

13.3

KEY CONCEPT

The geologic time scale shows Earth's past.

Sunshine State STANDARDS

SC.D.1.3.2: The student knows that over the whole Earth, organisms are growing, dying, and decaying as new organisms are produced by the old ones.

SC.D.1.3.5: The student understands concepts of time and size relating to the interaction of Earth's processes (e.g., lightning striking in a split second as opposed to the shifting of the Earth's plates altering the landscape, distance between atoms measured in Angstrom units as opposed to distance between stars measured in light-years).

SC.H.1.3.6: The student recognizes the scientific contributions that are made by individuals of diverse backgrounds, interests, talents, and motivations.

VOCABULARY

uniformitarianism p. 474

geologic time scale p. 475

BEFORE, you learned

- Rocks and fossils give clues about life on Earth
- Layers of sedimentary rocks show relative ages
- Radioactive dating of igneous rocks gives absolute ages

NOW, you will learn

- That Earth is always changing and has always changed in the past
- How the geologic time scale describes Earth's history

EXPLORE Time Scales

How do you make a time scale of your year?

PROCEDURE

- 1 Divide your paper into three columns.
- 2 In the last column, list six to ten events in the school year in the order they will happen. For example, you may include a particular soccer game or a play.
- 3 In the middle column, organize those events into larger time periods, such as soccer season, rehearsal week, or whatever you choose.
- 4 In the first column, organize those time periods into even larger ones.

MATERIALS

- pen
- sheet of paper



WHAT DO YOU THINK?

How does putting events into categories help you to see the relationship among events?

Earth is constantly changing.

In the late 1700s a Scottish geologist named James Hutton began to question some of the ideas that were then common about Earth and how Earth changes. He found fossils and saw them as evidence of life forms that no longer existed. He also noticed that different types of fossilized creatures were found in different layers of rocks. Based on his observations of rocks and other natural evidence, Hutton came up with a new theory to explain the story told in the rocks. He was the first to present a hypothesis about Earth's changing over time.

OUTLINE

Remember to start an outline in your notebook for this section.

- I. Main idea
 - A. Supporting idea
 1. Detail
 2. Detail
 - B. Supporting idea



Gradual Change

This line shows how the Adirondack Mountains may have looked several hundred million years ago.



Over hundreds of millions of years, natural forces wore down the jagged peaks to form the rounded hills seen today.

READING TIP

To remember what *uniformitarianism* means, think of the word *uniform*, which means "same."

Hutton recognized that Earth is a constantly changing place. Wind, water, heat, and cold break down rocks. Other processes, such as volcanic eruptions and the building up of sediment, continue to form new rock. Earth's interior is constantly churning with powerful forces that move, fold, raise, and swallow the surface of the planet.

The same processes that changed Earth in the past continue to occur today. A billion years ago a river would have carried particles of rock just as a river does today. Similarly, volcanoes in the past would have erupted just as volcanoes do today. Hutton's theory of **uniformitarianism** (YOO-nuh-fawr-mih-TAIR-ee-uh-nihz-uhm) is the idea that

- Earth is an always-changing place
- the same forces of change at work today were at work in the past

Although this idea may seem simple, it is very important. The theory of uniformitarianism is the basis of modern geology.

Some changes on Earth are gradual. Mountains form and are worn down over many millions of years. Climate and the amount of ice on land can change over hundreds or thousands of years. Other changes are fast. A volcanic eruption, an earthquake, or a flood can cause huge changes over a period of minutes or days. Fast or slow, Earth is always changing.



CHECK YOUR READING

What was the new idea that Hutton had about Earth? Describe the idea in your own words.



Fast Change



READING VISUALS

COMPARE AND CONTRAST These photos show Mount St. Helens before and after it erupted in 1980. What rapid changes occurred during the eruption?

