Oceanography, An Invitation to Marine Science | 9e
Tom Garrison

4

Ocean Basins

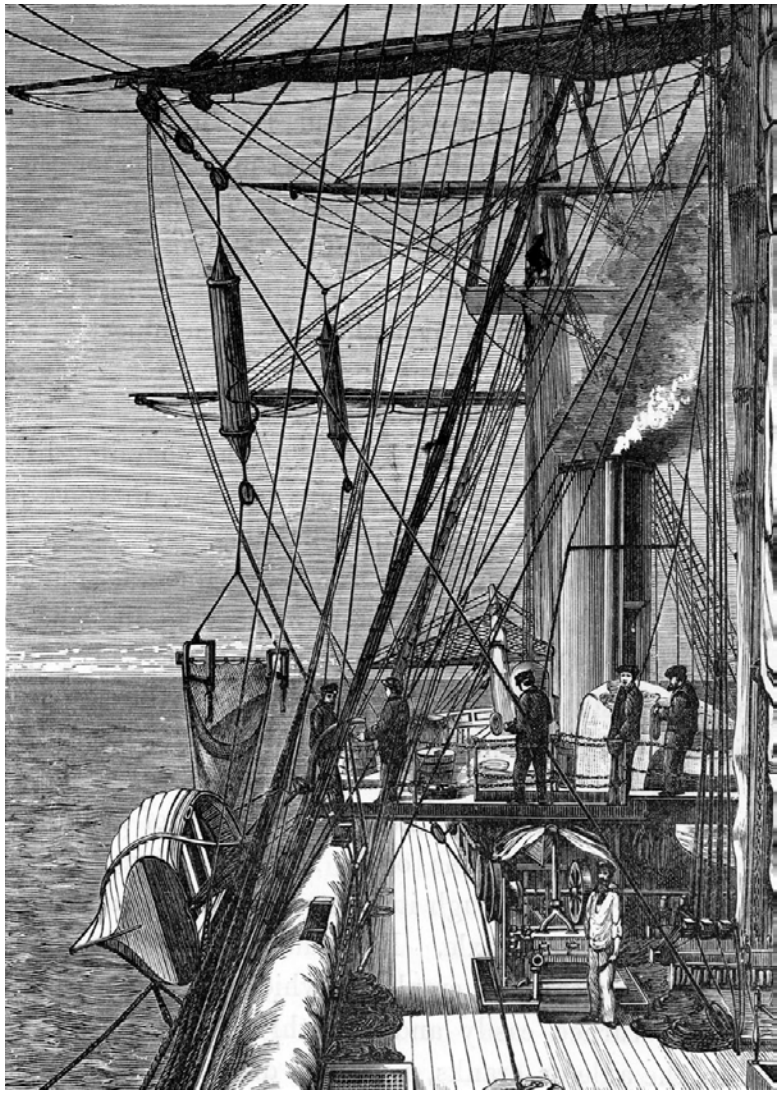
Key Concepts

- Tectonic forces shape the seabed
- The ocean floor is divided into continental margins and deep ocean basins
- The continental margins are seaward extensions of the adjacent continents and are usually underlain by granite
  - The deep seabeds have different features and are usually underlain by basalt

Key Concepts (cont'd.)

- The mid-ocean ridge system is perhaps Earth's most prominent feature
- Most of the water of world ocean circulates through the hot oceanic crust of the ridges about every 10 million years

The Ocean Floor Is Mapped by Bathymetry



An illustration from the Challenger Report (1880)

The discovery and study of ocean floor contours (topography) is called **Bathymetry.**

Early bathymetric studies were often performed using a weighted line to measure the depth of the ocean floor.

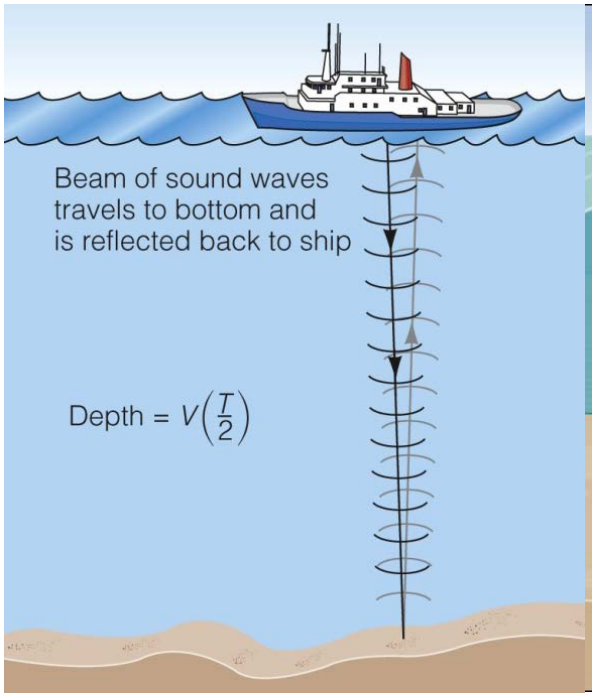
Seamen are handing the steam winch used to lower a weight on the end of a line to the seabed to find ocean depth.

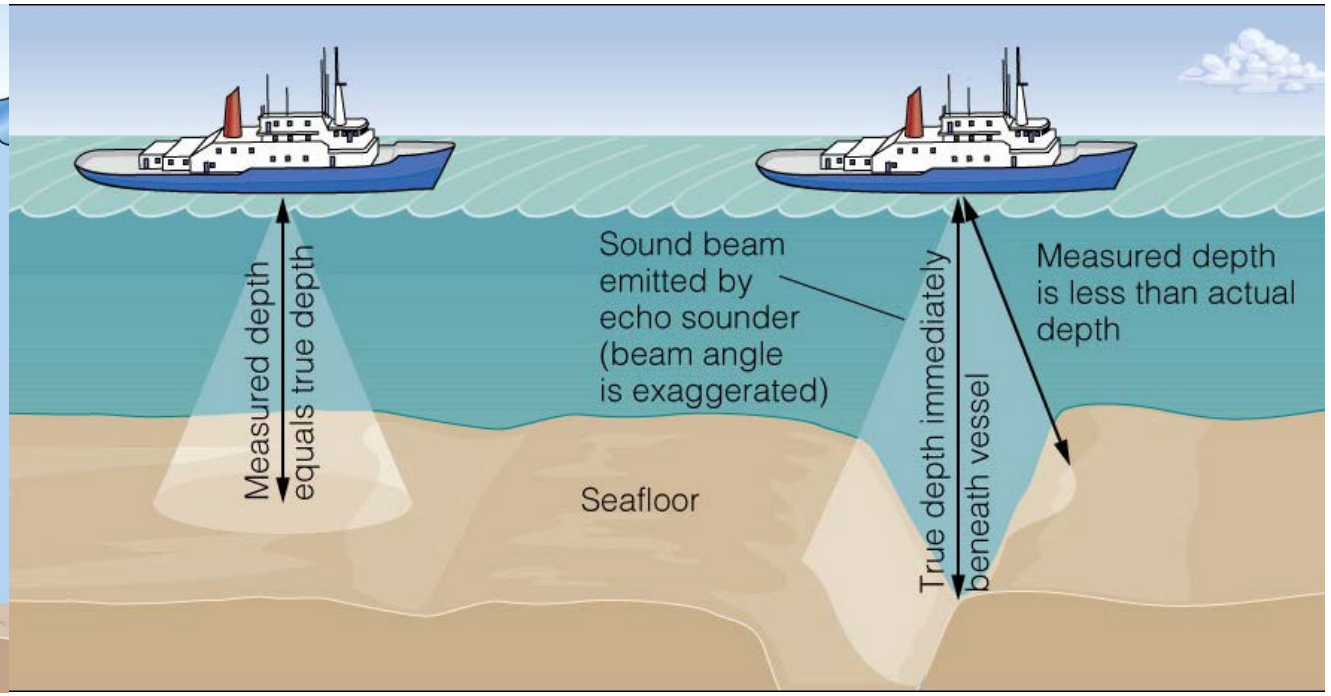
4.1 The Ocean Floor Is Mapped by Bathymetry

