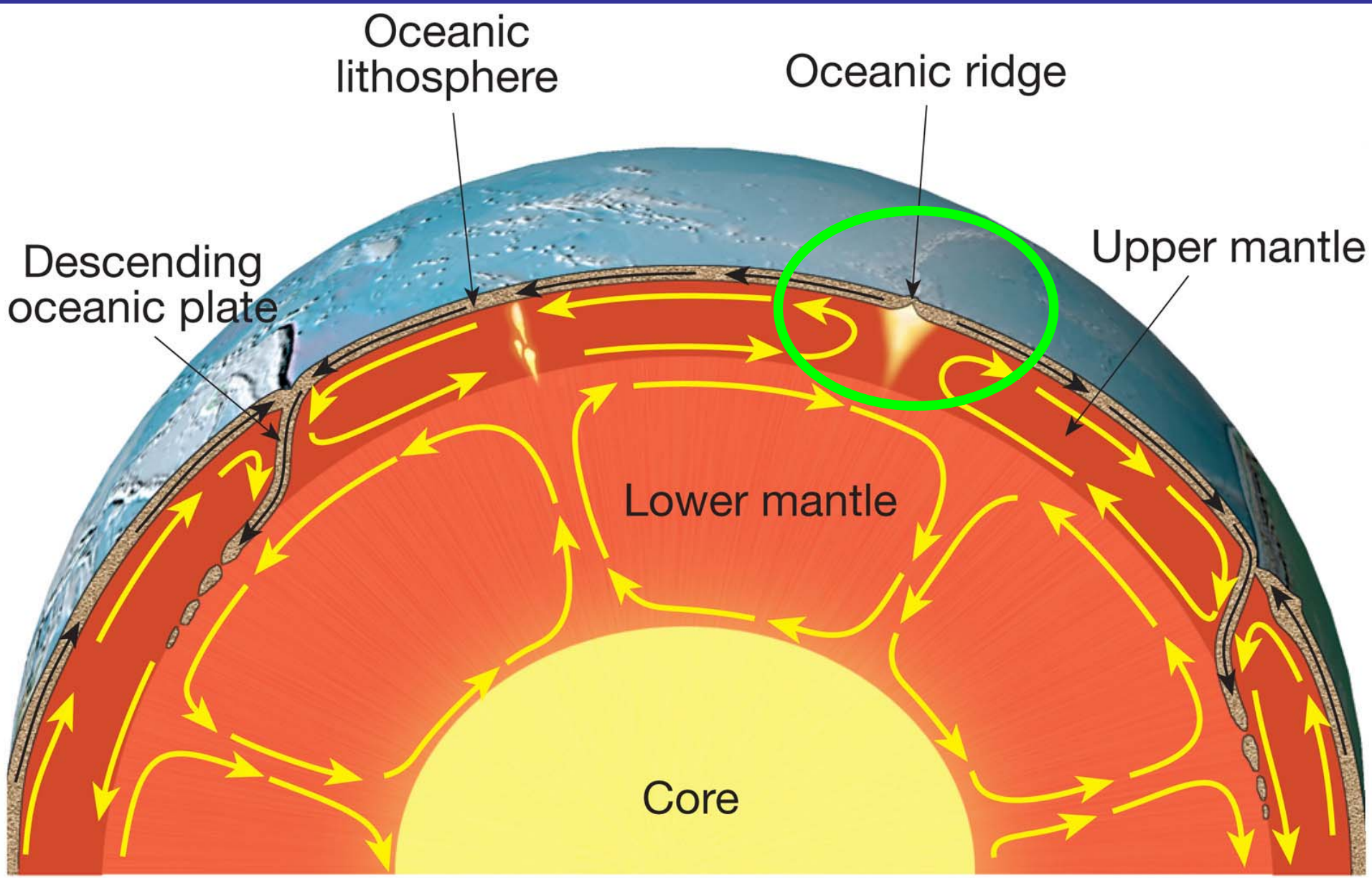
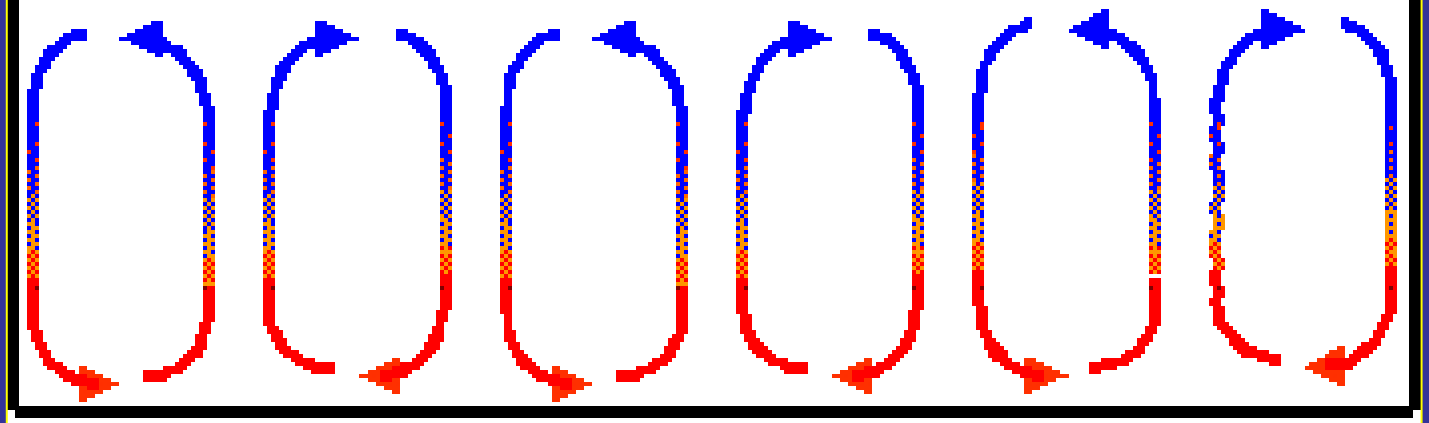

Oceanic lithosphere
Oceanic ridge
Descending oceanic plate
Upper mantle
Lower mantle
Core