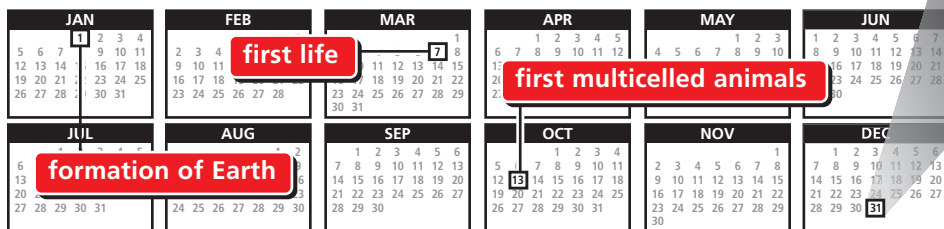
The geologic time scale divides Earth's history.

From a person's point of view, 4.6 billion years is a tremendous amount of time. To help make sense of it, scientists have organized Earth's history in a chart called the geologic time scale. The **geologic time scale** divides Earth's history into intervals of time defined by major events or changes on Earth.

Scientists use information from fossils and radioactive dating to figure out what happened over the 4.6 billion years of Earth's history. The oldest evidence of life is from about 3.8 billion years ago, but life may be even older. Organisms with more than one cell appeared around 1 billion years ago, and modern humans appeared only 100,000 years ago.

Imagine Earth's history compressed into one year. If Earth forms on January 1, the first life we have evidence for appears in the beginning of March. Life with more than one cell appears months later, in the middle of October. Humans do not show up until 11 minutes before midnight on the last day of the year, and they do not understand how old Earth is until about a second before midnight.

first humans



first life

first multicelled animals

formation of Earth

If Earth's history is compared to a calendar year, humans appear just before midnight on December 31.

READING TIP

As you read, find the eons, eras, and periods on the chart below.

Divisions of Geologic Time

The geologic time scale is divided into eons, eras, periods, and epochs (EHP-uhks). Unlike divisions of time such as days or minutes, the divisions of the geologic time scale have no fixed lengths. Instead, they are based on changes or events recorded in rocks and fossils.

Eon The largest unit of time is an eon. Earth's 4.6-billion-year history is divided into four eons.

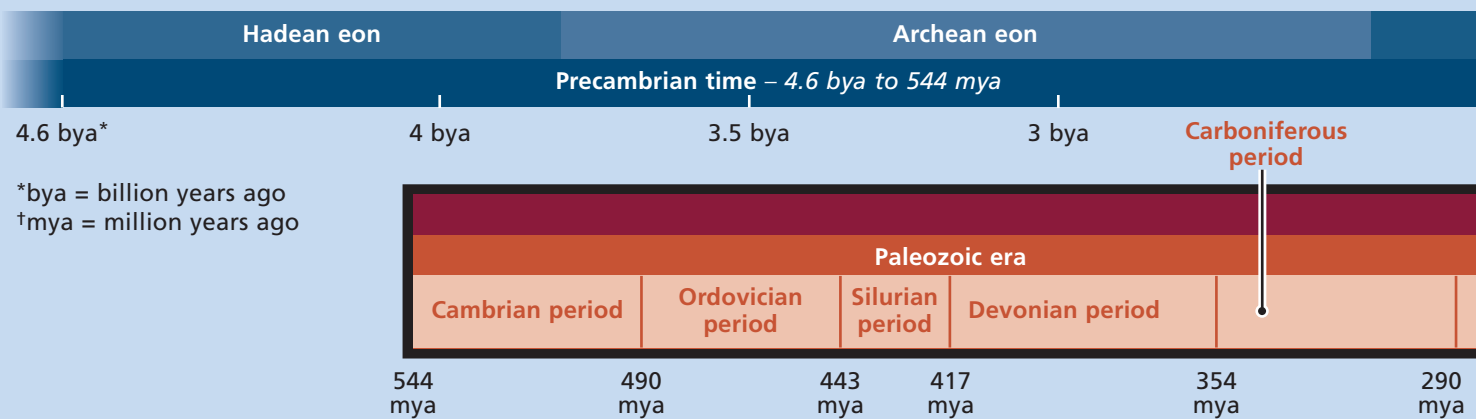
Era Eons may be divided into eras. The most recent eon is divided into three eras: the Paleozoic, the Mesozoic, and the Cenozoic.

