Plate Tectonics

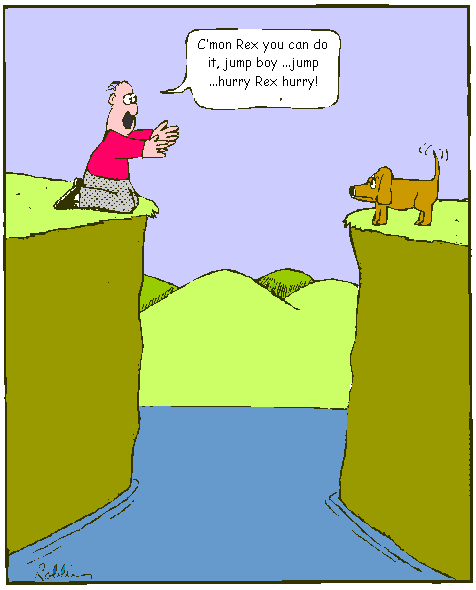
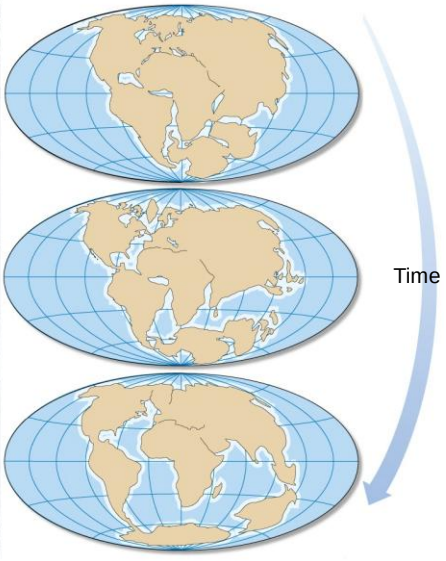


Plate tectonics is responsible for:

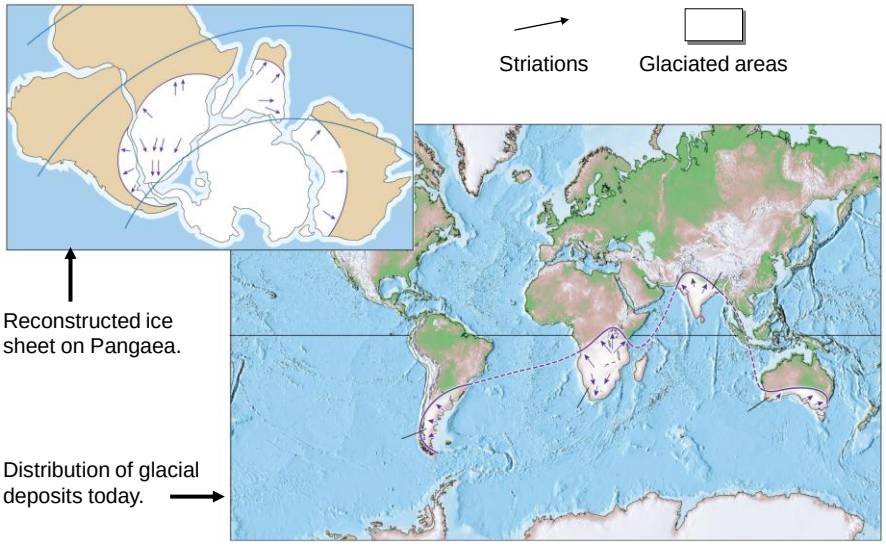
- Volcanoes
- Earthquakes
- Mountain belts (e.g., Rockies)
- Normal faults
- Reverse/thrust faults
- Transform (strike-slip) faults
- Age of the ocean crust
- Sediment in Deltas
- Etc., etc., etc., etc.…

Alfred Wegener



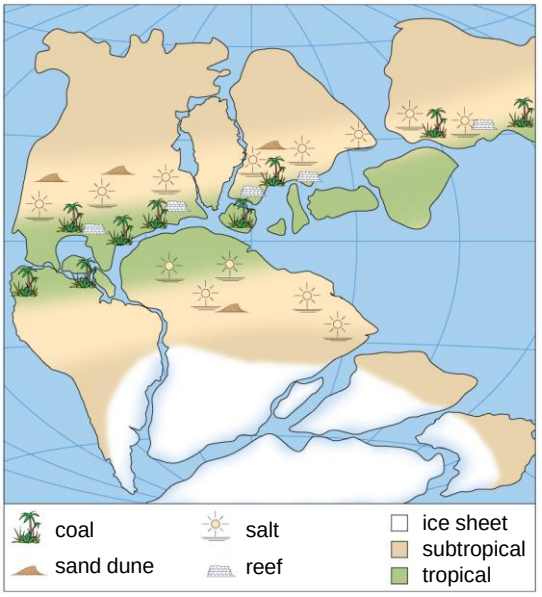
Breakup of Pangaea.

Evidence of continental drift — 1: Glacial deposits.

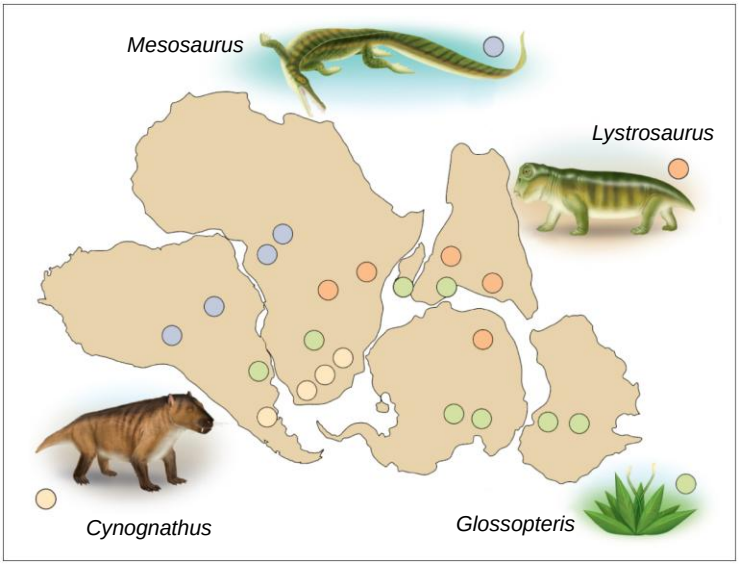


Evidence of continental drift — 1: Climate belts

Rock types indicative of specific climates align in belts, at appropriate latitudes, on Pangaea.

