Earth's History

" The present is the key to the past"- Hutton

Fossils - remains or traces of plants and animals preserved in rock.

- Fossils are found in sedimentary rock.

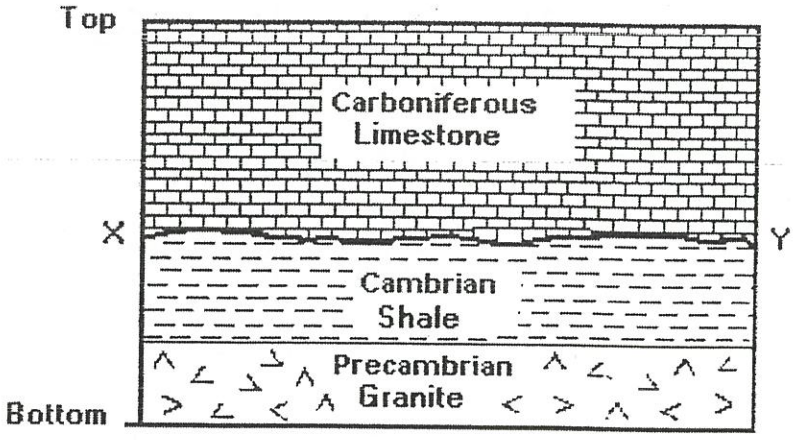
Relative age- a comparative age
Absolute age- an exact age

To determine the relative age of rock layers we use the following criteria:

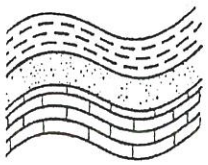
1. Original Horizontality --- Rock layers are deposited horizontally
2. Principle of Superposition --- Oldest on bottom youngest on top.
3. Faults and folds are always younger than the rocks they cut through.
4. Intrusions are always younger than the rocks they cut through.
5. Inclusions are always older than the rocks they are cemented in.

ORIGINAL HORIZONTALITY:
Sedimentary rocks form in horizontal layers in depositional environments.

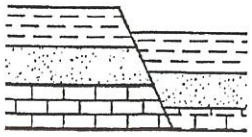
PRINCIPLE OF SUPERPOSITION:
Oldest layer = Bottom
Youngest layer = Top



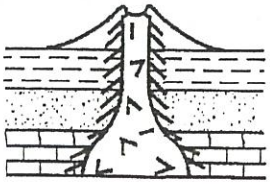
Label the diagrams either folded, faulted, tilted or intruded



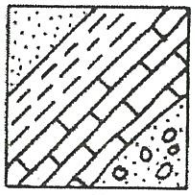
Fold



Fault

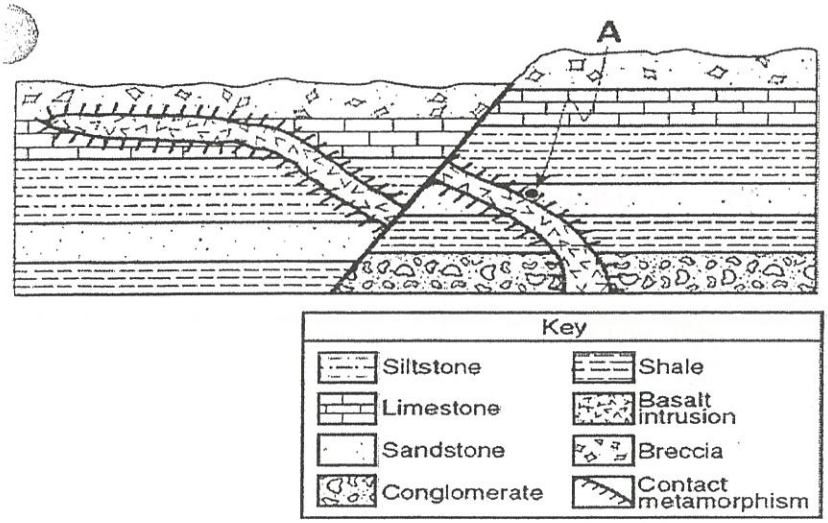


intrusion



Tilt

CROSS CUTTING RELATIONSHIPS: A fault or intrusion is younger than the rock they cut through.



1. What occurred first the deposition of the siltstone or the Basalt intrusion?
Siltstone

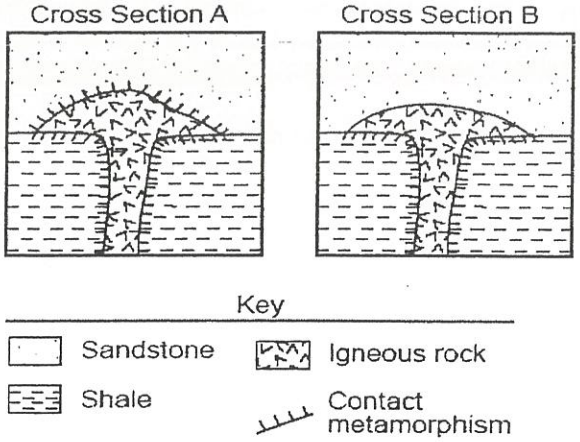
2. What occurred first the deposition of the sedimentary layers or the fault?
sedimentary layers

IGNEOUS INTRUSIONS AND EXTRUSIONS:

Intrusion: magma squeezes through pre-existing rocks and crystallizes.

Extrusion: lava flows and solidifies at Earth's surface (includes volcanoes).

