Chapter 2
Plate Tectonics and the Ocean Floor

Continental drift

- Alfred Wegener, a German meteorologist and geophysicist, was the first to advance the idea of mobile continents in 1912
- Wegener identified several lines of evidence to support the idea that the continents had drifted

Evidence for continental drift

- Matching coastlines on different continents

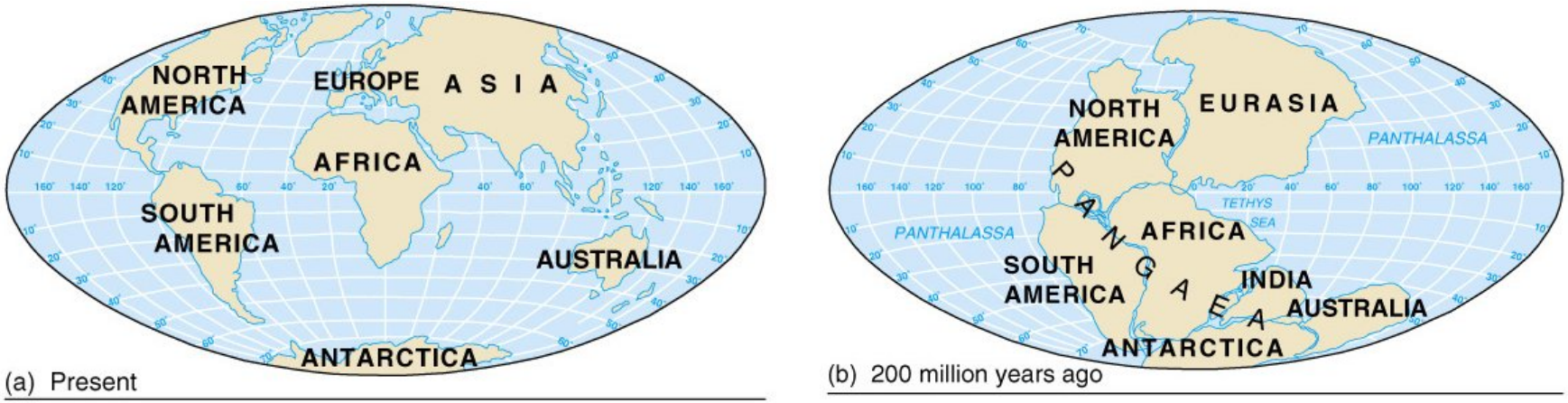
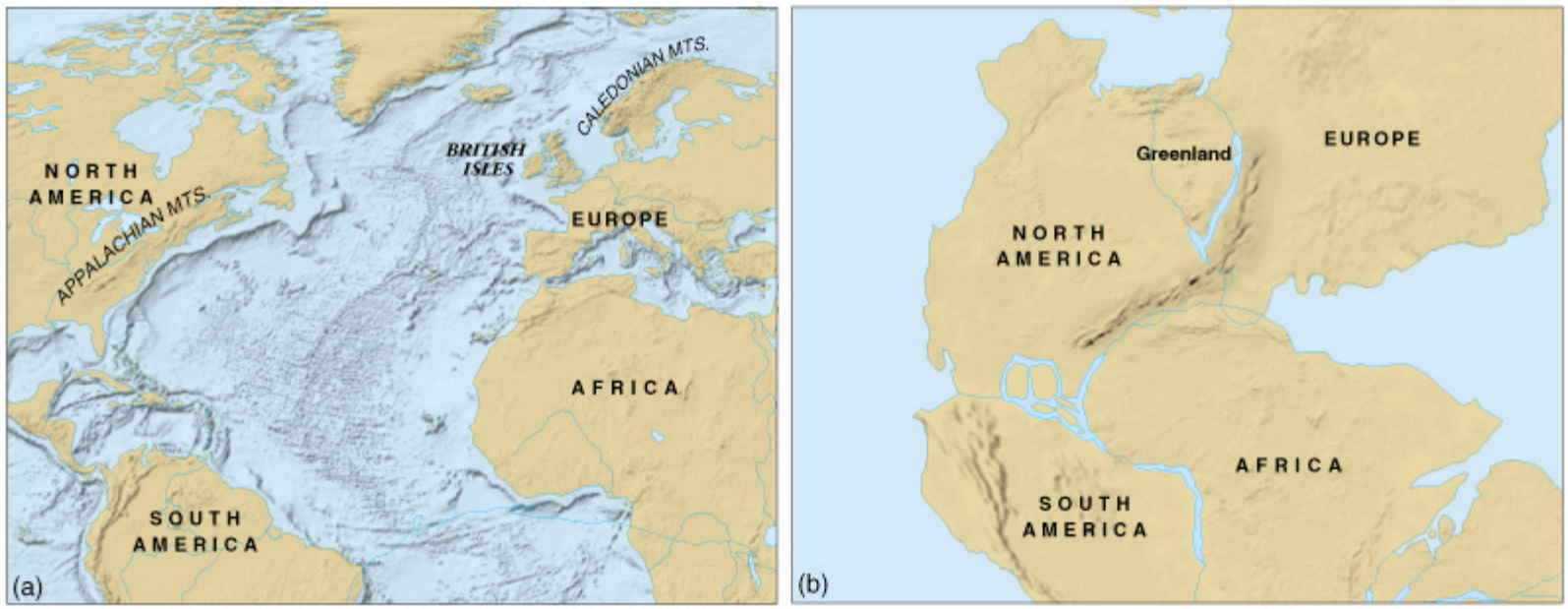


