

Alfred Wegener's Theory of Continental Drift Became Modern Plate Tectonics



Alfred Wegener



Wegener in
Greenland about
1912. He froze to
death there in 1930.

The Scientific Method

Science is self correcting.

The history of science is littered with theories that were accepted; but, little by little, evidence accumulated that cast doubt on the original theory and pointed the way to a new, more comprehensive explanation.

The geocentric view of the solar system gave way to the heliocentric view 500 years ago.

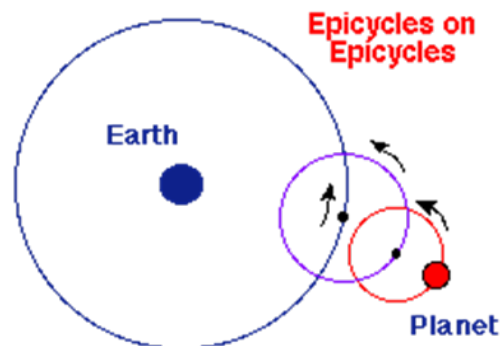
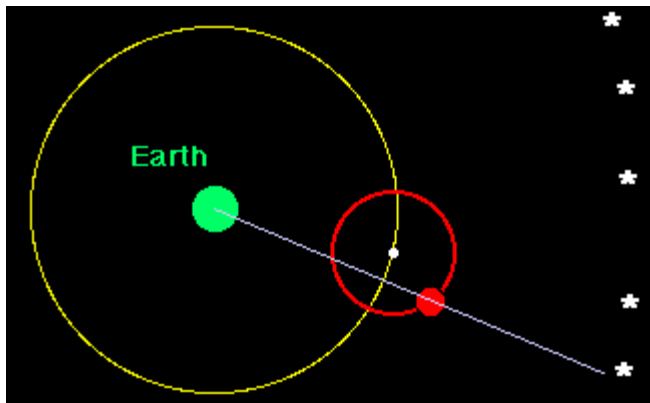
The view that animals get larger over time was shown to be wrong.

The Scientific Method

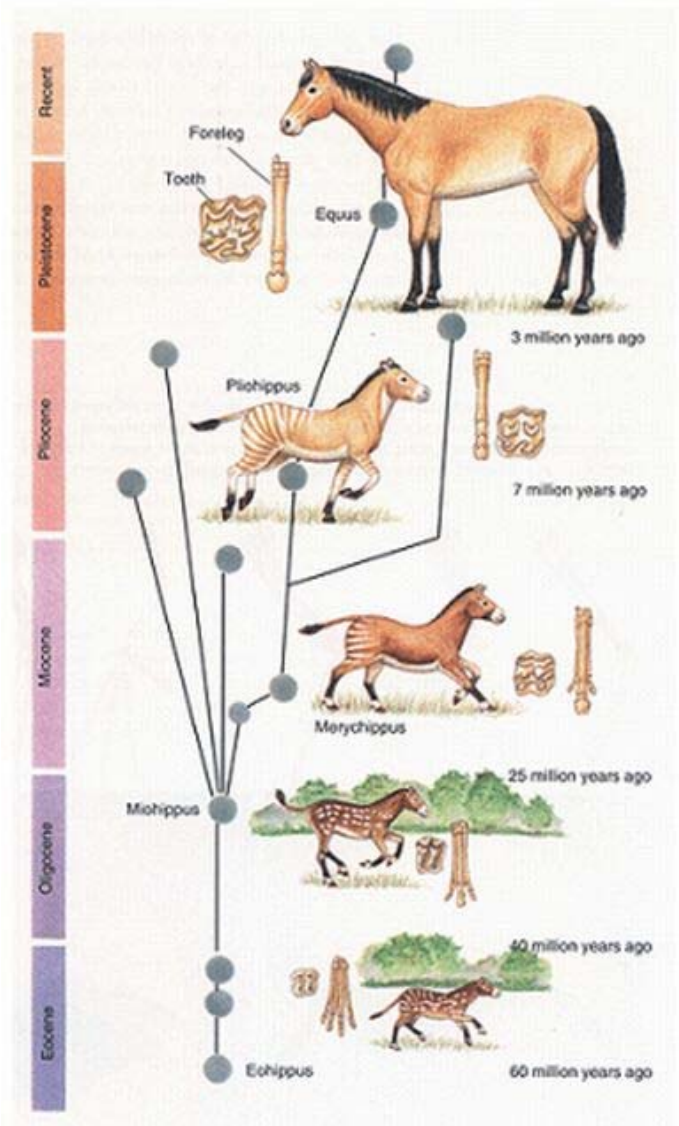
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The geocentric view of the solar system gave way to the heliocentric view 500 years ago.



The view that animals get larger over time was shown to be wrong. The horse has, but the gibbon has gotten smaller.



Próunarsaga hestsins.

Wegener Noticed the
Similarity of the Coastlines
of South America and
Africa

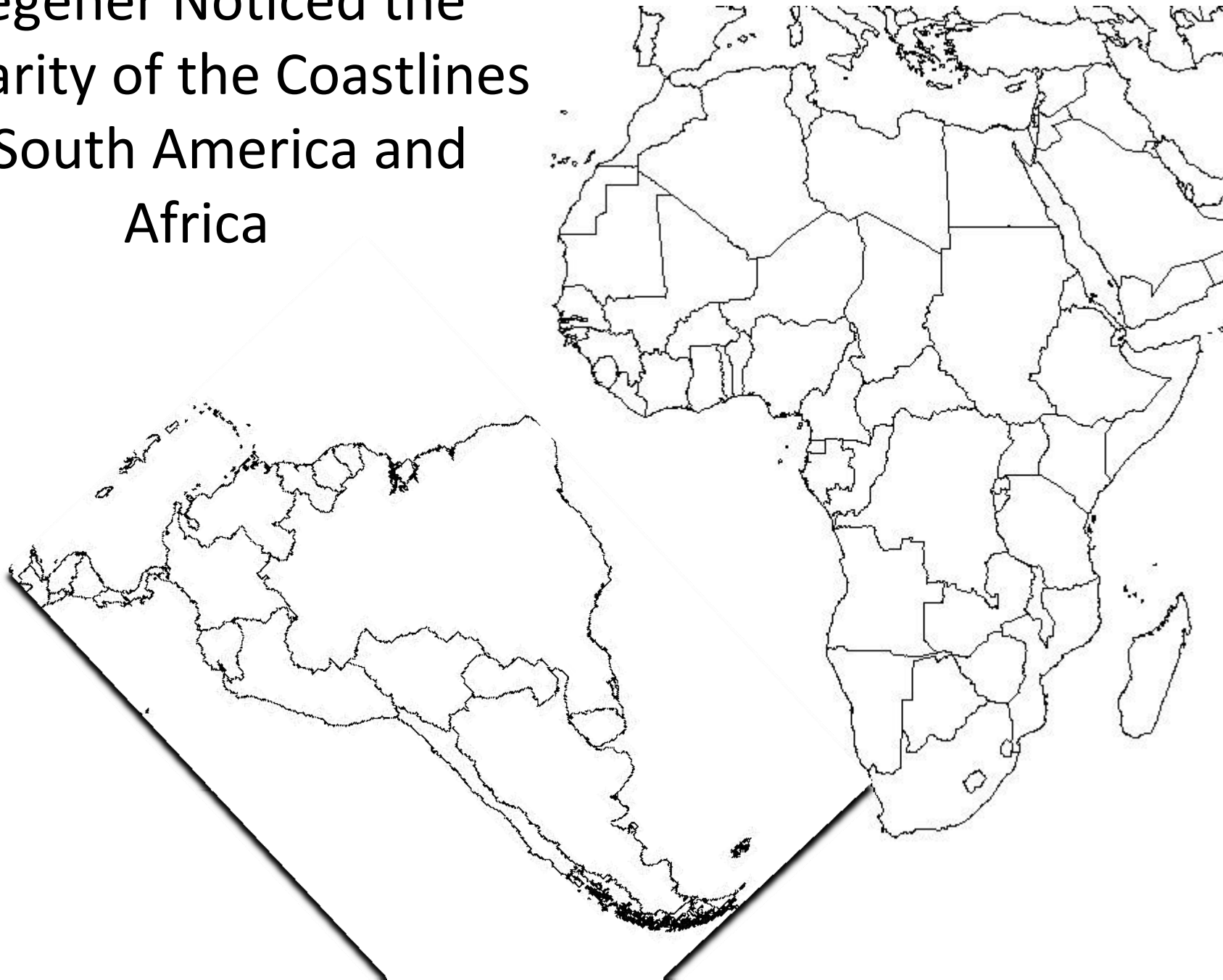


Plate Tectonics and the Scientific Method

Plate tectonics was originally called the “Theory of Continental Drift” originated by Alfred Wegener. The development of the theory is an excellent example of the application of the scientific method.

Plate Tectonics represents a total shift of scientific paradigm. The prevailing view was that the continents had always had the same positions on the planet that they do today. This is a very logical view. However Wegener attempted to provide convincing evidence that, over long periods or geological time, the continents moved across the surface of the earth. This was a radical view.

The Steps in the Scientific Method Are:

- Observation
- Research Question
- Hypothesis
- Prediction
- Evidence and Experimentation
- Theory

The most important step is the development of a testable hypothesis that will provide definitive evidence that proposed relationships are correct or that they are wrong.

- Observation:
 - The coasts of Africa and South America fit together like pieces of a puzzle.
- Research Question:
 - Why do they fit together so precisely?
- Hypothesis:
 - They were part of a larger continent in the remote past that split apart somehow?
- Prediction:
 - If they were connected, the geology at corresponding positions along the coastline should correlate.

Rock Sequences Were Nearly the Same at Corresponding Points on Both Sides of the Atlantic

South America

Sandstone

Siltstone

Sandstone

Slate

Granite

Africa

Limestone

Loess

Sandstone

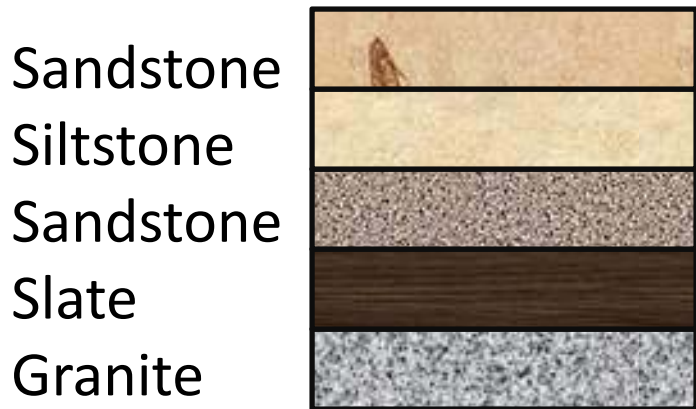
Slate

Granite

One basic rule of geological processes is that the newest rock is on the top and the rocks get older layer by layer toward the bottom. The top layers are not identical because a lot has happened in the 80 million years they have been separated.

