

Plate Tectonics:

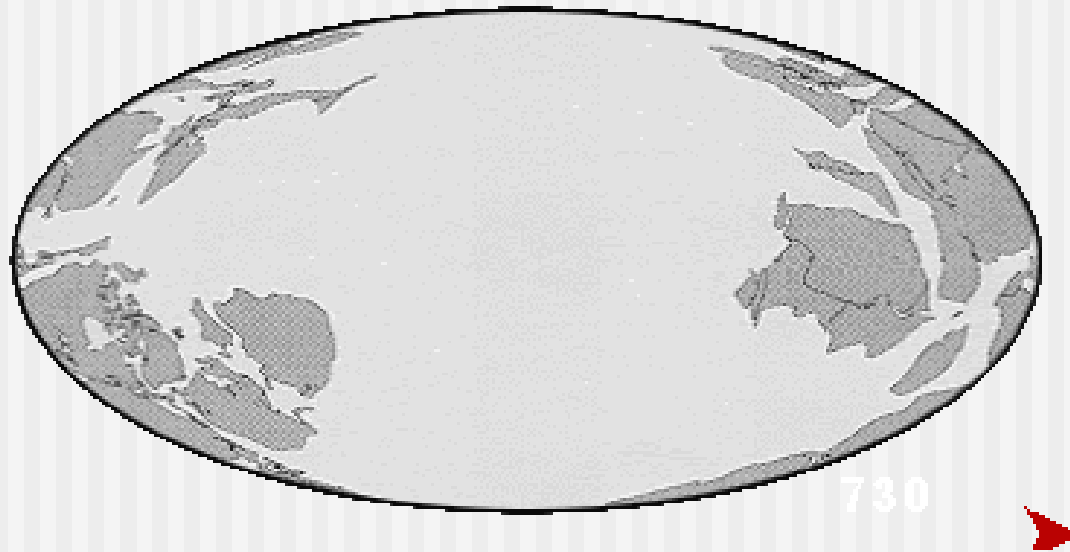
Continental Drift



<https://www.youtube.com/watch?v=uMuJxd2Gpx0>

Plate tectonics is a unifying theory that attempts to explain natural phenomena such as earthquakes and volcanoes.

Continental Drift



Continental Drift

- Alfred Wegener - 1912
 - large “supercontinent” (Pangaea) existed and then split into pieces
 - fossil & glacial deposit evidence



Wegener not able to provide
MECHANISM for his theory

Major mechanism later found in the
OCEANS: _____

Evidence for Continental Drift

- **THE JIGSAW FIT OF THE CONTINENTS** - there is a noticeable jigsaw fit between many of our continents - for example, between the East Coast of South America and the West Coast of Africa, which suggests that at some point in time the continents were once assembled together.

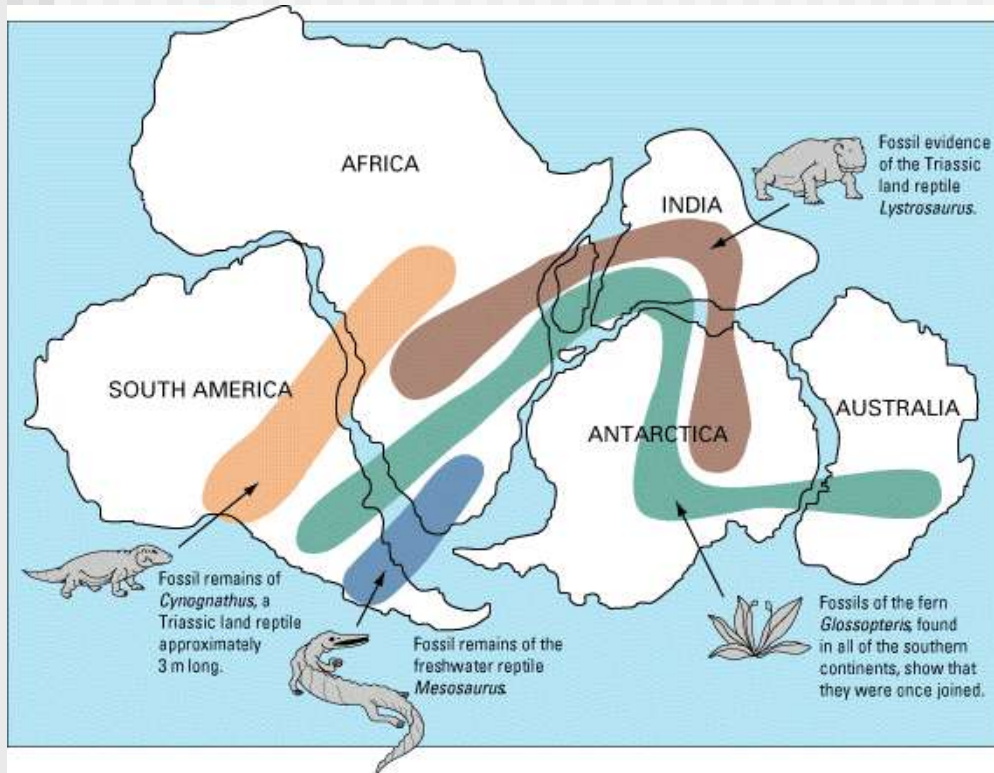
Evidence for Continental Drift



Evidence for Continental Drift

- **PLANT / ANIMAL FOSSILS** - A number of identical fossils have been found distributed across the southern continents, again suggesting that they were once joined. Fossils of the **Mesosaurus** dating back 280 million years ago have been found in South America and Africa (and nowhere else) - it is known from the fossil that this animal could not swim. Plant Fossils, such as **Glossopteris** (a tree) have been found in South America, Africa, India and Australia.

