Ch 2, part II

A Detailed Look at Seafloor Spreading

- Mid-ocean ridges discovered by Harry H. Hess

- Validity of seafloor spreading established by:
  - Identification and mapping of oceanic ridges
  - Dating of volcanic rocks on the floor of the ocean
  - Understanding and mapping of the paleomagnetic history of ocean basins

Paleomagnetism

- Earth's magnetic field can be represented by dipole
  - Forces extend from North to South Poles
  - Caused by convection in the outer core

- Magnetic field has permanently magnetized some surface rocks at the time of their formation
  - Iron-bearing minerals orient themselves parallel to the magnetic field at the critical temperature known as *Curie Point*

- Paleomagnetism is the study of magnetism of such rocks

Magnetic Reversals

- Volcanic rocks show magnetism in opposite direction as today
- Earth's magnetic field has reversed
  - Cause not well known
  - Reversals are random
- Occur on average every_____years?

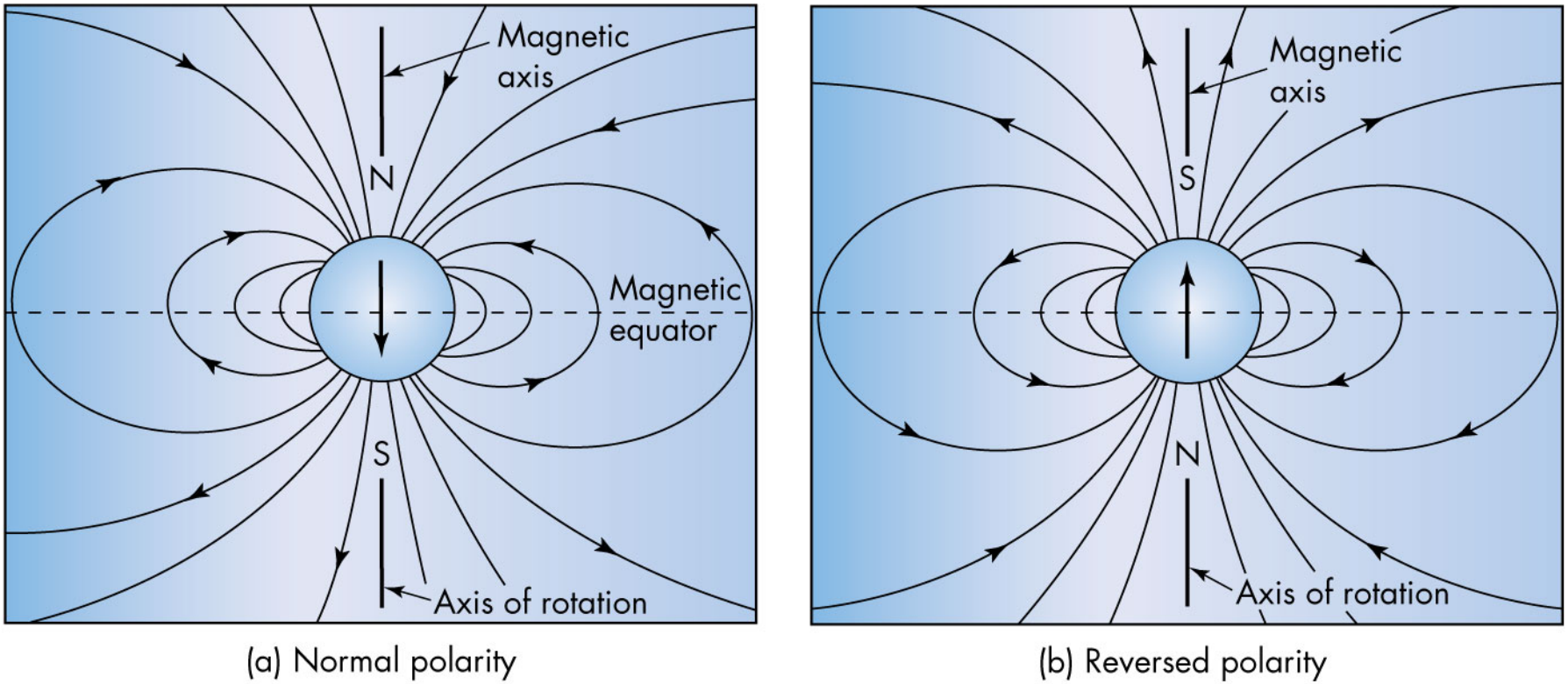


Figure 2.13

Magnetic Stripes

- Geologists towed magnetometers along ocean floor
  - Instruments that measure magnetic properties of rocks
- When mapped, the ocean floor had stripes
  - Areas of “regular” and “irregular” magnetic fields
- Stripes were parallel to oceanic ridges
- Sequences of stripe width patterns matched the sequences established by geologists on land

