

What Is the Geologic Column?

Chapter 10 Lesson 1

ByDesign Science, Level 6

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What is the Geologic Column?

- ◆ Rock layers found all around the world are filled with clues about creatures that lived in the past.



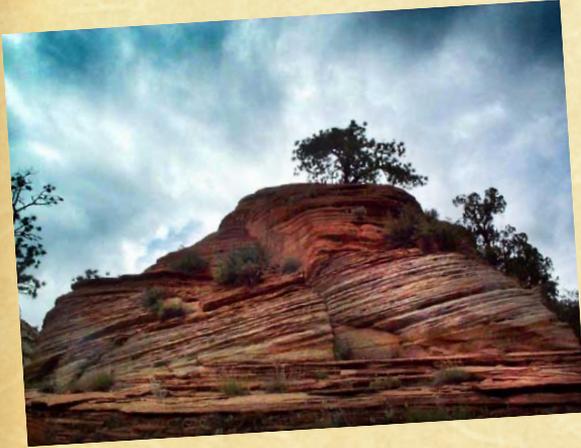
- ◆ What ideas have you heard to explain why some of these creatures are not here anymore?

Rock Layers

- ◆ Rock layers, or strata, usually form when sediment is carried along by moving water.
- ◆ When the water slows down, the largest pieces are deposited first followed by increasingly smaller sediment.
- ◆ Sediments become cemented together and harden into rock layers during lithification.

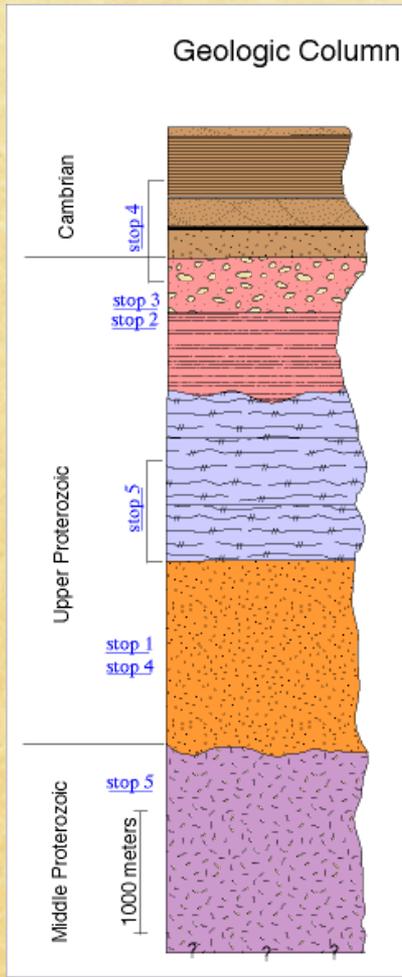


Rock Layers



- ◆ Strata are usually laid down horizontally, but they do not always remain in horizontal layers.
- ◆ As you know, the movement of tectonic plates can cause earthquakes, volcanoes, and mountain building.
- ◆ As these processes happen, along with weathering, erosion, and deposition, rock formations change.
- ◆ The evidence left behind provides clues that scientists can study to solve the mystery of the rock's history.

Rock Layers



- ◆ The rock layers and the fossils found in them make up what we call the geologic column.
- ◆ Most of the geologic column is buried out of sight, but where sections of it are visible, people have discovered millions of fascinating fossils.

Fossils

- ◆ Usually when a living organism dies, it decomposes.
- ◆ However, if an organism is buried rapidly before it can decompose, there is a chance it may be preserved.
- ◆ These preserved remains are called fossils.
- ◆ Scientists understand that most types of animals are fossilized quickly or not at all.



Fossils

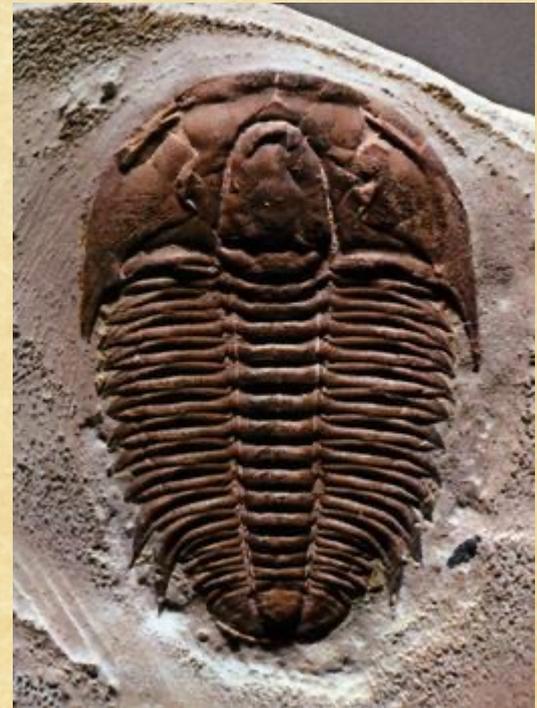


- ◆ This is especially true if the fossil has preserved soft tissues – like muscle or skin – implying that the animal was buried very rapidly, and its remains became mineralized rather than decomposing.

