absolute age the numeric age of a rock


South Rim, Grand Canyon National Park

Four Absolute Dating Methods:

1. Erosion Rate

- practical only for rocks that formed in the past 20,000 years.

Four Absolute Dating Methods, *continued*

2. Deposition Rate

- geologists know the rates of deposition for sedimentary rocks.
- provides only an estimate of absolute age.

End Of Slide

Four Absolute Dating Methods, *continued*

3. Varve Count

varve a layer of sediment deposited annually in a lake

- varves can be counted like tree rings to determine the age of the sedimentary deposit.

Reading check

How are varves like tree rings?

End Of Slide

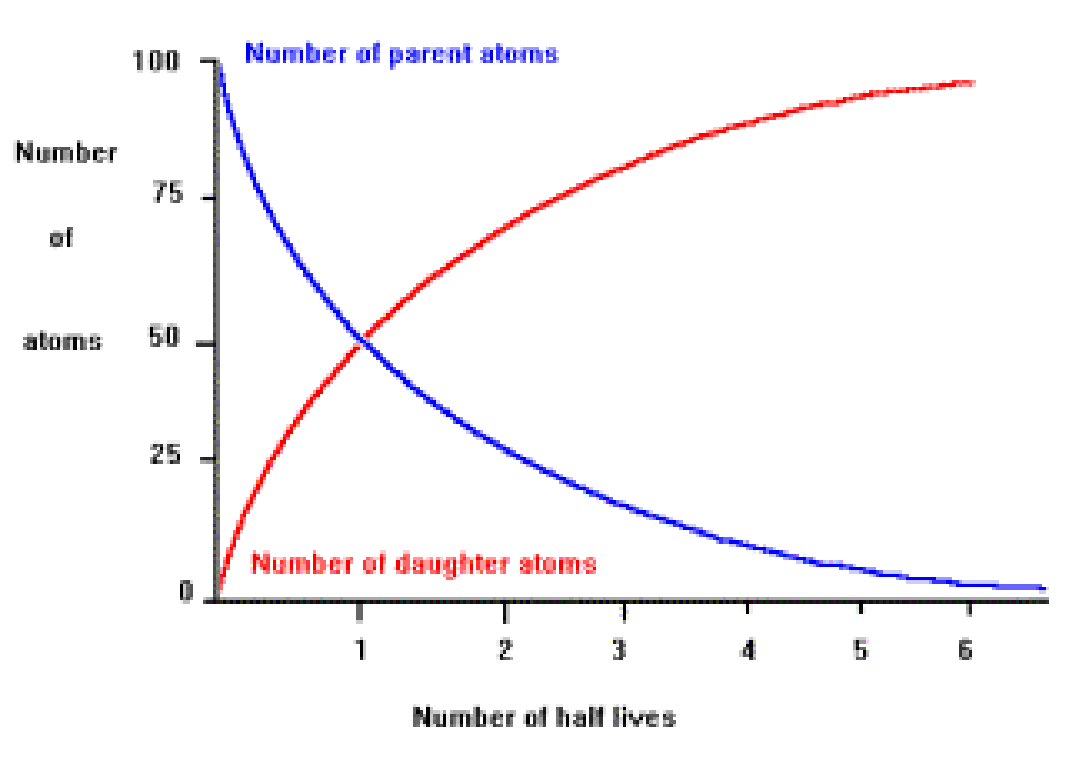
Reading check, *continued*

How are varves like tree rings?

Varves are like tree rings in that varves are laid down each year. Thus, counting varves can reveal the age of sedimentary deposits.

Four Absolute Dating Methods

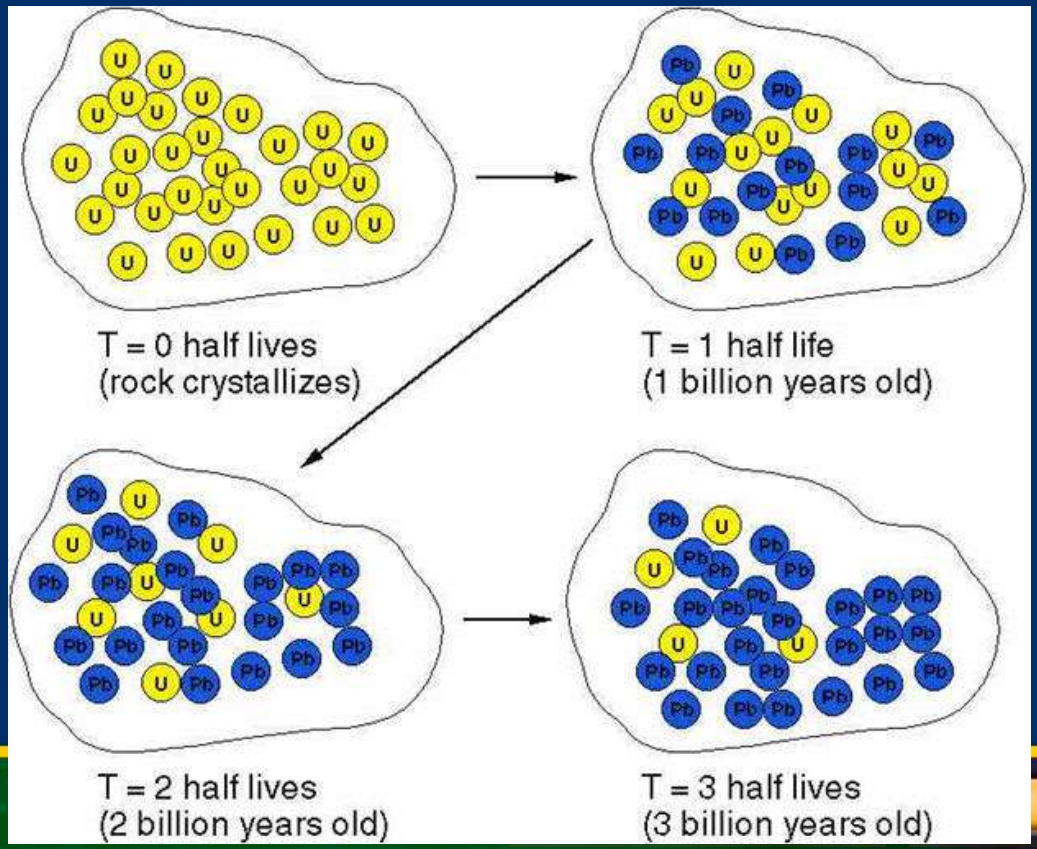
4. **radiometric/radioactive dating** uses the natural breakdown of radioactive atoms to measure the age of rock



End Of Slide
Resources

Four Absolute Dating Methods

- Rocks generally contain small amounts of radioactive material that can act as natural clocks.



End Of Slide
Resources

Radiometric Dating, cont..

- *Radioactive isotope:*
  - A type of atom that is unstable and eventually breaks down/decays into another type of atom
- These can be counted to determine age.