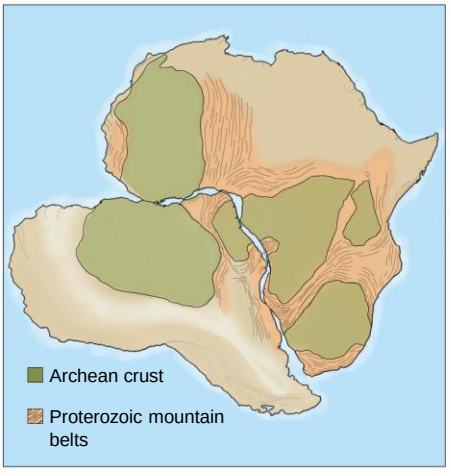


Evidence of continental drift — 3: Distribution fossils



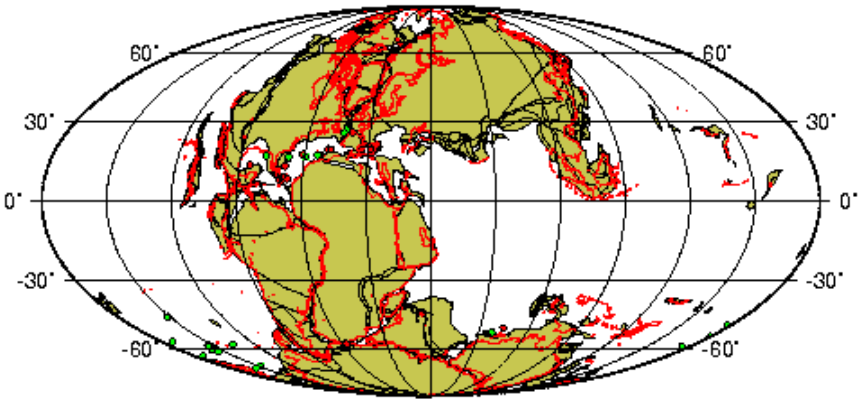
Fossils of the same land organisms occur on all continents.

Evidence of continental drift — 3: Similarity of rocks across the Atlantic

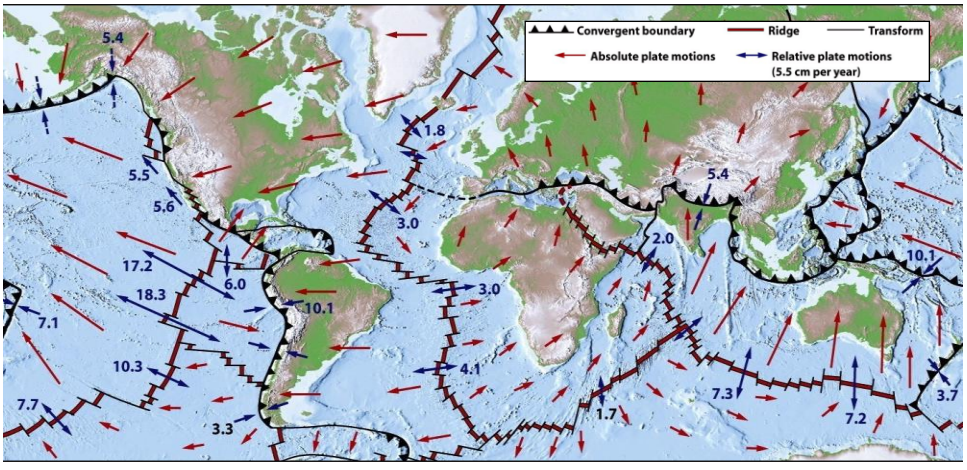


Archean crustal blocks.

Late Paleozoic mountain belts.

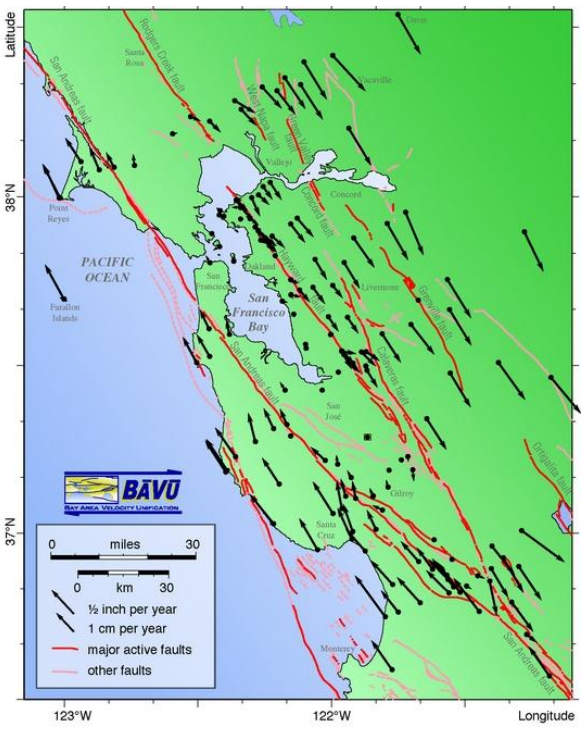


150 My Reconstruction



Today, geologists can measure plate velocities in real time.
This information is critical for earthquake hazard prediction.

plate velocities and plate motion



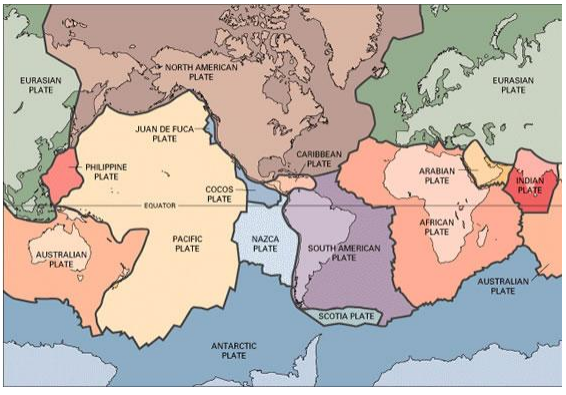
The Key Features of Plate Tectonics

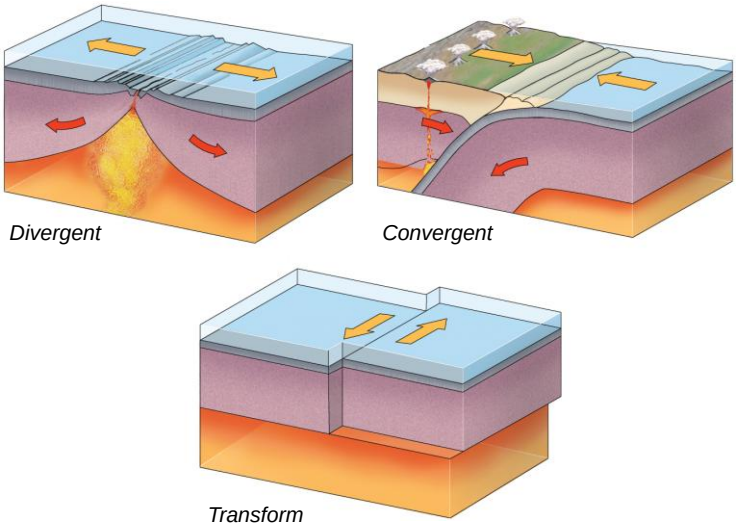
(1) The Earth's crust is continually created and destroyed (recycled).

(2) Ocean crust, formed at *divergent margins*, is mafic and dense.