Fluid cools by losing heat from surface





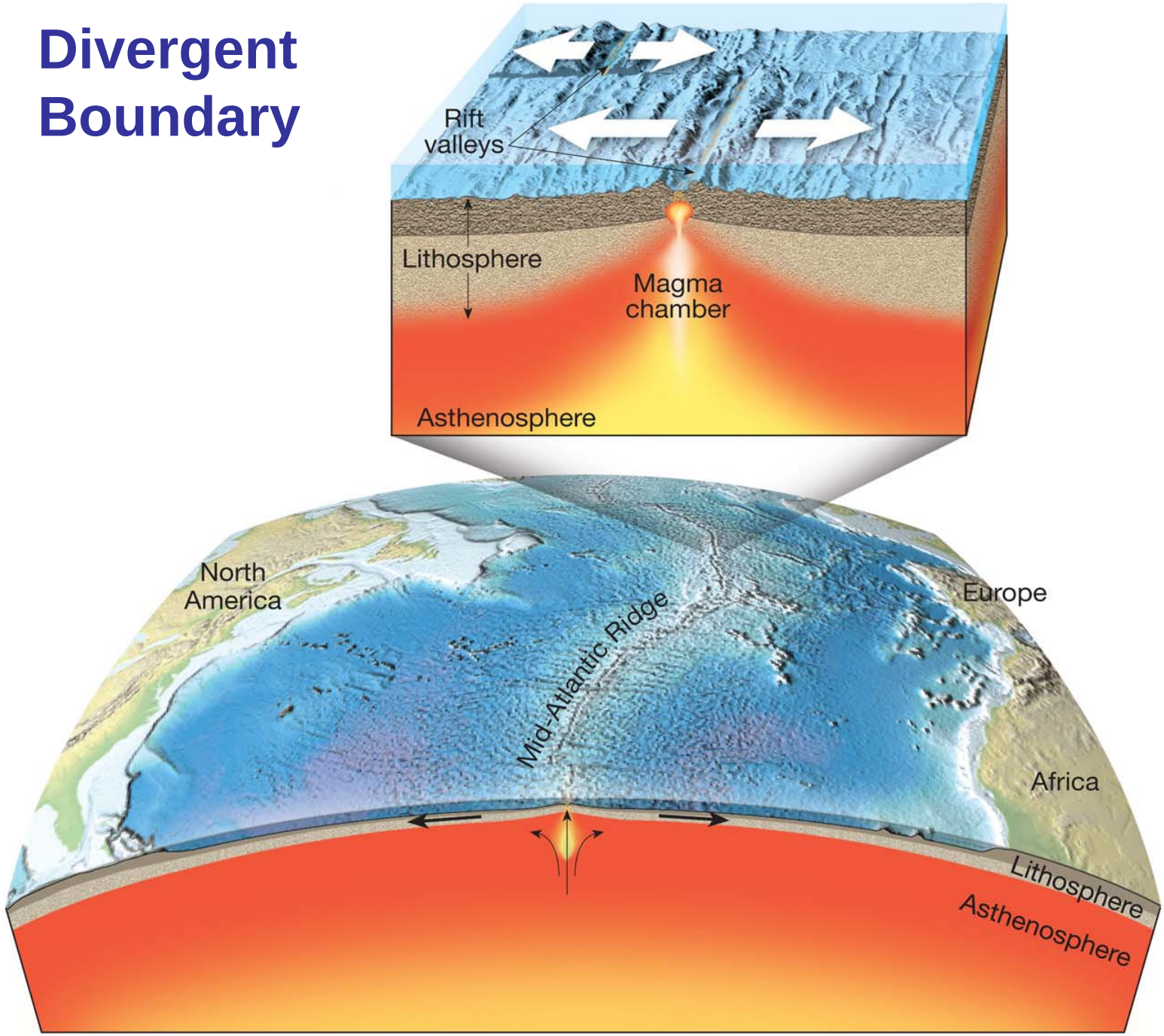
Convection cell

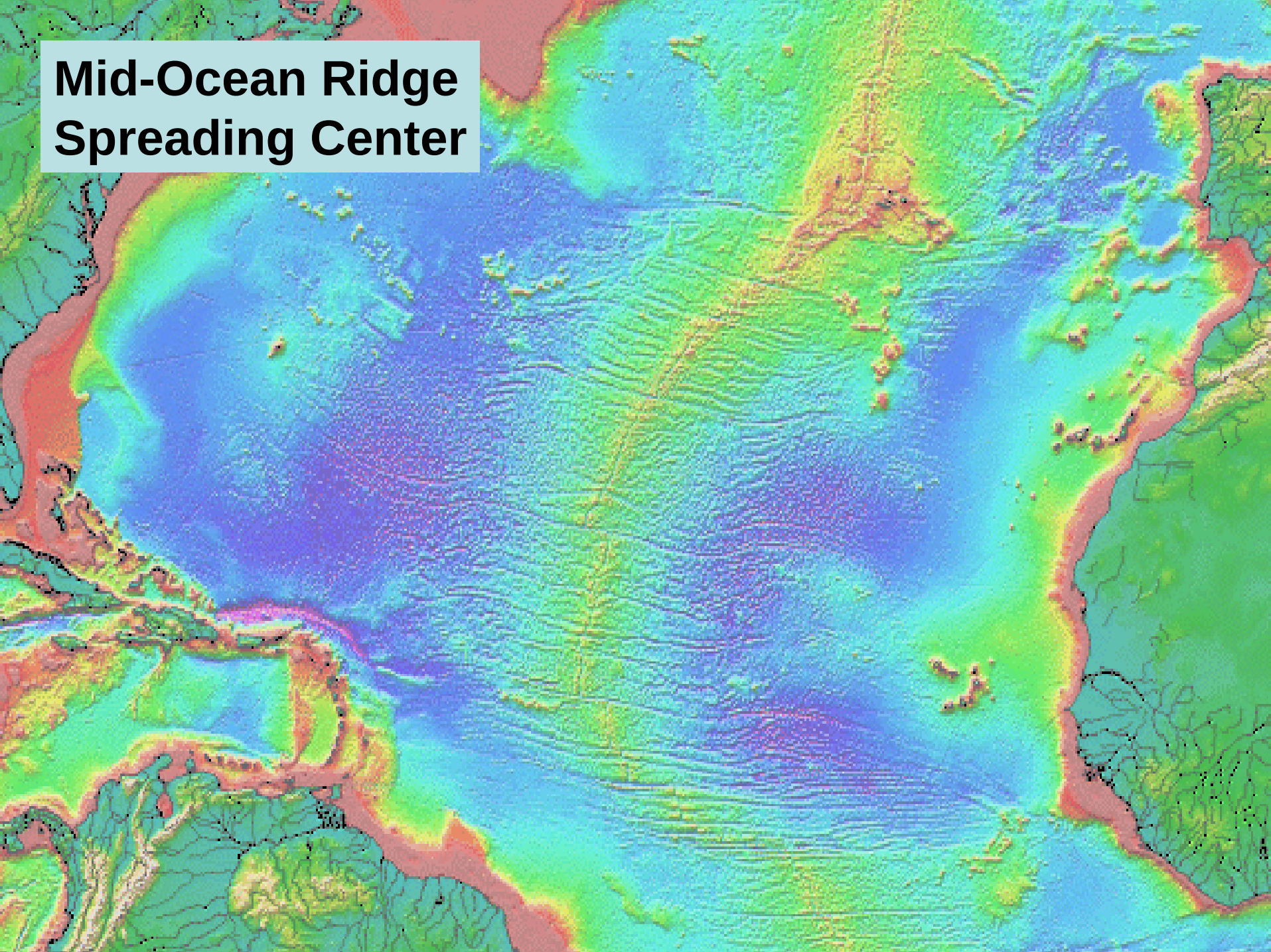
Warm, low density fluid rises

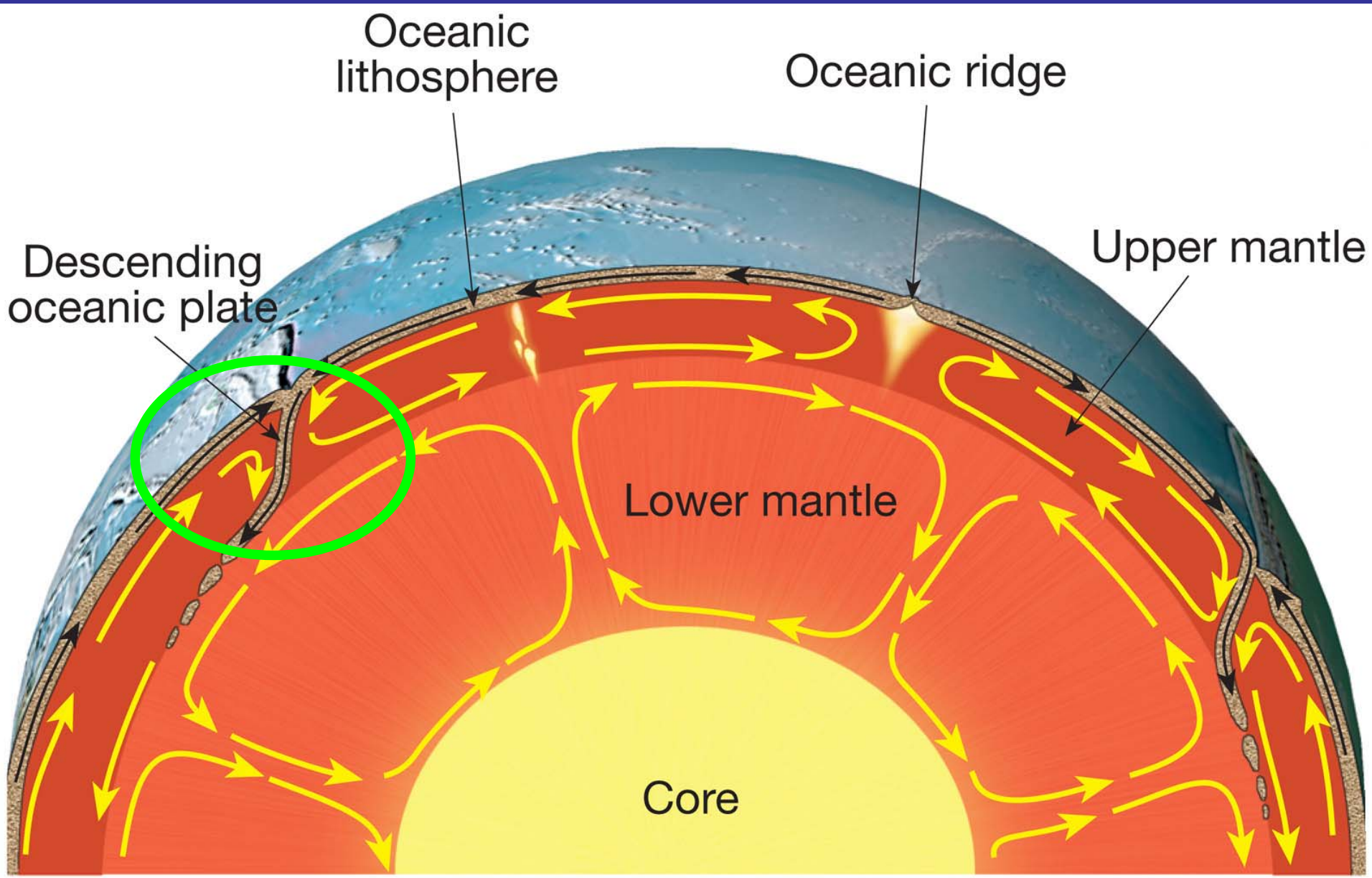
Cool, high density fluid sinks



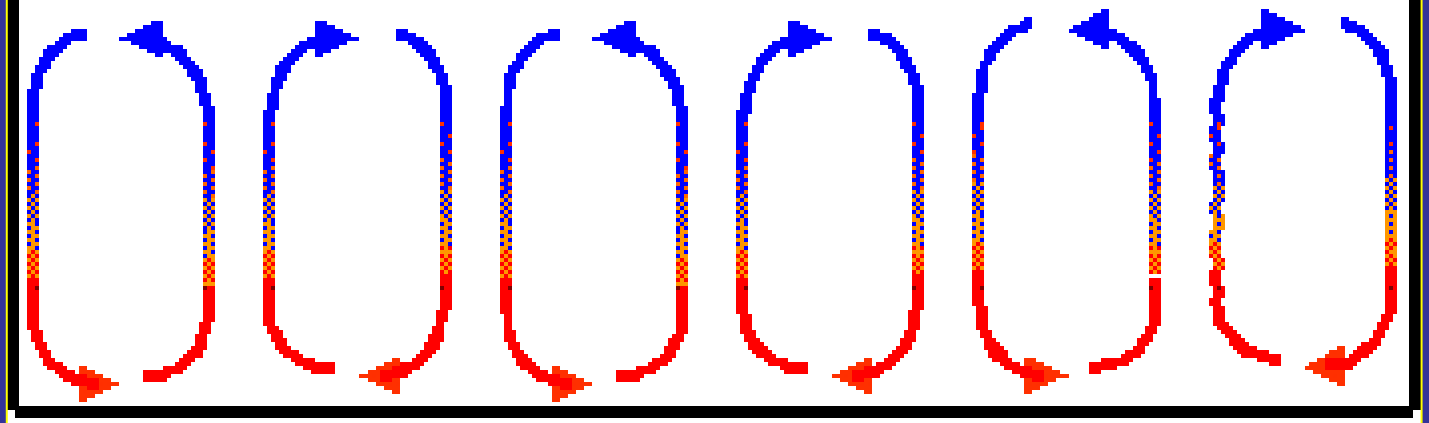
Divergent Boundary




Mid-Ocean Ridge
Spreading Center


Oceanic lithosphere
Oceanic ridge
Descending oceanic plate
Upper mantle
Lower mantle
Core

