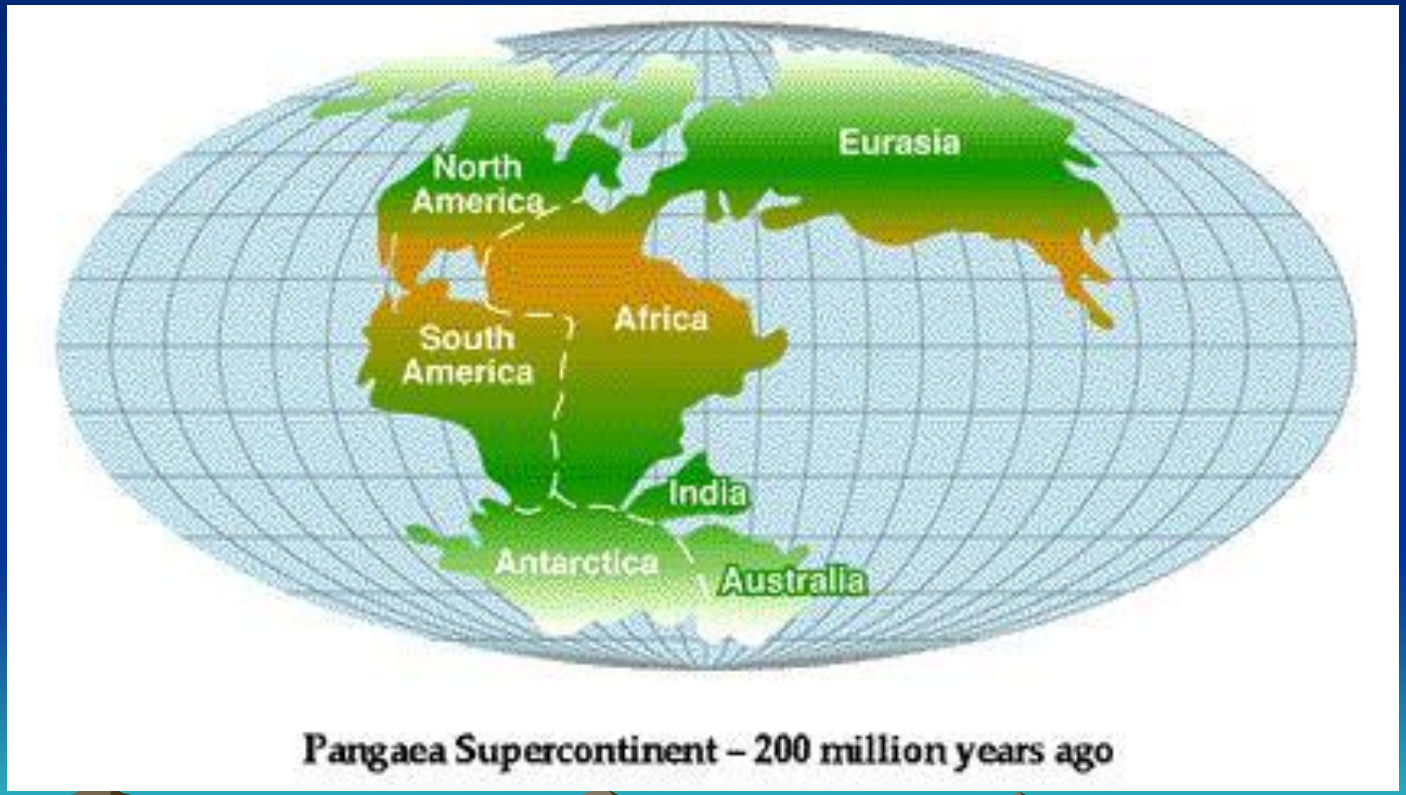
Plate Tectonics

Looking at the world map, what do you notice about the shape of the continents?

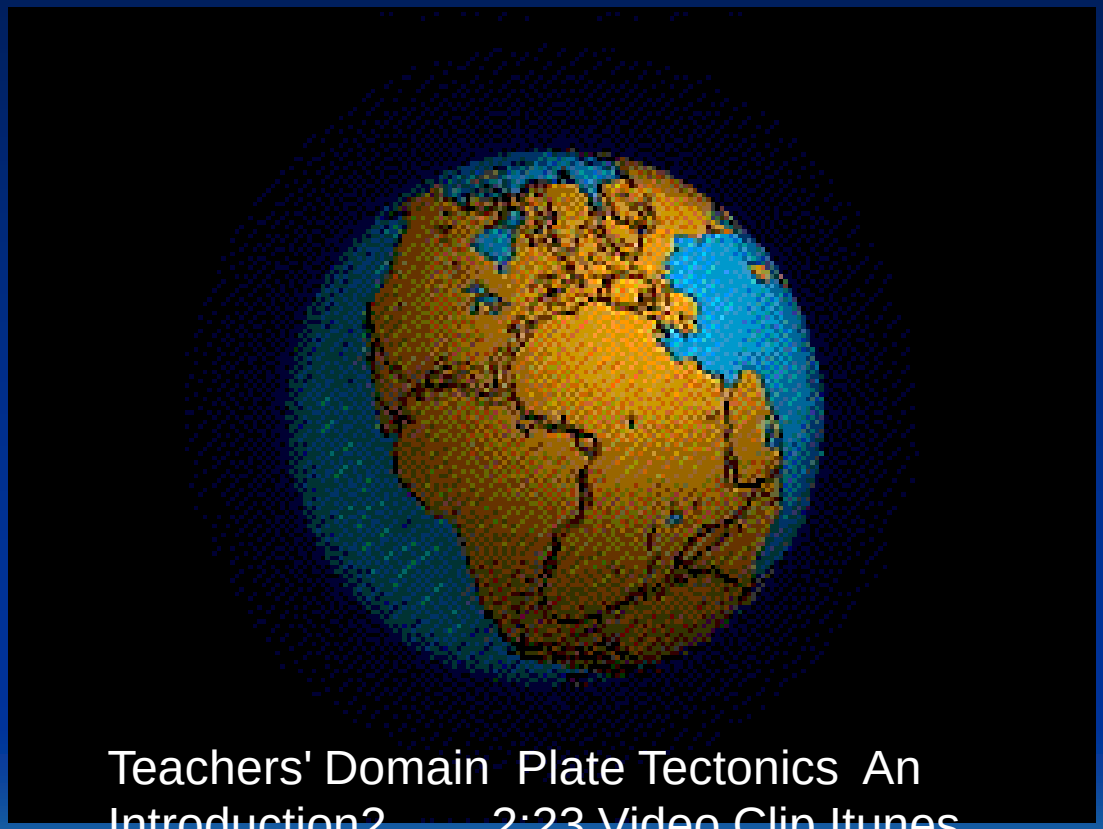
Jot down your ideas on your paper...

The thing is…the world didn't always look like this! It used to look like this:



Pangaea Supercontinent – 200 million years ago

How is this possible?!?!?

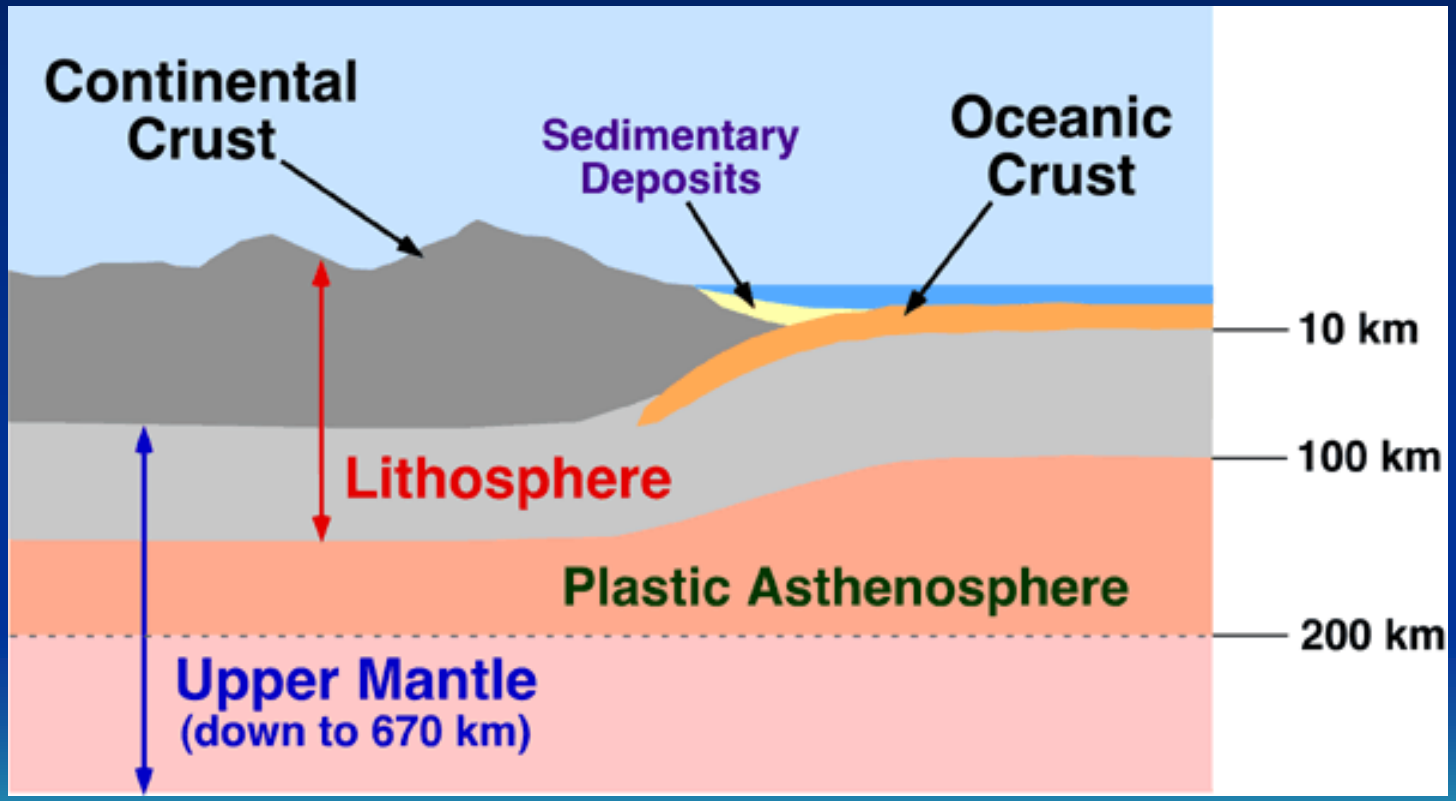


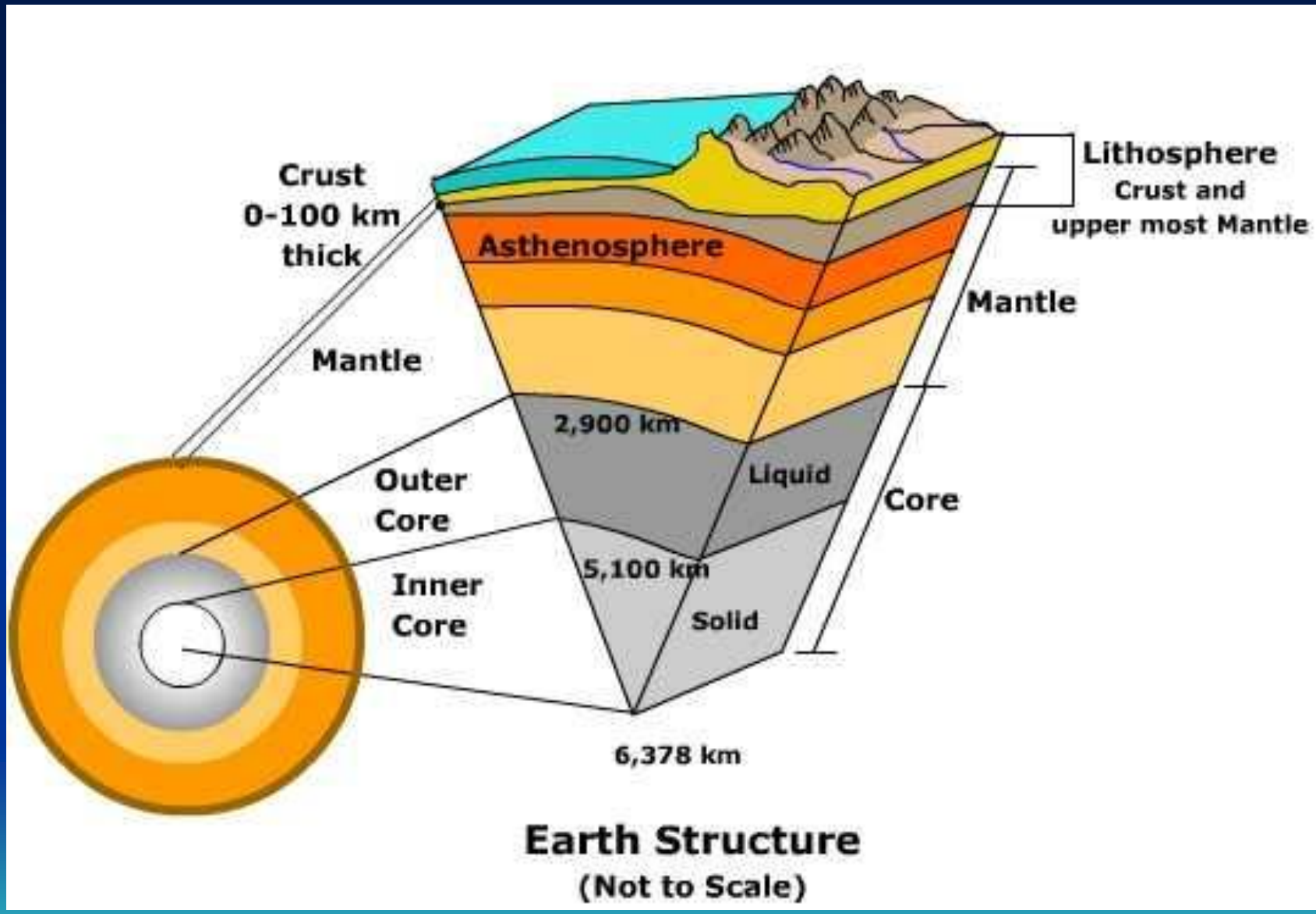
Teachers' Domain Plate Tectonics An Introduction2 2:23 Video Clip Itunes

