The Science of Geology

The subject of this text is **geology**, from the Greek *geo*, "Earth," and *logos*, "discourse." It is the science that pursues an understanding of planet Earth. Geology is traditionally divided into two broad areas—physical and historical. **Physical geology** examines the materials composing Earth and seeks to understand the many processes that operate beneath and upon its surface (**FIGURE 1.1**). The aim of **historical geology**, on the other hand, is to understand the origin of Earth and its development through time. Thus, it strives to establish a chronological arrangement of the multitude of physical and biological changes that have occurred in the geologic past. The study of physical geology logically precedes the study of Earth history because we must first understand how Earth works before we attempt to unravel its past. It should also be pointed out that physical and historical geology are divided into many areas of specialization. **TABLE 1.1** provides a partial list.

TABLE 1.1

Different Areas of Geologic Study*

Archaeological Geology	Ocean Sciences
Biogeosciences	Paleoclimatology
Engineering Geology	Paleontology
Forensic Geology	Petrology
Geochemistry	Planetary Geology
Geomorphology	Sedimentary Geology
Geophysics	Seismology
History of Geology	Structural Geology
Hydrogeology	Tectonics
Medical Geology	Volcanology
Mineralogy	

* Many of these areas of study represent interest sections and specialties of associated societies affiliated with the Geological Society of America (**www.geosociety.org**) and the American Geophysical Union (**www.agu.org**), two professional societies to which many geologists belong.

Every chapter of this book represents one or more areas of specialization in geology. changing. In fact, it is changing as you read this page and will continue to do so into

The Importance of Sedimentary Rocks

Most of solid Earth consists of igneous and metamorphic rocks. Geologists estimate these two categories represent 90 to 95 percent of the outer 16 kilometers (10 miles) of the crust. Nevertheless, most of Earth's solid surface consists of either sediment or sedimentary rock! Across the ocean floor, which represents about 70 percent of Earth's solid surface, virtually everything is covered by sediment. Igneous rocks are exposed only at the crest of mid-ocean ridges and at some volcanic areas. Thus, while sediment and sedimentary rocks make up only a small percentage of Earth's crust, they are concentrated at or near the surface—the interface among the geosphere, hydrosphere, atmosphere, and biosphere. Because of this unique position, sediments and the rock layers that they eventually form contain evidence of past conditions and events at the surface (**FIGURE 6.1**). Furthermore, it is sedimentary rocks that contain fossils, which are vital tools in the study of the geologic past. This group of rocks provides geologists with much of the basic information they need to reconstruct the details of Earth history.

Such study is not only of interest for its own sake but has practical value as well. Coal, which provides a significant portion of our electrical energy, is classified as a sedimentary rock. Moreover, other major energy sources—oil, natural gas, and uranium—are derived from sedimentary rocks. So are major sources of iron, aluminum, manganese, and phosphate fertilizer, plus numerous materials essential to the construction industry, such as cement and aggregate. Sediments and sedimentary rocks are also the primary reservoir of groundwater. Thus, an understanding of this group of rocks and the processes that form and modify them is basic to locating additional supplies of many important resources.

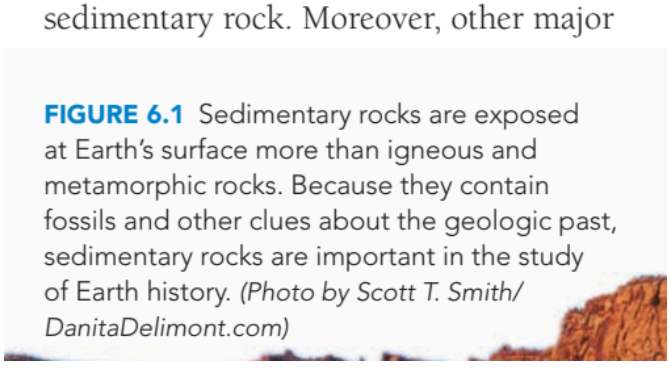


FIGURE 6.1 Sedimentary rocks are exposed at Earth's surface more than igneous and metamorphic rocks. Because they contain fossils and other clues about the geologic past, sedimentary rocks are important in the study of Earth history. *(Photo by Scott T. Smith/DanitaDelimont.com)*

CONCEPT CHECK 6.1

1. How does the volume of sedimentary rocks in Earth's crust compare to igneous and metamorphic rocks?
2. Why are sedimentary rocks important?

