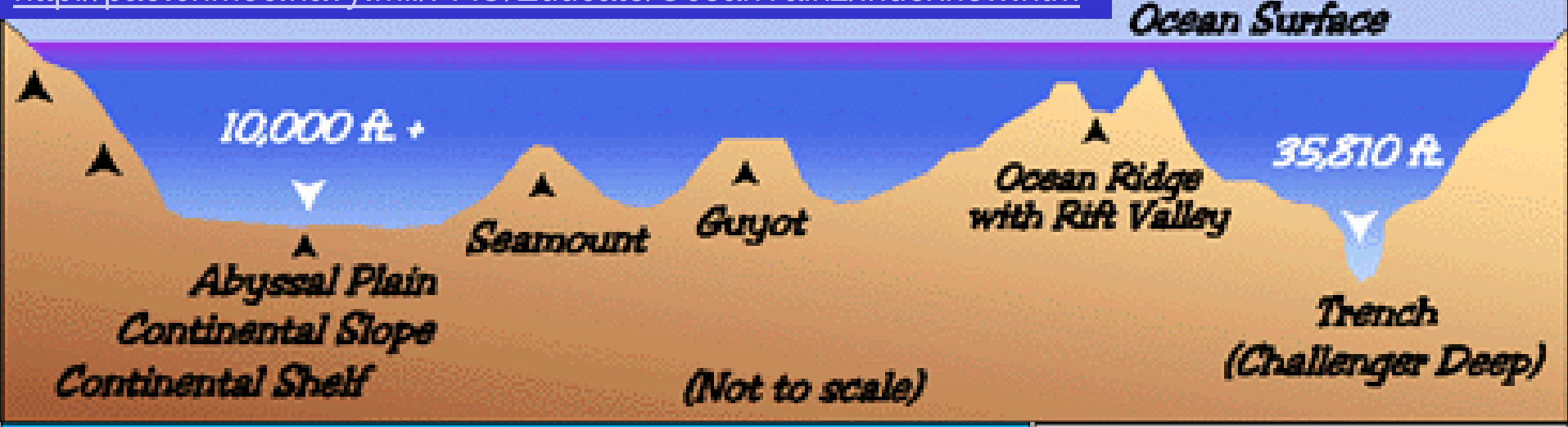
# *The concept of 'Global Plate Tectonics'*

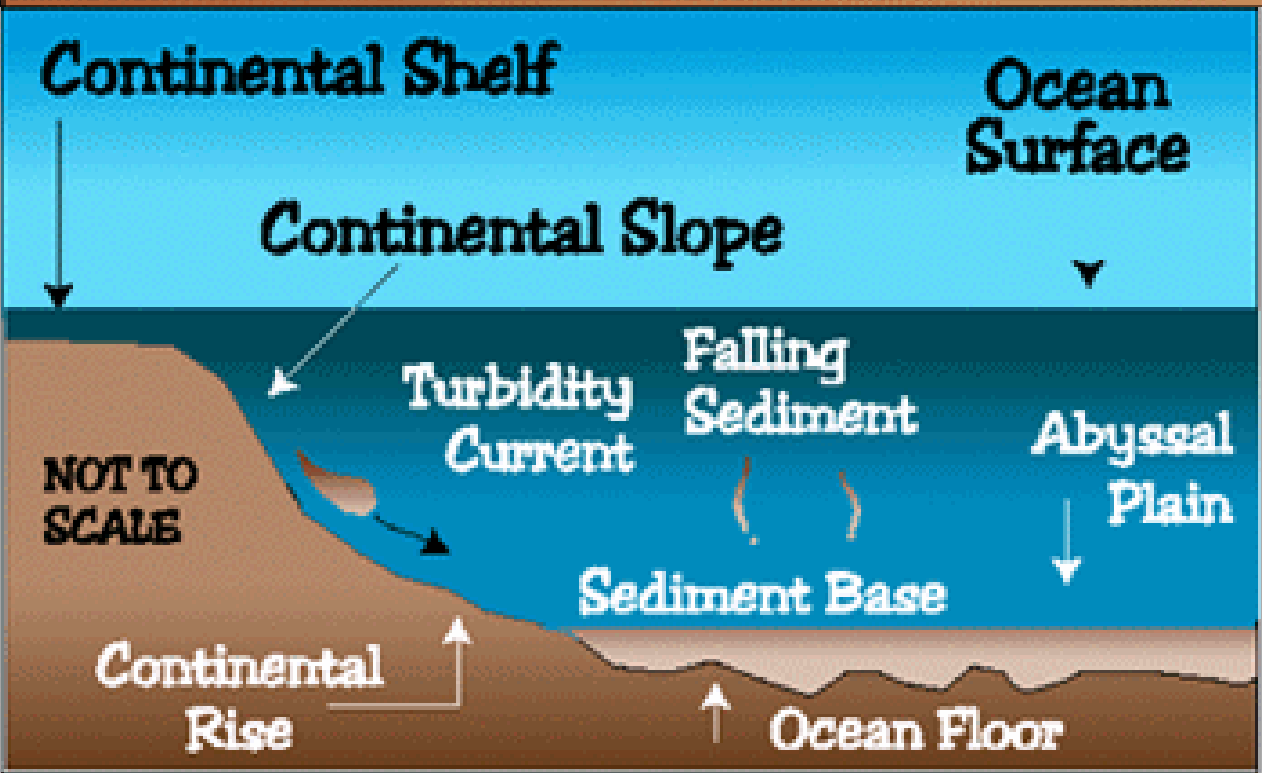
- **is a unifying theme in modern geology that integrates the earlier ideas of**
  - **continental drift,**
  - **sea-floor spread, and**
  - **mountain building**
- **To explain why the present ocean floor, which covers only ~71% of earth's surface area, has ≤200 Ma old rocks, compared to up to ~4.2 Ga old rocks on land, while there is no evidence of any change in earth's surface area during this period.**

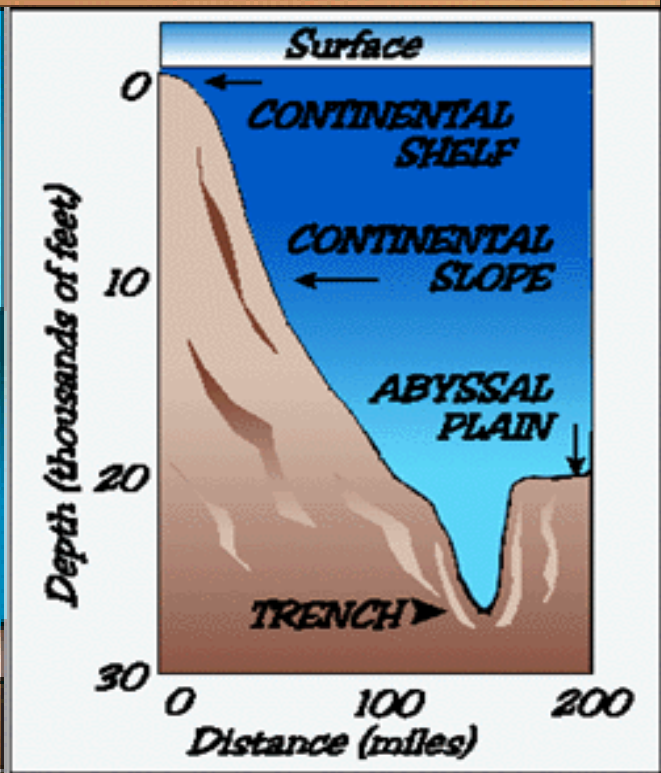

**To Alfred Wegener, the evidence of 250-300 Ma glaciation in today's far flung continents pointed to their having once been joined together and located at the south pole.**

# FEATURES OF THE UNDERWATER WORLD

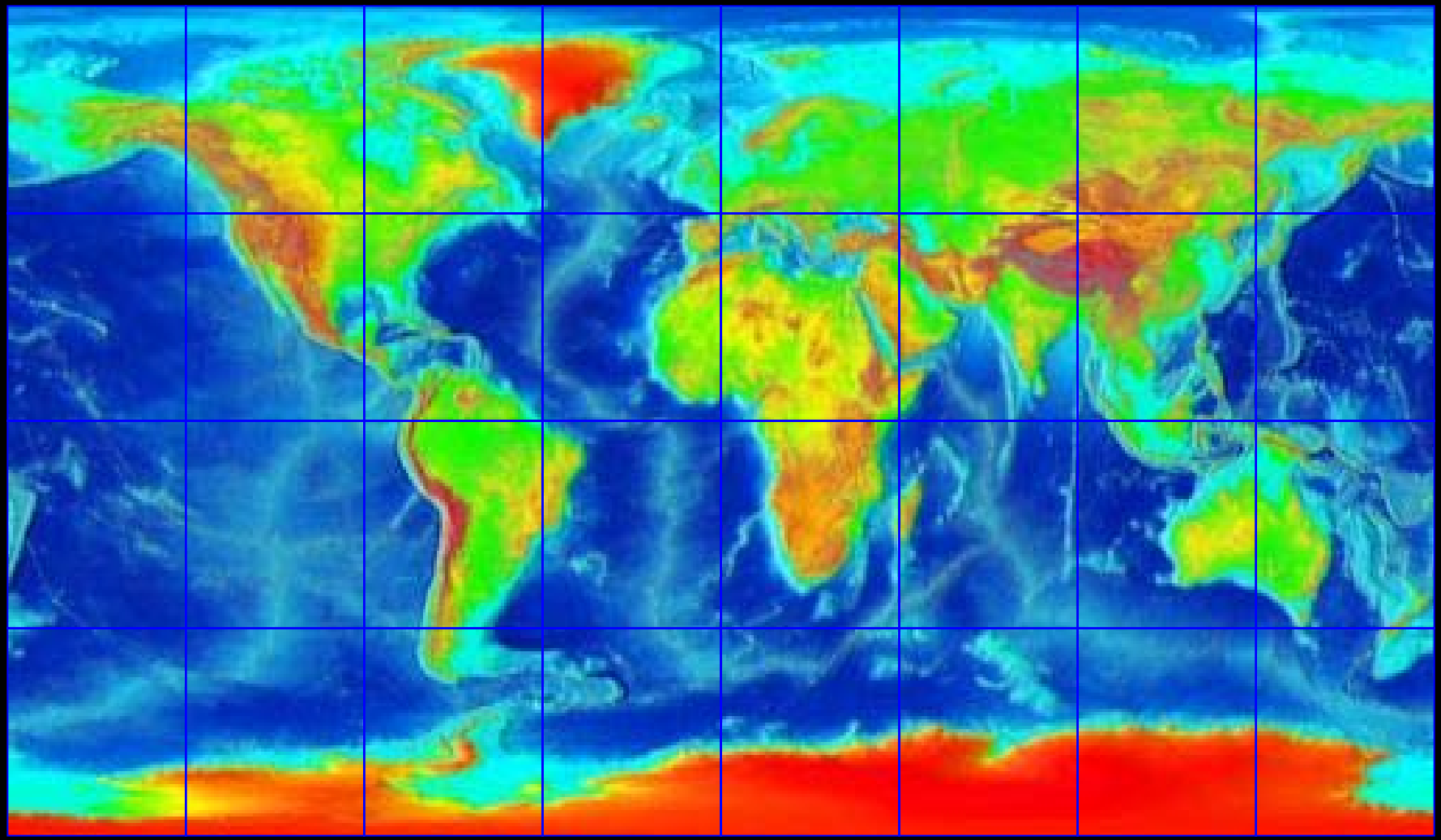
http://pao.cnmoc.navy.mil/PAO/Educate/OceanTalk2/indexnew.htm



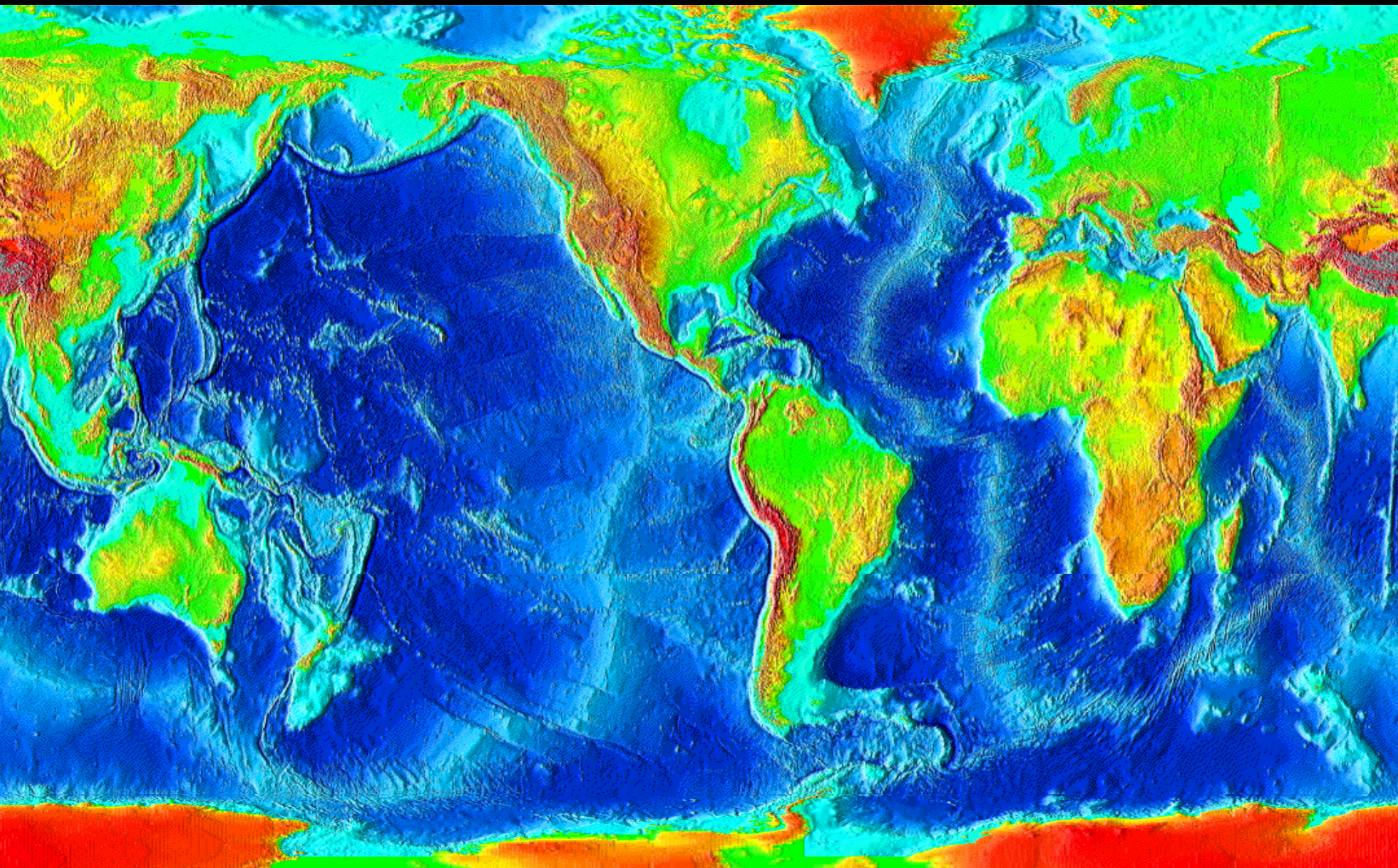



**This is the relief map of the world. If you go to the URL below, you will be able to click on any of the 45°×45° grids here to view enlarged versions of them.**

