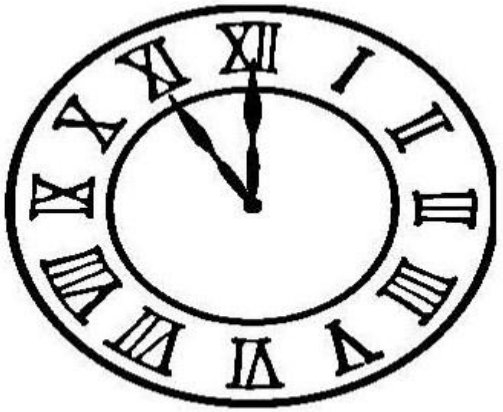
Geologic History

Relative Time and Absolute Time

Relative Time



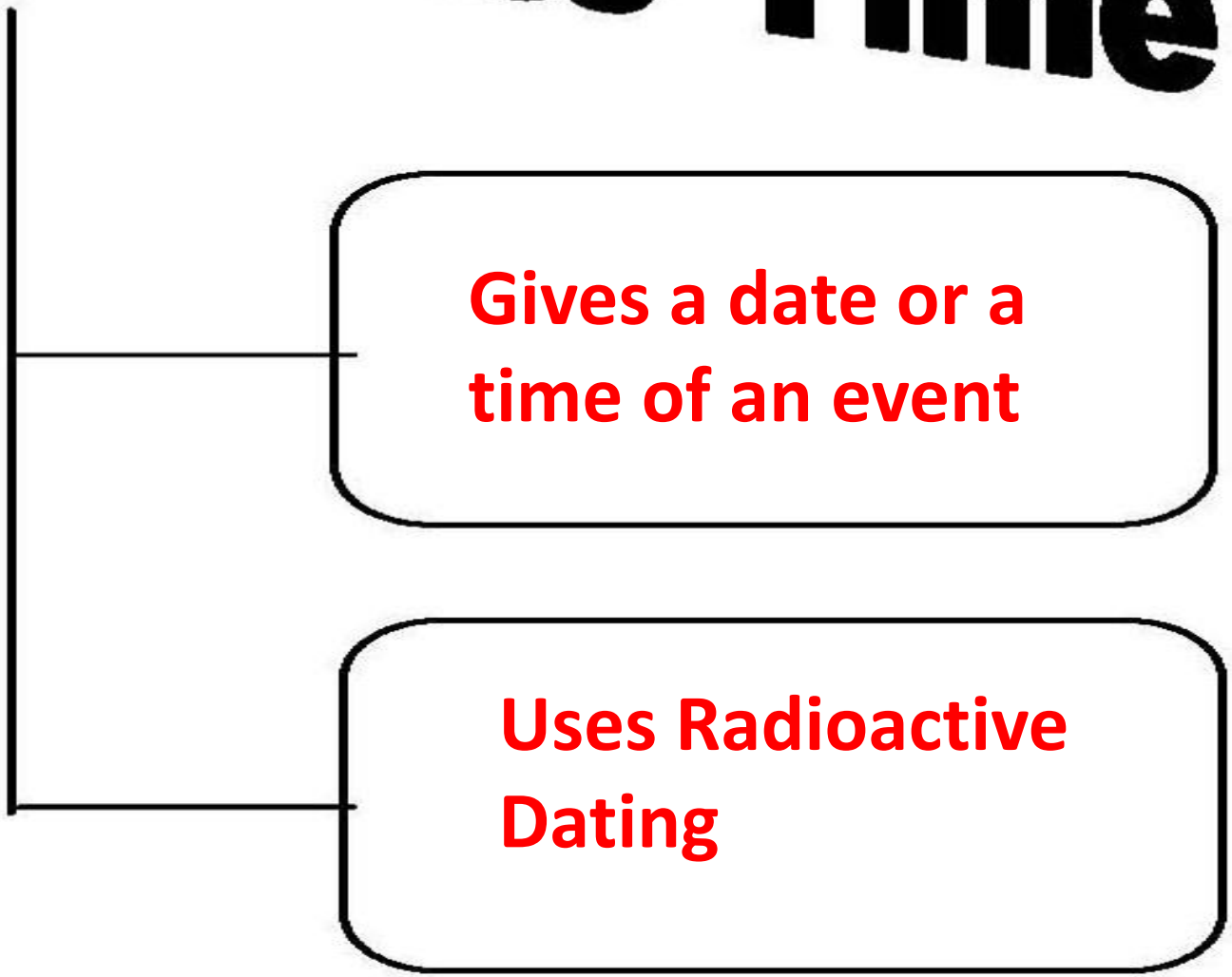
Places events in order from oldest to youngest.

Does not give exact dates or times.

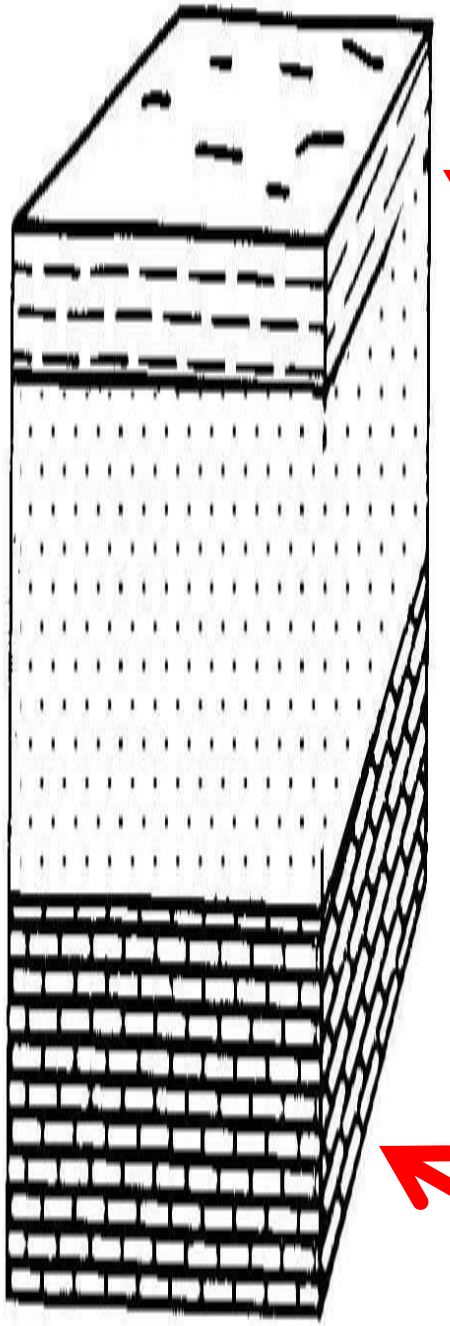
Uses Law of Superposition

Put these in order relative to one another

Absolute Time



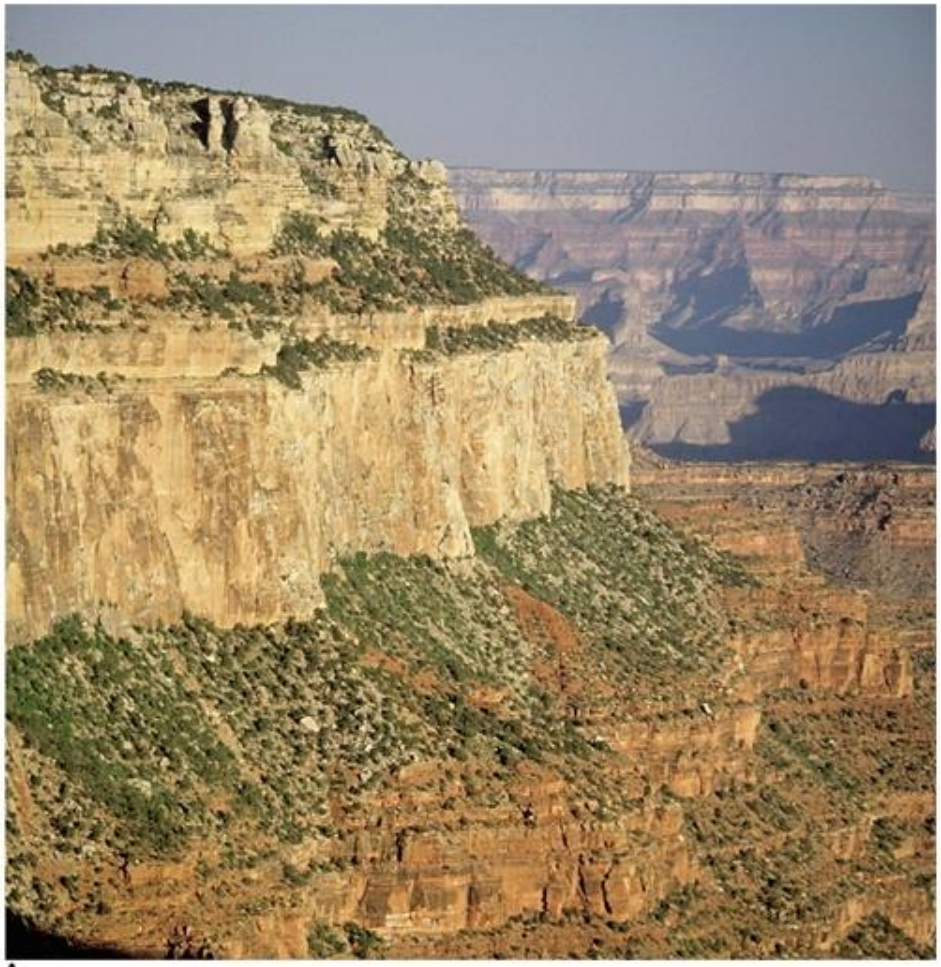
Law of Superposition:



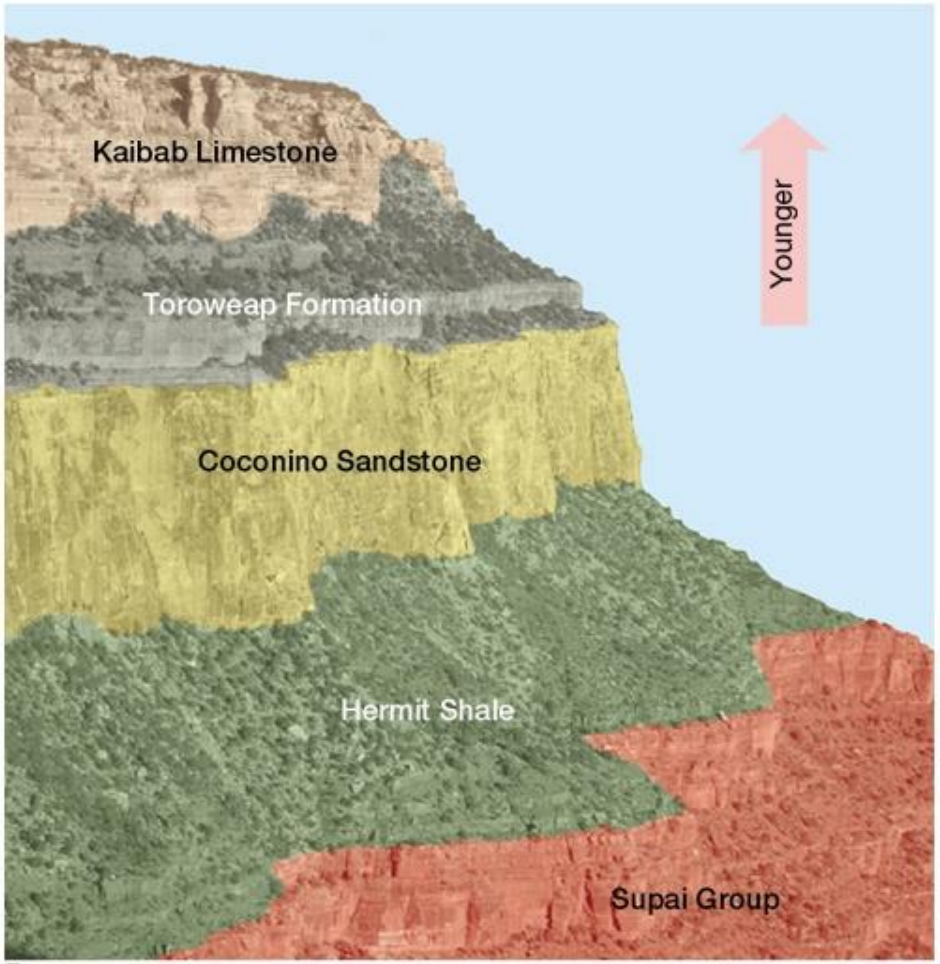
youngest

The oldest rock layers are on the bottom.

oldest

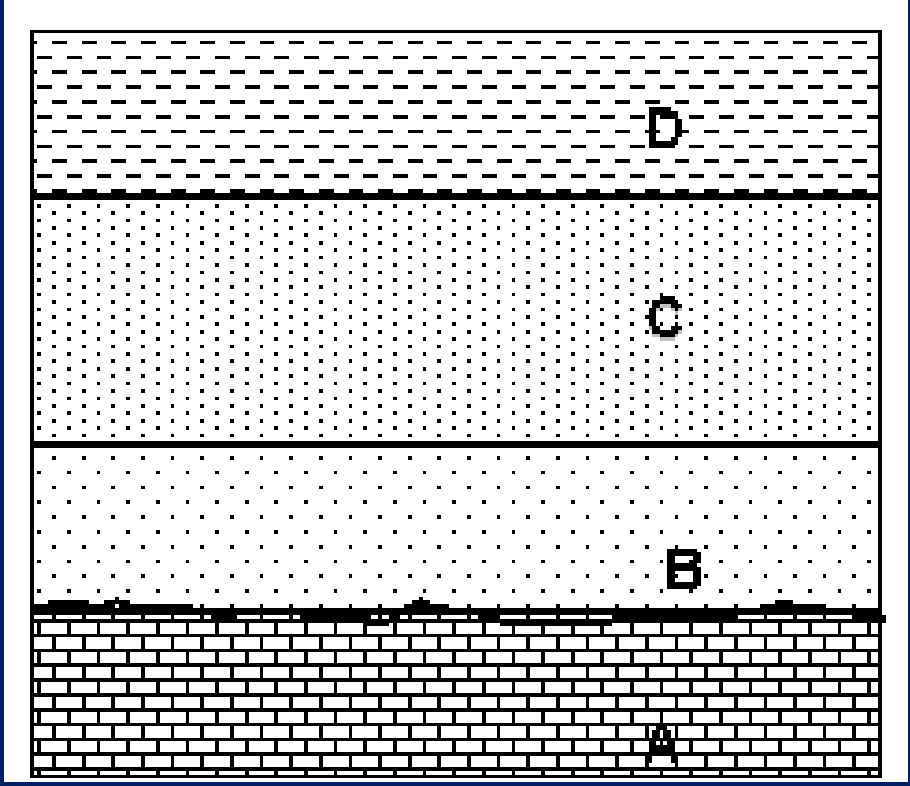


A.