Fluid cools by losing heat from surface





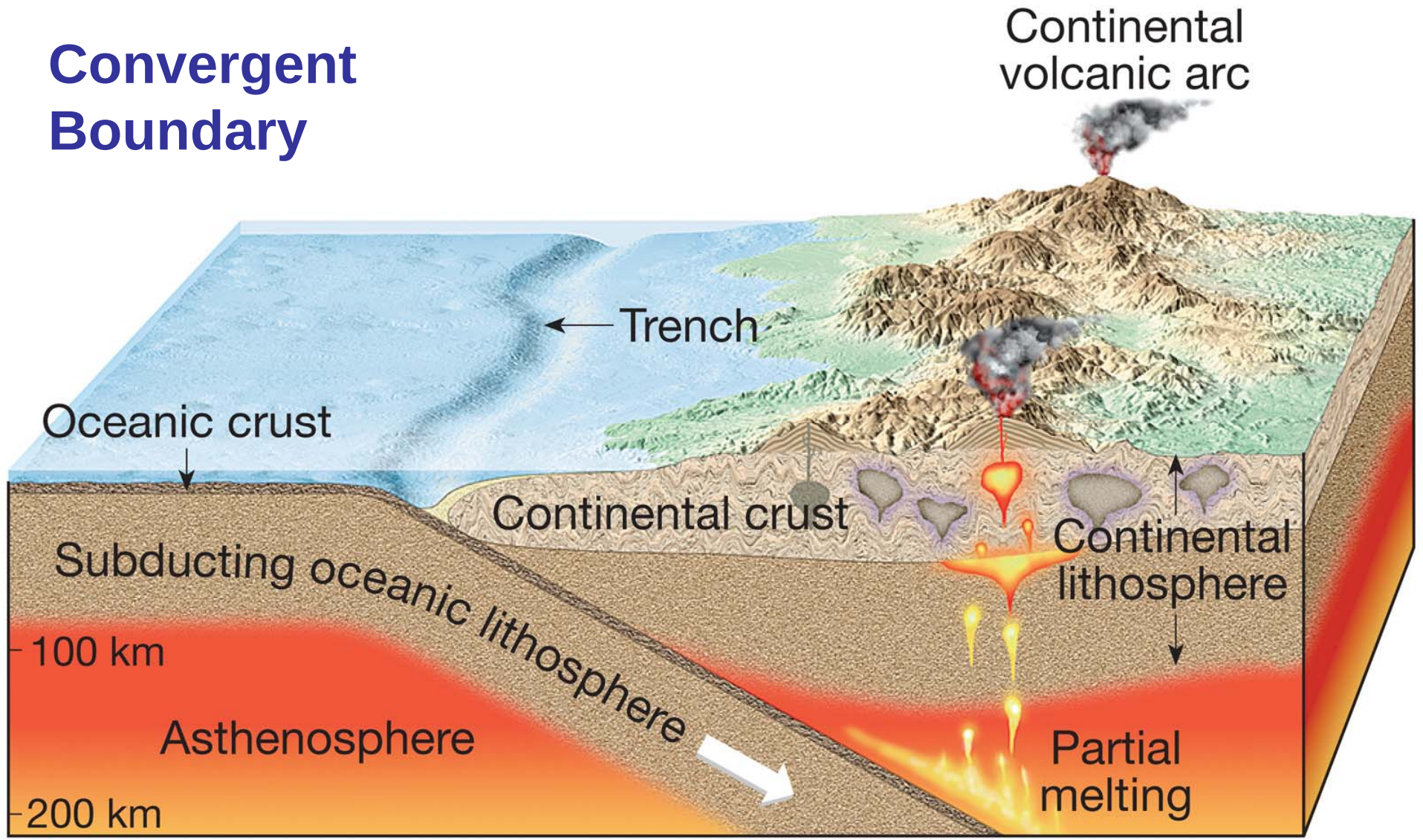
Convection cell

Warm, low density fluid rises

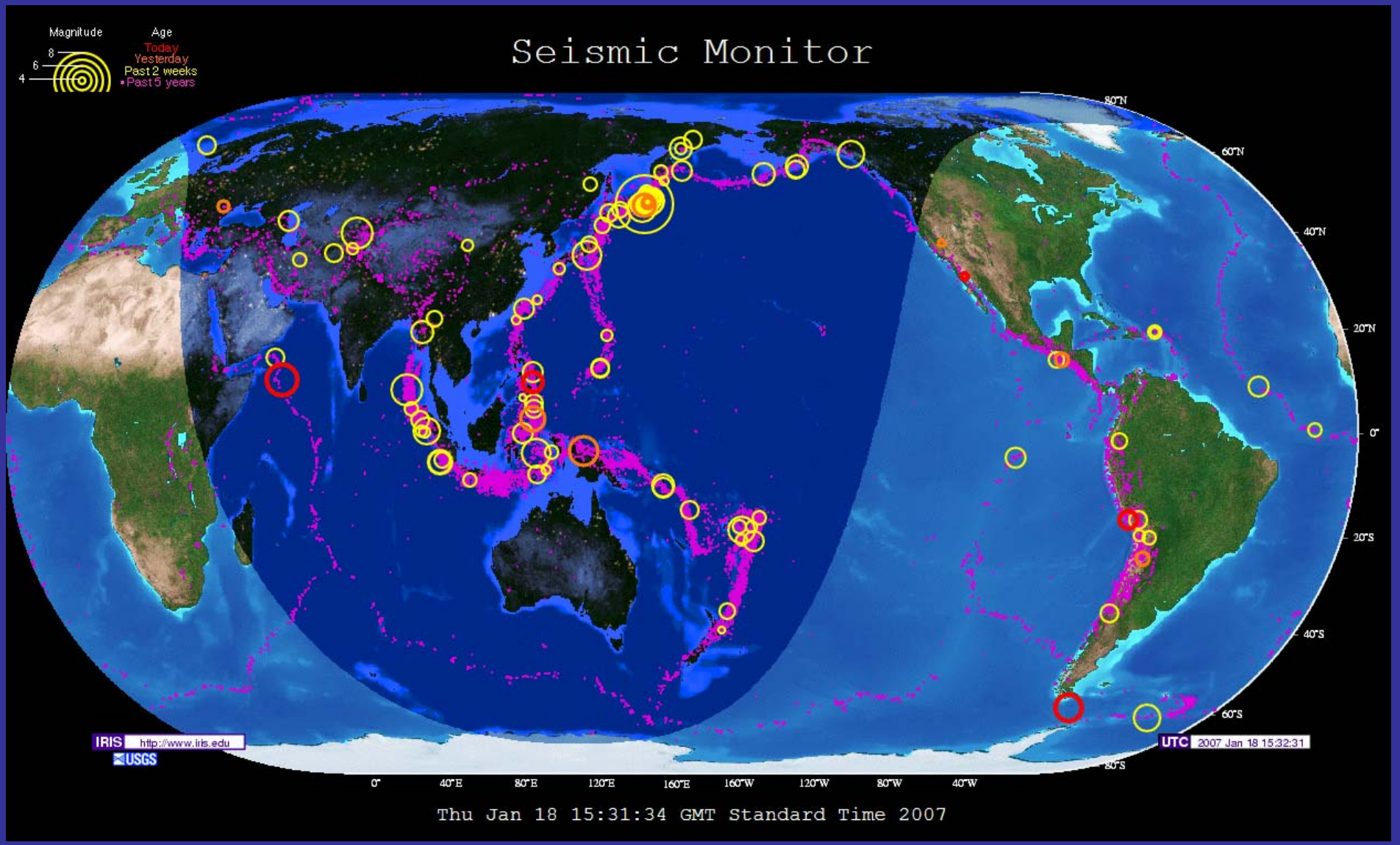
Cool, high density fluid sinks



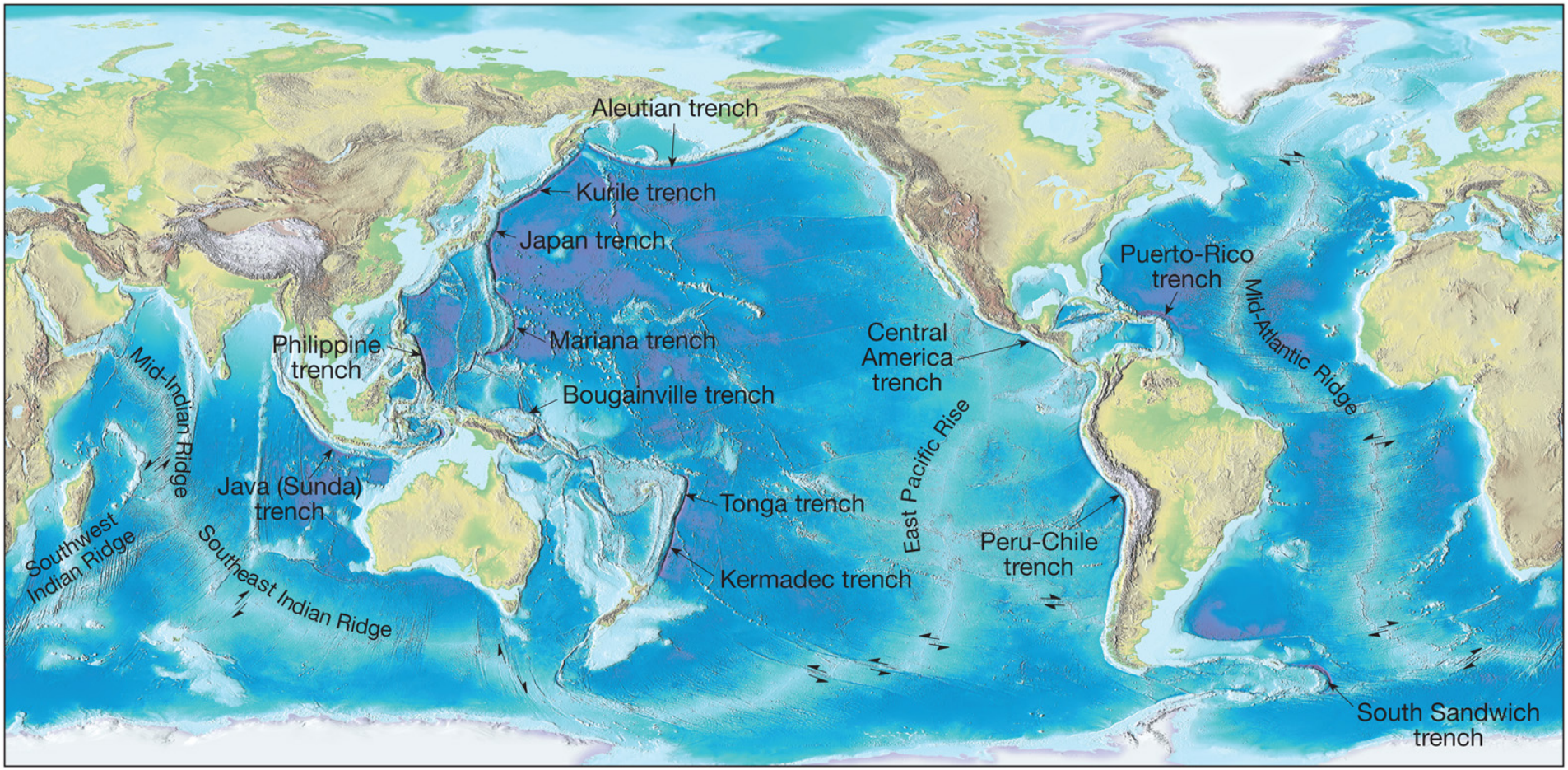
Convergent Boundary



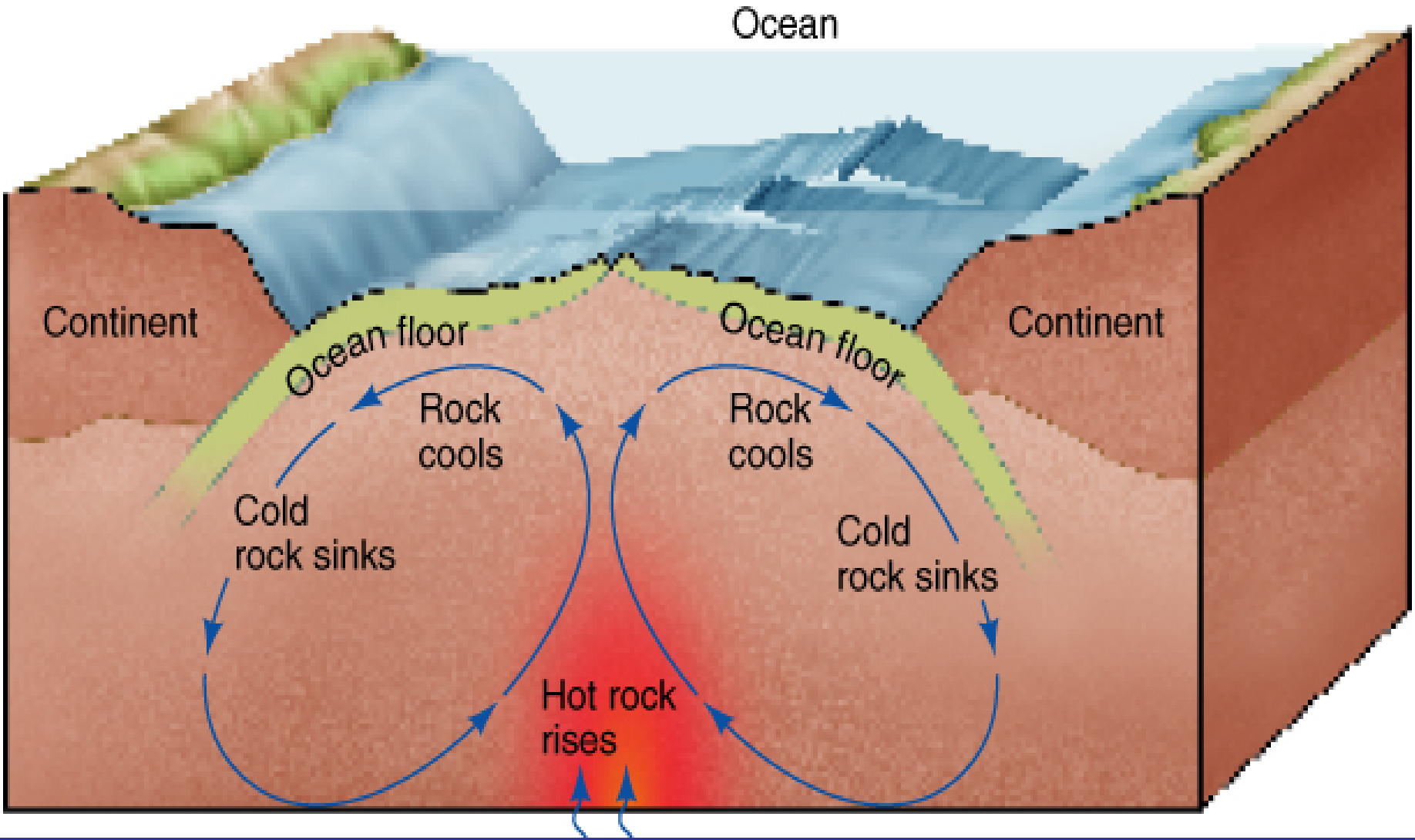
Oceanic Trench



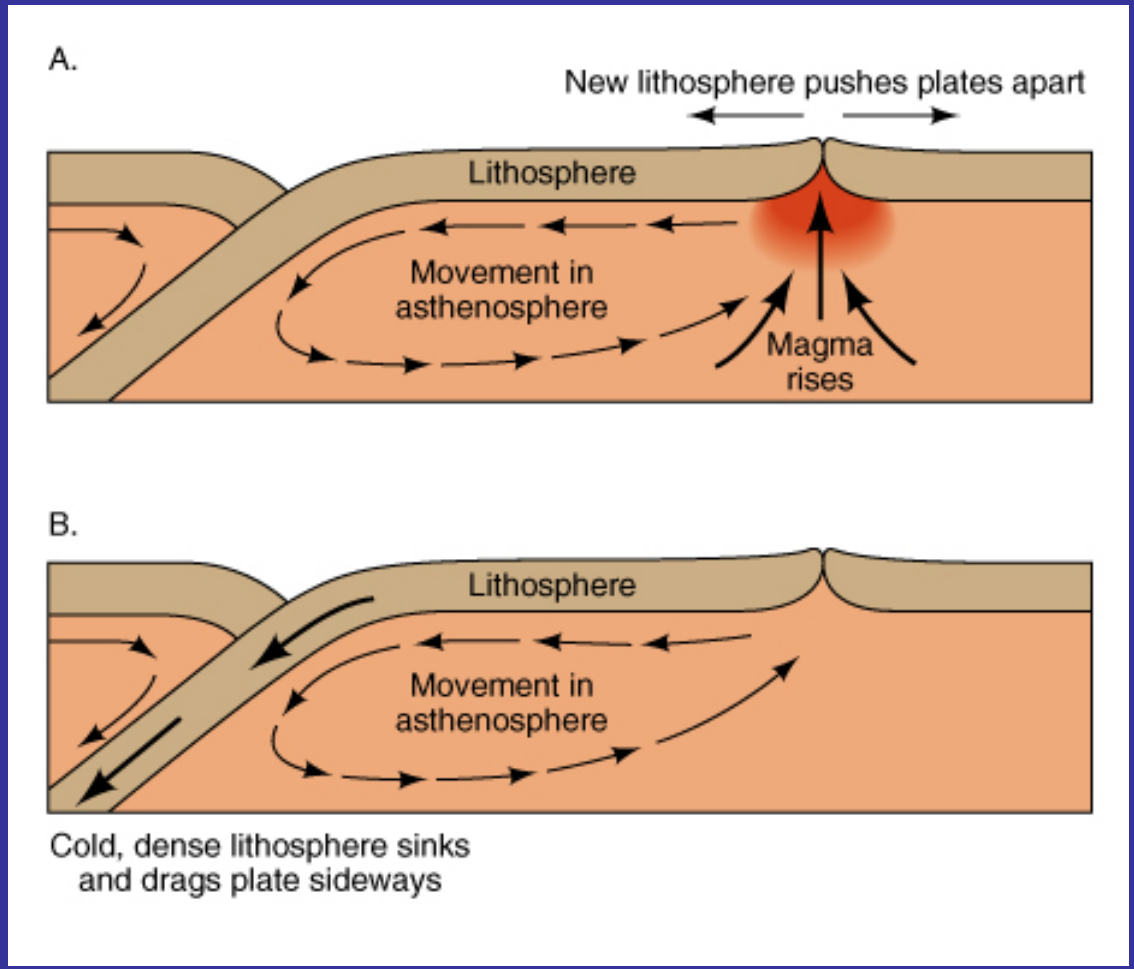
Where are the world's earthquakes?



