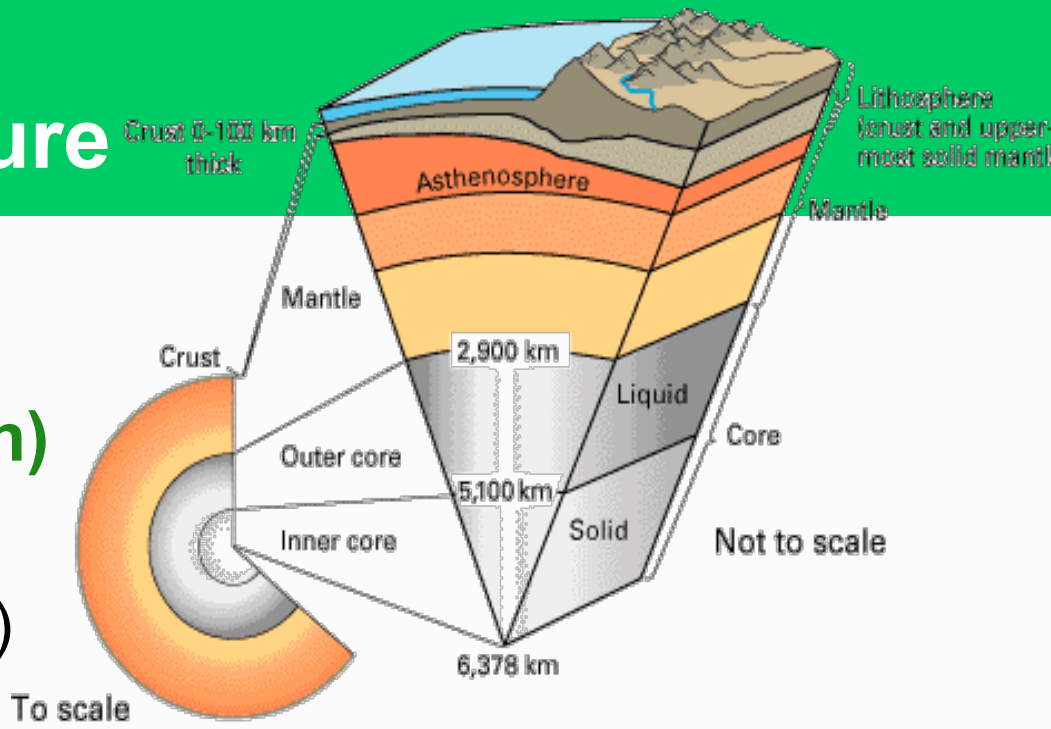
Earth’s Geological Cycle

What Are the Earth's Major Geological Processes?

- Main Processes:
  1. Plate Tectonics
  2. Rock Cycle
  3. Soil Formation

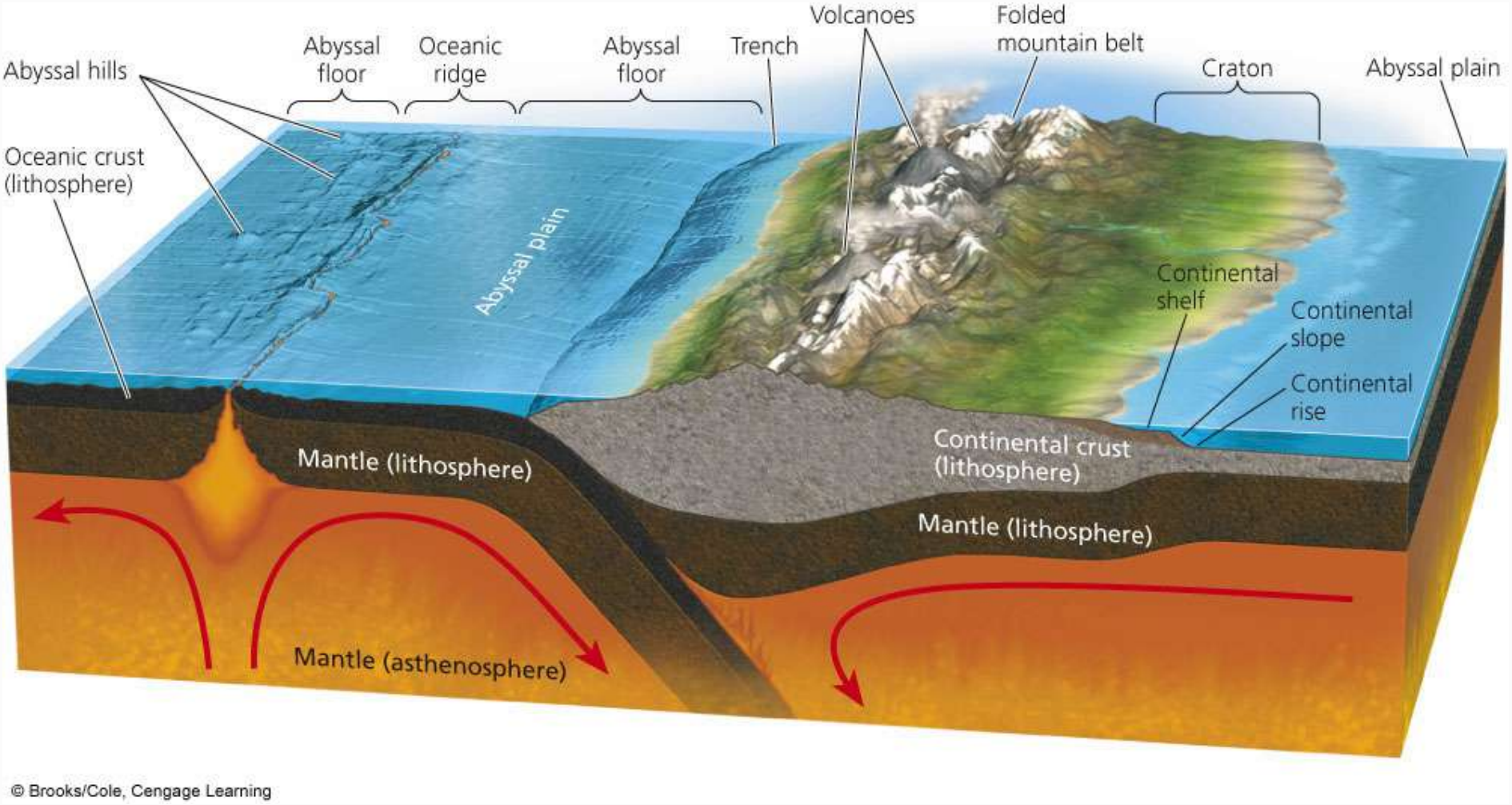
The Earth's Structure



- Earth's Interior
  - **Core (Nickel & Iron)**
    - Inner Core (solid)
    - Outer Core (liquid)
  - **Mantle**
    - Inner mantle (magma in motion)
    - Asthenosphere – outer part of mantle, flexible rock
    - Outer mantle (solid)
  - **Crust**
    - Continental crust
    - Oceanic crust: 71% of crust, DENSE

