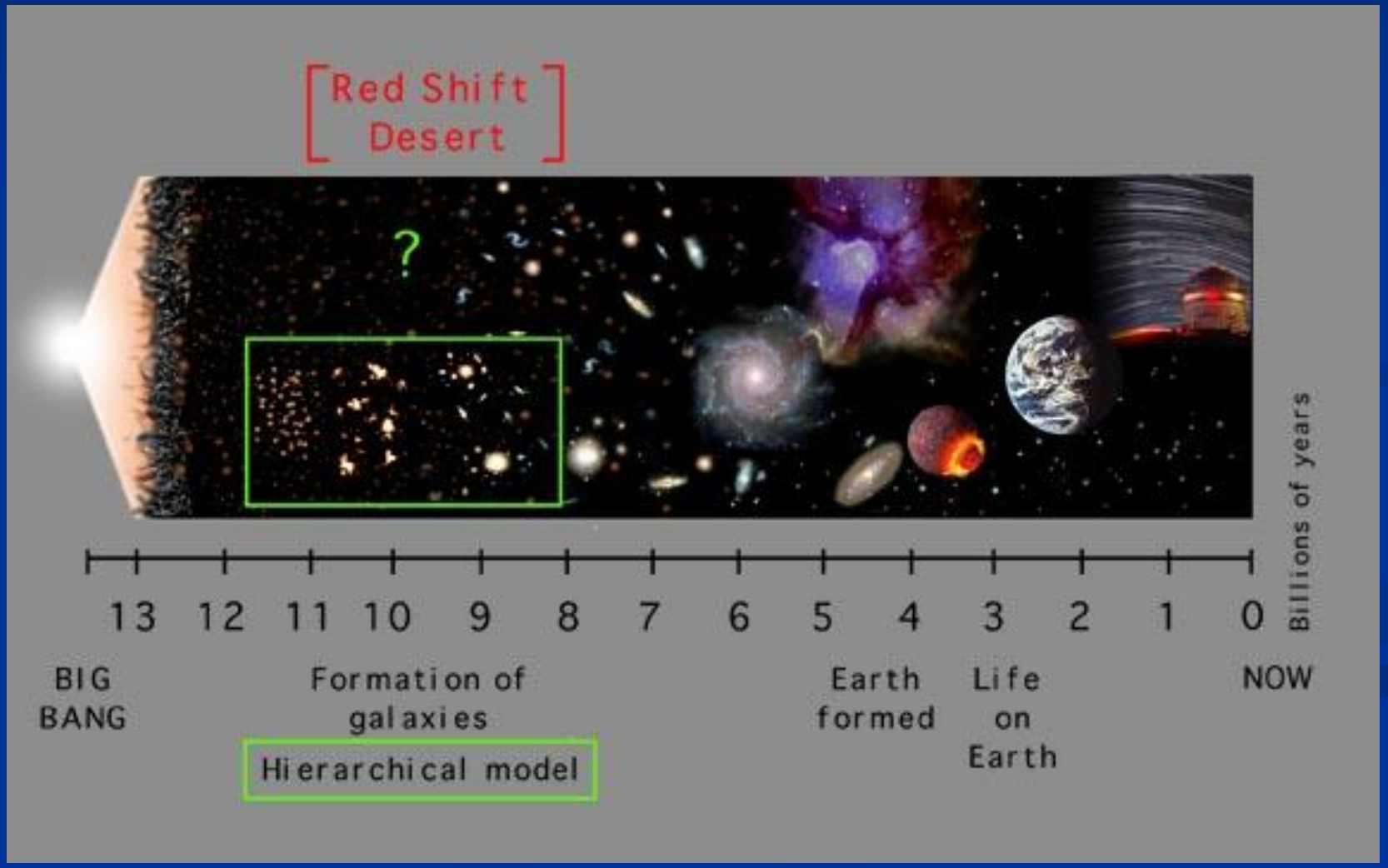
Geological Time
How old is the Earth

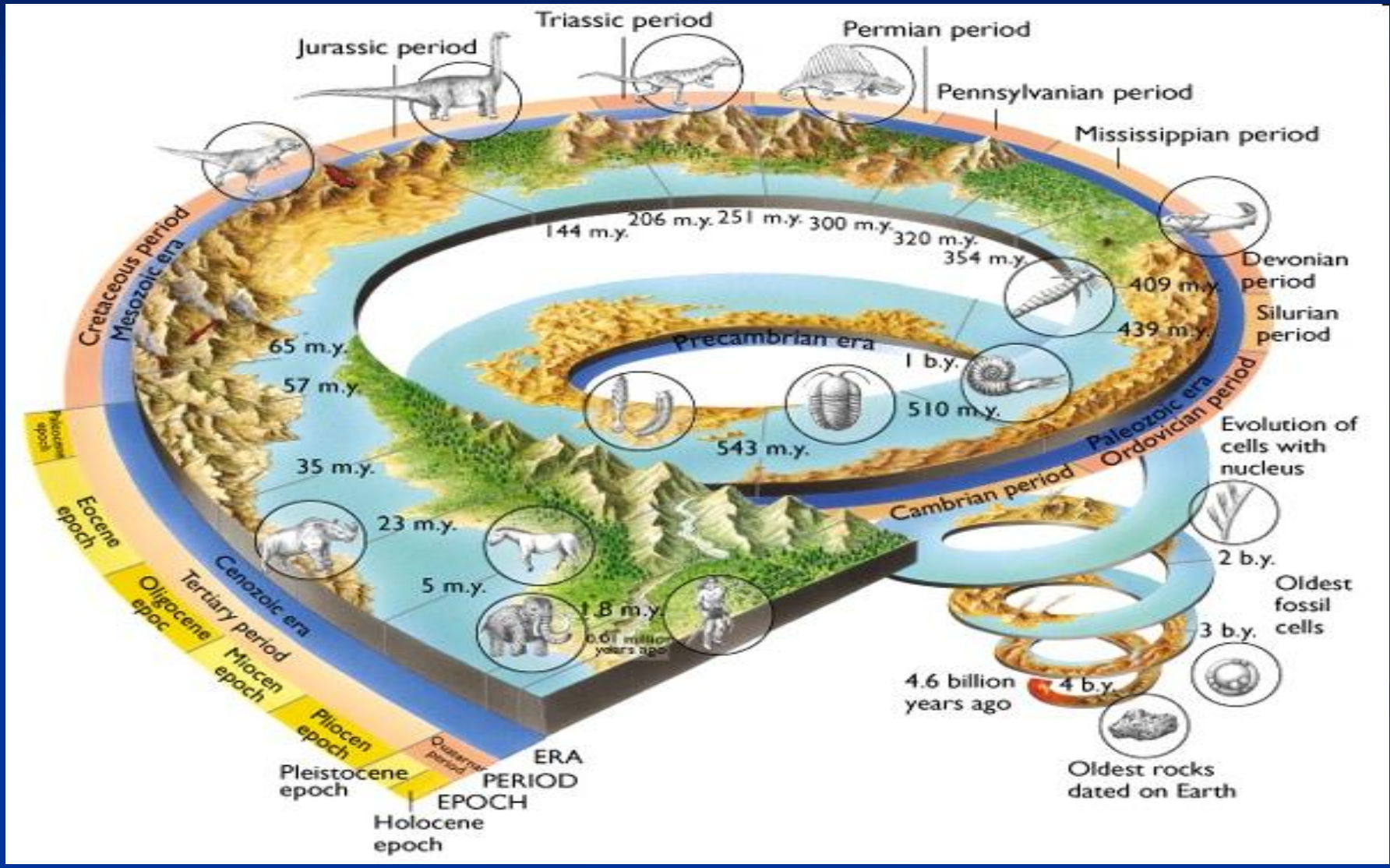


How old is everything?

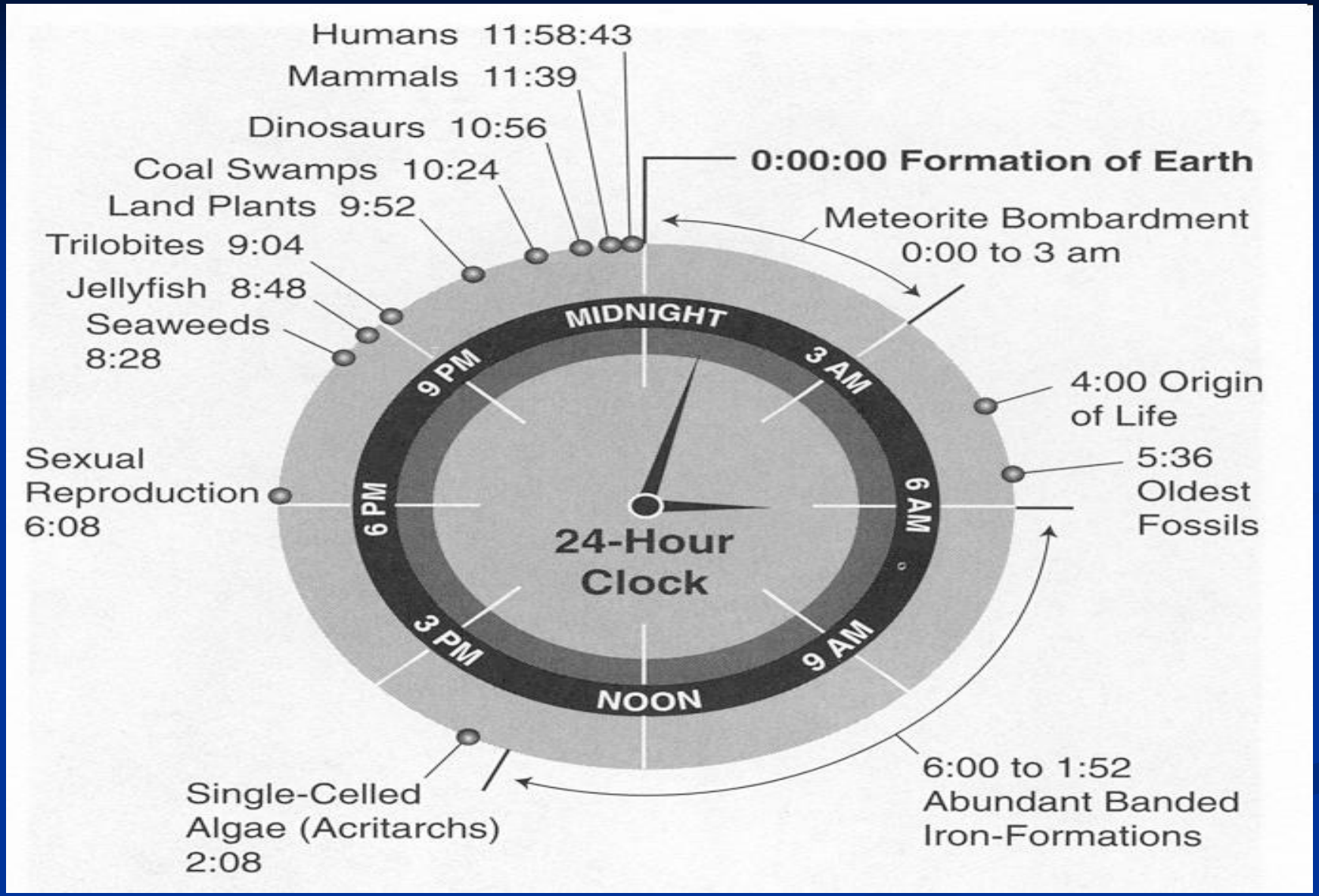
Universe?

- Universe ~ 14 Billion Years Old
- Milky Way Galaxy?
- Milky Way Galaxy - 10 Billion Years Old
- Solar System?
- Solar System -4.6 Billion Years Old
- Earth?
- Earth – 4.6 Billion Years Old (Same as Solar System)
- (Rule of 5's. ~ 5, 10, 15)

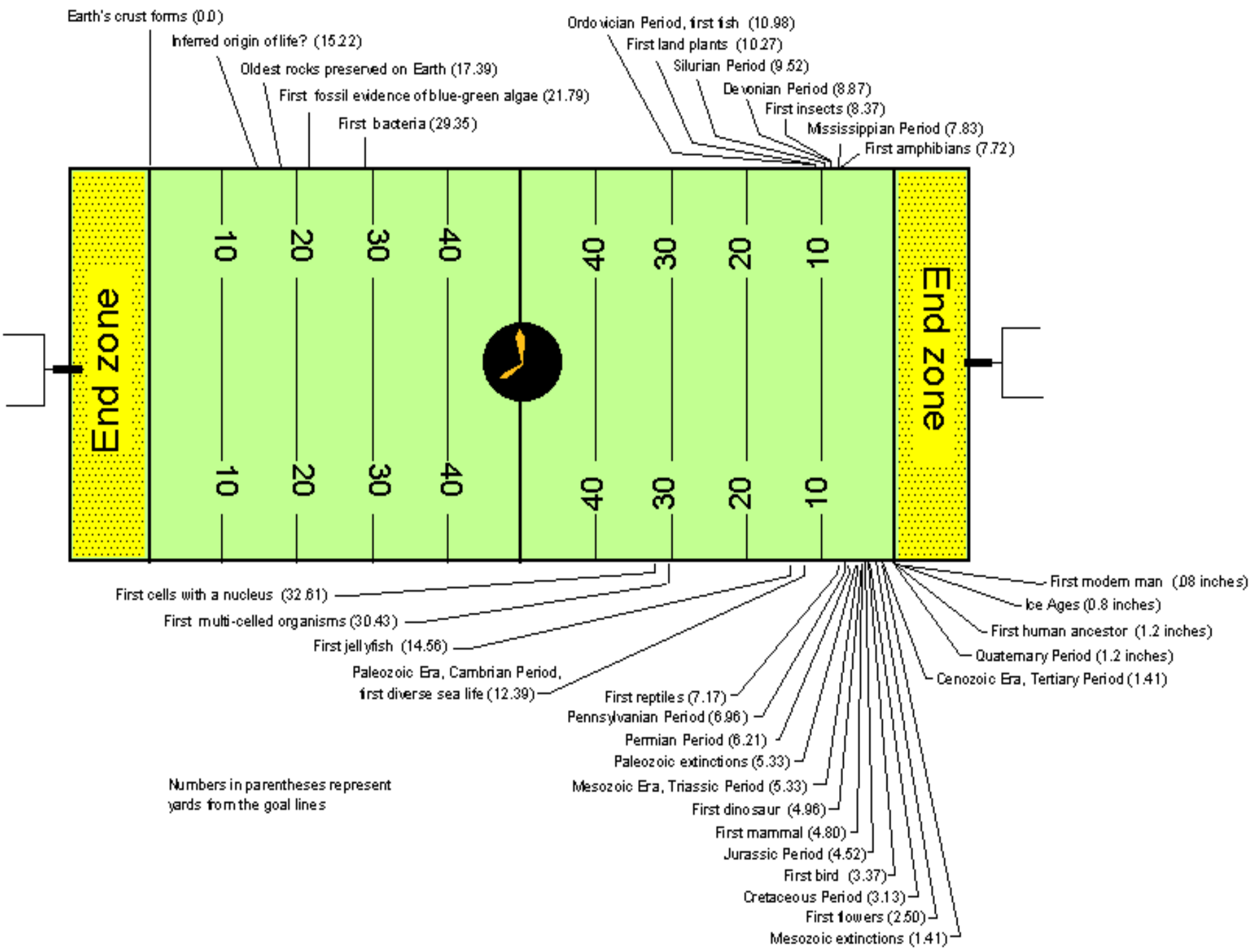
Geologic Time



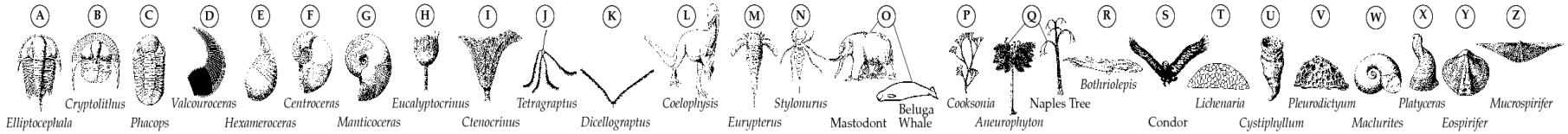
Earth Clock



Keep in mind 2/3's of the Universe timeline has gone by before the Earth even formed


