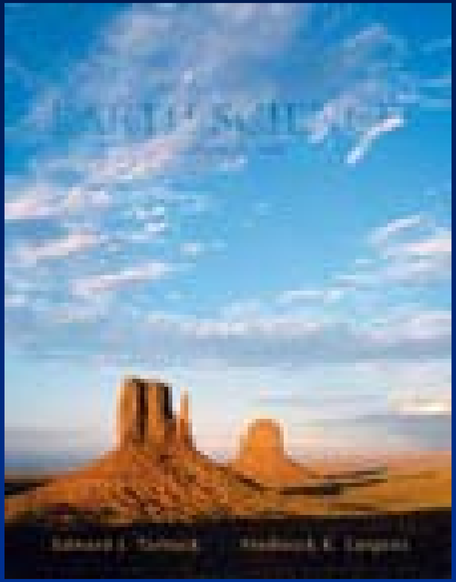


Lecture Outlines PowerPoint

Chapter 7

Earth Science, 12e

Tarbuck/Lutgens

Earth Science, 12e

Plate Tectonics: A Scientific Theory Unfolds

Chapter 7

Continental drift: an idea before its time

- Alfred Wegener
  - First proposed hypothesis, 1915
  - Published *The Origin of Continents and Oceans*
- Continental drift hypothesis
  - Supercontinent called Pangaea began breaking apart about 200 million years ago
  - Continents “drifted” to present positions
  - Continents “broke” through the ocean crust

Pangaea approximately 200 million years ago

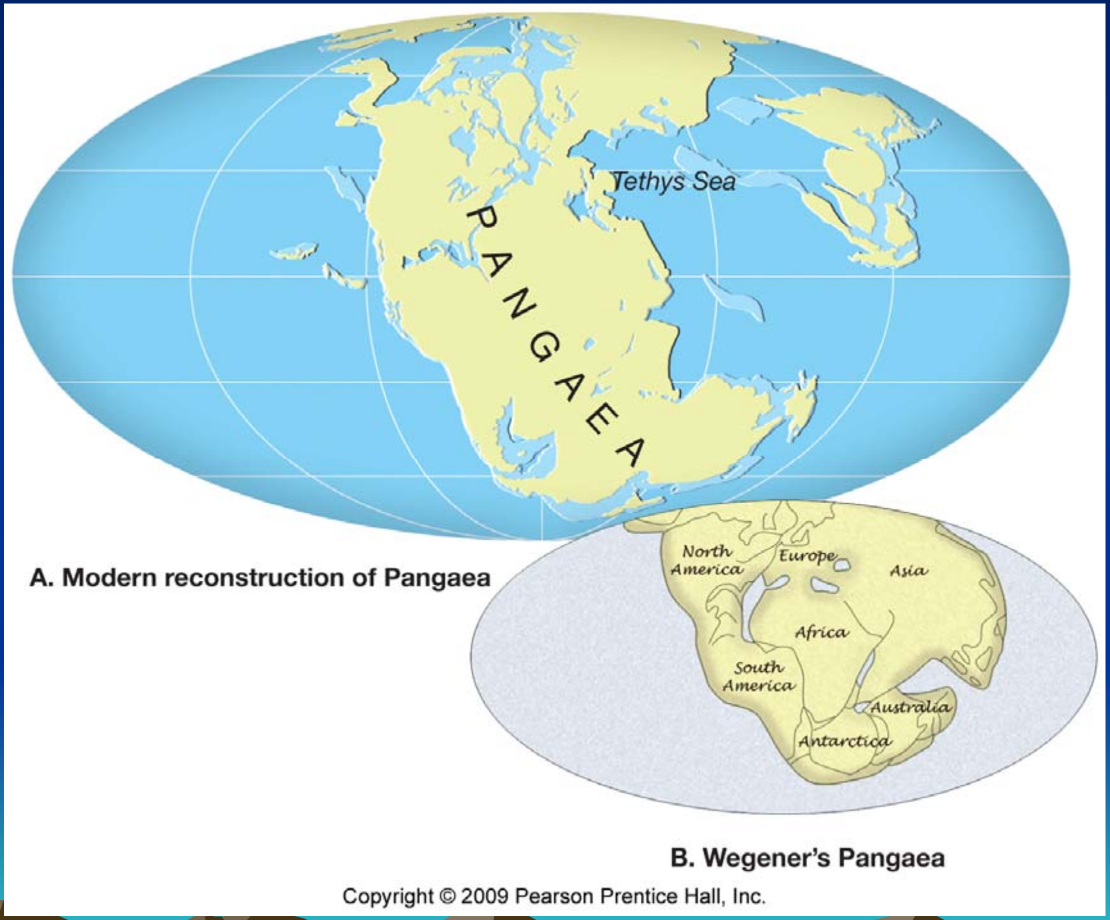


Figure 7.2

Continental drift: an idea before its time

- Wegener's continental drift hypothesis
  - Evidence used by Wegener
    - Fit of South America and Africa
    - Fossils match across the seas
    - Rock types and structures match
    - Ancient climates
  - Main objection to Wegener's proposal was its inability to provide a mechanism

Similar mountain ranges on different continents

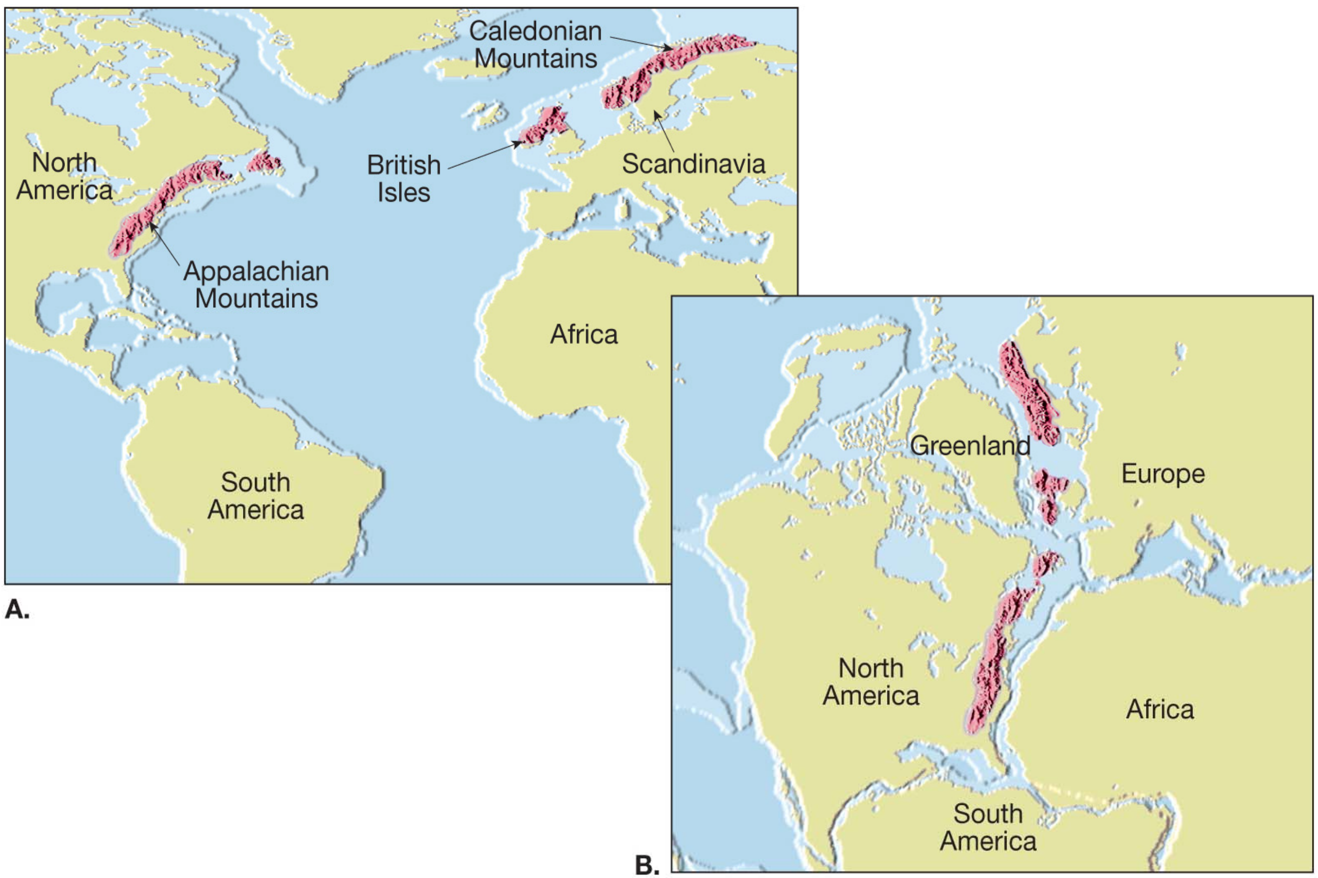
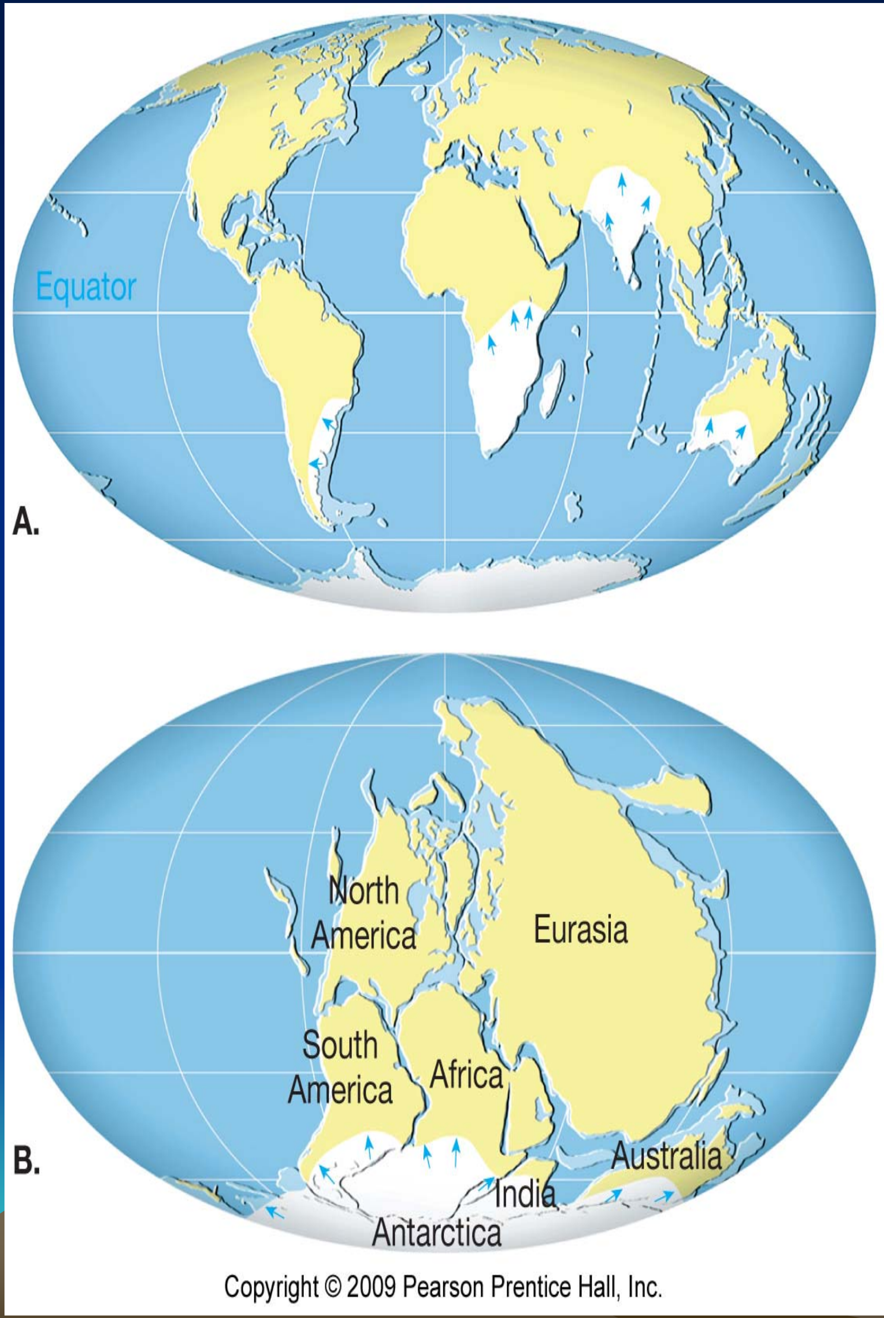


