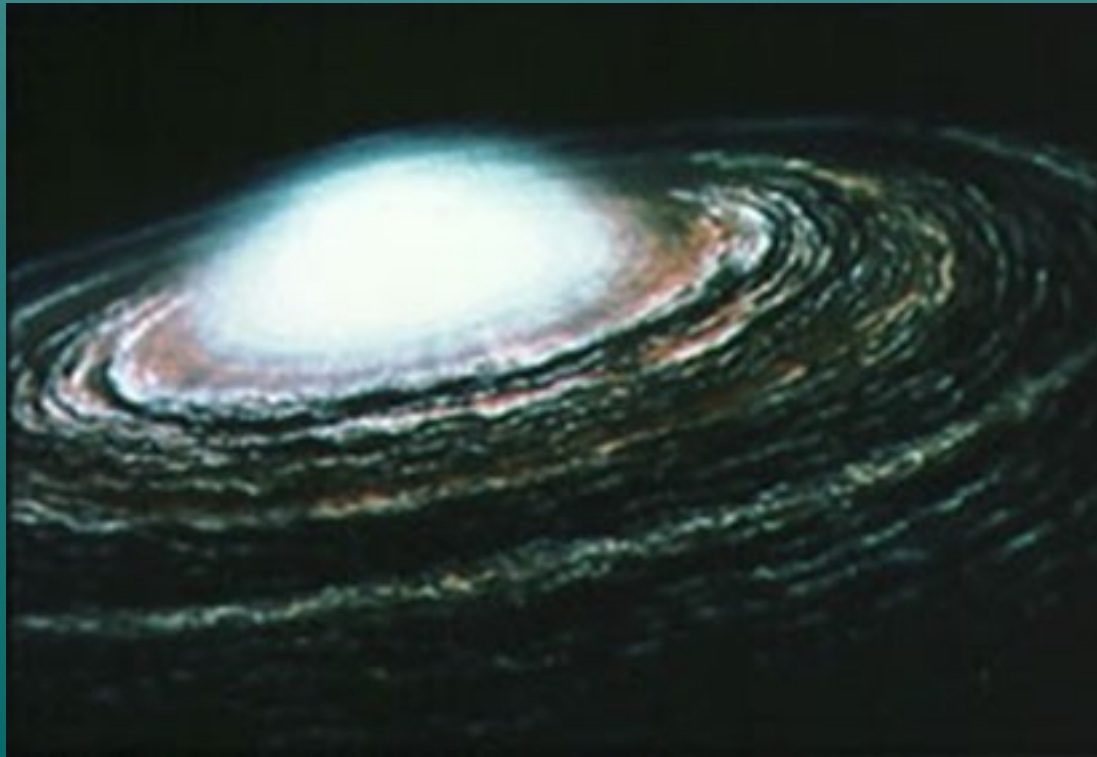


# *What is the origin of the Earth?*

- ◆ *~ 5 billion years ago, a cloud of fine, rocky fragments, dust, & gases (H & He) began to contract due to gravity*
- ◆ The cloud of material began to rotate and continues to contract. . .
- ◆ The more it contracted the faster it rotated. . .

- This continued rotation caused the cloud of dust and gas to “flatten” into a disk-like shape.
- .
- All the dense, heavy material collected in the middle of the rotating cloud.



- ◆ The H and the He compacted in the middle of the still rotating cloud, eventually igniting thermonuclear fusion, thus giving birth to the SUN. . .
- ◆ Large clusters of gas, dust, & fine rock particles still revolved around the young Sun.
- ◆ The clusters composed of denser materials remained relatively close to the Sun, while the less dense clusters were farther from the Sun.  
. .

- ◆ The clusters of particles attracted more and more particles, eventually forming the 8 protoplanets...
- ◆ Over billions of years, the Sun and the 8 planets evolved into our Solar System.
- ◆ The Earth is the 3rd planet from the Sun. . .




- ◆ Shortly after the Earth formed, radioactive material and particles that were still colliding caused partial melting of the Earth's interior. . .
- ◆ This melting caused the dense, heavy materials to migrate to the center of the Earth, while the lighter material floated towards the surface.

