SECTION 1

Looking at Fossils

Key Concept Fossils provide evidence of how life and environmental conditions have changed.

What You Will Learn

- Evidence of past life is preserved as fossils in sedimentary rock and in other materials.
- The study of fossils reveals information about how Earth's environments and organisms have changed.
- Index fossils can be used to date rock layers.

Why It Matters

Understanding fossils will help you understand how scientists piece together Earth's history.

Vocabulary

- fossil
- trace fossil
- index fossil

READING STRATEGY

Graphic Organizer In your **Science Journal,** make a Spider Map that shows the different ways that fossils can form.

A paleontologist named Luis Chiappe found a dinosaur nesting ground in Argentina. How did he know the area had been a dinosaur nest? He studied fossil eggs found there.

Fossilized Organisms

The trace or remains of an organism that lived long ago is called a **fossil.** Fossils can form in several ways. The ways in which fossils form are outlined below.

Fossils in Rocks

When an organism dies, either it begins to decay or it is eaten by other organisms. Sometimes, however, organisms are quickly buried by sediment when they die. The sediment slows down decay and preserves the organisms. Hard parts, such as shells, teeth, and bones, are more resistant to decay than soft parts are. So, the hard parts of organisms are more often preserved than soft parts are. The fossils are preserved when sediment hardens to form sedimentary rock.

Standards Check **How is evidence of past life preserved in sedimentary rock?** **7.4.c, 7.4.e**

Fossils in Amber

Imagine that an insect is caught in soft, sticky tree sap. Suppose that the insect is covered by more sap. If the sap hardens quickly enough, it preserves the insect inside. Hardened tree sap is called *amber.* Some of the best insect fossils are found in amber, as shown in **Figure 1.** Frogs and lizards have also been found in amber.

Figure 1 *These insects are preserved in amber. They are more than 38 million years old.*

7.3.c Students know how independent lines of evidence from geology, fossils, and comparative anatomy provide the bases for the theory of evolution.
7.4.c Students know that the rock cycle includes the formation of new sediment and rocks and that rocks are often found in layers, with the oldest generally on the bottom.
7.4.e Students know fossils provide evidence of how life and environmental conditions have changed.

Figure 2 *Scientist Vladimir Eisner studies the upper molars of a 20,000-year-old woolly mammoth found in Siberia, Russia. The almost perfectly preserved male mammoth was excavated from a block of ice in October 1999.*

Frozen Fossils

In October 1999, scientists removed a 20,000-year-old woolly mammoth from the frozen ground of the Siberian tundra. Some of the remains of this mammoth are shown in **Figure 2.** Woolly mammoths, which are relatives of modern elephants, became extinct about 10,000 years ago. Cold temperatures slow down decay. So, many frozen fossils are preserved from the last ice age. By studying the fossils, scientists hope to learn more about the mammoth and its environment.

Fossils in Asphalt

There are places where asphalt wells up at Earth's surface in thick, sticky pools. The asphalt deposits known as the La Brea Tar Pits in Los Angeles, California, for example, are at least 38,000 years old. These pools of thick, sticky asphalt have trapped and preserved many kinds of organisms for the past 38,000 years. From these fossils, scientists have learned about the past environment of southern California.

fossil (FAHS uhl) the trace or remains of an organism that lived long ago, most commonly preserved in sedimentary rock

Petrification

Organisms buried in sediment are sometimes preserved by petrification. *Petrification* is the filling or replacement of an organism's tissues with minerals that have different chemical compositions than the original tissues did. In one form of petrification, the space in an organism's hard tissue—for example, bone—is filled with a mineral. In another form of petrification, the organism's tissues are completely replaced by minerals. Petrified wood has undergone this type of replacement.

Standards Check **What is petrification?** 7.3.c

Figure 3 *These dinosaur tracks are located in Arizona. They show that the dinosaur was running when it made these tracks.*

Other Types of Fossils

Besides their hard parts—and in rare cases their soft parts—do organisms leave behind any other clues? What other evidence of past life do paleontologists look for? Many fossils are not body parts at all!

Trace Fossils

Any fossilized evidence of animal activity is called a **trace fossil.** Tracks, such as the ones shown in **Figure 3,** are an example of a trace fossil. These fossils form when animal footprints fill with sediment and are preserved in rock. Tracks reveal a lot about the animal that made them, including how big it was and how fast it was moving. Scientists have found parallel paths of tracks showing that a group of dinosaurs moved in the same direction. These discoveries have led paleontologists to hypothesize that some dinosaurs moved in herds.