Types of Fossils:

Body Fossils

- ◆ Preserved remains of animals or plants



Types of Fossils:

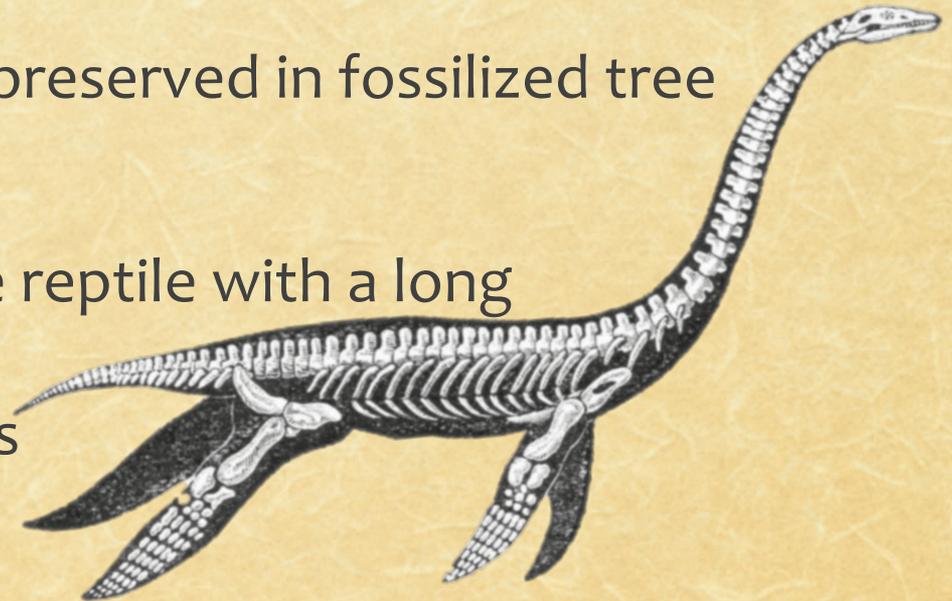
Trace Fossils

- ◆ Evidence (or traces) of an organism's behavior or activities



Types of Fossils: Actual Remains

- ◆ Bones and shells are the most common types of fossils.
- ◆ Woolly mammoth fur, skin, and other body parts are sometimes found preserved in ice.
- ◆ Insects can be found preserved in fossilized tree resin called amber.
- ◆ A plesiosaur, a marine reptile with a long neck and flippers, was found in tar sands in Canada.



Types of Fossils: Footprints and Trails

- ◆ Footprints give clues about:
 - ◆ The size of the organism that made them.
 - ◆ Whether it walked on two or four feet.
 - ◆ How quickly or slowly it moved.
- ◆ Trails provide similar clues about snakes, worms, and other footless creatures.



Types of Fossils:

Petrified Fossils

- ◆ When an organism's soft parts are mineralized, they are said to be petrified.
- ◆ Entire petrified trees were found in Petrified Forest national Park in Arizona.



- ◆ Tiny arthropods are beautifully preserved in 3D in the Orsten fauna in Sweden.

Types of Fossils: Burrows and Borings

- ◆ *Burrows* are holes or small tunnels made by worms and other organisms that lived in mud or soft sand.
- ◆ *Borings* are holes or tunnels made by organisms that lived in wood or other hard materials.



- ◆ Burrows and borings provide clues about the size of the organisms that made them and sometimes about their feeding habits.

Types of Fossils: Fossilized Eggs & Nests

- ◆ These provide evidence about:
 - ◆ The number of offspring an adult may have produced.
 - ◆ The size of the young.
 - ◆ How their parents may have taken care of them.



Types of Fossils:

Fossil Molds and Casts

- ♦ A *mold* is the impression left in sediment by a body part, such as a shell, that is preserved (the body part disappears).
- ♦ A *cast* forms when a fossil mold becomes filled with minerals or mud.