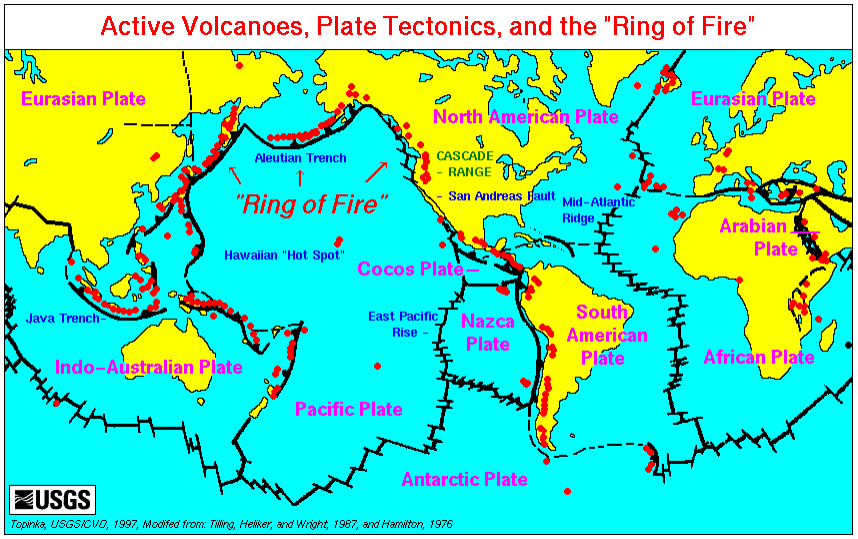
(3) As ocean crust ages and cools, it sinks beneath continents at *convergent subduction zones.*

(4) Because Earth is a spherical body, there are also *transform (strike-slip) boundaries* that accommodate motion parallel to the current overall motion of the plates.





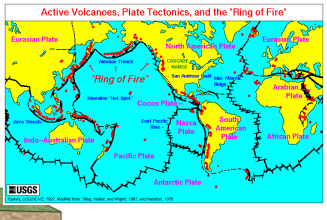
The three types are defined by the relative motion of plates.

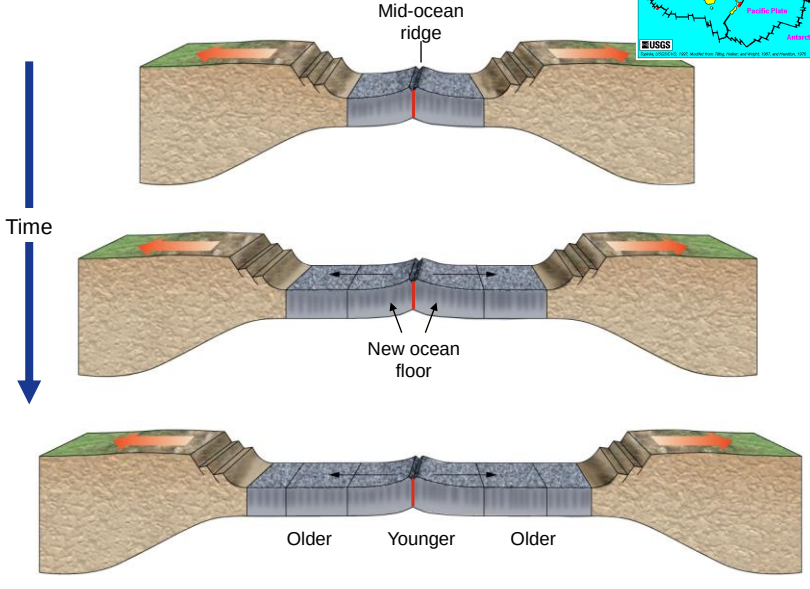


Basic Plate Boundaries

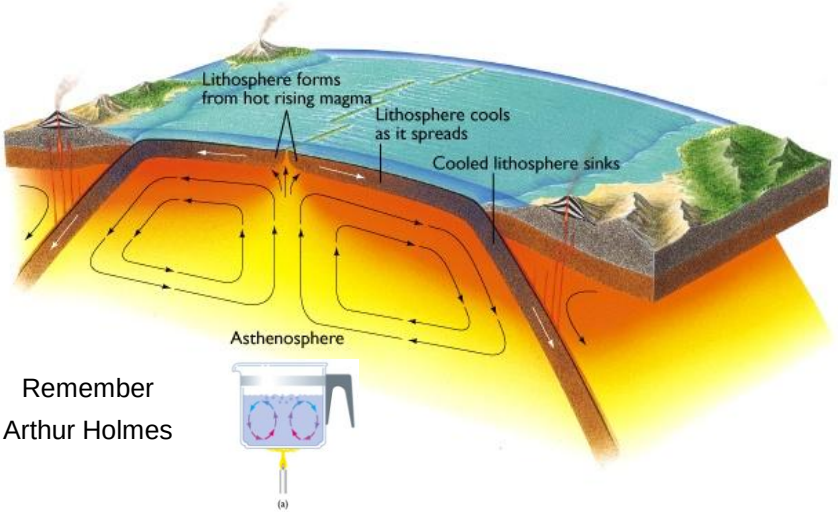
Geologists define three types of plate boundary, based simply on the relative motions of the plates on either side of the boundary. These basic types—divergent, convergent, and transform plate boundaries—are shown in the following three-part animation.