Earth's crust forms (0.0)
Inferred origin of life? (15.22)
Oldest rocks preserved on Earth (17.39)
First fossil evidence of blue-green algae (21.79)
First bacteria (29.35)
Ordovician Period, first fish (10.98)
First land plants (10.27)
Silurian Period (9.52)
Devonian Period (8.87)
First insects (8.37)
Mississippian Period (7.83)
First amphibians (7.72)
End zone
10
20
30
40
40
30
20
10
10
20
30
40
40
30
20
10
End zone
First cells with a nucleus (32.61)
First multi-celled organisms (30.43)
First jellyfish (14.56)
Paleozoic Era, Cambrian Period,
first diverse sea life (12.39)
First reptiles (7.17)
Pennsylvanian Period (6.96)
Permian Period (6.21)
Paleozoic extinctions (5.33)
Mesozoic Era, Triassic Period (5.33)
First dinosaur (4.96)
First mammal (4.80)
Jurassic Period (4.52)
First bird (3.37)
Cretaceous Period (3.13)
First flowers (2.50)
Mesozoic extinctions (1.41)
First modern man (.08 inches)
Ice Ages (0.8 inches)
First human ancestor (1.2 inches)
Quaternary Period (1.2 inches)
Cenozoic Era, Tertiary Period (1.41)
Numbers in parentheses represent
yards from the goal lines

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 – 1.6	Humans, mastodonts, mammoths
		TERTIARY – NEOGENE	PLIOCENE	1.6 – 5.3	Large carnivores
			MIOCENE	5.3 – 24	Abundant grazing mammals Earliest grasses
		TERTIARY – PALEOGENE	OLIGOCENE	24 – 33.7	Large running mammals
			EOCENE	33.7 – 54.8	Many modern groups of mammals
			PALEOCENE	54.8 – 65	
	MESOZOIC	CRETACEOUS	LATE	65	Extinction of dinosaurs and ammonoids Earliest placental mammals Climax of dinosaurs and ammonoids
			EARLY	142	Earliest flowering plants Decline of brachiopods Diverse bony fishes
		JURASSIC	LATE		Earliest birds
			MIDDLE		Abundant dinosaurs and ammonoids
			EARLY	206	
		TRIASSIC	LATE		Modern coral groups appear
			MIDDLE		Earliest dinosaurs and mammals with abundant cycads and conifers
			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	544	Earliest chordates, diverse trilobites Earliest trilobites Earliest marine animals with shells
PROTEROZOIC	LATE			580	Ediacaran fauna
	MIDDLE			1300	Soft-bodied organisms
	EARLY			1900	Stromatolites
ARCHEAN	EARLY			2500	Oldest multicellular life First appearance of sexually reproducing organisms Transition to atmosphere containing oxygen Oldest microfossils Geochemical evidence for oldest biological fixing of carbon Oldest known rocks Estimated time of origin of Earth and solar system
				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).

TRILOBITES, NAUTILOIDS, AMMONOIDS, CRINOIDS, GRAPTOLITES, EURYPTERIDS, DINOSAURS, MAMMALS, BIRDS, VASCULAR PLANTS, PLACODERM FISH, CORALS, GASTROPODS, BRACHIOPODS

Earth's first forest

Earth's first coral reef

Tectonic Events Affecting Northeast North America

Rifting, Passive Margin, Transform Collision, Subduction, Continental Collision, Rifting, Passive Margin

Important Geologic Events in New York

- Advance and retreat of last continental ice
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- Development of passive continental margin
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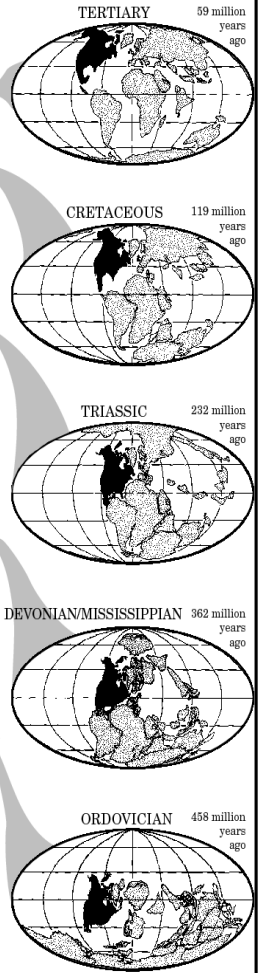
Inferred Position of Earth's Landmasses



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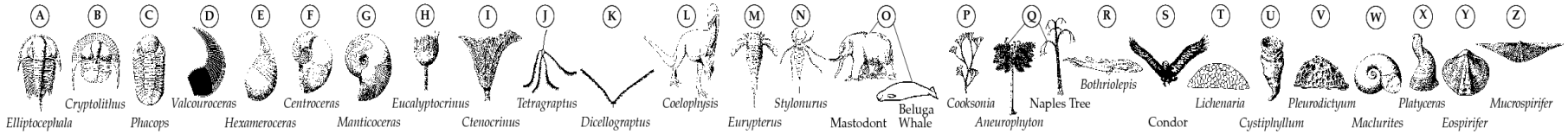

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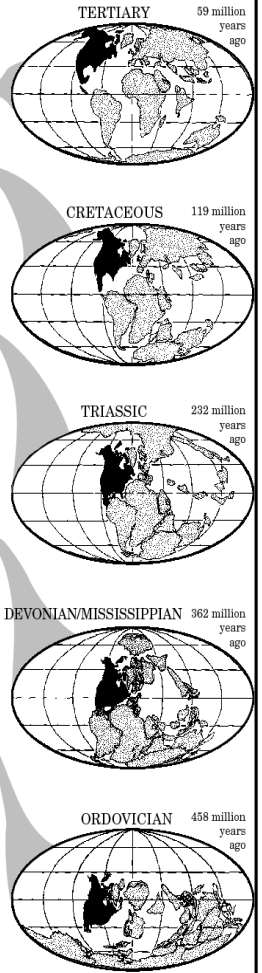

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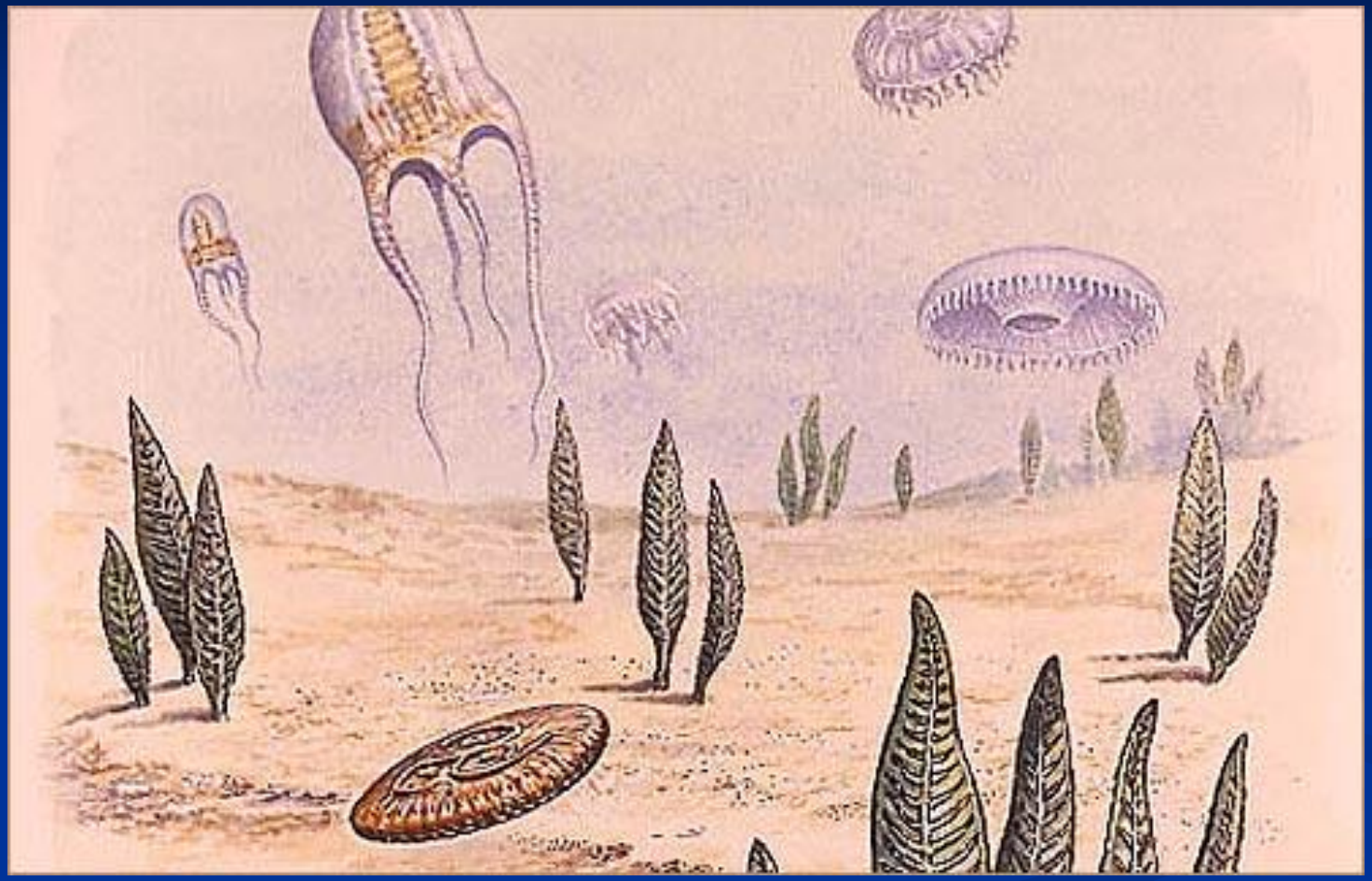
Geologic History

Our place in Earth's history.

Geological Calendar

http://www.timetoast.com/timelines/63215

Precambrian



Early life was dominated by soft bodied animals. We do not know much about this time period because they did not leave many fossils.

Paleozoic Era Begins

Cambrian

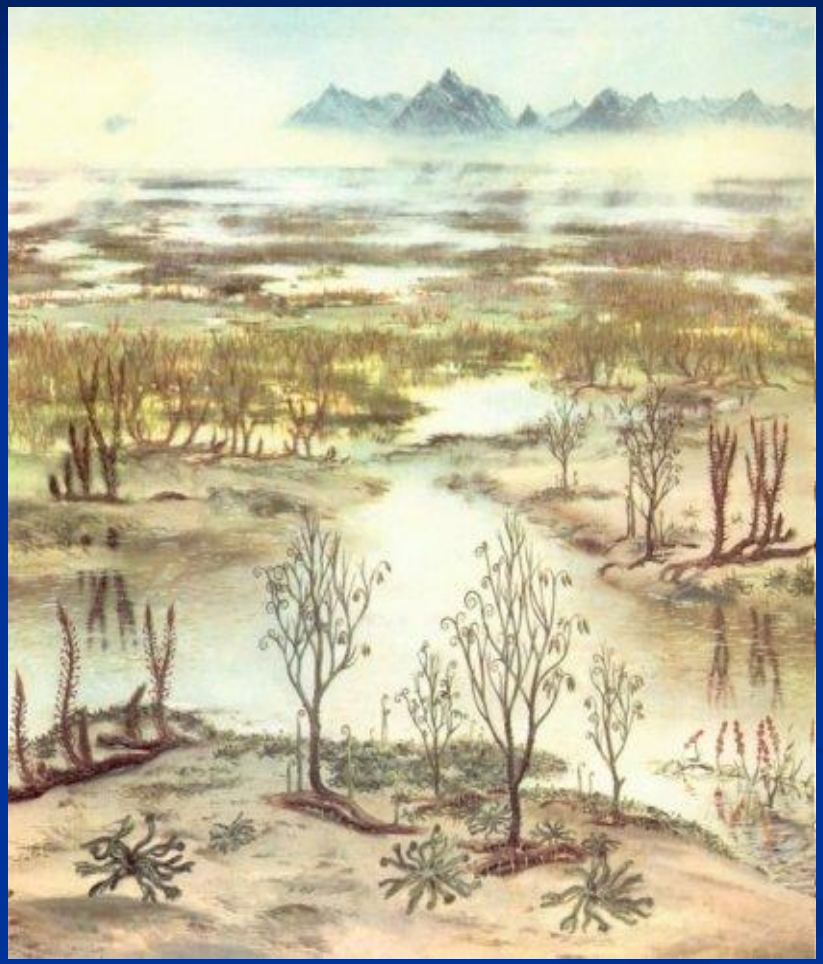
Great diversity of life with "Shelly Parts". This lead to an explosion in the fossil record.

Earliest Fish.

Ordovician

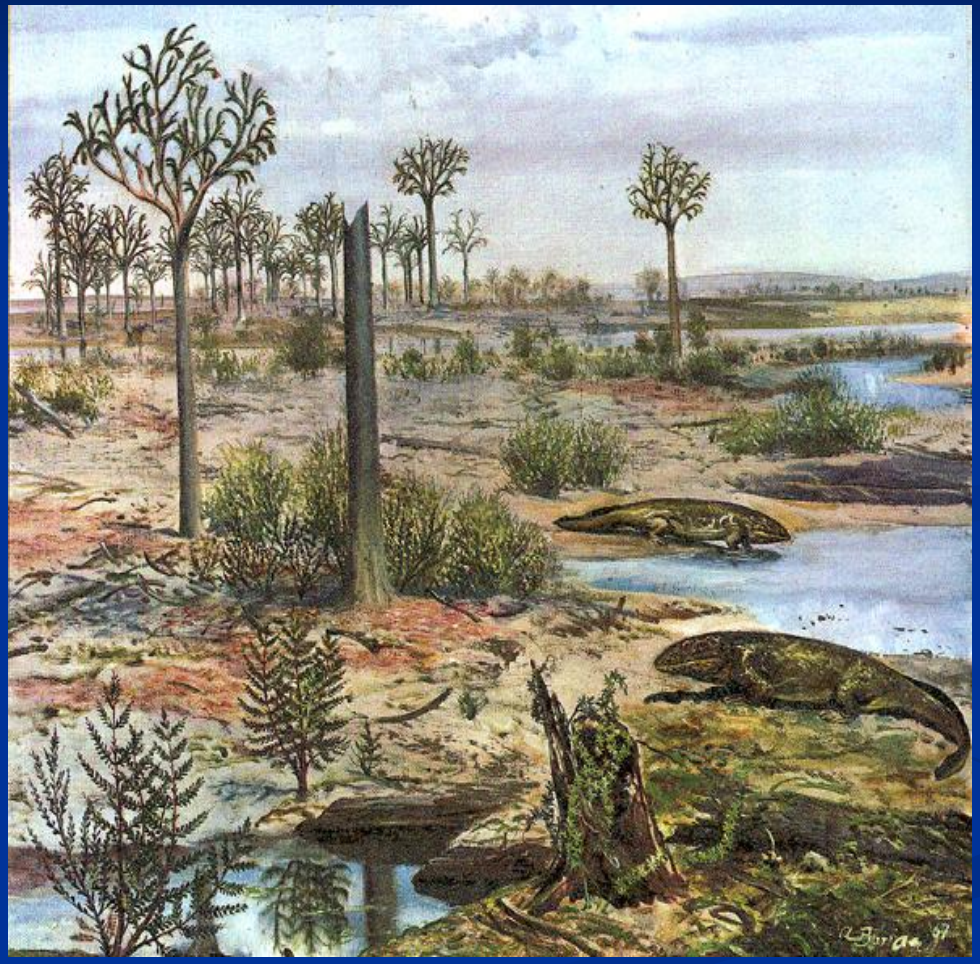
First Coral Reefs and invertebrates dominate

Silurian



Earliest land plants, animals and insects.