Rock Sequences Were Nearly the Same at Corresponding Points on Both Sides of the Atlantic

South America

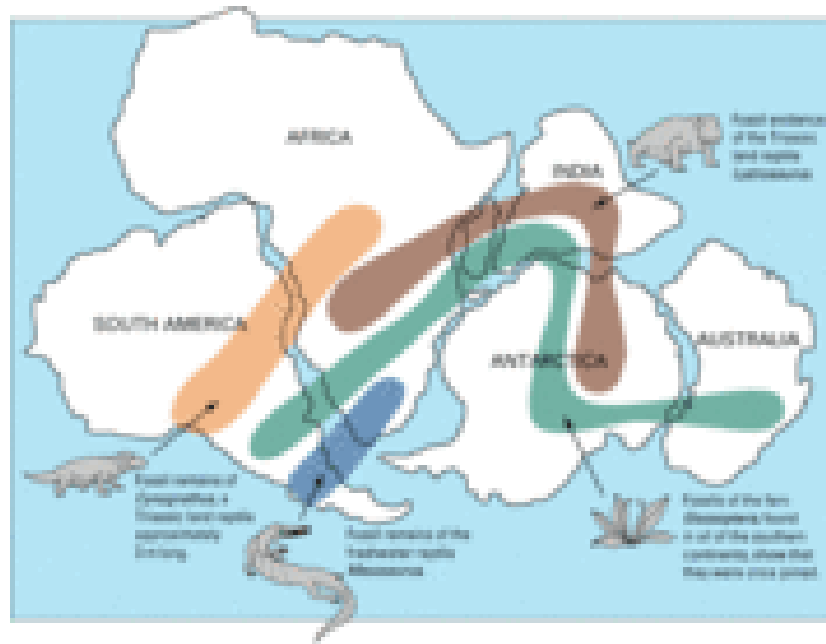


Africa

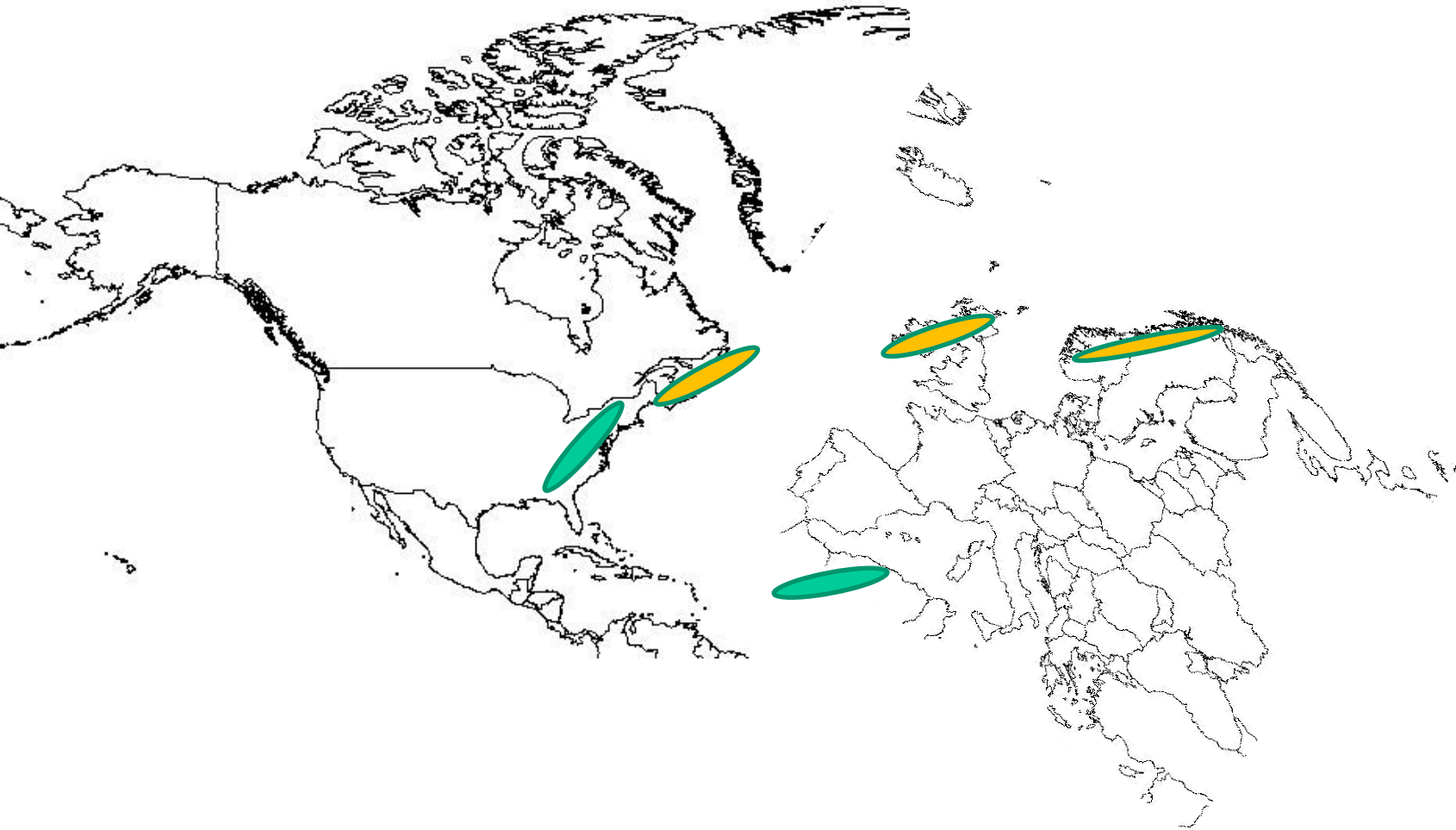


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Fossils of the Same Species Occurred at Corresponding Points on Both Sides of the Ocean



Geologic Structure in Newfoundland Matched that of Ireland and Scotland and also Scandinavia.
Geologic Structure of Appalachian Mountains Matched Morocco and Algeria in North Africa

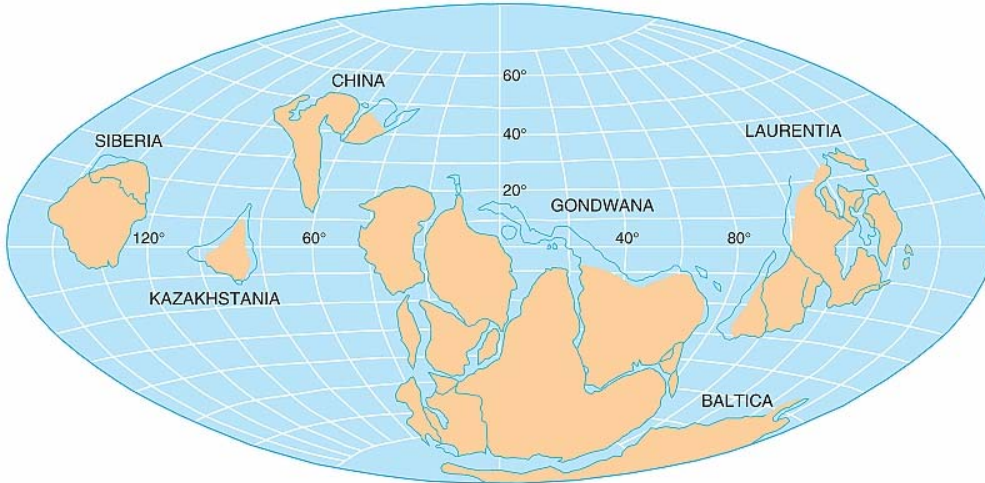


The Geologic Structure of the Appalachian Mountains Is nearly Identical to the Atlas Mountains of Morocco Because they Were Formed by the Same Processes When They Were Part of the Same Chain.

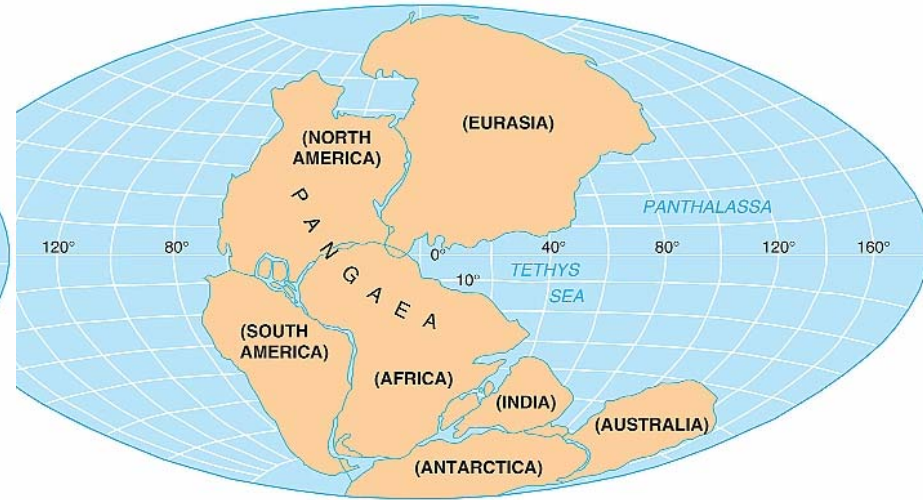


- Evidence and Experimentation: His fieldwork in Africa and South America showed that
 - The rock sequences correlated
 - Index fossils correlated
 - Paleo climates correlated
 - Geologic structure correlated.
- Theory: Wegener published his book *The Origin of the Continents and Oceans* in 1912 just prior to World War I. Unfortunately, it was never really accepted by geologists because no knowledge of forces capable of pushing continents around. The theory was revived in the 1950s when Sonar technology developed during World War II provided detailed knowledge of the structure of the ocean floor. It took a lot of time for technology to catch up with the theory.

