CC **TOPIC XIII**

E A R T H H I S T O R Y

I. The early earth

A. Formed from a giant cloud of dust and debris drawn together by gravity about 4.6 billion years ago (or 4600 million).
   1. Earth's early atmosphere was due to outgassing of water vapor, carbon dioxide, nitrogen, and lesser amounts of other gasses from its interior.
      a) Evolution of life caused dramatic changes in the composition of the earth's atmosphere.
      b) Free oxygen did not form until oxygen-producing plants evolved.
      c) The earth's ancient climate was much warmer than today.
   2. Earth's oceans formed due to precipitation over millions of years.
      a) Oceans started out as fresh water, with salt building up over time (currently 3.5% dissolved salts)
      b) The presence of an early ocean is indicated by sedimentary rock of marine origin dating back about 4 billion years.

II. **Relative age** - putting geologic events in chronological order (1^{st}, 2^{nd}, 3^{rd}, etc.)

A. Methods of relative age dating:
   1. **Original horizontality** - all sedimentary rocks were *originally* laid down in horizontal (level) layers.
   2. **Superposition** - older rocks are always below younger ones... at the **bottom**. Some ***exceptions***:
      a) an overturned fold in the rock
      b) an overthrust fault (rock strata pushed up on top of other rock strata)
   3. **Intrusions and extrusions**
      a) **Intrusions** (**inclusions**) - molten rock that "invades" pre-existing rock, and then cools and hardens... **are *YOUNGER* than all surrounding rock.**
         1) contact metamorphism - found along outer edge of intrusions (*younger* than the surrounding rock)
      b) **Extrusions** - lava flows on the land surface that cool and harden... **are *YOUNGER* than rocks below, but *OLDER* than rocks above.**
   4. **Rock structural features** - a rock must be ***OLDER*** than any fault, joint (small crack), fold, or erosional surface (wavy line indicating loss of strata) that is found in that rock.
   5. **Internal rock characteristics**
      a) Sediments are ***OLDER*** than the sedimentary rock that they make up.

III. CORRELATION - showing that rocks or geologic events that occurred in different places are the **same <u>AGE</u>**.

A. Methods of correlation:

1. **<u>INDEX FOSSILS</u>** - the *<u>best</u>* method of rock correlation
   a) Index fossils must:
      1) **have a <u>wide</u> geographic distribution** (lived all over the world)
      2) **have lived on earth only a <u>short</u> geologic time** (only one layer)
2. **<u>Volcanic ash deposits</u>** - good time markers, since they have a **<u>wide</u>** geographic distribution (horizontal), but in a **<u>very</u>** small period of time (vertical)
3. **<u>Meteoric debris</u>** - rocks that fall to earth from space that are used to determine the age of the earth, and also that the inner core is iron/nickel.
   a) Impact craters can be identified in the earth's crust.
   b) Impacts correlate with mass extinctions (like dinosaurs), and also global climate changes.

IV. Geologic history from the rock record

A. The characteristics of rocks indicate the processes by which they formed, and the environment in which these processes took place.

B. Fossils and relative age
   1.) Fossils can be used to place past events in order.

C. the **GEOLOGIC TIME SCALE** (see Ref. Tables... p. 8 & 9)
   1. Uses its own "calendar", divided into **eras**, **periods**, and **epochs**, based upon the ***<u>fossil record</u>*** found in rocks.
      a) shows <u>human</u> existence has been **<u>very</u> brief** compared to all of geologic time.
   2. Can be correlated to the N.Y.S. map (see Ref. Tables... p. 3), which shows age of surface bedrock.

V. Unconformities

A. A **break** from the usual rock pattern, due usually to **<u>erosion</u>**. It means that some of the original rock record has been **<u>LOST</u>**.
   1. where tilted strata meets horizontal strata

VI. ABSOLUTE Age Dating - in years.

A. Done by **radioactive age dating** methods
   1. Most elements have several isotopes
      ex. **Carbon ^{12}** and **Carbon ^{14}** (different # of neutrons in nucleus)
   2. The center, or nucleus, of some isotopes is unstable. Therefore, it emits radiation to become stable. This is called **radioactive decay.**
      This decay takes place at a STEADY RATE ... *NOTHING* can happen to an isotope that will change this rate!!!

      ex. **Uranium 238** (will emit particles and slowly change into lead... Pb)

B. **HALF-LIFE** - time it takes for ½ of a radioactive sample (any size) to decay to stable form.
   1. Each isotope has its **own** half-life (see Ref. Tables ... p. 1). By determining how much radioactive isotope is left compared to the stable form now present (like looking at an hour glass), the **absolute age** of the rock can be determined.

VII. Ancient life and evolution

A. Shows likelihood that more complex life forms evolved from less complex life forms. There are, however, gaps.
   1. **Similar** species are always in competition to meet their individual needs.
   2. Two fossils that are somewhat similar may represent a developmental change over time.
   3. A wide variety of life forms has existed in the past ... most organisms that ever lived on the earth are now **extinct** (all died out).
   4. Fossils lead to inferences about past earth environments (like Wayland once being under an ocean).