Oceanic Trenches



Spreading ridge and subduction trench form a complete convection cell

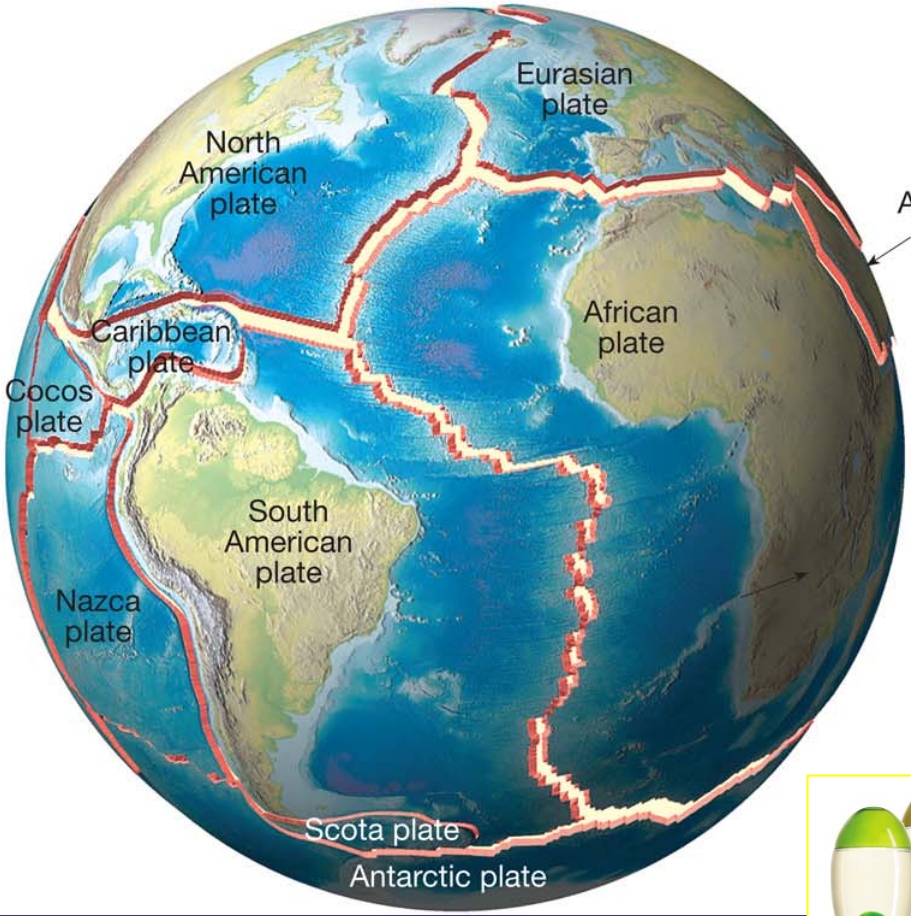


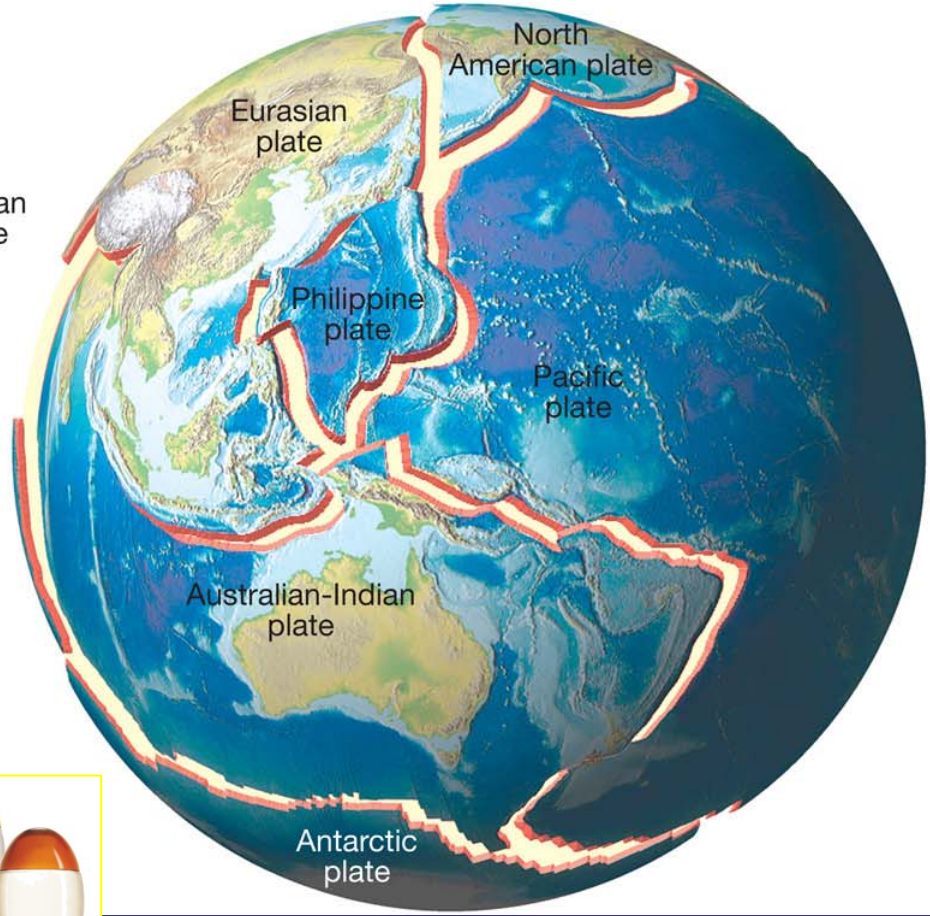
“Ridge Push”

“Slab Pull”

What drives this system?

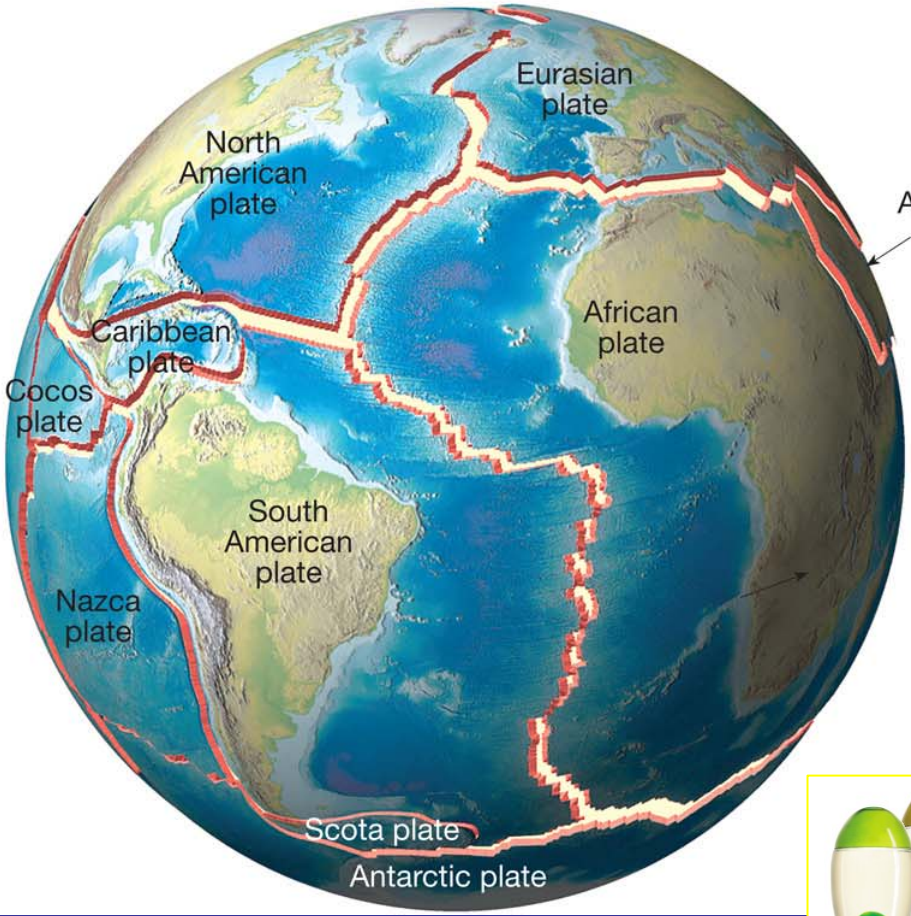
Plate boundaries: ridges, trenches, and…?