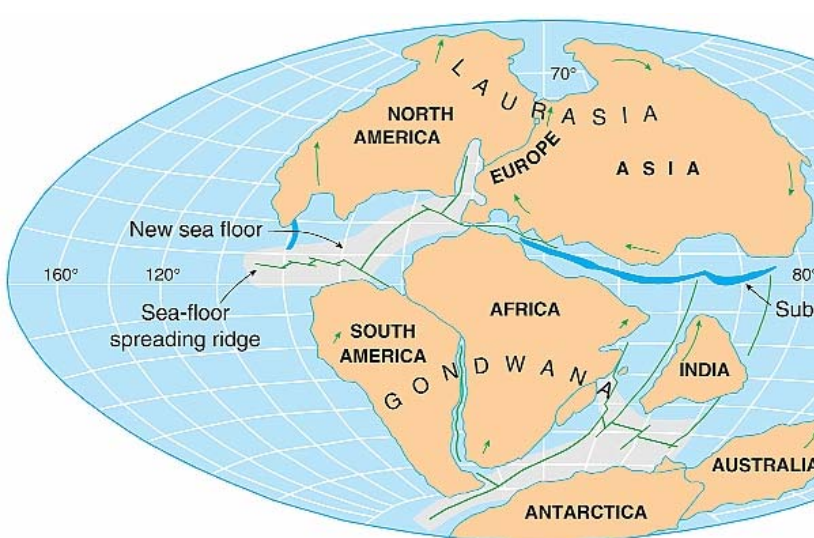
The Breakup of Pangaea



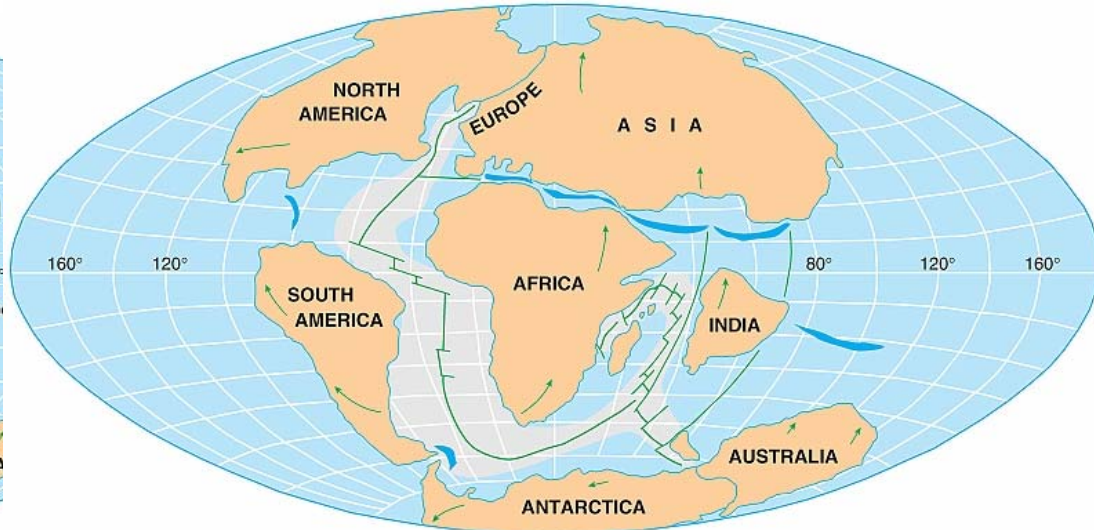
(a) 465 million years ago
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(b) 225 million years ago
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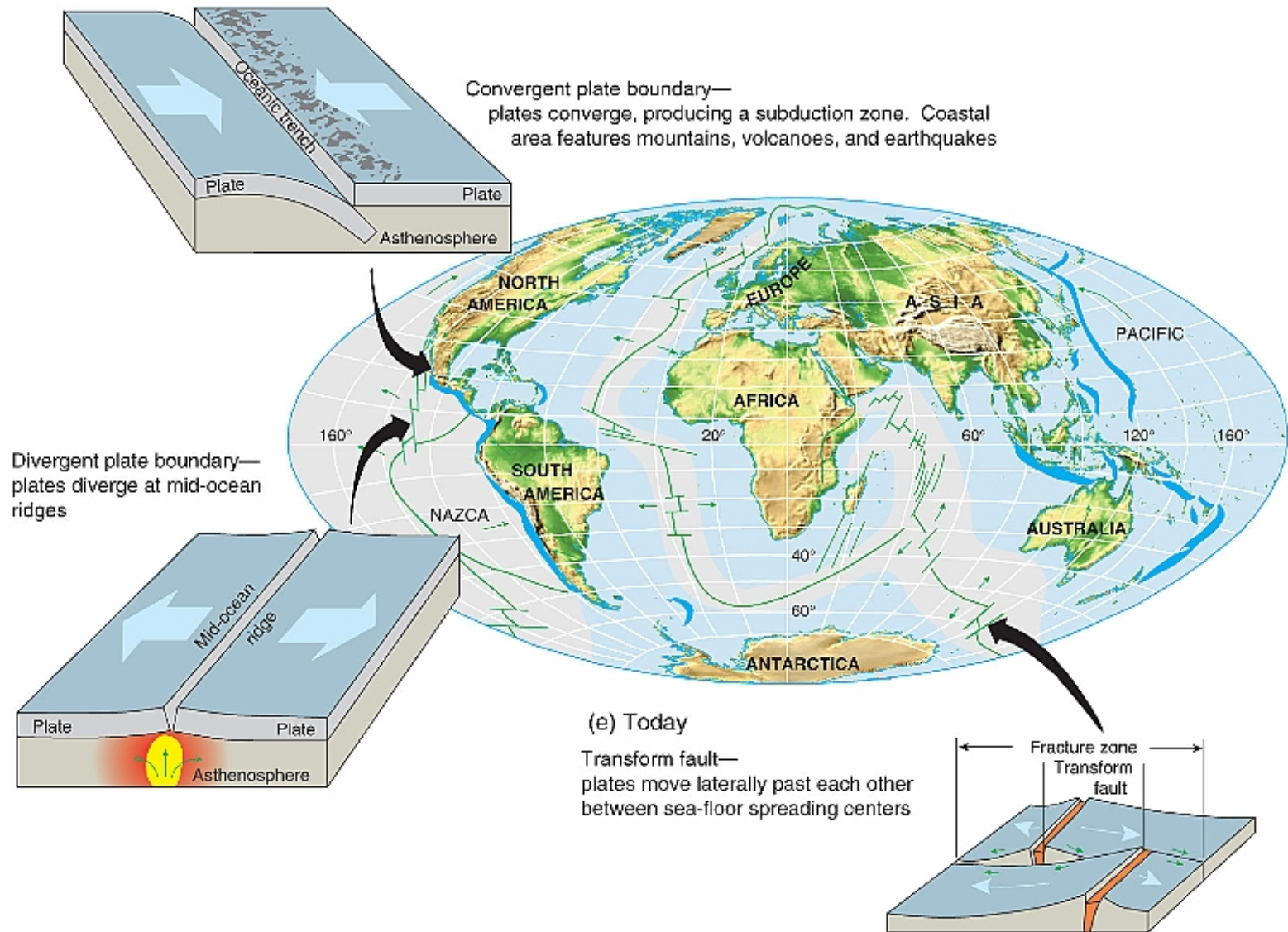


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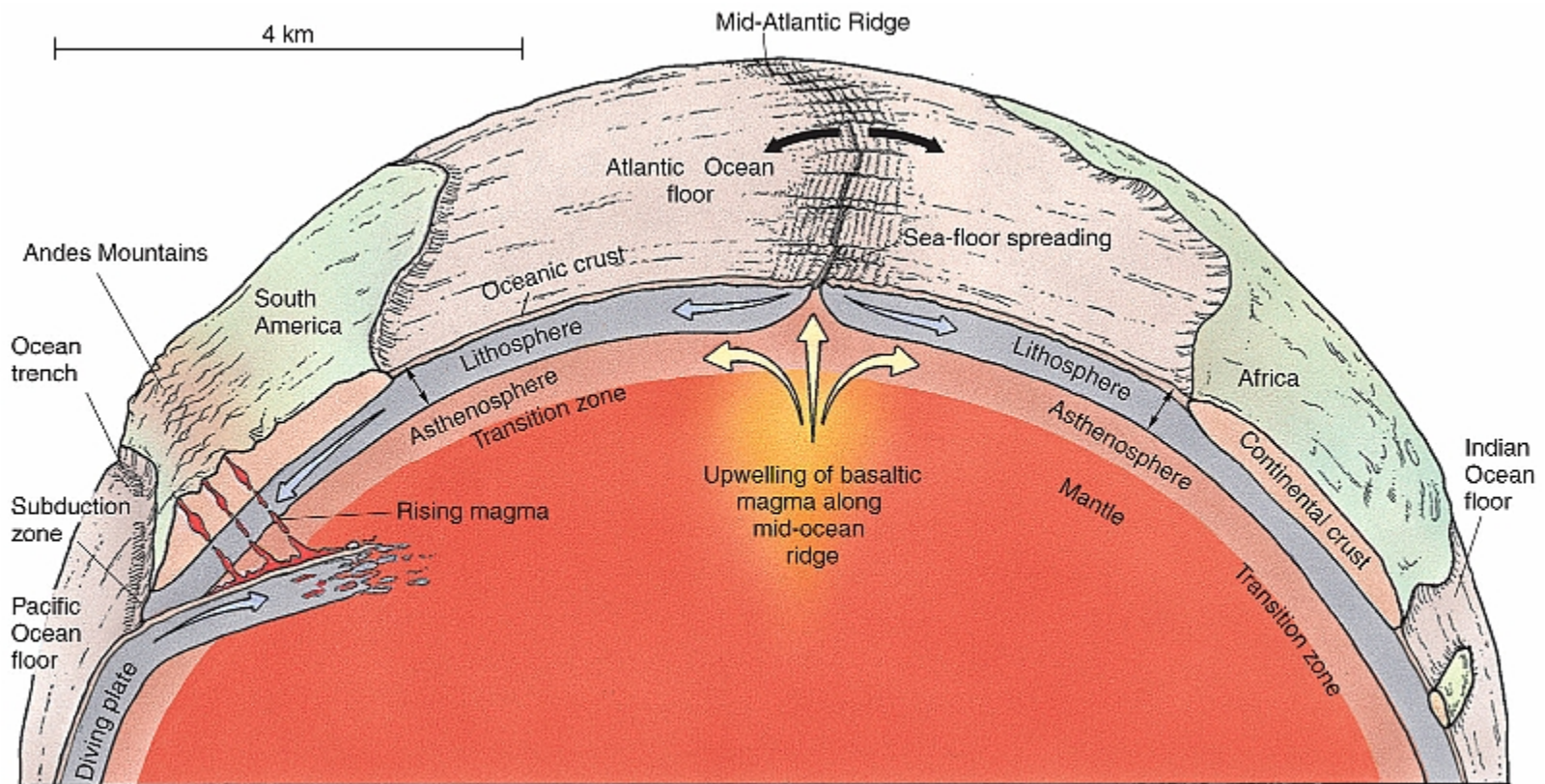


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The Current Arrangement of Continents