LITHOSPHERE

Major Features of the Earth's Crust and Upper Mantle



The Earth Beneath Your Feet Is Moving

- **Why do the tectonic plates move?**
  - **Convection cells**, or **currents**
    - Liquid rock is heated near the core and rises, cooler rock falls = convection currents INSIDE the earth

Theory of Plate Tectonics

- **Alfred Wegner 1912**
  - Noticed coastlines of the east coast of South America and the west coast of Africa seemed to fit together like a jigsaw puzzle – PANGEA

- **Theory Says**: the Earth's lithosphere is made up individual plates riding over the fluid mantle that create different types of plate boundaries and shape earth's landscape

Types of Boundaries

- Three types of boundaries between plates
  1. **Divergent plates**
     - **Magma**
     - **Oceanic ridge**
  2. **Convergent plates**
     - **Subduction zone**
     - **Trench**
     - **Volcano**
  3. **Transform fault; e.g., San Andreas fault**

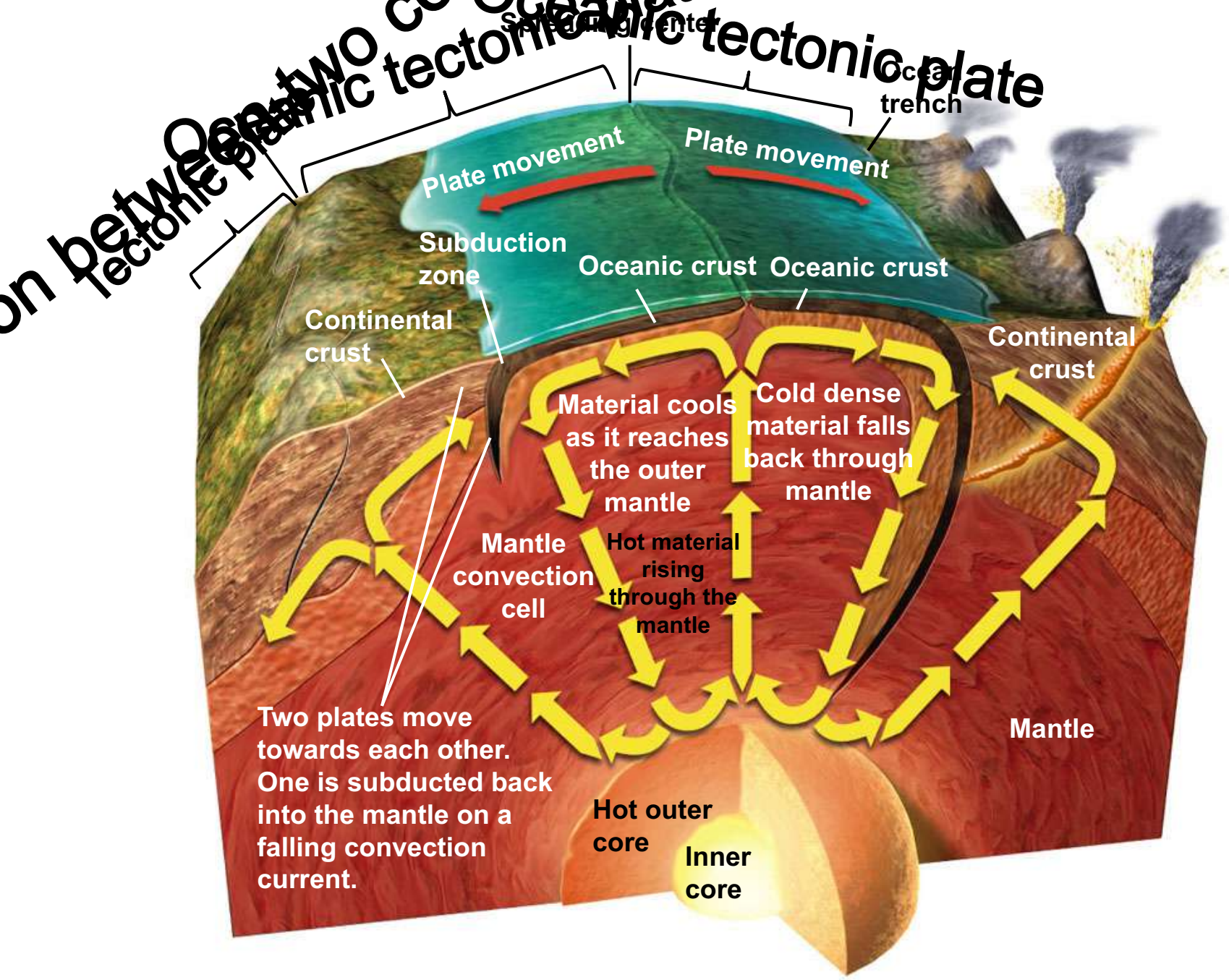
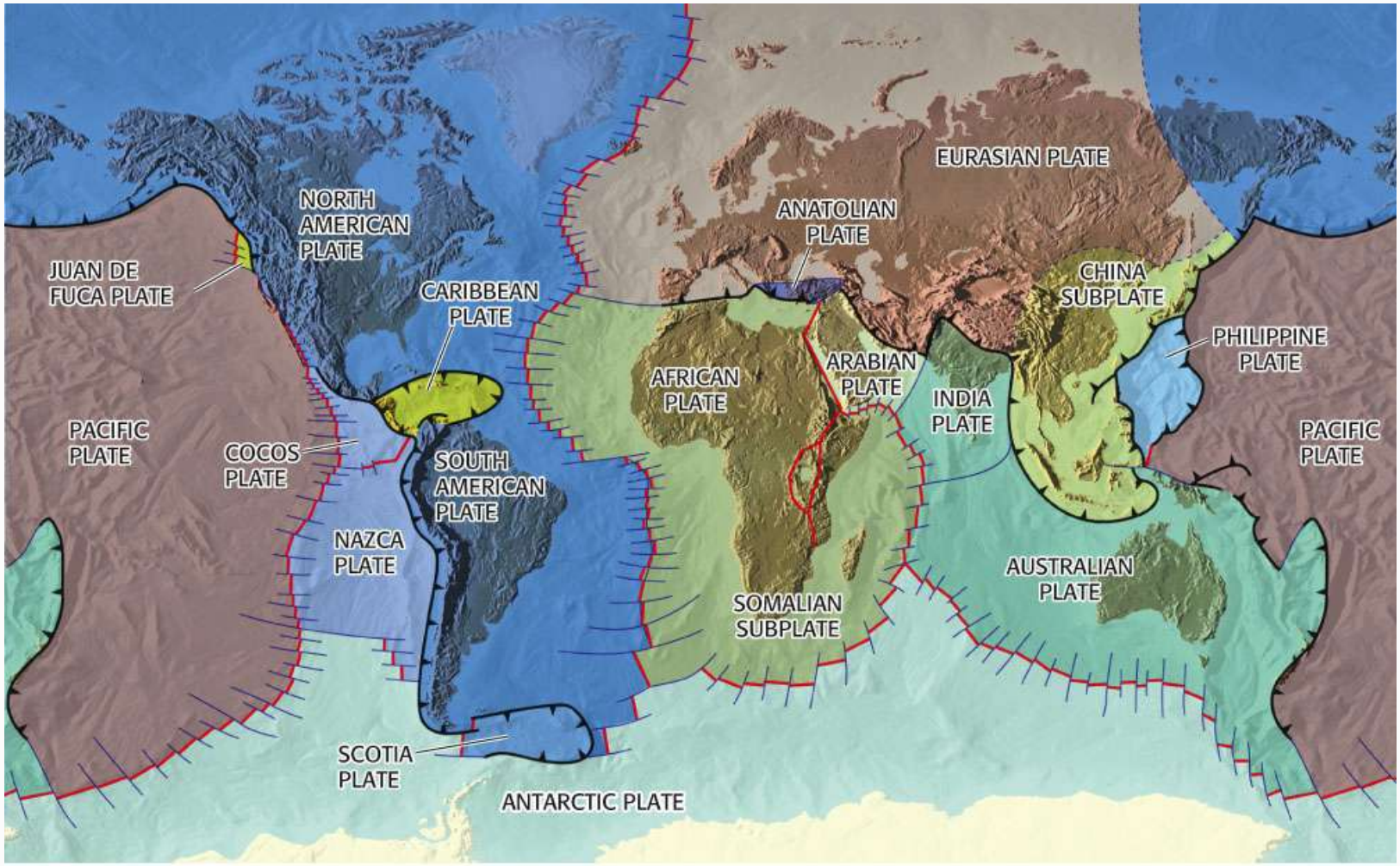