Figure 2-2

Evidence for continental drift

- Matching mountain ranges across oceans



Today **300 million years ago**

Figure 2-4

Evidence for continental drift

- Glacial ages and climate evidence

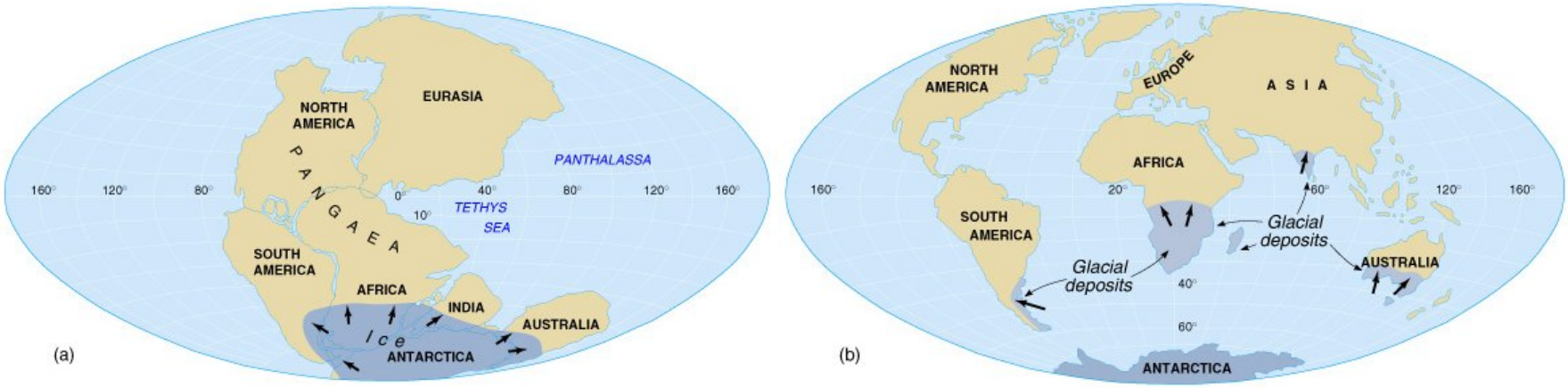


Figure 2-5

Evidence for continental drift

- Distribution of fossils such as *Mesosaurus*

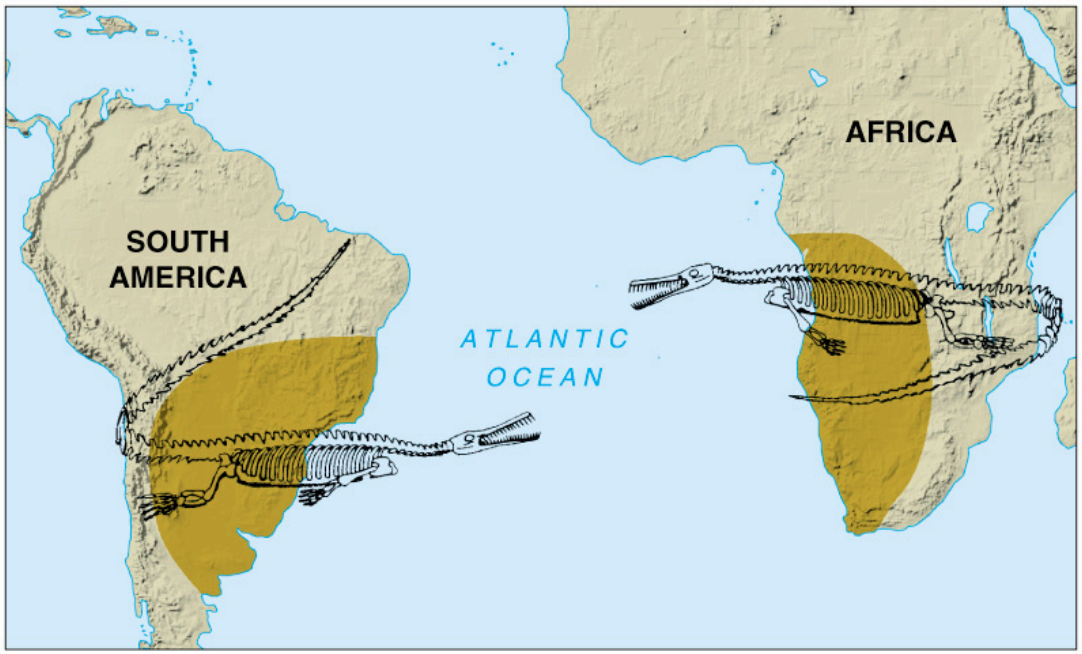


Figure 2-6

Objections to the continental drift model

- Wegener envisioned continents plowing through ocean basins
- Wegener did not provide a plausible mechanism to explain how the continents could have drifted apart
- Most Earth scientists rejected continental drift because it was
  - Too far-fetched
  - Contrary to the laws of physics

The theory of plate tectonics

- Continental drift was reexamined in the 1960s when new information became available
  - Sea floor features became better known
  - A technique was developed that enabled scientists to determine the original positions of rocks on Earth (paleomagnetism)

Evidence for plate tectonics

- Earth's magnetic field affects all magnetic objects on Earth

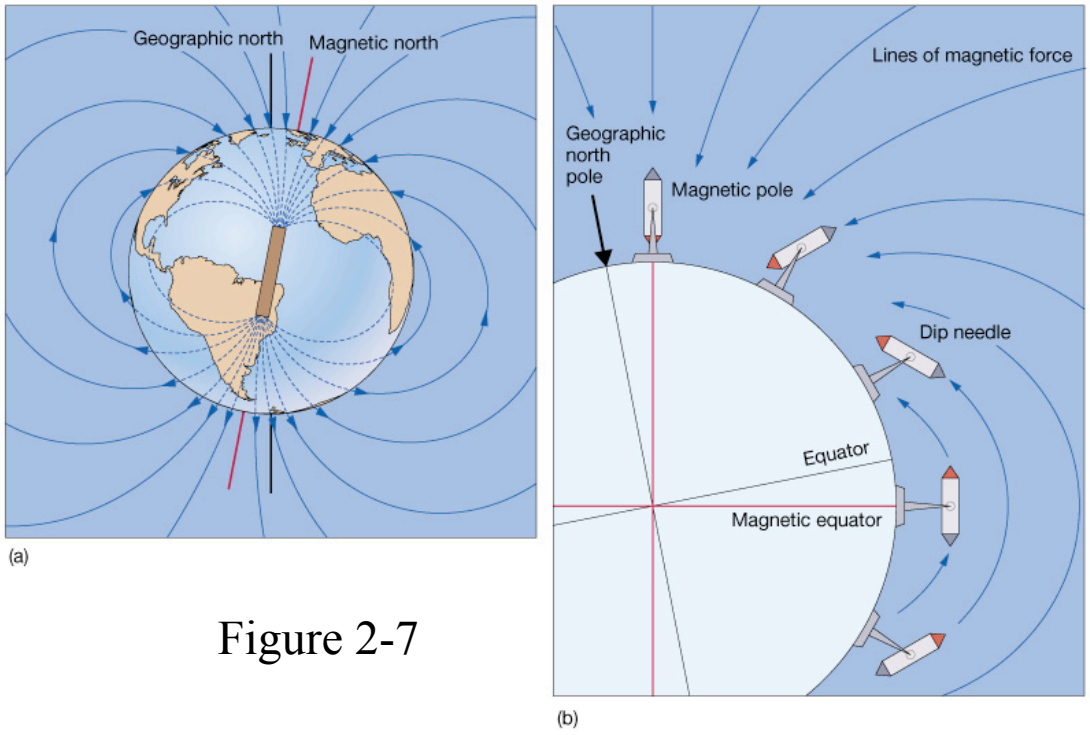


Figure 2-7

Evidence for plate tectonics

- When rocks cool at Earth's surface, they record Earth's magnetic field (normal or reversed polarity)

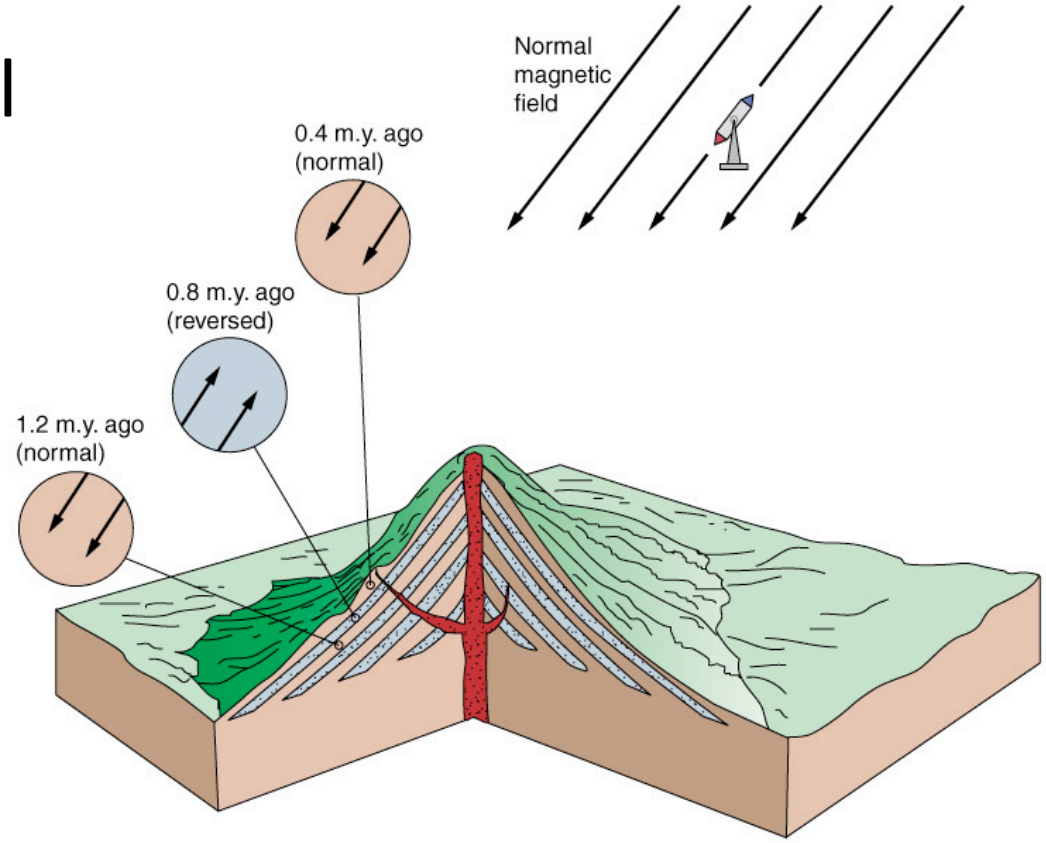


Figure 2-9

Evidence for plate tectonics

- Paleomagnetic studies indicate alternating stripes of normal and reverse polarity at the mid-ocean ridge
- Pattern was created by sea floor spreading

