# Geo Hist Complete Notes

Monday, March 25, 2019 11:12 PM

# GEOLOGIC HISTORY

**Aim: To investigate the principles geologists use to interpret Earth's history.**

**How can we determine the sequence of geologic events and the way things happened over time?**

**-Geologists use clues (*structure, composition, fossil content*), from the rock record to piece together the sequence of geologic events and interpret Earth's history over its 4.6 billion year life.**

**Relative Dating -The process of dating rocks by comparing them to other rocks with no reference to a specific year or absolute date.**

***Absolute Age* - date when the event actually occurred.**
***Relative Age* - the age compared to something else.**

## How do we establish a sequence of events and relative age?

**1.*Principle of Uniformity (Uniformitarianism)* - The present is the key to the past. The processes that shape Earth now are the same as in the past.**

**2. *Principle of Original Horizontality* - Sediments are originally laid down horizontal to the surface. Rock is always older than the processes that changed it.**

**3. *Principle of Superposition* - In undisturbed rock layers the bottom layer is oldest, with each overlying layer younger than the one underneath, and the youngest layer at the top.**

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**4. Principle of Cross-Cutting Relationships – A geologic feature (intrusion, fault, unconformity) which cuts another is the younger of the two features.**

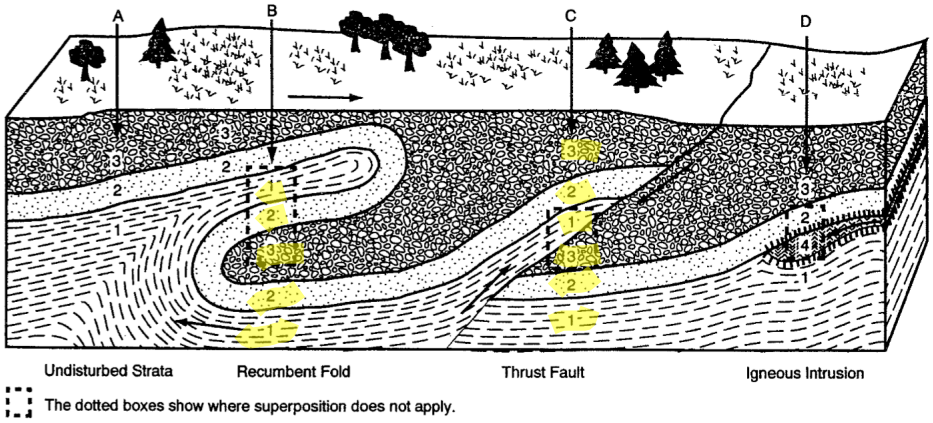
A gap in the rock record →

**5. Law of Included Fragments - a method of relative dating in geology which states that clasts in a rock are older than the rock itself**

# Exceptions to the Principle of Superposition

**Factors that can cause young layers to be below older layers.**

**1. *Folding and Faulting* - Crustal movement and deformation can place older rocks on top of *younger* rocks**




**2. *Igneous Intrusions and Extrusions***

**a. *Intrusions* - molten magma invading preexisting rock and crystallizing. They are always younger than rock layers beneath, and older than the rocks that form on top of it.**

LOOK FOR CONTACT METAMORPHISM

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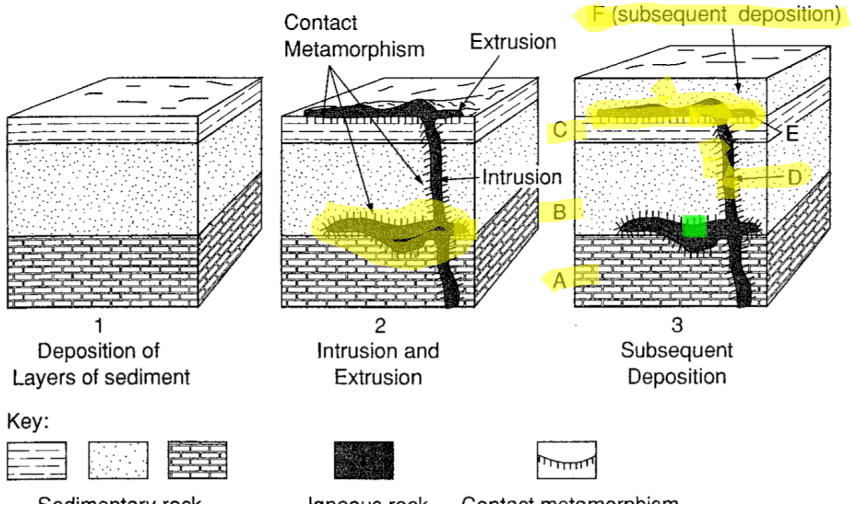
**b. *Extrusions* - molten magma flowing onto Earth's surface and solidifying. They are younger than rocks beneath them, and older than rocks on top of them**
***Contact Metamorphism* - the changing of an existing rock through contact with hot liquid rock.**

