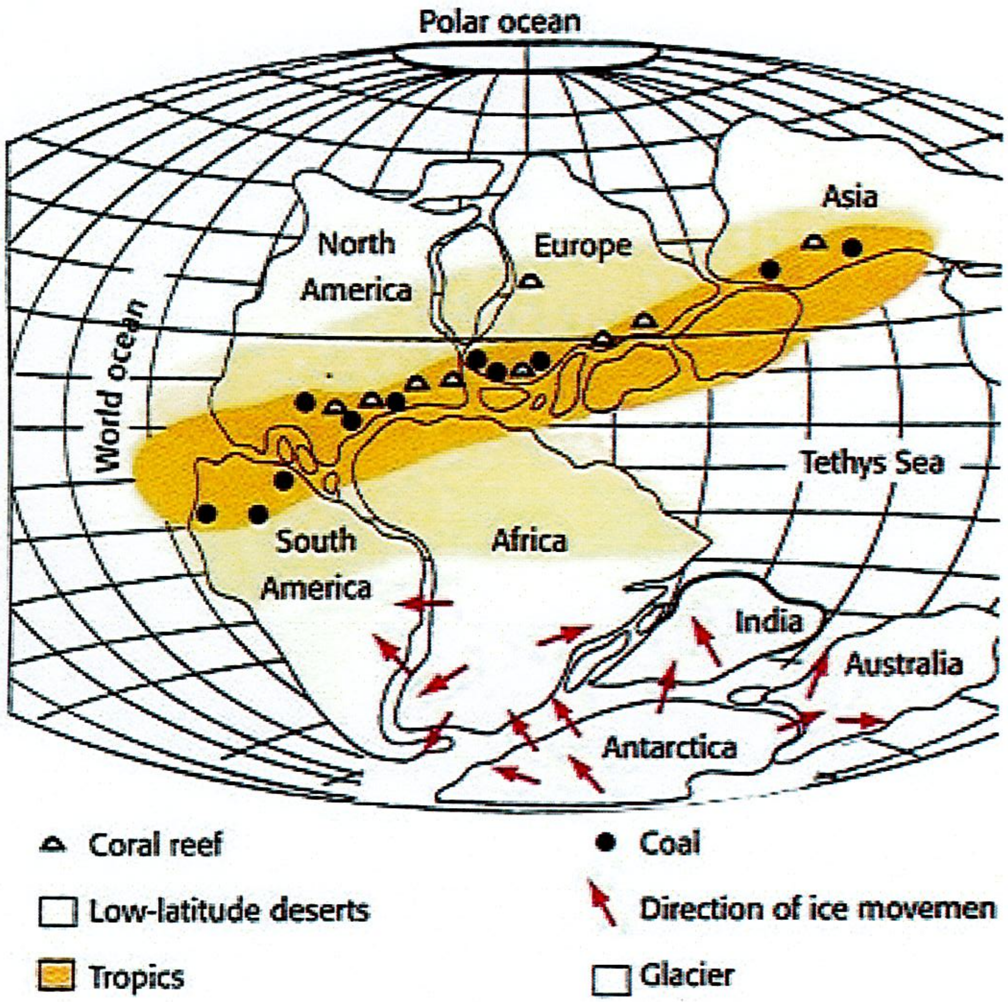
Rock sequence (noun) is a set of rocks contained in a series of layers, used to interpret the last conditions over a period of time.

Rock sequences in South America, Africa, India, Antarctica, and Australia show outstanding similarities and also similar ages. Alfred Wegener showed that the same three layers occur at each of these localities. This is very unlikely to happen by chance, since unique conditions in the surrounding environment and events dictate what type of rocks are produced.

Each rock sequence has three layers. The bottom (oldest) layer is called **tillite** and is thought to be dirt produced from a glacier. The middle layer is composed of sandstone, shale, and coal beds. Glossopteris fossils are in the bottom and middle layers. The top (youngest) layer is lava flows. The same three layers are in the same order in areas now separated by great distances. So the same events and conditions occurred in 5 distant continents or that the rock layers were made when all the continents were part of Pangaea. Thus, theory is that they formed in a smaller contiguous area that was later broken and drifted apart.



