Name _____ Class _____ Date _____

CHAPTER 8 The History of Life on Earth

SECTION 1

Evidence of the Past

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What are fossils?
- What is the geologic time scale?
- How have conditions on Earth changed with time?

National Science Education Standards

LS 1a, 3d, 5b, 5c

What Are Fossils?

In 1995, geologist Paul Sereno found a dinosaur skull in a desert in Africa. The skull was 1.5 m long. The dinosaur it came from may have been the largest land predator that ever existed!

Scientists like Paul Sereno look for clues to help them learn what happened on Earth in the past. These scientists are called paleontologists. *Paleo* means "old," and *onto* means "life." Therefore, *paleontologists* study "old life," or life that existed in the past. One of the most important ways paleontologists learn about the past is by studying fossils.☑

A **fossil** is the traces or remains of an organism that have been preserved over thousands of years. Some fossils form when an organism's body parts, such as shells or bones, are preserved in rock. Other fossils are signs, such as imprints, that an organism once existed. The figure below shows one way that this kind of fossil can form.

❶ An organism dies and is buried by sediment, such as mud or clay.

❷ After the organism dies, its body rots away. An imprint, or *mold*, is left in the sediment. The mold has the same shape as the organism's body.

❸ Over time, the mold fills with a different kind of sediment. The sediment forms a *cast* of the organism. The sediment can turn into rock, preserving the cast for millions of years.

STUDY TIP

Organize After you read this section, make a Concept Map using the vocabulary terms from the section.

READING CHECK

1. Define What is a paleontologist?

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TAKE A LOOK

2. Infer If a paleontologist found the cast of this fossil, would the paleontologist be able to tell what the inside of the organism looked like? Explain your answer.

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How Do Scientists Know the Ages of Fossils?

There are two main methods that scientists use to learn how old a fossil is: relative dating and absolute dating. During **relative dating**, a scientist estimates how old a rock or fossil is compared to other rocks or fossils. ☑

READING CHECK

3. Define What is relative dating?

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Almost all fossils are found in a kind of rock called *sedimentary rock*. Sedimentary rocks form in layers. In most bodies of sedimentary rock, the oldest layers are found at the bottom. The newest layers are found at the top. Scientists can use this information to estimate the relative ages of fossils in the layers. Fossils in the bottom layers are usually older than fossils in the top layers.

The second way that scientists learn the age of fossils is by absolute dating. During **absolute dating**, scientists learn the age of a fossil in years. Absolute dating is more precise than relative dating.

Critical Thinking

4. Compare How is absolute dating different from relative dating? Give two ways.

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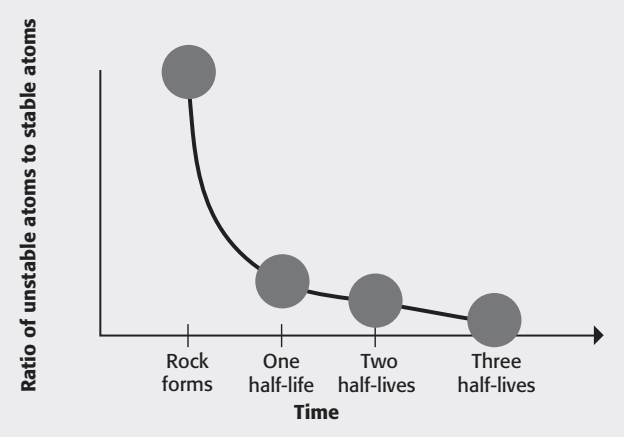
One kind of absolute dating uses atoms. *Atoms* are tiny particles that make up all matter. Some atoms are unstable and can *decay*, or break down. When an atom decays, it becomes a different kind of atom. It may also give off smaller particles, energy, or both. The new atom that forms is stable—it does not decay.

Each kind of unstable atom decays at a certain rate. This rate is called the atom's *half-life*. Scientists know the half-lives of many different kinds of unstable atoms. They can measure the ratio of these unstable atoms to stable atoms in a rock. They can use this ratio to calculate the age of the rock and any fossils in it.



This figure shows how scientists can use half-lives to date rocks. After each half-life, the ratio of unstable to stable atoms in the rock decreases. Scientists can learn the age of the rock by measuring the ratio of unstable to stable atoms in it.