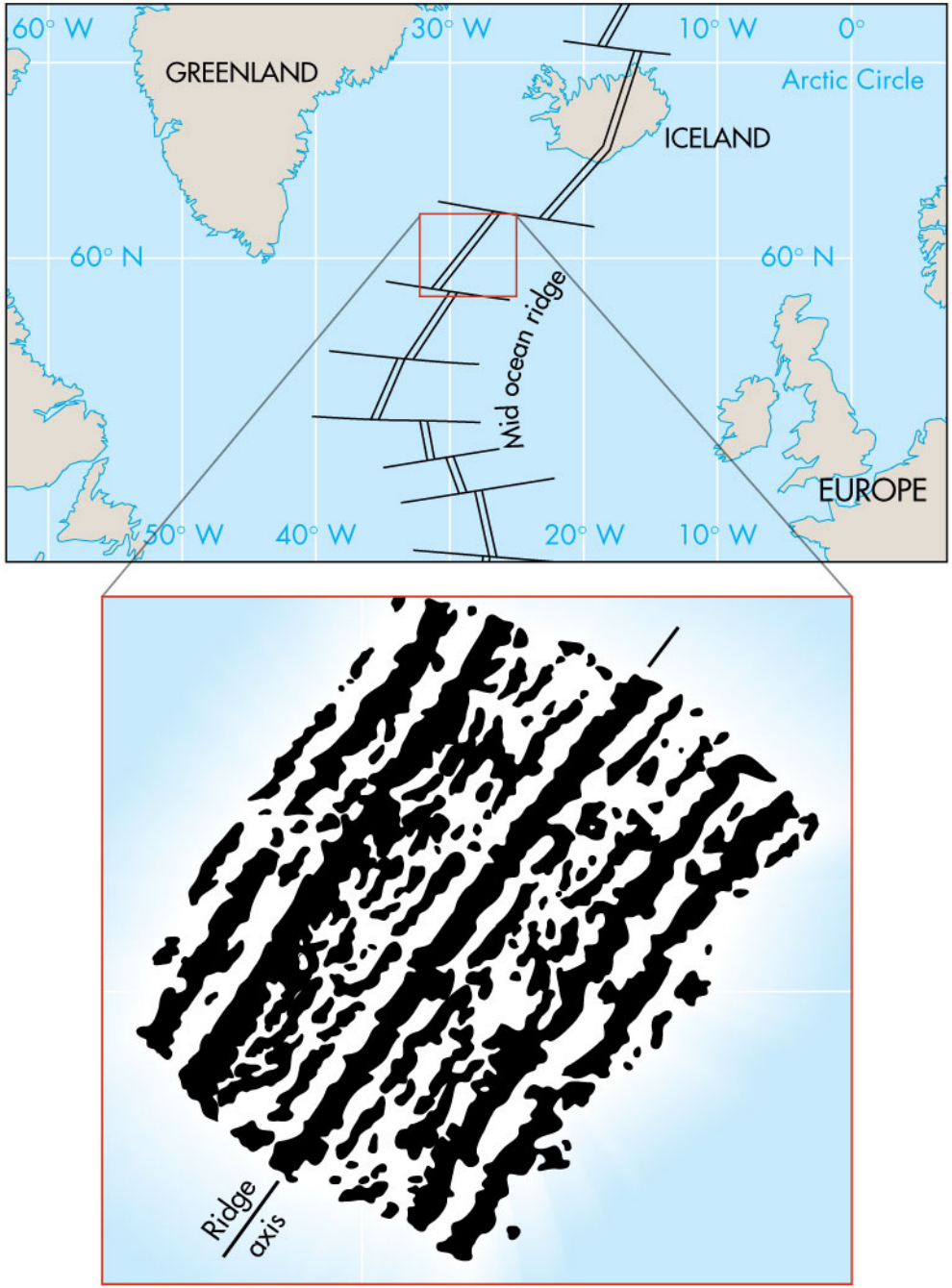


Figure 2.14

Seafloor Age

- Using the magnetic anomalies, geologists can infer ages for the ocean rocks
- Seafloor is no older than 200 million years old
- Spreading at the mid-ocean ridges can explain stripe patterns
- Rising magma at ridge is extruded
  - Cooling rocks are normally magnetized
  - Field is reversed with new rocks that push old rocks away

