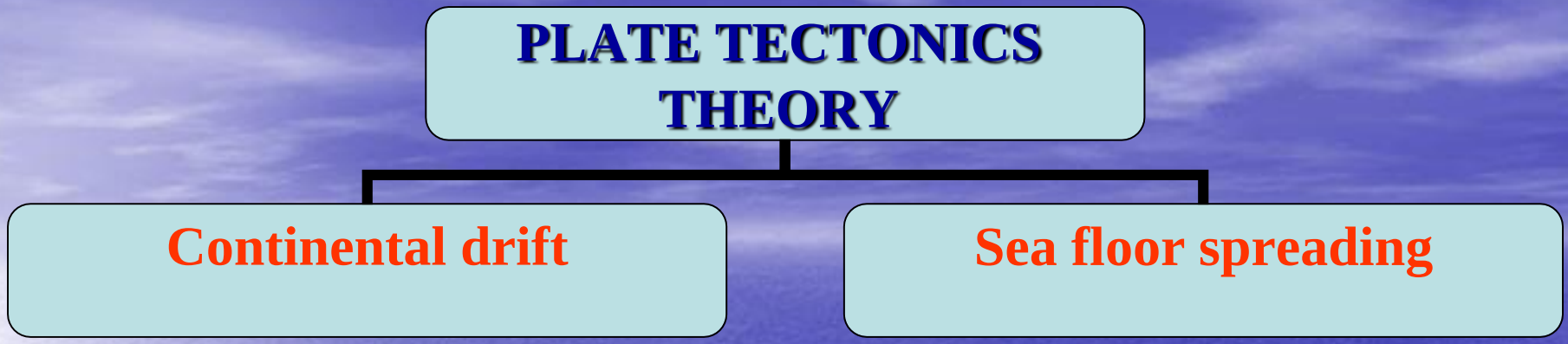
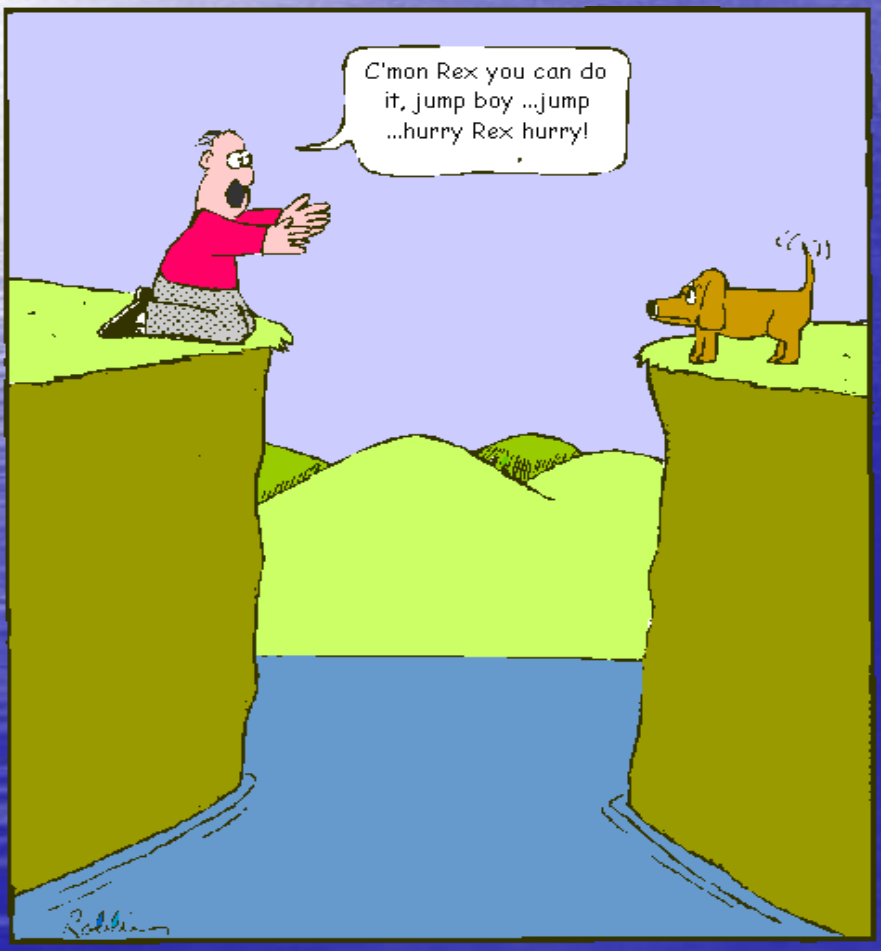
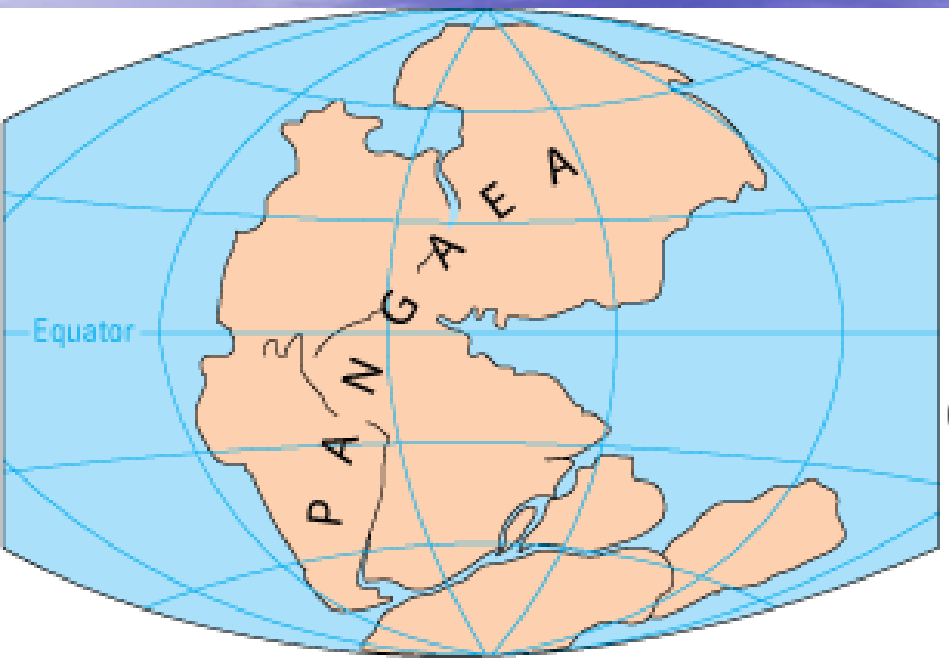