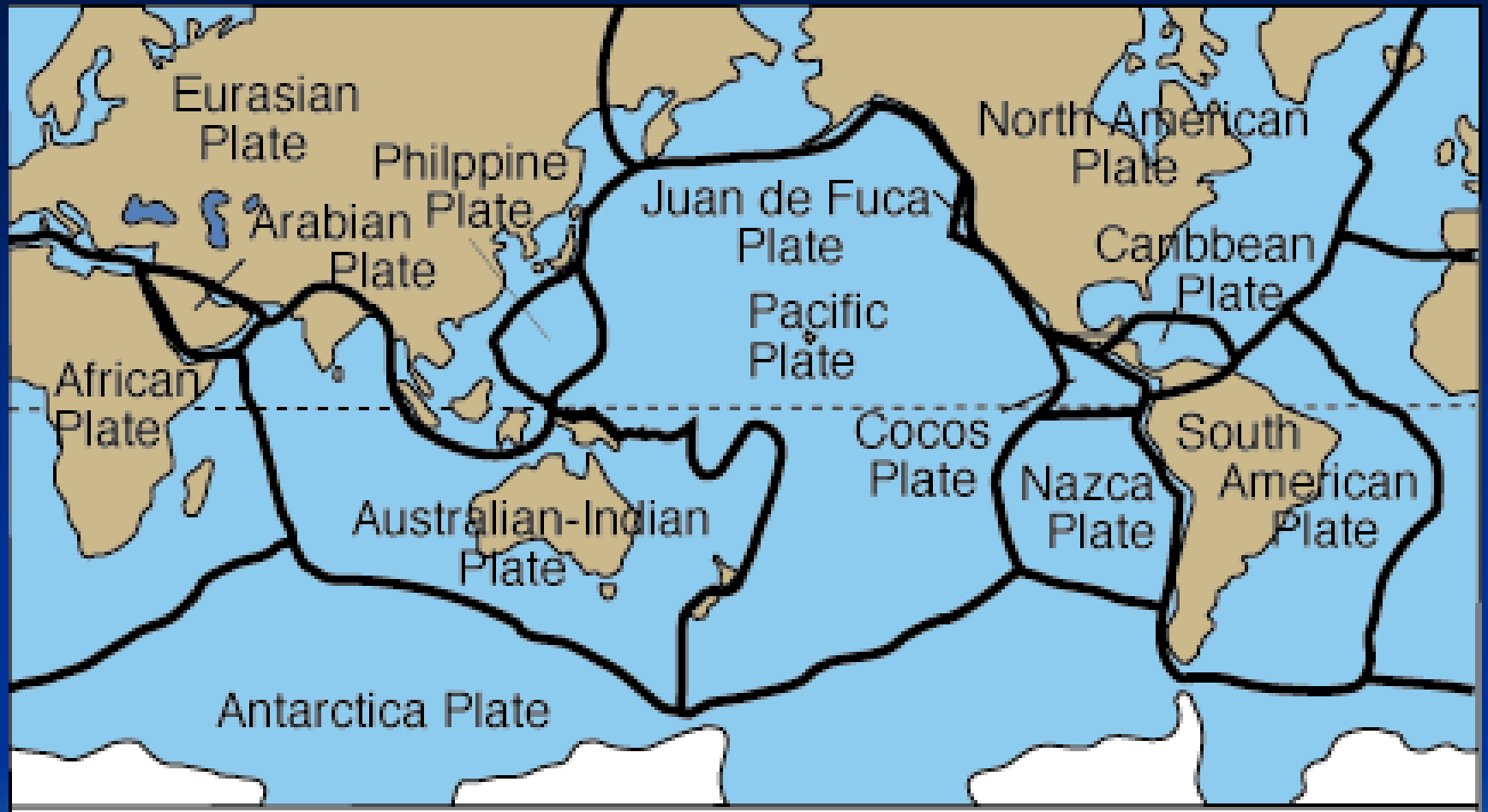
Plate Tectonics Theory

- The lithosphere is **divided** into a number of large and small **plates** and the plates are floating on the **mantle**

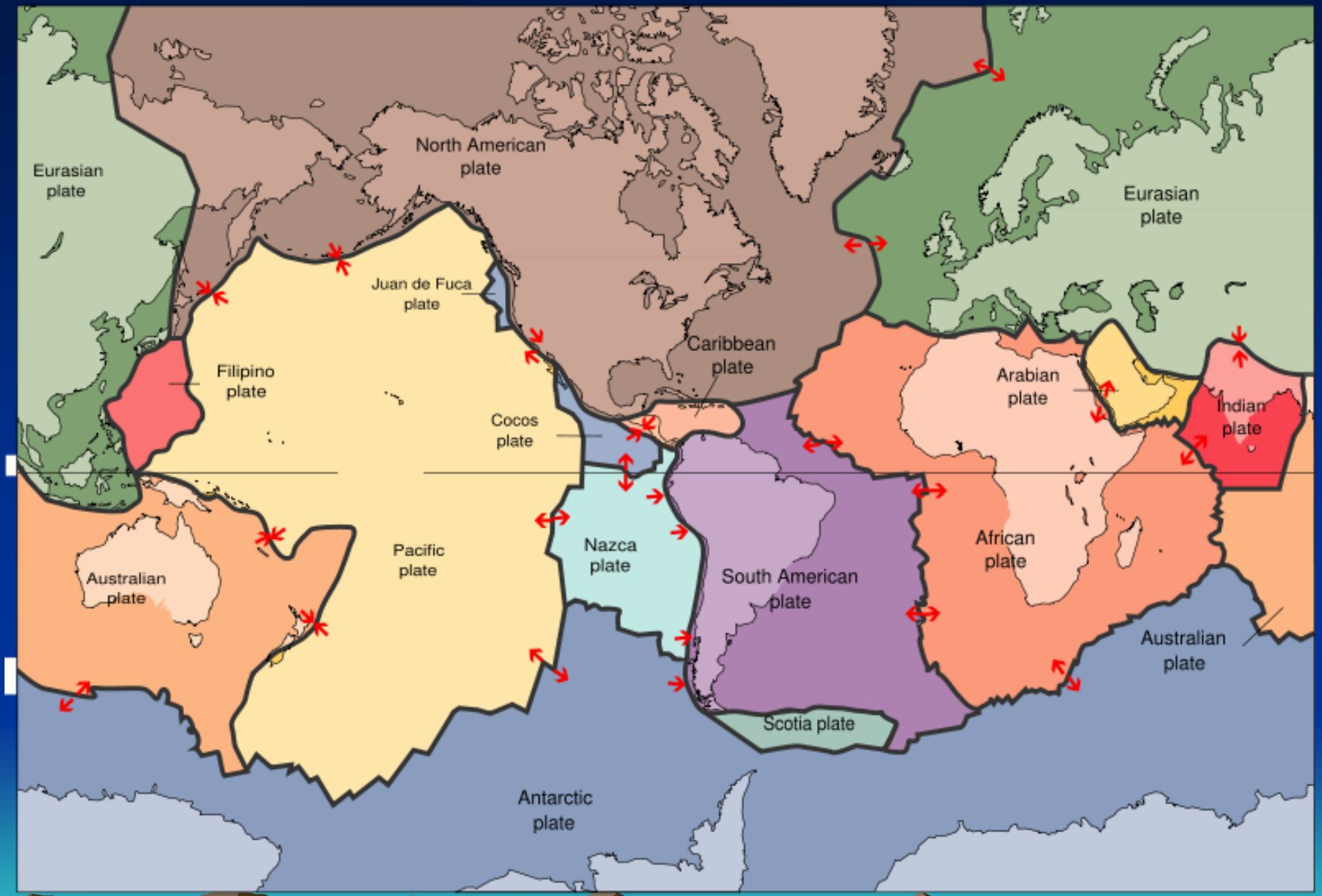
Lithosphere = the Earth's crust plus the upper portion of the mantle layer




Crust
0-100 km
thick
Mantle
Asthenosphere
Lithosphere
Crust and
upper most Mantle
Mantle
2,900 km
Liquid
Outer
Core
Core
5,100 km
Inner
Core
Solid
6,378 km
Earth Structure
(Not to Scale)



Major tectonic plates of the world.


Eurasian plate
North American plate
Eurasian plate
Juan de Fuca plate
Caribbean plate
Filipino plate
Arabian plate
Indian plate
Cocos plate
Pacific plate
Nazca plate
African plate
Australian plate
South American plate
Australian plate
Scotia plate
Antarctic plate

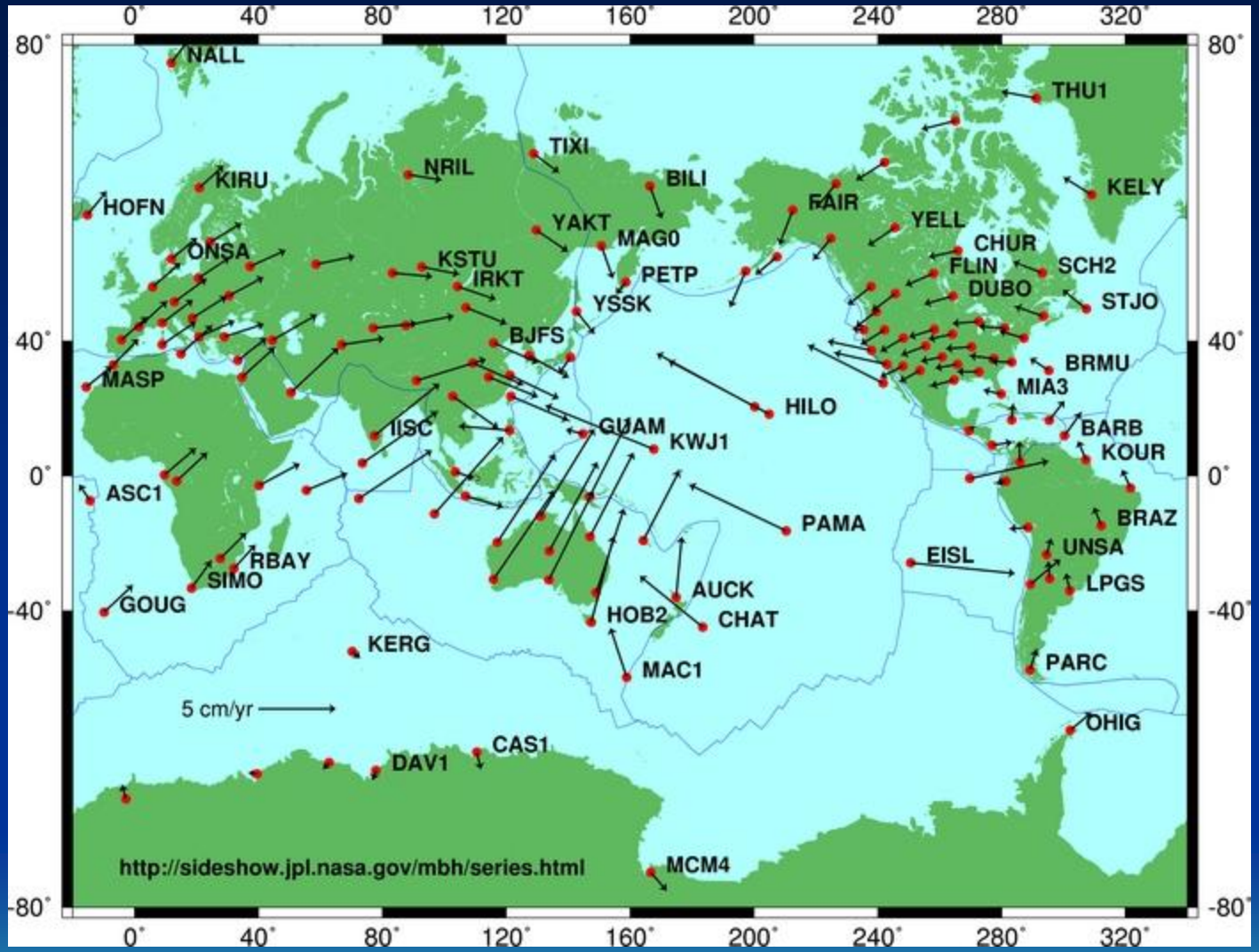
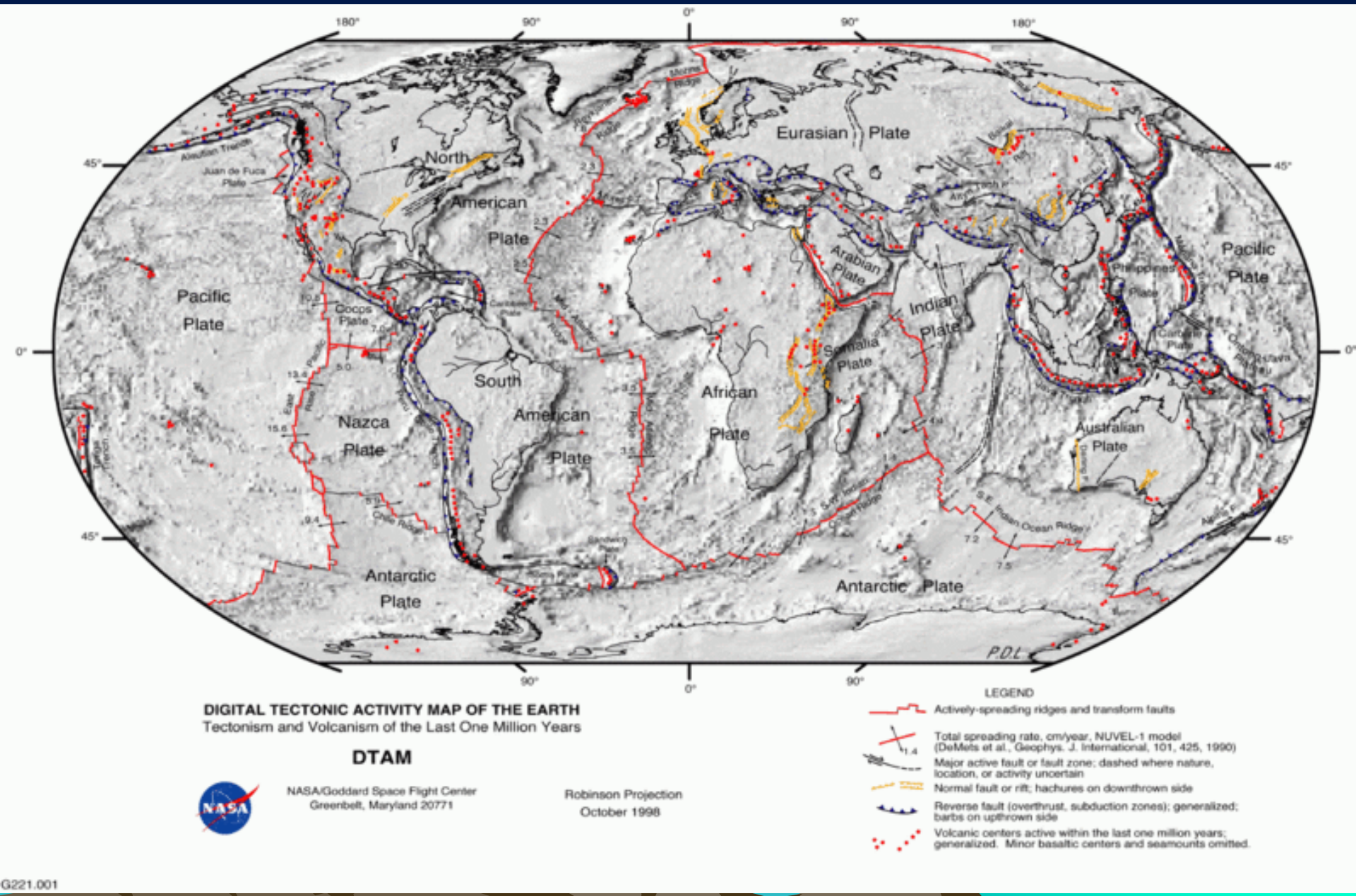


Plate motion based on The Global Positioning System (GPS)



DIGITAL TECTONIC ACTIVITY MAP OF THE EARTH

Tectonism and Volcanism of the Last One Million Years

DTAM

NASA/Goddard Space Flight Center
Greenbelt, Maryland 20771

Robinson Projection
October 1998

LEGEND

- Actively-spreading ridges and transform faults
- Total spreading rate, cm/year, NUVEL-1 model (DeMets et al., Geophys. J. International, 101, 425, 1990)
- Major active fault or fault zone; dashed where nature, location, or activity uncertain
- Normal fault or rift; hachures on downthrown side
- Reverse fault (overthrust, subduction zones); generalized; barbs on upthrown side
- Volcanic centers active within the last one million years; generalized. Minor basaltic centers and seamounts omitted.