## IGNEOUS INTRUSIONS AND EXTRUSIONS



Sedimentary rock | Igneous rock | Contact metamorphism (transition zone)

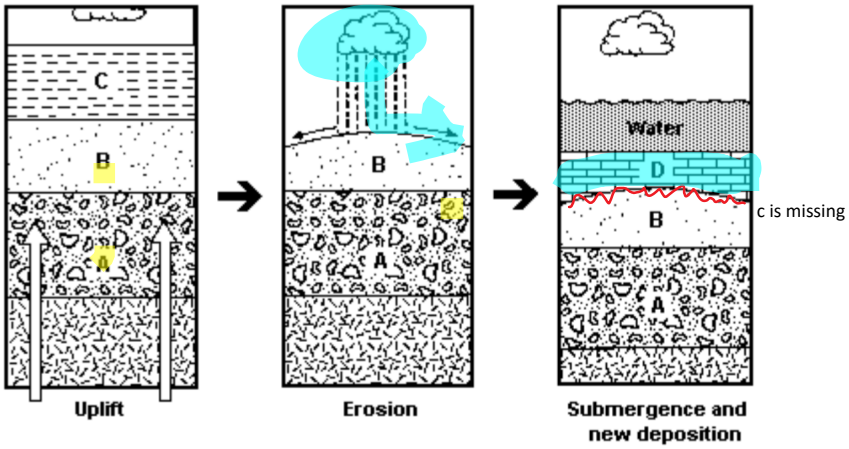


## What is an Unconformity?

**A *gap or missing piece* of the rock record. (Seen as a bumpy line between 2 rock layers). Caused by the burial of an erosional surface by younger rocks or sediments.**

## 4 Steps to Create an Unconformity

- **1. *Uplifting* (Emergence)**
- **2. *Weathering and erosion of the surface* (rocks are now missing)**
- **3. *Subsidence* (Submergence) (sinking back below sea level)**
- **4. *More deposition* (on top of eroded surface).**



# CORRELATION OF ROCKS

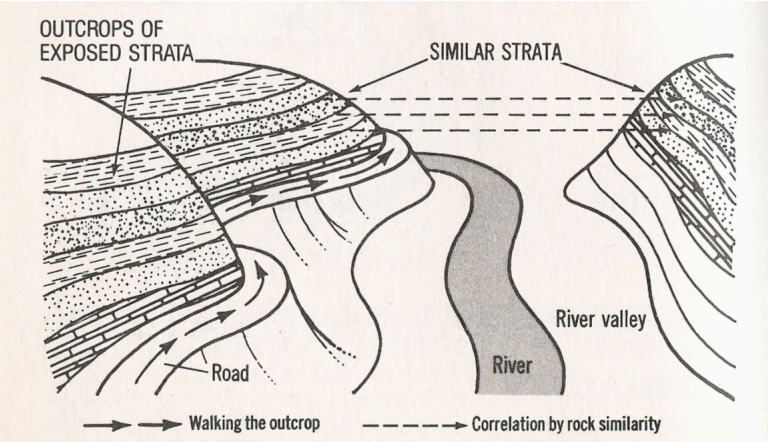
**Aim: How do geologists match similar rock strata at different locations to see if they formed at the same time?**

**What does correlating rocks tell us?**
**1. About Earth's Processes (i.e. continental drift, ice ages, weather, animals)**
**2.How to find minerals in rocks of a specific age.**
**3. The sequence of geologic events.**

## Methods of Correlation

**1. *Walking the Outcrop (bedrock exposed to Earth's surface)* - Observing and physically following the rocks layers from one place to another. Looking for similar rock type, mineral composition, environment of formation.**

### Walking the Outcrop

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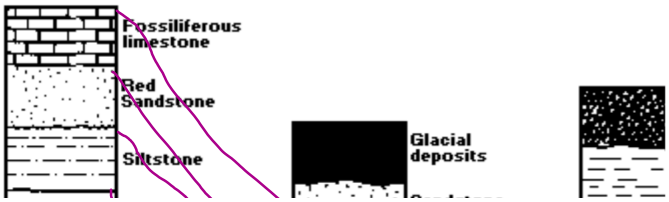
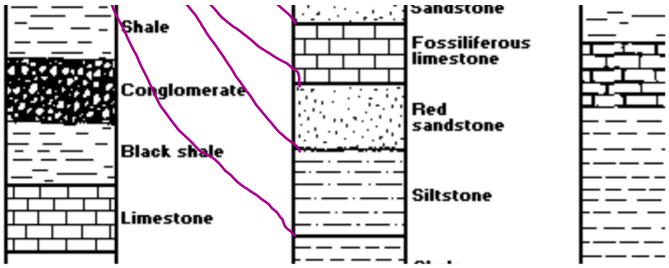
**2. *Matching Similar Rock Characteristics in Different Locations* - Correlating rocks on the basis of:**