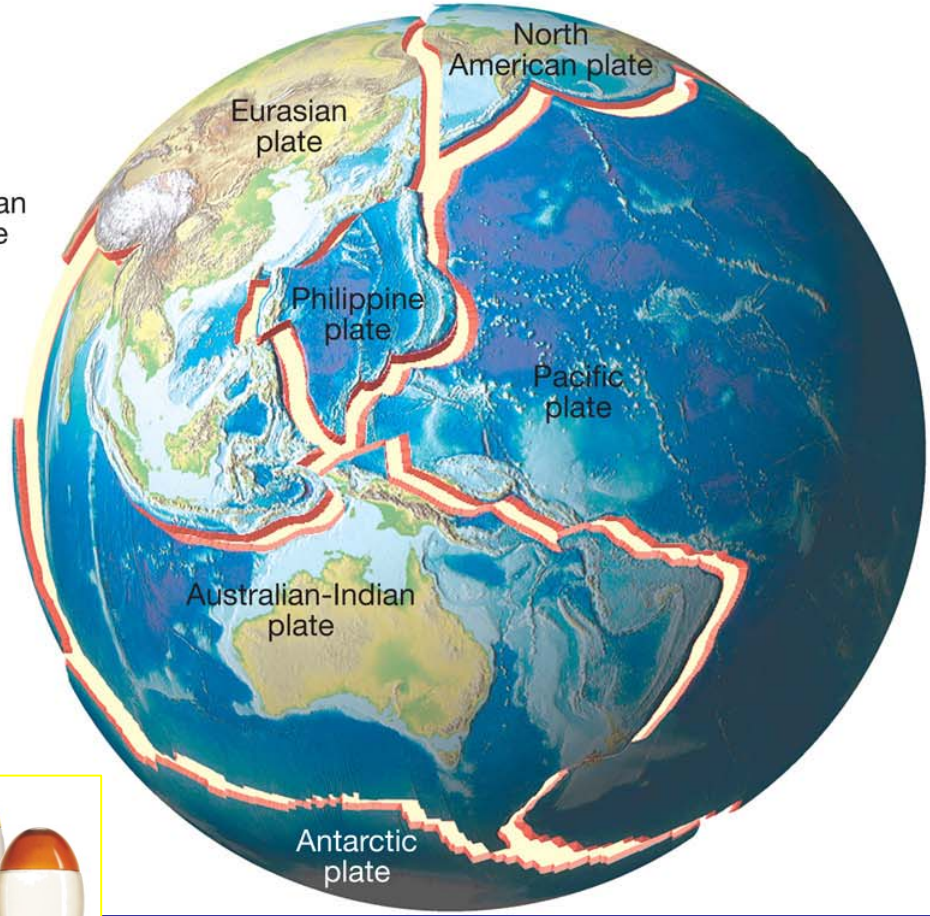






Ridges, trenches, and transform faults

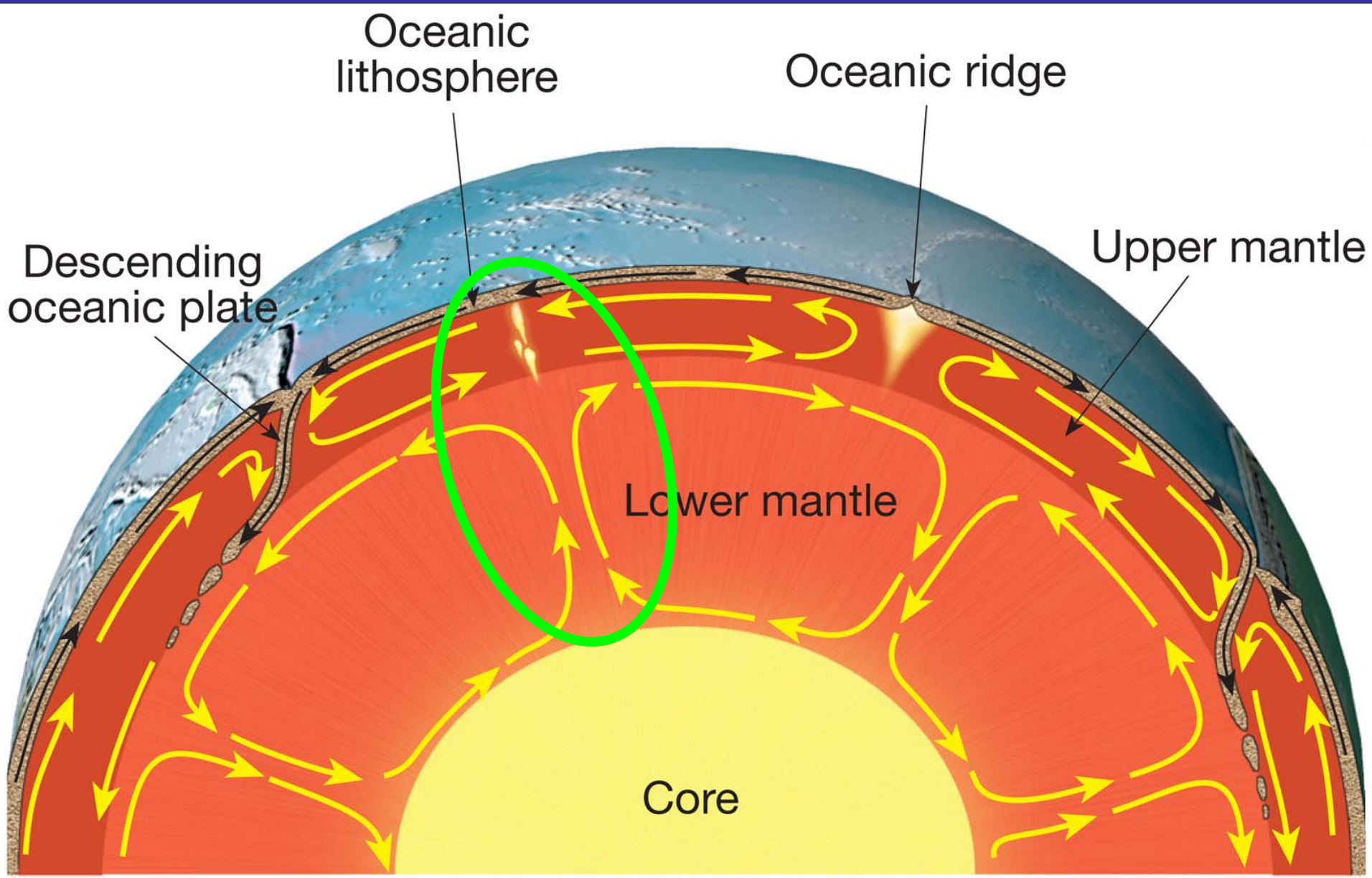


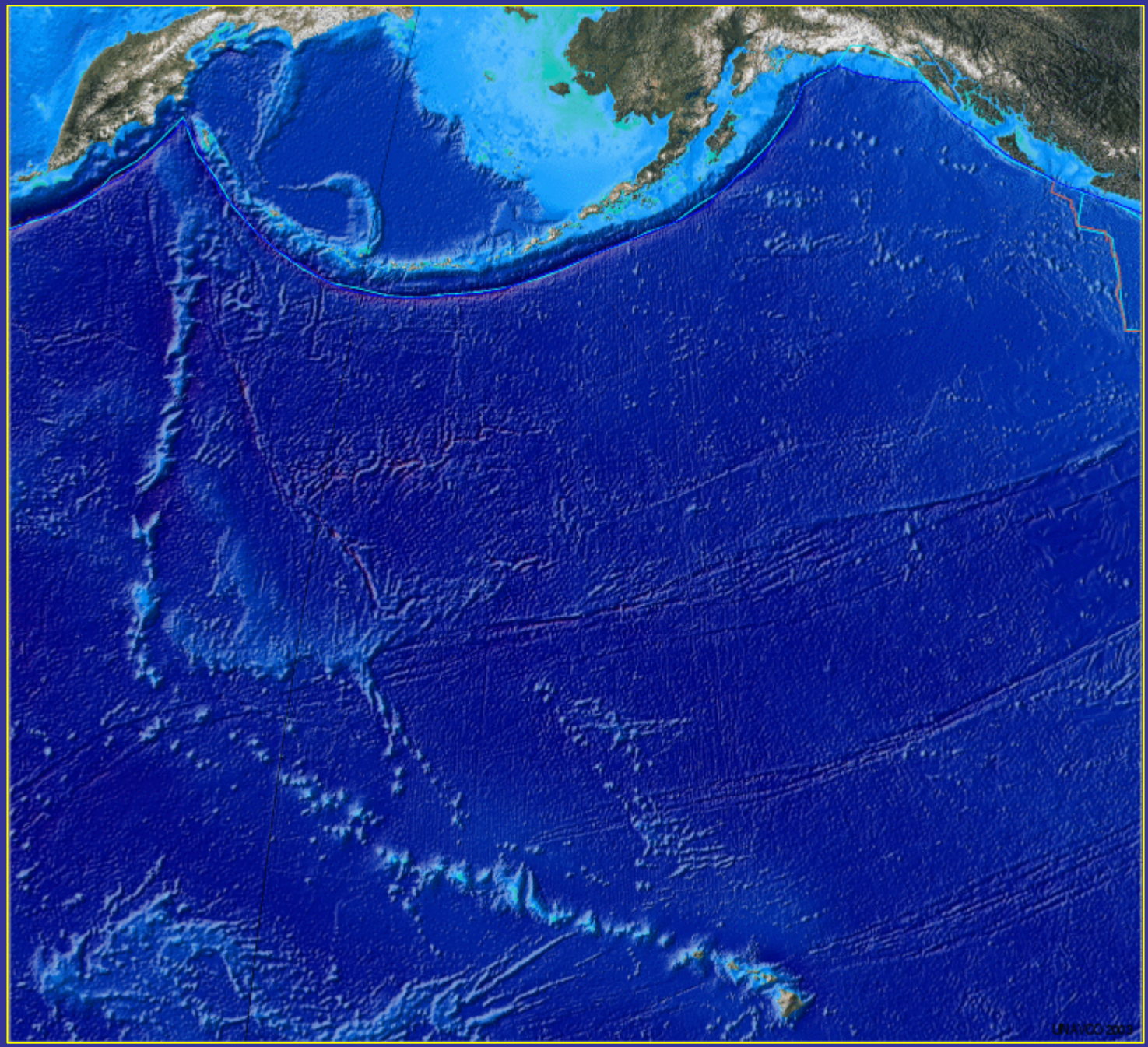


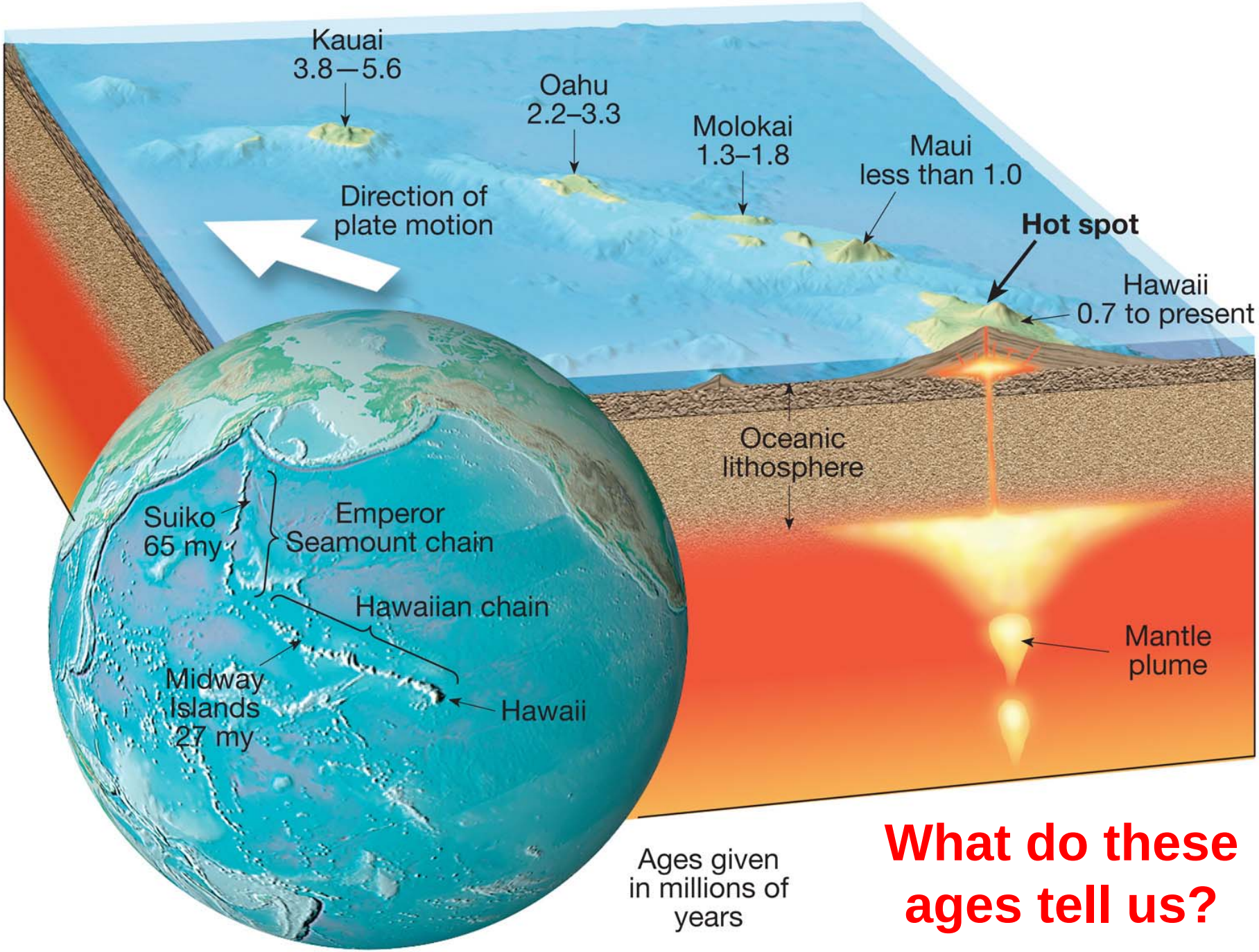
Transform faults are not <u>directly</u> related to mantle convection



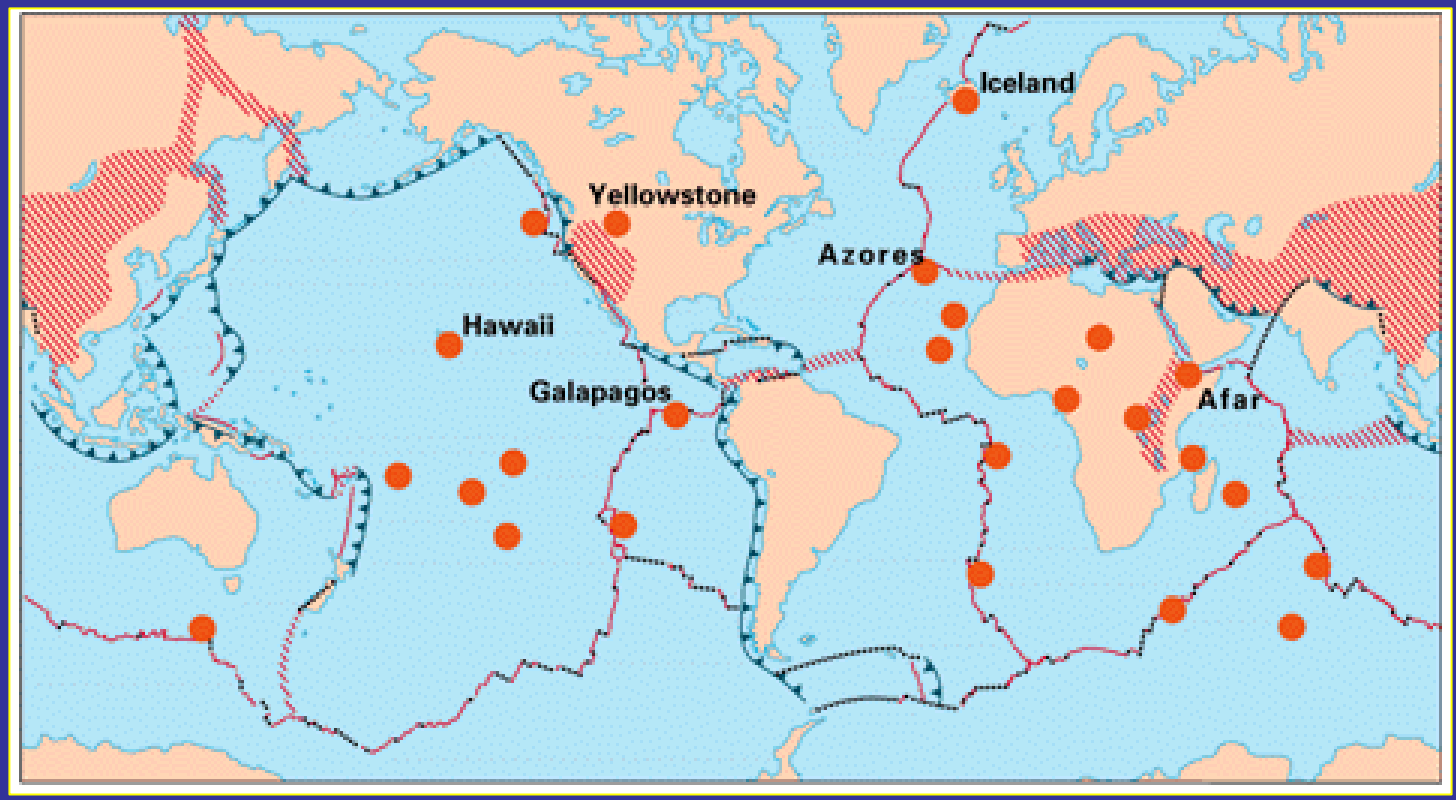
…necessary for doing geometry on a sphere


Oceanic lithosphere
Oceanic ridge
Descending oceanic plate
Upper mantle
Lower mantle
Core

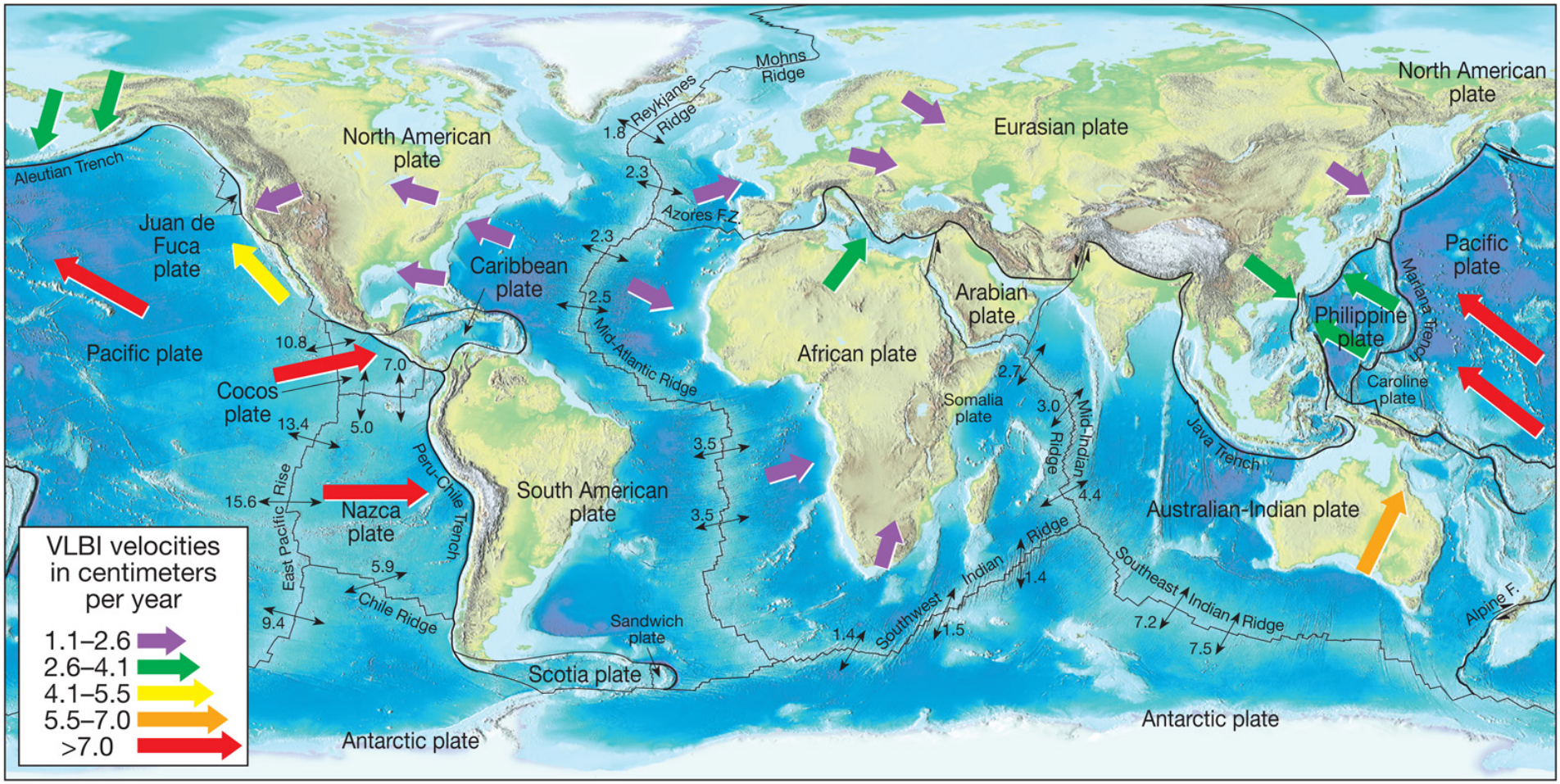

UNAVCO 2009



What do these ages tell us?