Fig. 14-3, p. 346

The Earth's Major Tectonic Plates



The San Andreas Fault as It Crosses Part of the Carrizo Plain in California, U.S.

The Geological Cycle: Some Parts of the Surface Build Up & Some Wear Down

- **Internal geologic processes**
  - Generally **build up** the earth's surface

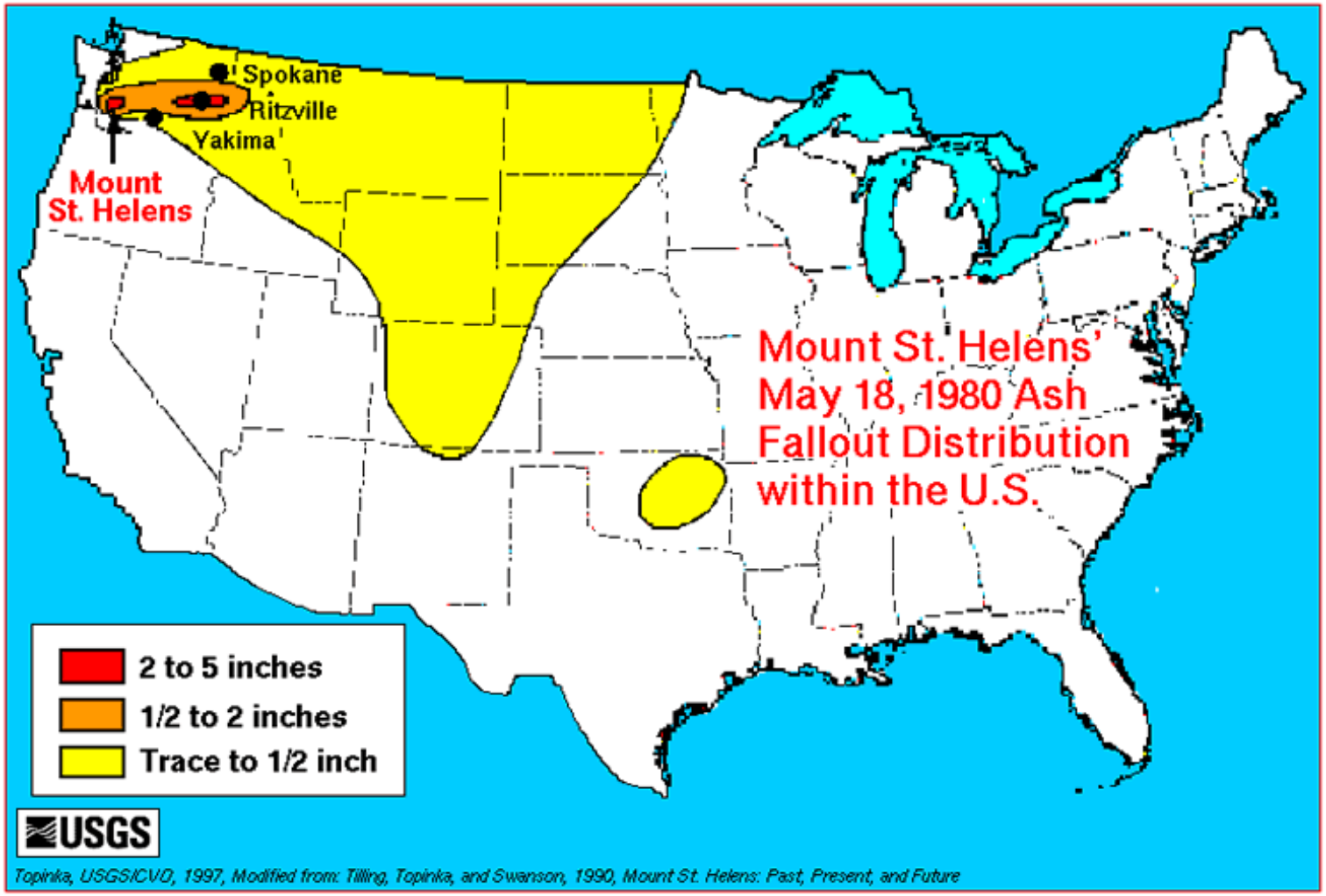
- **External geologic processes**
  - Generally **wear down** the earth's surface
  - **Driven directly or indirectly by sun and gravity**
    - **Weathering**
      - Physical, Chemical, and Biological
    - **Erosion**
      - Wind
      - Flowing water
      - Human activities
      - **Glaciers**