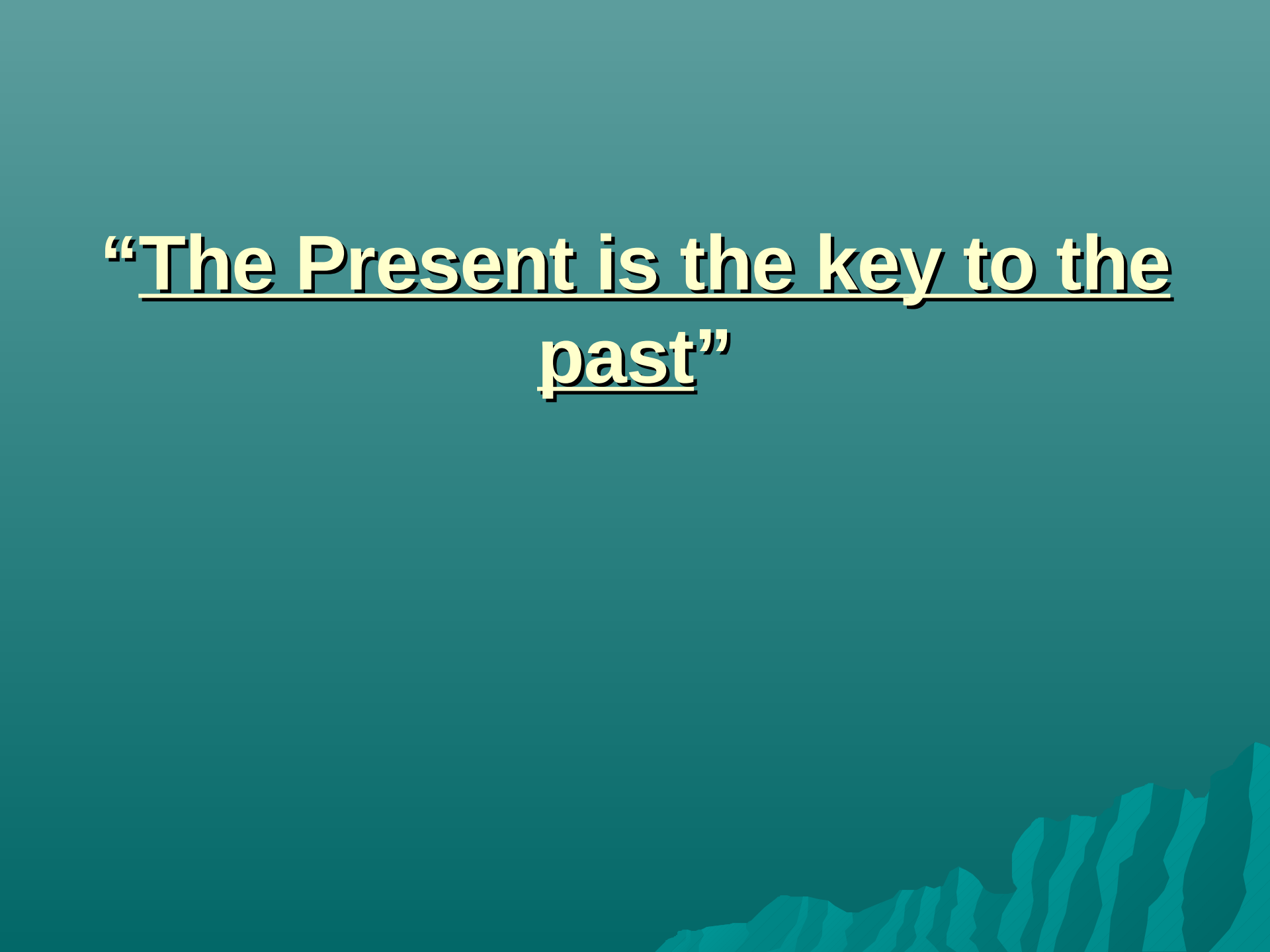
- ◆ The movement of the materials that composed the early Earth allowed gases to escape.
- ◆ These gases eventually formed the early atmosphere, which in turn formed the oceans.

# *How is the Earth Studied?*

Principle of Uniformitarianism – the assumption that the natural processes operating in the past are the same as those that can be observed operating in the present.



**“The Present is the key to the  
past”**



# There are two ways to determine how old something is. . .

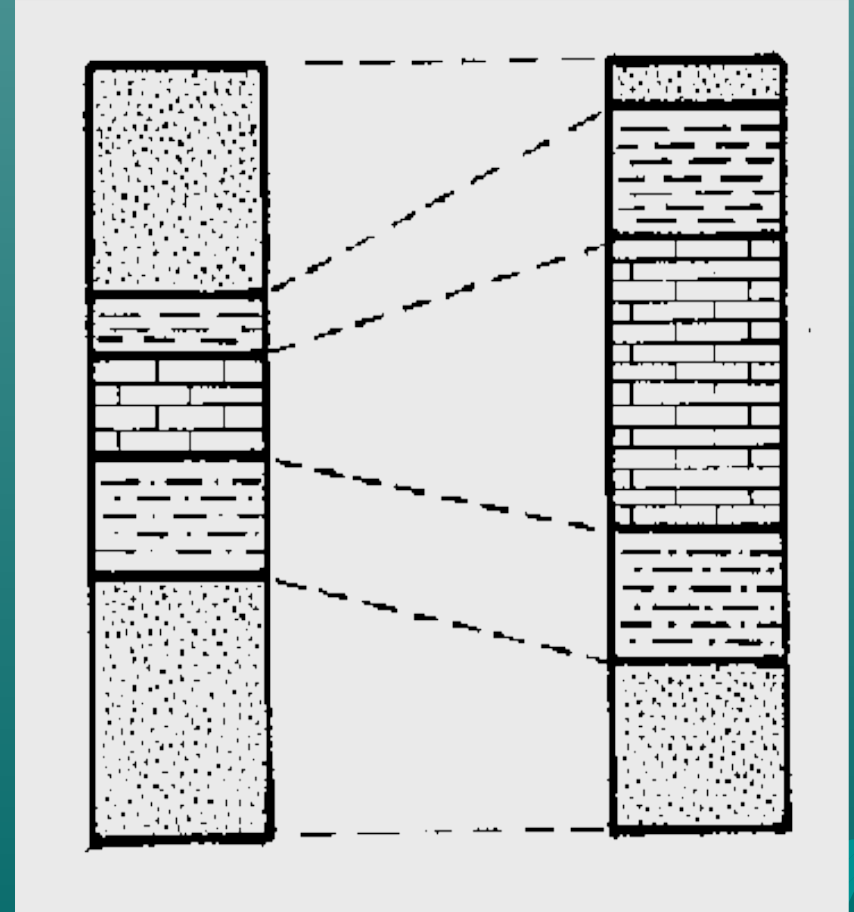
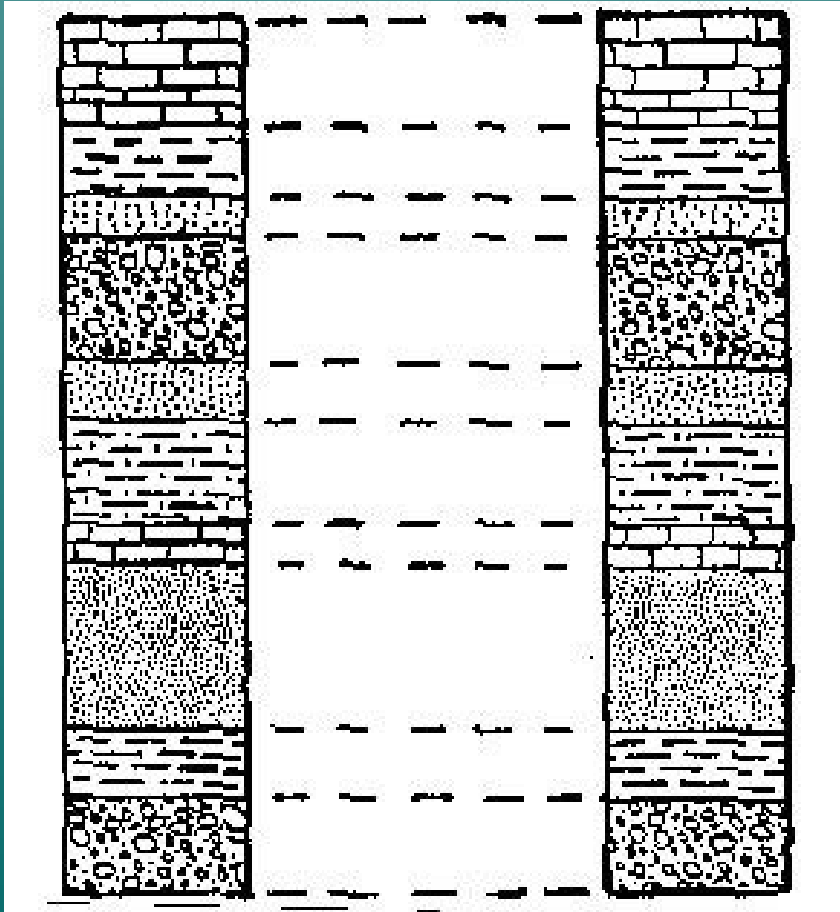
- ◆ Relative age – The age of a fossil or rock compared with others around it. Relative age does not give you an age in years! You just use it to determine if something is older or younger than something else.
- ◆ Absolute age – The actual age, in years.

