



GS FOUNDATION BATCH FOR CSE 2024

Geography - 01 (Continental Drift Theory)

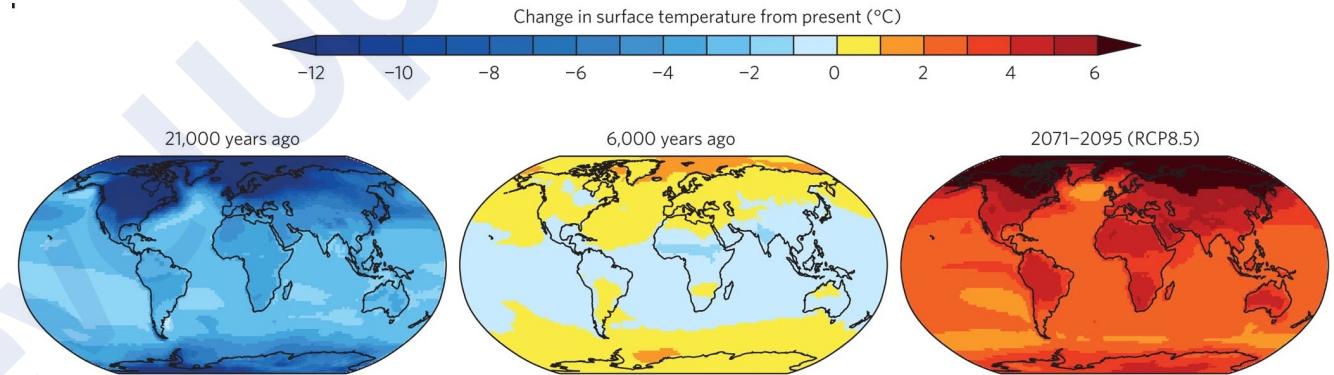
Continental Drift Theory: Background

Debate: Major Variation in Earth's Climate

- The continental drift theory was proposed by Wegener to explain major variations in the earth's climate.

The cause for such variations can be-

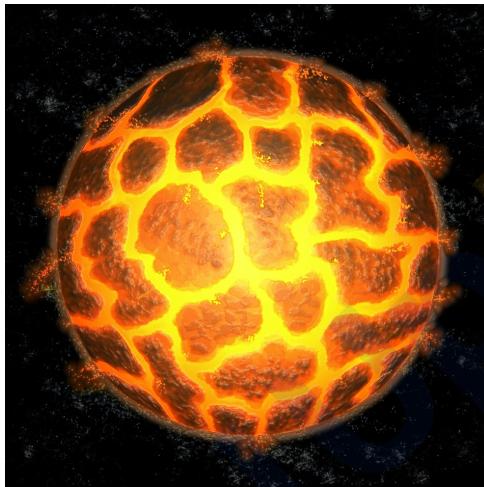
- The continents remained stationary, while the climatic zones changed.
- The climatic zones remained stationary and the continental land might have displaced.
- As Wegner did not find any evidence of changes in climatic zones, he proposed continental drift as the reason.



Continental Drift Theory: Background

Debate: Academic Debate

- Debate about the permanency of Earth's Crust
- How did the crust form?
- How did the ocean and continent differentiate?
- How did ocean and continents change in time and why?
- What was the nature of the first crust and the first ocean and the continent?
- How did the landforms in ocean and continents differ?



Continental Drift Theory: Background

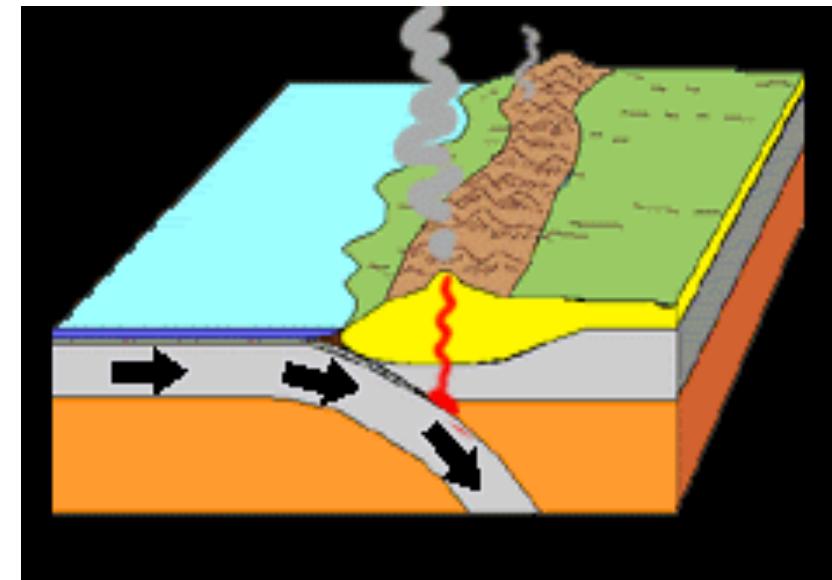
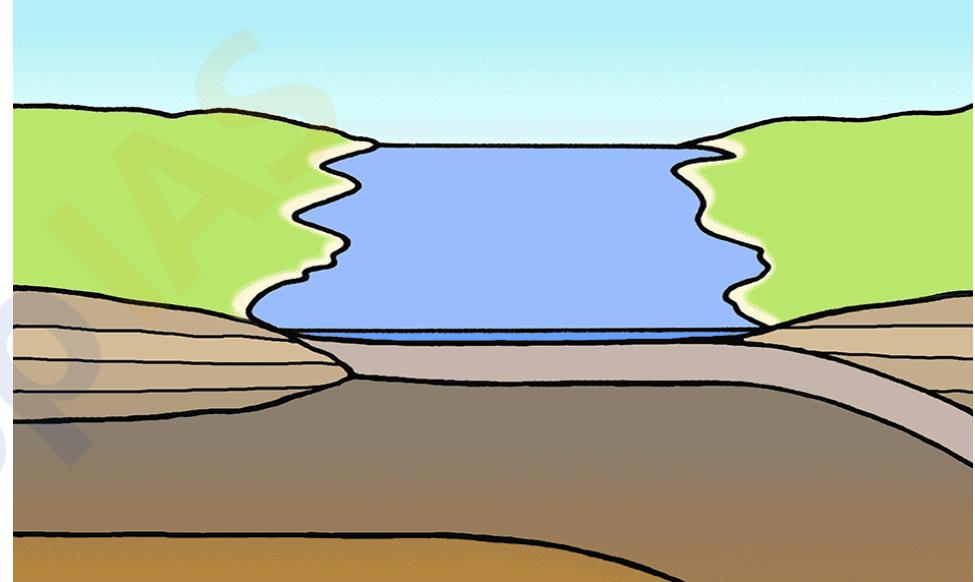
Debate: Academic Debate

- What is the mystery of the fold mountains?

Fold mountains: Composed of marine sediments and have long linear chain of mountain. Fold Mountains are unique to the earth and understanding fold mountain is like understanding the evolution of the crust.

Earlier Interpretation:

Mountains are the wrinkles on the earth's surface associated with the cooling.



Ideas prevalent at that time

Older Idea:

- Ocean and continents were like what they are today and oceans do not move and change. This is called as the permanency of the ocean and the continents.