CONTINENTAL DRIFT

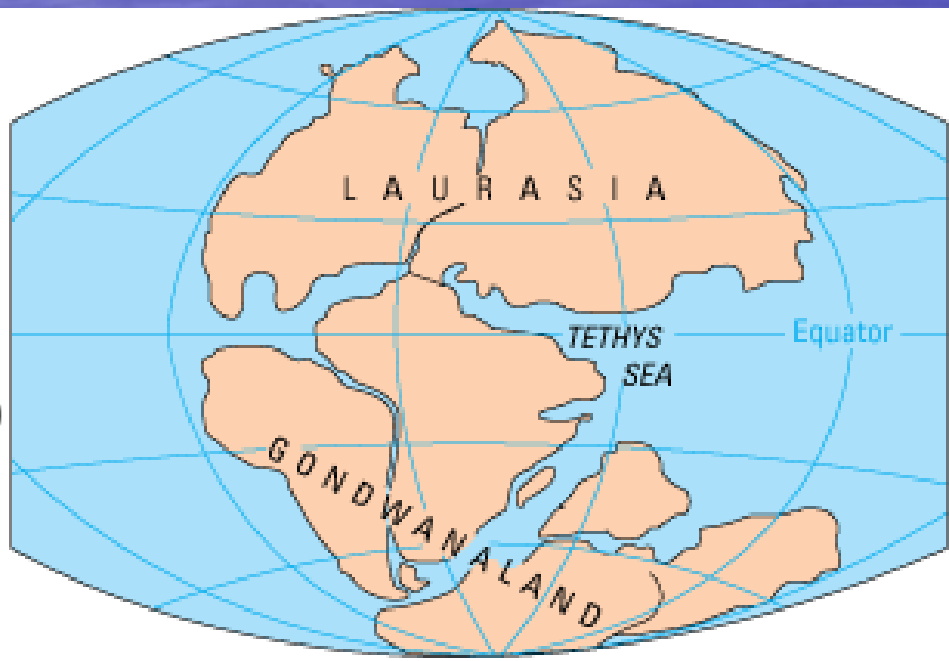
CONTINENTAL DRIFT

1. The fitness of continents and Continental Reconstruction



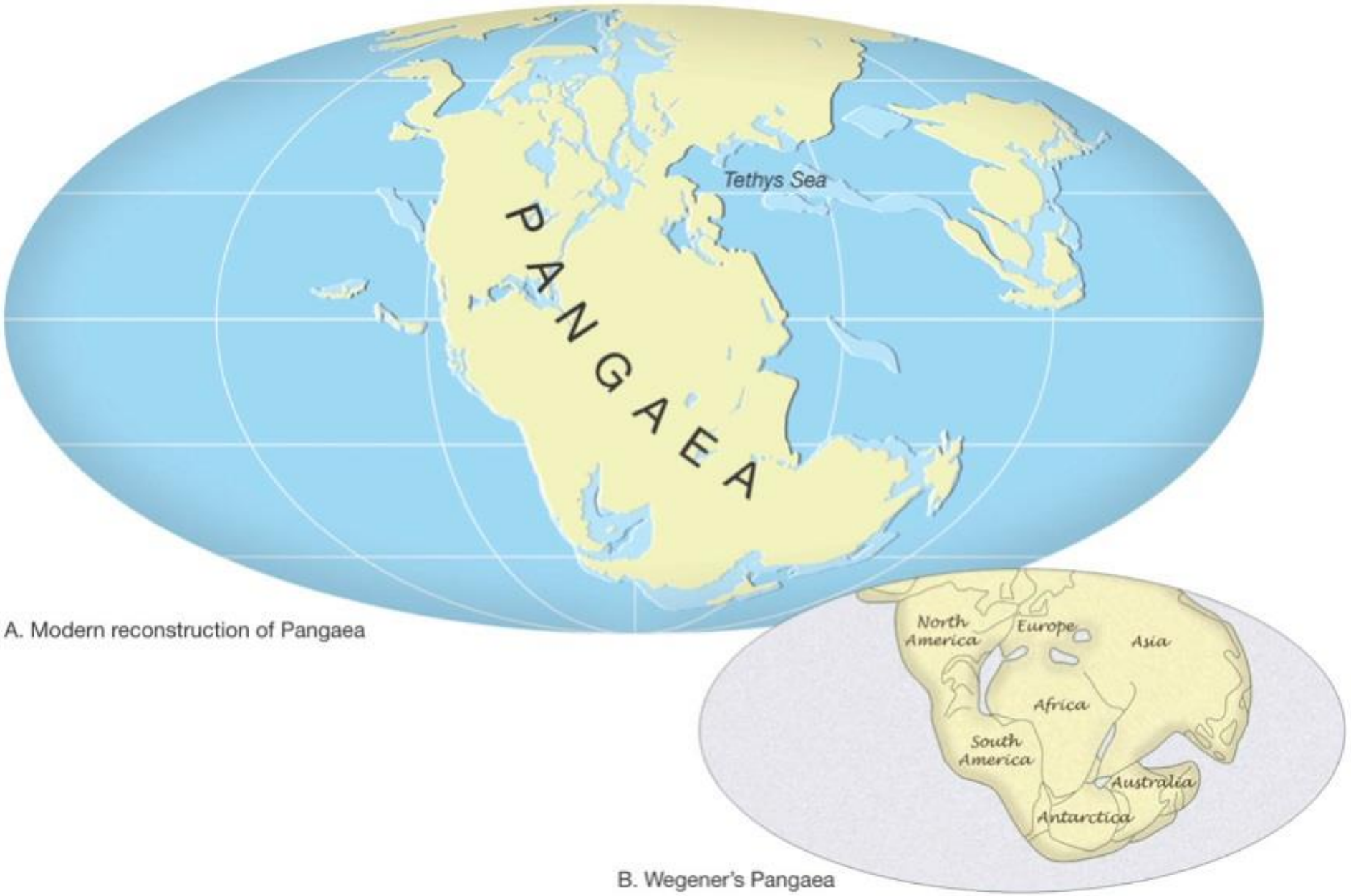


PERMIAN
225 million years ago



TRIASSIC
200 million years ago

Earth ~200 million years ago



A. Modern reconstruction of Pangaea

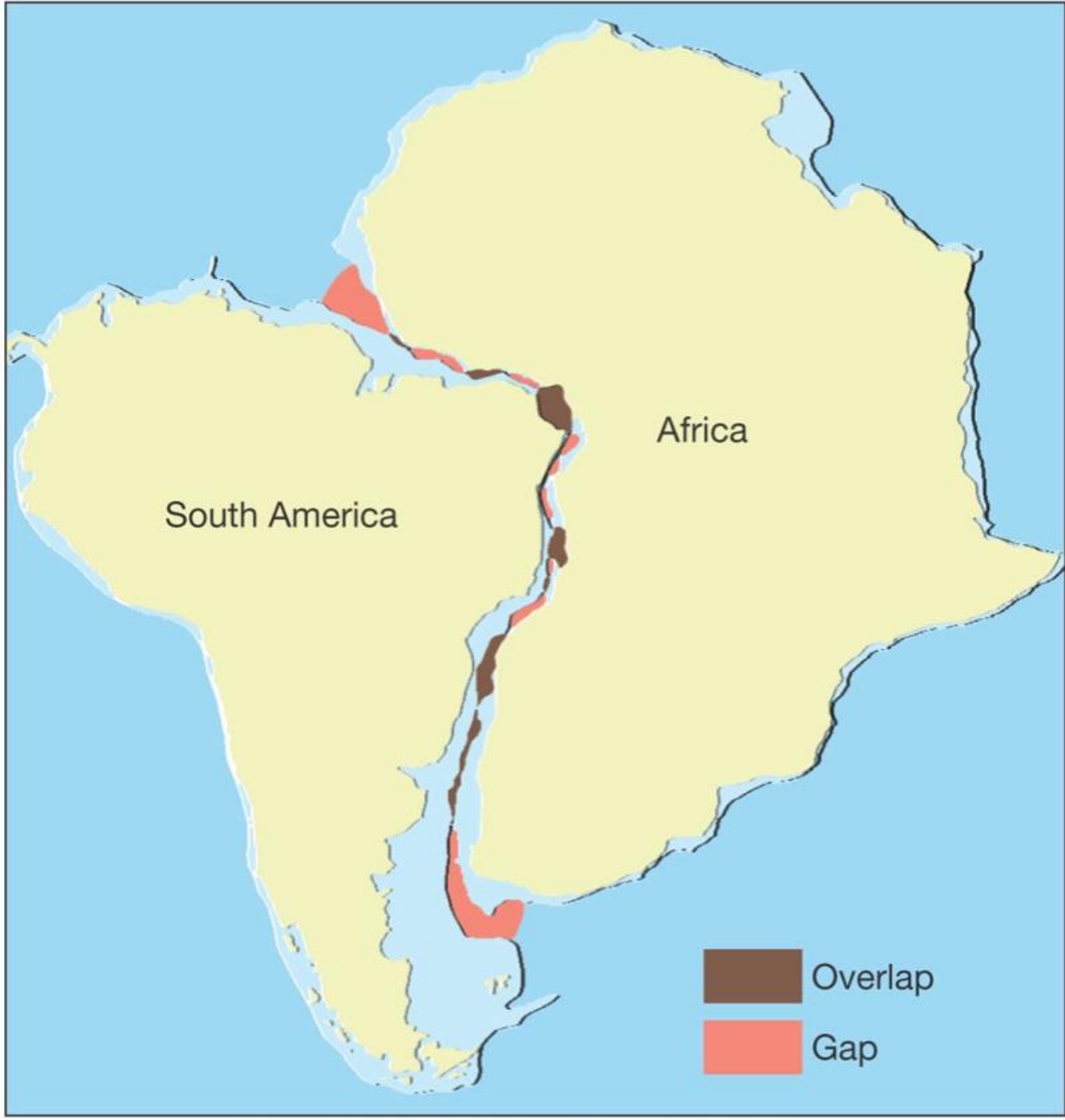
B. Wegener's Pangaea

1.1 Geometrical reconstruction of continents

- Manually.
- Mathematically **on continental slope.**
  (Bullard of Cambridge).
  (done by computer at 500 fathom= 927 m not at coastlines) which minimize the degree of misfit.

Continental Drift: Evidence