- Advances in Bathymetry
  - Echo sounding
  - Multi-beam Systems
  - Satellite Altimetry

- Multibeam systems combine many echo sounders

Echo Sounders Bounce Sound off the bottom

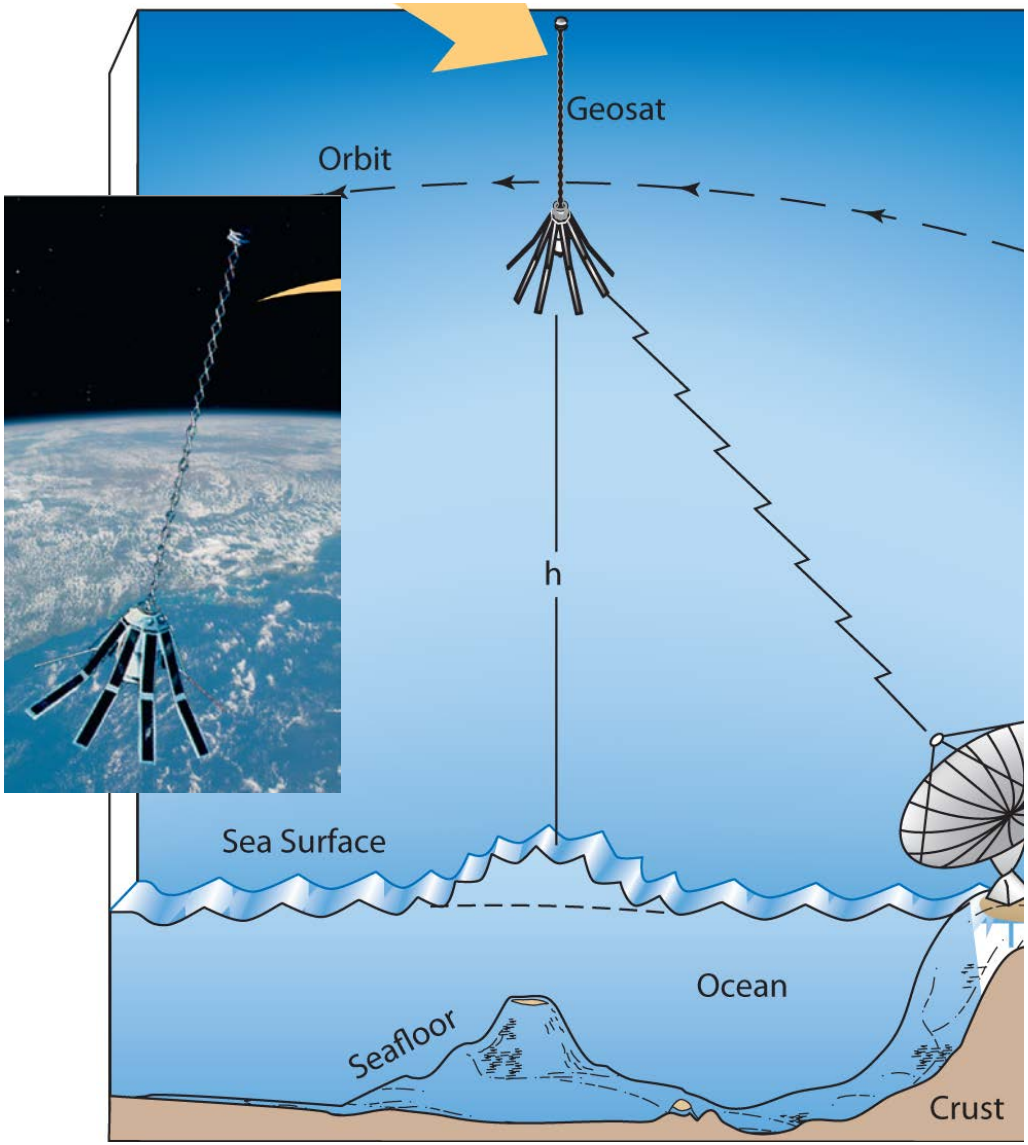




Echo sounding is a method of measuring seafloor depth using powerful sound pulses.

