Key words

continent
Pangaea

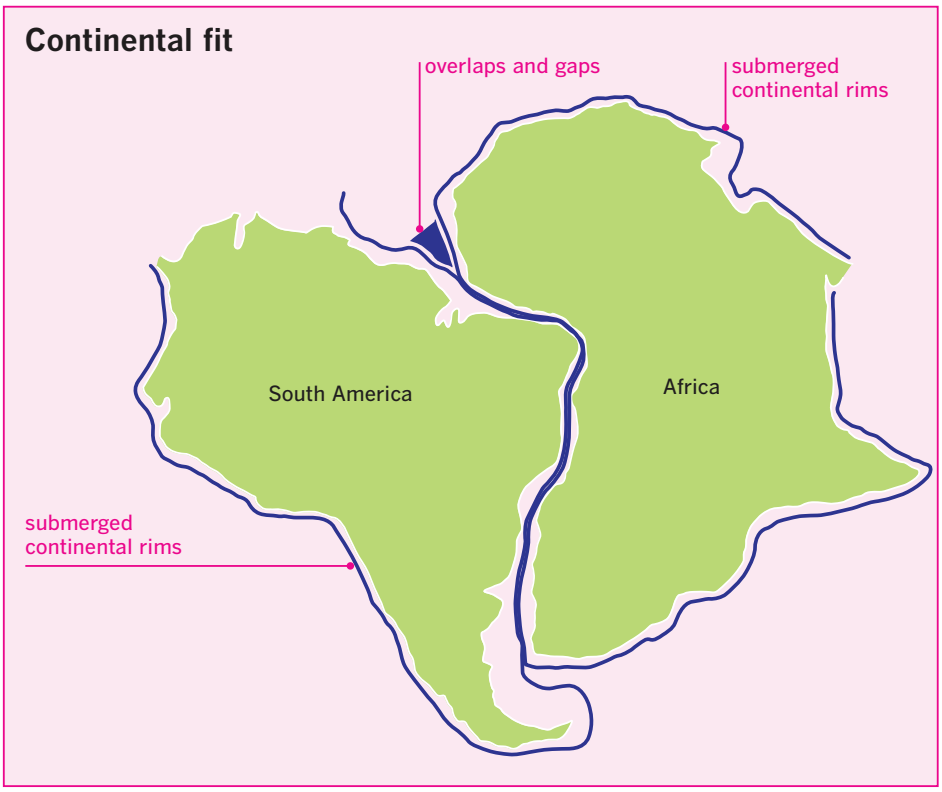
Continental fit

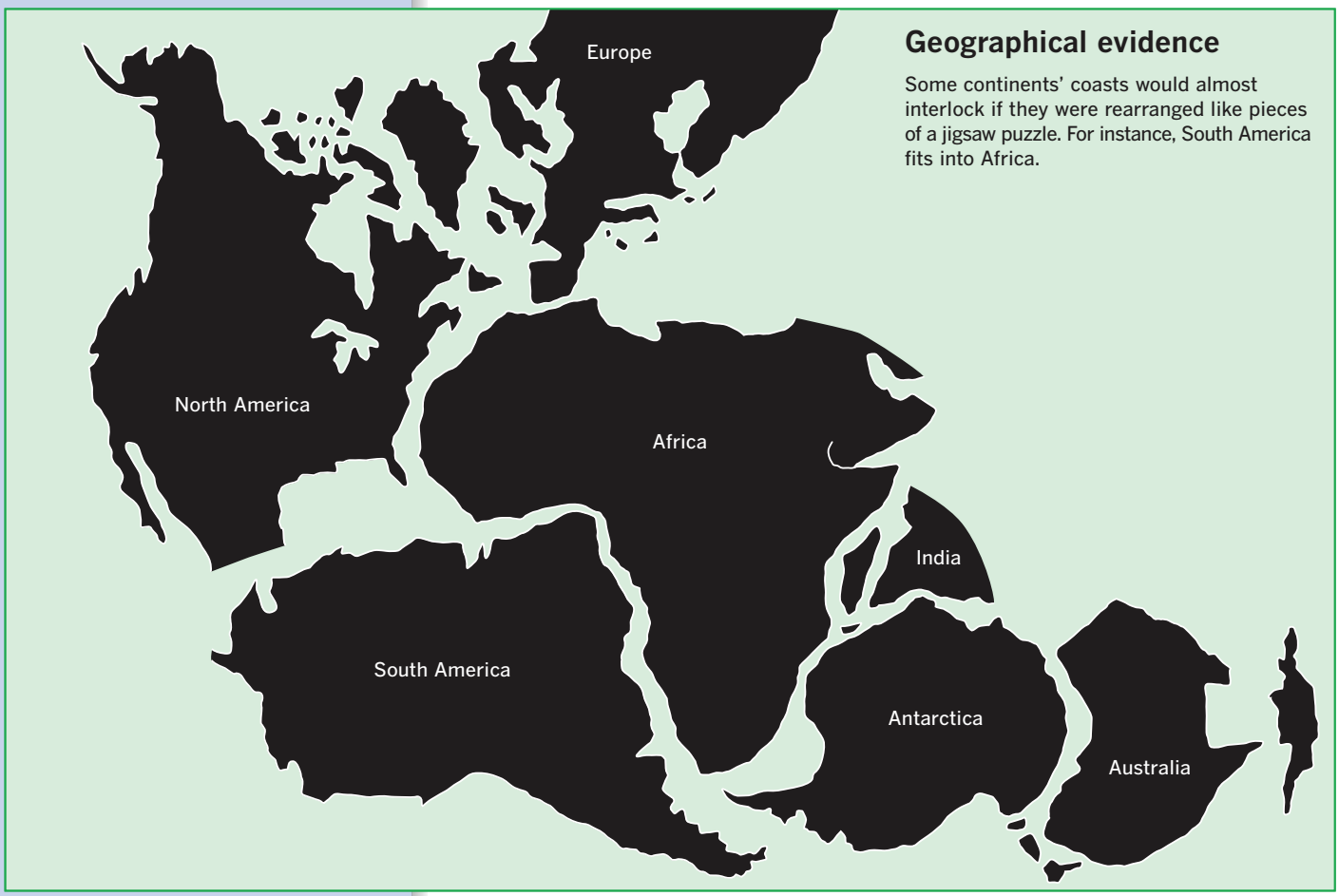
- In 1915 German meteorologist Alfred Wegener (1880–1930) proposed that the continents had drifted around the world.
- One clue was continental fit: South America and Africa almost fit together along the submerged rims of their continental shelves.