Sea Floor Spreading



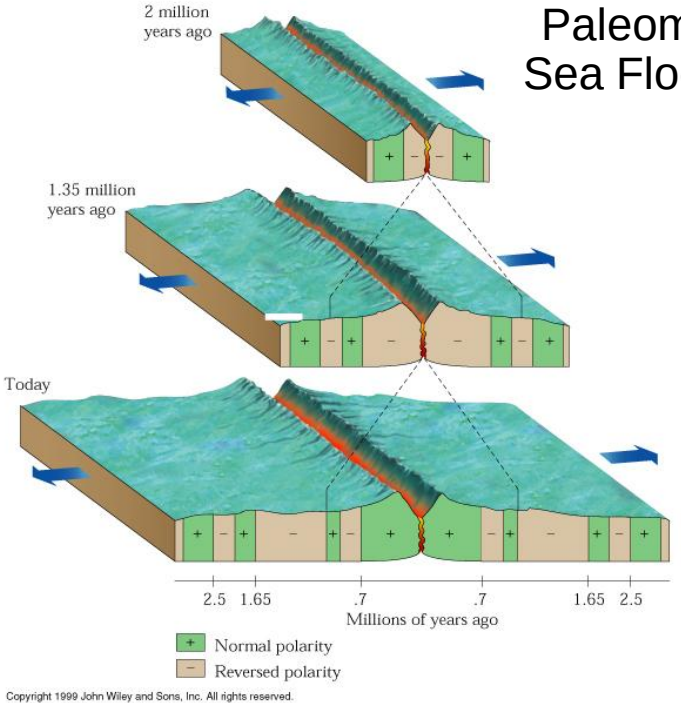


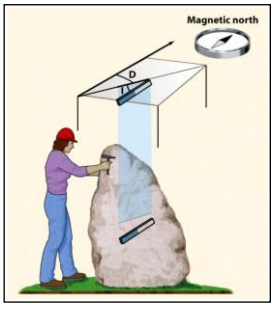
Sea Floor Spreading

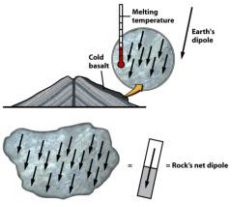


Remember
Arthur Holmes

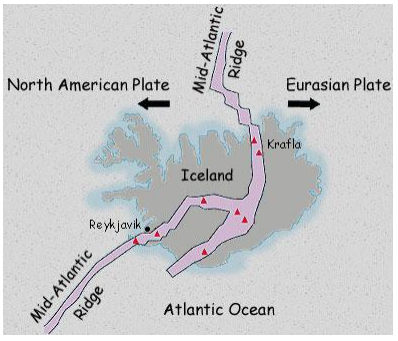
Paleomagnetism & Sea Floor Spreading



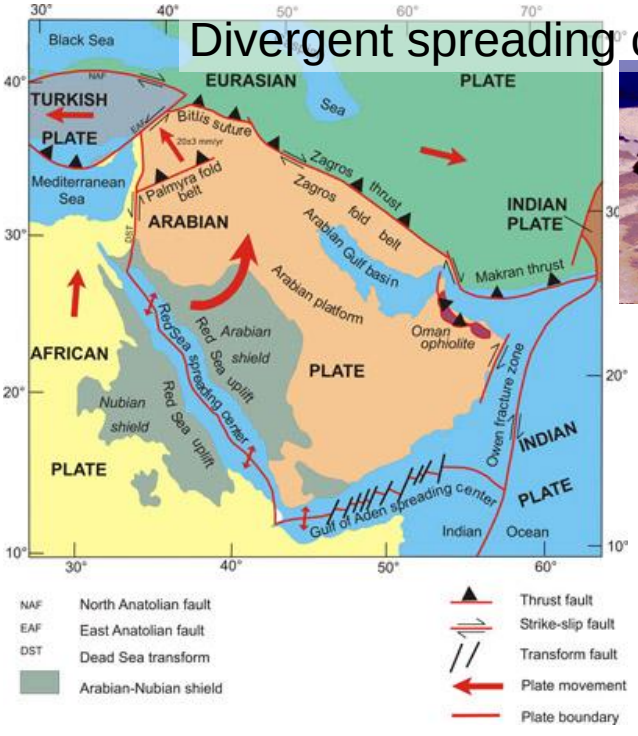


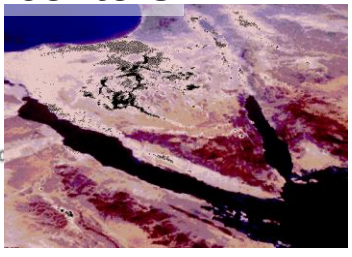


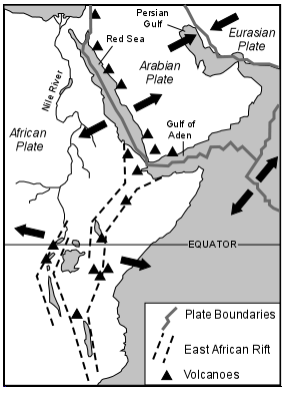
Divergent spreading centers



Divergent spreading centers



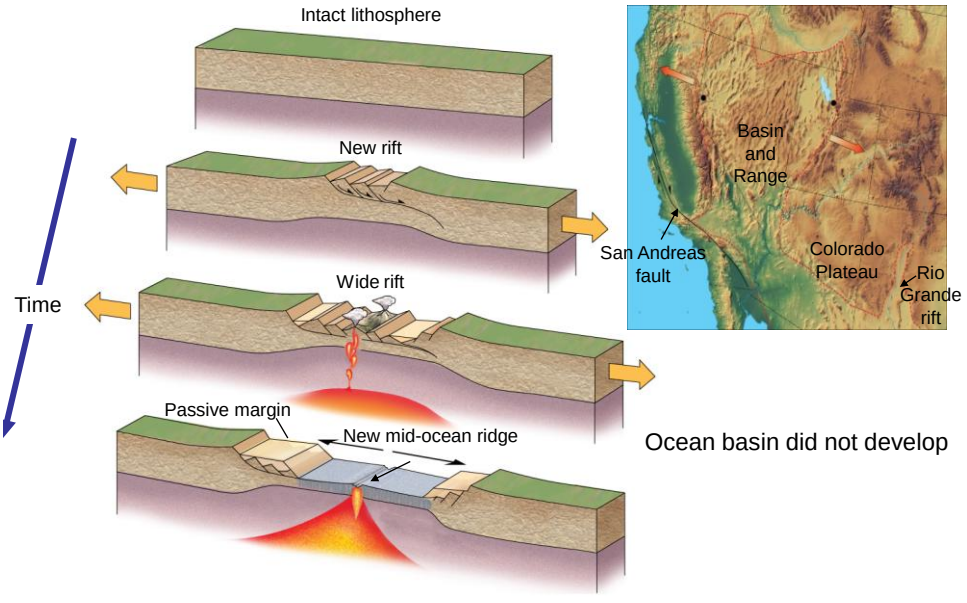


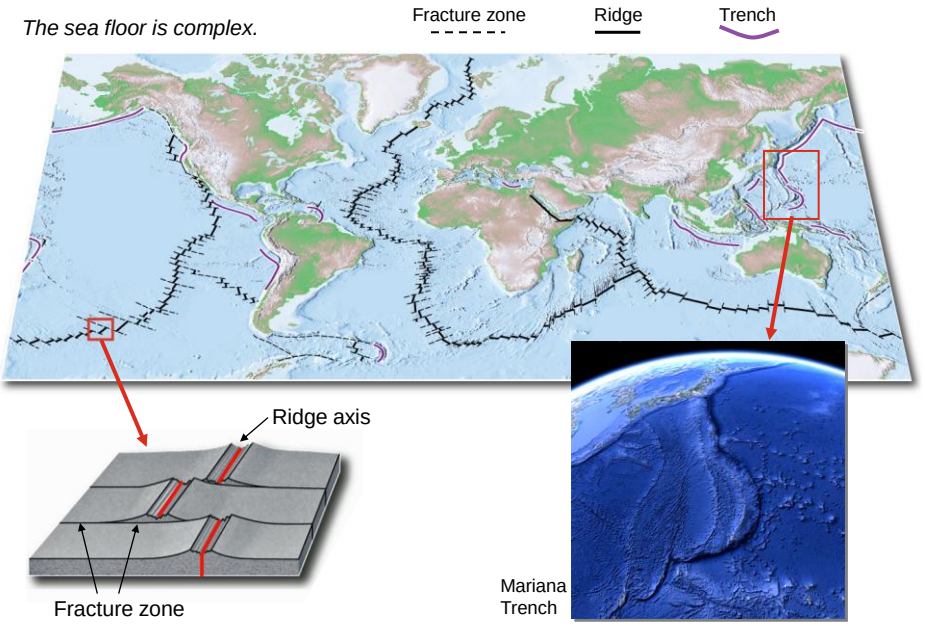


The Process of Rifting

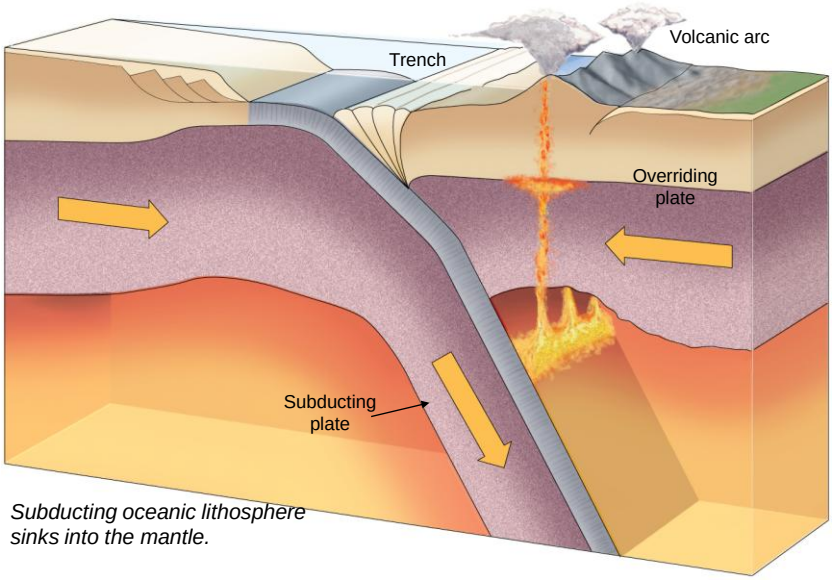
Rifting is the process by which a continent splits and separates to form a new divergent boundary. This animation shows the progressive formation and evolution of a continental rift, and the formation of a mid-ocean ridge.