Burrows are another kind of trace fossil. Burrows are shelters made by animals, such as clams, that bury themselves in sediment. Like tracks, burrows are preserved when they are filled with sediment and are buried quickly. A *coprolite* (KAHP roh LIET), a third kind of trace fossil, is preserved animal dung.

Standards Check **Name three kinds of trace fossils.** 7.4.e

trace fossil (TRAYS FAHS uhl) a fossilized structure, such as a footprint or a coprolite, that formed in sedimentary rock by animal activity on or within soft sediment

Molds and Casts

Molds and casts are two more kinds of fossils. The impression left in sediment or in rock where a plant or animal was buried is called a *mold*. **Figure 4** shows two types of molds from the same organism—an internal mold and an external mold. 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 the outside of an organism looked like.

Figure 4 *The fossil on the left is the internal mold of an ammonite. It formed when sediment filled the ammonite's shell. The shell later dissolved away. On the right is the external mold of the ammonite. It shows the external features of the shell.*

Using Fossils to Interpret the Past

All of the fossils that have been discovered on Earth are part of the fossil record. The *fossil record* is the history of life in the geologic past as indicated by the traces or remains of living things. Read on to find out more about the fossil record, including what scientists can learn from it.

The Information in the Fossil Record

The fossil record offers only a partial history of life on Earth. Some parts of this history are more complete than others. For example, scientists know more about organisms that had hard body parts than about organisms that had only soft body parts. Scientists also know more about organisms that lived in environments that favored fossilization. The fossil record is incomplete because most organisms never became fossils. And many fossils have not been discovered yet.

A History of Environmental Changes

Would you expect to find marine fossils on the mountain shown in **Figure 5**? The presence of marine fossils means that the rocks in these mountains formed in a very different environment. They formed at the bottom of an ocean.

Fossils can also contain evidence of climate change. For example, scientists have found fossil evidence of forests and freshwater organisms in Antarctica. The climate must have been warmer in the past for forests to grow and for fresh water to remain unfrozen. So, fossils are evidence of climate change in Antarctica. By studying life in the fossil record, scientists can tell what climates were like in the past.

Figure 5 *This scientist has found fossils of marine life at the top of mountains in the Yoho National Park in Canada. The marine fossils are evidence that these rocks were pushed up from below sea level.*

Quick Lab

Connecting Fossils to Climates

7.4.e

1. Imagine that you go on an expedition to a desert near your home and find the two fossils shown here. Write a description of each fossil.
2. Formulate a hypothesis about the type of organism each fossil represents.
3. Formulate a hypothesis about the environment in which these organisms lived.
4. Is the environment you described in step 3 different from the desert environment in which the fossils were found? If so, how would you explain this difference?

15 min

SCHOOL to HOME

Fossil Hunt

Go on a fossil hunt with a parent or guardian. Find out what kinds of rocks in your local area may contain fossils. Take pictures or draw sketches of your trip and of any fossils that you find. Keep your notes and drawings in your **Science Journal.**

ACTIVITY

A History of Changing Organisms

To determine how life on Earth has changed, scientists look for similarities between different fossils. Scientists also look for similarities between fossils and living organisms. By studying these relationships, scientists can interpret how life has changed over time. 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. So, it does not provide paleontologists with a continuous record of changes in life on Earth.

Dating the Fossil Record

To understand the history of life on Earth, paleontologists put fossils in order based on age. In some cases, scientists can use absolute dating methods, such as radiometric dating, to determine the age of fossils. More commonly, they use relative dating methods, especially superposition, to establish the relative ages of fossils. Fossils found in older layers of rock are from more ancient life-forms. Fossils found in younger rock layers are from organisms that lived more recently.

Standards Check **Would you expect to find fossils of an organism that lived recently in very old rock layers or in younger rock layers? Why?** 7.3.c

index fossil (IN DEKS FAHS uhl) 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

