Introducing Geology and an Overview of Important Concepts

Physical Geology,

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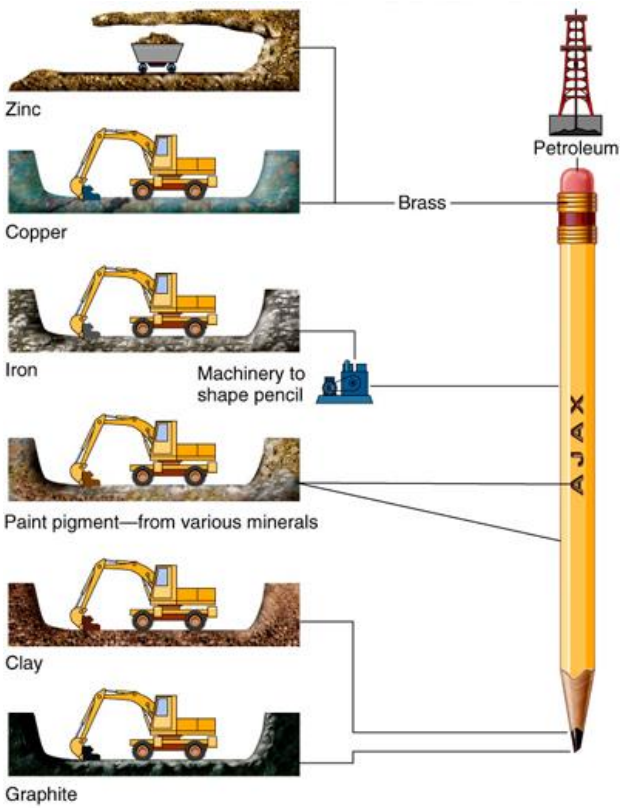
Geology in Today's World

- *Geology* - The scientific study of the Earth
  - *Physical Geology* is the study of Earth's materials, changes of the surface and interior of the Earth, and the forces that cause those changes

- Practical Aspects of Geology
  - Natural resources
  - Geological hazards
  - Environmental protection

Practical Aspects of Geology

- *Natural Resources*
  - All manufactured objects depend on Earth's resources
  - Localized concentrations of useful geological resources are mined or extracted
  - If it can't be grown, it must be mined
  - Most resources are limited in quantity and *non-renewable*



Resource Extraction and Environmental Protection

- *Coal Mining*
  - Careless mining can release acids into groundwater
- *Petroleum Resources*
  - Removal, transportation and waste disposal can damage the environment

Alaska pipeline

- *Dwindling resources can encourage disregard for ecological damage caused by extraction activities*

Geologic Hazards

- *Earthquakes*
  - Shaking can damage buildings and break utility lines; large undersea quakes may generate *tsunamis*
- *Volcanoes*
  - Ash flows and mudflows can overwhelm populated areas
- *Landslides, floods, and wave erosion*

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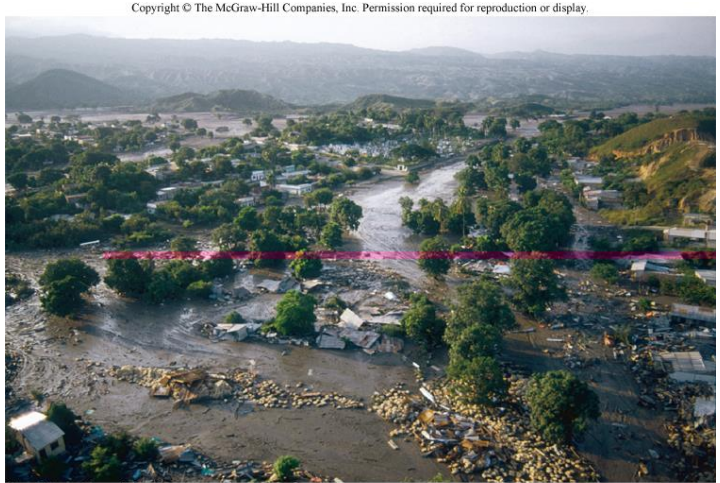
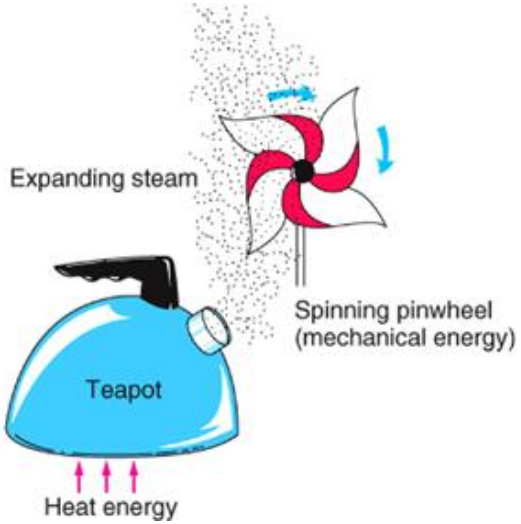
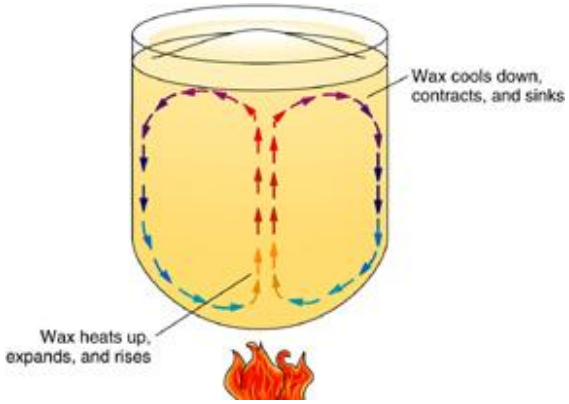