Figure 7.7



Paleoclimatic evidence for continental drift

Figure 7.8

Plate tectonics: the new paradigm

- More encompassing than continental drift
- Associated with Earth’s rigid outer shell
  - Called the lithosphere
  - Consists of several plates
    - Plates are moving slowly
    - Largest plate is the Pacific plate
    - Plates are mostly beneath the ocean

Plate tectonics: the new paradigm

- Asthenosphere
  - Exists beneath the lithosphere
  - Hotter and weaker than lithosphere
  - Allows for motion of lithosphere
- Plate boundaries
  - All major interactions among plates occur along their boundaries

Plate tectonics: the new paradigm

- Plate boundaries
  - Types of plate boundaries
    - Divergent plate boundaries (constructive margins)
      - Two plates move apart
      - Mantle material upwells to create new seafloor
      - Ocean ridges and seafloor spreading
        - Oceanic ridges develop along well-developed boundaries
        - Along ridges, seafloor spreading creates new seafloor

Divergent boundaries are located along oceanic ridges

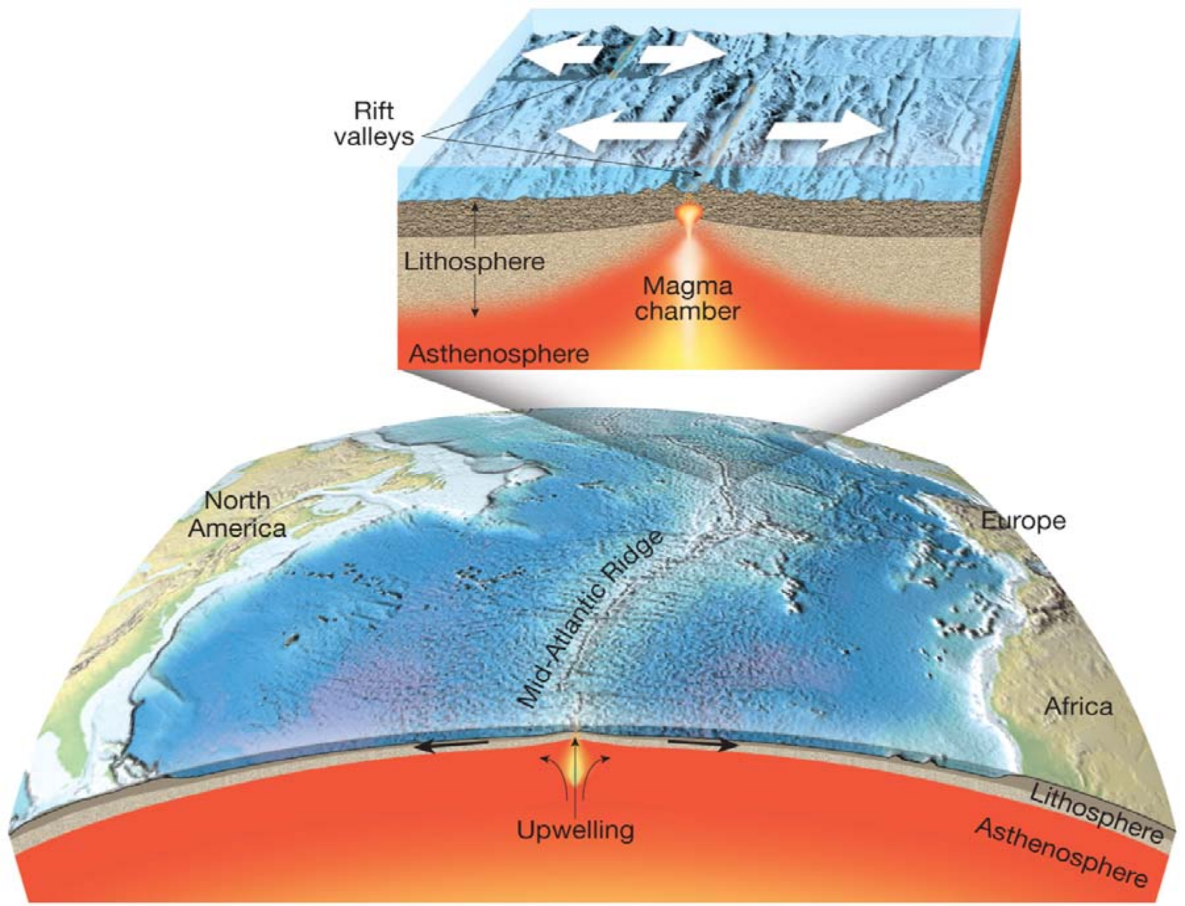


Figure 7.11

Plate tectonics: the new paradigm

- Plate boundaries
  - Types of plate boundaries
    - Divergent plate boundaries (constructive margins)
      - Continental rifts form at spreading centers within a continent
    - Convergent plate boundaries (destructive margins)
      - Plates collide, an ocean trench forms, and lithosphere is subducted into the mantle