Volcanoes Release Molten Rock from the Earth's Interior

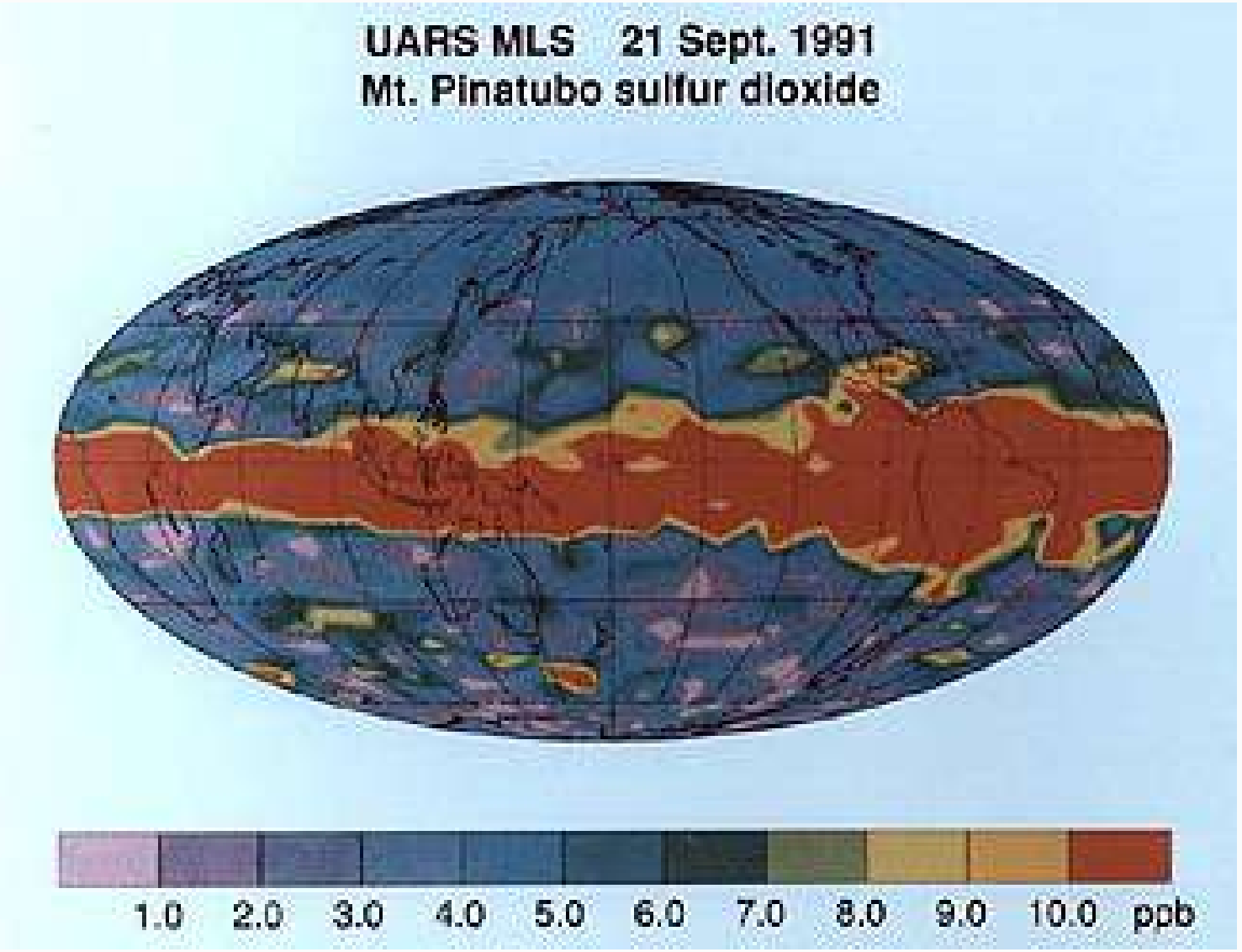
- 1980: Eruption of Mount St. Helens
  - Worst volcanic disaster in US History
- 1991: Eruption of Mount Pinatubo
  - Largest eruption of 20th century
  - Cooled the earth's temperatures for 15 months