B.

Using this principle, label the strata below from oldest to youngest.



youngest

oldest

ROCK CORRELATION

Original Horizontality: All layers are deposited horizontally at first.

Uniformitarianism: Events that happened in the past happen the same way now.

Cross Cutting: Faults, cracks, lava, that cuts through a rock layer is younger then the rock layer.

Sequence of events:

A) _____

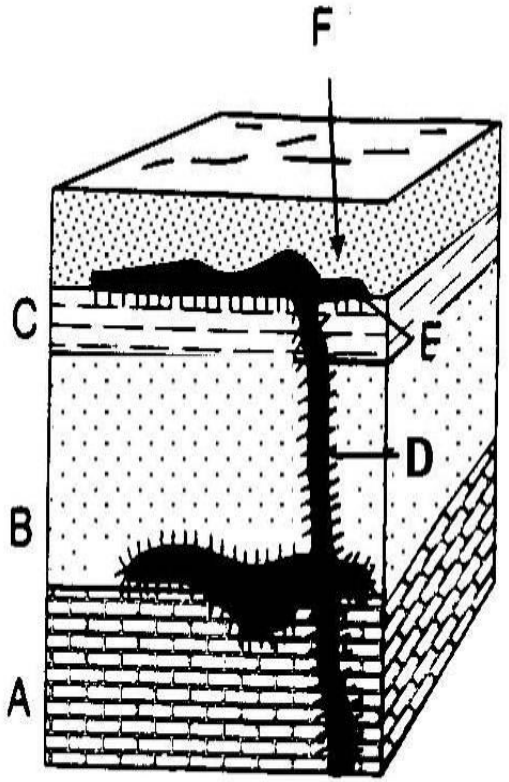
B) _____

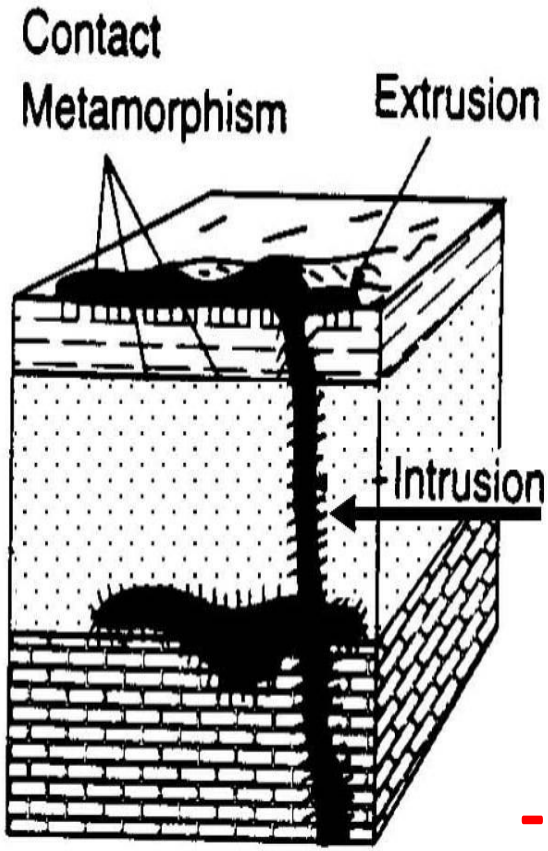
C) _____

D) _____

E) _____

F) _____





Intrusion:

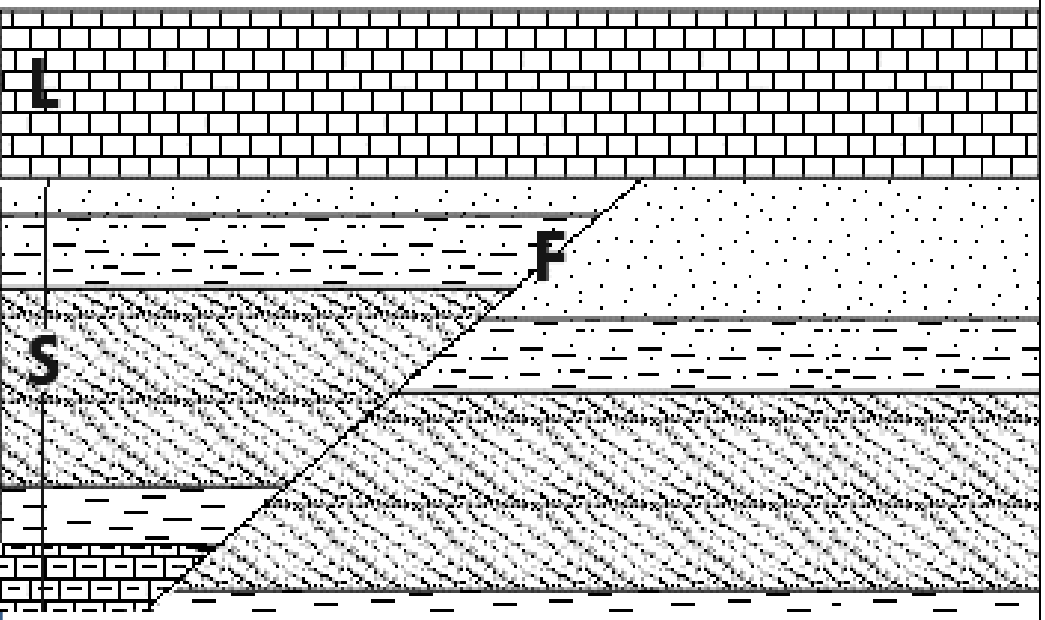
- Younger than the rock layer it goes through (tick marks are younger)

Extrusion:

- Older than rock layers above it.

- Tick Marks= Contact Metamorphism.

Folds, faults, tilting - Are all younger than the rocks they are in.



Which is older:

F or S

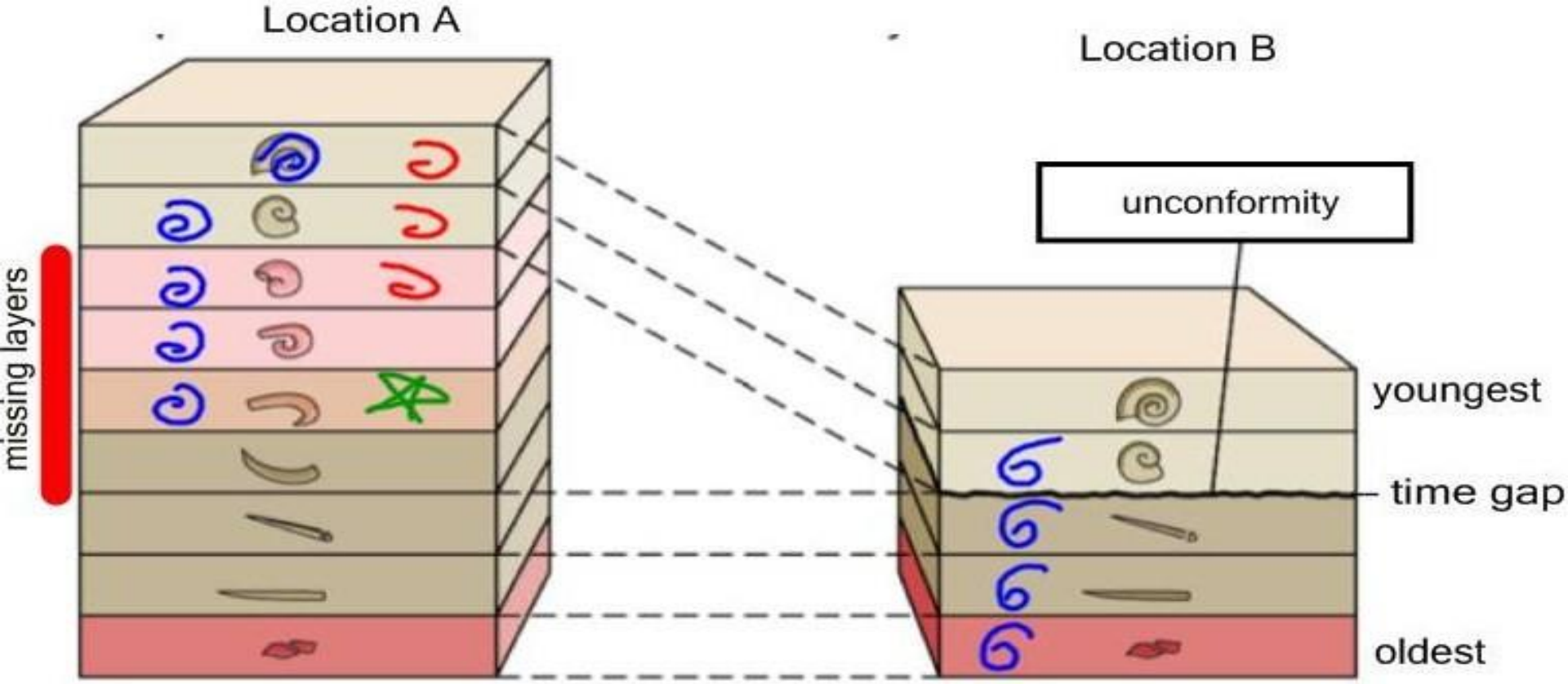
How do you know?

F cuts through S S must have been there first (it's older)

Unconformity:

- Buried erosional surface, representing a gap in geologic time.

- Caused by extensive erosion.



4 steps produce an unconformity

1. Uplift – area of crust uplifted above sea level
2. Erosion – some time after uplift
3. Submergence (subsidence) below sea level
4. Deposition – new sediments deposited on top of the buried eroded surface

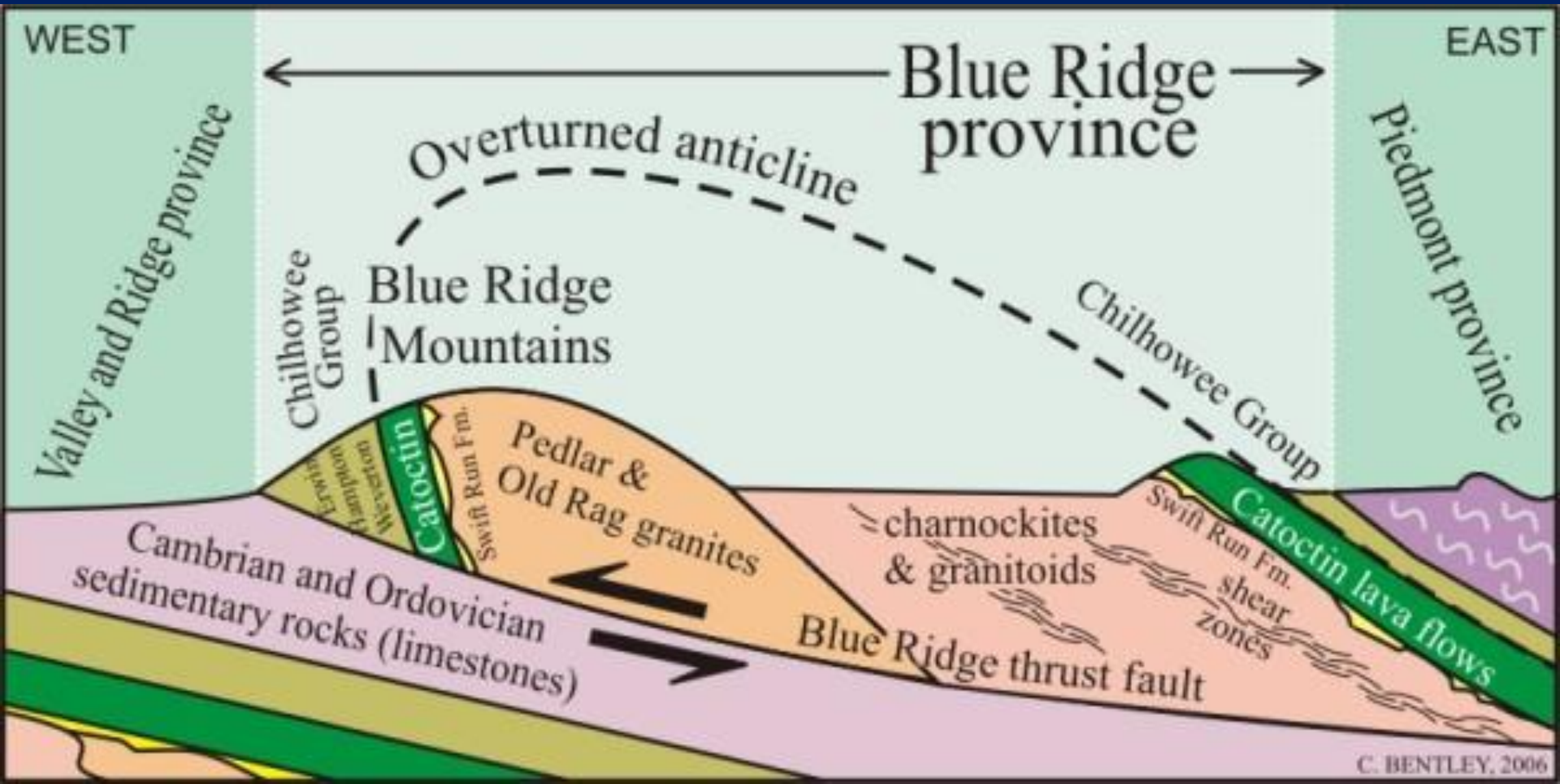
Observe an animation showing the formation of an unconformity.