G221.001

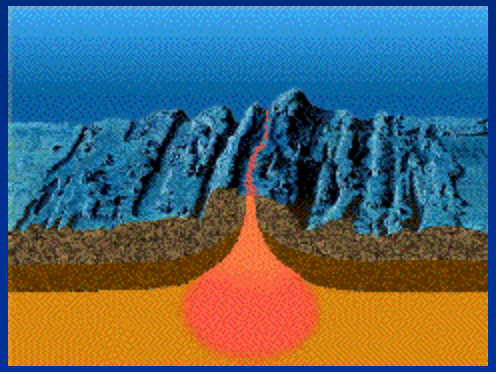
Plate Boundaries

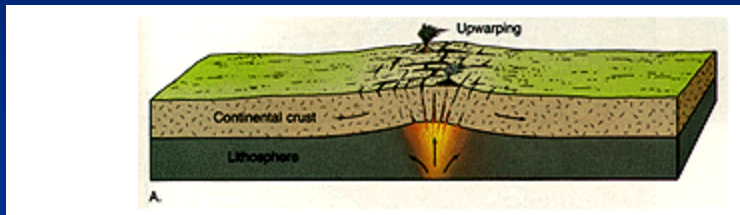
Divergent boundary:

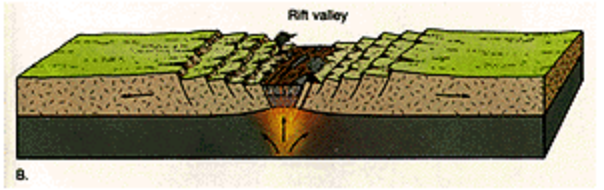
- Plates are moving **away** from each other
- Midocean ridges are **created** and **new** ocean floor plates are created

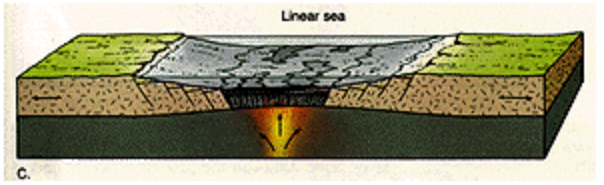
Plate Boundaries

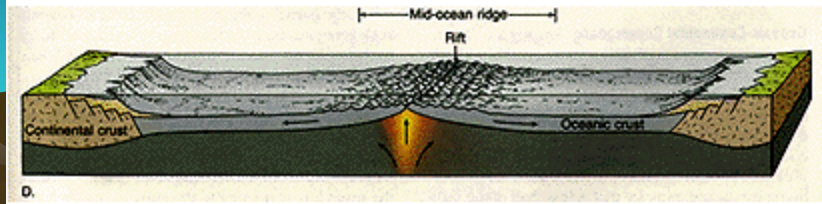
Divergent boundary:





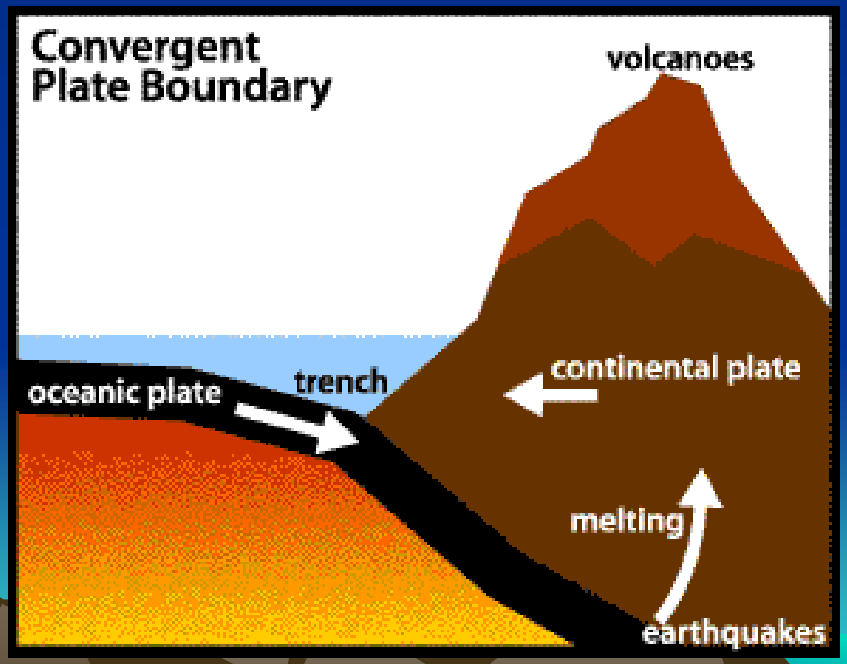






Leif the Lucky Bridge Bridge between continents in Reykjanes peninsula, southwest Iceland across the Alfagja rift valley, the boundary of the Eurasian and North American continental tectonic plates.

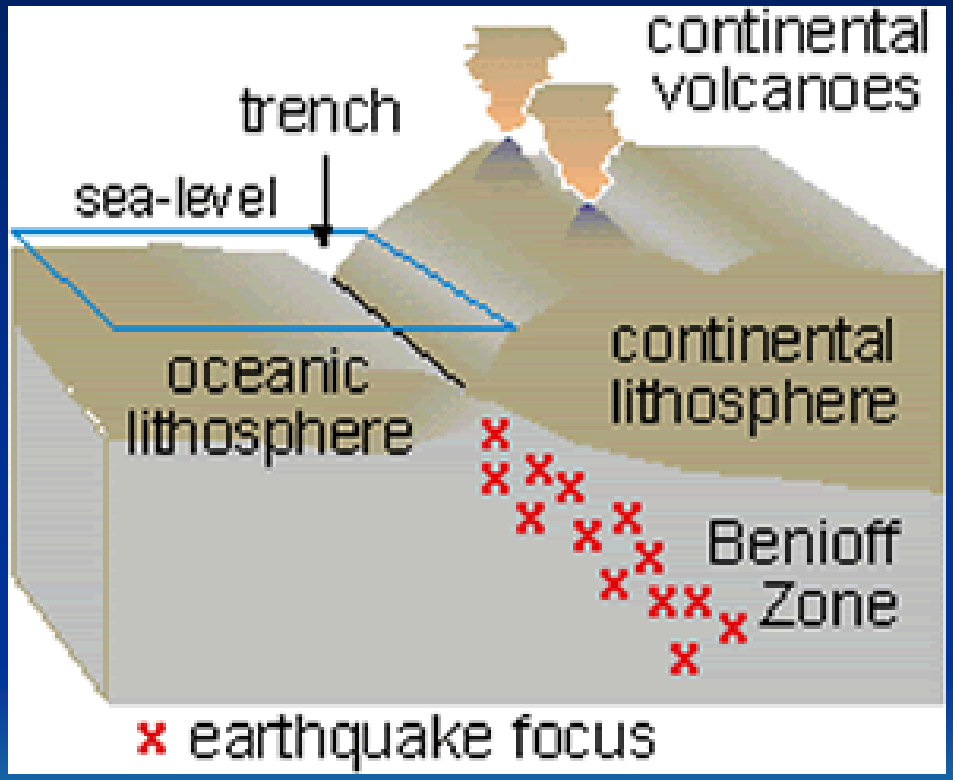
- **Convergent Boundary**: plates are moving **toward** each other and are colliding (3 types)

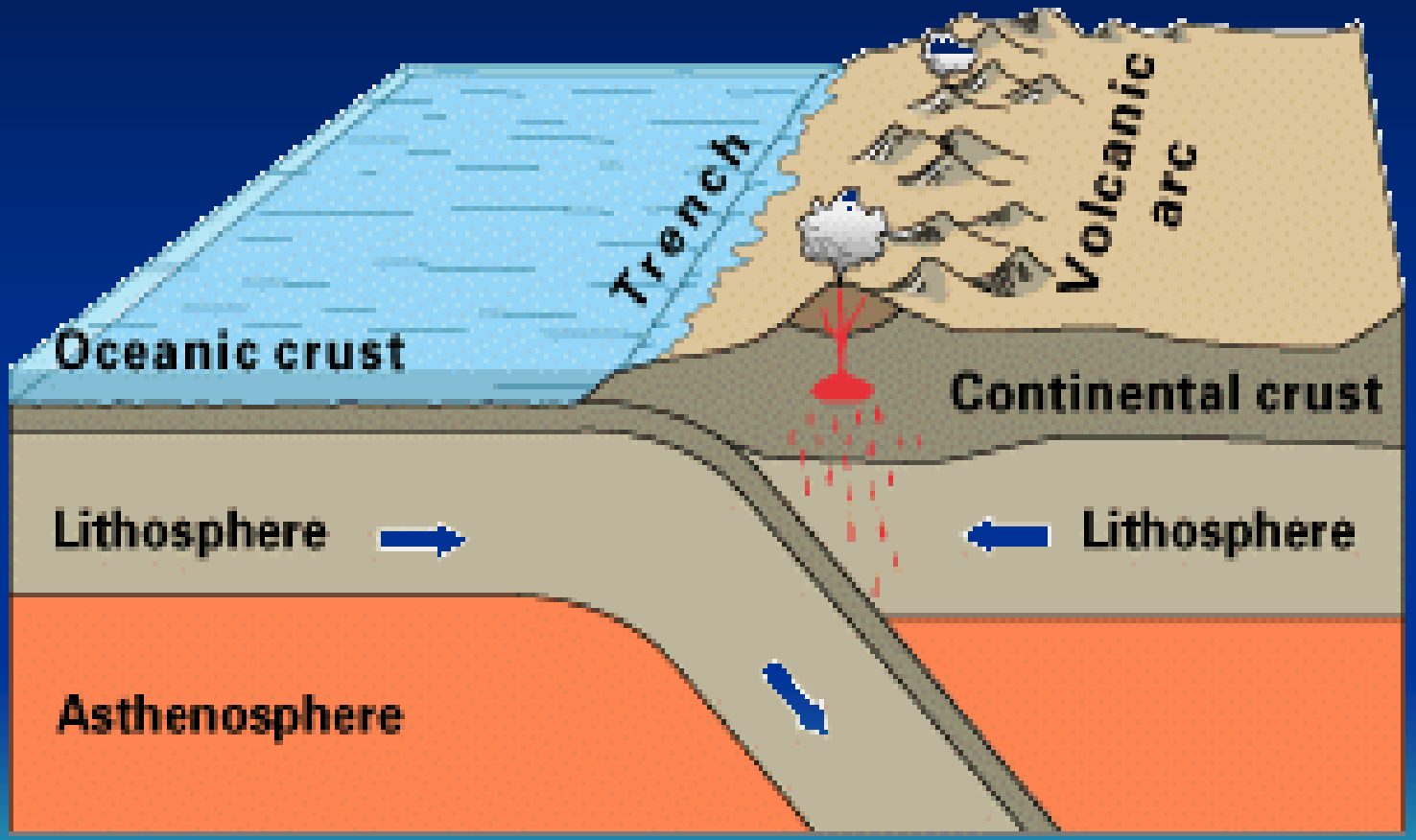


When Ocean Plates collide with Continental Plates

- **Create subduction zones**, trenches
- Create near coast volcanoes
- **Benioff shear** zones (a pattern of earthquakes as an ocean plate grinds down the underneath side of a continent)