CLIMATE CHANGES IN ANTARCTICA



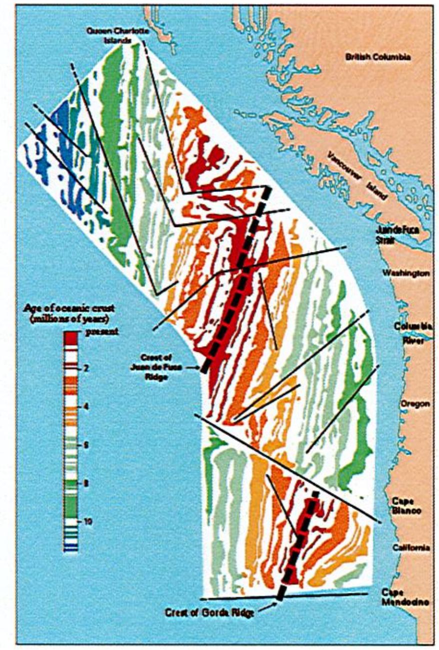
Alfred Wegener collected data on climate of different continents in the past. One indicator of past climate is the finding of a rock called **coal**. Coal is a variety of solid, flammable, sedimentary, organic rocks, formed from vegetation that has been squished by pressure and heat over millions of years. Coal is formed in warm moist tropical climates around the equator; since these are the places were plant life flourishes.

Wegener found coal deposits were in Antarctica, which currently has climate unsuitable for coal formation. So that means that the continent of Antarctica must have once had warm moist tropical climate. Such climate conditions could only exist if the continent was located near or on the equator.

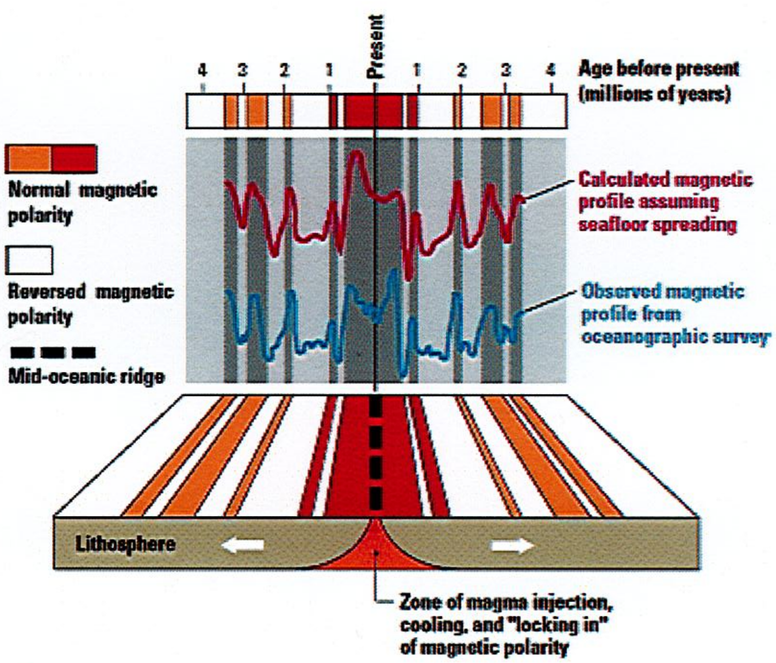
In addition, the same type of coal is found in Asia, Europe, North America, and South America. This indicates that these continents were once part of a supercontinent which once had climates conducive to coal formation

PALEOMAGNETISM

Paleomagnetism is the study of the record of the Earth's magnetic field in rocks, sediment, or archeological materials.



In the mid-1950s, a research ship tugging a magnetometer performed a detailed study of the magnetic strength of the Pacific sea floor. What they found seemed puzzling. When the results were finally plotted a bizarre striped patterned emerged of alternating stripes of direction of magnetism. The pattern didn't seem to make sense. How could rock distributed over such relatively short distances record such drastically different magnetic record? More puzzling was that this pattern was found in many places that were surveyed. This was not an anomaly.



The rocks making up the seafloor, known as basalt, are iron-rich and contain a strongly magnetic mineral (magnetite) and can locally distort compass readings. Some of the stripes of rock have **normal polarity**, characterized by the magnetic minerals in the rock having the same polarity as that of the Earth's present magnetic field. These stripes would make the north end of the rock's "compass needle" pointing toward magnetic north. . However some of the rock stripes display **reversed polarity**, indicated by a polarity alignment opposite to that of the Earth's present magnetic field. In this case, the north end of the rock's compass needle would point south.

Most surprisingly, the alternating directions of the magnetic polarity recorded in seafloor rocks suggest that Earth's magnetic fields have wondered in the past and even flipped!