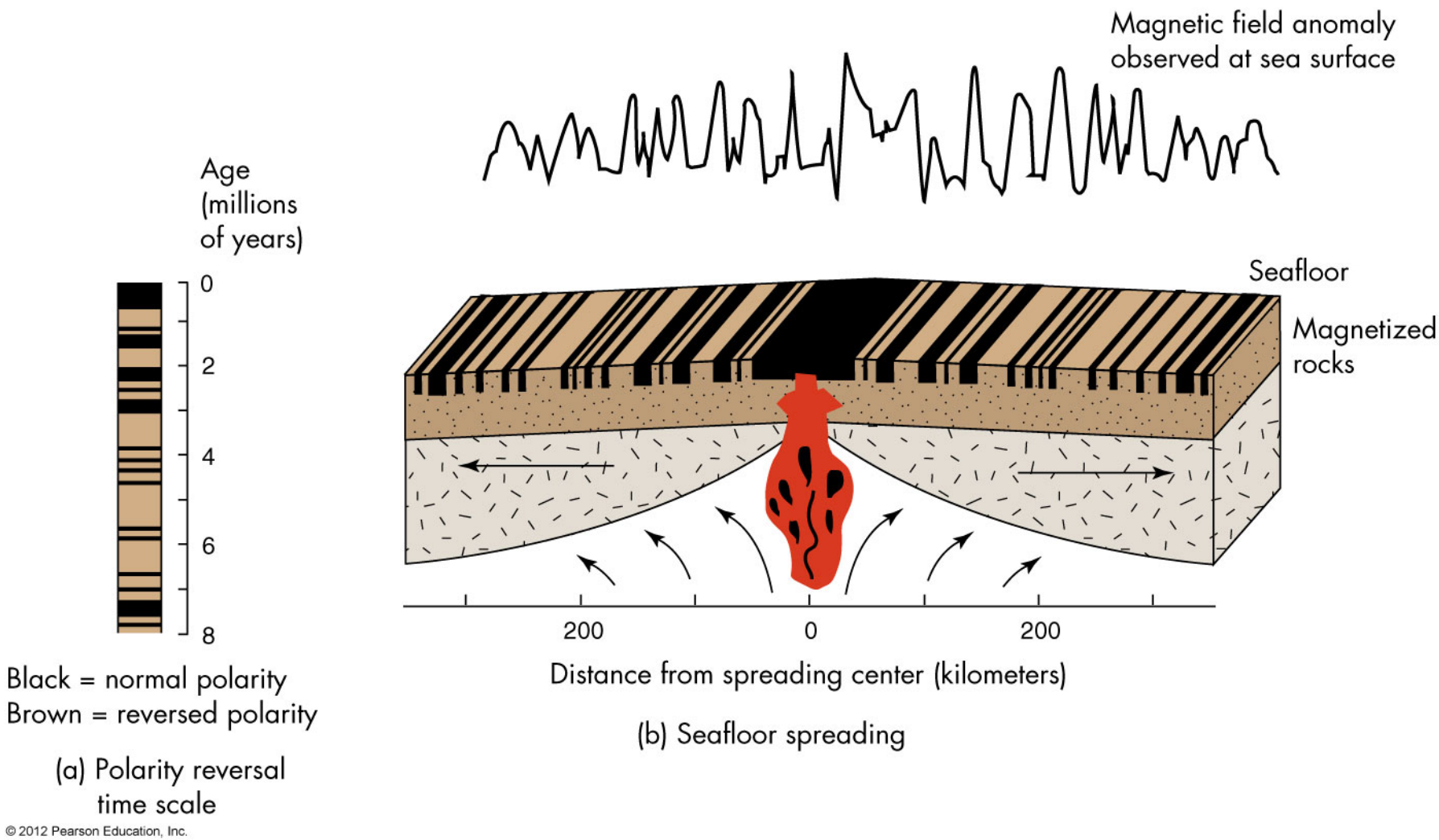


Figure 2.15

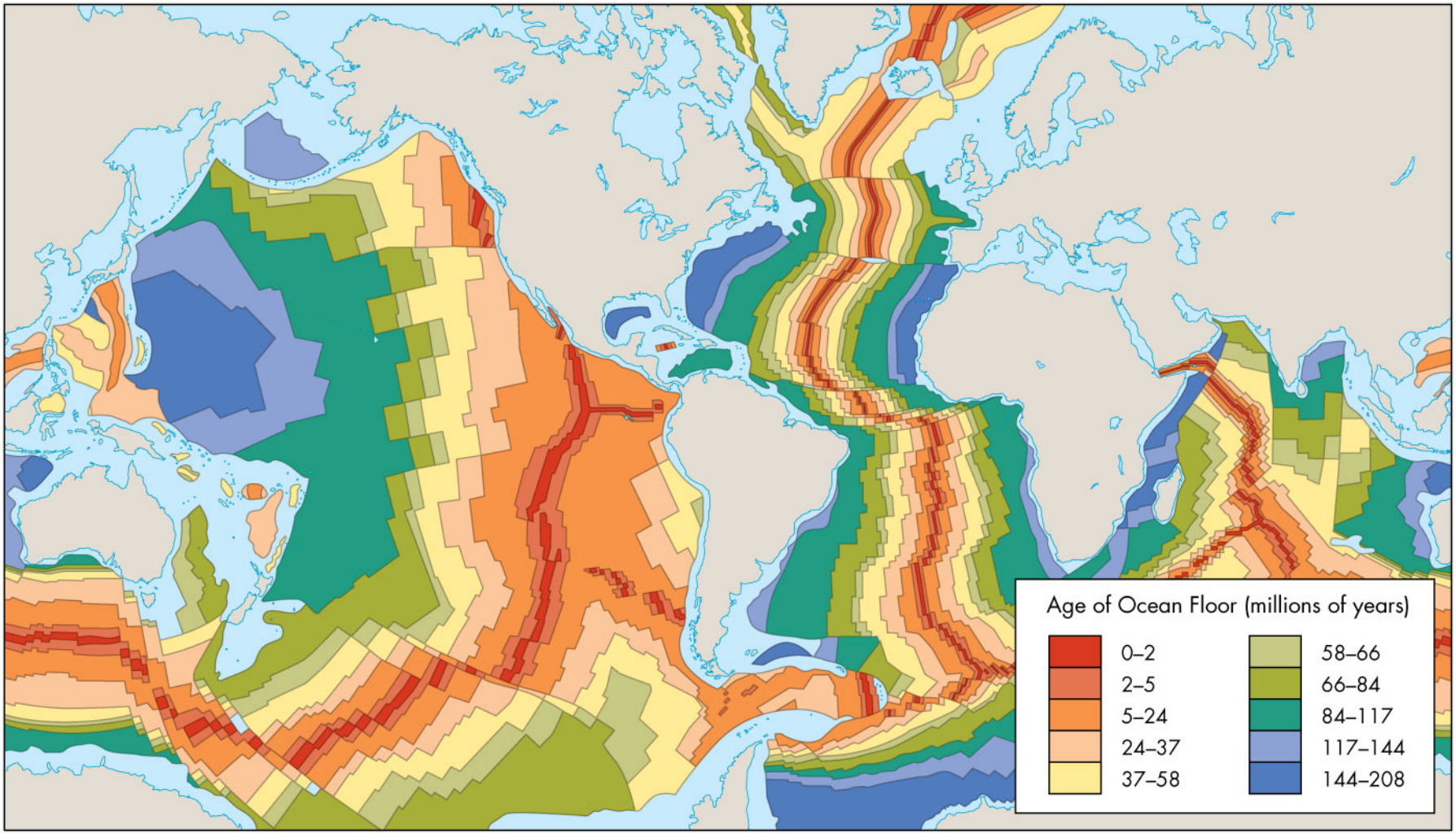


Figure 2.16

Hot Spots

- Volcanic centers resulting from hot materials from deep in the mantle