	Half-Life	Time unit	Emitter
Uranium-238	4,468	billion of years	alpha
Thorium-234	24,10	days	beta -
Protactinium-234	6,70	hours	beta -
Uranium-234	245 500	years	alpha
Thorium-230	75380	years	alpha
Radium-226	1 600	years	alpha
Radon-222	3,8235	days	alpha
Polonium-218	3,10	minutes	alpha
Plomb-214	26,8	minutes	beta -
Bismuth-214	19,9	minutes	beta -
Polonium-214	164,3	microseconds	alpha
Plomb-210	22,3	years	beta
Bismuth-210	5,015	years	beta
Polonium-210	138,376	days	alpha
Plomb-206	Stable		

Radiometric Dating, *continued*

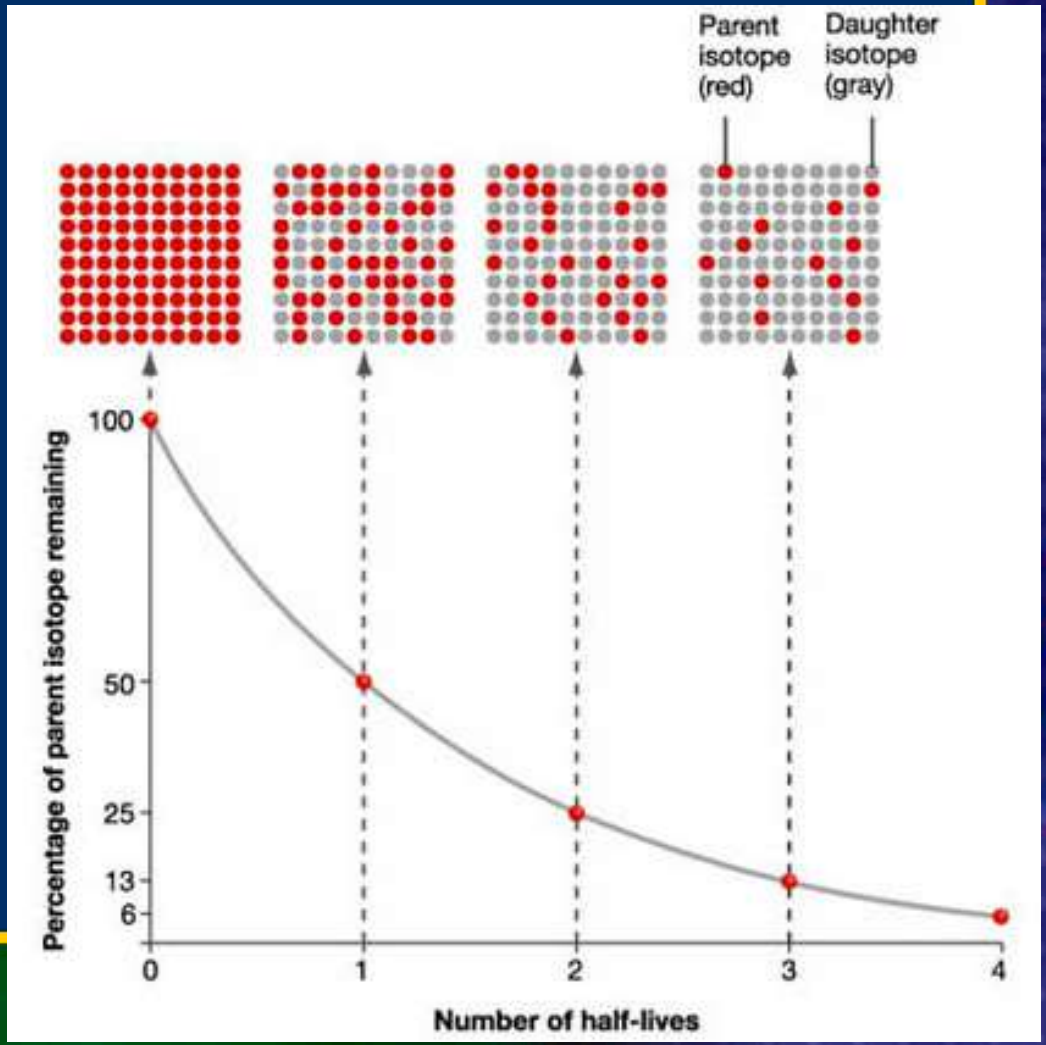
- Steps:
  1. measure the concentration of the *parent isotope (ex: U-235)*
  2. measure the concentration of the *daughter isotopes (*ex: Pb-205)
  3. Then, using the known decay rate, calculate the age of the rock.

End Of Slide

Radiometric Dating, *continued*

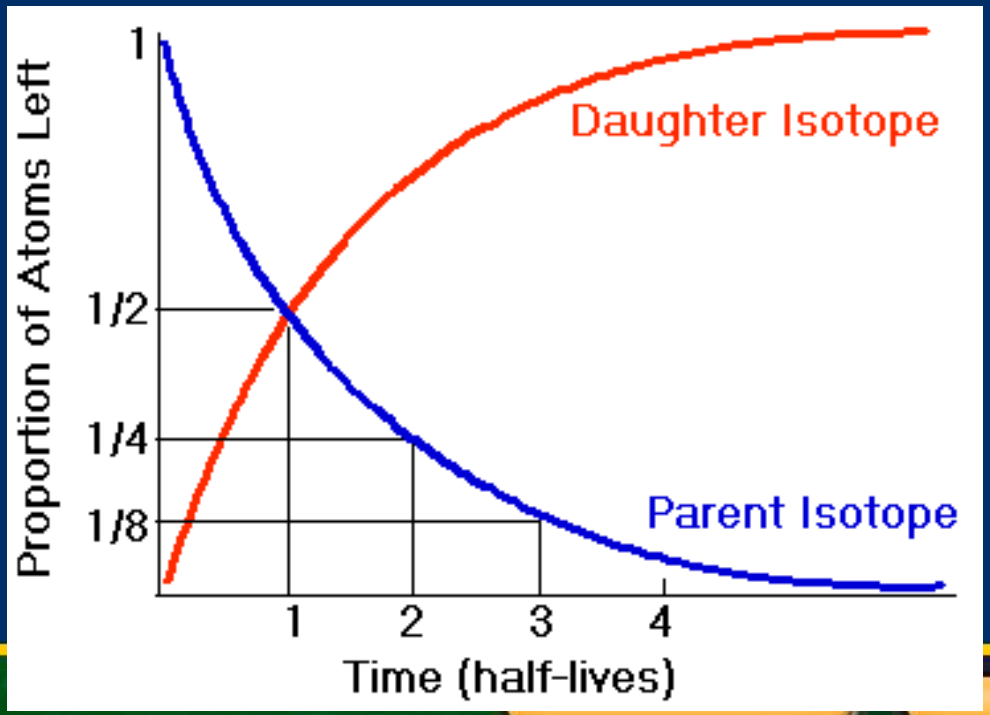
half-life time required for half of a sample to decay

- half life is constant (always the same)



Radiometric Dating, *continued*

- The greater the percentage of daughter isotopes present in a sample, the older the rock is.