Evolution of a continental rift – Nevada, about 55 million years ago





Subduction consumes the ocean between two continents.

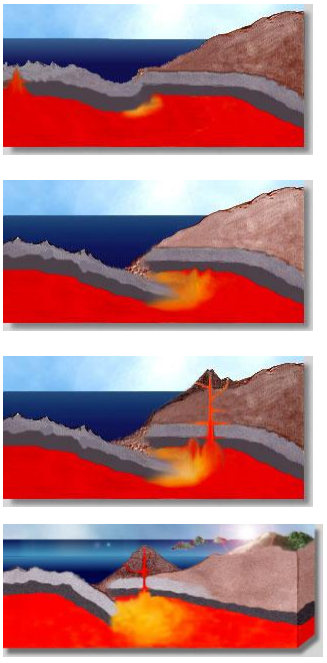


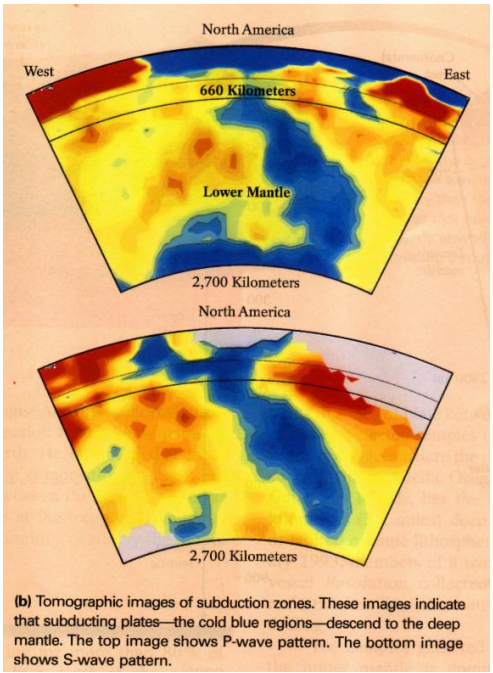
Subducting oceanic lithosphere sinks into the mantle.

The Process of Subduction

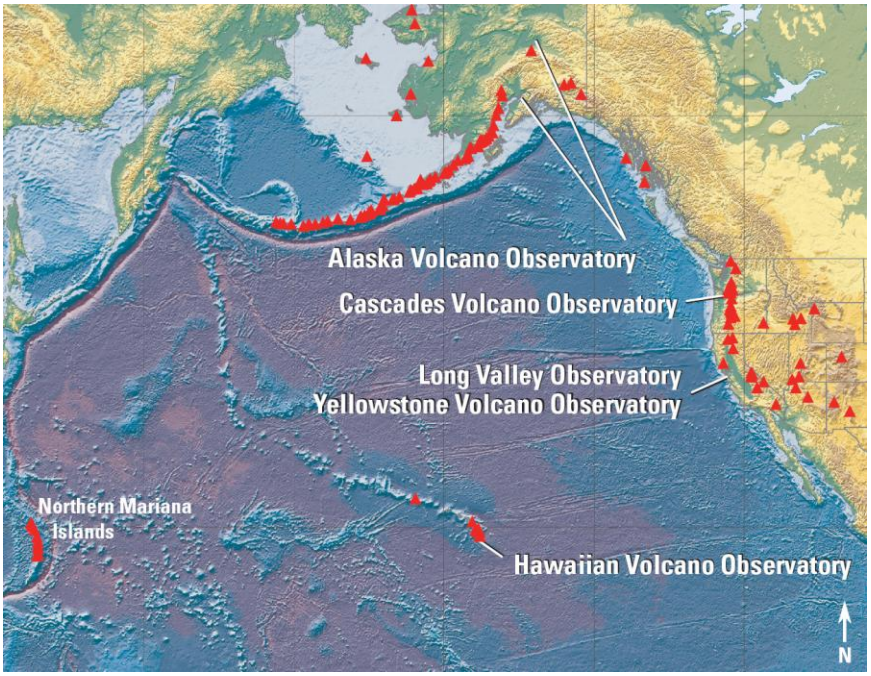
At convergent plate boundaries or convergent margins, two plates, at least one of which is oceanic, move toward each other. But rather than butting each other like angry rams, one oceanic plate bends and begins to sink down into the asthenosphere beneath the other plate. This sinking process, termed subduction, is shown in the following animation.