Satellites Can Be Used to Map Seabed Topography

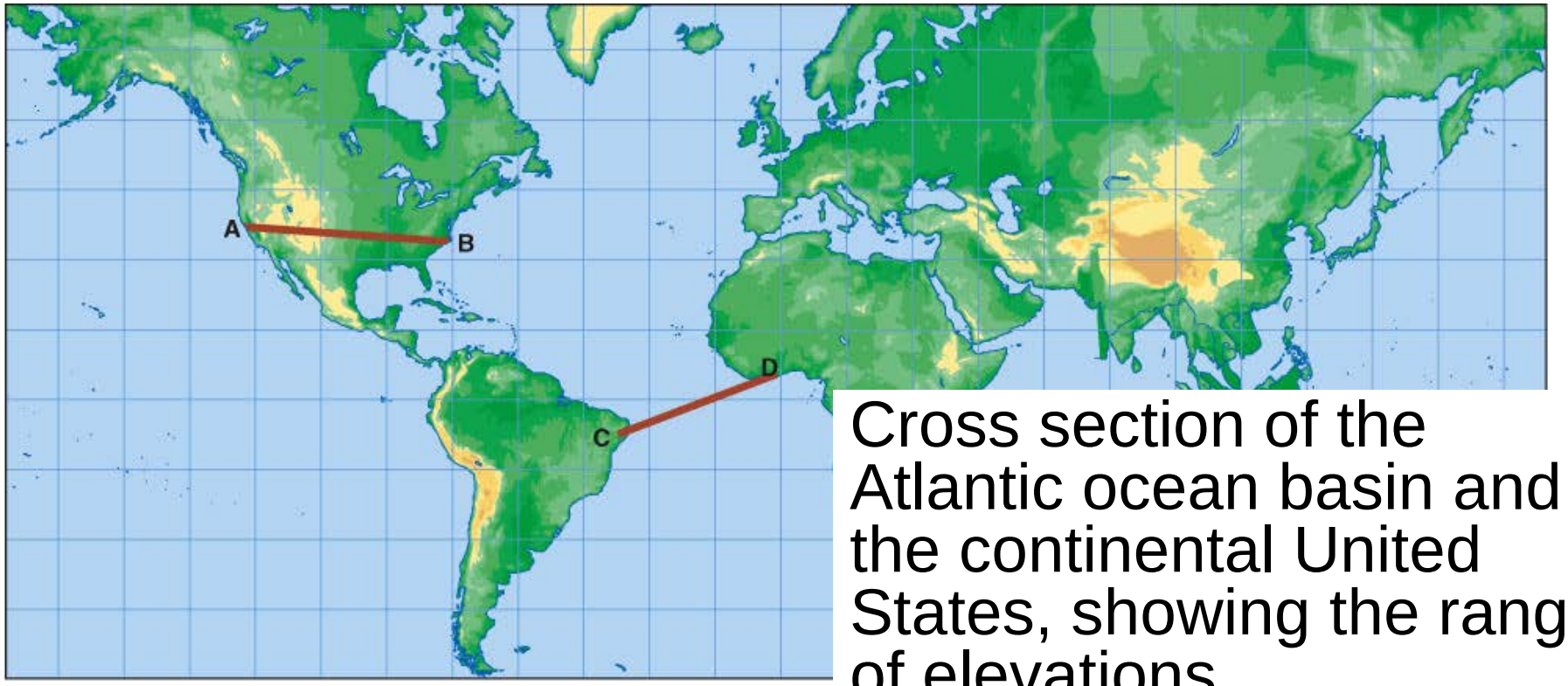
- Measures small variations in elevation of surface water



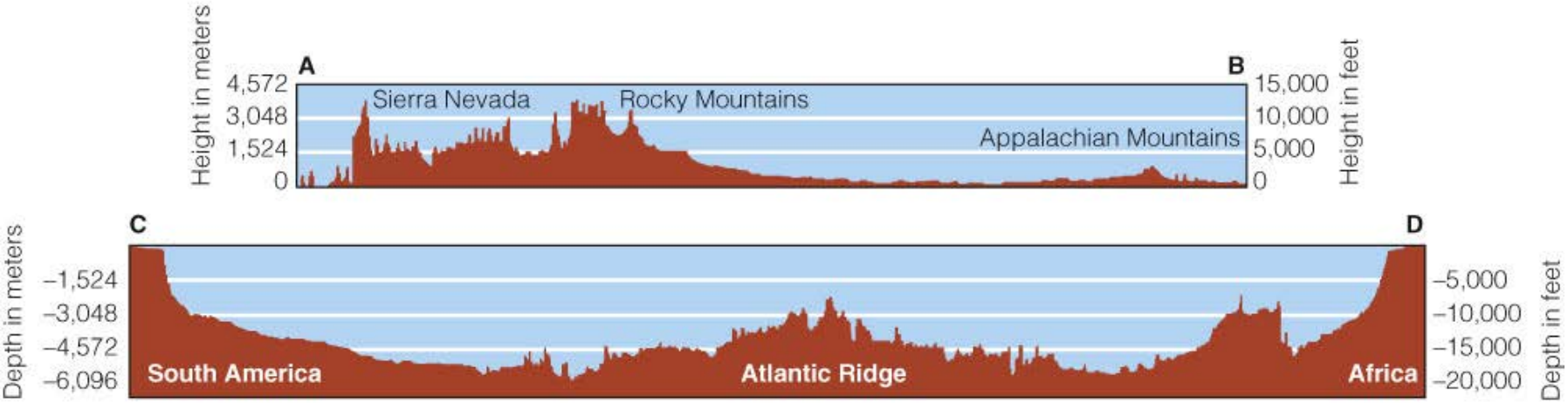
Geosat, a U.S. Navy satellite (1985-90), measured sea surface height from orbit. Moving at 7 km (4 mil)/sec. Geosat bounced 1,000 pulses of radar energy off the ocean every second. Height accuracy was within 0.03 m (1 in).

Distortion of sea surface above a seabed feature when the extra gravitational attraction "pulls" water toward it from the sides, forming a mound of water over itself.

The Topography of Ocean Floors



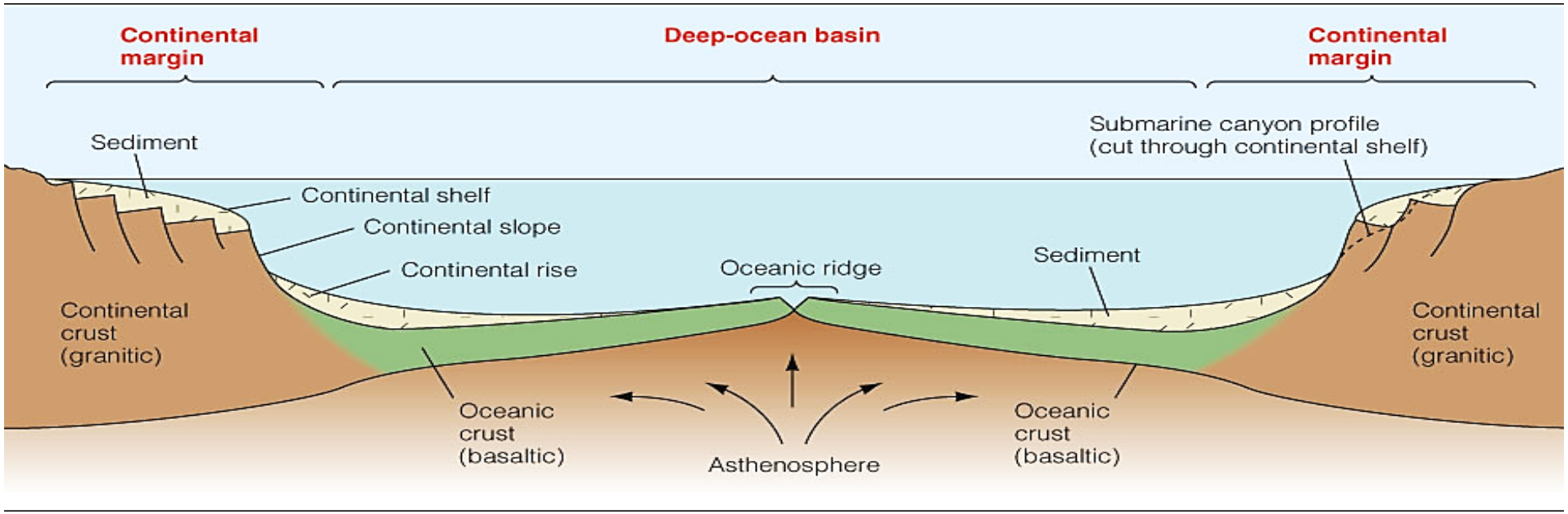
Cross section of the Atlantic ocean basin and the continental United States, showing the range of elevations.