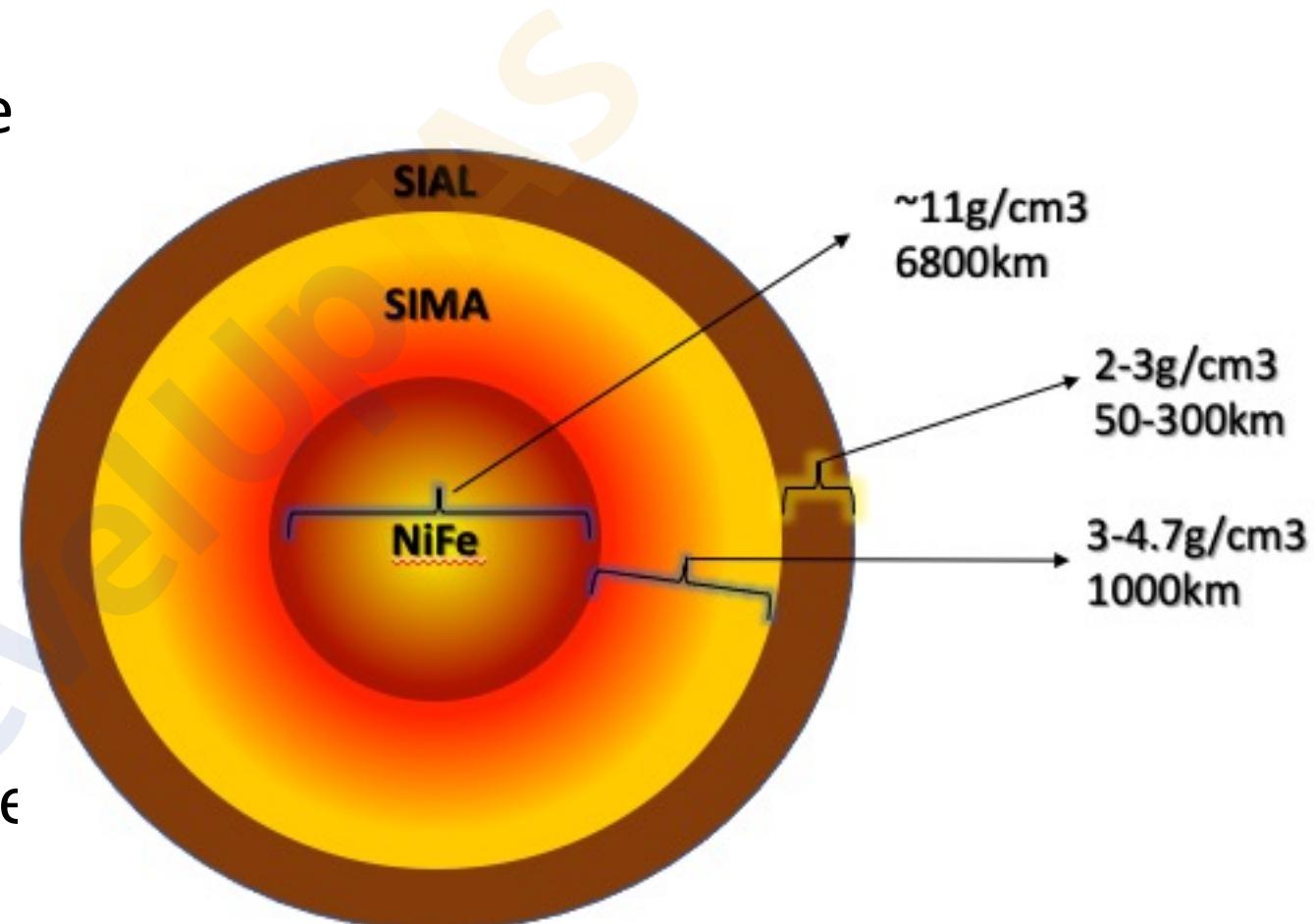
Newer Idea: Some of the observation from the voyages of 14th and 15th century mentioned that continents and oceans could have been broken and moved.

1. Matching coastline of South Atlantic
2. Eastern coastline of South America seems to be matching with the western coast of Africa
3. Coal fields of USA in Appalachian in East match with the coal fields of Western Europe (Pennines)



Assumptions:

- He proposed three layers of the earth with
 - Outer SiAl,
 - Intermediate SiMa,
 - Inner NiFe.
- SiAl was the continental mass whereas Oceanic crust was SiMa.
- SiAl masses were assumed to be floating on SiMa without any resistance.



The postulates

Super continent– Pangea,
Super ocean – Panthalassa

Fold mountains, islands
volcanos and earthquakes are
result of SIAL floating over SIMA

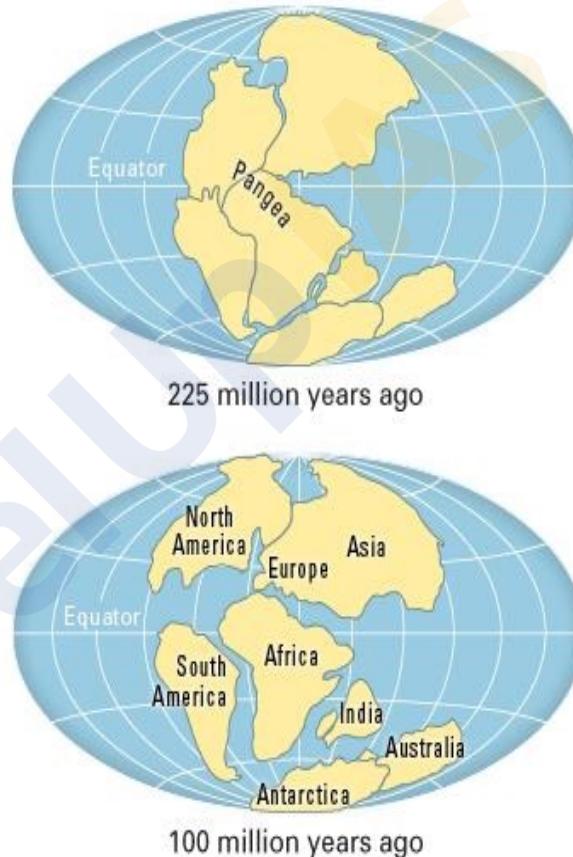
Pangea was mostly in southern
hemisphere

mid Mesozoic era → it broke and
drifted apart.

- Northern part- Angaraland/ Lauresia
- Southern part- Gondwanaland.
- In between lies – Tethys sea

Theory:

- Proposed by **Alfred Wegner** in 1912
- During the Carboniferous period (250 million years ago), there was only one supercontinent (Pangea) and a single ocean (Panthalassa)
- Pangaea consisted of all the present continents merged together.
- This Supercontinent started to split during the Mid Mesozoic period (230-180 million years ago) into Angaraland /Laurasia (North) and Gondwanaland (South). The water body separating the two was Tethys sea.
- The northern portion i.e. Angaraland consisted of North America, Greenland, and Eurasia without India and Arabia.