5 largest volcanic eruptions in recent history

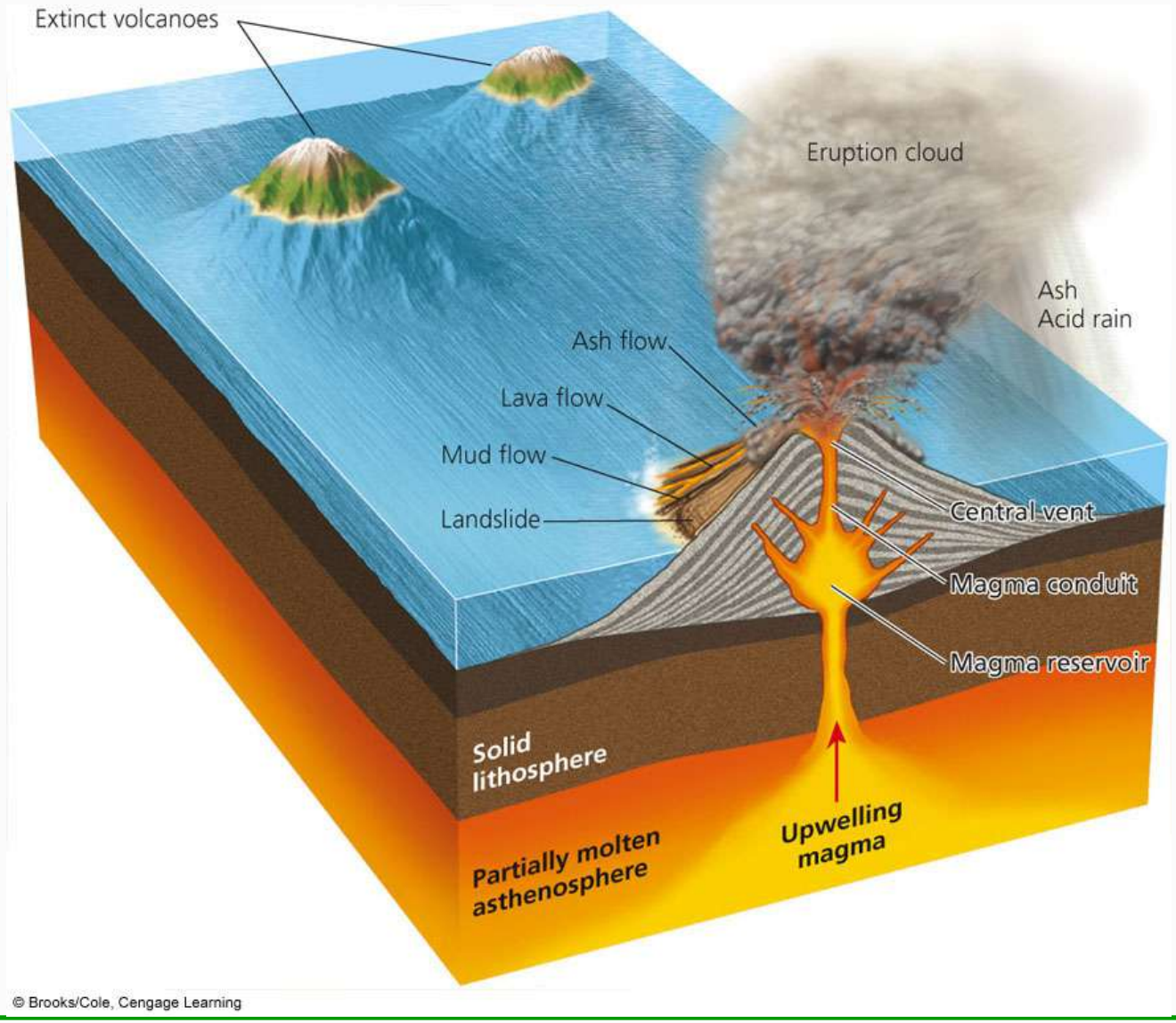
- Benefits of volcanic activity


Spokane
Ritzville
Yakima
Mount St. Helens
Mount St. Helens' May 18, 1980 Ash Fallout Distribution within the U.S.
2 to 5 inches
1/2 to 2 inches
Trace to 1/2 inch
USGS
Topinka, USGS/CVO, 1997, Modified from: Tilling, Topinka, and Swanson, 1990, Mount St. Helens: Past, Present, and Future

Mount Pinatubo


UARS MLS 21 Sept. 1991
Mt. Pinatubo sulfur dioxide
1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 ppb

