

Topic 10 – Earth's History

Vocabulary

Absolute age – actual age in years when a geological event occurred using radioactive dating

Carbon 14 dating – the use of carbon 14 (^{14}C) in dating rocks, useful for dating recent materials

Correlation – a process showing the same rock layers are similar in age, material and fossils, located in different regions

Cross cutting relationships – a method of relative dating where igneous intrusions, faults and mineral veins are younger than the rock they cut across

Extrusion – igneous rock that cooled on the surface of the earth

Fossils – solidified remains of once living remains

Half-life – the time for half of a radioactive isotope to decay into a nonradioactive material

Inclusion – piece of an older rock surrounded by solidified younger rock material

Isotope – a variety of an element that has the same atomic number and chemical properties but a different atomic mass

Index fossil – a fossil that is used to determine relative age, must have lived for a short geologic period of time, but is widely distributed

Outgassing – the seeping of gas from the earth's interior.

Radioactive dating – the use of radioactive isotopes to determine the age of bedrock

Radioactive decay – spontaneous decay of a radioactive isotope into a stable atom, each isotope has its own decay rate

Superposition – oldest rock layers are on the bottom and the youngest are on top

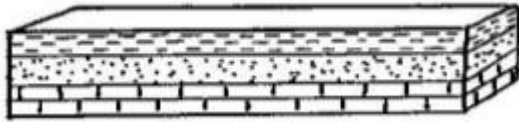
Unconformity – buried eroded rock surface that has gaps in the geologic time record

Overview of Topic

I. Relative Dating

a. Superposition

- Sedimentary layers deposited horizontal
- Sequenced in what happened first to what happened last



Youngest on top

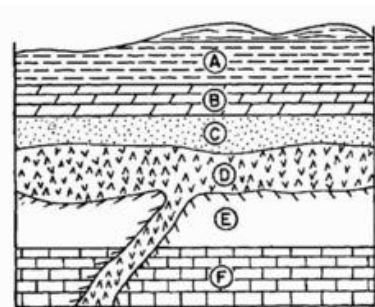
- Shale deposited last
- Sandstone deposited
- Limestone deposited first

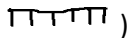
Oldest on bottom

b. Intrusions, extrusions and inclusions

- Intrusions

- Magma intrudes and burns (contact metamorphism) the surrounding rock slightly changing the rock
- Superposition still applies; oldest at bottom, but an intrusion can be the youngest or somewhere in between

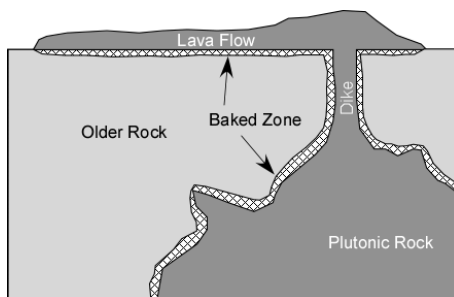


Contact metamorphism () represent burning. Rock cannot be burned if it isn't present.

Intrusion (D) is older than layer (C) because there is no burning on (C). Layer (D) is younger than (E) because it burned layer (E).

- Extrusions

- Magma flows on surface burning everything under it and surface is exposed to the air.



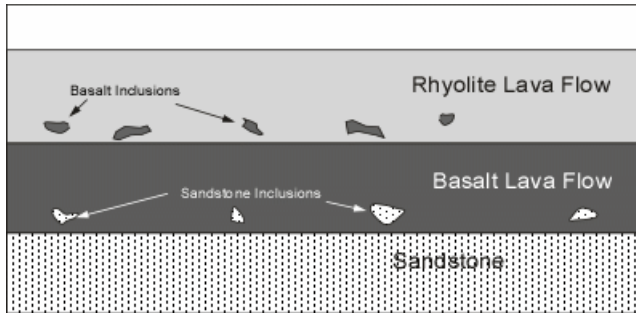
Baked zone is burning
Extrusion is the youngest, it is on top.

Dike is any intrusion to cut across rock layer.

Sill is parallel to rock layer, the lava flow is a sill.

- Inclusions

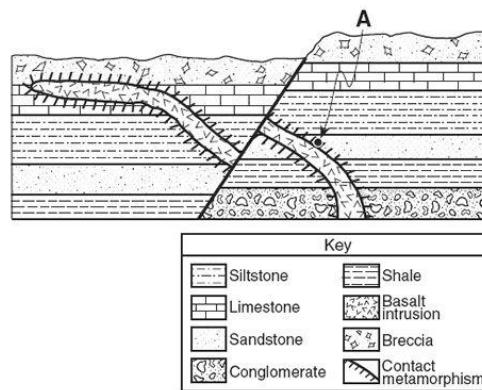
- Pieces of parent bedrock are found in the intrusion or extrusion that flowed within or on the parent rock.