- **Appearance**
- **Color**
- **Mineral Composition**

**This can be deceiving because 2 rocks can be similar, yet be different ages.**






**3. *Index Fossils* - (almost exclusively in sedimentary rocks) A fossil that existed over a large part of the world for a short time.**
**Qualifications to be an Index Fossil:**

- ***Easily recognizable and abundant***
- ***Lived over a large area***
- ***Short lived and occur in only a few rocks layers widespread.***

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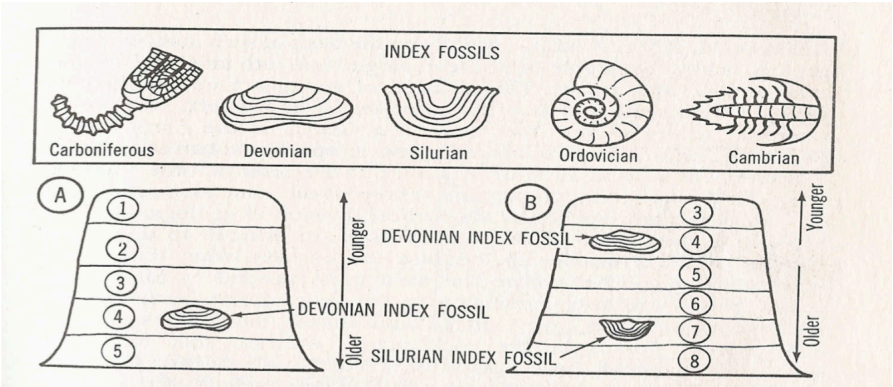
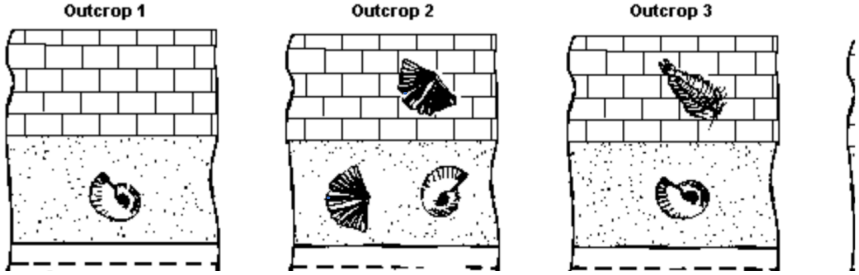
**Different Index Fossils are Found in Specific Layers of the Geologic Column**




**Which fossil appears to be the best index fossil? Why?**



***It's short lived and only in a few layers!***



**4. *Volcanic Ash Deposits* - Small pieces of extrusive igneous rocks shot out of volcanic eruptions that settles in sediments. This ash can be useful in correlating rocks because it is short lived and covers a large portion of Earth.**

# Radiometric Dating – Radioactive Decay

**Aim: How can we use the natural radioactivity in rocks to determine the absolute or actual dates of geologic events?**

***Radioactive (Radiometric) Dating*** **-The process of dating rocks to determine the actual age in years of a rock by using radioactive elements.**

***Radioactive Decay*** **-The process by which an unstable radioactive element breaks down or decays into a more stable element. (ESRT pg.1) The moment an igneous rock crystallizes unstable radioactive elements in the rock begin to decay or breakdown and they release energy in the process.**

****Radioactive elements decay at a *constant rates* that are *not affected* by changes in *mass, temperature or pressure*.**

**Some radioactive elements we will study are:**

1. ***Carbon - 14***
2. ***Potassium - 40***
3. ***Rubidium - 87***
4. ***Uranium - 238***

Half Life

P.1 ESRT page 1

**These elements are all isotopes.**

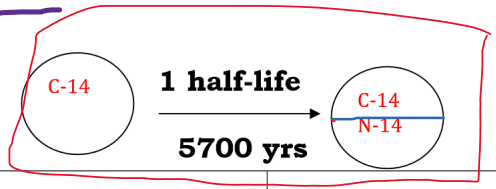
***Isotopes*** **- atoms of an element that have the same number of protons but a different number of neutrons in their nucleus than the parent isotope. (Example – C12- normal has 6 protons and 6 neutrons where C14 –radioactive has 6**

**protons and 8 neutrons). The extra neutrons make the isotopes unstable.**

**How do we measure the rate of radioactive decay?**

**- The rate of decay is measured by *half-life*; the amount of time it takes for half of the radioactive atoms to decay to a stable *decay product*.**