Devonian



Earliest Amphibians. Earths first forests.

Carboniferous

Large and numerous Trees (formation of our current coal).
Earliest Reptiles. Gigantic animals due to large amounts of oxygen


Copyright: Jörg Schneider (2007)
www.geology.cz/foto/14570

Permian

Mammal-like reptiles

Permian Extinction

- 95+% of marine life and over 70% of land animals wiped out.
- No one truly knows why yet.

Mesozoic Era Begins

Triassic

Earliest dinosaurs, earliest mammals.

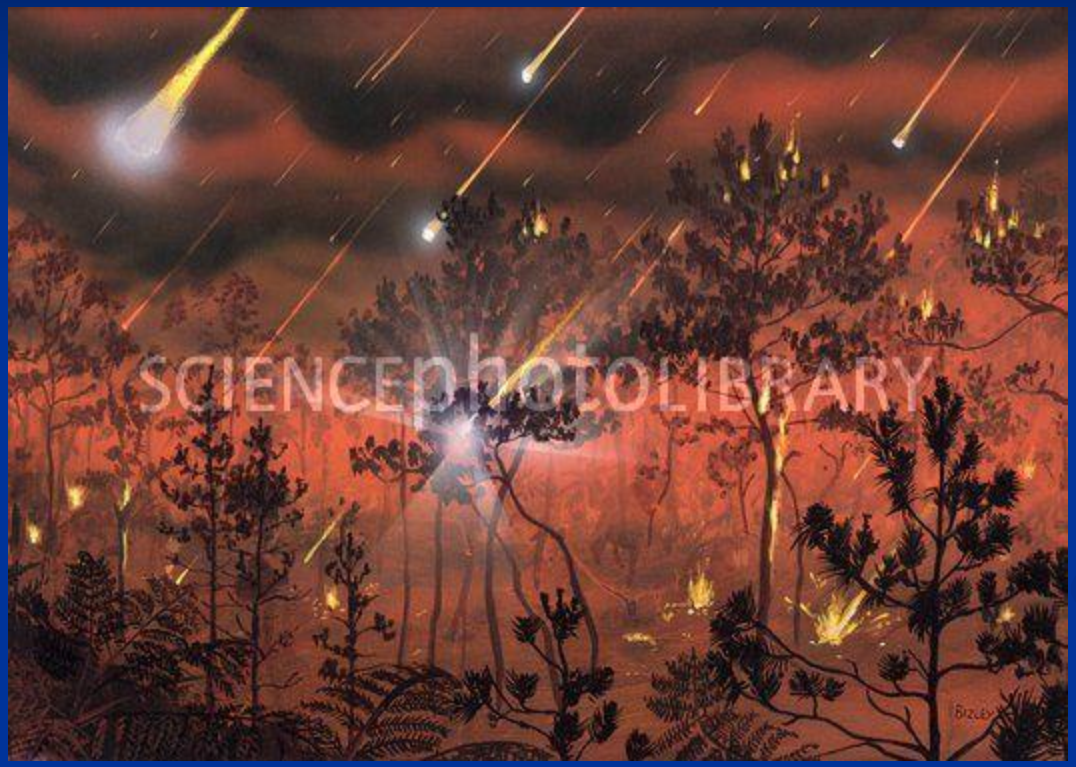
Jurassic

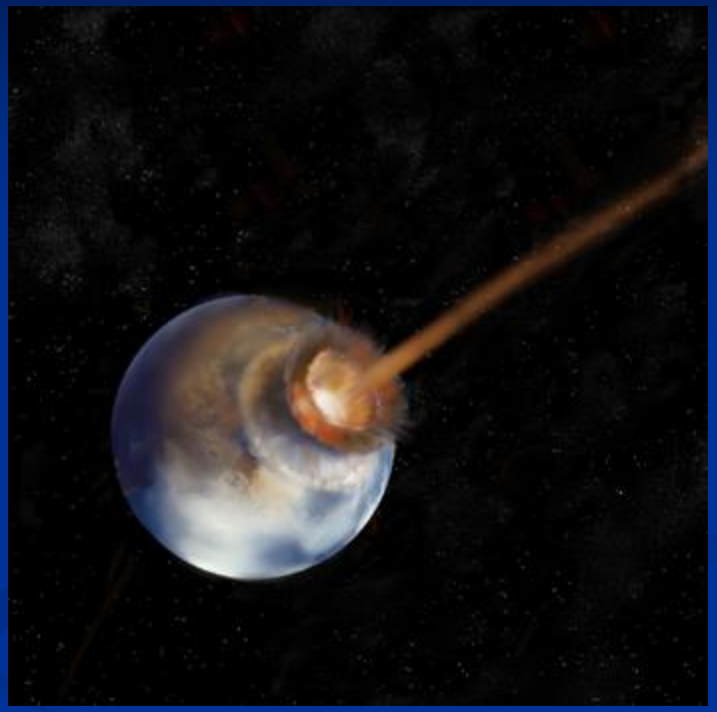
Abundant dinosaurs and earliest birds.

Cretaceous

Earliest flowering plants.

Cretaceous (K-T) Extinction

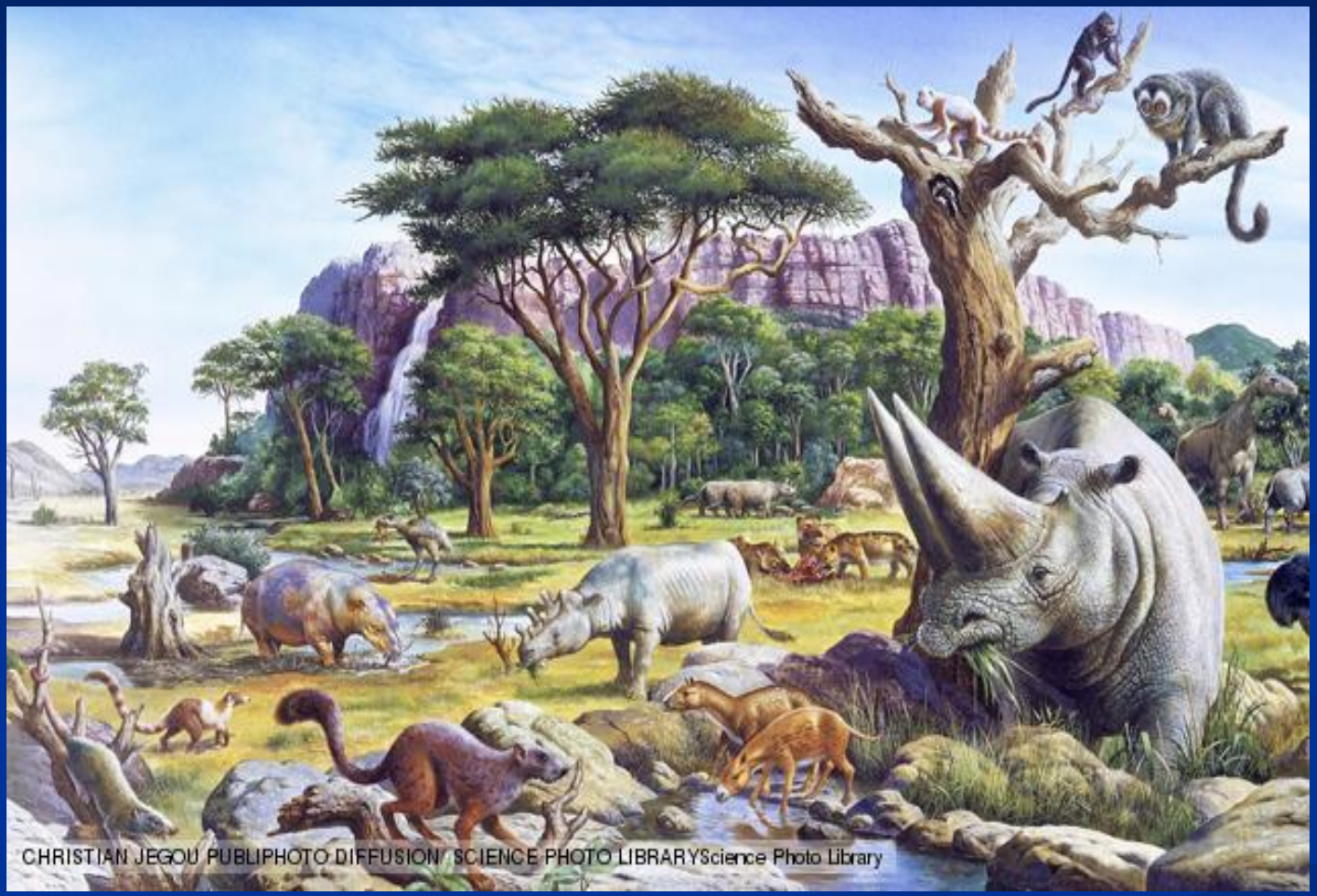




- Impact event (Mass extinction)
- 85% of species died out.
- KT Boundary left behind.

Cenozoic Era Begins

Paleogene



Earliest grasses, mammals begin to take over.

Neogene

Abundant grazing mammals. Large carnivorous mammals.

Quaternary

Humans, Mastodonts, mammoths.

- The cosmos
- The lost worlds of planet earth

How do we find the age of the Earth?

James Hutton – Father of modern geology

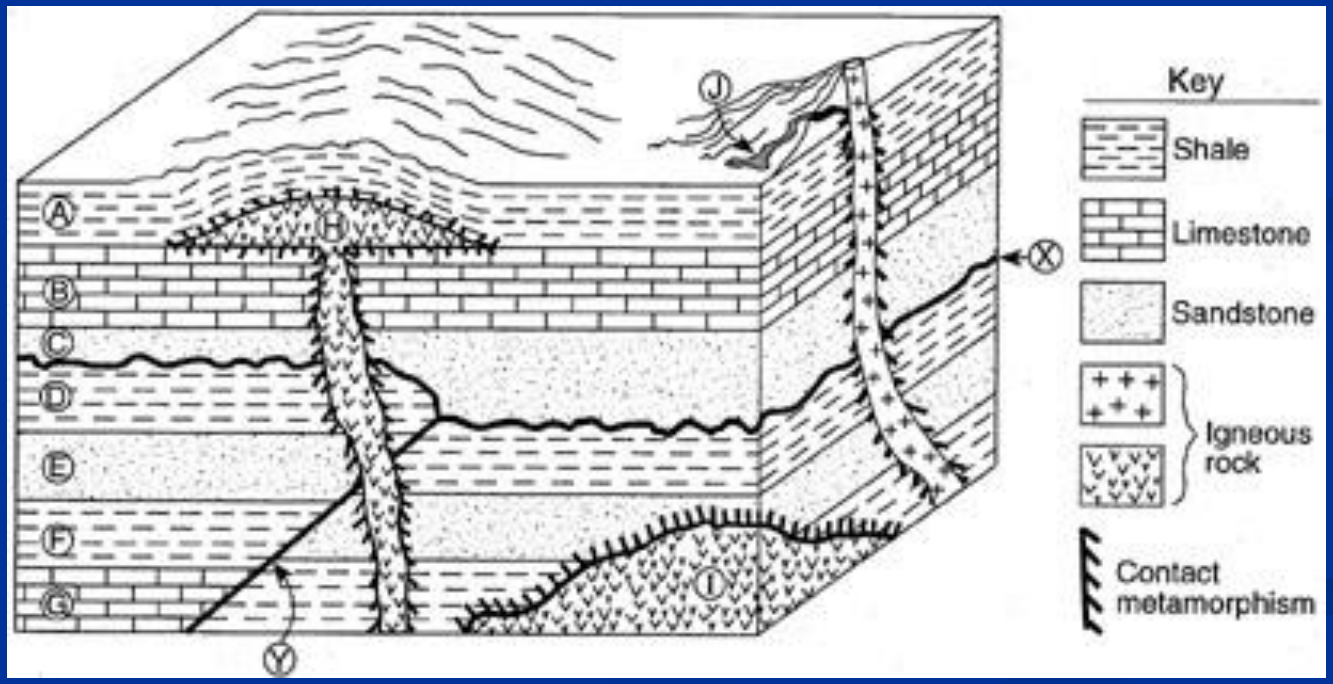
Uniformitarianism?

* Uniformitarianism – Laws operating today are the same that operated in the past.

- (Uniform – the same)
  - "The Present is the key to the Past"

How to find relative age

- Sequencing?
- Sequencing – putting the age of events in order.



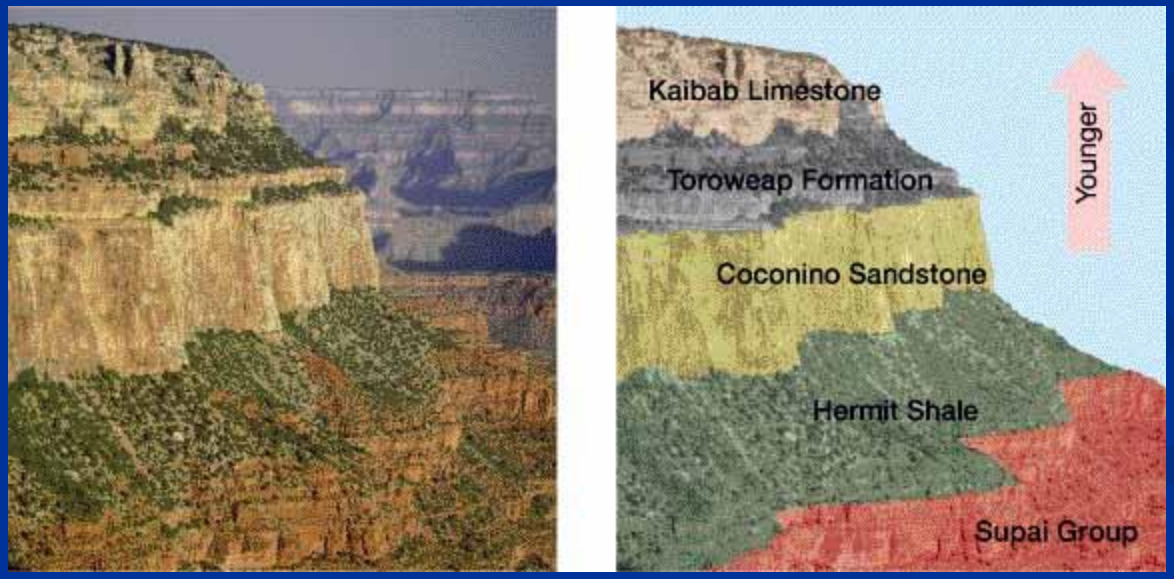
Relative Dating

- Relative dating?
- Relative dating: Giving an order to when things happened. (Relationship to each other)
- Such as: 1st, 2nd, 3rd
- Not an exact age.