225 million years ago



150 million years ago



100 million years ago

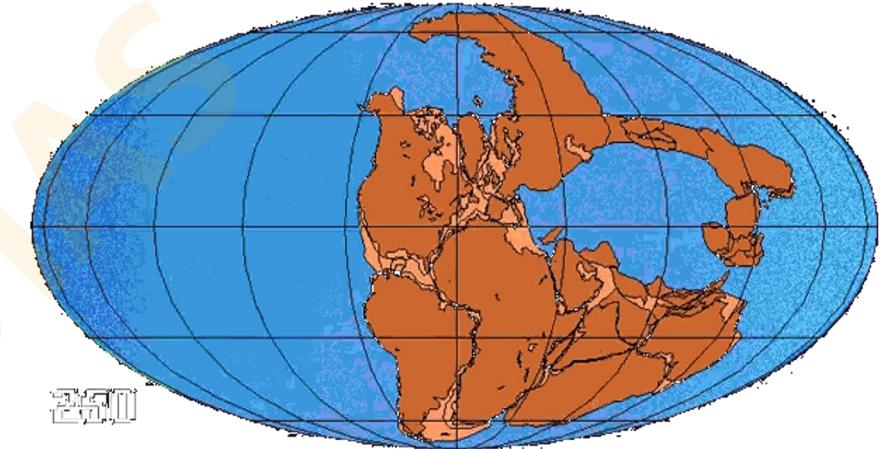


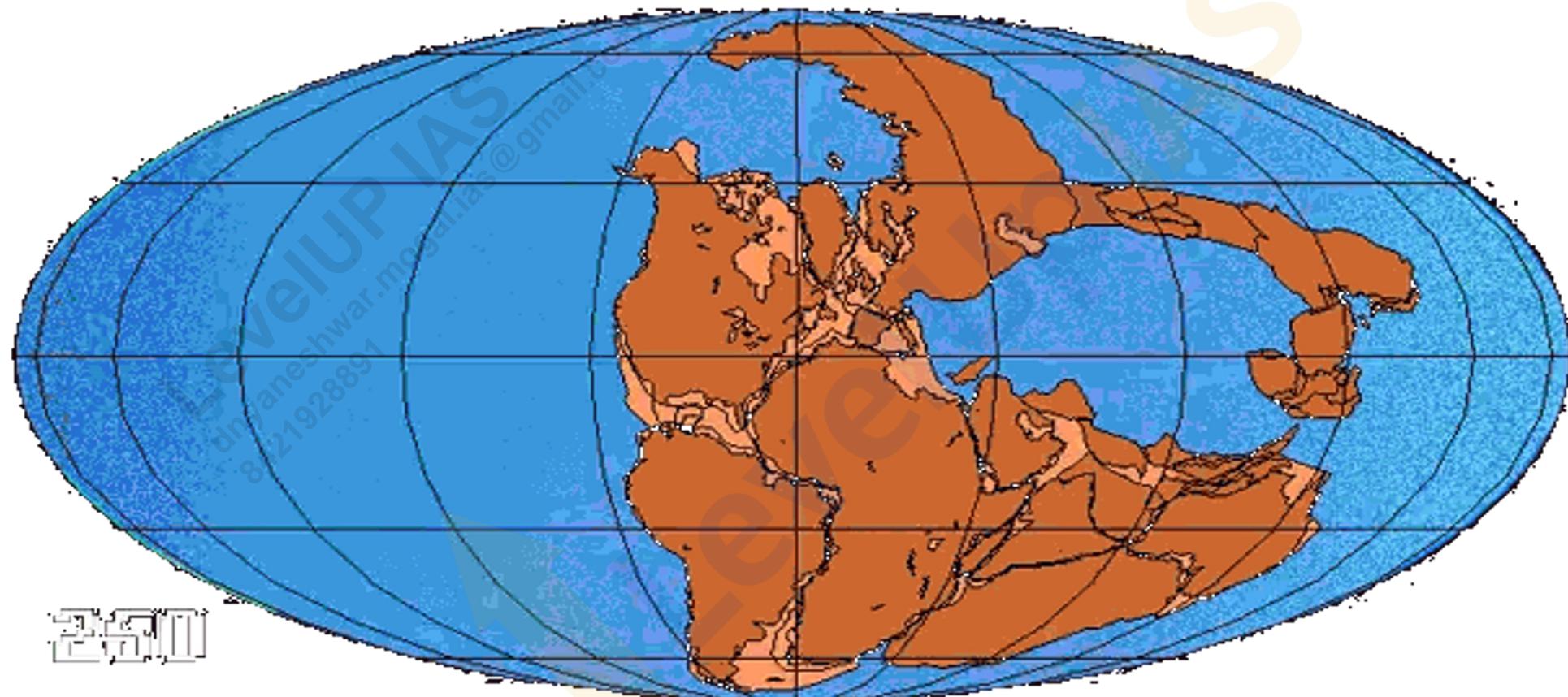
Earth today

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Theory:

- The Gondwanaland consisted of Africa with Arabia, South America, India, Australia, and Antarctica.
- Gradually, there was a separation in North America from Eurasia and South America from Africa as Laurasia started to move towards the West.
- India started moving towards the North, Australia got separated from Antarctica and moved towards North
- Around 20 MYA, Arabia got separated from Africa and merged into Asia
- As continent moved and scrapped the ocean floor, the ocean floor got broken and deformed. This lead to Earthquake, Volcano, Mountain Building.



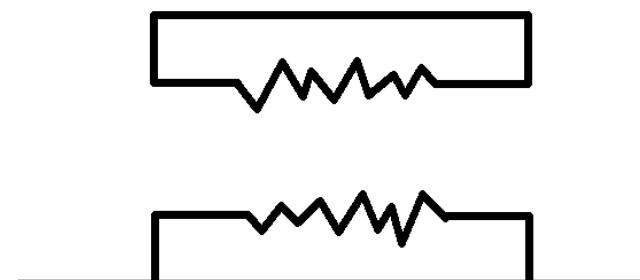
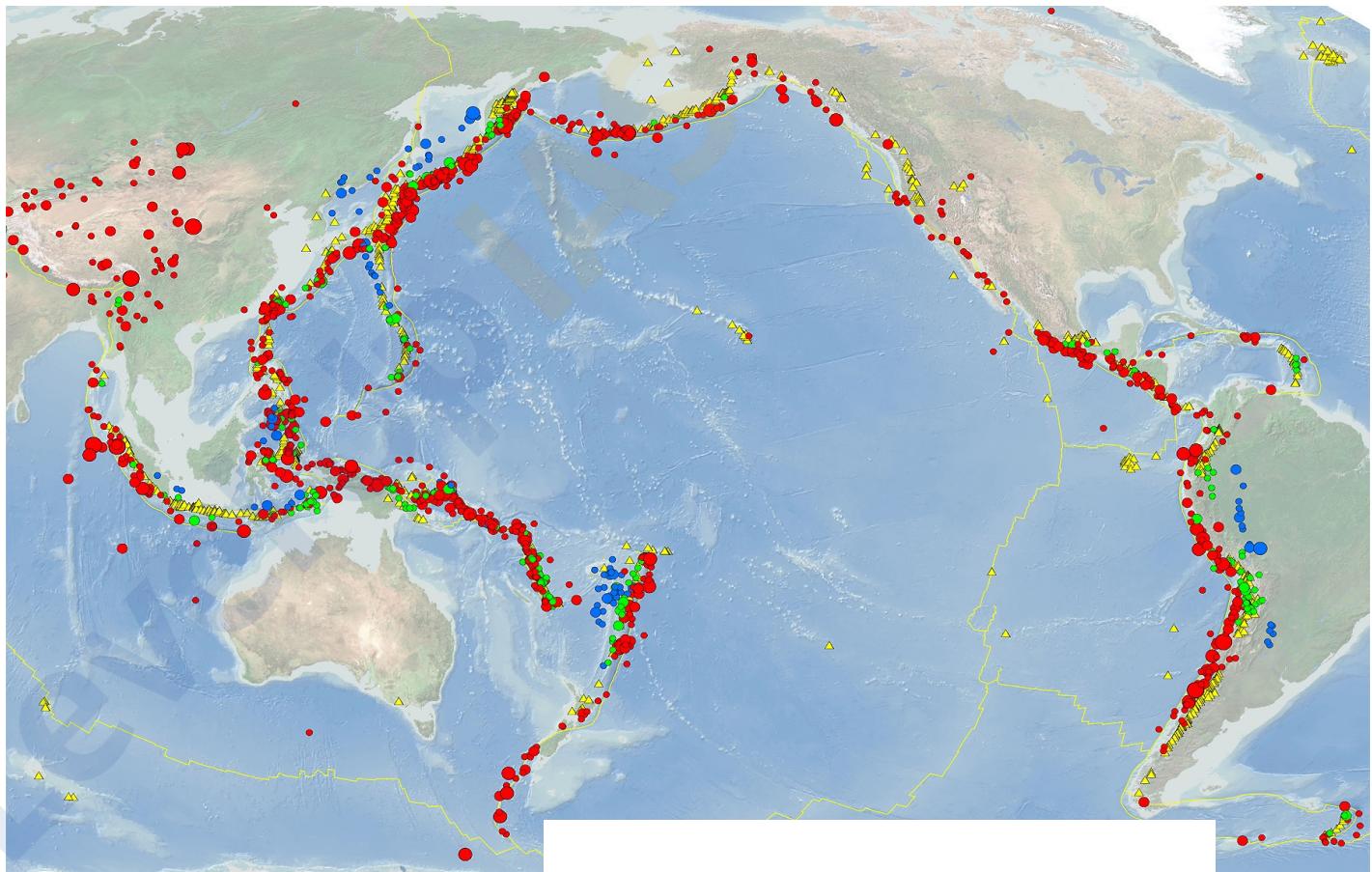