Tight fit of the continents, especially using continental shelves.



It shows that there are:

overlaps

Examples:

Iceland

Niger

Bahame platform

gaps

Examples:

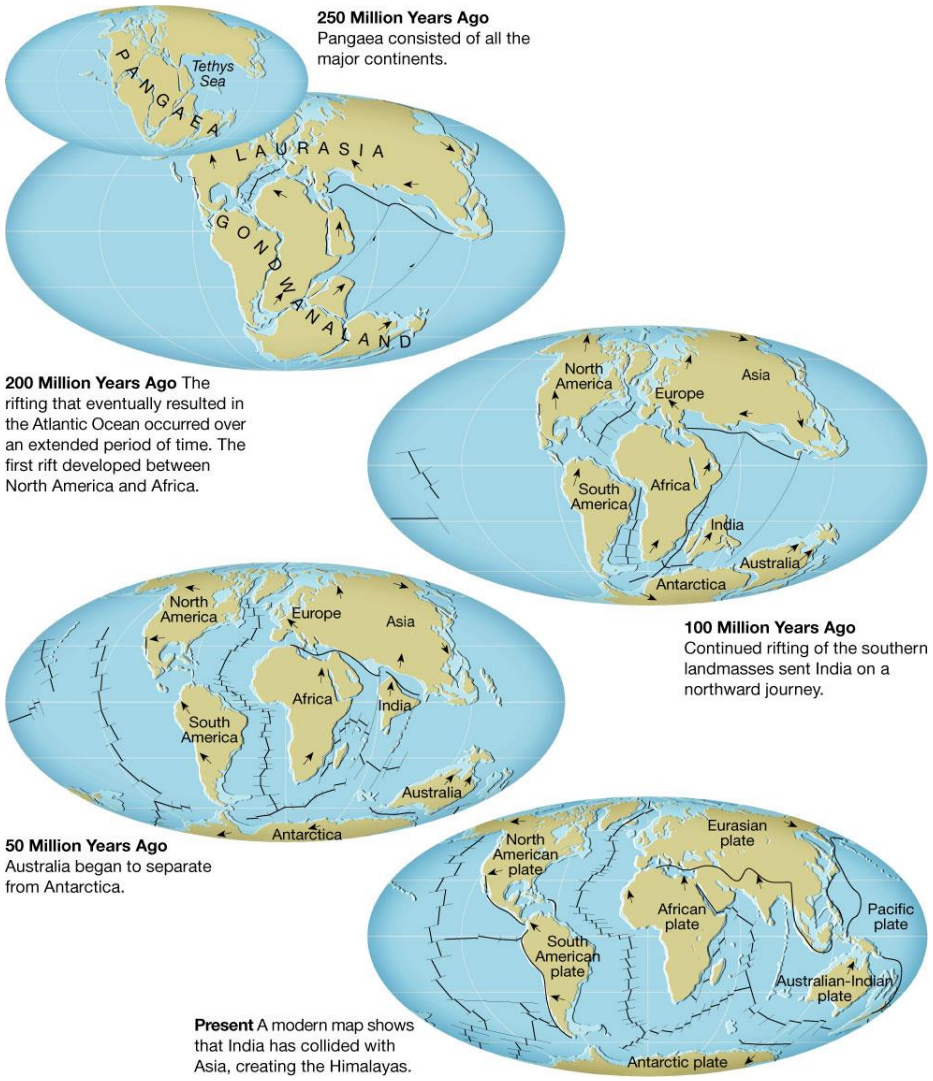
Iberian Peninsula

Caribbean Sea

The Continental Drift Hypothesis

- Proposed by Alfred Wegener in 1915.
- Supercontinent Pangaea started to break up about 200 million years ago.
- Continents "drifted" to their present positions.
- Continents "plowed" through the ocean crust.

Breakup of Pangaea



Continental Drift: Evidence

Geographic fit of South America and Africa

Rock types and structures match across oceans

Fossils match across oceans

Ancient glacial features

Fold mountain belts.

