SECTION 1

The Study of Earth's History

Key Concept Slow geologic processes and major catastrophic events have shaped Earth's surface in the past and continue to shape Earth today.

What You Will Learn

- Uniformitarianism describes uniform change in Earth's geology, and catastrophism describes sudden change.
- Modern geology describes most change as gradual but acknowledges rare, sudden changes.

Why It Matters

Understanding the processes that shape Earth's surface today help us understand Earth's past.

Vocabulary

- uniformitarianism
- catastrophism
- paleontology

READING STRATEGY

Graphic Organizer In your **Science Journal,** create a Process Chart that shows how the theory of Earth's geologic history has changed over time.

How do mountains form? How old is Earth? Have you ever asked these questions? Nearly 250 years ago, a Scottish farmer and scientist named James Hutton did. Searching for answers to his questions, Hutton spent more than 30 years studying rock formations in Scotland and England.

The Early Study of Geology

In 1788, James Hutton collected his notes and wrote *Theory of the Earth*. In *Theory of the Earth,* he stated that the key to understanding Earth's history is all around us. In other words, processes that we observe today—such as erosion and deposition—do not change over time. This idea is now called uniformitarianism. **Uniformitarianism** is the idea that the same geologic processes that shape Earth today have been at work during all of Earth's history. **Figure 1** shows some of the observations that Hutton used to develop the idea of uniformitarianism.