The East African rift – a divergent boundary on land

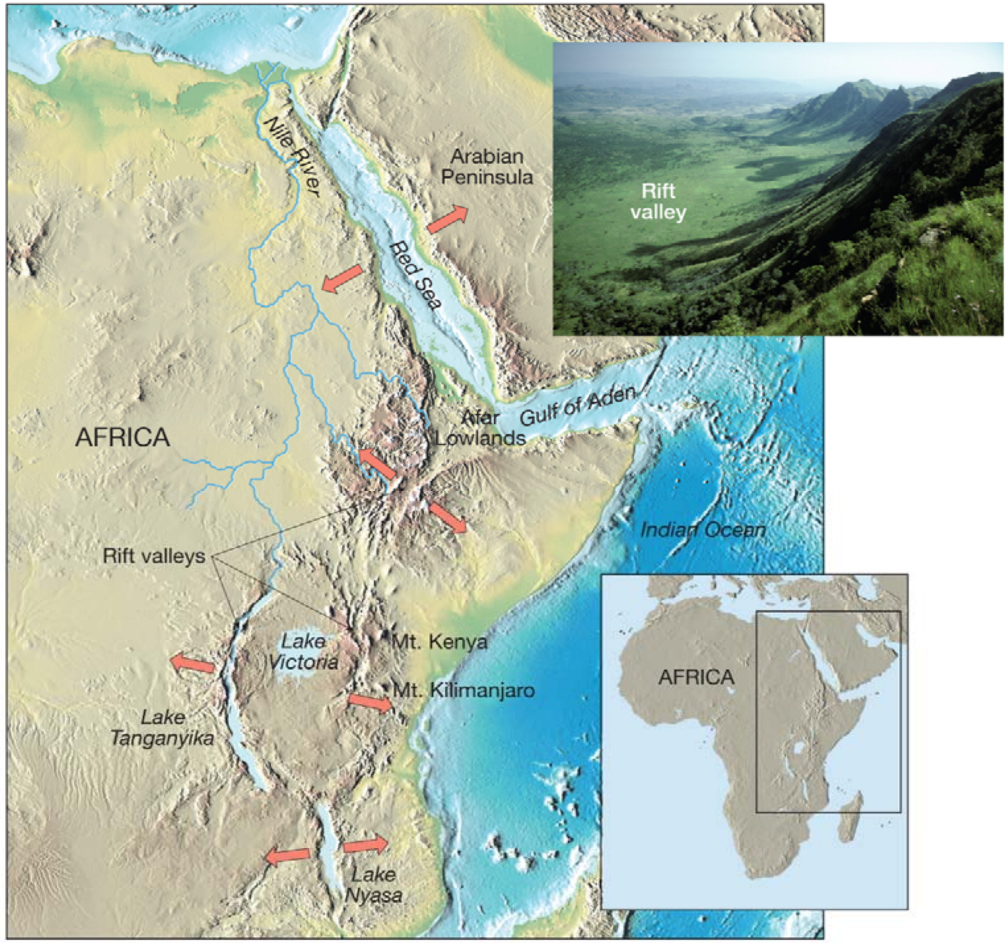


Figure 7.13

Plate tectonics: the new paradigm

- Plate boundaries
  - Types of plate boundaries
    - Convergent plate boundaries (destructive margins)
      - Oceanic–continental convergence
        - Denser oceanic slab sinks into the asthenosphere
        - Pockets of magma develop and rise
        - Continental volcanic arc forms
        - Examples include the Andes, Cascades, and the Sierra Nevadan system

An oceanic–continental convergent plate boundary

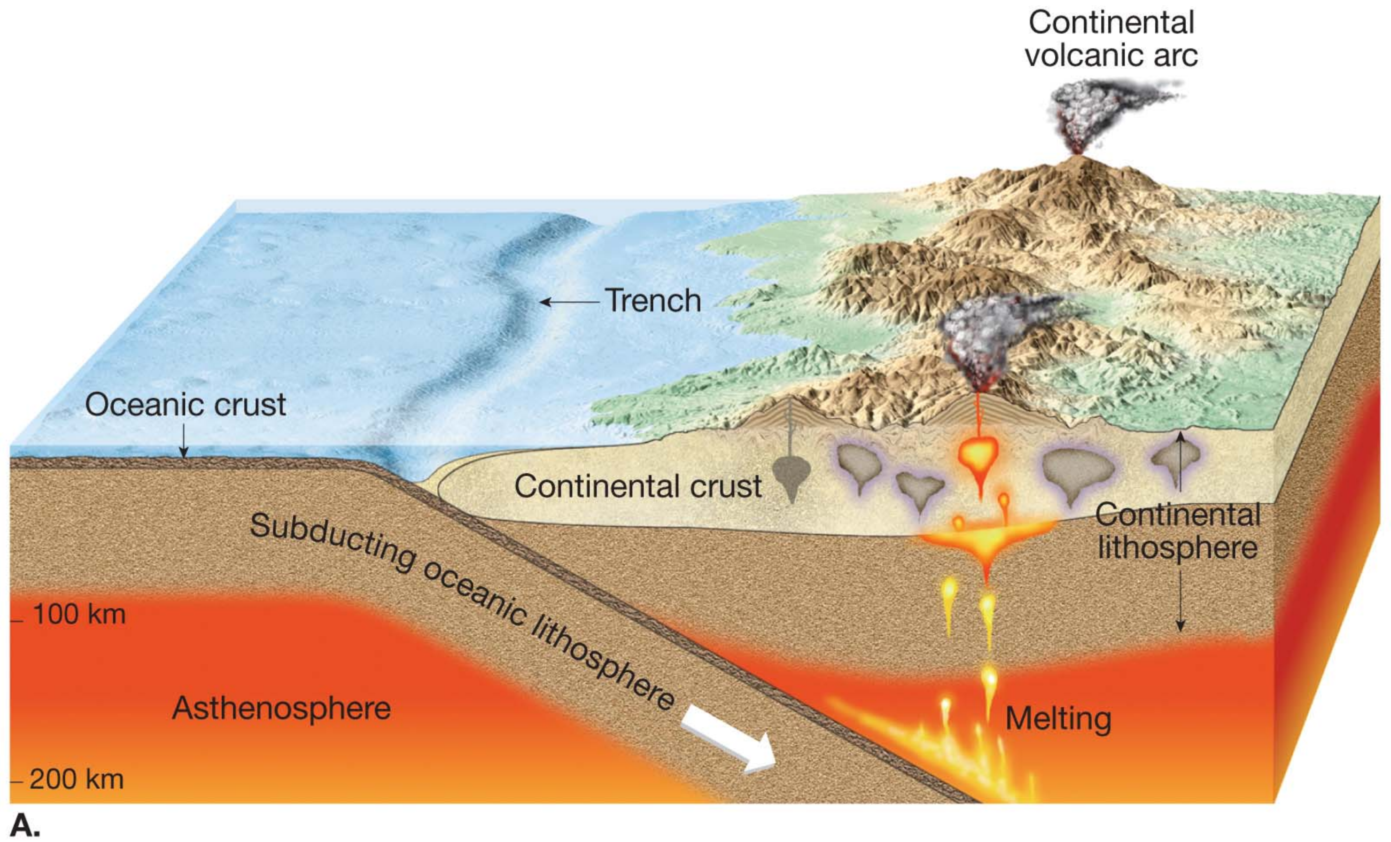


Figure 7.15 A

Plate tectonics: the new paradigm

- Plate boundaries
  - Types of plate boundaries
    - Convergent plate boundaries (destructive margins)
      - Oceanic–oceanic convergence
        - Two oceanic slabs converge and one descends beneath the other
        - Often forms volcanoes on the ocean floor
        - Volcanic island arc forms as volcanoes emerge from the sea
        - Examples include the Aleutian, Mariana, and Tonga islands