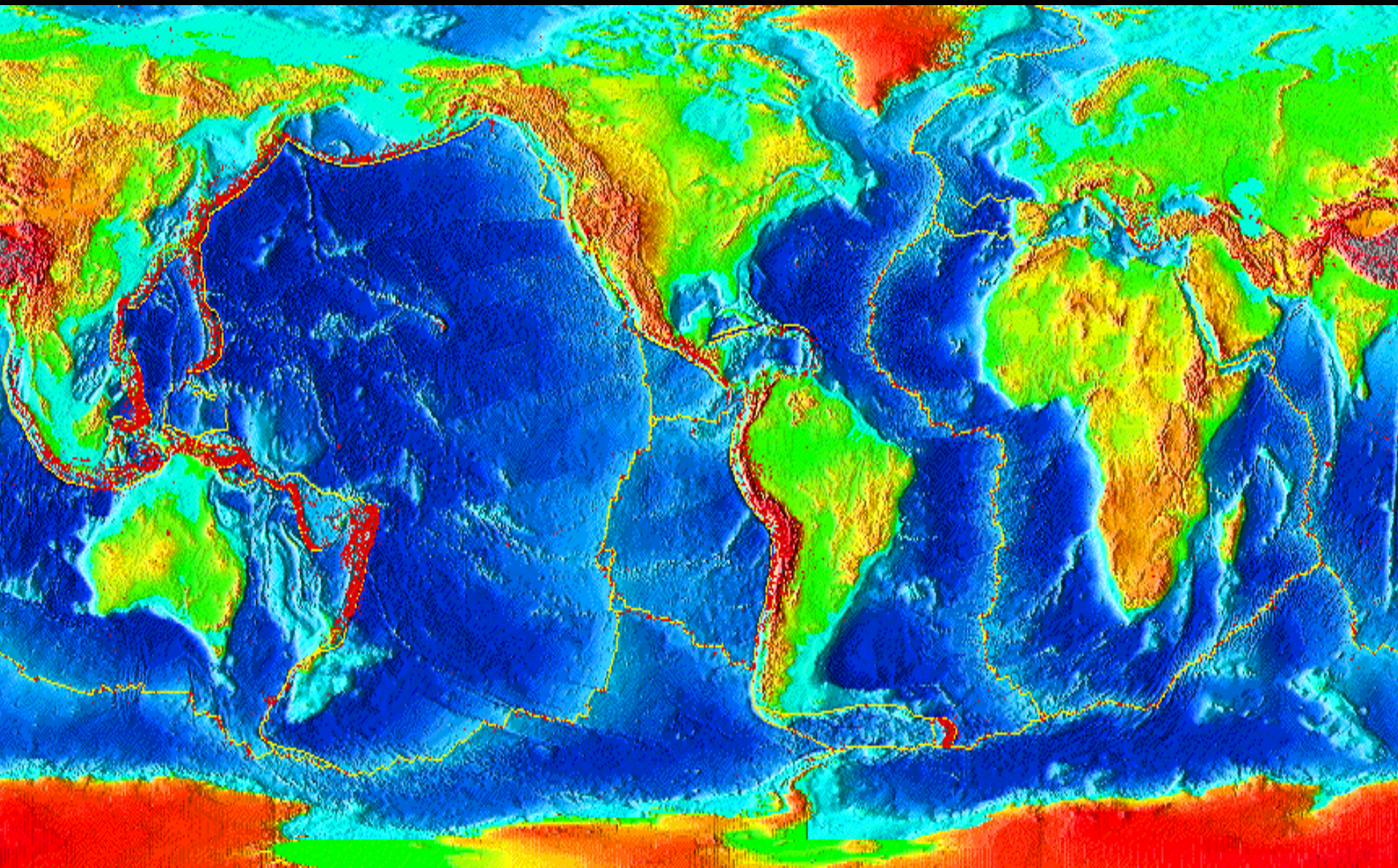


http://www.ngdc.noaa.gov/mgg/image/2minrelief.html

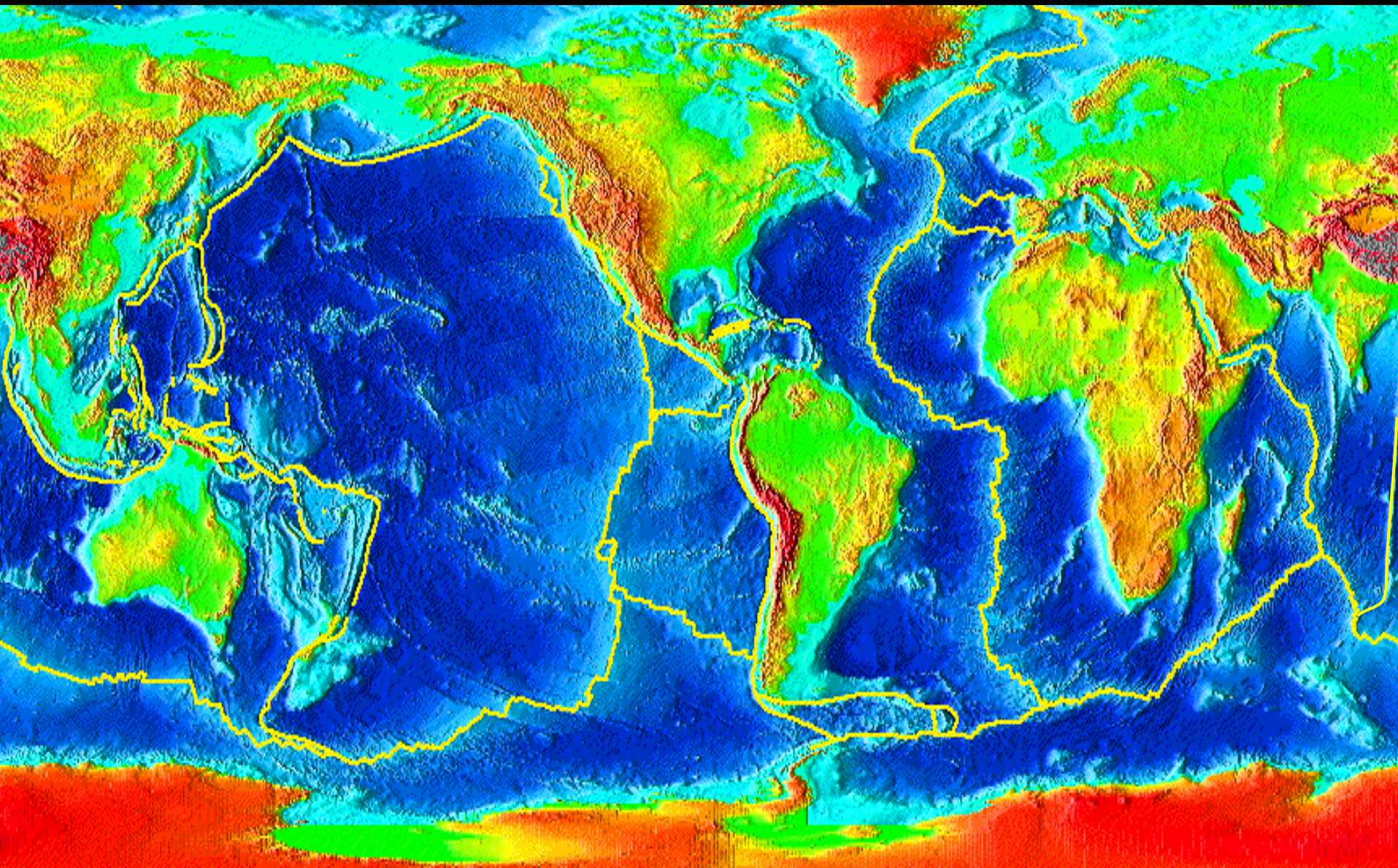
# The sea floor is not a flat surface



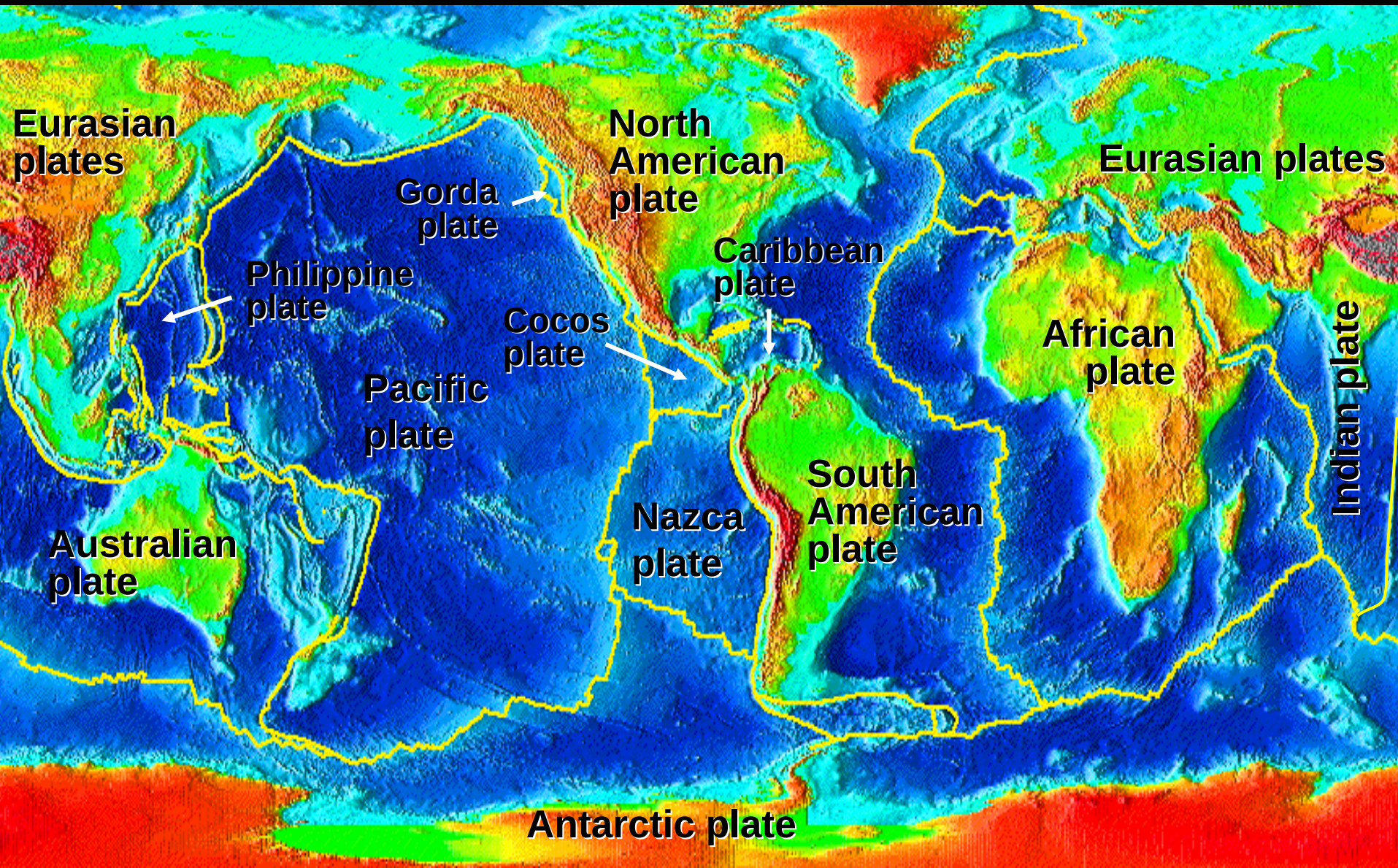
# Earthquake epicenters display a typically nonrandom distribution