- Uses techniques such as
  - super positioning (ordering layers)
  - Index fossils

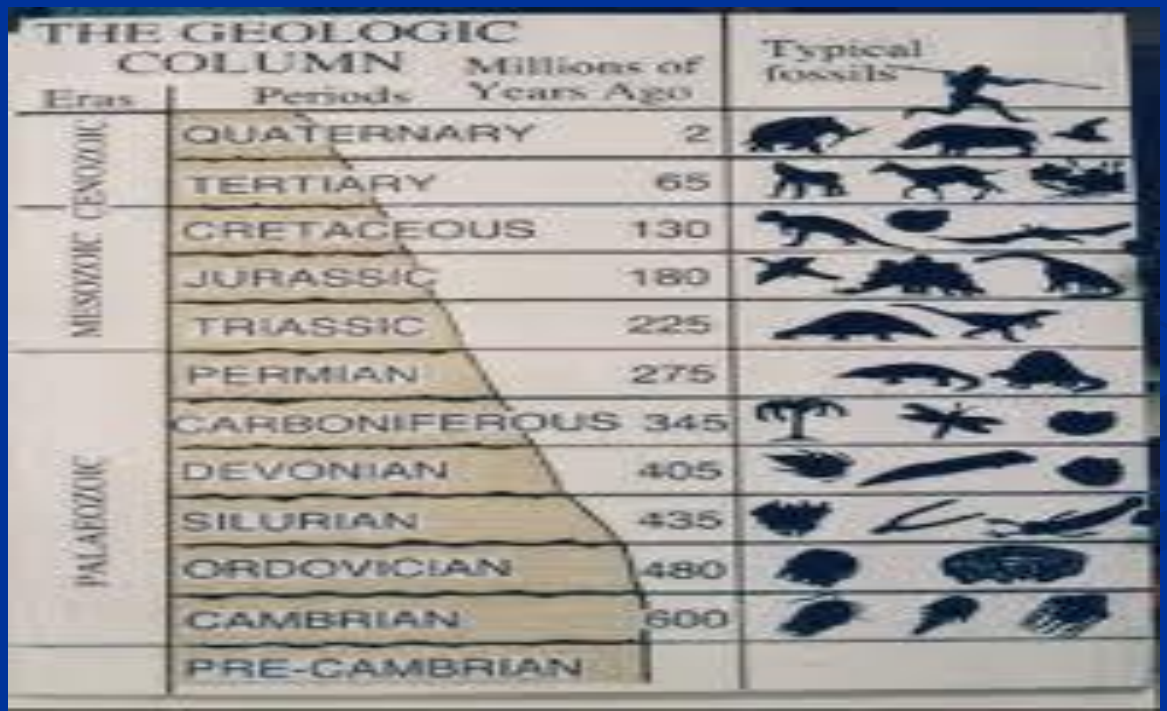
Super Positioning

- Superposition?
- Superposition – If rocks have not been disturbed oldest rocks are on bottom.



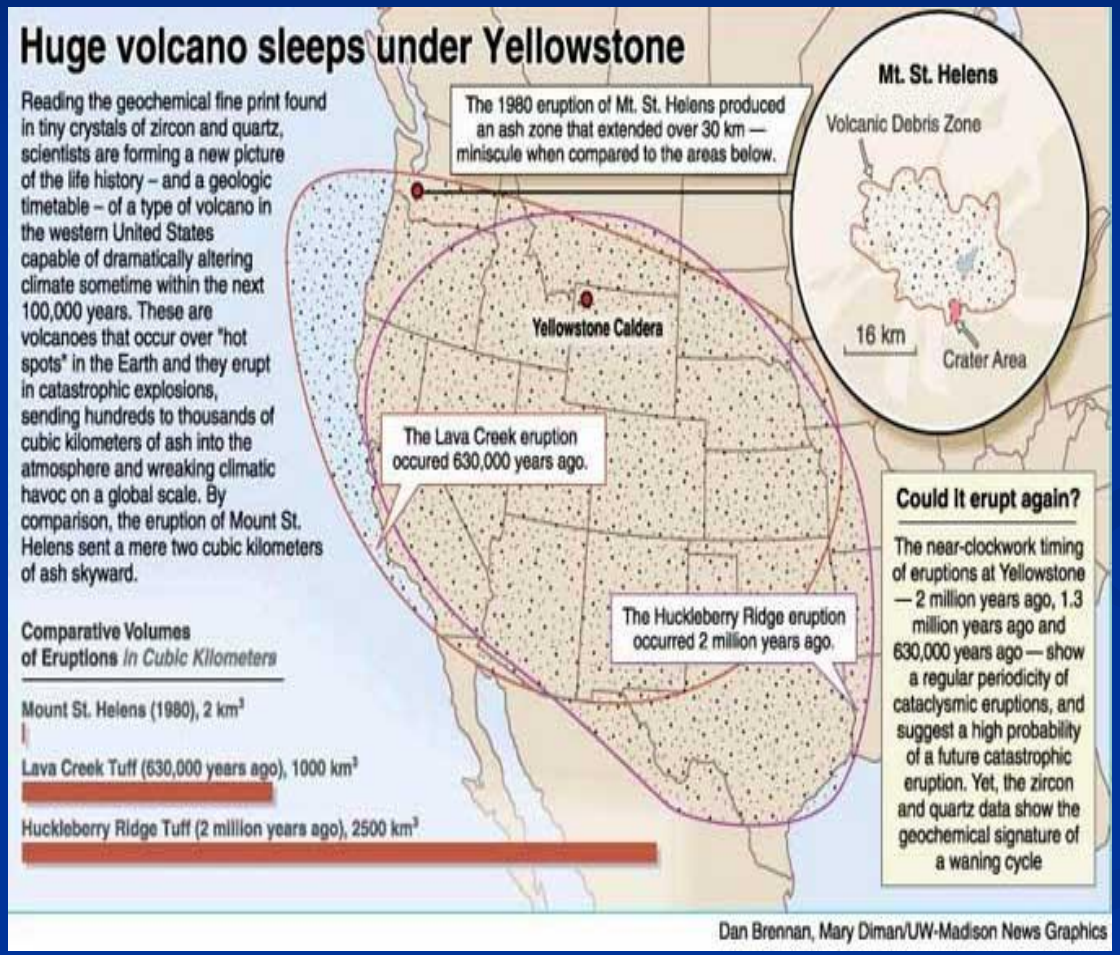
Index fossils

- Index fossil?
- Index fossils – Fossils that lived during a specific time period. Used to find the relative age.

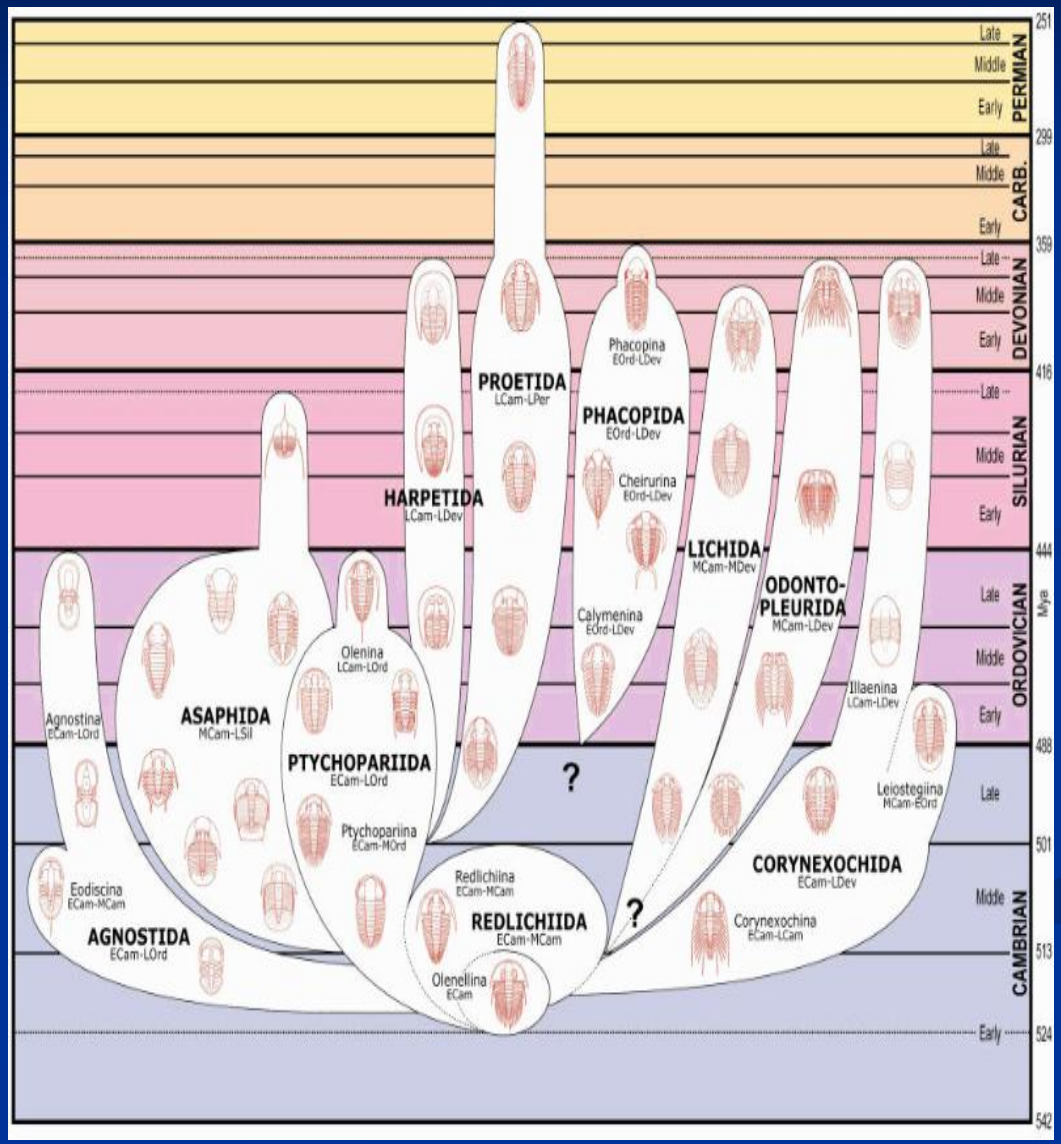


- A good index fossil should be:
- Good index fossils:
- Live for a short period of geologic time.
- (or else you will have too big of a range)
- Cover a wide area
- (or you will have nothing to compare it to)

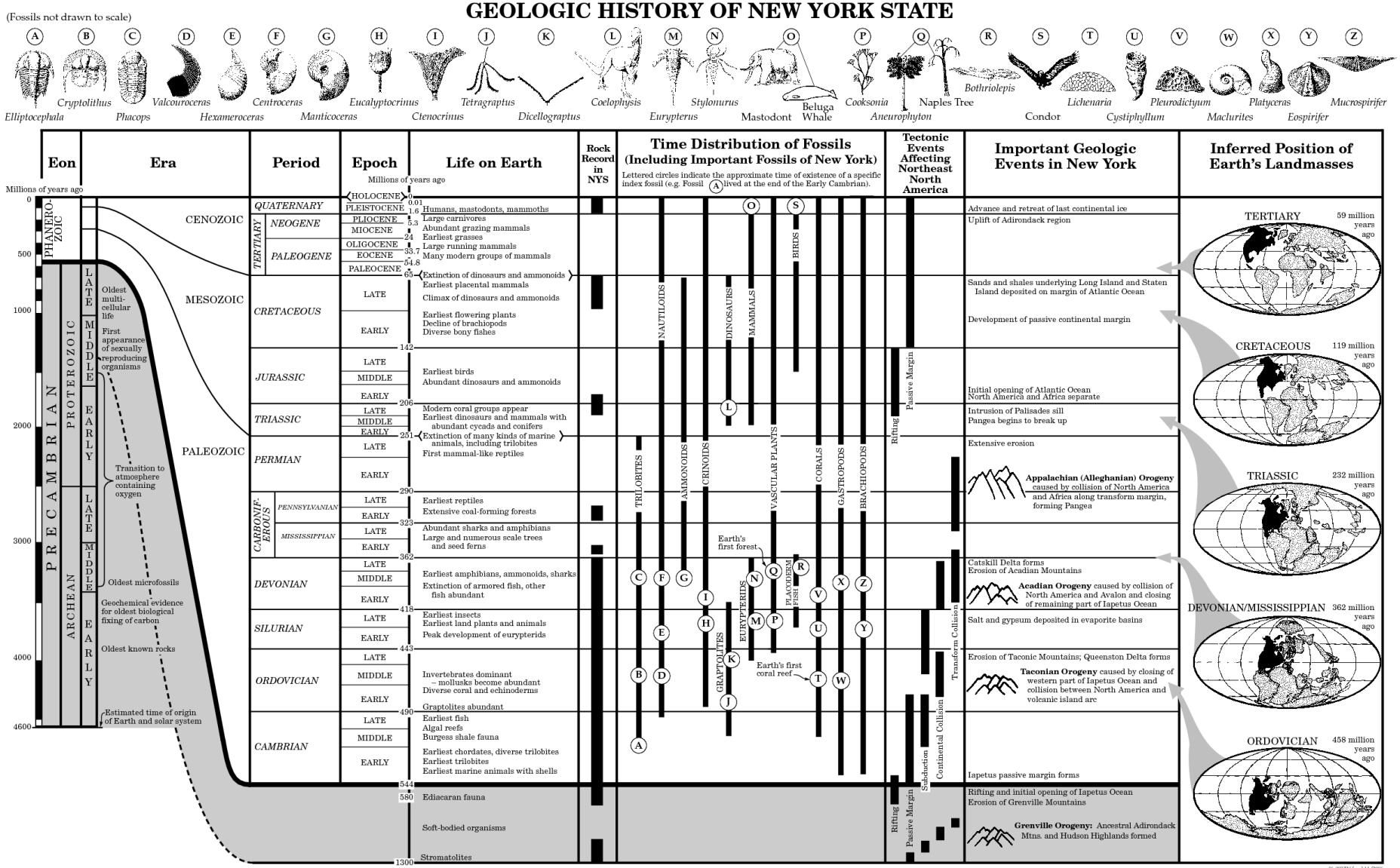
- Volcanic ash also works well.
- .