A global jigsaw puzzle

- Like pieces of a gigantic jigsaw puzzle, most continents and part of Asia also seem to fit together.
- This boosted the belief that continents are fragments of a single prehistoric supercontinent, *Pangaea*.

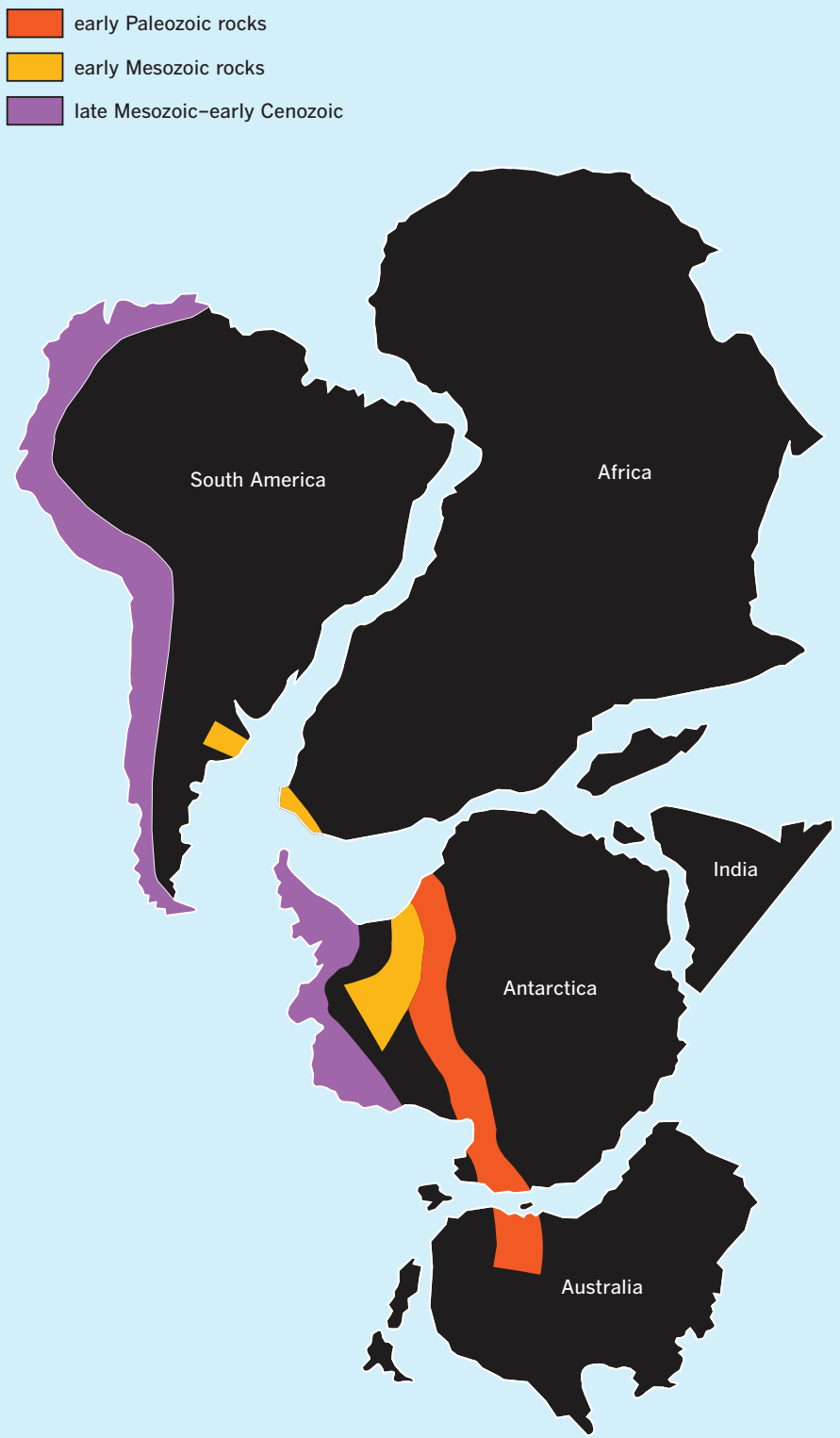
Continental drift: fit





Continental drift: geology

Geologic evidence



Key words

craton

Geologic evidence

- Three mountain-building phases successively tacked rocks onto the shields or *cratons* (ancient cores) of southern continents.
- These three old mountain zones survive as three belts of rocks of matching ages straddling the southern continents, if these are shown joined together in a particular way.
- Early Paleozoic mountains ran through Antarctica and Australia.
- Early Mesozoic mountains ran through South America, southern Africa, and Antarctica.
- Late Mesozoic and early Cenozoic mountains ran through South America and Antarctica.
- These geologic linkages suggest that southern continents were once joined before being separated by continental drift.

Caledonian Mountains

- Geologic clues to past links between northern landmasses include rocks folded in early Paleozoic times into the Caledonian Mountains.
- The fold axes of this great chain passed through West Africa, northeast North America, Newfoundland, Ireland, Wales, Scotland, Greenland, and Norway.
- It is therefore logical to conclude that these places formed a continuous landmass before the Atlantic Ocean separated them.