Standards Check **What is uniformitarianism?** 7.4.a

Figure 1 Hutton's Observations

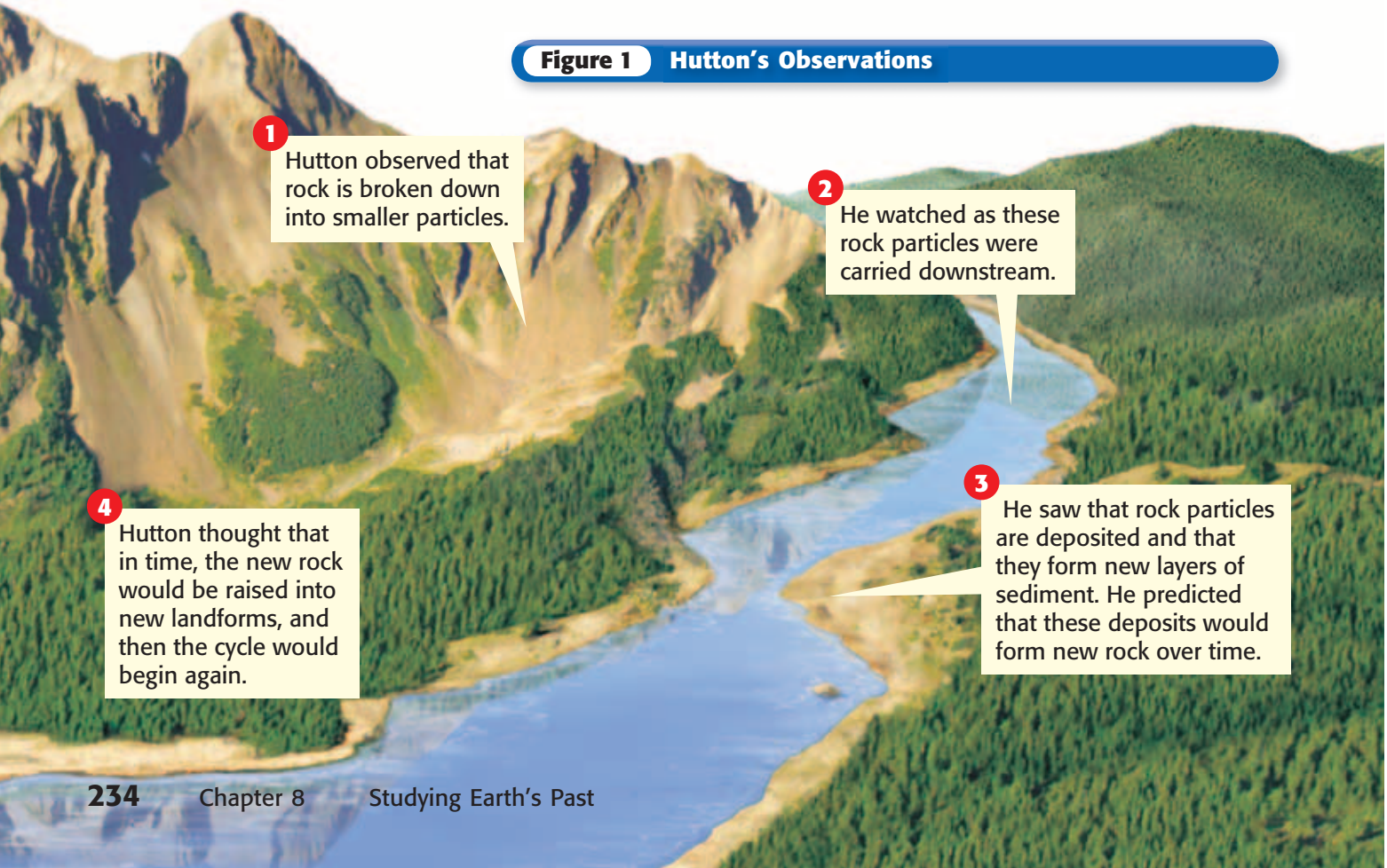

Figure 2 *This photograph shows Siccar Point on the coast of Scotland. Siccar Point is one of the places where Hutton observed the results of gradual geologic processes.*

Uniformitarianism Versus Catastrophism

In Hutton's time, most people thought that Earth was only a few thousand years old. To explain Earth's history, most scientists supported catastrophism. **Catastrophism** is the idea that geologic change happens suddenly. Supporters of catastrophism thought that Earth's surface is shaped mainly by rare, sudden events. These unpredictable events caused rapid geologic change over large areas—sometimes over the whole planet.

Scientists debated Hutton's theory because it suggested that Earth is much older than most people thought it was. A few thousand years was not nearly enough time for the gradual geologic processes that Hutton described. Hutton thought that very slow processes needed a very long time to produce large effects. For example, the rocks that he saw at Siccar Point, shown in **Figure 2,** were deposited and folded. Hutton thought that the rock took a long time to form and to be deformed.

uniformitarianism (YOON uh FAWRM uh TER ee uhn IZ uhm) a principle that geologic processes that occurred in the past can be explained by current geologic processes

catastrophism (kuh TAS truh FIZ uhm) a principle that states that geologic change occurs suddenly

Wordwise The prefix *cata-* means "against" or "very." The root *stroph-* means "to turn." The suffix *-ism* means "a belief in."

Standards Check **What is catastrophism?** 7.4.b

A Victory for Uniformitarianism

Despite Hutton's work, most scientists continued to believe in catastrophism. Only after the work of British geologist Charles Lyell did people begin to think of uniformitarianism as geology's most important principle. From 1830 to 1833, Lyell published three books called *Principles of Geology.* In those books, he wrote about uniformitarianism. Using Hutton's notes and new evidence of his own, Lyell successfully challenged the principle of catastrophism. Lyell supported the idea that major geologic change happened gradually. For at least a century after Lyell's work, most geologists agreed with uniformitarianism and not catastrophism.

7.4.a Students know Earth processes today are similar to those that occurred in the past and slow geologic processes have large cumulative effects over long periods of time.
7.4.b Students know the history of life on Earth has been disrupted by major catastrophic events, such as major volcanic eruptions or the impacts of asteroids.
7.4.e Students know fossils provide evidence of how life and environmental conditions have changed.

Quick Lab

Geology Flip Book

7.4.a
7.4.b

1. Arrange **25 pieces of blank paper** (about 8 cm × 12 cm) into a stack. Use a **stapler** to fasten the stack together at one of the long sides.

2. With a **pencil,** draw a geologic feature, such as a mountain, on the last page of your book. On each of the next pages in order, draw a slightly different scene to show gradual changes to the feature.
3. Watch the change happen by flipping through the book quickly.
4. Does your book better illustrate uniformitarianism or catastrophism? How could you change the drawings to illustrate both?