Types of Fossils: Fossilized Wastes

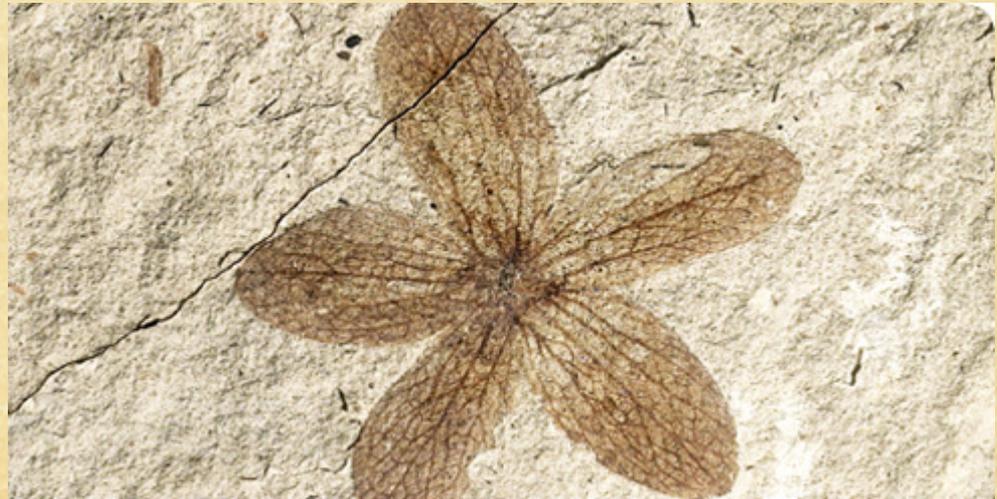
- ◆ *Coprolites* are fossilized dung that often contains bits of other organism' bones, teeth, or shells.
- ◆ *Gastroliths* are fossilized gizzard stones that are sometimes found among reptile bones.



- ◆ Coprolites and gastroliths provide clues about an organism's diet.

Types of Fossils: Carbon Films

- ♦ Carbon forms very thin sheets that were once a part of a plant or animal.



Types of Fossils



loading..



Studying the Layers



- ◆ While William Smith (1769-1839) was supervising the digging of the Somerset Canal in England, he observed that the same kinds of fossils always occurred in a specific order in the rock layers.
- ◆ He used his observations to support the law of superposition, which states that newer layers form on top of existing layers.
- ◆ Using this approach, he could successfully predict the type of fossils that would be found above or below any layer he was studying.

Studying the Layers

Division of Geological Time		Era	Period	Rocks	Dominant Life	Index Fossils		
Cenozoic	65	Quaternary	2			Mammals	Pecten, Neptunea	
		Tertiary	65				Venericardia, Calyptraphorus	
Mesozoic	136	Cretaceous	136				Reptiles & Ammonites	Inoceramus, Scaphites
		Jurassic	190				Perisphinctes, Nerinea	
		Triassic	225				Trophites, Monotis	
Palaeozoic	570	Permian	280			Amphibians	Leptodus, Parafusulina	
		Carboniferous	Pennsylvanian			310		Dictyoclostus
			Mississippian			345		Cactocrinus, Prolecanites
		Devonian	395				Fish	Mucrospirifer, Palmatolepus
		Silurian	430				Hexamoceras, Crystiphyllum	
		Ordovician	500			Invertebrates	Tetragraptus, Bathyrus (Trilobite)	
		Cambrian	570			Sea-Weeds	Paradoxides (Trilobite), Billingsella	
Proterozoic	Archaeozoic	Precambrian						

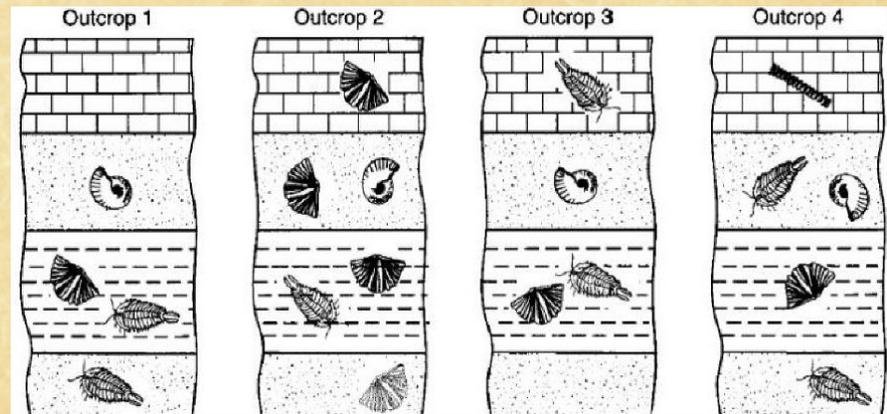
Studying the Layers

- ◆ Using Smith's principles, Sir Roderick Murchison (1792-1871) carefully collected fossils from different layers.
- ◆ He found that the fossil communities changed as he worked his way down through the layers of rock in Wales.
- ◆ Later, he was invited by the czar to study the fossil communities in Russia.
- ◆ Murchison began to believe that the same sequence of fossil communities was preserved throughout the world.