Period Each era is subdivided into a number of periods.

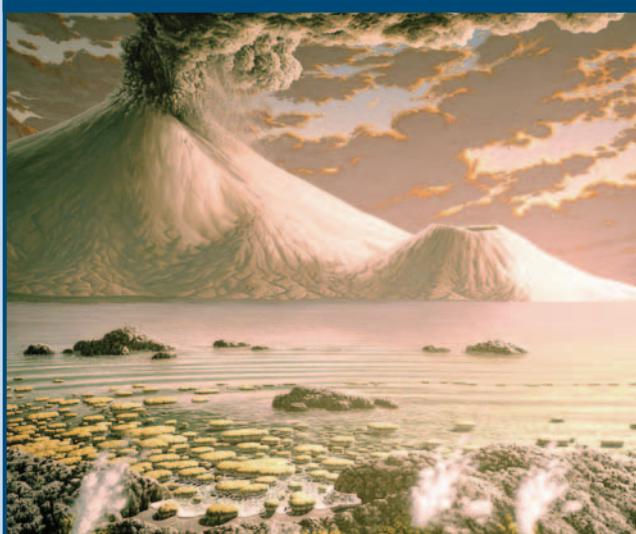
Epoch The periods of the Cenozoic, the most recent era, are further divided into epochs.

Geologic Time Scale

The geologic time scale divides Earth's history into eons, eras, periods, and epochs.



Precambrian Time at 3.6 Billion Years Ago



For nearly 4 billion years, during most of Precambrian time, no plants or animals existed.

Paleozoic Era at 544 Million Years Ago



At the beginning of the Paleozoic era, all life lived in the oceans.

The Hadean, Archean, and Proterozoic eons together are called Precambrian time and make up almost 90 percent of Earth's history. The fossil record for Precambrian time consists mostly of tiny organisms that cannot be seen without a microscope. Other early forms of life had soft bodies that rarely formed into fossils.

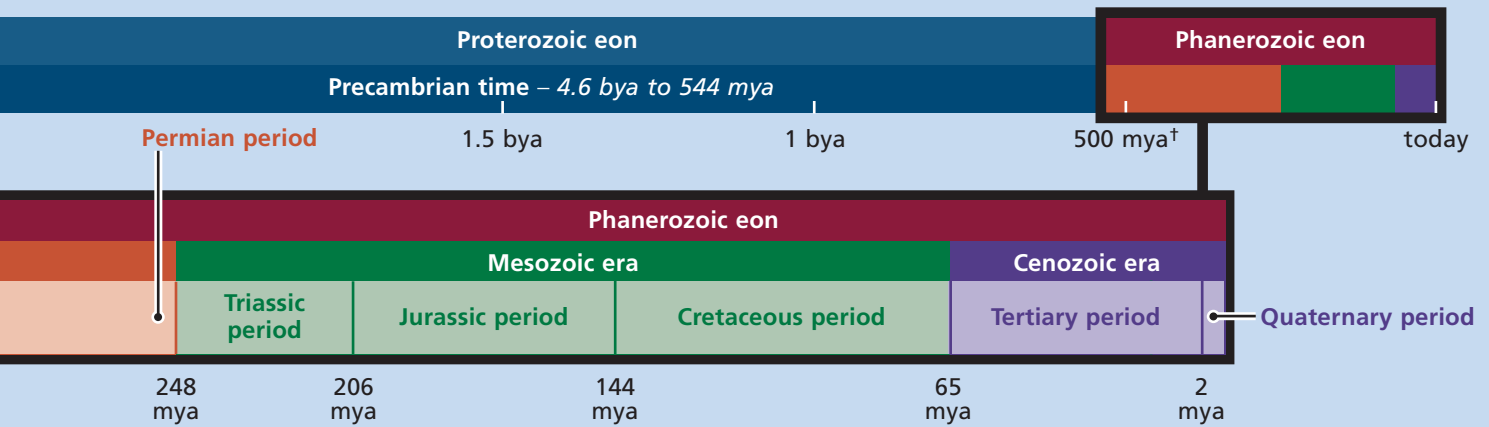
The Phanerozoic eon stretches from the end of Precambrian time to the present. Because so many more changes are recorded in the fossil record of this eon, it is further divided into smaller units of time. The smaller time divisions relate to how long certain conditions and life forms on Earth lasted and how quickly they changed or became extinct.