Hot Spot locations



Absolute Plate Motion

Mantle convection / Plate tectonic summary

Convection	Landform	Boundary Type
1) Upwelling (hot)	Mid-ocean ridge	Divergent
2) Sinking (cool)	Ocean trench *(Subduction zone)*	Convergent
3) ----	Transform fault	Transform
4) Hot Spot (hot) *(Concentrated upwelling)*	Volcanoes	----



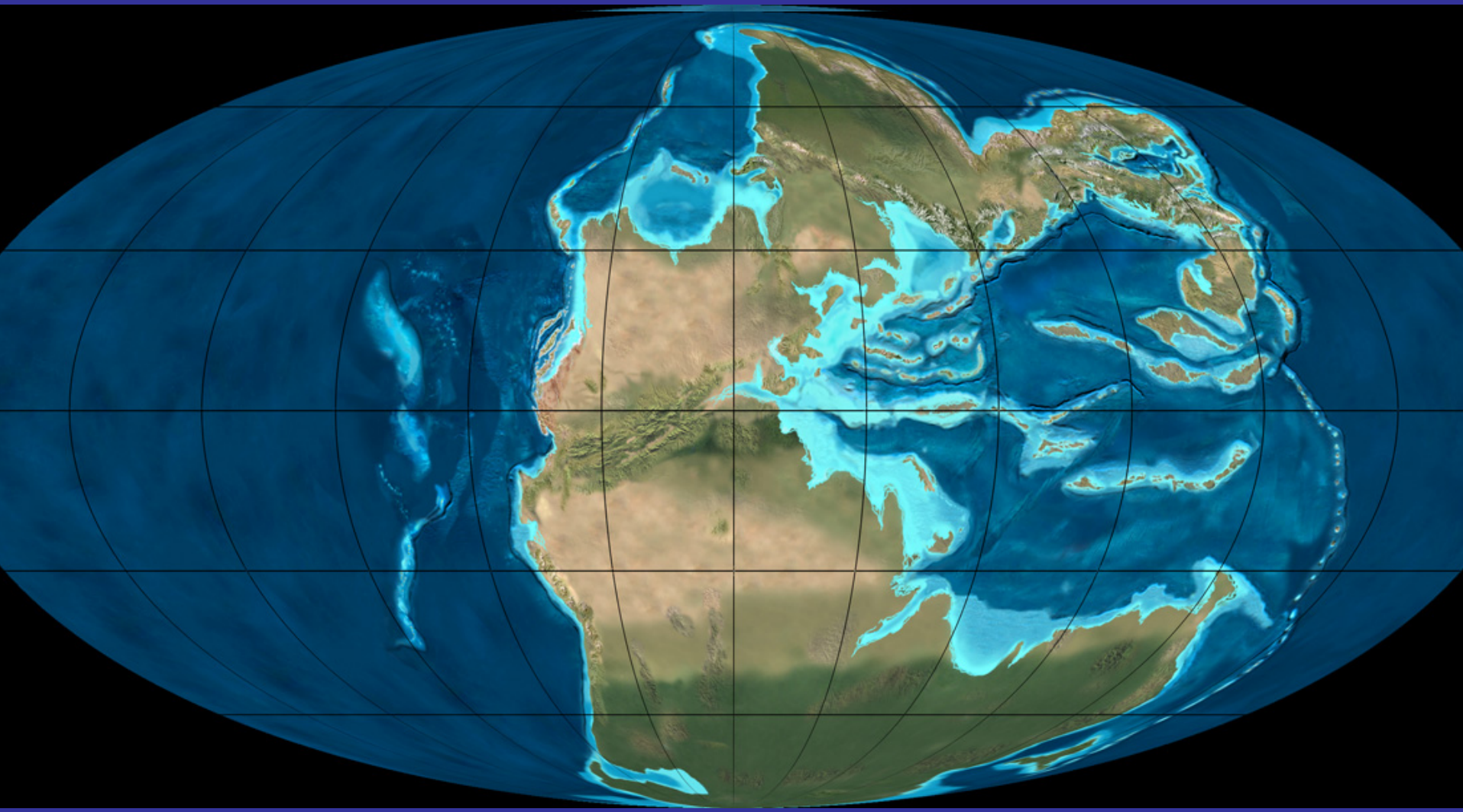
Alfred Wegener
Meteorologist

The Origins of Continents and Oceans
1915

“Continental drift”

Modern Earth

Pangaea (240 Mya)



Pangaea


Eurasia
North America
Africa
South America
India
Antarctica
Australia

“Utter, damned rot!”

President of the prestigious American Philosophical Society

“If we are to believe this hypothesis, we must forget everything we have learned in the past 70 years and start all over again”

American scientist

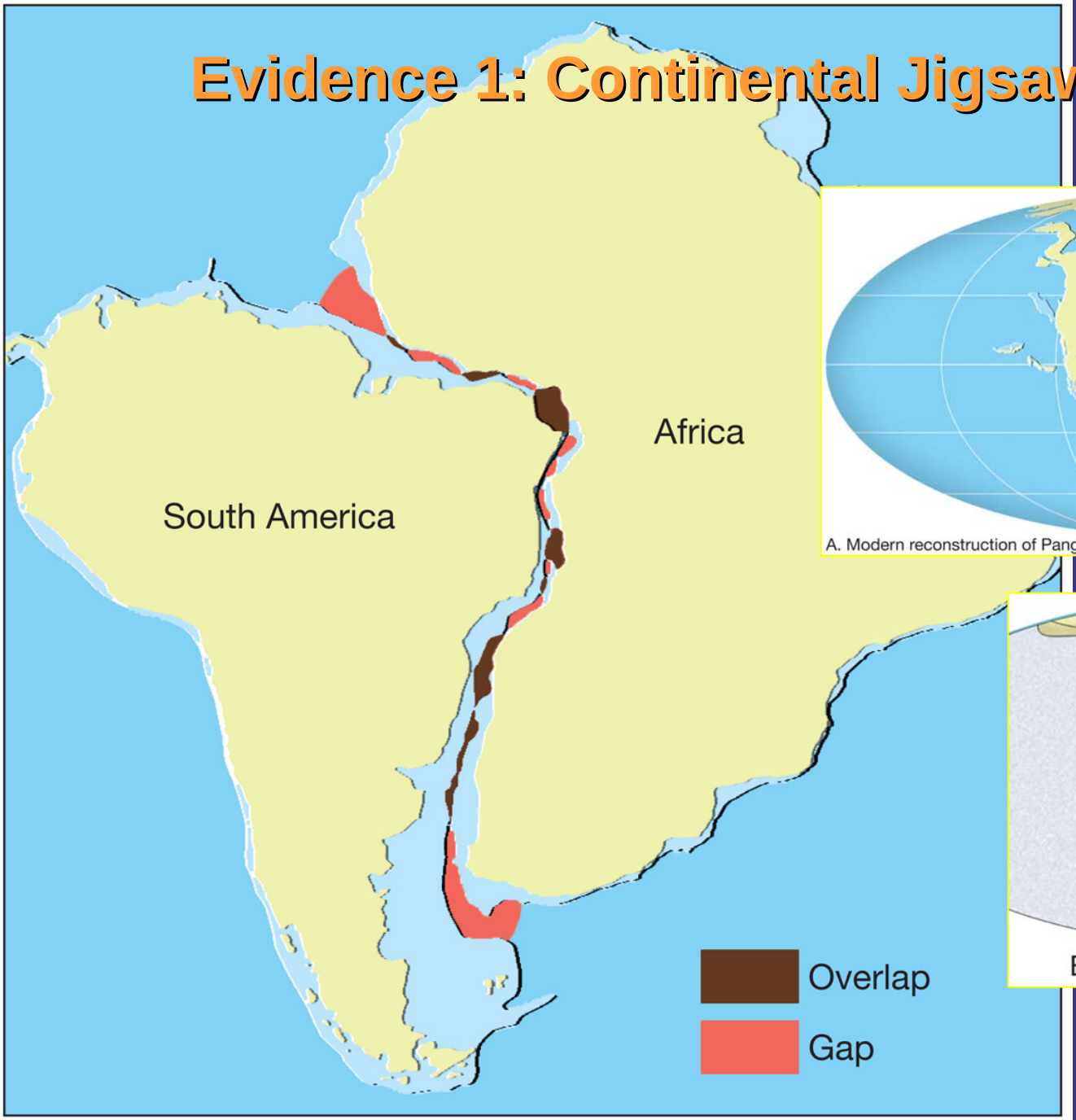
“Anyone who valued his reputation for scientific sanity would never dare support such a theory”

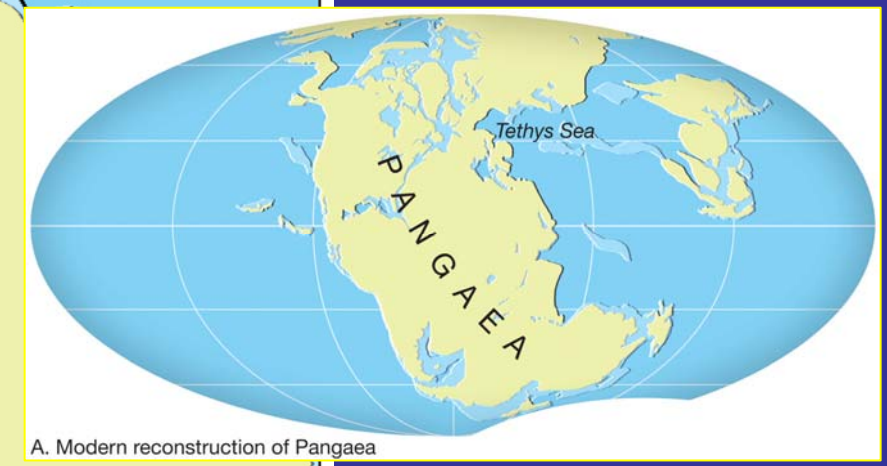
British geologist

How should we test this idea?

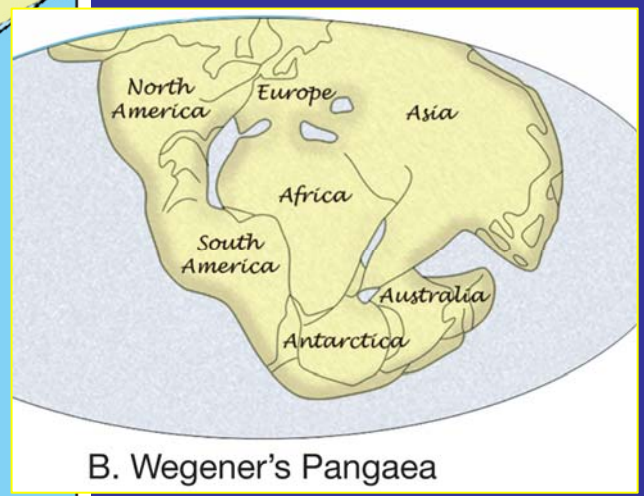


Evidence 1: Continental Jigsaw Puzzle





A. Modern reconstruction of Pangaea

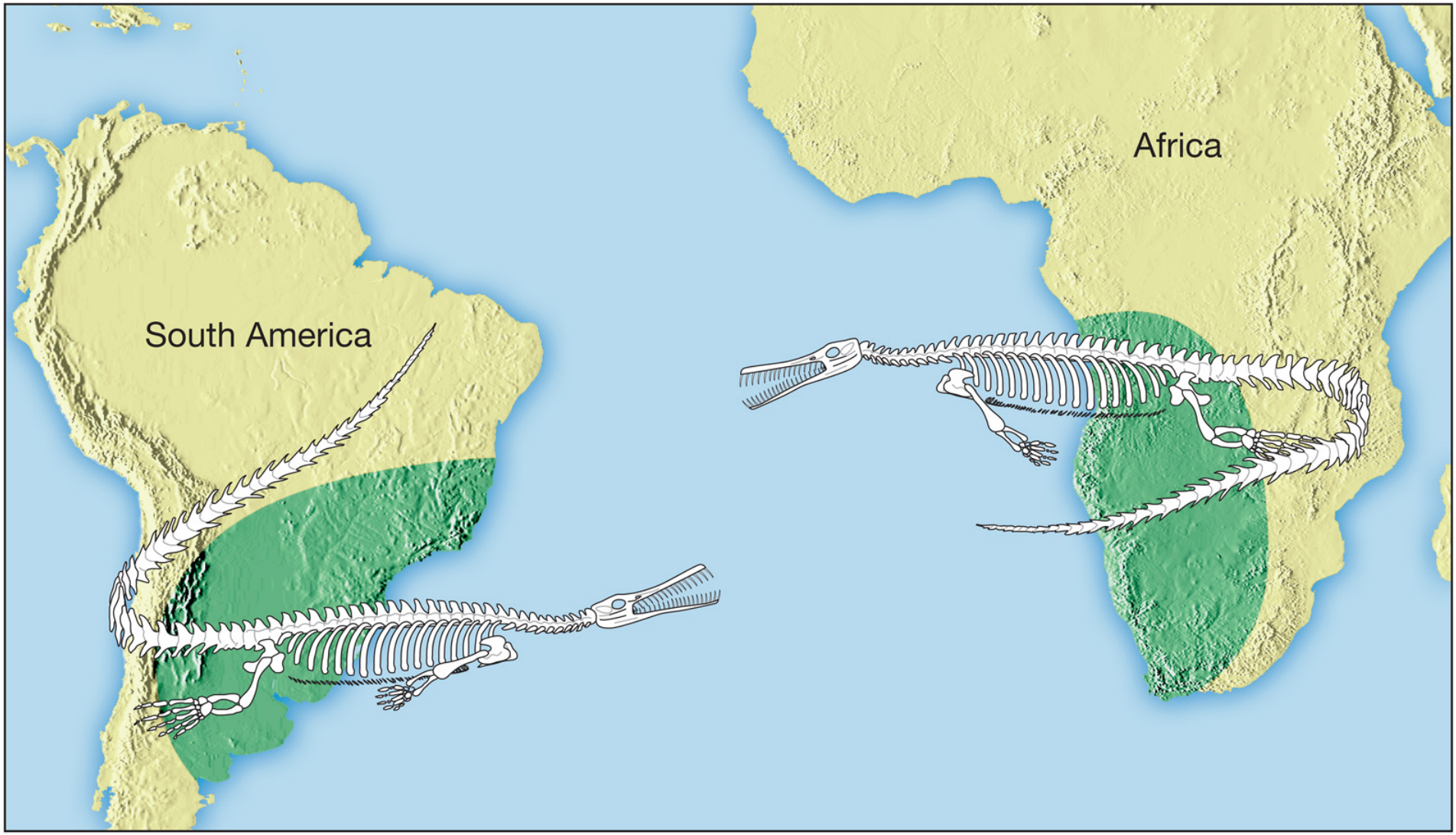


B. Wegener's Pangaea

How far can this guy swim?