Math Focus

5. Read a Graph How does the ratio of unstable to stable atoms change over time?

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What Is the Geologic Time Scale?

Think about some important things that have happened to you. You probably know the day, month, and year in which many of these events happened. The divisions of the calendar make it easy for you to remember these things. They also make it easy for you to talk to someone else about things that happened in the past.

In a similar way, geologists use a type of calendar to divide the Earth's history. This calendar is called the **geologic time scale**. The Earth is very old. Therefore, the divisions of time in the geologic time scale are very long.

Geologists use the geologic time scale to help make sense of how life on Earth has changed. When a new fossil is discovered, geologists figure out how old it is. Then, they place it in the geologic time scale at the correct time. In this way, they can construct a history of life on Earth. The figure below shows part of the geologic time scale.

Era	Period	Millions of years ago
Cenozoic era	Quaternary	1.8
	Tertiary	65.5
Mesozoic era	Cretaceous	146
	Jurassic	200
	Triassic	251
Paleozoic era	Permian	299
	Carboniferous	359
	Devonian	416
	Silurian	444
	Ordovician	488
	Cambrian	542
Precambrian time		4,600

Critical Thinking

6. Predict Consequences All geologists use the same basic geologic time scale. What might happen if every geologist used a different geologic time scale to study the Earth's history? Explain your answer.

Say It

Investigate Many geologic time-scale divisions are named after certain places on Earth. Research one of the periods in the Paleozoic era to find out where its name comes from. Share your findings with a small group.

TAKE A LOOK

7. List Give the three periods in the Mesozoic era in order from oldest to most recent.

STANDARDS CHECK

LS 5c Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on Earth no longer exist.

Word Help: occur
to happen

Word Help: environment
the surrounding natural conditions that affect an organism

Word Help: insufficient
not enough

Word Help: survival
the continuing to live or exist; the act of continuing to live

Word Help: indicate
to be or give a sign of; to show

8. Infer How could global cooling cause a species to go extinct?

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How Do Geologists Divide the Geologic Time Scale?

Many of the divisions of the geologic time scale are based on information from fossils. As scientists discover new fossils, they may add information to the geologic time scale. For example, most fossils that have been found are from organisms that have lived since Precambrian time. Therefore, little is known about life on Earth before this time. As scientists find more fossils from Precambrian time, more information may be added to the time scale.

Most of the divisions in the geologic time scale mark times when life on Earth changed. During many of these times, species died out completely, or became **extinct**. A *mass extinction* happens when many species go extinct at the same time.

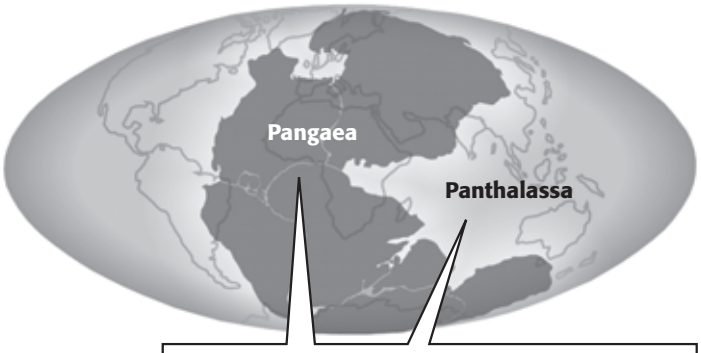
Scientists do not know what causes all mass extinctions. The table below gives some events that may cause mass extinctions.

Event	How it causes mass extinction
Comet or meteorite impact	can throw dust and ash into the atmosphere, causing global cooling
Many volcanic eruptions	can throw dust and ash into the atmosphere, causing global cooling
Changing ocean currents	can cause climate change by changing how heat is distributed on Earth's surface

How Has the Earth's Surface Changed?

Geologists have found fossils of tropical plants in Antarctica. These kinds of plants cannot live in Antarctica today because the climate is too cold. The fossils show that Antarctica's climate must once have been warmer.

In the early 1900s, German scientist Alfred Wegener studied the shapes of the continents and the fossils found on them. From his observations, he proposed a hypothesis that all the continents were once joined together. They formed a large land mass called *Pangaea*. Since then, the continents have moved over the Earth's surface to their present locations.