What are the two classifications of the ocean floor?

Continental Margins = submerged outer edge of a continent

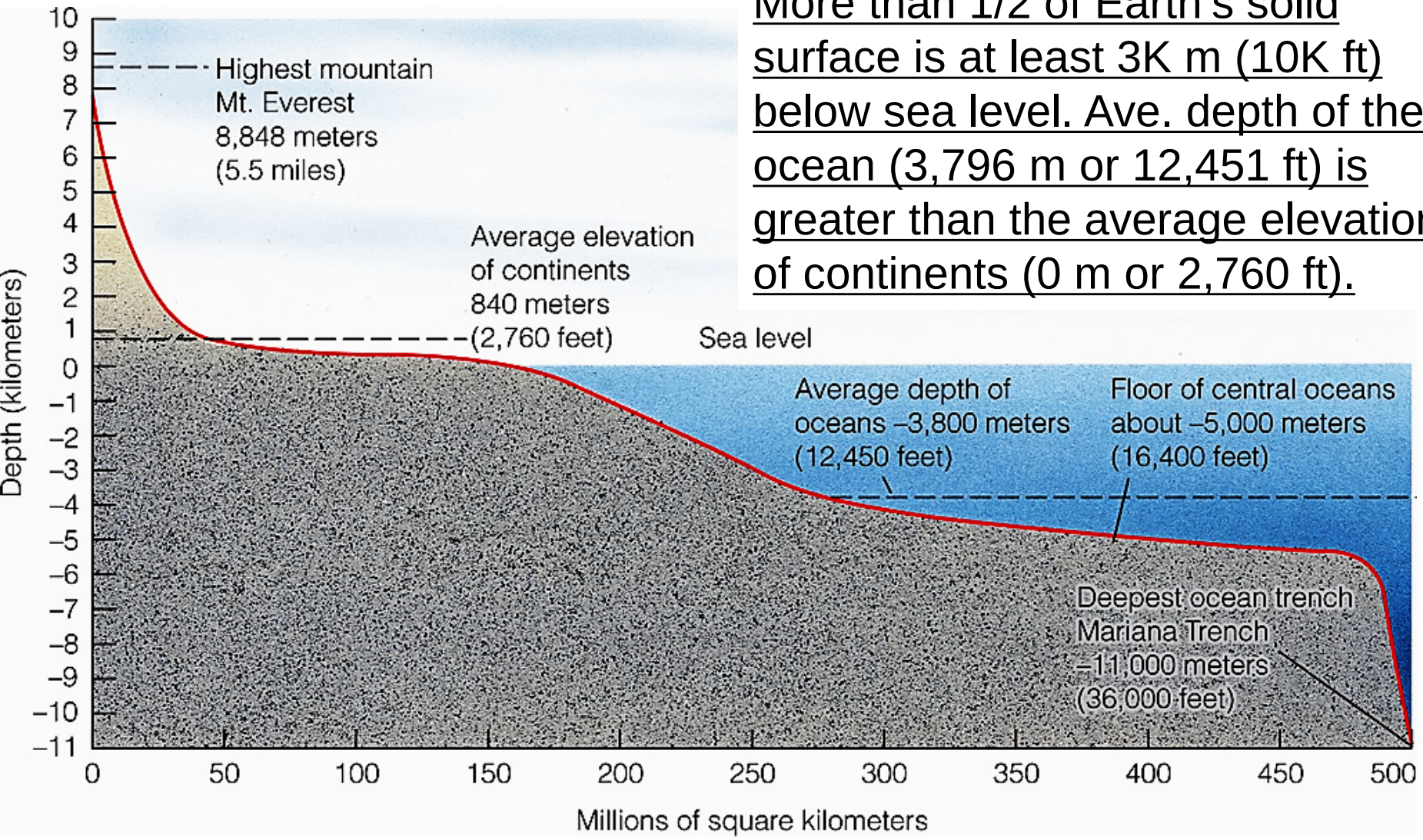
Ocean Basin = deep seafloor beyond the continental margin



Ocean-Floor Topography Varies with Location

- Continental crust differs from oceanic crust

More than 1/2 of Earth's solid surface is at least 3K m (10K ft) below sea level. Ave. depth of the ocean (3,796 m or 12,451 ft) is greater than the average elevation of continents (0 m or 2,760 ft).