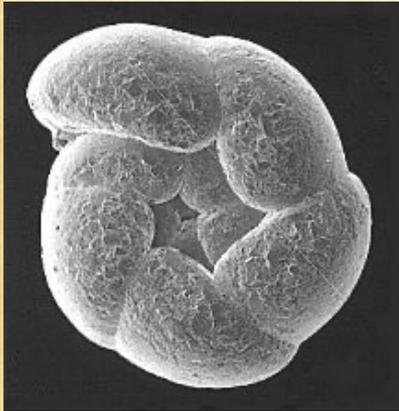


Studying the Layers

- ◆ This specific order of fossils is observable data, and other geologists have confirmed Murchison's idea that the same pattern is consistent in the rock layers throughout the world.
- ◆ Fossils that occur consistently in a limited portion of the geologic column but are abundant and widespread in that limited portion are called index fossils.



Studying the Layers



- ◆ The lowest section of the geologic column, the Precambrian, contains microfossils, but relatively few macrofossils.
- ◆ *Microfossils* are the remains of small organisms – such as bacteria and protists – that can only be studied using a microscope.
- ◆ *Macrofossils* are larger and visible without a microscope.

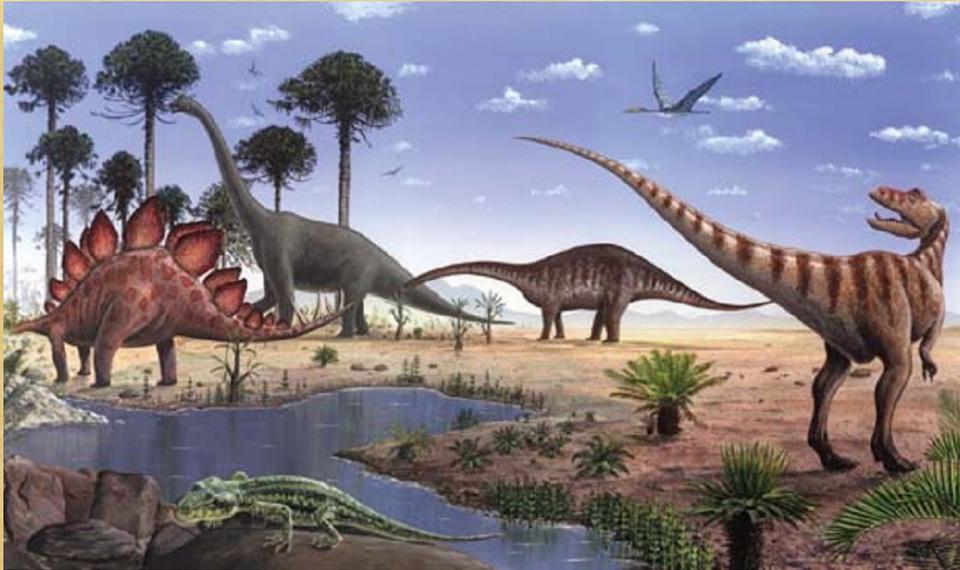
Studying the Layers

- ◆ Above the Precambrian layers, in a subdivision called the **Paleozoic**, various marine fossils are found.
- ◆ These animals include trilobites and fish.
- ◆ In addition, scientists have found amphibians and huge dragonflies with a wingspan of nearly a meter (3 feet).
- ◆ Near the top of the Paleozoic layers, some fossils of land animals appear.
- ◆ A high percentage of fossils found in these lower layers are creatures that are not extinct.



Studying the Layers

- ◆ Above the Paleozoic are the **Mesozoic** layers, which contain a mixture of fossils from marine animals, land animals, and some birds.



- ◆ The most well-known animals in these layers are the dinosaurs.

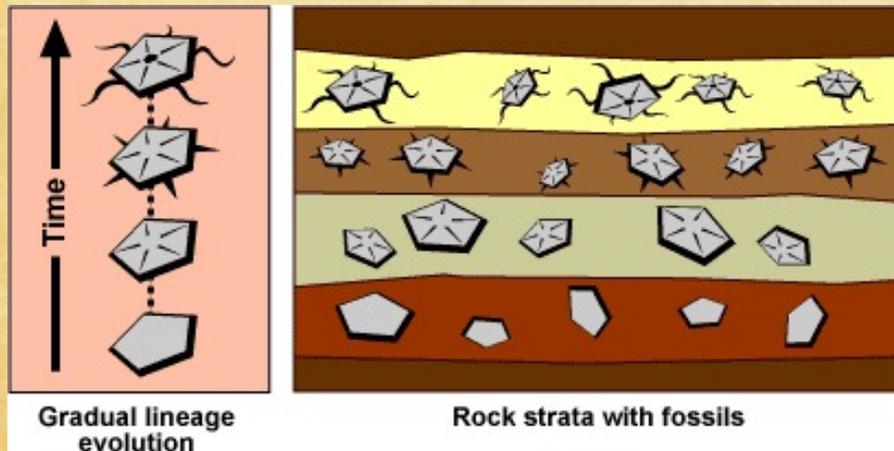
Studying the Layers

- ◆ Above the Mesozoic are the **Cenozoic** layers, which contain fossils from many land animals and birds.
- ◆ Among the interesting animals found in these layers are saber-toothed cats, tiny horses, beavers 6-8 feet tall, woolly mammoths, and sloths the size of elephants.