Continental drift: biology

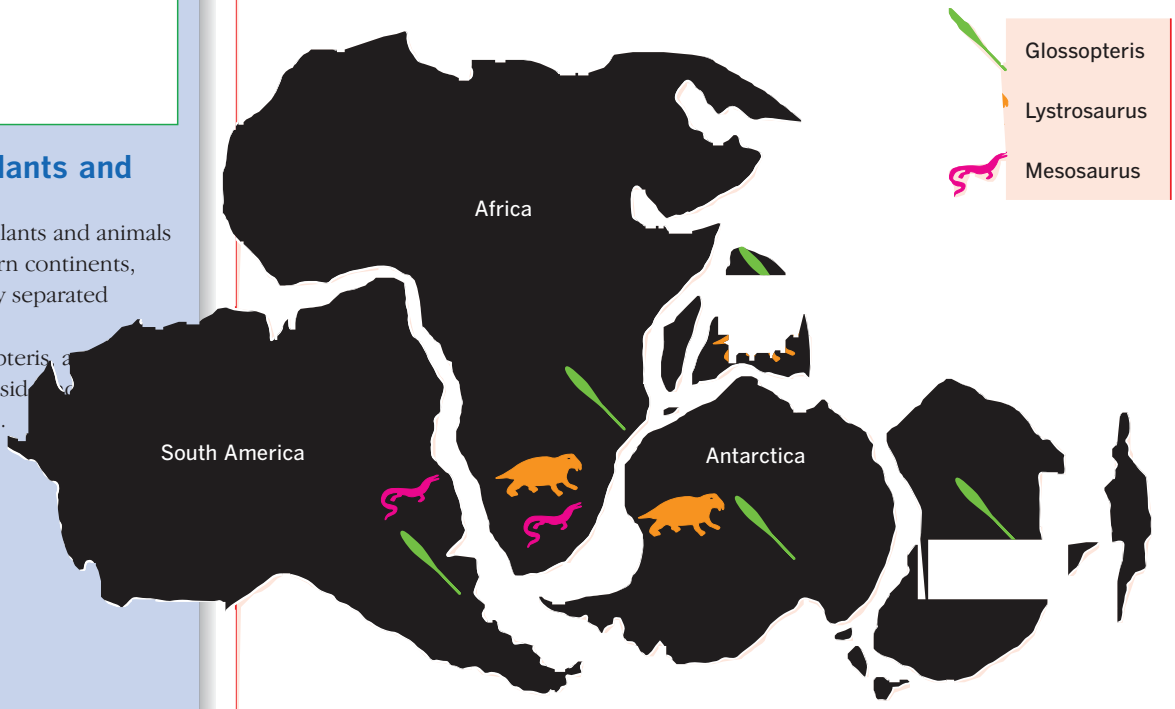
Key words

continent
fossil
glacier
tillite

Permian land plants and animals

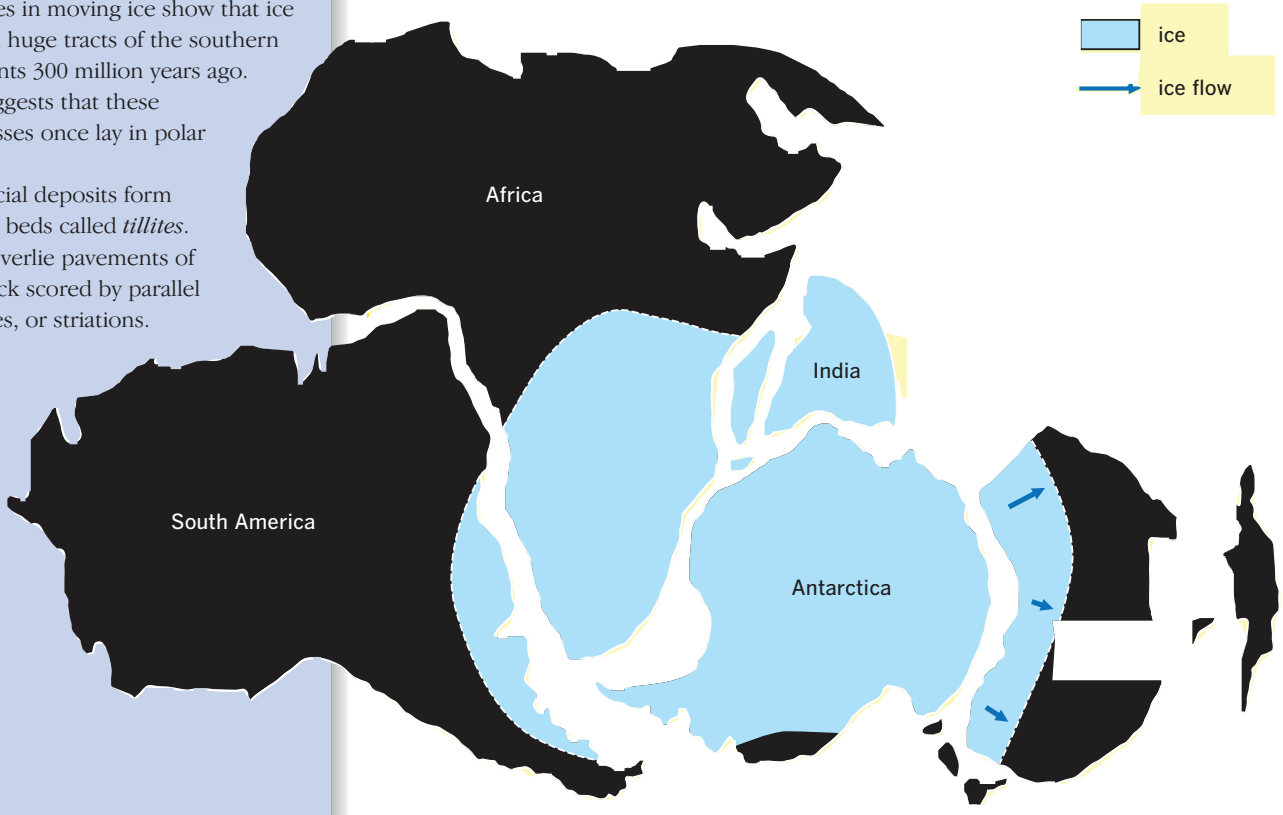
- Identical fossil land plants and animals appear in the southern continents, which are now widely separated by the sea.
- Examples are Glossopteris, a Lystrosaurus, a synapsid, Mesosaurus, a reptile.

Biological evidence



Climatic evidence

- Glacial deposits and rocks scratched by stones in moving ice show that ice covered huge tracts of the southern continents 300 million years ago. This suggests that these landmasses once lay in polar regions.
- The glacial deposits form boulder beds called *tillites*. These overlie pavements of solid rock scored by parallel scratches, or striations.



