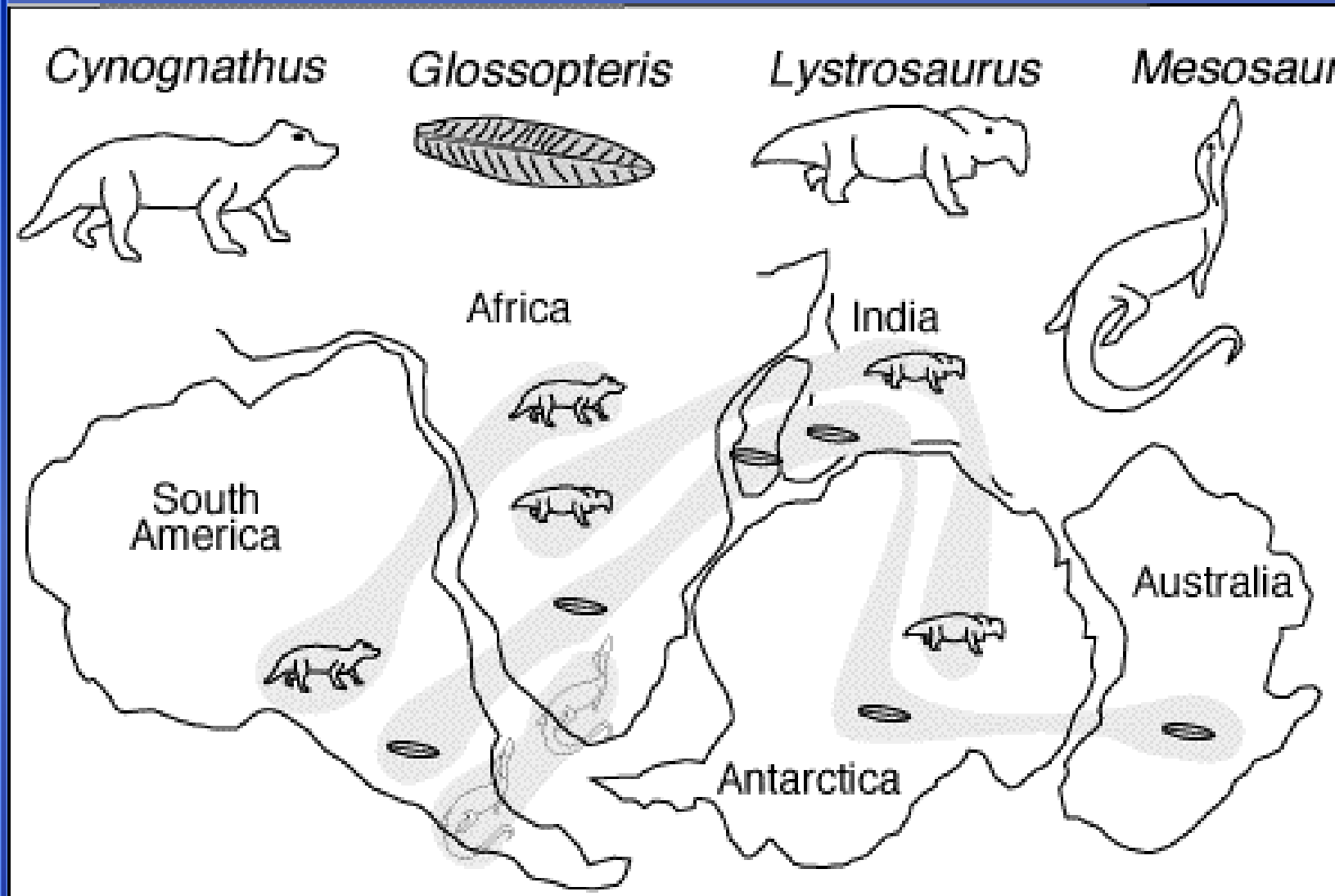
Chapter 19

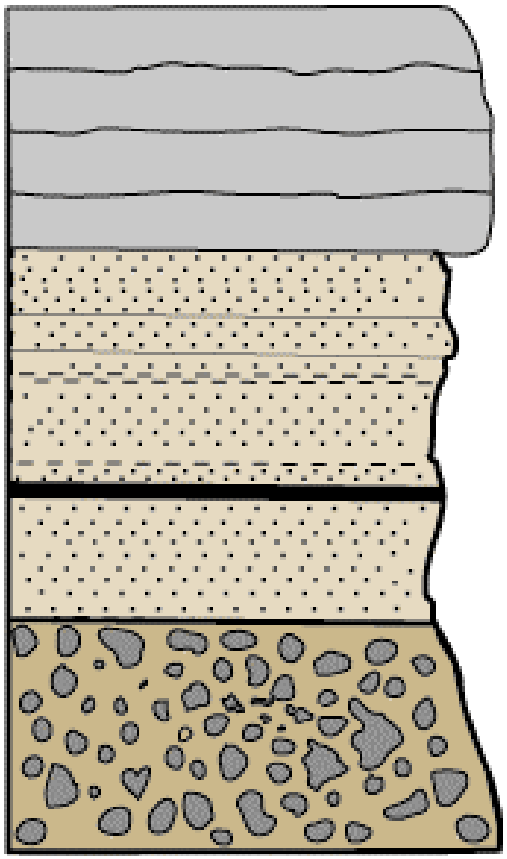
Plate Tectonics

Alfred Wegener

- A man with an idea.
- In 1912
- Noticed similar shapes
- similar fossils
- Similar rock structures
- Similar evidence from glaciers
- on continents



Distribution of fossils across the southern continents of Pangea.



Similar layers of rock were formed in Antarctica, Australia, South America, Africa, and India before Pangea broke apart. Glossopteris fossils were found in the rocks on each continent.

Grooves carved by glaciers (shown by arrows) provided evidence for continental drift. This diagram assumes the continents were in their present-day locations.

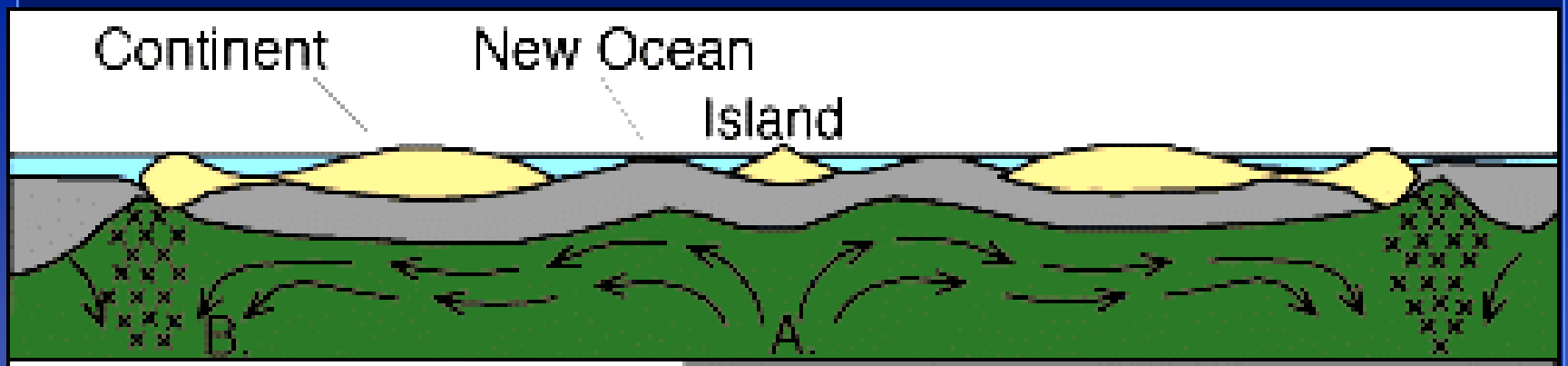
The distribution of glacial features can be best explained if the continents were part of Pangaea.

Problems With the Theory

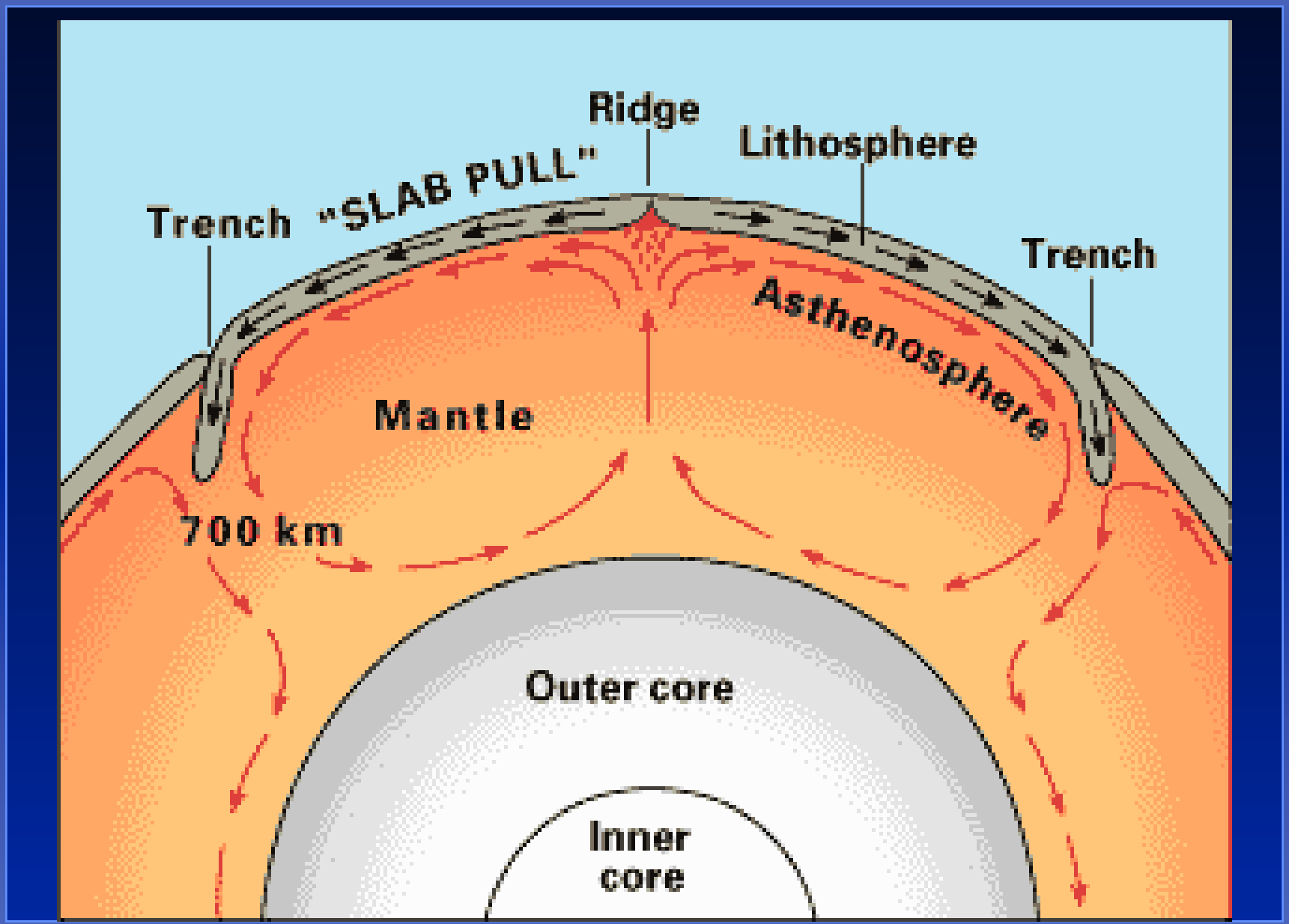
- Though winds or ocean currents could explain the fossils
- Thought the poles moved, so that you could get the glaciers
- Didn't explain how it happened.
- Though that it was due to the Earth spinning on its axis
- Scientists in the southern hemisphere accepted it first
- They believed the rocks

Solution

- Arthur Holmes- 1928
- Convection currents move the plates.