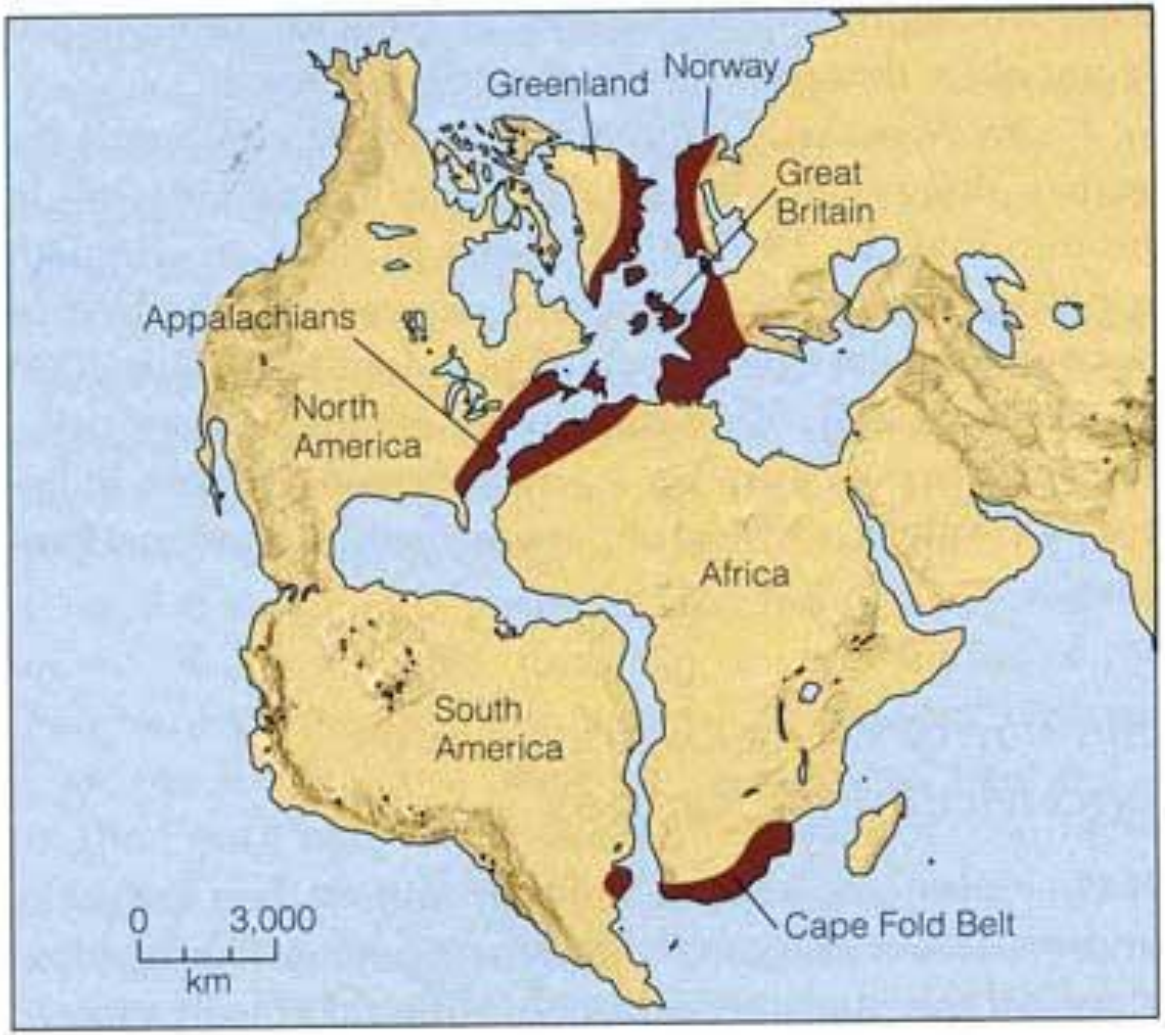
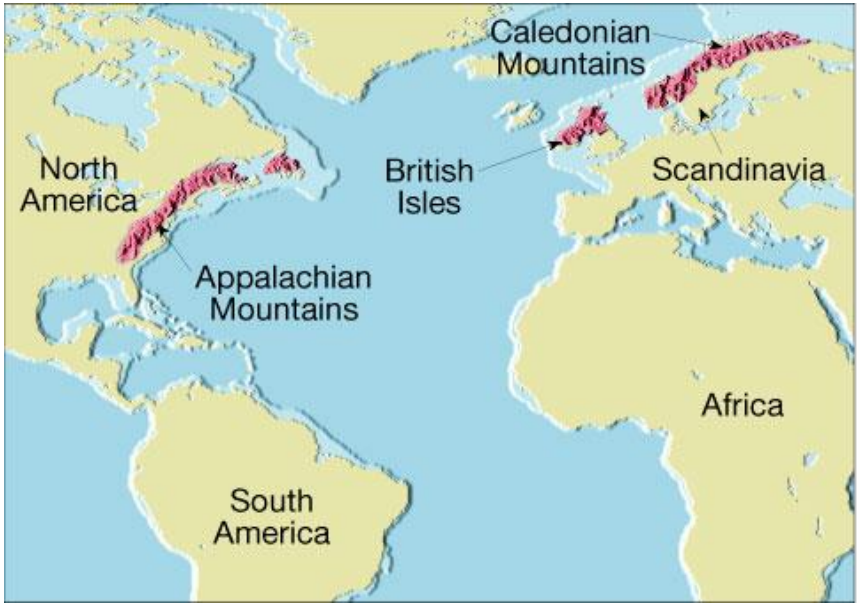


Figure 2.5

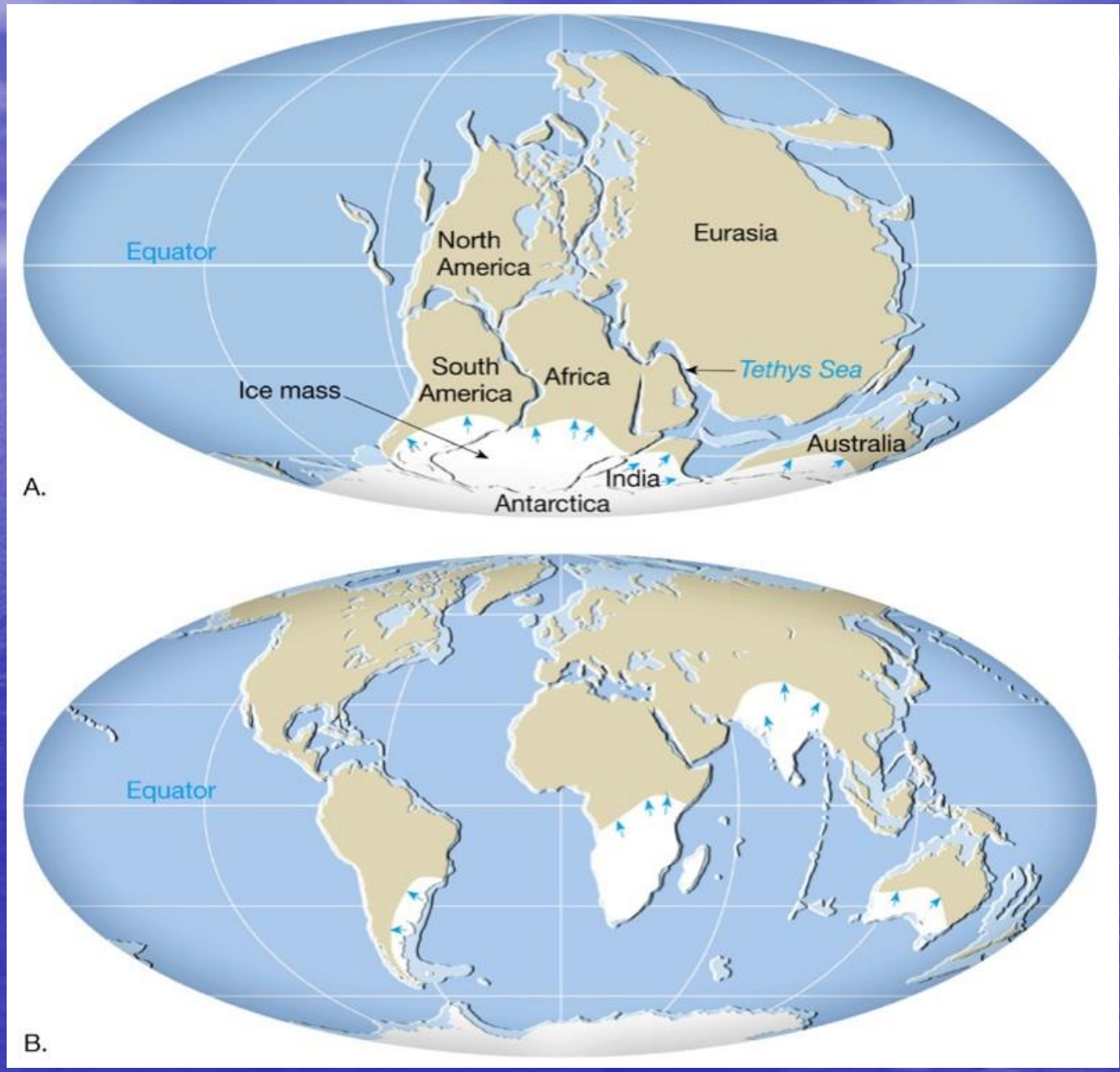
When continents are brought together, their mountain ranges form a single continuous range of the same age and style of deformation throughout. Such evidence indicates that the continents were at one time joined and were subsequently separated.

