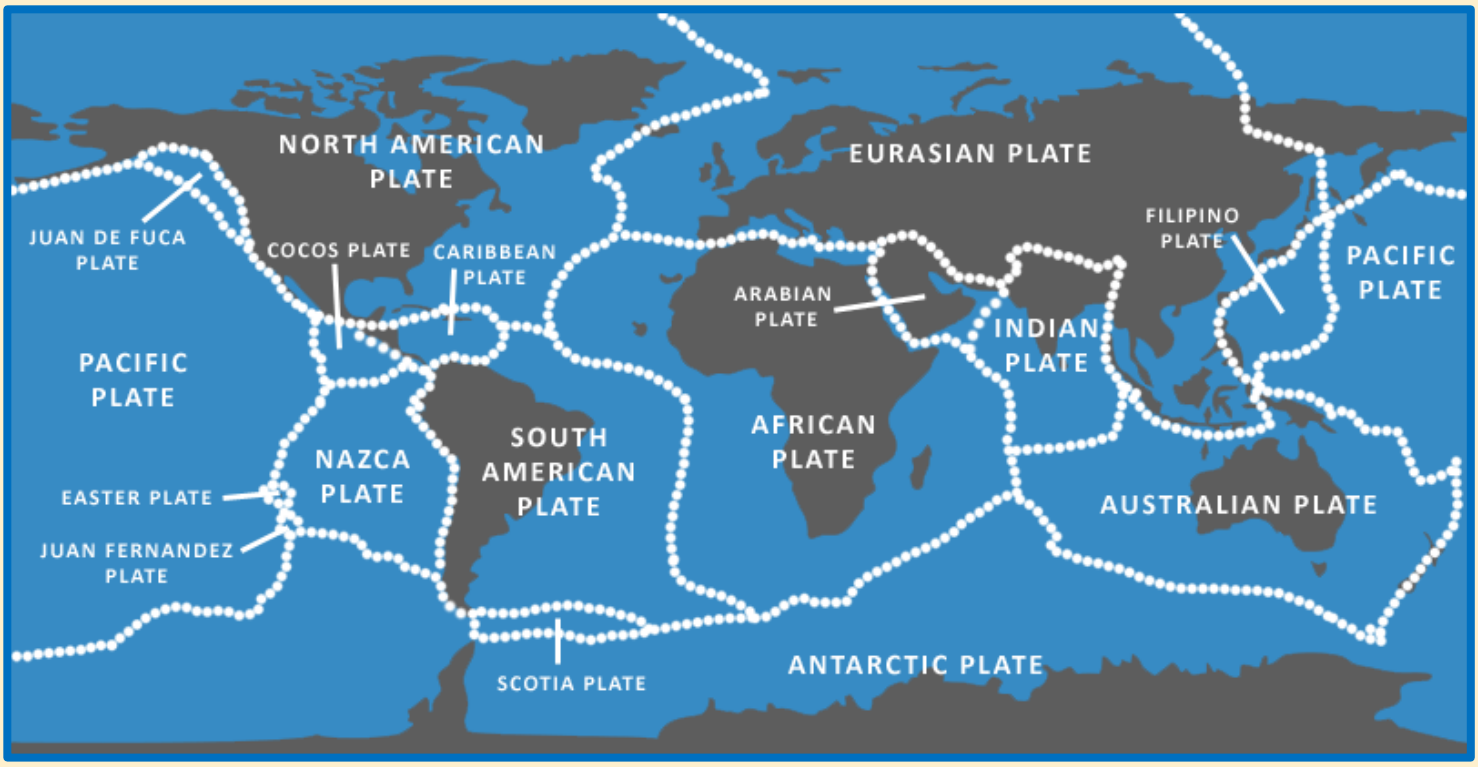
Plate Tectonics

EVIDENCE OF CONTINENTAL DRIFT

Adam Suttle | Geology: Unit 1 Module 3 | 27.03.17



Key definitions (pages 24 to 25)

Plate tectonics: A theory explaining the structure of the earth's crust from the interaction of the rigid lithospheric plates that move slowly over the underlying upper mantle/asthenosphere.