# Methods used to determine relative age. . .

- ▣ **Original horizontality** – This principle states that sediments are originally deposited as horizontal layers.
- ▣ **Principle (or law) of Superposition** – Sedimentary layers are deposited on top of each-other, leaving the oldest layers on the bottom and the youngest on top.

*Once the relative age of  
something is  
determined . . . then what?*

- Correlation – The process of matching rocks on different outcrops by looking at rock types, fossils, etc.



- **Outcrop** – A location at Earth's surface where bedrock is exposed without a cover of soil or other materials.



# Correlation Techniques:

- “Walking the Outcrop” – done by following a layer of rock from one end of the outcrop to the other.

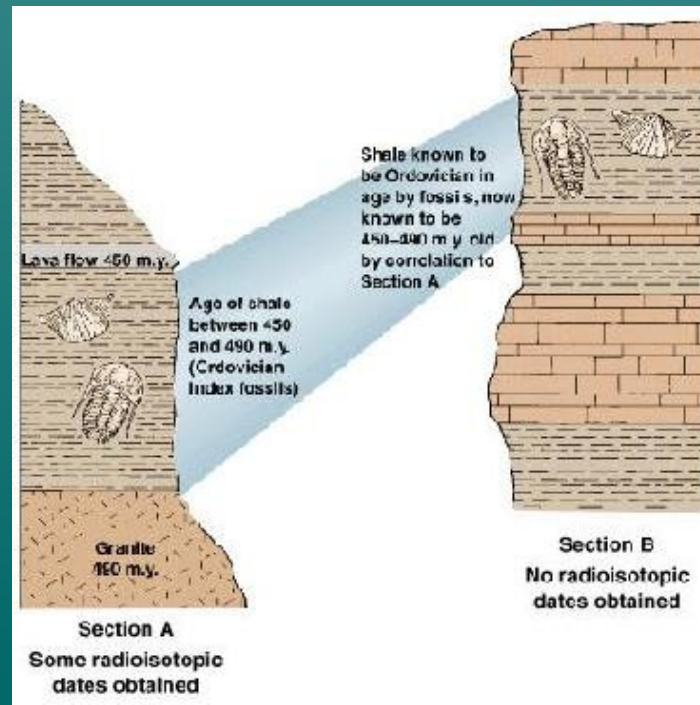


# Correlation Techniques:

























- Similar rock types – rocks in different outcrops can be matched if similar rock types are found in a similar pattern.