An oceanic–oceanic convergent plate boundary

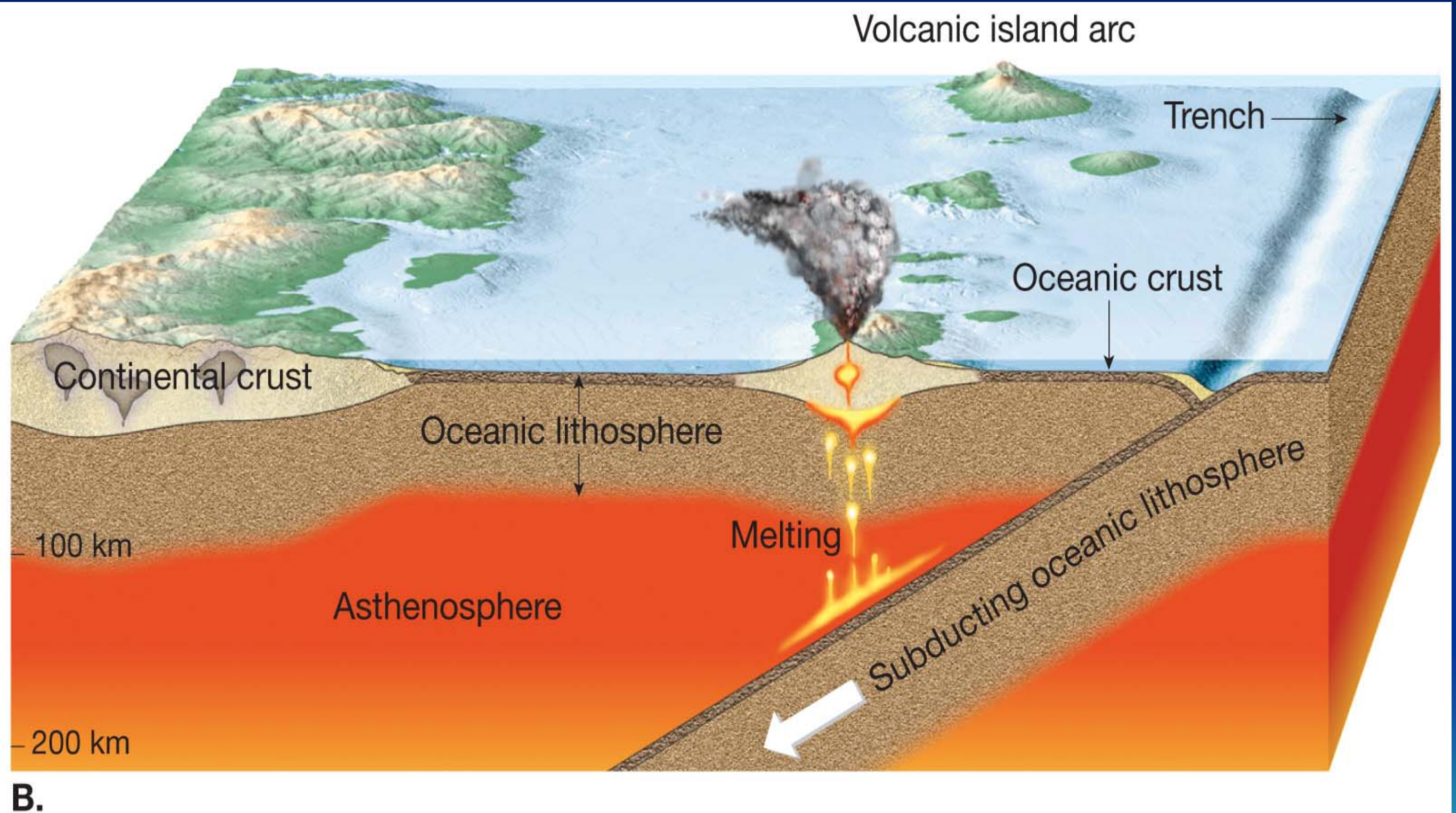


Figure 7.15 B

Plate tectonics: the new paradigm

- Plate boundaries
  - Types of plate boundaries
    - Convergent plate boundaries (destructive margins)
      - Continental–continental convergence
        - When subducting plates contain continental material, two continents collide
        - Can produce new mountain ranges such as the Himalayas