Creation of a Volcano

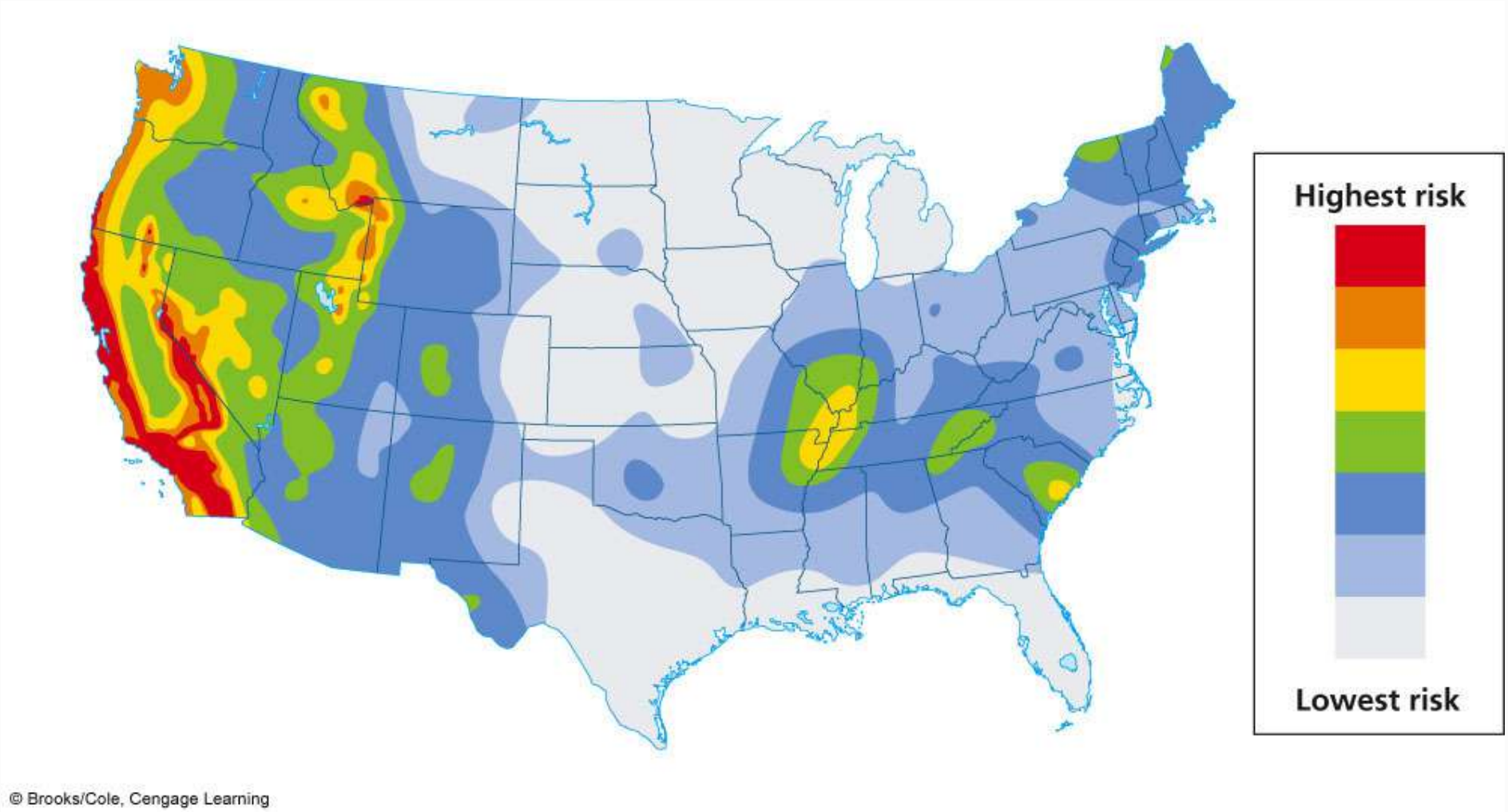


Measuring Earthquakes

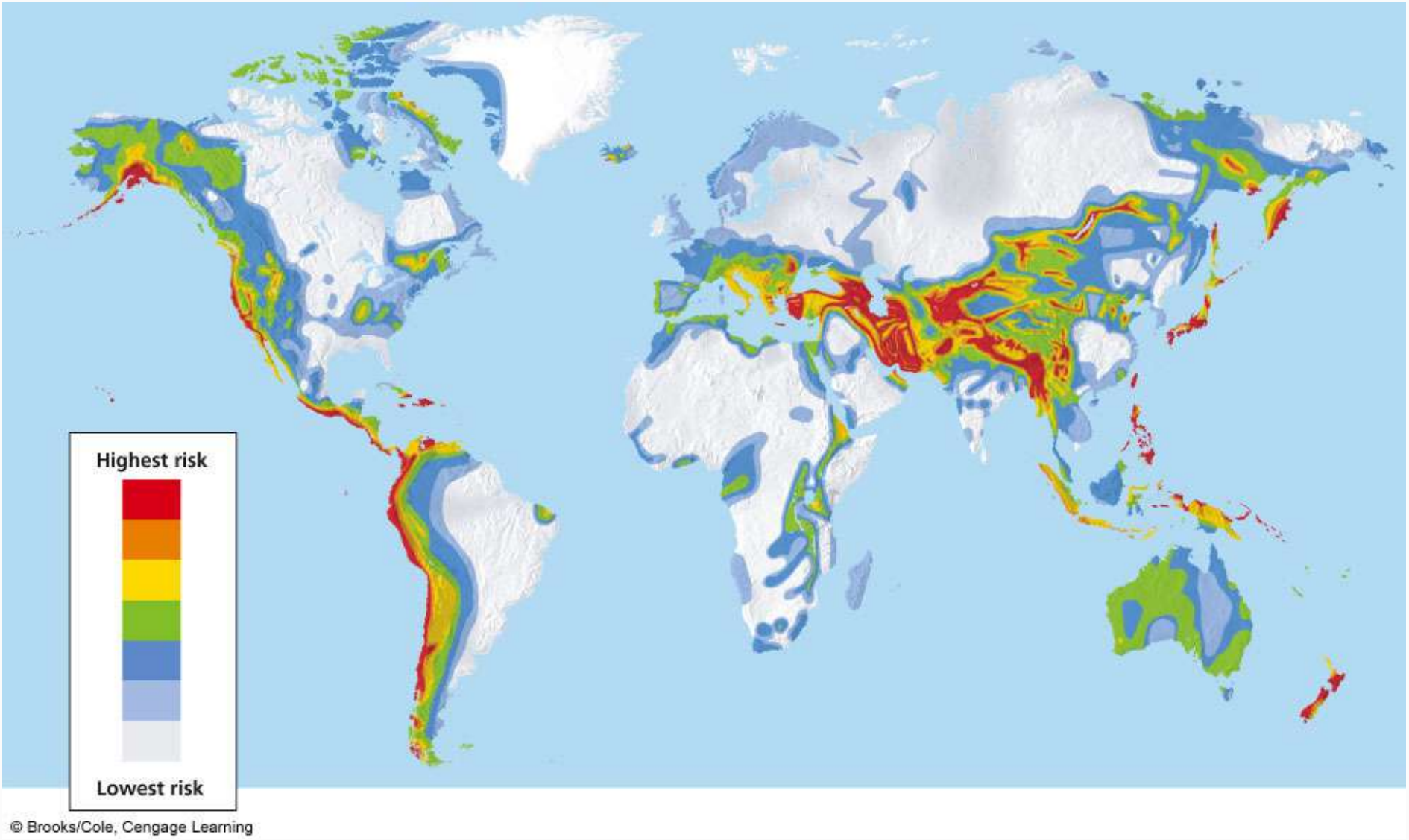
- **There are more than one million earthquakes a year!!**
  - Most are too small to be felt

- **Richter scale**
  - **Insignificant:** <4.0
  - **Minor:** 4.0–4.9
  - **Damaging:** 5.0–5.9
  - **Destructive:** 6.0–6.9
  - **Major:** 7.0–7.9
  - **Great:** >8.0
    - Largest ever recorded: 9.5 in Chile on May 22, 1960