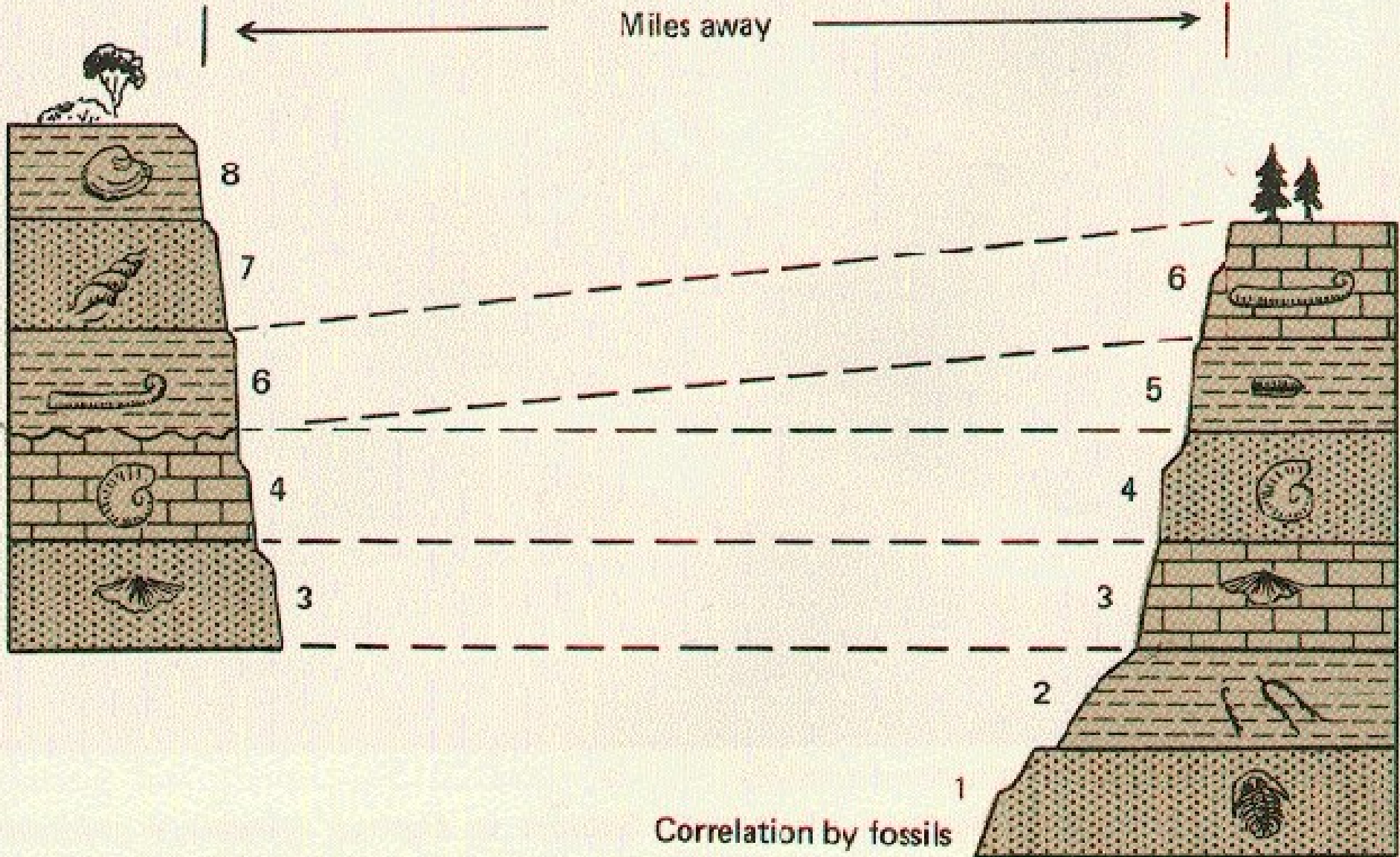
# Correlation Techniques:

- Index fossils - used to find the age of the rock in which it is found. The best index fossils are organisms that were around for a short time, but were found over a large area.



# Index Fossils

CENOZOIC ERA (Age of Recent Life)	Quaternary Period	<i>Pecten gibbus</i>		<i>Neptunea tabulata</i>	
	Tertiary Period	<i>Calyptrophorus velatus</i>		<i>Venericardia planicosta</i>	
MESOZOIC ERA (Age of Medieval Life)	Cretaceous Period	<i>Scaphites hippocrepis</i>		<i>Inoceramus labiatus</i>	
	Jurassic Period	<i>Perisphinctes tiziani</i>		<i>Nerinea trinodosa</i>	
	Triassic Period	<i>Trophites subbullatus</i>		<i>Monotis subcircularis</i>	
PALEOZOIC ERA (Age of Ancient Life)	Permian Period	<i>Leptodus americanus</i>		<i>Parafusulina bosei</i>	
	Pennsylvanian Period	<i>Dictyoclostus americanus</i>		<i>Lophophyllidium proliferum</i>	
	Mississippian Period	<i>Cactocrinus multibrachiatus</i>		<i>Prolecanites gurleyi</i>	
	Devonian Period	<i>Mucrospirifer mucronatus</i>		<i>Palmatolepus unicornis</i>	
	Silurian Period	<i>Cystiphyllum niagarensis</i>		<i>Hexamoceras hertzeri</i>	
	Ordovician Period	<i>Bathyrurus extans</i>		<i>Tetragraptus fructicosus</i>	
	Cambrian Period	<i>Paradoxides pinus</i>		<i>Billingsella corrugata</i>	
	PRECAMBRIAN				



# Correlation Techniques:

- Volcanic ash deposits - When a volcano erupts violently, a layer of volcanic ash is spread over a large area. These ash falls are very rapid events, which makes them a very reliable time marker



# ***Does the law of superposition and correlation always work?***

Stuff that may go wrong when trying to determine relative age:

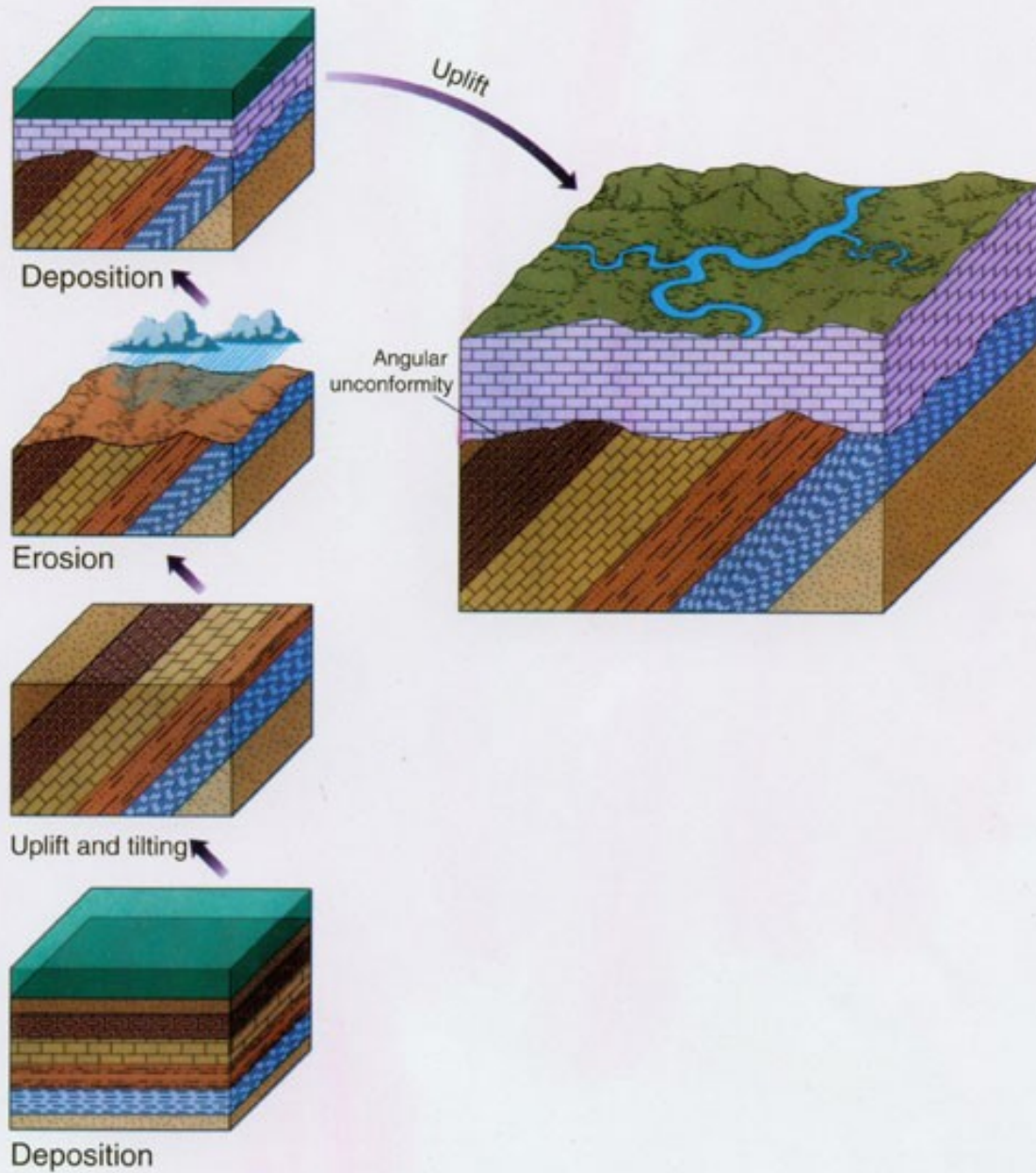
- ◆ **Unconformities** – Breaks, or gaps, in a series of rock layers.

# Types of Unconformities

- Angular unconformity – A place where sedimentary layers at one angle are in contact with sedimentary layers at a different angle.