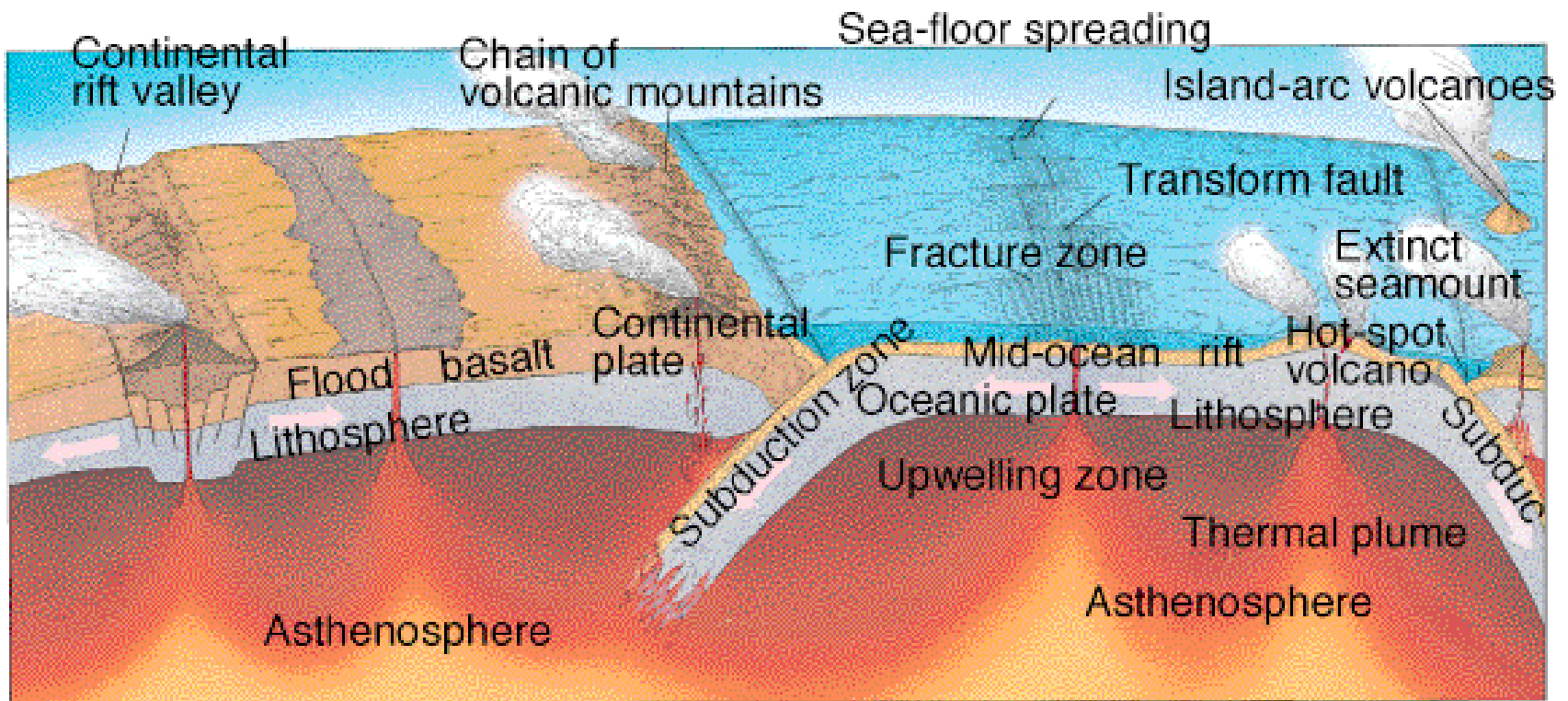


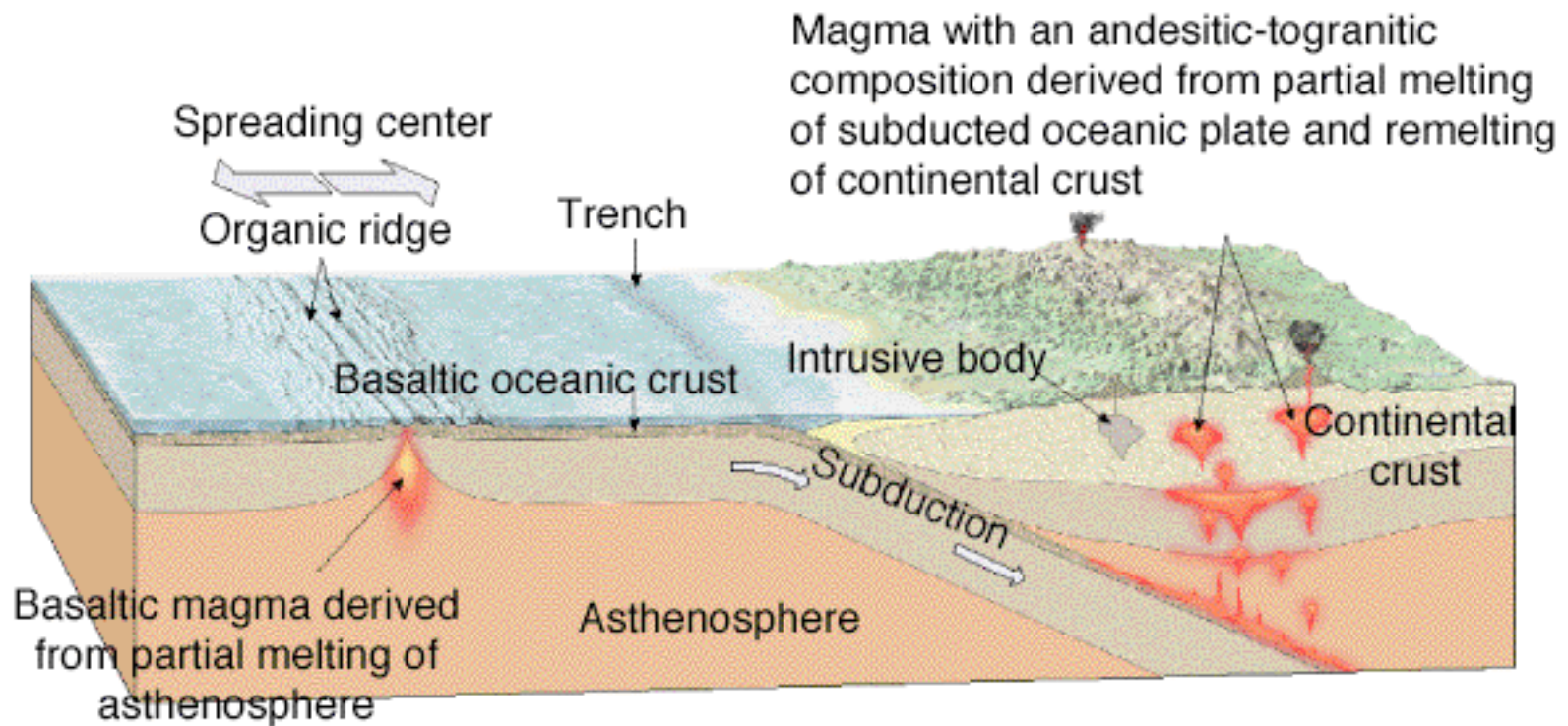
The Mid-Atlantic Ridge Is Created by Active Sea Floor Spreading that Drives Africa and South America Apart



(a)