Benioff Shear Zones



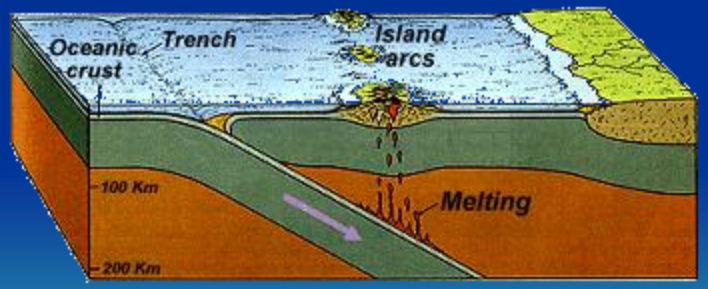


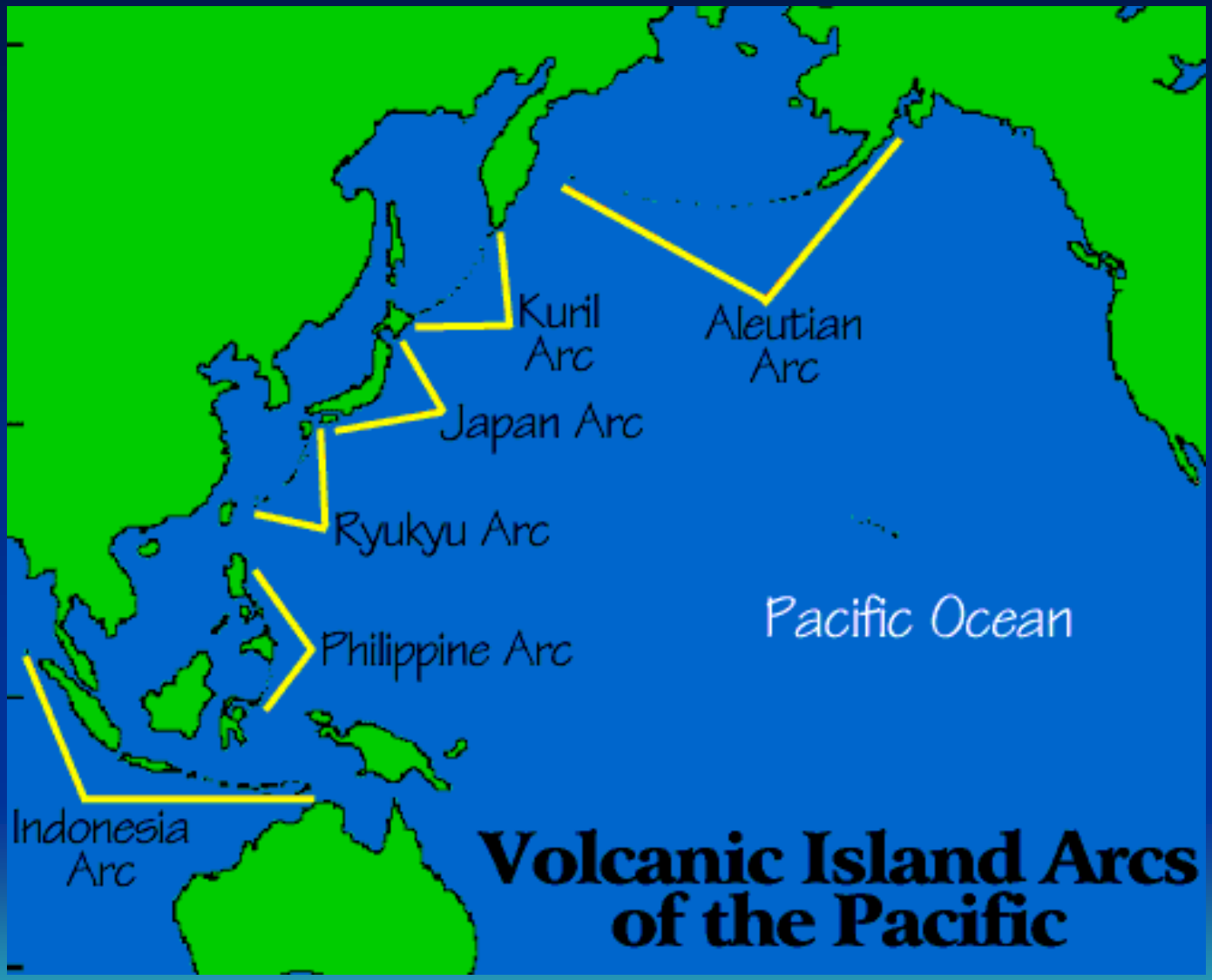
Oceanic-continental convergence

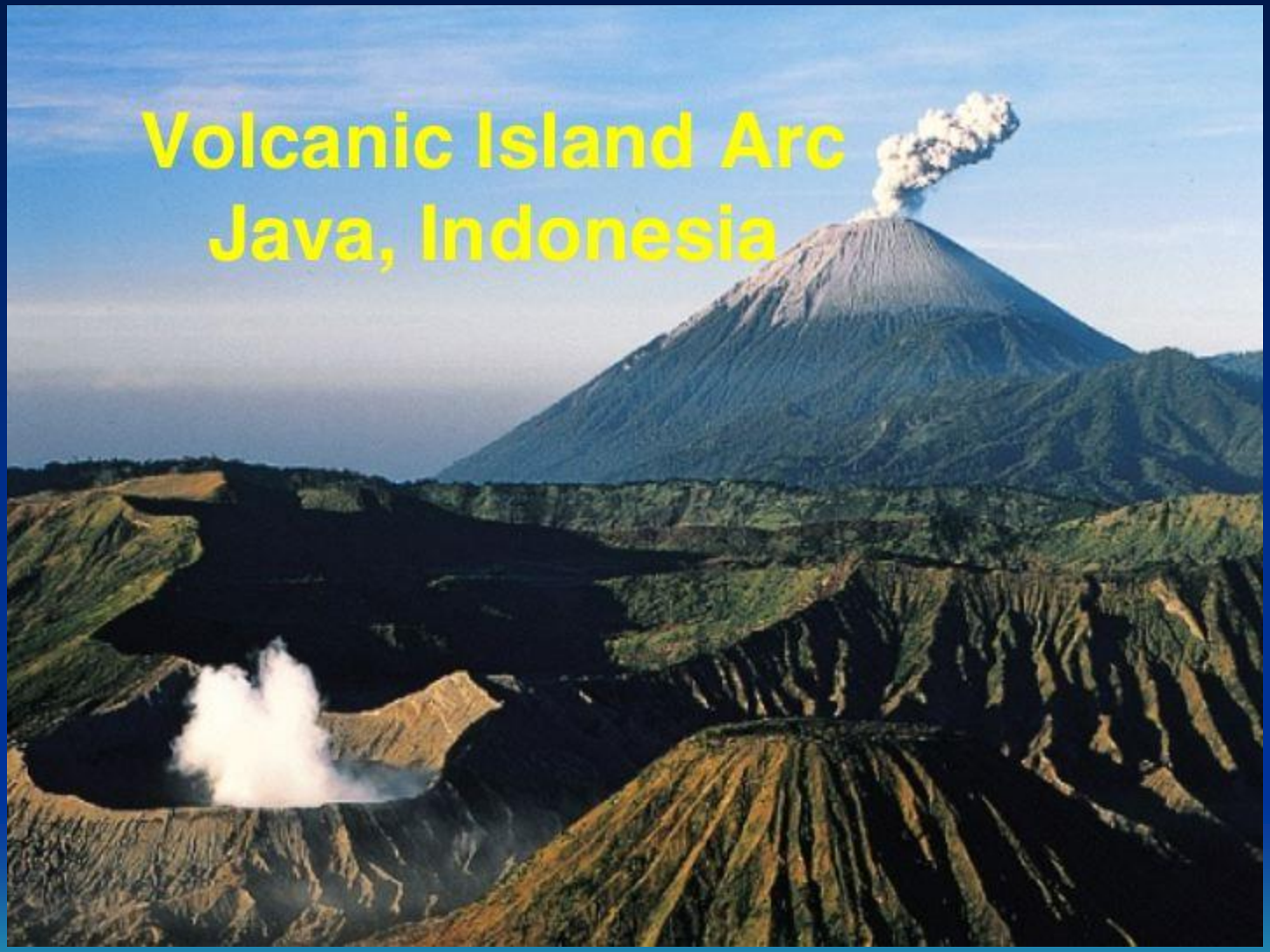
When ocean plates collide with other ocean plates

Island arcs are created

(a pattern of volcanic islands created from a subduction zone that is located off the coast)

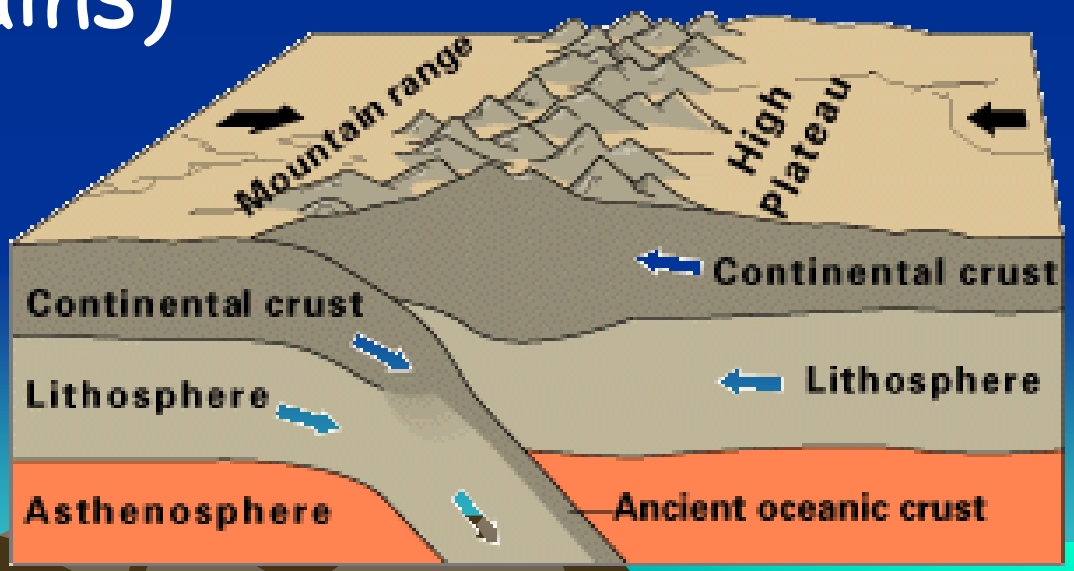



Kuril
Arc
Aleutian
Arc
Japan Arc
Ryukyu Arc
Philippine Arc
Pacific Ocean
Indonesia
Arc
Volcanic Island Arcs
of the Pacific


Volcanic Island Arc
Java, Indonesia

When a continental plate collides with another continental plate

- **Mountain ranges** are created
- (*example*: Himalayan Mountains)



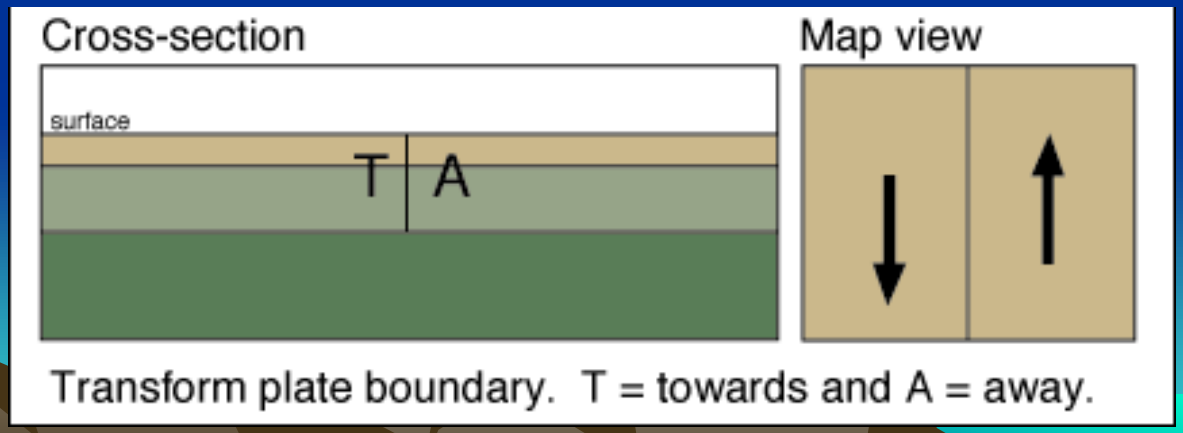
Continental-continental convergence

Himalayan Mountains

Mountains 2:46

Transform Fault Boundary

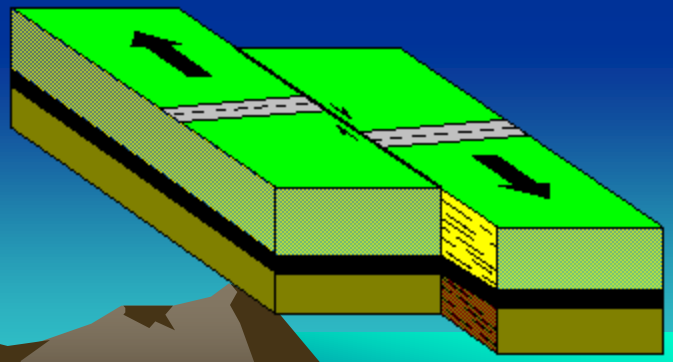
- Plates are neither moving toward nor away from each other, they are moving **past one another**.



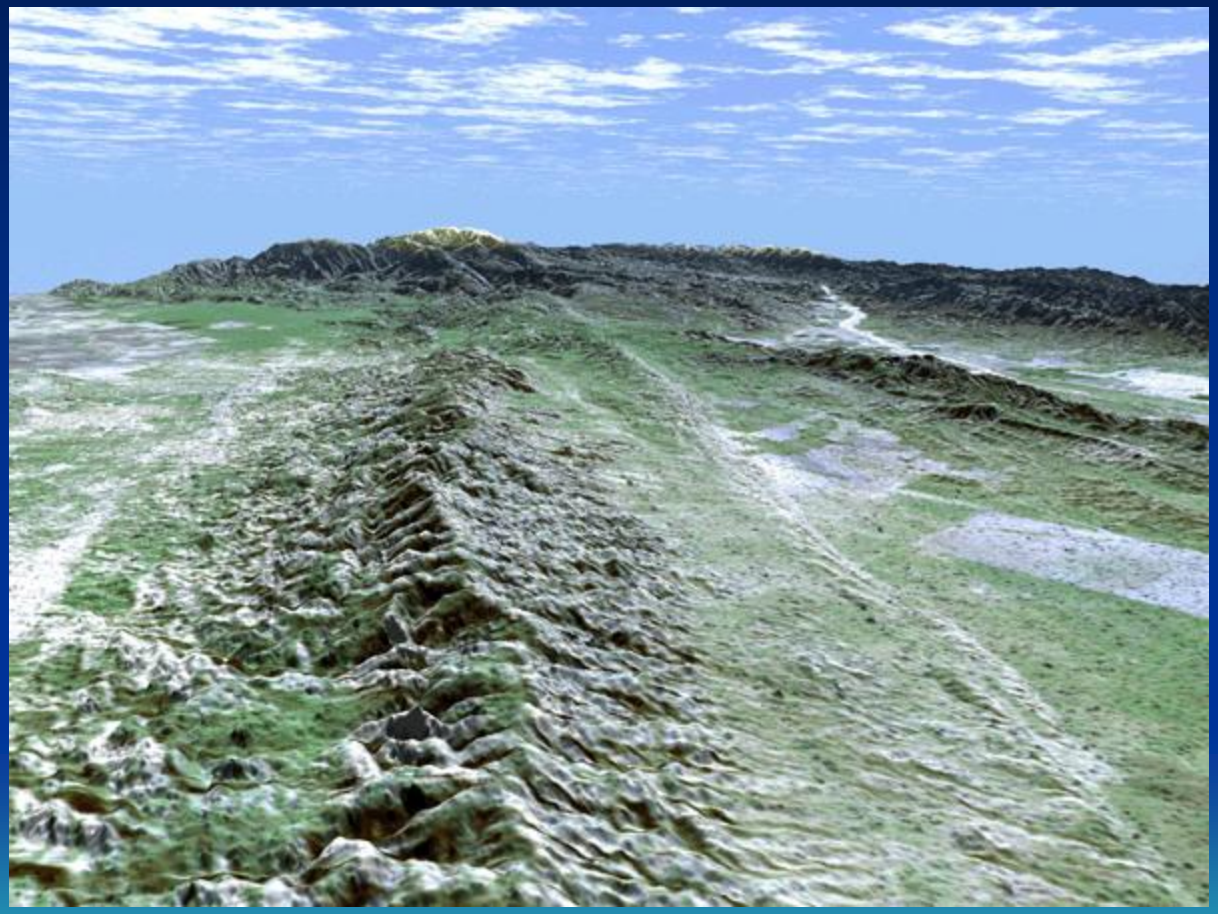
Transform plate boundary. T = towards and A = away.