A continental–continental convergent plate boundary

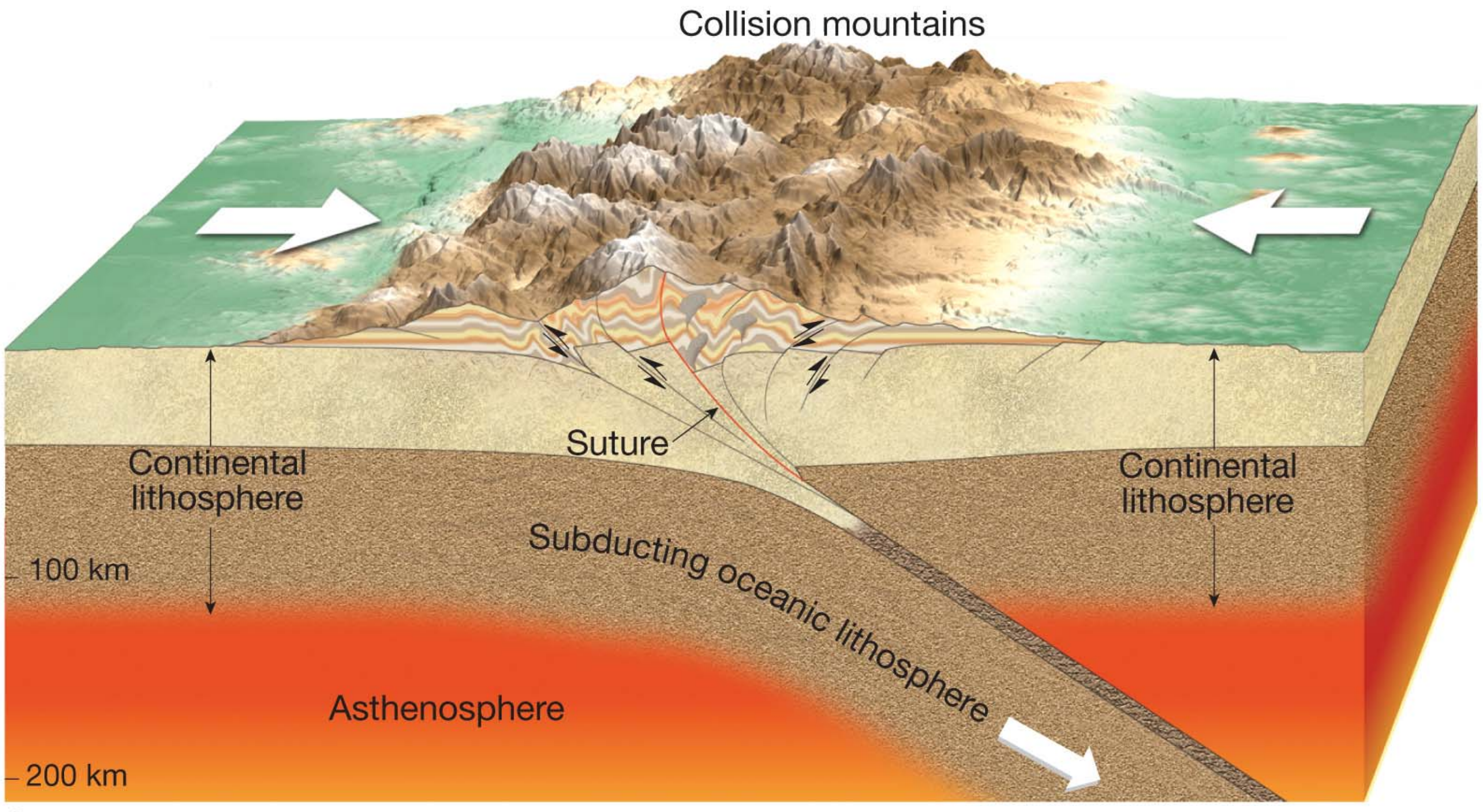


Figure 7.15 C

The collision of India and Asia produced the Himalayas

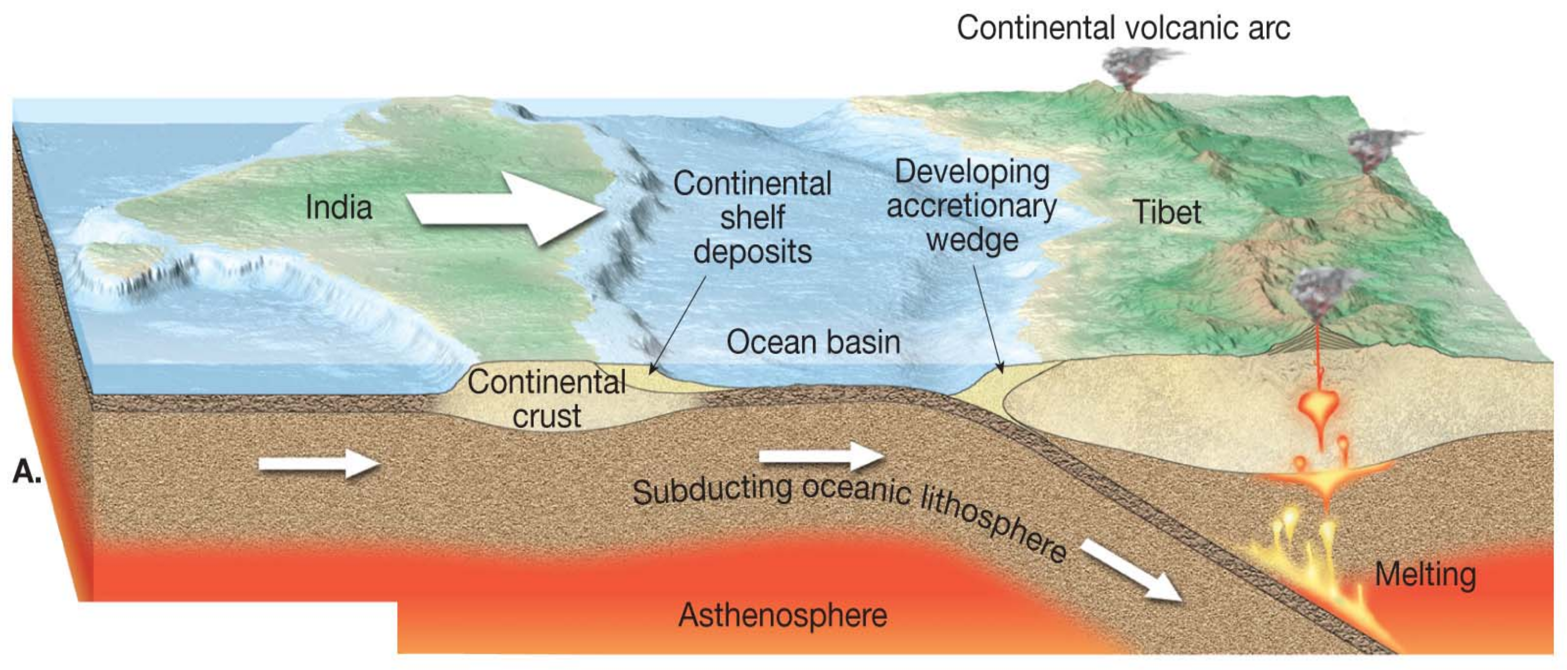


Figure 7.16 A

The collision of India and Asia produced the Himalayas

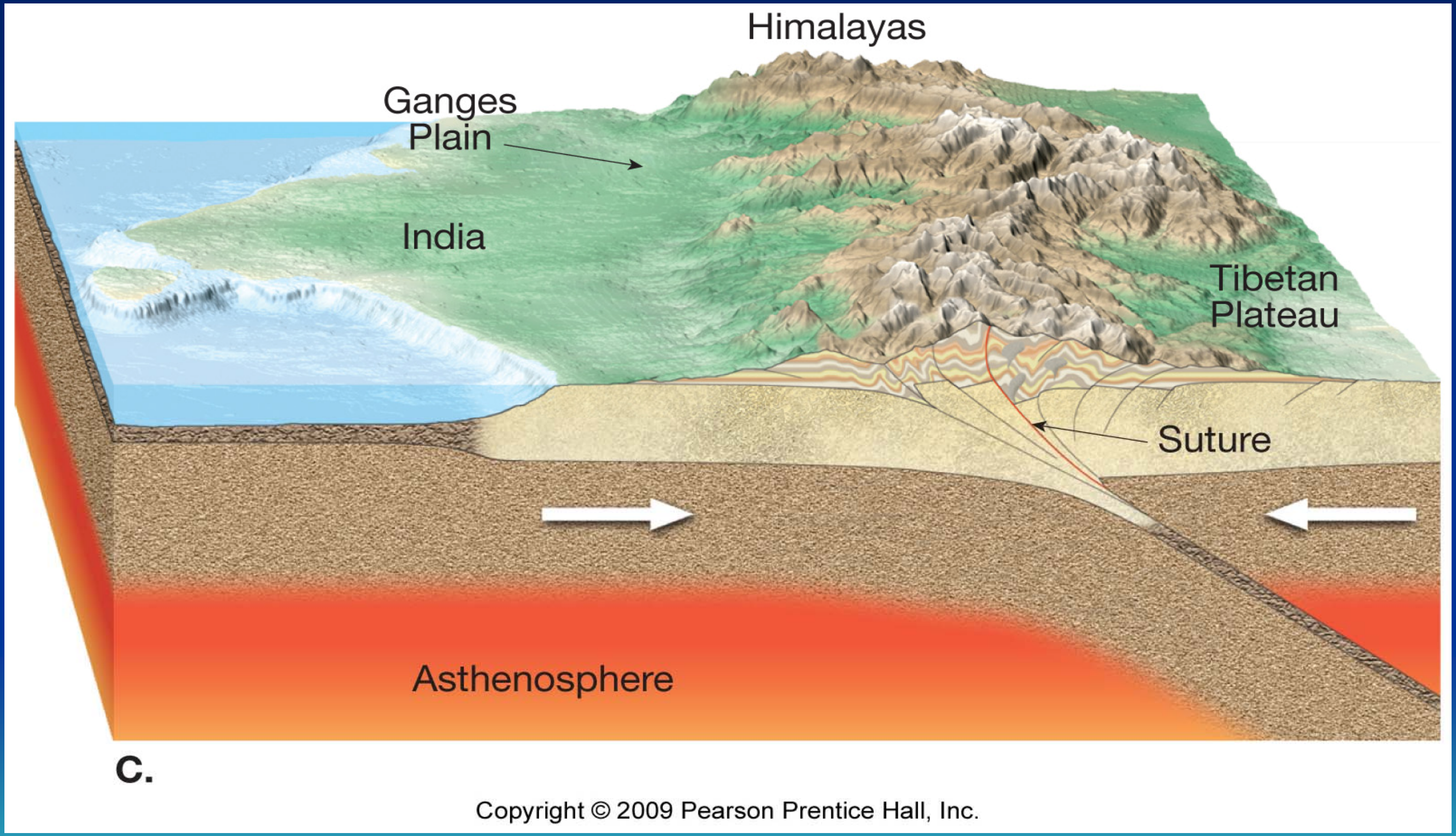


Figure 7.16 C

Plate tectonics: the new paradigm

- Plate boundaries
  - Types of plate boundaries
    - Transform fault boundaries
      - Plates slide past one another
        - No new crust is created or destroyed
      - Transform faults
        - Most join two segments of a mid-ocean ridge
        - Aid the movement of oceanic crustal material

Testing the plate tectonics model

- Evidence from ocean drilling
  - Some of the most convincing evidence confirming seafloor spreading has come from drilling directly into ocean-floor sediment
    - Age of deepest sediments
    - Thickness of ocean-floor sediments verifies seafloor spreading

Testing the plate tectonics model

- Hot spots and mantle plumes
  - Caused by rising plumes of mantle material
  - Volcanoes can form over them (Hawaiian Island chain)
  - Mantle plumes
    - Long-lived structures
    - Some originate at great depth, perhaps at the mantle–core boundary

The Hawaiian Islands have formed over a hot spot

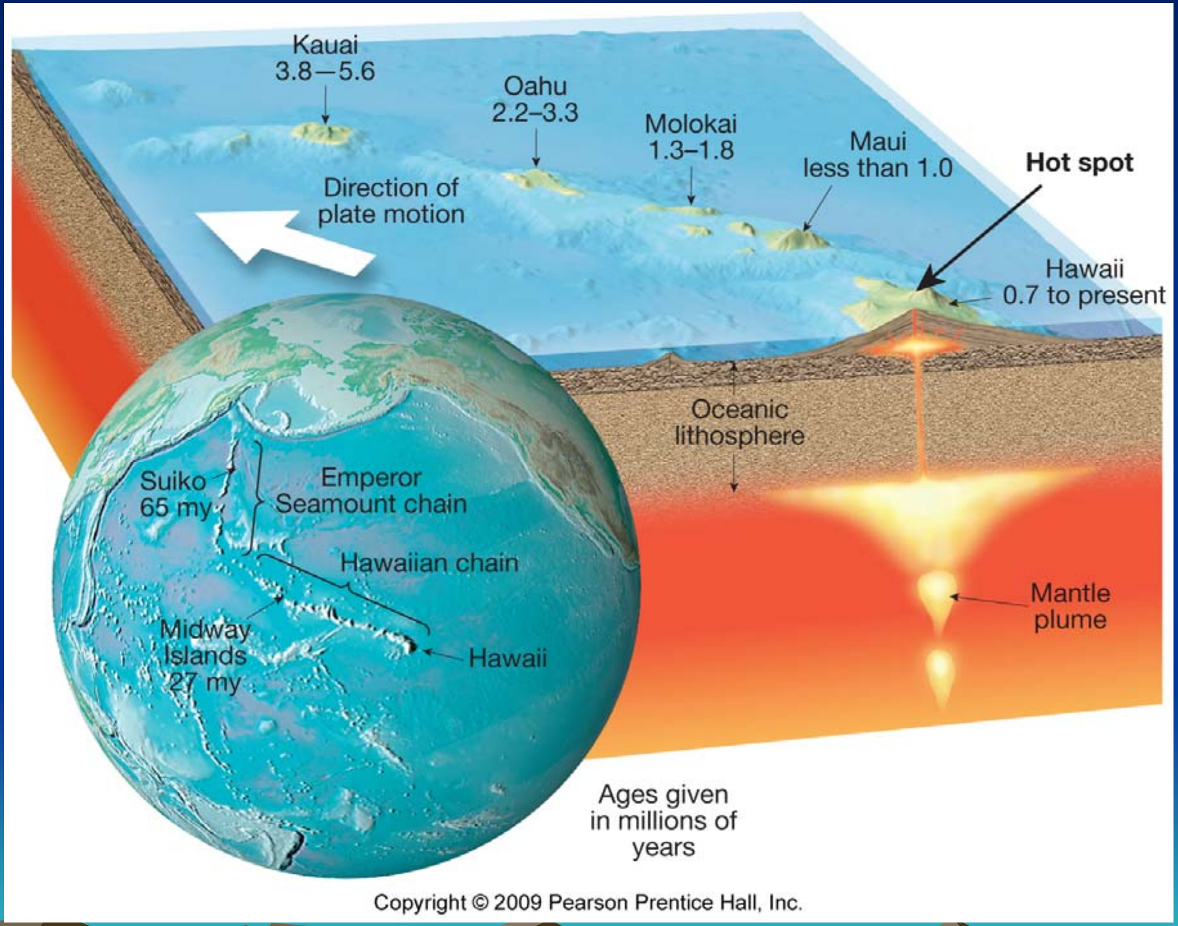


Figure 7.21

Testing the plate tectonics model

- Evidence for the plate tectonics model
  - Paleomagnetism
    - Probably the most persuasive evidence
    - Ancient magnetism preserved in rocks
    - Paleomagnetic records show
      - Polar wandering (evidence that continents moved)
      - Earth’s magnetic field reversals
        - Recorded in rocks as they form at oceanic ridges