Continental Margins May Be Active or Passive

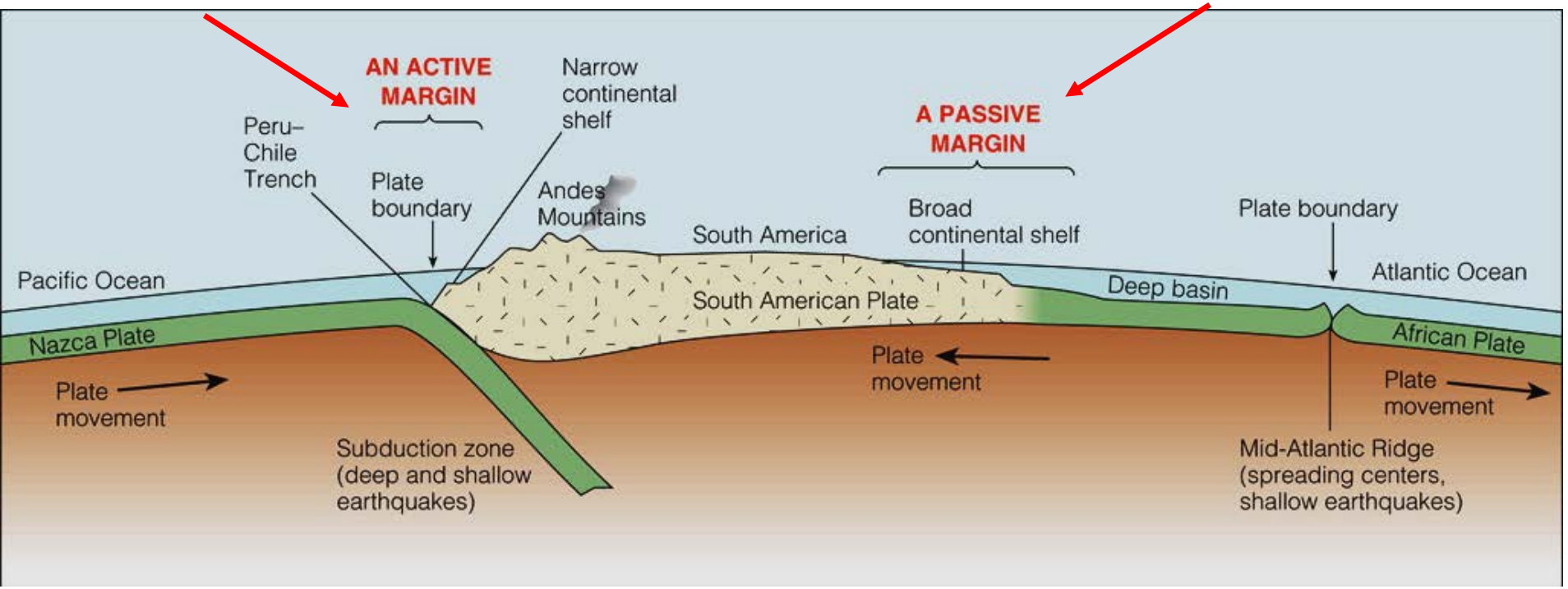
- Passive margins – little tectonic activity, (Atlantic-type), face the edges of diverging tectonic plates. Very little volcanic or earthquake activity, broad have gentile inclines, and influenced more by sea level changes.

- Active margins – lots of tectonic activity, (Pacific-type), are located near the edges of converging plates. Sites of volcanic and earthquake activity, not as broad, steeper inclines, not effected as much by sea level changes.

Typical Continental Margins Bordering the Active Edges of a Moving Continent

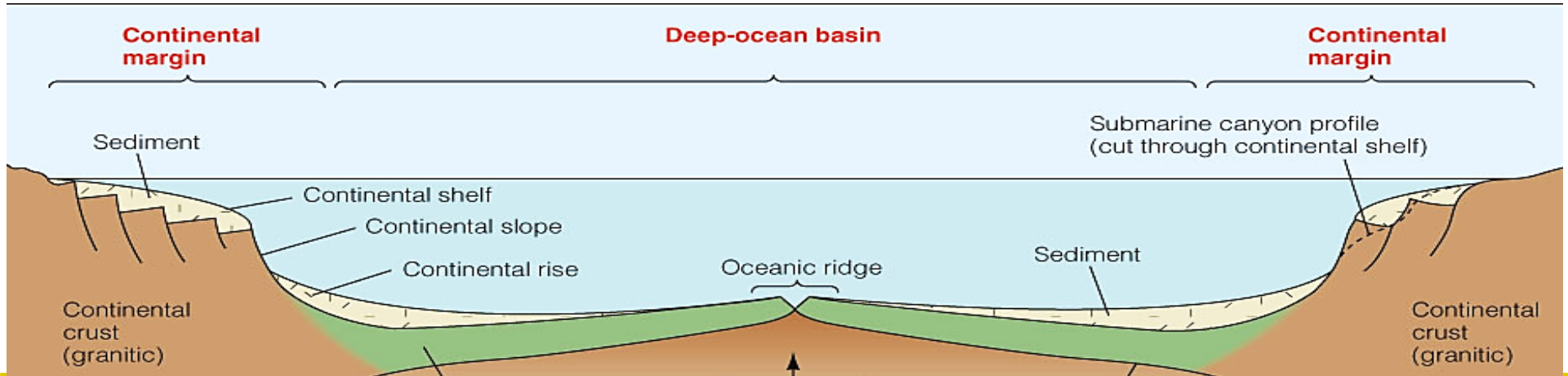
Pacific-type

Atlantic-type



Anatomy of a continental margin

- **Continental shelf** – the shallow, submerged edge of the continent.
- **Shelf break-** marks the transition from the continental shelf to the continental slope.
- **Continental slope** – the transition between the continental shelf and the deep-ocean floor.
- **Continental rise** – accumulated sediment found at the base of the continental slope.