Transform Fault Boundary

- The plates may move in **opposite** directions or in the **same** directions but at different rates and frequent **earthquakes** are created (example: San Andreas Fault)



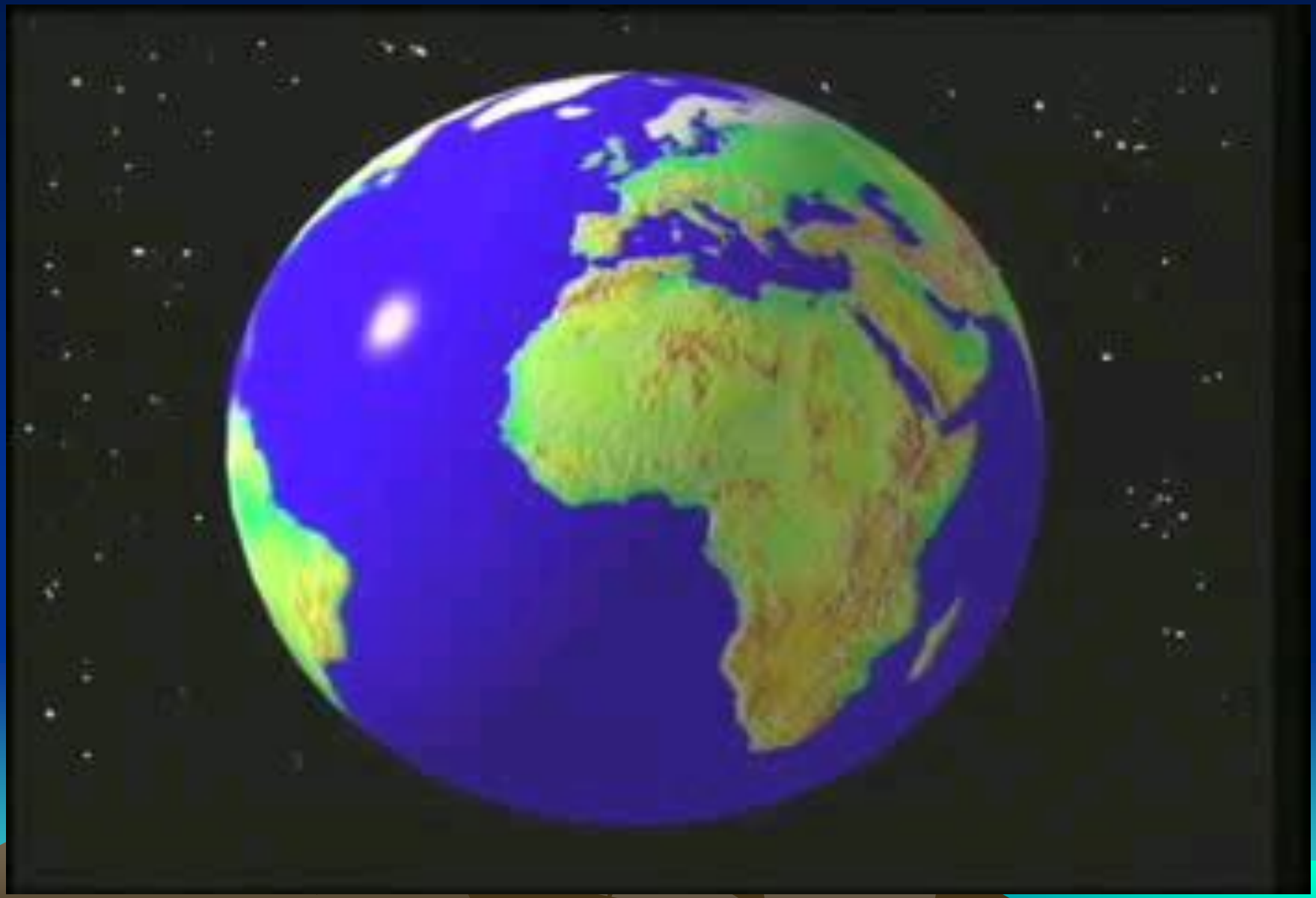
San Andreas Fault



So is the Earth getting bigger?

- No
- Plates are destroyed as fast as they are created (2 ways)
- Plates may be subducted and **melted** or may push be pushed upward to form **mountains**

Boundaries Between Tectonic Plates—1:23



How can Oreos model the plate boundaries? PRACTICE AT HOME

- ✓ Very carefully, take just the top cookie off the Oreo.
- ✓ Break the top cookie into 2 equal halves.
- ✓ Replace the cookie halves back on the Oreo

Using the cookie,

- ✓ Demonstrate a **transform** fault boundary
- ✓ Demonstrate a **divergent** plate boundary
- ✓ Demonstrate a **convergent** plate boundary

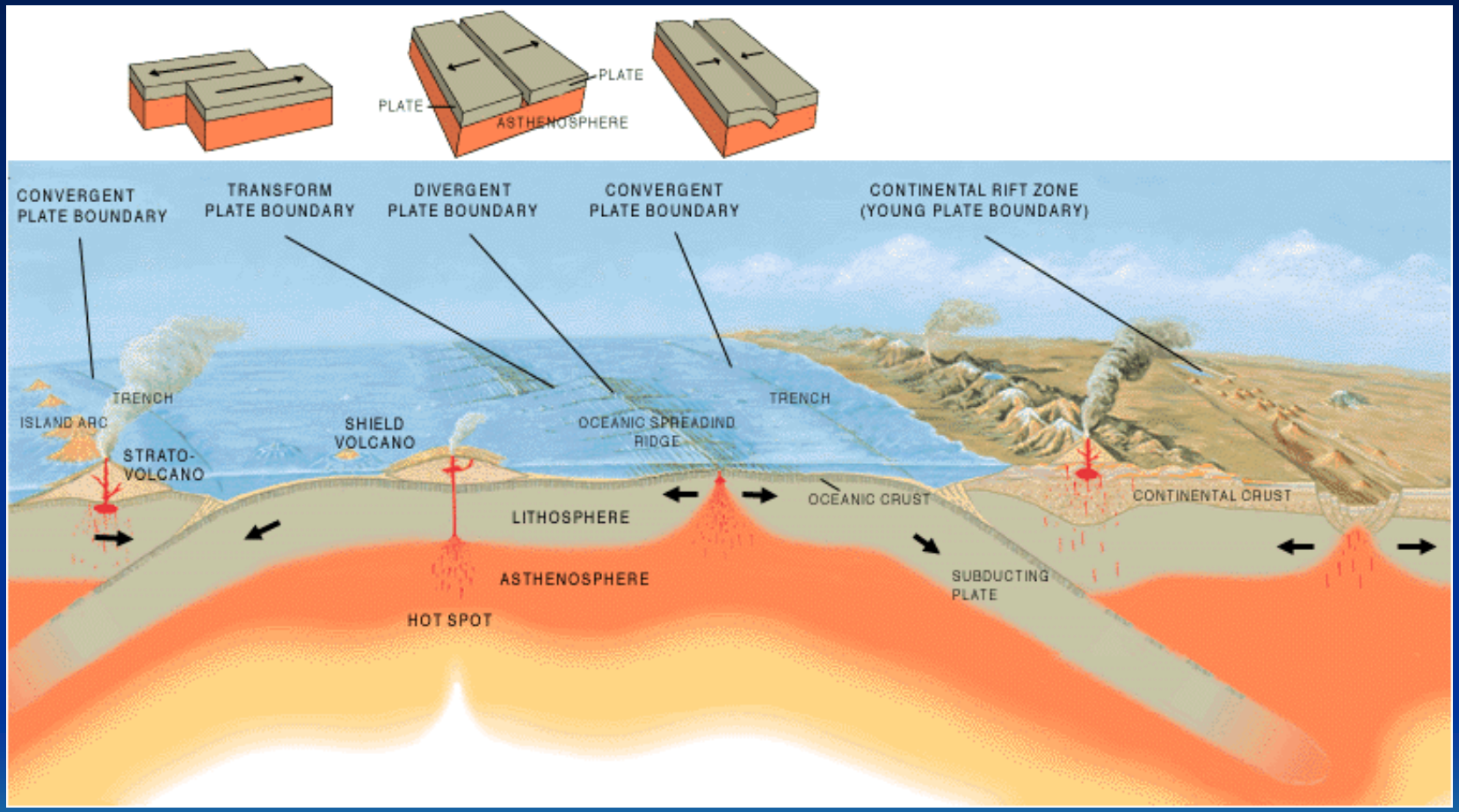
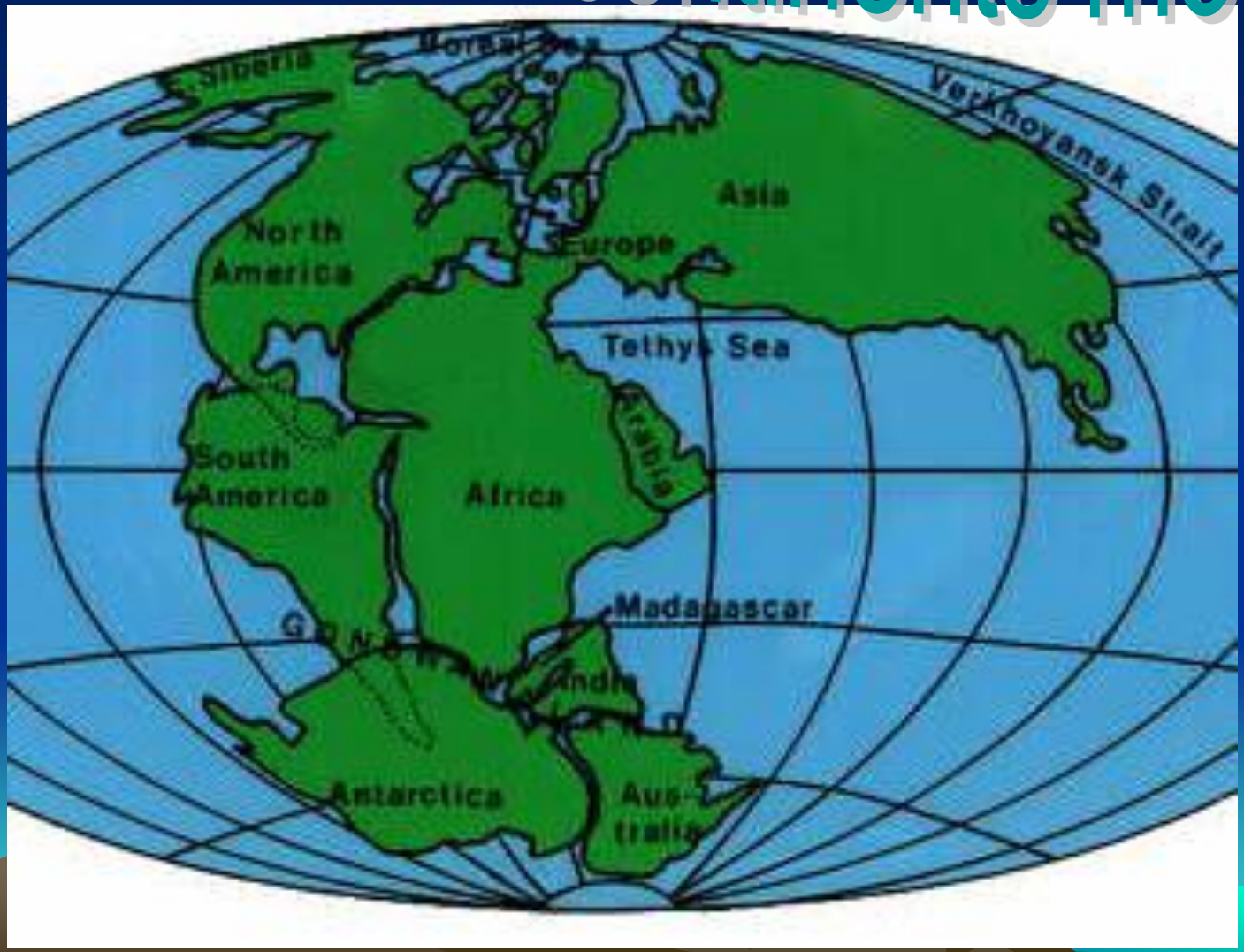


PLATE
PLATE
ASTHENOSPHERE
CONVERGENT PLATE BOUNDARY
TRANSFORM PLATE BOUNDARY
DIVERGENT PLATE BOUNDARY
CONVERGENT PLATE BOUNDARY
CONTINENTAL RIFT ZONE (YOUNG PLATE BOUNDARY)
TRENCH
ISLAND ARC
STRATO-VOLCANO
SHIELD VOLCANO
OCEANIC SPREADIND RIDGE
TRENCH
OCEANIC CRUST
CONTINENTAL CRUST
LITHOSPHERE
ASTHENOSPHERE
HOT SPOT
SUBDUCTING PLATE

So how do the continents move?



Seafloor Spreading Theory:

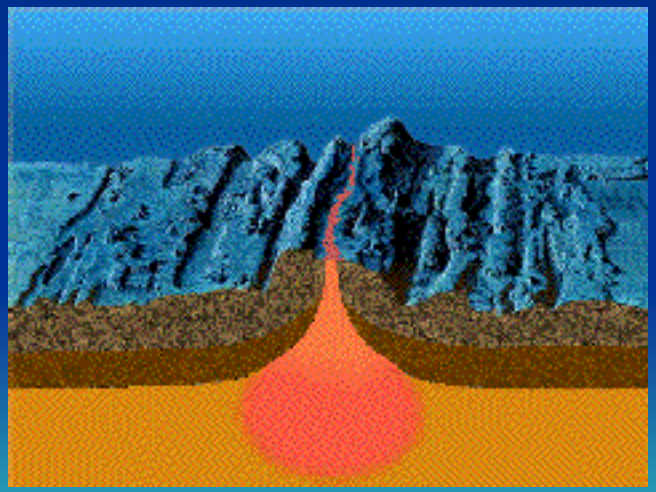
- **Ocean** floors are moving like broad **conveyor belts**

- **New** ocean floor crust is being created at the **midocean ridges**

What causes this?