- http://www.classzone.com/books/earth_science/terc/content/visualizations/es2902/es2902page01.cfm?chapter_no=29

Volcanic Ash- A good Geologic Time Marker.
-Very wide spread


Carlisle Island
Chuginadak Island
NASA

Overturned - It is possible for older rock to be found on top of younger rocks due to extreme crustal movement.

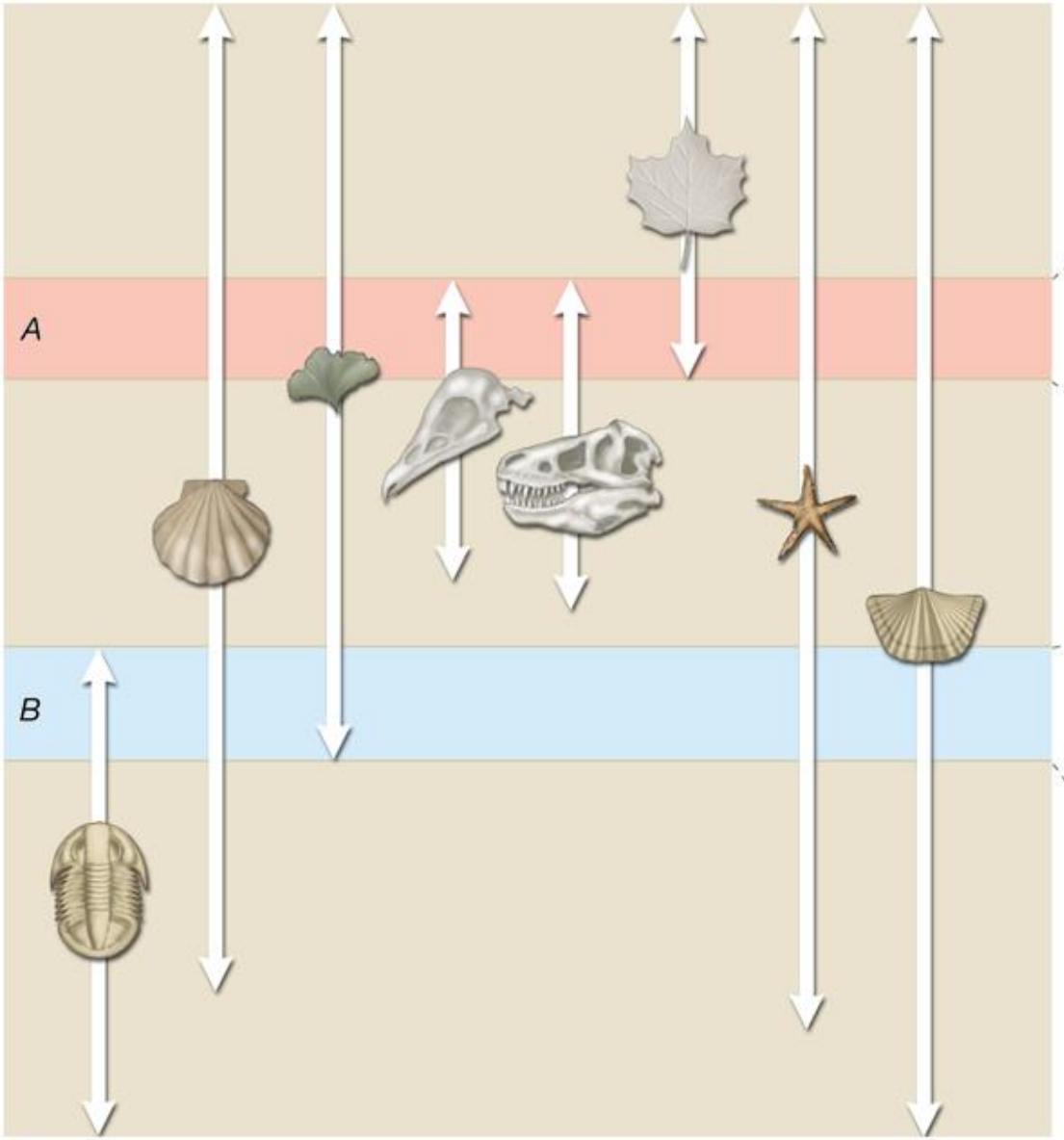


Index fossil — **Geologic Time Marker.**

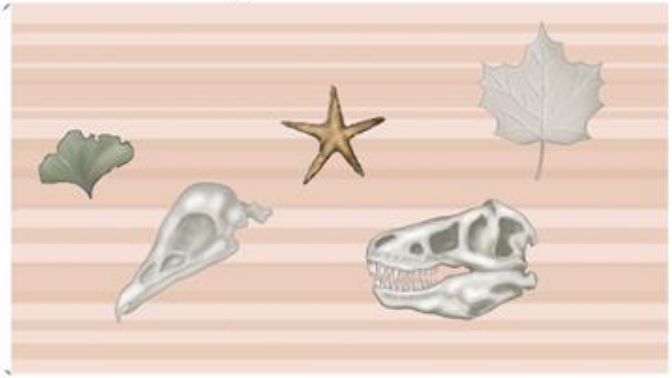
2 things that make a good index fossil

1) **Lived over a large geographic area (large horizontal distribution)**

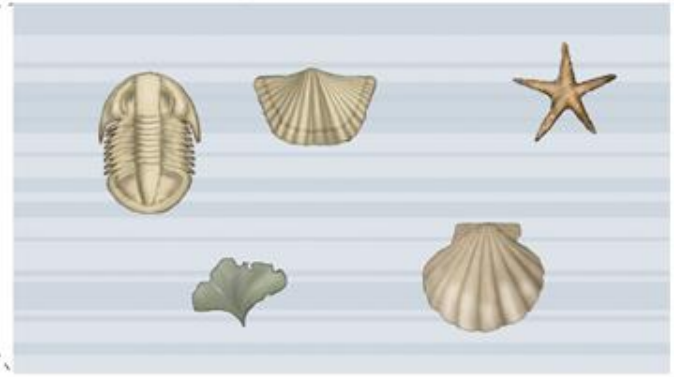
2) **Lived for a short period of time (small vertical distribution)**