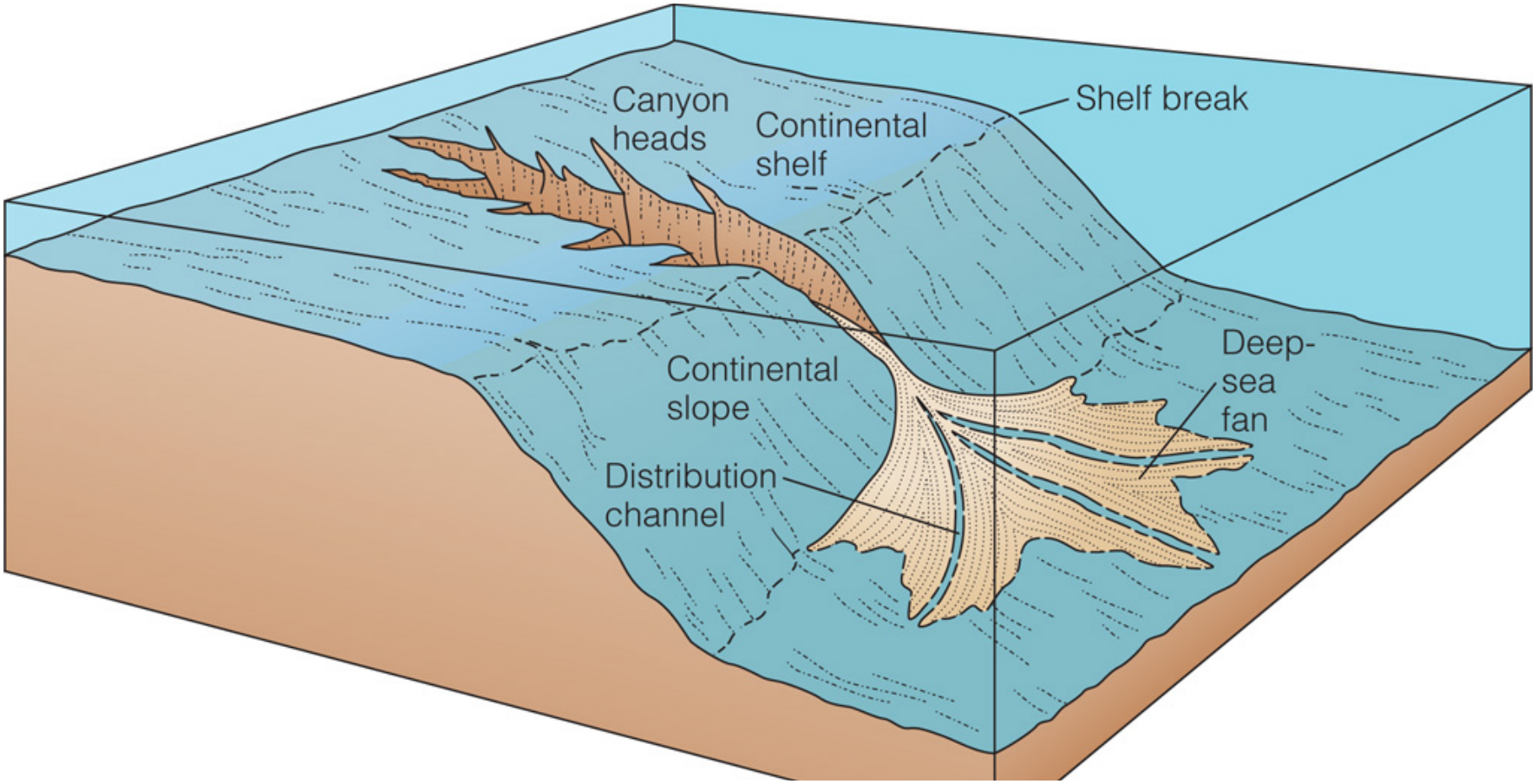


Continental Slope

- Transition between shelf and deep-ocean floor
  - Formed of sediments, inclined about 4º
  - Shelf break – abrupt transition
- Submarine canyons
  - Cut into the continental shelf and slope
  - Formed by turbidity currents
    - Sediment mixed with water – denser than surrounding water

Continental Rise

- Forms from accumulated sediment at the bottom of the continental slope



Submarine canyons are a feature of some continental margins. They cut into the continental shelf and slope, often terminating on the deep-sea floor in a fan-shaped wedge of sediment.

Other ocean basin features

- **Submarine canyons-** deep cuts into the continental shelf, and slope.
- **Abyssal plains-** flat featureless expanses of ocean basin (floor)
- **Abyssal hills-** extend out of sediment of abyssal plains
- **Oceanic ridges-** underwater mountain chains formed at spreading zones.
- **Seamounts**- submerged volcanic projections
- **Guyots**- submerged flat top projections that formed from eroded seamounts.
- **Trenches**- deep depressions formed by subducted plates

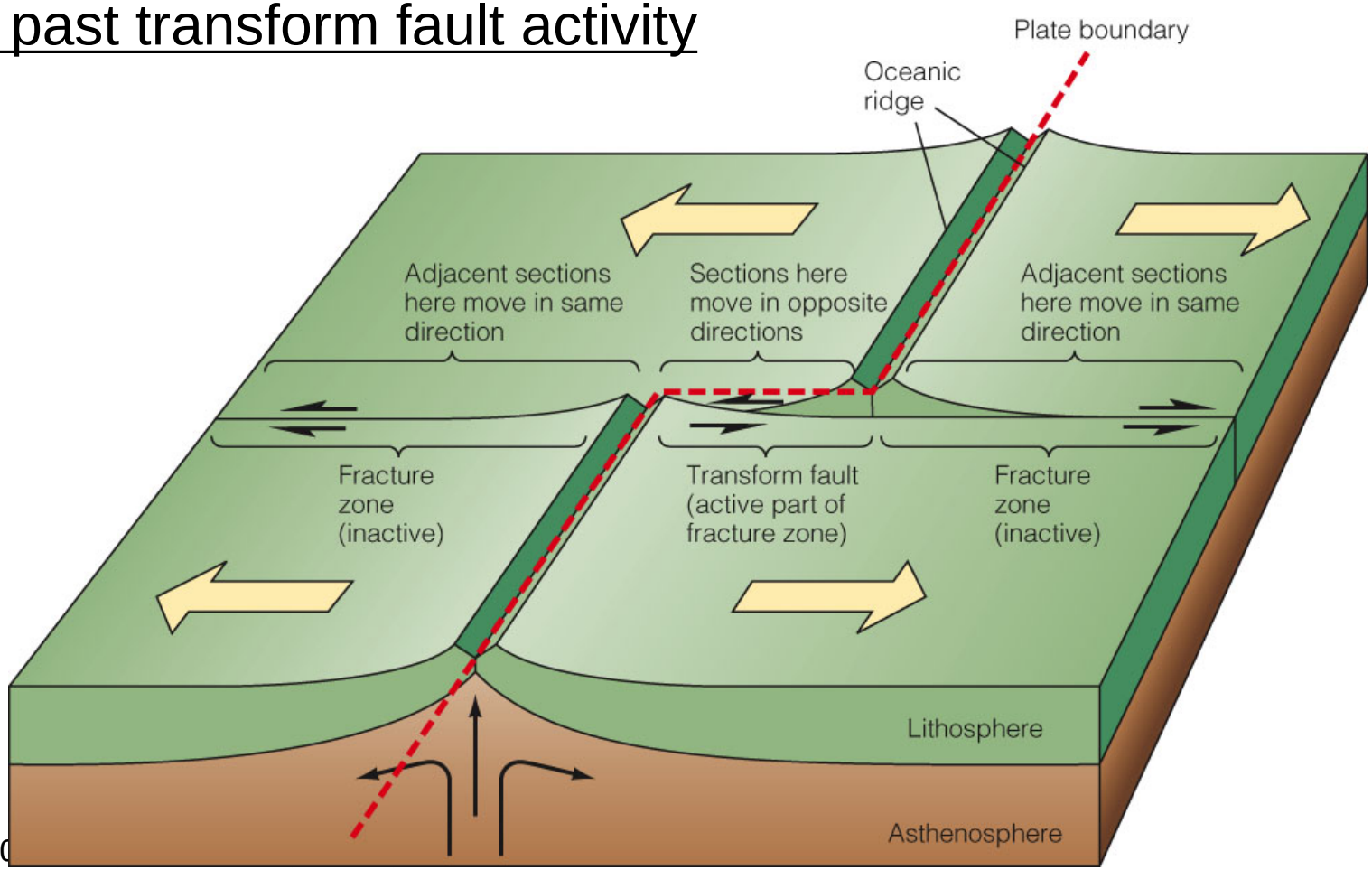
Oceanic Ridges Circle the World

- Ocean ridges-Mountainous chain of young basaltic rock at an active spreading center

Transform faults and fracture zones

Mid-Atlantic ridge displaced by transform faults (active part of fracture zones)

Fracture zones – seismically inactive areas that show evidence of past transform fault activity