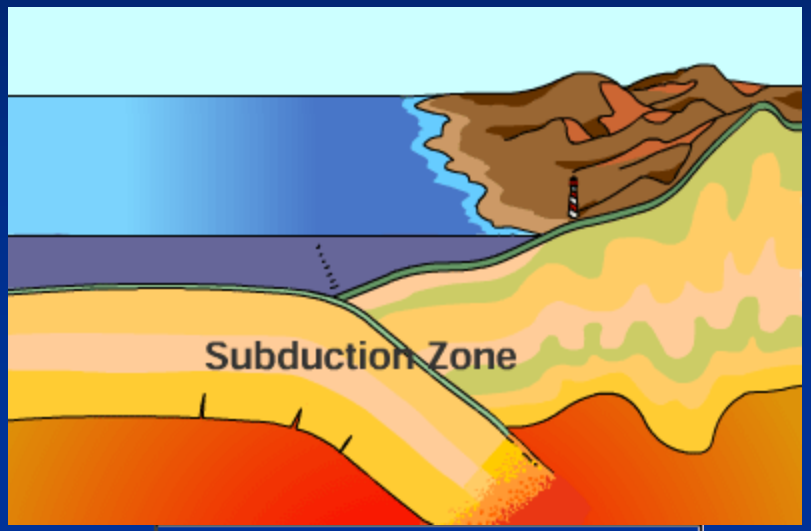
Convection currents within the mantle

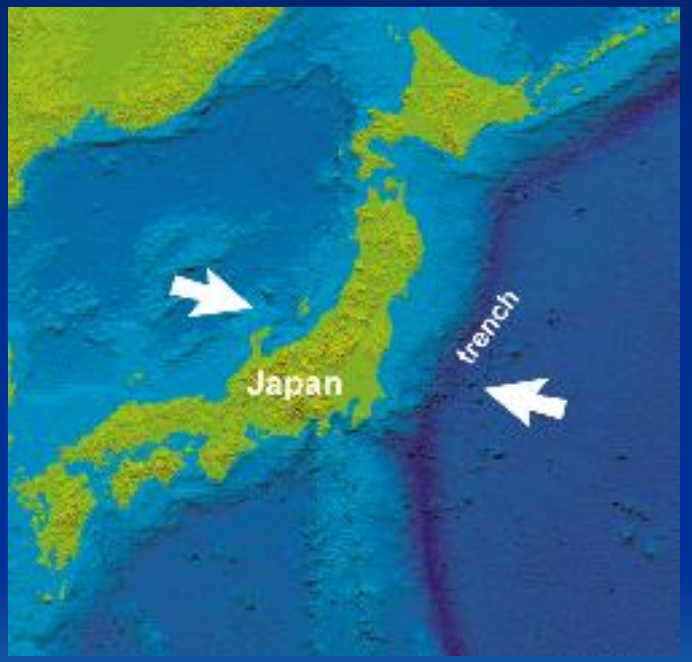
- The up-welling leg of the current creates a **divergent** boundary which produces **midocean ridges**

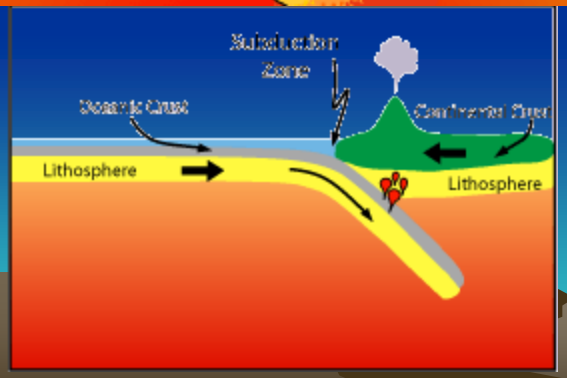


Convection Current Demo

- The down-welling leg of the current creates one type of **convergent** boundary that results in **trenches** and a **subduction** zone

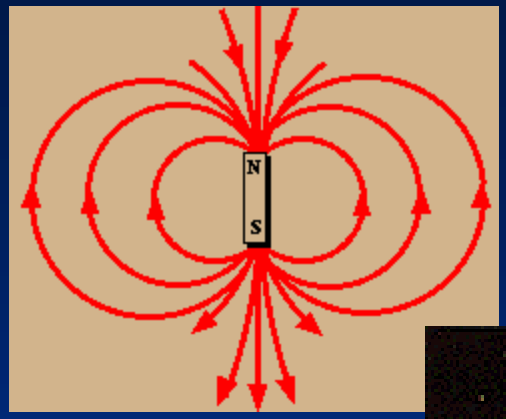


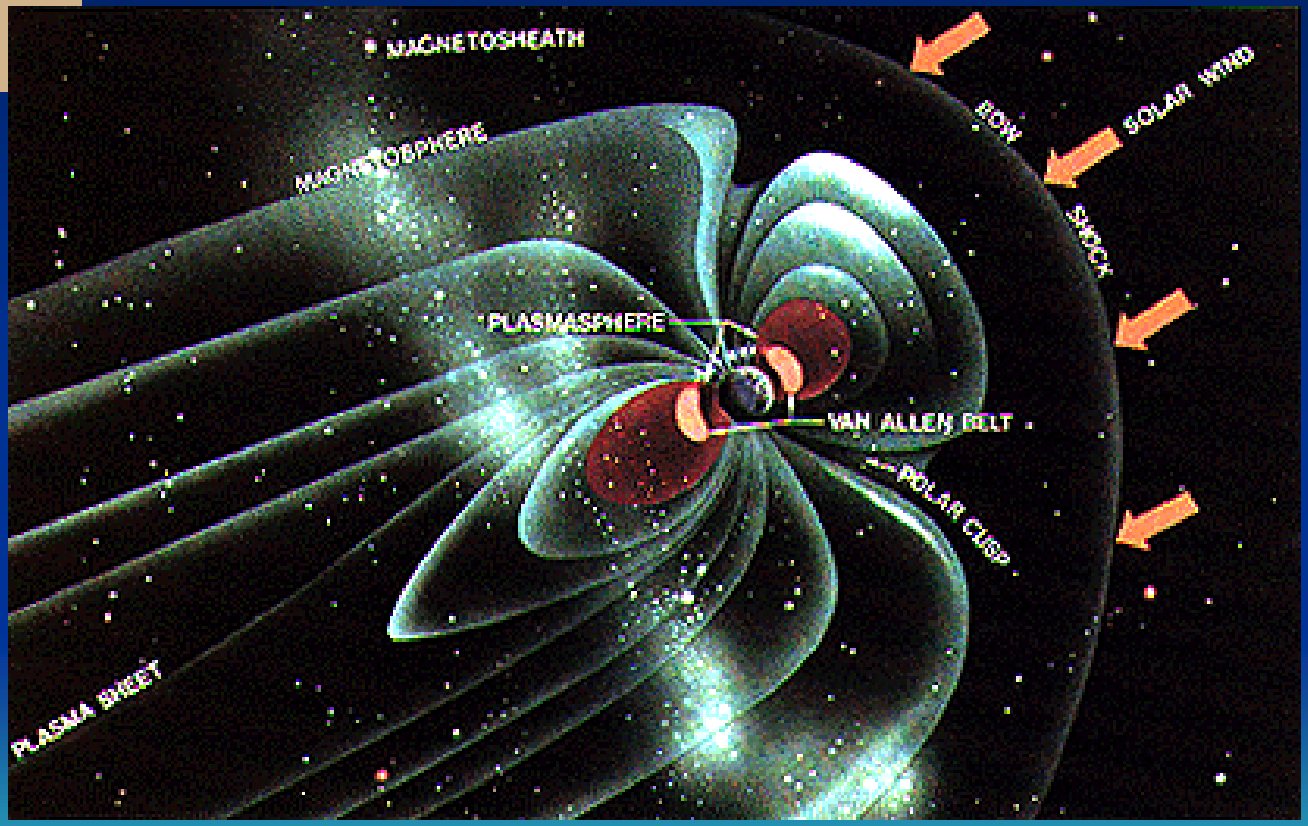




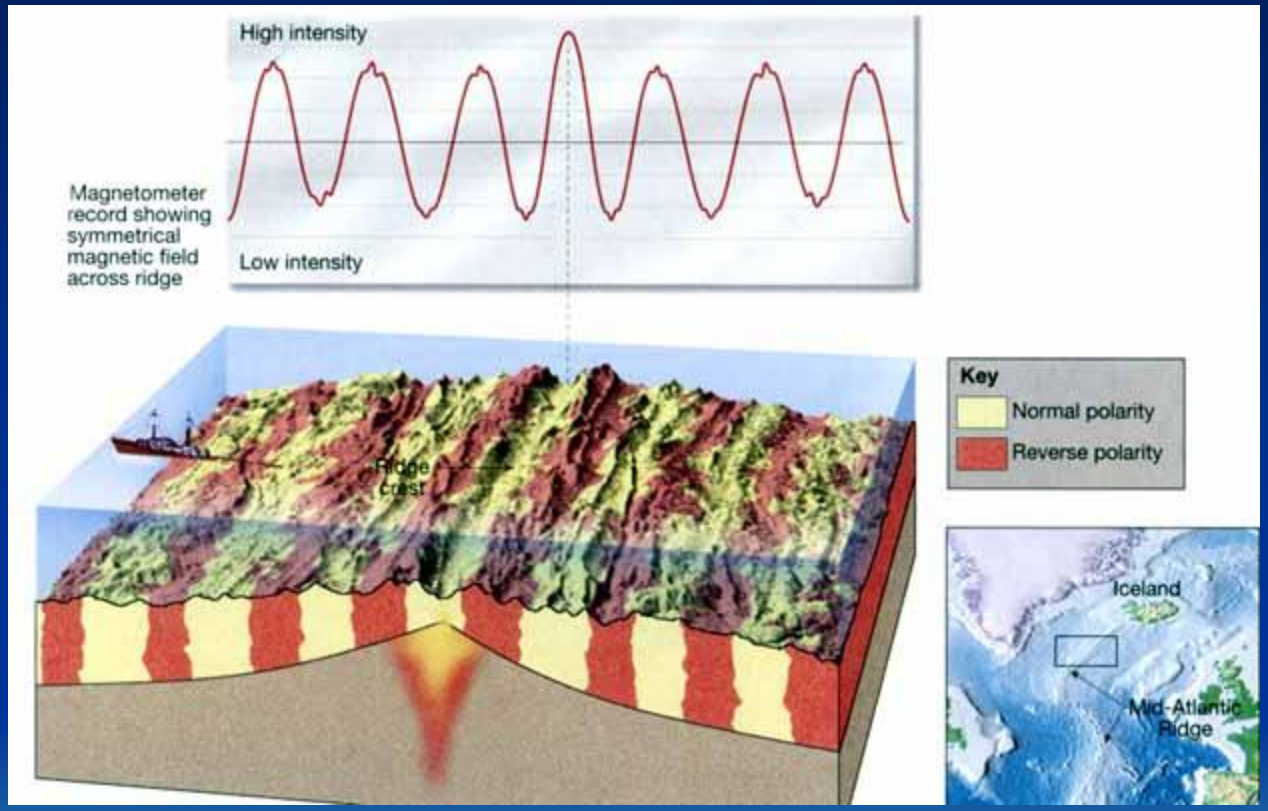
What evidence do we have to support this idea?

- Midocean ridges are **warmer** than surrounding ocean floors
- **Active volcanoes** on ridges, earthquakes on ridges
- Midocean ridge rocks are **younger** than surrounding ocean floor rocks
- Midocean ridge volcanoes are **younger** than volcanoes further away


N
S


MAGNETOSHEATH
MAGNETOSPHERE
BOW
SHOCK
SOLAR WIND
PLASMASPHERE
VAN ALLEN BELT
POLAR CUSP
PLASMA SHEET

Polar Reversal Magnetism



Magnetic Poles

Magnetic Field Reversals—2:54

Speed of Spreading

- Atlantic Ocean - 2-3 cm/year
- South Pacific Ocean - **15-18** cm/year

Seafloor Spreading

The Seafloor is Spreading Clip—4:01

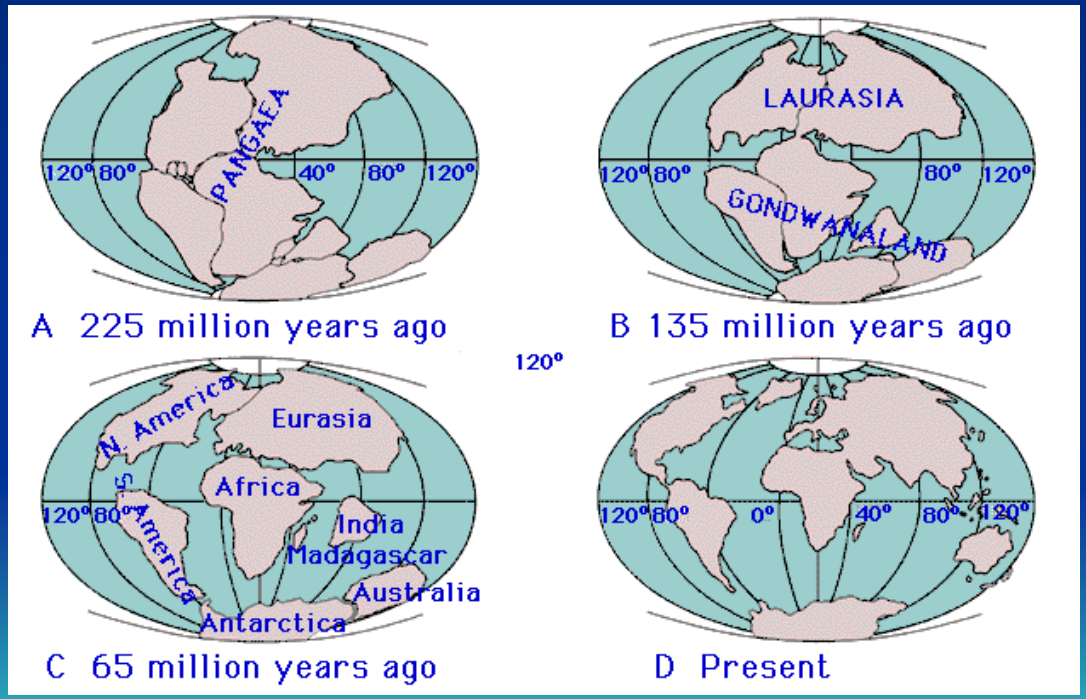
How Earth's Structure Affects Plate Tectonics—5:43

http://videos.howstuffworks.com/science-channel/29268-100-greatest-discoveries-sea-floor-spreading-video.htm