Huge volcano sleeps under Yellowstone
Reading the geochemical fine print found in tiny crystals of zircon and quartz, scientists are forming a new picture of the life history – and a geologic timetable – of a type of volcano in the western United States capable of dramatically altering climate sometime within the next 100,000 years. These are volcanoes that occur over "hot spots" in the Earth and they erupt in catastrophic explosions, sending hundreds to thousands of cubic kilometers of ash into the atmosphere and wreaking climatic havoc on a global scale. By comparison, the eruption of Mount St. Helens sent a mere two cubic kilometers of ash skyward.
Comparative Volumes of Eruptions In Cubic Kilometers
Mount St. Helens (1980), 2 km³
Lava Creek Tuff (630,000 years ago), 1000 km³
Huckleberry Ridge Tuff (2 million years ago), 2500 km³
The 1980 eruption of Mt. St. Helens produced an ash zone that extended over 30 km — miniscule when compared to the areas below.
Mt. St. Helens
Volcanic Debris Zone
16 km
Crater Area
Yellowstone Caldera
The Lava Creek eruption occured 630,000 years ago.
The Huckleberry Ridge eruption occurred 2 million years ago.
Could it erupt again?
The near-clockwork timing of eruptions at Yellowstone — 2 million years ago, 1.3 million years ago and 630,000 years ago — show a regular periodicity of cataclysmic eruptions, and suggest a high probability of a future catastrophic eruption. Yet, the zircon and quartz data show the geochemical signature of a waning cycle
Dan Brennan, Mary Diman/UW-Madison News Graphics

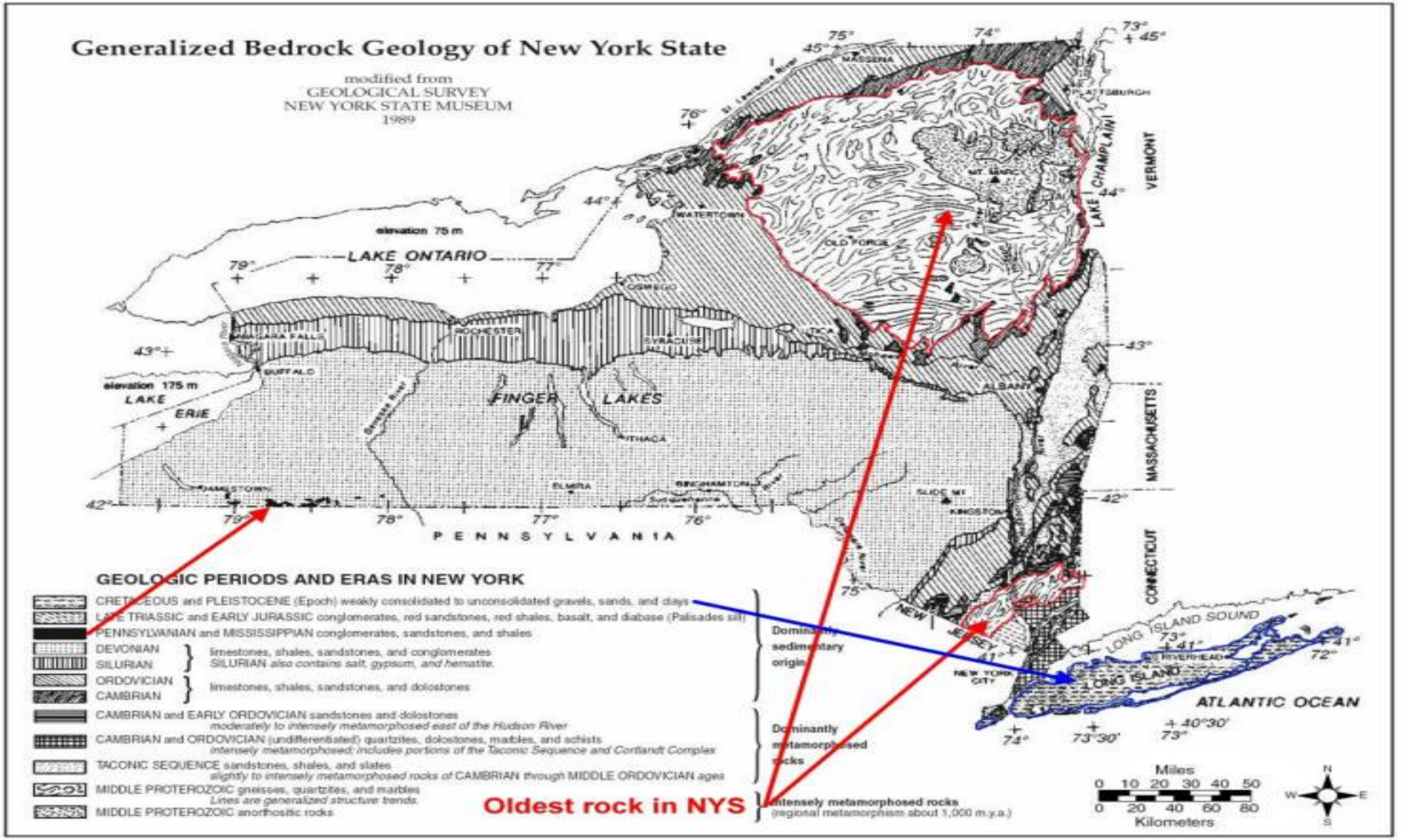
Trilobites The New York Fossil



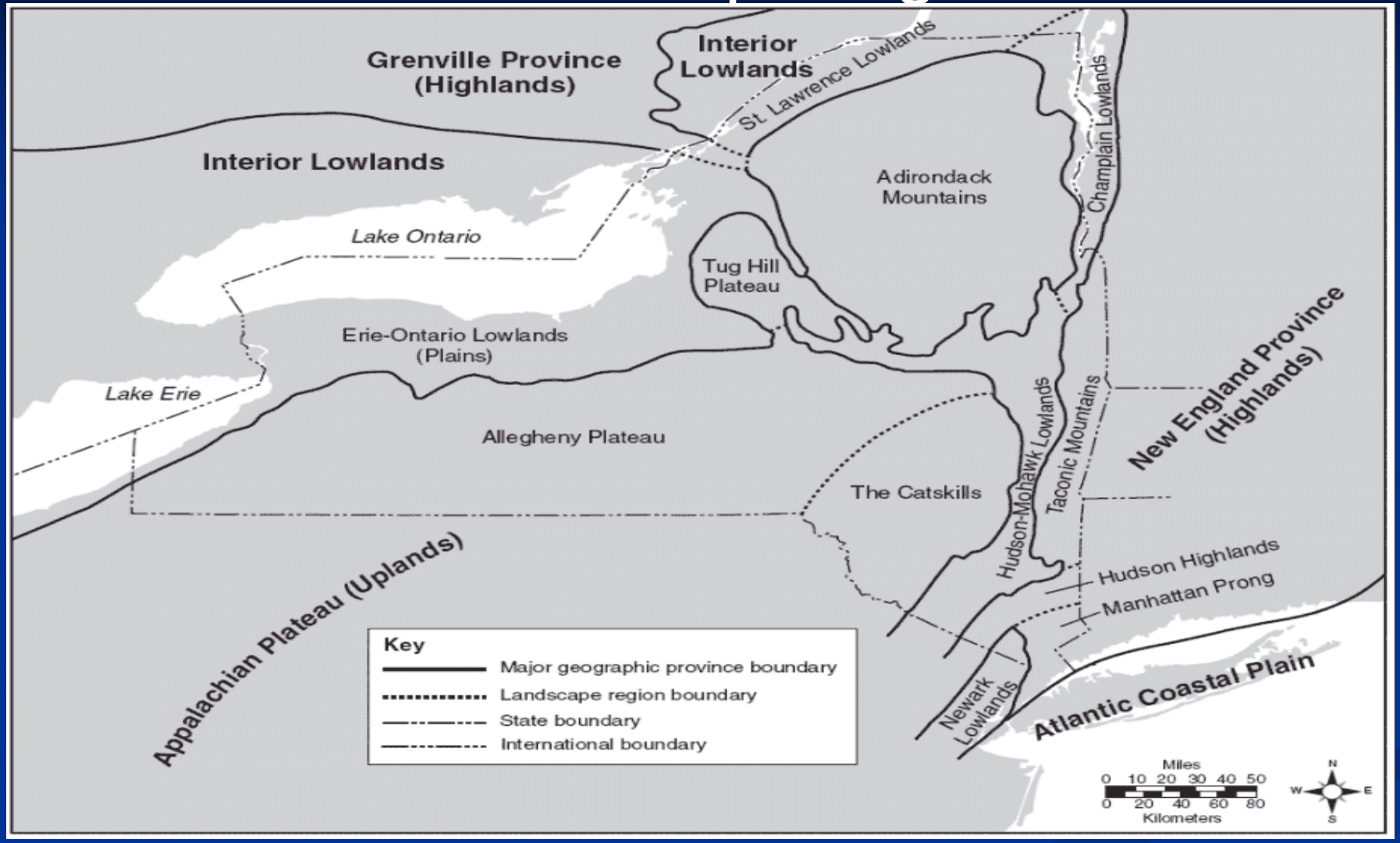
Geologic History of NYS R



Generalized bedrock Geology in NYS R



Generalized Landscape regions of NYS R

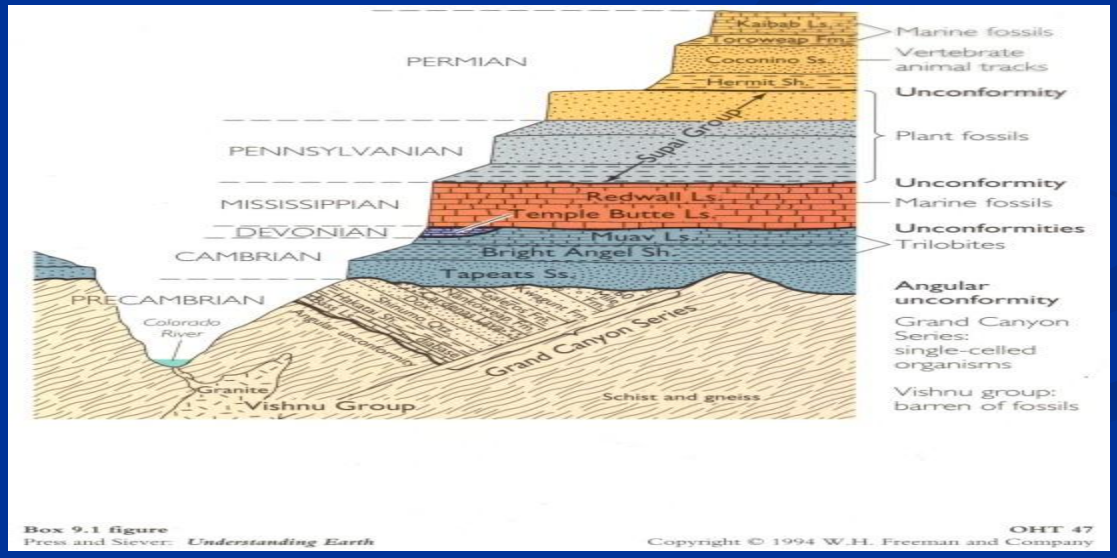


In the generalized Landscape Regions Chart the Allegheny Plateau is part of the Appalachian Plateau and can be interchanged.

4 Laws of Deposition

- 4 Laws of deposition
- 1) Law of Original horizontality –

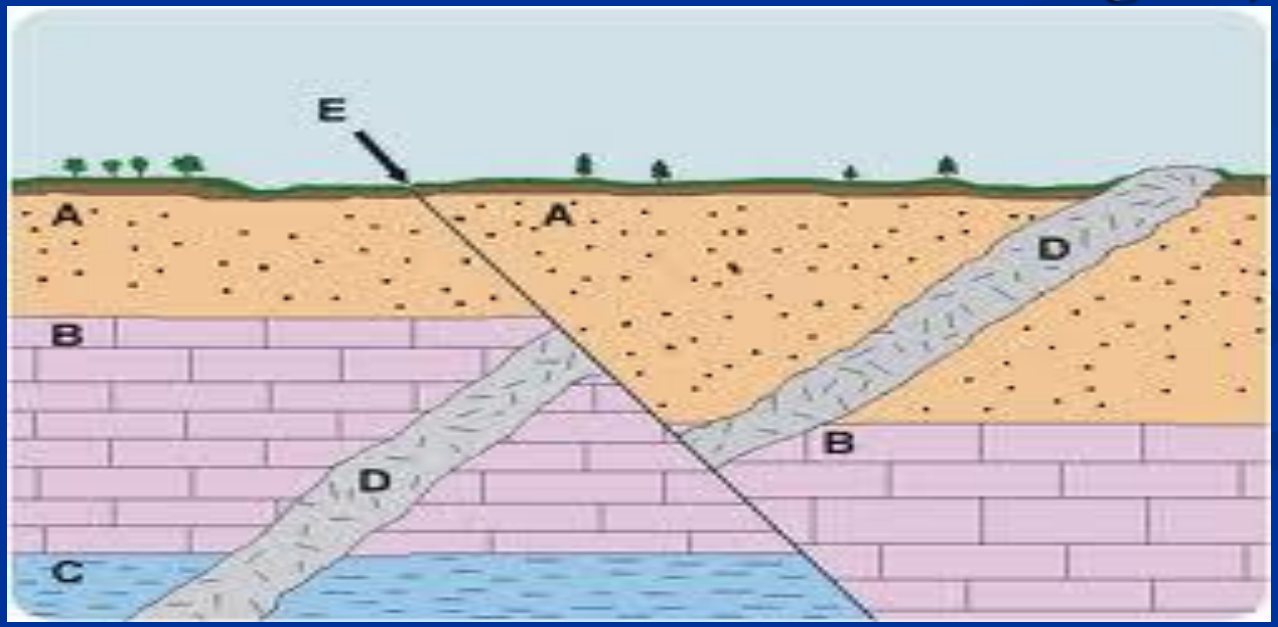
  Rock layers are originally put down horizontally.
- 2) Law of Super positioning – Oldest on bottom.