Radiometric Dating, *continued*

Geologically Useful Radioactive Isotopes

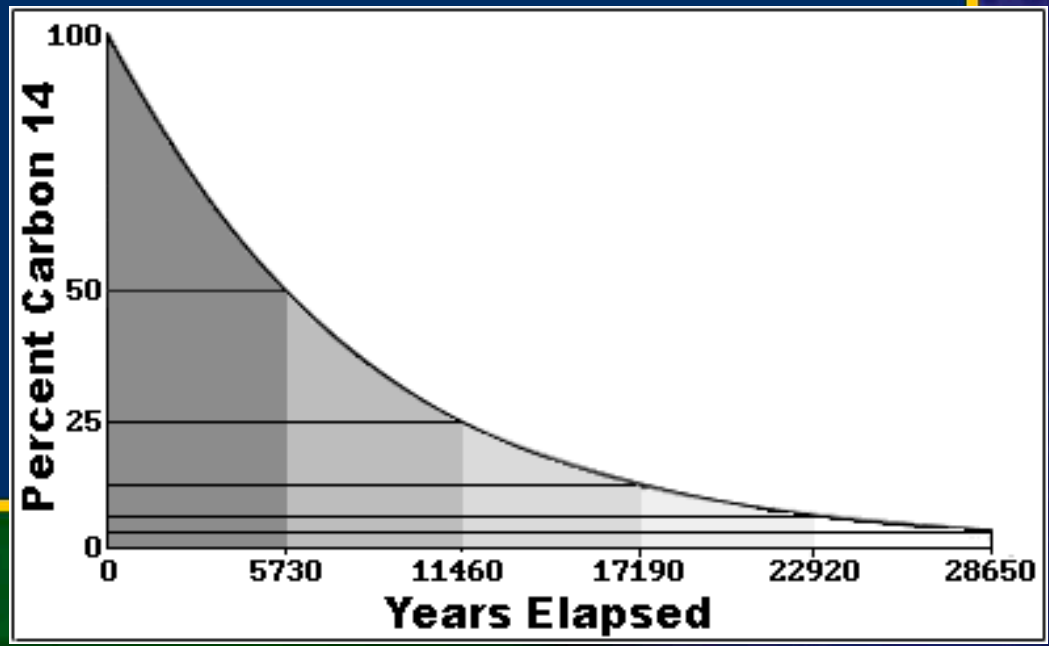
- Uranium-238 (^{238}U)
  - 4,470,000,000 half life
  - Decays into lead-206
  - useful for rocks over 10 million years old.
- Potassium-40 (^{40}K)
  - half-life of 1.25 billion years
  - Decays into calcium-40
  - Useful for rocks between 50,000 and 4.6 billion years old.

End Of Slide

Radiometric Dating, *continued*

Geologically Useful Radioactive Isotopes

- Carbon-14
  - Half life of 5,730 years
  - Decays into Nitrogen-14
  - Useful to determining age of substances up to 60,000 years old



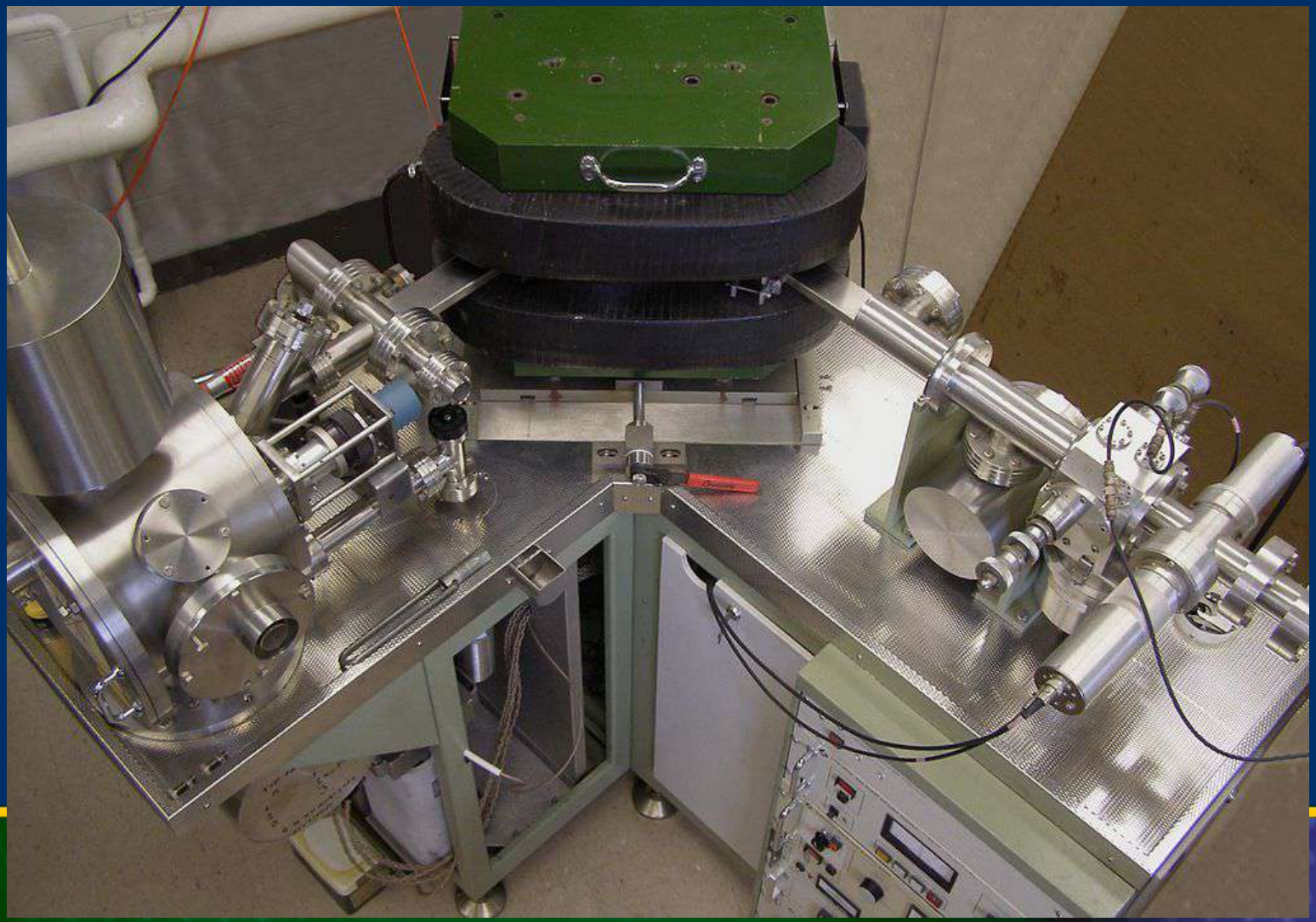
Radiometric Dating, *continued*

- first used in 1907
- Now is the main way we date things

- Requirements
  - Rock cannot have been altered
    - Take multiple measurements from different locations of rock body
  - Use multiple isotopes
    - For example, a study of the Amitsoq gneisses from western Greenland used five different radiometric dating methods to examine twelve samples and achieved agreement to within 30 Ma (million years) on an age of 3,640 Ma

End Of Slide

- Mass spectrometer is used for radioactive dating



In conclusion

- There are over 40 radiometric dating methods
- All the different dating methods agree
- Decay rates have been measured over 80 years with no observed changes
- The math behind this method is relatively simple
- This stuff is legit.

Objectives

- **Describe** four ways in which entire organisms can be preserved as fossils.
- **List** five examples of fossilized traces of organisms.
- **Describe** how index fossils can be used to determine the age of rocks.

Interpreting the Fossil Record

fossils the trace or remains of an organism that lived long ago, most commonly preserved in sedimentary rock

paleontology the scientific study of fossils

- Fossils are an important source of information for finding the relative and absolute ages of rocks.
- Fossils also provide clues to past geologic events, climates, and the evolution of living things over time.