Studying the Layers

- ◆ When scientists speak of the *fossil record*, they refer to the fossils, their placement within the strata, and the information that can be derived from them.
- ◆ Rock layers and the fossils found in them are observable data.



- ◆ Some of the data show very clearly that major changes have occurred in Earth's history.

Studying the Layers

- ◆ Fossil whalebones have been found in deserts.
- ◆ Fossil seashells have been found on mountaintops all over the world.
- ◆ Fossils of broad-leafed evergreen plants that grow in tropical forests have been found in Alaska.



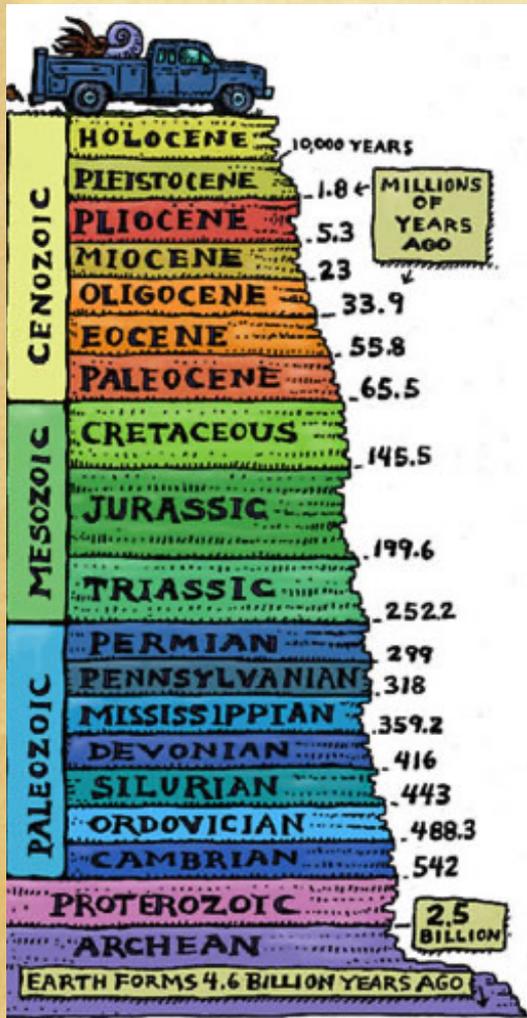
Scripture Spotlight



*Read about the Rock of Escape in **1 Samuel 23:19-28**.*

1 Samuel 23:19-28 describes a dramatic rescue experienced by David in the wilderness. He named the place Rock of Escape.

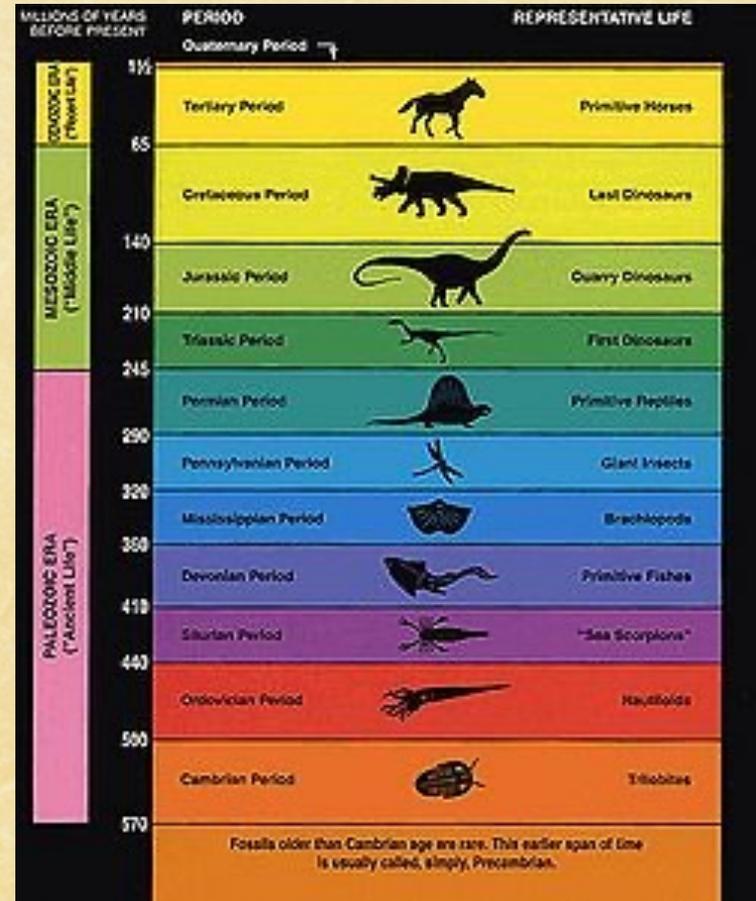
Time Inferences



- ♦ The geologic column has come to be closely associated with millions of years of evolutionary history, but it was not that way at first.
- ♦ Most of the scientists who first described and published the relationships between the layers and the fossils believed in the biblical account of Earth's history.