R

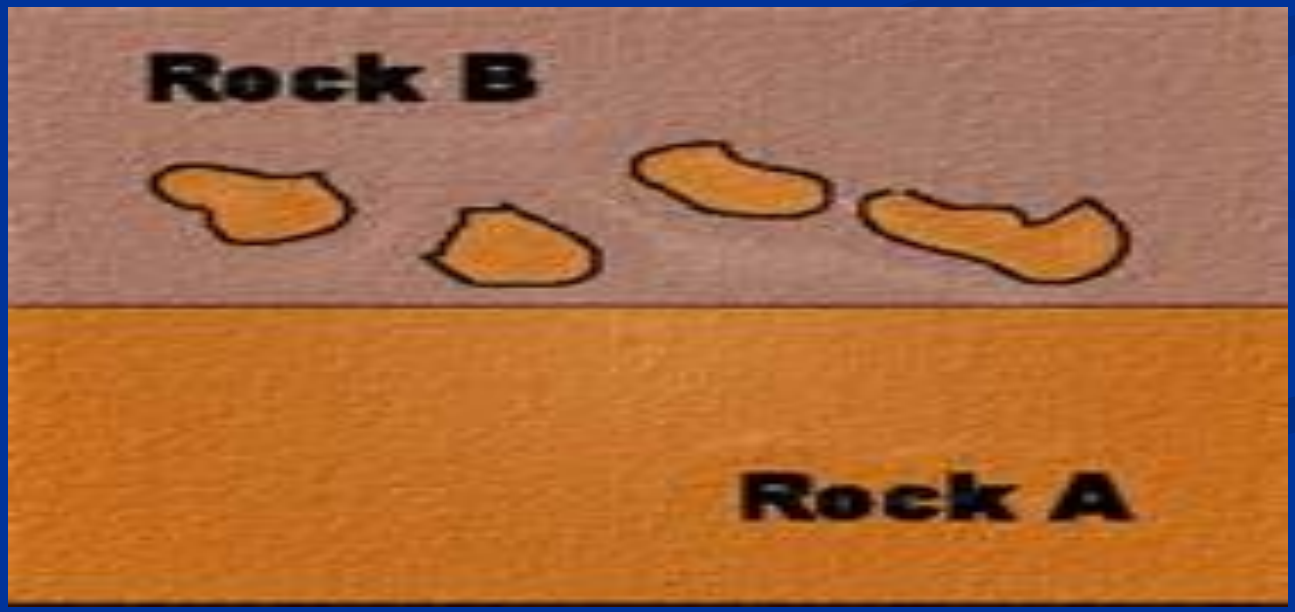
- 3) <u>Law of Cross Cutting Relationships</u> –

  A fault or intrusion that cuts through a rock must be younger than the rock. (rock had to be there first or the fault could not cut through it)



R

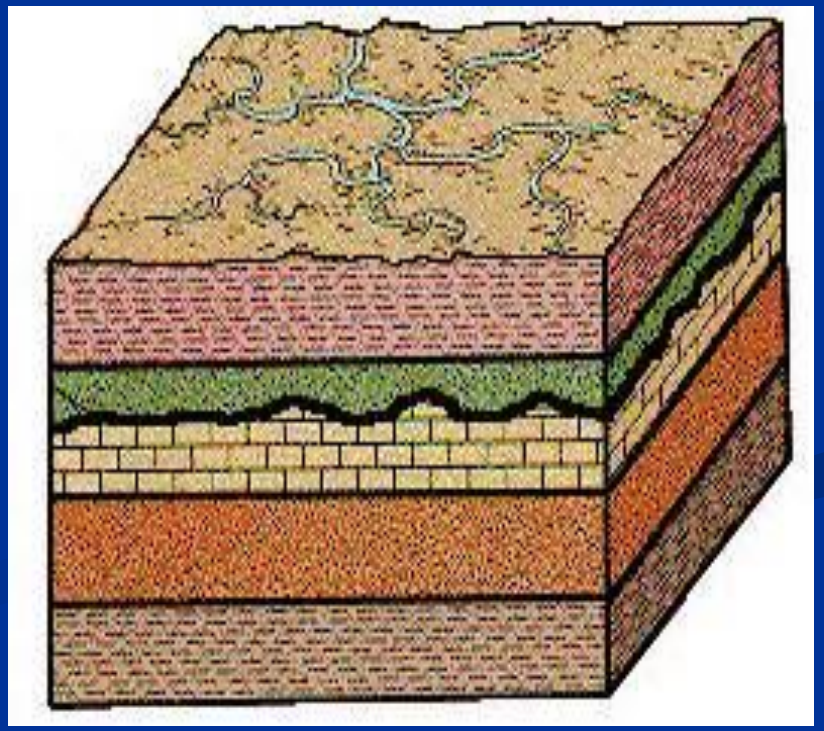
- 4) Law of inclusions – A piece of rock contained in another rock must be older than the rock around it (you cannot place something inside a rock after it hardened).



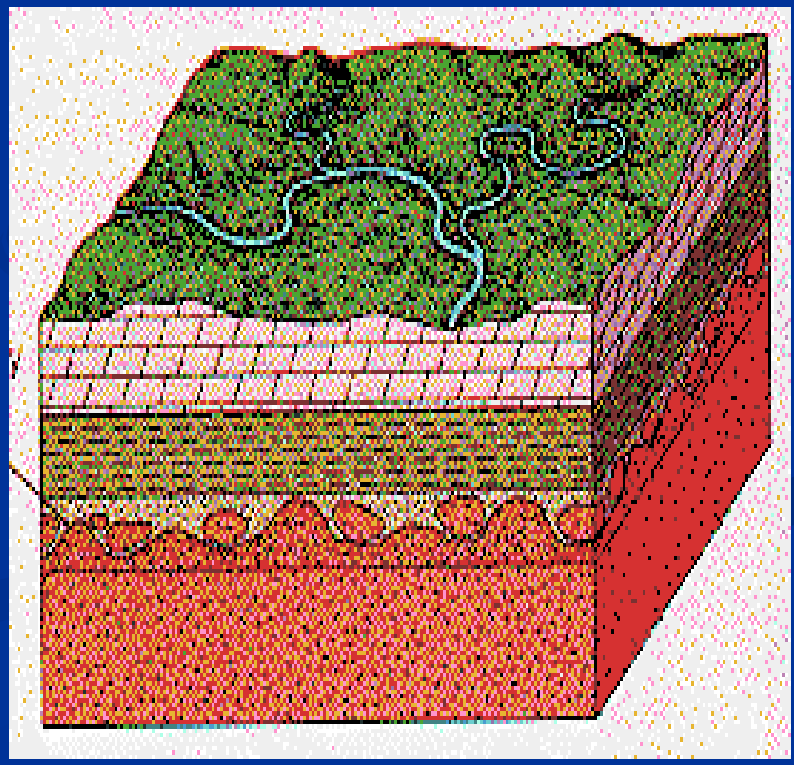
What can go wrong R

- Unconformities – Deposition stops, something happens and deposition continues.

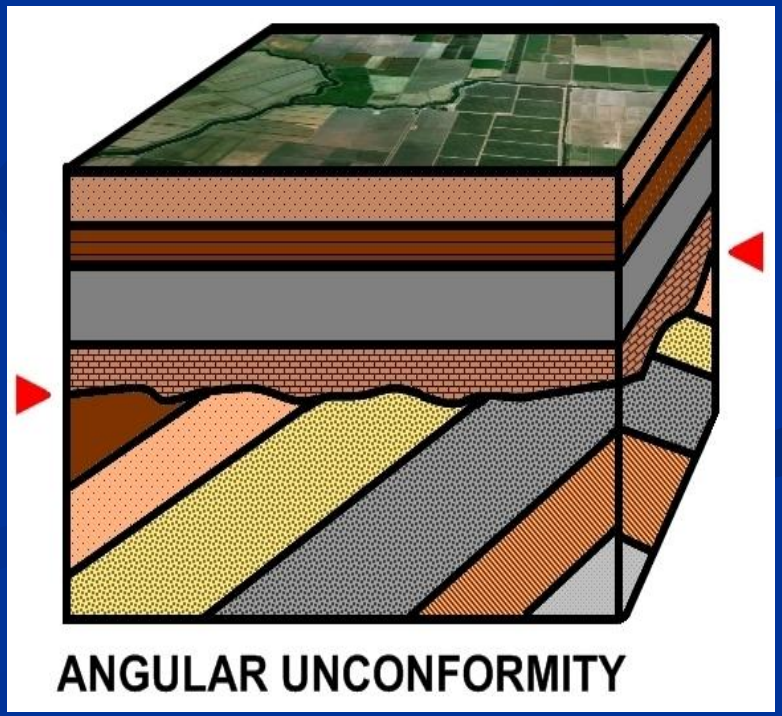
- 1) Disconformities – 2 sedimentary rocks separated by a period of erosion (Discontinued).
- (shown with squiggly lines as erosion)



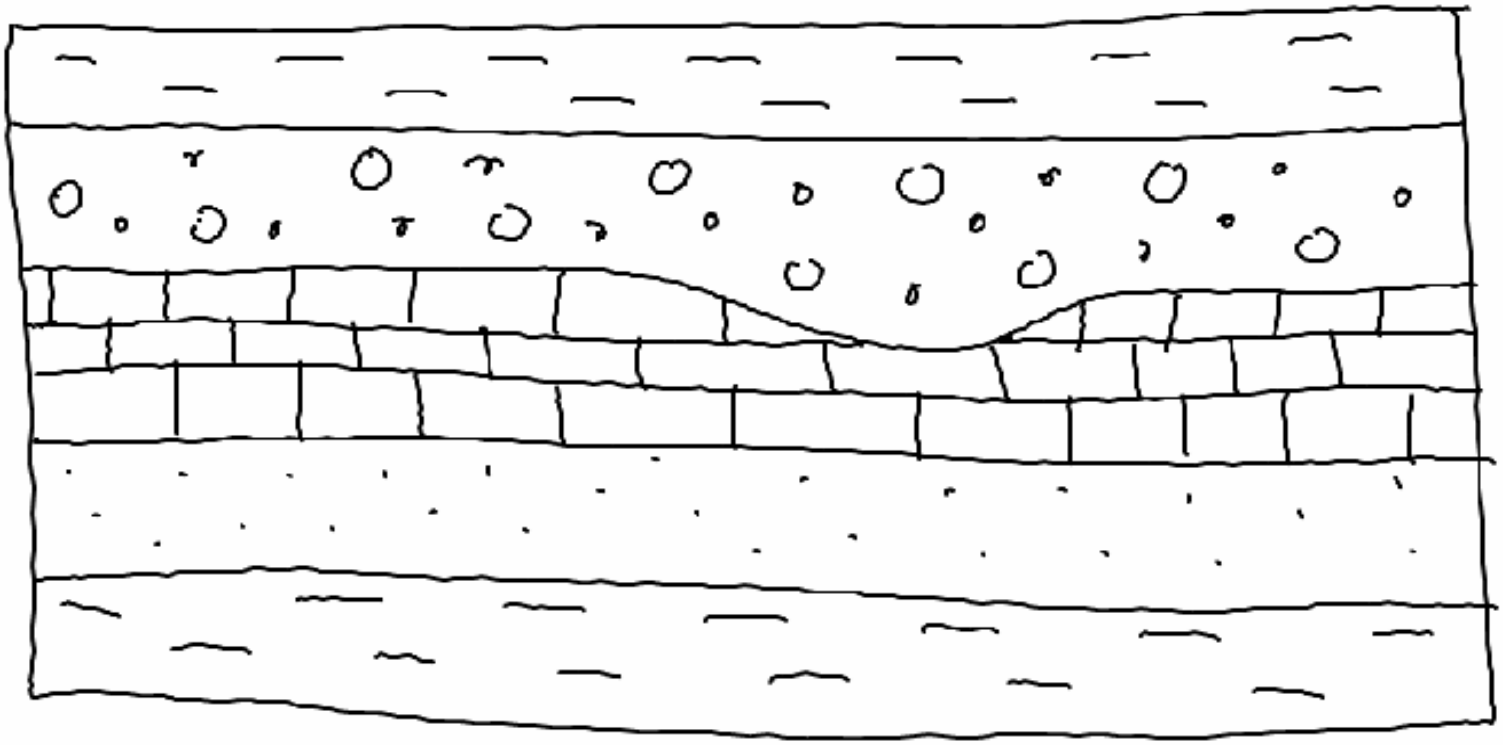
- 2) Nonconformities – Metamorphic or Igneous rock is next to sedimentary rock (non/not the same).



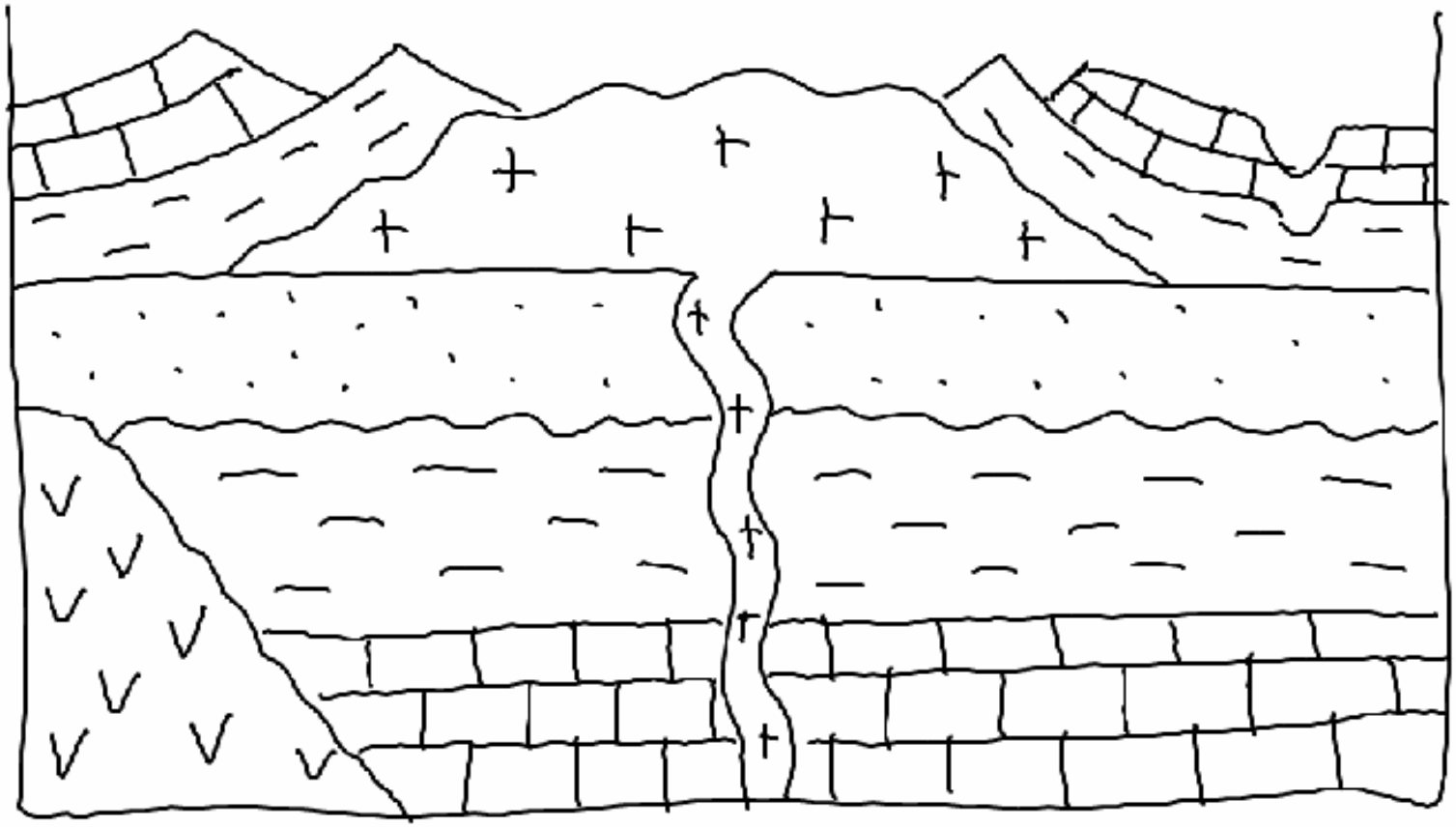
- 3) Angular Unconformities – pause in deposition followed by deformation (tilting/folding).



