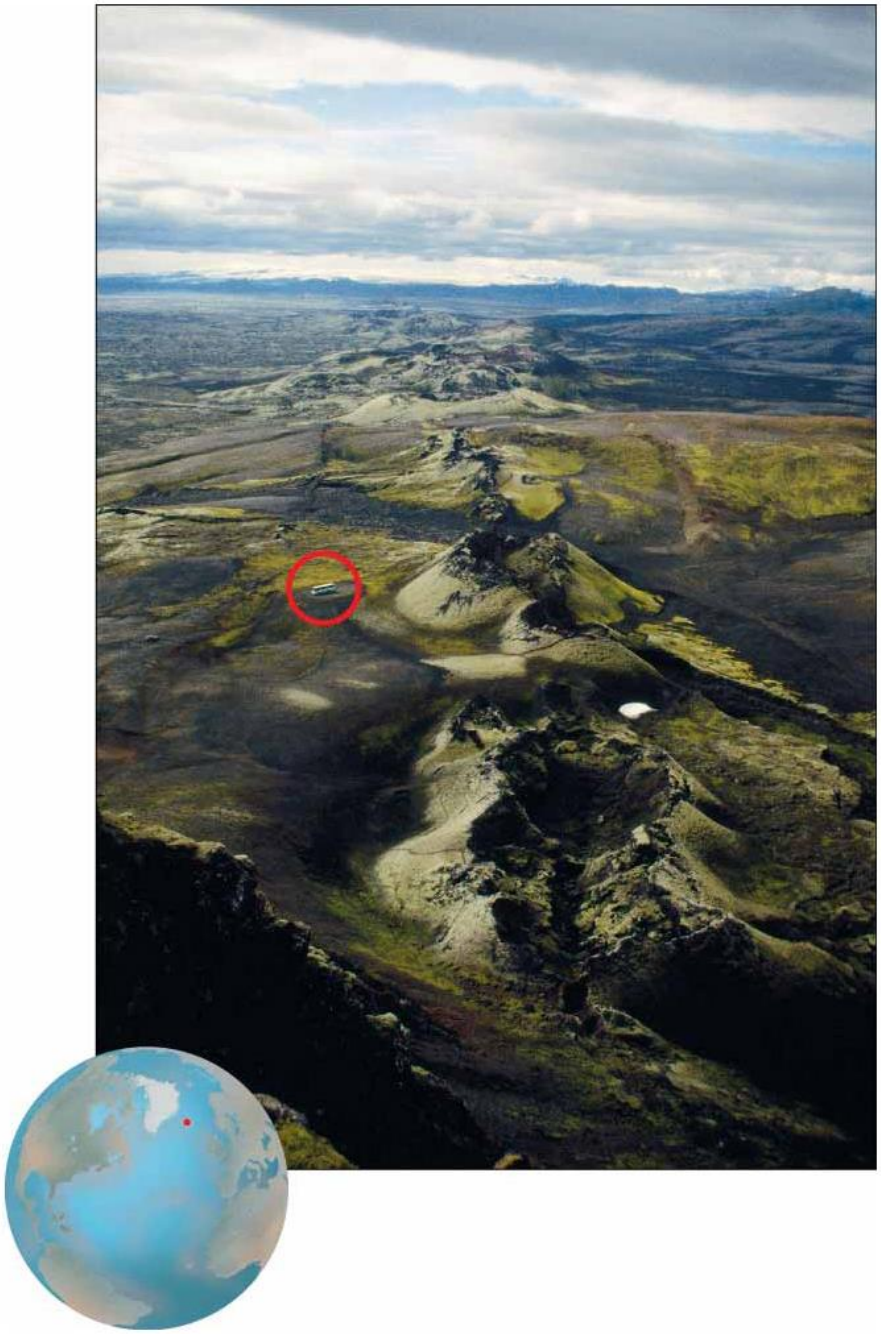

Plate Tectonics and Ocean Basins

Pictured: a rift valley in Iceland (that's a bus in the red circle).

Iceland is where the Mid-Atlantic Ridge can be found on land.

Outline for Today

- Activity #2:

  On the sign-in sheet, please write:

  1) Your full name
  2) Your example of a plate boundary (location & type)

- How (and where) plate boundaries create continents & oceans (Chapter 3)

- Continental margins, basins, ridges (Chapter 4)

Learning Goals: Earth Structure & Plate Tectonics

- Earth's layers are arranged by density.
- Land exists because continents float (why?).
- The Earth's surface is fragile and is broken into "plates" that are like tiles on a floor. Plates move as the layer below them moves.
- The collision of plates causes formation of continents and oceans.

  (We'll talk about this on 1/25)
- Several lines of evidence support the theory of plate tectonics.

Learning Goals: Ocean Basins

- Tectonic forces shape the seabed.
- The ocean floor is divided into
  - continental margins (usually granite) and
  - deep-ocean basins (usually basalt)
- The mid-ocean ridge is perhaps Earth's most prominent feature, but basin floor is the most common.
- Most of the ocean's water circulates through the hot oceanic crust of the ridges, every 10 million years.

Learning Goals: Ocean Basins

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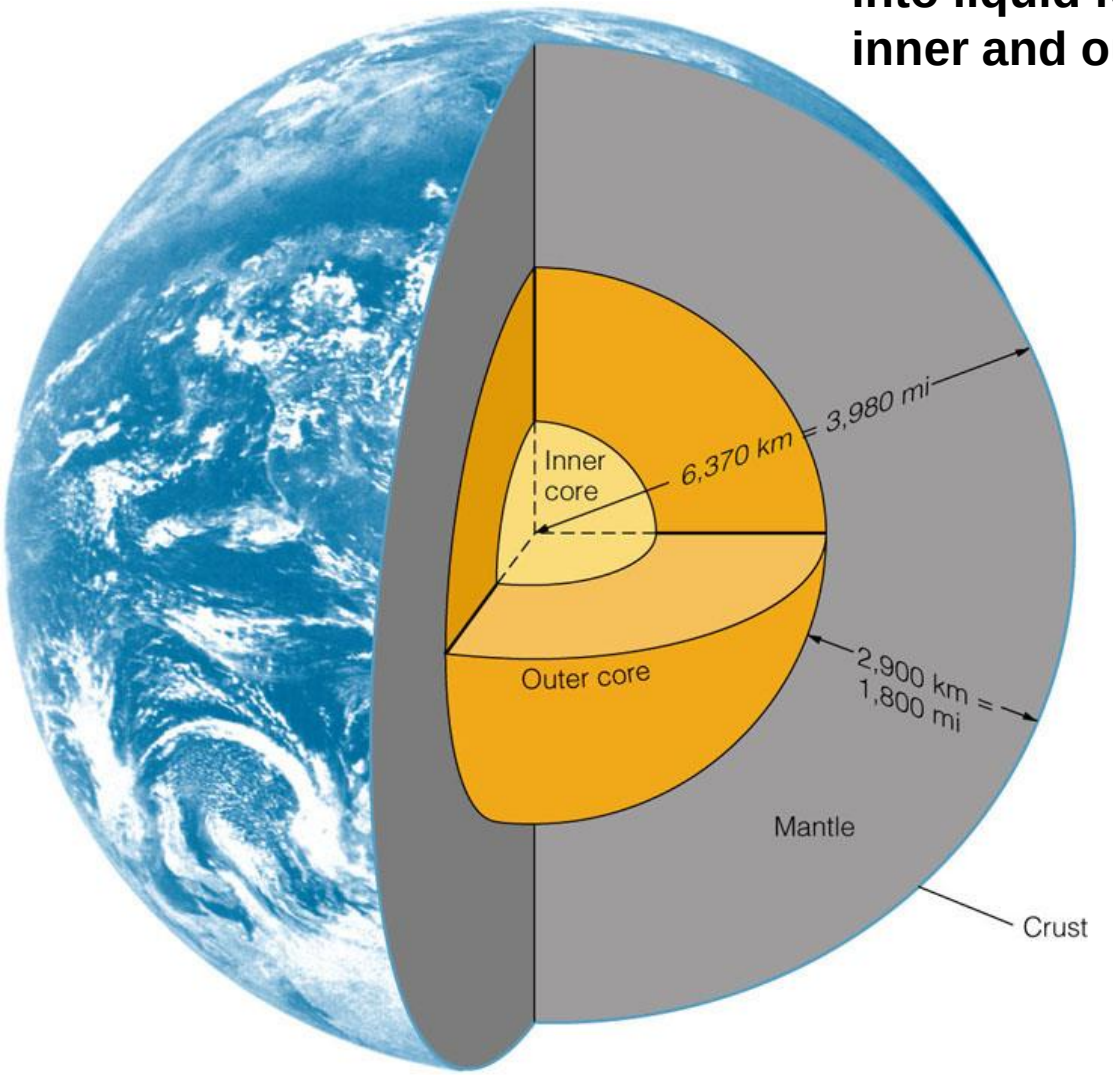
Brief recap of Earth's structure:

Temperature increases as you go deeper, but PRESSURE increases more. There is so much pressure in the inner core that the iron and nickel cannot go into liquid form. The composition of the inner and outer cores is similar.



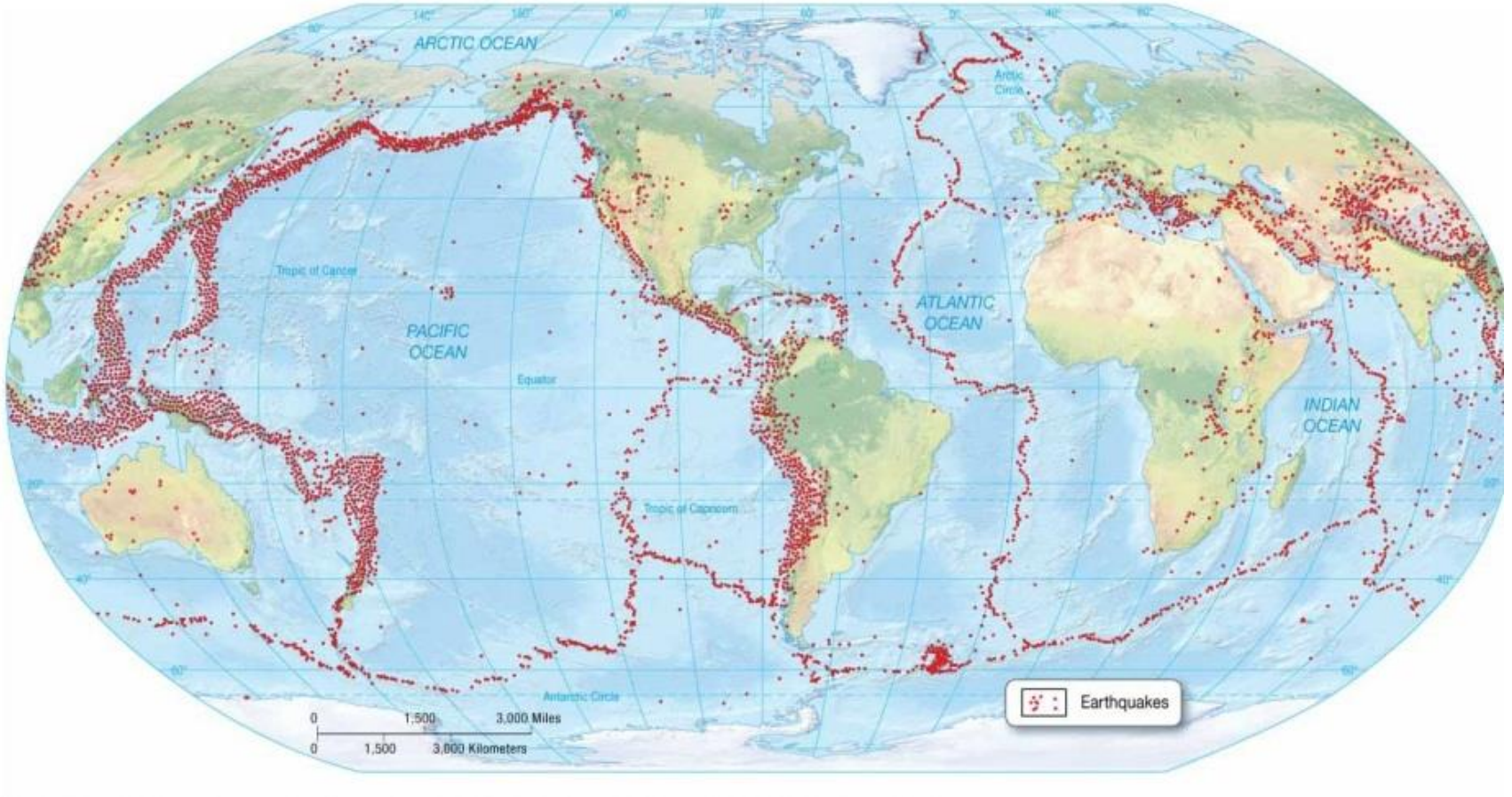
Inner Core –
Solid Iron & Nickel
Why is it solid??
PRESSURE