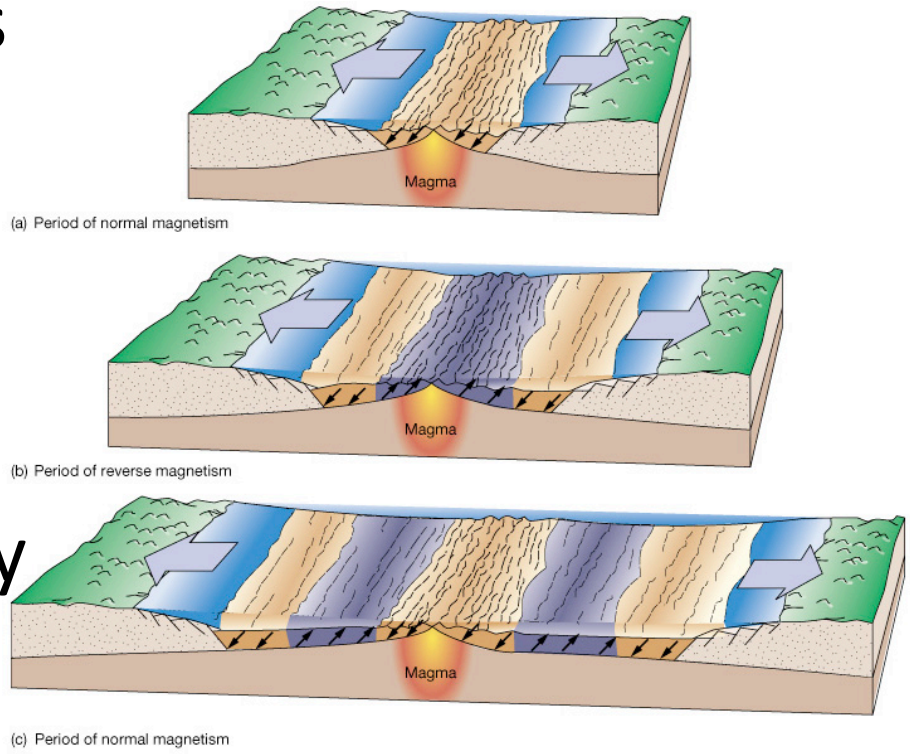


Figure 2-11

Evidence for plate tectonics

- Harry Hess envisioned new sea floor being created at the mid-ocean ridge and destroyed in deep ocean trenches

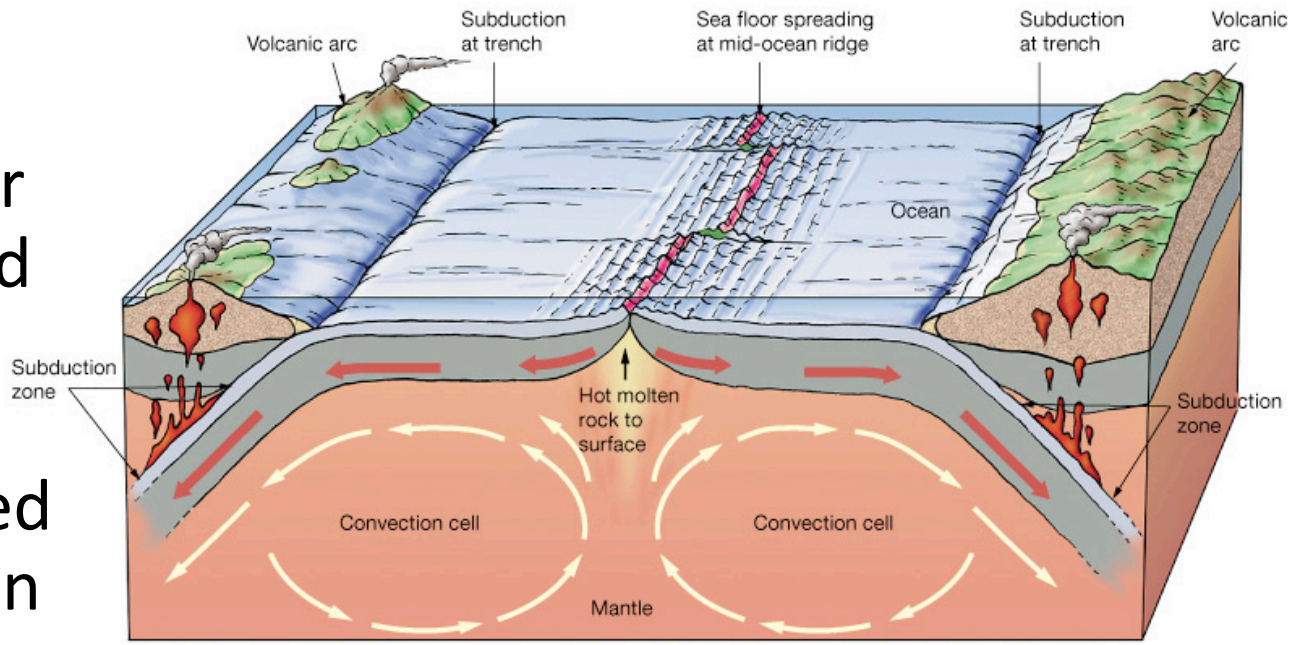


Figure 2-10

Evidence for plate tectonics

- Age of the sea floor matches pattern predicted by sea floor spreading
  - Youngest sea floor is at mid-ocean ridge
  - Sea floor is older with increasing distance from mid-ocean ridge

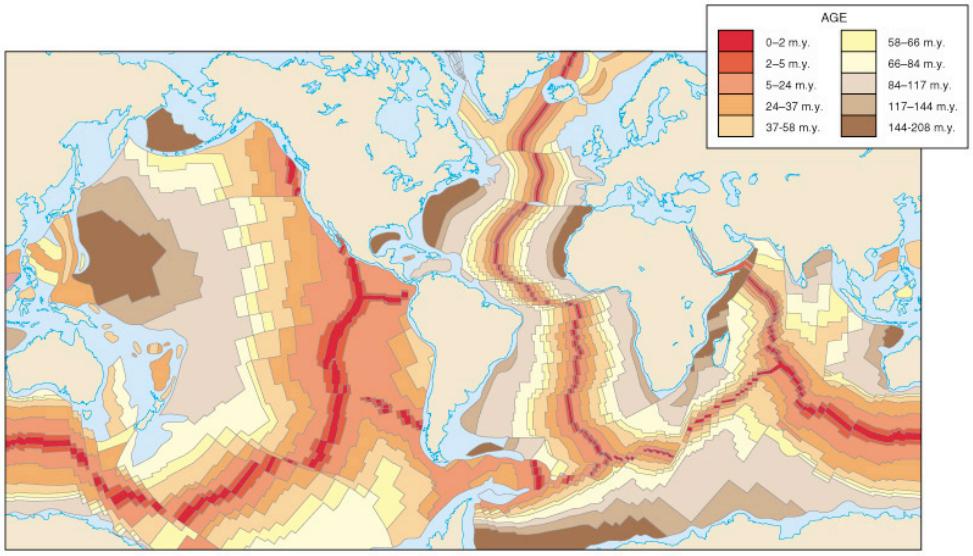


Figure 2-12

Evidence for plate tectonics

- Pattern of worldwide earthquakes (*left*) matches plate boundaries (*right*)