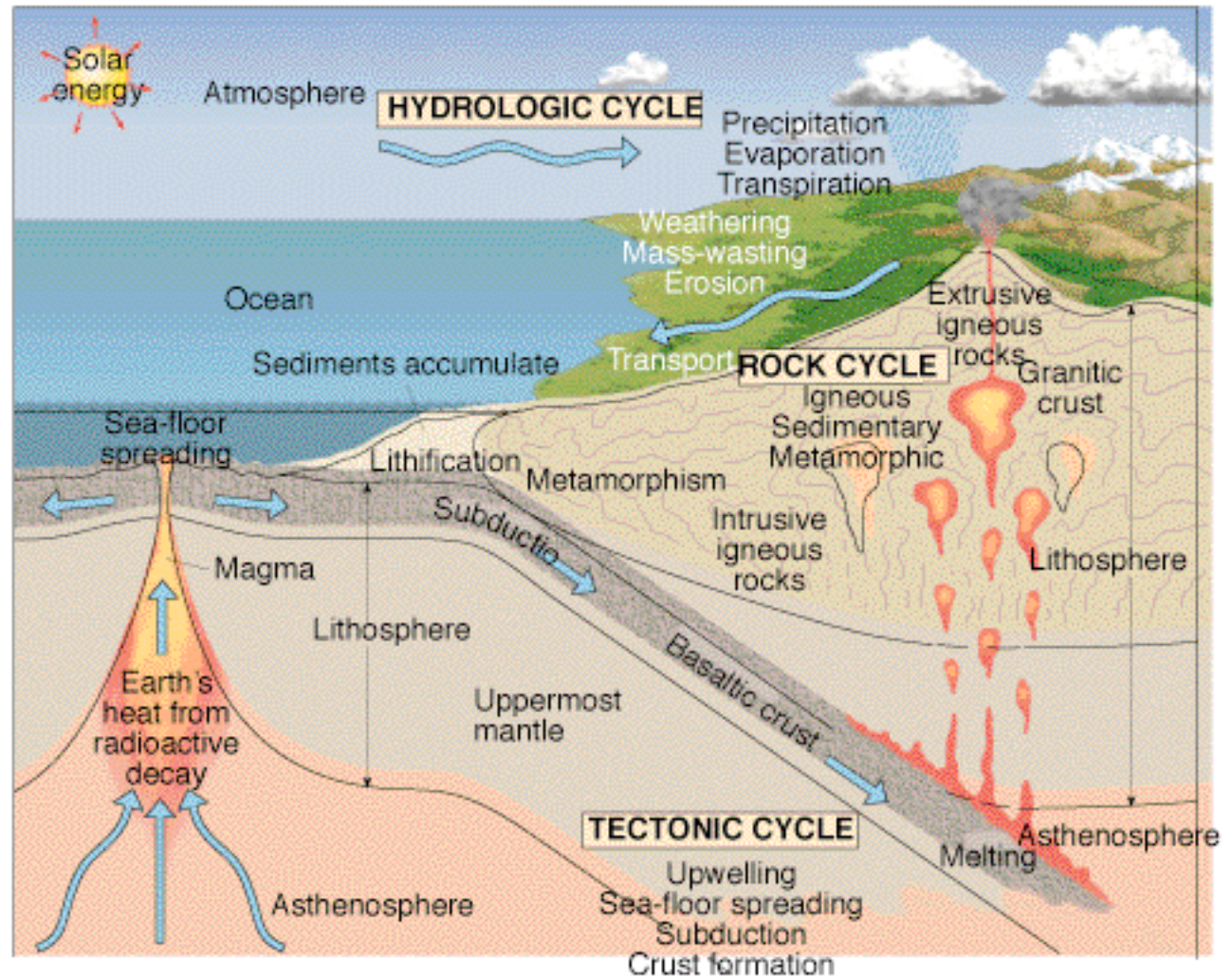
Principal Features Caused by Tectonics

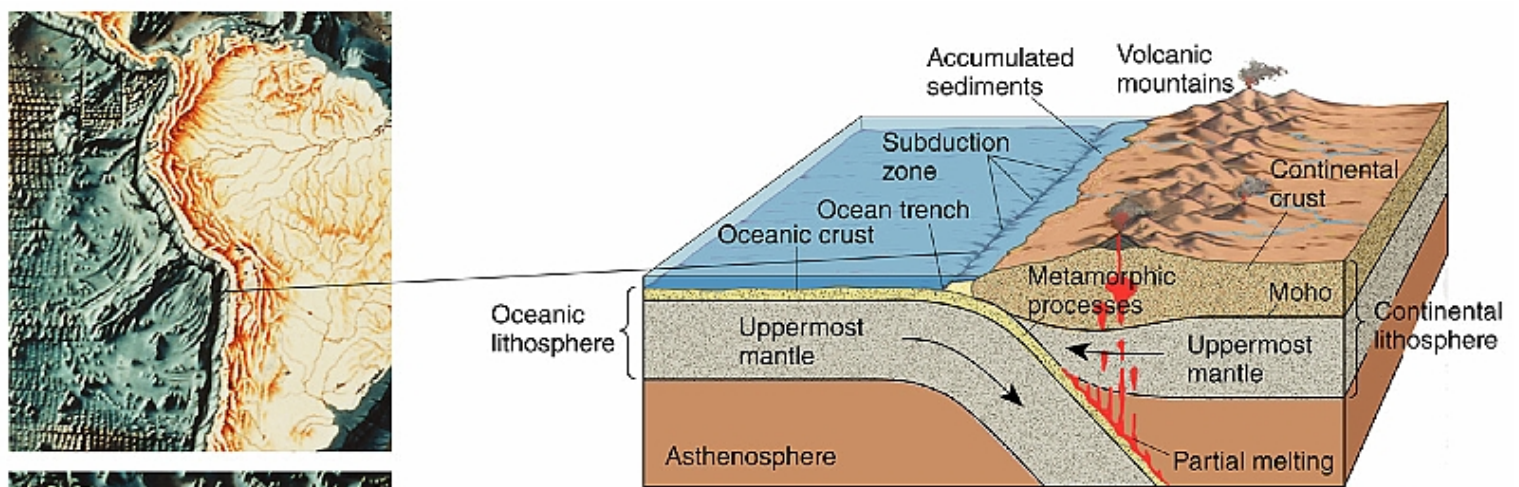




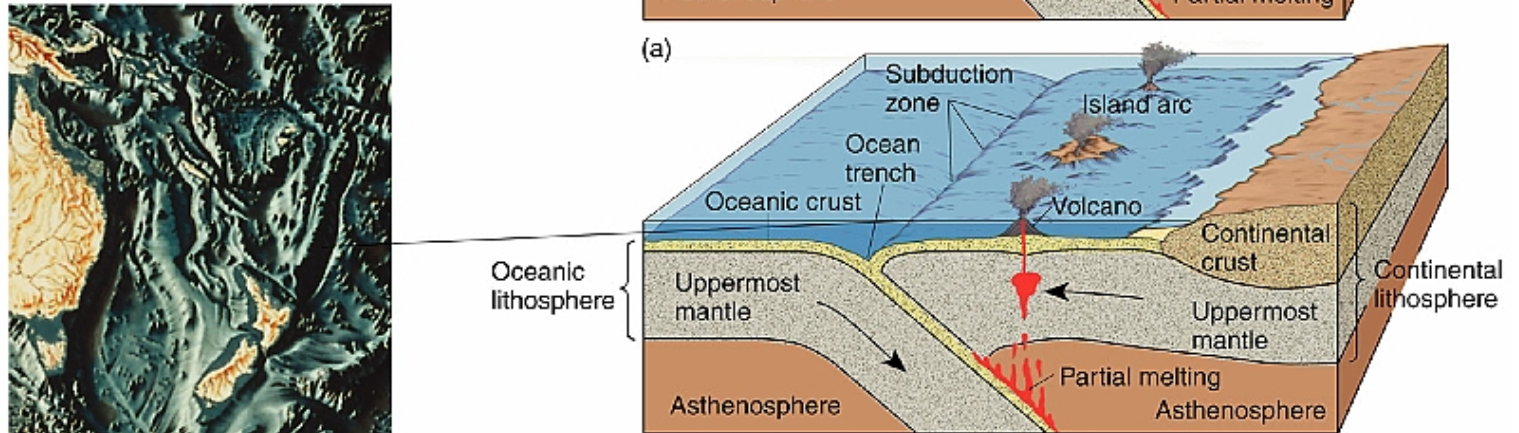
The Interaction of 3 Cycles Determines What Type of Rock is Formed and Where It Occurs.

Igneous rocks form either from the ocean floor or where magma moves upward through the continental plate. Metamorphic rocks form near by where heat and pressure alter the form of the original rock. Sedimentary rocks form at or near the surface where the hydrological cycle operates.

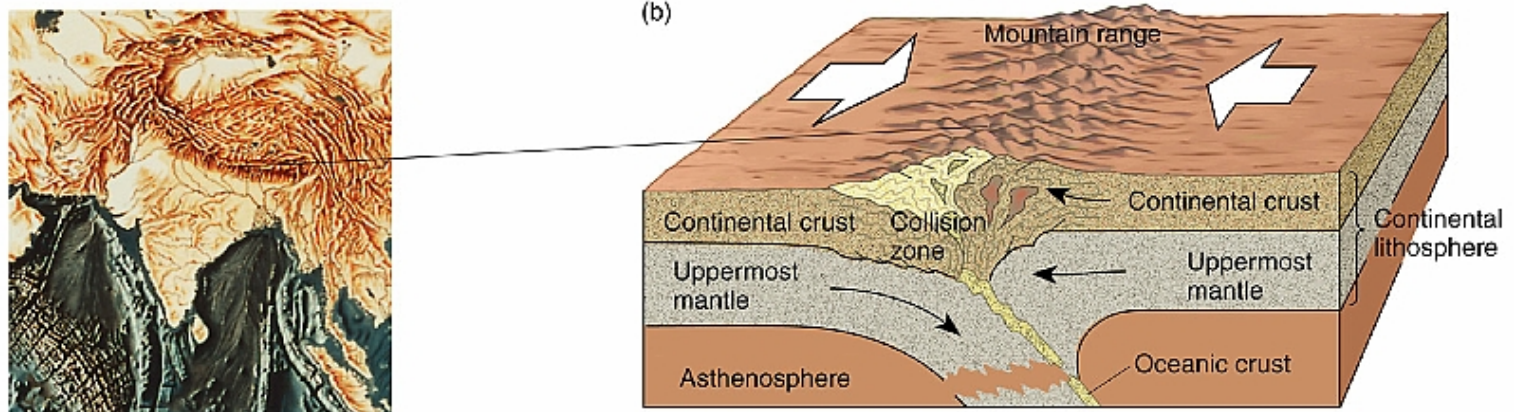




(a)

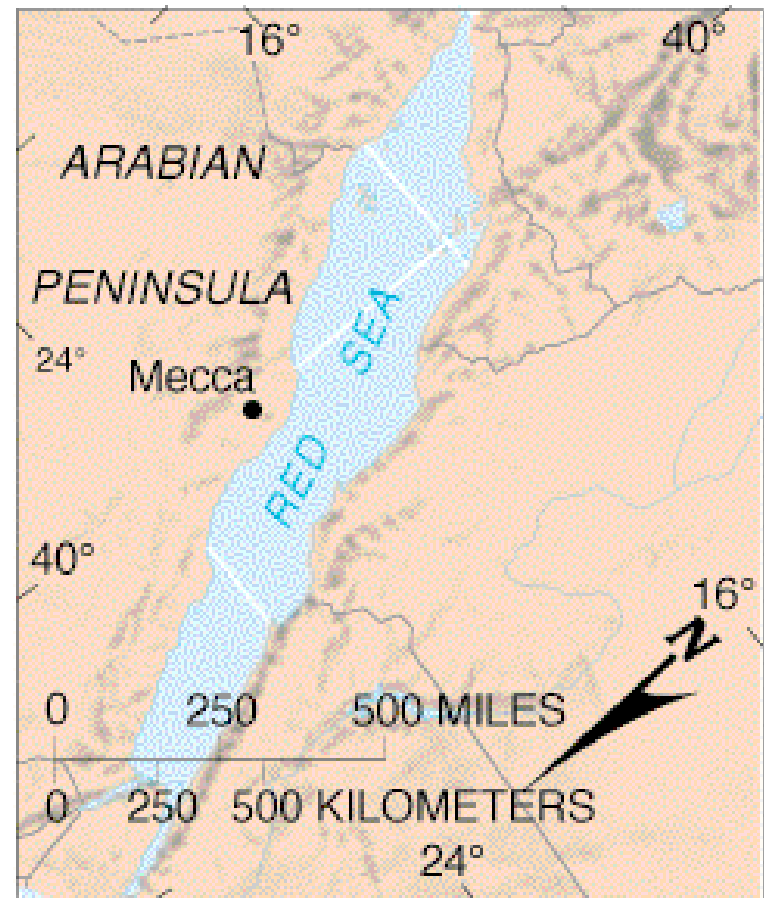


(b)

