

Lecture Notes Earth Science

Chapter 2

Minerals and Rocks • *Section 1 Summary*

Key Concepts

- What is a mineral?
- What are the three major groups of rock, and how do they form through the rock cycle?
- How are minerals and rocks used and processed?

A mineral is a naturally occurring, inorganic solid that forms on or beneath Earth's surface. Almost all minerals have a crystal shape. Each mineral has a definite chemical composition. More than 3,000 minerals have been identified.

Rocks are made up of a combination of minerals. **Geologists classify rocks into three major groups: igneous rock, sedimentary rock, and metamorphic rock. The rocks in each group form through different steps in the rock cycle.**

Igneous rocks form from molten material deep inside Earth. The material slowly cools and hardens to form a rock. If the material cools slowly, large crystals form. If the material cools quickly, small crystals form.

Sedimentary rocks are made from pieces of rocks that have been broken down by processes involving water and weather. The pieces are called sediment. **Sediment** can also contain remains of plants and animals. The sediment gets moved by water and wind and gets deposited in layers. Over millions of years, the sediments are squeezed together and become sedimentary rock.

Metamorphic rocks form when rocks are exposed to a great increase in temperature and pressure. This occurs deep within Earth's interior where it is hotter and the overlying rock cause great pressure. Minerals may get changed to other minerals forming a new rock. Mineral grains also become aligned in response to the increased pressure. If the heat and pressure become too great, the rock melts and the rock cycle begins again.

Minerals are the source of gemstones, metals, and other materials used to make many products. Gemstones are hard, colorful minerals that are used not only for jewelry but also for cutting, grinding and polishing. Minerals are used in foods, medicine, fertilizer, and building materials. Minerals are also the source of metals such as copper, iron, and silver.

Today, people use rocks for building materials and in industrial processes. A rock that contains a metal or mineral that can be mined and sold for a profit is called an **ore. To produce metal from ore, the ore must be mined, or removed from the ground. Then the ore must be processed to extract the metal.** Mining is done in one of three ways. Strip mining removes the overlying layers of soil and rock to reveal the ore beneath. Open pit mining involves digging a huge pit to get to the ore. Shaft mining is used when the ore occurs in veins far beneath the surface.

The mined ore must be processed before it can be used. During **smelting**, the ore is mixed with other substances and then melted. The useful ore separates from the rest of the rock. The pure ore is removed.

Rocks and Weathering ■ *Section 2 Summary*

Key Concepts

- How do weathering and erosion affect Earth's surface?
- What are the causes of mechanical weathering and chemical weathering?

- What determines how fast weathering occurs?

Weathering is the process that breaks down rock and other substances of Earth's surface. **Erosion** is the removal of rock particles by wind, water, ice, or gravity. **Topography is reshaped by weathering and erosion. These processes work together continuously to wear down and carry away the rocks at Earth's surface.** The weathering and erosion that geologists observe today also shaped Earth's surface millions of years ago. How do geologists know this? Geologists make inferences based on the principle of **uniformitarianism**. This principle states that the same processes that operate today operated in the past.

There are two kinds of weathering: mechanical weathering and chemical weathering. Both types of weathering act slowly, but over time they break down even the biggest, hardest rocks. The type of weathering in which rock is physically broken into smaller pieces is called **mechanical weathering**. **The causes of mechanical weathering include freezing and thawing, release of pressure, plant growth, actions of animals, and abrasion.** The term **abrasion** refers to the grinding away of rock by rock particles carried by water, ice, wind, or gravity.

In cool climates, water expands when it freezes and acts as a wedge. This process is called **ice wedging**. With repeated freezing and thawing, cracks slowly expand until pieces of rock break off.

Another type of weathering that attacks rocks is **chemical weathering**, a process that breaks down rock through chemical changes. **The causes of chemical weathering include the action of water, oxygen, carbon dioxide, living organisms, and acid rain.** Chemical weathering can produce new minerals as it breaks down rock. Chemical and mechanical weathering often work together. As mechanical weathering breaks rocks into pieces, more surface area becomes exposed to chemical weathering.

Water is the most important cause of chemical weathering. Water weathers rock by dissolving it. The oxygen in air is an important cause of chemical weathering. Iron combines with oxygen in the presence of water in a process called **oxidation**. The product of oxidation is rust.

The most important factors that determine the rate at which weathering occurs are the type of rock and the climate. Some types of rock weather more rapidly than others. For example, some rock weathers easily because it is **permeable**, which means that it is full of air spaces that allow water to seep through it.

How Soil Forms ■ *Section 3 Summary*

Key Concepts

- What is soil made of, and how does it form?
- How do scientists classify soils?
- What is the role of plants and animals in soil formation?