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Wegener's explanation of Volcanism and Earthquake

1. As Sial is hard, brittle and light. It floats over SiMa and can get deformed, split and can cut the ocean floor. The rupture on the ocean floor results in volcanism on the ocean floor

2. While scrapping Sial over Sima, there are disturbance leading to Earthquake



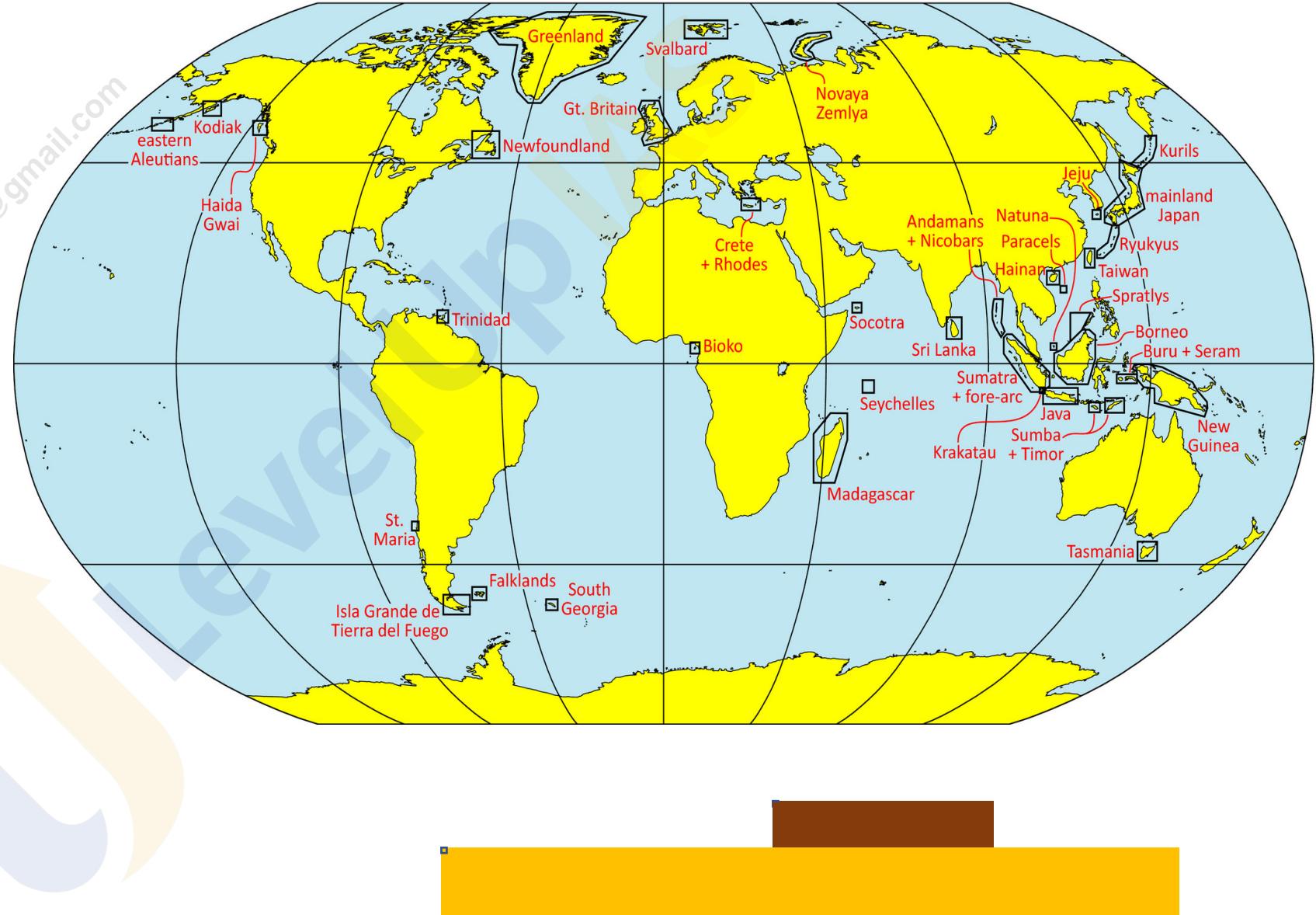
Wegener's explanation of Fold Mountains

SiAL scraps the ocean floor and accumulates the sediments on the leading edge. The sediments are marine sediments at the pile up and form the fold mountains on the edge of the continents.



Wegener's explanation of Islands

- As SiAL floats over the SiMA.
- SiAL are subjected to tremendous drag and friction the trailing edge break off to form the islands.
- Trailing Edge is unable to keep pace with the leading edge and hence breaks off.
- Wegner used this to justify the continents moving north and westward with an evidence at all the major continents having islands are at the South East corner.