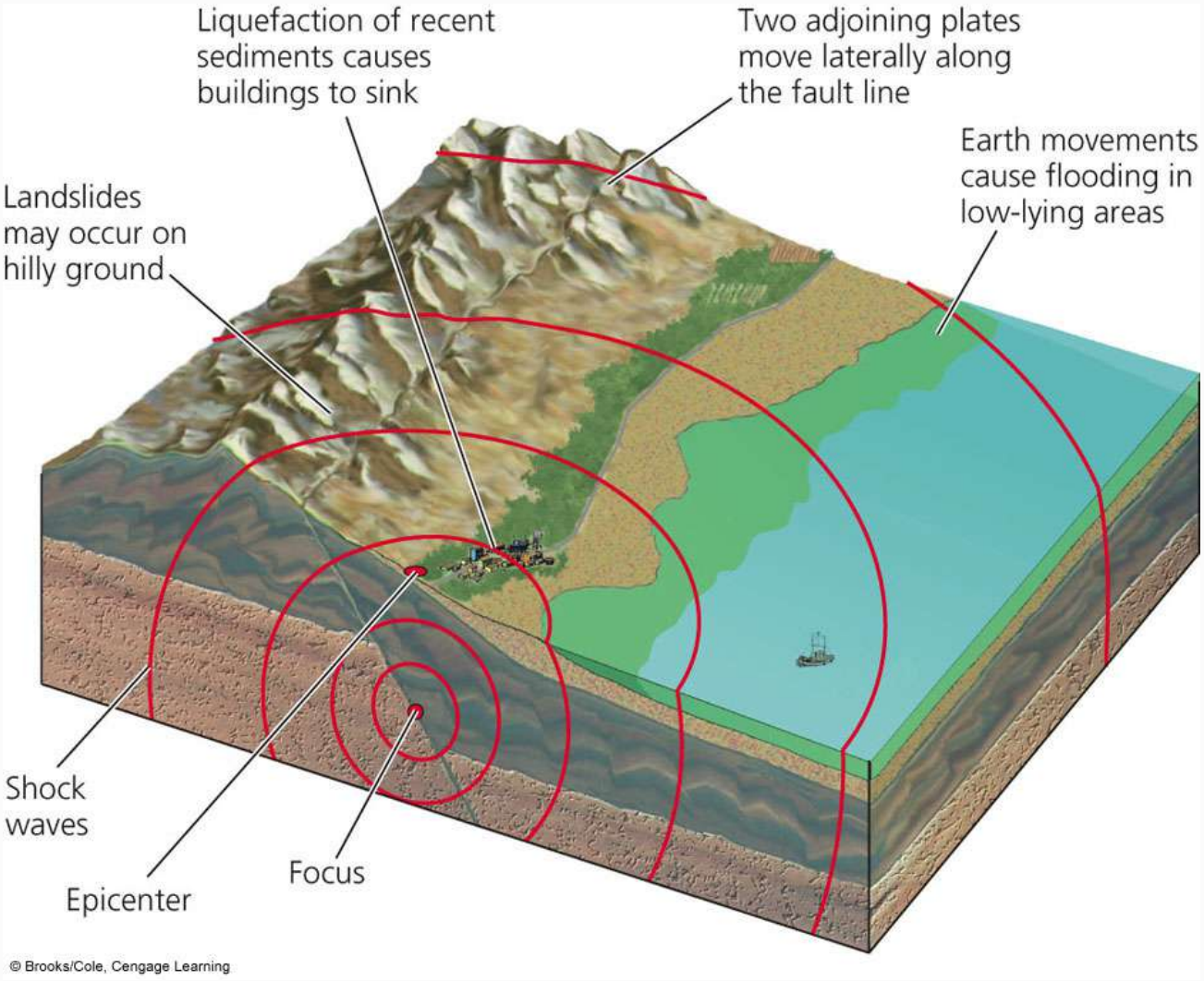
Areas of Greatest Earthquake Risk in the United States



Areas of Greatest Earthquake Risk in the World



Major Features and Effects of an Earthquake



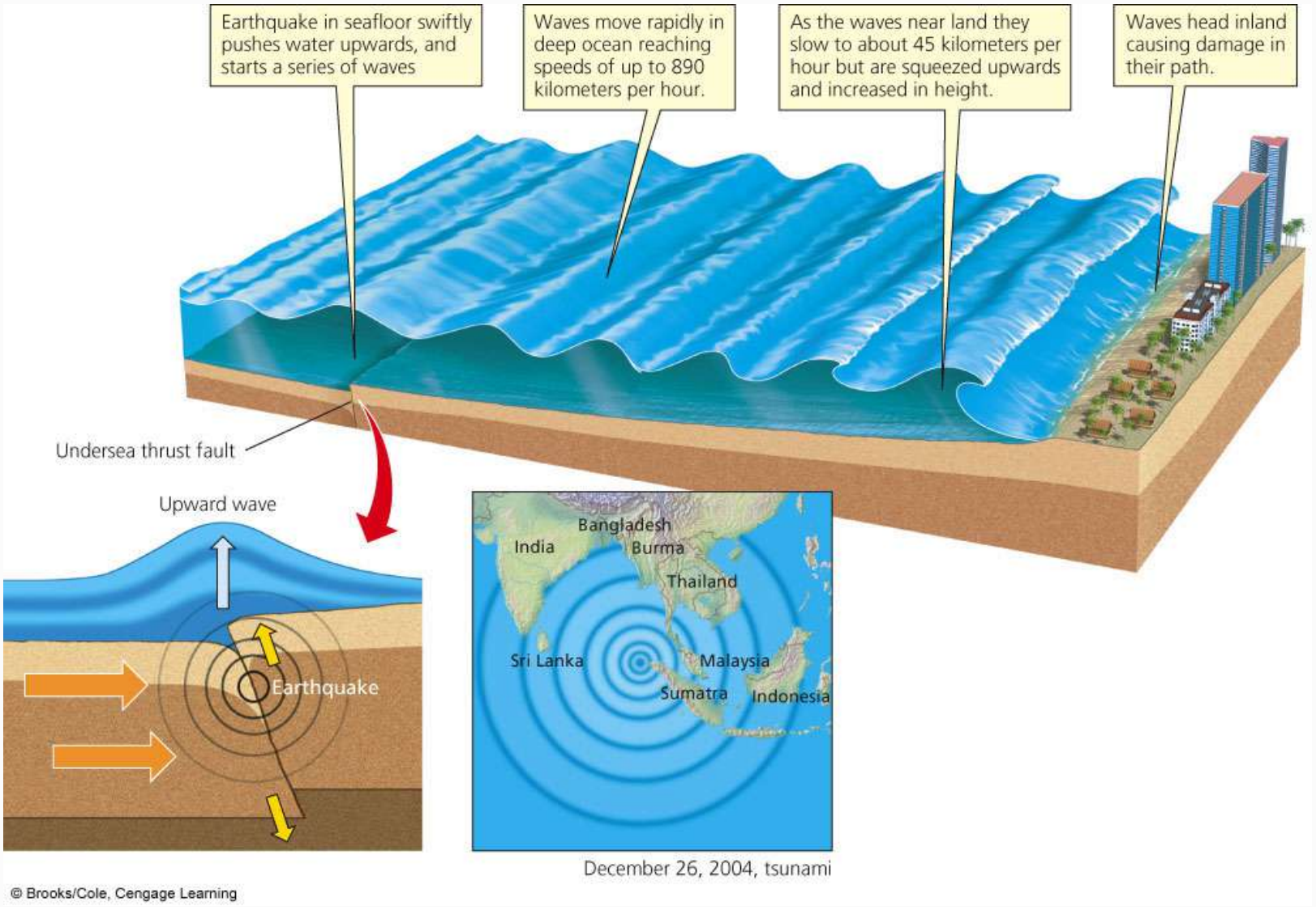
Earthquakes on the Ocean Floor Can Cause Huge Waves Called Tsunamis