End Of Slide

Interpreting the Fossil Record, *continued*

- Almost all fossils are discovered in sedimentary rock.
- The fossil record provides information about the geologic history of Earth.
- Scientists can use this information to learn about how environmental changes have affected living organisms.

End Of Slide

Fossilization

- Only dead organisms that are buried quickly or protected from decay can become fossils.
- Generally only the hard parts of organisms, such as wood, bones, shells, and teeth, become fossils.
- In rare cases, an entire organism may be preserved.
- In some types of fossils, only a replica of the original organism remains. Others merely provide evidence that life once existed.

End Of Slide

Fossilization

Mummification

- Mummified remains are often found in very dry places, because most bacteria which cause decay cannot survive in these places.
- Some ancient civilizations mummified their daed by carefully extracting the body's internal organs and then wrapping the body in carefully prepared strips of cloth.

End Of Slide

Fossilization

Amber

- Hardened tree sap is called *amber*. Insects become trapped in the sticky sap and are preserved when the sap hardens.
- In many cases, delicate features such as legs and antennae have been preserved. In rare cases, DNA has been recovered from amber.

Fossilization

Tar Seeps

- When thick petroleum oozes to Earth's surface, the petroleum forms a tar seep.
- Tar seeps are commonly covered by water. Animals that come to drink the water can become trapped in the sticky tar.
- The remains of the trapped animals are covered by the tar and preserved.

End Of Slide
Chapter menu
Resources

Fossilization

Freezing

- The low temperatures of frozen soil and ice can protect and preserve organisms.
- Because most bacteria cannot survive freezing temperatures, organisms that are buried in frozen soil or ice do not decay.

Fossilization

Petrification

- Mineral solutions such as groundwater replace the original organic materials that were covered by layers of sediment with new materials.
- Some common petrifying minerals are silica, calcite, and pyrite.
- The substitution of minerals for organic material other results in the formation of a nearly perfect mineral replica of the original organism.

End Of Slide

Types of Fossils

trace fossil a fossilized mark that formed in sedimentary rock by the movement of an animal on or within soft sediment

- In some cases, no part of the original organism survives in fossil form. But the fossilized evidence of past animal movement can still provide information about prehistoric life.
- A trace fossils in an important clue to the animal's appearance and activities.

End Of Slide

Reading Check

What is a trace fossil?

Reading Check

What is a trace fossil?

A trace fossil is a fossilized evidence of past animal movement, such as tracks, footprints, borings, or burrows, that can provide information about prehistoric life.

Types of Fossils

Imprints

- Carbonized imprints of leaves, stems, flowers, and fish made in soft mud or clay have been found preserved in sedimentary rock.
- When original organic material partially decays, it leaves behind a carbon-rich film. An imprint displays the surface features of the organism.

End Of Slide

Types of Fossils

Molds and Casts

- Shells often leave empty cavities called *molds* within hardened sediment. When a shell is buried, its remains eventually decay and leave an empty space.
- When sand or mud fills a mold and hardens, a natural cast forms.
- A cast is a replica of the original organism.

End Of Slide

Types of Fossils

Coprolites

- Fossilized dung or waste materials from ancient animals are called *coprolites*.
- They can be cut into thin sections and observed through a microscope. The materials identified in these sections reveal the feeding habits of ancient animals, such as dinosaurs.

Types of Fossils

Gastroliths

- Some dinosaurs had stones in their digestive systems to help grind their food. In many cases, these stones, which are called *gastroliths,* survives as fossils.
- Gastroliths can often be recognized by their smooth, polished surfaces and by their close proximity to dinosaurs remains.

End Of Slide
Chapter menu
Resources

Index Fossils

Index fossils

- Index fossil a fossil that is used to establish the age of rock layers because it is distinct, abundant, and widespread and existed for only a short span of geologic time.
- Paleontologists can use index fossils to determine the relative ages of the rock layers in which the fossils are located.

Index Fossils

Index fossils

- To be an index fossil, a fossil must be present in rocks scattered over a large region, and it must have features that clearly distinguish it from other fossils.
- In addition, organisms from which the fossil formed must have lived during a short span of geologic time, and the fossil must occur in fairly large numbers within the rock layers.

End Of Slide

Index Fossils and Absolute Age

- Scientists can use index fossils to estimate absolute ages of specific rock layers.
- Because organisms that formed index fossils lived during short spans of geologic time, the rock layer in which an index fossil was discovered can be dated accurately.
- Scientists can also use index fossils to date rock layers in separate area.
- Index fossils are used to help locate rock layers that are likely to contain oil and natural gas deposits.