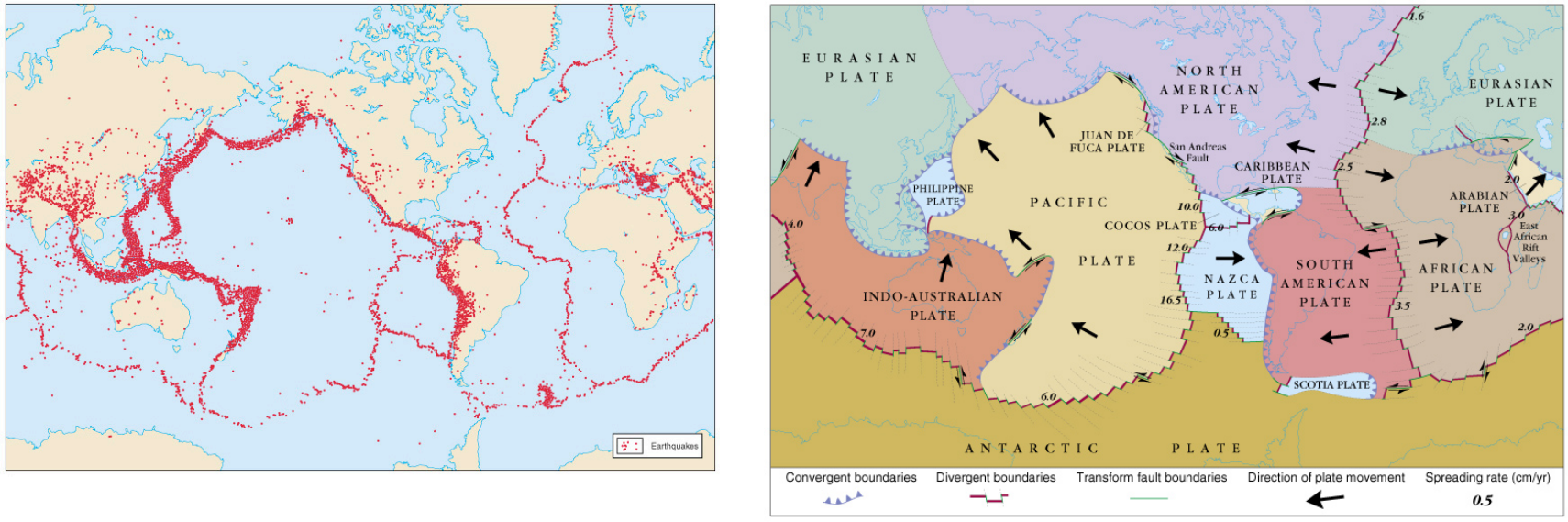


Figure 2-13

Earth structure

- Chemical composition
  - Crust
  - Mantle
  - Core
- Physical properties
  - Lithosphere
  - Asthenosphere
  - Mesosphere
  - Outer core
  - Inner core

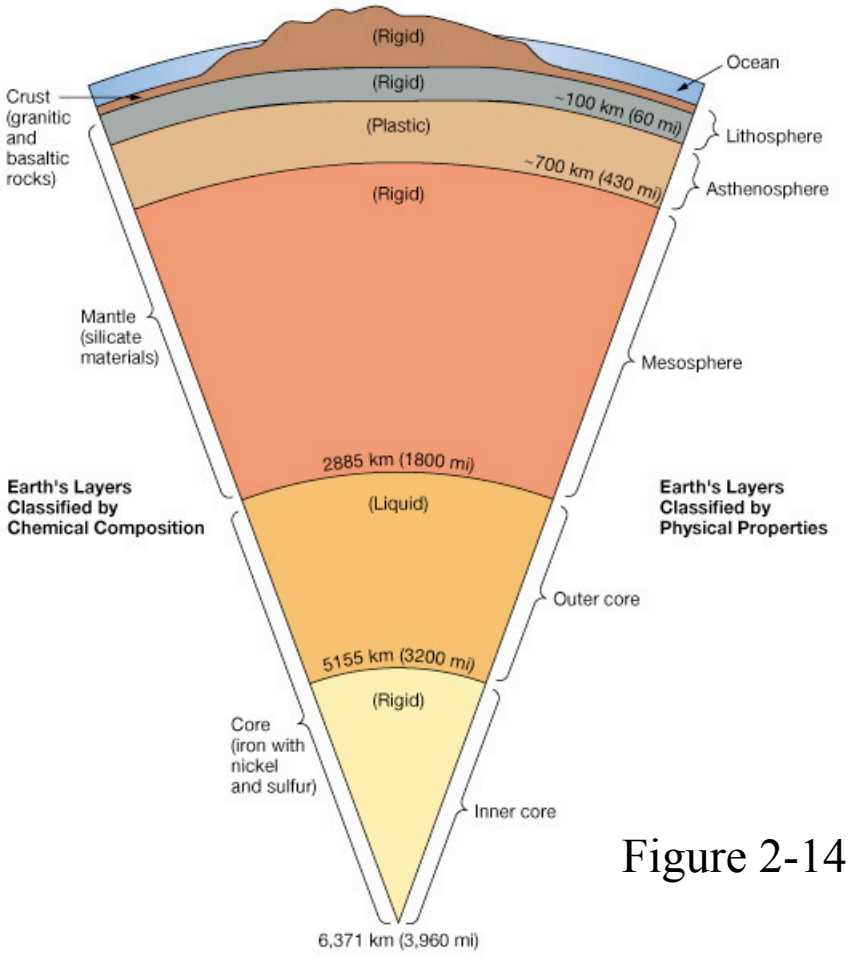


Figure 2-14

Principles of plate tectonics

- The outermost portion of Earth is composed of a mosaic of thin rigid plates (pieces of lithosphere) that move horizontally with respect to one another
- Plates interact with each other along their edges (called plate boundaries)
- Plate boundaries have a high degree of tectonic activity (mountain building, earthquakes, active volcanoes)

The 3 types of plate boundaries

1. Divergent
2. Convergent
3. Transform

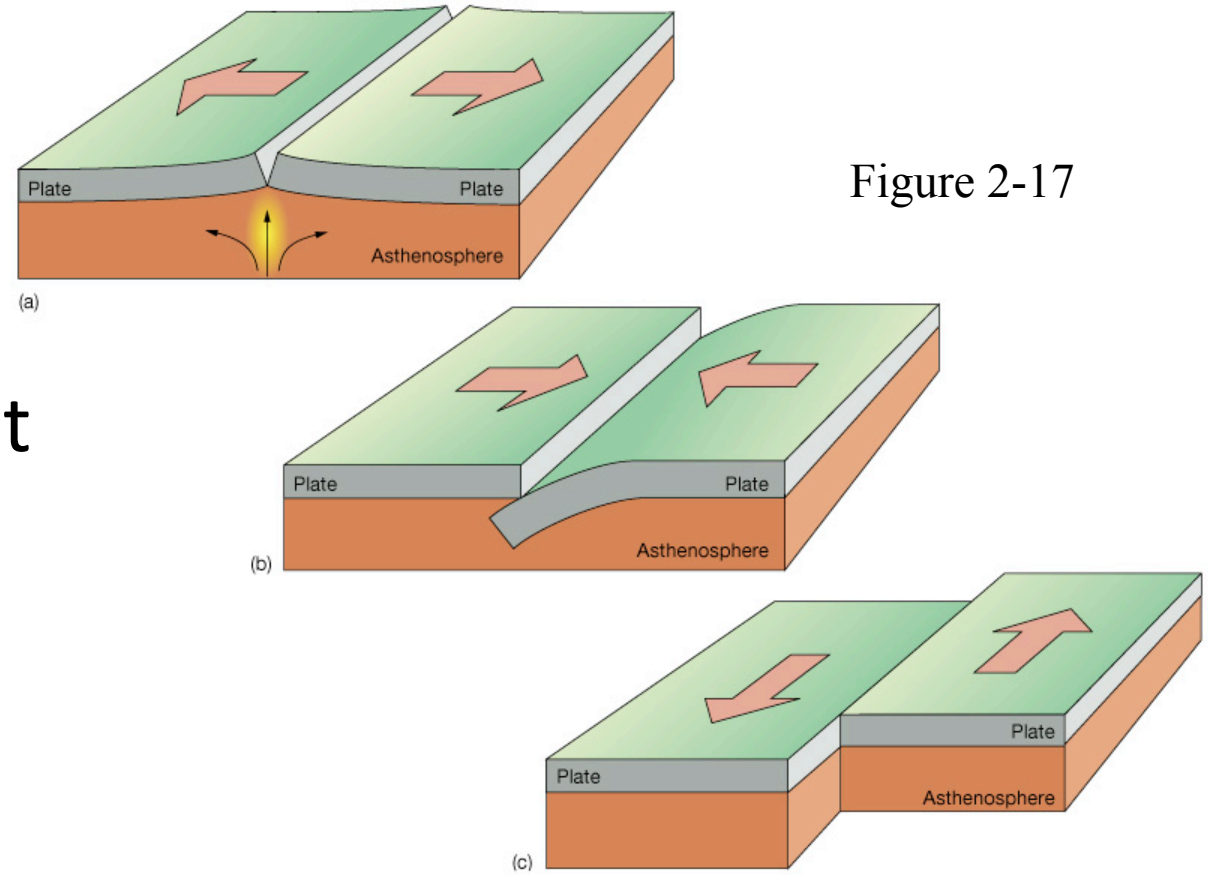


Figure 2-17

Divergent plate boundaries

- The Mid-Atlantic Ridge is a divergent plate boundary where sea floor spreading occurs