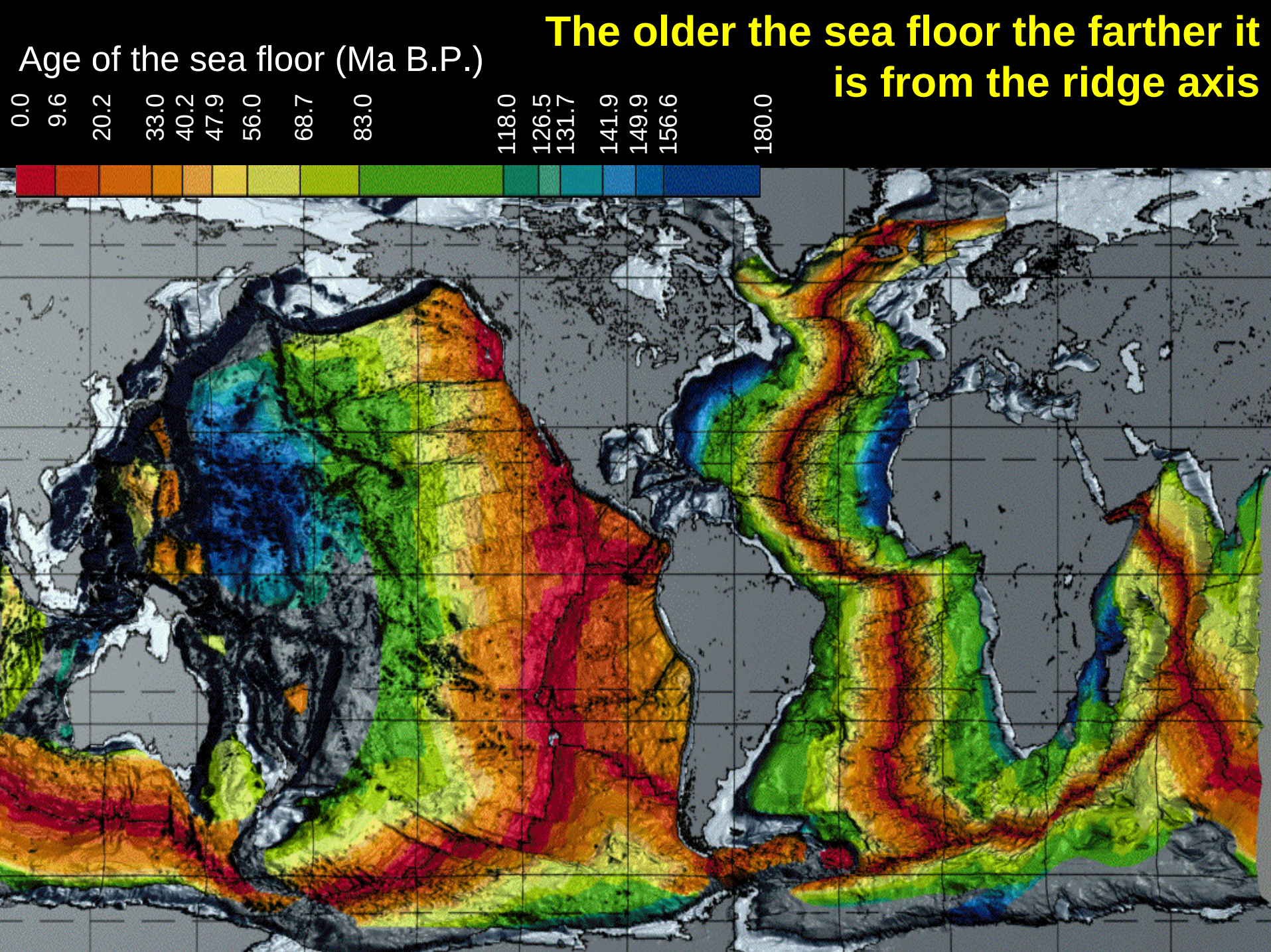


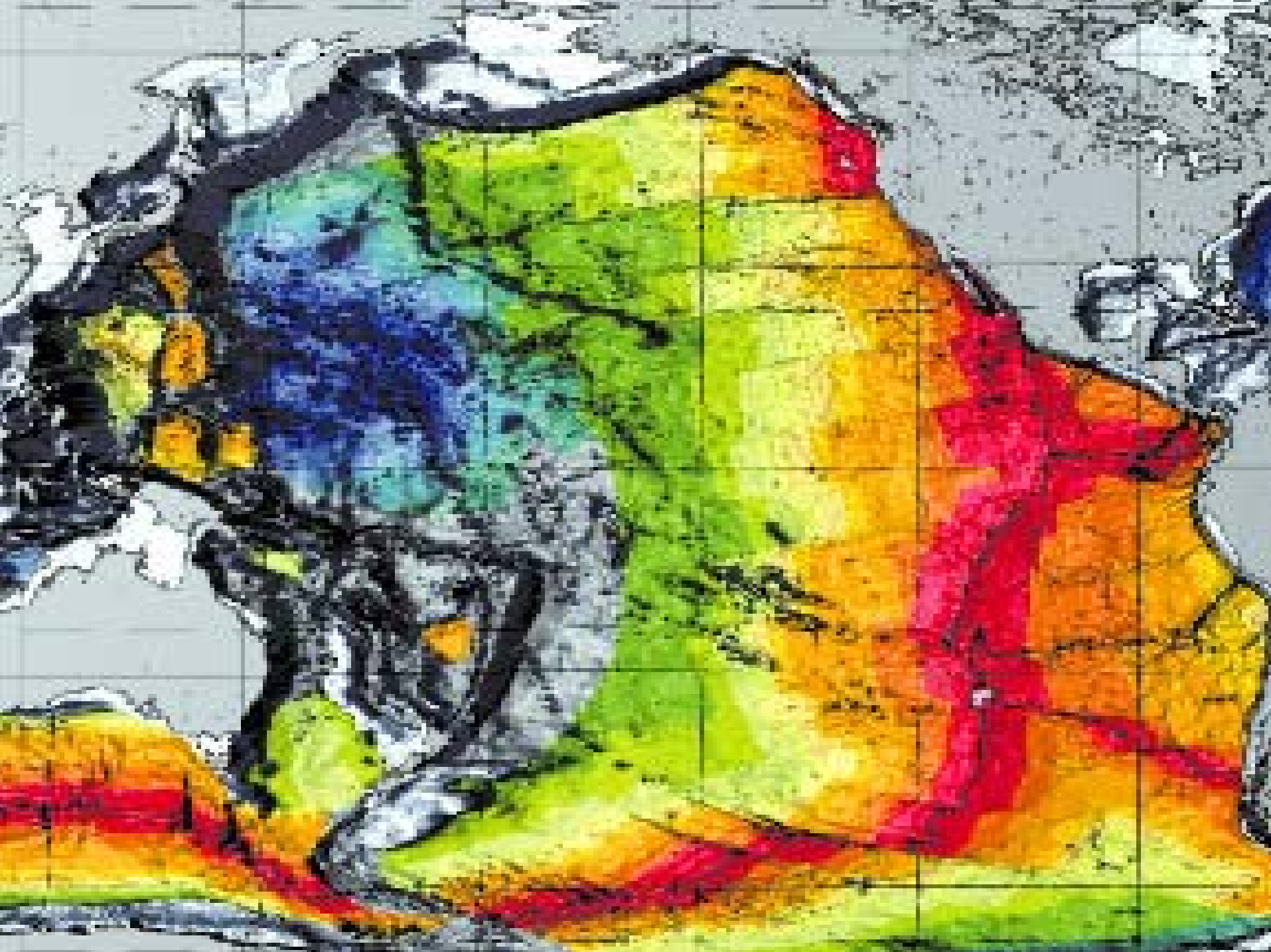
# Seismicity defines the plate boundaries