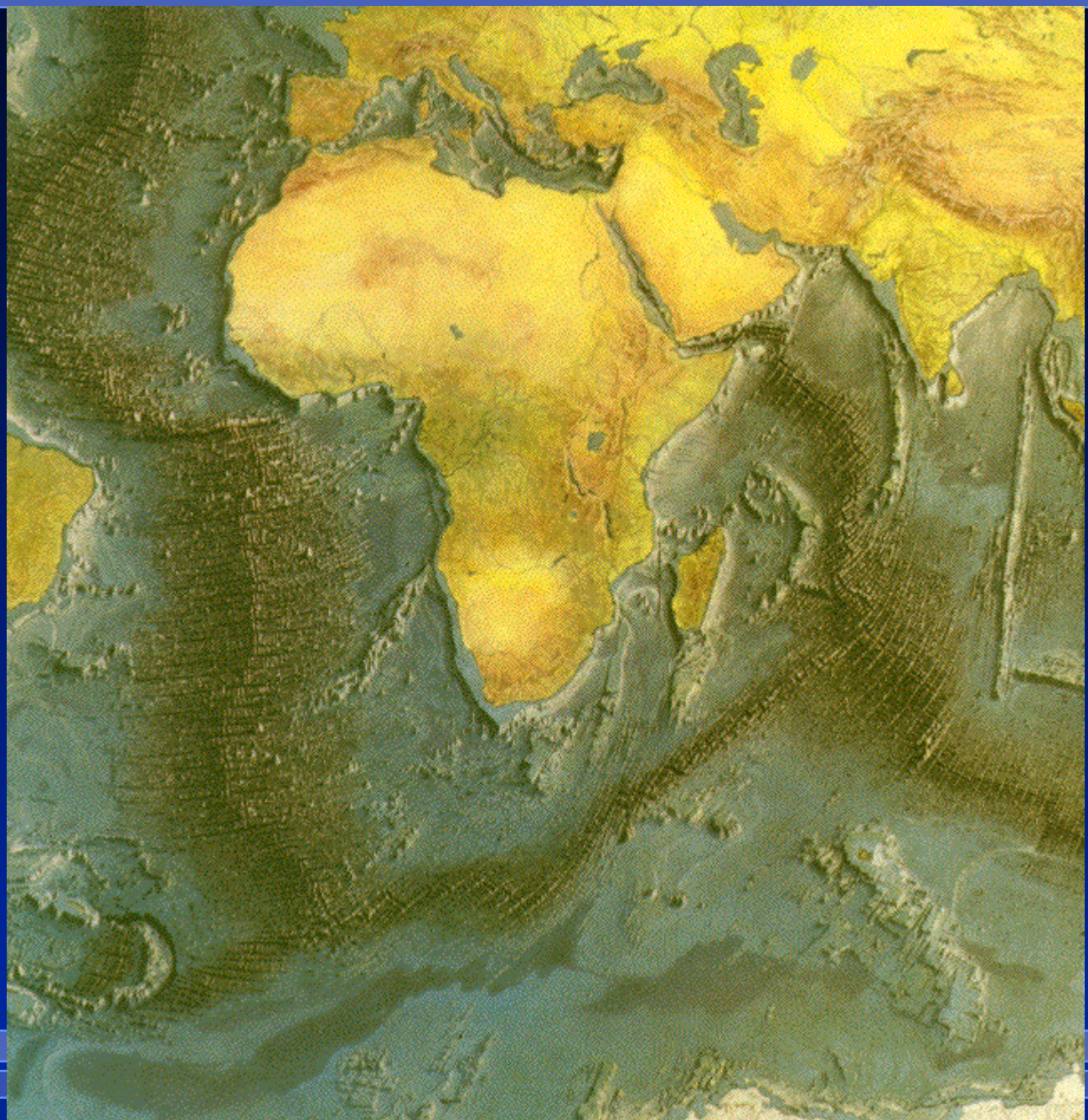


Holmes' model of convection currents. A. areas of upwelling. B. areas of downwelling and melting.


Ridge
Lithosphere
"SLAB PULL"
Trench
Trench
Asthenosphere
Mantle
700 km
Outer core
Inner
core

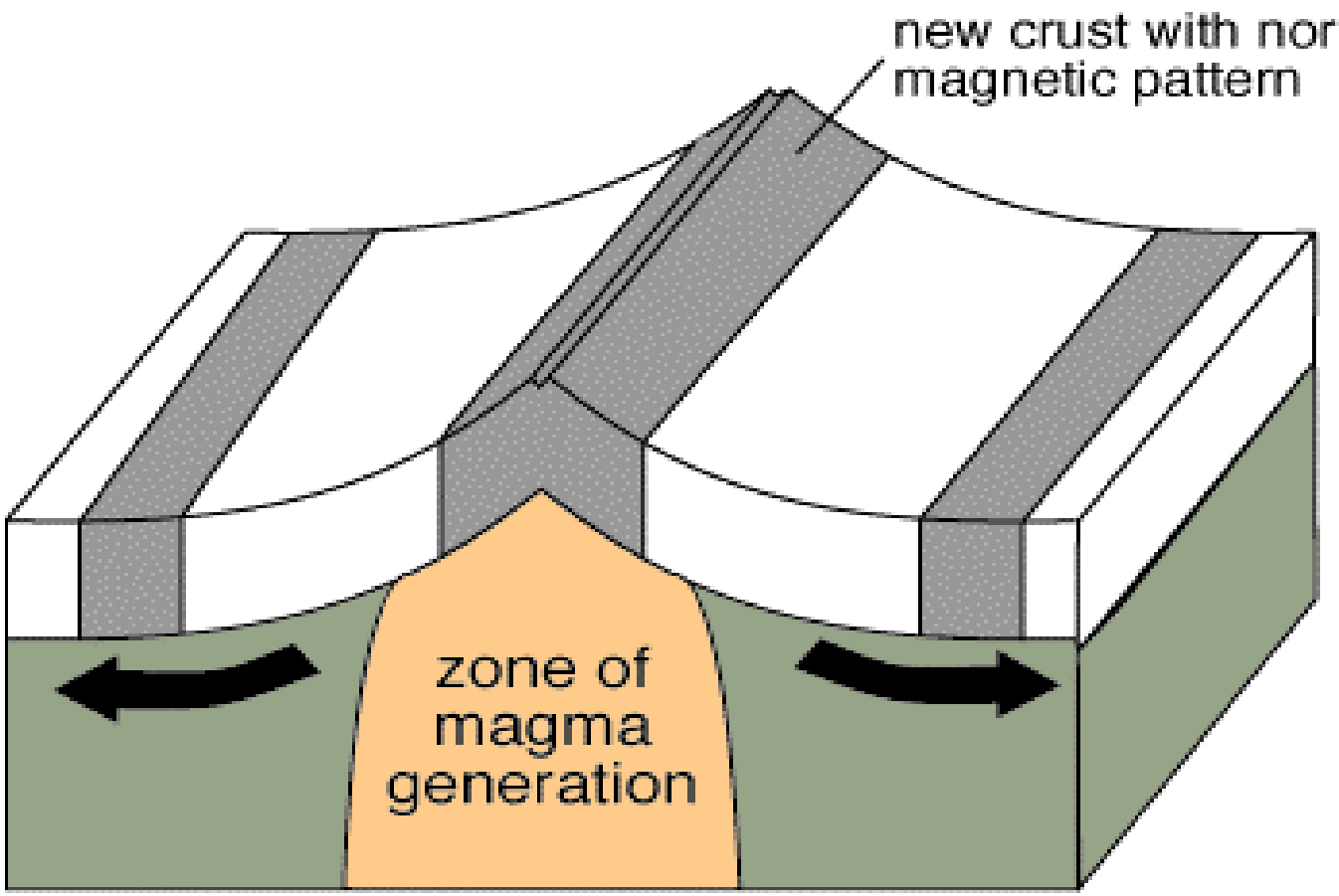
Ocean-Floor Spreading

- In the 1950's and 1960's mapped the ocean floor
- Examined underwater mountain ranges
- Run for 37,500 miles around the earth.
- Found a rift valley in the center
- Harry Hess - 1962 explained
  - new ocean floor is made at the mid-ocean ridge
  - Is pushed under other crust at the trenches

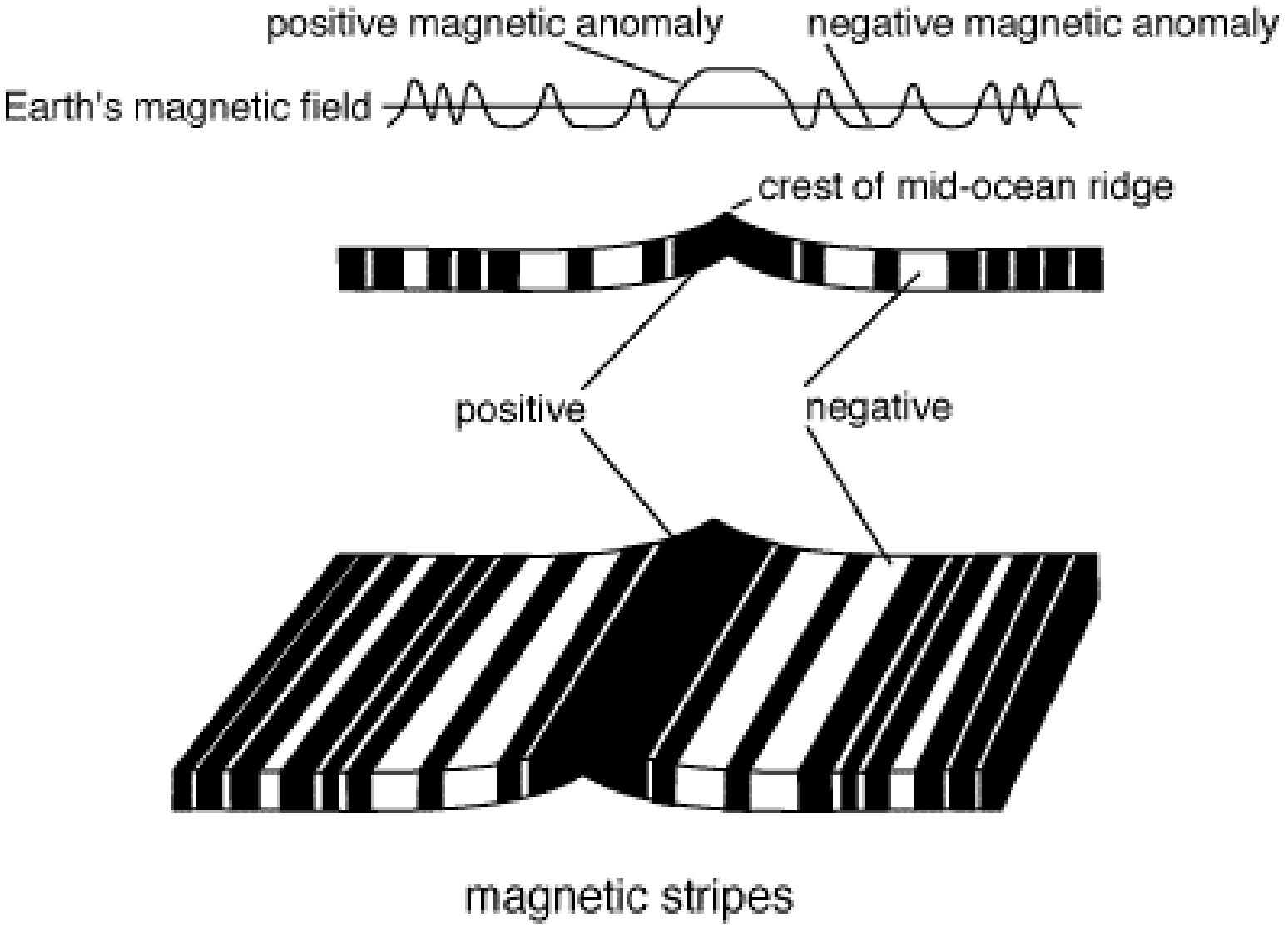


Evidence trapped in rocks

- Earth is a magnet
- When lava cools it keeps track of which way the magnetic pole points.
- Every few hundred thousand years the magnetic field switches direction.
- Has made stripes of alternating directions on the ocean floor.

