

## Topic 6

### Earth's Internal Structure and Tectonic Process

- Geologic Time
- Internal Structure and Energy
- Geologic Cycle
- Rock Cycle
- Tectonic Cycle
- Plate Tectonics
- Earthquakes
- Volcanism

KEY LEARNING CONCEPTS

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Chapters 12 & 13

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## Geography of the Lithosphere

- To this point, we have focused on systems operating within the **atmosphere** or **hydrosphere**
- Now we turn our attention to the lithosphere and:
  - ☒ **exogenic systems?**
    - ◆ reshape and wear down landscapes
  - ☒ **endogenic systems?**
    - ◆ create new crust and rejuvenate landforms

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## History of Earth History

● Creationist interpretations:

☒ Neptunism



☒ Catastrophism



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## History of Earth History

### Scientific Interpretations

#### Plutonism

- Earth's interior is molten, all rocks of volcanic origin, James Hutton (1795), *Theory of the Earth*

#### Uniformitarianism (gradualism)

- the present is the key to the past**
- same processes operating to shape the Earth today have been operating throughout geologic time, James Hutton (1795), *Theory of the Earth*; Charles Lyell (1830), *Principles of Geology*

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## Geologic Time

### Most endogenic and exogenic systems operate v. slowly

### Intervals of time are determined by:

#### relative ages:

- principle of faunal succession
- principle of superposition

#### absolute ages:

- radioactive dating techniques



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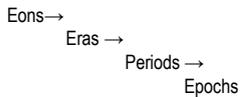
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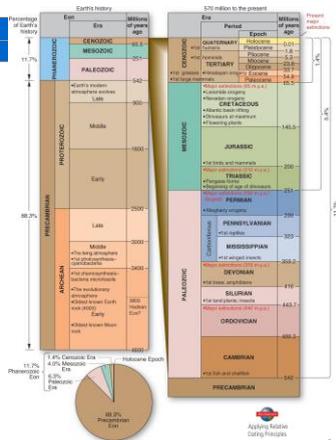


## Geologic Time Scale

Divides Earth's history into:



Analogous to:



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## Earth's Internal Energy

Two sources of energy drive endogenic systems:

1. \_\_\_\_\_
2. \_\_\_\_\_



Note: friction is also important on a v. local/regional scale

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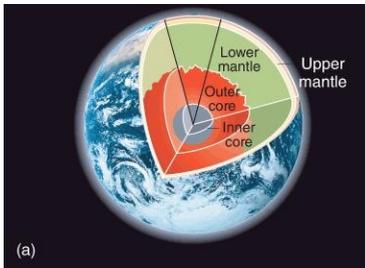
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## Earth in Cross-Section

heavier elements migrated inward



lighter elements were displaced outward

concentric zones of differential composition and thermal characteristics

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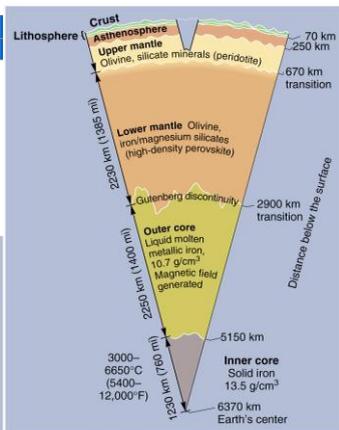
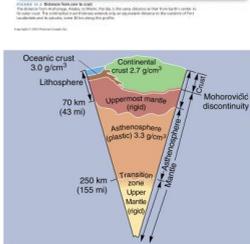
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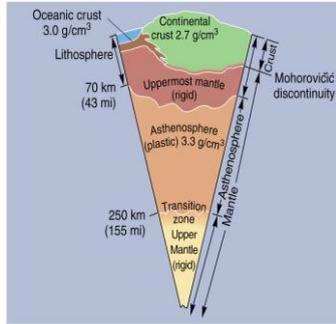


## Upper Mantle

Upper mantle divided into:

- Upper mantle
- Asthenosphere
- Upper most mantle

Upper most mantle  
+ Crust  
= Lithosphere



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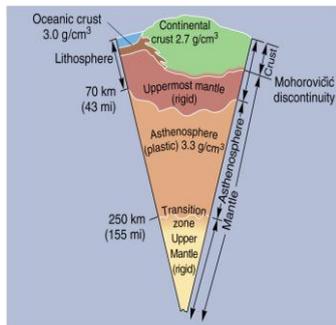
## Asthenosphere

Radioactive decay:

- increased heat energy
- convective currents
- **plastic** deformation

Heat energy variable  
- results in?

Depth of convection?



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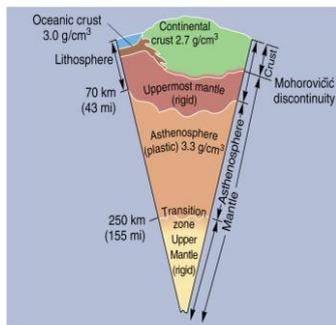
## Lithosphere

Extends from surface to depth of approx. 70 km

Includes:

- **Oceanic crust**
- **Continental crust**

Boundary between crust and uppermost mantle?