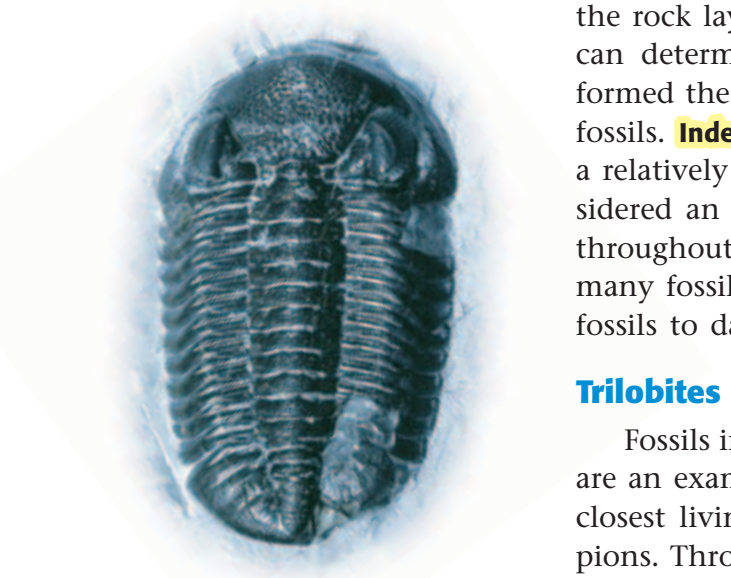

Figure 6 *Paleontologists know that any rock layer that contains a fossil of the trilobite* Phacops *is about 400 million years old.*

Using Fossils to Date Rocks

Scientists have found that some types of fossils appear all over the world, but only in certain rock layers. Scientists date the rock layers above and below these fossils. Then, scientists can determine the time span in which the organisms that formed the fossils lived. These types of fossils are called index fossils. **Index fossils** are fossils of organisms that lived during a relatively short, well-defined geologic time span. To be considered an index fossil, a fossil must be found in rock layers throughout the world. It must also be easy to identify, and many fossils of that organism must exist. Scientists use index fossils to date rock layers in which the fossils are found.

Trilobites as Index Fossils

Fossils in a group of trilobites (TRIE loh BIETS) called *Phacops* are an example of an index fossil. Trilobites are extinct. Their closest living relatives are horseshoe crabs, spiders, and scorpions. Through the dating of rock, paleontologists have determined that *Phacops* lived approximately 400 million years ago. So, when scientists find *Phacops* in rock layers anywhere on Earth, they know that the rock layers are approximately 400 million years old. A *Phacops* fossil is shown in **Figure 6.**

Ammonites as Index Fossils

Ammonites (AM uh NIETS), another index fossil, were marine mollusks similar to a modern squid. Ammonites were common in ancient oceans and lived in coiled shells. A genus of ammonites called *Tropites*, shown in **Figure 7,** is a common index fossil. *Tropites* lived between 230 million and 208 million years ago. So, it is an index fossil for that period of time. If scientists find *Tropites* in a rock layer, they know the rock layer formed between 230 and 208 million years ago.

Figure 7 Tropites *is a kind of coiled ammonite.* Tropites *existed for only about 20 million years, which makes it a good index fossil.*

SECTION Review

7.3.c, 7.4.c, 7.4.e

Summary

- Fossils are the traces or remains of an organism that lived long ago.
- Fossils can be preserved in sedimentary rock, amber, asphalt, or ice and by petrification.
- Trace fossils are any naturally preserved evidence of animal activity. Tracks, burrows, and coprolites are examples of trace fossils.
- Scientists study fossils to determine how environments and organisms have changed over time.
- An index fossil is a fossil that can be used to establish the age of rock layers.

Using Vocabulary

1. Use *fossil, trace fossil,* and *index fossil* in separate sentences.

Understanding Concepts

2. **Listing** Describe five ways fossils can form.
3. **Applying** Explain how an index fossil can be used to date rock.
4. **Demonstrating** How can fossils be used to provide evidence of how life and environmental conditions on Earth have changed?
5. **Concluding** Explain why the fossil record contains an incomplete record of the history of life on Earth.

Critical Thinking

6. **Making Inferences** You find a fossil of clam A in rock layer A and a fossil of clam B in rock layer B. If rock layer B is older than rock layer A, what can you infer about the relative ages of clams A and B?
7. **Applying Concepts** What could you conclude if you found a fossil of a tropical plant in a rock that is in a polar climate?

Math Skills

8. **Solving Problems** If a scientist finds the remains of a plant between a rock layer that contains 400 million–year-old *Phacops* fossils and a rock layer that contains 230 million–year-old *Tropites* fossils, how old could the plant fossil be?

Challenge

9. **Applying Concepts** Imagine that you have discovered a dinosaur fossil in Antarctica. What types of information would you look for in order to determine the environment in which the dinosaur lived?

Internet Resources

For a variety of links related to this chapter, go to www.scilinks.org

Topic: Looking at Fossils

SciLinks code: HY70886