

Earth Science

Chapter 8 – The Rock Record

Section 3 – The Fossil Record

E.Q.: *What are the four ways fossils can be preserved and how are trace and index fossils used to determine the age of the fossils?*

STANDARDS:

- SES4. Students will understand how rock relationships and fossils are used to reconstruct the Earth's past.**
- Describe and apply principles of relative age (superposition, original horizontality, cross-cutting relations, and original lateral continuity) and describe how unconformities form.**
 - Interpret the geologic history of a succession of rocks and unconformities.**
 - Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited.**
 - Explain how sedimentary rock units are correlated within and across regions by a variety of methods (e.g., geologic map relationships, the principle of fossil succession, radiometric dating, and paleomagnetism).**
 - Use geologic maps and stratigraphic relationships to interpret major events in Earth history (e.g., mass extinction, major climatic change, tectonic events).**

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.**
- 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.**

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.**

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 dead by carefully extracting the body's internal organs and then wrapping the body in carefully prepared strips of cloth.**

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.**

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.**

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.**

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.**

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.

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.

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.

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.

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.

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.

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.

- 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.

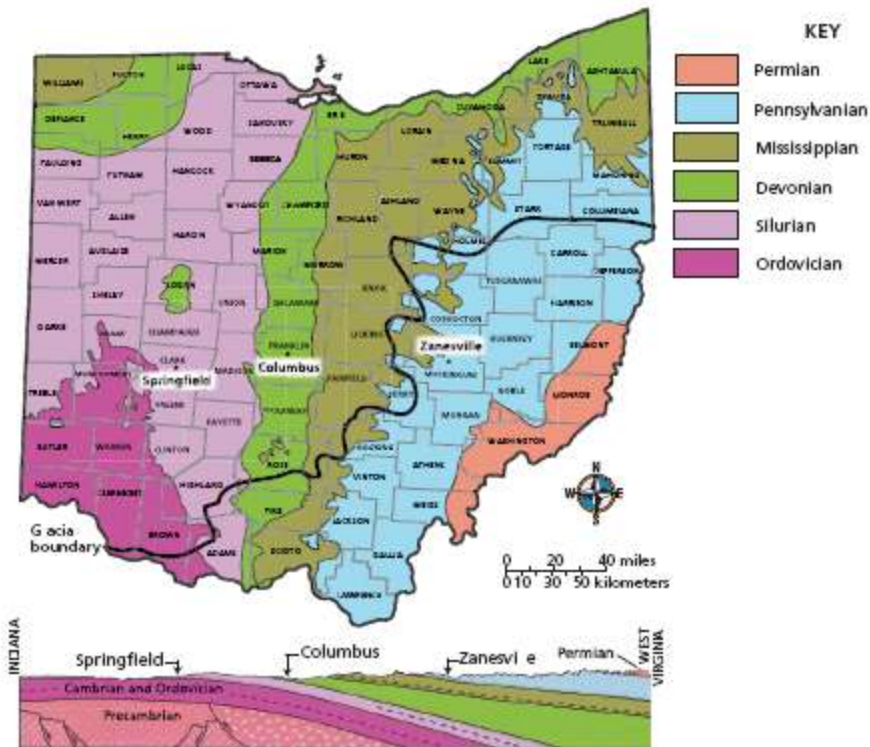
Index Fossils and Absolute Age

- 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.



Maps in Action

Geologic Map of Bedrock in Ohio



Review Quiz

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.
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
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
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**

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.