The inclusion are older than the rock they are in.

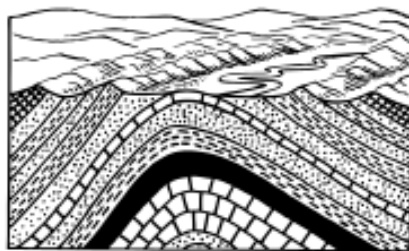
c. Faults and folds

- Superposition applies, older at bottom, faults or folds happen once rock is deposited.



Fault cuts across every layer it is the oldest.

Sometimes the diagrams show younger deposited layers on top, fault didn't break, therefore older.



Folding can only happen if rock layers are already present. Limestone is the oldest, folding happened last.

II. Correlation

a. Exposed bedrock

- Walking in a canyon shows exposed bedrock. What is missing would mostly likely be the same bedrock.
- Fills in the gaps of what should be there

b. Similarities

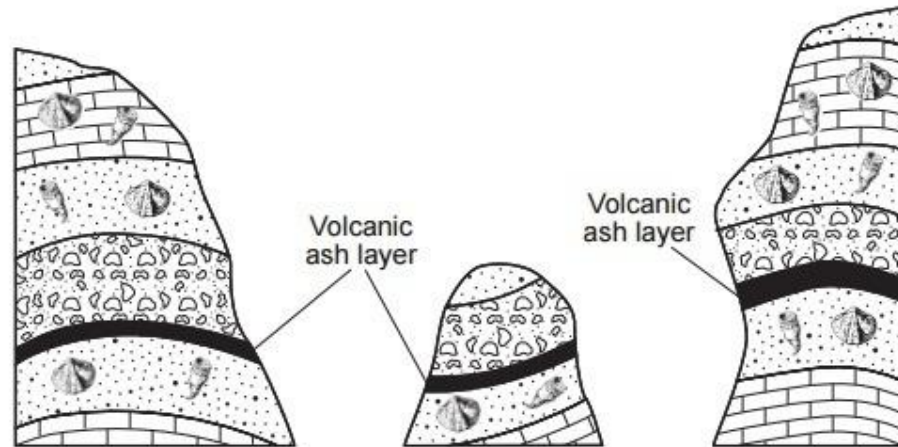
- Look for similar rock types

c. Index fossils

- Similar fossils only found in that layer, not other layers

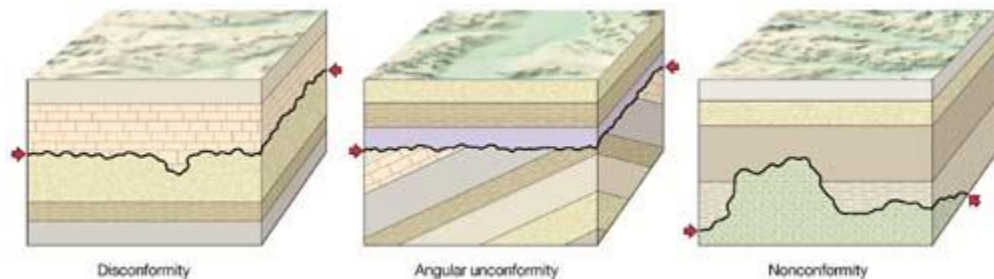
d. Volcanic ash and meteorites

- Covers a very large area



e. Unconformities



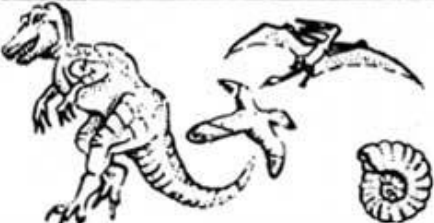


- They are missing layers in the rock record from erosion of material.
- Often indicated by dark heavy line.