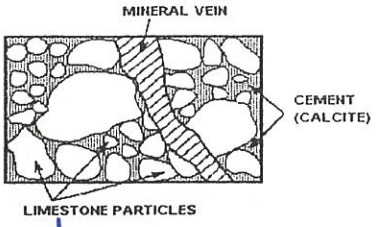
Contact metamorphism: occurs when intrusions or extrusions add heat to the surrounding rock and cause changes to occur.



Cross Section A = Intrusion Cross Section B = Extrusion

Sequence of events in order from oldest to youngest	
Cross Section A	**Cross Section B**
Int + cont.	sandstone
sandstone	int + cont
shale	Shale

Inclusions: The rocks contained within another rock are Older than the cement



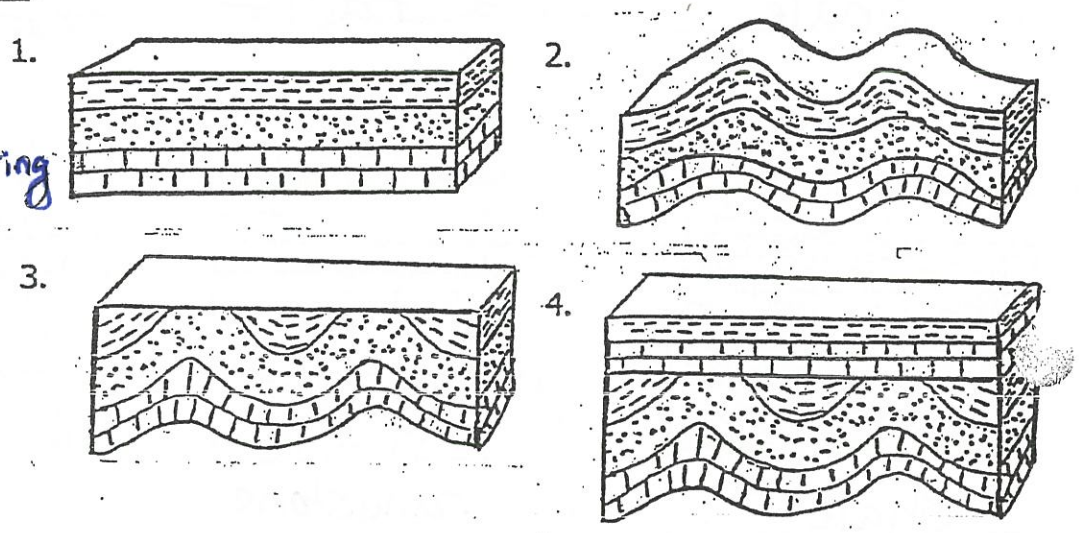
Unconformity- 1. buried erosional surface between two rock layers of different ages.

2. No longer horizontal because a layer is missing or is unpreserved
3. Represented by a bold / squiggle line.

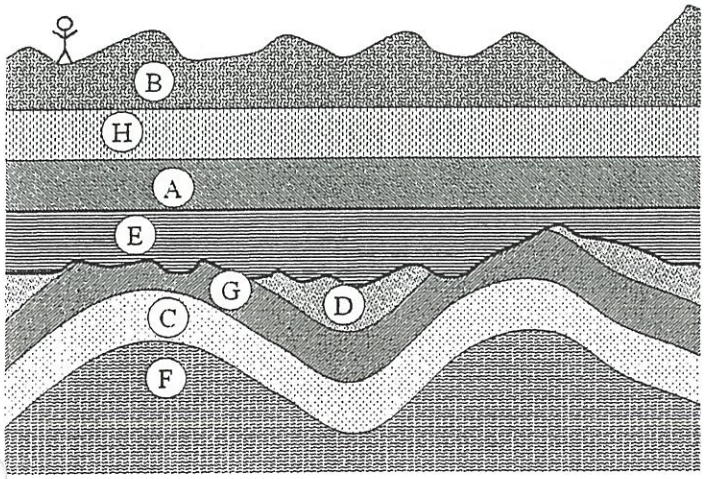
How an unconformity forms:

3 steps:

1. Deposition
2. Folding
3. Buried Weathering and Erosion



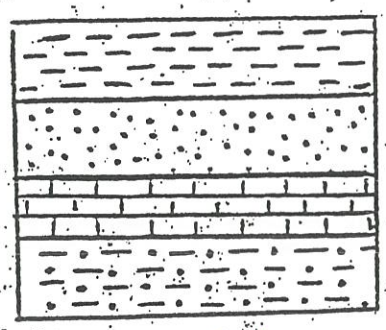
Place these layers in order based on when they formed. Add in **unconformity** and **fold**



	youngest
11.	Weathering + Erosion
10.	B
9.	H
8.	A
7.	E
6.	Unc.
5.	Fold
4.	D
3.	G
2.	C
1.	F
	oldest

Determining Relative Age:

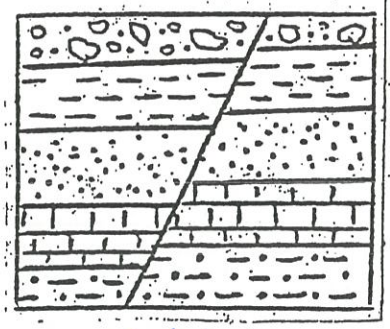
Identify both the oldest rock or event and the youngest rock or event:



oldest Siltstone

youngest Shale

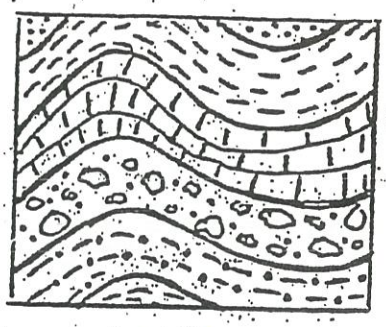
2.