Matching Mountain Ranges



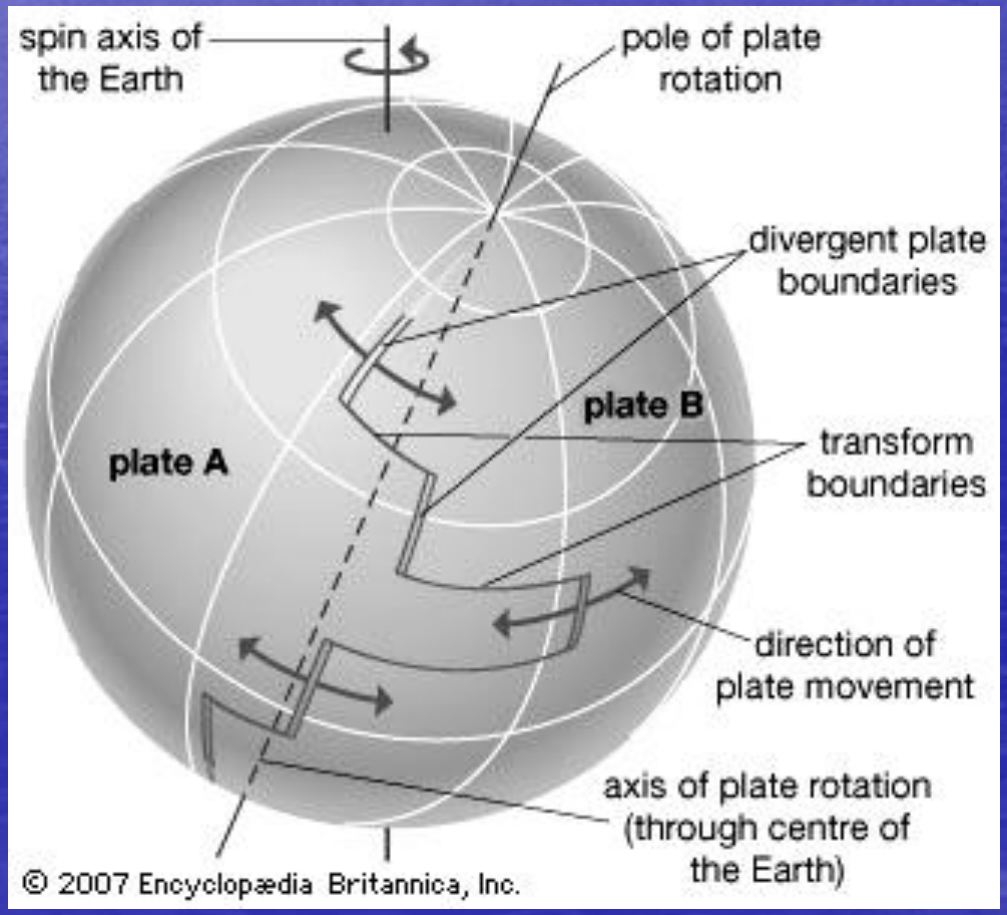
Continental Drift: Evidence

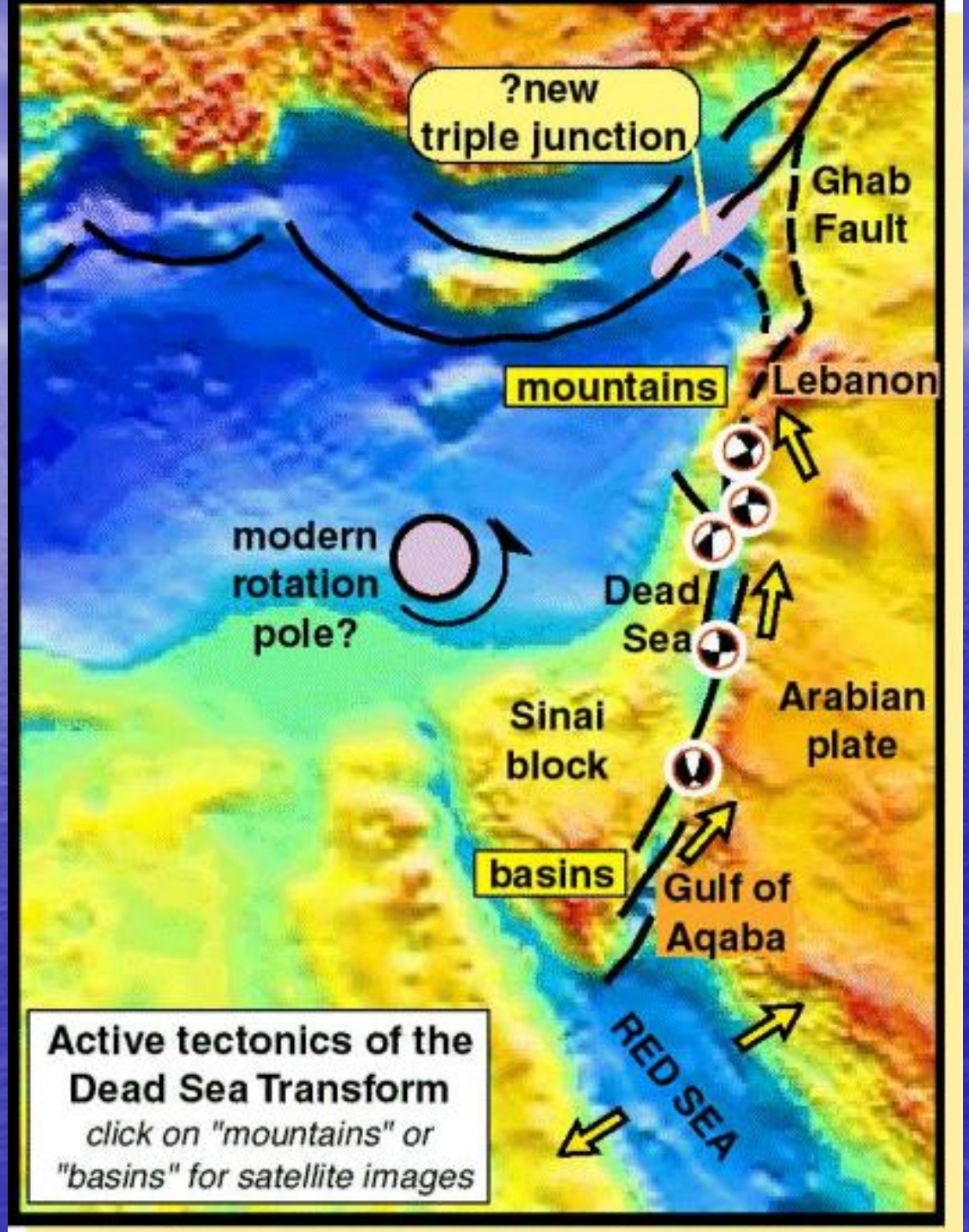
Glacial features of the same age restore to a tight polar Distribution (300-250M. Y. ago).