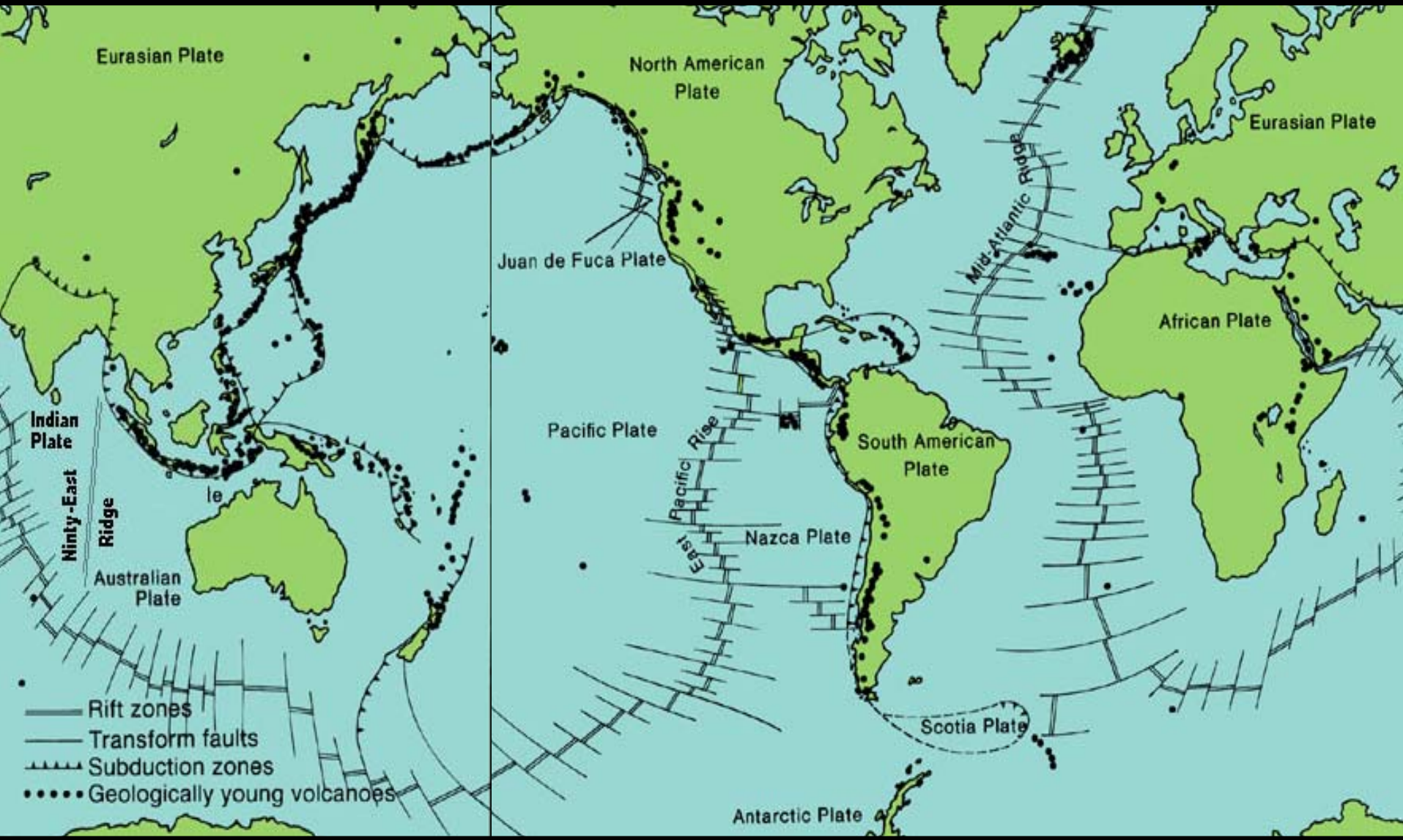


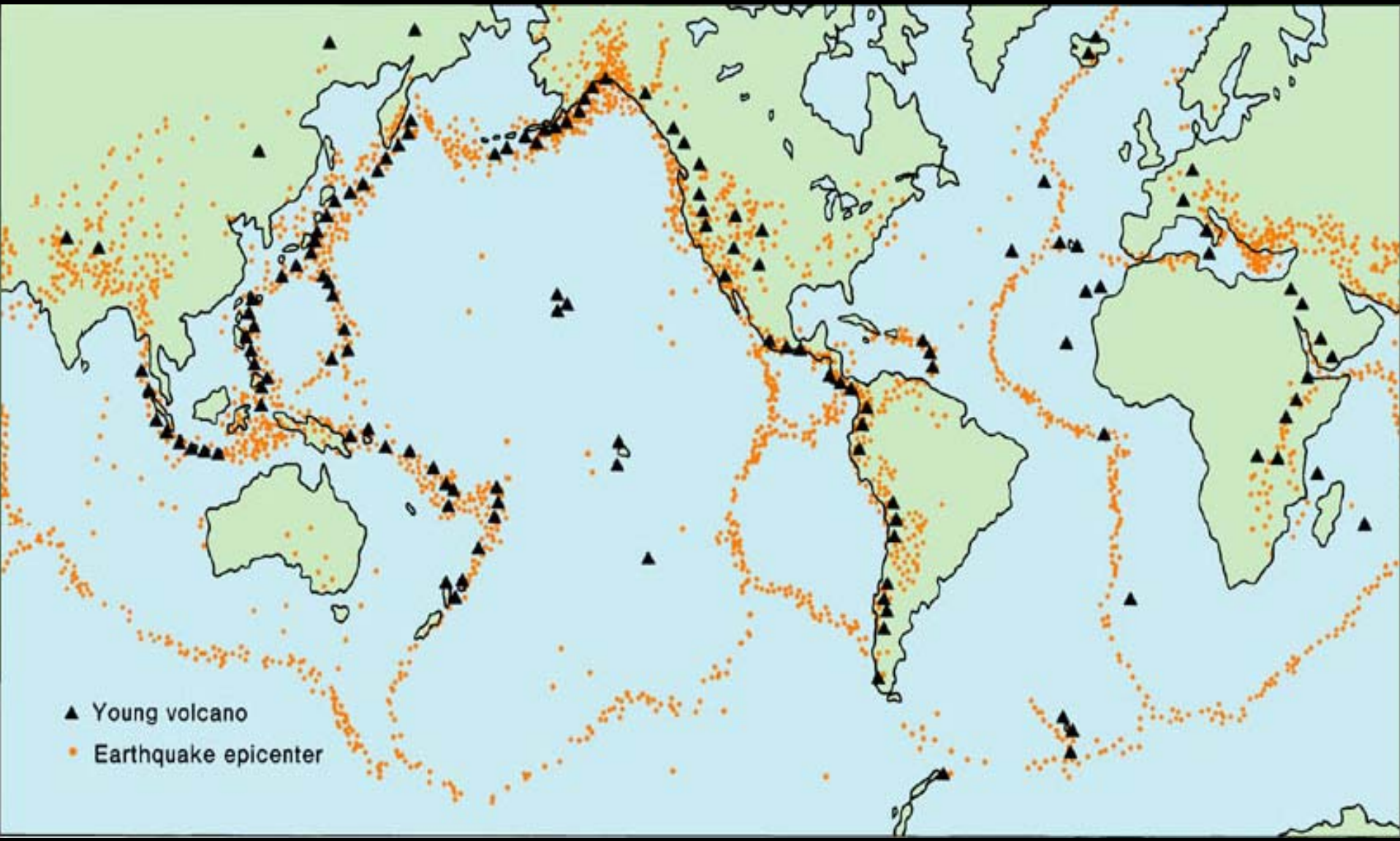
# Some major plates

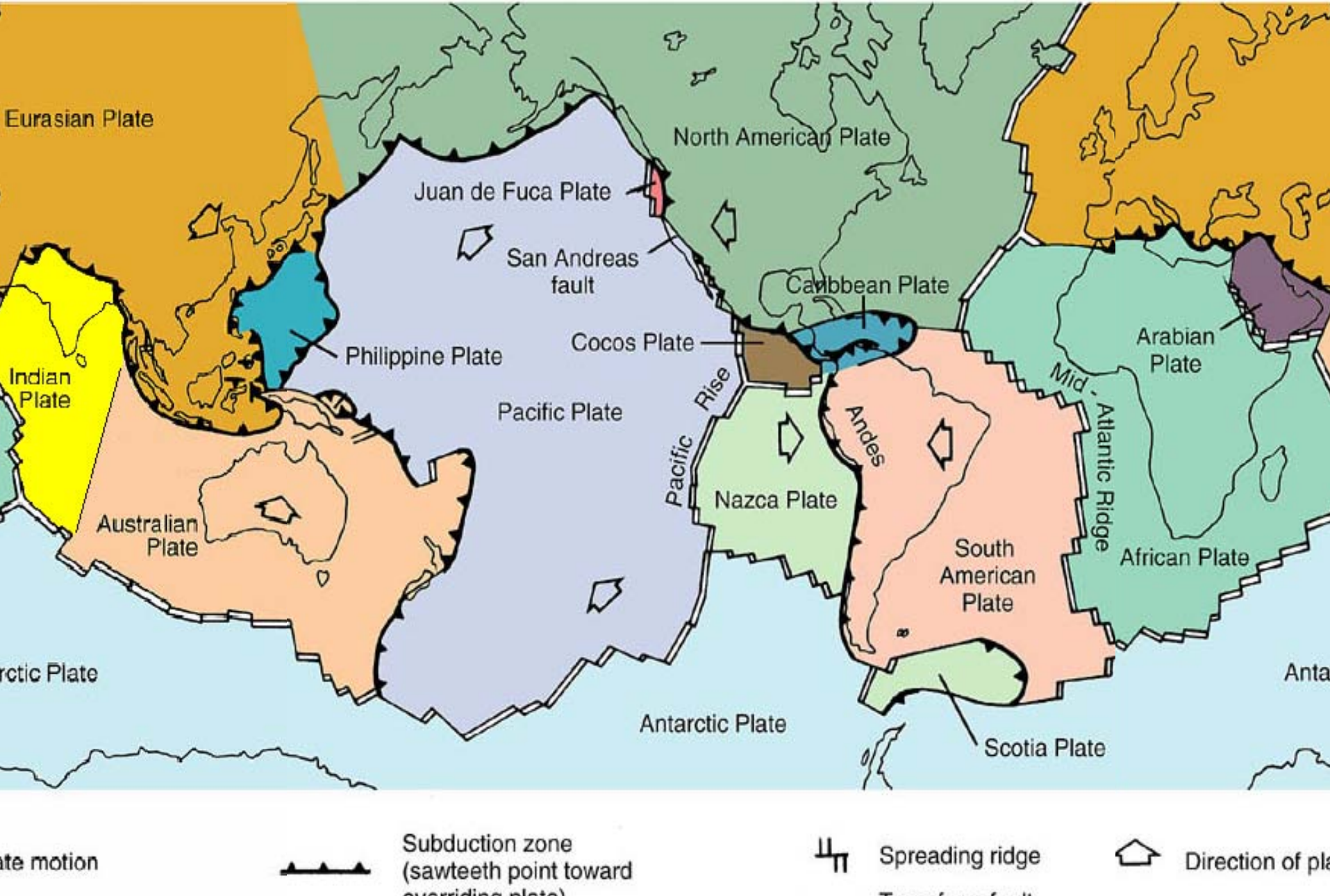


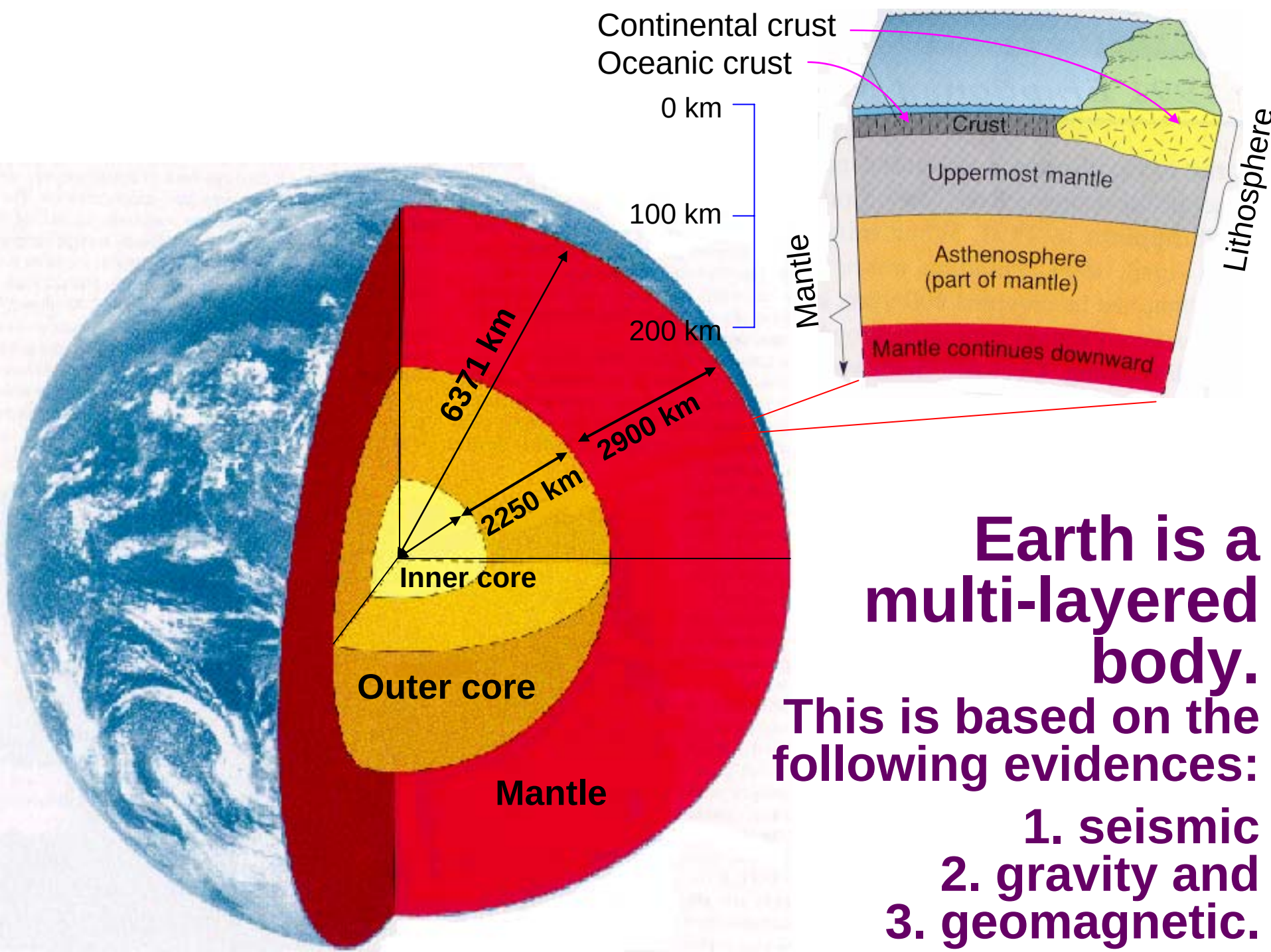

Age of the sea floor (Ma B.P.)
0.0
9.6
20.2
33.0
40.2
47.9
56.0
68.7
83.0
118.0
126.5
131.7
141.9
149.9
156.6
180.0
The older the sea floor the farther it is from the ridge axis




Eurasian Plate
North American Plate
Eurasian Plate
Juan de Fuca Plate
Mid-Atlantic Ridge
African Plate
Indian Plate
Pacific Plate
South American Plate
Pacific Rise
East
Nazca Plate
Ninty-East Ridge
Australian Plate
Scotia Plate
Antarctic Plate
Rift zones
Transform faults
Subduction zones
Geologically young volcanoes


Young volcano
Earthquake epicenter


Eurasian Plate
North American Plate
Juan de Fuca Plate
San Andreas fault
Caribbean Plate
Arabian Plate
Philippine Plate
Cocos Plate
Indian Plate
Pacific Plate
Pacific Rise
Mid-Atlantic Ridge
Andes
Nazca Plate
Australian Plate
South American Plate
African Plate
Antarctic Plate
Scotia Plate
Subduction zone (sawteeth point toward overriding plate)
Spreading ridge
Transform fault
Direction of pla

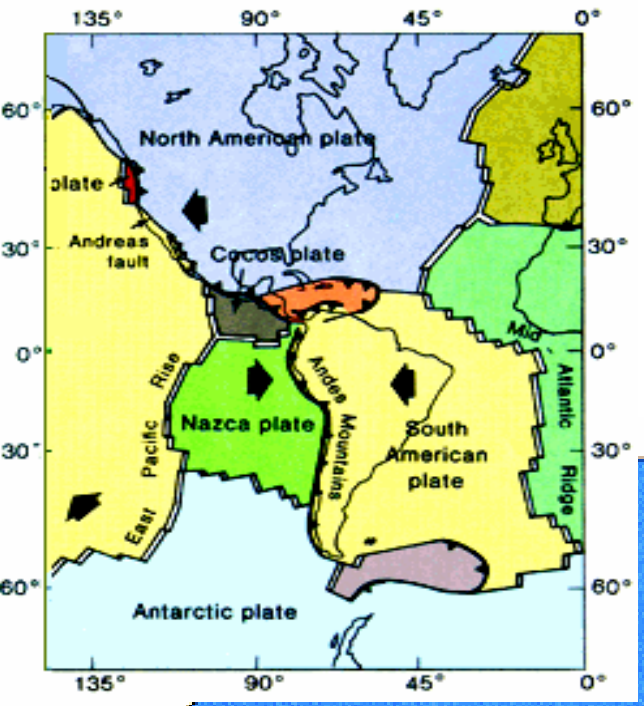


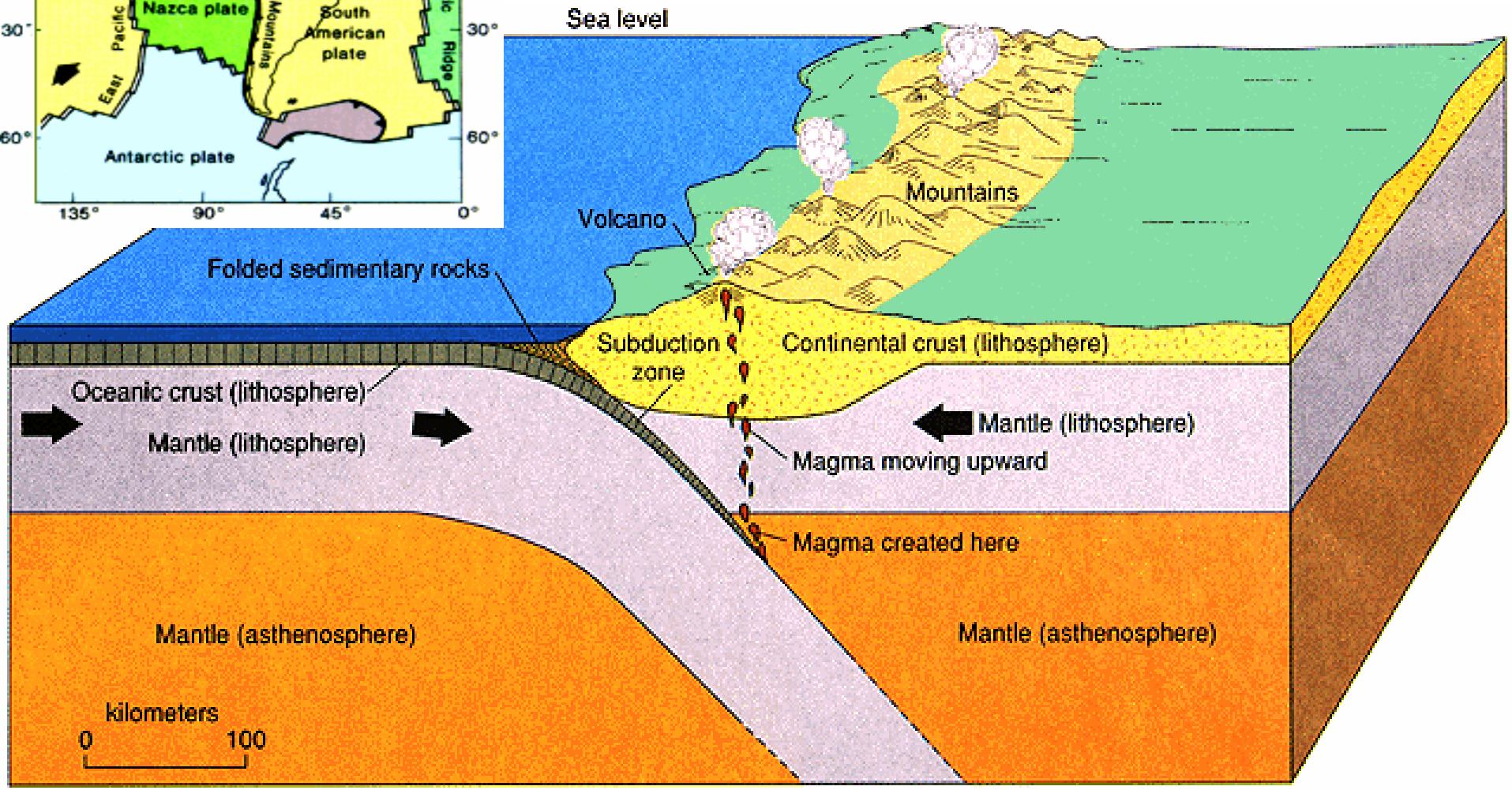

# Earth is a multi-layered body.

## This is based on the following evidences:

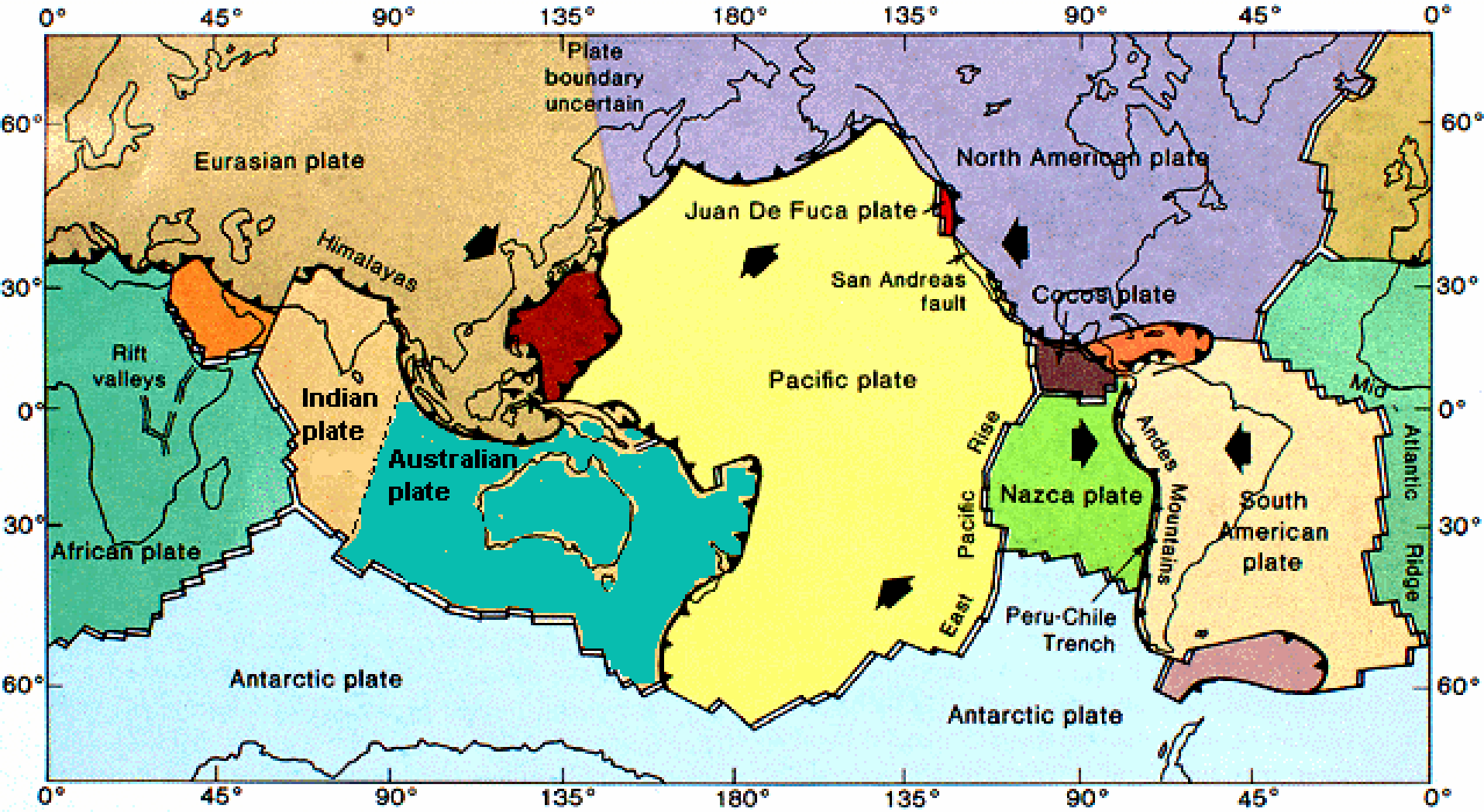
1. seismic
2. gravity and
3. geomagnetic.

