

12.4 The Geologic Time Scale



Reading Focus

Key Concepts

- What is the geologic time scale?
- How is the geologic time scale constructed?

Vocabulary

- ◆ geologic time scale
- ◆ eon
- ◆ Precambrian time
- ◆ era
- ◆ period
- ◆ epoch

Reading Strategy

Outlining As you read, make an outline of the important ideas in this section. Use the green headings as the main topics and fill in details from the remainder of the text.

The Geologic Time Scale

I. Structure of the Time Scale

- A. _____ ?
- B. _____ ?

Section 12.4

1 FOCUS

Section Objectives

- 12.12** Describe the geologic time scale.
- 12.13** Explain how the geologic time scale is organized.

Reading Focus

Build Vocabulary

L2

Paraphrase Tell students to list the vocabulary terms on a sheet of paper, leaving enough space for definitions. As they read, students should write the definitions in their own words.

Reading Strategy

L2

Sample answers include:

The Geologic Time Scale

- I. Structure of the Time Scale
 - A. Divided into eons, eras, periods, and epochs
 - 1. *Phanerozoic* means “visible life.”
 - 2. Three eras in the Phanerozoic: Paleozoic, Mesozoic, Cenozoic
 - 3. Cenozoic divided into epochs

You may have seen a timeline of major events in human history. Such a timeline might include events like the Industrial Revolution and the Apollo moon landings. Geologists have developed a timeline for events in Earth’s history. The **geologic time scale** is a timeline that divides Earth’s history into units representing specific intervals of time. ➤ **The geologic time scale is a record that includes both geologic events and major developments in the evolution of life.**

Geologists developed the geologic time scale during the 1800s. They used the fossil record to arrange Earth’s rocks in chronological order by relative age. During the 1900s, radiometric dating enabled scientists to add dates to the geologic time scale. Today, geologists continue to revise the time scale as dating techniques improve and as new discoveries change their views of Earth’s long history.

Structure of the Time Scale

The geologic time scale is divided into eons, eras, periods, and epochs. ➤ **Eons represent the longest intervals of geologic time. Eons are divided into eras. Each era is subdivided into periods. Finally, periods are divided into still smaller units called epochs.** Figure 21 shows the structure of the geologic time scale. In general, the breaks between units on the time scale mark major geologic events or changes in life forms, or both.



Figure 20 These cliffs on the coast of England are made of rock that formed about 200 million years ago. Over geologic time, forces in the crust slowly bent the rock’s flat-lying layers into folds.

Facts and Figures

Changes to the Geologic Time Scale If you look at different reference books, you might notice that the time boundaries between different eras and periods are slightly different. This is part of the scientific process, and happens for two reasons. The rate of radioactive decay is extremely slow for isotopes that are useful for dating, which makes determining the exact rates

of decay a difficult task. As physics experiments get more advanced and accurate, the exact numbers are refined, sometimes causing a reassessment of geologic ages. In addition, new fossils are continuously being discovered. Since time divisions are often based on extinction events, new fossils can sometimes shift the locations of the time-division boundaries.

2 INSTRUCT

Structure of the Time Scale

Use Visuals

L1

Figure 21 Make enlarged copies of the time scale so that all students can easily read it. Ask students to identify the era, period, and epoch in which they live. (era: Cenozoic; period: Quaternary; epoch: Holocene) Ask: **When did the Holocene Epoch began?** (0.01 million years ago)
Visual

Integrate Language Arts

L2

Recorded history is generally thought to have begun with the Sumerians, who developed cuneiform writing some 5000 years ago. Ask: **Assuming that Earth is 4.6 billion years old, what percentage of geologic time is represented by recorded history?** (approximately 0.000001 percent)
Logical