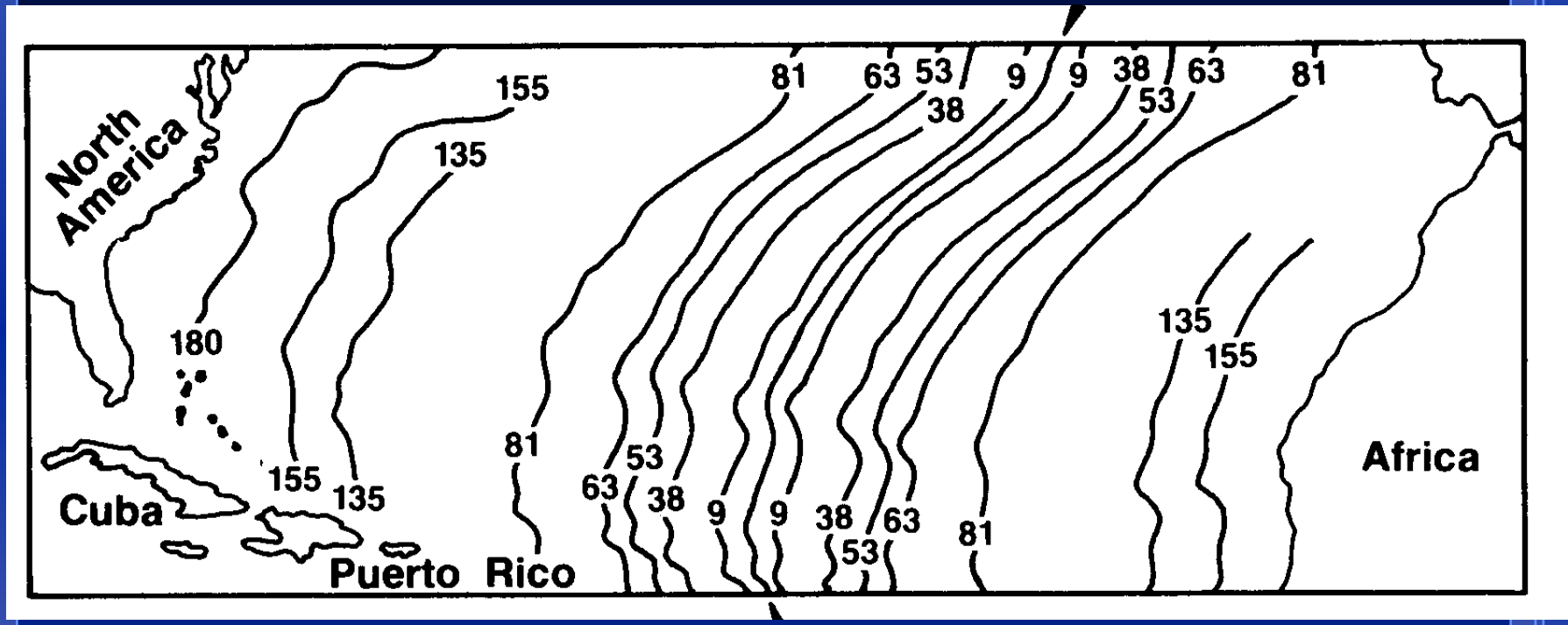


At the present time, rocks record a normal pattern because the north magnetic pole is in the northern hemisphere.


positive magnetic anomaly
negative magnetic anomaly
Earth's magnetic field
crest of mid-ocean ridge
positive
negative
magnetic stripes

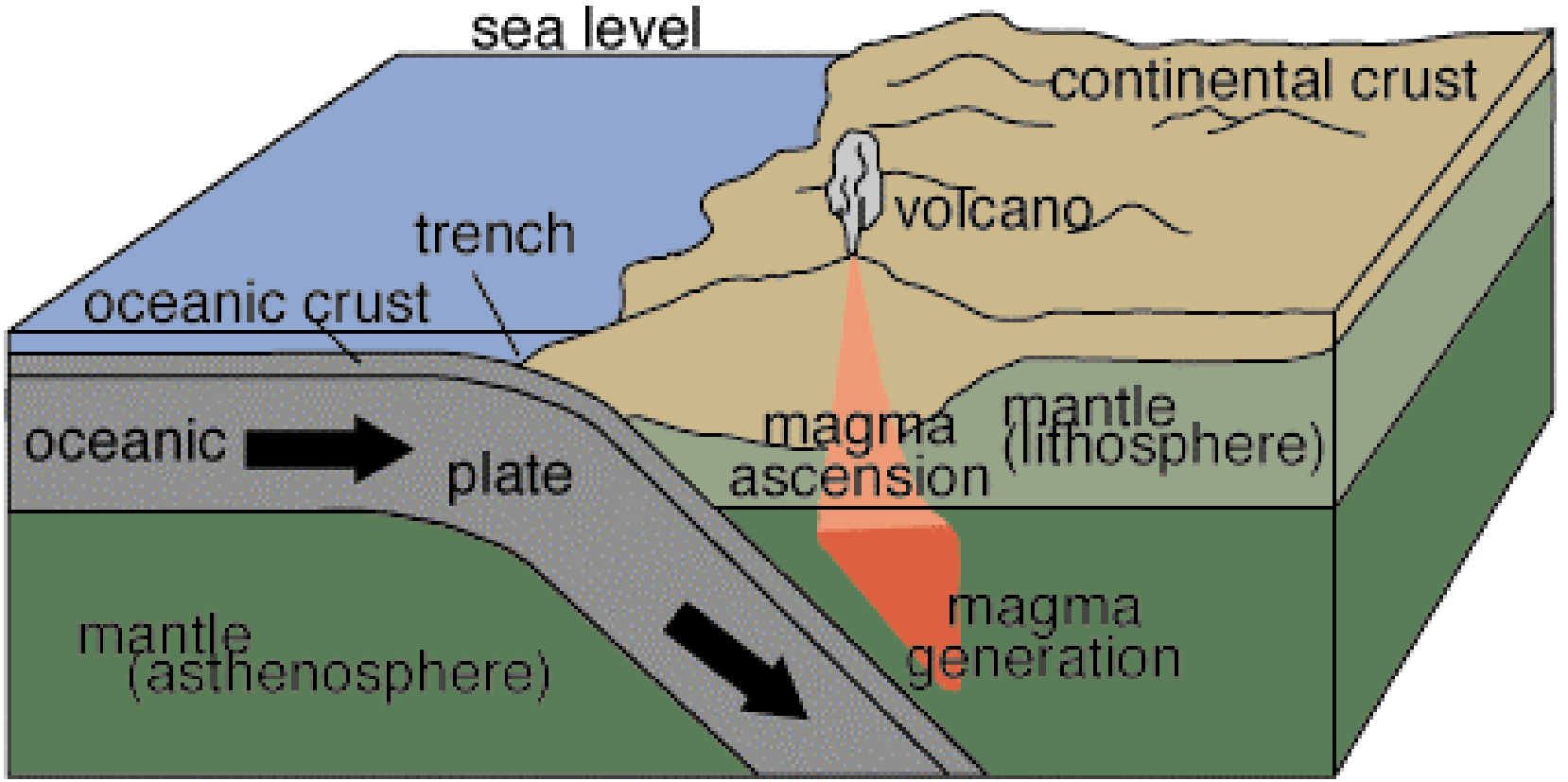
Other Evidence

- By drilling they have found that rocks near the ridge are youngest, and they get older as you get further away.

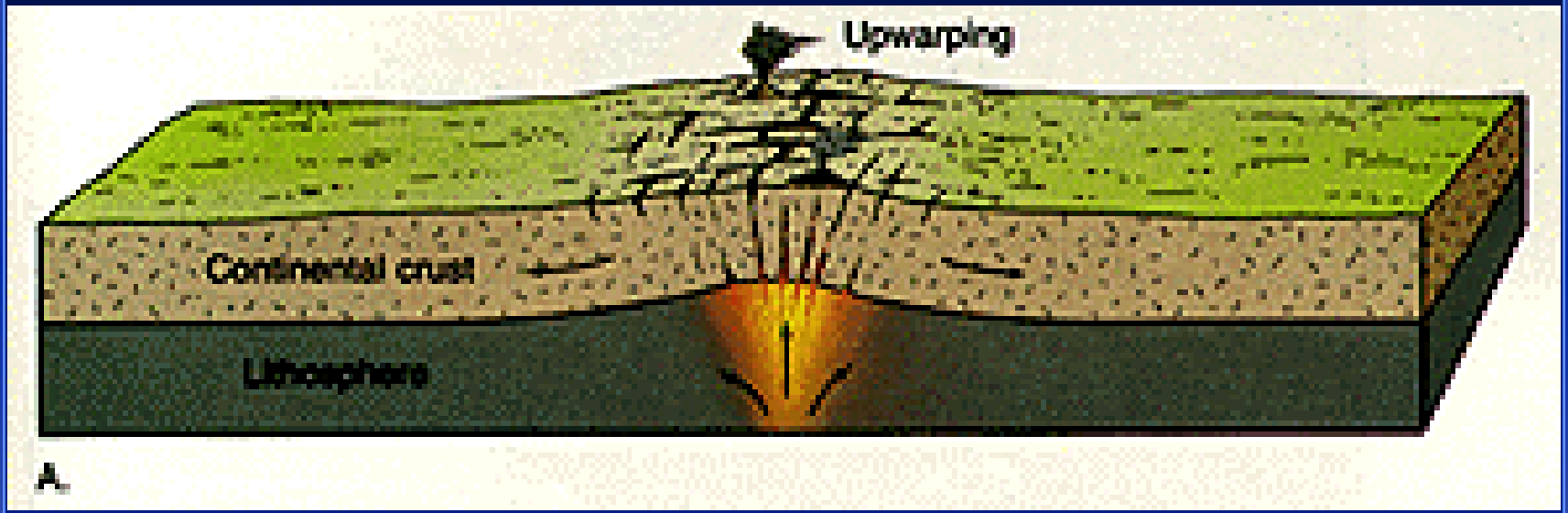

North America
155
135
180
155
135
Cuba
Puerto Rico
81
63
53
38
9
9
38
53
63
81
81
63
53
38
9
9
38
53
63
81
135
155
Africa

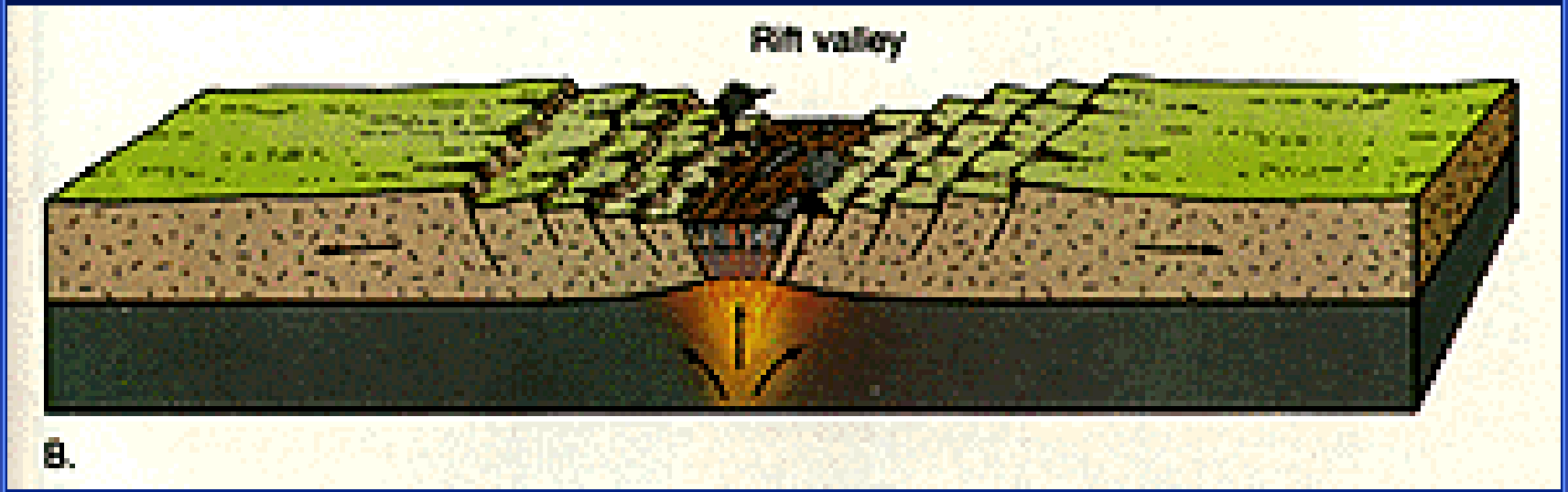
Where does it go?