Evidence 2: Fossils match across Atlantic



Mesosaurus (260 Mya)

Evidence 3: Rock types & structures match



U.S., Africa, Greenland, British Isles, Scandinavia





What do these striations result from?



Would glacial striations form in an environment like this?



Would glacial striations form in an environment like this?



Would glacial striations form in an environment like this?

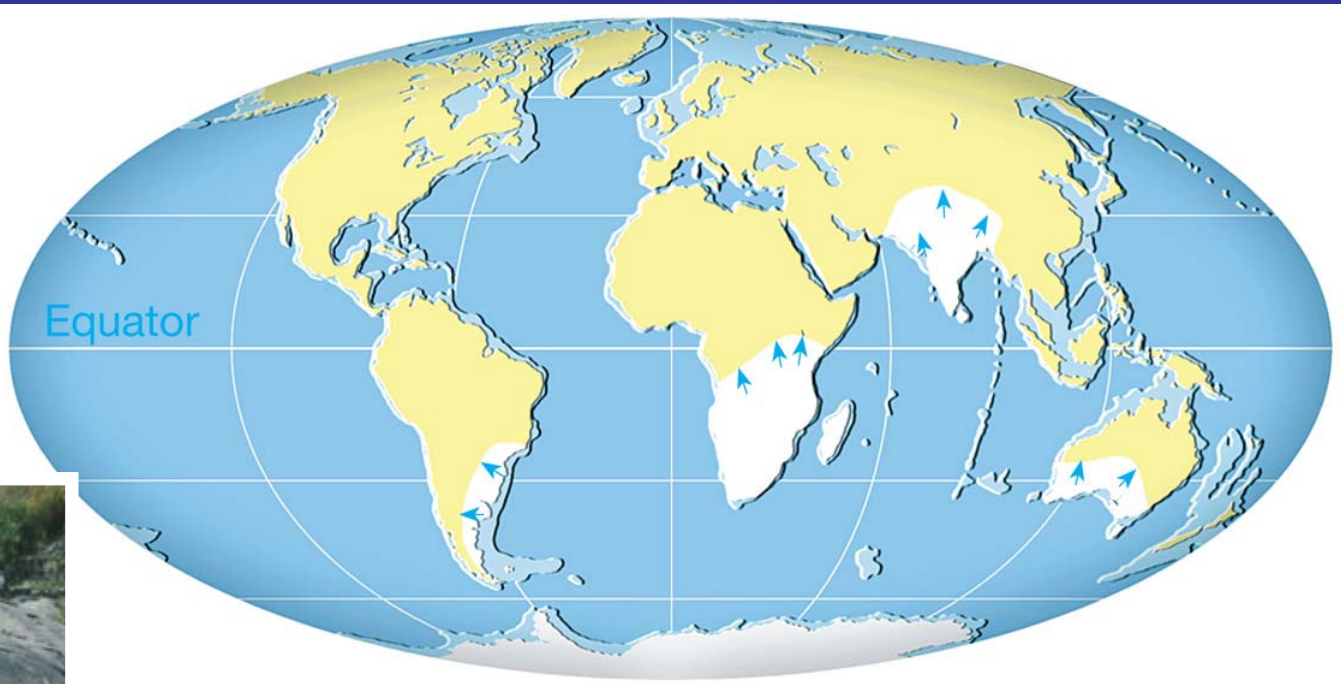


Would glacial striations form in an environment like this?