# A convergent plate boundary, e.g., the convergence of Nazca and South American plates

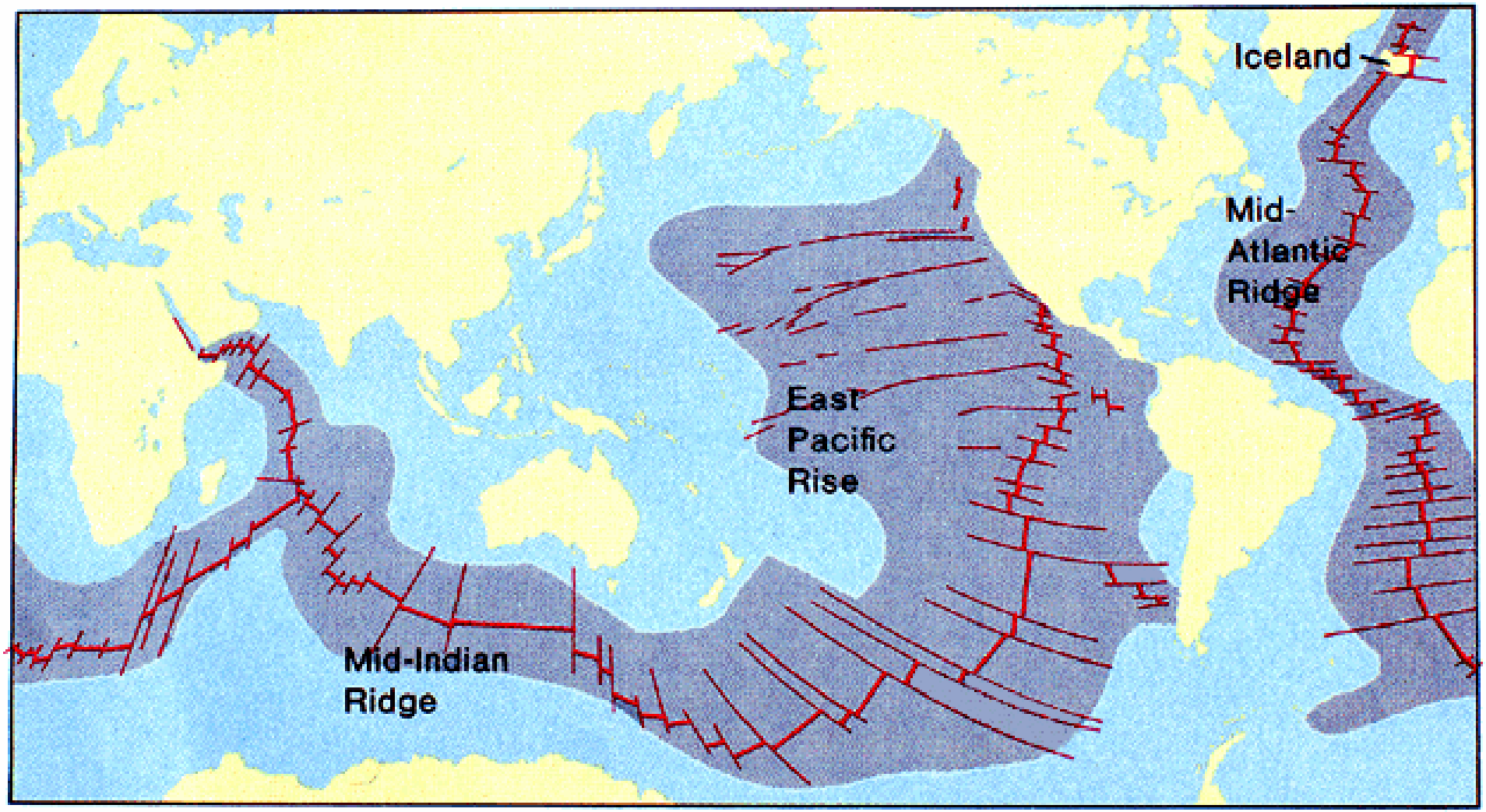


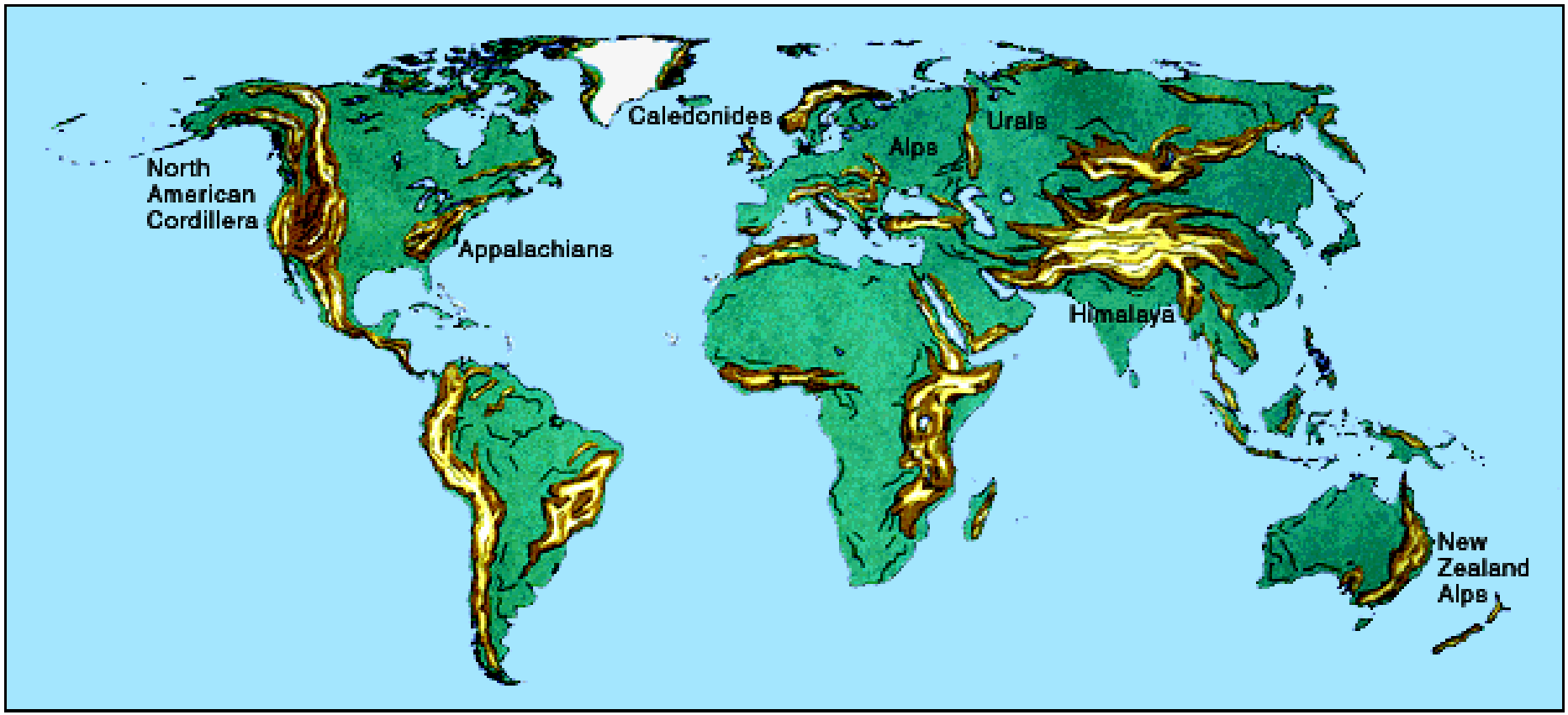
# Major plates of the world



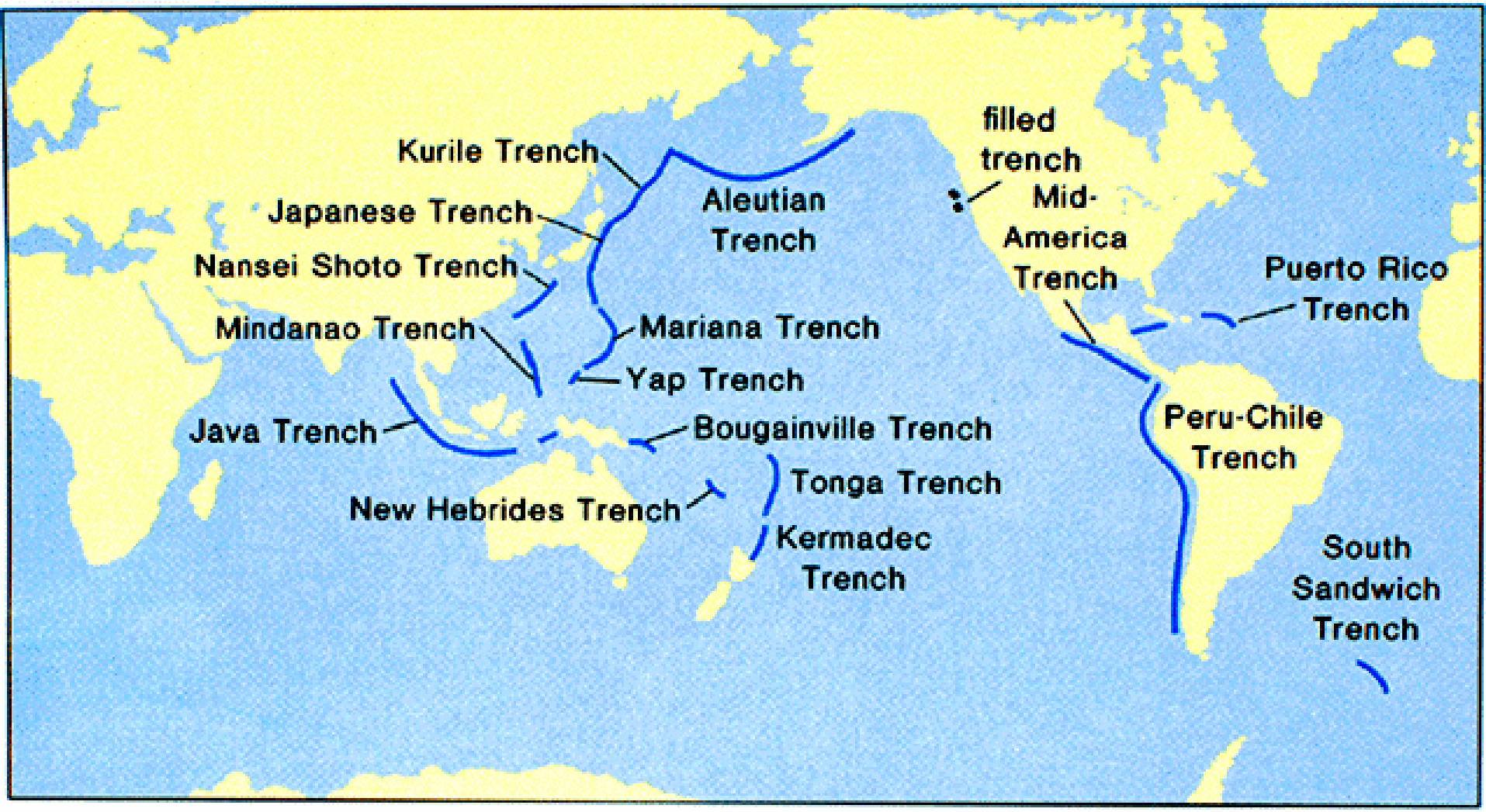
# Mid-oceanic ridges & fracture zones



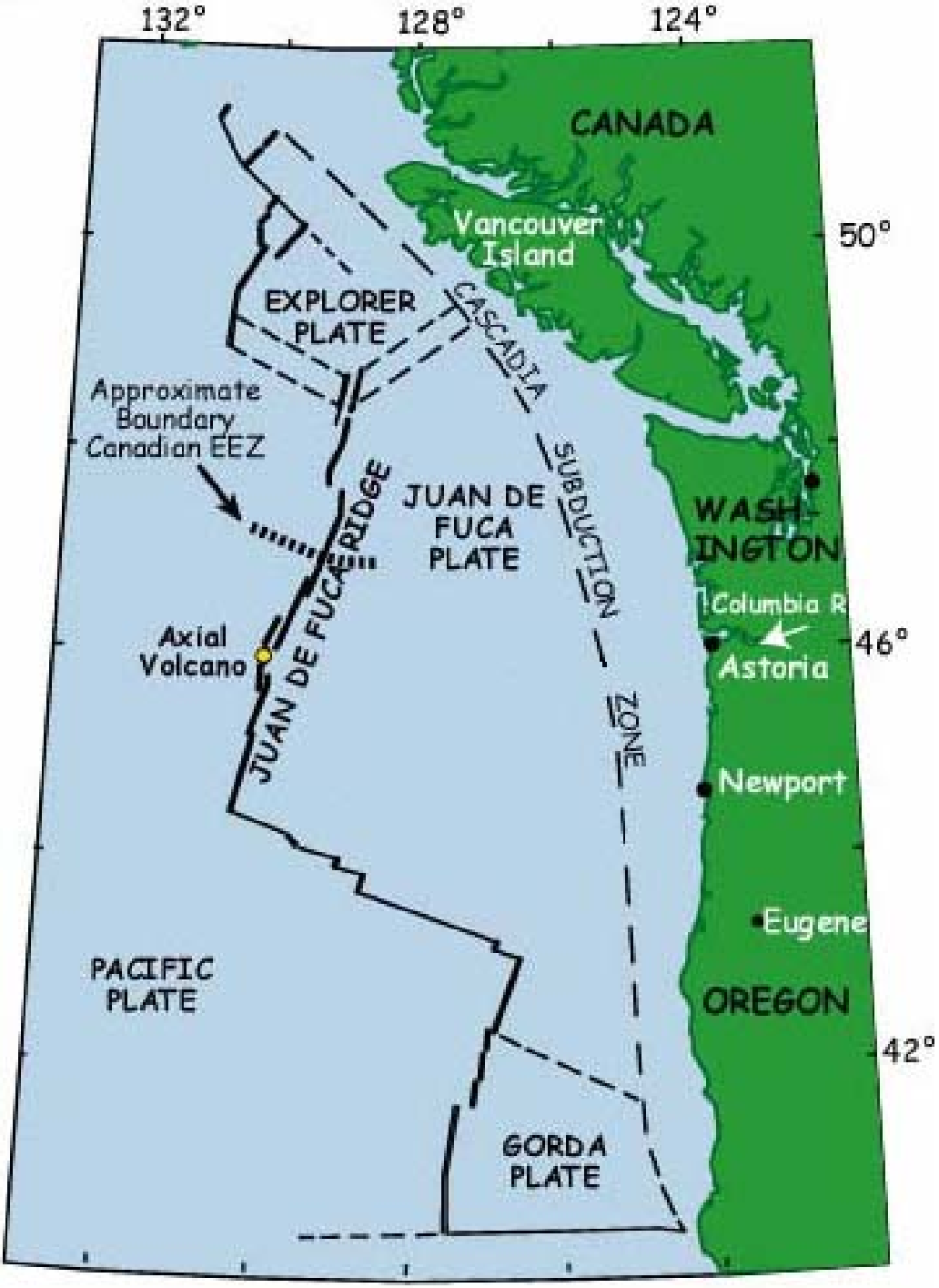
# Major mountain belts of the world



# Distribution of oceanic trenches

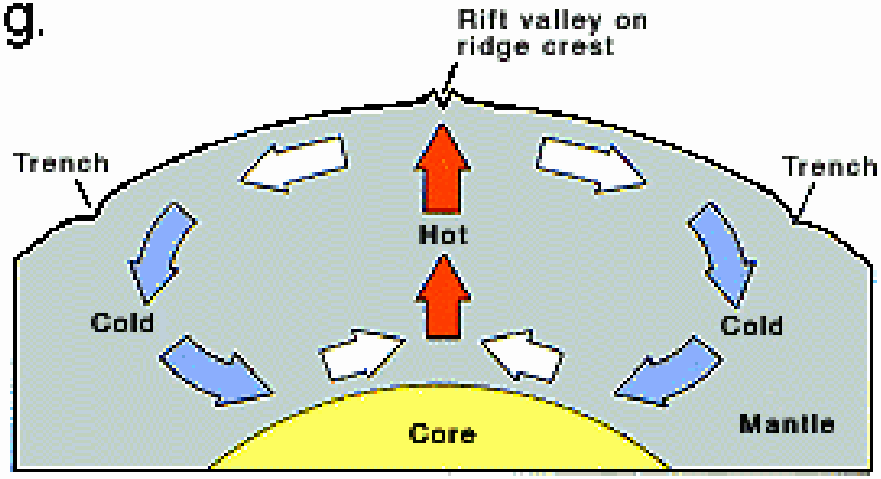


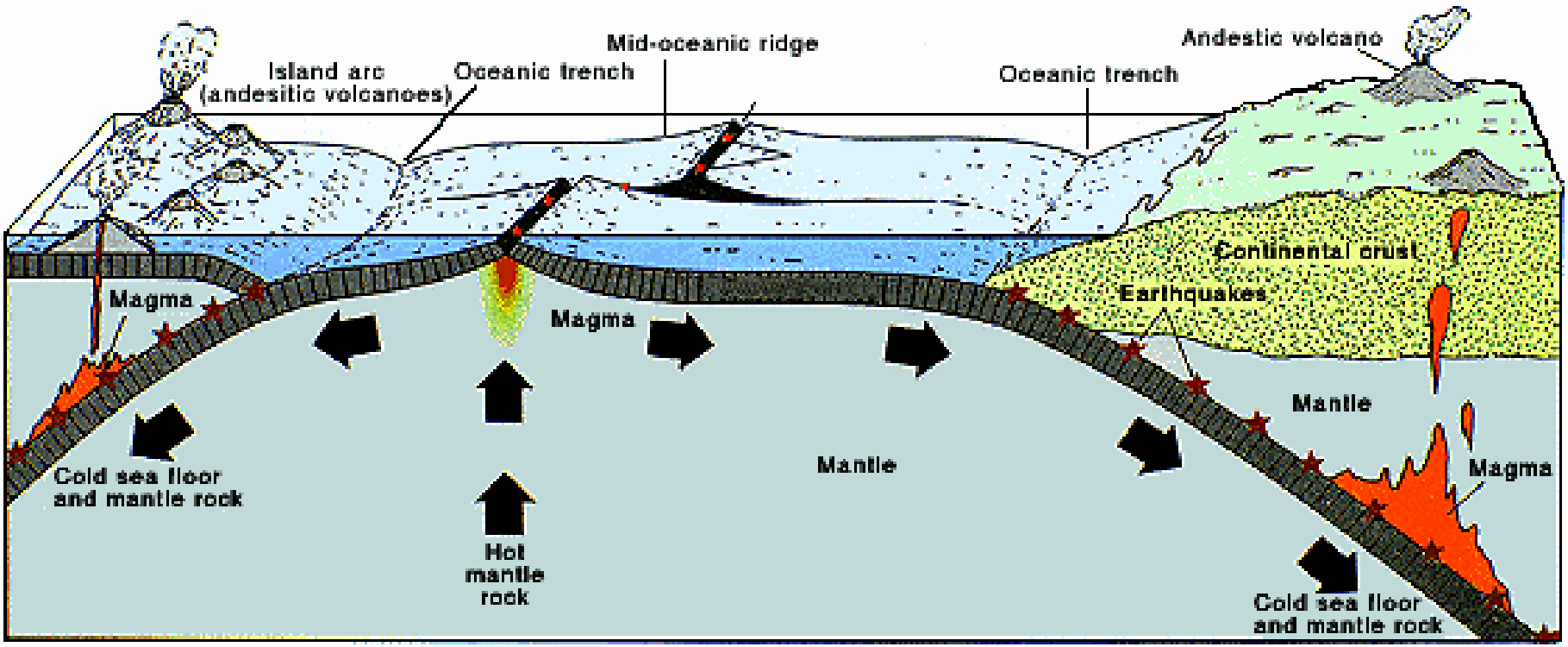