Continental drift: polar paths

Key words

continent
pole

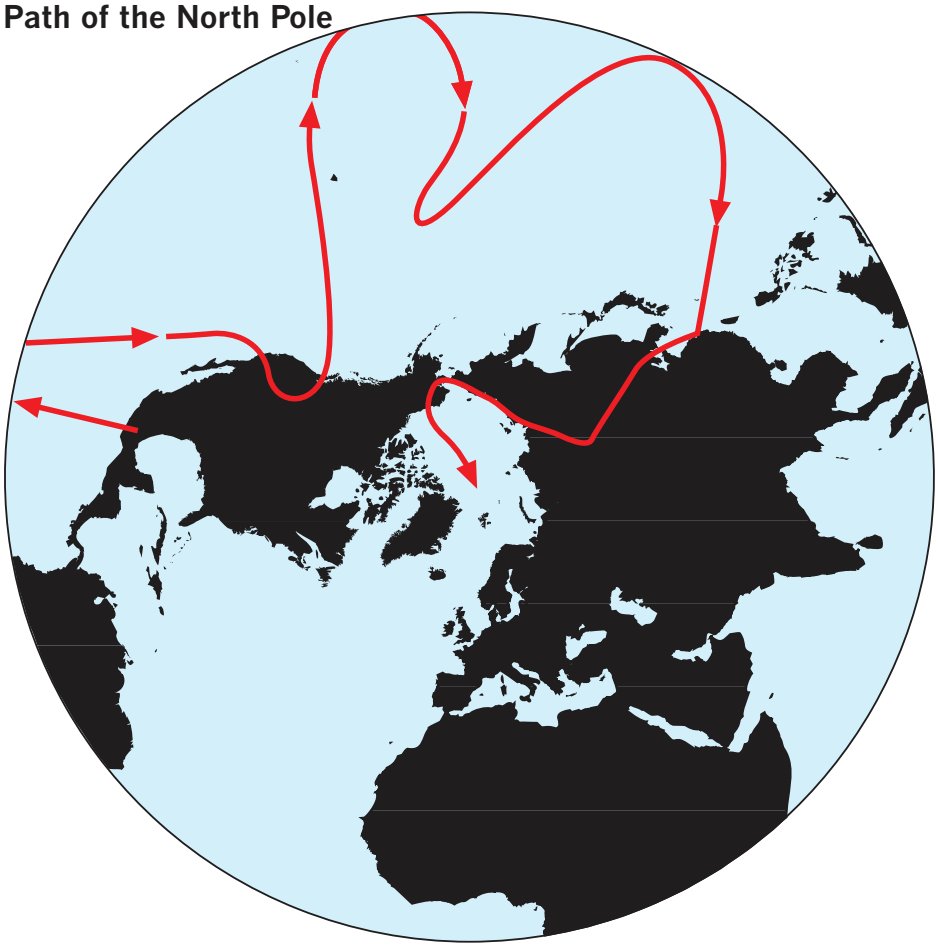
North Pole

- Further proof of continental drift lies in paleomagnetic evidence.
- Some rocks contain magnetic grains aligned with the magnetic poles' positions when those rocks were formed.
- Studies of such alignments show the north magnetic pole apparently wandering across the North Pacific Ocean over the last 2,250 million years.
- Tests have shown that in fact it is the continents that have wandered.

South Pole

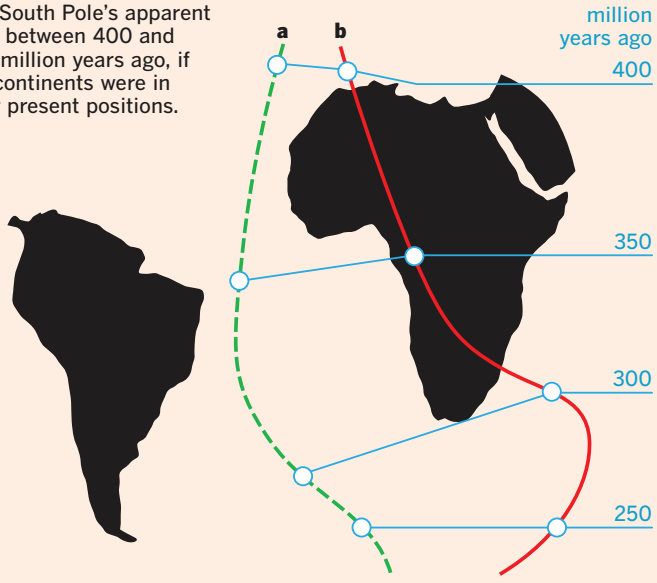
- Paleomagnetic studies in different continents reveal two apparent polar wander paths, not one.
- South American rocks show a different polar wander path from that shown by the rocks of Africa.
- If both continents were joined, a single wander path appears, indicating that both continents were once joined but have since moved apart.

Path of the North Pole

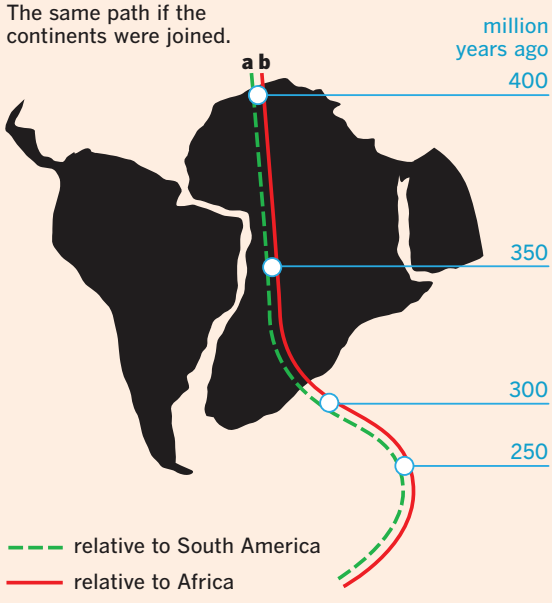


Path of the South Pole

The South Pole's apparent path between 400 and 250 million years ago, if the continents were in their present positions.