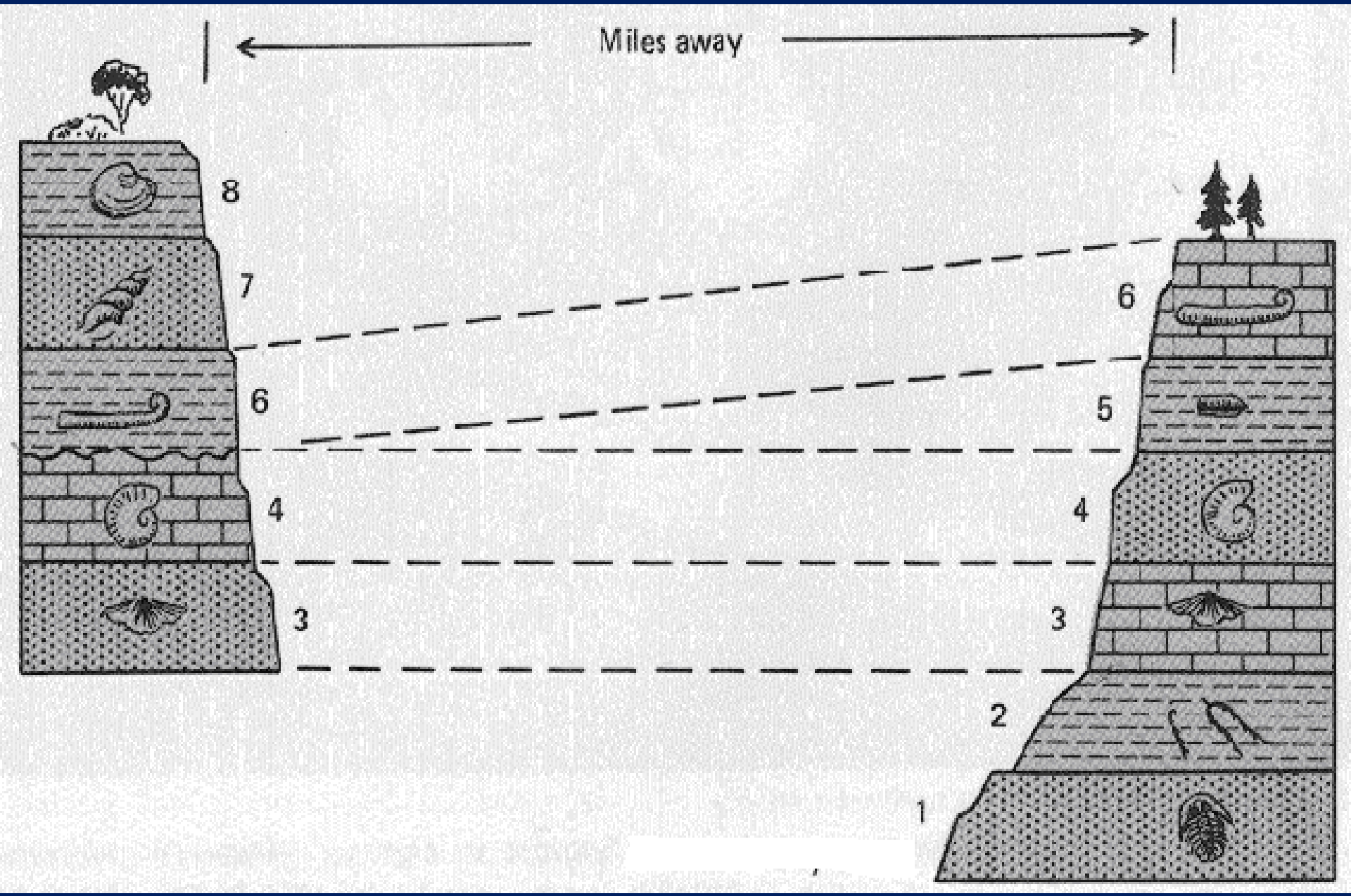


Age of rock unit *A*



Age of rock unit *B*

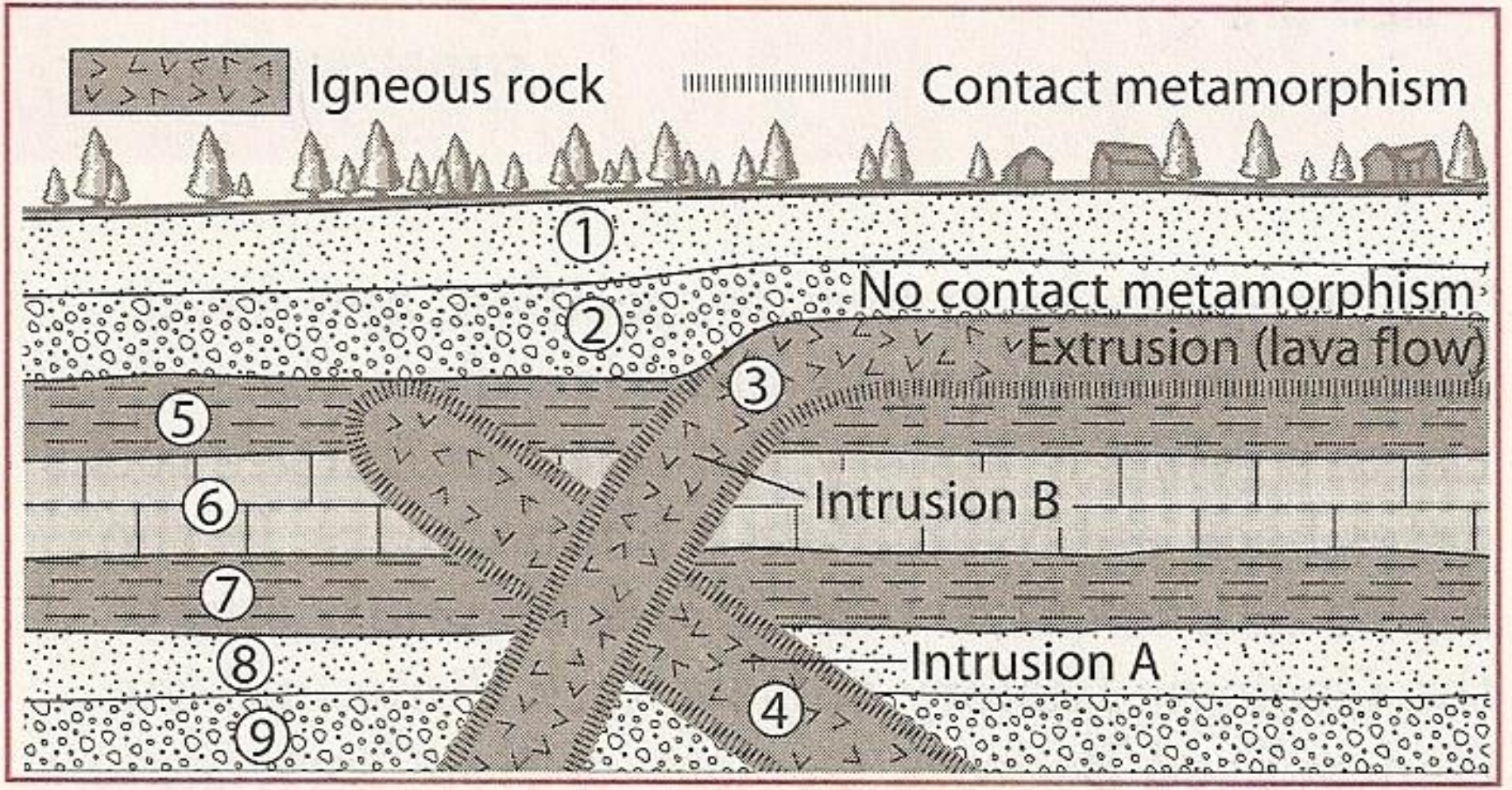


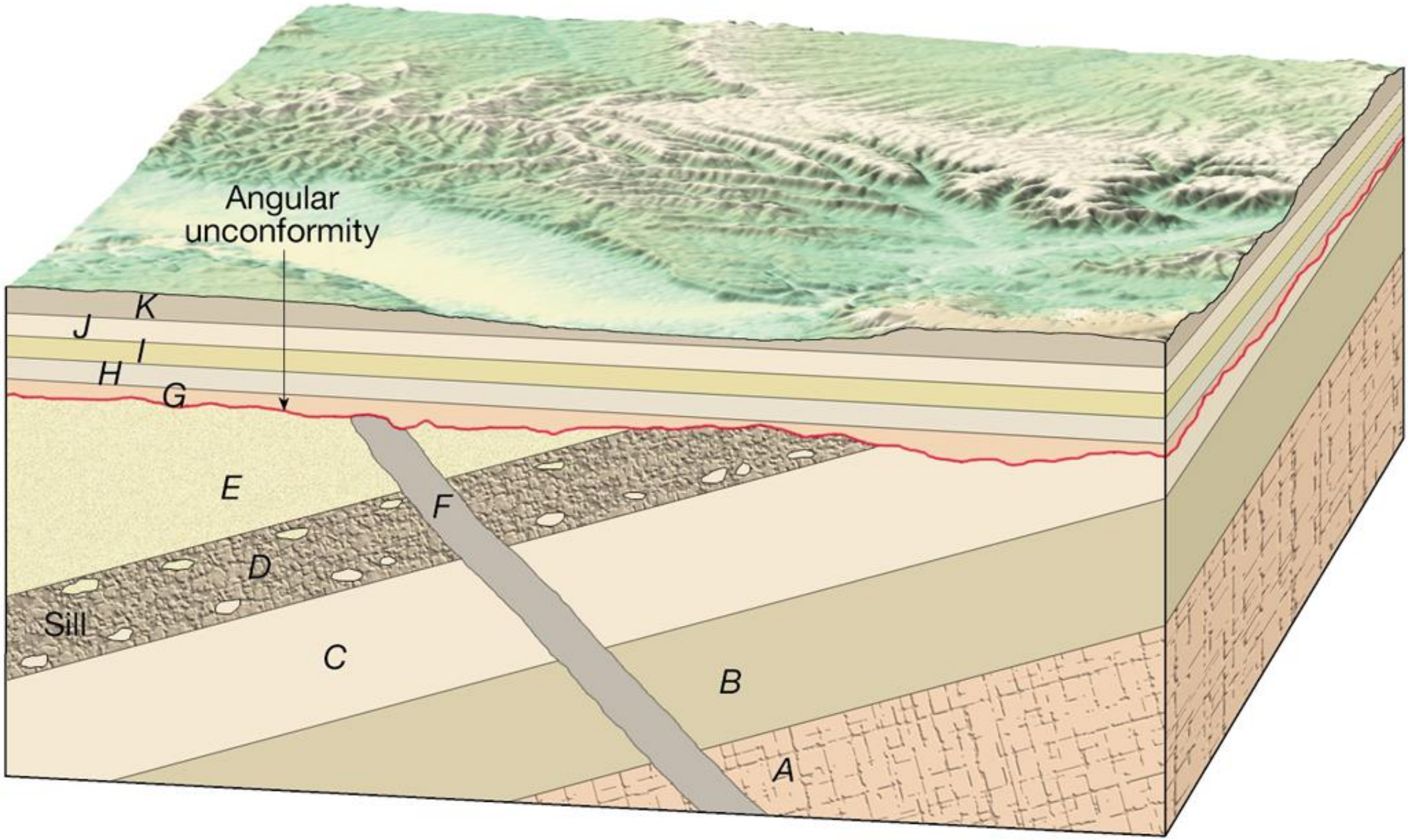

Miles away
8
7
6
6
5
4
4
3
3
2
1

Eurypterus

NY State Fossil

Silurian index fossil


Igneous rock
Contact metamorphism
1
No contact metamorphism
2
Extrusion (lava flow)
3
5
6
Intrusion B
7
8
Intrusion A
4
9



Complete packet pages 5 – 9

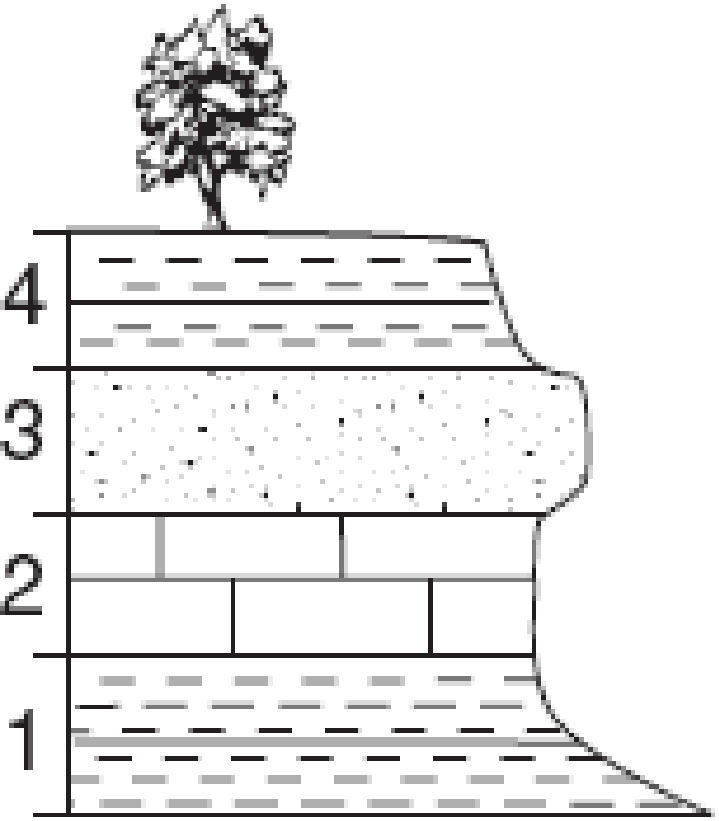
Relative Dating Lab

Correlations

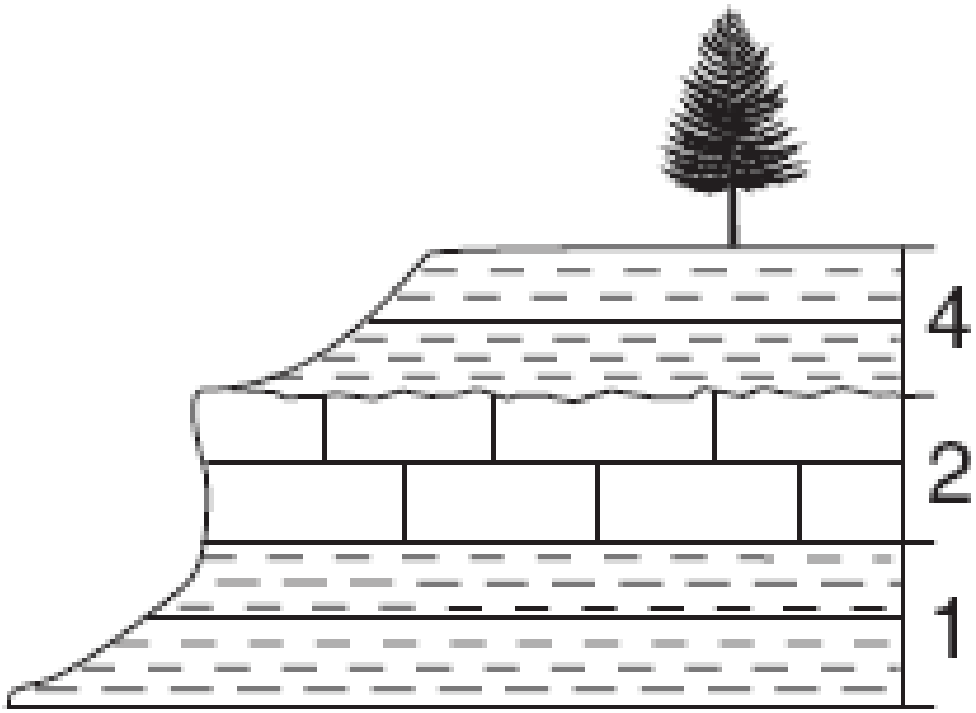
The process of matching rocks or geologic events occurring at different locations of the same age is called **Correlation**

There are three techniques used to make correlations.

1) Correlation by matching similar rock, fossils and volcanic ash.



Outcrop A



Outcrop B

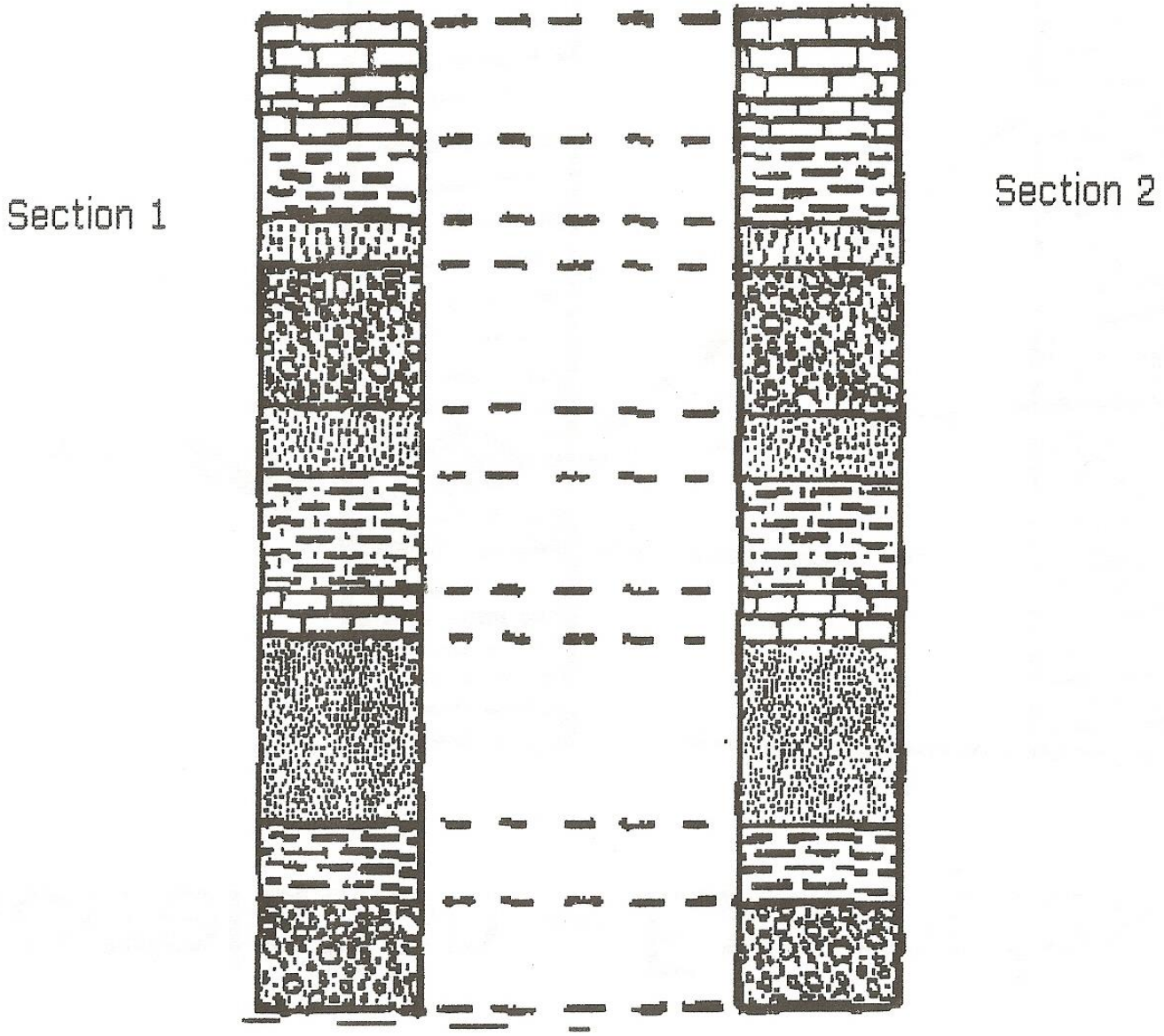
Which statement best explains why rock layer 3 is missing from outcrop *B*?

(1) A fault exists between outcrops *A* and *B*.