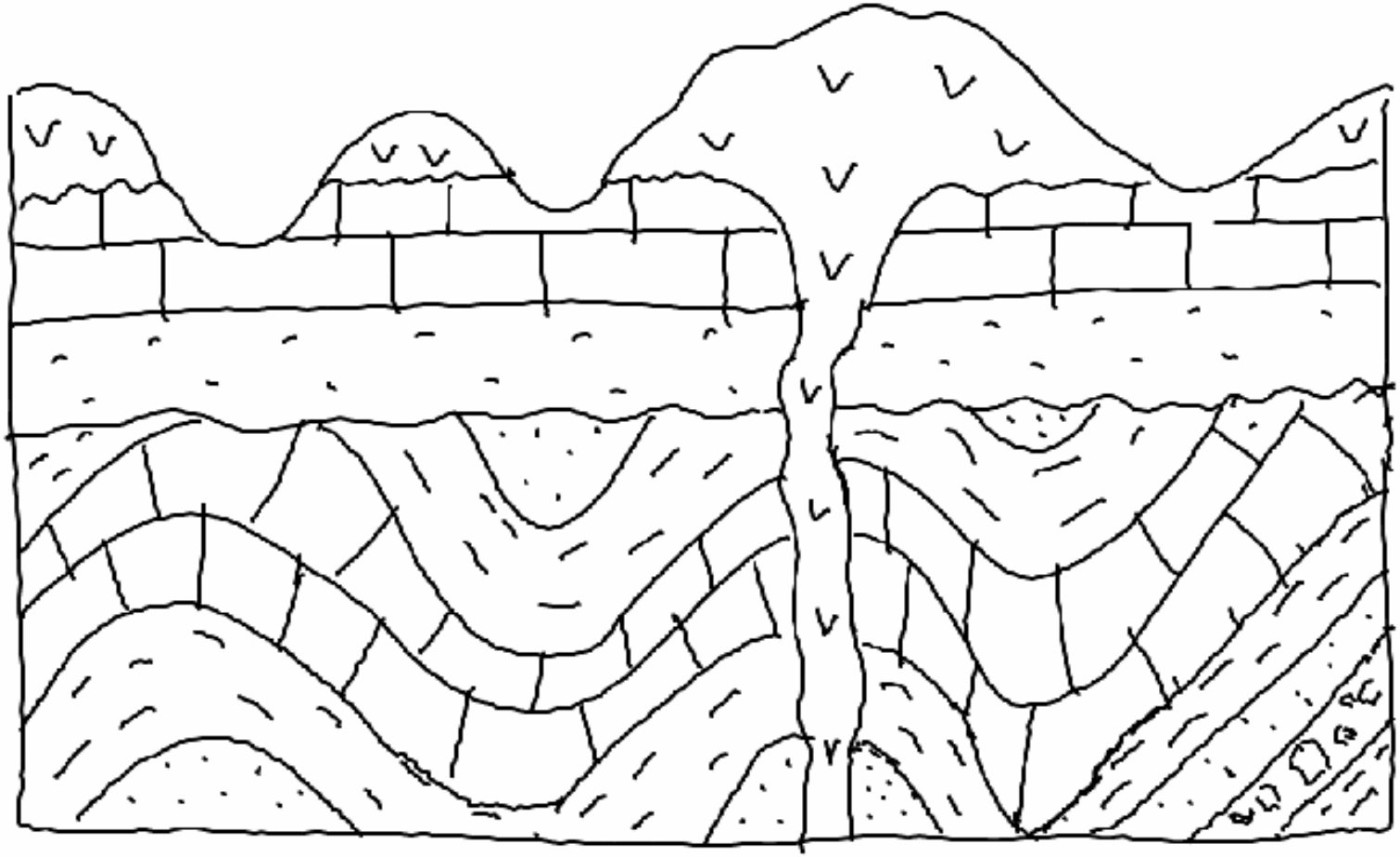
A



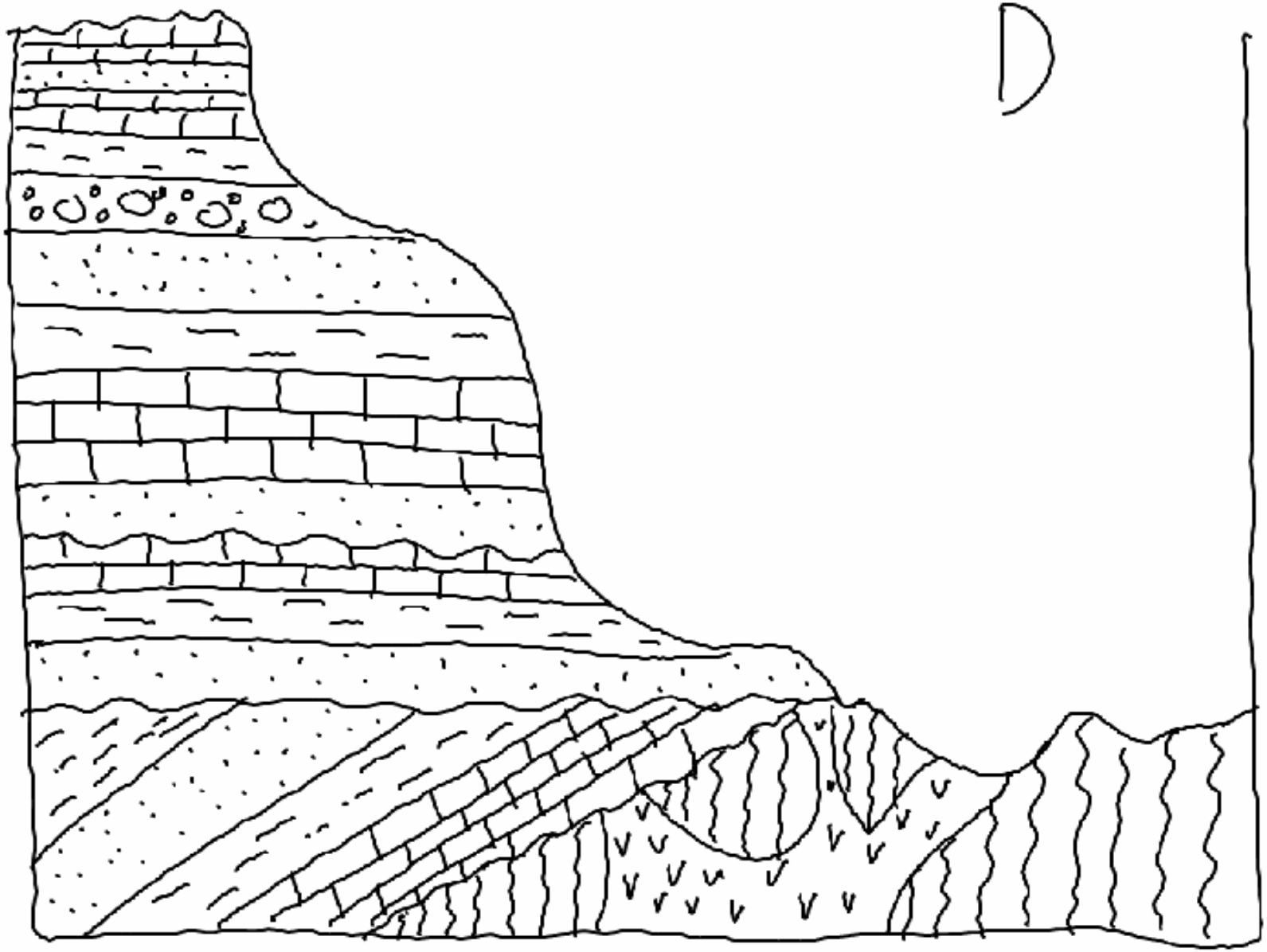
B



C



D



Sequencing Lab (R)

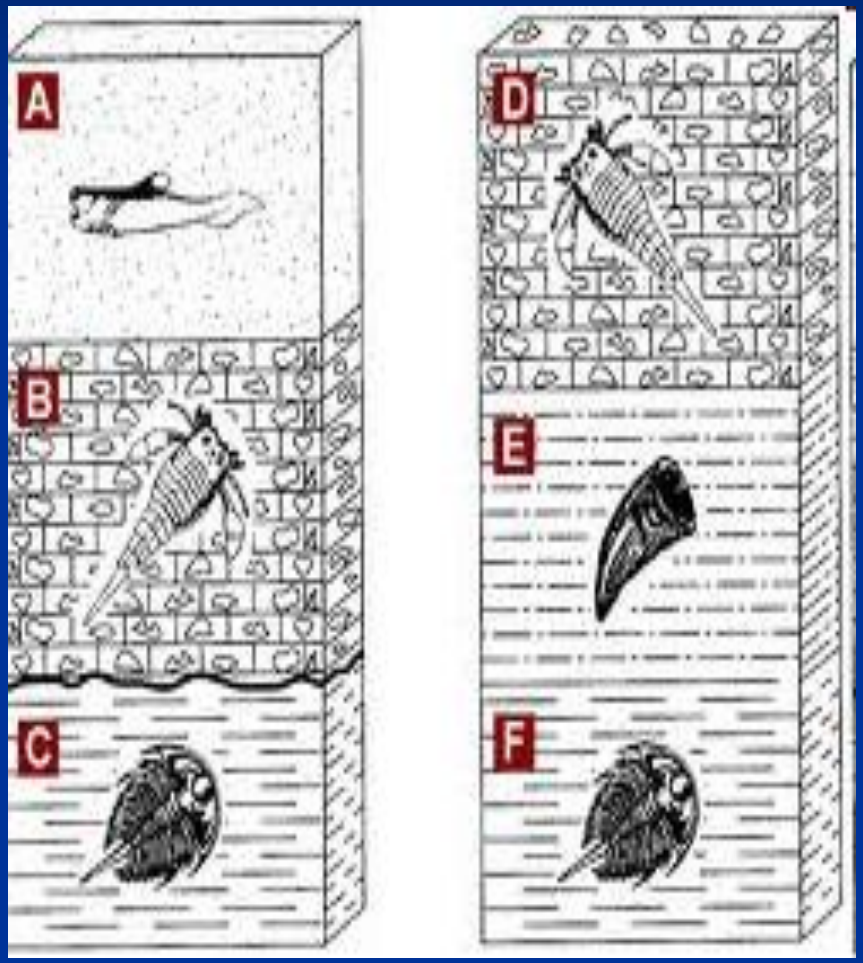
- Pur – Learn to sequence rocks
- Pro – Explain how you can find the sequence
- Data – 4 Outcrops sequenced
- Con – Father of Geology
- Uniformitarianism?
- Relative dating?
- 4 laws of deposition?
- Unconformity?
- 3 major unconformities?

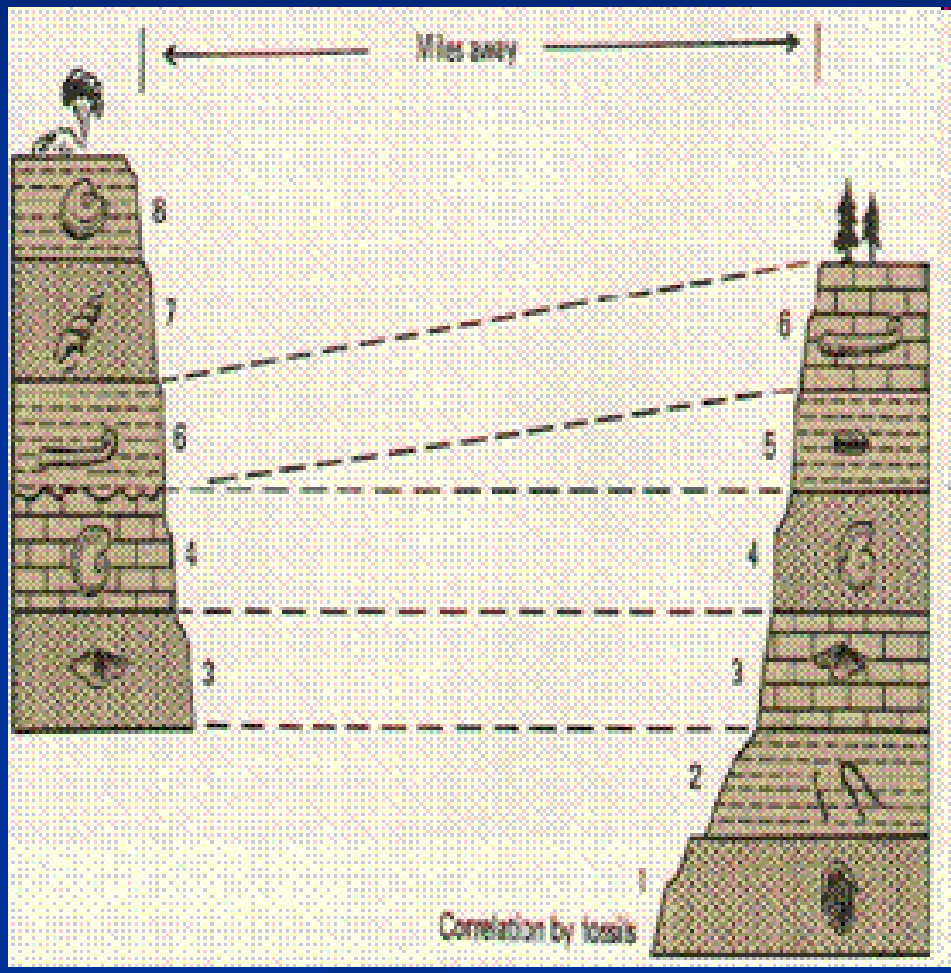
Filling in the Gaps R

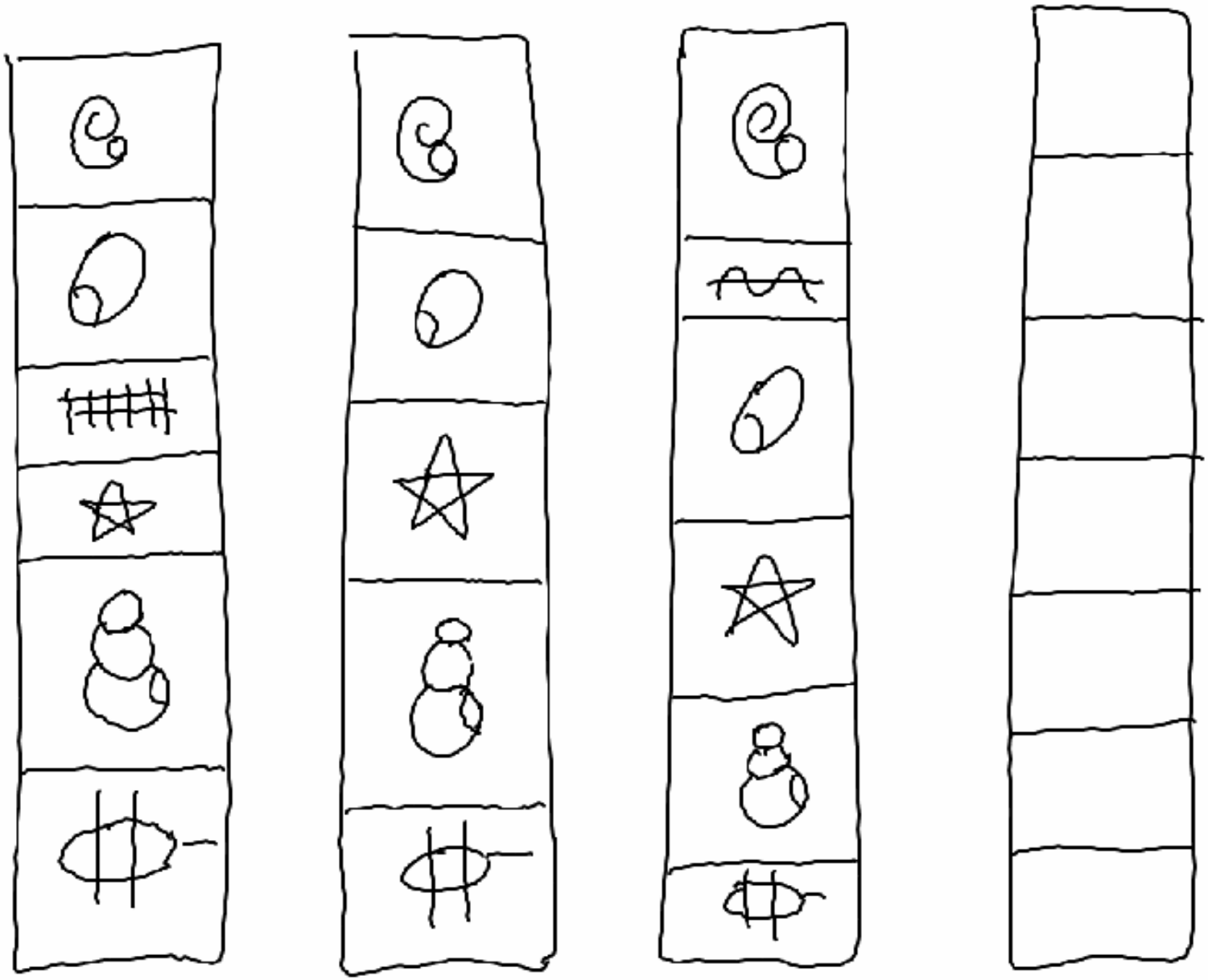
- Correlation – Comparing multiple outcrop sequences with each other so you can find a fuller more complete geologic timeline.