Polar wandering paths for Eurasia and North America

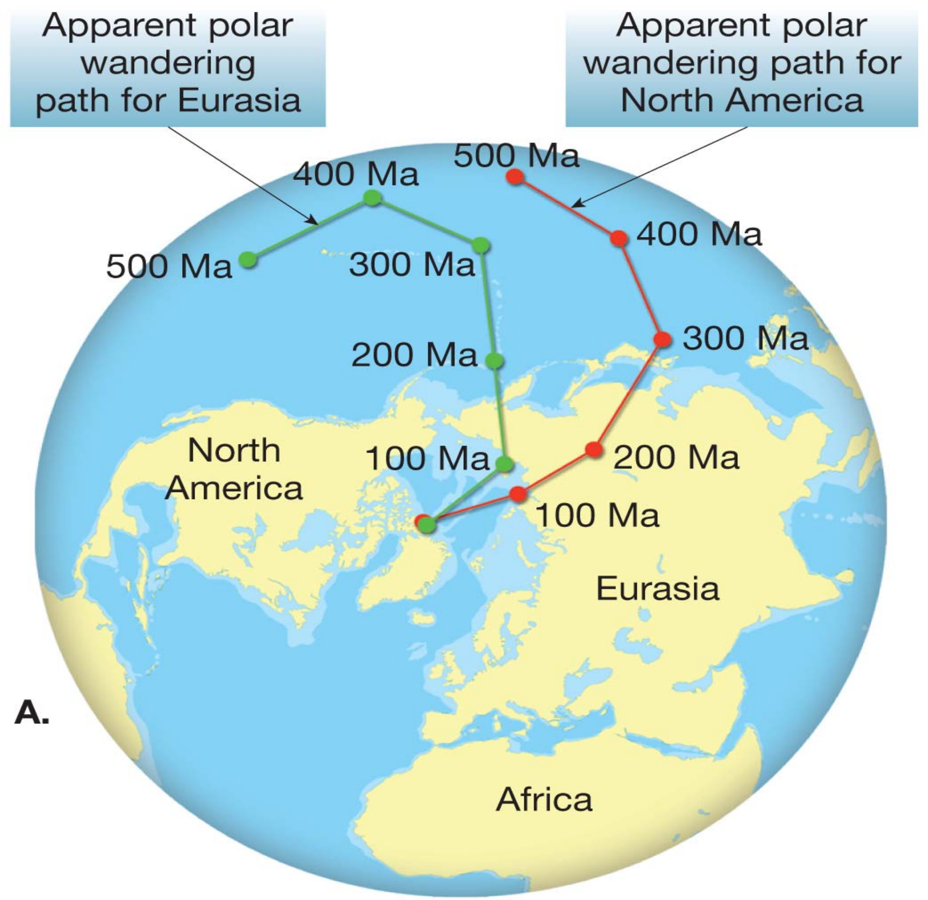


Figure 7.24 A

Paleomagnetic reversals recorded by basalt flows

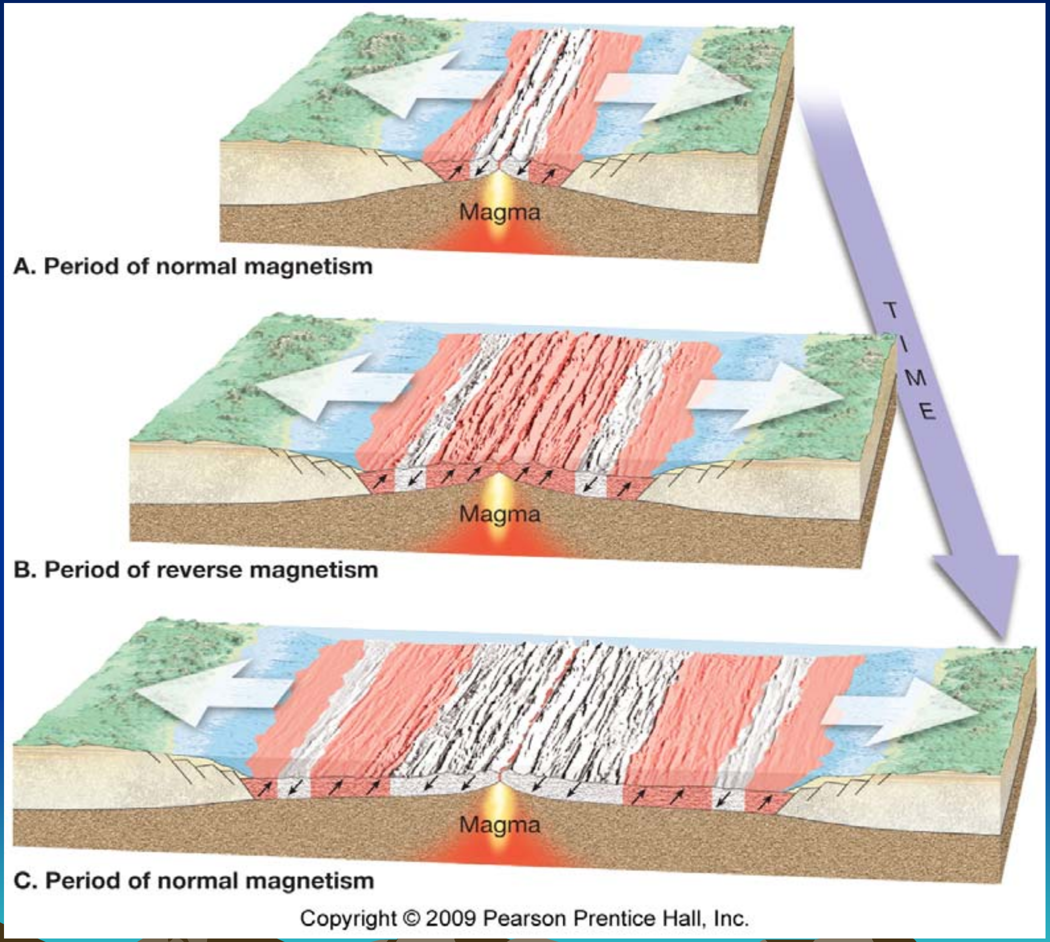


Figure 7.27

Measuring plate motion

- Measuring plate motion
  - By using hot spot “tracks” like those of the Hawaiian Island–Emperor Seamount chain
  - Using space-age technology to directly measure the relative motion of plates
    - Very Long Baseline Interferometry (VLBI)
    - Global Positioning System (GPS)