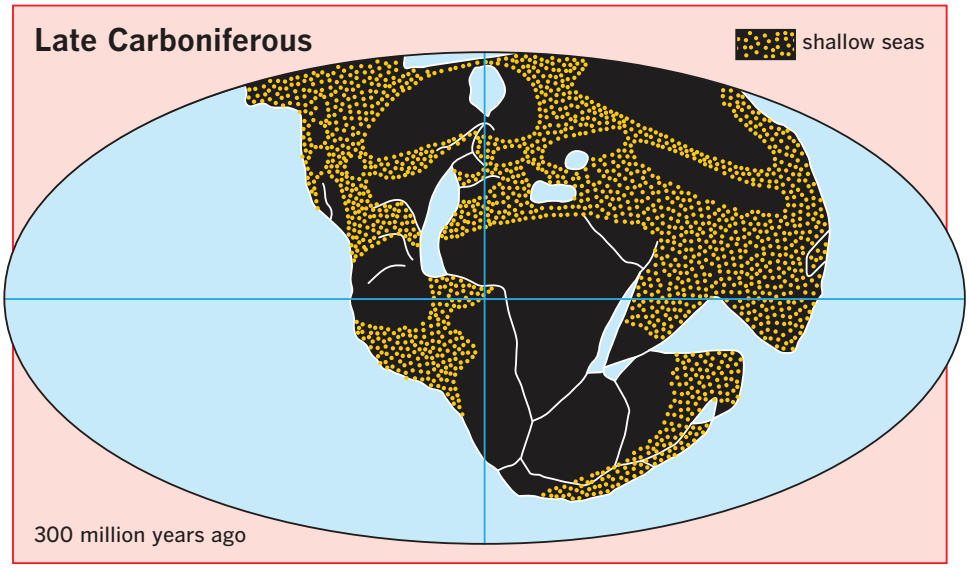
The same path if the continents were joined.

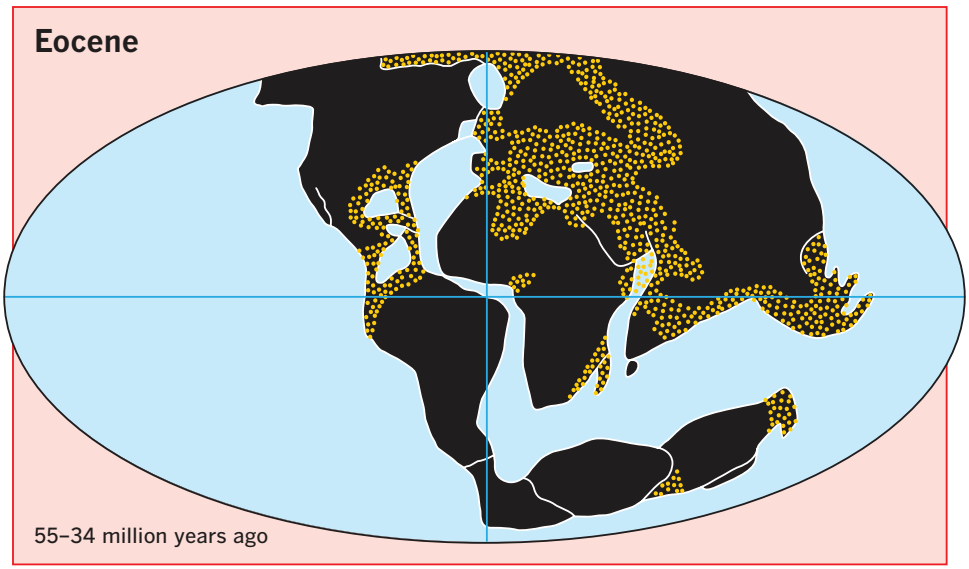


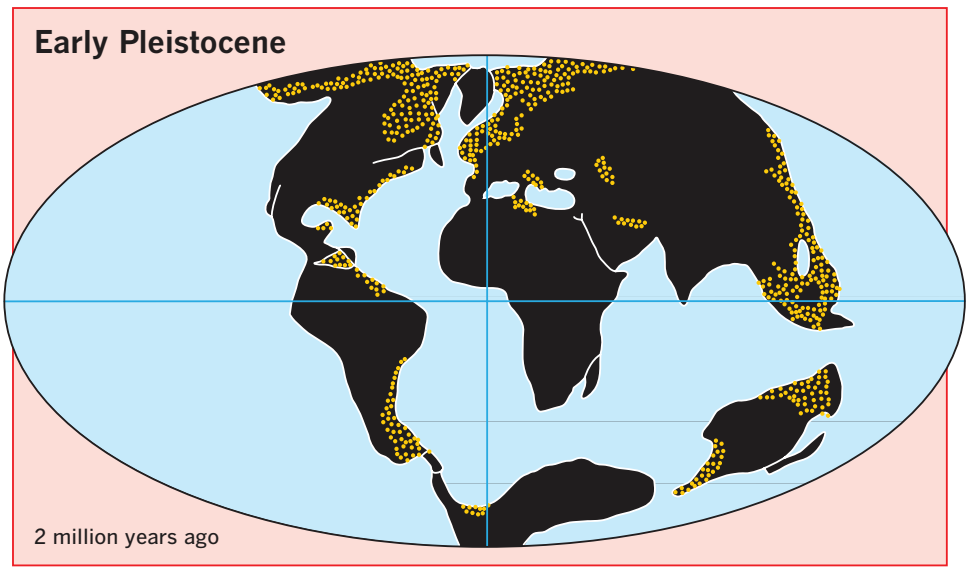
Key words

continental drift

Wegener's theory







Three world maps

- Maps show the arrangements of landmasses at three stages in the past as envisaged in a 1915 publication by Alfred Wegener, a German meteorologist now famous as an early proponent of the theory of *continental drift*.
- Wegener showed Africa where it is today as a point of reference.
- Stippled areas indicate the presence of shallow seas.

Late Carboniferous

- Late in the Carboniferous period there was only a single landmass, known as Pangaea (Greek for "all land"). One ocean, the Panthalassa (Greek for "all sea"), covered most of the rest of the world.