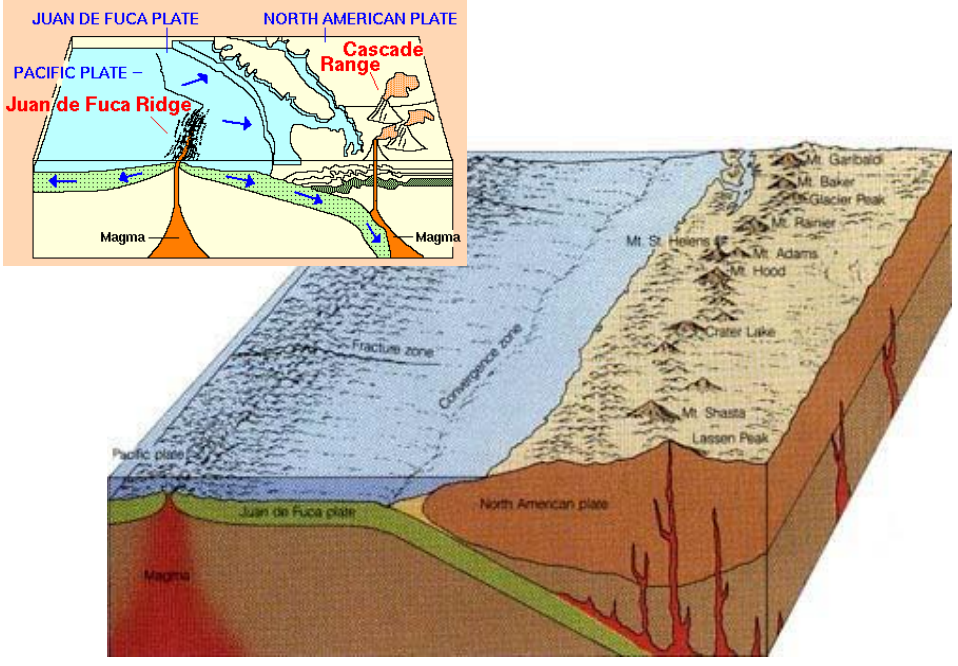
Congergent Plate Tectonics

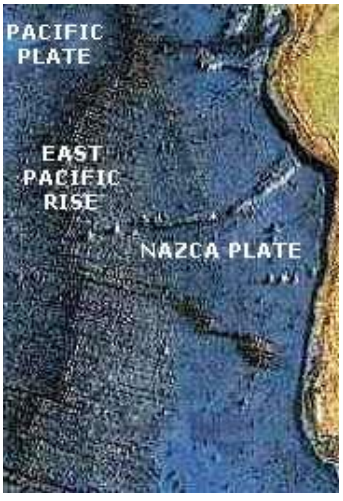


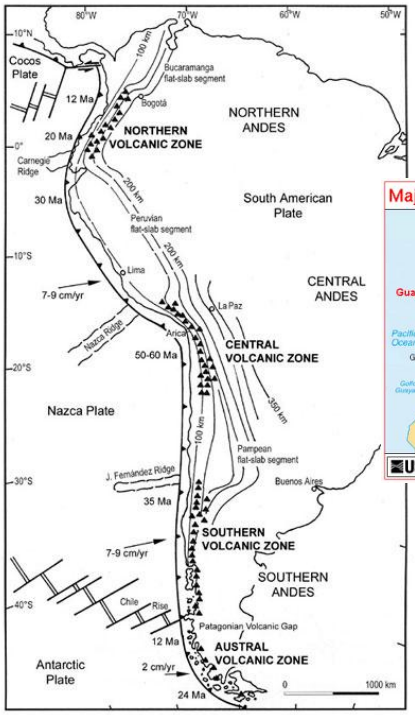


(b) Tomographic images of subduction zones. These images indicate that subducting plates—the cold blue regions—descend to the deep mantle. The top image shows P-wave pattern. The bottom image shows S-wave pattern.

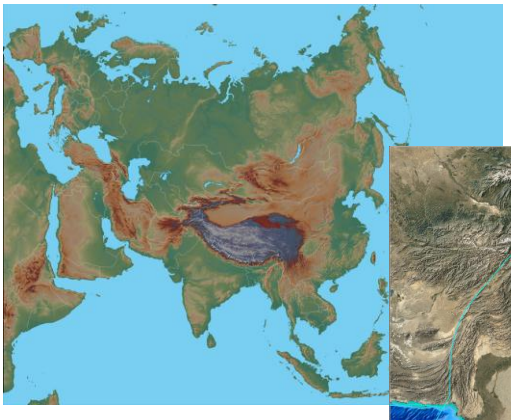

Alaska Volcano Observatory
Cascades Volcano Observatory
Long Valley Observatory
Yellowstone Volcano Observatory
Northern Mariana Islands
Hawaiian Volcano Observatory
N

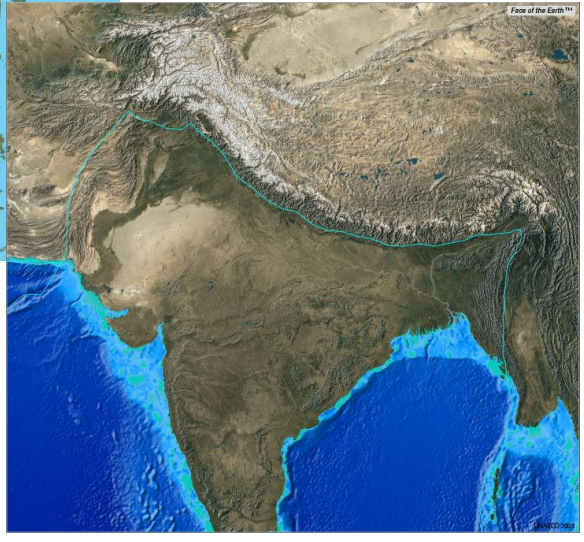

JUAN DE FUCA PLATE
NORTH AMERICAN PLATE
PACIFIC PLATE
Juan de Fuca Ridge
Cascade Range
Magma
Magma
Mt. Garibaldi
Mt. Baker
Glacier Peak
Mt. Rainier
Mt. St. Helens
Mt. Adams
Mt. Hood
Crater Lake
Fracture zone
Convergence zone
Mt. Shasta
Lassen Peak
Pacific plate
Juan de Fuca plate
North American plate
Magma



