What Are Fossils?

Scientists can tell us many things about organisms, such as dinosaurs, that lived millions of years ago. How do scientists learn about these organisms if they have never seen them? They study fossils. A fossil is the trace or remains of an organism that lived long ago.

Some fossils are made from parts of an organism’s body. These fossils are called body fossils. Other fossils are simply signs, such as footprints, that an organism was alive. These fossils are called trace fossils.

FOSSILS IN ROCKS

Usually, when an organism dies, it begins to decay or it is eaten by other organisms. Sometimes, organisms are quickly buried by sediment when they die. The sediment can help preserve the organism. Hard parts, such as shells, teeth, and bones, are preserved more often than soft parts, such as organs and skin. When the sediment hardens to form sedimentary rock, the parts of the organism that remain can become body fossils.

FOSSILS IN AMBER

Sometimes, organisms such as insects are caught in sticky tree sap. If the sap hardens around the insect, a fossil is created. Hardened tree sap is called amber. Some of the best insect fossils are found in amber. Frogs and lizards have also been found in amber.
FROZEN FOSSILS
Ice and cold temperatures slow down decay and can allow body fossils to form. Woolly mammoths, which are relatives of modern elephants, became extinct about 10,000 years ago. However, scientists have found frozen remains of mammoths preserved in blocks of ice.

PETRIFICATION
Organisms can also become fossils by petrifaction. During petrifaction, minerals replace all or part of an organism’s tissues. For example, minerals may fill the tiny spaces in an animal’s bones. Sometimes, the organism’s tissues are completely replaced by minerals. For example, petrified wood forms when minerals replace all of the tissue in a piece of wood.

FOSSILS IN ASPHALT
In some places, asphalt or tar bubbles up to the Earth’s surface and forms sticky pools. The La Brea asphalt deposits in Los Angeles, California, are at least 38,000 years old. These pools have trapped and preserved many different organisms. From these fossils, scientists have learned about the ancient environment of southern California.

FOOTPRINTS
Remember that trace fossils are evidence that an organism was once alive. A footprint is an example of a trace fossil. Footprints may be preserved as trace fossils when they are filled with sediment and harden into rock. Footprints can show how big an animal was and how fast it was moving. For example, parallel paths of dinosaur tracks have led scientists to hypothesize that some dinosaurs moved in herds.

TAKE A LOOK
4. Explain Why are these tracks considered trace fossils?

These dinosaur tracks are found in Arizona. They show that the dinosaur was running when it made the tracks.
BURROWS AND COPROLITES

Burrows are another kind of trace fossil. Burrows are shelters made by animals, such as clams, that dig into sediment. A burrow can be preserved when it is filled with a different kind of sediment and buried quickly.

Coprolites, or preserved animal dung, are another example of trace fossils.

MOLDS AND CASTS

Molds and casts are two more kinds of fossils. A mold is an impression, or print, left in sediment where a plant or animal was buried. The figure below shows two types of molds from the same organism. One is an internal mold of the inside of the shell. The other is an external mold of the outside of the shell.

A cast is an object that forms when sediment fills a mold and becomes rock. Like a mold, a cast can show what the inside or outside of an organism looked like.

What Can We Learn from Fossils?

Think about your favorite outdoor place. Imagine the plants and animals around you. Now, imagine that you are a scientist at the same site 65 million years from now. What types of fossils would you dig up? Would you find fossils for every organism that existed? Based on the fossils you found, what would you guess about how this place used to look?

Fossils can show scientists three main things:

- What kind of organisms lived in the past
- How the environment has changed with time
- How organisms have changed with time
THE INFORMATION IN THE FOSSIL RECORD

Scientists have used fossils to learn some of the history of life on Earth. However, scientists cannot learn everything about life from fossils. This is because most organisms never became fossils, and many fossils have not been discovered yet.

Scientists know more about some kinds of ancient organisms than others. Remember that hard body parts are more likely to form fossils than soft body parts. Therefore, scientists know more about organisms with hard body parts than about organisms with only soft body parts. Some organisms lived in environments where fossils can form more easily. Scientists know more about these organisms than those that lived in other environments.

TAKE A LOOK
7. Explain Why do scientists know more about some kinds of ancient organisms than others?

8. Explain How can scientists find out how life has changed?

Fossils of organisms with hard parts, such as shells, are more common than fossils of organisms without hard parts.

This organism lived in an environment with a lot of sediment. Fossils form more easily in environments with a lot of sediment. Therefore, organisms that lived in these environments are more likely to be found as fossils.

A HISTORY OF ENVIRONMENTAL CHANGES

Fossils can show evidence of climate change. For example, Antarctica is covered with ice and snow in the present. However, scientists have found fossils of forest and freshwater organisms in Antarctica. They have even found fossils of dinosaurs in Antarctica! These fossils show that Antarctica’s climate must have been warmer in the past.

A HISTORY OF CHANGING ORGANISMS

To understand how life on Earth has changed, scientists compare fossils. Scientists also look for similarities between fossils and living organisms. However, only a small fraction of the organisms that have existed in Earth’s history have been fossilized. As a result, the fossil record is incomplete. This means that scientists do not have a complete record of changes in life on Earth.

Copyright © by Holt, Rinehart and Winston. All rights reserved.
How Do Scientists Know How Old Fossils Are?

To understand the history of life on Earth, scientists have put fossils in order based on their ages. Scientists learn the ages of fossils in different ways. In some cases, they can use **absolute dating methods**, such as radiometric dating, to determine the age of fossils. More commonly, scientists use relative dating methods.

**Relative dating methods** can’t tell scientists the exact age of a fossil. However, relative dating can show which fossils are older than others. Fossils found in older layers of rock come from more ancient life forms. Fossils found in younger layers of rock are from more recent organisms.