III. Geologic History

a. Time Scale

- Broken up by different event usually fossil evidence into smaller sections of time
- Page 8 and 9 ESRT

ERA	PERIOD	EPOCH	AGE (Millions of Years Ago)	SUCCESION OF LIFE	TYPICAL LIFE FORMS
CENOZOIC "Age of Mammals"	Quaternary	Pleistocene	1		Man Woolly mammoth
	Tertiary	Pliocene Miocene Oligocene Eocene Paleocene	12 25 36 60 63		Saber-tooth cat Horses Primitive mammals
MESOZOIC "Age of Reptiles"	Cretaceous	Upper Lower	135		Dinosaurs First flowering plants
	Jurassic		181		First birds
	Triassic		230		Ammonoids
PALEOZOIC "Age of Invertebrates"	Permian		280		Reptiles
	Pennsylvanian Mississippian		310 345		Insects Coal forests Amphibians
	Devonian		405		Brachiopods Fish
	Silurian		425		Crinoids
	Ordovician		500		Nautiloids
	Cambrian		600		Trilobites
PRECAMBRIAN ERAS			3,000		Algae Worm tubes Indirect evidence of life
PROTEROZOIC ERA					
ARCHEOZOIC ERA					

This an example of how geologic is set up using relative dating. Older simpler fossil evidence is found in deepest layers, while more complex in top layers. Radioactive dating is also used to get a more accurate time.

- IV. Absolute Dating
 a. Isotopes and decay
 - Page 1 ESRT

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

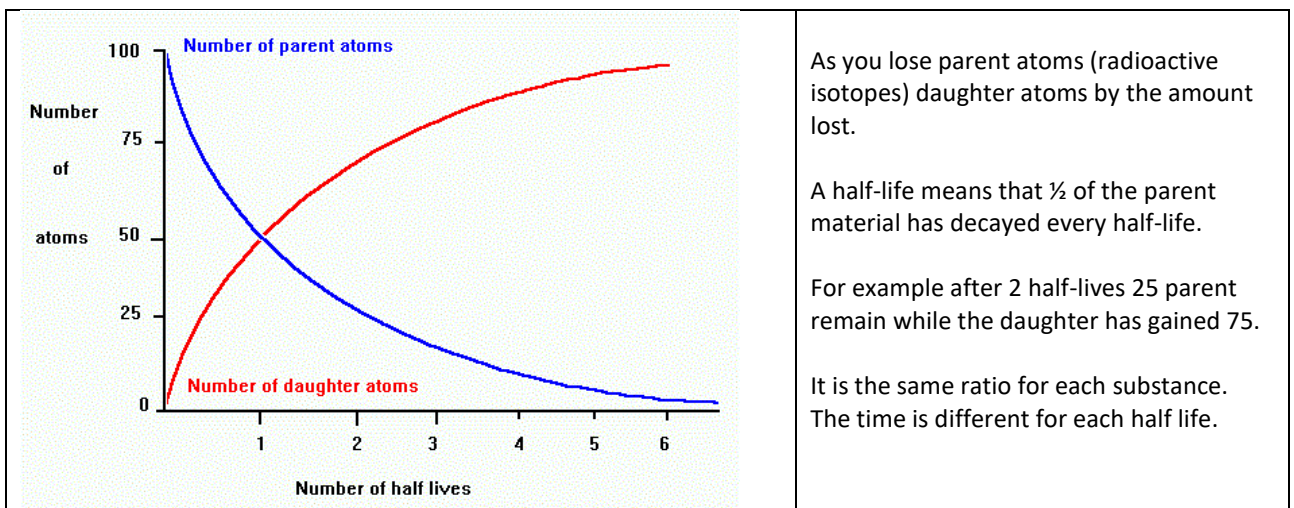
These are the only isotopes that will be asked about. For example what is the half life of carbon – 14? 5,700 year for one half life. Two half lifes is 2×5700 , which is 11,400 years. Carbon 14 decays into nitrogen 14, the disintergration.

Carbon 14 is most useful for organisms that are believed to be relativley young. Very old organisms such as Trilobites had most of the Carbon 14 decayto be accurate. You need to use a isotope with a lnger half – life.