Outer Core –
Liquid Iron & Nickel

Mantle –
Silicon & Oxygen

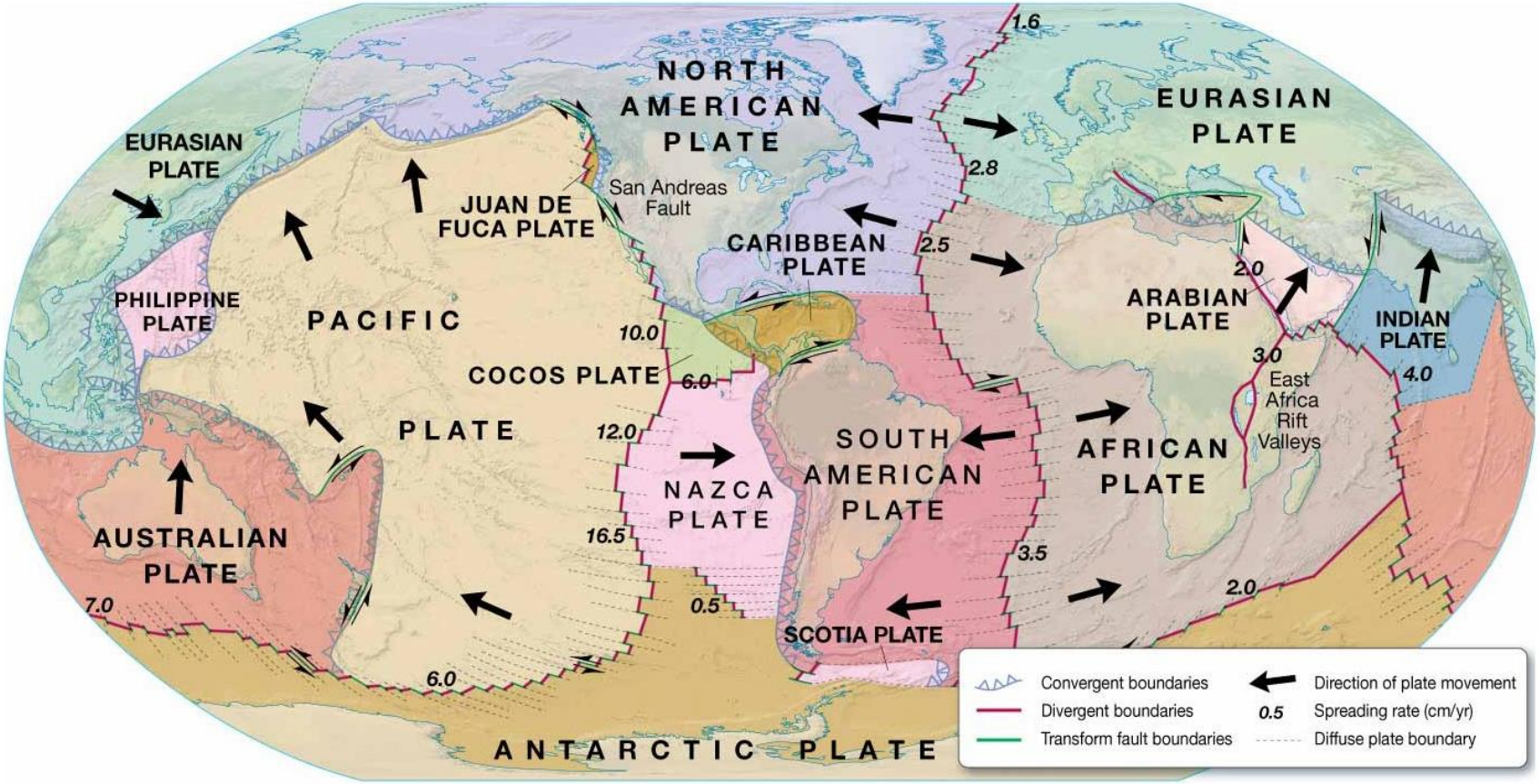
Crust -
Solid basalt or granite.
Oxygen, Silicon, Aluminum

Earthquakes as Evidence

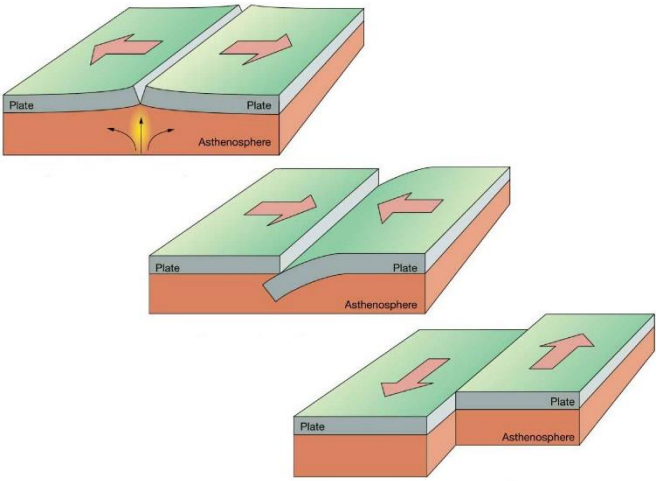


- Most large earthquakes occur at subduction zones.
- Earthquake activity mirrors tectonic plate boundaries.

Global Plate Boundaries



For today, 1/25:



1) Choose one type of plate boundary that you find most interesting (or confusing):
    a) Divergent
    b) Convergent
    c) Transform

2) Write down the name of one example of the plate boundary you have chosen.

3) (Optional) Bring an image (printed or electronic) of your example.

Recommended source:
http://mapmaker.education.nationalgeographic.com/

Your examples of plate boundaries:

Divergent

Red Sea

Mid-Atlantic Ridge

East Africa Rift Valley-II

East Pacific Rise

Galapagos Rise

Convergent

Pacific Ring of Fire

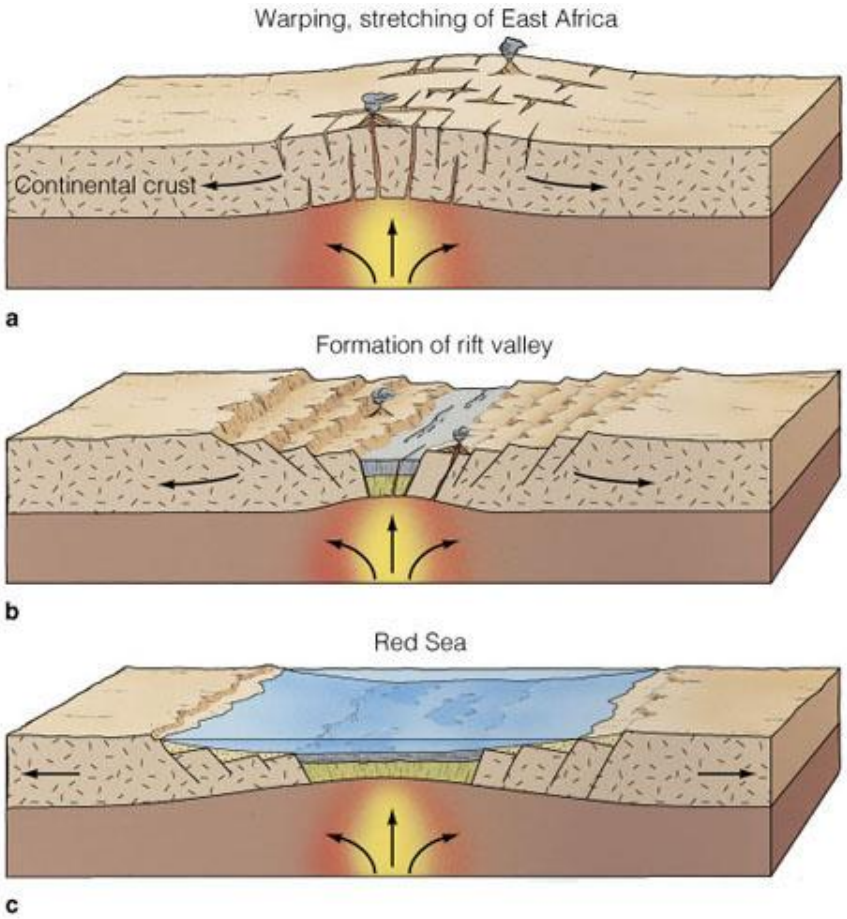
Washington/Oregon

Transform

Pacific Ring of Fire

San Andreas Fault

Divergent Boundary



Denser material from below is forced up.

Continents are forced apart at **spreading center**.