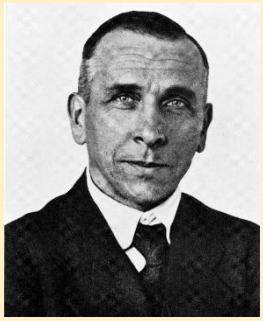
Continental drift: Is the large-scale horizontal movement of continents over geological time.

Evaporates: are minerals formed by the evaporation of saline water, for example, halite (rock salt) and gypsum.

An apparent polar wandering curve: is depicted by a line on a map that joins up the apparent positions of the magnetic north pole over time.

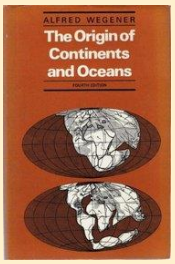
Background context

By viewing a map it is clear to see South America and Africa have coastlines that would fit together. For 300 years, since reasonably accurate maps became available, scientist have suggested these two continents could have once been joined.

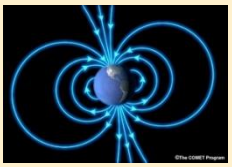


Alfred Wegener, in his book **The Origin of Continents and Oceans**, set out evidence for continental drift. Alfred Wegener claimed that: the **continents fitted together**, and mapped the **distribution of rocks and ancient glaciation.**

<u>However, Alfred Wegener's theory of continental drift was not widely accepted until 50 years after his death because at the time:</u>



1. He had insufficient evidence
2. Scientists believed in simpler theories (such as a land mass that sunk leaving behind a bridge between continents)
3. He himself was not a geologist (he studied astronomy/meteorology)
4. Most Earth scientists **could see no mechanism by which continents** could be **moved.**



It was only since the 1950s with evidence from **paleomagnetism** and from the **sea floor,** that the theory of continental drift has been accepted.

TODAY'S THEORY

Roughly **250 Ma**, a colossal landmass named **Gondwanaland** is believed to have existed and has now split to from continents: **South America, Africa, Antarctica, India and Australia.**

Gondwanaland broke up ~ **167 Ma (Jurassic**), the fragments drifting apart to form the continents. The evidence for its **former existence can still be seen in the rocks of South America and Africa.**

FIT OF CONTINENTS

Using the present coastline of South America and Africa does not give an exact jigsaw fit. This is because:

1. **Sea level** is **constantly changing**, so a c**oastline** is a **temporary** feature.
2. **Deposition and erosion** has occurred since the two continents **drifted apart 167 Ma.**
3. Where there has been **erosion** of the continents, **there is a gap.**
4. Where there has been **deposition** of sediment , there is an **overlap.**

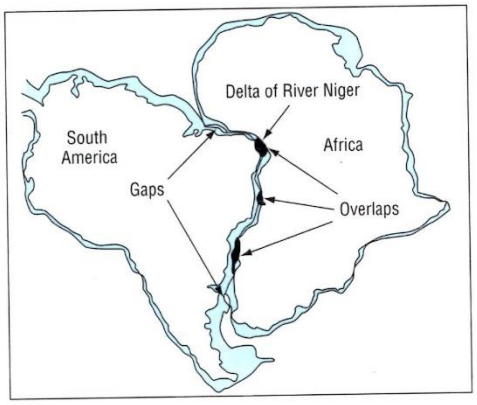


Figure 2 Gaps and overlaps

Optimal jigsaw fits can be seen at depths of 100m or 500m observing the edge of a continental shelf of a specific depth.

ROCK TYPES

In order to conclude that rocks from either side of an ocean were once part of the **same outcrop**:

- Distinctive characteristics (**mineral composition and physical features**) must be the same
- **Ages of the sample** must be determined to be the same using **radiometric dating.**

Such examples of matching rocks include, Precambrian cratons, Carboniferous coals and tillites.