2. Euler's theory

The movement of a portion of a sphere across its surface is defined by a single angular rotation about a pole of rotation (Euler pole of rotation).




?new
triple junction
Ghab
Fault
mountains
Lebanon
modern
rotation
pole?
Dead
Sea
Sinai
block
Arabian
plate
basins
Gulf of
Aqaba
RED SEA
Active tectonics of the
Dead Sea Transform
click on "mountains" or
"basins" for satellite images

- Atlantic Ocean formed before 200 M.y. in early Jurassic.

- It has Different poles of rotation at different ages:

  - 180 M.y. for North Atlantic
  - 130 M.y. for south Atlantic.
  - Before 80 M.y. the two parts have a unified pole of rotation.

3. GEOLOGICAL EVIDENCES FOR CONTINENTAL DRIFT

1- Fold mountain belts.

2- Age provinces

3- Igneous rock type (province) {Mesozoic dolerite dykes}

4- Stratigraphic sections (flora: glossopteris & gangamopteris)

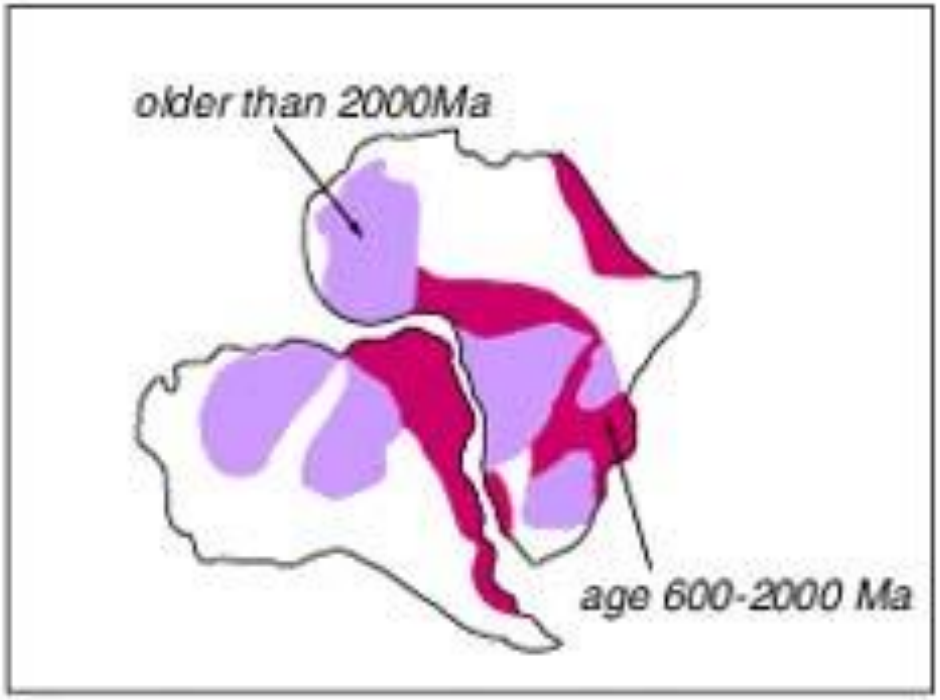
5- Metallogenic provinces (manganese; iron ore; gold & tin)

1- Fold mountain belts.

Continental Drift: Evidence

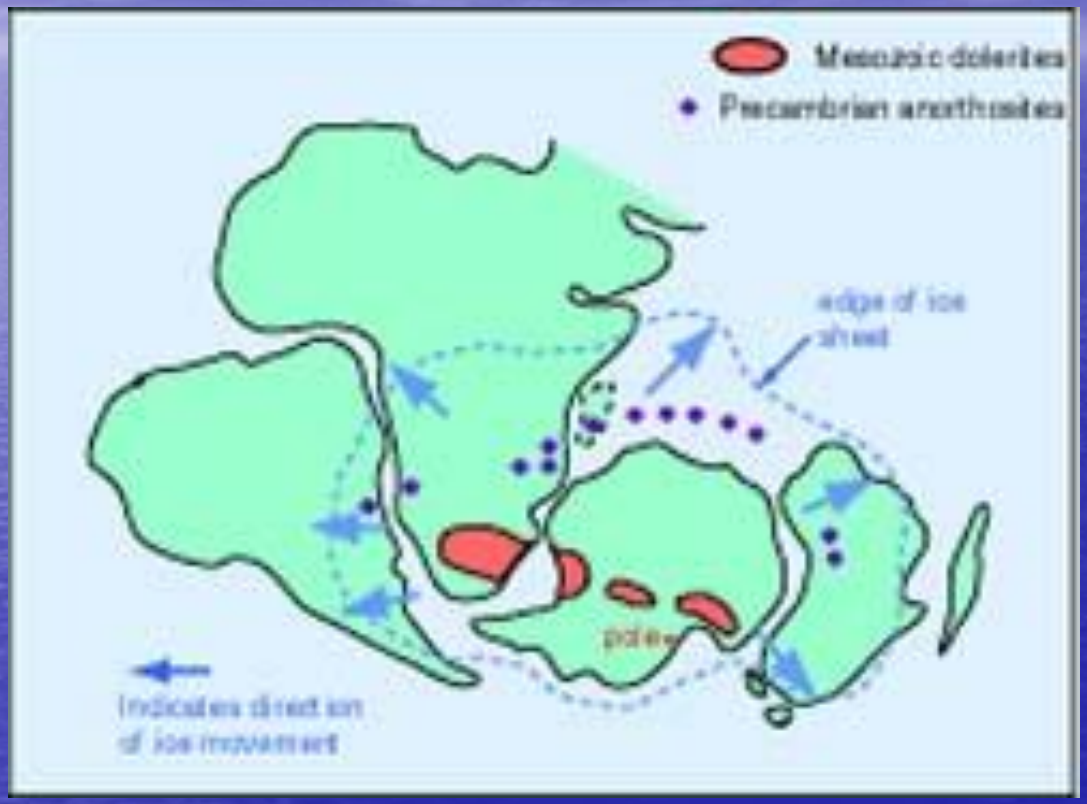
Correlation of mountains with nearly identical rocks and structures