About 245 million years ago, all of the continents were joined into one large land mass called *Pangaea*. It was surrounded by a huge sea called *Panthalassa*, which is Greek for "all seas."

TAKE A LOOK

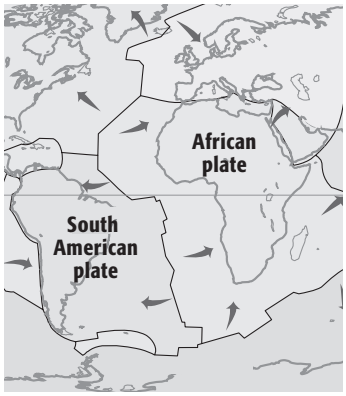
9. Infer On the map, circle the part of Pangaea that probably became the continent of Africa.

MOVING CONTINENTS

In the 1960s and 1970s, new technology allowed geologists to learn more about the Earth's crust. They found that the crust is not one solid chunk of rock. Instead, it is broken into many pieces called *tectonic plates*. These plates move slowly over the Earth's surface. Some of the plates have continents on them. As the plates move, the continents are carried along. The theory of how the plates move is called the theory of **plate tectonics**. ☑

READING CHECK

10. Explain Why do continents move?



The continents ride on tectonic plates. The plates move slowly over the Earth's surface.

The theory of plate tectonics explains why fossils of tropical plants have been found in Antarctica. Millions of years ago, Antarctica was located near the equator. Over time, the plate containing Antarctica has moved to its current location.

EFFECTS OF PLATE MOTIONS ON LIVING THINGS

Sudden changes on Earth's surface, such as a meteorite impact, may cause mass extinctions. Slower changes, such as tectonic plate movements, give populations of organisms time to adapt. Geologists use fossils of organisms to study how populations have adapted to changes on Earth.

Name _____ Class _____ Date _____

Section 1 Review

NSES LS 1a, 3d, 5b, 5c

SECTION VOCABULARY

absolute dating any method of measuring the age of an event or object in years

extinct describes a species that has died out completely

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

geologic time scale the standard method used to divide the Earth's long natural history into manageable parts

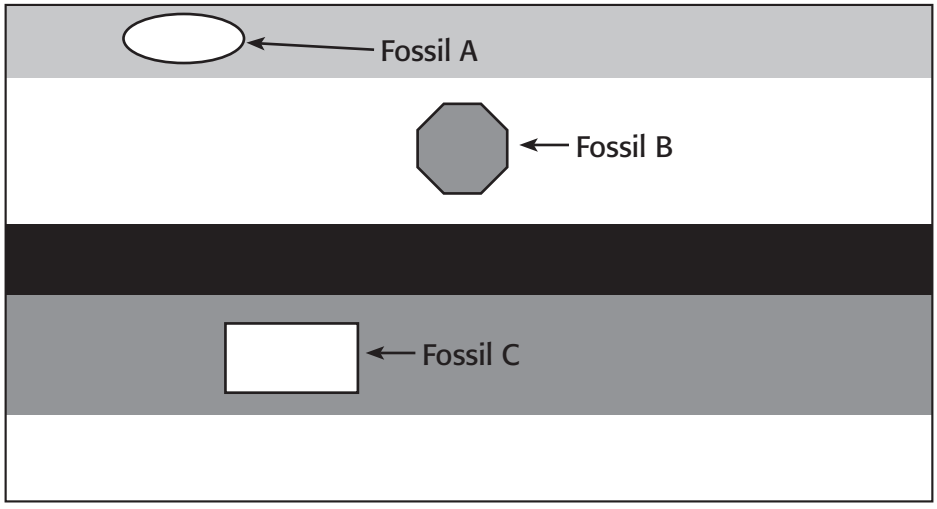
plate tectonics the theory that explains how large pieces of the Earth's outermost layer, called tectonic plates, move and change shape

relative dating any method of determining whether an event or object is older or younger than other events or objects

1. Define Write your own definition for *geologic time scale*.

2. List Give three things that can cause mass extinctions.

3. Compare Which fossil in the rock layers below is probably the oldest? Explain your answer.



4. Explain Describe one way that a fossil can form.