# Seismic gaps along San Andreas fault



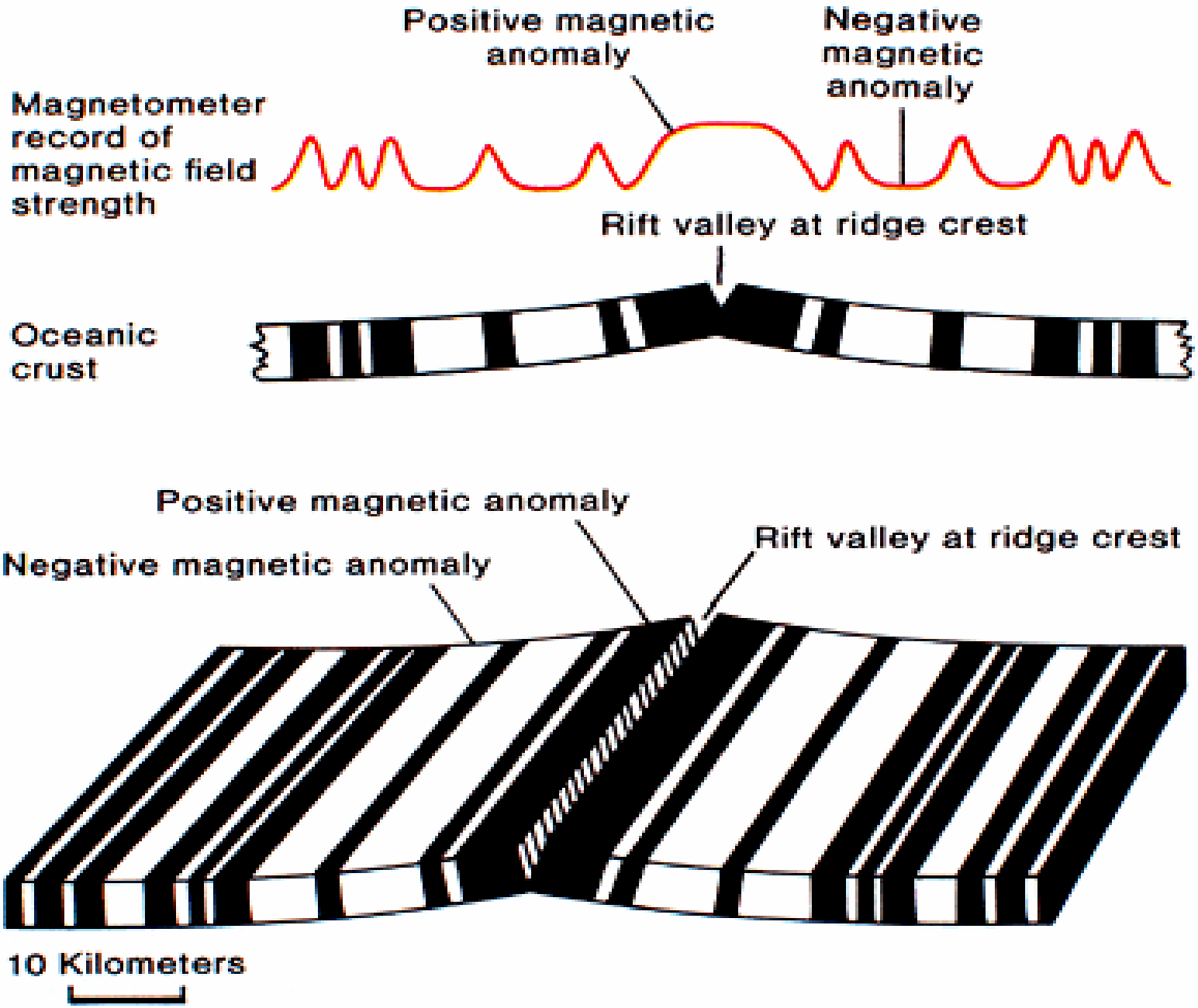

**Juan de Fuca ridge and the associated plates and plate boundaries off the Pacific North-east and Canada. Note that the Cascadia subduction zone is also called the "Filled Trench", as this trench got filled by sediments carried by the huge runoff from land that has characterized this region particularly since the Last Ice Age.**

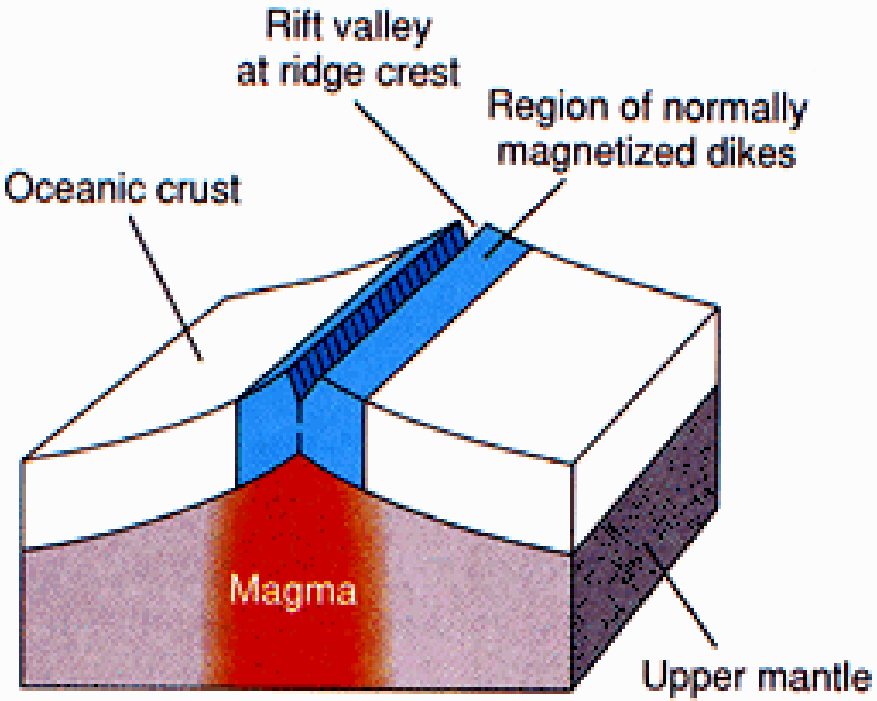
# Sea-floor spreading.