2- Age provinces



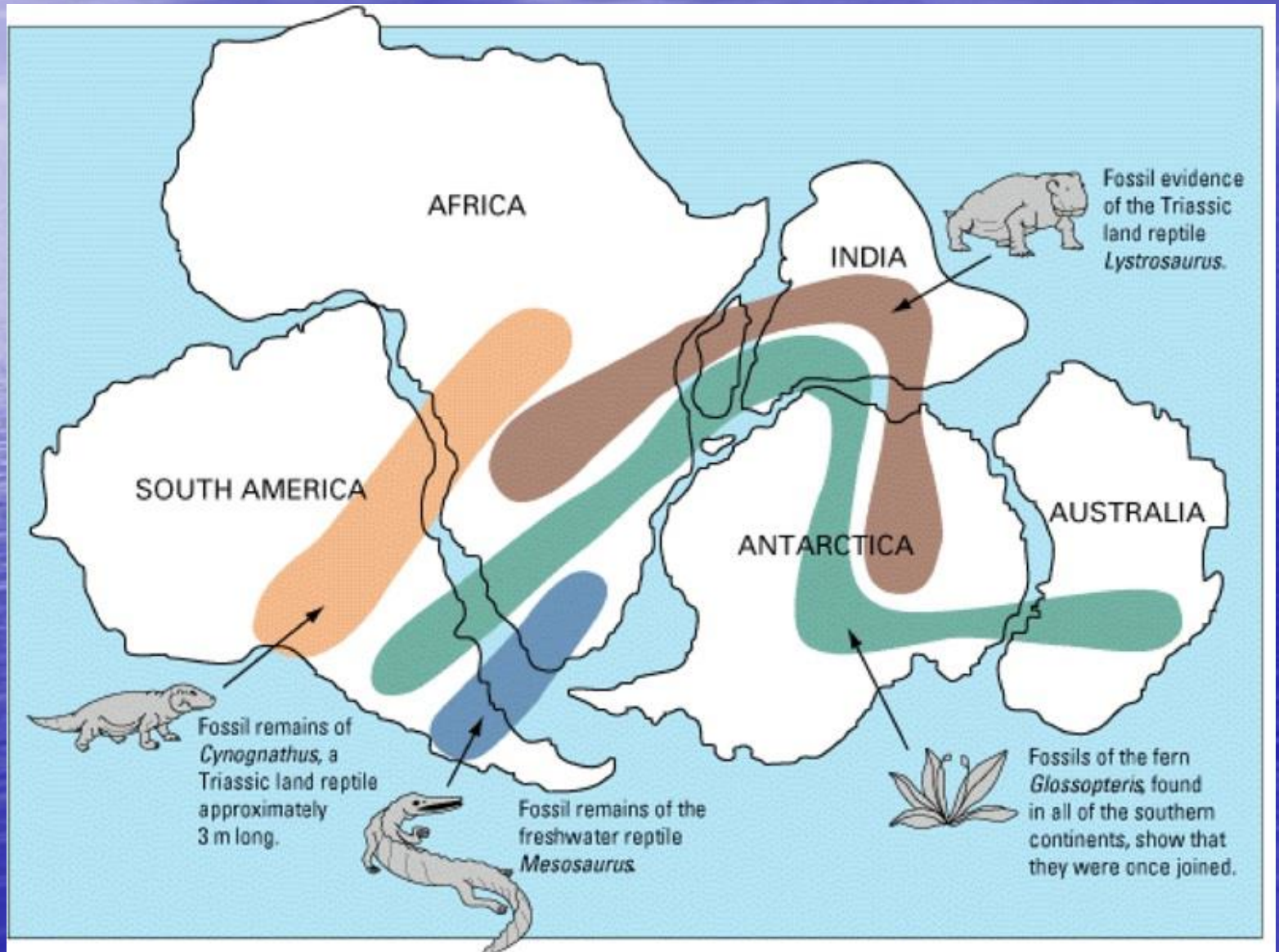
Match of cratons (purple) and ancient orogenic belts (pink) between South America and Africa

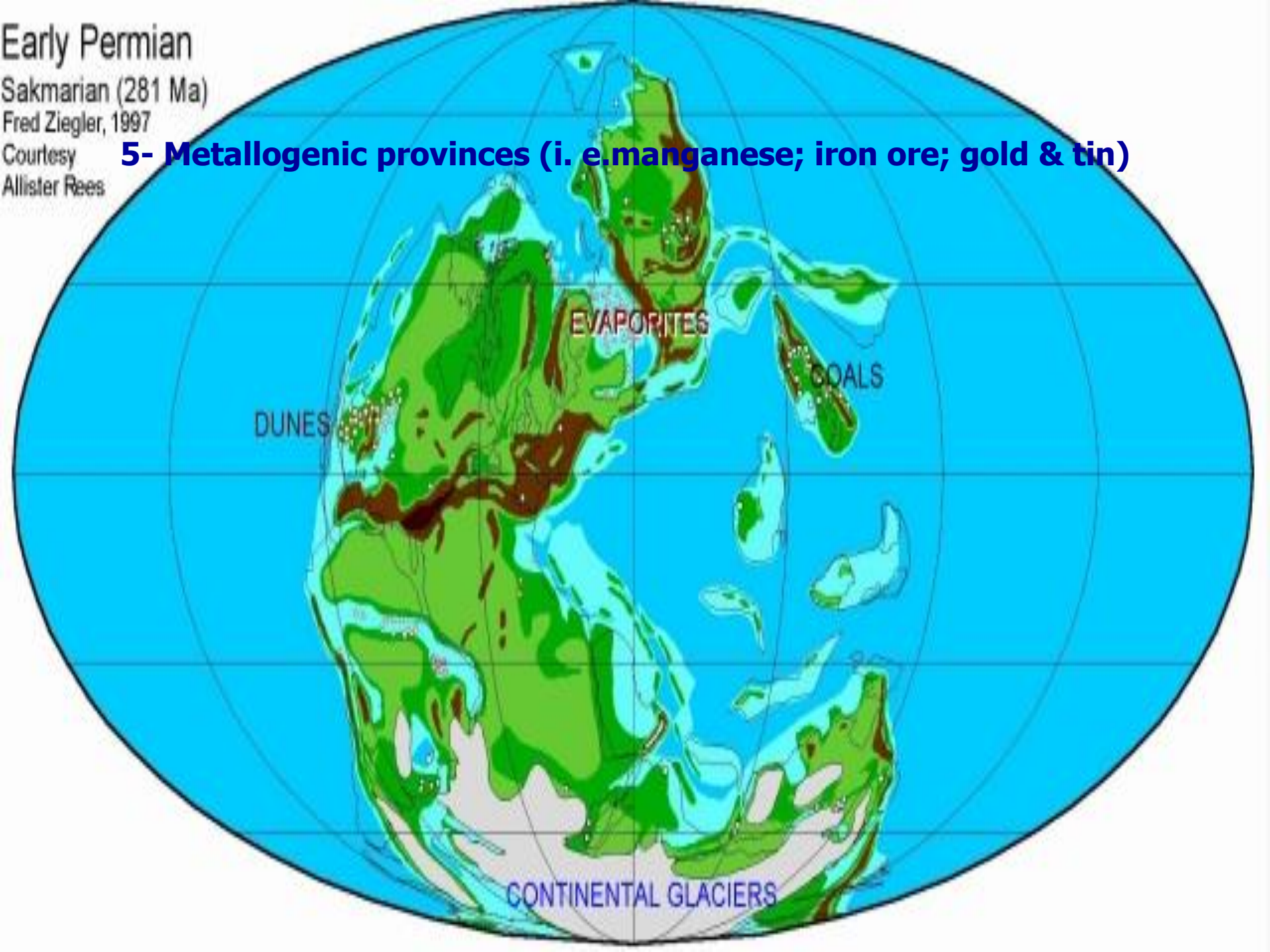
3- Igneous rock type (province) {Mesozoic dolerite dykes}