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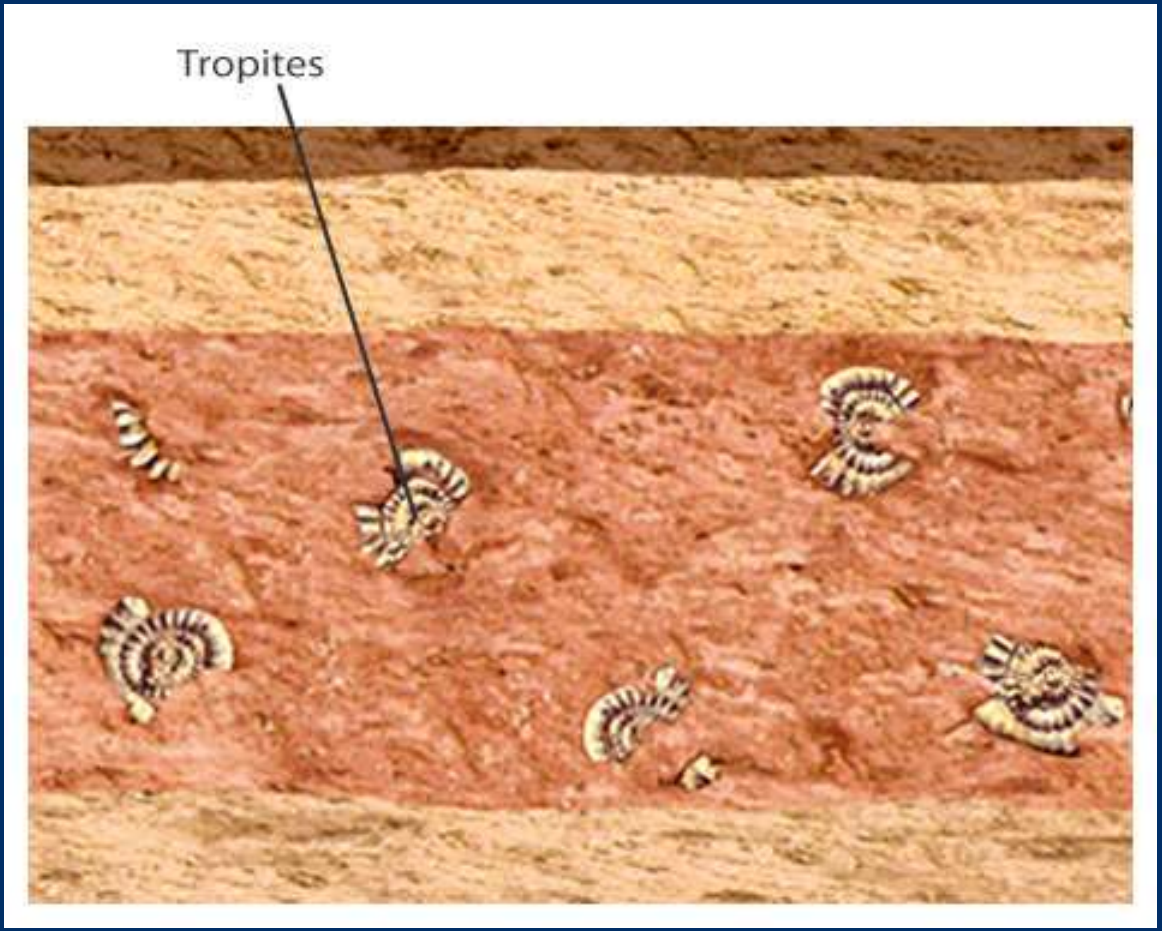
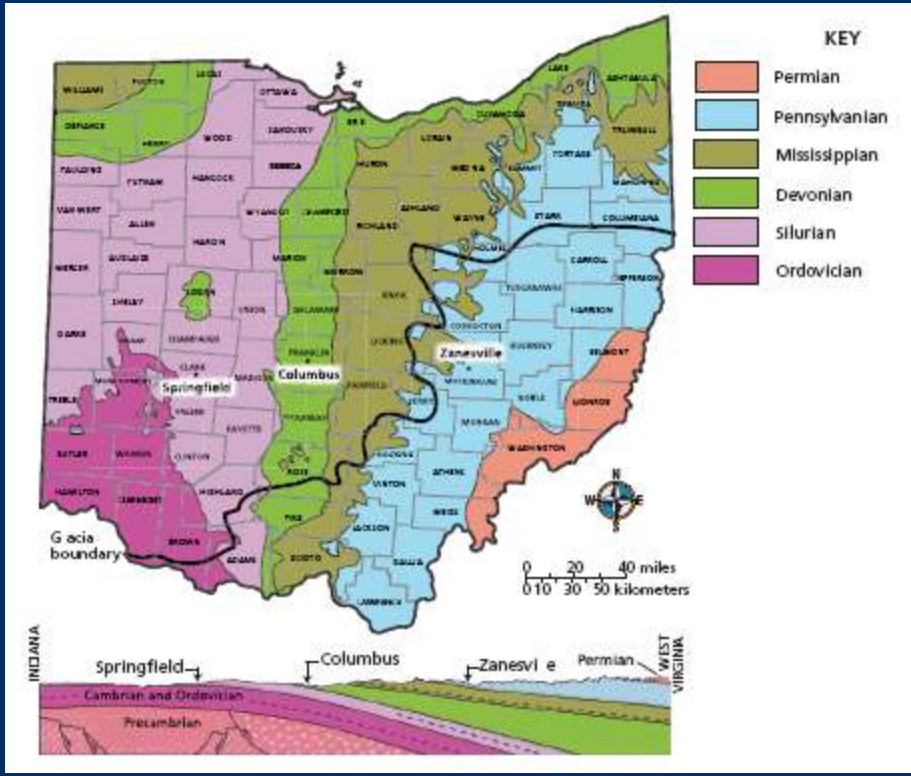
Index Fossils



Maps in Action

Geologic Map of Bedrock in Ohio



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Brain Food Video Quiz

End Of Slide

Multiple Choice

1. A scientist used radiometric dating during an investigation. The scientist used this method because he or she wanted to determine the

A. relative age of rocks.

B. absolute age of rocks.

C. climate of a past era.

D. fossil types in a rock.

Multiple Choice, *continued*

1. A scientist used radiometric dating during an investigation. The scientist used this method because he or she wanted to determine the

A. relative age of rocks.

B. absolute age of rocks.

C. climate of a past era.

D. fossil types in a rock.

Multiple Choice, *continued*

2. Fossils that provide direct evidence of the feeding habits of ancient animals are known as

F. coprolites

G. molds and casts

H. imprints

I. trace fossils

Multiple Choice, *continued*

2. Fossils that provide direct evidence of the feeding habits of ancient animals are known as

F. coprolites

G. molds and casts

H.imprints

I. trace fossils

Multiple Choice, *continued*

3. One way to estimate the absolute age of rock is

A. nonconformity
B. varve count
C. the law of superposition
D. the law of crosscutting relationships

Multiple Choice, *continued*

3. One way to estimate the absolute age of rock is

A. nonconformity

B. varve count

C. the law of superposition

D. the law of crosscutting relationships

Multiple Choice, *continued*

4. To be an index fossil, a fossil must

F. be present in rocks that are scattered over a small geographic area

G. contain remains of organisms that lived for a long period of geologic time

H. occur in small numbers within the rock layers

I. have features that clearly distinguish it from other fossils

Multiple Choice, *continued*

4. To be an index fossil, a fossil must

F. be present in rocks that are scattered over a small geographic area

G. contain remains of organisms that lived for a long period of geologic time

H. occur in small numbers within the rock layers

I. have features that clearly distinguish it from other fossils

Multiple Choice, *continued*

5. Which of the following statements best describes the relationship between the law of superposition and the principle of original horizontality?

A. Both describe the deposition of sediments in horizontal layers.

B. Both conclude that Earth is more than 100,000 years old.

C. Both indicate the absolute age of layers of rock.

D. Both recognize that the geologic processes in the past are the same as those at work now.

Multiple Choice, *continued*

5. Which of the following statements best describes the relationship between the law of superposition and the principle of original horizontality?

A. Both describe the deposition of sediments in horizontal layers.

B. Both conclude that Earth is more than 100,000 years old.

C. Both indicate the absolute age of layers of rock.

D. Both recognize that the geologic processes in the past are the same as those at work now.

Short Response

6. What is the name for a type of fossil that can be used to establish the age of rock?

Short Response

6. What is the name for a type of fossil that can be used to establish the age of rock?

Index fossil

Reading Skills

Read the passage below. Then, answer questions 7–10.

Illinois Nodules

Around three hundred million years ago, the region that is now Illinois had a very different climate. Swamps and marshes covered much of the area. Scientists estimate that no fewer than 500 species lived in this ancient environment. Today, the remains of these organisms are found preserved within structures known as nodules. Nodules are round or oblong structures that are usually composed of cemented sediments. Sometimes, these nodules contain the fossilized hard parts of plants and animals. The Illinois nodules are extremely rare because many contain finely detailed impressions of the soft parts of the organisms together with the hard parts. Because they are rare, these nodules are desired for their incredible scientific value and may be found in fossil collections around the world.