Evidences

Jigsaw fit

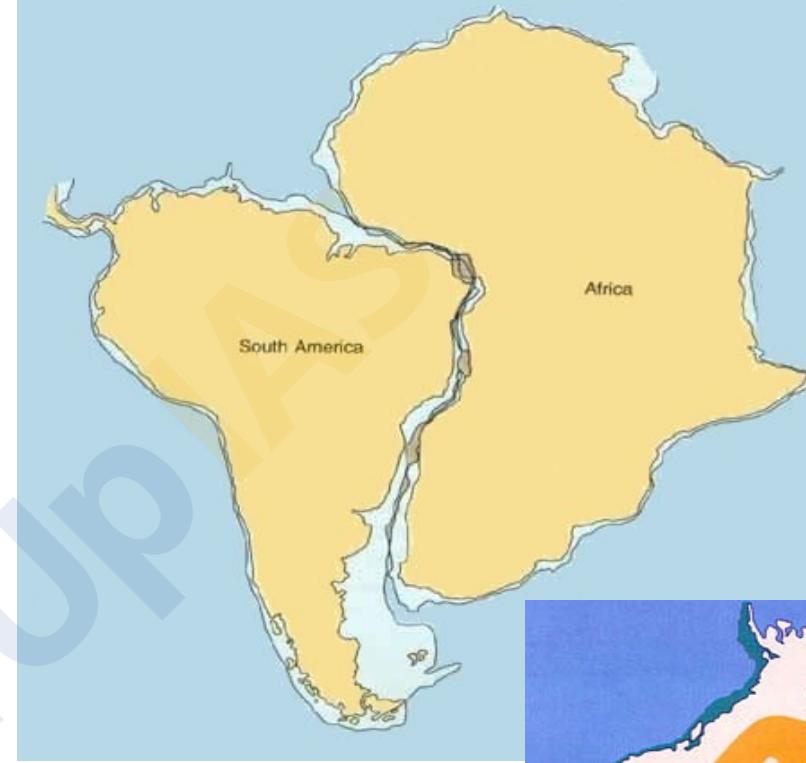
Structural fit/rock similarity

Fossil evidence

Paleo climatic evidence.

Evidence:

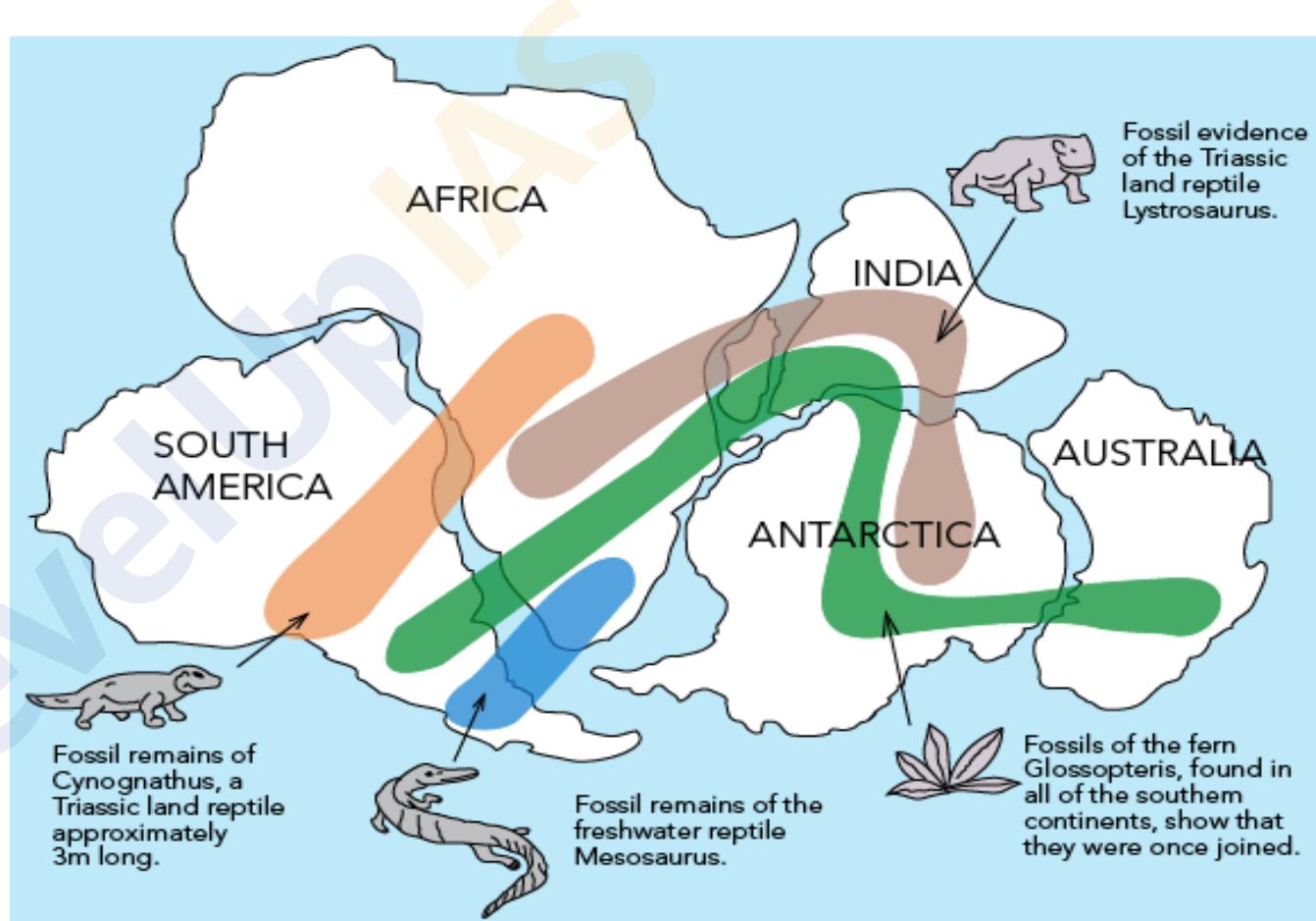
- 1. Jig Saw Fit:** Fitting shape of the coastline of the continents like the eastern side of the South America coast fits into the western Africa
- 2. Stratigraphic Evidence:** not only the shape match the rock type and the rock age also matches on the either side of the Atlantic Ocean
- 3. Structural Evidence:** Eastern Brazilian Highlands and the Borborema plateau seems to extend into the gulf of Guinea and the Loma mountains. Gold seams of Ghana has a match with those of the Brazil. Patagonian plateau has a structural similarities with Angola highland. Guyana highland seems to fit into Fouta Djallon and Loma mountains.



Evidence:

4. Fossil Evidence:

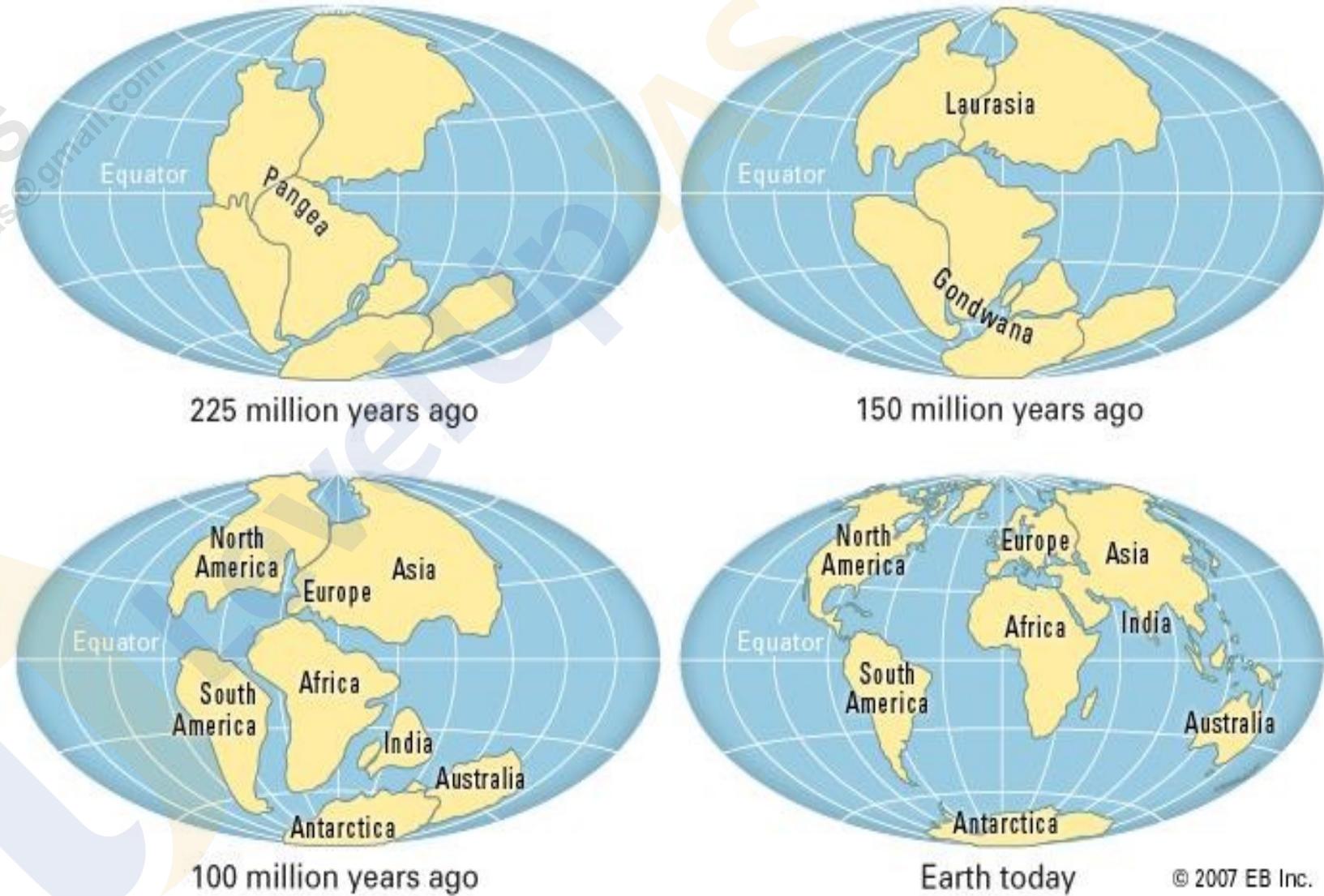
- **Mesasaurus**, an aquatic reptile whose fossil remains are found only in eastern South America and South Africa. Had it been able to swim across the vast Ocean, it should have been widely distributed.
- **The fossils of Glossopteris**, a fern grown only in supolar climate are now found in warm climatic regions separated by wide Oceans.
- **Fossil of Lystrosaurus**
- **Fossil of Cynognathus**



Evidence:

- Fossil Evidence:
Wegner's Explanation:

Wegener concluded that the continents must have been together and lifeform must have evolved at some location with continental breaking and the continental drift. Lifeform and their fossil remains must have got distributed in the typical distribution.



Evidence: Paleo Climatic Evidence

Distribution of Coal:

Richest coalfield of the world: Appalachian, Newfoundland, Pennines. The northern cool dry climate and not the dense forest of today have richest coal fields.

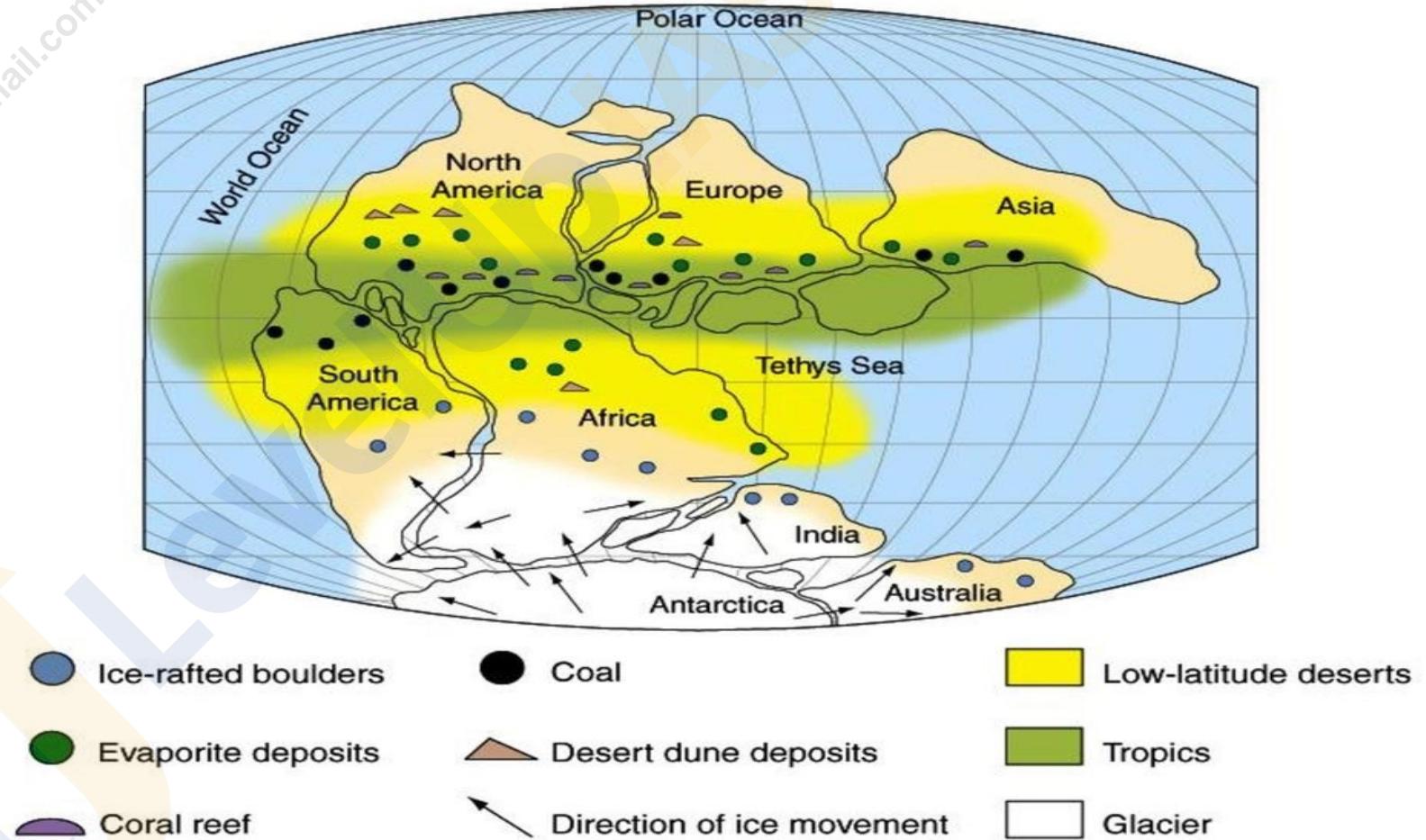
While African and South America almost no coal fields despite dense Equatorial forest there is no coal, India's coal is also of poor quality.