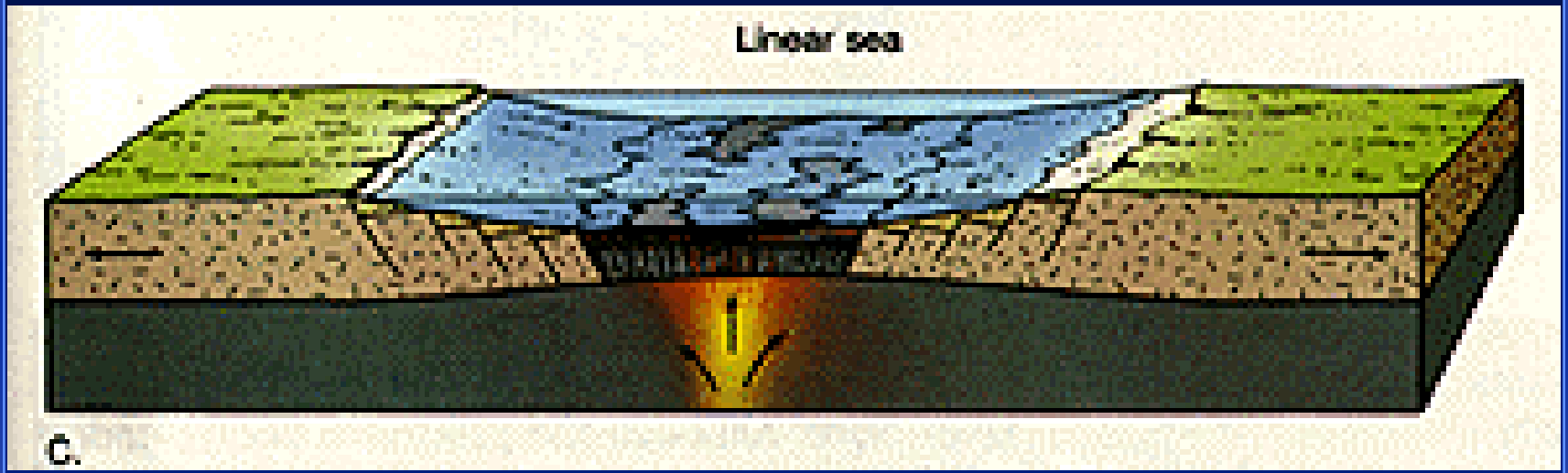
- At the edges of the plates one goes under the other
- called subduction
- It is melted and may make volcanoes.
- Evidence comes from earthquakes.
- The further you get from the edge, the deeper earthquakes are.

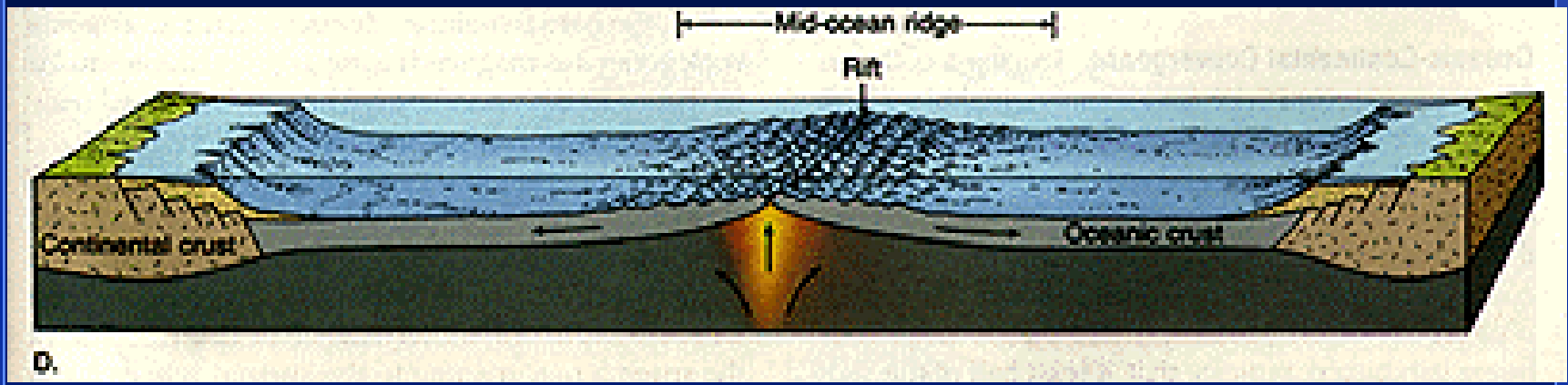


Magma is generated at subduction zones where dense oceanic plates are pushed under lighter continental plates.


Upwarping
Continental crust
Lithosphere
A.

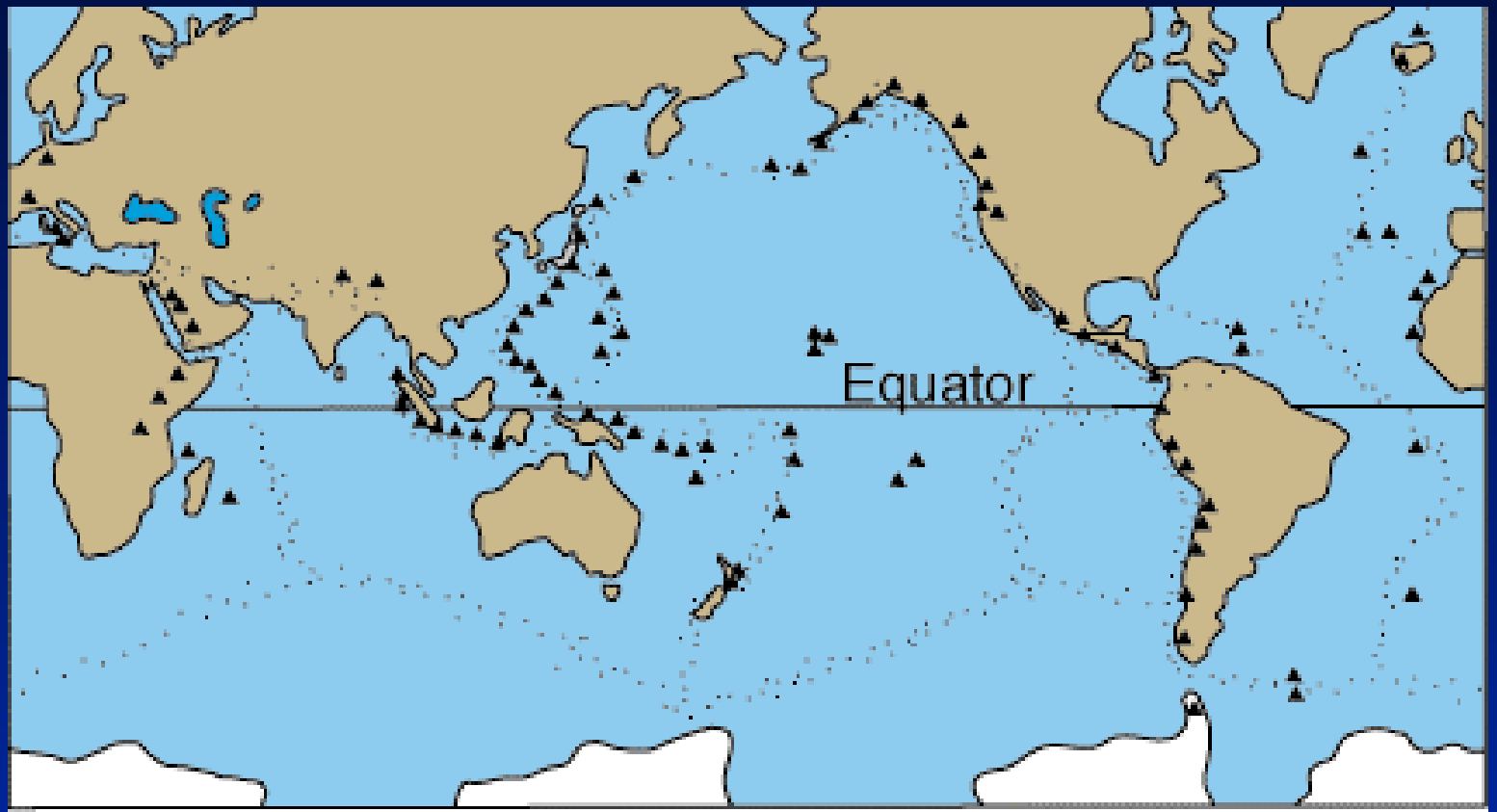

Rift valley
B.


Linear sea
C.


Mid-ocean ridge
Rift
Continental crust
Oceanic crust
D.

Earthquakes and Volcanoes

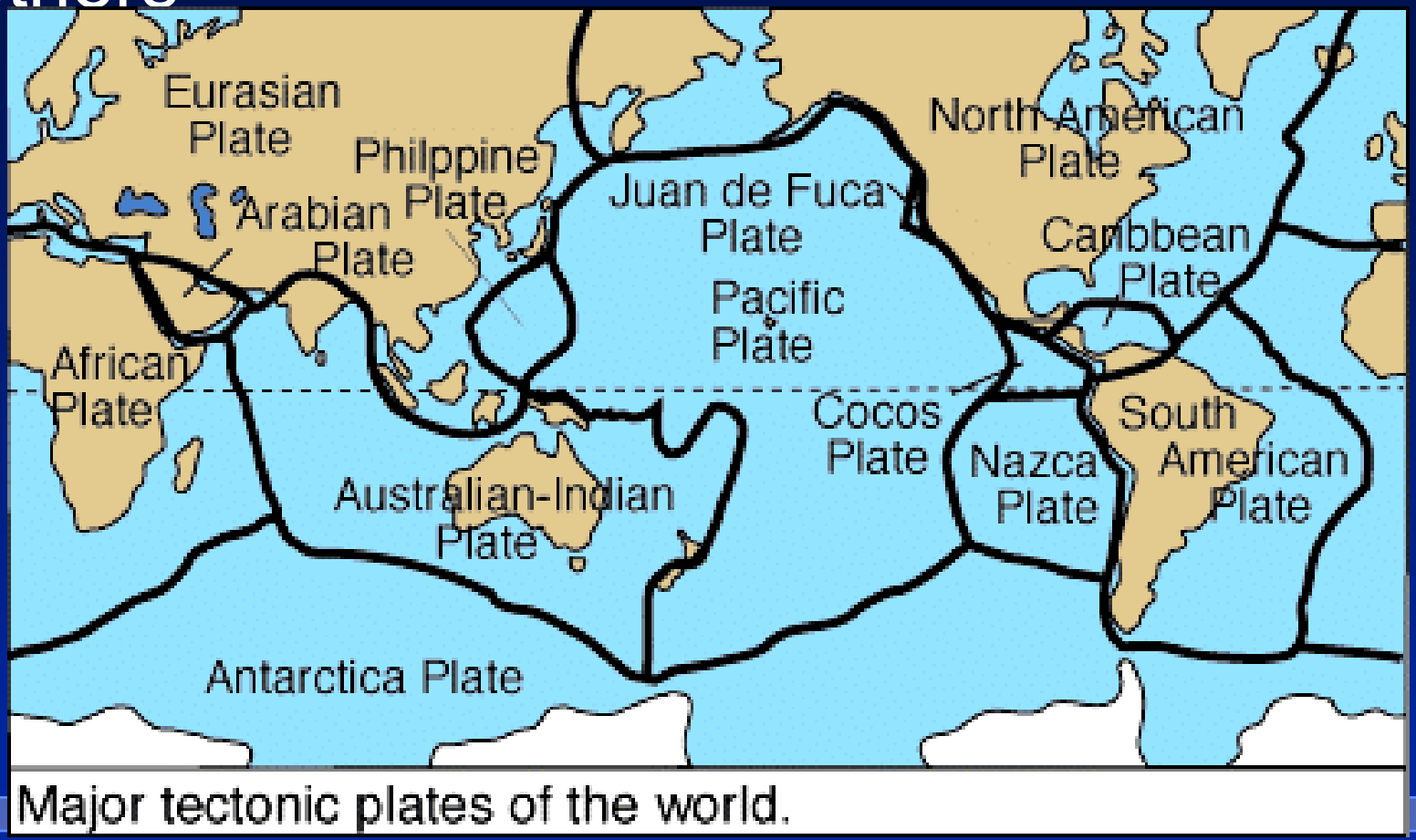
- Occur in zones around the world



Global distribution of volcanoes (▲) and earthquakes (· · · ·) based on Simkin and others (1989).

