

GLG 101 – CHAPTER 9 - GEOLOGIC TIME

- There are two types of dates that can be determined for rock layers. **Relative** dates indicate the order or sequence of formation of rock layers and of geologic events. **Absolute** dates give the age, in years, of a rock layer or event.
- Relative dates are obtained using a few simple principles. **Superposition** - the oldest layers are on the bottom, and layers get progressively younger upward.
- **Original Horizontality** - most rock layers (particularly sedimentary and igneous extrusive layers) are deposited in a horizontal (or nearly so) position.
- **Cross-cutting Relationships** – when a fault or intrusive rock cuts through/across other rocks, the fault or intrusion is younger than all the rocks it cuts through/across.
- **Inclusions** – A rock containing inclusions is younger than the inclusions themselves.
- **Unconformities** – time gaps in the rock record produced by a period of erosion after which deposition of younger layers continued. The three basic types are **angular unconformities**, **nonconformities**, and **disconformities**.
- **Angular unconformities** – older, tilted rock layers are overlain by younger, more horizontal layers.
- **Nonconformities** – older intrusive igneous or metamorphic rocks are overlain by younger sedimentary rock layers.
- **Disconformities** – An erosional time-gap is present between layers that are essentially parallel to each other.
- **Correlation** – matching up of two geologic phenomena (fossils, faults, rock layers) in different areas.
- **Fossils** can be used to correlate rock units across wide areas, by the principle of **fossil succession**. This principle notes that fossil organisms succeed each other in a definite and determinable order, based on evolution and extinctions, that is the same throughout the world. **Index fossils** (fossils that were present over very wide areas, but for a short span of geologic time) can be used to match rocks of the same age.
- **Radioactivity** is the spontaneous breaking apart of an unstable atomic nucleus. Three common types of such decay are 1) emission of **alpha particles** (a clump of two protons and two electrons, equivalent to the nucleus of a Helium atom), 2) emission of **beta particles** (electrons) from the nucleus, and 3) **capture of an electron** by the nucleus.
- Unstable radioactive versions or **isotopes** of particular atoms, called the **parent**, will decay to form **daughter products**. Each radioactive isotope has a definite and determinable rate of

decay, such that it will always take the same amount of time for half of the atoms of the parent to decay into the daughter product. This time is known as the isotope's **half-life**.

- **Radiometric dating** involves using the proportions of parent and daughter product present in a rock to determine how many half-lives have passed and, thus, the **absolute age** of the rock. This only works if the rock has been in a **closed system**, such that no additional losses or gains of either the parent or daughter product have occurred. Because the radioactive isotopes are relatively rare atoms, and are not found in all rocks in measurable quantities, and because sedimentary rocks contain fragments of other rocks of widely variable ages, **not all rocks can be radiometrically dated**.
- The **Geologic Time Scale** divides Earth's history into units of a variety of sizes. It is presented in chart form, with the oldest time at the bottom and the present at the top. This is designed to mimic a stack of rocks that follows the principle of superposition. The main (largest) divisions on the scale are called **eons**, and include the **Hadean** (4.6 to 3.8 Ga ago – Ga is a billion years), the **Archean** (3.8 to 2.5 Ga ago), the **Proterozoic** (2.5 Ga to 570 Ma ago – Ma is a million years), and the **Phanerozoic** (570 Ma ago to the present). The Phanerozoic is the period during which abundant fossilization of larger (easily visible to the naked eye) life forms has taken place. This began with the “Cambrian Explosion” of life with hard parts (i.e., shells) around 570 million years ago. Each subdivision of the Phanerozoic (meaning “visible life”) is based on significantly differing fossil organisms that dominated that period. The **Paleozoic** (“old life”) is sometimes known as the “age of fishes”; a time in which marine fossils dominate (570 Ma to 245 Ma ago). The **Mesozoic** (“middle life”) is sometimes known as the “age of reptiles” or the “age of the dinosaurs”; a time in which fossils of land creatures are dominated by reptilian forms (245 Ma to 66 Ma ago). The **Cenozoic** (“recent life”) is dominated by fossils of mammals (66 Ma ago to the present). The ends of the Paleozoic and Mesozoic Eras are marked by **mass extinctions** when most species on Earth rapidly died out. It is likely that large meteor impacts have played a large role in the climate changes that have led to such extinctions throughout Earth's history.