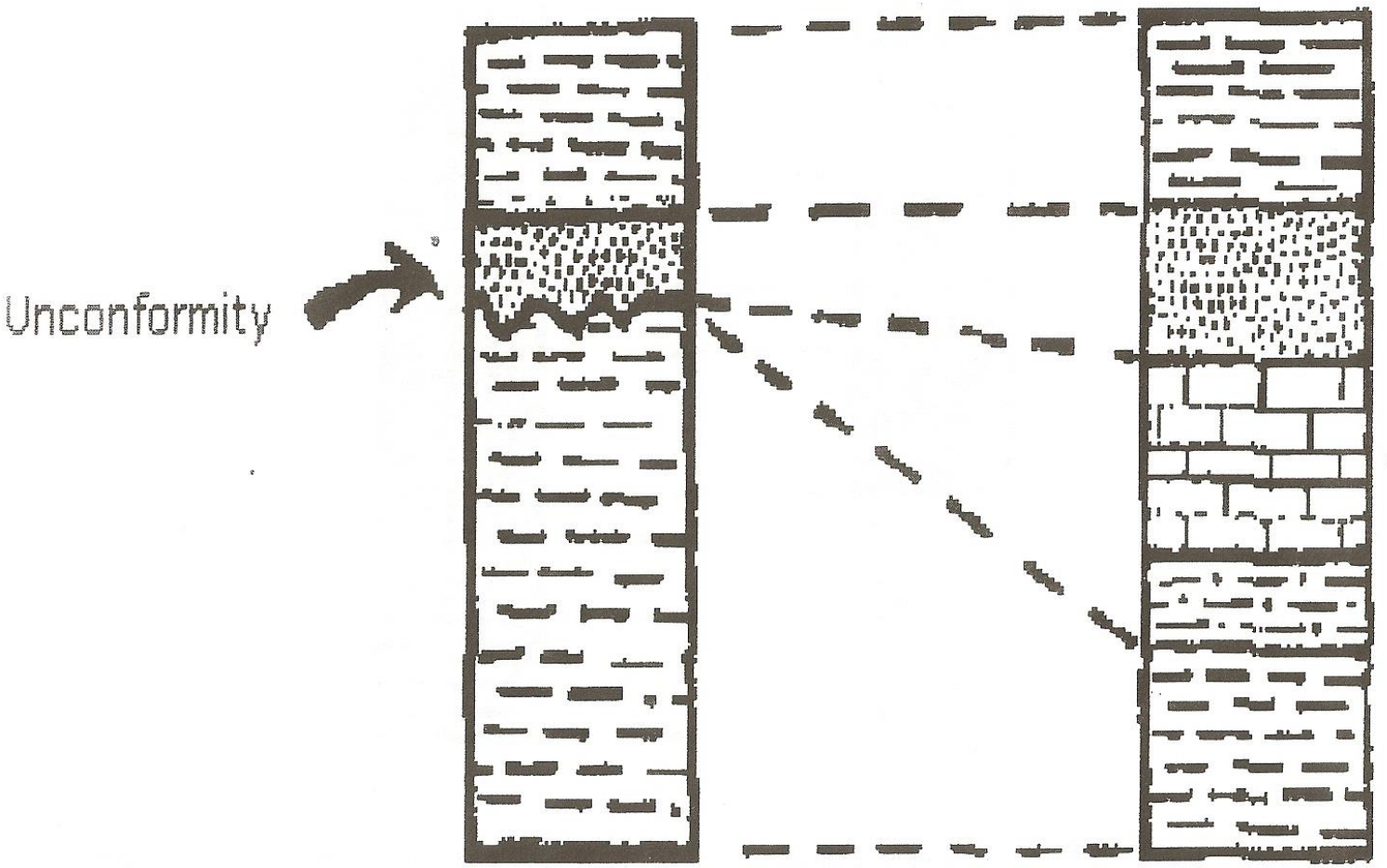
(2) Erosion created an unconformity between rock layers 2 and 4 in outcrop *B*.

(3) A volcanic eruption destroyed rock layer 3 in outcrop *B*.