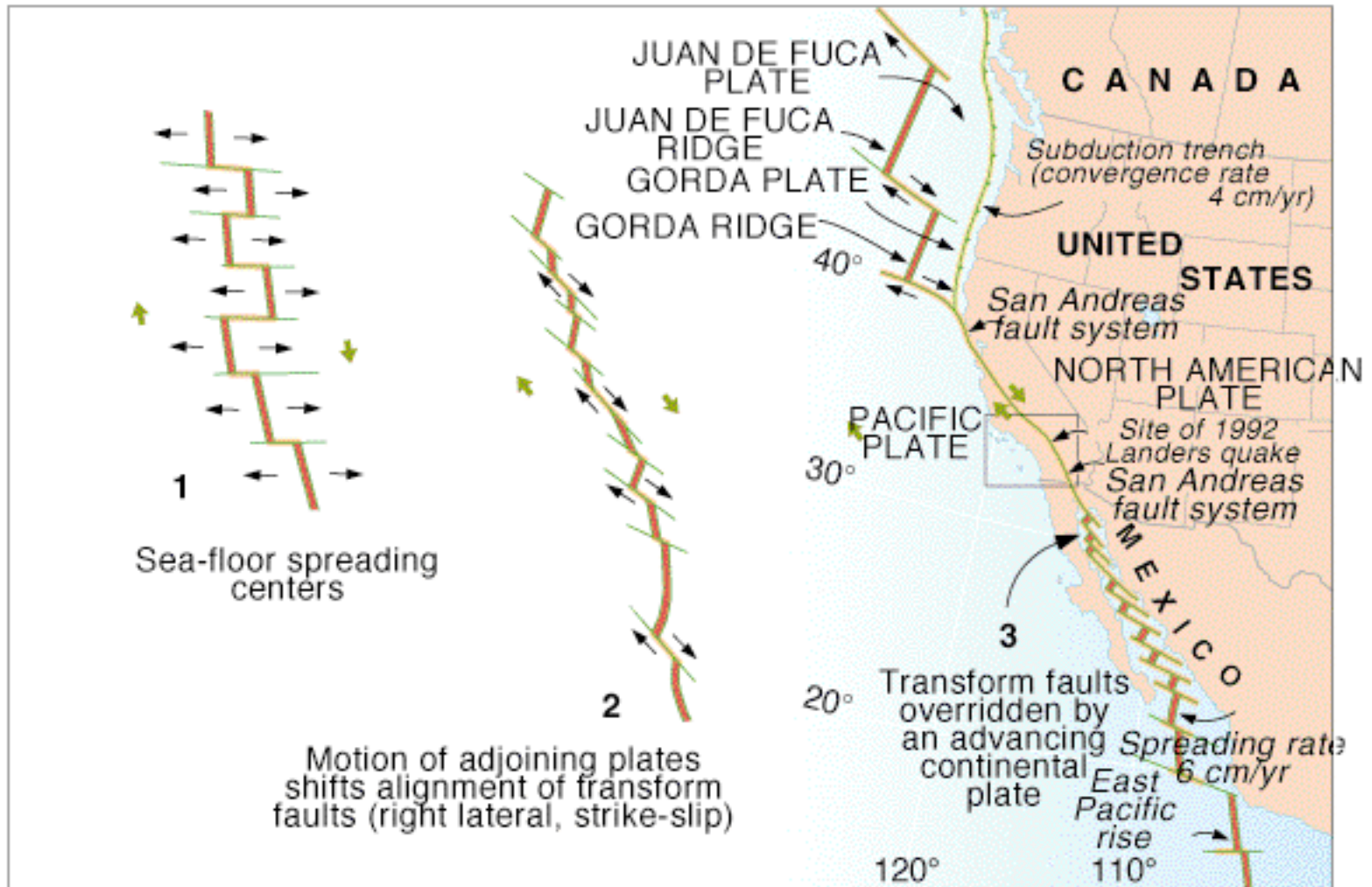


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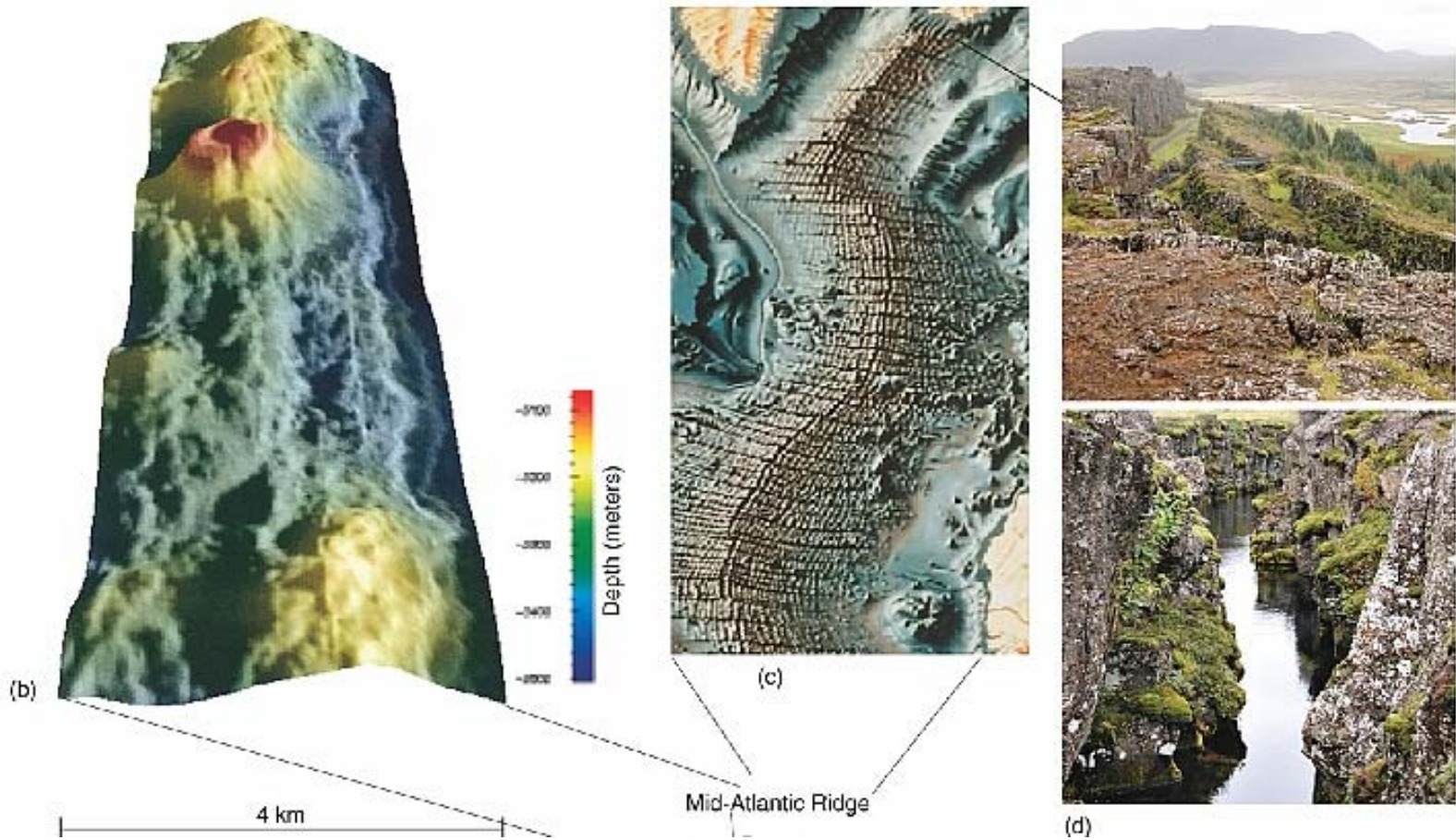
Arabia Continues to Separate from Africa Creating the Red Sea



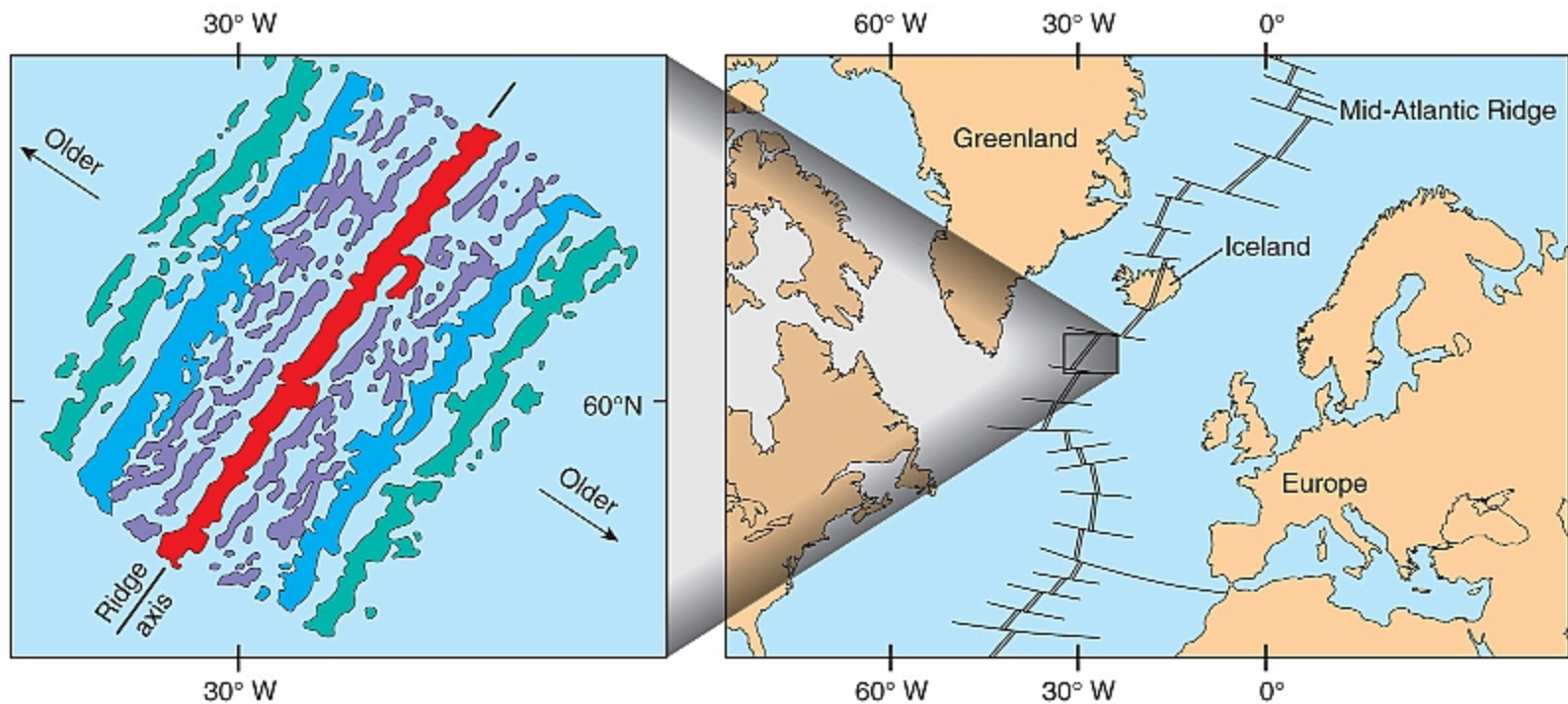
The San Andreas Fault is Really a Plate Boundary Between the North American Plate and the Pacific Plate. It is the source of Most California Earthquakes.



Sonar Image of Mid-Atlantic Ridge and Individual Volcanoes, Also Rift in Iceland

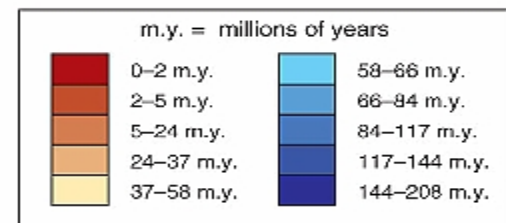
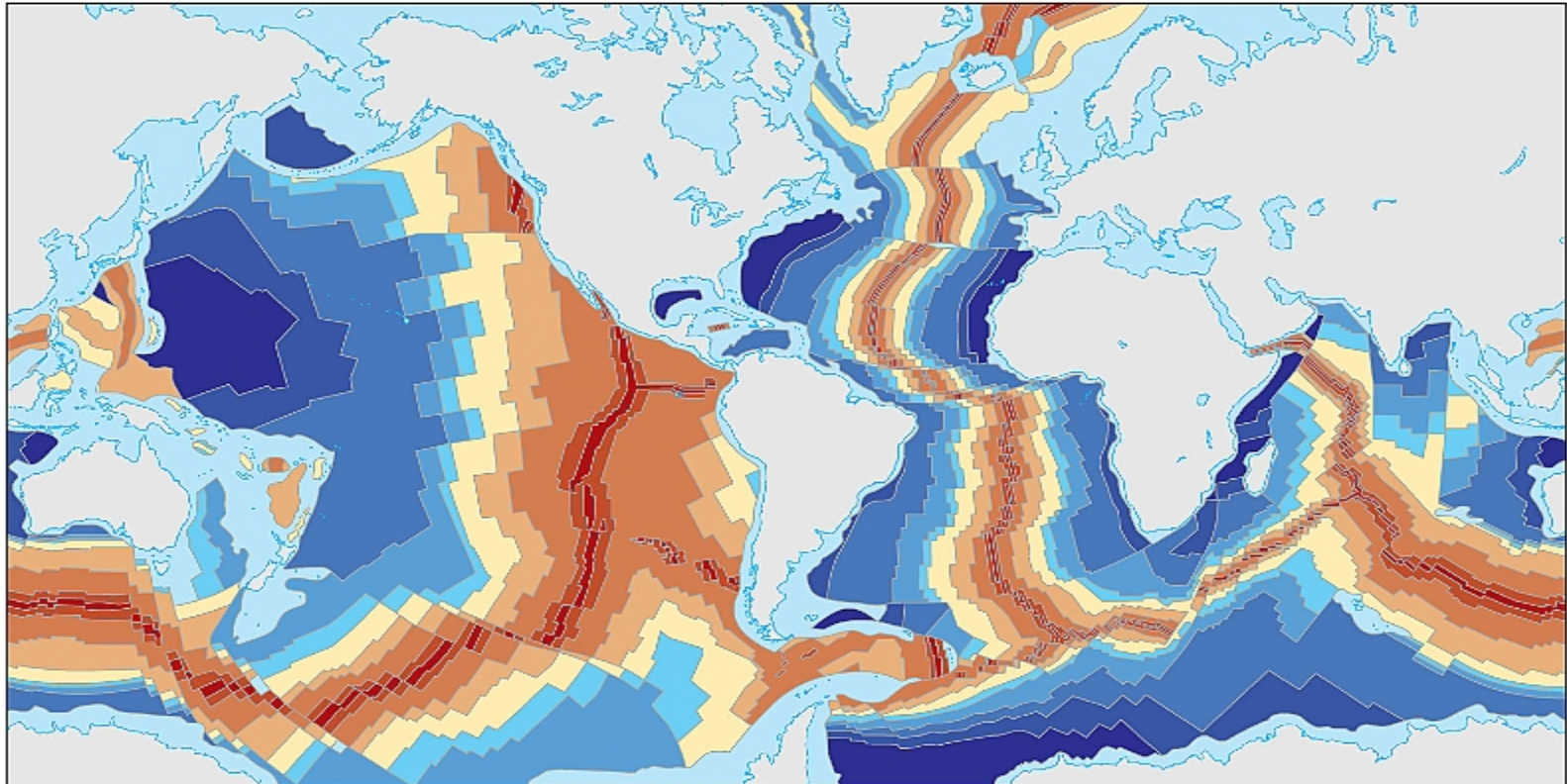


The Further Away from the Center of the Mid-Ocean Ridge, the Older the Rocks. The Pattern is Symmetrical on Both Sides Indicating that Corresponding Bands Were Formed at the Same Time



Map Showing Age of the Ocean Floor.