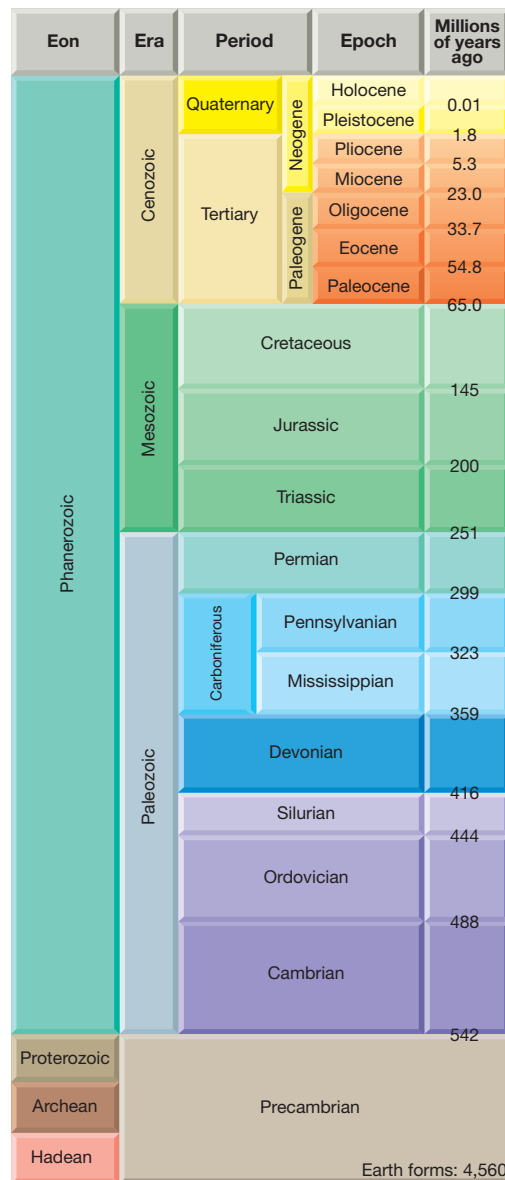


Figure 21 The Geologic Time Scale The Phanerozoic eon is broken into more subdivisions than earlier eons. Yet the Phanerozoic makes up only about 12 percent of Earth's history. This figure is not drawn to scale.

Eons Geologists divide Earth's history into four long units called **eons**. About 88 percent of geologic time is made up of the first three of these eons—the Hadean, Archaean, and Proterozoic. During these eons, Earth formed, the atmosphere and oceans developed, and early life evolved.

Another term for this long time span is **Precambrian time**. Precambrian fossils are scarce. One reason for this is that there is very little Precambrian rock left at the surface. Over billions of years, most Precambrian rocks have been eroded or metamorphosed, destroying or altering fossils. In addition, for most of Earth's history life existed only as single-celled organisms, and these do not leave easily identifiable fossils. Only very late in the Precambrian did multi-celled organisms evolve in the oceans.

About 540 million years ago, the Phanerozoic eon began. The term *Phanerozoic* comes from the Greek words meaning "visible life." The term is appropriate because the rocks of this eon contain abundant fossils. These fossils document the evolution of more complex life forms.

Notice on the time scale the many subdivisions of the Phanerozoic. These subdivisions reflect the large amount of data that geologists have about the rocks and fossils of the Phanerozoic in comparison with data from earlier eons.



What is Precambrian time?

Eras There are three **eras** within the Phanerozoic eon: the Paleozoic, Mesozoic, and Cenozoic eras. The term *Paleozoic* comes from the Greek words for "ancient life." During the Paleozoic era, most of the major groups of organisms that live on Earth today evolved. For example, vertebrates (animals with backbones) and plants appeared.

The term *Mesozoic* means "middle life." During the Mesozoic era, forests developed on land and many types of reptiles, including dinosaurs, became abundant. Later in the Mesozoic, the first mammals evolved.

Customize for Inclusion Students

Learning Disabled For students who have difficulty absorbing large blocks of text, use Figure 21 as a visual aid as you discuss the geologic time divisions. Consider adding benchmarks to the time scale to help students recall the various geologic divisions. For

example, you could point out that mass extinctions mark the end of both the Paleozoic and Mesozoic eras. The first fish appear in the fossil record in the Ordovician Period; the first land plants appear in the Silurian Period.