# Formation of an angular unconformity

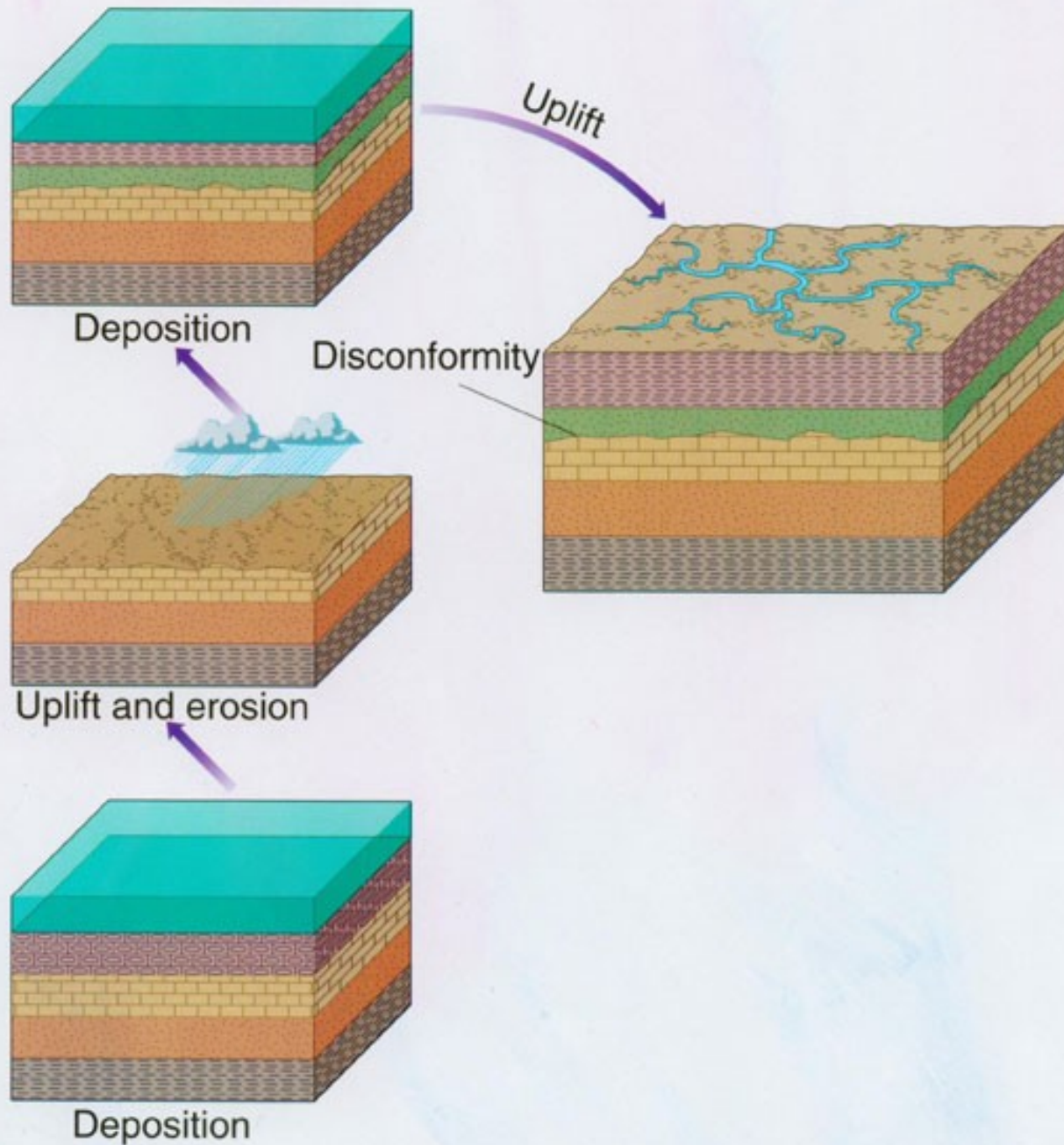


# Types of Unconformities

- Disconformity – An irregular erosional surface between parallel layers of rock. Erosional surfaces are usually drawn as squiggly lines.