Correlation – Examples

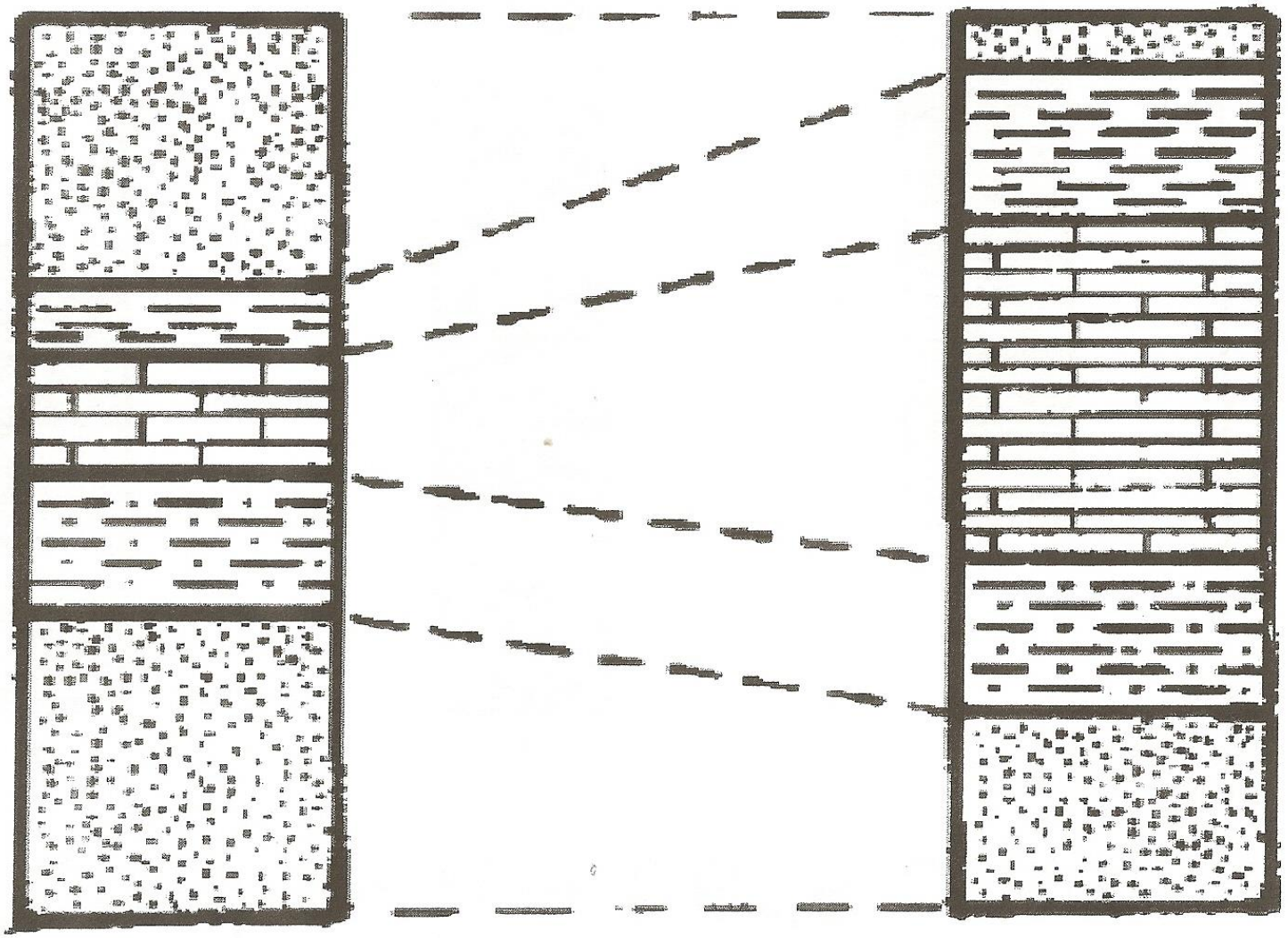


Correlation – Examples



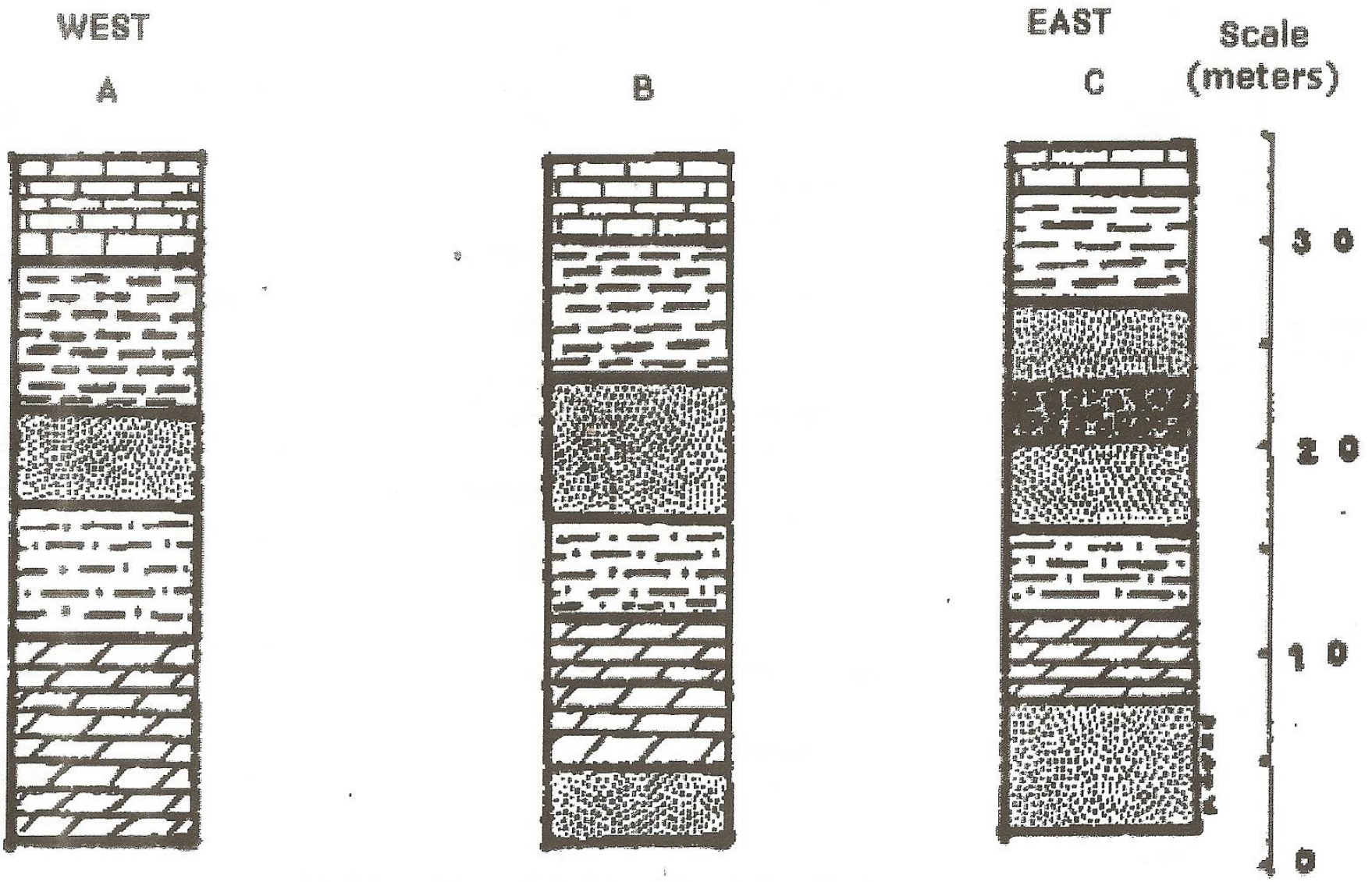
With an unconformity

Correlation – Examples

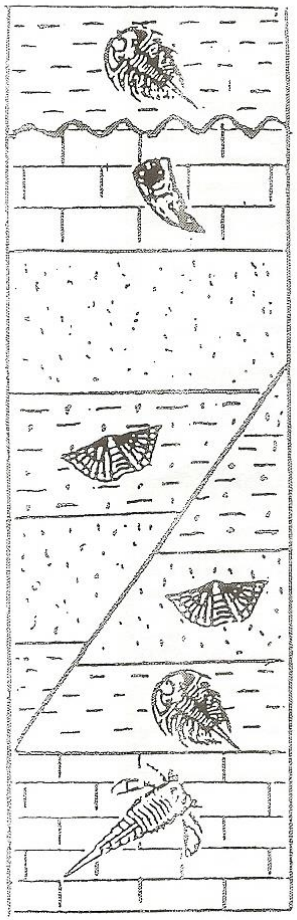


With a change in thickness

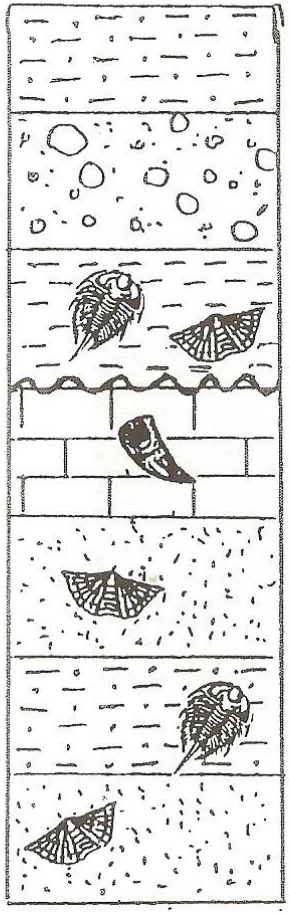
Correlation – Let's practice



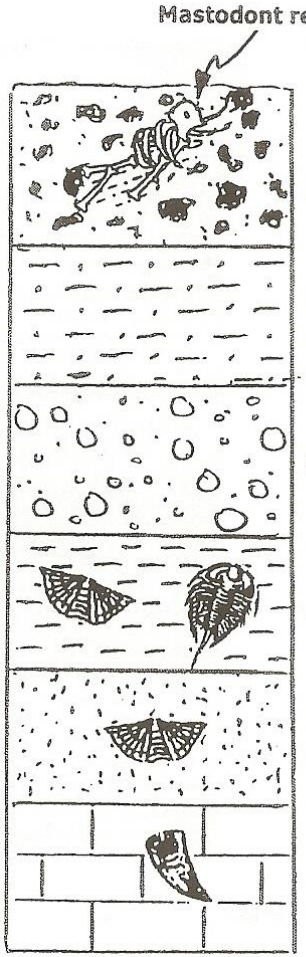
Correlation of Rock Columns



Column A



Column B

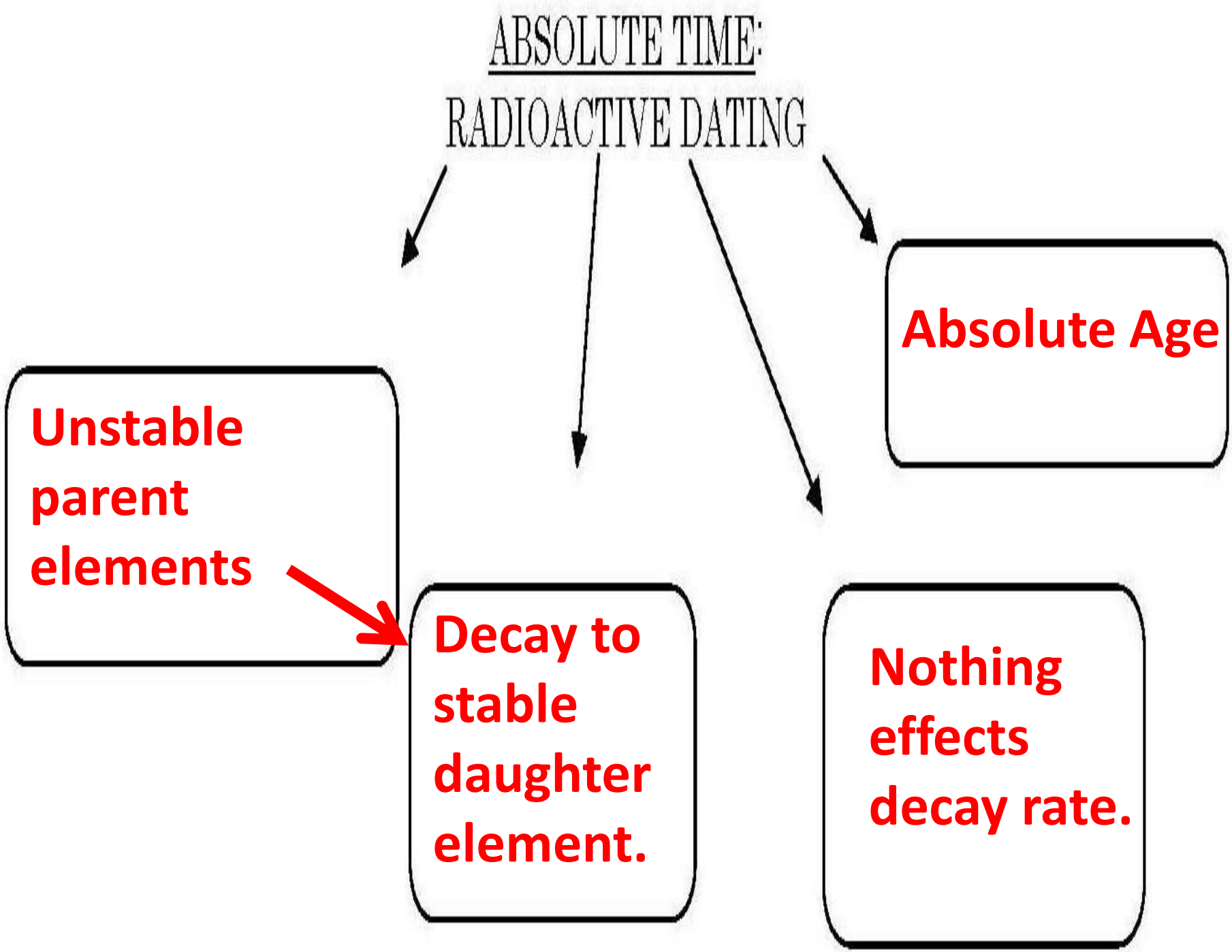


Column C

Rock Formations

Fossil Key: Eurypterid, Brachiopod, Horn Coral, Trilobite

Complete Packet page 10-11

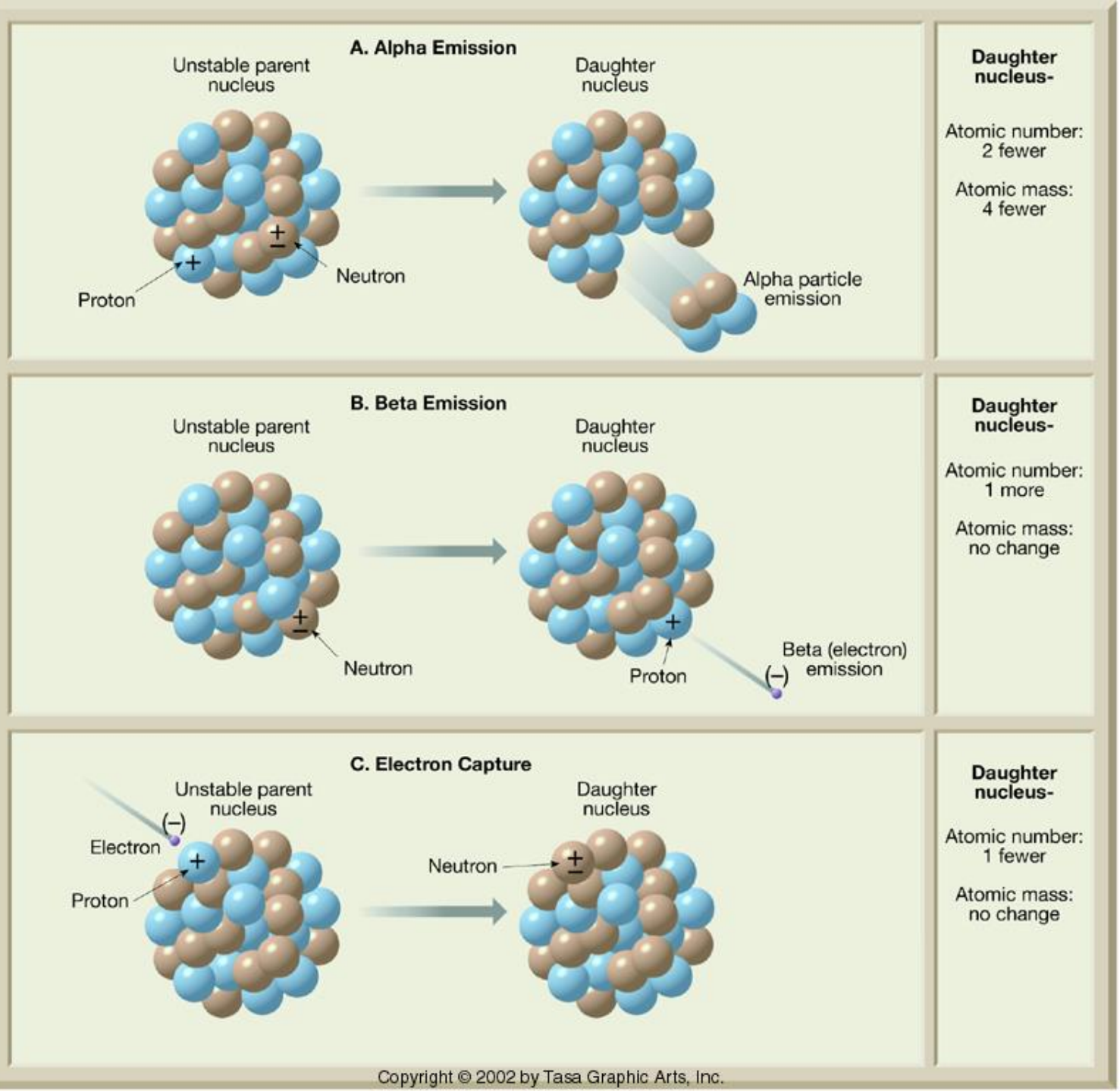

ABSOLUTE TIME:
RADIOACTIVE DATING
Absolute Age
Unstable parent elements
Decay to stable daughter element.
Nothing effects decay rate.

Half life · **Amount of time it takes for an isotope to decay and lose half its mass.**

Decay Product **What the isotope decays into**

ESRT Front cover

Radioactive Isotope	Decay product	Half – life (years)
Carbon · 14	Nitrogen ^{14}	5,700
Potassium · 40		
Uranium – 238		
Rubidium · 87		



Absolute Age

What can be done to change the half-life of a radioactive isotope?

Why is this important?

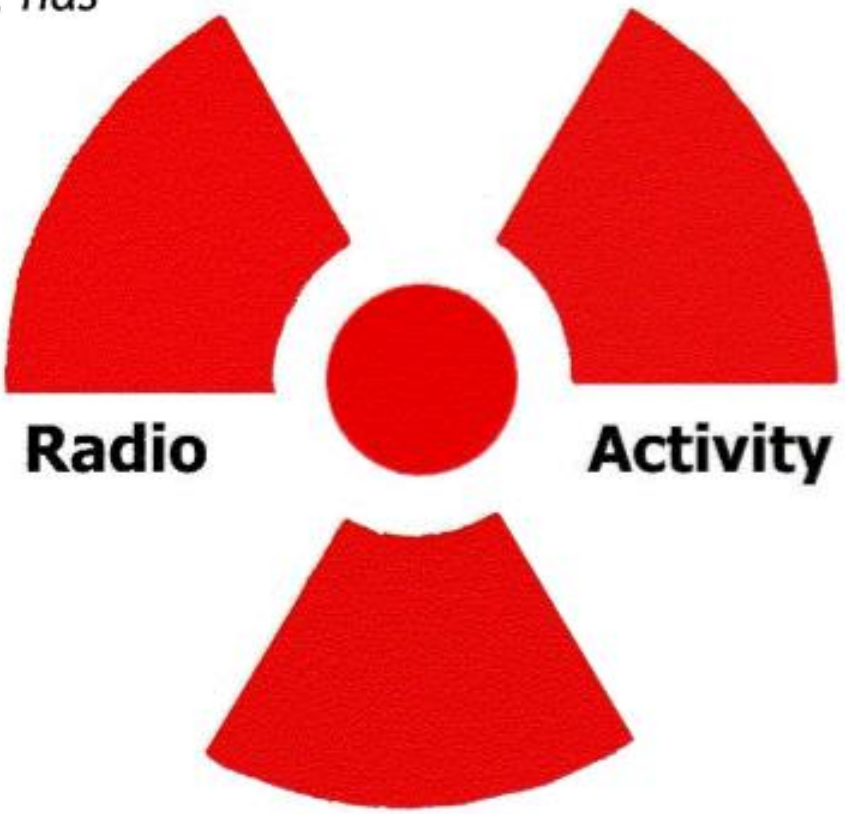
NOTHING!

it is reliable to calculate age

Radioactive Dating:

A radioactive isotope decays at a set rate.
THE SPEED OF ITS DECAY DOES NOT CHANGE

After each half life, 1/2 of the material has decayed into the decay product



Radioactive Decay Data

RADIOACTIVE ISOTOPE	DISINTEGRATION	HALF-LIFE (years)
Carbon-14	$C^{14} \rightarrow N^{14}$	5.7×10^3
Potassium-40	$K^{40} \rightarrow Ar^{40}$ / $K^{40} \rightarrow Ca^{40}$	1.3×10^9
Uranium-238	$U^{238} \rightarrow Pb^{206}$	4.5×10^9
Rubidium-87	$Rb^{87} \rightarrow Sr^{87}$	4.9×10^{10}

Radioactive Decay Data

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Rubidium-87	$Rb^{87} \rightarrow Sr^{87}$	4.9×10^{10}

5,700 years

1,300,000,000 years

4,500,000,000 years

490,000,000,000 years

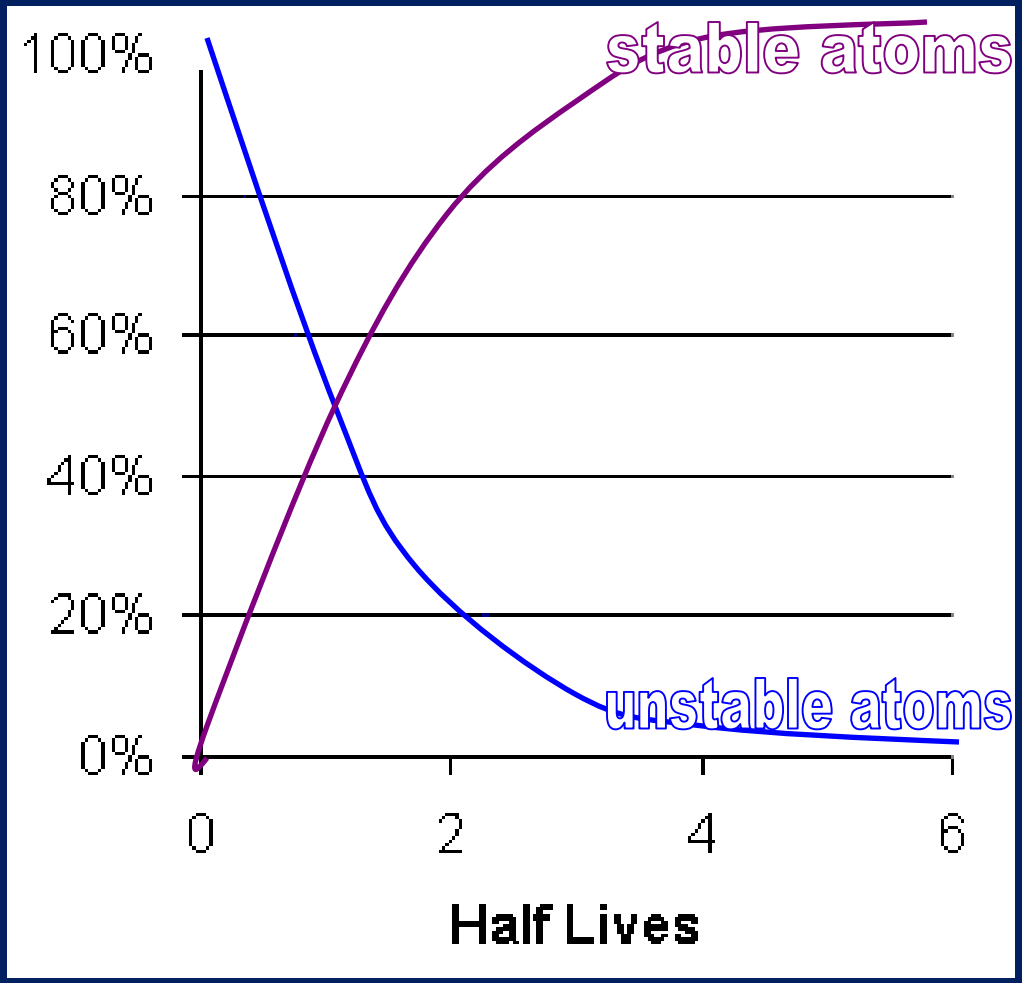
Radioactive dating gives geologists YEARS of age.