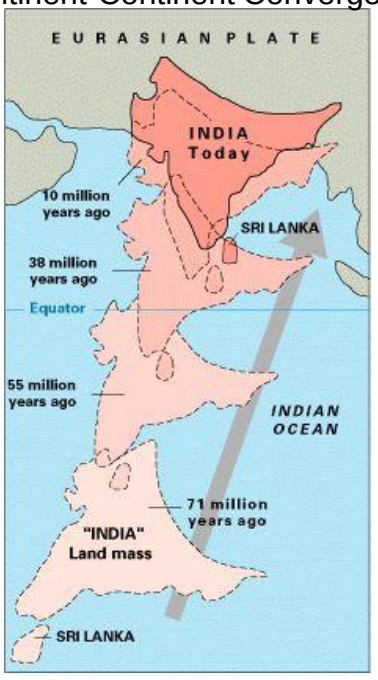


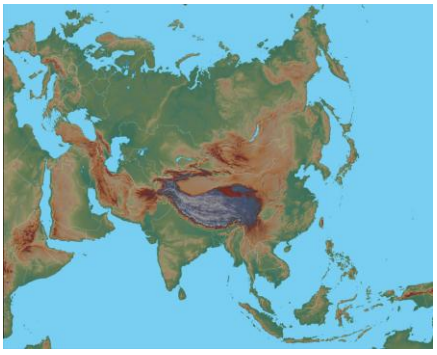
Continent-Continent Convergence

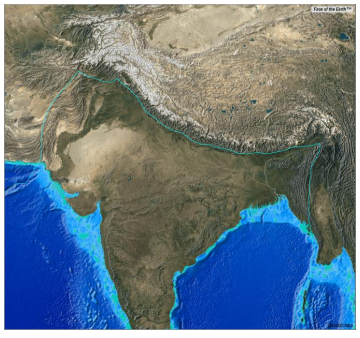




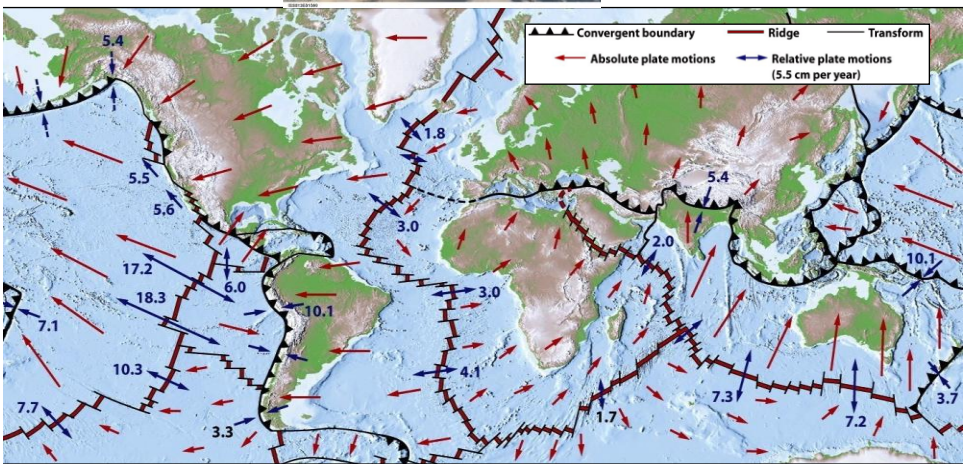
Continent-Continent Convergence



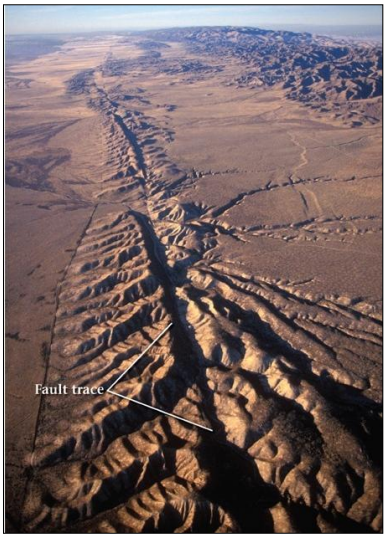


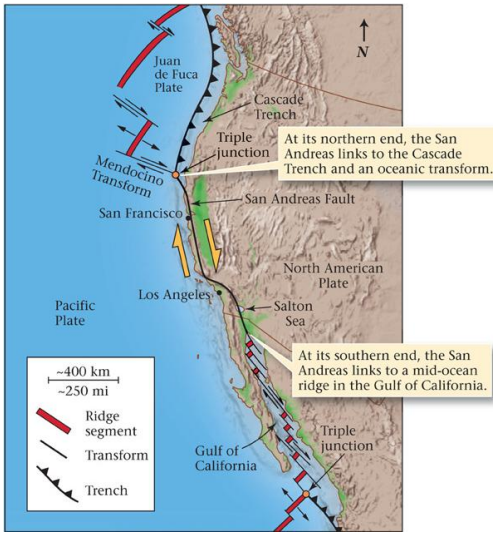


A curved Earth: Transform plate tectonic boundaries



Transform plate tectonic boundaries

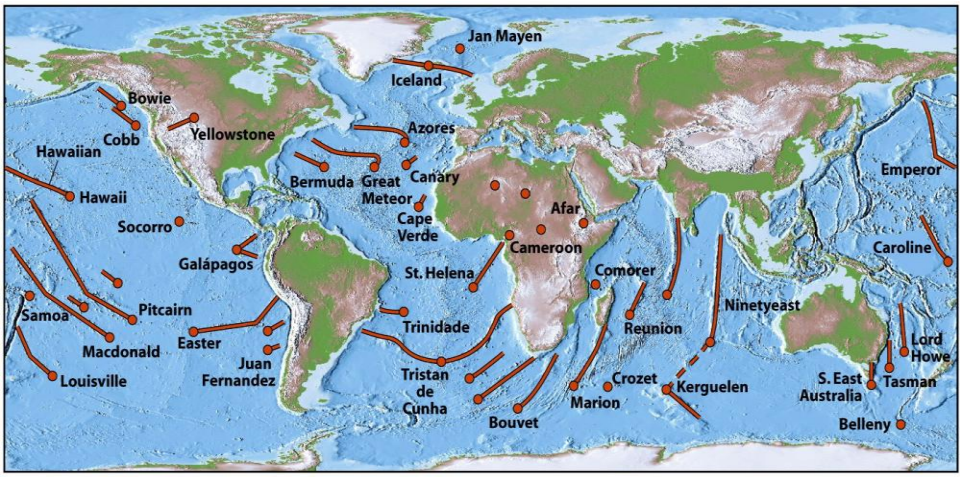




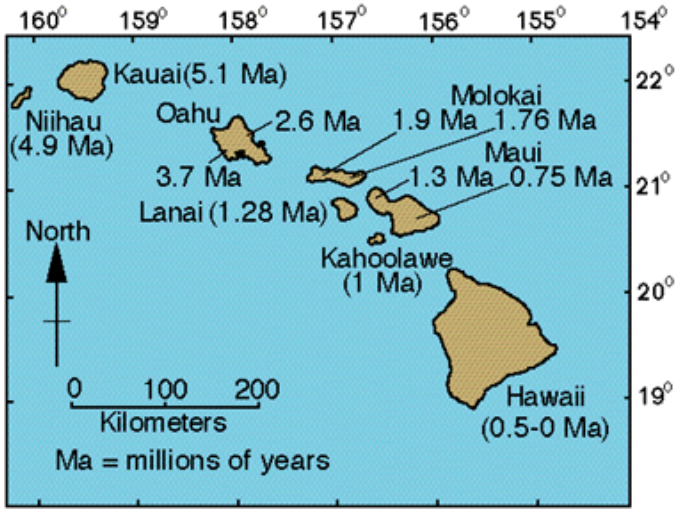
Transform Faulting

This animation shows the development of a transform fault along a divergent plate boundary. Plates slide past one another along a transform fault without the formation of new plate or the consumption of old plate. As this process occurs, new sea floor forms along the mid-ocean ridge.

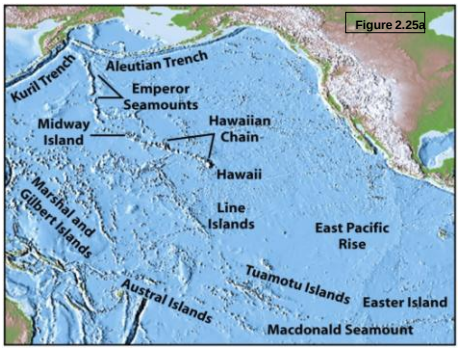
Hot Spot Volcanism: A plate tectonic exception?