Time Inferences

- ◆ Sometimes the names they assigned to the parts of geologic column reflected characteristics of the rock layers themselves
 - ◆ Like the Cretaceous (which means “chalky”)
 - ◆ Or Carboniferous (because of the carbon in the coal found there)



Time Inferences

EON	ERA	PERIOD	EPOCH	Ma		
Phanerozoic	Cenozoic	Quaternary	Holocene	0.01		
			Pleistocene	Late	0.8	
		Early		1.8		
		Tertiary	Neogene	Pliocene	Late	3.6
					Early	5.3
				Miocene	Late	11.2
					Middle	16.4
					Early	23.7
			Paleogene	Oligocene	Late	28.5
					Early	33.7
				Eocene	Late	41.3
					Middle	49.0
					Early	54.8
		Paleocene	Late	61.0		
	Early		65.0			
	Mesozoic	Cretaceous	Late	99.0		
			Early	144		
		Jurassic	Late	159		
			Middle	180		
			Early	206		
		Triassic	Late	227		
			Middle	242		
			Early	248		
	Paleozoic	Permian	Late	256		
			Early	290		
		Pennsylvanian		323		
		Mississippian		354		
		Devonian	Late	370		
			Middle	391		
			Early	417		
		Silurian	Late	423		
			Early	443		
Ordovician		Late	458			
		Middle	470			
		Early	490			
Cambrian		D	500			
		C	512			
	B	520				
	A	543				
	Precambrian	Proterozoic	Late	900		
Middle			1600			
Early			2500			
Archean		Late	3000			
		Middle	3400			
		Early	3800?			

- ♦ Often layers were named after the places where the fossils were first described.
- ♦ The *Jurassic* was named for the Jura Mountains of Switzerland
- ♦ And the *Permian* was named for the town of Perm in Russia where scientists first described the fossils found in these layers
- ♦ It was only later that the long ages suggested by some scientists influenced the interpretation of the geologic column.

Time Inferences

Geological Time Scale

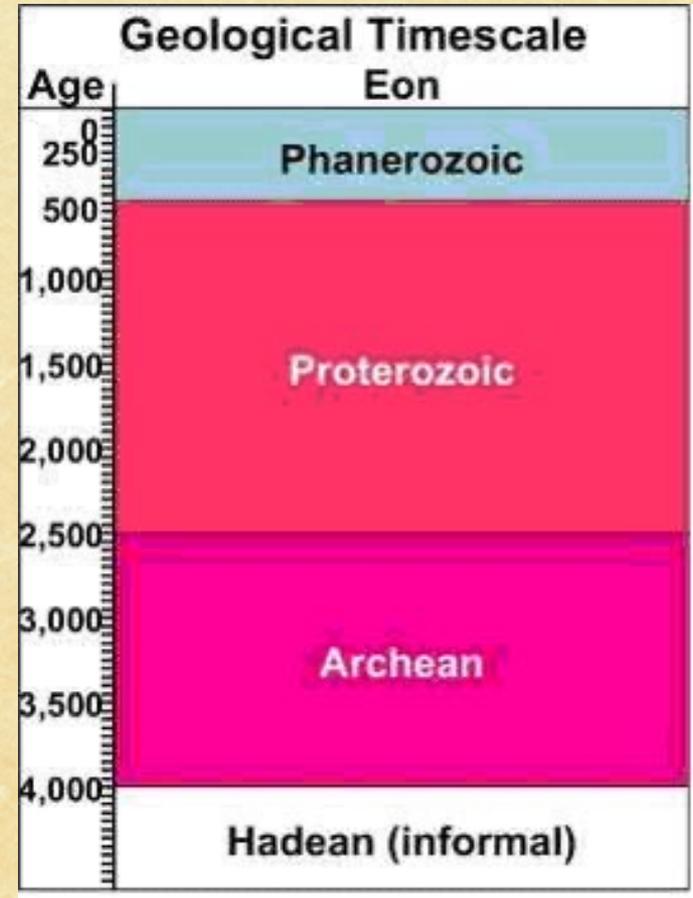
ERA	PERIOD	EPOCH / AGE	Million Years Ago	EVENTS
CENOZOIC <i>Age of Mammals</i>	Quaternary	<i>Holocene</i>	<i>Today</i>	Ice Age ends Humans are dominant
		<i>Pleistocene</i>	0.01	Earliest Humans appear Ice Age begins
	Tertiary	<i>Pliocene</i>	1.6	Hominids (human ancestors) appear
		<i>Miocene</i>	5.3	Grass becomes widespread
		<i>Oligocene</i>	23.7	Mammals are dominant
		<i>Eocene</i>	36.6	Eocene – Oligocene extinction event
		<i>Paleocene</i>	57.8	First large mammals appear
MESOZOIC <i>Age of Reptiles</i>	Cretaceous	<i>Extinction of Dinosaurs</i>	65.5	K-T extinction event Earth looks closer to present-day Flowering plants appear
	Jurassic		144	First Birds appear Pangaea splits into Laurasia, Gondwana Dinosaurs are dominant
	Triassic	<i>First Dinosaurs</i>	208	Pangaea cracks First mammals appear Reptiles are dominant
PALEOZOIC	Permian	<i>Age of Amphibians</i>	245	Permian – Triassic extinction event Pangaea forms
	Carboniferous		286	First reptiles appear First large cartilaginous fishes appear
	Devonian	<i>Age of Fishes</i>	360	Late Devonian extinction event First land animals appear First amphibians appear
	Silurian		408	First land plants appear First jawed fishes appear First insects appear
	Ordovician		438	Ordovician – Silurian extinction event First vertebrates appear
	Cambrian	<i>Age of Invertebrates</i>	505	End Botomian extinction event First fungi appear Trilobites are dominant
PRECAMBRIAN	Proterozoic Eon		570	First soft-bodied animals appear First multicellular life appear
	Achean Eon		2500	Photosynthesizing cyanobacteria appear First unicellular life appear
	Hadean Eon	<i>Priscoan Period</i>	3800	Atmosphere and oceans form Oldest rocks form as Earth cools
			4600	