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

Index fossil

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

Illinois Nodules

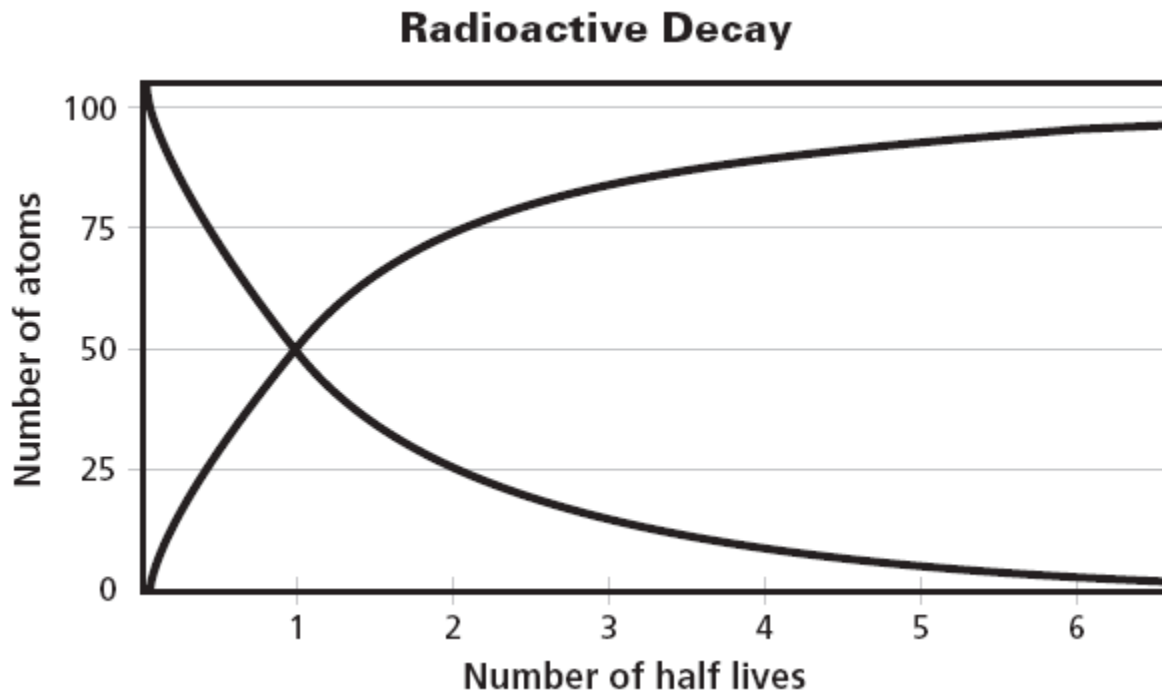
Around three hundred million years ago, the region that is now Illinois had a very different climate. Swamps and marshes covered much of the area. Scientists estimate that no fewer than 500 species lived in this ancient environment. Today, the remains of these organisms are found preserved within structures 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.

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.
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
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.

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.

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



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

A. one

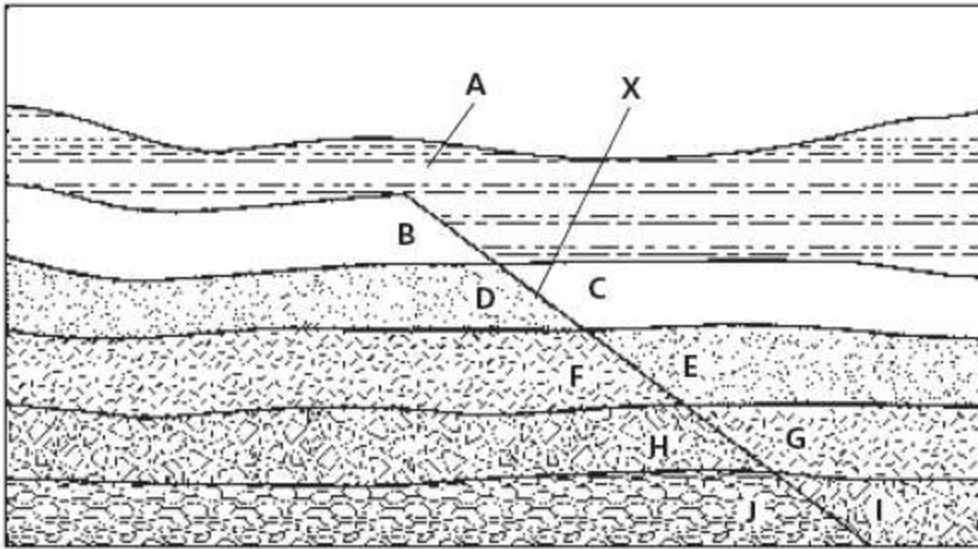
B. two

C. three

D. four a waning moon.

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

Layers of Rock with a Crosscutting Fault



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

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.