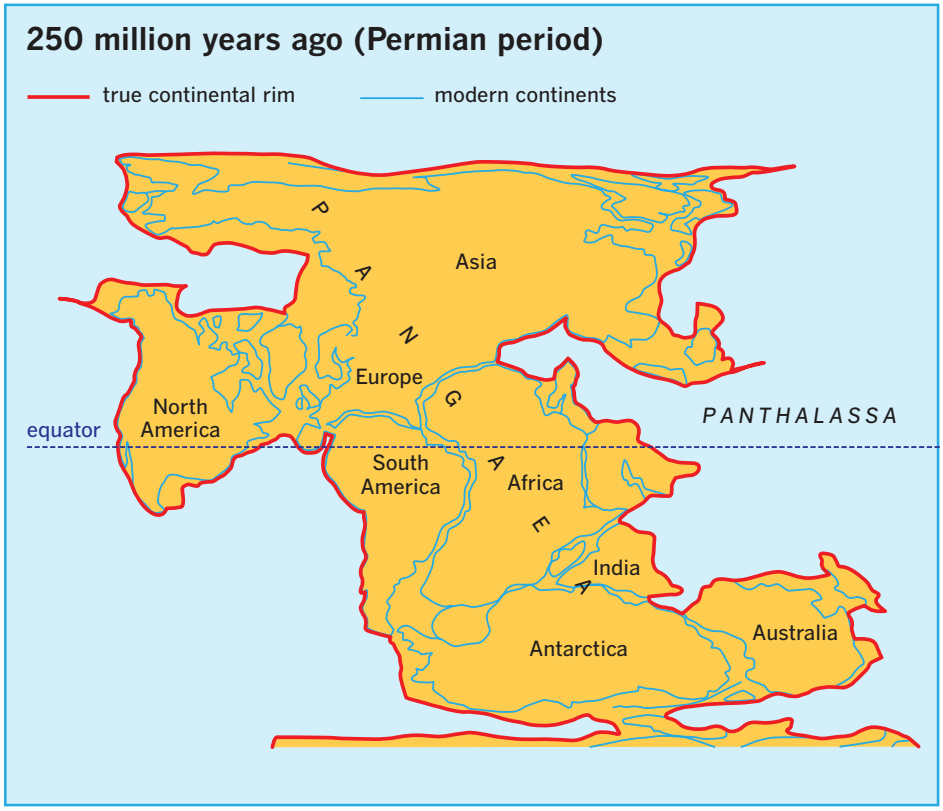
Eocene epoch

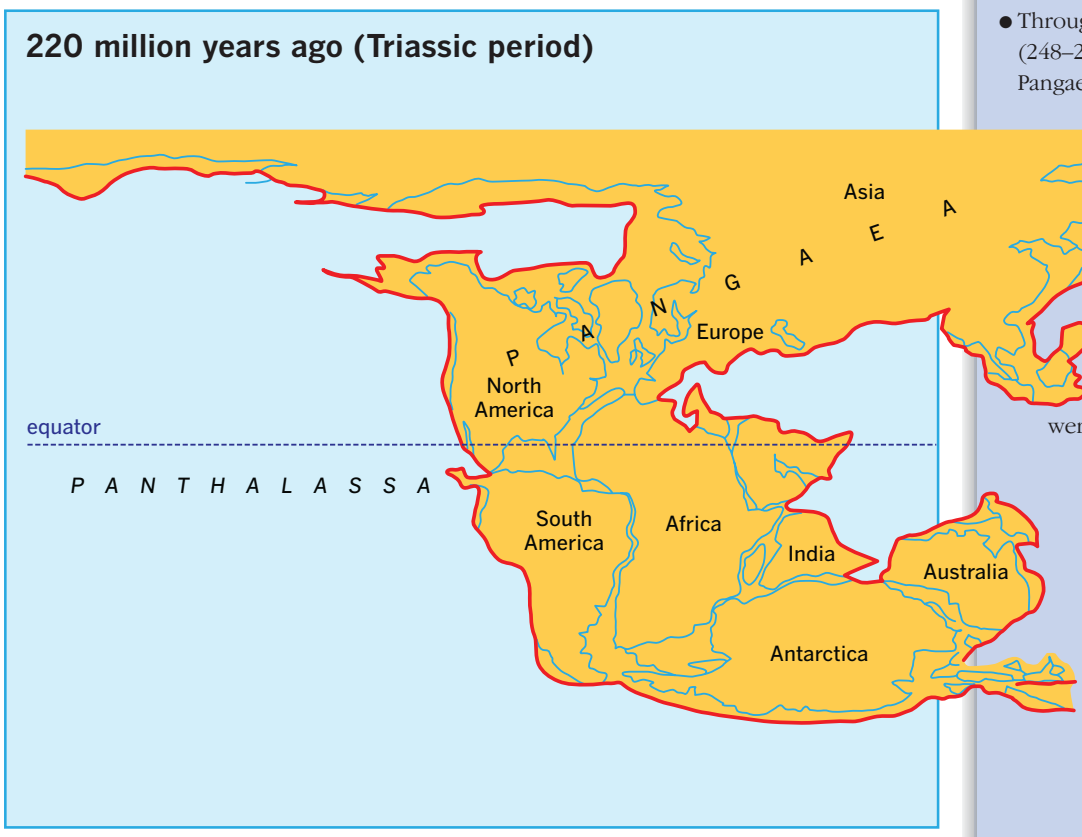
- Wegener's map shows Pangaea beginning to break up in the Eocene epoch, early in the Cenozoic era. In fact break-up began much sooner, in the Triassic period.

Early Pleistocene epoch

- By early in the Pleistocene epoch, the major continental landmasses of North and South America, Africa, Asia, Australia, and Antarctica are shown as having drifted apart. In fact they had virtually assumed their present positions well before this.

Continents: 250 million years ago





Key words

continent
period

Land through time

- Geologists today can reconstruct the configuration of the world's landmasses by continental drift at intervals from 250 million years ago.

Permian period

- In Permian times (about 290–248 million years ago) continents had fused into the single mighty landmass of Pangaea, surrounded by the immense Panthalassa Ocean.
- The continent of Europe collided with Siberia to form the Ural mountains, and other fusing lithospheric plates had formed most of the rest of Asia.
- Africa's (or South America's) collisions with Europe and North America pushed up Europe's Hercynian mountains and the Appalachians.

Triassic Period

- Throughout the Triassic period (248–206 million years ago) the Pangaean landmass drifted north, but parts of Europe and North America still lay inside the tropics.
- Ice sheets that once covered the southern continents had melted, world climates ranged from warm to mild, and deserts were extensive.
- Pangaea now showed signs of breaking up. Where rising plumes of magma domed and split Earth's crust, rifts appeared in North America, Northwest Africa, and Western Europe.