Physical Geology Concepts

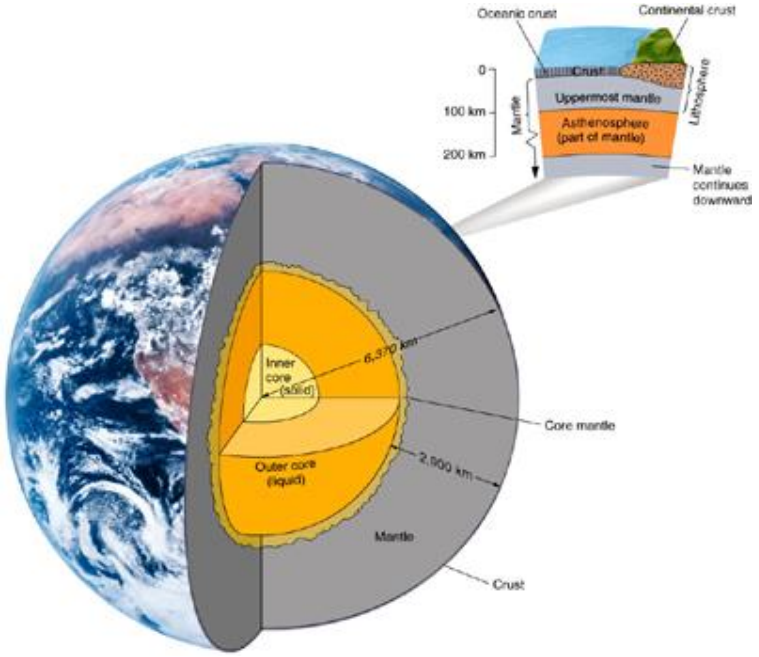
- *Earth's Heat Engines*
  - External (energy from the Sun)
    - Primary driver of atmospheric (weather) and hydrospheric (ocean currents) circulation
    - Controls weathering of rocks at Earth's surface
  - Internal (heat moving from hot interior to cooler exterior)
    - Primary driver of most geospheric phenomena (volcanism, magmatism, tectonism)