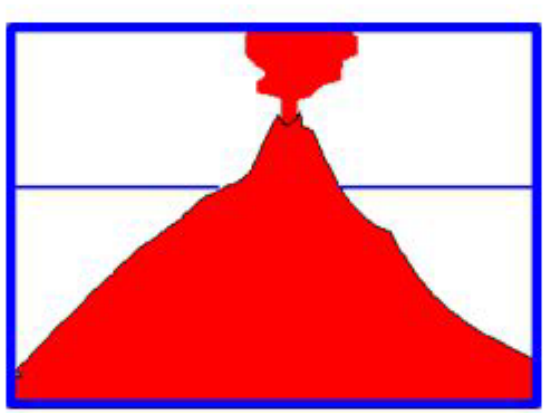


Heinrich Berann's Hand-Drawn Map of a Portion of the Atlantic Ocean Floor

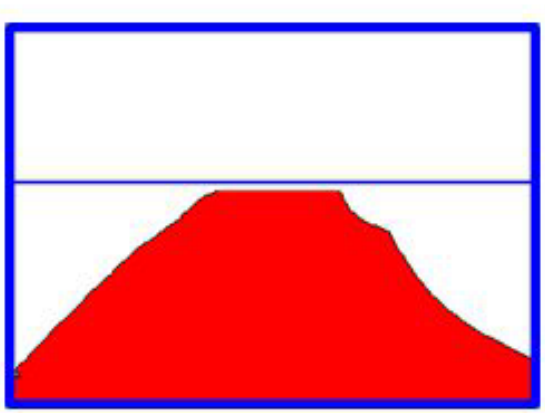
Hydrothermal Vents and Volcanic Seamounts to Guyots

- Hydrothermal vents
  - Superheated, chemically active water circulating around mid-ocean ridges
- Volcanic seamounts
  - Guyot –