oldest Siltstone

youngest Fault

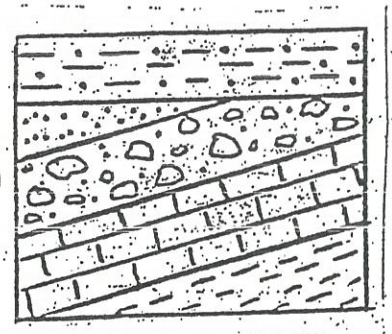
3.



oldest Shale

youngest Sandstone

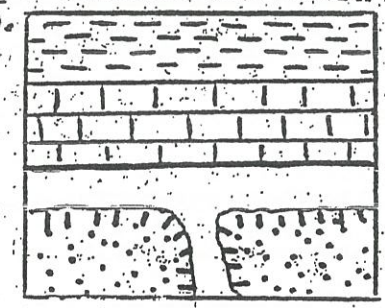
4.



oldest Shale

youngest Siltstone

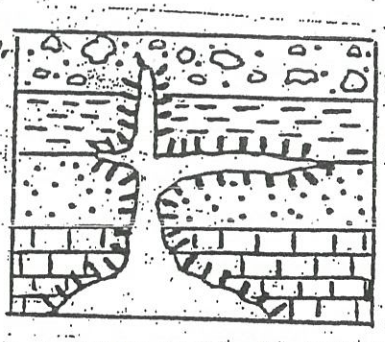
5.



oldest Sandstone

youngest Shale

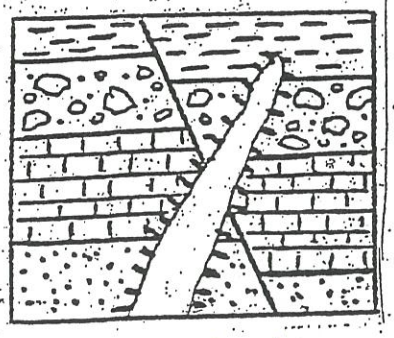
6.



oldest Limestone

youngest Int. + Cont.

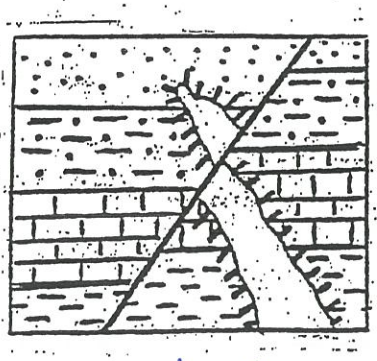
7.



oldest Sandstone

youngest Int. + Cont.

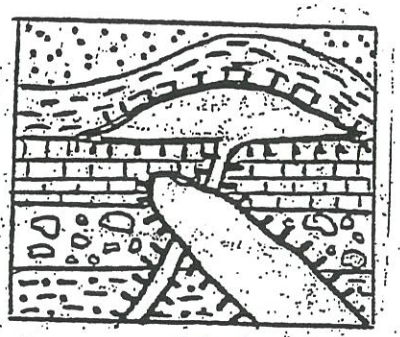
8.



oldest Shale

youngest Fault

9.



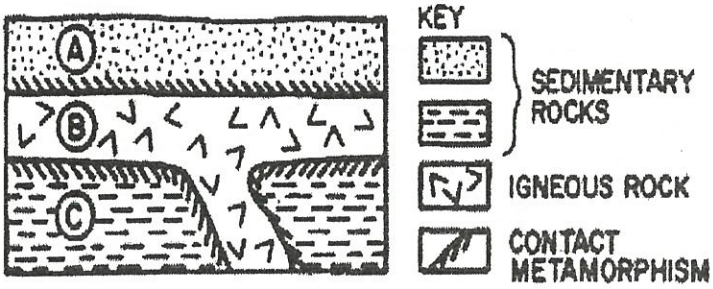
oldest Siltstone

youngest Int + Cont

Sequence of Events Practice

List the events needed to make the pattern of rock layers shown below in order. Assume that sedimentary rocks are deposited under water and that erosion happens above water.
Include the words: deposition, erosion, unconformity, fold, fault, and igneous intrusion where needed .

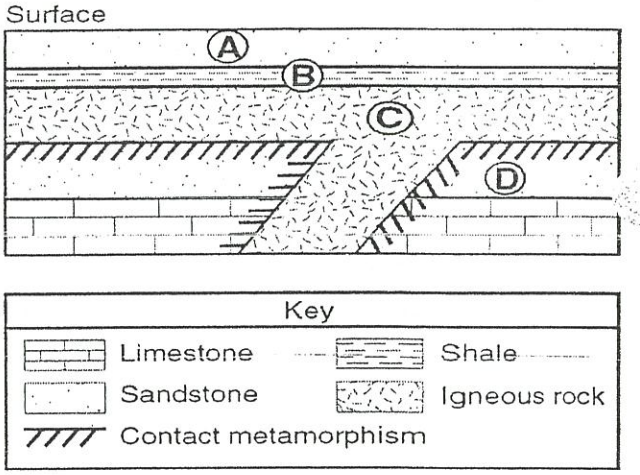
1. List the layers in order from youngest to oldest:



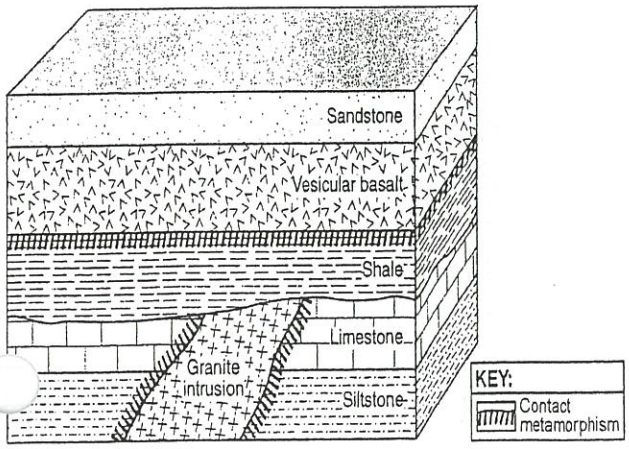
	youngest
3.	B = Int. C.M.
2.	A
1.	C
	oldest

2. List the order of events from youngest to oldest:

	youngest
5.	A
4.	B
3.	C + cont
2.	D
1.	limestone
	oldest

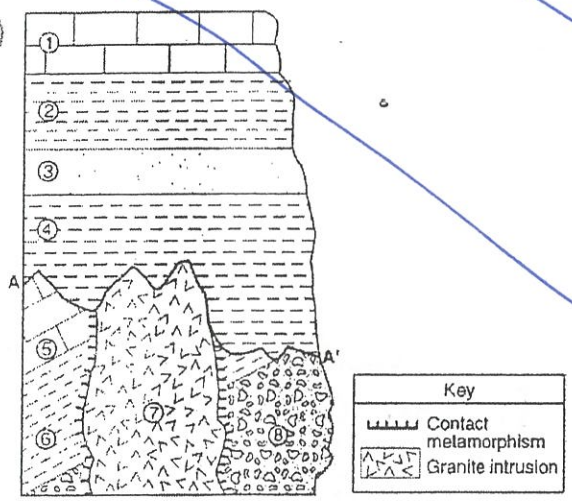


3. List the order of events from youngest to oldest:



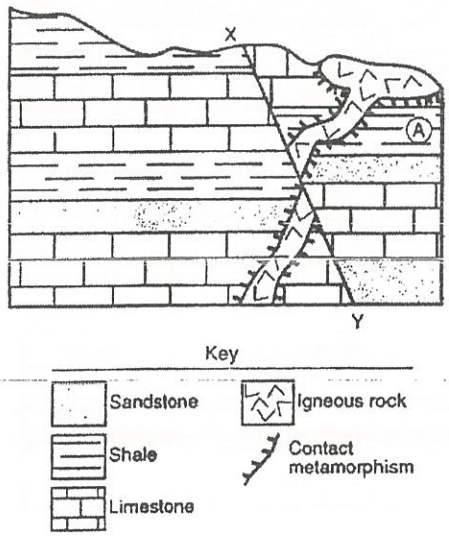
	youngest
7.	Sandstone
6.	Vesicular basalt + Cont.
5.	Shale
4.	unconformity
3.	Int. + cont.
2.	limestone
1.	Silstone
	oldest

4. List the order of events from youngest to oldest:



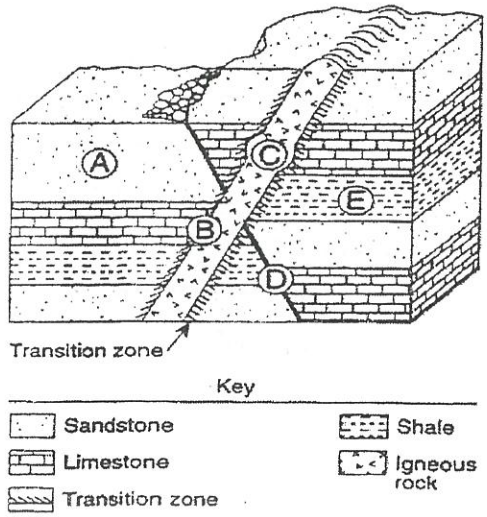
	Youngest
10.	
9.	
8.	
7.	
6.	
5.	
4.	
3.	
2.	
1.	
	oldest

5. List the order of events from youngest to oldest:



	youngest
9.	Weathering + Erosion
8.	Fault
7.	Int + C.M.
6.	Shale
5.	lime
4.	Shale
3.	Sand
2.	lime
1.	Sand
	oldest

6. List the order of events from youngest to oldest:



	youngest
8.	W + E
7.	Int + C.M.
6.	Fault
5.	Sand
4.	lime
3.	Silt
2.	Sand
1.	lime
	oldest

CORRELATION (MATCHING ROCK LAYERS)

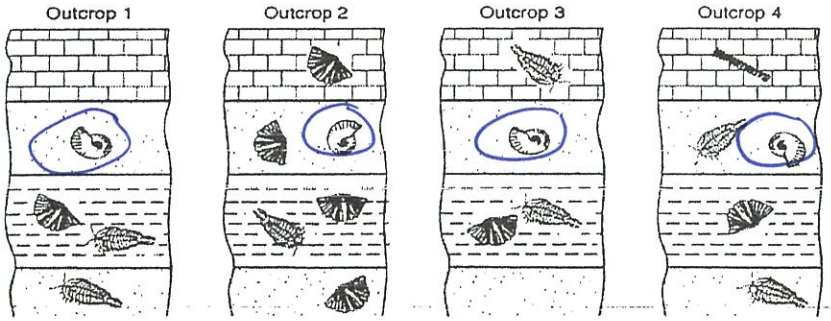
1. **Walking the outcrop**
   -Look for: sequence that they are in, rock type, color, texture, mineral composition, and fossils.