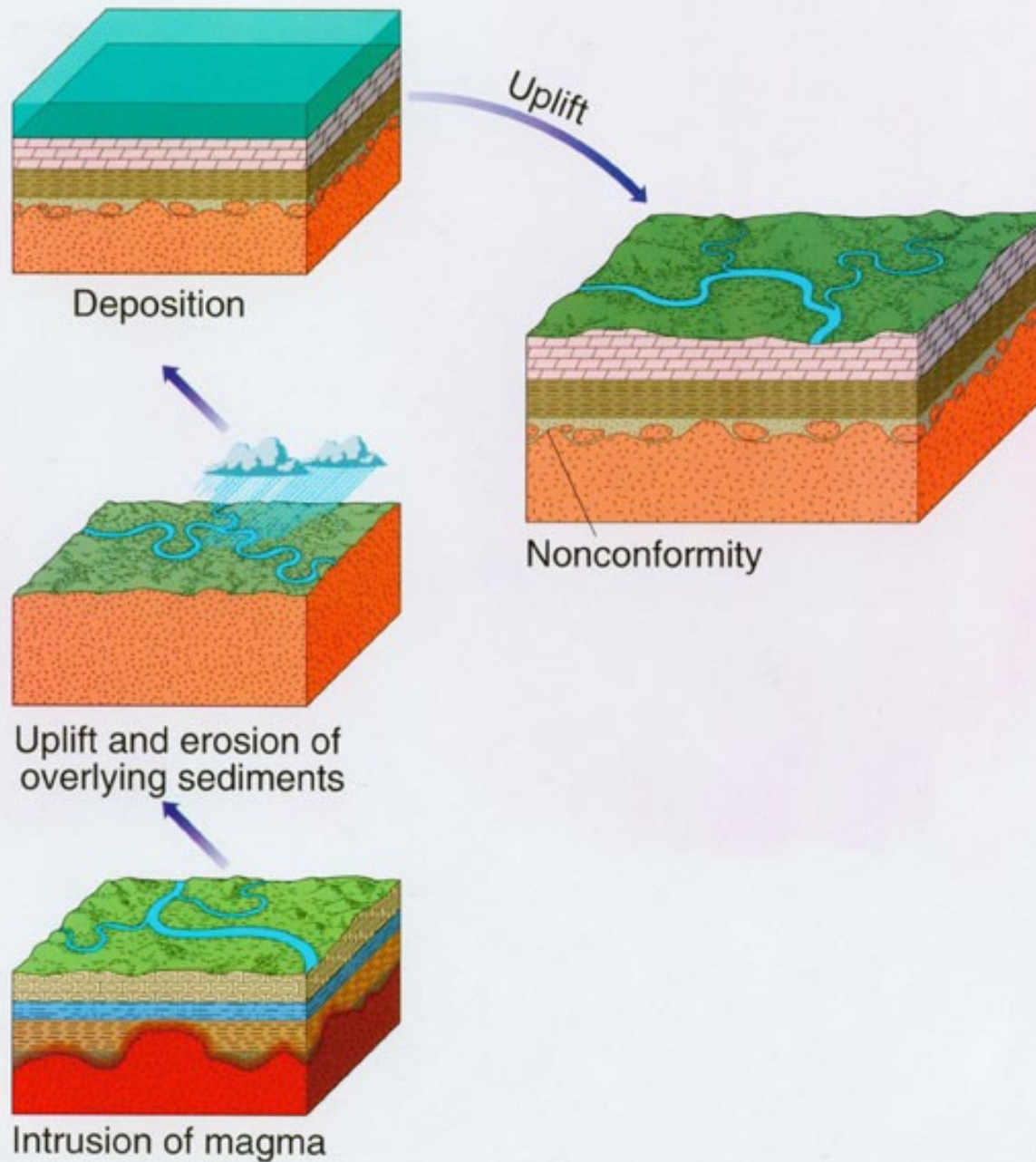
# Formation of a disconformity

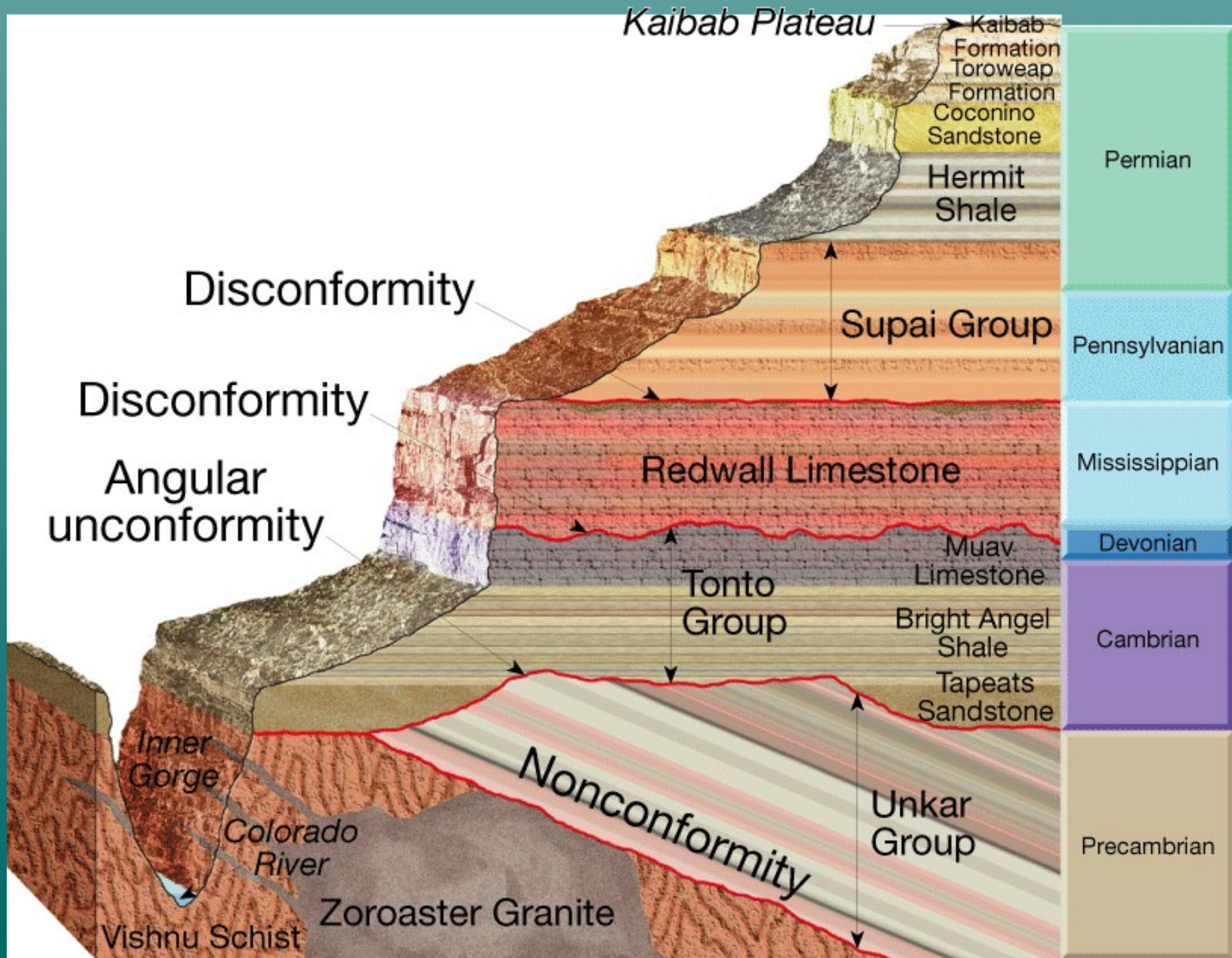


# Types of Unconformities

- Nonconformity - A place where sedimentary rock comes in contact with igneous or metamorphic rock.

# Formation of nonconformity





# Other problems with superposition and correlation:

- ◆ Hiatus – An area within a geologic cross section where a rock layer is not present, but it is present elsewhere
- ◆ Anomalies – Anomalies are unusual occurrences. Sometimes, areas will have an index fossil found in the incorrect time period. Other times, layers will be found in the incorrect order.

# What about Fossils?

- Paleontology – the science that uses fossils to study life in past geologic time.

# What about Fossils?

- Fossil – Any remains, trace, or imprint of a living thing that has been preserved in the Earth's crust.



# Fossilization can only occur if:

- ◆ The organisms must be buried soon after they die, or the trace of an organism must be buried soon after it is made.
- ◆ Organism must have hard body parts (invertebrates with shells, vertebrates with skeletons)

# Types of fossilization:

- Petrifaction – The process where organic matter is replaced with minerals. Petrified wood is the most well-known result of this process.



# Types of fossilization:

- Carbonization – The conversion of organic matter into carbon, or a carbon residue. Coal is formed through carbonization.



# Types of fossilization:

- Trace fossils – Footprints, trails, and other traces of life, where the organism itself is not necessarily preserved.

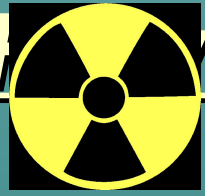


# Types of fossilization:

- Molds & Casts – A mold is an impression of a fossil in the rock. The original fossil may be dissolved away and the space filled in, leaving a cast.