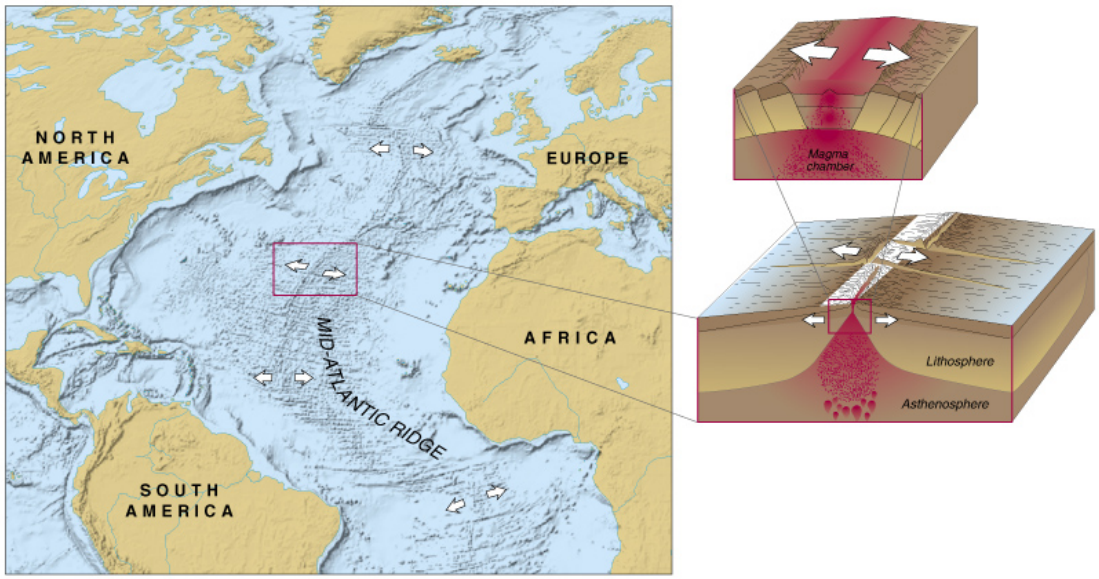


Figure 2-18

Divergent plate boundaries

- Iceland sits atop a divergent plate boundary where continental rifting occurs

Figure 2-19

Divergent plate boundaries

- Formation of an ocean basin by rifting and sea floor spreading

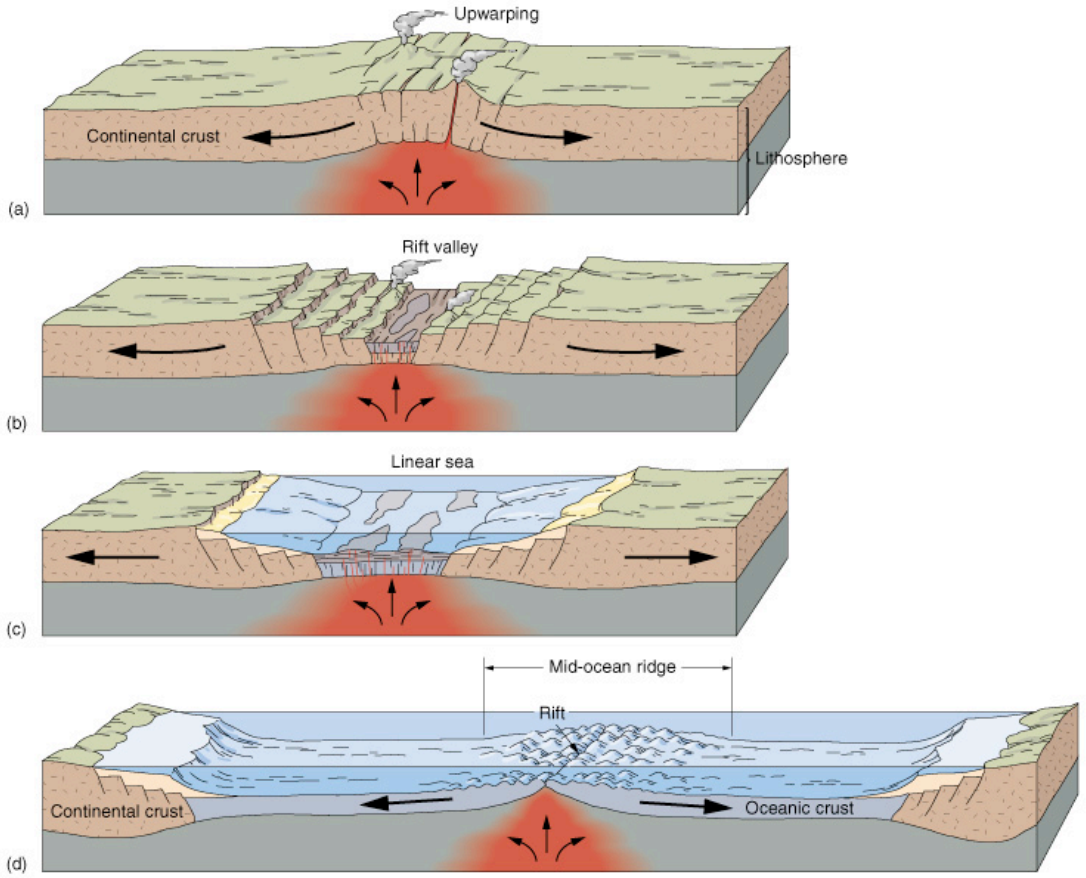


Figure 2-20

Convergent plate boundaries

- Convergent plate boundaries vary depending on the type of crust

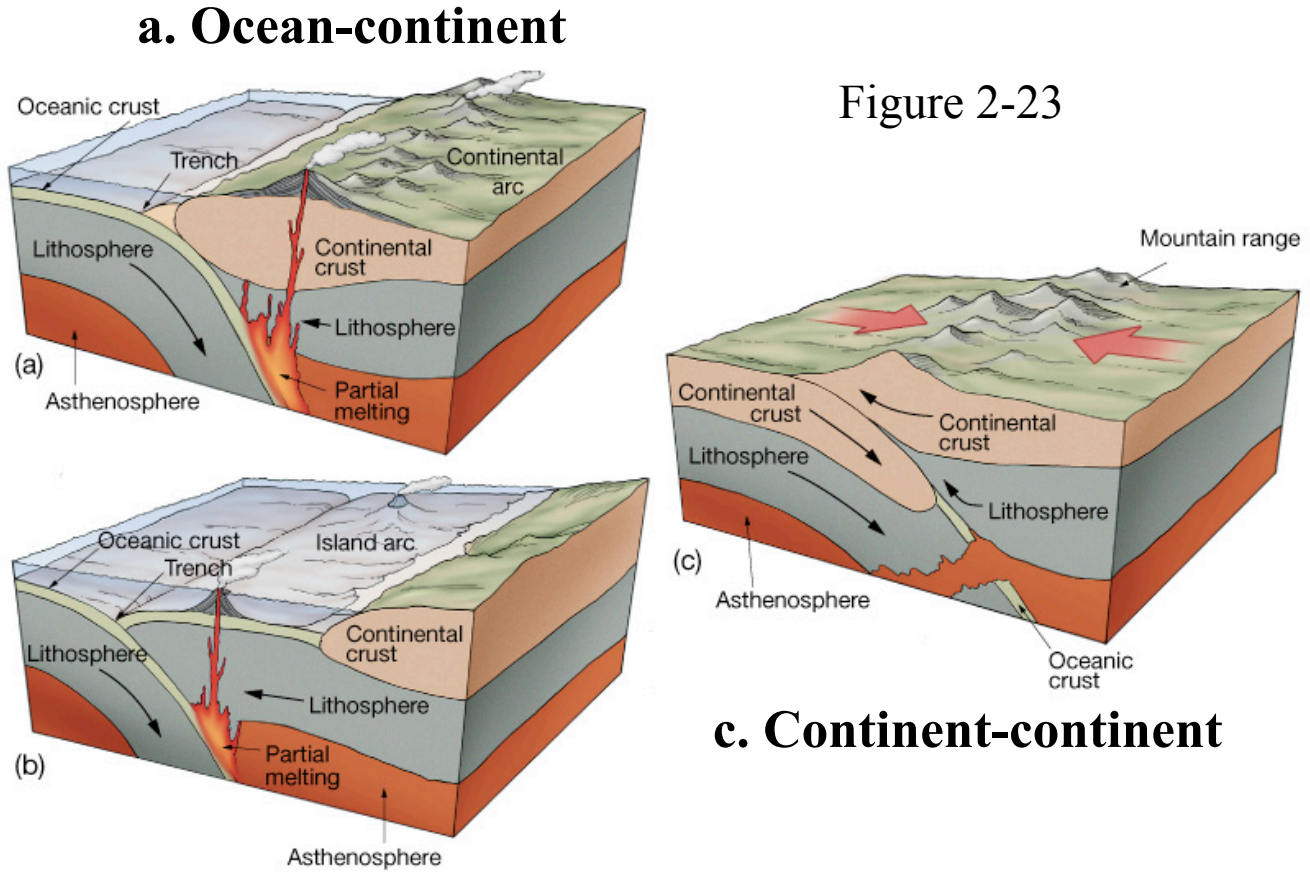


Figure 2-23

Convergent plate boundaries