The Youngest Rocks Lie Along the Upwelling Zones While the Oldest are Near the Continents



The Oldest Rocks
Comprising the Ocean
Floor are about 250
Million Years Old. These
Rocks in the Arbuckle
Mountains are over a
Billion Years Old.

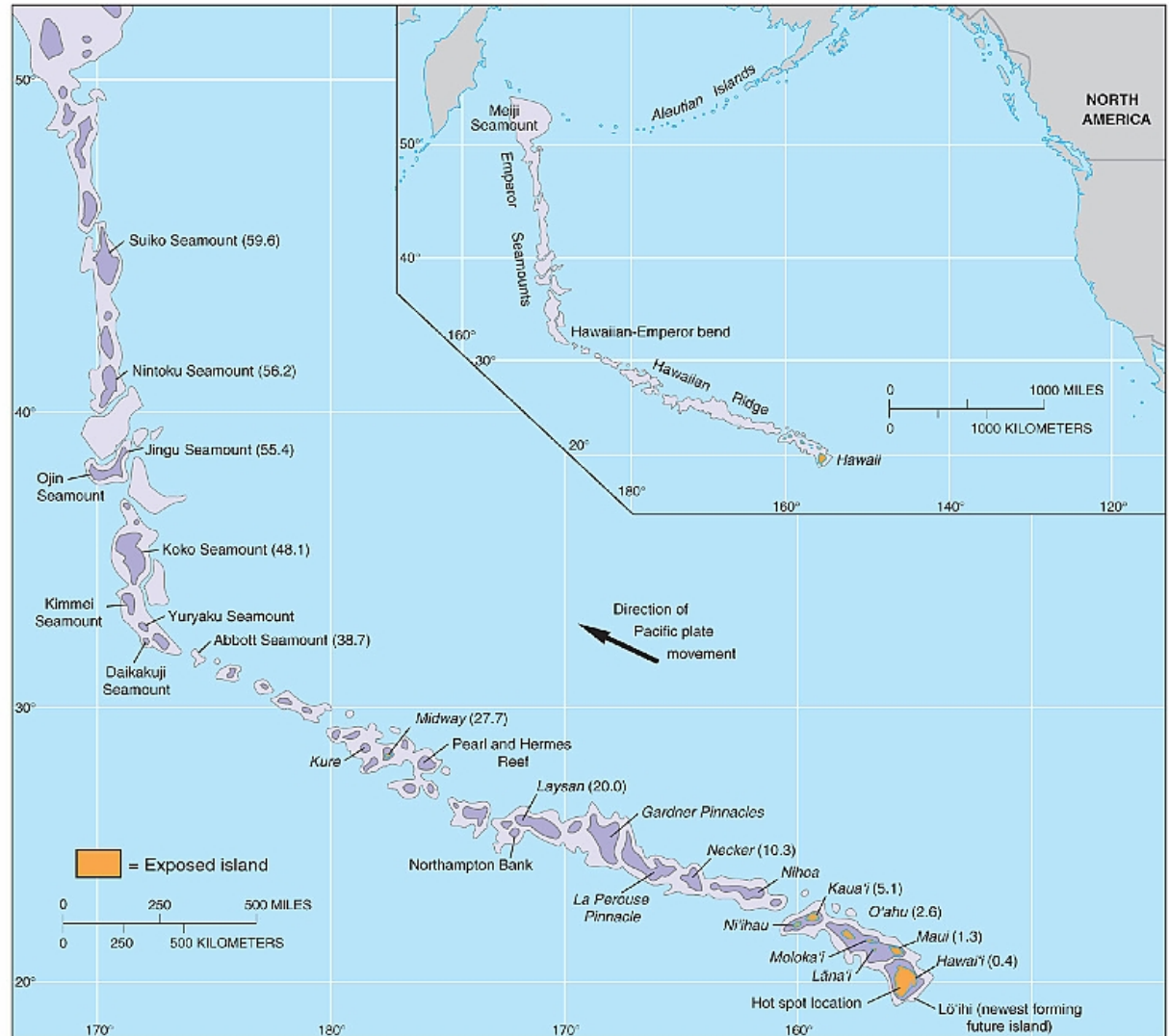


Enchanted Rock in the
Texas Hill Country is about
a Billion Years Old



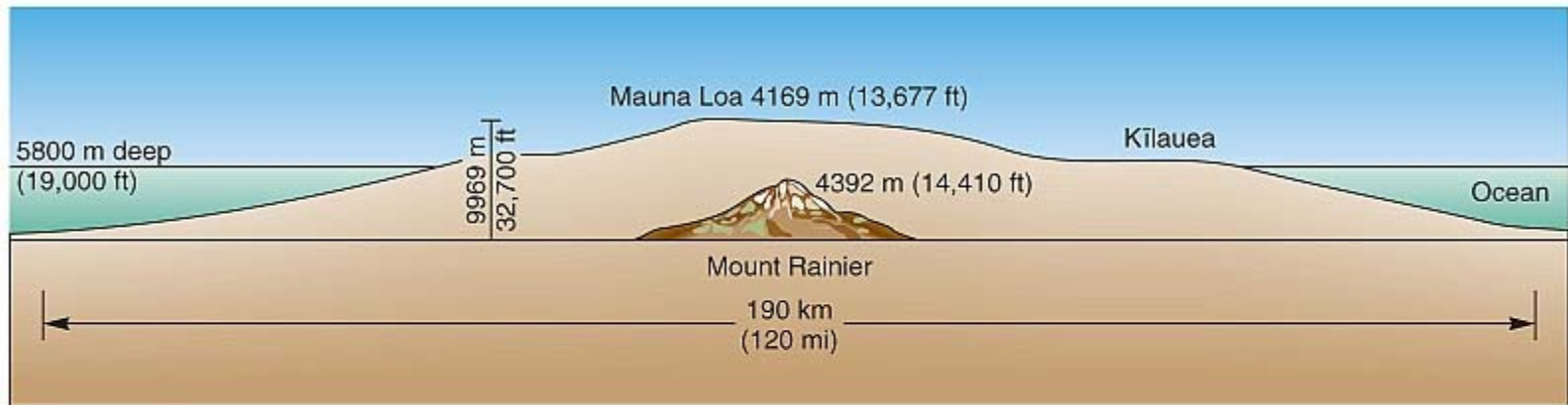
The Hawaiian Islands Are the Youngest Lava Flows from the Hawaiian Hotspot

The Seamounts extending far into the north Pacific are millions of years older. Note that first the Pacific plate move northward and then changed directions moving to west/north west



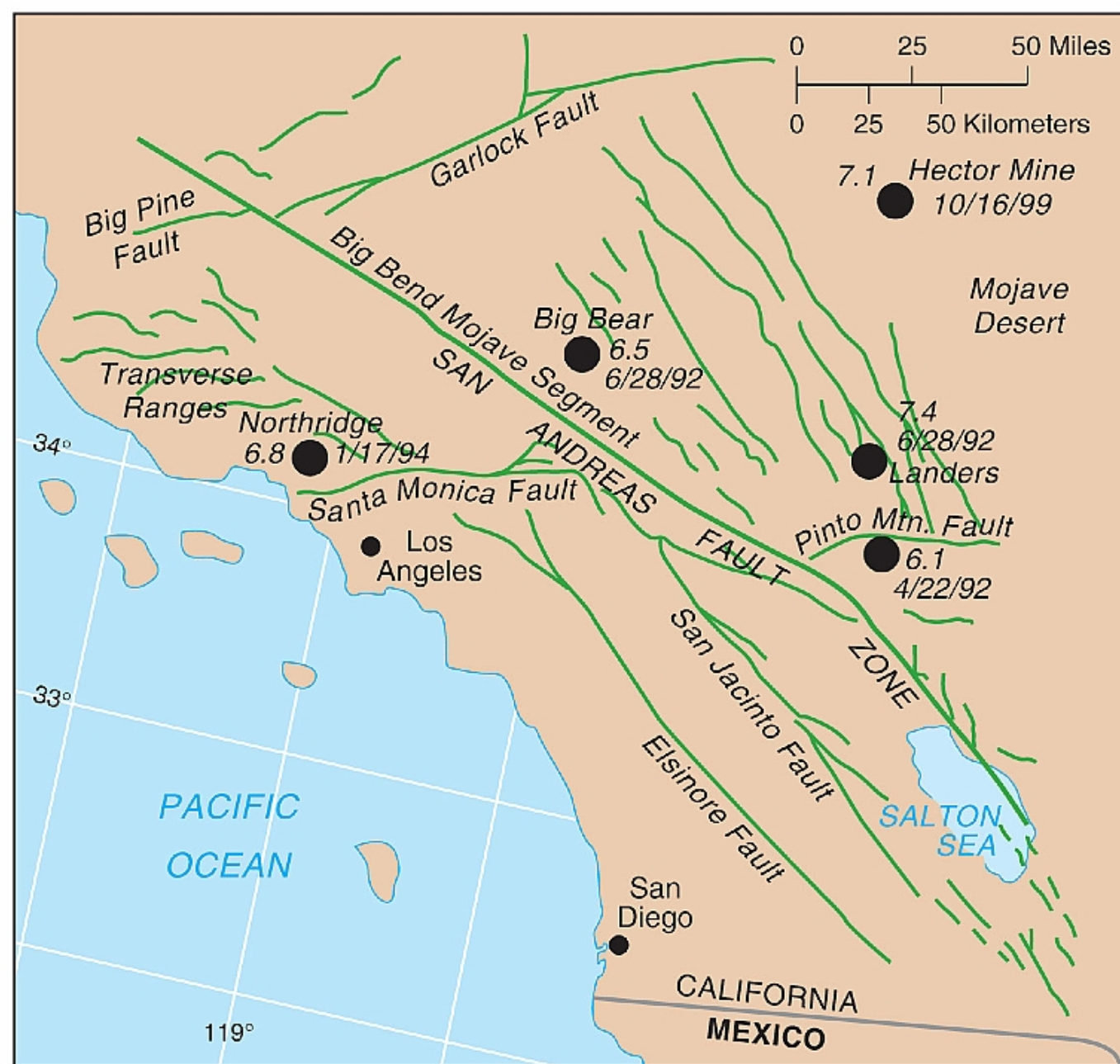
(a)

The Big Island of Hawaii Has Been Called the World's Biggest Lava Flow and the World's Highest Mountain at a Total Height of 32,700 ft.