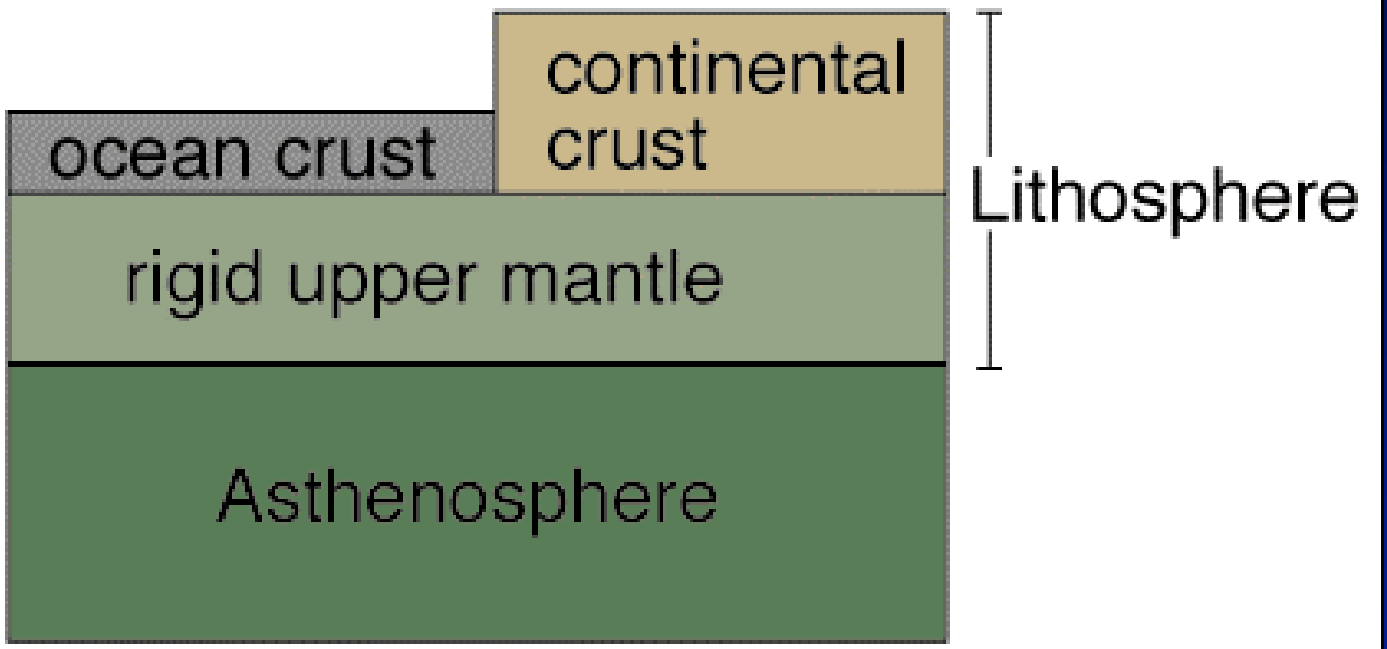
Lithospheric Plates

- There are 7 major ones,and several others

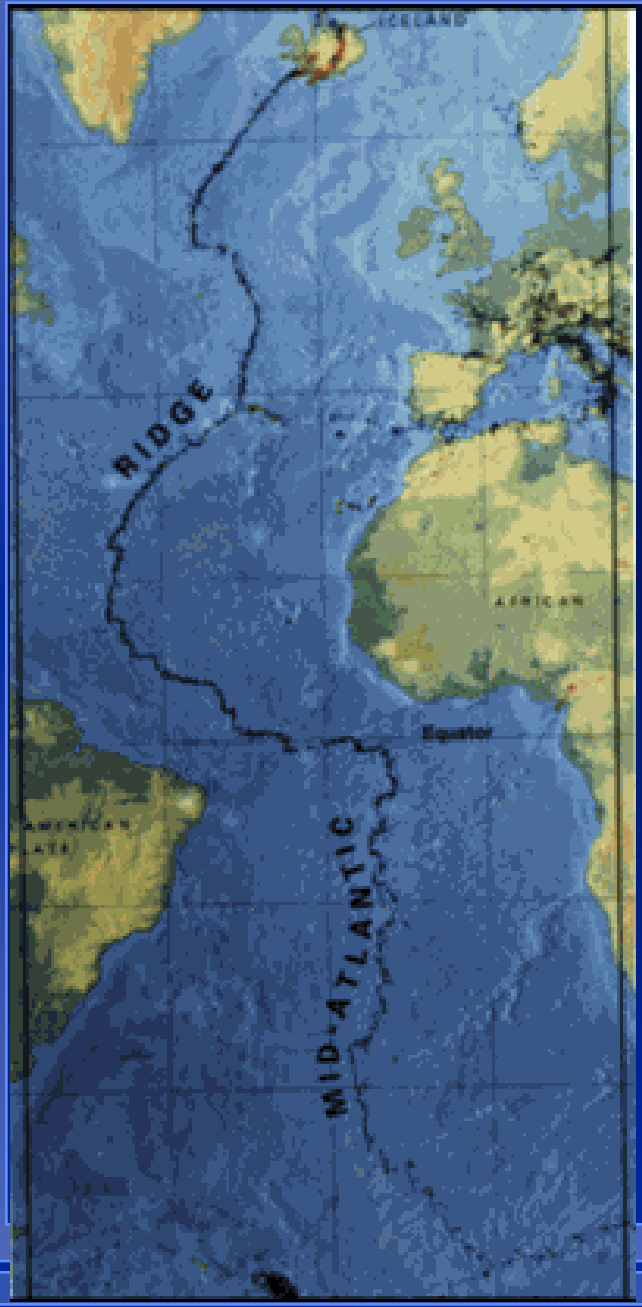


Major tectonic plates of the world.

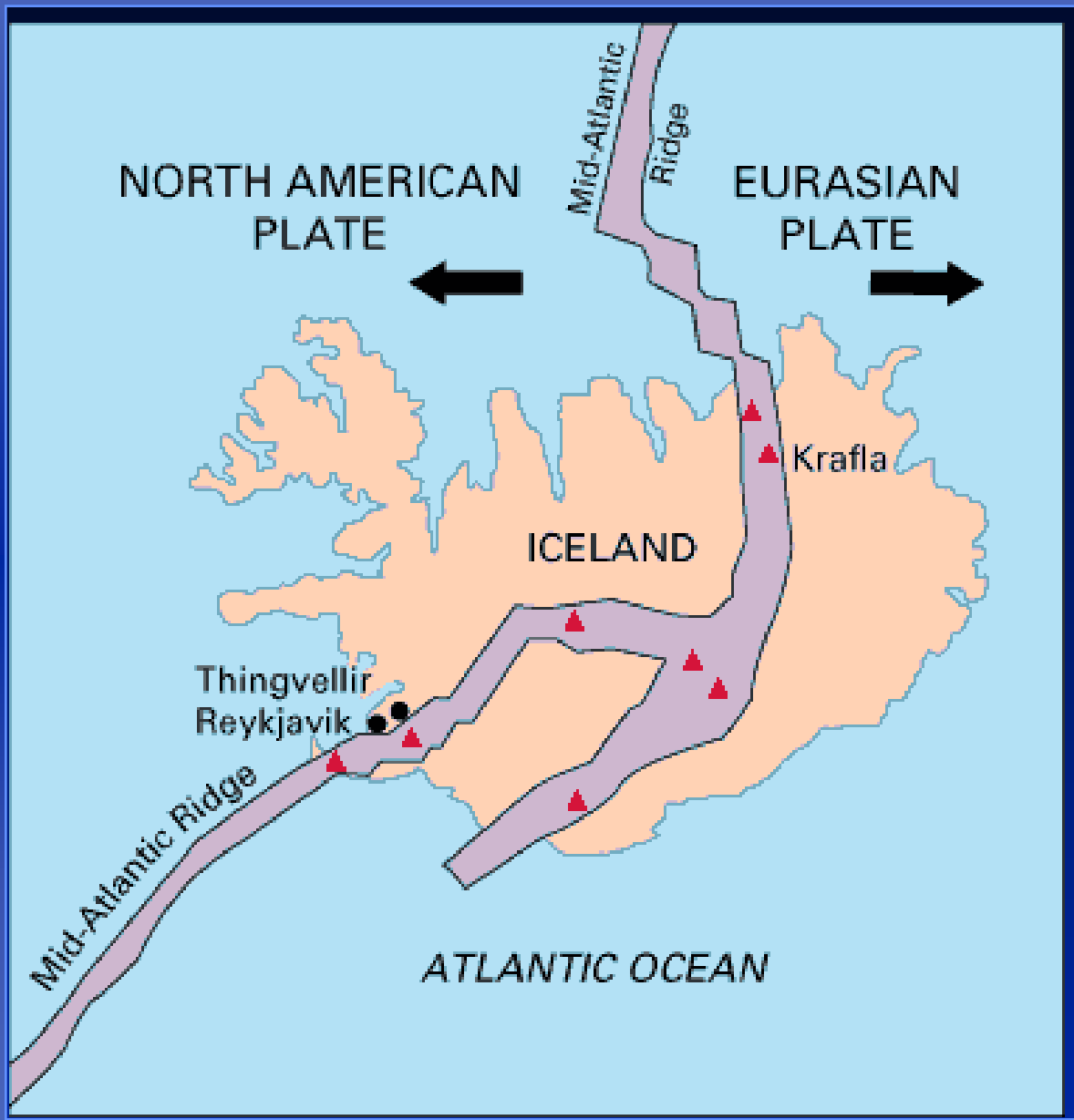
Parts of the lithosphere



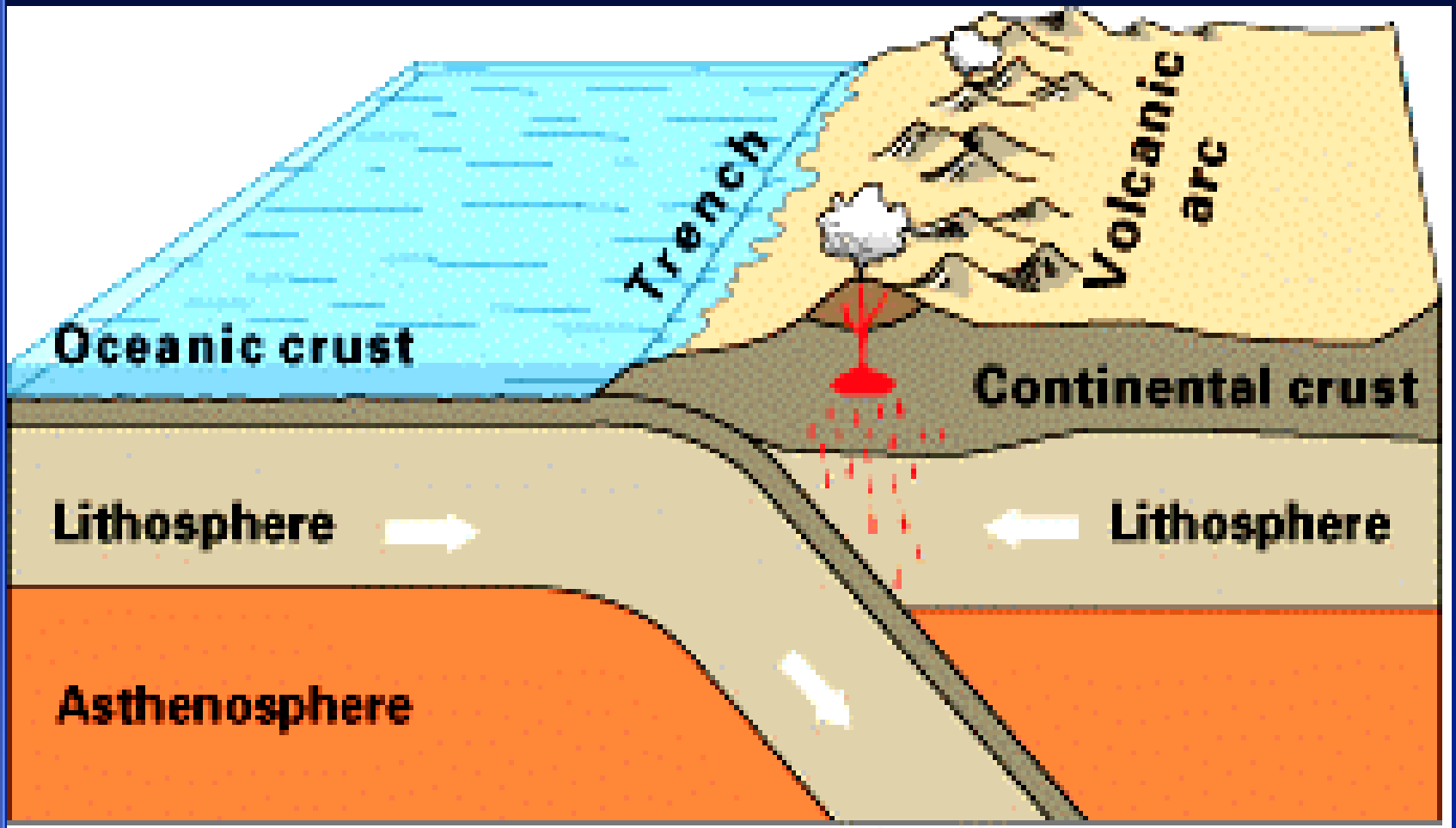
The Earth's outer layer is called the lithosphere. It is made of the rigid upper mantle and the crust. The lithosphere moves on the asthenosphere, part of the mantle that flows.