2. **Index Fossils:** lived in a Wide geographic area but only for a short time.

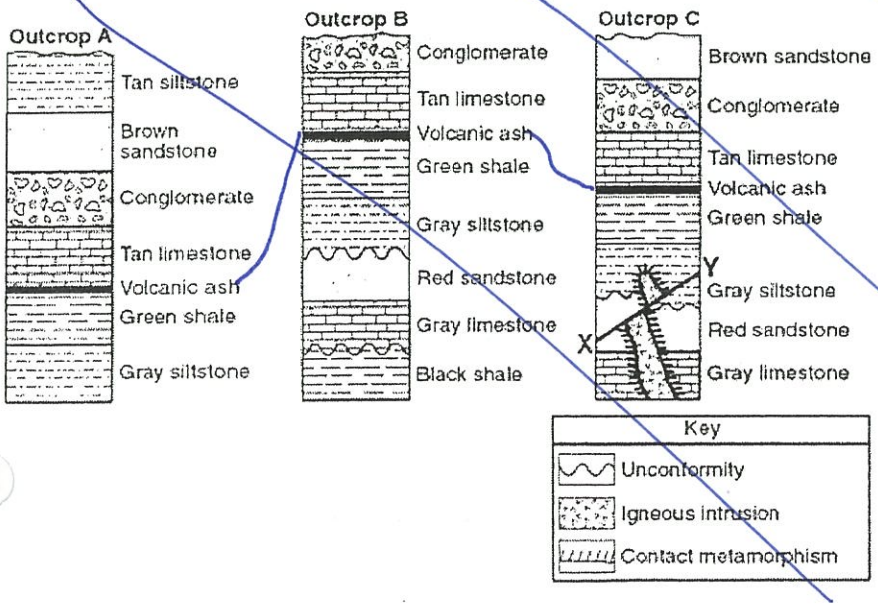
A	A	D
B	B	B
C	C	D

3. **Key beds:** like an index fossil because the eruption spreads ash over a large area but only for a short time
   -example- a layer of volcanic ash

A. Which of these is an index fossil? **Circle your answer**



B. List these layers in order from oldest to youngest:



	youngest
14.	
13.	
12.	
11.	
10.	
9.	
8.	
7.	
6.	
5.	
4.	
3.	Gray lime.
2.	unconformity
1.	Blake Shale

What can the rock and fossil records tell us about the history of the Earth?

Objective: To understand how geologic units of time are divided by mastering the ESRT pages 8-9.

A. What do we breathe in? Oxygen

B. When did this gas enter the Earth's atmosphere from the oceans? During what eon?
2200mya • Early Proterozoic in PreCambrian

Eon: largest unit of time (500 million to billions of years)
Era: second largest unit of time (100s of millions of years)
Period: third largest unit of time (20 to 80 million years)
Epoch: smallest unit (millions to 10s of millions of years)

Complete the following questions using your ESRT:

1. How old is the Earth? 4600 millions of years 4.6 billions of years
2. When does the Phanerozoic Eon begin (age in years)? 542 mya
3. What *eras* make up the Phanerozoic Eon? Paleozoic, Mesozoic, Cenozoic
4. What six *periods* make up the **Paleozoic Era**? For each period, describe **one** example of life found on Earth, **one** fossil group and **one** geologic event.

Period	Time (millions of years oldest to youngest)	Life on Earth	Index Fossil	Geologic Event
Permian	299-251			Pangaea continues to form
Carboniferous	359 to 299 mybp			Formation of Pangaea
Devonian	416-359		Earliest Ammonoids (Earliest Index Fossil G)	
Silurian	444-416	Abundant Eurypterids		
Ordovician	488 to 444 mybp			
Cambrian	542-488	Earliest Fish	Trilobites A	

5. Use your ESRT to determine which animal life became extinct at the end of the Permian Period and Paleozoic Era?
land + marine organisms (Trilobites

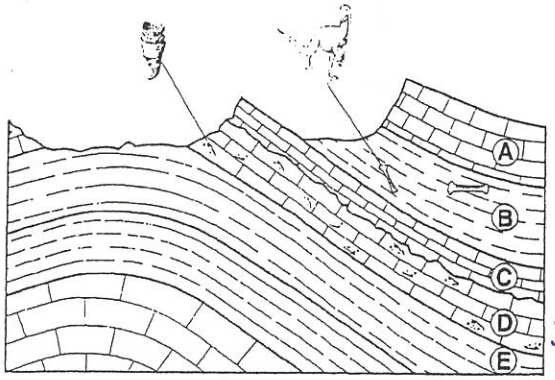
Complete the table below with information gathered about the *periods* that make up the Mesozoic Era.