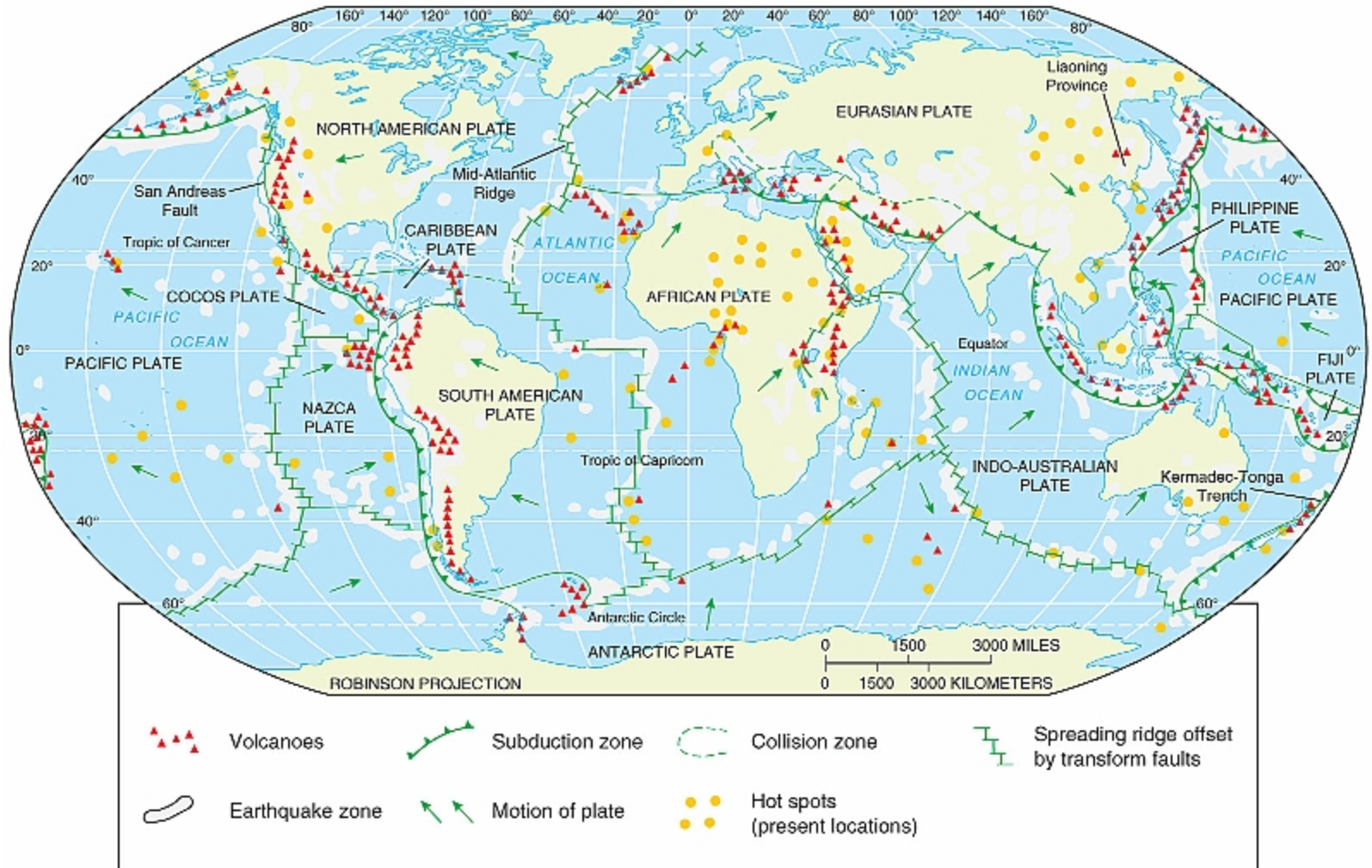
The Faults in Southern California.

The San Andreas Fault is a Plate Boundary. The Others are Secondary Faults Created By more Local Stresses.

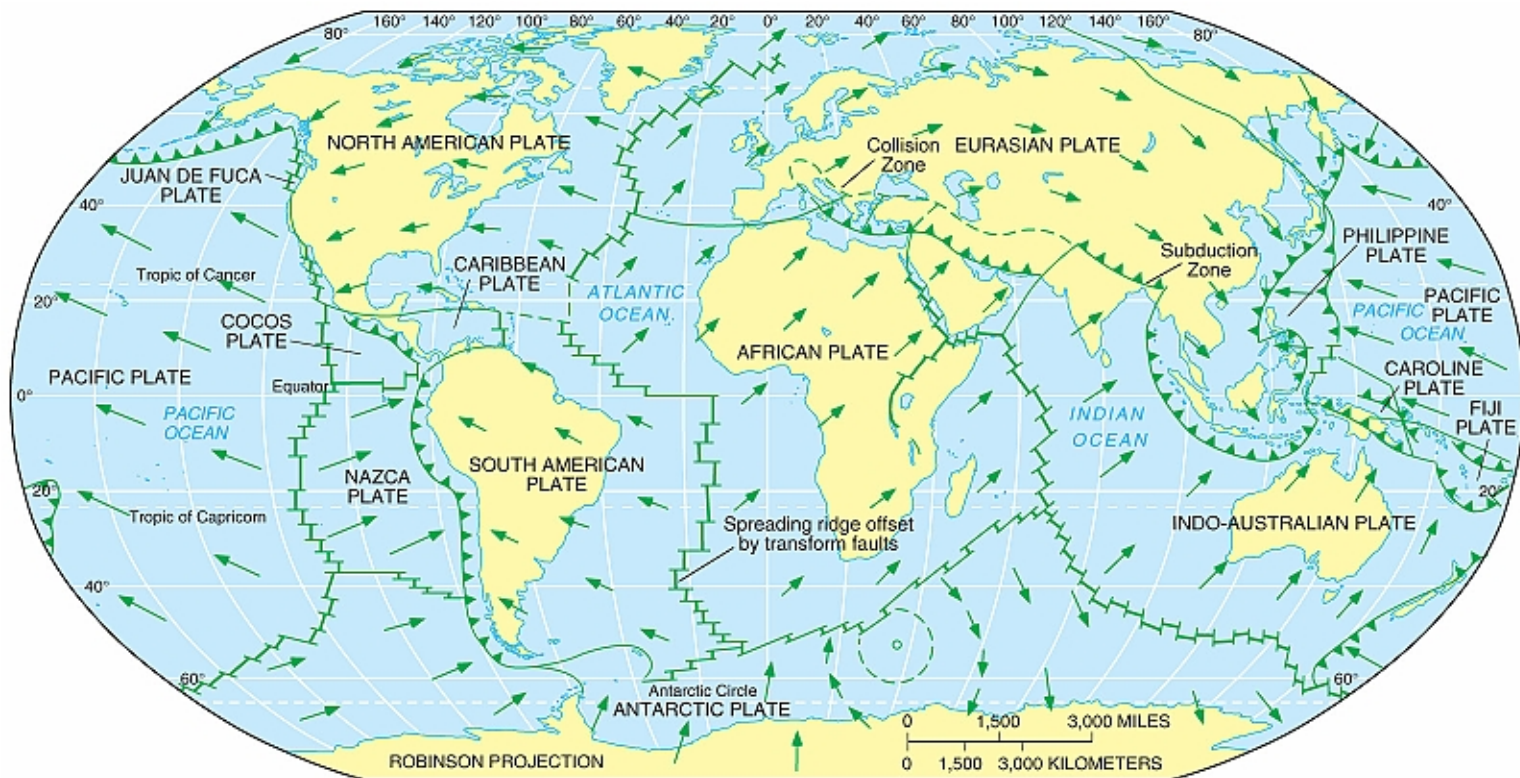


(b)

Plate Tectonics Explains the Locations of Nearly All Volcanoes and Most Earthquakes

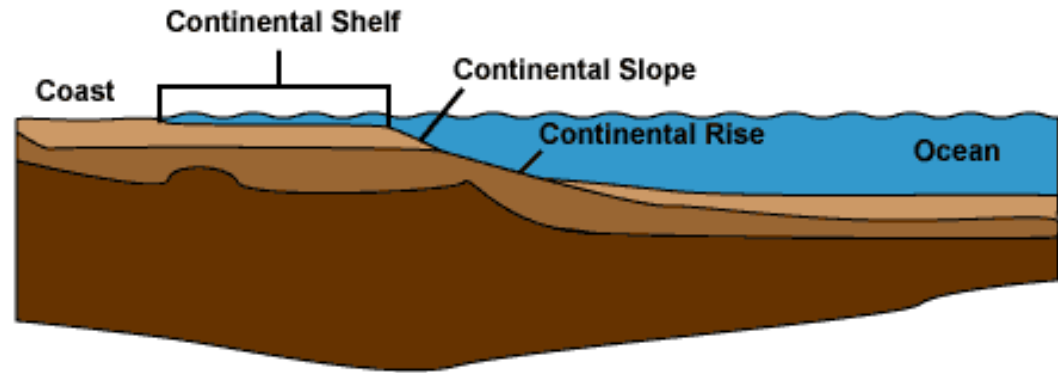


There Are 7 Major Plates. Each Continent is on Its Own Plate, Sort Of. India and Australia Are on the Same Plate Along with Much of the Indian Ocean. Most of the Pacific is a Single Plate with No Continent



The Continental Shelf Often Extends Out Into the Sea, But is Really Apart of the Continent.

The abrupt drop-off at the edge of the continental shelf really defines the edge of the continent.



Continental Shelves shown in cyan (light blue)

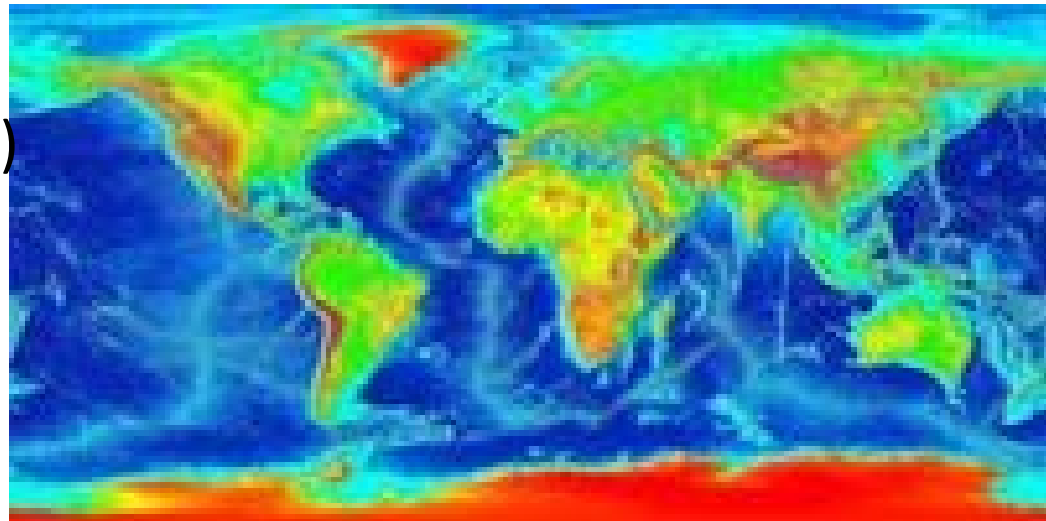


Plate Tectonics

Plate Tectonics is the basic organizing principle of the Earth Sciences because it explains so much:

- Why the continents slowly move across the earth.
- Why the Continents and Oceans are fundamentally different. The rocks that comprise the ocean floor are young and dense created by the process of sea floor spreading. The basement rocks that comprise the continents are old and less dense, so they literally float on a sea of magma underneath.
- First Order Landforms. The pattern of continents and oceans and largest landforms like mountain ranges.
- The Fossil Record. The continents were in different locations when prehistoric plants and animals died.
- Volcanoes. Volcanoes occur along plate boundaries or associated faults and hotspots.
- Earthquakes. Earthquakes occur when a plate suddenly shifts position.