ICELAND
RIDGE
AFRICAN
Equator
MID-ATLANTIC

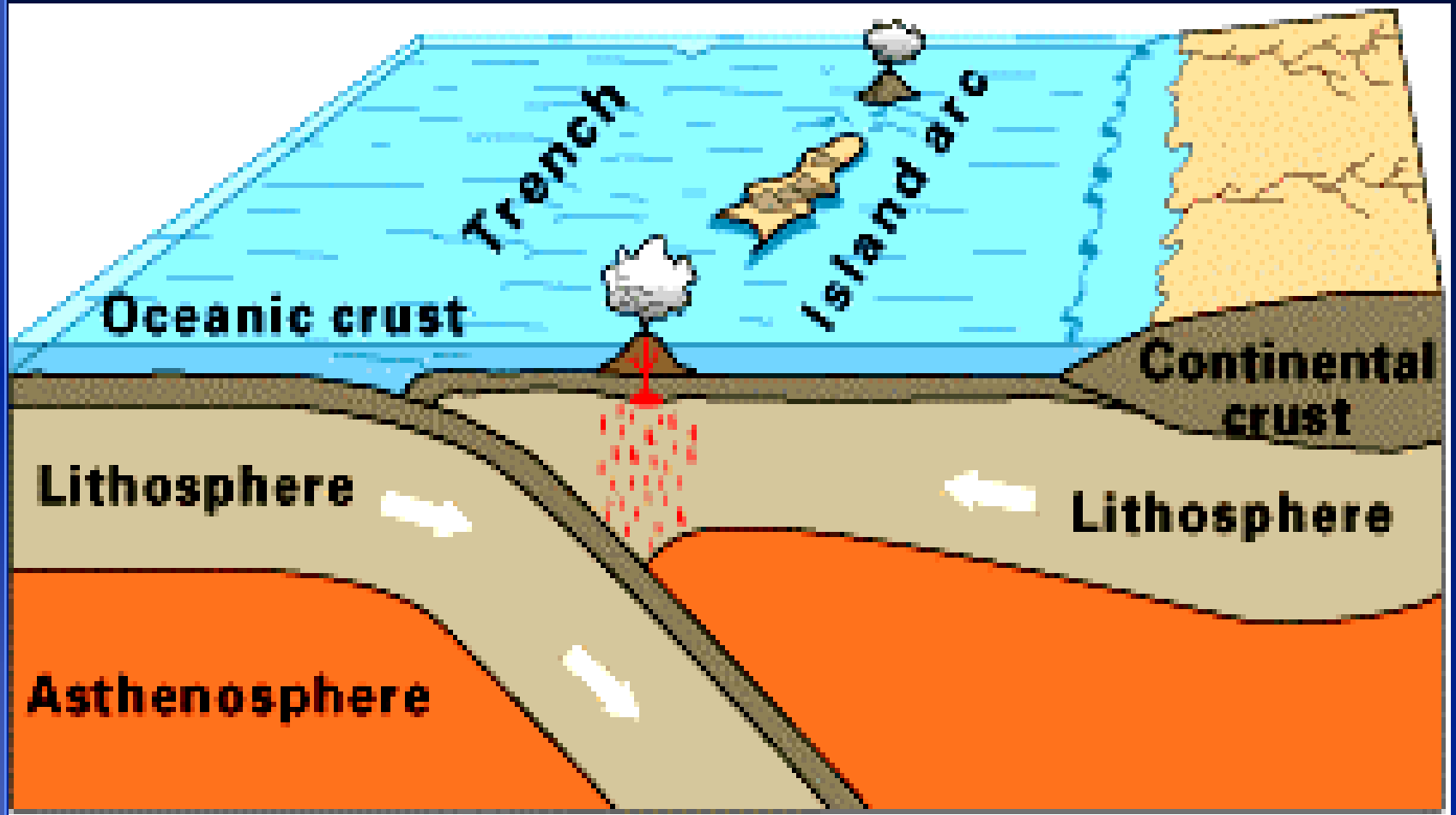
Iceland


NORTH AMERICAN PLATE
Mid-Atlantic Ridge
EURASIAN PLATE
Krafla
ICELAND
Thingvellir
Reykjavik
Mid-Atlantic Ridge
ATLANTIC OCEAN