- Materials move up through mantle and overlying plates
  - Found under both oceanic and continental crust
- Plates move over hot spots creating a chain of island volcanoes
  - Seamounts are submarine volcanoes
  - Example: Hawaiian Island Chain

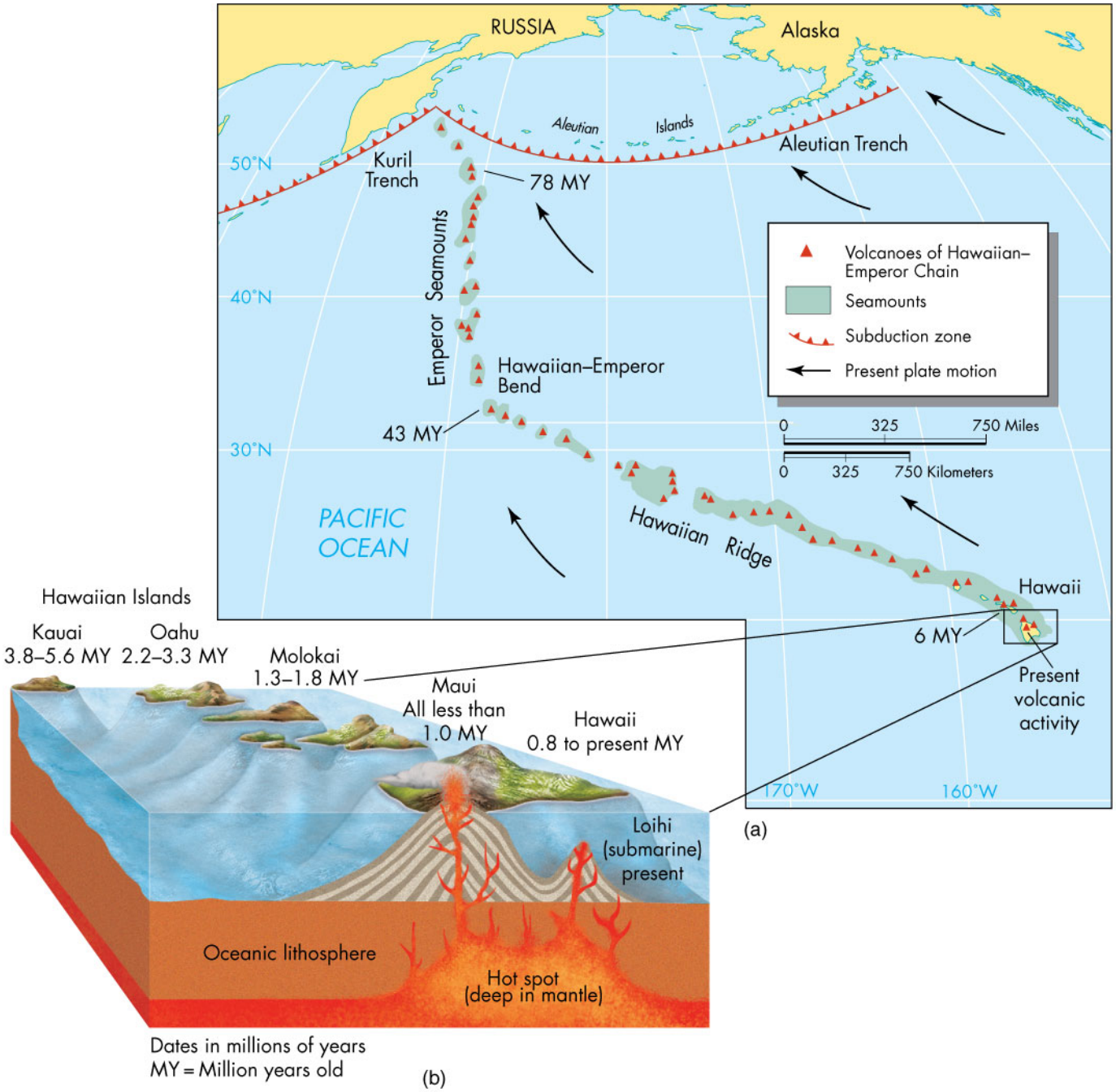
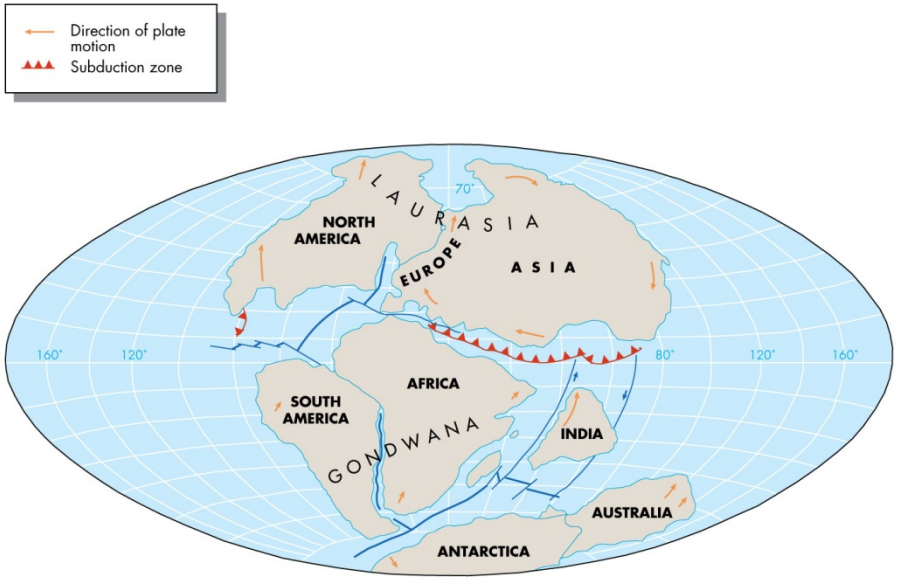