Evidence for Continental Drift



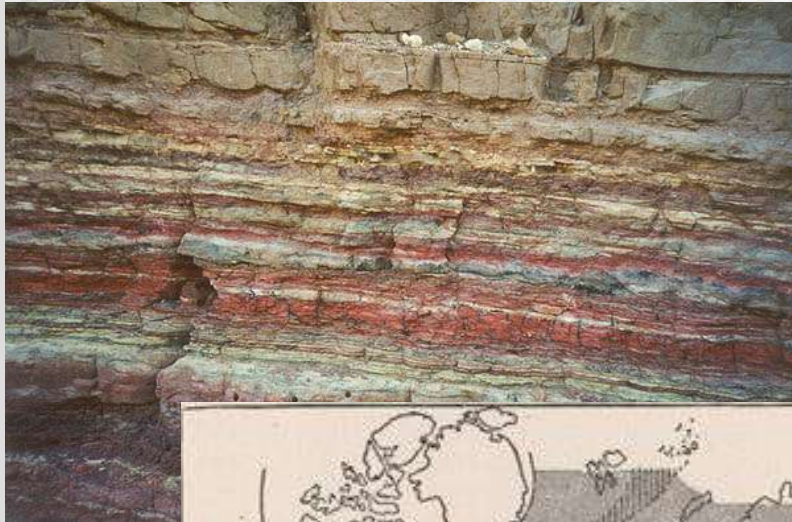
- Lystrosaurus: mammal like reptile, herbivore, about the size of a small dog.
- Mesosaurus: freshwater reptile, carnivore.
- Glossopteris: extinct seed fern was about 12 ft (3.6 m) tall.
- Cynognathus: metre-long predator of the Lower Triassic. It was one of the more mammal-like of the "mammal-like reptiles",



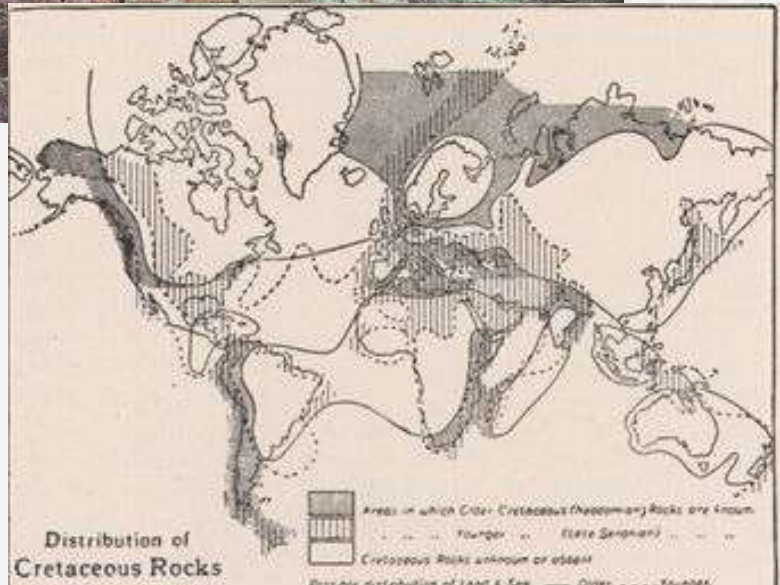
Evidence for Continental Drift

- **GEOLOGICAL SEQUENCES** - A number of continents show evidence of matching geological sequences with rocks of similar age, type, formation and structure occurring in different countries - e.g. the Appalachians (E. USA) show a geological match with mountains in NW Europe and if they were fitted together would form a single continuous mountain belt.

Evidence for Continental Drift



- Similar rock strata and fossils on either side of the Atlantic Ocean.



Folded mountains which, according to Wegener, resulted from the collisions of continents with one another.

Evidence for Continental Drift

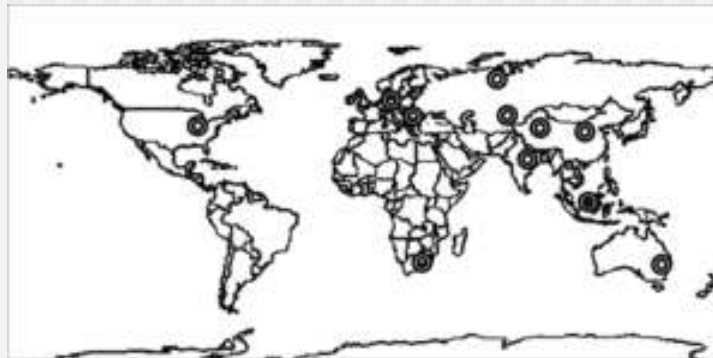
- **CLIMATOLOGICAL ANOMALIES** - A number of climatic anomalies have been discovered which suggest that continents must once have been in a different position and therefore have experienced a different climate. Coal which only forms under wet / warm conditions have been found beneath the Antarctica ice cap and there is evidence of glaciation in Brazil (which now has a equatorial climate)

Evidence for Continental Drift

- Wegener was aware that a continental ice sheet covered parts of South America, southern Africa, India, and southern Australia about 300 million years ago.