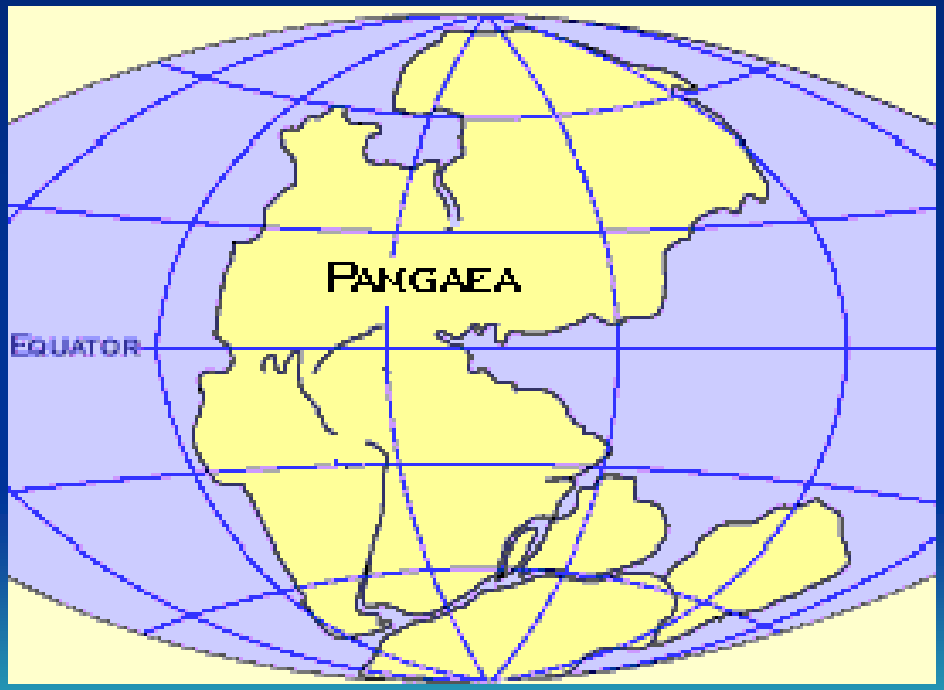
http://videos.howstuffworks.com/science-channel/29268-100-greatest-discoveries-sea-floor-spreading-video.htm

Continental Drift Theory

- The **continents** have shifted their position over geologic time

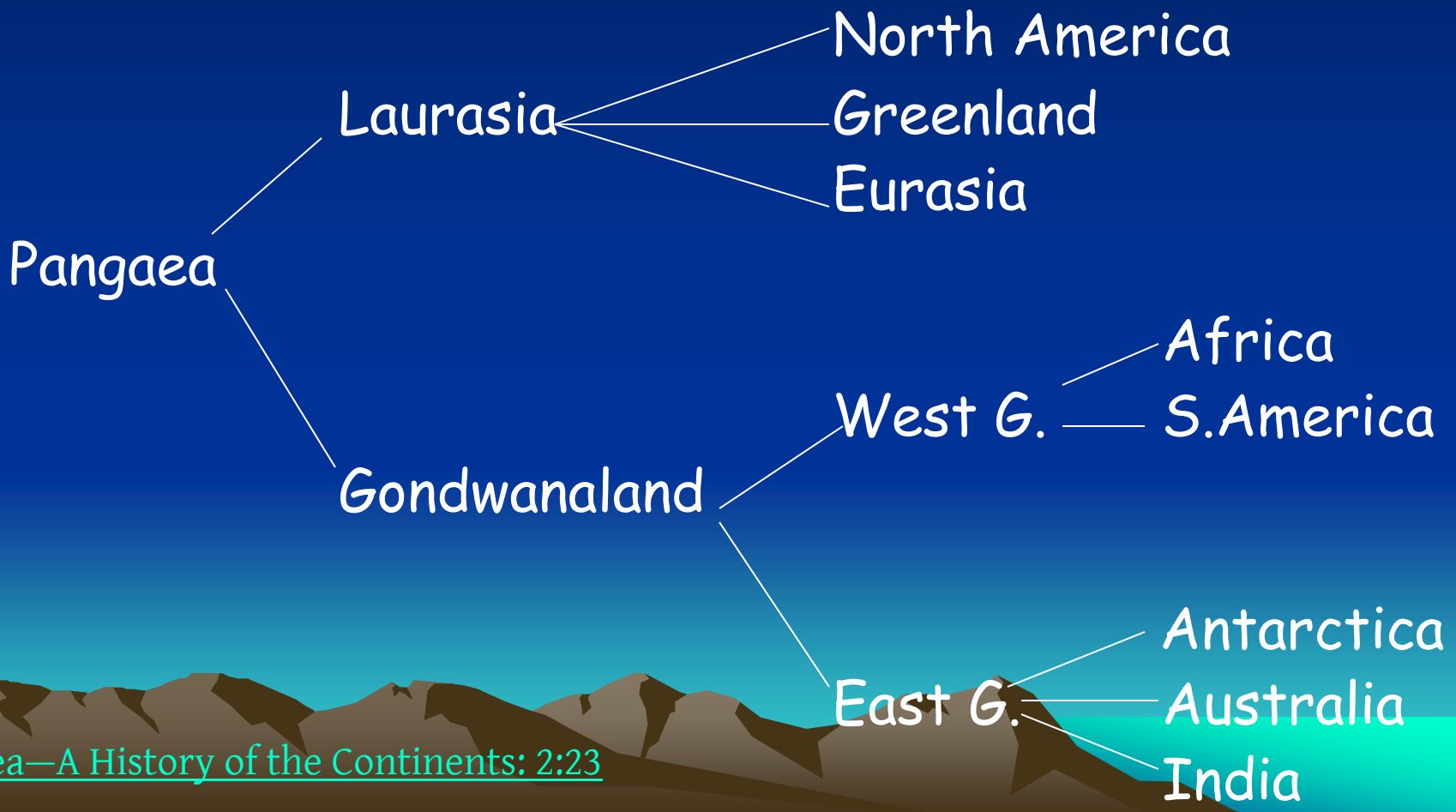


- At one time all land masses were **connected** into one piece called **Pangaea**



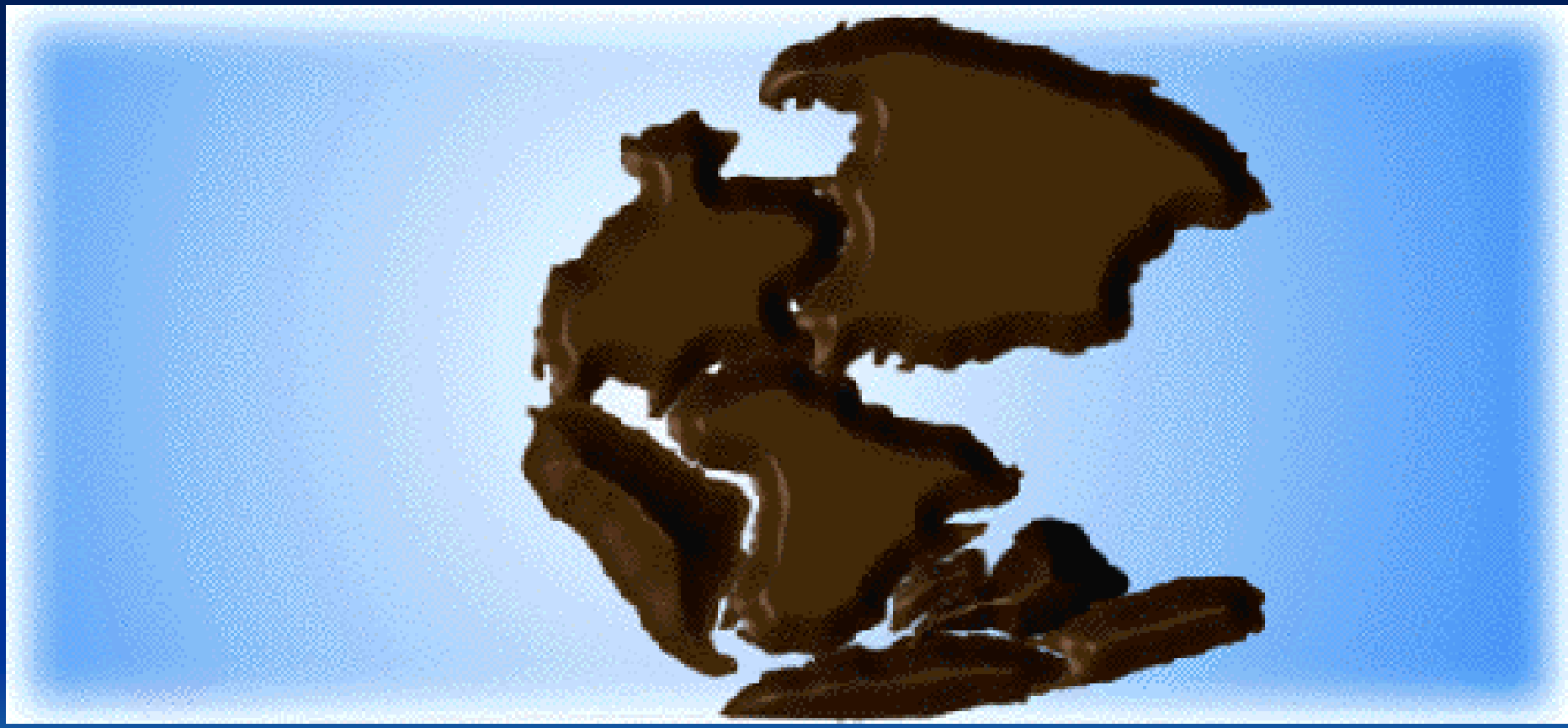
Continental Drift Theory 3—2:21

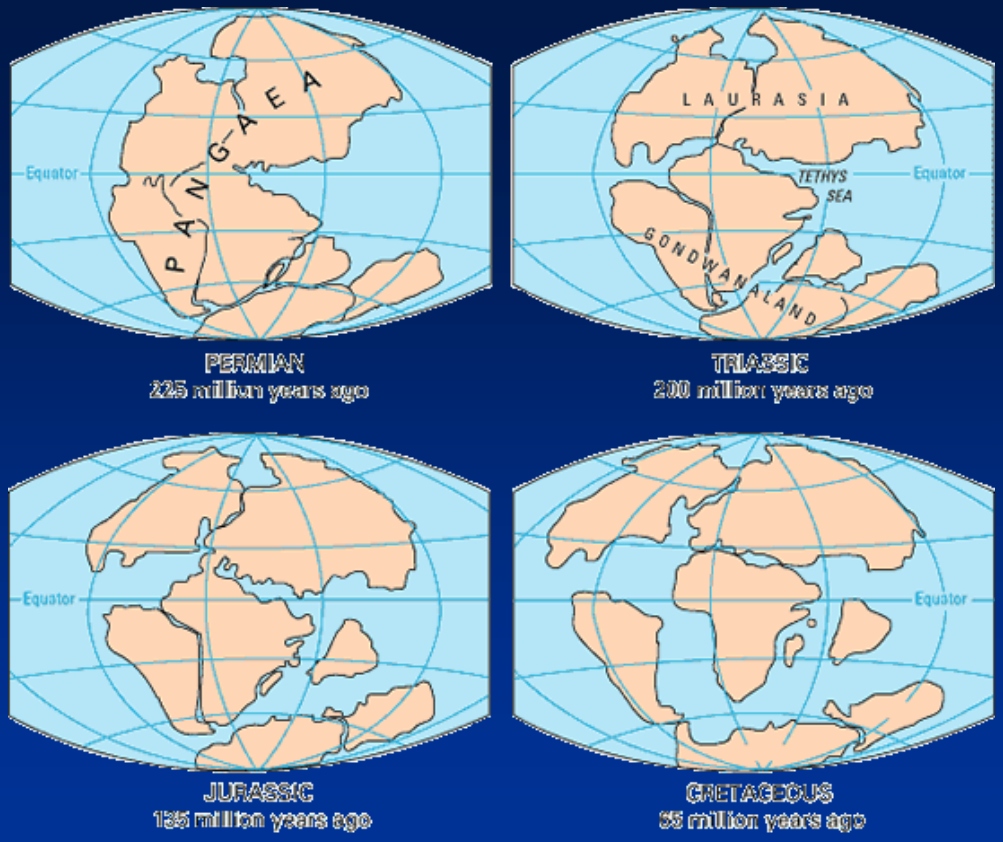
- Pangaea began to split apart 200 million years ago
- Diagram



Pangaea—A History of the Continents: 2:23

The First Continents 4:57





http://videos.howstuffworks.com/science-channel/29267-100-greatest-discoveries-continental-drift-video.htm

Continents

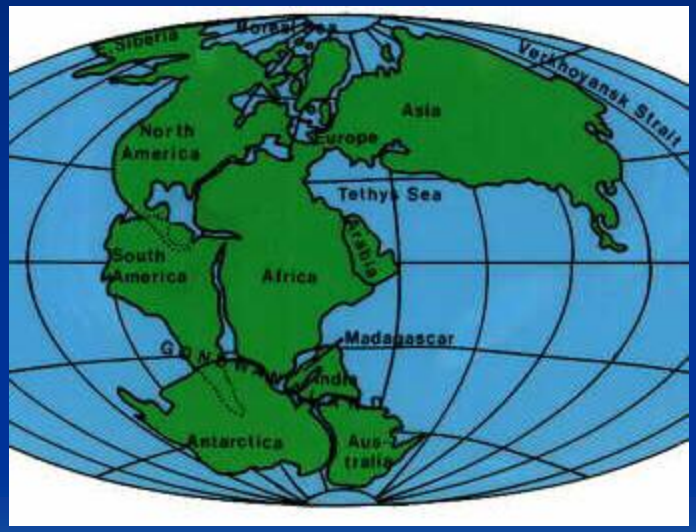
- The continents are like packages on the seafloor conveyor belt


Pangea
250 MYA


SUPER CONTINENTS 80 MILLION YEARS AGO
North America
LAURASIA
Eurasia
South America
Africa
GONDWANALAND
Australia
Antarctica