Directions and rates of plate motions

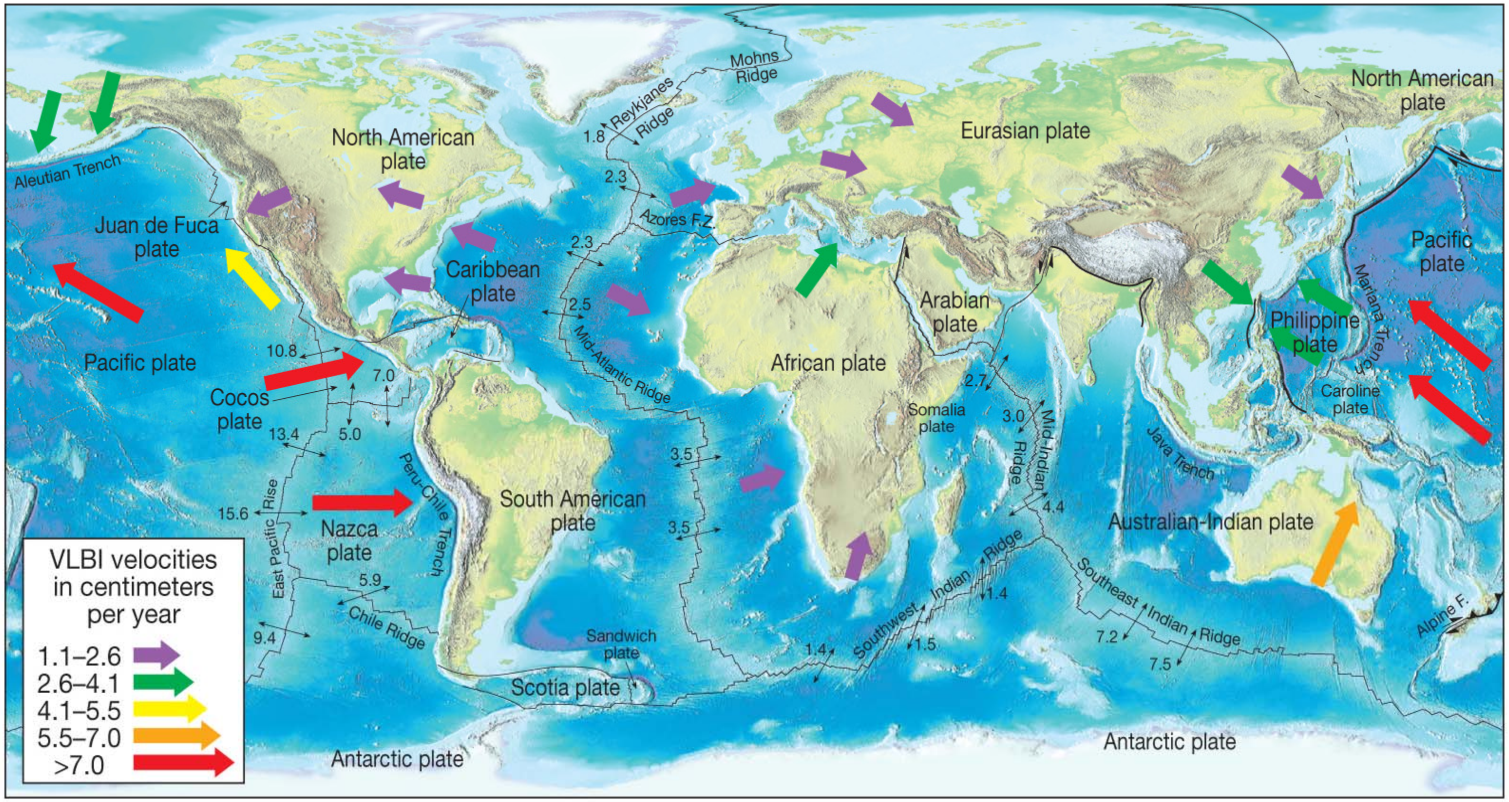


Figure 7.28

What drives plate motion

- Driving mechanism of plate tectonics
  - No one model explains all facets of plate tectonics
  - Earth’s heat is the driving force
  - Several models have been proposed
    - Slab-pull and slab-push model
      - Descending oceanic crust pulls the plate
      - Elevated ridge system pushes the plate

Several mechanisms contribute to plate motion

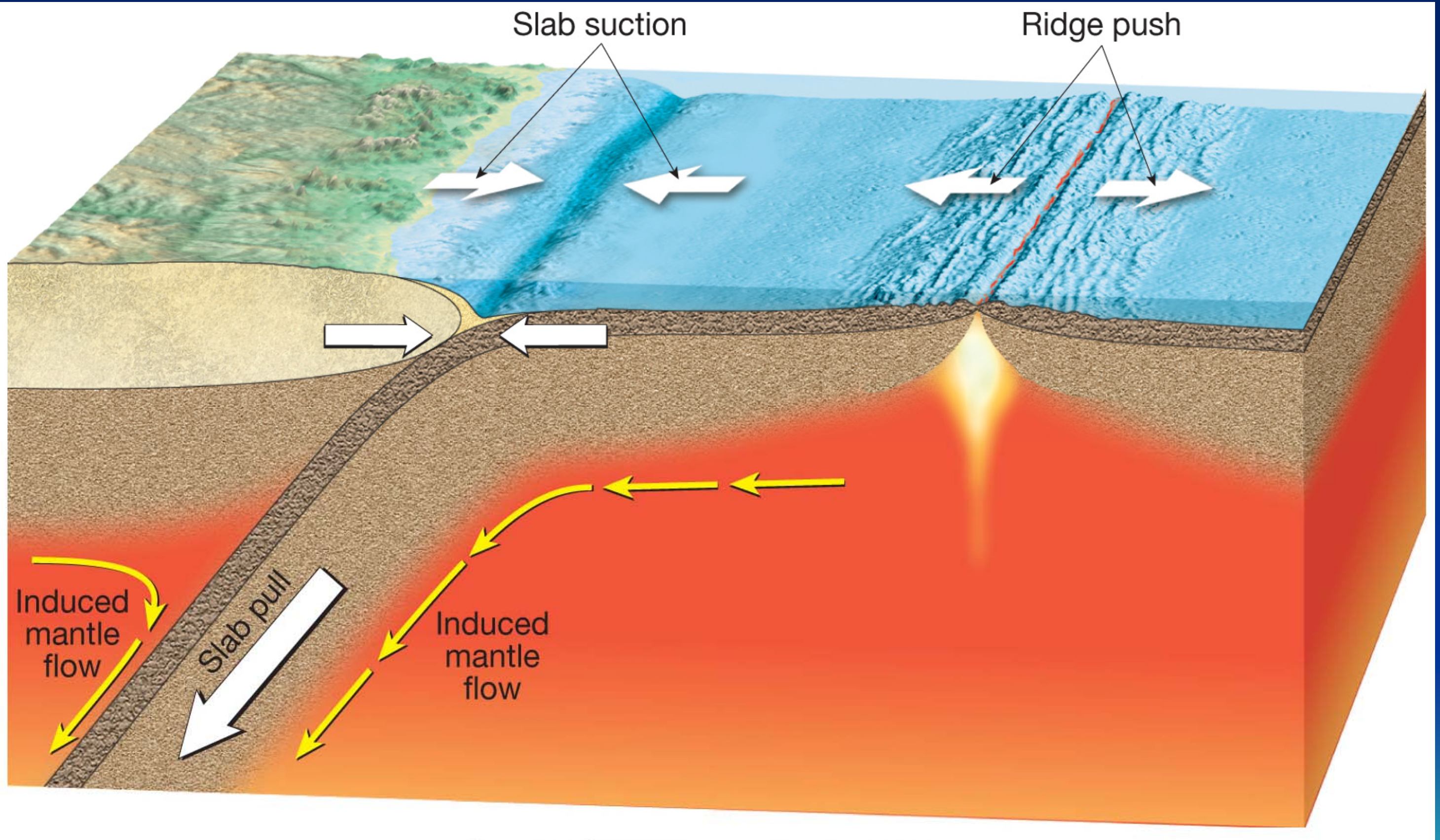
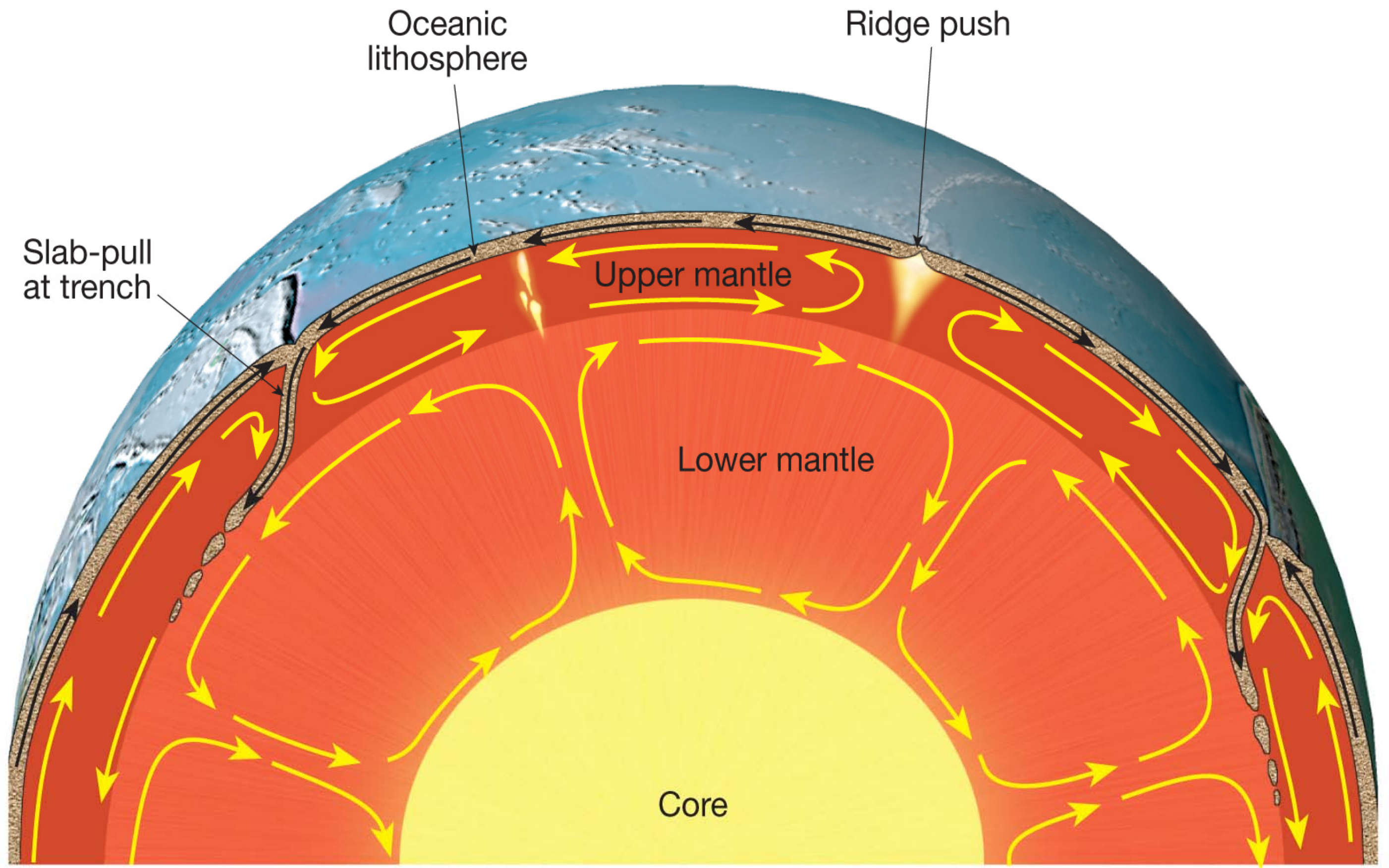