Denser material sinks, creating depression **(rift valley).**

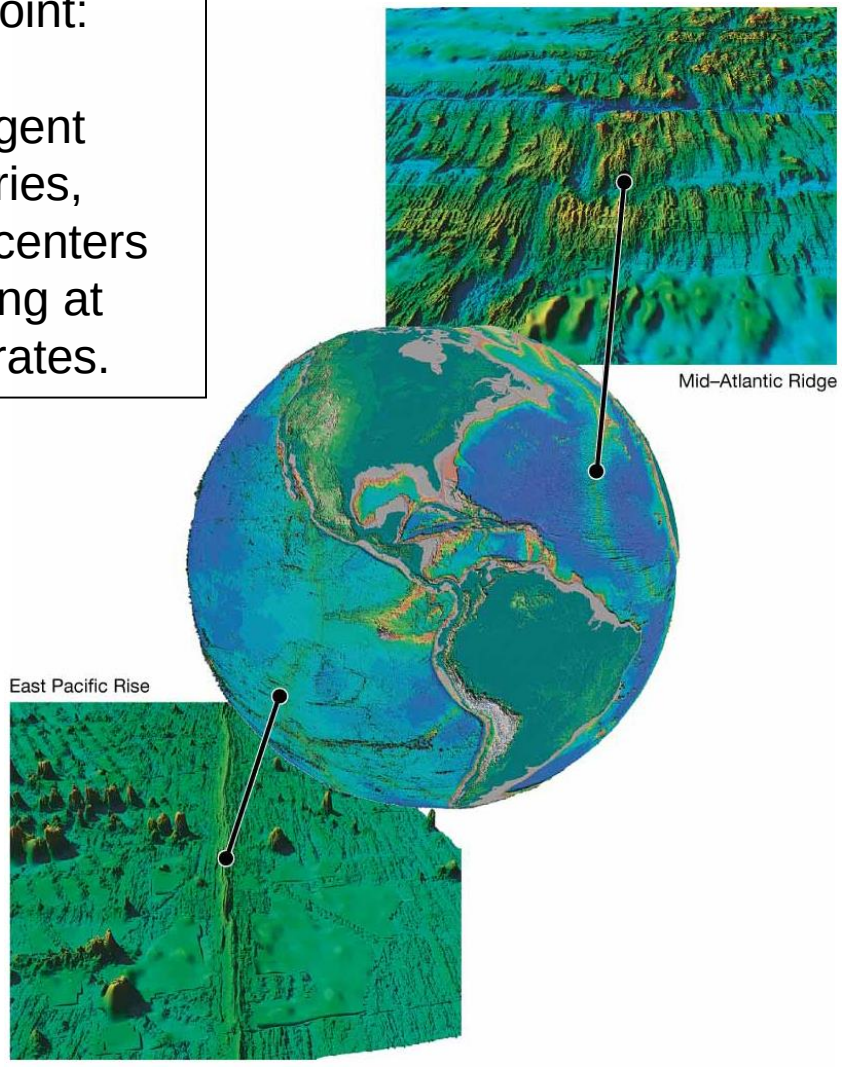
d

Examples of Spreading Centers

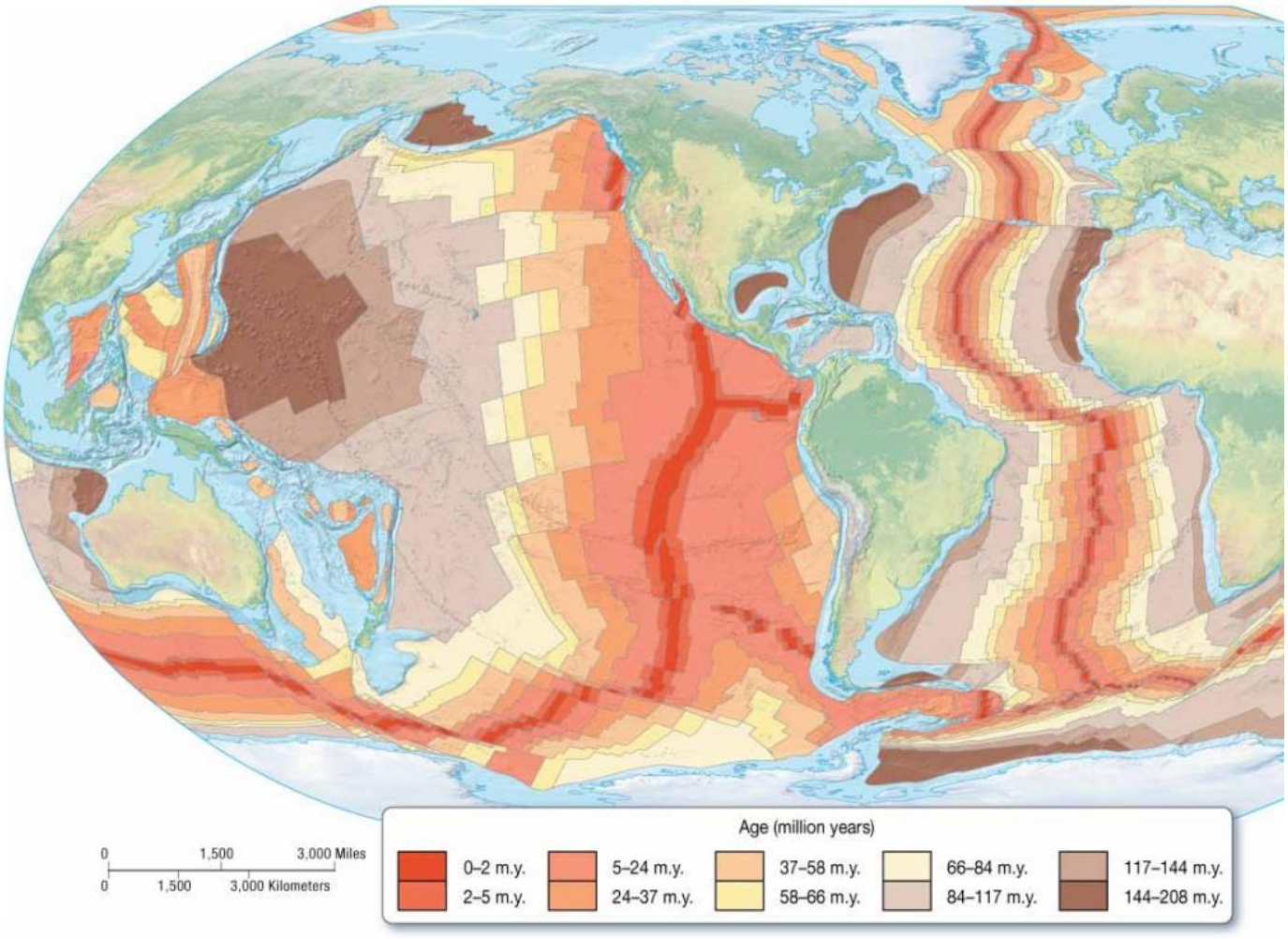
- East Pacific Rise
  - Fast-spreading
  - Gentle slopes
- Mid-Atlantic Ridge
  - Slow-spreading
  - Steep slopes
- Southwest India
  - Deep rift valley
  - Widely scattered volcanoes

Big-picture point:

At divergent boundaries, spreading centers are moving at different rates.



Age of Ocean Floor



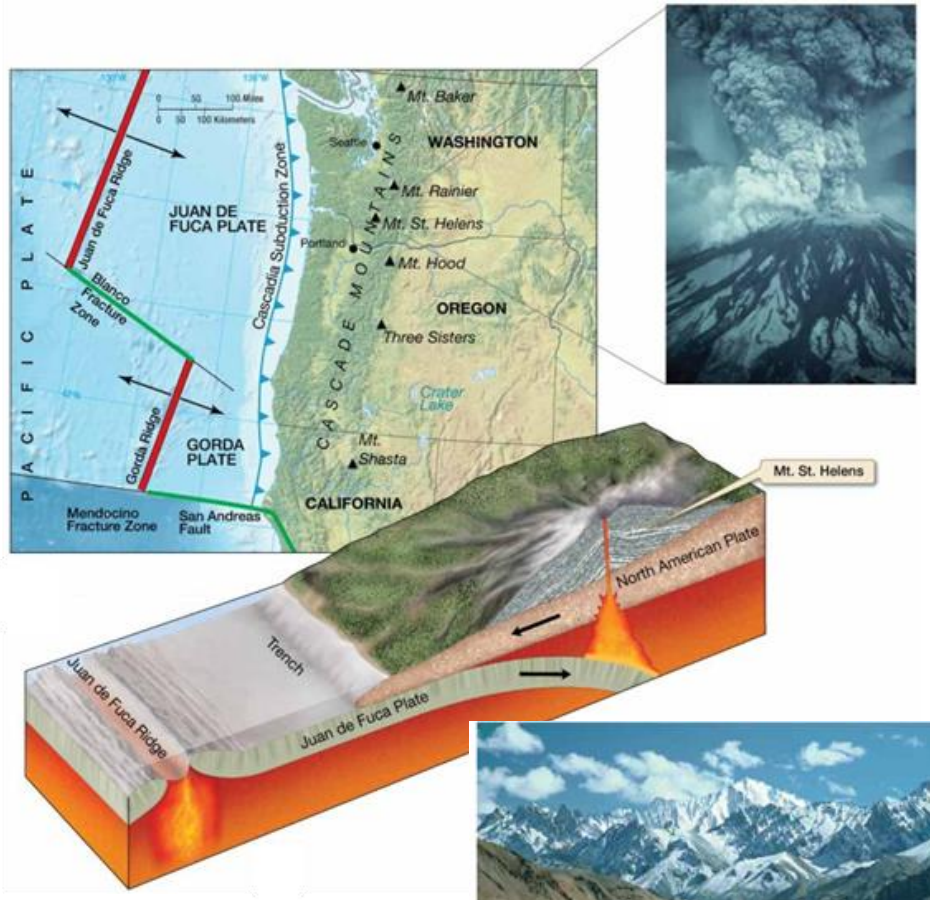
- First determined by deep-sea drilling in the late 1960s
- Radiometric dating of ocean rocks showed a symmetric pattern of age distribution around mid-ocean ridges.
- Another piece of evidence that supports the theory of plate tectonics.

Convergent Boundary Features

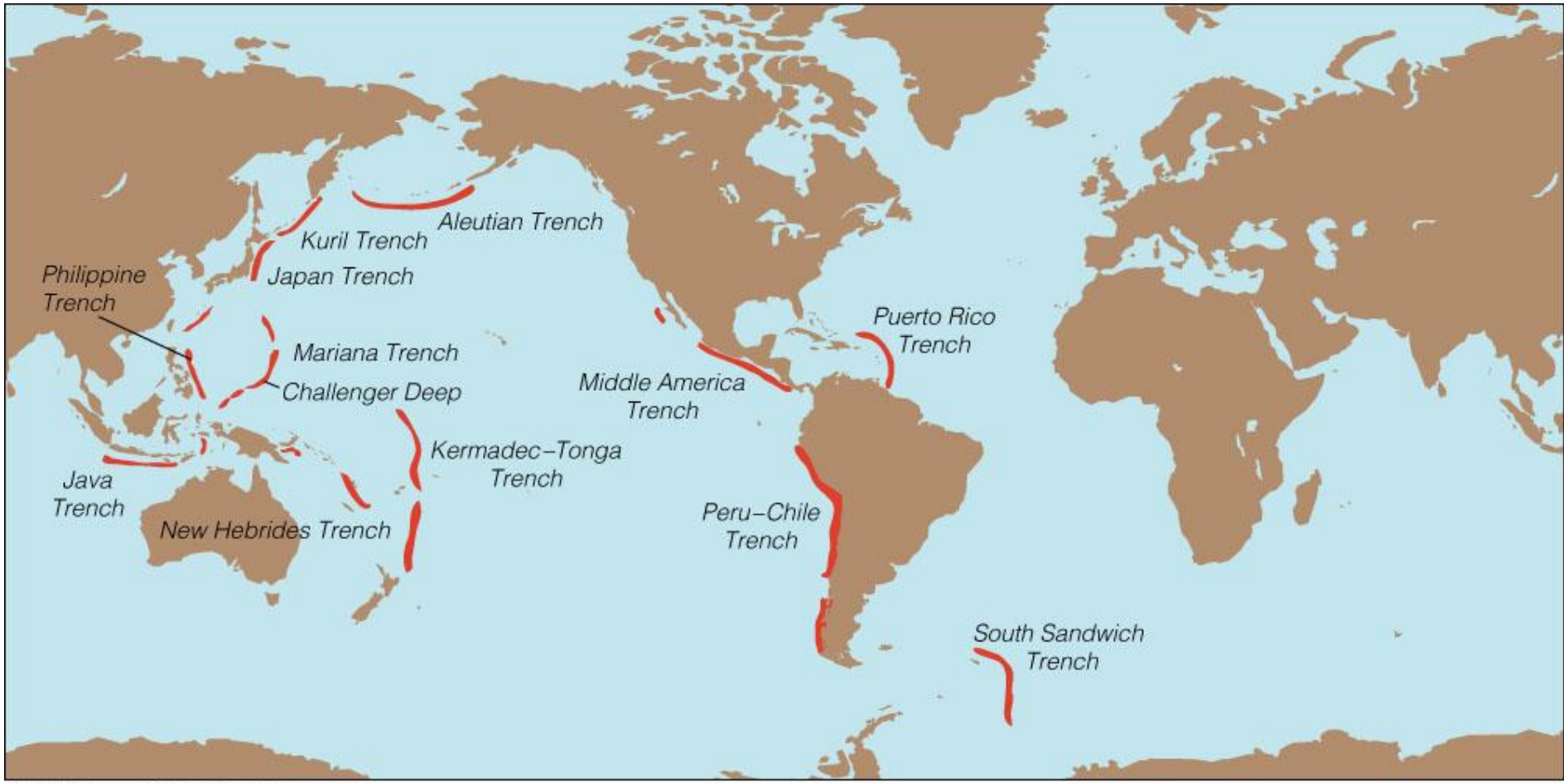
- Plates move toward each other
- Oceanic crust destroyed
  - Ocean trench
  - Volcanic arc
- Deep focus earthquakes
  - Great forces involved
  - Mineral structure changes associated

Types of Convergent Boundaries

- Oceanic-Continental Convergence
  - Ocean plate is subducted
  - Continental arcs generated
  - Explosive volcanic eruptions