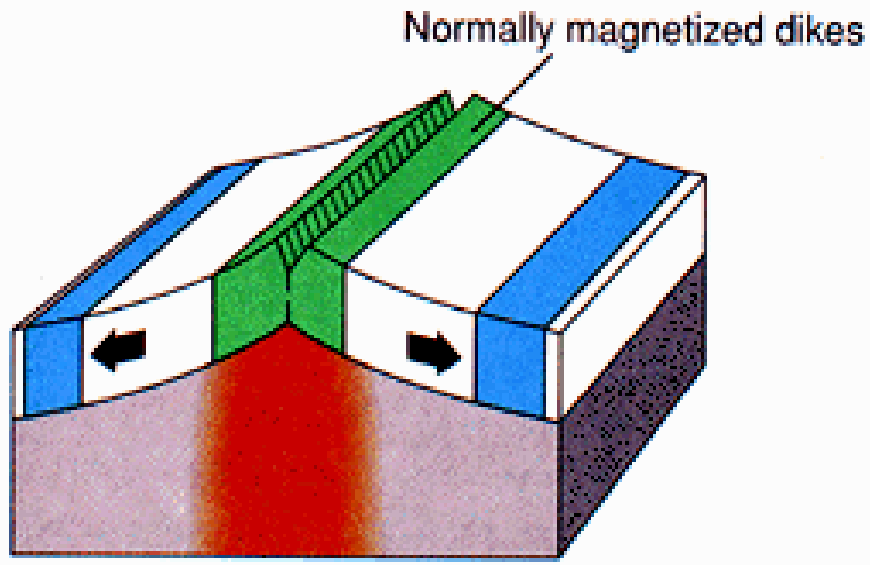



# Marine magnetic anomalies

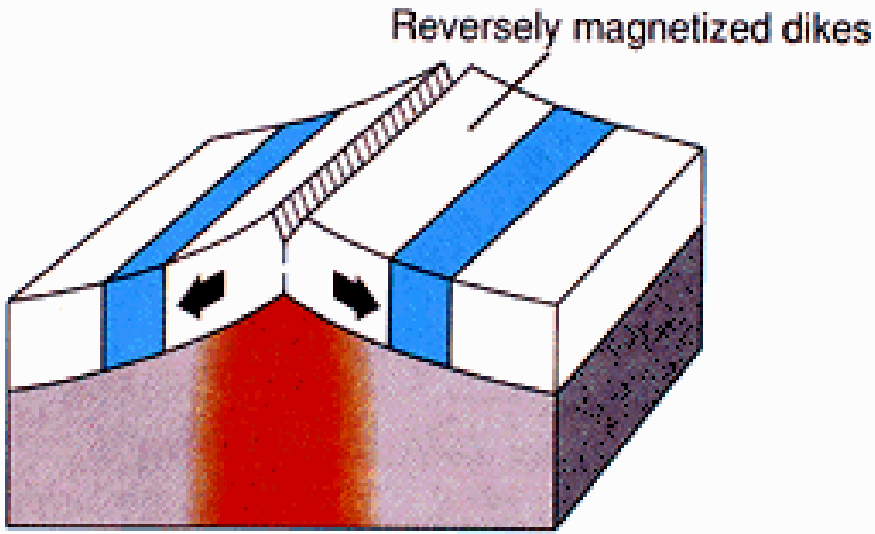





Time of normal magnetism

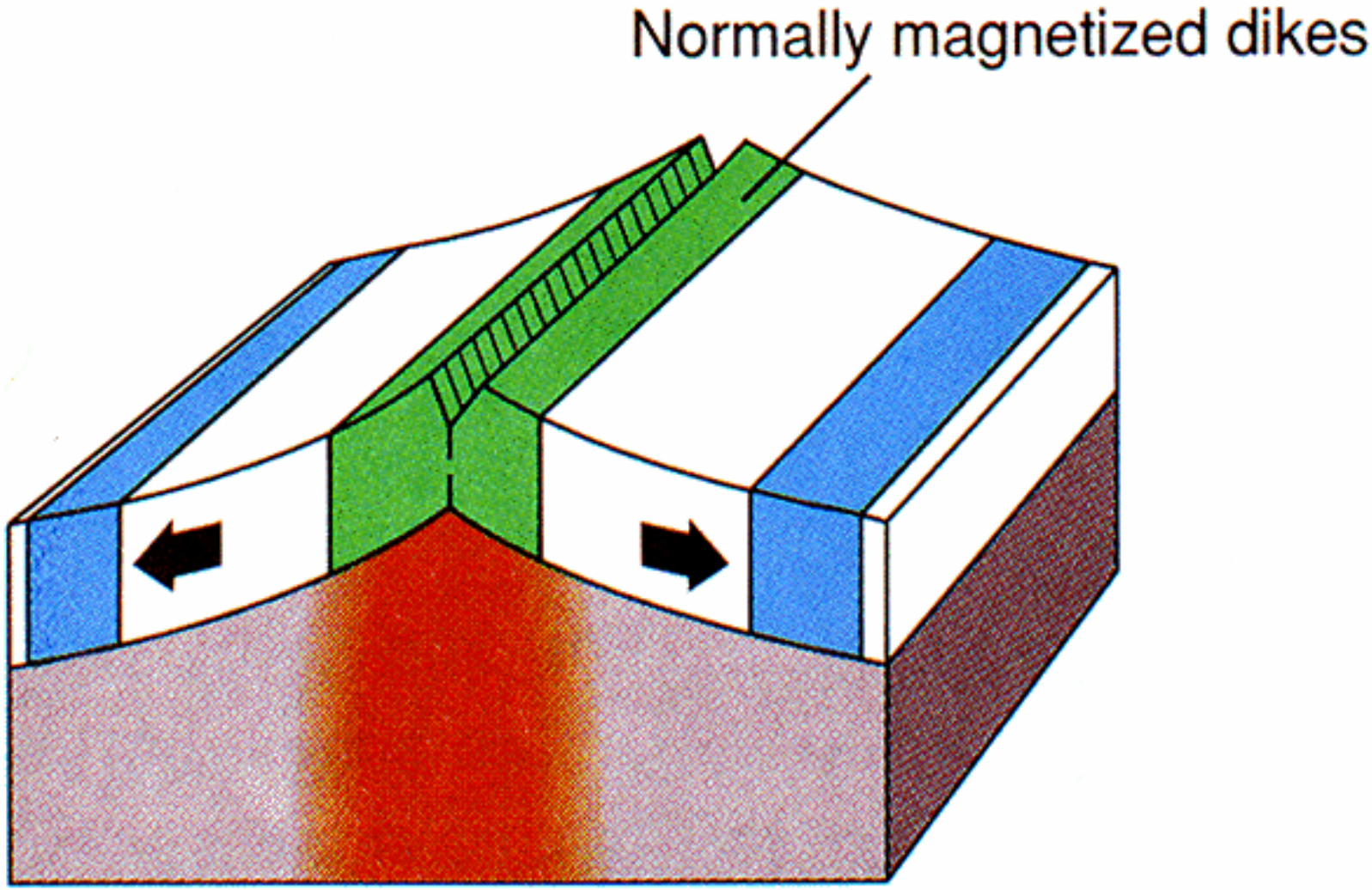


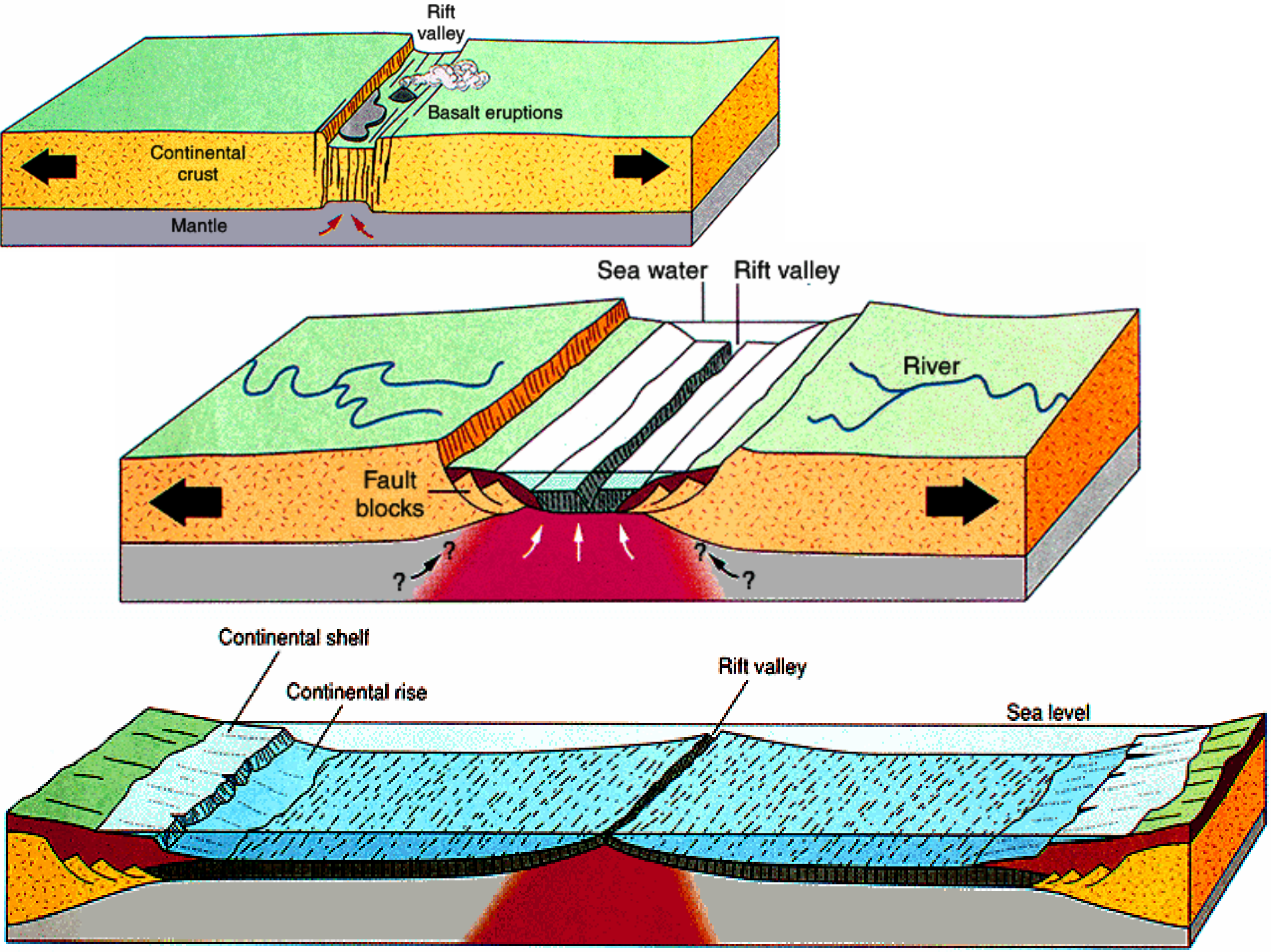

Time of normal magnetism

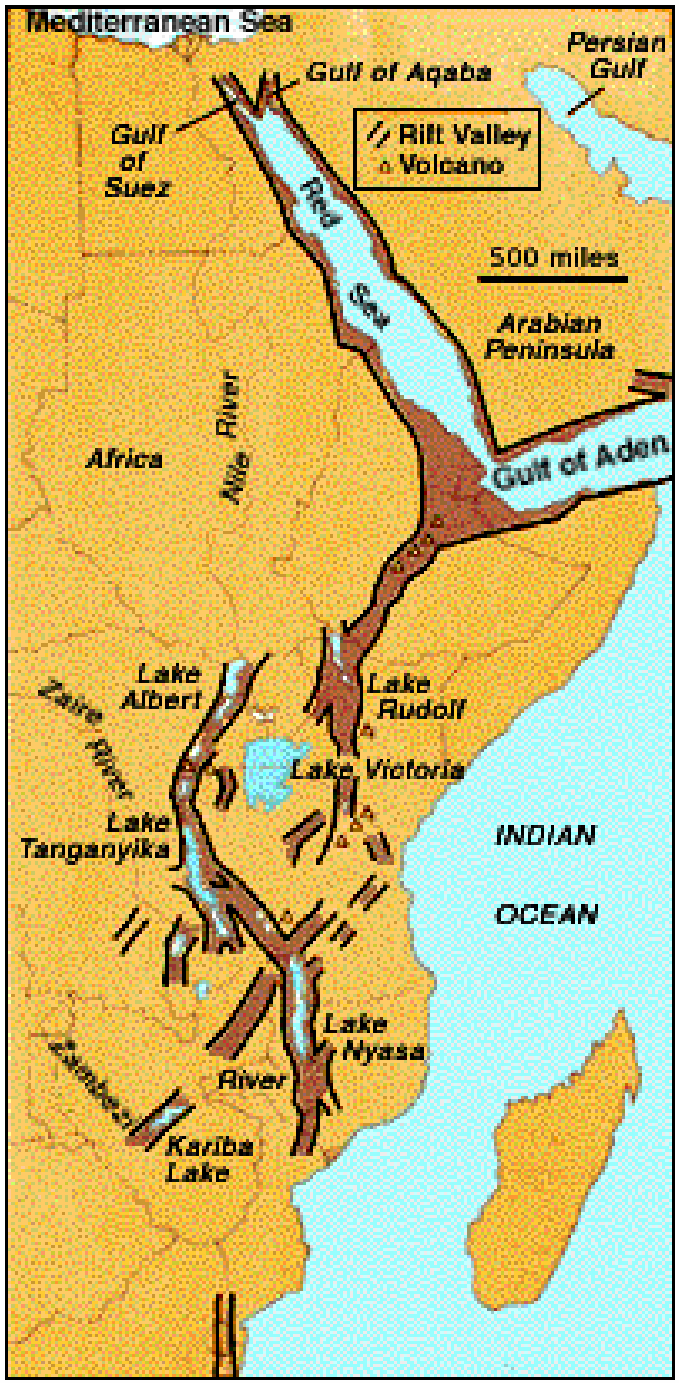



Time of reverse magnetism

# The origin of magnetic anomalies

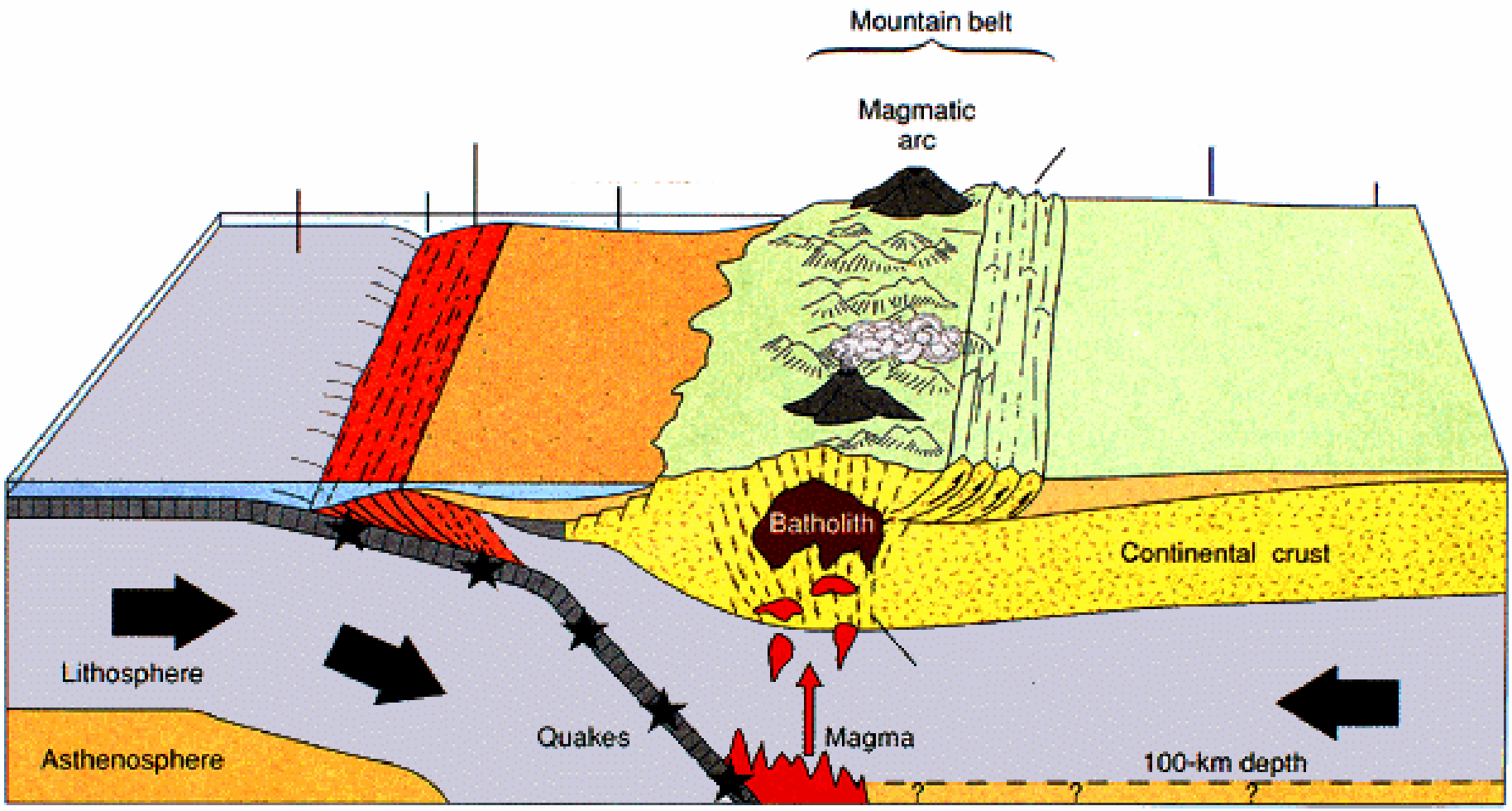

Normally magnetized dikes
Time of normal magnetism


Rift valley
Basalt eruptions
Continental crust
Mantle
Sea water
Rift valley
River
Fault blocks
? ? ? ?
Continental shelf
Continental rise
Rift valley
Sea level