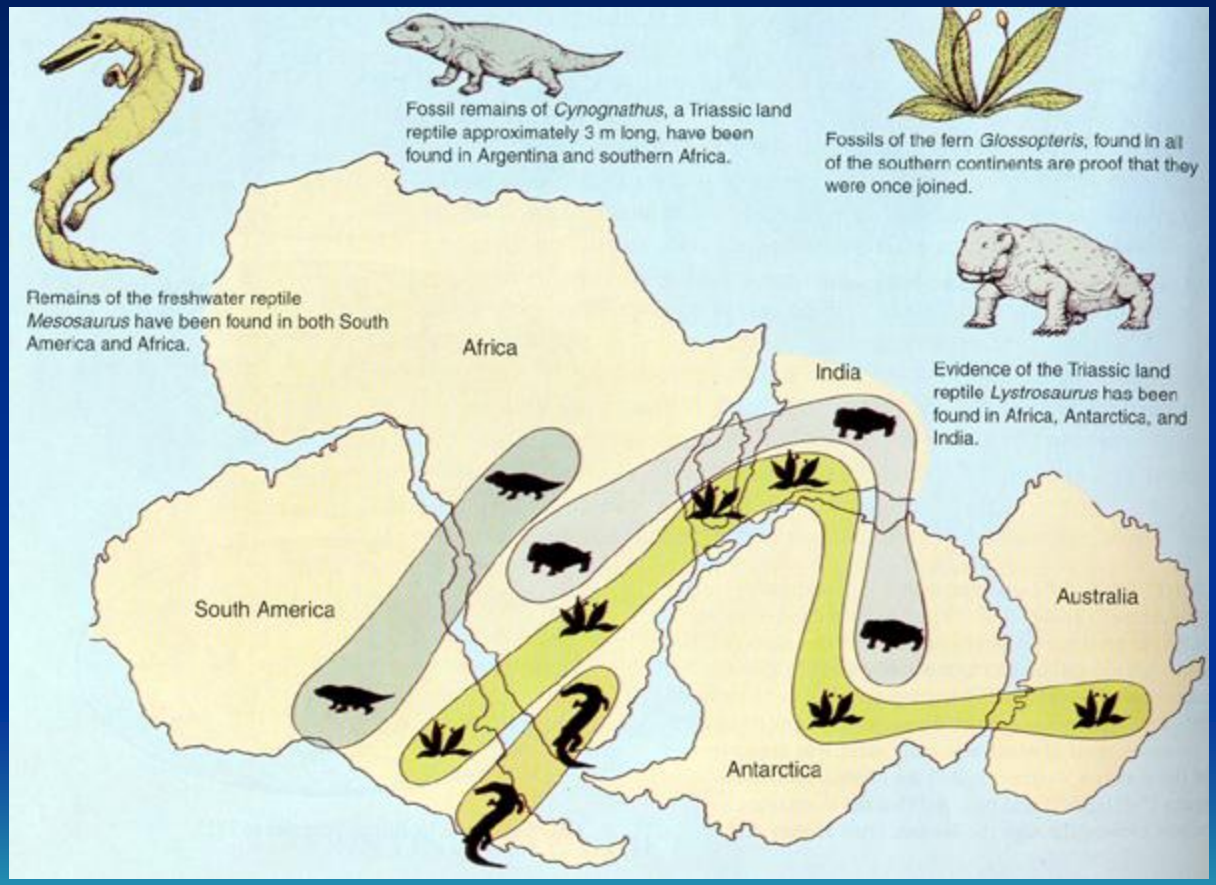
Evidence

- High percentage **fit** of continents at the 500 fathom level

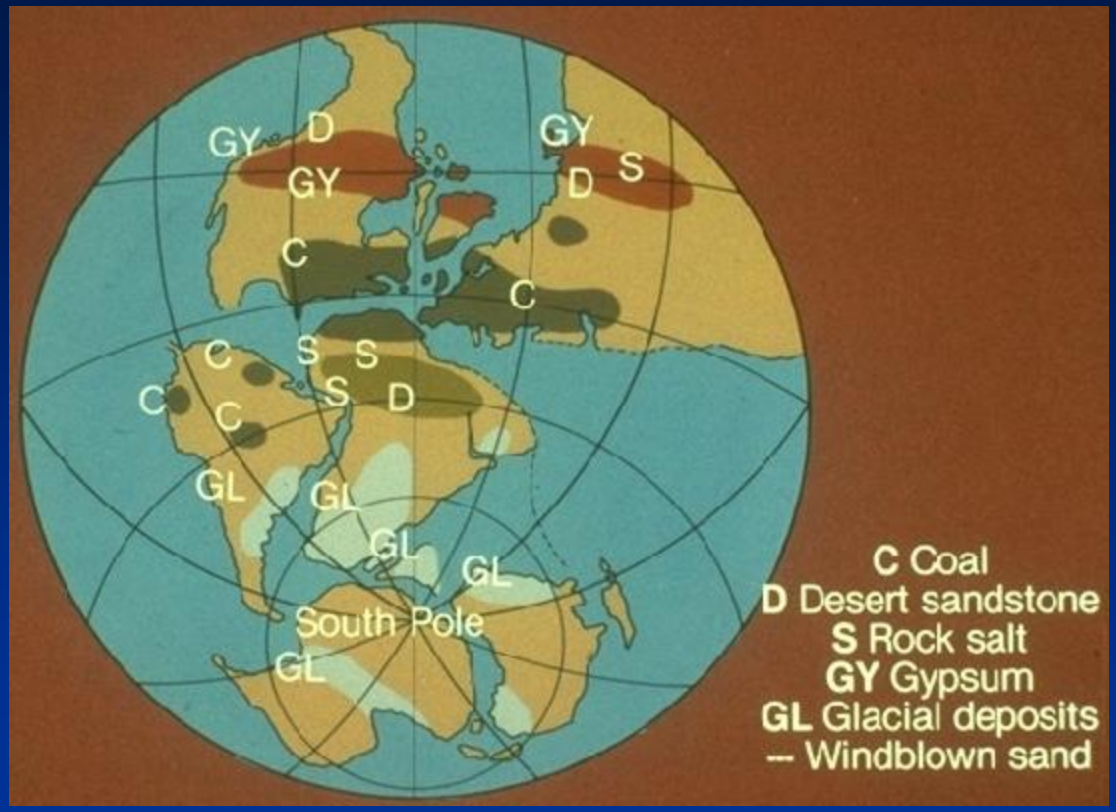


Evidence

- Minerals, fossils, and mountains on now **different** continents **match** if the continents were together



The Mystery of Brachiosaurus (~5 min)

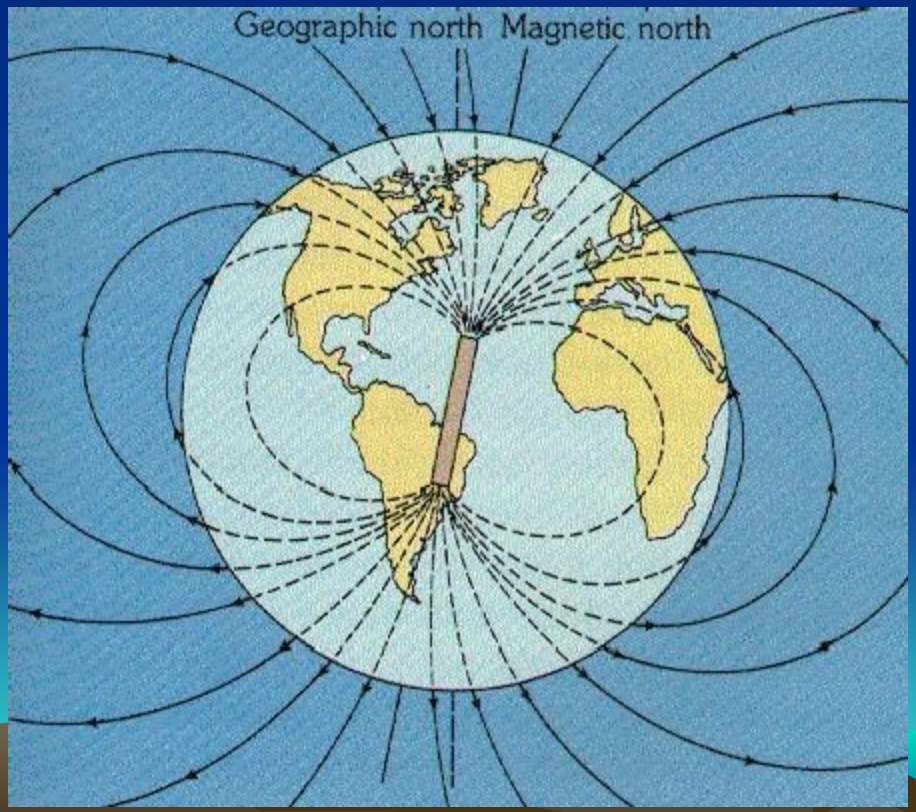

GY
D
GY
GY
D
S
C
C
C
S
S
C
S
D
C
GL
GL
GL
GL
South Pole
GL
C Coal
D Desert sandstone
S Rock salt
GY Gypsum
GL Glacial deposits
-- Windblown sand

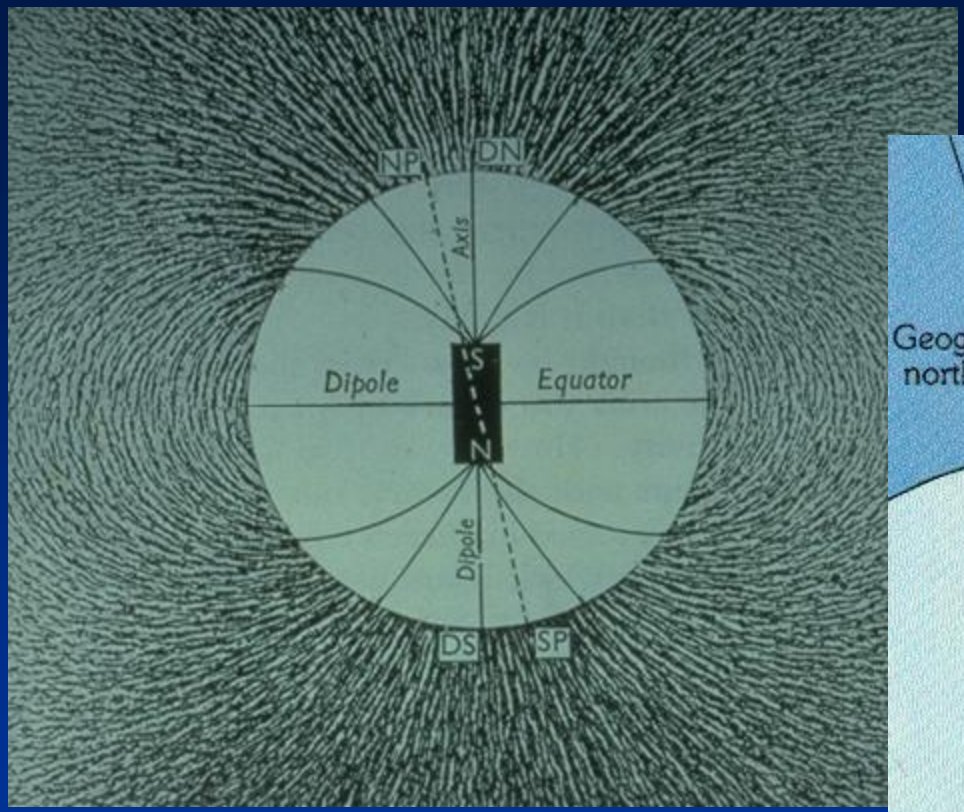
Evidence

- Glaciation patterns indicate a **common** ice cap at the South Pole

Evidence

- **Paleomagnetism** (magnetism of old rocks) indicate a common pole if the continents were all connected




NP
DN
Axis
Dipole
S
N
Equator
Dipole
DS
SP

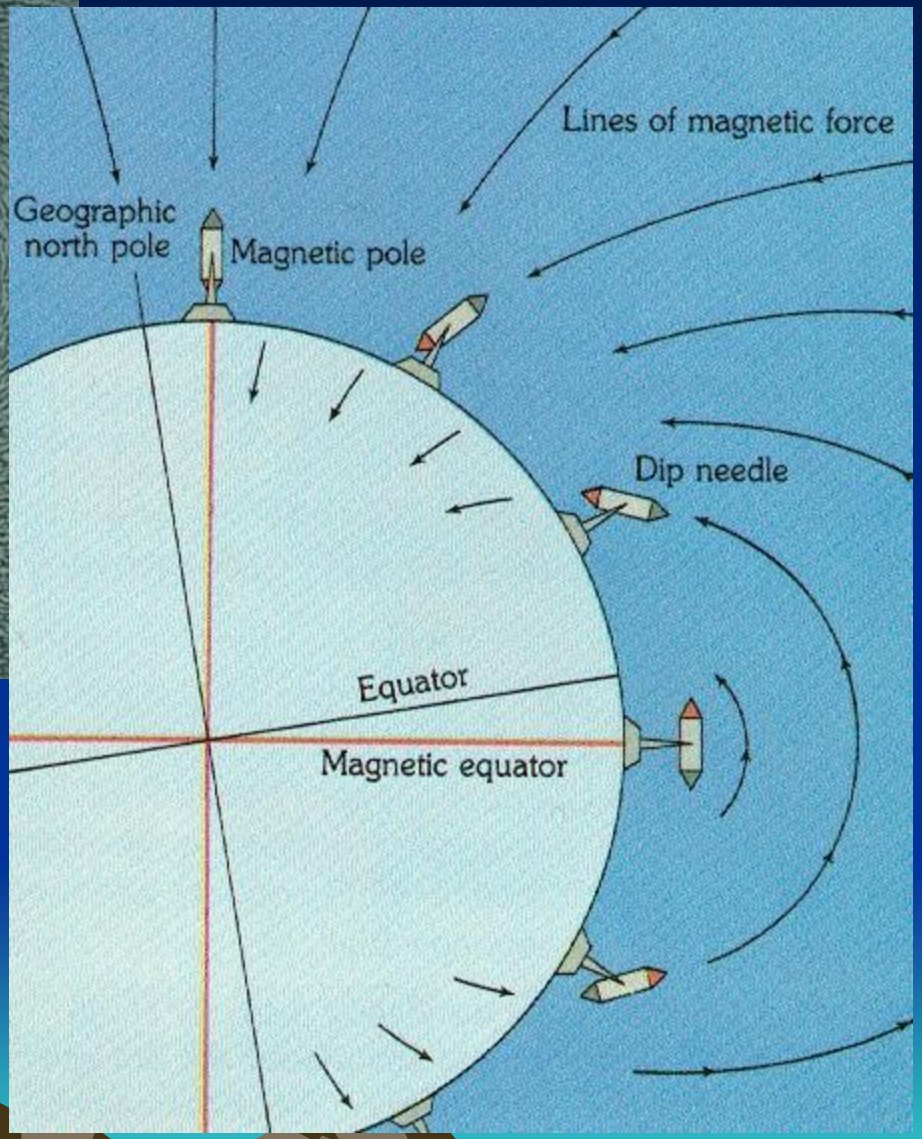

Lines of magnetic force
Geographic north pole
Magnetic pole
Dip needle
Equator
Magnetic equator

Plate Tectonics 2 –4:22

Plate Tectonics by Brainpop

http://www.brainpop.com/science/earthsystem/platetectonics/

http://www.brainpop.com/science/earthsystem/platetectonics/