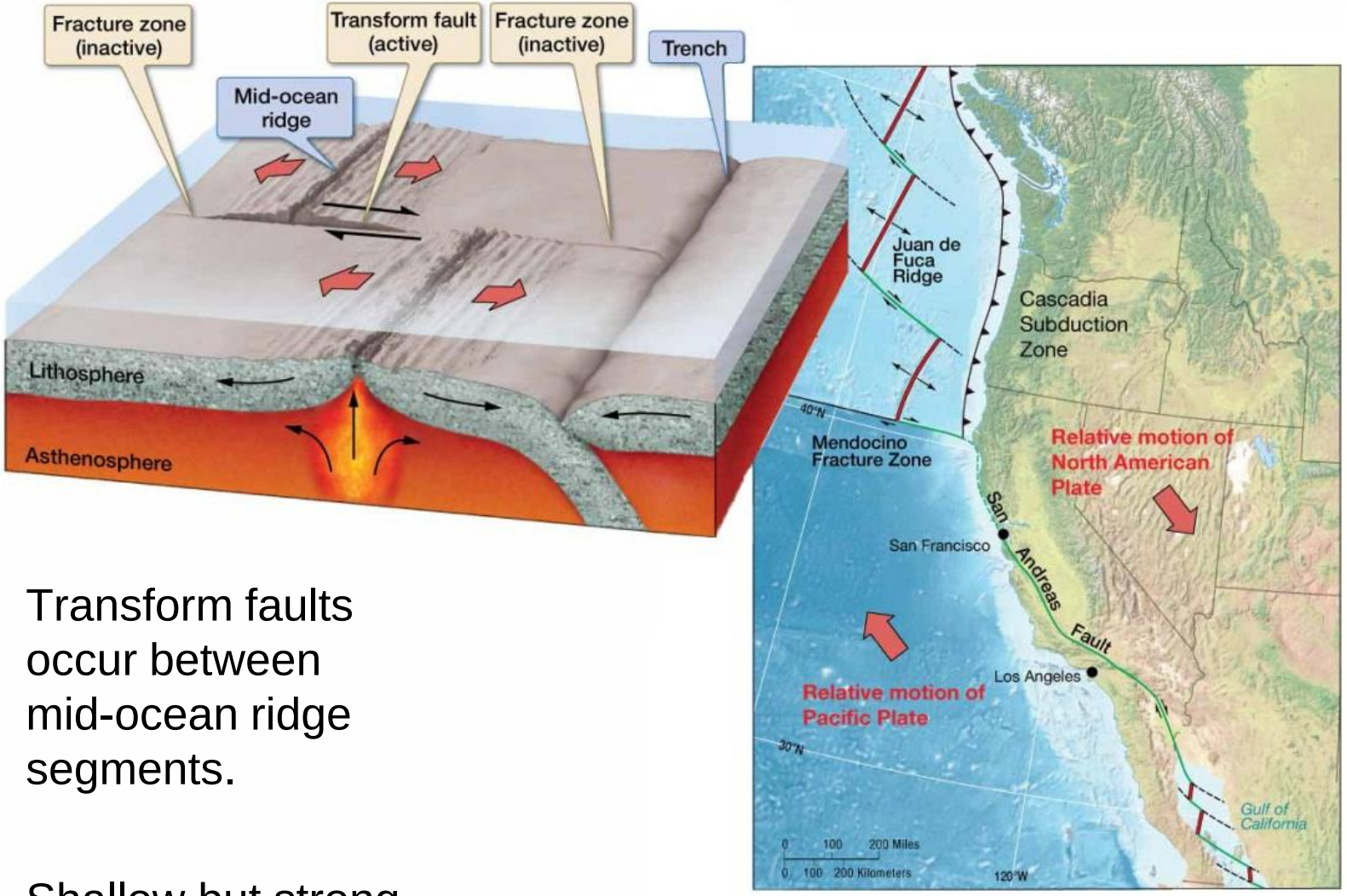
Also:
Oceanic-oceanic: volcanic arcs AND
Continental-continental: Himalayas from India-Asia collision



Trenches – arc-shaped depression caused by subduction.

Island arcs – region of islands found near trenches

Transform Boundary Features



- Transform faults occur between mid-ocean ridge segments.
- Shallow but strong earthquakes happen here.

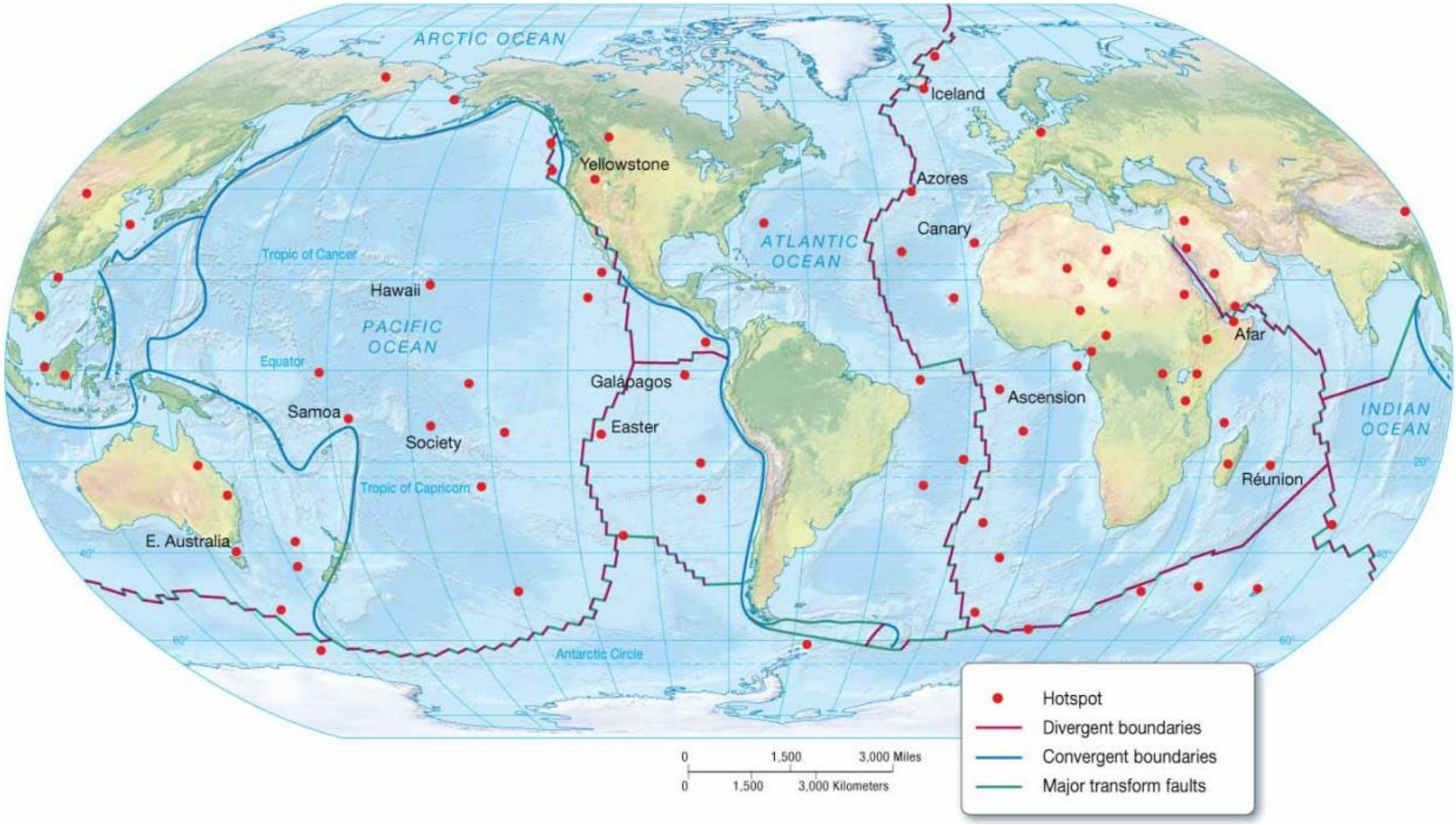
Examples of Plate Boundaries

TABLE 2.1 CHARACTERISTICS, TECTONIC PROCESSES, FEATURES, AND EXAMPLES OF PLATE BOUNDARIES

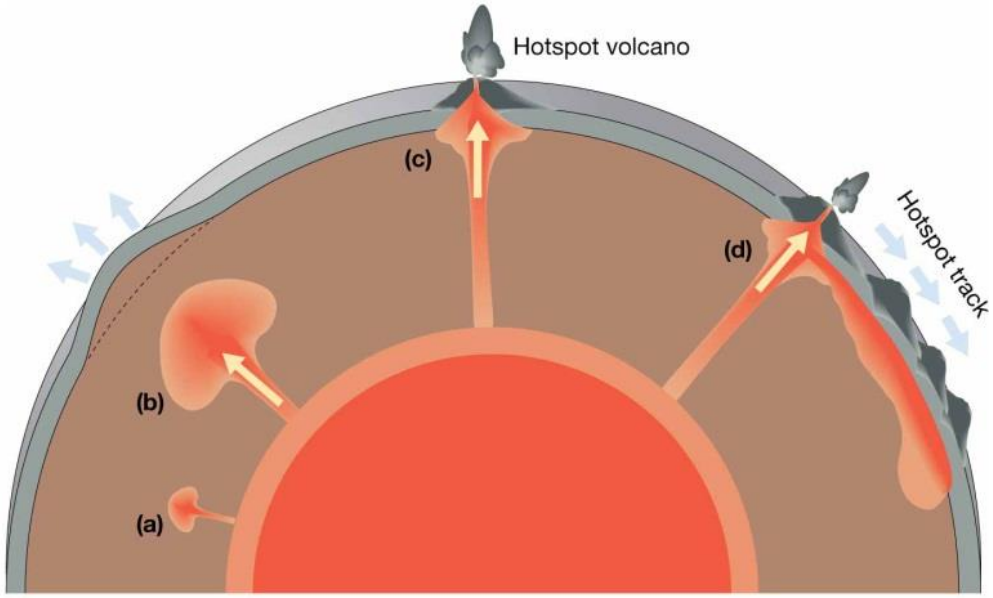
Plate boundary	Plate movement	Crust types	Sea floor created or destroyed?	Tectonic process	Sea floor feature(s)	Geographic examples
Divergent plate boundaries	Apart ← →	Oceanic-oceanic	New sea floor is created	Sea floor spreading	Mid-ocean ridge; volcanoes; young lava flows	Mid-Atlantic Ridge, East Pacific Rise
		Continental-continental	As a continent splits apart, new sea floor is created	Continental rifting	Rift valley; volcanoes; young lava flows	East Africa Rift Valleys, Red Sea, Gulf of California
Convergent plate boundaries	Together → ←	Oceanic-continental	Old sea floor is destroyed	Subduction	Trench; volcanic arc on land	Peru–Chile Trench, Andes Mountains
		Oceanic-oceanic	Old sea floor is destroyed	Subduction	Trench; volcanic arc as islands	Mariana Trench, Aleutian Islands
		Continental-continental	N/A	Collision	Tall mountains	Himalaya Mountains, Alps
Transform plate boundaries	Past each other → ←	Oceanic	N/A	Transform faulting	Fault	Mendocino Fault, Eltanin Fault (between mid-ocean ridges)
		Continental	N/A	Transform Faulting	Fault	San Andreas Fault, Alpine Fault (New Zealand)

From “Essentials of Oceanography” – your textbook has a similar table (3.1)

Hotspots occur within single plates.



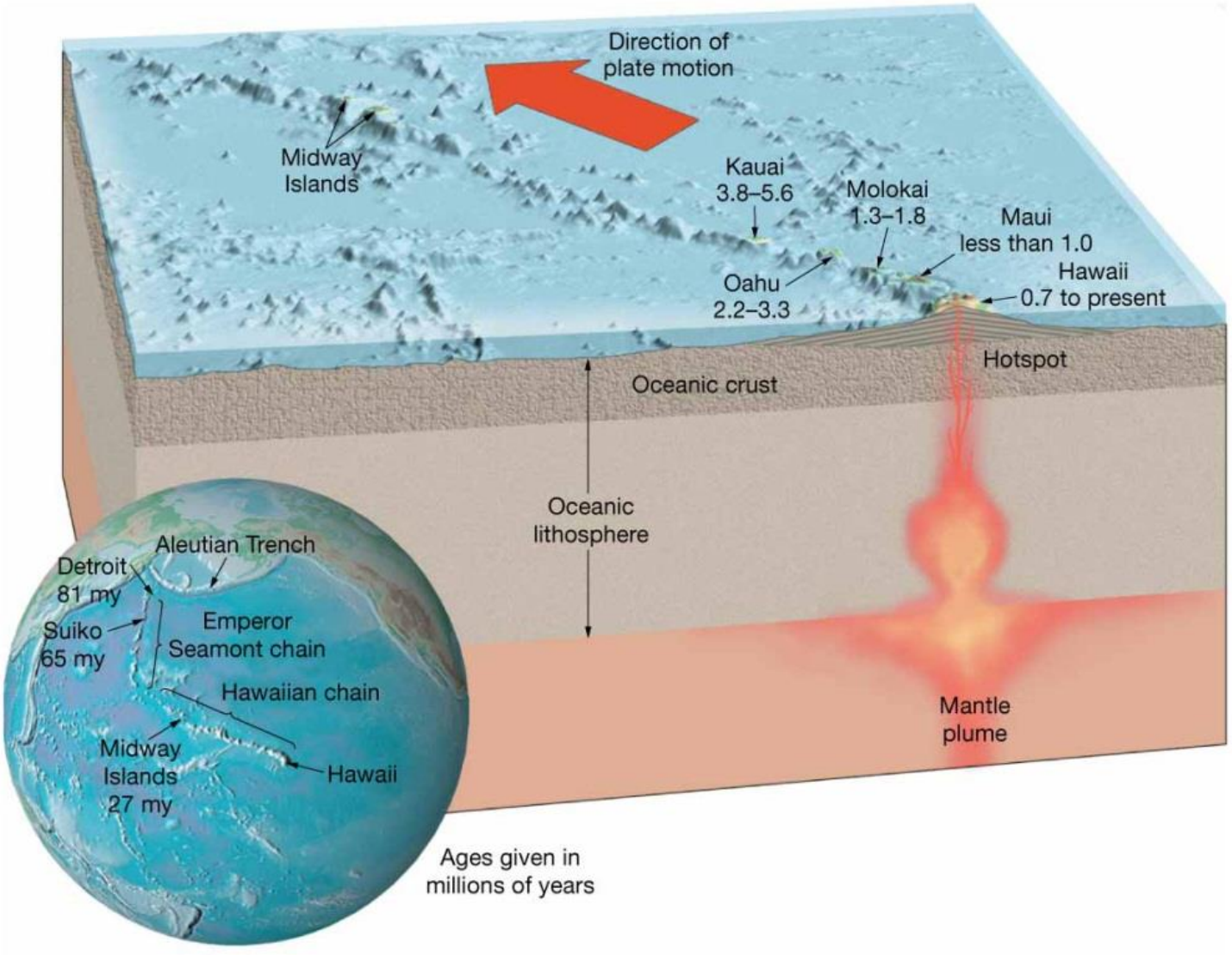
How are hotspots created?