Figure 2.17

Plate Tectonics, Continental Shape and Mountain Ranges

- Movement of plates is responsible for present shapes and locations of continents
- 180 million years ago there was the break-up of Pangaea
  - Supercontinent extending from pole to pole and halfway around Earth
- Seafloor spreading 200 million years ago separated Eurasia and North America from southern continents; Eurasian from North America; southern continents from each other
- 50 Million years ago India crashed into China creating the Himalayas

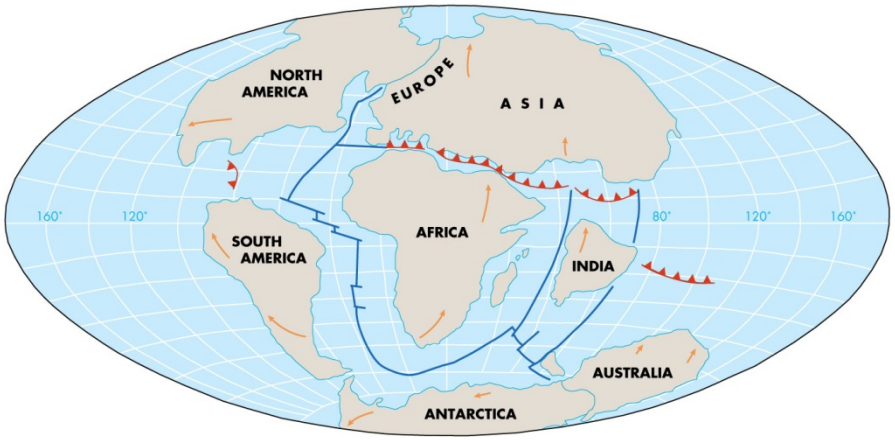
(a) 180 million years ago



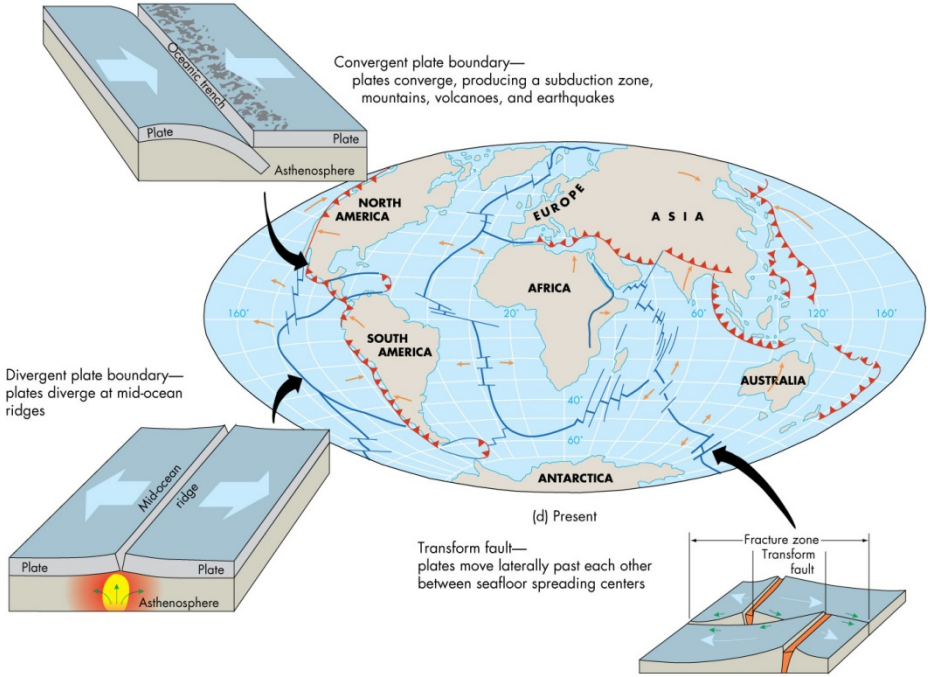
(b) 135 million years ago

Direction of plate motion
Subduction zone

Figure 2.18a, b



(c) 65 million years ago



(d) Present

Figure 2.18c, d

Understanding Plate Tectonics Solves Geologic Problems

- Reconstruction of Pangaea and recent continental drift clears up:
  - Fossil data difficult to explain with separated continents
  - Evidence of glaciation on several continents