- An ocean-continent convergent plate boundary produces the Cascadia subduction zone and Cascade Mountains

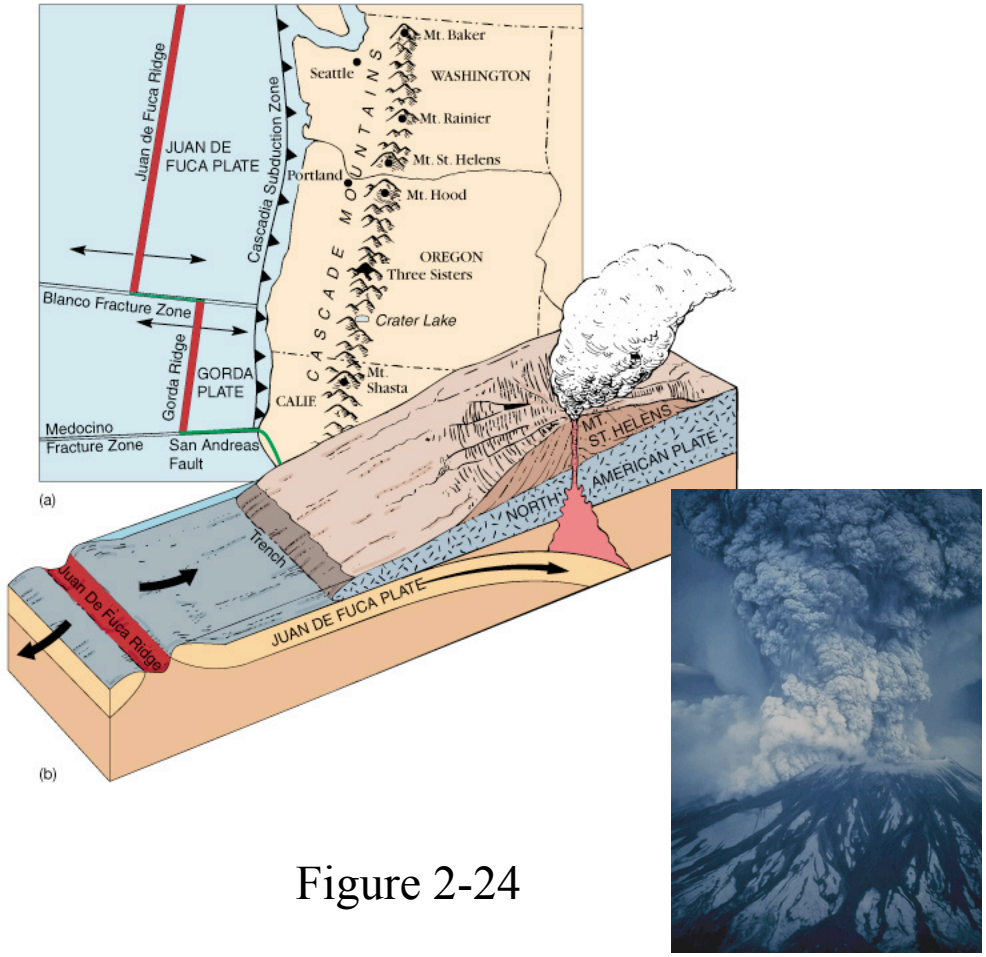


Figure 2-24

Convergent plate boundaries

- A continent-continent convergent plate boundary produces the Himalaya Mountains

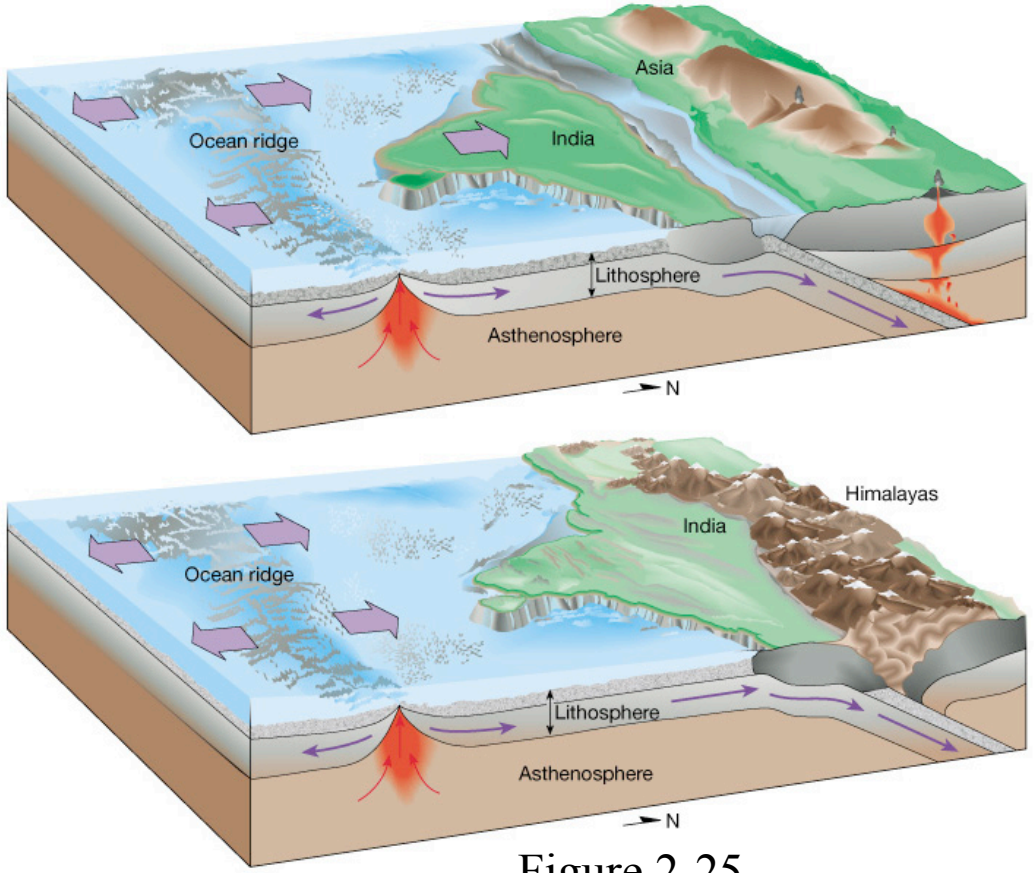


Figure 2-25

Transform plate boundaries

- Transform plate boundaries occur between segments of the mid-ocean ridge
- Can also occur on land (ex: San Andreas Fault)