Period	Time (millions of years before present)	Life on Earth	Fossils	Geologic Event
Cretaceous			Mammals, Birds, Dinosaurs	
		Earliest birds		Initial Opening of the Atlantic Ocean- North America and Africa Separate
	251 to 200 mybp			

6. The Mesozoic Era is marked by the introduction and extinction of this large animal dinosaurs.
7. Coelophysis is an index fossil of the animal group from question 6 that is found about 210 million years before present.
8. In what geologic *period* do the condor, mastodont, and beluga whale index fossils occur? Quaternary.
9. What Eon, Era, Period, and Epoch do we live in now?
   Holocene Quaternary Cenozoic Phanerozoic

Use pages 2&3, and 8&9 in your E.S.R.T to answer the following questions.

10. How old is the rock found in the Allegheny Plateau landscape region in millions of years? (Devonian)- 416 - 359mya
11. How old is the rock found in Watertown in millions of years? (Ordovician) 488 - 444mya
12. What landscape region would stromatolites be found in? Adirondacks
13. Approximately how many million years older than bedrock layer B is bedrock layer D?
    a. 150
    b. 220
    c. 340
    d. 420



Triassic

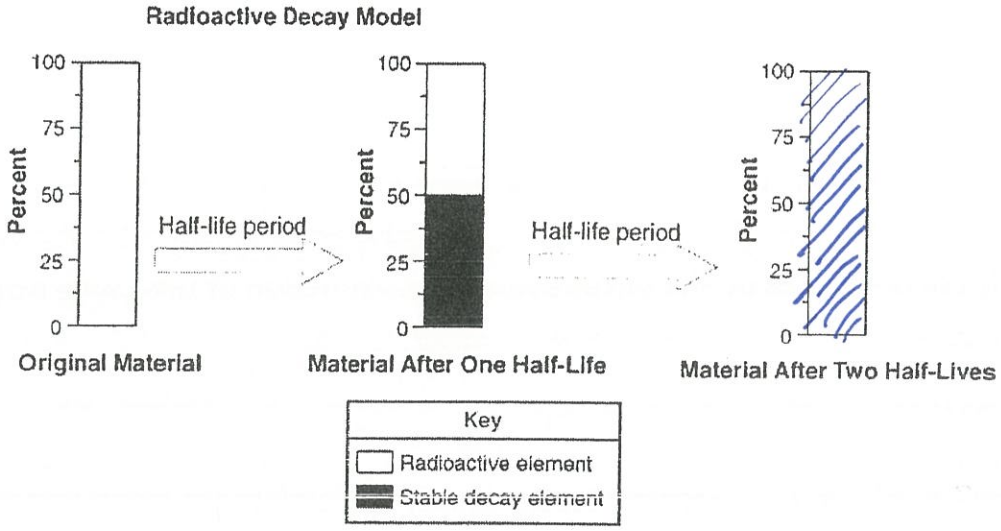
Silurian

RADIOACTIVE DATING

Define: Half-life- Time it takes a radioactive element to decay by 1/2

Decay Product- The stable element (daughter)

Radioactive Isotope	Decay Product	Half-life (years)
Carbon ^{14}	Nitrogen ^{14}	5700 years
Potassium ^{40}	Argon ^{40} Calcium ^{40}	1.3×10^9
Uranium ^{238}	lead ^{206}	4.5×10^9
Rubidium ^{87}	Strontium ^{87}	4.9×10^{10}



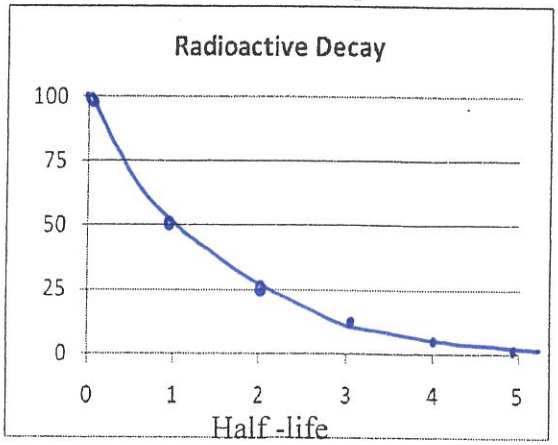
1. Why are radioactive isotopes useful in determining the absolute age of a rock?

They are always the same.

2. What can be done to change the half-life of a radioactive isotope? Why is this important?

Nothing! You get an exact age.

Draw the generic graph for the half-life of a radioactive isotope.



3. What radioactive isotope could be used to determine the absolute age of material that was recently living?

Carbon 14

Radioactive Decay Practice:

1. What is the half life of uranium-238?
   A. 4500 years
   B. 45,000 years
   C. 4,500,000,000 years
   D. 45,000,000,000 years

2. If there is a 100g sample of C14, how many grams of C14 would remain after three half-lifes? How long would this take? Show all work. 12.5g 17,100 yrs. 1 (100) 5700, 2 (50) 5700, 3 (25) 5700, 12.5

3. The rate of decay (half-life time) is ***not*** affected by outside conditions such as:
   A. Weathering + Erosion
   B. Climate
   C- Heat + Pressure

4. Carbon 14, an isotope used to date recent organic remains, would most likely be useful in determining the age of a
   A. Beluga whale
   B. Trilobite
   C. Coelophysis
   D. Armored fish