A craton = a large stable block of the earth's crust forming the nucleus of a continent.

PALAEOMAGNETISM

We can **analyse iron-rich minerals** in some rocks which hold a **record of the Earth's magnetic field** at their **formation period.**

A large number of rocks are c**ollected** and **dated (radiometric dating),** the **direction** of the **palaeomagnetism is measured.**

This is then plotted as **an apparent polar wandering curve**.
This curves for **South America and Africa**; **before 160 Ma**, **one North pole** was in **two positions** at the **same time**. However, it is known that the magnetic pole cannot **significantly change position**. Instead, if we assume the **North pole remained fixed**, it must be the **continents** that have **moved** and rotated slightly.

If the two continents were r**epositioned** next to each other, the **two curves match up**, and there is **only one position for the pole**.

The curves diverge only after the continents start to **drift apart.**

Rocks preserve magnetic patterns that reflect magnetic fields that are different from today. Today's magnetic field resembles a bar magnet which is nearly but not exactly parallel to the N and S rotational pole. The constant motion of the molten core, together with earth's rotation, maintains the field.

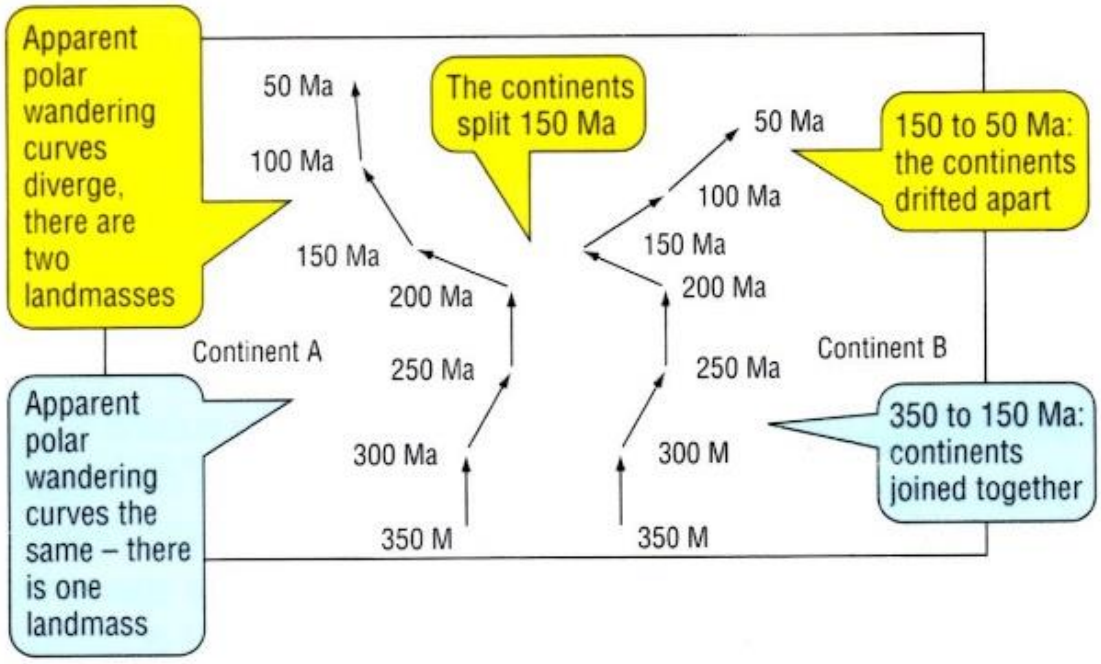


Figure 3 Polar wandering curves for two continents

GLACIATION

In both **South America** and **Africa**, **tillite deposits** or **boulder clay** can be observed.