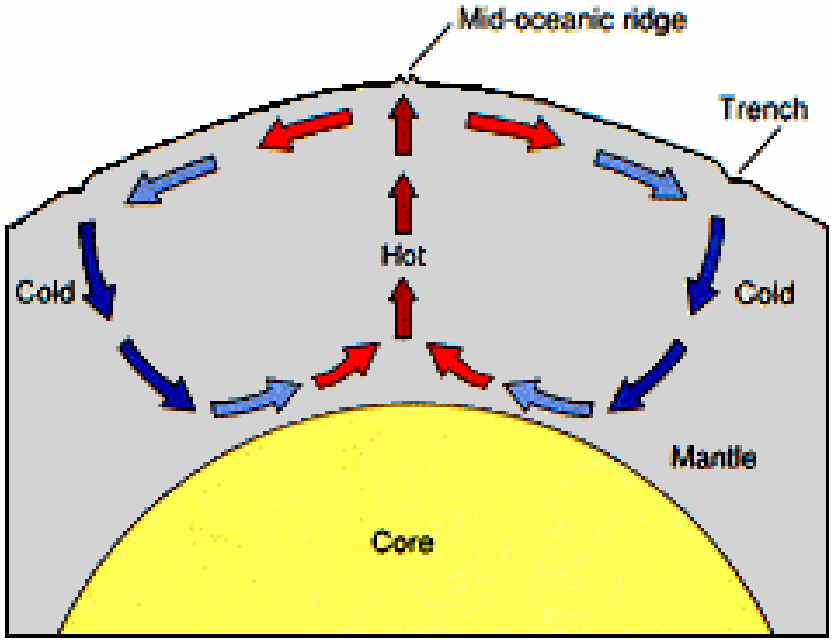

# *East African Rift valleys and the Red Sea Rift*

# Ocean-continent convergence

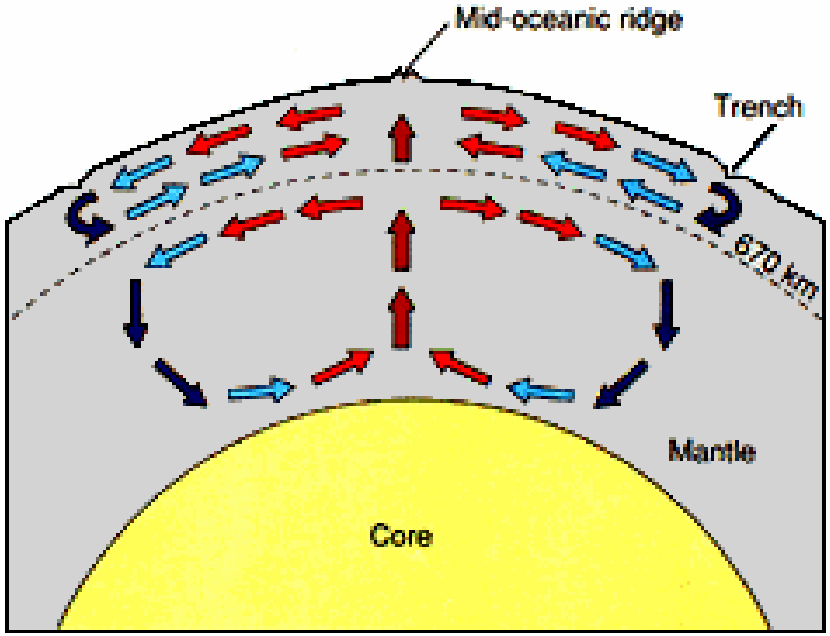


# *Models of mantle convection*

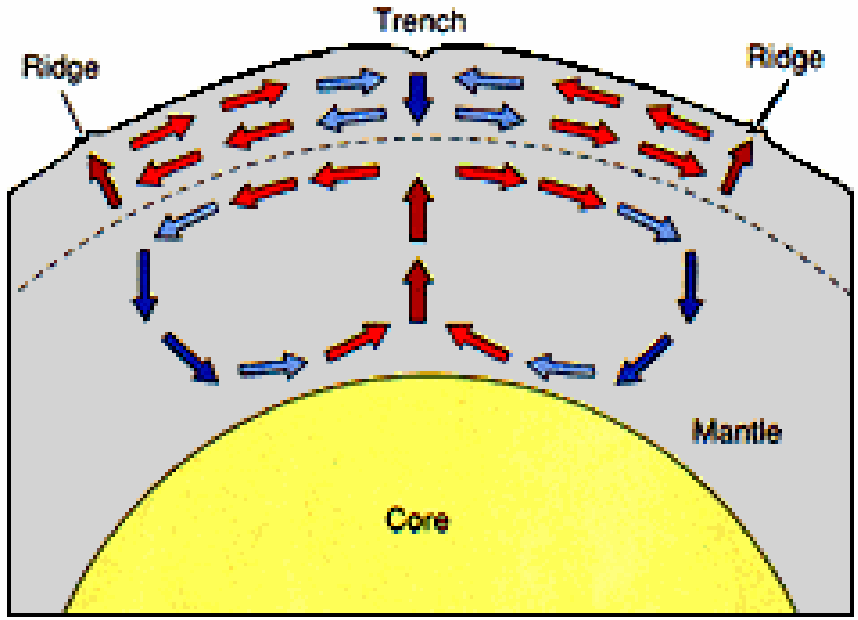
**A. Whole-Mantle**
**B. Two-Layer (Ridge)**
**C. Two-Layer (Trench)**




A

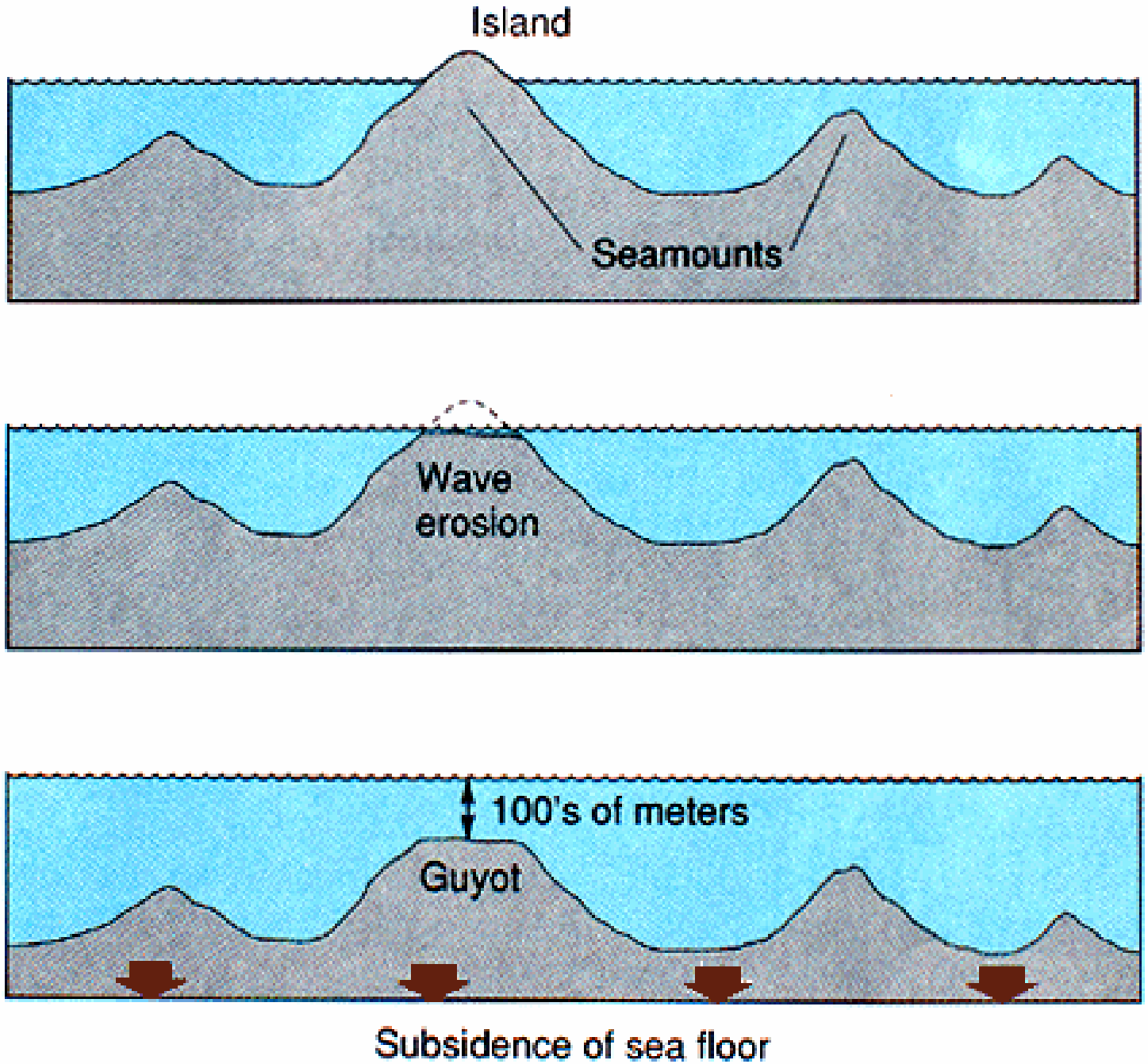



B

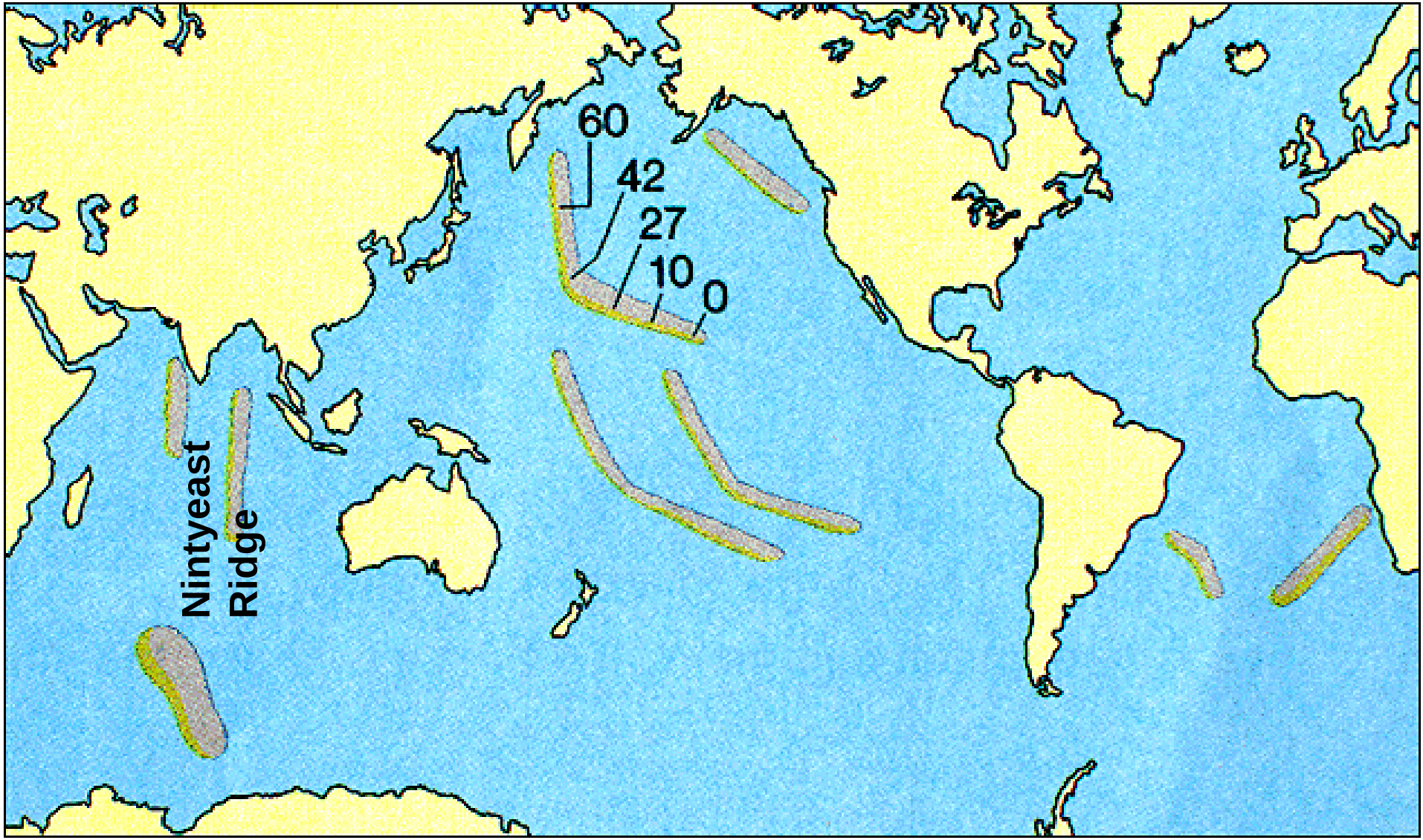



C

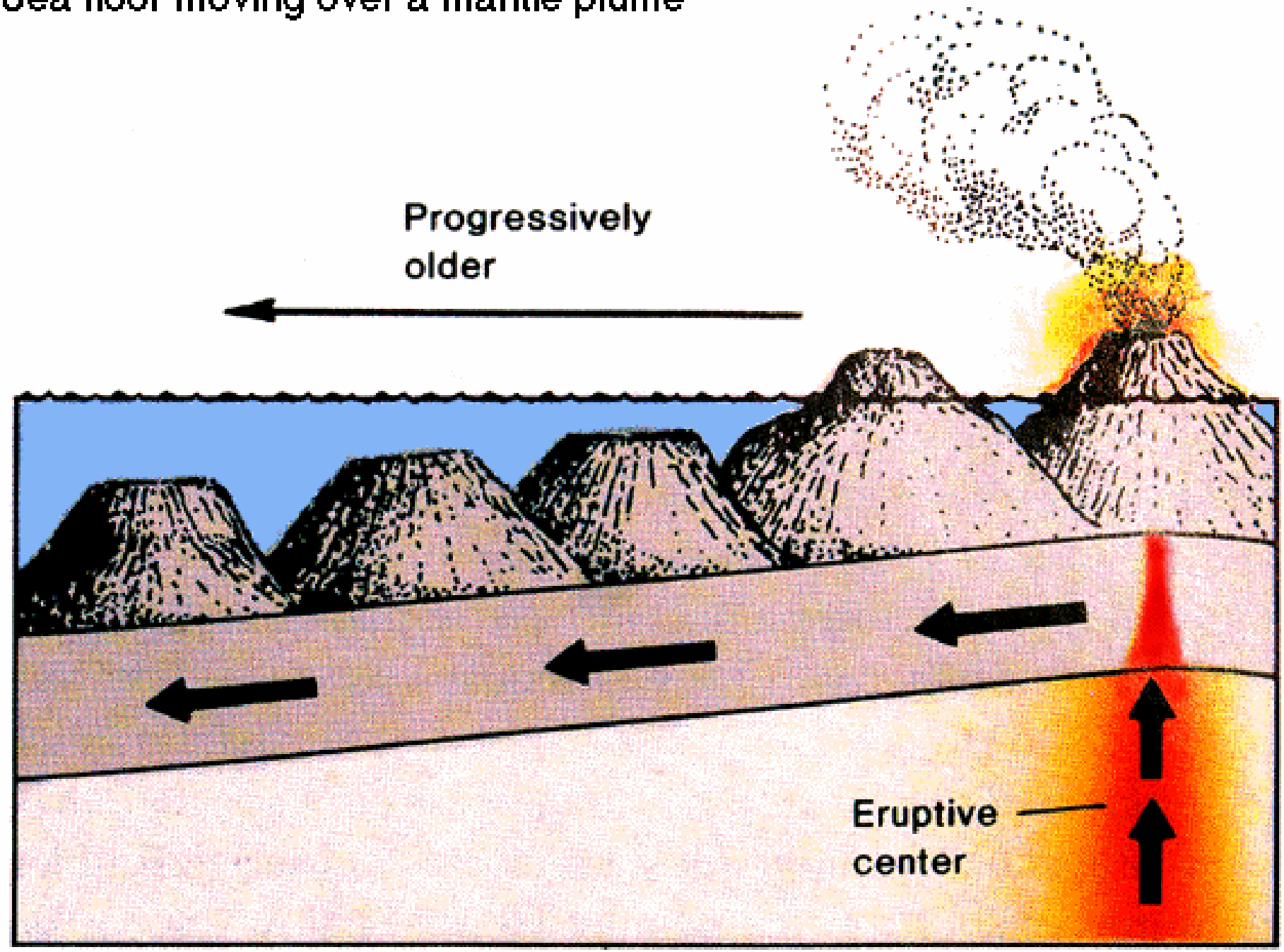
# Seamounts & guyots.



# Distribution of aseismic ridges



Sea floor moving over a mantle plume



# Global distribution of mantle plumes