What is happening here?

a) A plume of hot, buoyant material breaks off from the deep mantle or core.
b) The plume rises rapidly and elevates Earth's surface.
c) The plume head melts and creates a hotspot volcano.
   The plume is now within a plate.
d) The plate moves, and carries with it the hotspot volcano.
   As a volcano becomes separated from the magma source, it becomes inactive. Island arcs are formed.

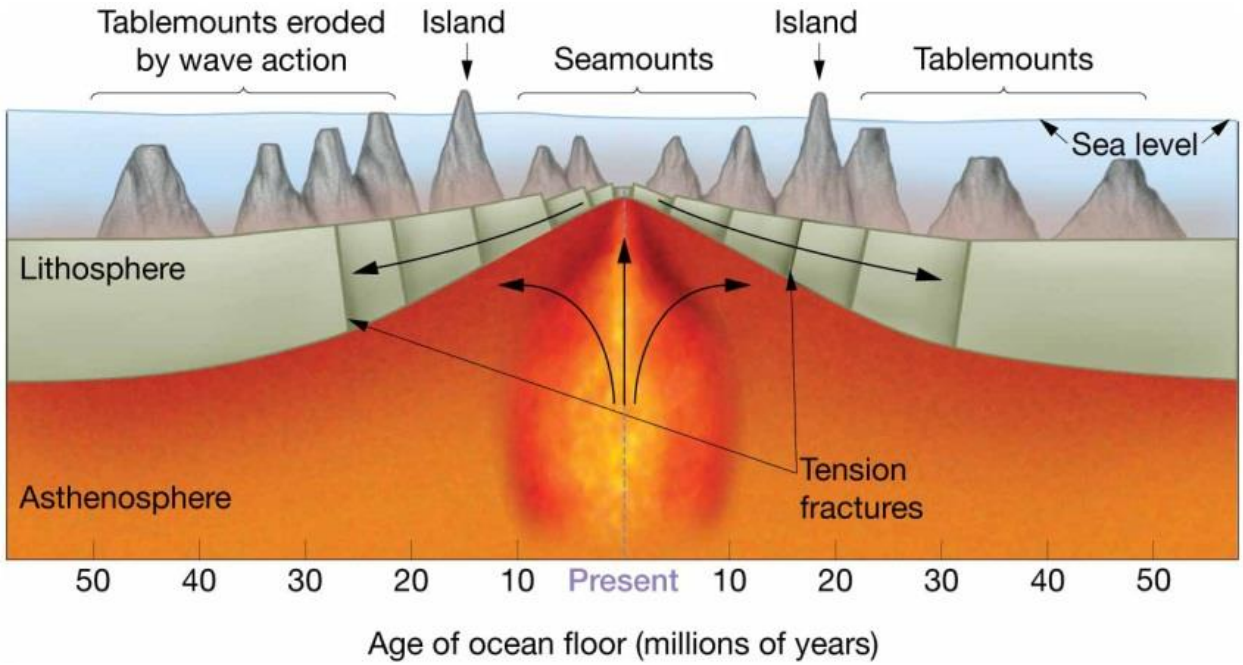
Hawaiian Islands were formed over a hotspot, as the plate moved.



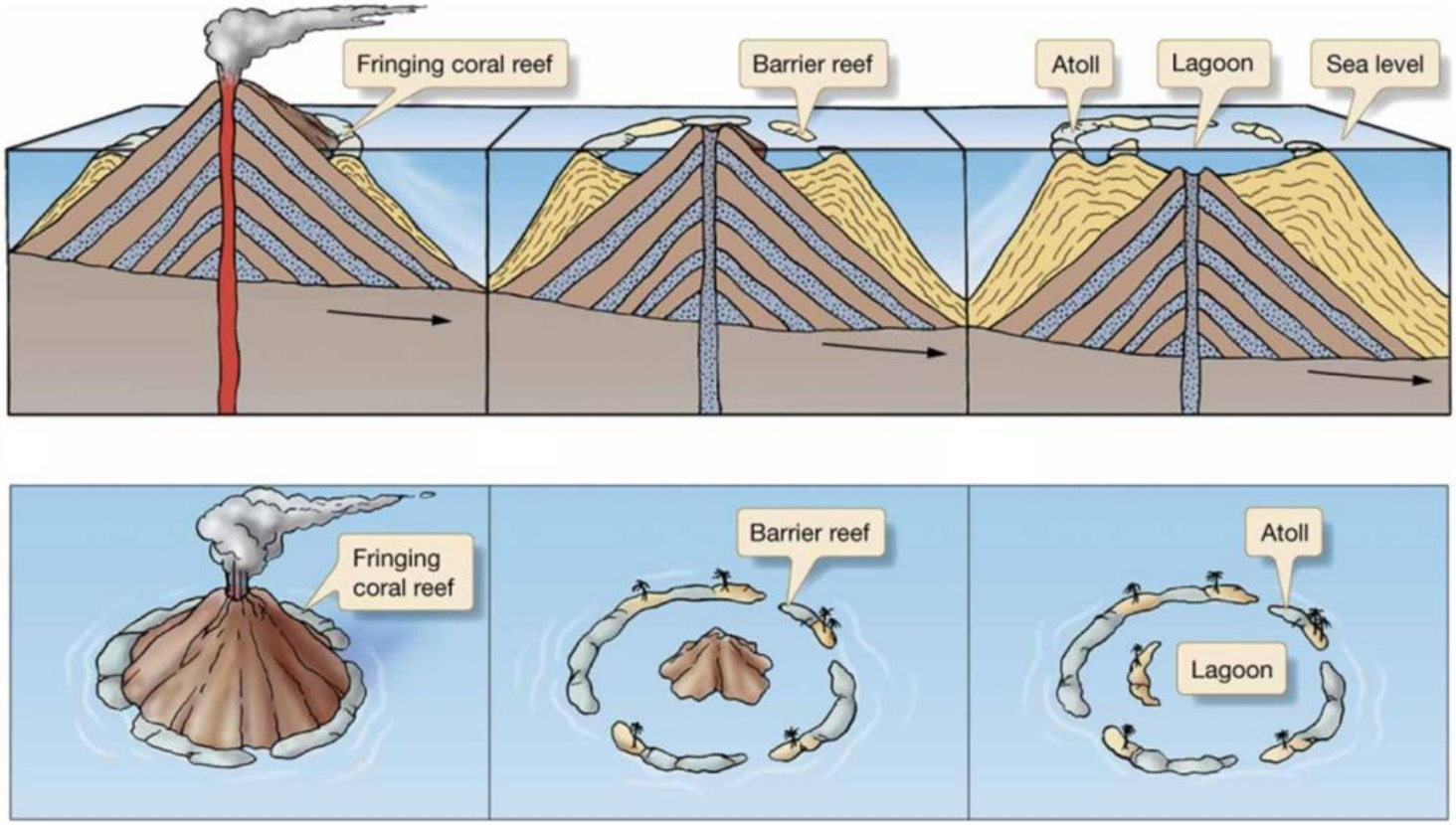
Other “intraplate” features

- Seamount
  - Rounded top
- Tablemount or guyot (“guy-oh”)
  - Flattened top
- Subsidence of flanks of mid-ocean ridge
- Wave erosion may flatten seamount

“intraplate” means within one plate, NOT at a plate boundary



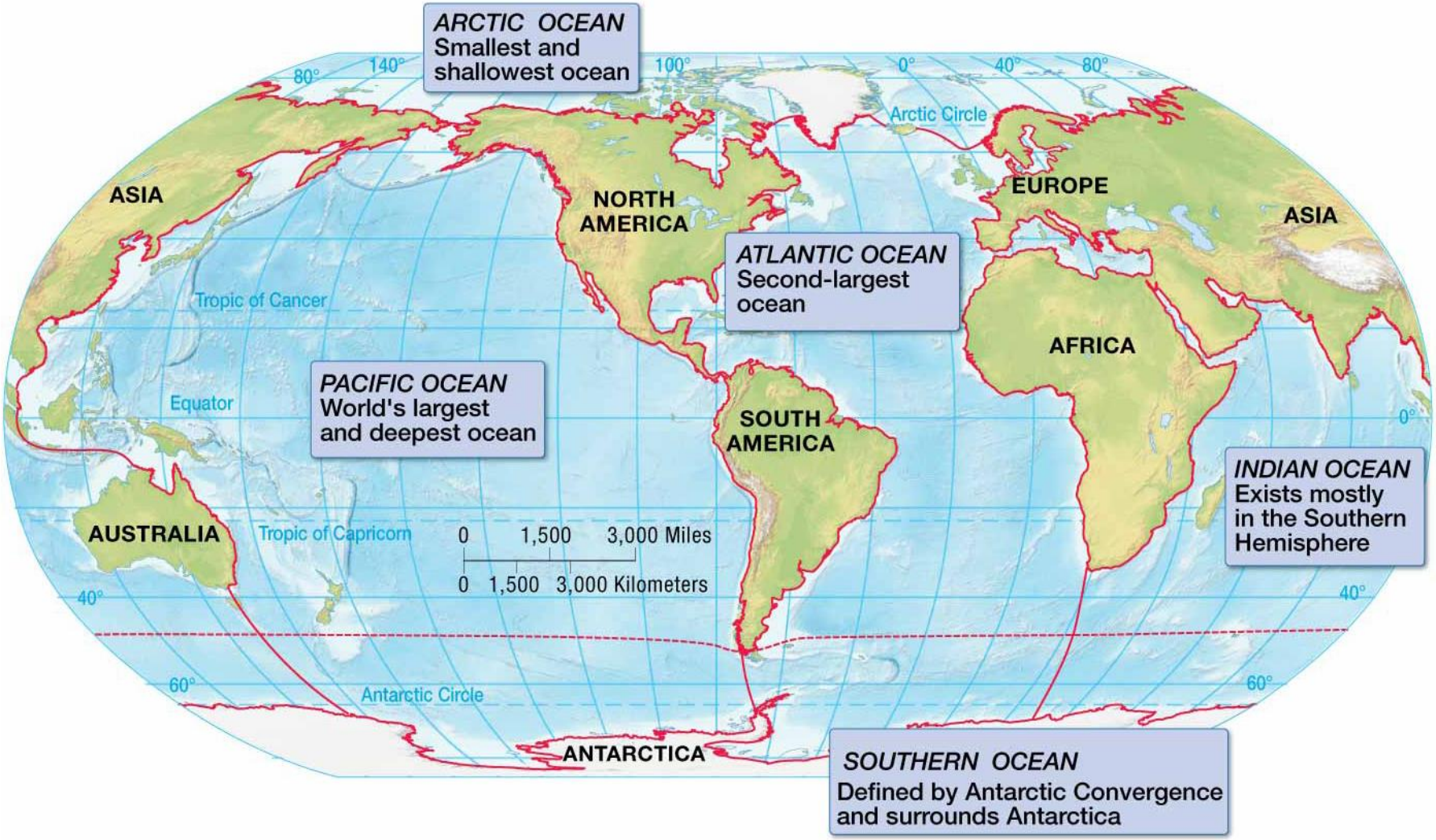
Coral Reef Development*



Animation:
http://oceanservice.noaa.gov/education/kits/corals/media/supp_coral04a.html

* recall: Charles Darwin proposed this theory before seeing these types of coral reefs.