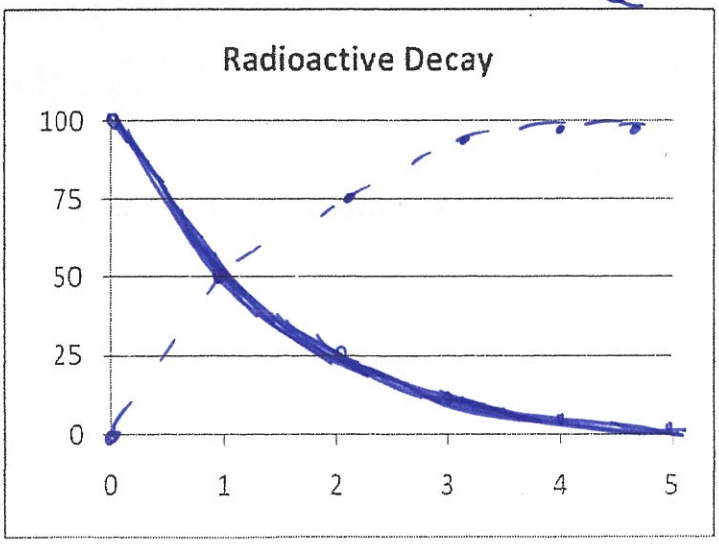
5. The characteristics of uranium 238 that makes it useful for accurately dating the age of a rock is the isotopes
   A. resistance to weathering and erosion
   B. constant half life
   C. common occurrence in sediments
   D. organic origin

6. Uranium 238 that crystallized at the same time Earth formed has undergone approximately how many half lives?
   A. four half lives
   B. one half life
   C. two half lives
   D. three half lives

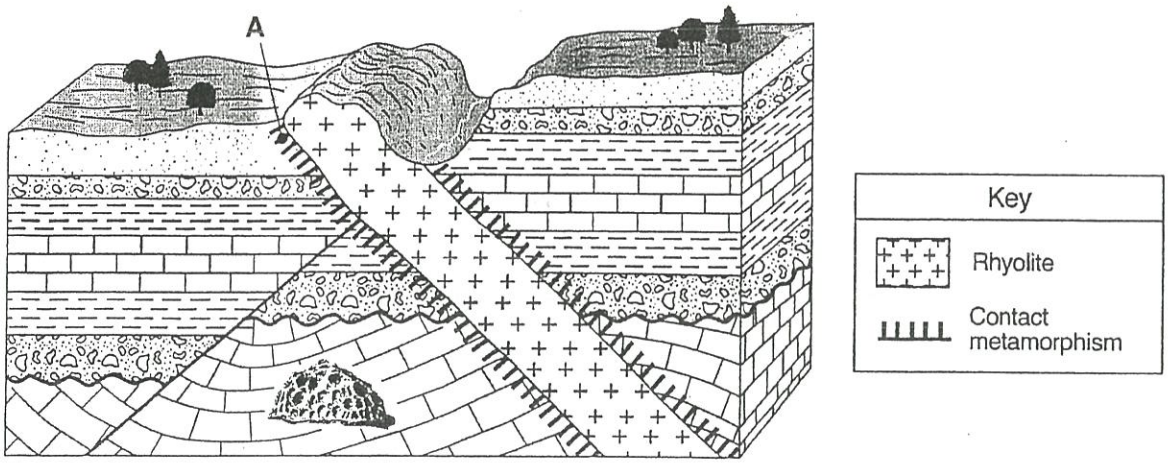
7. The absolute age of a rock is the approximate number of years ago that the rock formed. The absolute age of an igneous rock can best be determined by
   A. comparing the sizes of the crystals found in the upper and lower parts of the rock
   B. comparing the amounts of decayed and undecayed radioisotopes in the rock
   C. examining the environment in which the rock is found
   D. examining the rocks relative position in a rock outcrop

8. What is the approximate age of Mastodont remains if there are 20 grams of Carbon 14 and 60 grams of Nitrogen 14 remaining after decay? 1 (80) 5700, 2 (40) 5700, 11,400 years old.

9. Graph the relative values of % Decay versus Half-Lives for both the parent and daughter isotopes.



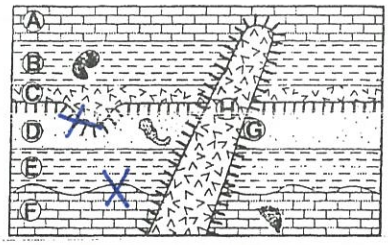
1. Base your answer to the following question on the block diagram below, which shows rock units that have not been overturned. Point *A* is located in the zone of contact metamorphism. A New York State index fossil is shown in one of the rock units.

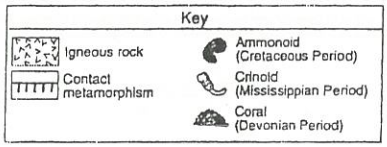


(Not drawn to scale)

State the evidence shown by the block diagram that supports the inference that the fault is older than the rhyolite. It's underneath it!

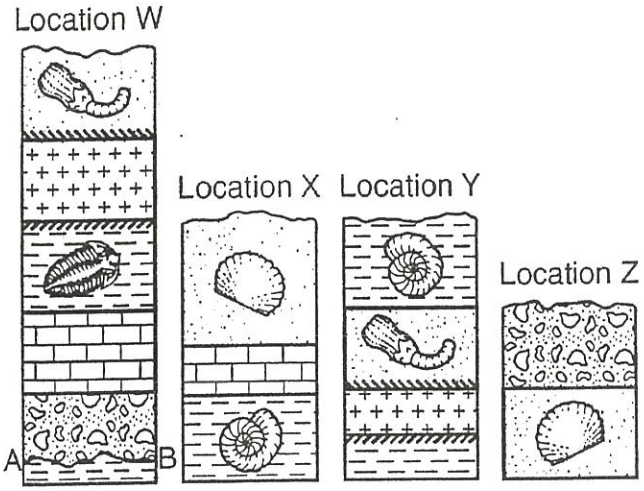
Base your answers to questions 2 through 7 on the geologic cross section in your answer booklet. Rock units *A* through *H* are shown. Several rock units contain fossils. Rock unit *G* was formed in a zone of contact metamorphism.