Reading Skills, *continued*

7. According to the passage above, which of the following statements about nodules is correct?

A. Nodules are rarely around or oblong.

B. Nodules are usually composed of cemented sediments.

C. Nodules are rarely found outside of Illinois.

D. Nodules will always contain fossils.

Reading Skills, *continued*

7. According to the passage above, which of the following statements about nodules is correct?

A. Nodules are rarely around or oblong.

B. Nodules are usually composed of cemented sediments.

C. Nodules are rarely found outside of Illinois.

D. Nodules will always contain fossils.

Reading Skills, *continued*

8. What is the most unusual feature of the nodules found in modern-day Illinois?

F. their bright coloration

G. the fact that they come in many more unusual shapes than other nodules

H. the fact that they contain both the soft and hard parts of animals

I. their extremely heavy weight

Reading Skills, *continued*

8. What is the most unusual feature of the nodules found in modern-day Illinois?

F. their bright coloration

G. the fact that they come in many more unusual shapes than other nodules

H. the fact that they contain both the soft and hard parts of animals

I. their extremely heavy weight

Reading Skills, *continued*

9. Which of the following statements can be inferred from the information in the passage?

A. Illinois nodules are sought by scientists.

B. Nodules can be purchased from the state.

C. Similar nodules can be found in nearby Iowa.

D. Nodules contain dinosaur fossils.

Reading Skills, *continued*

9. Which of the following statements can be inferred from the information in the passage?

A. Illinois nodules are sought by scientists.

B. Nodules can be purchased from the state.

C. Similar nodules can be found in nearby Iowa.

D. Nodules contain dinosaur fossils.

Reading Skills, *continued*

10. What might scientists learn from nodules that contain the soft and hard parts of an animal?

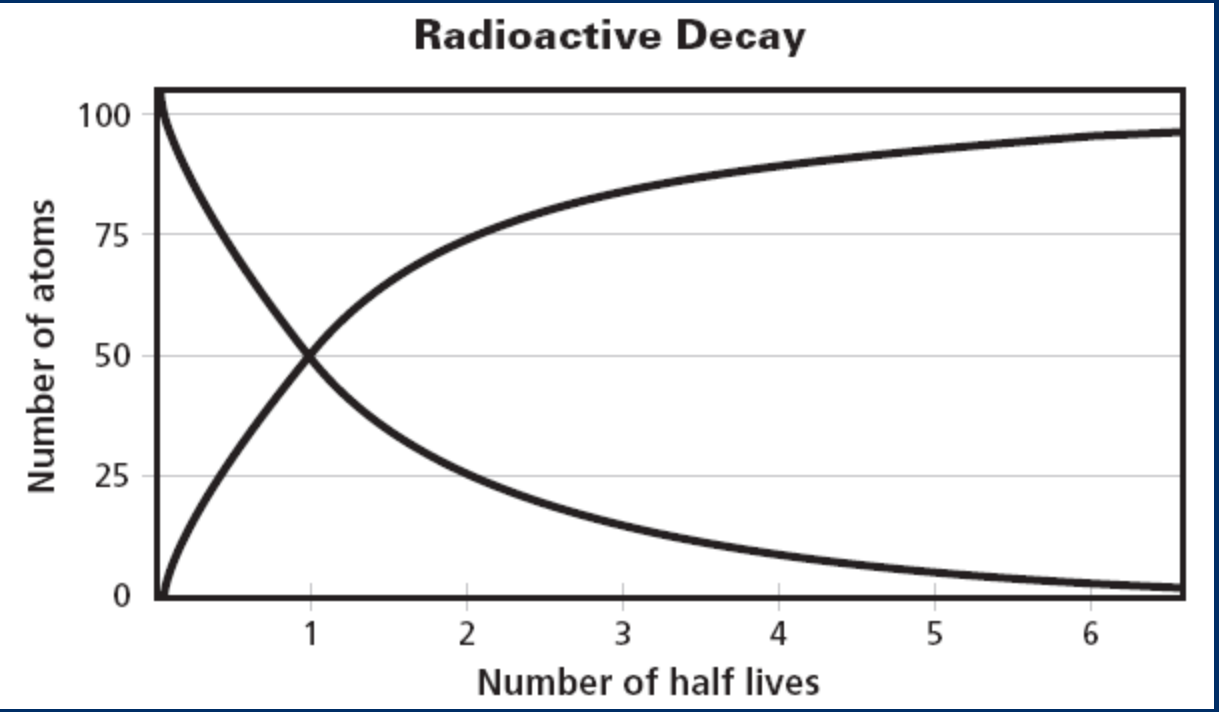
Reading Skills, *continued*

10. What might scientists learn from nodules that contain the soft and hard parts of an animal?

Your answer should include the following points: Fossils that include the soft parts of animals are rare and may include impressions of organs or muscles; scientists can use these animal parts to learn more about the internal structures and body systems of ancient animals; scientists can compare the internal systems of ancient animals to the internal systems of modern animals in order to see how different animals and body systems have changed over time.

Interpreting Graphics

Use the figure below to answer question 11. The graph shows the rate of radioactive decay.



Interpreting Graphics, *continued*

11. How many half-lives have passed when the number of daughter atoms is approximately three times the number of parent atoms?

A. one

B. two

C. three

D. four a waning moon.

Interpreting Graphics, *continued*

11. How many half-lives have passed when the number of daughter atoms is approximately three times the number of parent atoms?

A. one

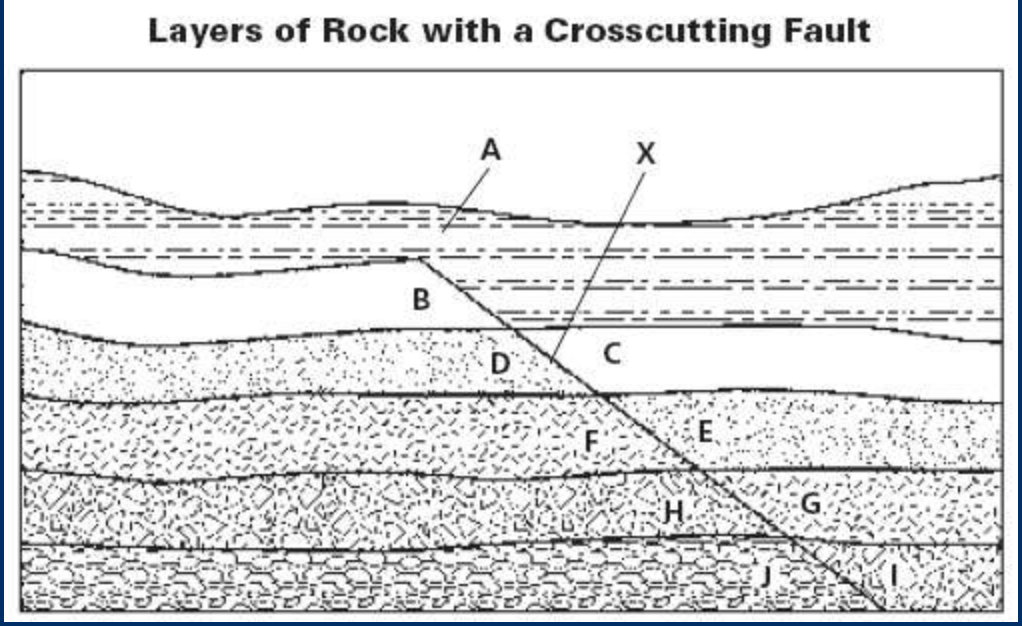
B. two

C. three

D. four a waning moon.

Interpreting Graphics, *continued*

The diagram below shows crosscutting taking place in layers of rock. Use this diagram to answers questions 12 and 13.