- **Poorly sorted**
- **Angular** clasts
- Mineralogically and texturally **immature**
- **Rock flour** (< 0.0625mm) to **boulders** (>256mm)
- **Fine grained matrix**
- **Scratched clasts**
- **Low energy** with rapid deposition from ice
- **Erratics** entrained in ice and deposited (don't represent composition of local rock)

This **fossil boulder clay or tillite** was deposited by an ice sheet present during the Carboniferous (~300Ma).

Glacial striations are used to **trace the movement** of the **glaciers** to one **common source** area in **central southern Africa**.

Gondwanaland probably occupied a position **near to the south pole** during the **Carboniferous (~300 Ma), as ice sheets can't extend** to the **equator.** Africa and South America are now **much further north** nearer to the **equator**. This provides clear evidence the **continents have moved**.

FOSSILS

If the two continents, South America and Africa were once joined then there will be **similarities in the fossil records** found on the continents.

If the contents were always **separated** then **animals and plants living on the land or in the shallow seas surrounding the continents will be of different species/families** so different fossil records will be preserved. Such **organisms** would **never** be able to **spread across a wide ocean.**

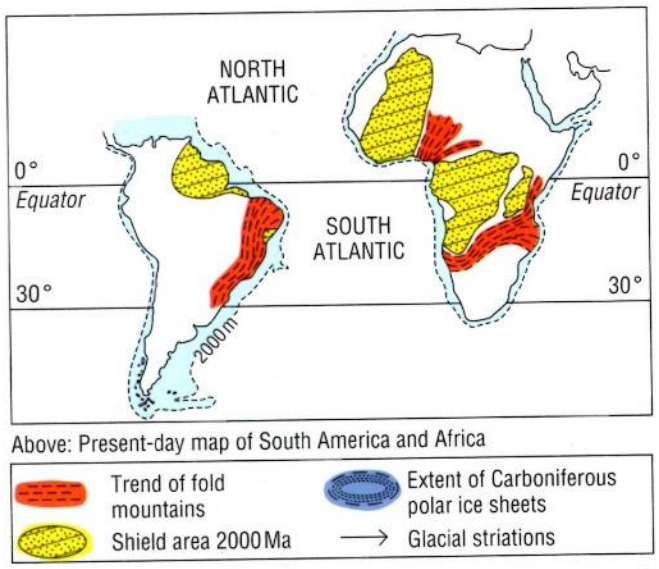
Carboniferous:

Land-based reptiles (like Mesosaurus) and plants (such as Glossopteris) are found in both Africa and South America.

MOUNTAIN CHAINS

Fold mountain chains are linear features hundreds of kilometers long. The map of **Gondwanaland** shows how one fold mountain chain **crosses from Africa to South America and back to Africa.**

The trend of the geological feature provides a way to **map across continents**.



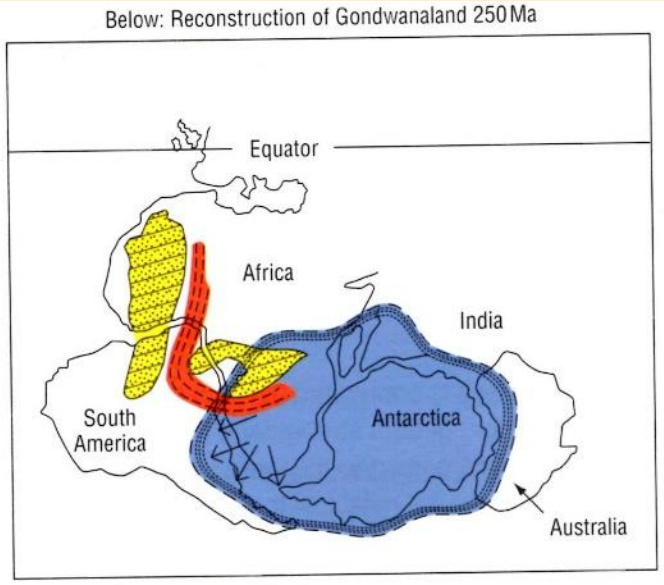


Figure 1 Map of Gondwanaland and fit of Africa with South America