

## Section 1

### Terms to Learn

uniformitarianism  
catastrophism

### What You'll Do

- ◆ Identify the role of uniformitarianism in Earth science.
- ◆ Contrast uniformitarianism with catastrophism.
- ◆ Describe how the role of catastrophism in Earth science has changed.

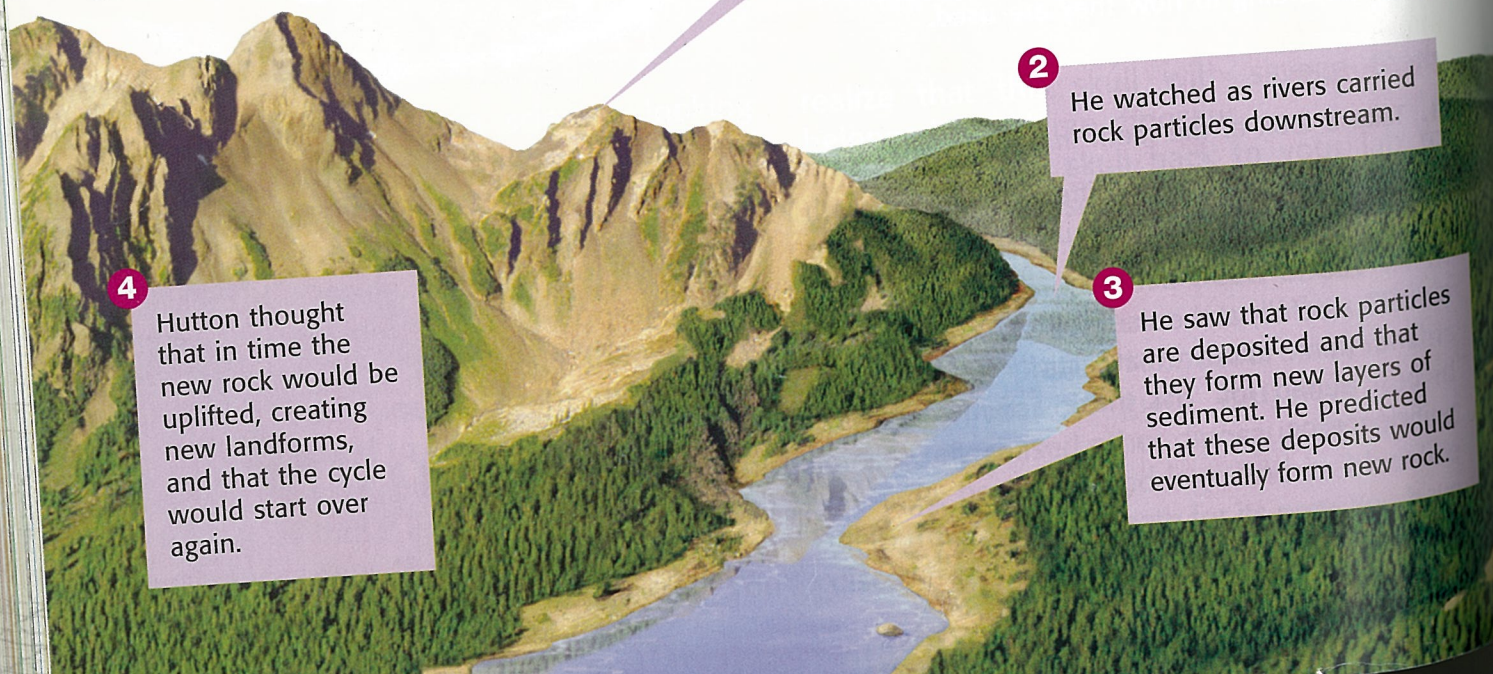
## Earth's Story and Those Who First Listened

Humans have wondered about Earth's history for thousands of years. But the branch of Earth science called *geology*, which involves the study of Earth's history, got a late start. The main concept of modern geology was not outlined until the late eighteenth century. Within a few decades, this concept replaced a more traditional concept of Earth's history. Today, both concepts are an essential part of Earth science.

### The Principle of Uniformitarianism

In 1795, a philosopher and scientist named James Hutton published *Theory of the Earth*, in which he wrote that Earth's landforms are constantly changing. As shown in **Figure 1**, Hutton assumed that these changes result from geologic processes—such as the breakdown of rock and the transport of sediment—that remain uniform, or do not change, over time. This assumption is now called uniformitarianism. **Uniformitarianism** is a principle that states that the same geologic processes shaping the Earth today have been at work throughout Earth's history. "The present is the key to the past" is a phrase that best summarizes uniformitarianism.

**Figure 1** Hutton observed gradual, uniform geologic processes at work. Judging by the slowness of the processes, he concluded that the Earth must be incredibly old.