Soil is the loose, weathered material on Earth's surface in which plants can grow. **Bedrock** is the solid layer of rock beneath the soil.

Soil is a mixture of rock particles, minerals, decayed organic material, air, and water. The decayed organic material in soil is **humus**, a dark-colored substance that forms as plant and animal remains decay. Humus helps create spaces in soil for air and water that plants must have. The **fertility** of soil is a measure of how well the soil supports plant growth.

Soil texture depends on the size of individual particles. The largest soil particles are gravel. Next in size are sand particles, followed by silt particles. Clay particles are the smallest. Texture is important for plant growth. Plants can "drown" for lack of air in clay soil, and they may die from lack of water in sandy soil. The best soil for growing most plants is **loam**, which is soil that is made up of about equal parts of clay, sand, and silt.

Soil forms as rock is broken down by weathering and mixes with other materials on the surface. It

is constantly formed wherever bedrock is exposed. Soil formation continues over a long period, and gradually soil develops layers called horizons. A **soil horizon** is a layer of soil that differs in color and texture from the layers above or below it. The top layer, the A horizon, is made up of **topsoil**, a crumbly, dark brown soil that is a mixture of humus, clay, and other minerals. The next layer, the B horizon, often called **subsoil**, usually consists of clay and other particles washed down from the A horizon, but little humus. Below that layer is the C horizon, which contains only partly weathered rock.

Scientists classify different types of soil into major groups based on climate, plants, and soil composition. The most common plants found in a region are also used to help classify the soil. Soils are classified as either **acidic** or **basic**. The most fertile soils have a pH between 6 and 7.5.

Soil teems with living things. **Some soil organisms make humus, the material that makes soil fertile. Other soil organisms mix the soil and make spaces in it for air and water.** Plants contribute most of the organic remains that form humus. The leaves that plants shed form a loose layer on the ground called **litter**. Humus forms in a process called decomposition, in which organisms that live in the soil turn dead organic material into humus. The organisms that break the remains of dead organisms into smaller pieces and digest them with chemicals are called **decomposers**. Fungi, bacteria, worms, and other organisms are the main soil decomposers. Earthworms do most of the work of mixing humus with other materials in soil. Earthworms and burrowing animals also help aerate, or mix air into, the soil.

Soil Conservation ■ *Section 4 Summary*

Key Concepts

- Why is fertile soil considered a nonrenewable resource?
- How can soil lose its value?
- What are some ways that soil can be conserved?

The prairie soils of the central United States took many thousands of years to develop. Prairie soil was once rich with humus because it was covered with tall grass. The **sod**—the thick mass of tough roots at the surface of the soil—kept the soil in place and held onto moisture. Today, farm crops have replaced the prairies. But prairie soils are still among the richest in the world.

A **natural resource** is anything in the environment that humans use. Soil is one of Earth's most valuable resources because everything that lives on land, including humans, depends directly or indirectly on soil. Plants depend directly on soil to live and grow. Animals depend on plants for food. Fertile soil is valuable because there is a limited supply. It can take hundreds of years for just a few centimeters of soil to develop. **Because fertile soil is in limited supply and takes a long time to form, it is considered a nonrenewable resource.**

The value of soil is reduced when soil loses its fertility and when topsoil is lost due to erosion. This occurred in large parts of the South in the late 1800s in areas where only cotton had been grown. In the early 1900s, a scientist named George Washington Carver developed new crops and farming methods that helped restore soil fertility in the South.

Soil can be lost to erosion by water or wind. Water or wind erosion can occur wherever soil is not protected by plant cover. Plants break the force of rain, and plant roots hold soil in place.

Wind erosion was the cause of soil loss on the Great Plains in the 1930s. By 1930, almost all of the Great Plains had been turned into farms or ranches. Plowing removed the grass from the Great Plains and exposed the soil. In times of drought, the topsoil quickly dried out, turned to dust, and blew away. Wind blew the soil east in great, black clouds. The problem was most serious in the southern Plains states. This area was called the **Dust Bowl**. The Dust Bowl helped people appreciate the value of soil.

Soil conservation is the management of soil to prevent its destruction. **Soil can be conserved through contour plowing, conservation plowing, and crop rotation.** **Contour plowing** is the practice of plowing fields along the curves of a slope. This prevents rain from washing soil away. **Conservation plowing** disturbs the soil and its plant cover as little as possible. Dead weeds and stalks of the previous year's crop are left in the ground to help return soil nutrients, retain moisture, and hold soil in place. In **crop rotation**, every year different crops are planted in the field.