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## Lithification

● Conversion of sediments to rock by?

- 1.
- 2.
- 3.



● Study of sequence, spacing, distribution, and age of sed. rx. is called \_\_\_\_\_

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**TABLE 11.3** Clast Sizes and Related Sedimentary Rock Form

| Unconsolidated Sediment | Grain Size      | Rock Form                                     |
|-------------------------|-----------------|---|
| Boulders, cobbles       | >80 mm          | Conglomerate (breccia, if pieces are angular) |
| Pebbles, gravel         | >2 mm           | Conglomerate                                  |
| Coarse sand             | 0.5–2.0 mm      | Sandstone                                     |
| Medium-to-fine sand     | 0.062–0.5 mm    | Sandstone                                     |
| Silt                    | 0.0039–0.063 mm | Siltstone (mudstone)                          |
| Clay                    | <0.0039 mm      | Shale   |

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## Clastic vs. Chemical Sed. Rx.



evaporation hydrothermal activity

lithification of organics

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## Plate Tectonics & Continental Drift

- As accurate maps showing entire continents became available, it was noted that some continents appeared to “fit together”
- Alfred Wegener (1912) was the first to present a hypothesis to explain this
  - ▣ **continental drift**



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## Continental Drift?

- He used evidence from:
  - ▣ fossil record
  - ▣ climatic record
  - ▣ geologic record



- **But . . .** he couldn't explain how entire continents actually move?

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## Sea Floor Spreading

- Then in the 1960's Harry Hess and Robert Dietz propose theory of sea floor spreading
  - ▣ Based on existence of interconnected ridges, called **mid-ocean ridges**
    - ◆ result of crust being pulled apart
    - ◆ caused by convective currents in the asthenosphere
    - ◆ extrusion of lava creates new sea floor

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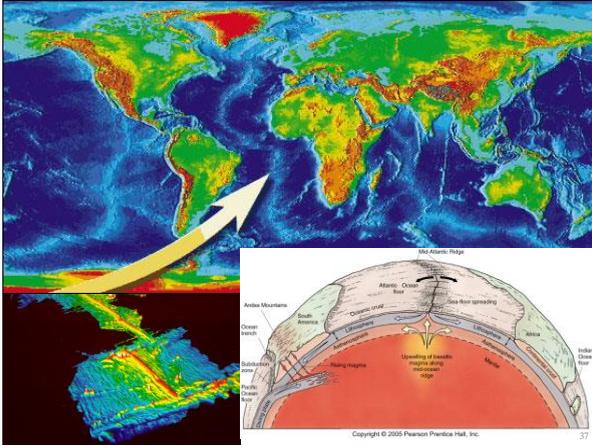
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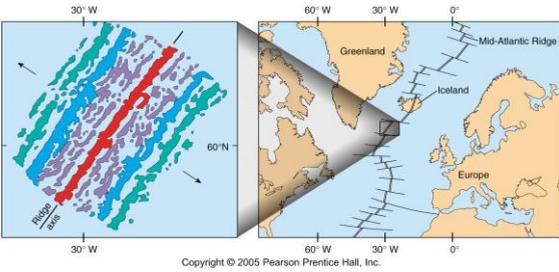
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### Magnetic Reversals



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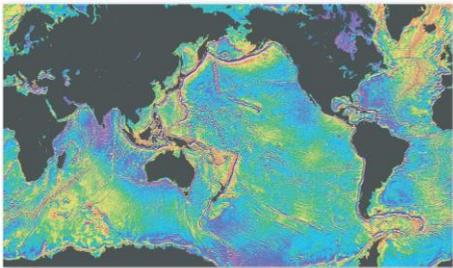
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### Ocean Floor



**FIGURE 11.20 The ocean floor revealed.**  
A global gravity anomaly map derived from Geosat and ERS-1 altimeter data. The radar altimeters measured sea surface heights. Variation in sea-surface elevation is a direct indication of the topography of the ocean floor. (Image courtesy of D. T. Sandwell, Scripps Institution of Oceanography. All rights reserved, 1995.)

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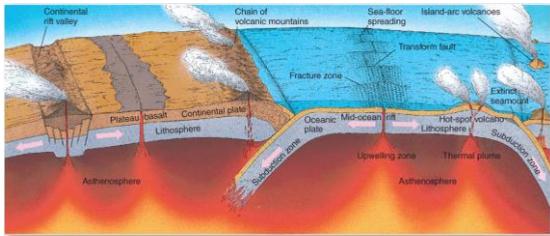








## Forces and Features at Plate Boundaries



**FIGURE 12.27 Tectonic settings of volcanic activity.** Magma rises and lava erupts from rifts, through crust above subduction zones, and where thermal plumes at hot spots break through the crust. (Adapted from U.S. Geological Survey, *The Dynamic Planet* (Washington, DC: Government Printing Office, 1989).)



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