Distribution of Carboniferous and Permian glacial deposits in S. South America, India, S. Australia and Antarctica (Gondwanaland)



Vast coal deposits in North America which show evidence of a tropical climate

Wegener's proposed mechanism for continental drift

- Wegener was well aware of how difficult it was to propose a mechanism for continental drift

He hypothesized that two types of forces were involved

A. Pole-fleeting force

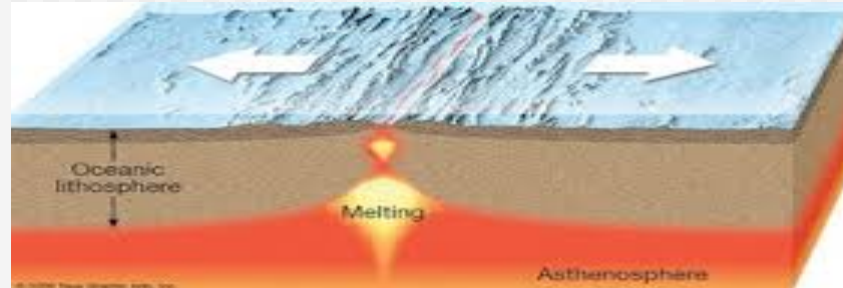
1. Rotation of earth on its axis creates a centrifugal force
2. This force deflects somewhat the pull of gravity toward the equator
3. Wegener suggested that this force was responsible for moving Gondwanaland to the north

B. Tidal attraction of the sun and moon to move North and South America toward the west

None of his explanations were excepted and science ignored his theory until the mid 1960's.

Supporting evidence for Plate Tectonics Theory:

- **1. Discovery of the Mid-Atlantic Ridge (Ewing)** - Ocean floor mapping led to the discovery of a global mid-oceanic ridge mountain chain zig-zagging around the continents.
- **2. Magnetic Variations on the Ocean Floor (Palaeomagnetism)** - during cooling, minerals in the Basaltic rock, align themselves along the Earth's magnetic field - forming a permanent record of magnetic field in the rocks. Periodic variations in the earth's magnetic field, have produced almost symmetrical magnetic patterns in the rocks either side of the Mid-Atlantic ridge (alternating stripes of magnetically different rocks).
- **3. Theory of Sea-Floor Spreading (Hess)** - development of new oceanic crust.



The rebirth of continental drift after World War II

After World War II, there was a sustained effort by the U.S. to chart the ocean floor

- A. This exploration, combined with several other discoveries, led to a rebirth of the continental drift model
- B. By the late 1960s, virtually all geologists accepted continental drift. This was a major paradigm shift--The textbooks had to be rewritten
- C. What evidence led to this thought revolution?

Seafloor spreading

- Since World War II research vessels with sonic depth recorders have crisscrossed the oceans, resulting in the construction of detailed maps of the ocean surface
- Mid-ocean ridges were found to be dominant features of the ocean floors

Examples

1. Mid-Atlantic Ridge
2. East Pacific Rise



Paleomagnetism and polar wandering

- The earth is structured as if a giant bar magnet is oriented north-south within the earth
- The orientation today is not exactly north-south, but is off by 11 degrees
- Compass needles line up with magnetic field
- We don't completely understand why the earth acts as a magnet, though it is probably related to its liquid metal outer core
- Perhaps this metal core acts as a generator, or dynamo, which generates its own electric field--a field that changes over time.

The rules of Plate Tectonics

- 1. Continental crust is less dense, or lighter, than Oceanic crust so it doesn't sink. It is never destroyed and is considered permanent.
- 2. Oceanic crust is heavier so it can sink below Continental crust. It is constantly being formed and destroyed at ocean ridges and trenches.
- 3. Continental crust can carry on beyond the edges of the land and finally end far below the sea. This explains why the edges of all the continents don't have deep trenches right up against their coastlines.

The rules of Plate Tectonics

- 4. Plates can never overlap. This means that they must either collide and both be pushed up to form mountains, or one of the plates must be pushed down into the mantle and be destroyed.
- 5. There can never be gaps between plates, so if two plates move apart, as in the middle of the Atlantic, new rock will be formed to fill the space.
- 6. We know the Earth isn't getting bigger or smaller, so the amount of new crust being formed must be the same as the amount being destroyed.

The rules of Plate Tectonics

- 7. Plate movement is very slow. This is partly why Wegener's original ideas were ignored. Nobody could 'see' the continents moving. When the plates make a sudden movement we call it an Earthquake, and it's the only time we are directly aware of the plates moving.