Ocean Basins (Chapter 4)



Learning Goals: Ocean Basins

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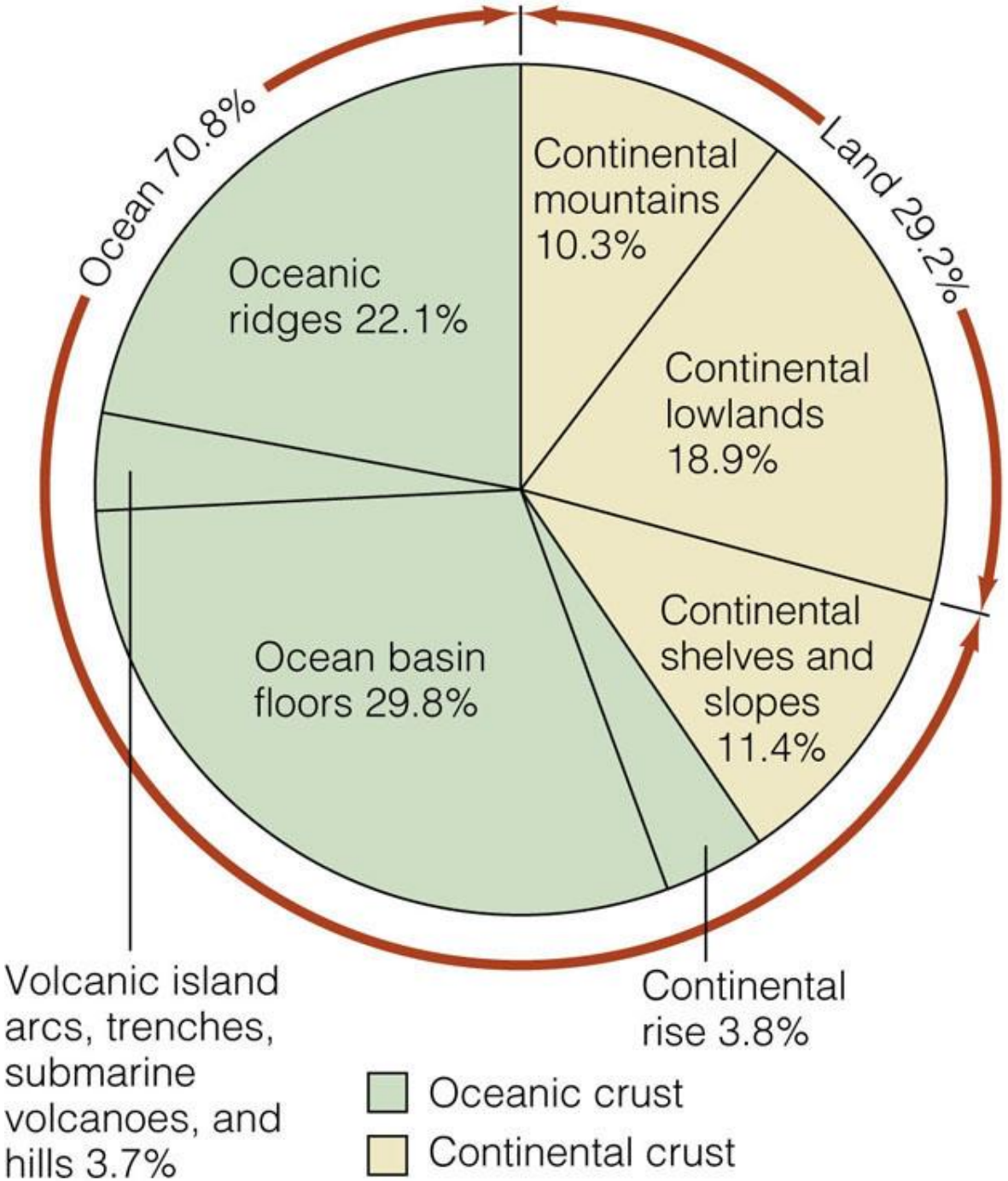
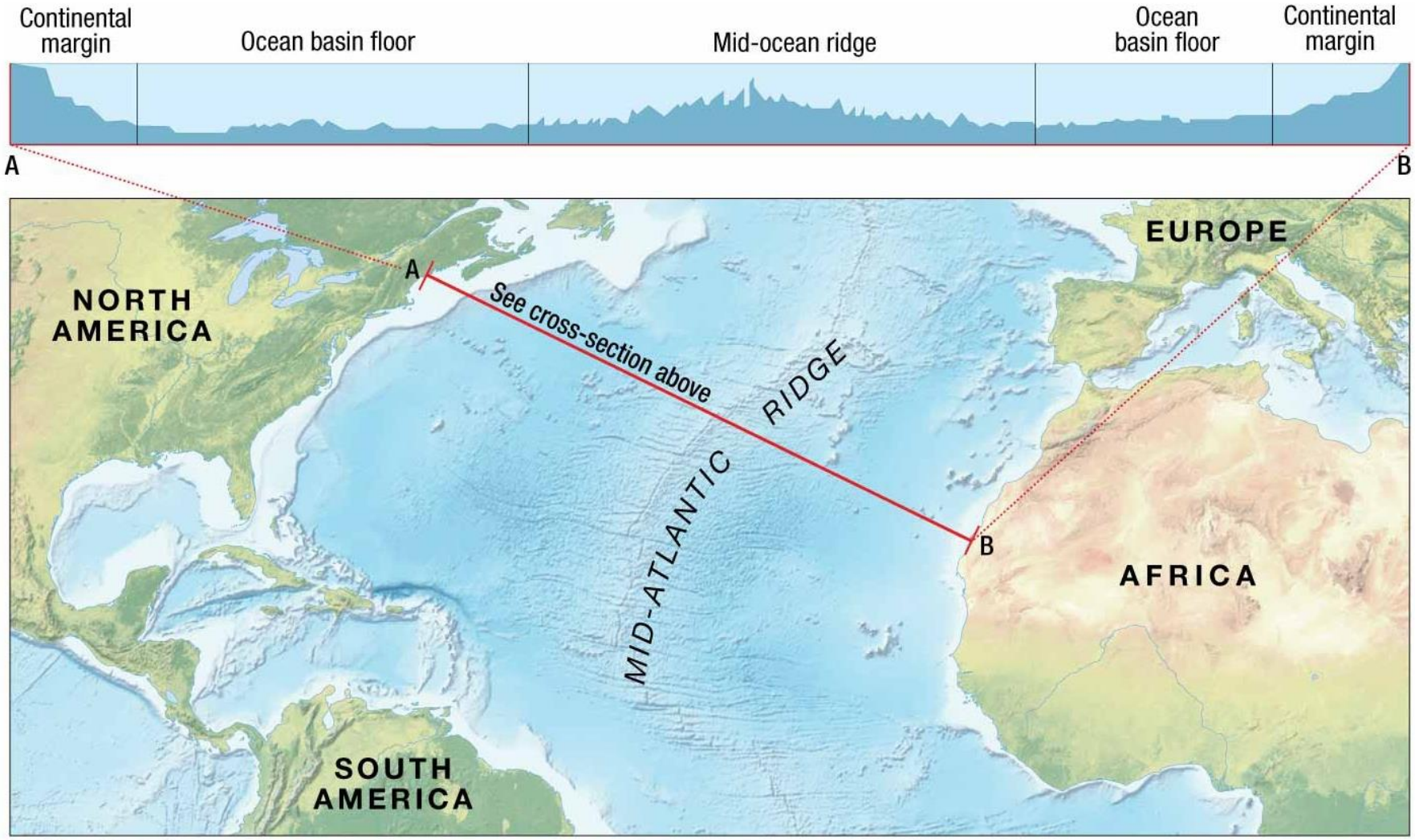
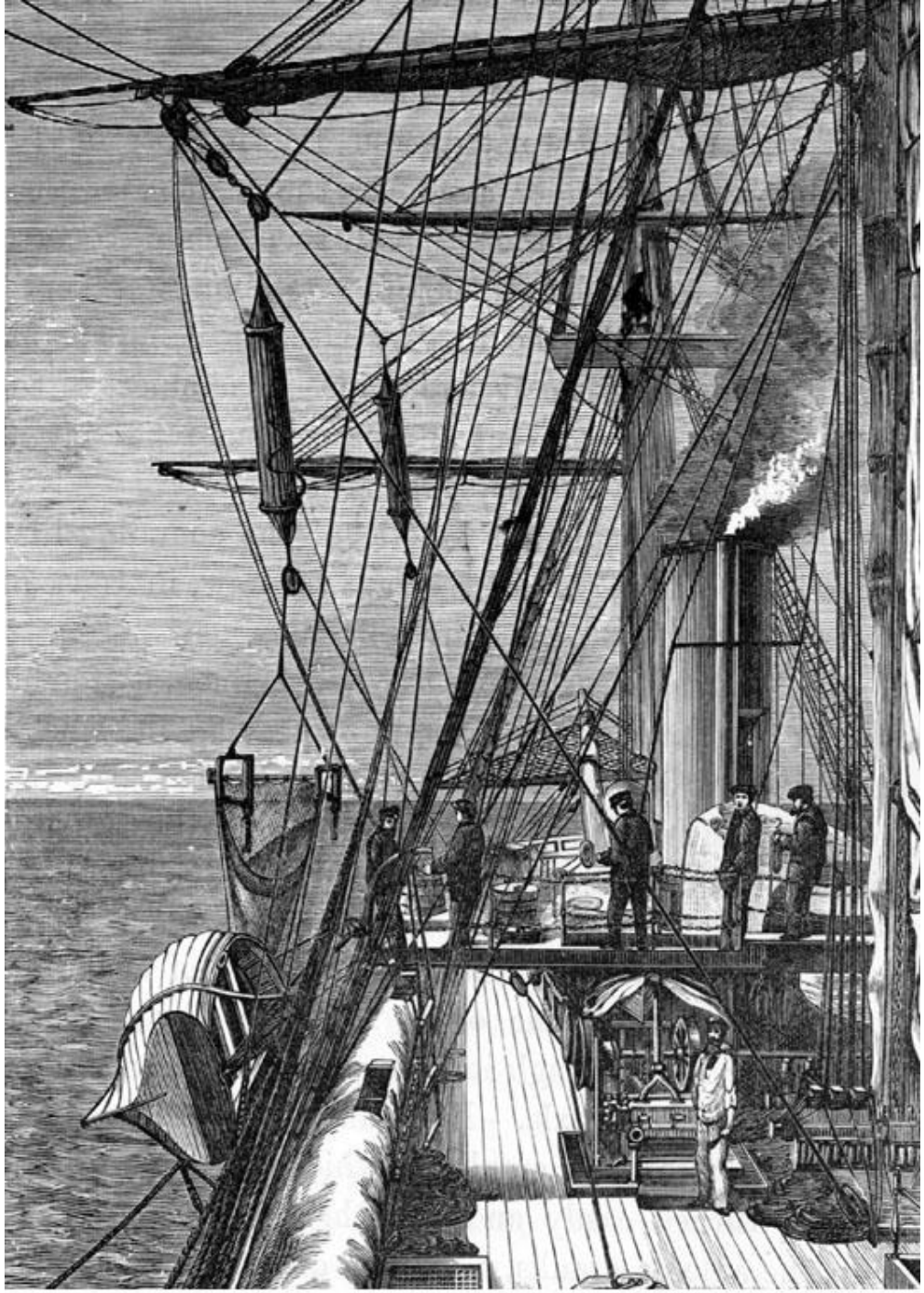


