GEOS 1001 Theme 2: Evolution of the Planet

~Concepts of Deep Time and Geological Principles~ (Sabin)

- Age of the Earth: 4.5 billion years, age of the universe: 13.7 billion years
- Why should we care about geosciences?
    - A lot of the things we deal with everyday link back to it
    - Knowledge on it can contribute to our security and prosperity
    - Placing discussions of climate into geological context of planetary evolution
- Geological time: 4.5 billion years of Earth history
    - Earth was originally magma dominated before the early formation of the ocean and atmosphere
    - Continents were originally barren→ no plant life→ a lot of erosion
    - Biological evolution contributed to Earth's evolution→ explosion of simple then life brought about even more changes on Earth
    - Predation about 500 million years ago
    - Onset of complex life→ hard parts in trilobites
    - Earth has undergone 5 major mass extinctions
    - Holocene only around 2 million years ago
        - Period of stability, stable enough to support complex life
        - Humans arrived only at the last minute
    - History written mostly on rocks, fossils and mineral records
        - We reconstruct Earth's history by studying these records
- Why do we look into the past?
    - To understand our world better→ Earth's evolution and our present
    - To understand in order to predict→ to create models
    - Use rocks→ have clues to the past
    - *Paleo= deep time
- Pages of Earth's History: Minerals, Rocks, Fossils
    - Minerals (form to make rocks)
        - Chemically pure substances with repeating crystal structures
        - Ordered atomic structures→ chemical structures repeat
        - Crystal habits→ how they look, they look like crystals
        - Can contain other elements in them
        - *Diamonds ←→ Graphite
            - Excavation of diamonds should be quick, otherwise the prolonged heat and pressure will return it to graphite
            - Metastable→ can revert back to its old state with heat and pressure
        - Most abundant in Earth's crust: Silicon (30%) and Oxygen (45%)
        - Cannot be identified by colour alone
    - Rocks (product of minerals combined together)
        - Igneous: cooling and crystallisation
            - Volcanic in nature→ from cooling molten rocks
            - Magma→ molten rock underground, Lava→ molten rock at surface
            - Intrusive/Plutonic
                - Forms underground→ magma

            - Cools slowly→ can form into big crystals
        - Extrusive/Volcanic
            - Formed at the surface→ lava
            - Cools quicker→ finer grained rocks
    - Metamorphic: heat and pressure + recrystallization
        - Cooked pre-existing rock→ apply pressure and heat
        - When cooked, crystals realign→ rocks get cooked, not melted
        - Contact→ more on heat, edges of magma chambers
        - Regional→ more on pressure, convergent plate boundaries
    - Sedimentary: deposition, compaction, cementation
        - Fine-grained, made up of pieces of other rocks that have been eroded, deposited and cemented (with heat and pressure)
        - Names usually based on size of the element
        - Sediment size is telling of the energy in the system
            - Big→ from more upstream, from near the mountain to tumbling down to the river (conglomerate)
            - Small→ more downstream, less energy in the system, small sediments begin to settle (sandstone)
    - All rocks start out as igneous rocks→ eroded to sediments→ cemented to sedimentary rocks→ melted to igneous or squished and cooked to metamorphic→ can get melted to igneous or eroded again
  - Fossils (more on impressions than the remains)
- First principles of geology (how do we interpret the rocks?)
  - Relative age→ whether the rock is older or younger
    - Charles Lyell→ sequence of events in a landscape
  - 1. Uniformitarianism
    - Present as the key to the past→ processes we see today should have operated as well in the past
    - Assuming geological processes have not changed much in Earth's history
    - Look at present day environments and infer the past
  - 2. Principle of Superposition
    - Stratigraphy→ sediment transport through rivers create horizontal layers
    - Rocks at the bottom are older than rocks at the top
  - 3. Original Horizontality
    - Sediments assumed to be deposited horizontally
    - With folded lines→ it was first deposited horizontally, then something happened to make it fold
  - 4. Principle of Lateral Continuity
    - Horizontal layers should be continuous
    - Stratigraphic correlation→ infer layers of wide regions together
  - 5. Cross-cutting relationships
    - Rocks that are being cut are older
    - Faults create an offset and cut through existing rock
    - Telling of chronology of the layers