FLORIDA
Content Preview

Notice how changes on Earth's surface over time affected the kinds of animals and plants that lived at the time as you will learn in Chapter 14.

CHECK YOUR READING

What part of geologic time makes up most of Earth's history?



Mesozoic Era at 195 to 65 Million Years Ago



During the Mesozoic era, dinosaurs lived along with the first mammals, birds, and flowering plants.

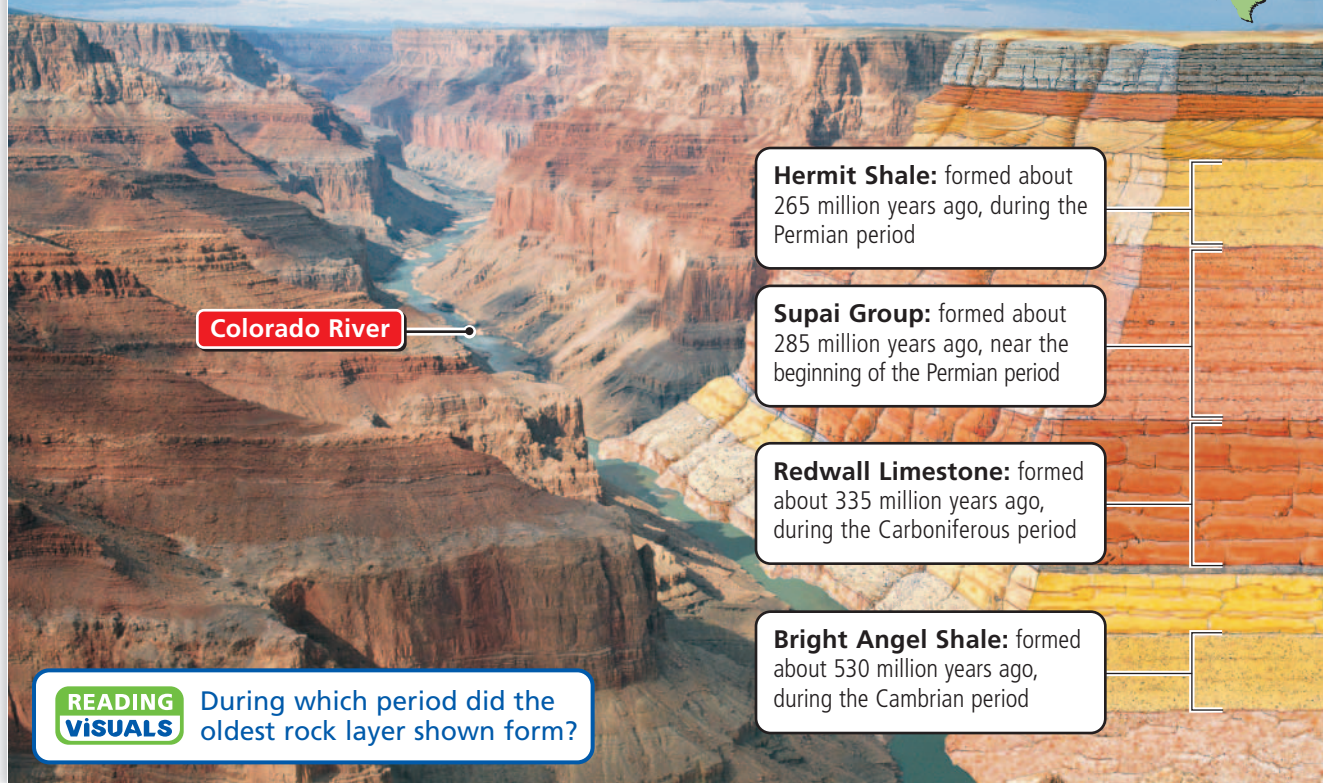
Cenozoic Era at Present Day



The first humans appeared in the later part of the Cenozoic era, which continues today.