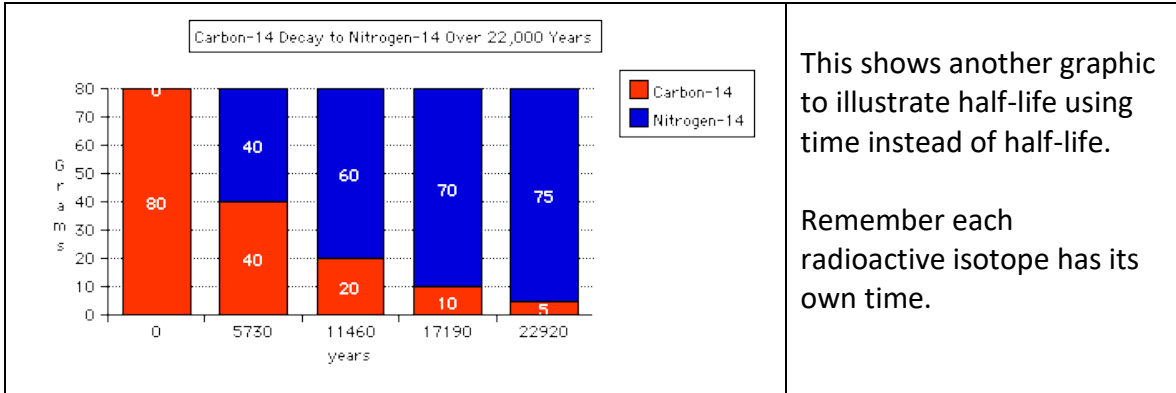
- Uranium 238

Used to determine the age of the Earth, currently is believed to be 4,600,000,000 years old. 4.6 billion years. 4,600 million years

- Half – life



b. Radioactive dating
 - Carbon 14 dating



This shows another graphic to illustrate half-life using time instead of half-life.

Remember each radioactive isotope has its own time.

0 Ha	1 Half life	2 Half lifes	3 Half lifes
100 % Parent (Black)	50% Parent (black) 50% Daughter (white)	25% Parent (Black) 75% Daughter (White)	12.5% Parent (Black) 87.5% Duaghter (White)

V. Page 8 and 9 ESRT

This portion of the reference table is meant to be used like a book. Don't fold one side under another.

The columns along the top of pages 8 & 9 intersect with the rows across pages 8 & 9.

For example:

What Amminoid species index fossil in New York State can be found in bed rock from the Devonian period and how many years ago was this?

You should see the letter G, which is found along the bottom of page 8, in this example it is *Manticoceras* and it is approximately 359 to 416 million years old

<https://www.youtube.com/watch?v=bMBgiwevVD8> page 8

<https://www.youtube.com/watch?v=fqMQhSVUujs> page 9

This is a difficult table to use. There are two timelines representing the events from the beginning of Earth, the other is for the Paleozoic, Mesozoic and Cenozoic eras.

It represents fossils in New York, rock record in New York, Life on Earth and important geologic events on Earth.

Use the worksheet and the answer key to sharpen your skill from the ESRT page 8 and 9.

Directions: Use pages 8 and 9 of your ESRT to complete the worksheet.

1. What is the Age of the Earth in millions of years? Billions of years?
2. How many Periods in time are indicated in the geologic timeline?
3. What group of organisms went extinct at the end of the Paleozoic era?
4. What was the life on Earth during the Jurassic Period?
5. What period was *Cooksonia* abundant in New York State?
6. What is the period of time and how many years ago did *Coelophysis* roamed New York State?
7. What major extinction signaled that start of the Cenozoic era?
8. What is the name of the *Trilobite*, *Ammonoid* and *Nautiloid* that existed during the same Period of time?
9. Give examples of the fossils found in the rock record that existed in New York State approximately 430 million years ago.
10. *Graptolites* are now extinct as a species. List the *Graptolite* index species found in NY State?

11. What is the *era* where mammals are considered to be dominant?

Answers to page 8 and 9 ESRT questions

1. 4,600 million or 4,600,000,000 years or 4.6 billion years
2. 12 or 13 periods
3. Dinosaurs
4. Dinosaurs
5. Silurian
6. Triassic about 200 million years ago
7. Dinosaurs
8. Trilobite – *Phacops*: Amminoid - *Manticoeras*: Nautiloid – *Cetroceras*
9. Nautiloids, Crinoids, Eurypterids, Cooksonia, Cystiphyllum, Eospirifer
10. *Tetragraptus*, *Dicellograptus*
11. Cenozoic

Earth Science Reference Table – (ESRT)

Pages from ESRT used in Topic 10.