Key words

batholith
Gondwana
Laurasia
period

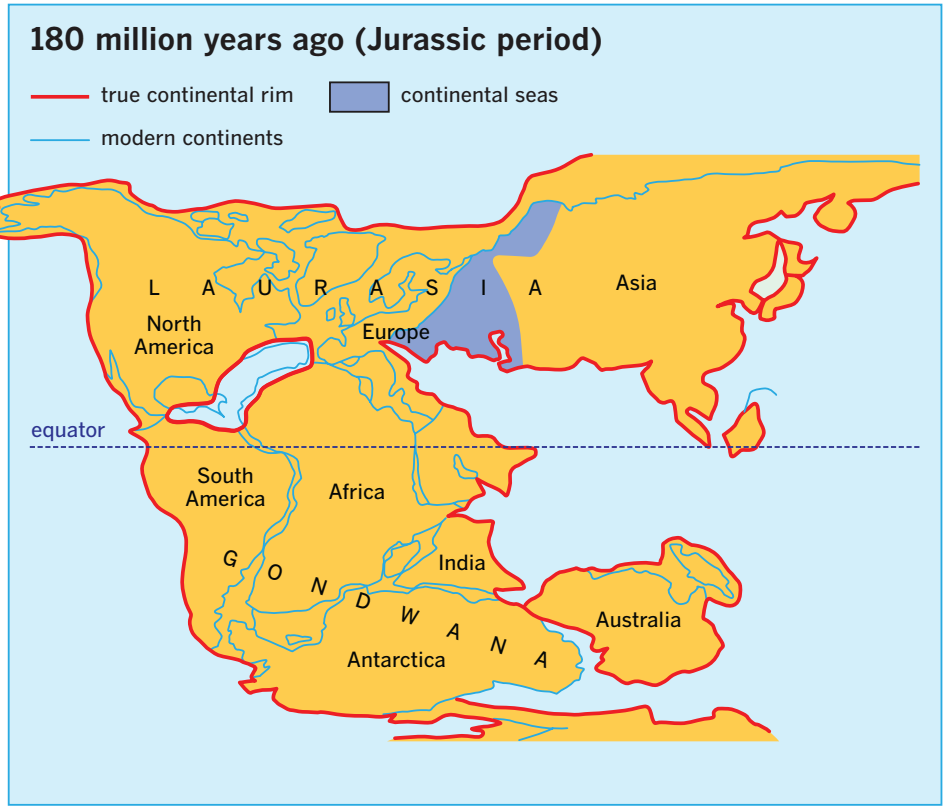
Jurassic period

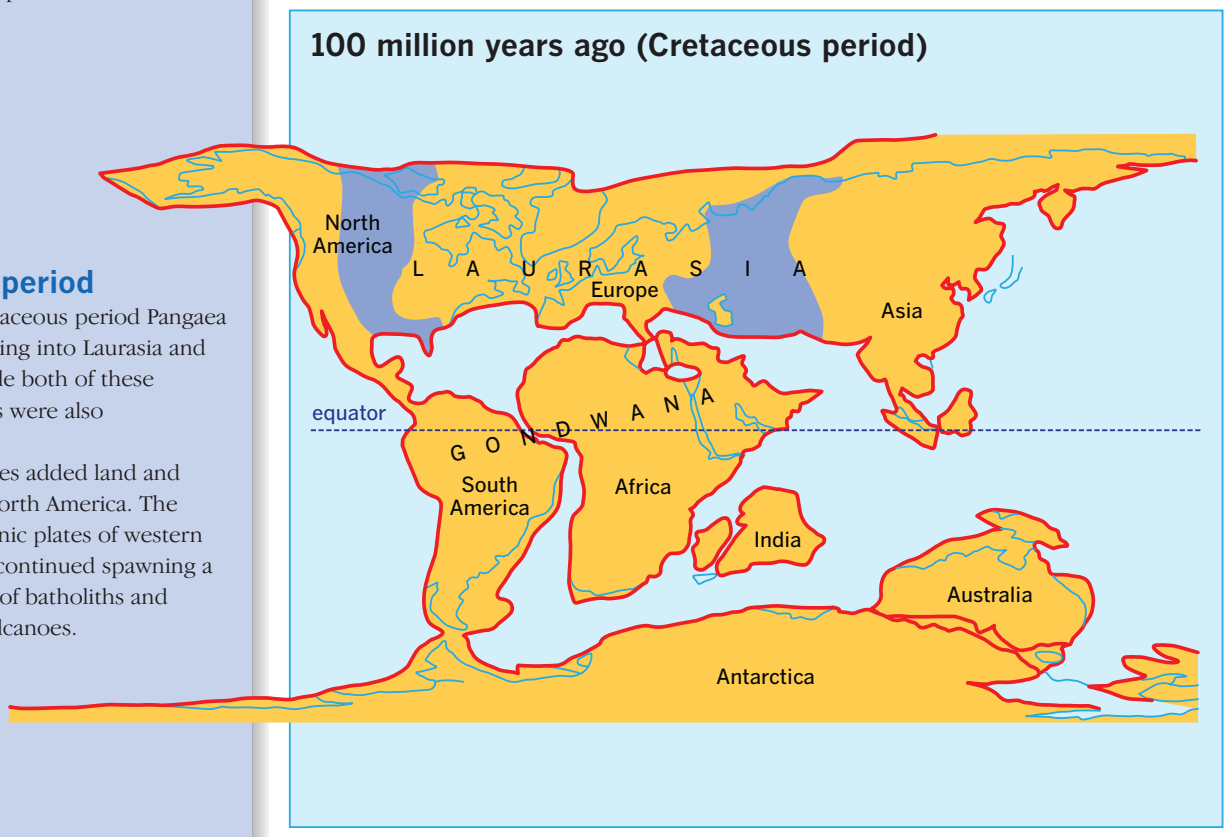
- In the Jurassic period (about 206–144 million years ago) Pangaea began breaking up into the continents we know today.
- The first split opened up what would become the North Atlantic Ocean.
- The resulting northern supercontinent is known as *Laurasia*, and the southern supercontinent as *Gondwana*.
- Rifting began separating Africa/South America from Antarctica/Australia but the Indian subcontinent was probably still stuck to East Africa.
- Mountains rose in western North America as the continent moved west and overrode an oceanic plate.
- Africa pushed against southern Europe, shedding minicontinents later tacked onto lands as far apart as Spain and the Arabian peninsula.

Cretaceous period

- During the Cretaceous period Pangaea continued splitting into Laurasia and Gondwana, while both of these supercontinents were also fragmenting.
- Dramatic changes added land and mountains to North America. The overriding oceanic plates of western North America continued spawning a great island arc of batholiths and Andean-type volcanoes.