C-14




C-N

| TIME IN HALF LIVES | % ORIGINAL ISOTOPE | %DECAY PRODUCT |
|---|---|---|
| 1 half-life | 50 | 50 |
| 2 half-lives | 25 | 75 |
| 3 half-lives | 12.5 | 87.5 |

#years
5,700
11,400
17,106

| Half-life | Mass of Original Carbon-14 Remaining (grams) | Numb |
|---|---|---|
| 0 | 1 | |
| 1 | $\frac{1}{2}$ | |
| 2 | $\frac{1}{4}$ | |
| 3 | $\frac{1}{8}$ | |
| 4 | $\frac{1}{16}$ | |
| 5 | | |

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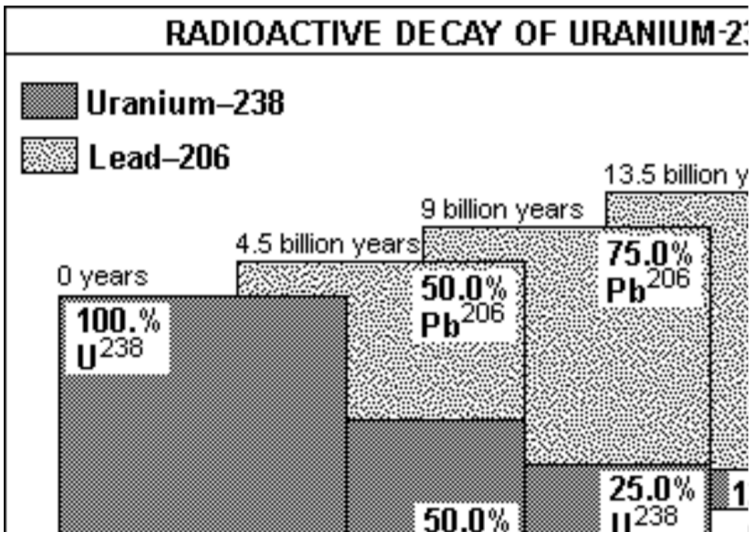

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***Radioactive dating*** **- Comparing the amount of radioactive element left in a rock to the amount to the amount of stable product formed to determine the absolute age of the rock.**

**<u>Important Isotopes for Dating Rocks</u> - We use radioactive elements with long half-lives (Rb-87) to date rocks because most rocks are very old. Isotopes with short 1/2 lives like C-14 (5700 years) are used to date rocks of recent origin and organic material (once living things) up to 50,000 years old.**

**Which radioactive isotope would be better to use when dating rocks from the Carboniferous?** ***Potassium -40***

**Which element would you use to date dinosaur bones?** WOOLLY MAMMOTH BONES
***Carbon -14***

*** Unstable U - 238 decays to stable a stable isotope Pb - 206**

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**Example - half- life of U - 238 = 4.5 billion years, if we found a rock with 50 % U - 238 and 50 % Pb -206 how old is the rock?** ***4.5 x $10^9$***

**If there was 12.5% U-238 and 87.5% Pb-206 how old is the rock?** ***13.5 x $10^9$***

# GEOLOGIC TIME SCALE

**Aim: How can we use rock formations to develop a geologic time scale?**

***Geologic Time Scale*** **– A summary of the major events in Earth's past that are preserved in the rock record. (Fossil Evidence)**

**How was the time scale developed?**
**- By using geological *evidence*, dating techniques and deductive reasoning.**

**How are the units of geologic time divided?**
**- Based on the distinguishing characteristics of the period and *life forms* they contain. (Each unit is a *different* amount of time).**

## 4 Divisions of the Geologic Time Scale

**- *Eons* (the longest segments) are divided into *Eras,* Eras into *Periods*, and Periods into *Epochs*.**

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**Eons**

**1. *Precambrian* - 85% of Earth's history. Beginnings of life for which we don't have much fossil evidence; life was small and didn't have hard parts to form fossils, ancient rocks have been metamorphosed eroded, and missing from the rock record.**

**2. *Phanerozoic* (most recent eon) - Divided into 3 Eras**

**- *Paleozoic*- ancient life - 8.5% of history**

**- *Mesozoic* - middle life - 3.5% of history**

**- *Cenozoic* - 3% - recent life (Humans)**

**Eras are Divided into Periods -many are named for the geologic area where the fossil evidence was found. (Devonian - Devon England)**

***Cambrian* - 540 mya -Beginning of complex life. From this point on we have fossil evidence.**

***Evolution* – The gradual change of an organism over time**

**What does the geologic time scale tell us of evolution?**

**- By looking at the development of fossil evidence recorded in the rocks, Charles Darwin developed the *Theory of Organic Evolution*. He wrote a book called "Origin of the Species" which proposed the theory of survival of the fittest or *natural selection*.**

**What is the theory of natural selection?**

***Organisms that can survive produce offspring that have inherited the most favorable traits for surviving a particular environment.***

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