- **Tsunami, tidal wave**
  - **Caused by movement of the ocean floor**
  - **Can travel as fast as a jet plane across open ocean**

- Detection of tsunamis
  - DART (http://nctr.pmel.noaa.gov/Mov/DART_04.swf)
  - Pressure recorders on the ocean floor measure changes in pressure (increased waves)

- December 2004: Indian Ocean tsunami
  - Magnitude of 9.15
  - Role of coral reefs and mangrove forests in reducing death toll

Formation of a Tsunami and Map of Affected Area of Dec 2004 Tsunami



Shore near Gleebruk in Indonesia before and after the Tsunami on June 23, 2004

http://oar.noaa.gov/podcast/2009/video/NOAA_TsunamiForecastingNoMusic.mov

Gravity and Earthquakes Can Cause Landslides

- **Mass wasting (Slope Movement by Gravity)**
  - Slow movement
  - Fast movement
    - Rockslides
    - Avalanches
    - Mudslides
- Increased due to human activities
  - Forest Clearing
  - Road building
  - Crop Growing
  - Building houses on steep slopes

The Cycling of Earth's Rocks

- *The three major types of rocks found in the earth's crust—sedimentary, igneous, and metamorphic—are recycled very slowly by the process of erosion, melting, and metamorphism.*

The crust is composed of rocks & minerals

- **Minerals- elements or inorganic compounds that occur naturally in the earth's crust as a solid with a regular internal crystalline structure**
  - **Ex: gold, diamond, silver, salt, quartzite**

- **Rocks – a solid combination of one or more minerals found in the earth's crust**
  - **Example: Granite = mica + feldspar + quartz**

Classifying Rocks

- There are three broad classes of rocks, based on formation
  1. **Sedimentary (deposited)**
  2. **Igneous (volcanic)**
  3. **Metamorphic (heat & pressure)**

There Are Three Major Types of Rocks (1)

1. Sedimentary
   - Sandstone
   - Shale
   - Dolomite
   - Limestone
   - Lignite
   - Bituminous coal

There Are Three Major Types of Rocks (2)

2. Igneous

(form the bulk of the earth's crust)

- Granite
- Lava rock

There Are Three Major Types of Rocks (3)

3. **Metamorphic**
   - **Anthracite**
   - **Slate**
   - **Marble**

The Earth's Rocks Are Recycled Very Slowly

- **Rock cycle**

- Slowest of the earth's cyclic processes

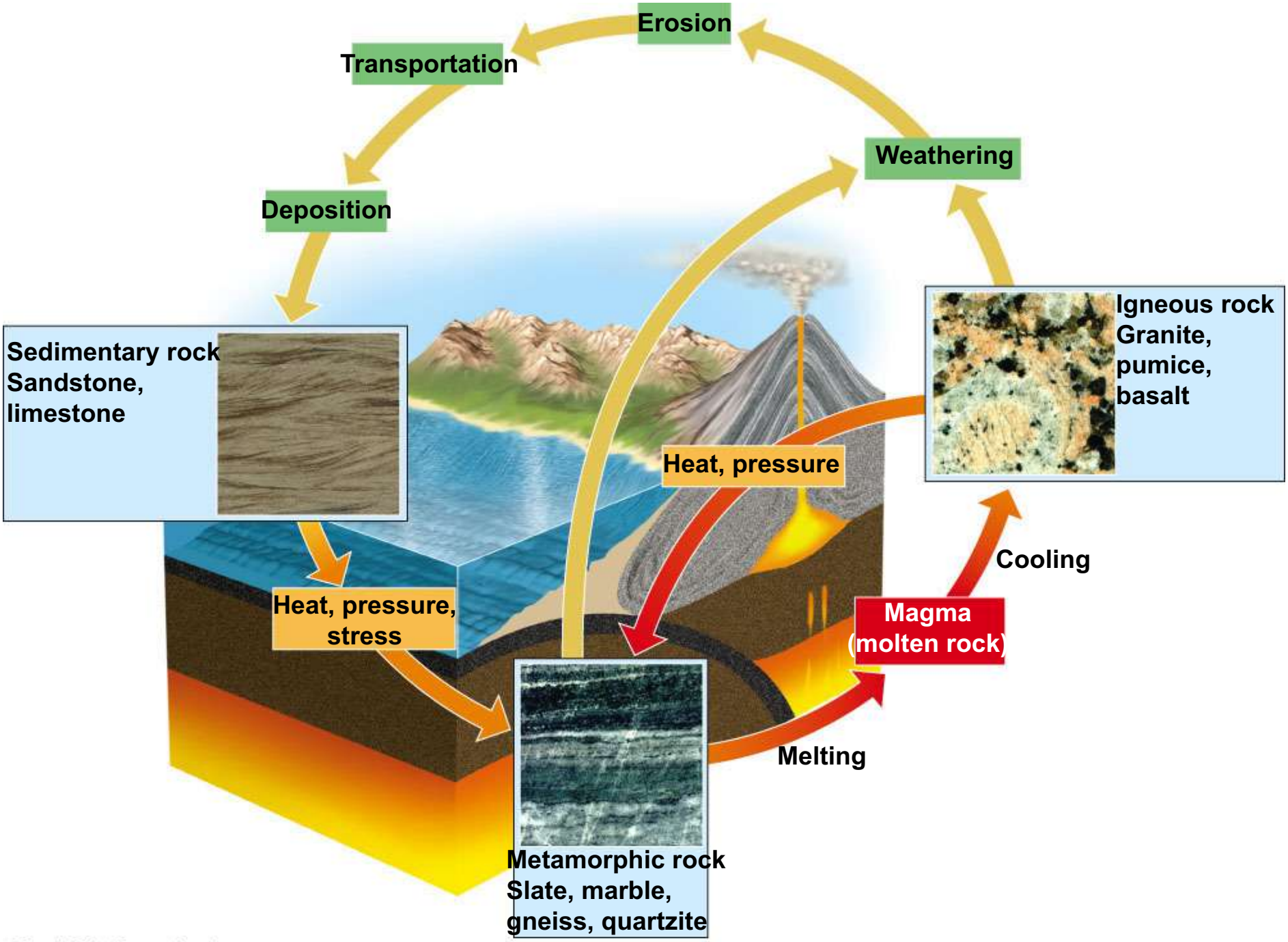


Fig. 14-13, p. 354