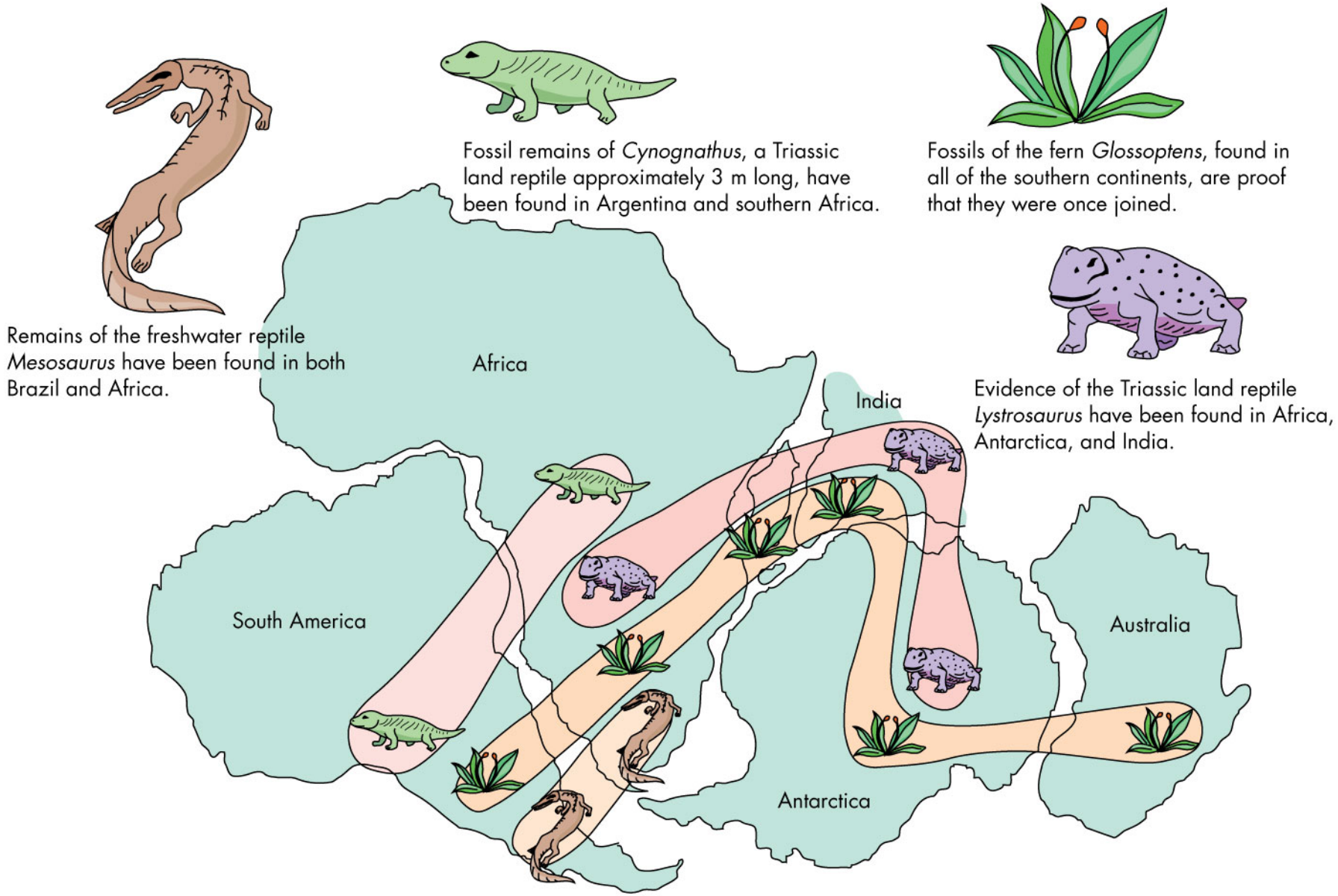
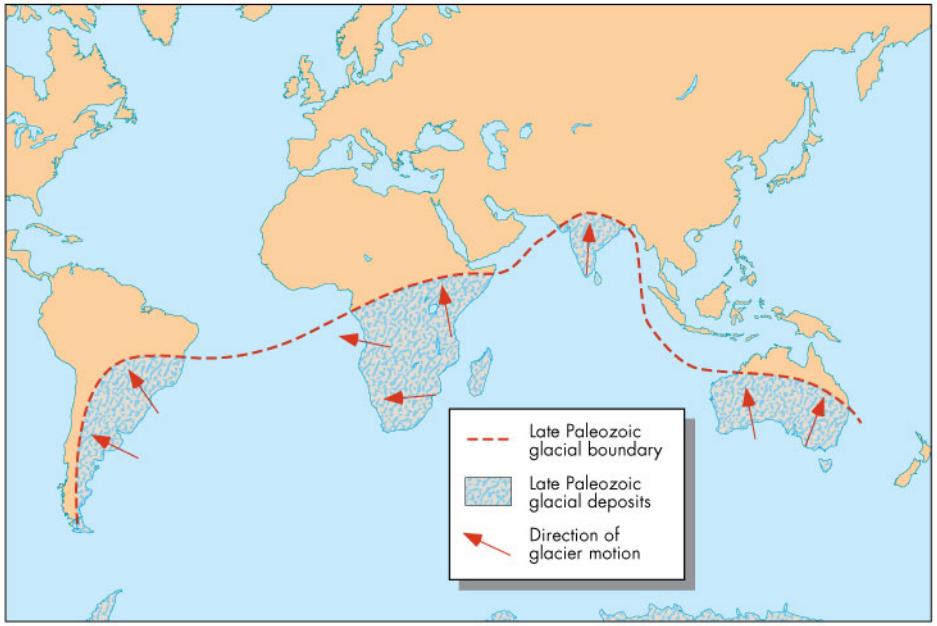
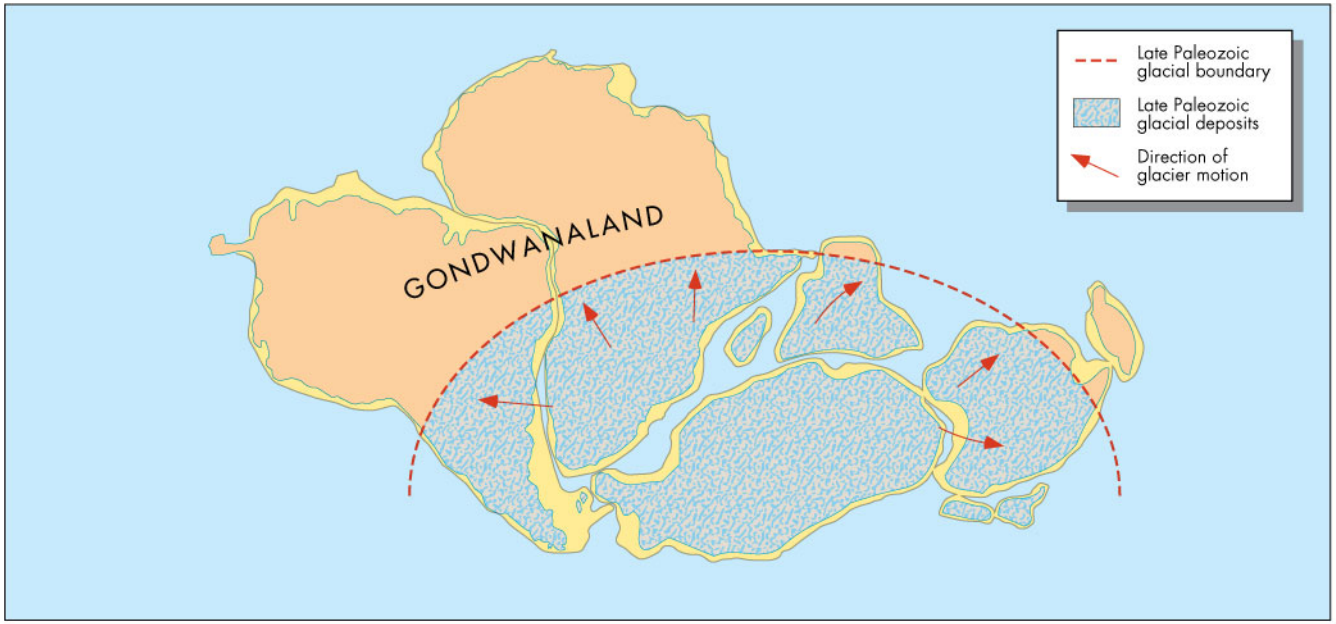


Figure 2.19



(a)



(b)