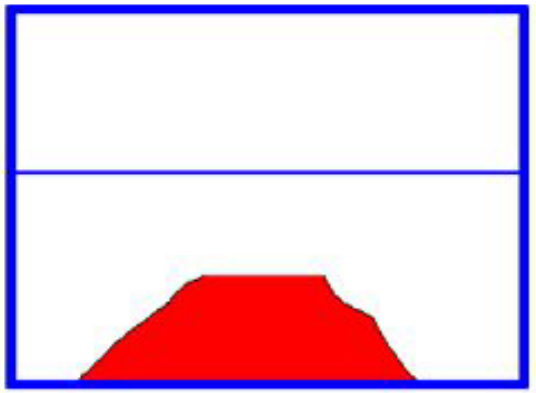
flat-topped seamount



Seamount rises above water

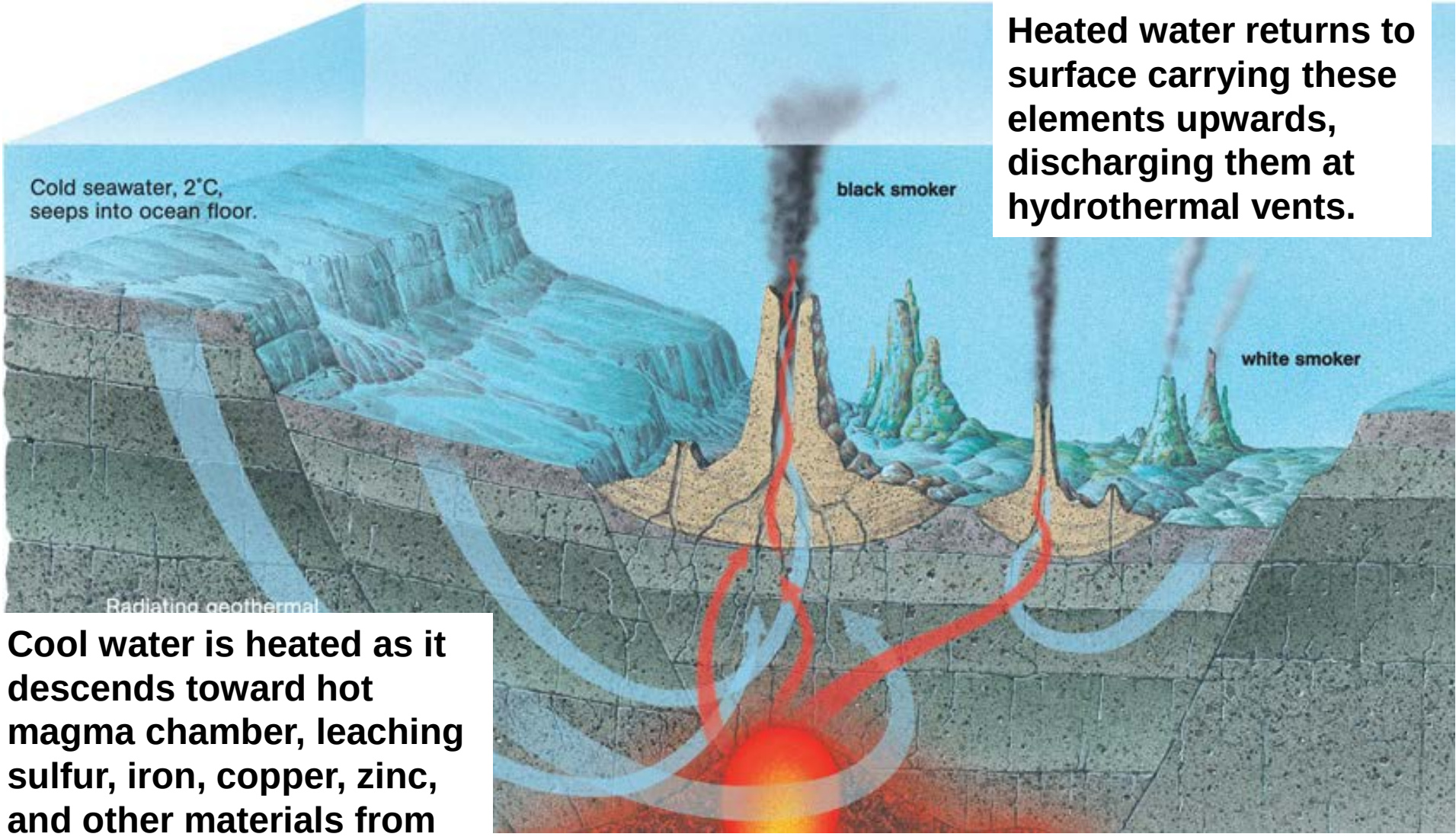


Erosion by waves flattens the top of the mount



The seamount becomes submerged to form a Guyot

Cross-Section of the Central Part of a Mid-Ocean Ridge

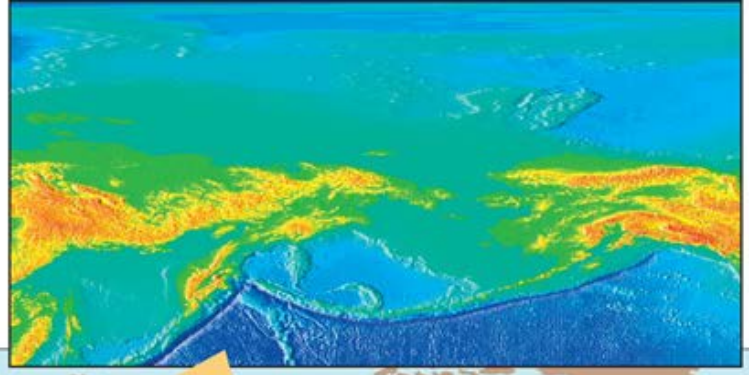


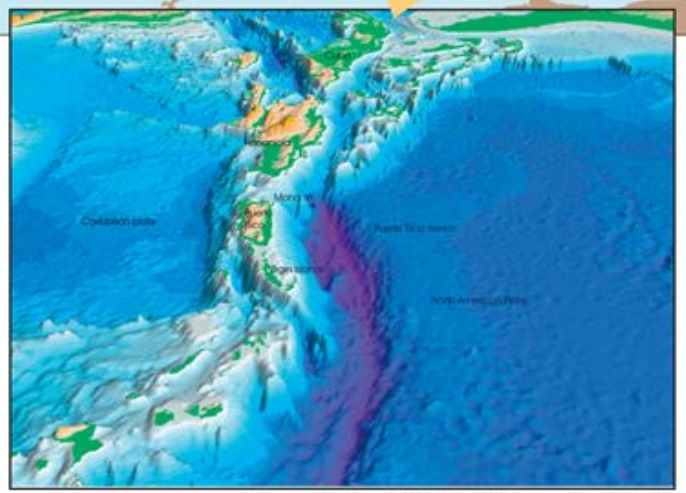
Heated water returns to surface carrying these elements upwards, discharging them at hydrothermal vents.

Cool water is heated as it descends toward hot magma chamber, leaching sulfur, iron, copper, zinc, and other materials from surrounding rocks.

Trenches and Island Arcs Form in Subduction Zones

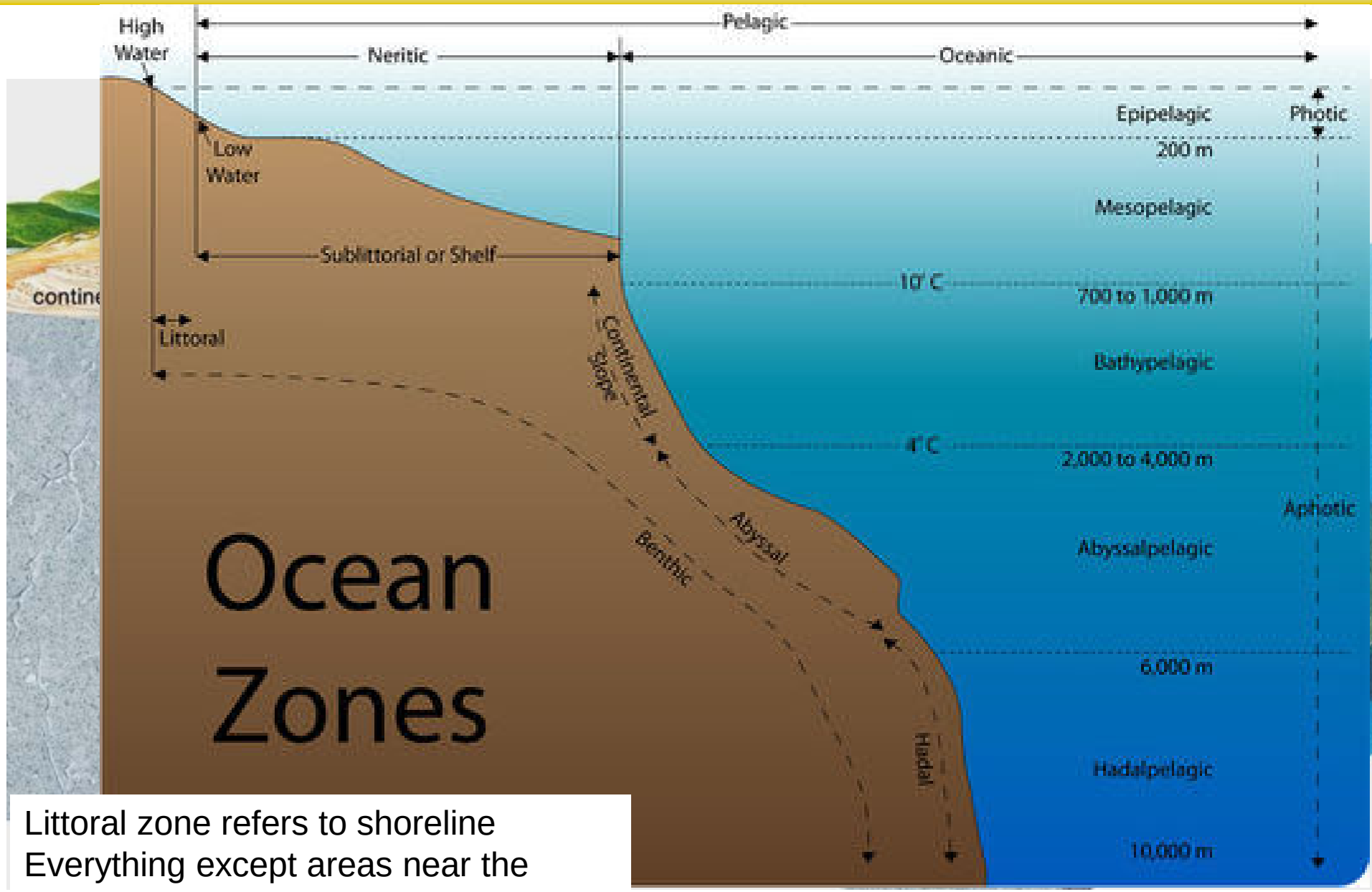
- Arc-shaped depressions in deep-ocean floor caused by subduction of a converging plate
- Most trenches are around the edges of the active Pacific.
- Trenches are the deepest places in Earth's crust :3-6 km (1.9-3.7 mi) deeper than adjacent basin floor.
- Ocean's greatest depth is Mariana Trench 11km (~ 7mi) below sea level.
  - Island arc – curving chain of volcanic islands and seamounts
    - Found parallel to trenches





top to bottom: NOAA; © Cengage Learning; USGS

Marine Environment Classified in Distinct Zones



Littoral zone refers to shoreline
Everything except areas near the coast and sea floor is the pelagic zone