USING FOSSILS TO DATE ROCKS

Scientists can use fossils of certain types of organisms to learn how old rock layers are. These fossils are called index fossils. **Index fossils** are fossils of organisms that lived during a relatively short period of time. Because they lived for only a short time, their fossils are only found in rocks of a certain age. To be an index fossil, a fossil must have three features:

- The organism must be common in rocks from most of the world.
- The organism must have lived for only a geologically short period of time (a few million years to a few hundred million years).
- The organism must be easy to identify.

Trilobites and ammonites are two kinds of organisms that are used as index fossils. The figures below show examples of these fossils.

The trilobite *Phacops* is an example of an index fossil. *Phacops* lived about 400 million years ago. Therefore, rocks that contain *Phacops* fossils are probably about 400 million years old.

The ammonite *Tropites* is an index fossil. *Tropites* lived from between 230 million and 208 million years ago. Because it lived for such a short time, it is a good index fossil.

**READING CHECK**

9. Describe How do scientists put fossils in order?

**TAKE A LOOK**

10. Identify What feature of these organisms made them more likely to be preserved as fossils?
SECTION 4 Review

SECTION VOCABULARY

| **cast** | a type of fossil that forms when sediments fill in the cavity left by a decomposed organism |
| **fossil** | the trace or remains of an organism that lived long ago, most commonly preserved in sedimentary rock |
| **index fossil** | a fossil that is used to establish the age of a rock layer because the fossil is distinct, abundant, and widespread and the species that formed that fossil existed for only a short span of geologic time |
| **mold** | a mark or cavity made in a sedimentary surface by a shell or other body |
| **trace fossil** | a fossilized mark that formed in sedimentary rock by the movement of an animal on or within soft sediment |

1. **List** Give three examples of trace fossils.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

2. **Explain** Why is the fossil record incomplete?

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

3. **Infer** Which organism is more likely to be found as a fossil in amber, a beetle or a rabbit? Explain your answer.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

4. **Apply Concepts** What could you conclude if you found a fossil of a tropical plant in a cold climate?

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

5. **List** What three features must a fossil have in order to be an index fossil?

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
Earth Science Answer Key continued

8. Possible answers: There was no deposition happening at that time; there was a lot of erosion happening at that time.

9. erosion, nondeposition

10. a place where part of a sequence of parallel rocks is missing

11. Rocks are pushed up and eroded. Later, sediment is deposited on top of the eroded rock.

12. The rock layers below an angular unconformity are tilted and may be any kind of rock.

Review

1. An unconformity can form if no sediment is deposited for a long time. An unconformity can also form if layers of rock are eroded away.

2. an angular unconformity

3. The youngest rock layers are at the top, and the oldest rock layers are at the bottom.

4. to interpret rock sequences and to identify rock layers

5. A sequence of rock layers is uplifted and eroded. Then, sediment is deposited on the exposed rock layers. After a while, the sediment turns into rock.

SECTION 3 ABSOLUTE DATING: A MEASURE OF TIME

1. atoms of an element with different numbers of neutrons

2. Radioactive isotopes can break down. Stable isotopes do not break down.

3. The amount of parent isotope decreases, and the amount of daughter isotope increases.

4. 8 mg

5. No, because K-Ar dating can be used only for rocks that are older than about 1 million years.

6. by eating plants

<table>
<thead>
<tr>
<th>Parent isotope</th>
<th>Daughter isotope</th>
<th>Half-life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium-40</td>
<td>argon-40</td>
<td>1.3 billion years</td>
</tr>
<tr>
<td>Uranium-238</td>
<td>lead-206</td>
<td>4.5 billion years</td>
</tr>
<tr>
<td>Rubidium-87</td>
<td>strontium-87</td>
<td>48 billion years</td>
</tr>
<tr>
<td>Carbon-14</td>
<td>nitrogen-14</td>
<td>5,730 years</td>
</tr>
</tbody>
</table>

Review

1. Radiometric dating uses known rates of radioactive decay to determine the age of a rock sample.

2. After 1 million years, there would be \( \frac{1}{2} \times (20 \text{ mg}) = 10 \text{ mg} \) of parent isotope remaining. After 2 million years, \( \frac{1}{2} \times \left( \frac{1}{2} \right) \times (20 \text{ mg}) = 5 \text{ mg} \) of parent isotope would remain.

3. uranium-238, rubidium-87

4. Potassium-40, because it can be used to date rocks that are older than about 1 million years.

5. C-14 dating can be used only on the remains of living organisms. Igneous rocks do not contain these remains. C-14 dating can be used only on remains that are less than 50,000 years old. Dinosaur bones are older than this.

SECTION 4 LOOKING AT FOSSILS

1. Body fossils are fossilized parts of an organism. Trace fossils are signs that an organism once existed.

2. shells, teeth, bones

3. when minerals replace an organism’s tissue

4. They are not made of parts of an organism, but they show that an organism once existed.

5. an impression left in sediment

6. the kinds of organisms that lived in the past; how the environment has changed; how organisms have changed

7. Organisms that had hard parts or lived in certain environments were more likely to be fossilized when they died.

8. They compare fossils. They also compare fossils to living organisms.

9. Answers include: according to their age, by absolute and relative dating methods

10. their shells

Review

1. tracks, burrows, coprolites

2. Only a small fraction of the organisms that have existed in Earth’s history have been fossilized. Many fossils have not yet been discovered.

3. A beetle, because fossils in amber are made when an organism gets stuck in tree sap. Smaller organisms that can be found on trees are more likely than other organisms to become fossils in amber.

4. The climate was probably much warmer when the plant was alive.

5. It must be common throughout the world. It must have existed for a relatively short geologic time. It must be easy to identify.