Evidence 4: Ancient climates

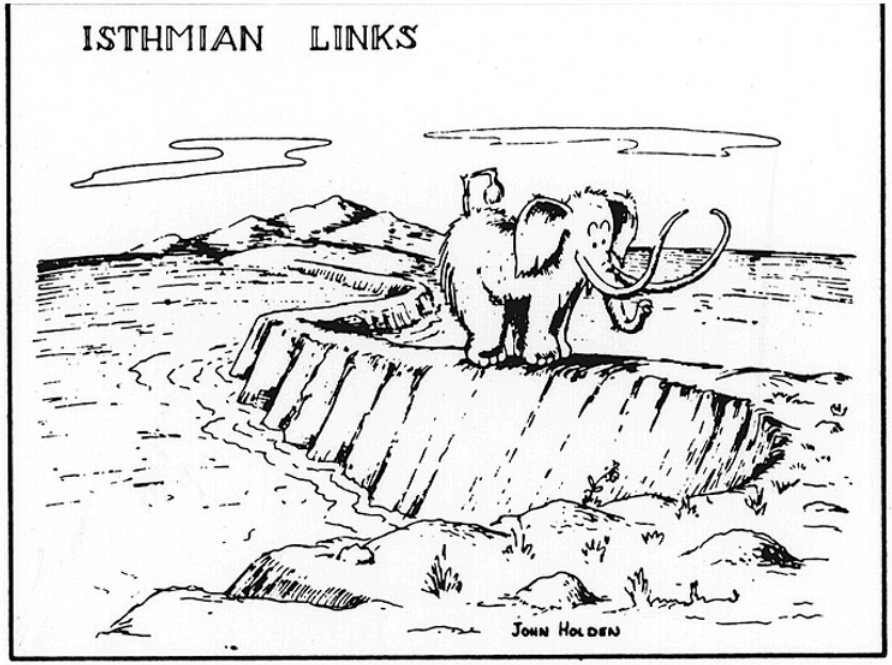


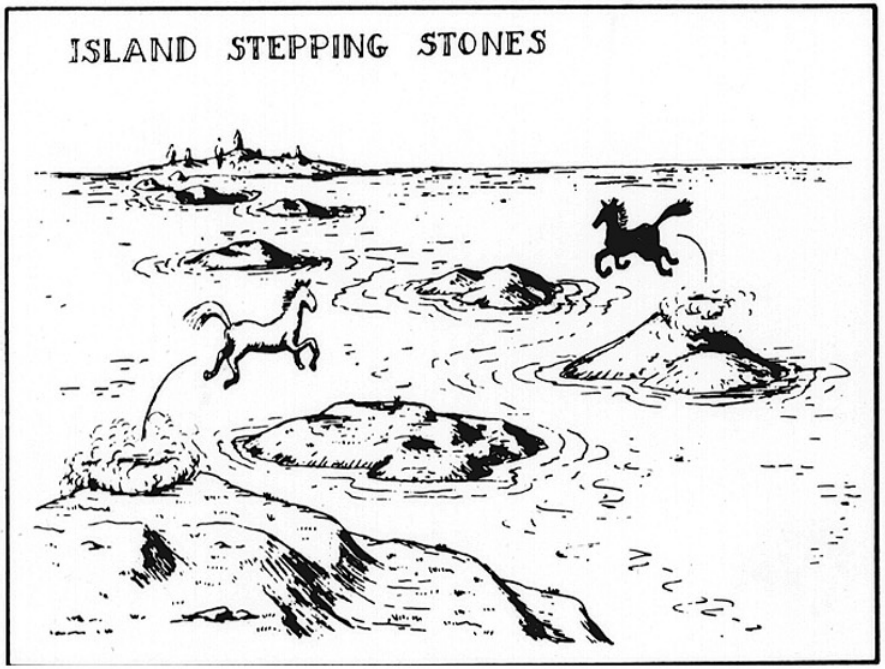


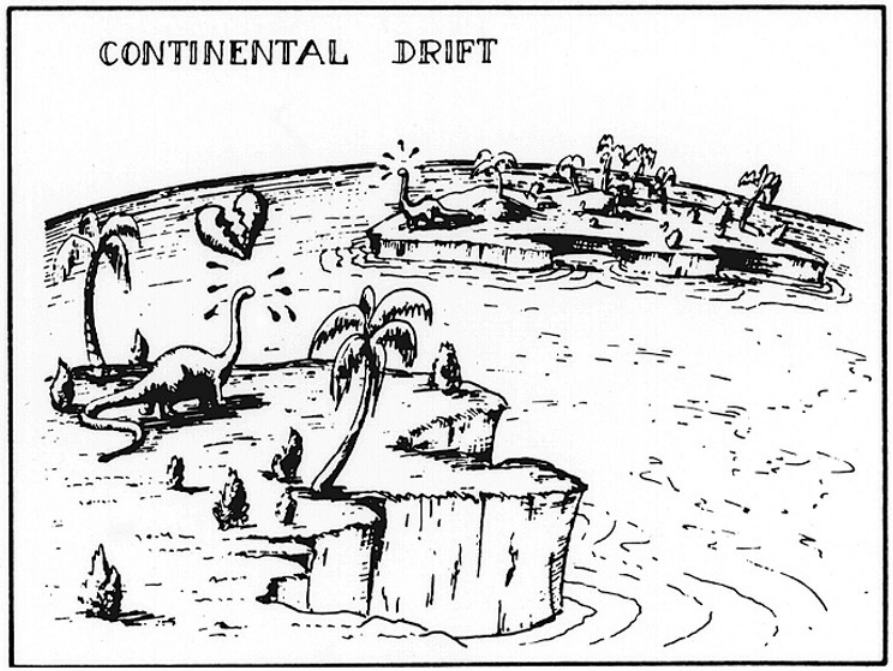


The alternatives…











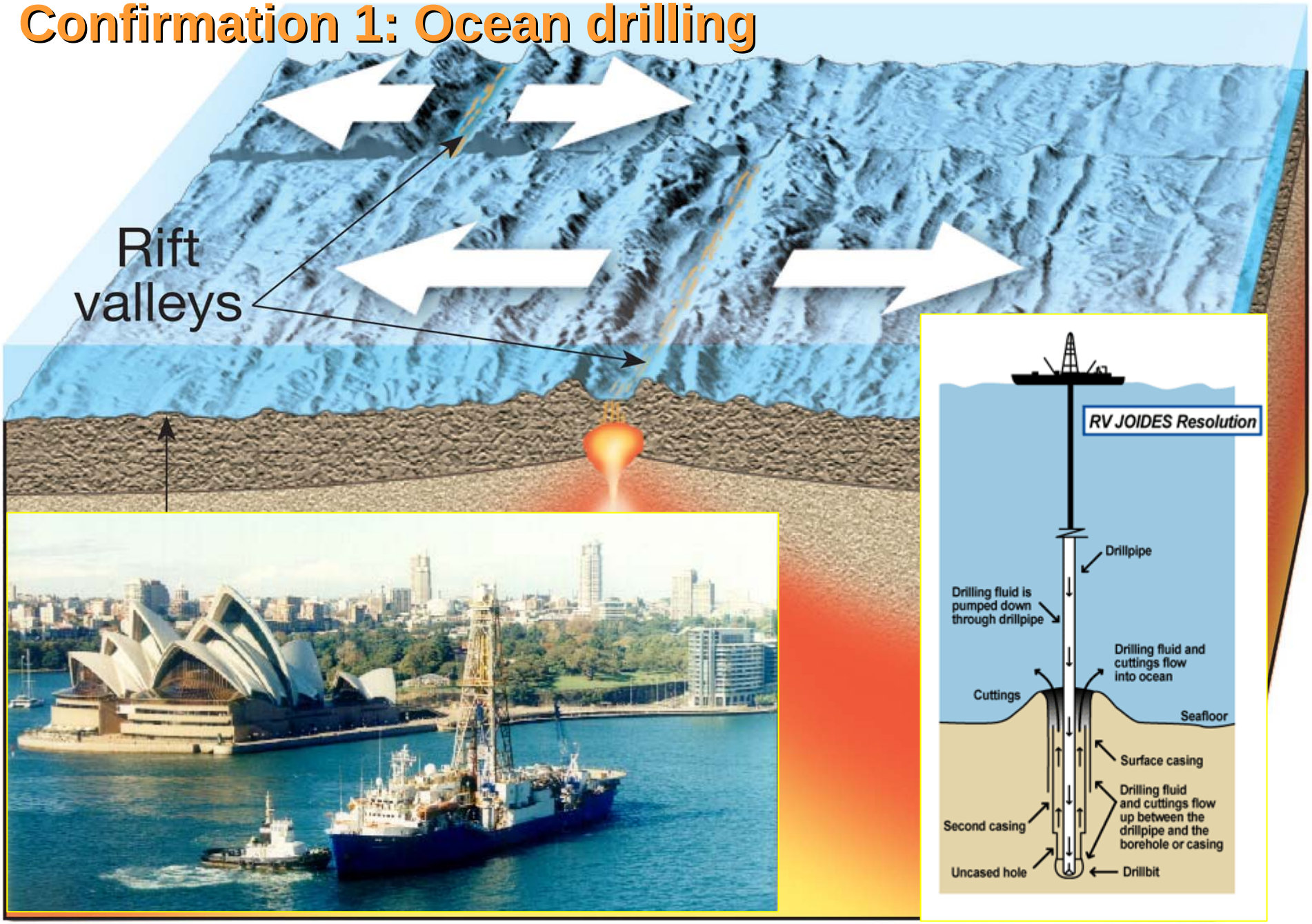




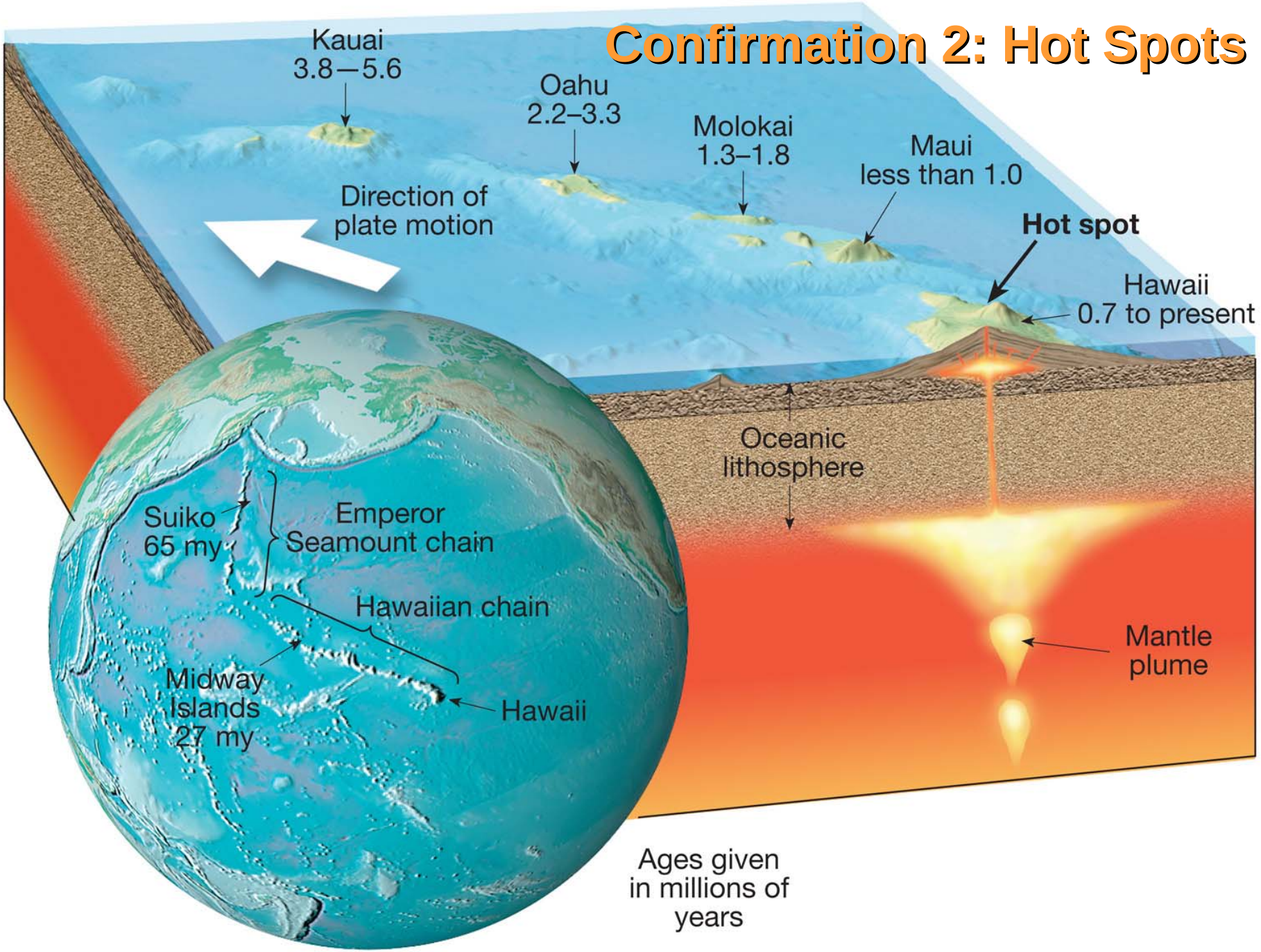
1950s-1960s

Post-WWII Military Industrial Complex

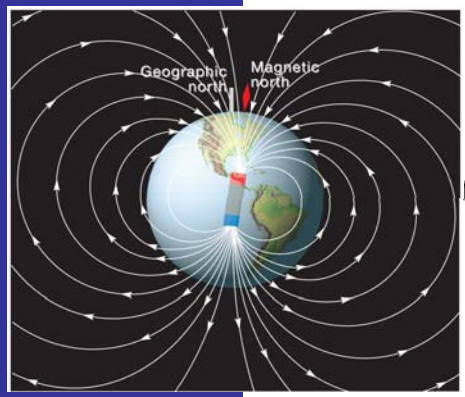
Confirmation 1: Ocean drilling

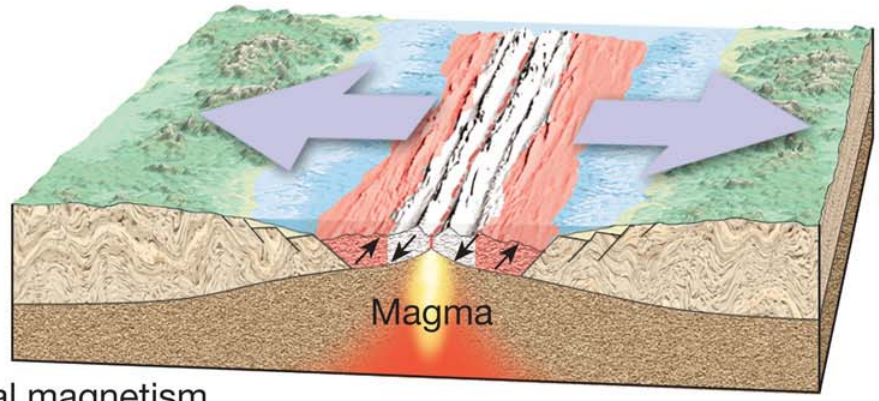


Confirmation 2: Hot Spots

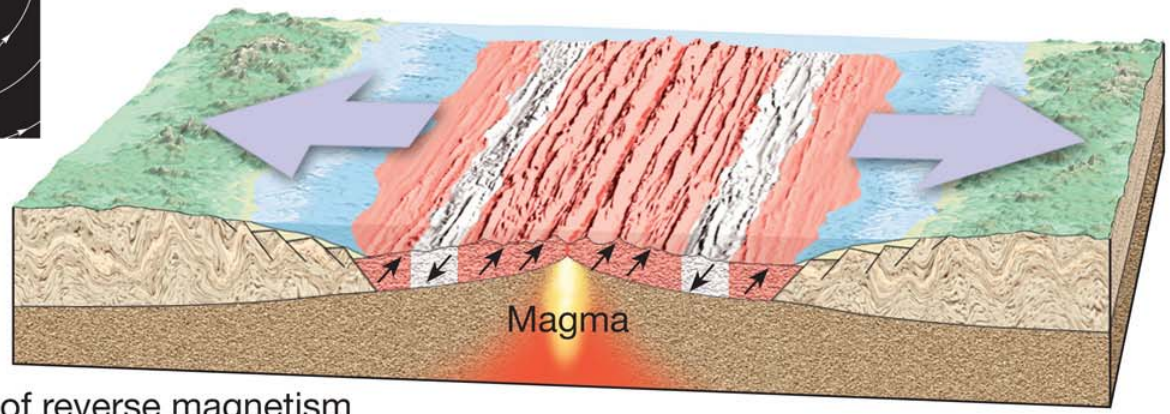


Confirmation 3: Paleomagnetism

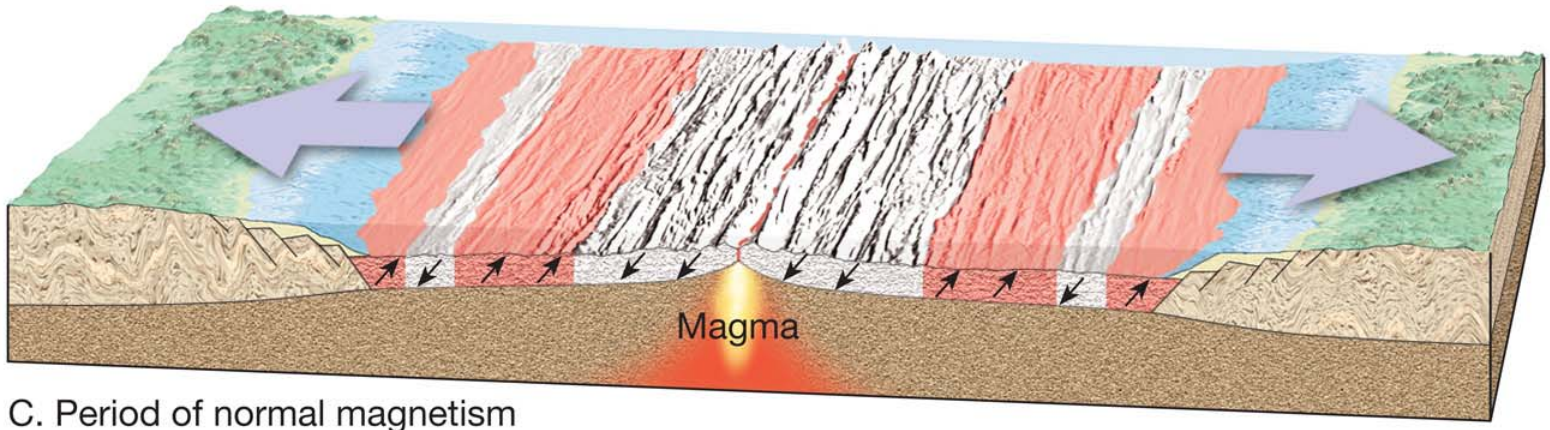




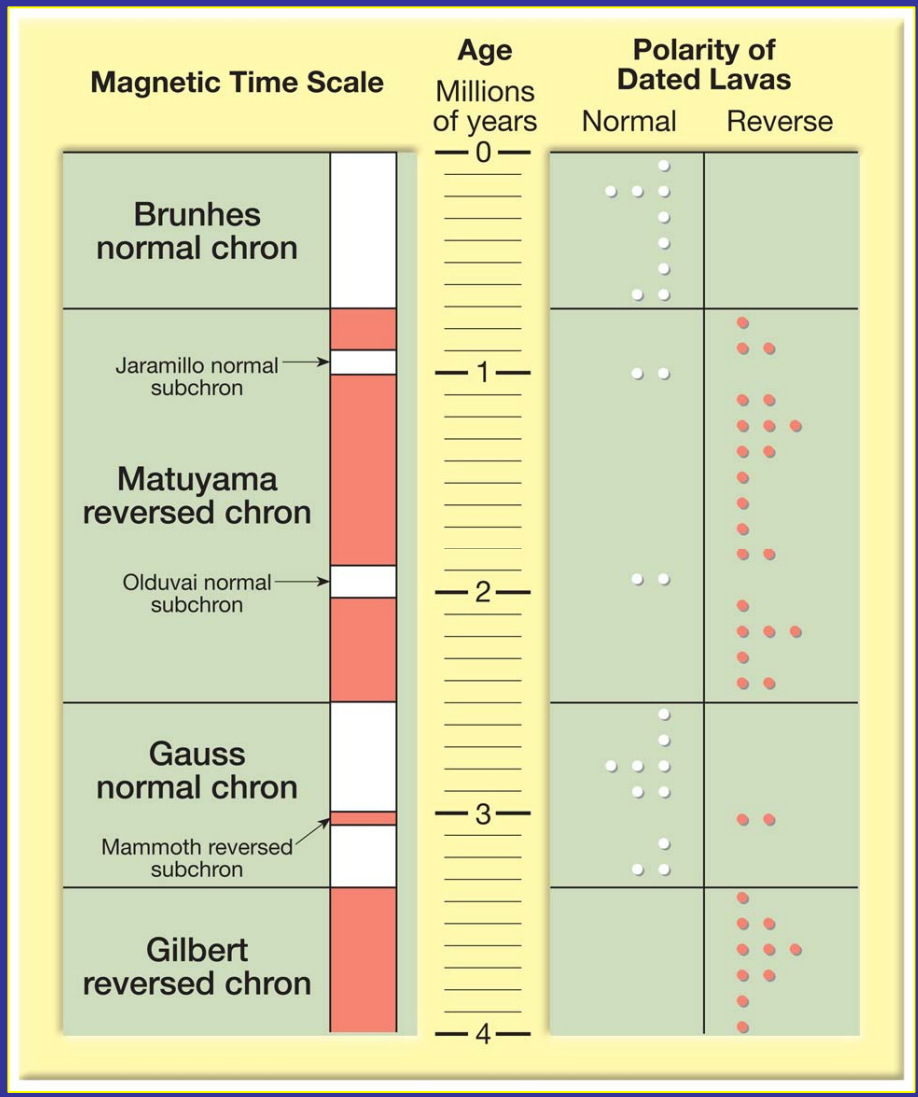
normal magnetism



B. Period of reverse magnetism



C. Period of normal magnetism





Magnetism of seafloor matches time scale of Earth's magnetic field

Support for plate tectonic model

1. Continental jigsaw puzzle
2. Fossils match across Atlantic
3. Rock types/structures match across Atlantic
4. Ancient climates (i.e. glaciers in Africa)

5. Ocean drilling confirms increasing age with distance from mid-ocean ridges
6. Hot spots track plate movement
7. Paleomagnetism of lavas at ridges tracks formation of new seafloor