Geology = Study of the Earth (Physical & Historical)

Includes - study of earth
- study of earth processes:
- study of earth’s history:

Subsystems: Atmosphere, Biosphere, , Lithosphere, , Core
How does Geology Affect our Lives

- Natural Events
- Economics and Politics
- Our role as Decision-makers
- Consumers and Citizens
- Sustainable Development

Global Geologic and Environmental Issues Facing Humankind

- Overpopulation
- Global Warming (climate change, greenhouse effect)

Figure 1-4 p9
Earth Materials

Rocks: Naturally formed solid that is an aggregate of one or more minerals

Minerals: a solid that includes the following

1. Naturally occurring
2. Inorganic solid
3. Definite chemical composition
4. Definite crystalline structure
Earth Processes

Physical changes (mechanical)
- same minerals broken into smaller pieces
  ex. unloading,
  , and organic activity.

Chemical changes
- start with one mineral ( )...end up with a different one.
  ex. , , ,

** Physical and chemical changes depend on**
- rock composition
- climate
- topography

Earth’s History

Historical Geology = study of the origin and evolution of earth’s continents, oceans, atmosphere,

- the earth is about 4.6 billion years old
  
- Origin of the Universe : Did It Begin with a Big Bang?

- Expanding universe - Hubble’s shows that galaxies are moving away from one another at tremendous speeds. Calculating the rate of movement yields a time when all matter occupied a single point years approximately (bya)
- Pervasive background radiation of 2.7° above absolute zero:

- **Origin of the Solar System**
  - about 90% of material (mass) concentrated in the center of nebula cloud (forming the sun)
  - the other 10% (called a solar nebula) surrounded the center
  - Solar nebula condensed into large masses called planetesimals → 7 of the 8 planets came from this solar nebula
- **Early Earth**
  - accreted chunks of rock –
  - uniform composition and density
  - earth heated up due to meteorite impacts, gravitational compression, radioactive decay
  - resulting into different layers

  Why is this important?
  - formation of crust
  - emission of gases from interior and atmosphere
  - dense core and
Layers of the Earth = consists of 3 layers: core, mantle, and crust

Why Layers or this Differentiation

Density differences due to variations in
- 
- 
- 

- Core
  - iron and nickel
  - inner core
  - outer core
  - ºC
  - 10 to 13 g/cm³
  - 16% earth’s volume

- Mantle
  - earth’s volume
  - 3.3 to 5.7 g/cm³
  - mostly (dark-green, dense igneous rock containing iron and magnesium)
  - 2900 km thick
  - lower mantle
    - solid,
  - upper mantle
    - consists of asthenosphere and the lithosphere
      - : behaves plastically and
slowly flows. generates magma
- **lithosphere**: solid, rigid part of upper mantle and crust
- broken into plates that slides on top of asthenosphere due to convection cells
- **Crust**  
  2 types  
  - 20 to 90 km thick  
  - 2.7 g/cm$^3$  
  -  
  - Oceanic crust  
  - more dense than continental 3 g/cm$^3$  
  -
Internal Processes

* Lithosphere floats on asthenosphere*

- **Theory of Plate Tectonics** – is broken into several segments that move about on top the asthenosphere.
- **Boundaries**: where plates meet. Three types

- **Divergent Boundaries**:
  - ex. Mid-Atlantic Ridge
  - Mid-Oceanic Ridge

* New oceanic crust is formed
- **Convergent** Boundaries:

  - **Subduction Zone**
    - Subduction –
  - **Transform** Boundaries:

    ![Diagram](image)

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Rock cycle

- Interrelationships between earth’s internal and external processes and how each of the 3 major rock groups is related to the others.

- external processes
  -
  -

- internal processes
  -

* Plate movement drives the rock cycle*

- Three different types of rock involved in the rock cycle
  - rock:
1. **Igneous Rock**: forms when magma crystallizes or volcanic material solidifies at the surface

   - two types
     1) intrusive:
     2) external:

2. **Sedimentary Rock**:

   - precipitation of mineral matter from solution

3. **Metamorphic Rock**: forms from alteration of other rocks by heat, pressure or chemical activity of fluids. Ex. marble forms from limestone

   - Two types
     1) foliated:
     2) nonfoliated:

**Surface (external) Processes**

- What causes our topography to be the way that it is?
- Three major processes:

  - **Weathering**: breakdown of and due to and activity
- Erosion: removal of weathered material; caused by water, wind, ice & gravity

- Transport: movement of weathered material by water, wind, ice & gravity

Organic Evolution

- A little History first…

  - Archbishop Ussher and John Lightfoot
  - Age of the earth = sum of life-spans of Adam and Eve, their descendants, added five days for creation of the earth, they arrived at the date of
- James Hutton:

  - **Principle of Uniformitarianism**
    - laws have remained the same throughout the geological time and the same processes have always produced the same results. Therefore, if you wish to see how a rock was produced in the past, see how it is being produced today.
    - “The present is the key to the past”

- All present day organisms are related
- They have descended with modifications from earlier forms
- results in the survival to reproductive age of those best suited to their environment
- The traits which give organisms a reproductive advantage will be passed on to their offspring, and evolution occurs as organisms change through time

- Fossils: are the remains of past life, and the fossil record documents changes in life forms which predate human history.
Geologic Time Scale

- Time subdivided into units.

- Time Units of the Geologic Time Scale

1. **Eon**: largest unit
   - **Phanerozoic**: 570 mya - Present
   - **Precambrian**: 570 mya – 4.6 bya

2. **Era**: subdivisions of Phanerozoic
   - **Paleozoic**: “ancient life”
   - **Mesozoic**: “middle life”
   - **Cenozoic**: “recent life”

3. **Periods**: subdivisions of Era’s
   - 12 periods

4. **Epochs**:

*Subdivisions are based on major biological events*
How Does the Study of Geology Benefit Us?

- An understanding of the dynamic nature of the planet allows us to:

  - Appreciate the balance in delicate systems
  - Make appropriate choices about our interaction with the environment
  - Ensure that a quality future will be as we make difficult decisions regarding natural resource consumption