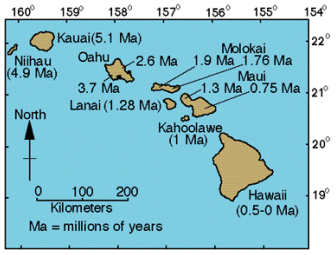


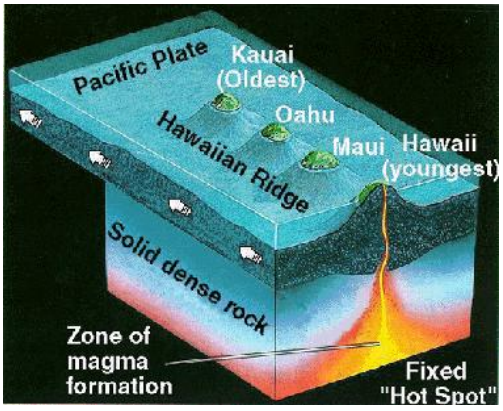
Hot Spot Volcanism



Hot Spot Volcanism



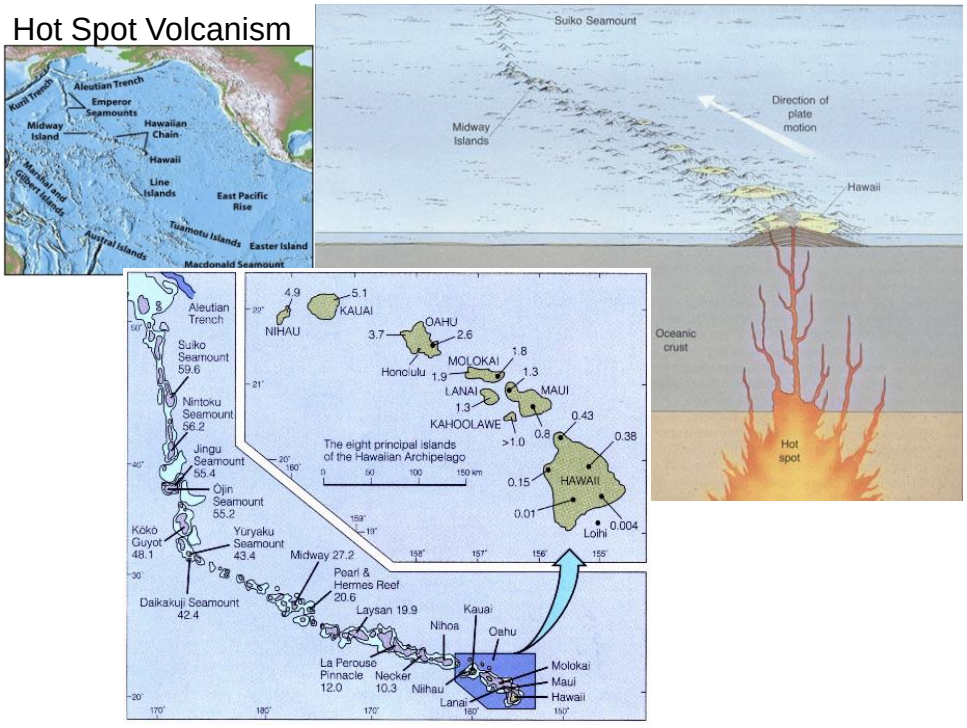




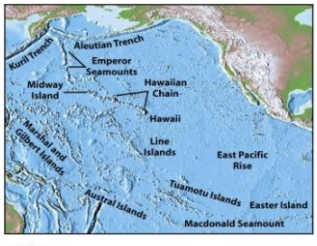
Hot Spot Volcanoes

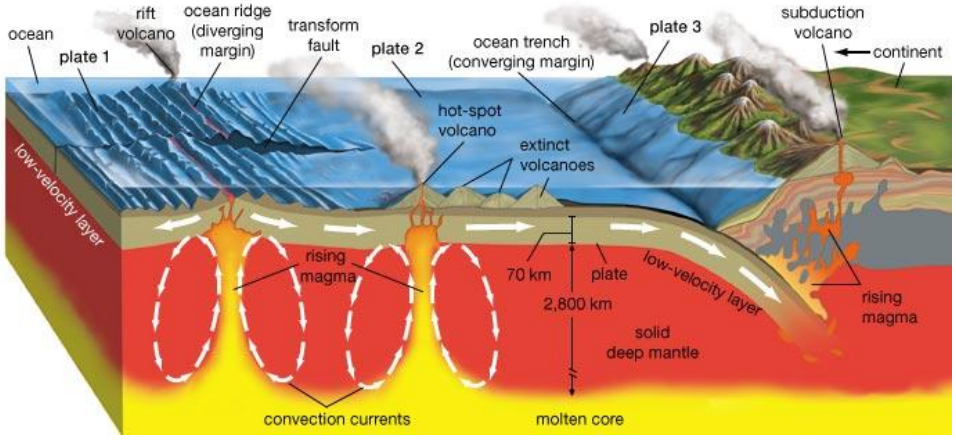
This animation shows how hot-spot volcanoes arise. A mantle plume beneath an oceanic plate creates a hot spot at the base of the lithosphere, and a volcano forms. Because the hot spot remains fixed as the plate moves over it, this volcano eventually becomes extinct and a new one forms. In time, a chain of extinct volcanoes develops, with a live volcano over the hot spot as the last link in the chain.

Hot Spot Volcanism



Hot Spot Volcanism: Fits into the picture of mantle convection





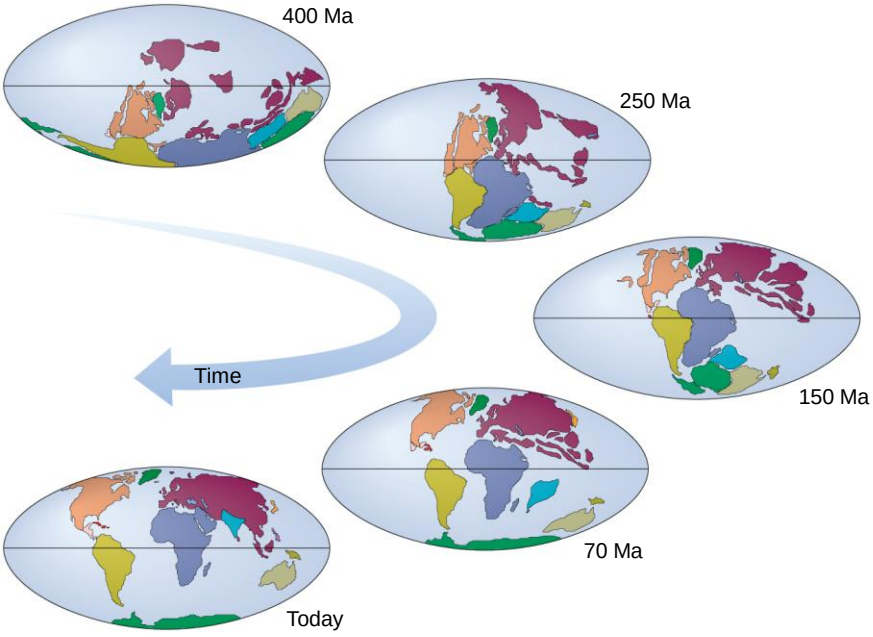
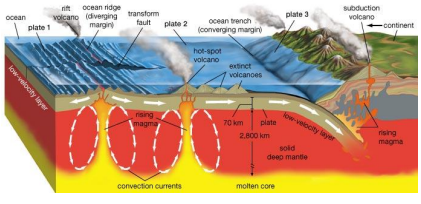
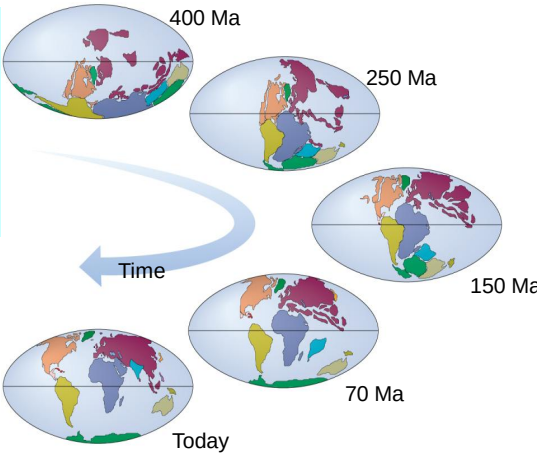


Plate Tectonics

Like any theory, plate tectonics has been rigorously tested. This model is consistent with the key tests thus far, including:

* sea floor spreading
* age structure of the plates
* seismic tomography
* hotspot tracks





Credits

Some of the images in this presentation come from:
Plummer, McGeary and Carlson, Physical Geology, 8/e;
Hamblin and Christiansen, Earth's Dynamic Systems, 8/e;
Press and Siever, Understanding Earth, 3/e;
Paul Tomascak (University of Maryland)