

# Chapter Outlines

**NOTE: This is intended to help students 'organize' their understanding of each topic. It is not a comprehensive study guide for quizzes or midterms, i.e. study your text!**

## Introducing Geology, Plate Tectonics, & Other Concepts

**Physical geology** is the study of the earth's rocks, minerals, and soils and how they have formed through time. Complex internal processes such as plate tectonics and mountain-building have formed these rocks and brought them to Earth's surface. Earthquakes are the result of sudden movement of crustal plates, releasing internal energy that becomes destructive at the surface. Internal heat and energy are released also through volcanic eruptions. External processes such as glaciation, running water, weathering, and erosion have formed the landscapes we see today.

### Practical Aspects of Geology

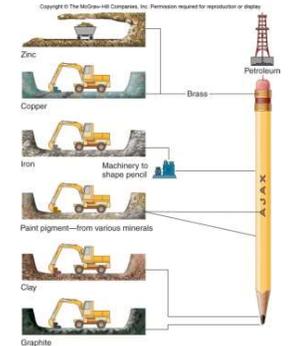
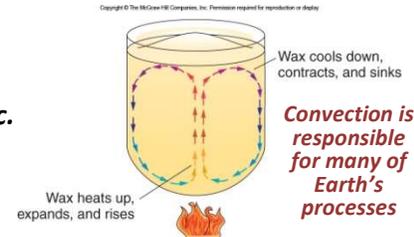
- Natural resources – Supplying the things we need
- Geological hazards – Avoiding them
- Environmental protection
- Understanding our surroundings – Aids us in making good decisions

### Resource Extraction & Environmental Protection of 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!**
- Many resources are limited in quantity and non-renewable
  - Careless mining can release acids into groundwater
  - Petroleum Resources - removal, transportation and waste disposal can 'damage' the environment



**Oil pipeline**  
(above-ground method)



**Most materials we use are mined**

### 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**



**Earthquake damage**



**Floods**

### Physical Geology Concepts

#### Earth's Systems

- **Atmosphere**—the gases that envelop Earth
- **Hydrosphere**—water on or near Earth's surface
- **Biosphere**—all living or once-living materials
- **Geosphere**—the solid 'rocky' Earth

#### Earth's Heat Engines

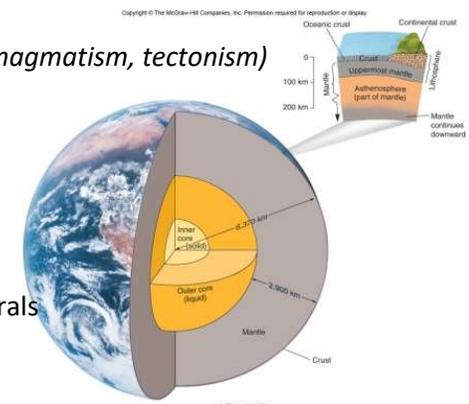
- **External** (*energy from the Sun*)
  - Primary driver of atmospheric (*weather*) and hydrospheric (*ocean currents*) circulation
  - Controls weathering of rocks at Earth's surface
- **Internal** (*heat moving from hot interior to cooler exterior*)
  - Primary driver of most geospheric phenomena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



**Heat can create convection currents similar to a lava lamp**

### Earth's Interior

- **Compositional Layers** (*defined by their composition*)
  - **Crust** (~3-70 km thick)
    - Very thin outer rocky shell of Earth
    - Continental crust differs from oceanic crust
  - **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** (defined by their physical characteristics)
  - **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

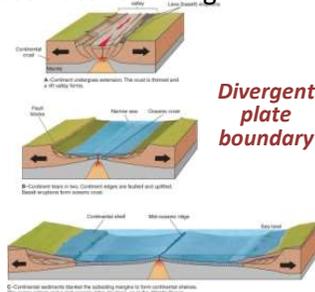


The coastlines of S. America & Africa appeared to 'fit' together

- **Continental Drift Hypothesis**
  - Originally proposed in early 20th century by Alfred Wegener to explain the "fit of continents", also 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 the origin and distribution of volcanoes, fault zones and mountain belts
  - As a result of plate tectonics, the same rock forming processes have been active through much of Earth's history...and continue today.

#### Tectonic Plate Boundaries

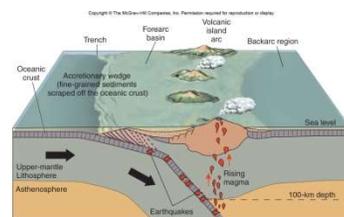
- **Divergent boundaries**
  - Plates move apart
  - Magma rises, cools and forms new lithosphere
  - Typically expressed as mid-oceanic ridges
- **Transform boundaries**
  - Plates slide past one another
  - Fault zones, earthquakes mark boundary
  - San Andreas fault in California is one example
-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



Divergent plate boundary

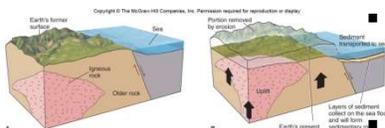


The San Andreas Fault is a transform plate boundary



Convergent plate boundary

### Surficial Processes



Uplift & erosion

#### Uplift

- Volcanic and/or tectonic forces build crust up above sea level
- Removal of material by erosion allows isostatic uplift of underlying rocks

#### Weathering and Erosion

- Rainfall and glaciers flow down slopes carrying 'sediment' with them
- Moving water, ice, and wind loosen and erode geologic materials, creating sediment

#### Deposition

- Loose sediment is deposited when the transporting agent loses its carrying power
- Sediments then get buried and harden into sedimentary rock

### Geologic Time "Nothing hurries geology" Mark Twain

#### 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 ~3 million years

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

History of life on Earth