Rock Layers in the Grand Canyon

Rock layers offer clues about conditions on Earth when the layers formed.



Colorado River

Hermit Shale: formed about 265 million years ago, during the Permian period

Supai Group: formed about 285 million years ago, near the beginning of the Permian period

Redwall Limestone: formed about 335 million years ago, during the Carboniferous period

Bright Angel Shale: formed about 530 million years ago, during the Cambrian period

READING VISUALS

During which period did the oldest rock layer shown form?

Phanerozoic Eon

The most recent eon, the Phanerozoic, began around 544 million years ago. Its start marks the beginning of a fast increase in the diversity, or variety, of life. The Phanerozoic eon is divided into three eras:

- the Paleozoic, whose name means “ancient life”
- the Mesozoic, whose name means “middle life”
- the Cenozoic, whose name means “recent life”

The Paleozoic era is the first era of the Phanerozoic eon. At the start of the Paleozoic, all life lived in the ocean. Fish, the first animals with backbones, developed during this time. Toward the end of this era, life moved onto land. Reptiles, insects, and ferns were common. A mass extinction occurred at the end of the Paleozoic era, 248 million years ago. A mass extinction is when many different life forms all die out, or become extinct, at once. The cause of this extinction is not completely understood.

The Mesozoic era spans the next 183 million years and is best known for the dinosaurs that ruled Earth. Mammals, birds, and flowering plants also first appeared during the Mesozoic. For some of this time, parts of North America were covered by a vast sea. The end of the

READING TIP

As you read, find each era in the geologic time scale on pages 476–477.

Mesozoic marks the end of the dinosaurs and many other animals in another mass extinction. This extinction may have been caused by one or more giant asteroids that slammed into Earth, throwing huge amounts of dust into the air. The dust blocked the sunlight, causing plants to die and, along with them, many animals.

The Cenozoic era, the most recent era, began 65 million years ago and continues today. The Cenozoic is often called the Age of Mammals because it marks the time when mammals became a main category of life on Earth.

The Cenozoic era is divided into two periods: the Tertiary and the Quaternary. The Quaternary period stretches from about 2 million years ago to the present. Most of the Quaternary has been a series of ice ages, with much of Europe, North America, and Asia covered in thick sheets of ice. Mammoths, saber-toothed cats, and other giant mammals were common during the first part of the Quaternary. Fossils of the first modern humans are also from this period; they are about 100,000 years old.

As the amount of ice on land shrank and grew, the ocean levels rose and fell. When the ocean levels fell, exposed land served as natural bridges that connected continents previously separated by water. The land bridges allowed humans and other animals to spread around the planet. It now seems that the end of Quaternary may be defined by the rise of human civilization.

Around 22,000 years ago, early humans used mammoth bones as building materials. This reconstruction shows what a bone hut may have looked like.



CHECK YOUR READING

How did falling ocean levels lead to the spread of humans and other animals on Earth?

13.3 Review

KEY CONCEPTS

1. Describe the concept of uniformitarianism.
2. What does the geologic time scale measure?
3. What was life like on Earth for most of its history?

CRITICAL THINKING

4. **Apply** What period, era, and eon do you live in?
5. **Evaluate** Some cartoons have shown early humans keeping dinosaurs as pets. From what you know about Earth's history, is this possible? Why or why not?

CHALLENGE

6. **Infer** How might the geologic time scale be different if the event that caused the mass extinction 65 million years ago had never occurred?