Use Carbon-14 for recent events only!!

#half lives	Isotope	=	Decay
0	= 100%	=	0%
1	= 50%	=	50%
2	= 25%	=	75%
3	= 12.5%	=	87.5%
4	= 6.25%	=	93.75%

As the half-lifes increase the amount of isotope **decreases** and the amount of Decay Produce **increases**...

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



Lets answer some questions…

What is the half life of uranium-238?

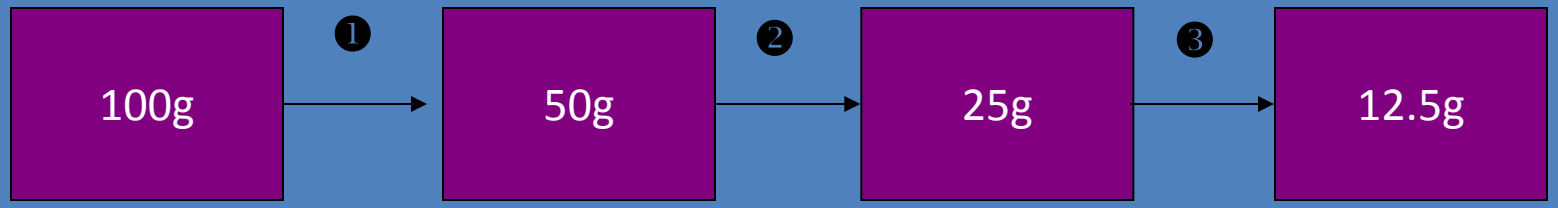
4.5×10^9

4,500,000,000

4.5 billion years

choice (c)

If there is a 100g sample of C^{14}, how many grams of C^{14} would remain after three half-lives? How long would this take? Show all work.



3 half-lives x $(5.7 \times 10^3) = 1.71 \times 10^4$

= 17,100 years

Complete packet pages 12 – 14

Absolute Dating Lab

Calculating Half-Life Problems

Name_____ Block_____

How to Calculate Half-Life Problems:

THE PROBLEM:

An isotope of cesium (cesium-137) has a half-life of 30 years. If 1.0 g of cesium-137 disintegrates over a period of 90 years, how many grams of cesium-137 would remain?

THE SOLUTION:

1. Draw a T-Table:

2. Label the left side with the unit of time mentioned in the problem.

TIME (yrs)	

3. Label the right side with the mass mentioned in the problem.

TIME (yrs)	MASS (g)

4. Begin by always writing a zero in the **TIME COLUMN**.

TIME (yrs)	MASS (g)
0	

5. Then, in the **TIME COLUMN** add one half-life at a time till you reach the total time given in the problem.

TIME (yrs)	MASS (g)
0	
30	
60	
90	

6. In the **MASS COLUMN**, always start with the mass originally given in the problem.

TIME (yrs)	MASS (g)
0	1.0
30	
60	
90	

7. Then keep dividing the number in the **MASS COLUMN** by 2 for each number of half-lives on the left column.

TIME (yrs)	MASS (g)
0	1.0
30	.50
60	.25
90	.125

8. <u>The rules are:</u>
   a. Add half-lives on the left.
   b. Divide by 2 on the right.

Add Half-Life	Divide by 2

9. How many times you added a half-life in the **TIME COLUMN** equals how many half-lives have occurred.

10. The last amount of mass at the bottom of the **MASS COLUMN** equals how much mass is left after radioactive decay has occurred.

Geologic Time Scale

Life on Earth:- The changing of an organism from simple to complex.

- Mutations may produce altered traits

- Natural selection – where an organism has a specific trait that aides in their survival

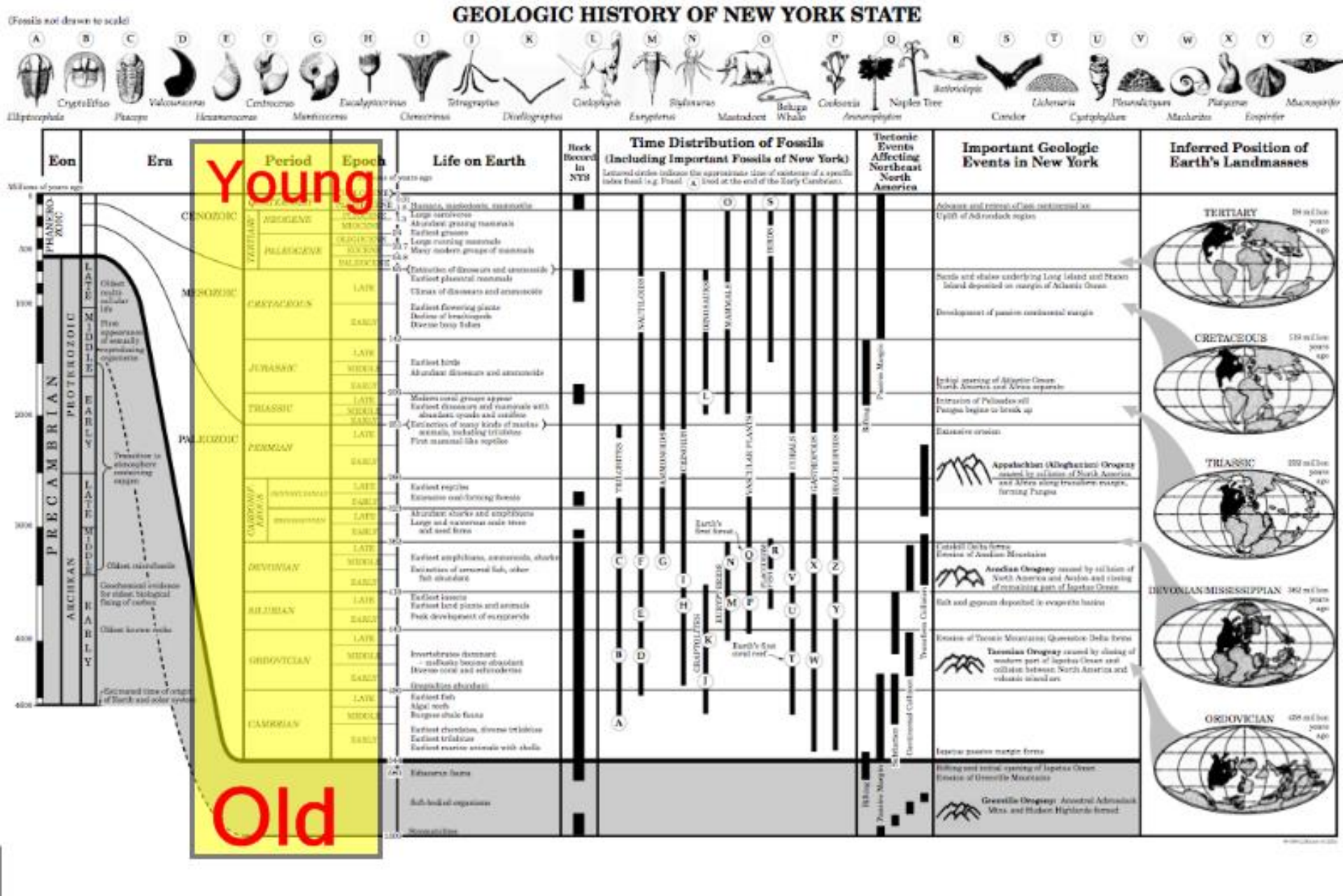
- Changes occur very slowly over a long period of time

Geologic Time Scale *ESRT pages 8 & 9*

- Describes the events that have taken place in the history of Earth.

Geologic Time Scale

Earth is about 4 billion years old.
The time periods are determined by events on earth.



Divisions of Time

Eons

Eras

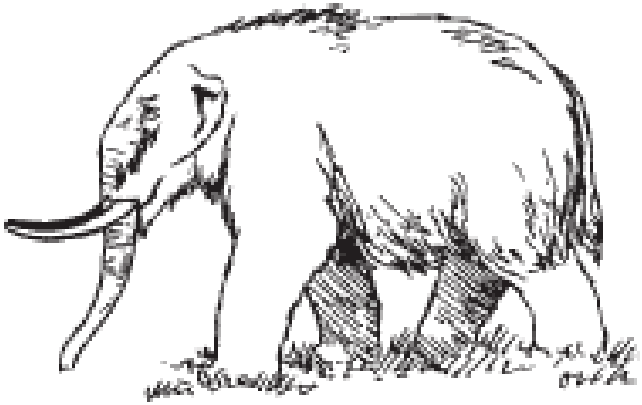
Periods

Epochs

Longest Time Period

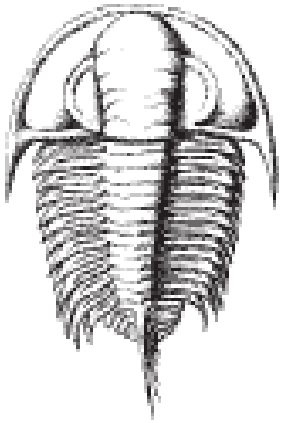
Shortest Time Period

Which fossil might be found in Devonian rock layers?



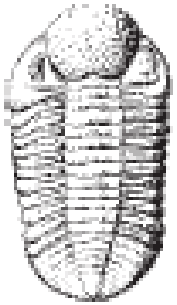
Mastodont

(1)



Elliptocephala

(2)



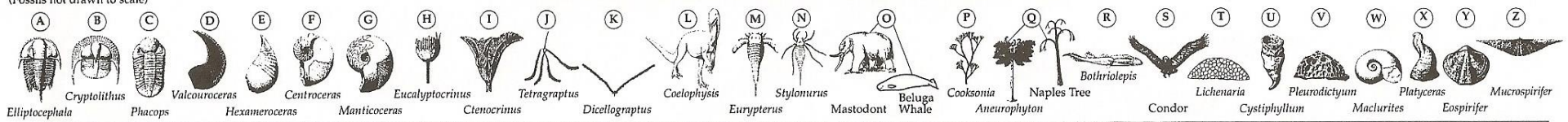
Phacops

(3)

Cystiphyllum

(4)

GEOLOGIC HISTORY OF NEW YORK STATE



Eon	Era	Period	Epoch	Millions of years ago	Life on Earth
PHANEROZOIC	CENOZOIC	QUATERNARY	HOLOCENE	0	
			PLEISTOCENE	0.01	Humans, mastodonts, mammoths
		TERTIARY NEOGENE	PLIOCENE	1.6	Large carnivores
			MIOCENE	5.3	Abundant grazing mammals
			OLIGOCENE	24	Earliest grasses
		TERTIARY PALEOGENE	EOCENE	33.7	Large running mammals
			PALEOCENE	54.8	Many modern groups of mammals
	MESOZOIC	CRETACEOUS	LATE	65	Extinction of dinosaurs and ammonoids Earliest placental mammals Climax of dinosaurs and ammonoids
			EARLY		Earliest flowering plants Decline of brachiopods Diverse bony fishes
		JURASSIC	LATE	142	
			MIDDLE		Earliest birds Abundant dinosaurs and ammonoids
			EARLY	206	
		TRIASSIC	LATE		Modern coral groups appear Earliest dinosaurs and mammals with abundant cycads and conifers
			MIDDLE		
			EARLY	251	Extinction of many kinds of marine animals, including trilobites
	PALEOZOIC	PERMIAN	LATE		First mammal-like reptiles
			EARLY	290	
		CARBONIFEROUS PENNSYLVANIAN	LATE		Earliest reptiles
			EARLY	323	Extensive coal-forming forests
		CARBONIFEROUS MISSISSIPPIAN	LATE		Abundant sharks and amphibians
			EARLY	362	Large and numerous scale trees and seed ferns
		DEVONIAN	LATE		
			MIDDLE		Earliest amphibians, ammonoids, sharks Extinction of armored fish, other fish abundant
			EARLY	418	
		SILURIAN	LATE		Earliest insects Earliest land plants and animals
			EARLY	443	Peak development of eurypterids
		ORDOVICIAN	LATE		
			MIDDLE		Invertebrates dominant – mollusks become abundant Diverse coral and echinoderms
			EARLY	490	Graptolites abundant
		CAMBRIAN	LATE		Earliest fish Algal reefs
			MIDDLE		Burgess shale fauna
			EARLY		Earliest chordates, diverse trilobites Earliest trilobites Earliest marine animals with shells
				544	
PROTEROZOIC	LATE			580	Ediacaran fauna
	MIDDLE				Soft-bodied organisms
	EARLY			1300	Stromatolites
ARCHEAN	LATE				Oldest multicellular life First appearance of sexually reproducing organisms
	MIDDLE				Transition to atmosphere containing oxygen
	EARLY				Oldest microfossils Geochemical evidence for oldest biological fixing of carbon Oldest known rocks
PRECAMBRIAN				4600	Estimated time of origin of Earth and solar system

Millions of years ago: 0, 500, 1000, 2000, 3000, 4000, 4600

Rock Record in NYS

Time Distribution of Fossils (Including Important Fossils of New York)

Lettered circles indicate the approximate time of existence of a specific index fossil (e.g. Fossil A lived at the end of the Early Cambrian).