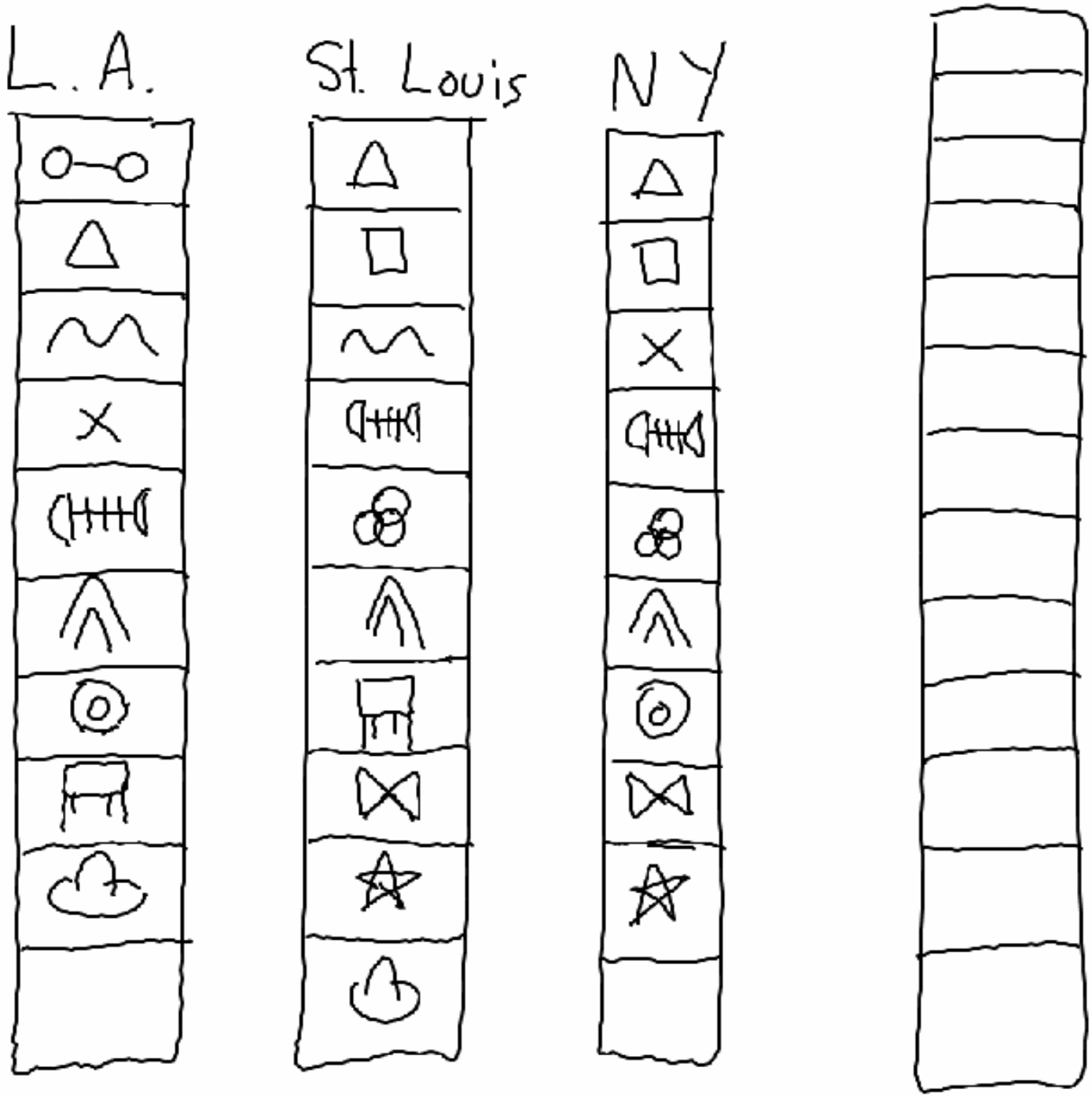
(like comparing 2 incomplete text books)

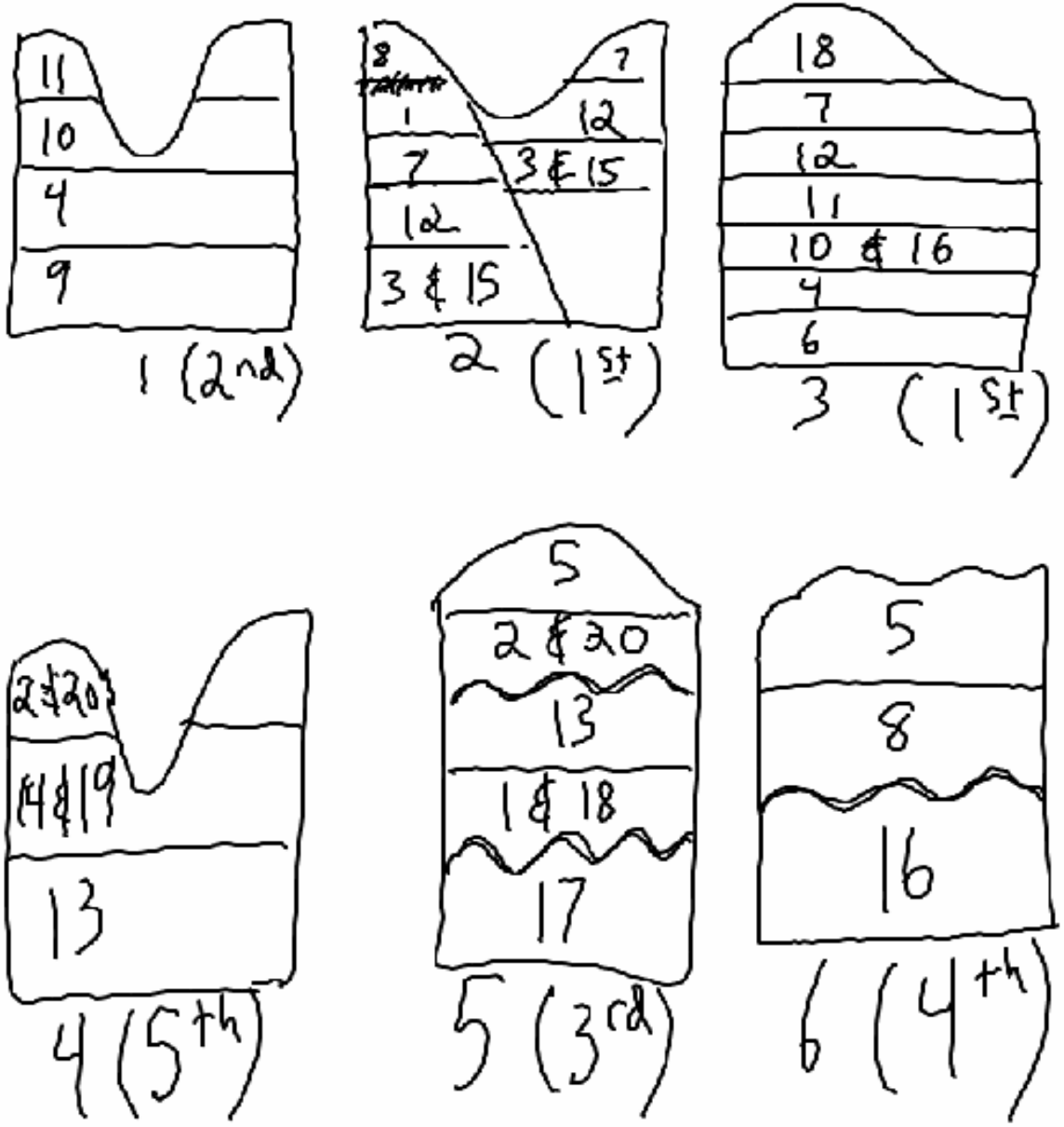
Correlating Rock Layers R








L. A.
St. Louis
NY


11
10
4
9
1 (2nd)
8
7
1
12
7
3 & 15
12
3 & 15
2 (1st)
18
7
12
11
10 & 16
4
6
3 (1st)
2 & 20
14 & 19
13
4 (5th)
5
2 & 20
13
1 & 18
17
5 (3rd)
5
8
16
6 (4th)

Correlation Lab (R)

Pur – Learn to correlate rock

Learn about index fossils

Pro – explain

Data – Correlate rocks,

Questions sheet

Con – What is correlation?

Why do we do it?

What are outcrops?

Index fossils (2 things needed to be useful)?

What do erosional features tell us?

How might a volcanic eruption help?

Absolute Dating

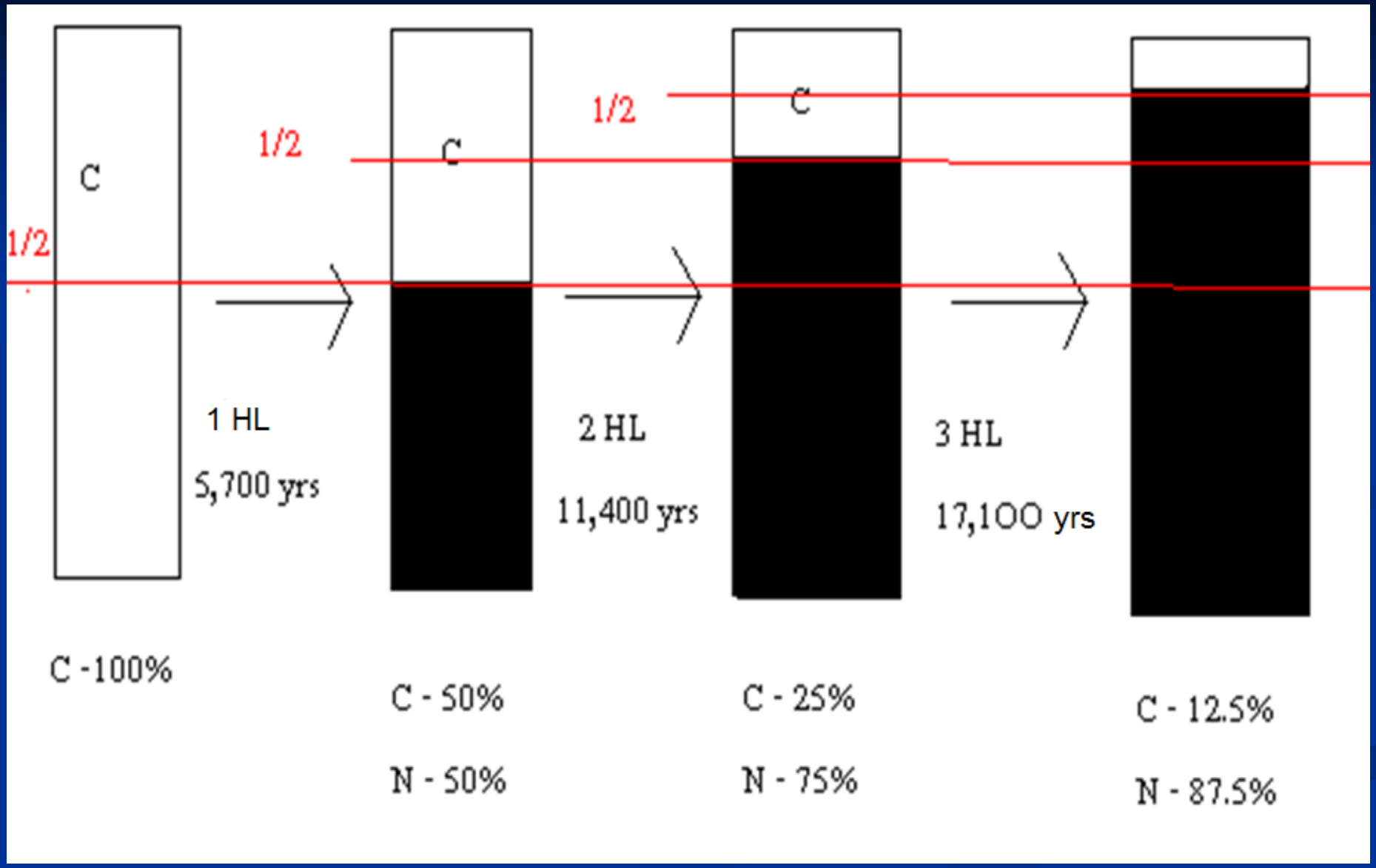
- Absolute dating?
- Absolute Dating – Finding the exact age of something using radioactive decay.

- Radioactive decay?
- Radioactive decay – Finding the speed something is breaking down using half lives.

Half Life

- Half life?
- Half life: The amount of time it takes for "half" of the "remaining" radioactive element to break down and become stable.
- Continually divides in half.
- 100 → 50 → 25 → 12.5 ……
- It will never truly become 0 (ripping paper)

.


C
1/2
1 HL
5,700 yrs
C -100%
C
1/2
C - 50%
N - 50%
2 HL
11,400 yrs
C
1/2
C - 25%
N - 75%
3 HL
17,100 yrs
C - 12.5%
N - 87.5%

Limits to half lives

- Limits to half lives?
- Limits to half lives:
- After ~10 HL's the numbers become too small to read.
- Enough time must pass to be able to get a reading.
- (ex. Half life of 1 million years cannot be read at 10 thousand years)

Different half lives

- Different elements?
- Different elements take different amounts of time to break down and have different uses.

- C14 takes 5,700 years (max reading ~ 50,000yrs)

 - It is good for finding things that "lived" recently

- U238 takes 4.5 Billion years

 - It is good for dating rocks from the far past.

- What affects how much time a half life will take?
- Half lives will decay at a set rate regardless of heat, pressure or outside forces.

Half life lab (R)

Pur – Absolute age, Radioactive decay & half lives

Pro – Explain steps

Data – Half life chart & questions

Con – Absolute age?

Radioactive decay?

Unstable vs stable elements?

Half lives?

Maximum # of half lives we can use and why?

Do you ever hit 0?

Does half life rate ever change?

C14 & U238 (what are they used for)?

YOU ARE DONE!!!!!!!!!!!!!!!!