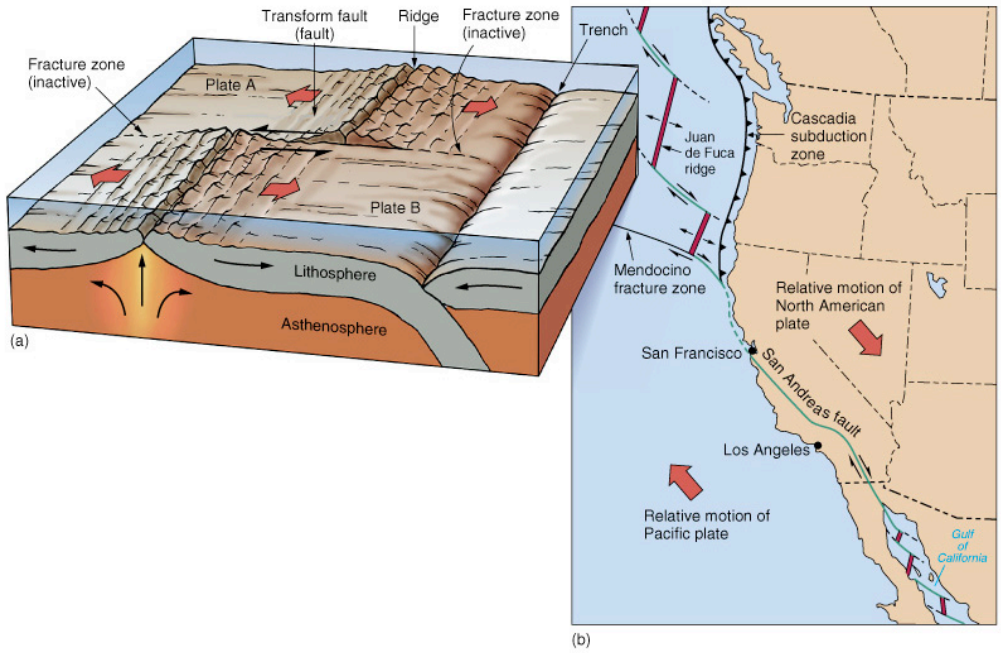


Figure 2-26

Hotspots and plate tectonics

- Hotspots are stationary and have abundant volcanic activity
- The lithospheric plate moves over the hotspot
- Creates a row of volcanoes progressively older toward one end (called a nematath)

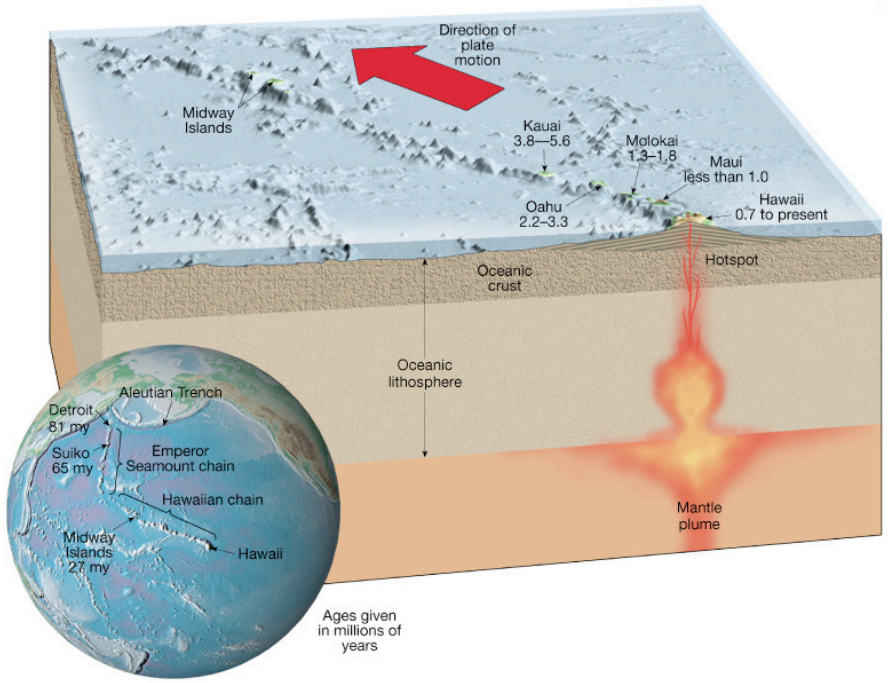


Figure 2-28

Stages of coral reef development

- If in tropical shallow water, coral reefs can form on the tops of volcanoes
  - Fringing reef
  - Barrier reef
  - Atoll