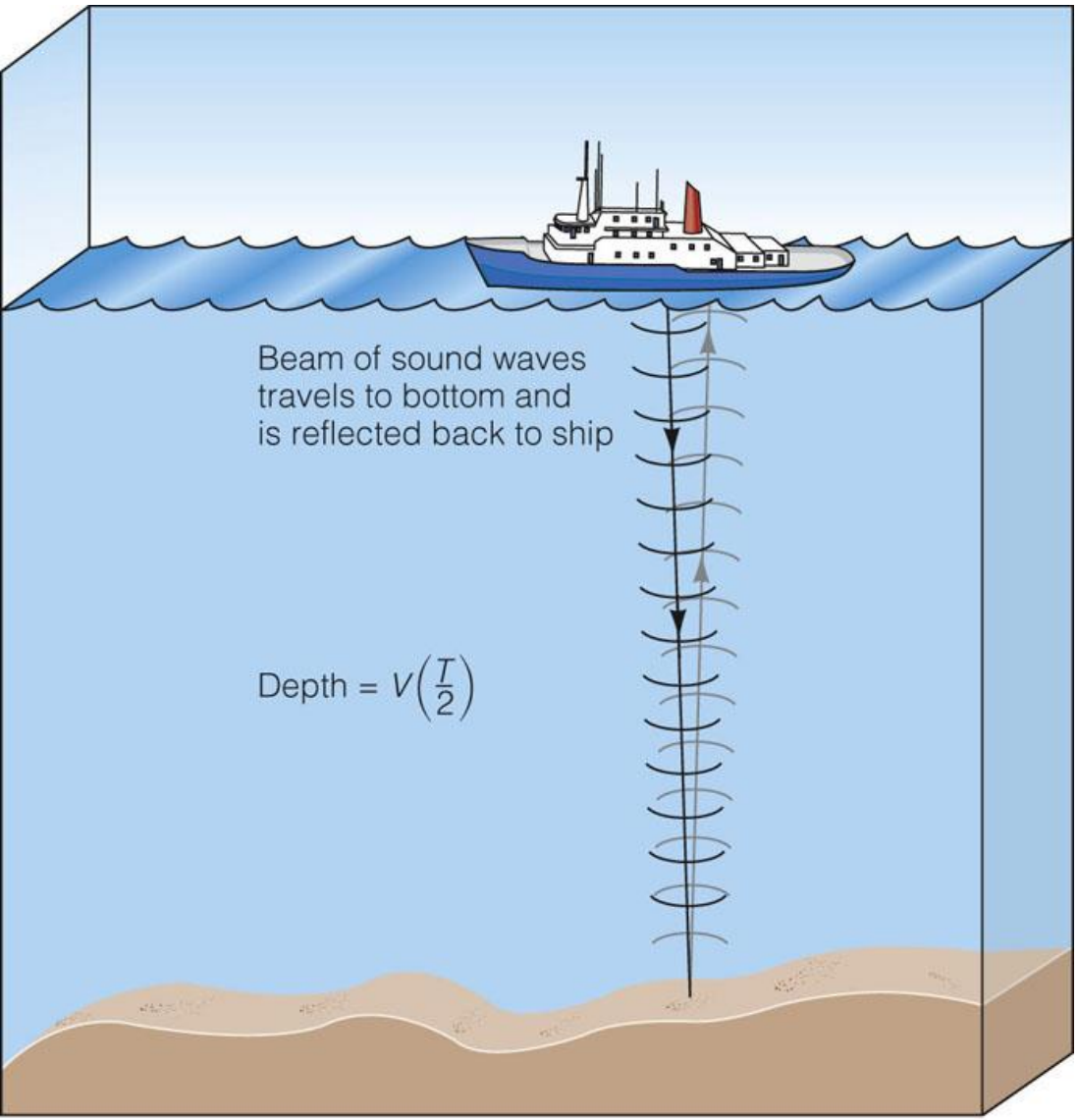
Three major categories: margin, basin, ridge





How is (was) ocean depth determined?

The HMS *Challenger* measured ocean depth by dropping weights off ships.



a

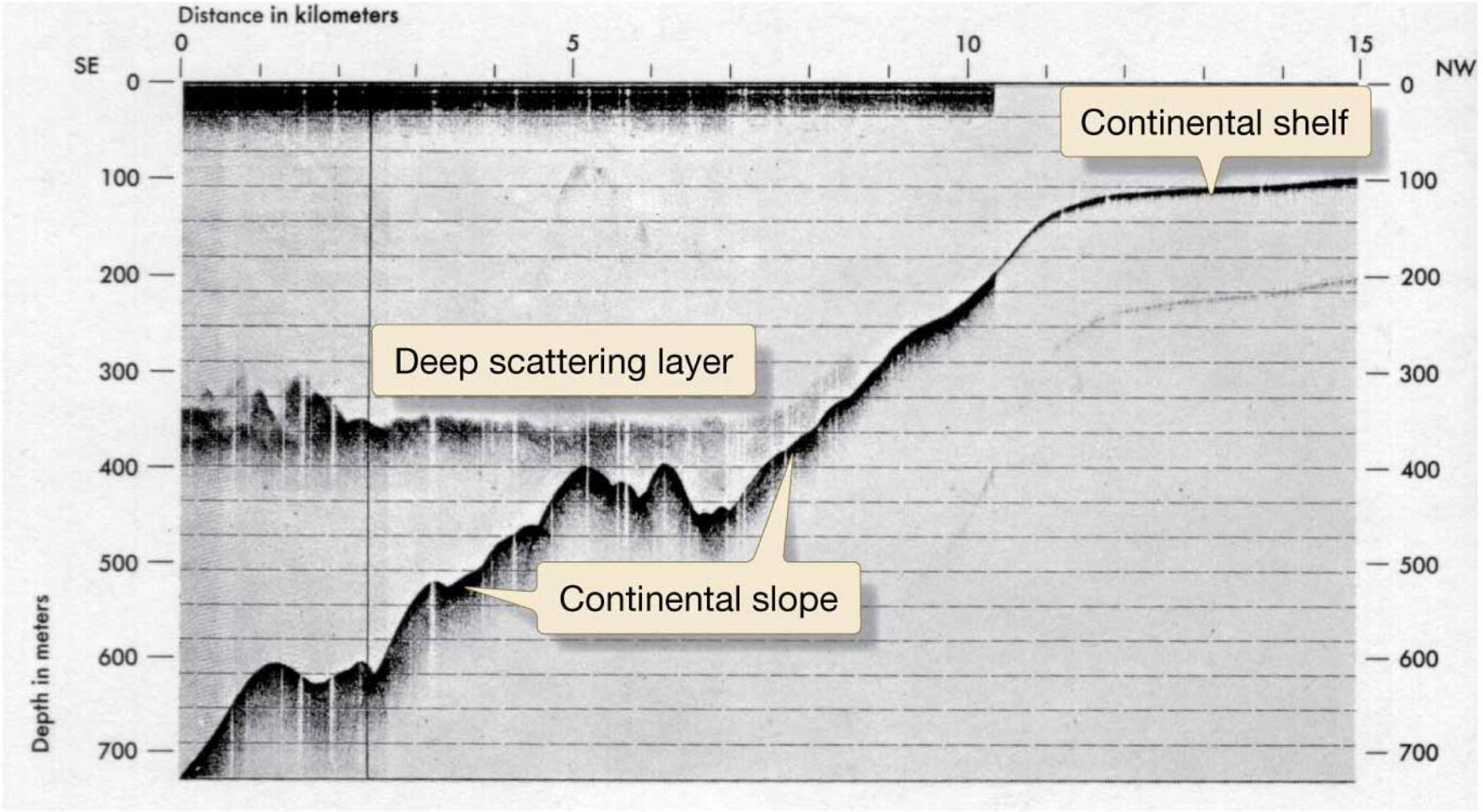
Echo sounding is much quicker.

Speed of sound ~5000 ft/s

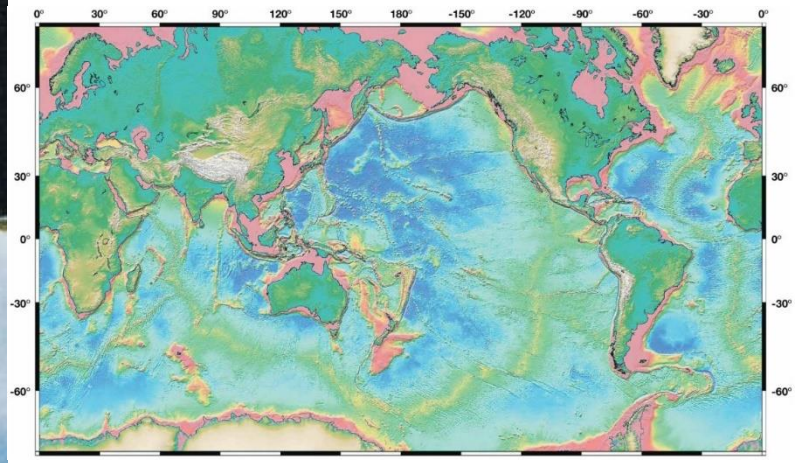
What is depth if it takes 4 seconds to return?

10,000 feet

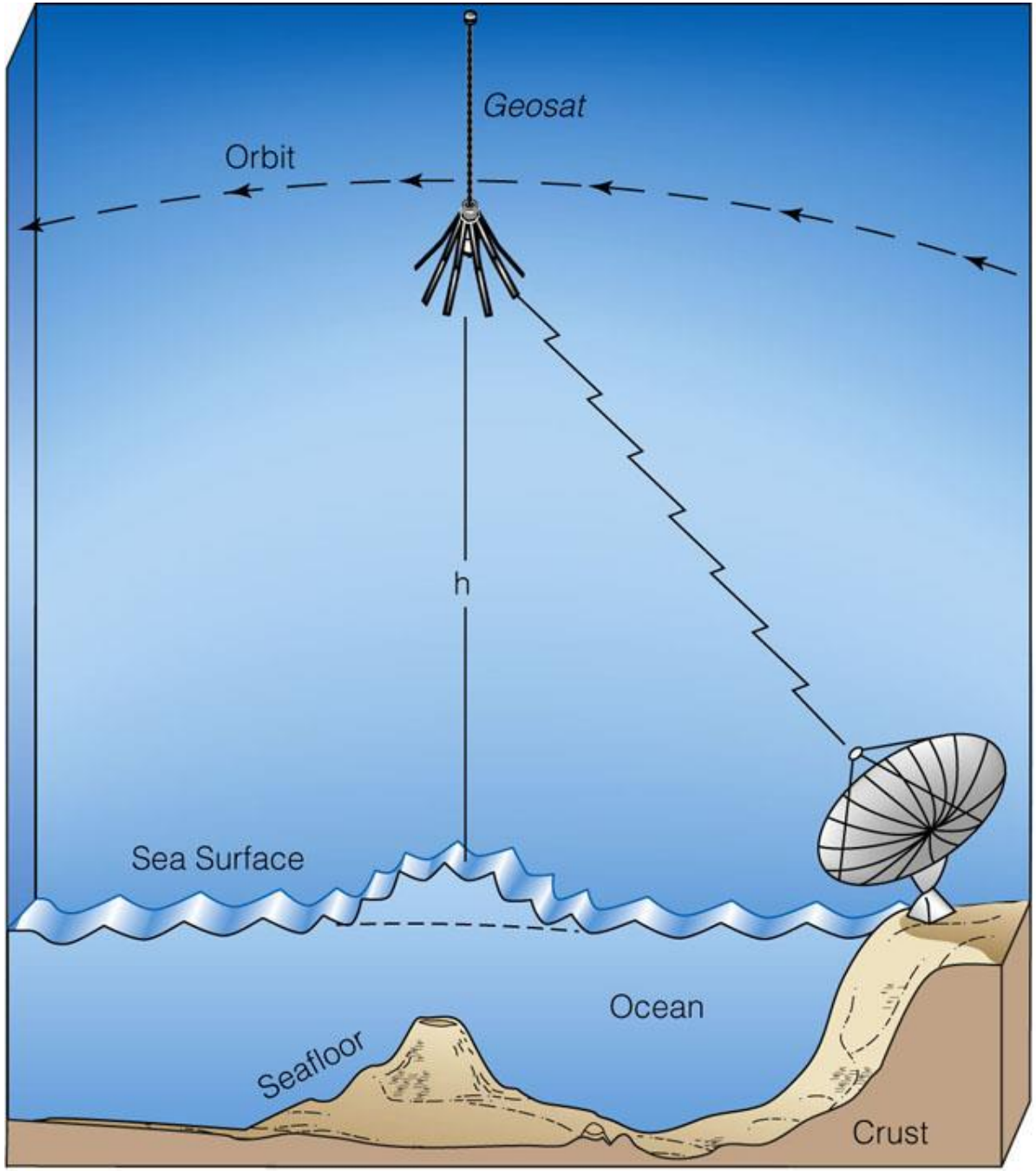
Echo Sounding Record



Satellites also detect ocean depths.