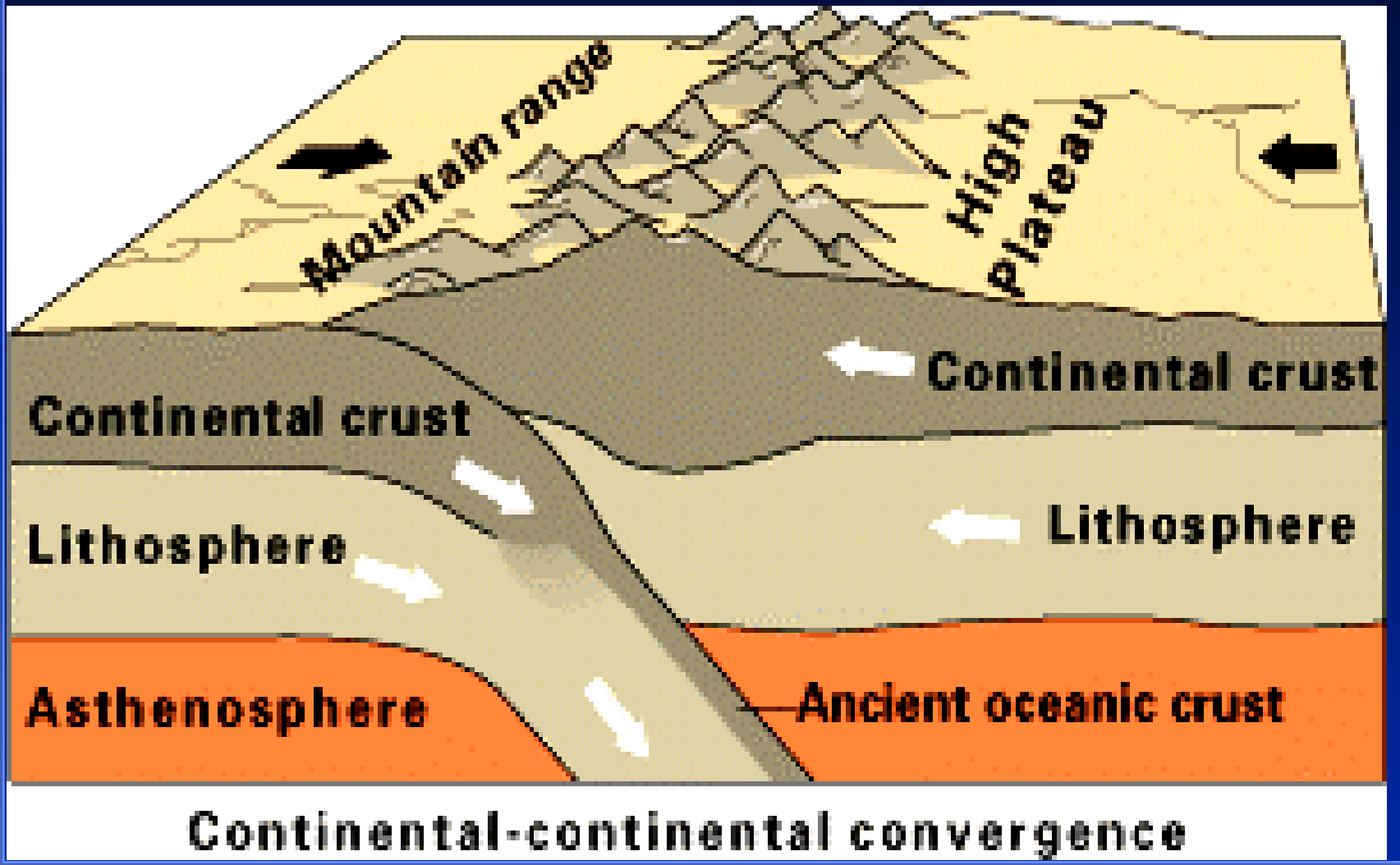
Convergent Boundary

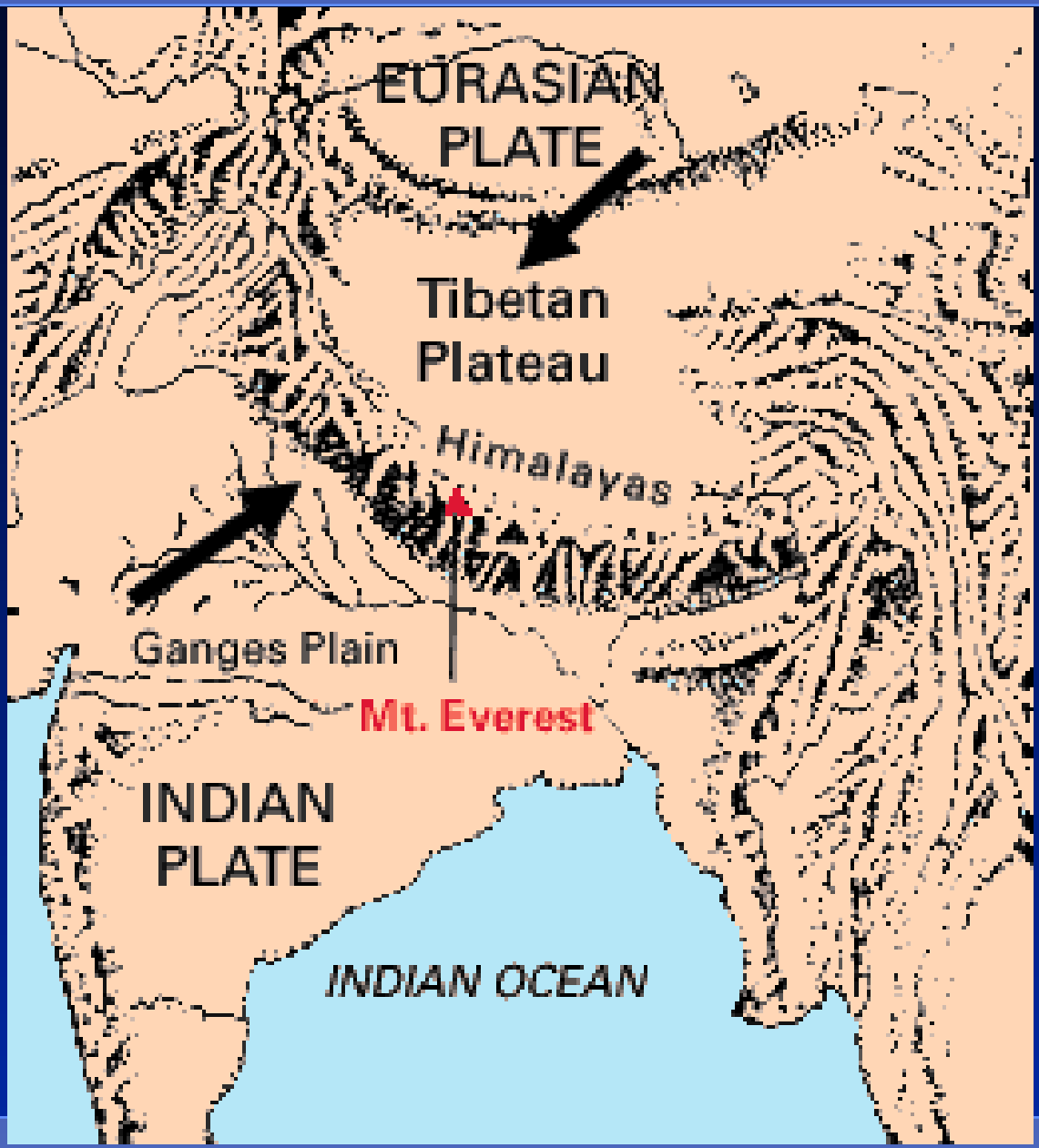


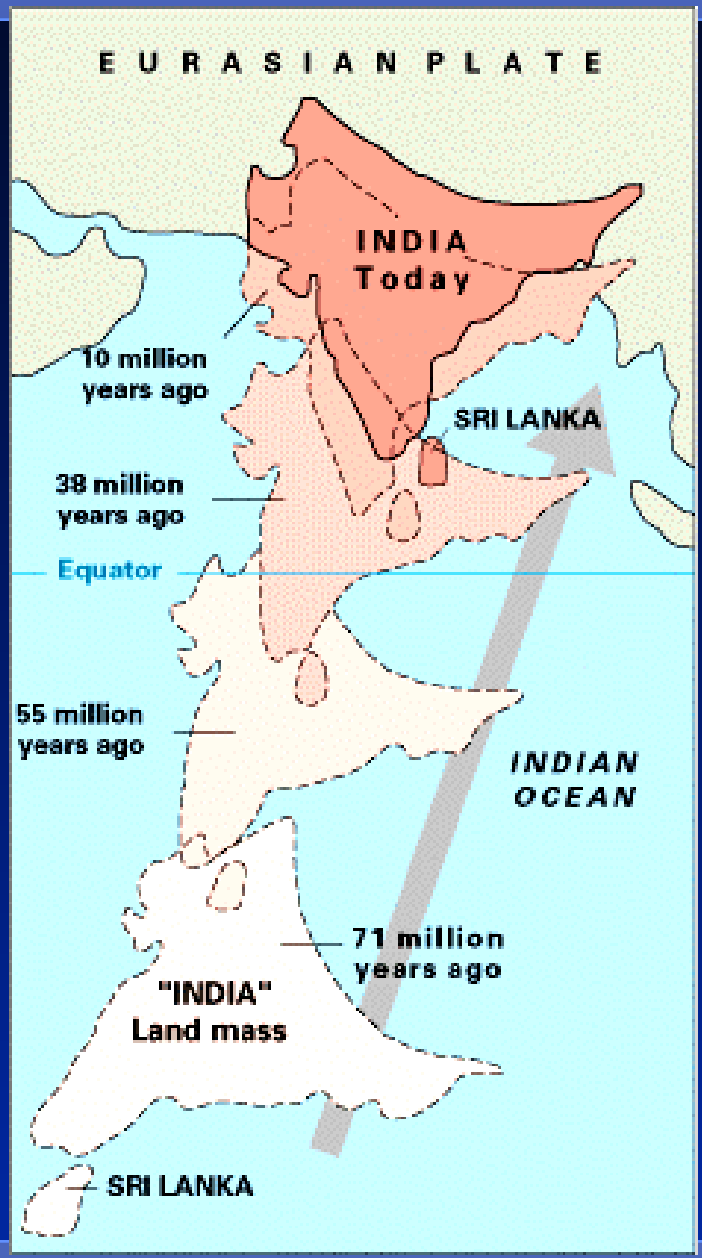
Convergent Boundary

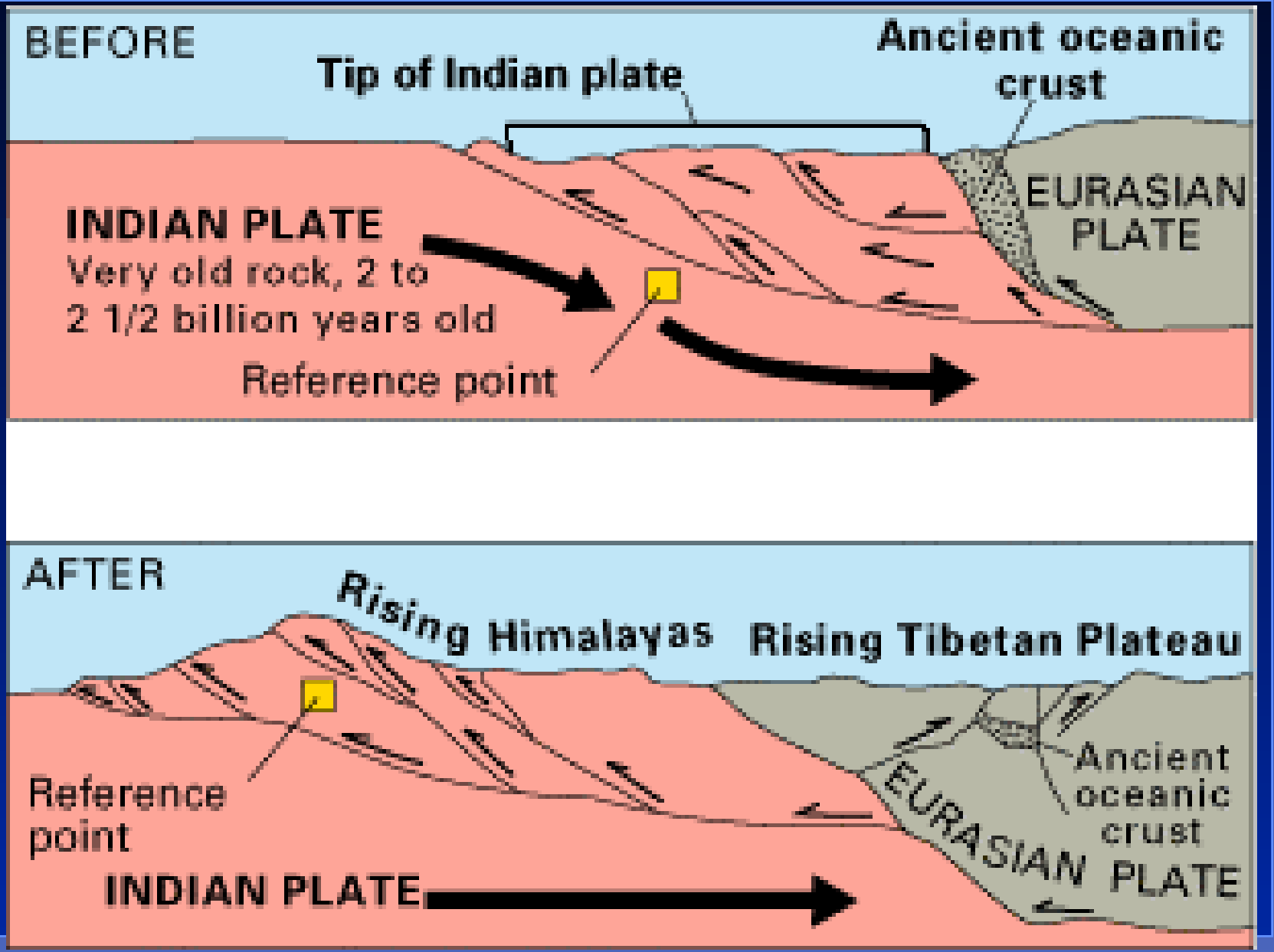


Convergent Boundary



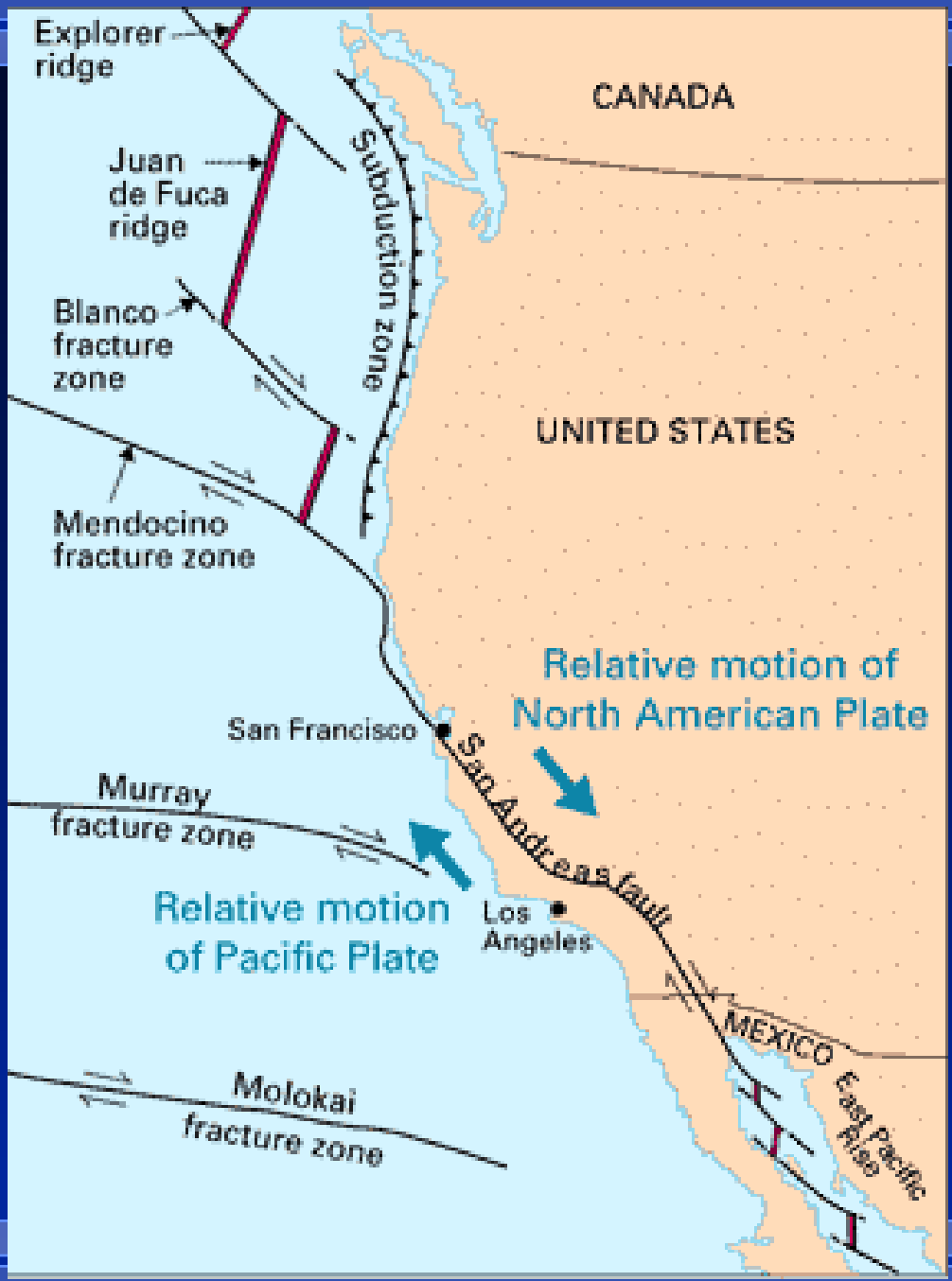

EURASIAN
PLATE
Tibetan
Plateau
Himalayas
Ganges Plain
Mt. Everest
INDIAN
PLATE
INDIAN OCEAN


EURASIAN PLATE
INDIA
Today
10 million
years ago
SRI LANKA
38 million
years ago
Equator
55 million
years ago
INDIAN
OCEAN
71 million
years ago
"INDIA"
Land mass
SRI LANKA