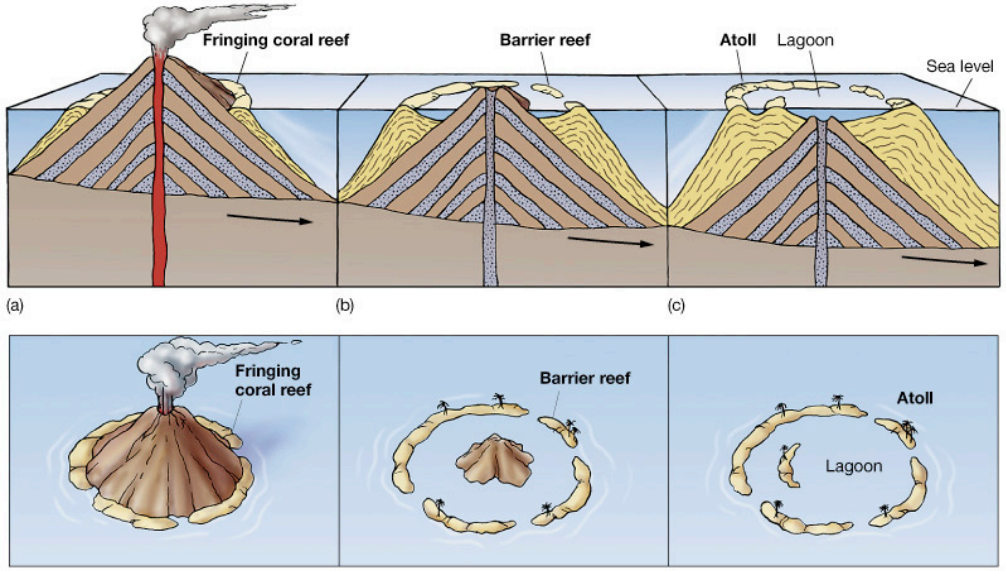


Figure 2-30

Atoll and barrier reefs in the Society Islands

Figure 2-32

Satellite positioning of locations on Earth

- Shows good agreement with predicted plate motion

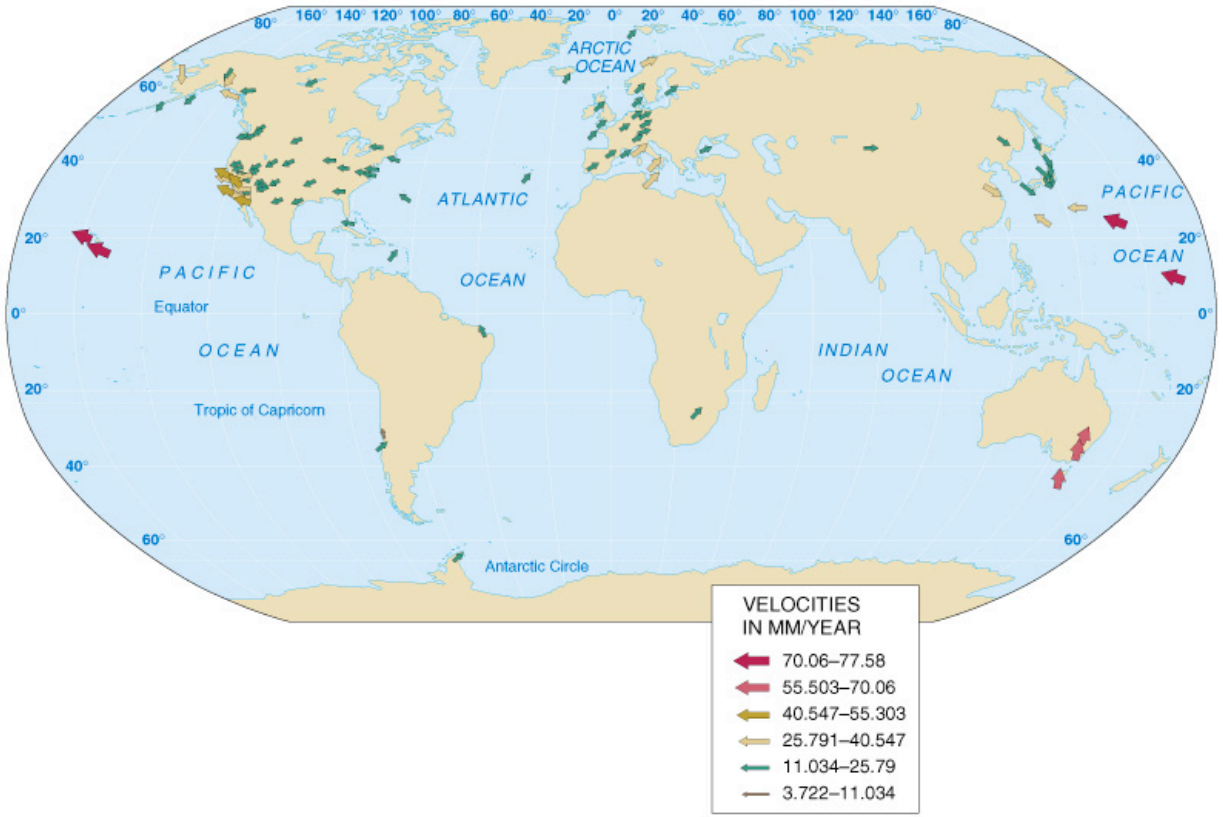


Figure 2-33

Paleogeography: A look at the past

- The positions of continents and oceans have changed in the past
- Internet site showing more detailed maps

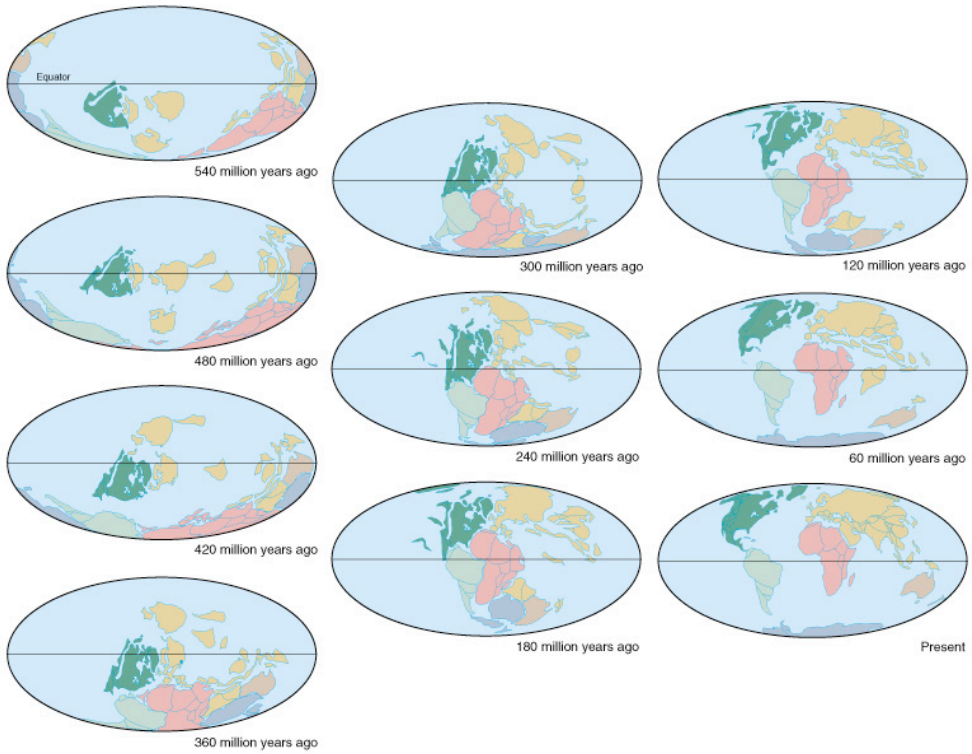


Figure 2-34

The world as it may look 50 million years in the future

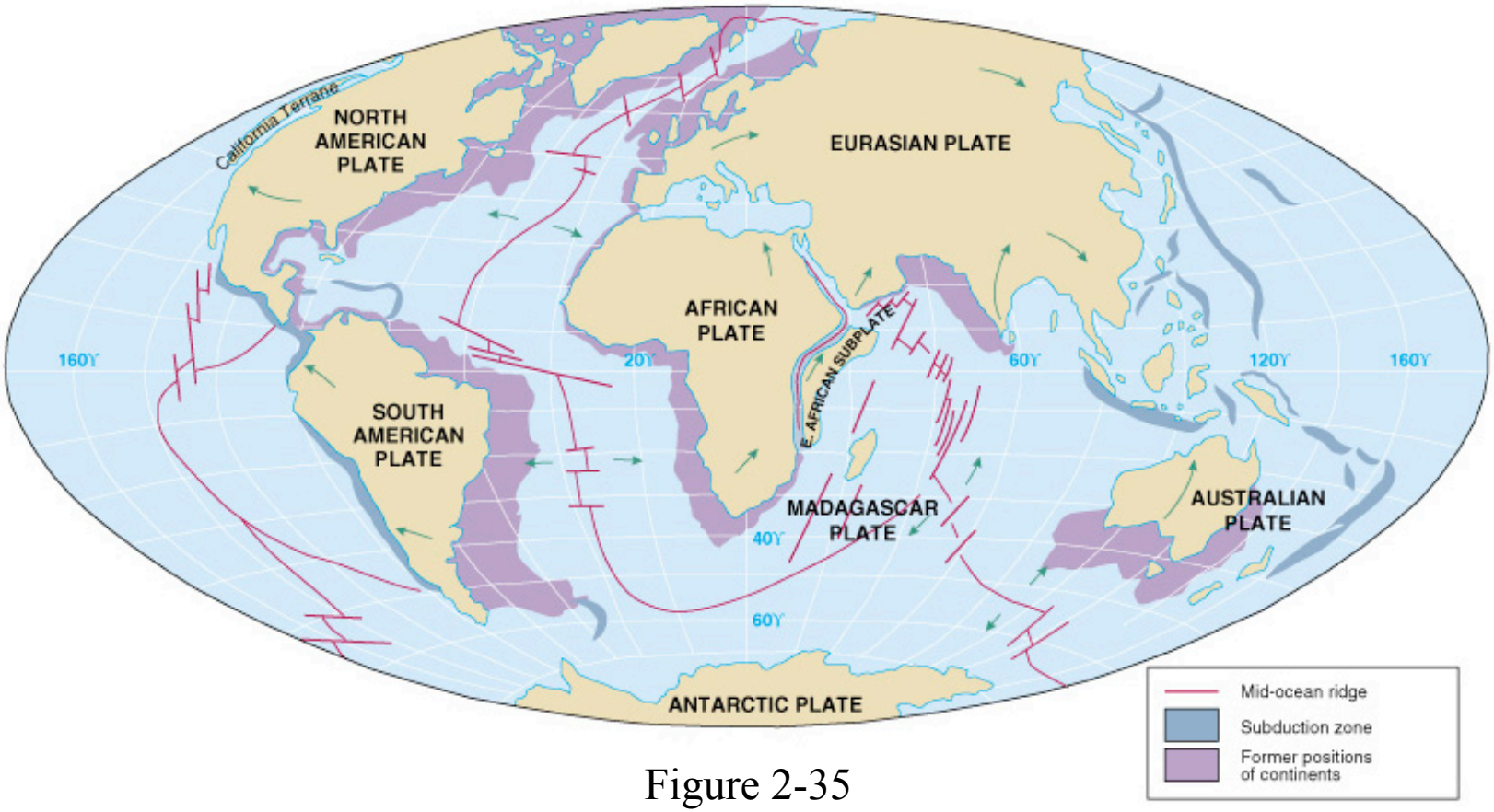


Figure 2-35