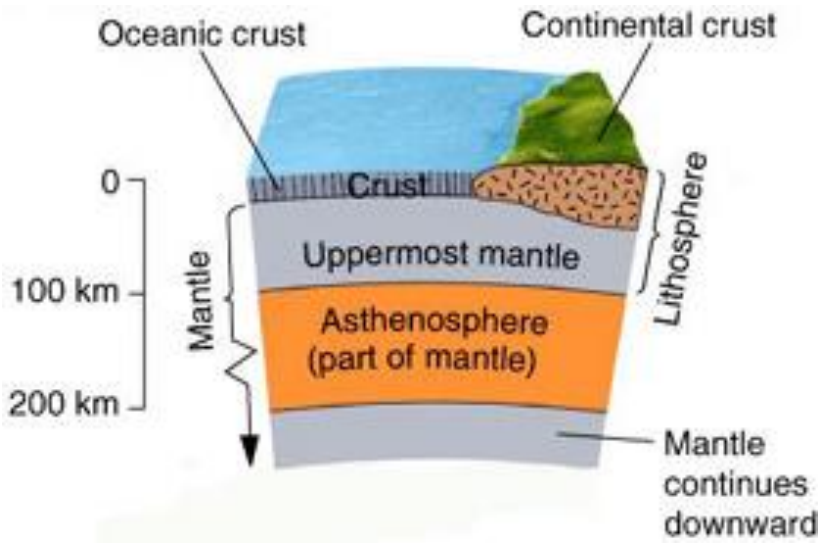
Earth's Interior

- Compositional Layers
  - *Crust* (~3-70 km thick)
    - Very thin outer rocky shell of Earth
      - Continental crust - thicker and less dense
      - Oceanic crust - thinner and more dense
  - *Mantle* (~2900 km thick)
    - Hot solid that flows slowly over time; Fe-, Mg-, Si-rich minerals
  - *Core* (~3400 km radius)
    - Outer core - metallic liquid; mostly iron
    - Inner core - metallic solid; mostly iron



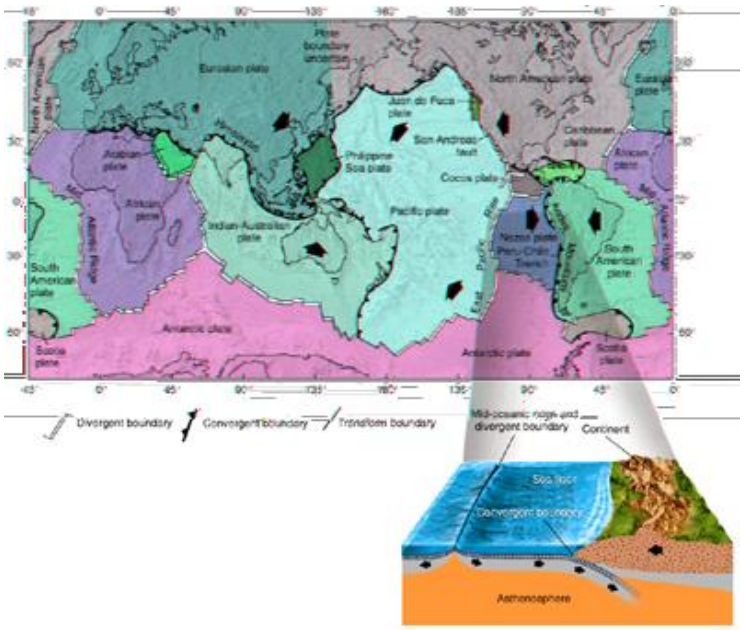
Earth's Interior

- Mechanical Layers
  - *Lithosphere* (~100 km thick)
    - Rigid/brittle outer shell of Earth
    - Composed of both crust and uppermost mantle
    - Makes up Earth's tectonic "plates"
  - *Asthenosphere*
    - Plastic (capable of flow) zone on which the lithosphere "floats"



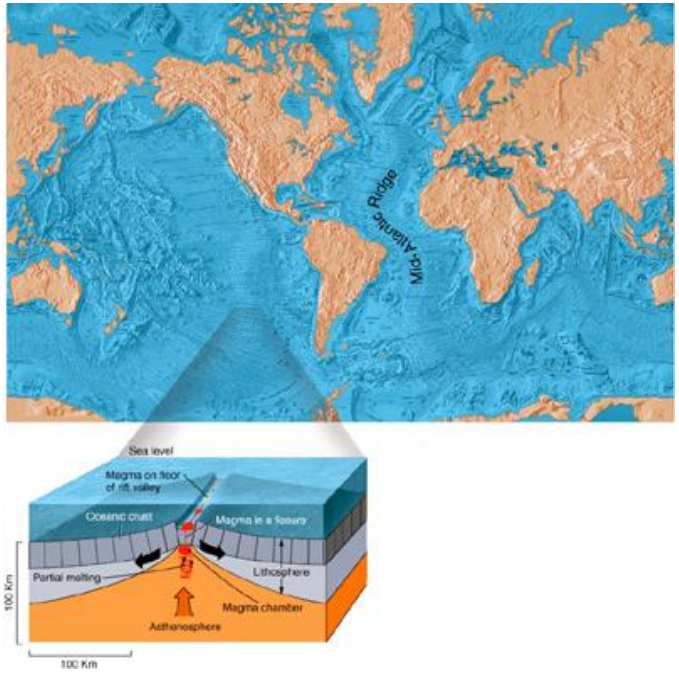
Theory of Plate Tectonics

- *Continental Drift Hypothesis*
  - Originally proposed in early 20th century to explain the "fit of continents", matching rock types and fossils across ocean basins, etc.
  - Insufficient evidence found for driving mechanism; hypothesis initially rejected
- *Plate Tectonics Theory*
  - Originally proposed in the late 1960s
  - Included new understanding of the seafloor and explanation of driving force
  - Describes lithosphere as being broken into *plates* that are in motion
  - Explains origin and distribution of volcanoes, fault zones and mountain belts