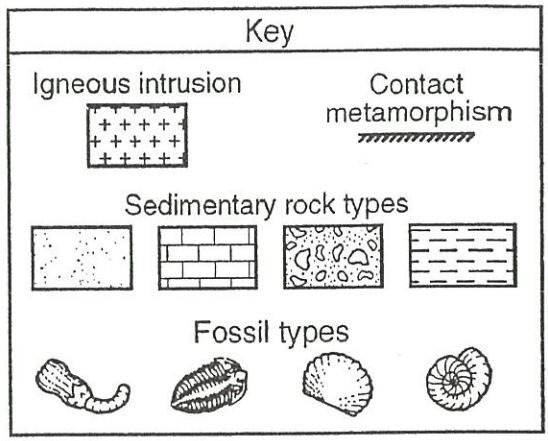




2. Explain why the absolute age of the fossils shown in the cross section can *not* be determined by using radioactive carbon-14. They are too old.
3. Identify *one* geologic period during which igneous intrusion *H* could have formed. Paleogene, or Neogene, or Quaternary
4. Identify the letter of the rock unit that was formed at the same time as igneous rock unit *H*. G is the Cont. Meta.
5. Describe the evidence shown in the cross section that indicates that rock unit *C* is younger than rock unit *D*. Contact meta.
6. Identify *two* possible geologic periods during which the sediments that formed rock unit *E* could have been deposited. Devonian - Mississippian
7. Place *two* Xs on the cross section *in your answer booklet* to show the locations of *two* unconformities that formed at different times in geologic history.

Base your answers to questions 8 through 10 on the cross sections below, which show widely separated outcrops at locations W, X, Y, and Z. The rock layers have not been overturned. Line *AB* in the cross section at location *W* represents an unconformity. Fossils are shown in some of the layers.





2 1 4 3

8. Identify *two* of the processes involved in the formation of the unconformity represented by line *AB* in the cross section at location *W*. Weathering + Erosion

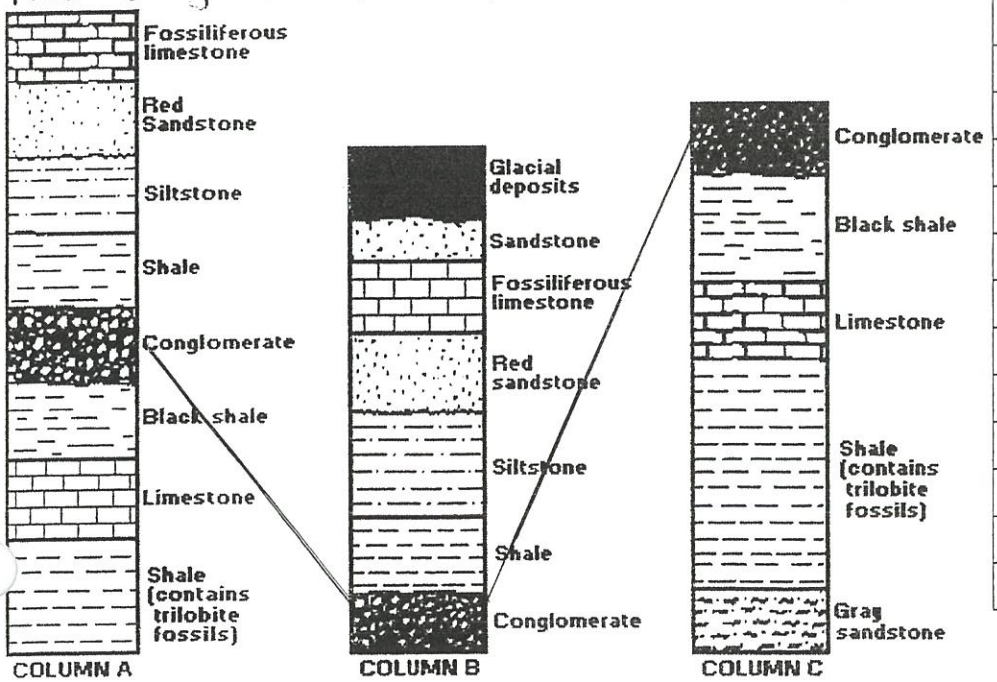
9. What evidence shown in the outcrop at location *W* suggests that the igneous intrusion occurred after both fossils were deposited at location *W*? Contact meta.

10. Determine the relative geologic age of the four fossils by correlating the rock layers between these outcrops. Number the fossils from 1 to 4 in order of relative age, with 1 as the oldest and 4 as the youngest.

CORRELATION OF ROCK LAYERS

Create one large geologic column from the three different columns:

The conglomerate has been done for you.



Youngest
Glacial Depo
sandstone
Fossil lime
red sand
Silt.
Shale
cong.
black shale
lime
Shale
Gray Sand
Oldest