25 min

Modern Geology—A Happy Medium

During the late 1900s, scientists such as Stephen J. Gould challenged uniformitarianism. They thought that catastrophes can play an important role in shaping Earth's surface. Today, scientists realize that neither uniformitarianism nor catastrophism accounts for all geologic change during Earth's history. Most geologic change is slow and uniform, but catastrophes that cause sudden changes have also happened during Earth's history. For example, craters have been found where meteorites, asteroids, and comets are thought to have struck Earth.

Catastrophes can affect small areas or the whole Earth. They can have short-term or long-term effects on climate. Some scientists think that an asteroid strike about 65 million years ago may have contributed to the disappearance of the dinosaurs. **Figure 3** shows an imaginary re-creation of this asteroid strike. The asteroid impact could have thrown debris into the atmosphere. The debris spread around the whole planet and fell to Earth for decades. This global debris cloud may have blocked the sun's rays, causing a cooling of Earth's climate that doomed the dinosaurs. A volcanic eruption that injects debris into the atmosphere can cause similar changes in climate.

Standards Check **What is one way that a catastrophe has disrupted the history of life on Earth?** 7.4.b

Figure 3 *Today, scientists think that sudden events are responsible for some changes during Earth's past. An asteroid hitting Earth, for example, may have contributed to the disappearance of the dinosaurs about 65 million years ago.*

Paleontology—The Study of Past Life

Studying the rate of geologic change provides only part of the picture of Earth's past. To get a fuller picture, scientists also study the organisms that lived on Earth and the conditions in which they lived. The science that deals with the study of past life is called **paleontology.** Scientists who study this life are called *paleontologists,* and the data they use are fossils. *Fossils* are the remains of organisms preserved by geologic processes.

Paleontologists study fossils to see how the environment has changed. Fossils of sea life may be found almost anywhere on Earth. They may be found in a rock layer in the desert or on a mountain peak. These fossils are evidence that the rock layer formed when the area was part of the ocean. Fossils also provide evidence of how life has changed. As conditions on Earth's surface changed, organisms changed or died out. For example, the fossil record contains evidence of animals that no longer exist, such as saber-toothed cats and woolly mammoths.

Standards Check **What are two things for which fossils can provide evidence?** 7.4.e

MATH PRACTICE

The Age of Earth

Today, geologists estimate that Earth is about 4.6 billion years old. How many times older is this age than early estimates of about 6,000 years? Record your work in your **Science Journal.**

paleontology
(PAY lee uhn TAHL uh jee) the scientific study of fossils
Wordwise The root *paleo-* means "old." The suffix *-logy* means "the science of."

SECTION Review

7.4.a, 7.4.b, 7.4.e

Summary

- Uniformitarianism assumes that geologic change is gradual. Catastrophism is based on the idea that geologic change is sudden.
- Modern geology is based on the idea that gradual geologic change is interrupted by catastrophes.
- Using fossils to study past life is called paleontology.

Using Vocabulary

1. Write an original definition for *uniformitarianism, catastrophism,* and *paleontology.*

Understanding Concepts

2. **Comparing** Compare catastrophism with uniformitarianism.
3. **Identifying** Give one example of catastrophic global change.

Critical Thinking

4. **Analyzing Methods** Describe how fossils can provide evidence of how environmental conditions and life have changed during Earth's history.
5. **Identifying Relationships** Why did many scientists disagree with the idea of uniformitarianism?

Math Skills

6. **Making Calculations** An impact crater left by an asteroid strike has a radius of 85 km. What is the area of the crater? (Hint: The area of a circle is πr^2.)

Challenge

7. **Analyzing Ideas** Imagine that you are explaining uniformitarianism and catastrophism to a friend. Describe an example of two related events that happen within the span of a human lifetime that demonstrate these two ideas.

Internet Resources

For a variety of links related to this chapter, go to www.scilinks.org
Topic: Earth's Story
SciLinks code: HY70450