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Inferred Position of Earth's Landmasses

TERTIARY 59 million years ago

CRETACEOUS 119 million years ago

TRIASSIC 232 million years ago

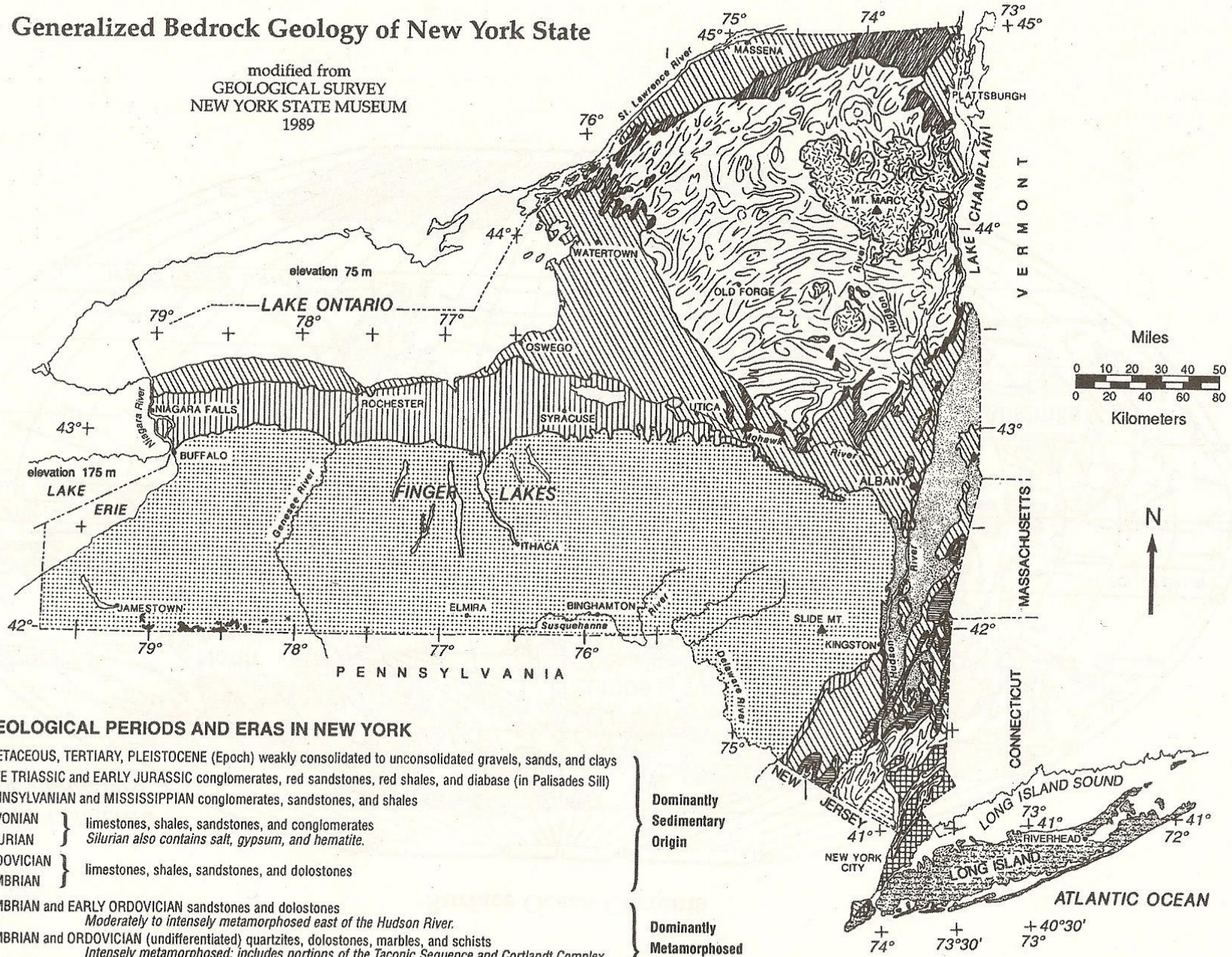
DEVONIAN/MISSISSIPPIAN 362 million years ago

ORDOVICIAN 458 million years ago

99-098 CDKlevel A/2001

Generalized Bedrock Geology of New York State

modified from
GEOLOGICAL SURVEY
NEW YORK STATE MUSEUM
1989



GEOLOGICAL PERIODS AND ERAS IN NEW YORK

Dominantly Sedimentary Origin

- CRETACEOUS, TERTIARY, PLEISTOCENE (Epoch) weakly consolidated to unconsolidated gravels, sands, and clays
- LATE TRIASSIC and EARLY JURASSIC conglomerates, red sandstones, red shales, and diabase (in Palisades Sill)
- PENNSYLVANIAN and MISSISSIPPIAN conglomerates, sandstones, and shales
- DEVONIAN, SILURIAN — limestones, shales, sandstones, and conglomerates. *Silurian also contains salt, gypsum, and hematite.*
- ORDOVICIAN, CAMBRIAN — limestones, shales, sandstones, and dolostones

Dominantly Metamorphosed Rocks

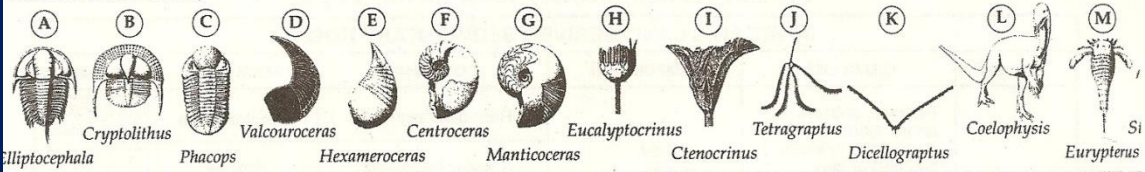
- CAMBRIAN and EARLY ORDOVICIAN sandstones and dolostones. *Moderately to intensely metamorphosed east of the Hudson River.*
- CAMBRIAN and ORDOVICIAN (undifferentiated) quartzites, dolostones, marbles, and schists. *Intensely metamorphosed; includes portions of the Taconic Sequence and Cortlandt Complex.*
- TACONIC SEQUENCE sandstones, shales, and slates. *Slightly to intensely metamorphosed rocks of* CAMBRIAN *through* MIDDLE ORDOVICIAN *ages.*

Intensely Metamorphosed Rocks (regional metamorphism about 1,000 m.y.a.)

- MIDDLE PROTEROZOIC gneisses, quartzites, and marbles. *Lines are generalized structure trends.*
- MIDDLE PROTEROZOIC anorthositic rocks

GEOLOGIC HISTORY

(Fossils not drawn to scale)



Millions of years ago	Eon	Era	Period	Epoch	Life on Earth	Rock Record in NYS	Time D (Including I
				Millions of years ago			Lettered circles indic index fossil (e.g. Foss
				HOLOCENE 0			
0	PHANEROZOIC	CENOZOIC	QUATERNARY	PLEISTOCENE 0.01–1.6	Humans, mastodonts, mammoths		
			TERTIARY – NEOGENE	PLIOCENE 5.3	Large carnivores		
				MIOCENE 24	Abundant grazing mammals Earliest grasses		
			TERTIARY – PALEOGENE	OLIGOCENE 33.7	Large running mammals		
				EOCENE 54.8	Many modern groups of mammals		
				PALEOCENE 65	Extinction of dinosaurs and ammonoids		
500		MESOZOIC	CRETACEOUS	LATE	Earliest placental mammals Climax of dinosaurs and ammonoids		NAUTILOIDS
1000				EARLY	Earliest flowering plants Decline of brachiopods Diverse bony fishes		
				142			
			JURASSIC	LATE	Earliest birds		
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				EARLY 206			
			TRIASSIC	LATE	Modern coral groups appear		
				MIDDLE	Earliest dinosaurs and mammals with abundant cycads and conifers		
2000				EARLY 251	Extinction of many kinds of marine animals, including trilobites		
		PALEOZOIC	PERMIAN	LATE	First mammal-like reptiles		TRILOBITES
				EARLY 290			
			CARBONIFEROUS – PENNSYLVANIAN	LATE	Earliest reptiles		
				EARLY 323	Extensive coal-forming forests		
			CARBONIFEROUS – MISSISSIPPIAN	LATE	Abundant sharks and amphibians		
3000				EARLY 362	Large and numerous scale trees and seed ferns		
			DEVONIAN	LATE			
				MIDDLE	Earliest amphibians, ammonoids, sharks		C F G
				EARLY 418	Extinction of armored fish, other fish abundant		
			SILURIAN	LATE	Earliest insects Earliest land plants and animals		E
				EARLY 443	Peak development of eurypterids		
4000			ORDOVICIAN	LATE			
				MIDDLE	Invertebrates dominant – mollusks become abundant Diverse coral and echinoderms		B D
				EARLY 490	Graptolites abundant		
			CAMBRIAN	LATE	Earliest fish Algal reefs		
				MIDDLE	Burgess shale fauna		A
				EARLY	Earliest chordates, diverse trilobites Earliest trilobites Earliest marine animals with shells		
				544			
				580	Ediacaran fauna		
					Soft-bodied organisms		
				1300	Stromatolites		
4600	PRECAMBRIAN – ARCHEAN						

PROTEROZOIC

LATE
- Oldest multicellular life

MIDDLE
- First appearance of sexually reproducing organisms

EARLY
- Transition to atmosphere containing oxygen

ARCHEAN

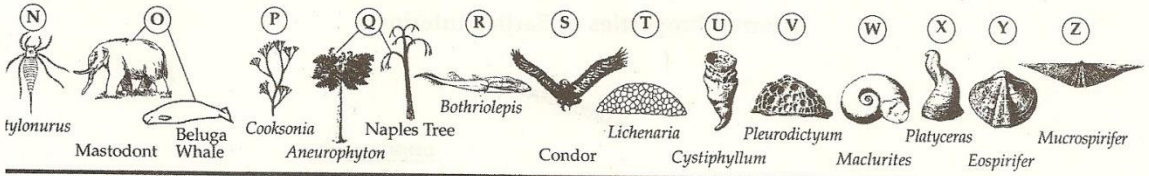
LATE

MIDDLE
- Oldest microfossils
- Geochemical evidence for oldest biological fixing of carbon

EARLY
- Oldest known rocks
- Estimated time of origin of Earth and solar system

AMMONOIDS

' OF NEW YORK STATE



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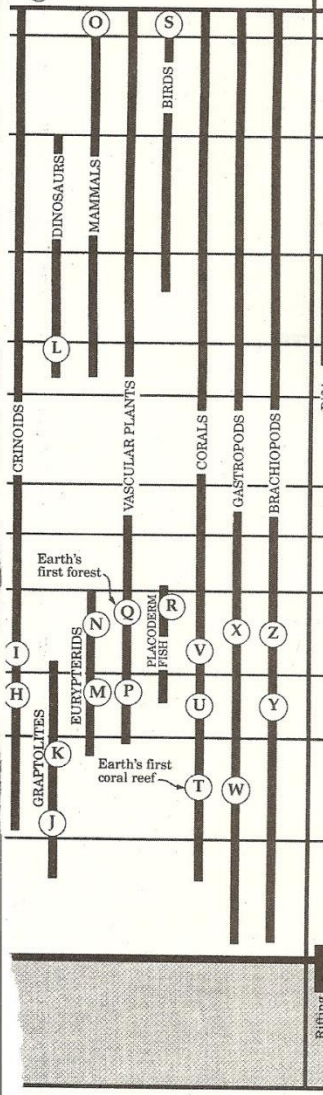
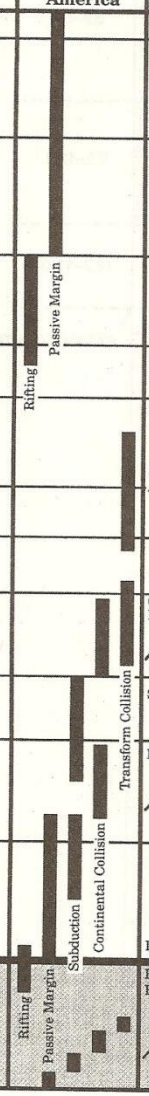


Tectonic Events Affecting Northeast North America



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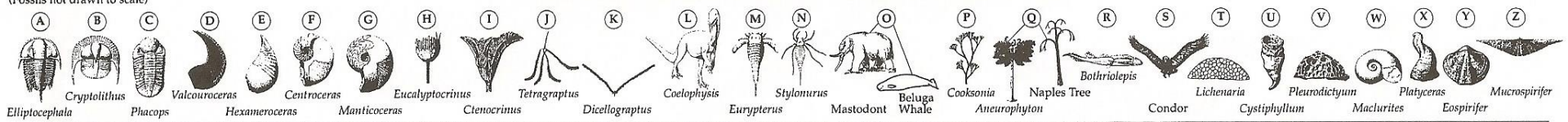

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Complete packet pages 15

Geo-Time Line Lab

Do landscape Regions with the packet (no power point)