Figure 2.20

Driving Mechanism

- Two possible driving mechanisms for plate tectonics
  - Ridge Push and slab pull
- Ridge push is a gravitational push away from crest of mid-ocean ridges
- Slab pull occurs when cool, dense ocean plates sink into the hotter, less dense asthenosphere
  - Weight of the plate pulls the plate along
- Evidence suggests that slab pull is the more important process

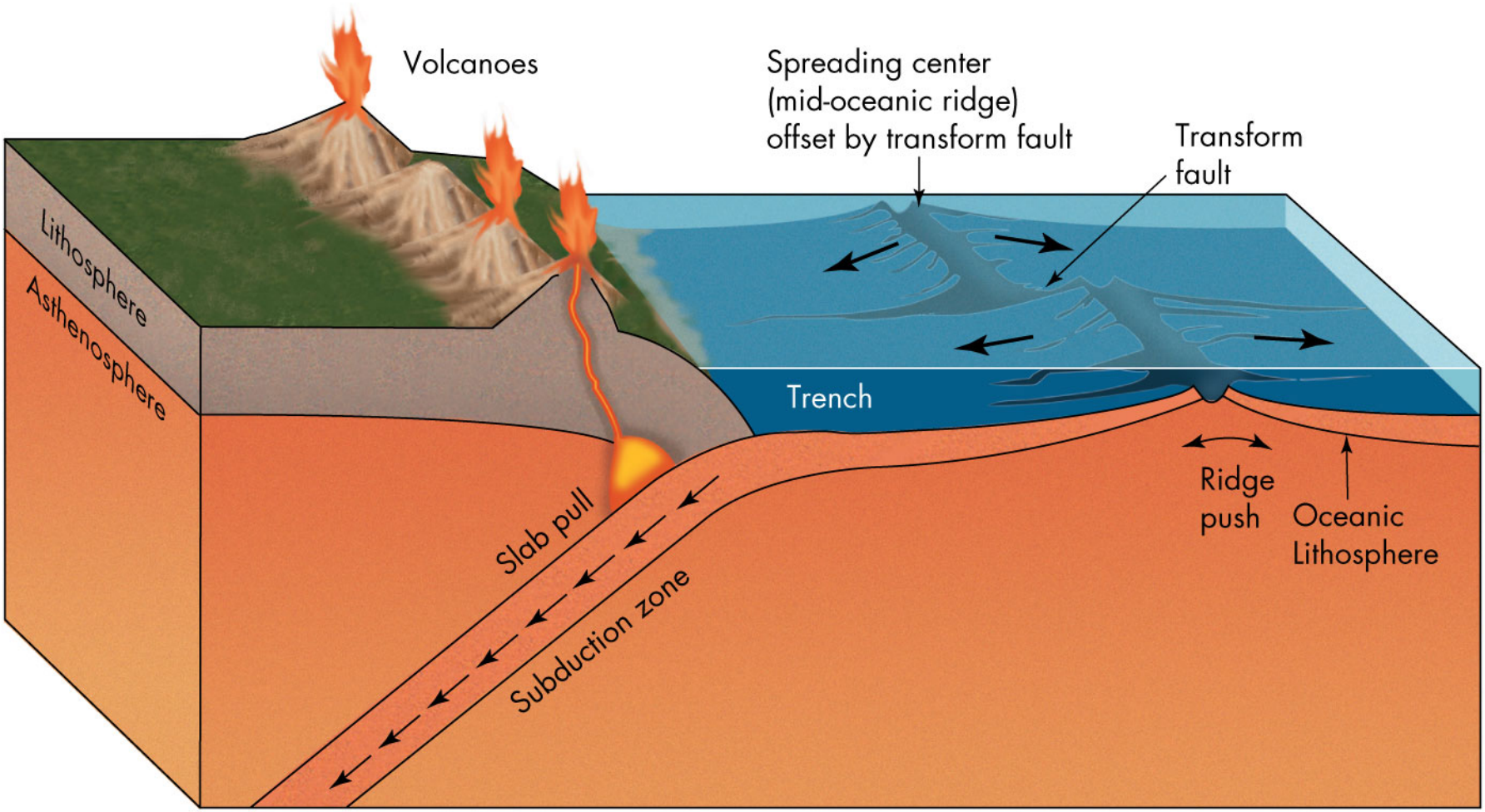


Figure 2.21

Plate Tectonics and Hazards

- Divergent plate boundaries (Mid-Atlantic Ridge) exhibit earthquakes and volcanic eruptions
- Boundaries that slide past each other (San Andreas Fault) have great earthquake hazards
- Convergent plate boundaries where one plate sinks (subduction zones) are home to explosive volcanoes and earthquake hazards
- Convergent plate boundaries where continents collide (Himalayas) have high topography and earthquakes

End

Annenberg's "Earth Revealed" Series:

http://www.learner.org/resources/series78.html

Rock Cycle w/ Quiz:

http://www.learner.org/interactives/rockcycle/index.html

Earth's Structure, Plate Tectonics, Quiz:

http://www.learner.org/interactives/dynamicearth/index.html

Internal Structure of
Earth and Plate Tectonics

Chapter 2