Page 1, 2, 3, 8 and 9

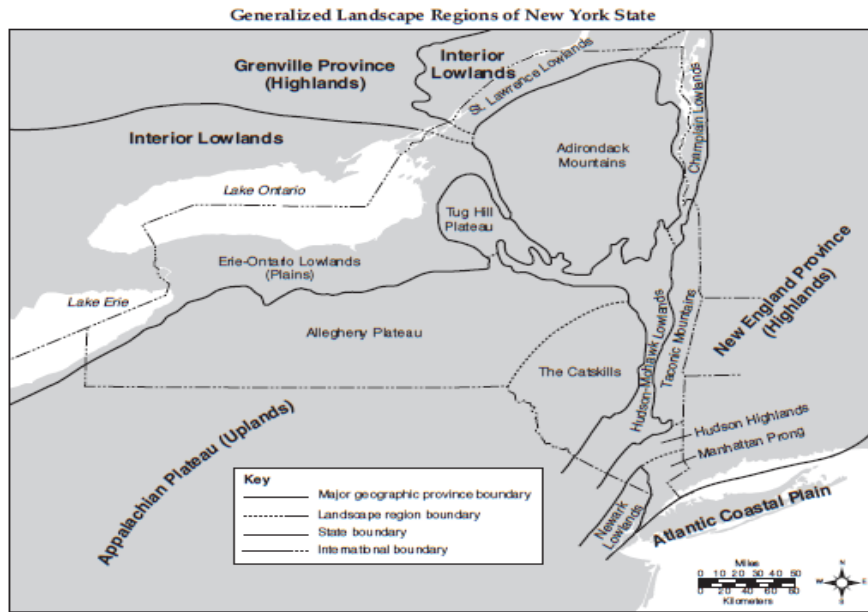
Radioactive Decay Data page 1

Radioactive Decay Data

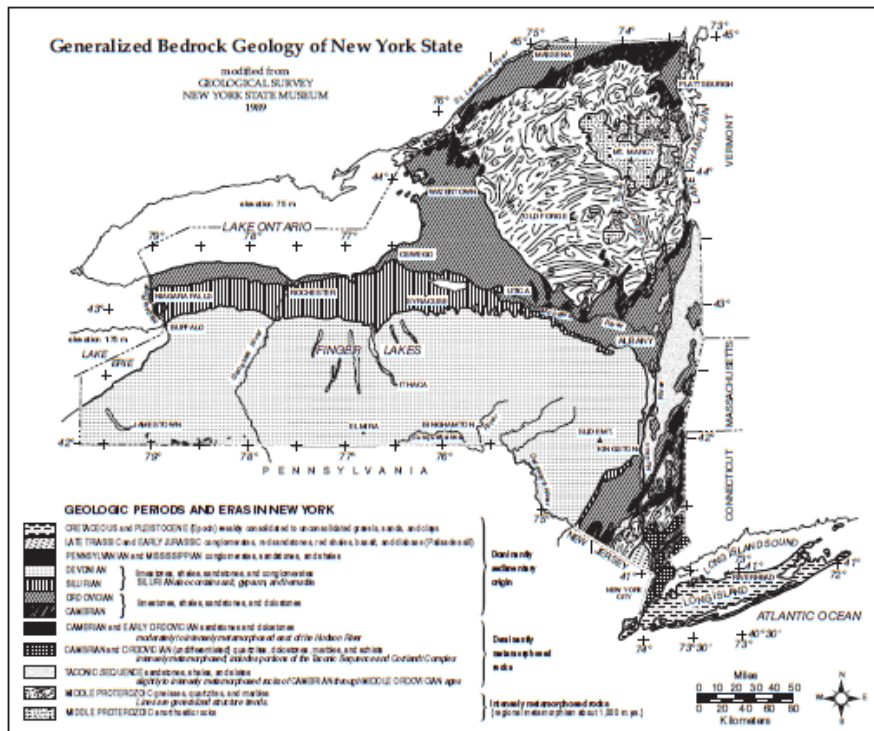
RADIOACTIVE ISOTOPE	DISINTEGRATION	HALF-LIFE (years)
Carbon-14	$^{14}\text{C} \rightarrow ^{14}\text{N}$	5.7×10^3
Potassium-40	$^{40}\text{K} \begin{cases} \rightarrow ^{40}\text{Ar} \\ \rightarrow ^{40}\text{Ca} \end{cases}$	1.3×10^9
Uranium-238	$^{238}\text{U} \rightarrow ^{206}\text{Pb}$	4.5×10^9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

- The table shows disintegration of parent atoms into daughter atoms and the half-life of each.
- The Regents should just reference these unless a table or specific data is given in the exam.

Generalized Bedrock Regions of New York page 2



Generalized Bedrock Geology of New York State page 3



- These pages are used together with page 8 and 9. If you identify the period of time of an organism, let's say Devonian you can find the bedrock type (limestone, sandstone) as well as the landscape region in New York (Alleghany Plateau).

Geologic History of New York State pages 8 and 9

- Do a YouTube search and view the videos.
- Questions might ask about what bedrock type you would find *Phacops*. Look to find the period then use page 3 to find the bedrock type, then page 2 to find the landscape region. You must work in this order to find the landscape region.