a



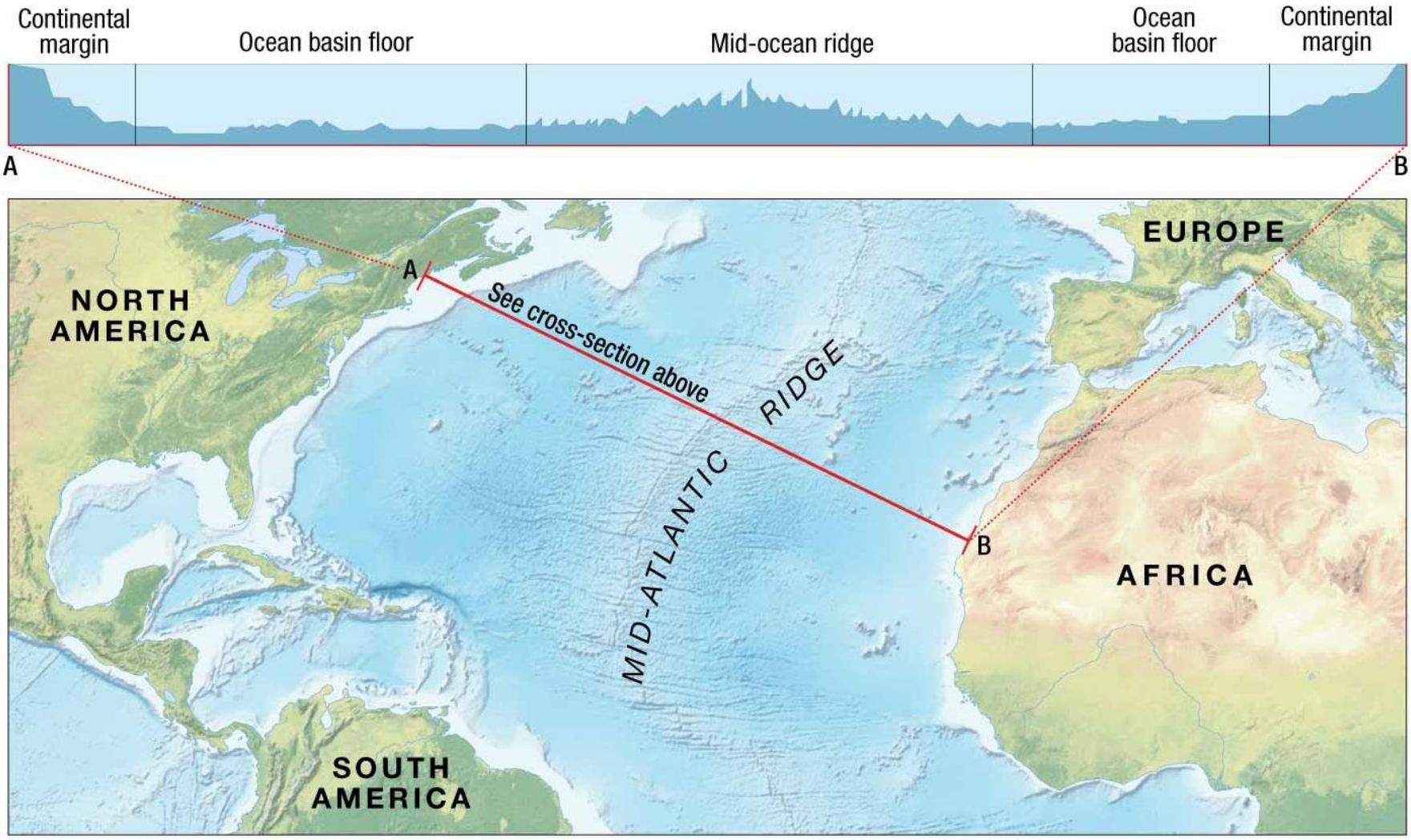
b

How do satellites work to measure bathymetry?

Differences in sea-surface height above a seabed feature are caused by the extra gravitational attraction of the feature, which “pulls” water toward it from the sides and forms a mound of water over itself.

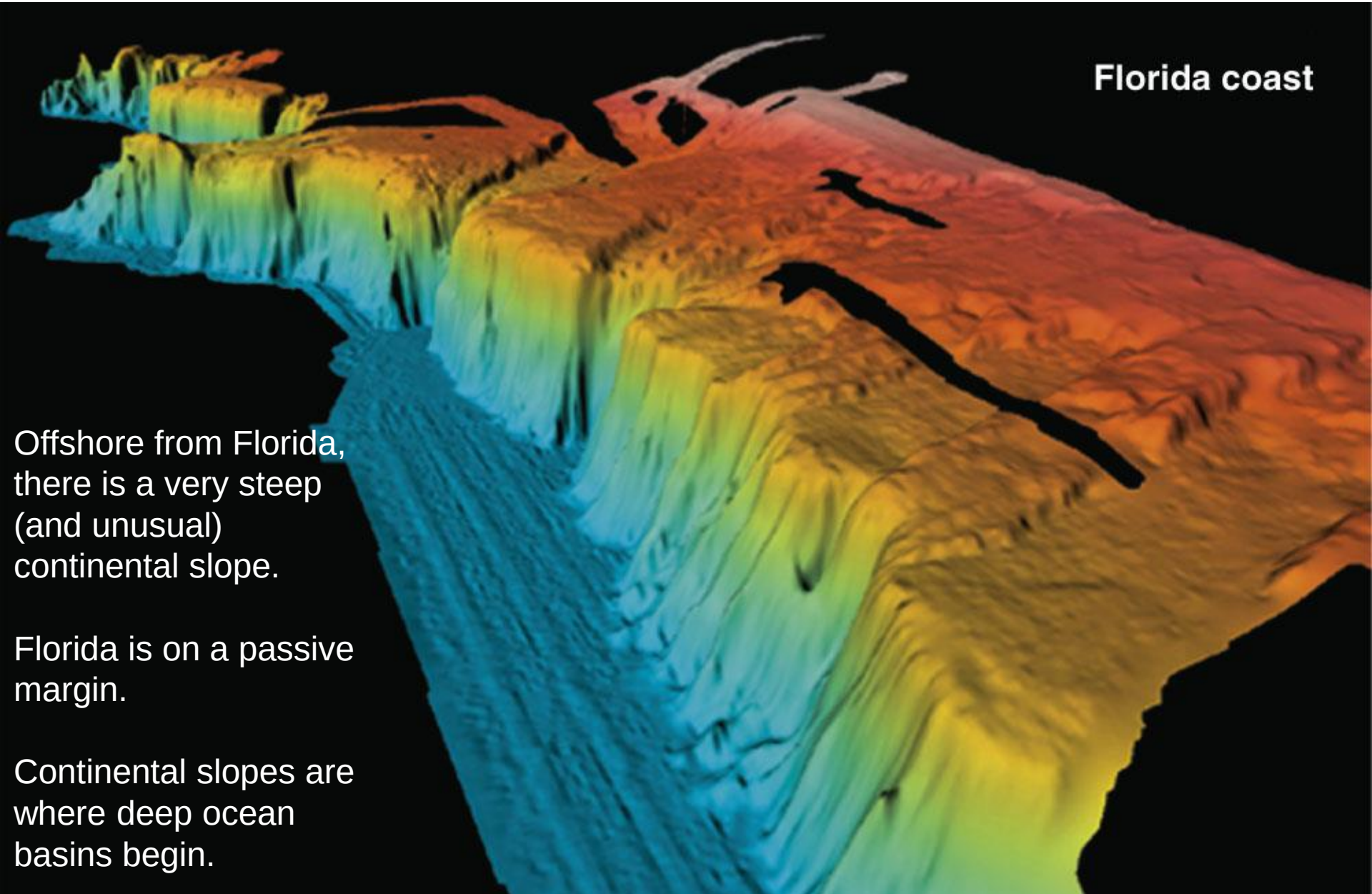
OR: Bottom features cause bumps on water.

Three major categories: margin, basin, ridge



Continental Margins

- Passive
  - Not close to any plate boundary
  - No major tectonic activity
  - East coast of United States
- Active
  - Associated with convergent or transform plate boundaries
  - Much tectonic activity



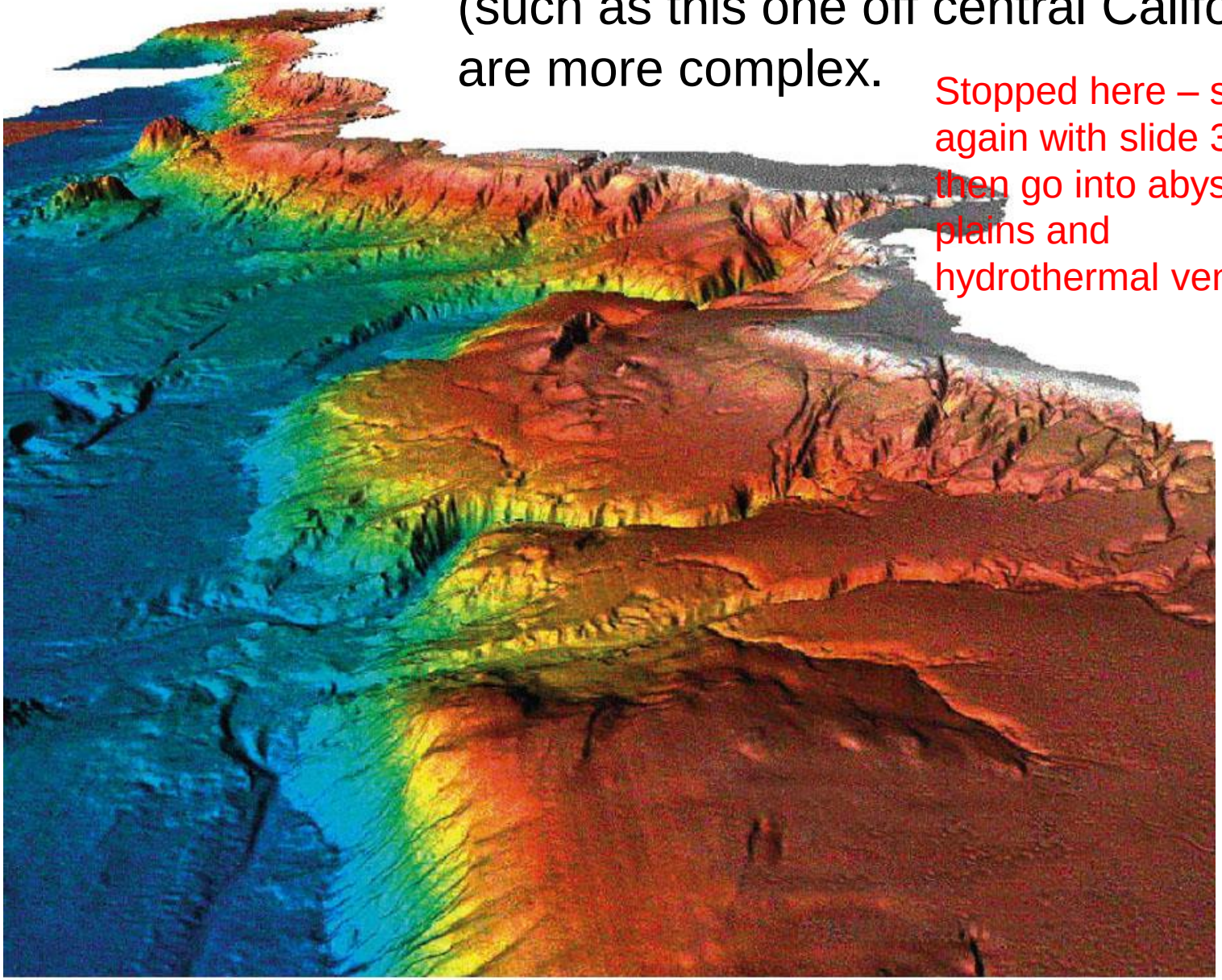
Offshore from Florida, there is a very steep (and unusual) continental slope.

Florida is on a passive margin.

Continental slopes are where deep ocean basins begin.

Active continental margins (such as this one off central California) are more complex.

Stopped here – start again with slide 35 and then go into abyssal plains and hydrothermal vents



Question

- The east coast of Florida would be considered a(n)

a) active margin
b) passive margin
c) transform margin
d) turbidity margin

Question

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a) active margin
b) passive margin
c) transform margin
d) turbidity margin