Figure 7.29

What drives plate motion

- Several models have been proposed
  - Plate–mantle convection
    - Mantle plumes extend from mantle–core boundary and cause convection within the mantle
    - Models
      - Layering at 660 kilometers
      - Whole-mantle convection

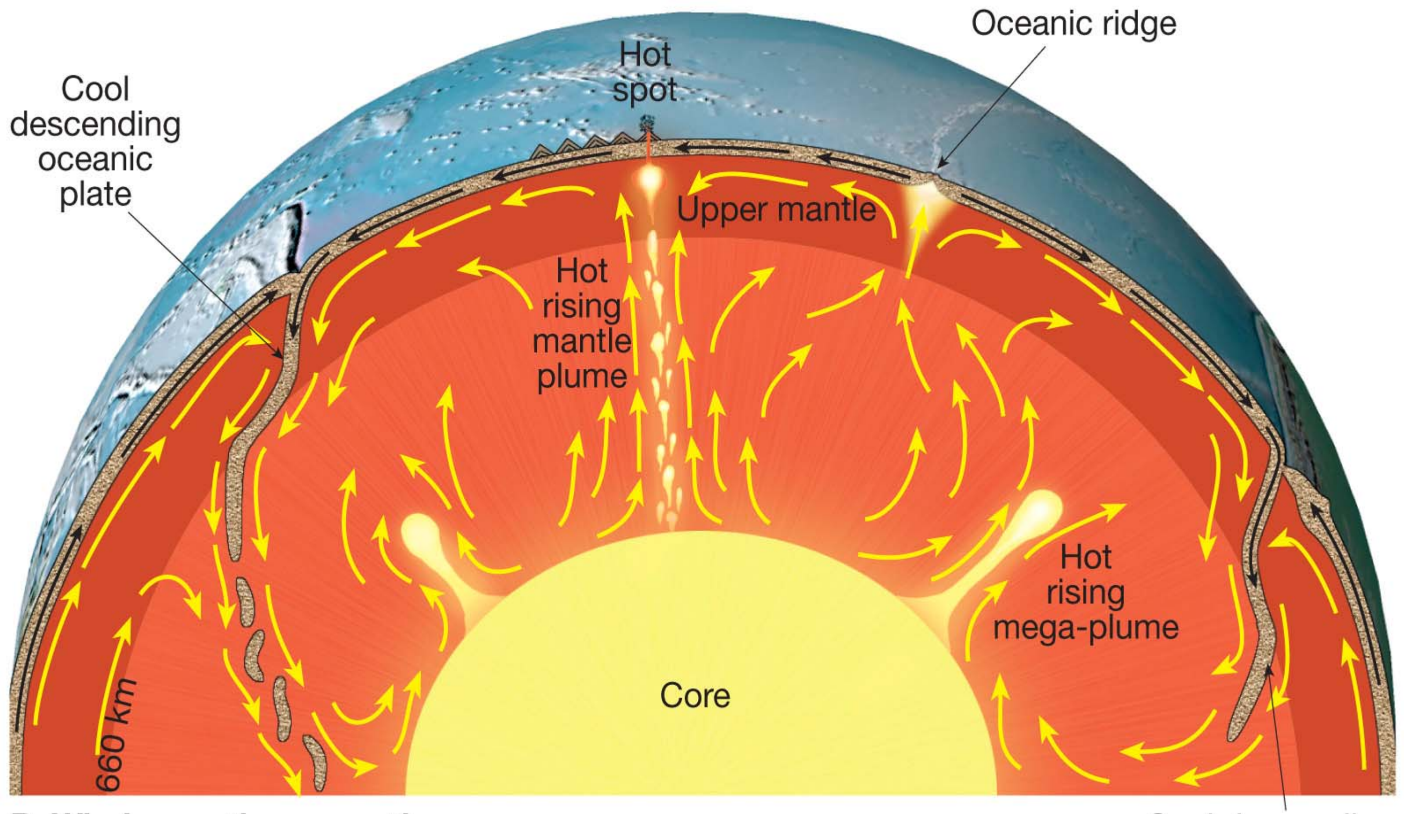
Layering at 660 km



A. Layering at 660 kilometers

Figure 7.30 A

Whole-mantle convection



B. Whole mantle convection

Figure 7.30 B

Plate tectonics into the future

- Present-day motions have been extrapolated into the future some 50 million years
  - Areas west of the San Andreas Fault slide northward past the North American plate
  - Africa collides with Eurasia, closing the Mediterranean and initiating mountain building
  - Australia and new Guinea are on a collision course with Asia

A possible view of the world 50 million years from now

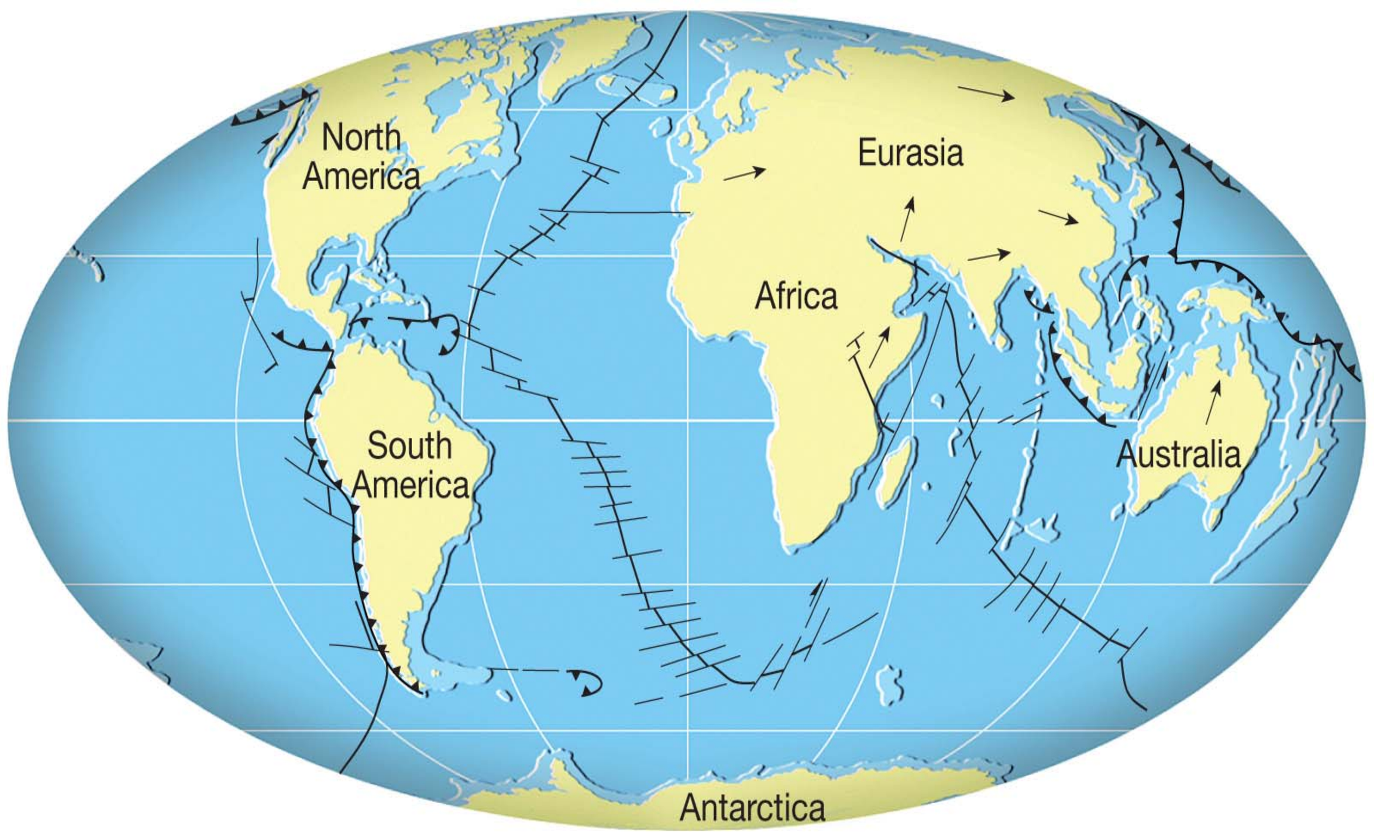


Figure 7.31

End of Chapter 7