The term *Cenozoic* means “recent life.” During the Cenozoic era, many different types of mammals and birds evolved, and flowering plants became abundant.

The fossil record shows that the Paleozoic and Mesozoic eras both ended with dramatic, worldwide changes in life forms. Many types of organisms became extinct, although others survived. The Cenozoic era continues today.

Periods and Epochs Each era is subdivided into **periods**. Different geologic events, environmental conditions, and life forms characterize each period. For example, the Carboniferous period is named for the large coal deposits that formed during that period. *Carboniferous* means “carbon bearing.” Other geologic periods are named for the region where geologists first described the period’s rocks and fossils. For example, Jurassic refers to the Jura Mountains of France and Switzerland.

Traditionally, geologists divided the Cenozoic era into two periods: the Tertiary and Quaternary. Today, most geologists divide the Cenozoic into the Paleogene and Neogene, as show in Figure 21. The periods of the Cenozoic are divided into still smaller units called **epochs**. For example, we live in the Holocene epoch of the Quaternary (or Neogene) period. The epochs of other periods, however are not usually referred to by specific names. Instead, the terms *early*, *middle*, and *late* are generally applied to the epochs of these earlier periods.

Figure 22 An imprint fossil preserves fine details of this prawn, a freshwater crustacean of the Jurassic period.



For: Links on the geologic time scale
Visit: www.SciLinks.org
Web Code: cjn-4125

Build Science Skills L2

Word Parts Point out to students that the names of certain units of geologic time come from Greek word parts. For example, Proterozoic, the last eon of Precambrian time, comes from the Greek *protero-* meaning “former” and *zoe* meaning “life.” Have students use a dictionary to find the Greek word parts that make up *Phanerozoic*, *Paleozoic*, *Mesozoic*, and *Cenozoic*. Then ask them to use this information to predict the meaning of each of these terms.

3 ASSESS

Evaluate Understanding L2

Have students brainstorm other ways to depict geologic time. For example, geologic time has been represented in calendars and on clocks.

Reteach L1

Have students list the three eras within the Phanerozoic. (*Paleozoic*, *Mesozoic*, *Cenozoic*)

Writing in Science

Check students’ definitions to make sure that the definitions contain the requested information about the geologic period.

Section 12.4 Assessment

Reviewing Concepts

1. What is the geologic time scale?
2. What subdivisions make up the geologic time scale?
3. How is the geologic time scale today different from the geologic time scale developed by geologists in the 1800s?
4. Why are there more subdivisions of the time scale for the Phanerozoic eon than for earlier eons?

Thinking Critically

5. **Interpreting Diagrams** To which era does each of the following periods belong: Ordovician, Tertiary, Permian, Triassic?
6. **Calculating** What percentage of geologic time is made up of the Cenozoic era?

Writing in Science

Writing a Definition Research one of the periods of the geologic time scale. Write a definition of the period that includes the name of the era to which the period belongs, when the period began and ended, one major event from the period, and an explanation of the period’s name.

Geologic Time 355



Download a worksheet on the geologic time scale for students to complete, and find additional teacher support from NSTA SciLinks.

Section 12.4 Assessment

1. The geologic time scale divides Earth’s history into units that each represent specific amounts of time.
2. eons, eras, periods, and epochs
3. During the 1800s, the geologic time scale was based on relative ages of the rock record. During the 1900s, absolute ages based on radiometric dating were added to the time scale.
4. There is more information in the rock and fossil record about the geologic events of this eon than there is about previous eons. Geologists base subdivisions of the time scale on these events.
5. Paleozoic, Cenozoic, Paleozoic, Mesozoic
6. About 1.4 percent

Answer to . . .

Reading Checkpoint *Precambrian time is the long span of time from Earth’s formation about 4.56 billion years ago to the beginning of the Cambrian period about 540 million years ago.*