Evidence: Paleoclimatic Evidence

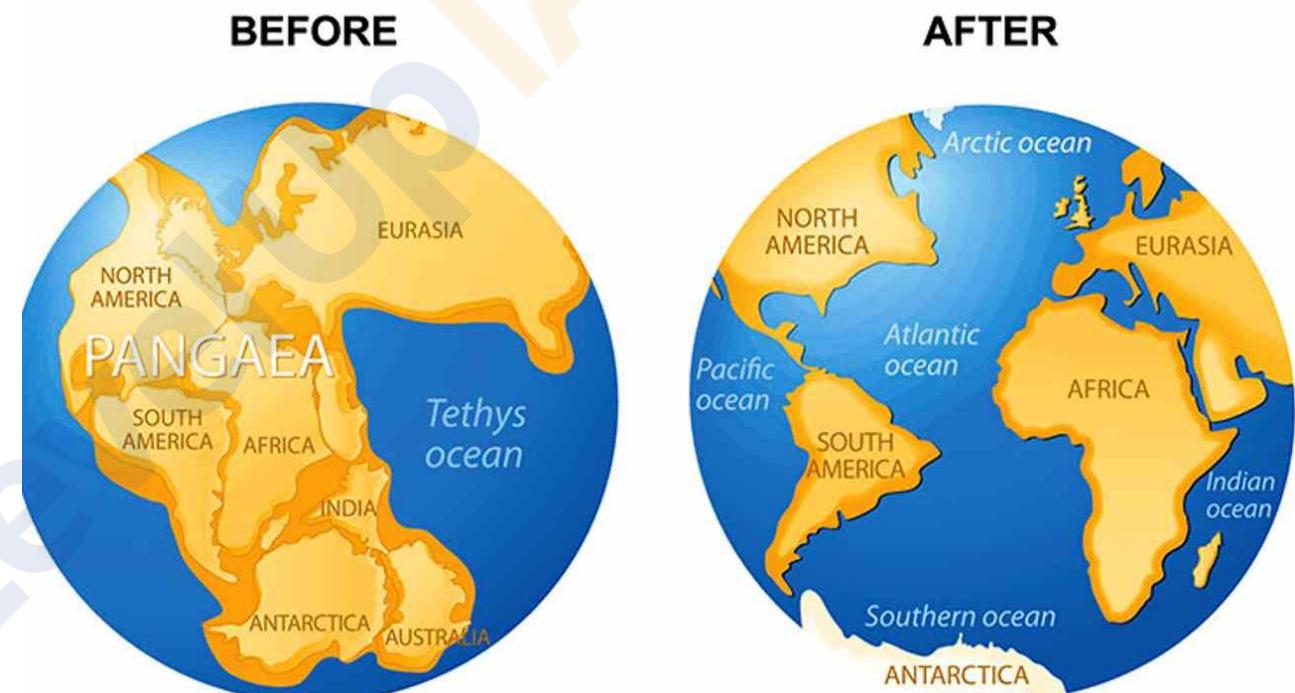
Glacial Till:

The similarity in the glacier and the Permafrost evidence of the glacial till and the Moraines of South America Africa and Antarctica. Parts of southern and the central India also have glacial erosion evidences and are of same age deposits of the South America and Durban. This seems to be climatic anomaly as India is in the tropical latitude.



Paleo Evidence are climatic Anomaly

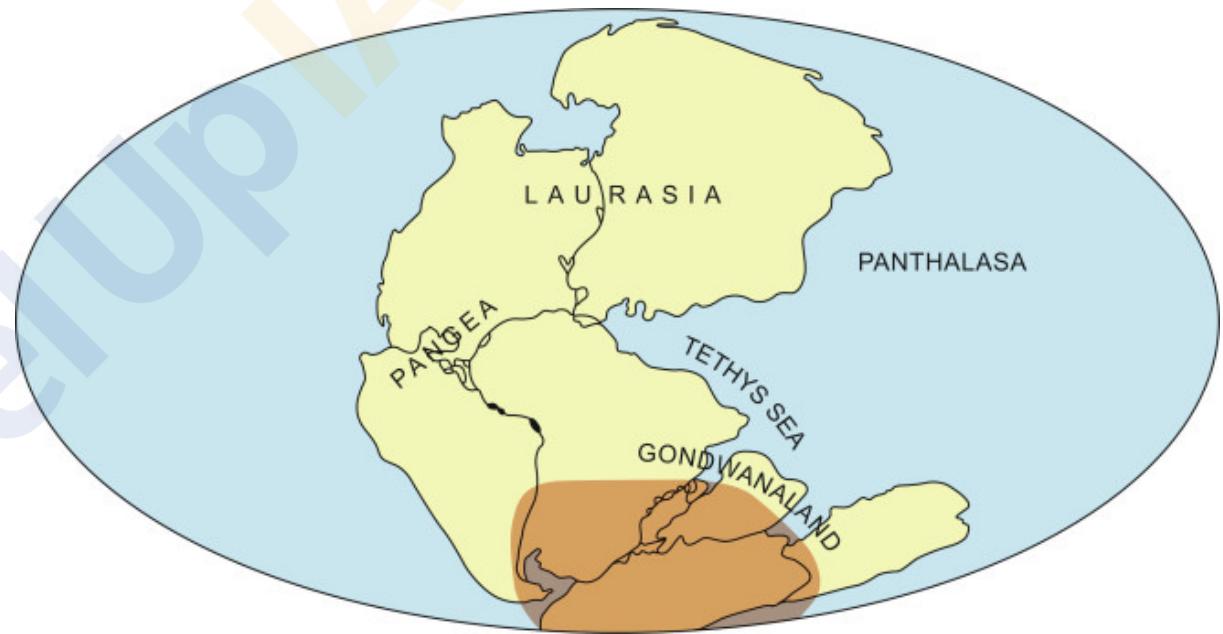
1. The northern temperate latitudes have coalfields indicating warm conditions unlike what they have today
2. The southern tropical latitudes have evidence of glaciations in Patagonia Durban and India. This is another climatic anomaly.



Evidence:

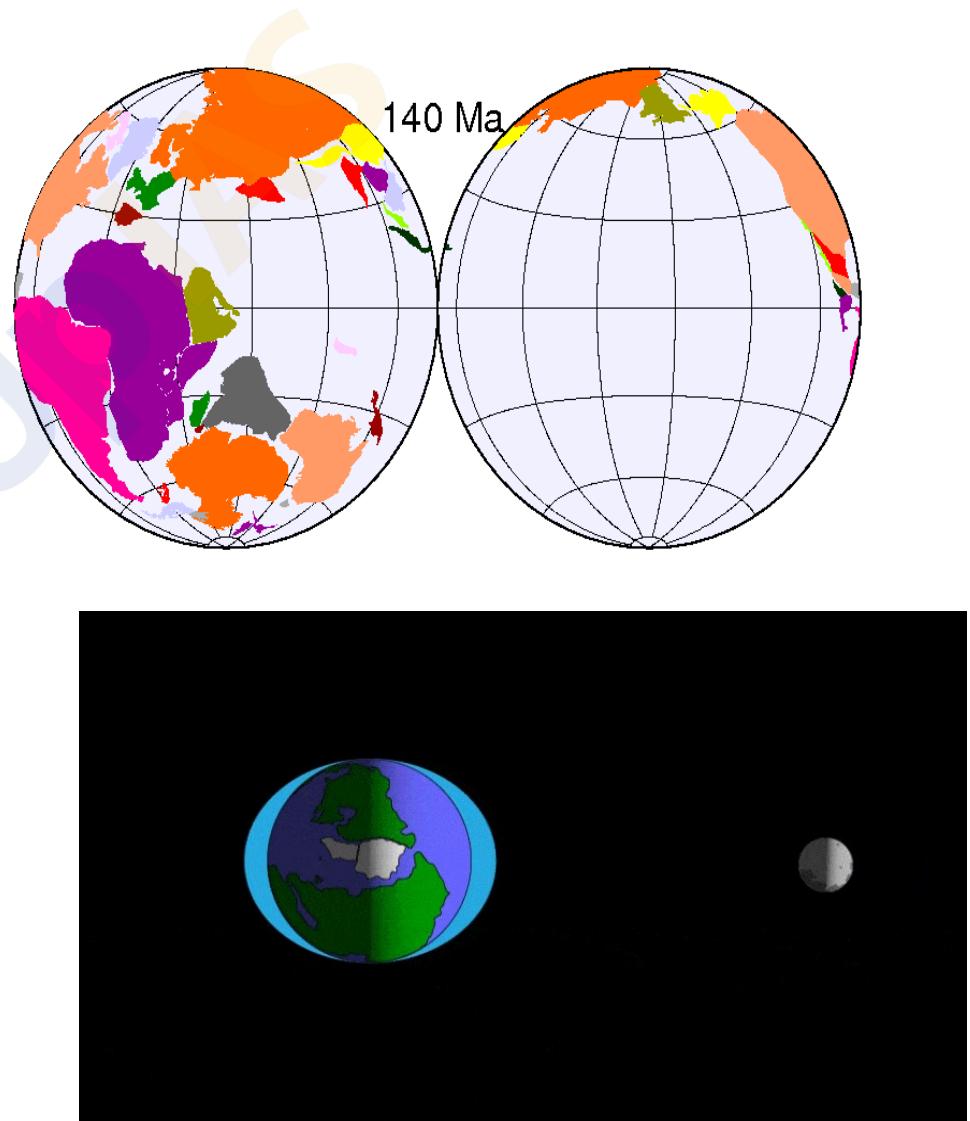
Paleo Climatic Evidence: Wegner's Explanation:

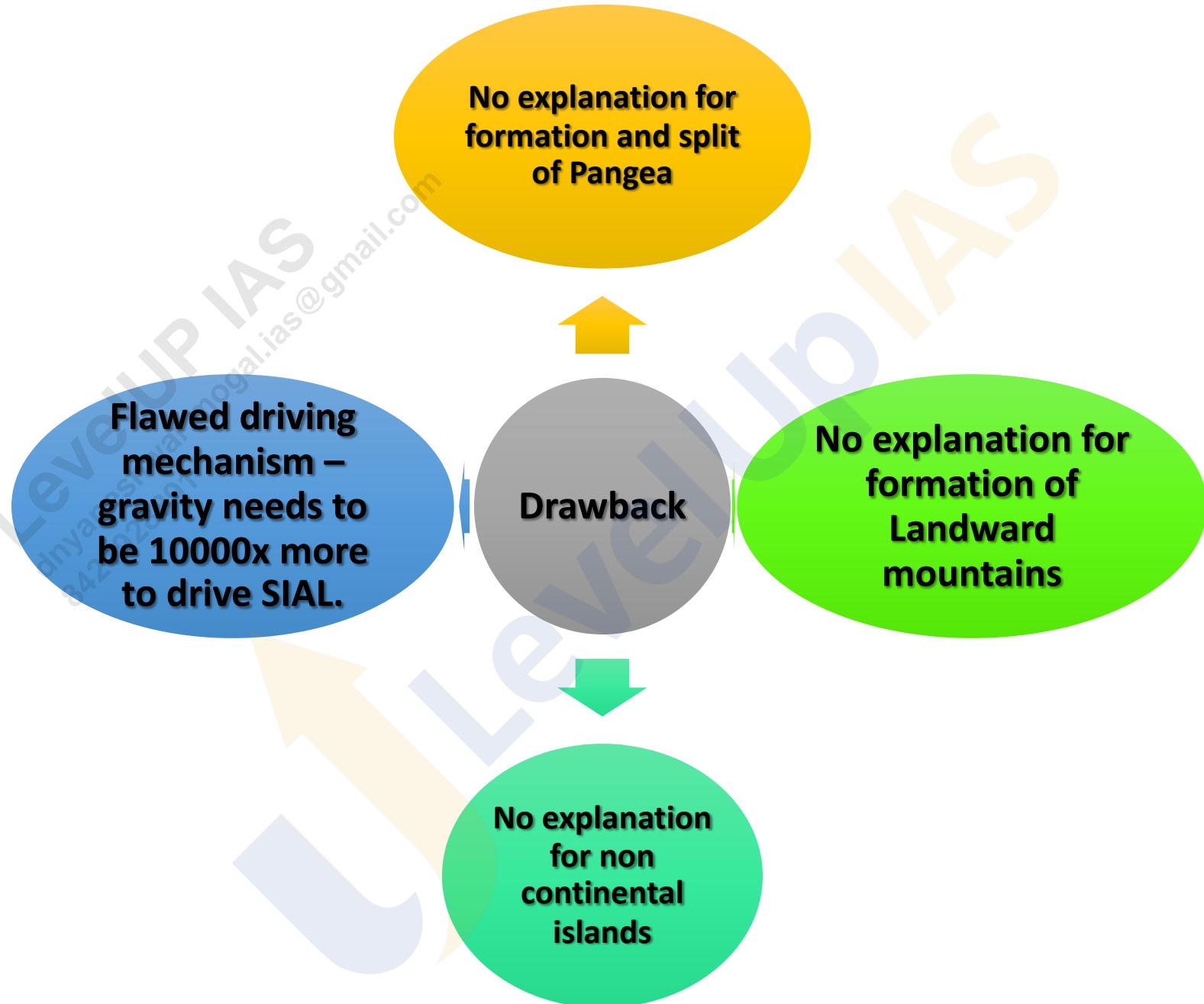
- Wegner explained that the continent is a part of Pangea was once together and located in the southern hemisphere.
- So the northern temperate locations were once in the southern latitude with warm wet conditions that forms the coal fields and
- The tropical locations of today were more close to the South poles and therefore have glacial evidences.
- Paleo-Climatic evidence are one of the most convincing evidence for the continents to have drifted



Forces:

- The forces suggested by Alfred Wegner as the cause of continental motion-
- Equatorward or North-South movement caused by the Pole-fleeing force due to Gravitational differential force and the force of Buoyancy to adjust the center of gravity and the center of Buoyancy.
- The westward movement caused by the tidal forces of the Sun and Moon.





Criticisms:

- Has used incorrect conceptualisation of Earth's Interior. Continents do not float over Ocean. Reality is Lithospheric plates float over asthenosphere
- No explanation on what created Pangaea. The theory did not describe the situations of pre-carboniferous times.
- No explanation why panagaea broke.
- Forces suggested are inadequate.
- In reality, island are not found in South East Section alone. All the island are not continental island.
- No explanation for landward mountains



Contribution

1. Logically deduced theory
2. Bold departures from the then existing idea that the continents and the oceans are permanent and static
3. Bold alternative to how fold mountains are formed that are uplifted marine sediments.
4. One of the pioneer to challenge permanency of the Continents and Oceans
5. Idea was correct even though the evidence and driving mechanism was incorrect. Idea was revived by Plate Tectonic Theory