Continental Drift: Evidence

4. Stratigraphic sections (flora: glossopteris & gangamopteris and fauna ……..)




Early Permian
Sakmarian (281 Ma)
Fred Ziegler, 1997
Courtesy
Allister Rees
5- Metallogenic provinces (i. e.manganese; iron ore; gold & tin)
EVAPORITES
COALS
DUNES
CONTINENTAL GLACIERS

Continental Drift

Wegener proposed the theory that the continents are drifting apart.

This was supported by fossil and rock type evidence; also matching of coastline shapes.

4. PALEOCLIMATOLOGICAL EVIDENCES FOR CONTINENTAL DRIFT

- The study of climatic indicators in ancient rocks can be used as sedimentlogical indicator to infer their ancient latitude.

1- Carbonate and reef deposits: (with 28^{o} latitude --warm water 25^{o}-30^{o} C).

2- Evaporates: hot arid conditions (high pressure zone)
Evaporitation rate > sedimentation rate
(Arid subtropical=10^{o}- 40^{o} latitude).

3- Red bed (arkosic sandstone, shale, conglomerates and hematite). They indicate:

a- oxidizing agent

b- Supply of iron

c- Hot climate <30^{o} lat.

4- Coal & Oil, They indicate

Organic remain degradation, Warm, humid climate, < 30^{o} latitudes.

5- Phosphates (western margins of continents and indicate shallow marine environment)

a- within 45^{o} lat.

b- Upwelling of cold deep water, nutrients rich. (major nutrients P, K, N).

c- in arid zone at low lat. along east-west seaways.

6- Bauxite deposit (Al_2O_3)

a- strong oxidation

b- Tropical to subtropical weathering.

7- Desert deposits

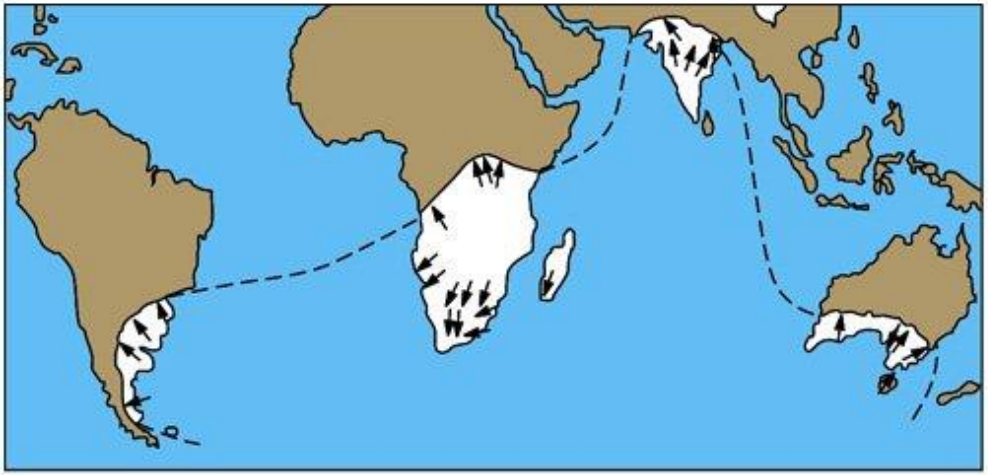
a- dune bedding of desert sandstone

b- Prevailing wind.

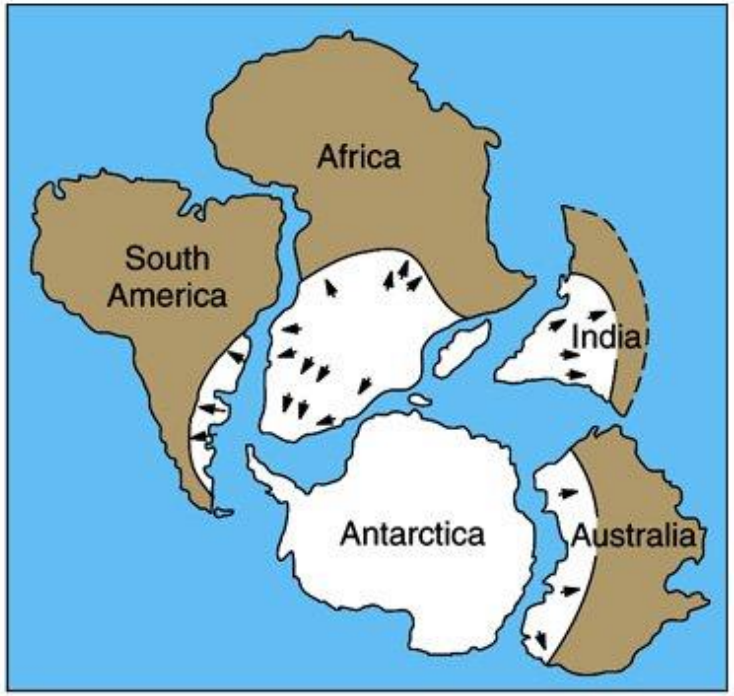
8- Glacial deposits (tillits)

30^o from the pole (60^o lat.).

Glacial deposits (tillits)



A



B

5. CHEMICAL INDICATORS

- Paleotemperature:

  by oxygen isotopes ratio O^{18}: O^{16}

6. PALAEONTOLOGICAL EVIDENCES

* Cont. Drift has affected the distribution of ancient animals and plants through forming barriers. An example of that is the forming of a huge ocean between two continents that prevent the migration of:

a. Terrestrial life forms: like Mesosaurus which is Permian reptile. It is 15 cm long, live in fresh water.

b. animals adapted to live in shallow marine environments.

* Most animals have short larval (يرقة) stage which prevents crossing oceans:

- Jurassic ammonite in India , Madagascar and Africa are similar and live in shallow seas.

7. PALAEOBOTANY

* In Carboniferous Period

-Glossopteris and Gangamopteris that are cold climatic forms that lived in Gondwana.

* After the separation the life diversified and had separate paths of evolution.

- Diversity was controlled by:
  - Climate
  - Change in topography by:
    - Drifting and plate tectonics
    - Geographic position (equator& poles). At equator life diversified 10 times more than poles.
    - In Pangaea 20 orders of reptiles.
    - After Pangaea 30 orders of mammals:
      - Genetic isolation
      - Divergence

Continental Drift: Reactions

Received well in Europe and southern hemisphere.

Rejected in U.S., where scientists staunchly preferred induction (incremental progress built on observation) over what they perceived as speculative deduction.

Lack of a suitable mechanism crippled continental drift's widespread acceptance.

Conflict remained unresolved because seafloors were almost completely unexplored.