Tectonic Plate Boundaries

- *Divergent* boundaries
  - Plates move apart
  - Magma rises, cools and forms new lithosphere
  - Typically expressed as *mid-oceanic ridges*
- *Transform* boundaries
  - Plates slide past one another
  - Fault zones, earthquakes mark boundary
  - San Andreas fault in California
- *Convergent* boundaries
  - Plates move toward each other
  - Mountain belts and volcanoes common
  - Oceanic plates may sink into mantle along a *subduction zone*, typically marked by a deep ocean trench



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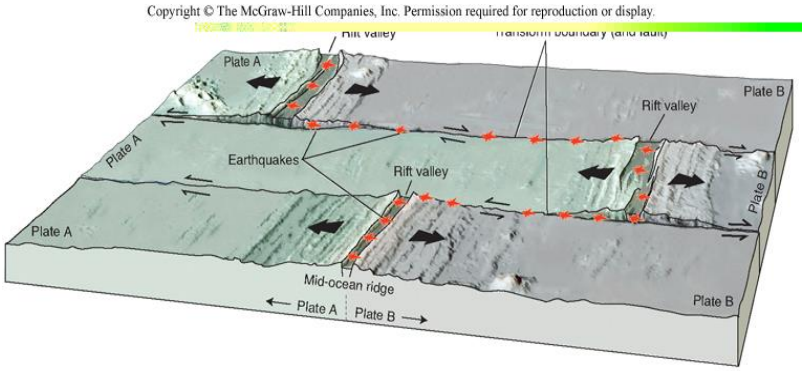

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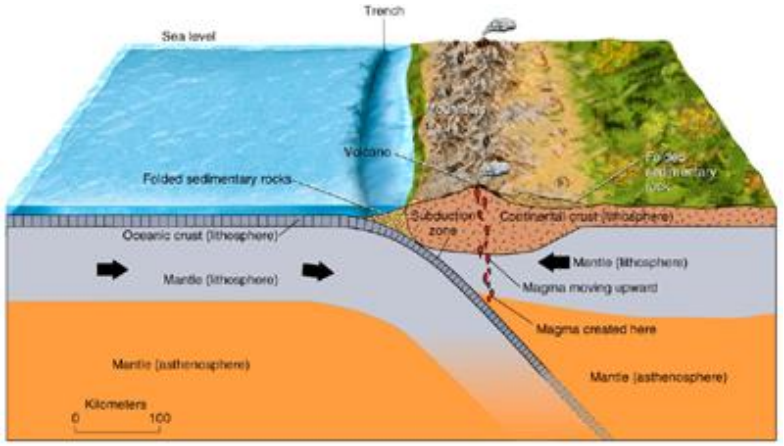

Geologic Time

- "Deep" Time
  - Most geologic processes occur gradually over millions of years
  - Changes typically imperceptible over the span of a human lifetime
  - Current best estimate for age of Earth is ~4.56 *billion* years
- Geologic Time and the History of Life
  - Complex life forms first became abundant about 544 million years ago
  - Reptiles became abundant ~230 million years ago
  - Dinosaurs became extinct (along with *many* other organisms) ~65 million years ago
  - Humans have been around for a few million years
- "Nothing hurries geology"

Mark Twain

TABLE 1.2 Some Important Ages in the Development of Life on Earth

Millions of Years before Present	Noteworthy Life	Eras	Periods
4	Earliest hominids	Cenozoic	Quaternary, Tertiary
65	First important mammals; Extinction of dinosaurs		
	First dinosaurs	Mesozoic	Cretaceous, Jurassic, Triassic
251			
300	First reptiles	Paleozoic	Permian, Pennsylvanian, Mississippian, Devonian, Silurian, Ordovician, Cambrian
400	Fishes become abundant		
544	First abundant fossils		
600	Some complex, soft-bodied life	Precambrian	(The Precambrian accounts for the vast majority of geologic time.)
3,500	Earliest single-celled fossils		
4,550	Origin of the Earth		