Interpreting Graphics, *continued*

12. Which of the letter combinations below belong to the same layer of rock before the fault disrupted the layer?

A. C and D

B. C and F

C. G and I

D. G and F

Interpreting Graphics, *continued*

12. Which of the letter combinations below belong to the same layer of rock before the fault disrupted the layer?

A. C and D

B. C and F

C. G and I

D. G and F

Interpreting Graphics, *continued*

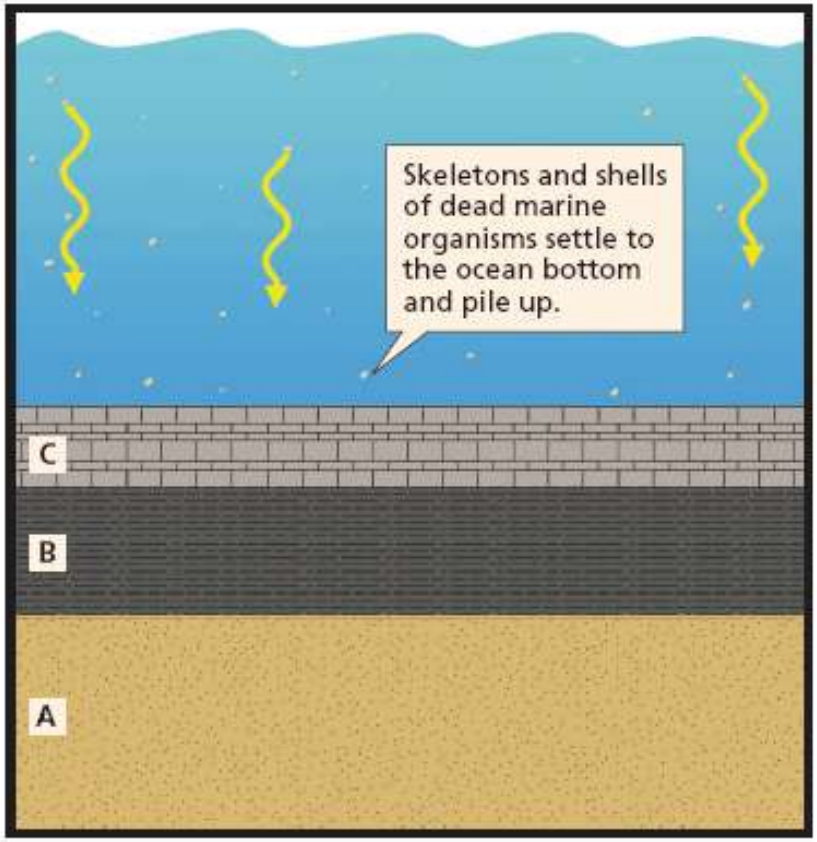
13. Which is older, structure B or structure X? Explain your answer. What structure shown on the diagram is the youngest?

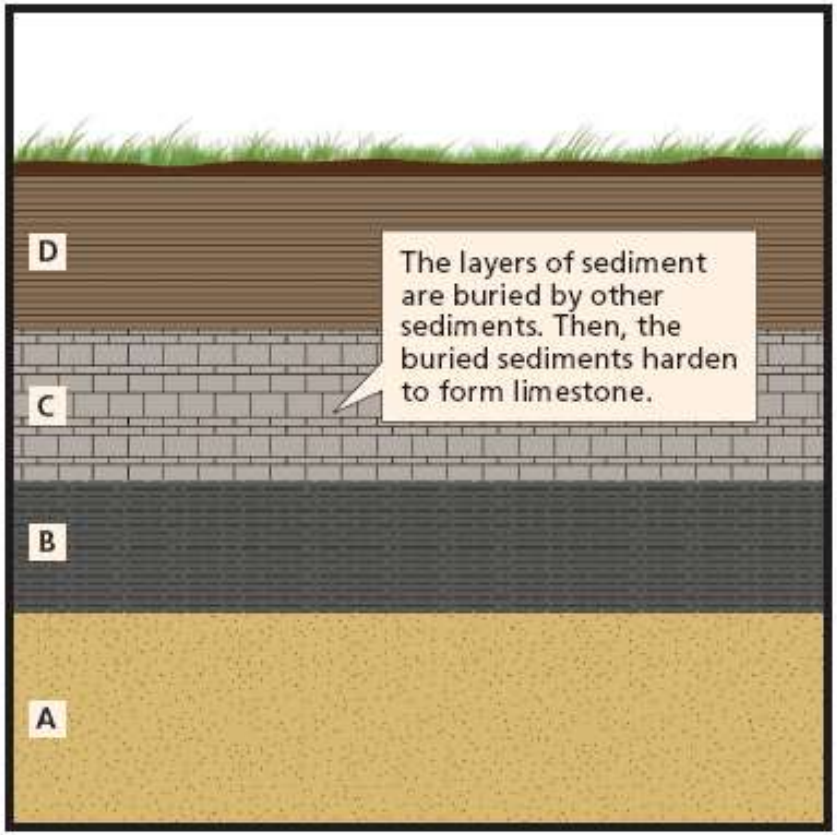
Interpreting Graphics, *continued*

13. Which is older, structure B or structure X? Explain your answer. What structure shown on the diagram is the youngest?

Your answer should include the following points: Structure X is a simple fault, which by definition is younger than the rock it cuts through; rock layer B must have formed before fault X occurred; rock layer A is the youngest structure shown on the diagram. The unbroken layer on top is the youngest structure shown in the diagram. This layer must have formed after the fault, it would be broken in the same way that the other rock layers were broken.

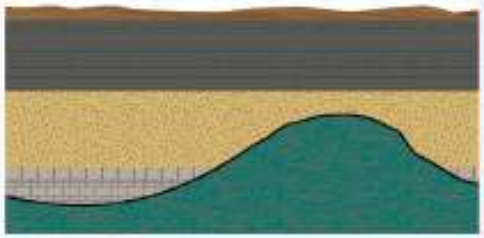
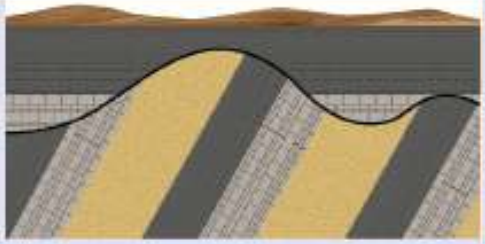
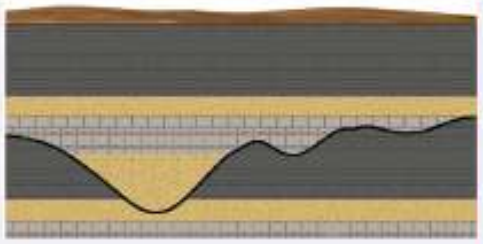
Law of Superposition