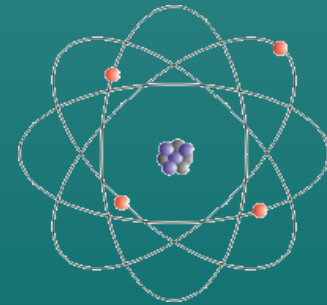


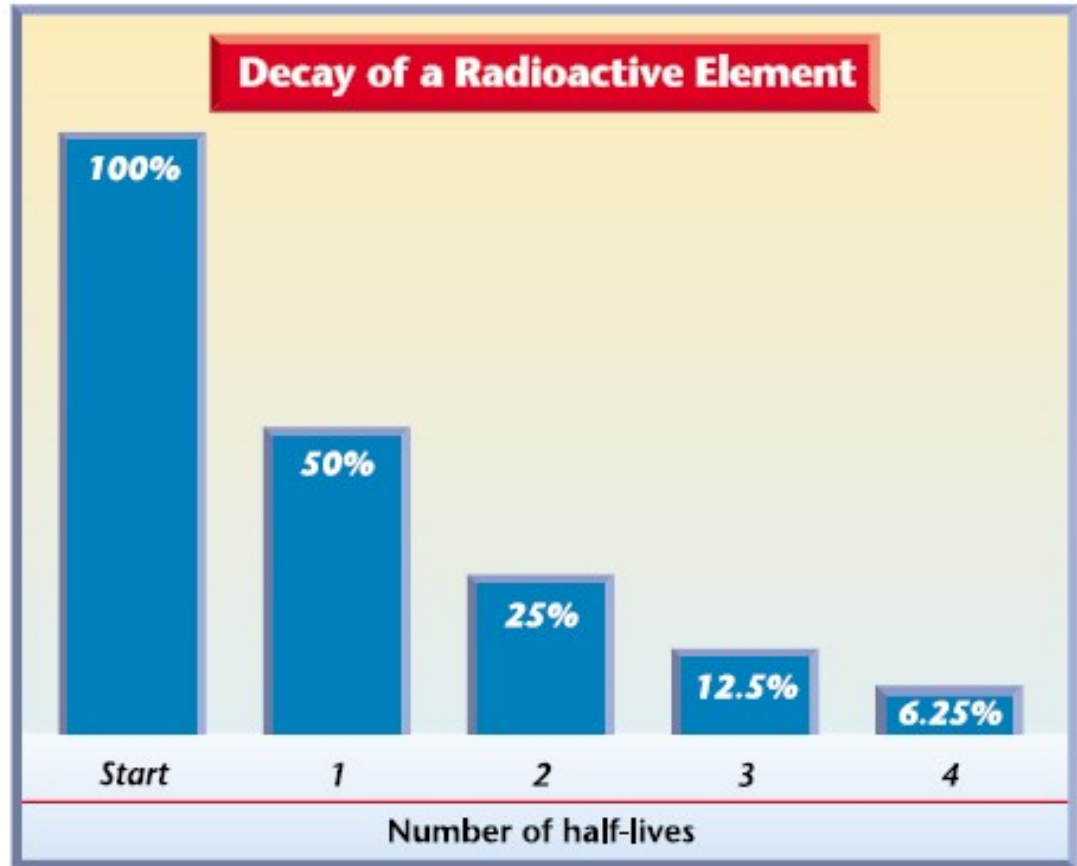
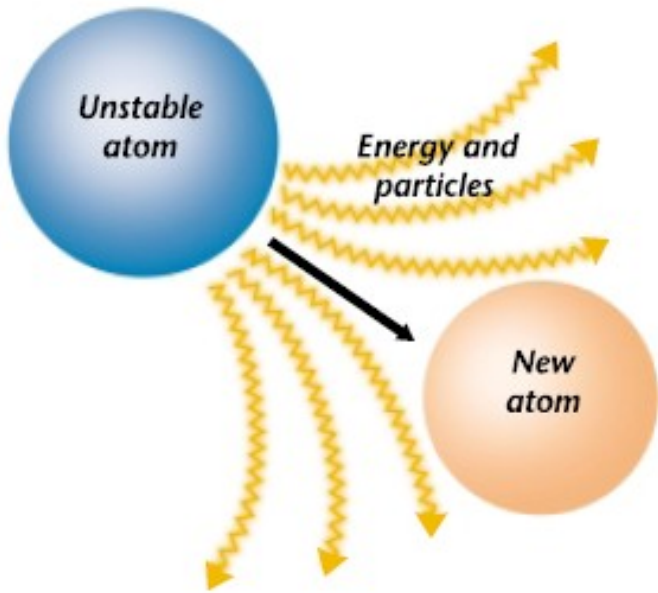





# *Is an absolute date determined?*

- Radioactive decay – The process by which unstable isotopes break apart spontaneously giving off energy, subatomic particles, or both.





- **Isotope** – Atoms of the same element that have the same number of protons (and hence the same chemical properties), but a different number of neutrons, and therefore, different atomic weights.

- ◆ Some rocks and other material contain elements with atomic nuclei that undergo radioactive decay. . . .
  - ◆ Geologists have determined the rate at which isotopes undergo radioactive decay. . . .
  - ◆ By determining how much of the isotope has become stable (or how much of the radioactive isotope remains), an absolute age can be determined. . . .
- 

- ◆ Half-life – The time required for half of a mass of radioactive atoms to decay.
- ◆ Carbon-14 – An isotope of Carbon found in all living things that is constantly replaced while an organism is alive but begins to decay as soon as it dies. This isotope is used to date “recent” fossils (thousands of years old).