Formation of Earth

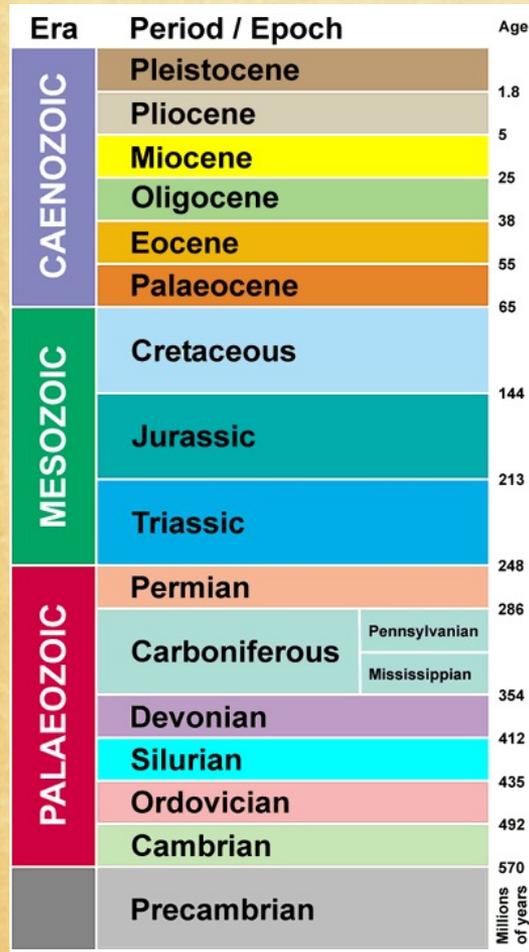
- ♦ The reason for the fossil sequence and the time span associated with it came to be associated with the newest scientific theory – evolution.
- ♦ As individual layers were grouped into larger categories, they were given names with time connotations.
- ♦ Now the geologic column is referred to as the geological time scale and uses divisions called eons, eras, and periods.

Time Inferences

- ◆ An **eon** is the largest division of geologic time.
- ◆ There are four eons:
 - ◆ Phanerozoic
 - ◆ Proterozoic
 - ◆ Archean
 - ◆ Hadean



Time Inferences



- ◆ Eons are divided into eras, which are still long periods of time, but shorter than eons.
- ◆ For example, the Phanerozoic eon is divided into three eras – Cenozoic, Mesozoic, Paleozoic.
- ◆ Each of these three eras contain at least three periods.
- ◆ A period is the basic unit on the geologic time scale.