Continents: 180 million years ago

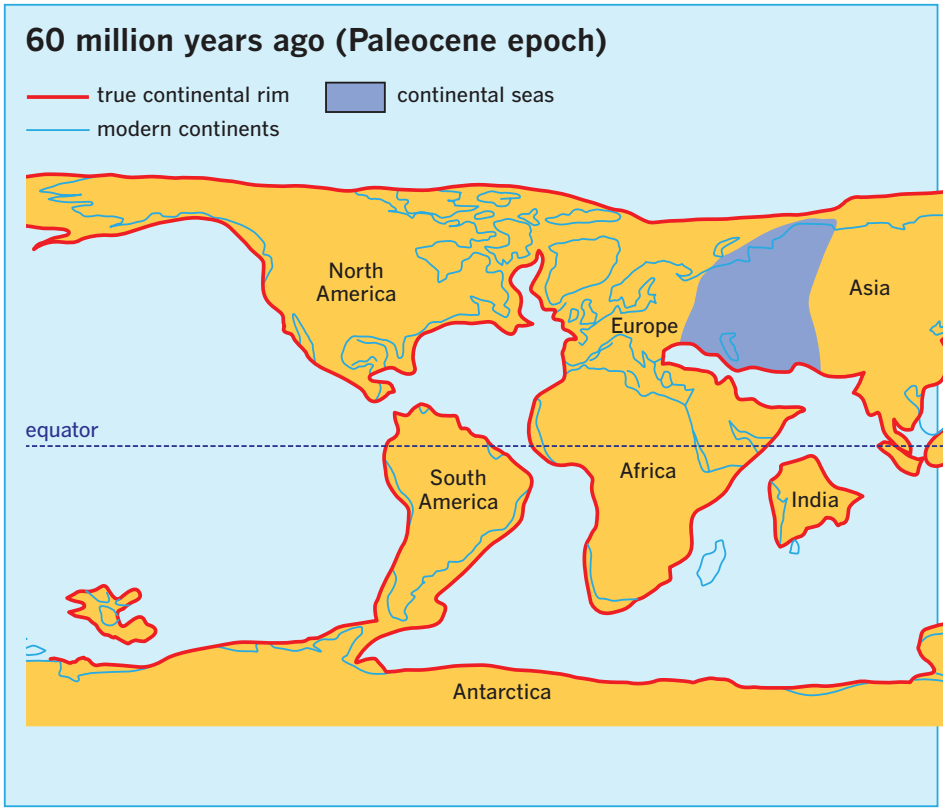


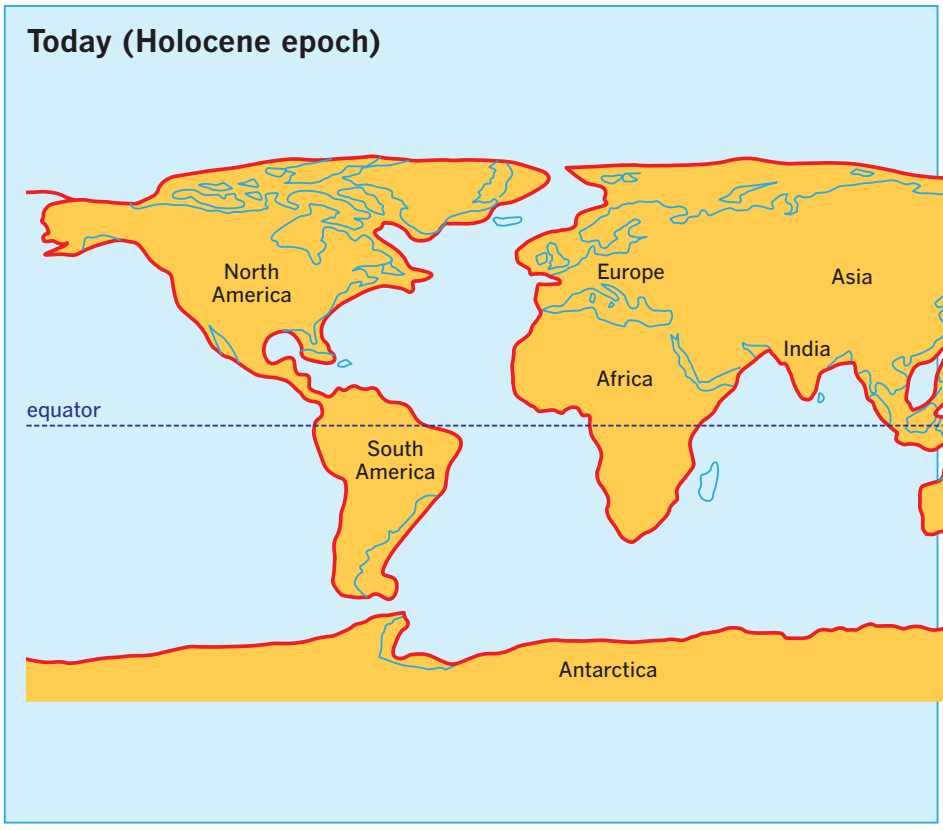


Continents: 60 million years ago

Key words

continent
epoch
period





Paleocene epoch

- The Paleocene epoch (65–55 million years ago) saw continents taking on their present shapes and locations.
- Shallow seas that had invaded parts of North America, Africa, and Australia in the Cretaceous period now drained away.
- North America was still linked to Asia and Europe.
- South America was an island cut off from North America.
- The subcontinent of India was heading toward Asia.
- Everywhere, mammals filled ecological niches left vacant when all non-bird dinosaurs had died out at the end of the Cretaceous period.

Holocene epoch

- In the Holocene epoch (present day), North America and Europe are separated by an ever-widening North Atlantic Ocean.
- South America and Africa are separated by an ever-widening South Atlantic Ocean.
- Greenland has been isolated from North America and Europe.
- India has impacted with Asia creating the vast Himalayan mountain range.
- North and South America have joined.
- Australia has separated from Antarctica and migrated northward.

Key words

asthenosphere
plate tectonics

Lithospheric plate movement

- Earth's lithospheric plates float on the *asthenosphere* (the semifluid upper mantle). Their movement across Earth's surface is believed to be driven by convection currents in the mantle.

Lithospheric plates