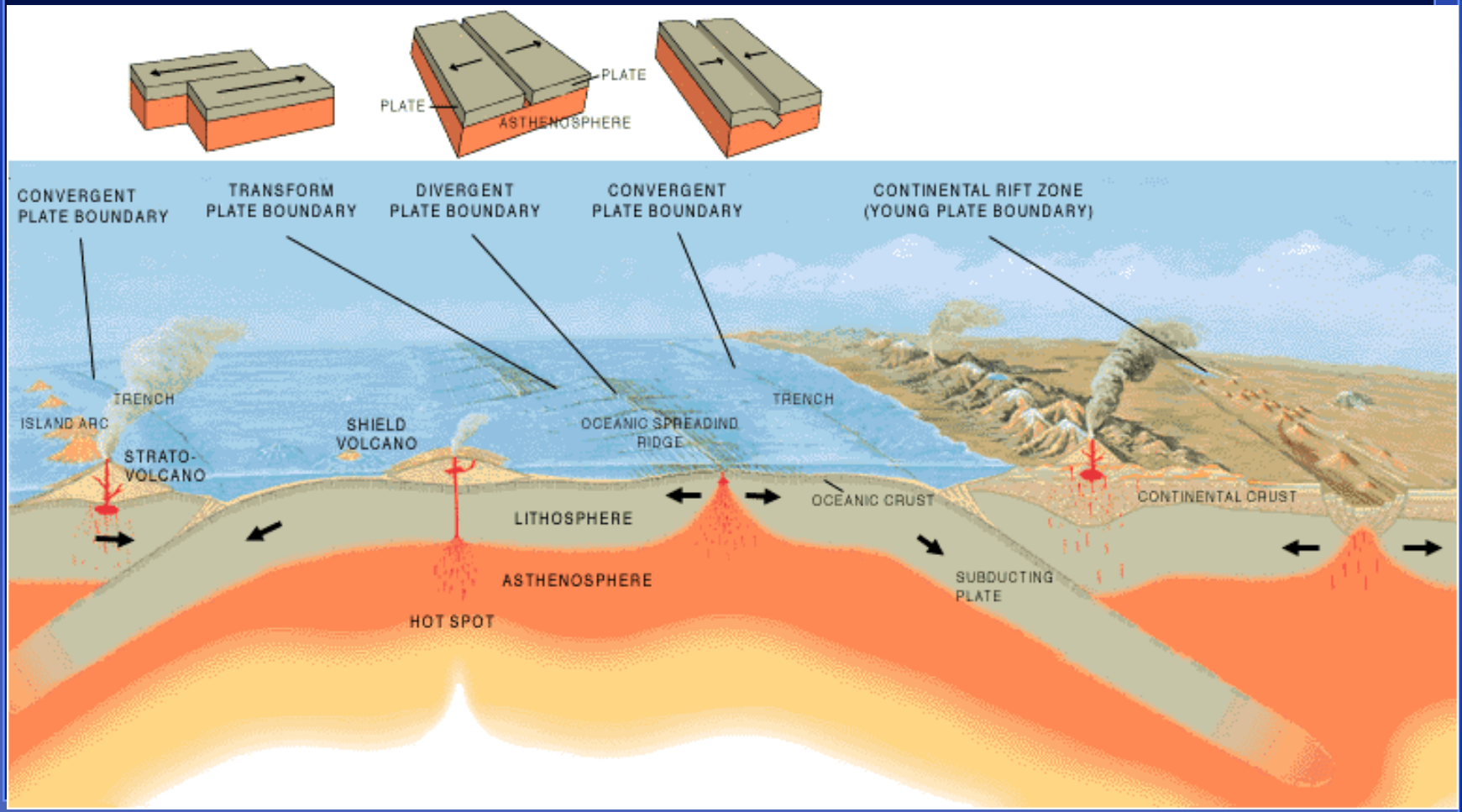

BEFORE
Tip of Indian plate
Ancient oceanic crust
EURASIAN PLATE
INDIAN PLATE
Very old rock, 2 to 2 1/2 billion years old
Reference point
AFTER
Rising Himalayas
Rising Tibetan Plateau
Reference point
Ancient oceanic crust
EURASIAN PLATE
INDIAN PLATE

Convergent Boundaries

- Continental and oceanic- ocean subducted, volcanoes on shore
- Oceanic and Oceanic- one is subducted, forms an island arc
- Continental and continental- folded mountains and a plateau

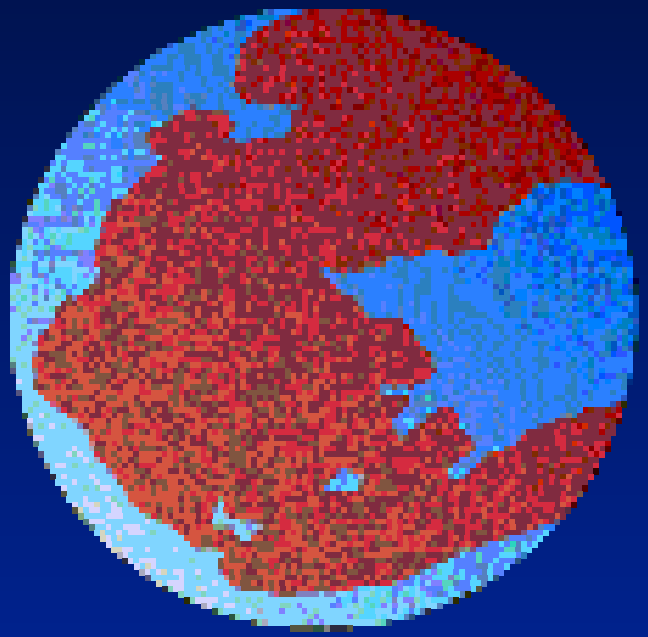

Explorer ridge
Juan de Fuca ridge
Blanco fracture zone
Mendocino fracture zone
Murray fracture zone
Molokai fracture zone
Subduction zone
CANADA
UNITED STATES
MEXICO
San Francisco
Los Angeles
San Andreas fault
East Pacific Rise
Relative motion of North American Plate
Relative motion of Pacific Plate

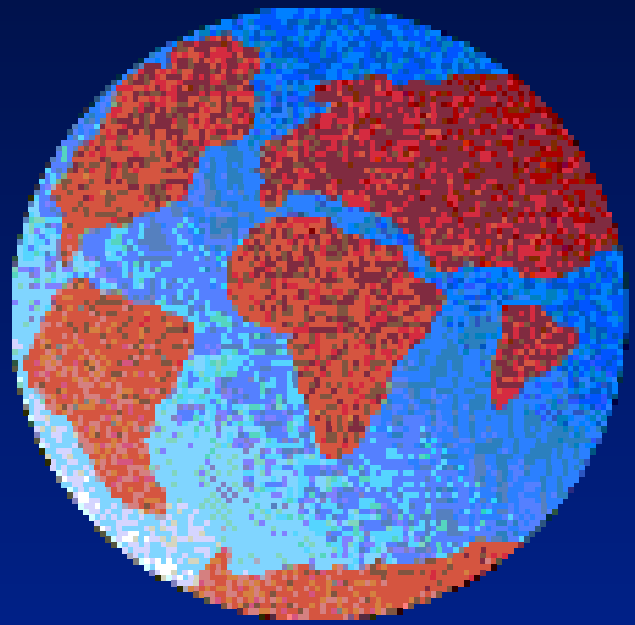
Boundary types

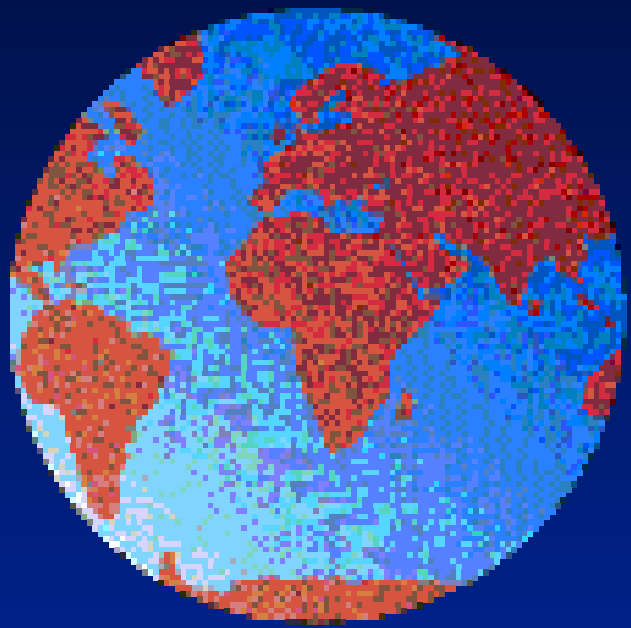


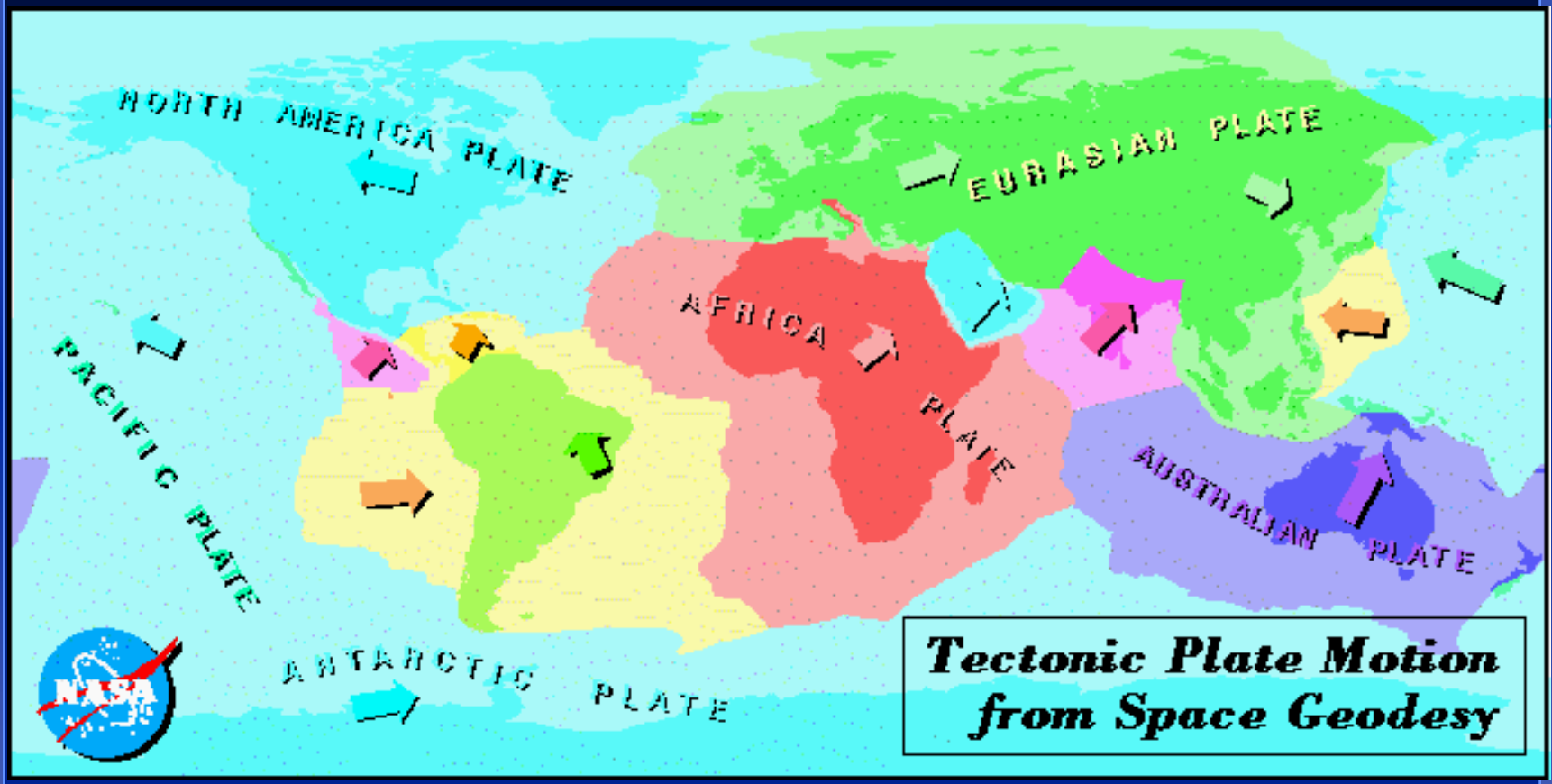
How Fast?

- Arctic Ridge 2.5 cm per year
- East Pacific rise, off the coast of Chile 15 cm/year
- Current movement tracked by satellites








NORTH AMERICA PLATE
EURASIAN PLATE
AFRICA PLATE
AUSTRALIAN PLATE
PACIFIC PLATE
ANTARCTIC PLATE
NASA
Tectonic Plate Motion
from Space Geodesy