Origins of Sedimentary Rock

Sedimentary Rocks

ESSENTIALS OF GEOLOGY **Introduction**

FIGURE 6.2 illustrates the portion of the rock cycle that occurs near Earth's surface—the part that pertains to sediments and sedimentary rocks. A brief overview of these processes provides a useful perspective.

- Weathering begins the process. It involves the physical disintegration and chemical decomposition of preexisting igneous, metamorphic, and sedimentary rocks. Weathering generates a variety of products, including various solid particles and ions in

DID YOU KNOW?

Coal is responsible for slightly more than half the electricity generated in the United States.

solution. These are the raw materials for sedimentary rocks.

- Soluble constituents are carried away by runoff and groundwater. Solid particles are frequently moved downslope by gravity, a process termed mass wasting, before running water, groundwater, wind, and glacial ice remove them. Transportation moves these materials from the sites where they originated to locations where they accumulate. The transport of sediment is usually intermittent. For example, during a flood, a rapidly moving river moves large quantities of sand and gravel. As the flood waters recede, particles are temporarily deposited, only to be moved again by a subsequent flood.
- Deposition of solid particles occurs when wind and water currents slow down and as glacial ice melts. The word *sedimentary* actually refers to this process. It is derived from the Latin *sedimentum*,

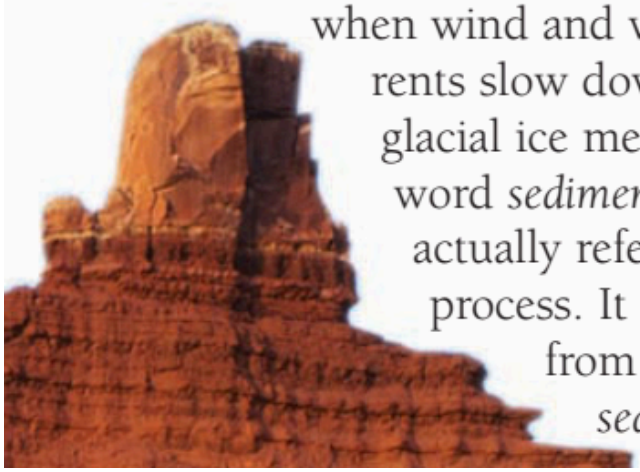


FIGURE 6.2 This diagram outlines the portion of the rock cycle that pertains to the formation of sedimentary rocks. Weathering, transportation, deposition, and diagenesis represent the basic processes involved. *(Left and center photos by E. J. Tarbuck; right photo by Jenny Elia Pfeiffer/Corbis)*

which means "to settle," a reference to solid material settling out of a fluid (water or air). The mud on the floor of a lake, a delta at the mouth of a river, a gravel bar in a stream bed, the particles in a desert sand dune, and even household dust are examples.

- The deposition of material dissolved in water is not related to the strength of wind or water currents. Rather, ions in solution are removed when chemical or temperature changes cause material to crystallize and precipitate or when organisms remove dissolved material to build shells.
- As deposition continues, older sediments are buried beneath younger layers and gradually converted to sedimentary rock (lithified) by compaction and cementation. This and other changes are referred to as *diagenesis* (*dia* = change ; *genesis* = origin), a collective term for all of the changes (short of metamorphism) that take place in texture, composition, and other physical properties after sediments are deposited.

Because there are a variety of ways that the products of weathering are transported, deposited, and transformed into solid rock, three categories of sedimentary rocks are recognized. As the overview reminded us, sediment has two principal sources. First, it may be an accumulation of material that originates and is transported as solid particles derived from both mechanical and chemical weathering. Deposits of this type are termed *detrital*, and the sedimentary rocks that they form are called **detrital sedimentary rocks**.

The second major source of sediment is soluble material produced largely by chemical weathering. When these ions in solution are precipitated by either inorganic or biologic processes, the material is known as *chemical sediment*, and the rocks formed from it are called **chemical sedimentary rocks**.

The third category is **organic sedimentary rocks**. The primary example is coal. This black combustible rock consists of organic carbon from the remains of plants that died and accumulated on the floor of a swamp. The bits and pieces of undecayed plant material that constitute the "sediments" in coal are quite unlike the weathering products that make up detrital and chemical sedimentary rocks.