## APPLY

### Making Assumptions

Examine the photographs at right. List the letters of the photos in the order you think the photos were taken. Now think of all the assumptions that you made to infer that order. Write down as many of these assumptions as you can. Compare notes with your classmates. Did you get the same sequence? Were your assumptions similar?

In science, assumptions must also be made. For example, you assume that the sun will rise each day. Briefly explain the importance of being able to count on certain things always being the same. How does this apply to uniformitarianism?



**Uniformitarianism Versus Catastrophism** In Hutton's time most people thought that the Earth had existed for only thousands of years. This was not nearly enough time for the gradual geologic processes that Hutton described to have shaped our planet. But uniformitarianism was not immediately accepted. Instead, most scientists believed in catastrophism. **Catastrophism** is a principle that states that all geologic change occurs suddenly. Supporters of catastrophism claimed that the formation of all Earth's features, such as its mountains, canyons, and seas, could be explained by rare, sudden events called *catastrophes*. These unpredictable catastrophes caused rapid geologic changes over large areas—sometimes even globally.

**Uniformitarianism Wins!** Despite Hutton's observations, catastrophism remained geology's guiding principle for decades. It took the work of Charles Lyell, another scientist, for people to seriously consider uniformitarianism.

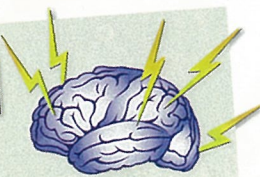
From 1830 to 1833, Lyell published three volumes collectively titled *Principles of Geology*, in which he reintroduced uniformitarianism. Armed with Hutton's notes and new evidence of his own, Lyell successfully challenged the principle of catastrophism. Lyell saw no reason to doubt that major geologic change happened the same way in the past as it does in the present—gradually.

## Biology CONNECTION

As a friend of Charles Lyell, Charles Darwin was greatly influenced by Lyell's uniformitarian ideas. Lyell's influence became clear when Darwin published *On the Origin of Species by Natural Selection* in 1859. Similar to uniformitarianism, Darwin's theory of evolution proposes that changes in species occur gradually over long periods of time.



## BRAIN FOOD



Did you know that the first dinosaur bones were not identified until 1841? Hutton and Lyell developed their ideas without knowledge of these giants of prehistory.

## Modern Geology—A Happy Medium

Today scientists realize that neither uniformitarianism nor catastrophism accounts for all of Earth's history. Although most geologic change is gradual and uniform, catastrophes do occur occasionally. For example, huge craters have been found where asteroids and comets are thought to have struck Earth in the past. Some of these strikes indeed may have been catastrophic. Some scientists think one such asteroid strike led to the extinction of the dinosaurs, as explained in **Figure 2**. The impact of an asteroid is thought to have spread debris into the atmosphere around the entire planet, blocking the sun's rays and causing major changes in the global climate.

**Figure 2** Today scientists think that sudden events are responsible for some changes in Earth's past. An asteroid hitting Earth, for example, may have led to the extinction of the dinosaurs 65 million years ago.



## REVIEW

1. Why do Earth scientists need the principle of uniformitarianism in order to make predictions?
2. What is the difference between uniformitarianism and catastrophism?
3. **Summarizing Data** How has the role of catastrophism in Earth science changed?

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## Section 2

### Terms to Learn

relative dating  
superposition  
geologic column  
unconformity

### What You'll Do

- ◆ Explain how relative dating is used in geology.
- ◆ Explain the principle of superposition.
- ◆ Demonstrate an understanding of the geologic column.
- ◆ Identify two events and two features that disrupt rock sequences.
- ◆ Explain how physical features are used to determine relative ages.

## Relative Dating: Which Came First?

Imagine that you are a detective investigating a crime scene. What is the first thing you would do? You might begin by dusting the scene for fingerprints or by searching for witnesses. As a detective, your goal is to figure out the sequence of events that took place before you arrived at the scene.

Geologists have a similar goal when investigating the Earth. They try to determine the order of events that led to how the Earth looks today. But instead of fingerprints and witnesses, geologists rely on rocks and fossils. Determining whether an object or event is older or younger than other objects or events is called **relative dating**.

## The Principle of Superposition

Suppose you have an older brother who takes a lot of photographs of your family but never puts them into an album. He just piles them in a box. Over the years, he keeps adding new pictures to the top of the stack. Think about the family history recorded in those pictures. Where are the oldest pictures—the ones taken when you were a baby? Where are the most recent pictures—those taken last week?

Rock layers, such as the ones shown in **Figure 3**, are like stacked pictures. The oldest layers are at the bottom. As you move from bottom to top, the layers get more recent, or younger. Scientists call this superposition. **Superposition** is a principle that states that younger rocks lie above older rocks in undisturbed sequences. "Younger over older" is a phrase you can use to remember this principle.

**Figure 3** Rock layers are like photos stacked over time—the younger ones lie above the older ones.