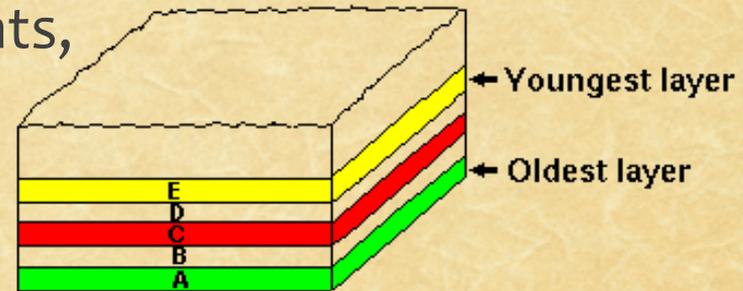
Time Inferences

	Prefix	Suffix	Meaning
Cenozoic	Ceno = recent	Zoic = animal life	Recent Animal Life
Mesozoic	Meso = middle	Zoic = animal life	Middle Animal Life
Paleozoic	Paleo = old	Zoic = animal life	Old Animal Life

- ◆ Notice how the meaning of the words Cenozoic, Mesozoic, and Paleozoic include the idea of time.
- ◆ Lower layers are considered *older* than higher layers because they were laid down earlier.

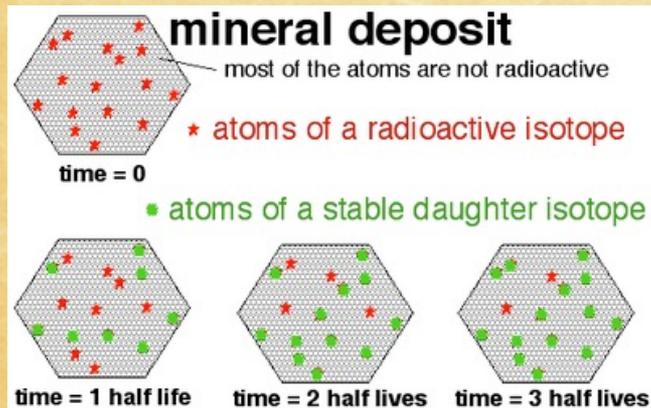
Time Inferences

- ♦ Scientists often refer to the age of one layer in relation to another.
- ♦ **Relative age** is the age of a rock or formation in relation relative to other rocks or formations, usually defined as a zone fossil name.
- ♦ **Relative dating** is the science of determining the relative order of past events, without necessarily determining their absolute age.



Time Inferences

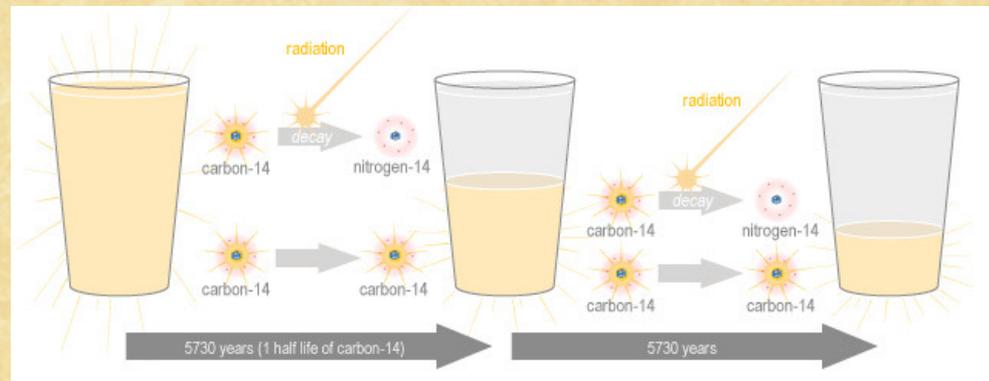
- ◆ Scientists have attempted to assign actual dates to the rock layers using a process called radiometric dating.
- ◆ Also, called absolute dating, it is a method of dating that compares the relative proportions of radioactive isotopes present in a sample.



- ◆ Certain elements that occur in nature decay predictably over time, changing from what we call a parent isotope to what we call a daughter isotope.

Time Inferences

- ◆ The more time that passes, the less parent isotope is left and the more daughter isotope there is.
- ◆ Scientists know that half-lives of various elements.
- ◆ They can compare the ratio of parent isotopes to daughter isotopes to figure out the age of the rock layers.



Time Inferences

- ◆ While the ratios of parent isotopes to daughter isotopes are actual data, the interpretation of those ratios as millions of years conflicts with both the biblical history of earth and scientific evidence that is difficult to explain if the layers were really laid down over millions of years.



- ◆ Short age geology predicts that there are more discoveries to be made about radiometric dating and that these discoveries will shed light on why these ratios indicate time spans that conflict with the chronological information found in the Bible.

Time Inferences

- ◆ The geologic column, which includes both the rock strata and the fossil record, is observable data.
- ◆ The time inferences associated with the geologic column are interpretations of that data, which are influenced by the worldview of the scientists who make them.