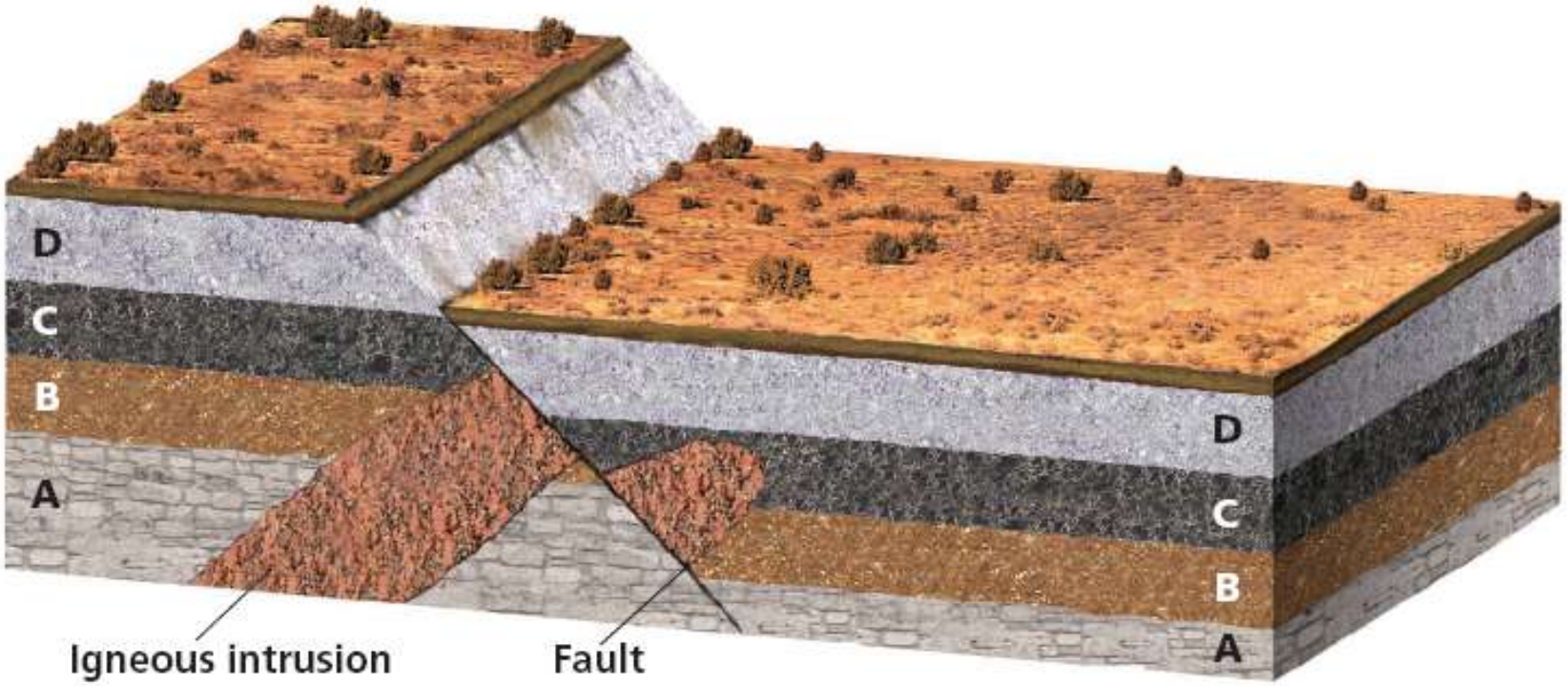


Types of Unconformities

Types of Unconformities

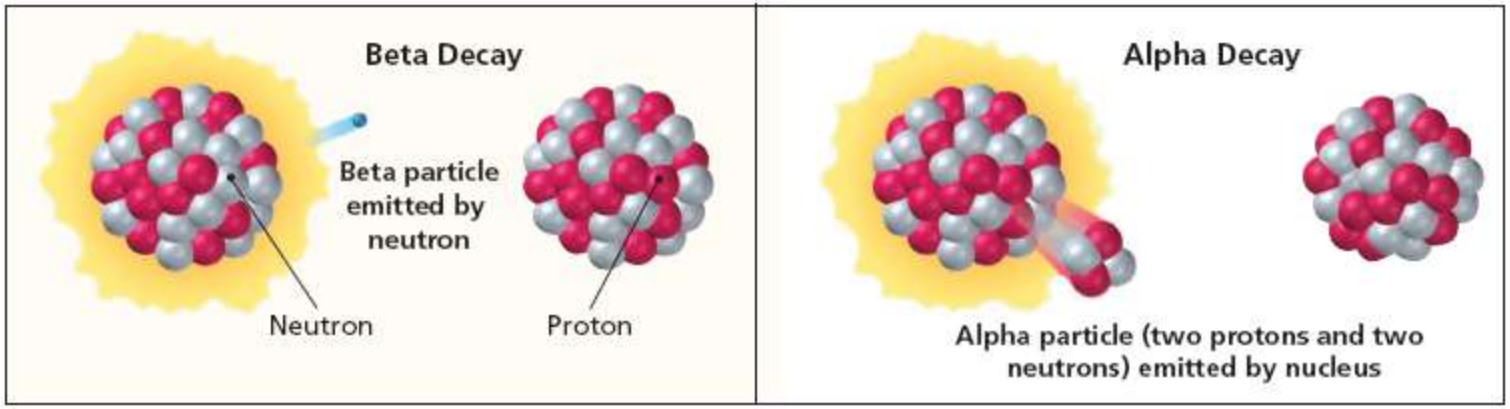
Type	Example	Description
Nonconformity		Unstratified igneous or metamorphic rock may be uplifted to Earth's surface by crustal movements. Once the rock is exposed, it erodes. Sediments may then be deposited on the eroded surface. The boundary between the new sedimentary rock and the igneous or metamorphic rock is a *nonconformity*. The boundary represents an unknown period of time during which the older rock was eroded.
Angular unconformity		An *angular unconformity* forms when rock deposited in horizontal layers is folded or tilted and then eroded. When erosion stops, a new horizontal layer is deposited on top of a tilted layer. When the bedding planes of the older rock layers are not parallel to those of the younger rock layers deposited above them, an angular unconformity results.
Disconformity		Sometimes, layers of sediments are uplifted without folding or tilting and are eroded. Eventually, the area subsides and deposition resumes. The layers on either side of the boundary are nearly horizontal. Although the rock layers look as if they were deposited continuously, a large time gap exists where the upper and lower layers meet. This gap is known as a *disconformity*.

Crosscutting Relationships

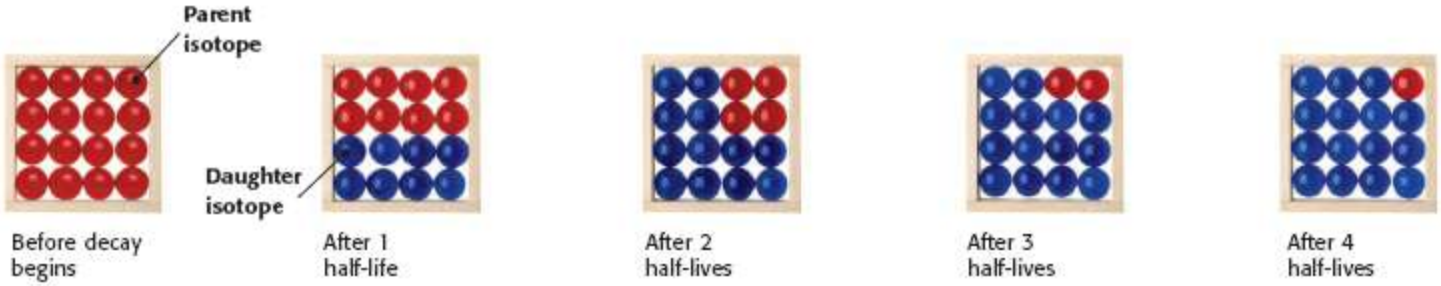


Radioactive Decay and Half-Life

Radioactive Decay



Half-Life



Geologic Map of Bedrock in Ohio