7.5 Weathering Breaks Down Rocks

LEARNING TIP

Preview the section and read the headings. How many types of weathering will you be learning about in this section?

An old cemetery can be an interesting place to visit. You can see how small, slow changes make a big difference after many years. For example, almost 200 years ago, the gravestone in **Figure 1** was polished and new. Today, the edges are chipped and the surface of the stone has tiny holes. In a few more years, the writing will be worn away. Eventually, the stone will crumble apart and disappear into the soil.

Figure 1
This old gravestone is starting to show wear. Compare it with a new gravestone to see how rock weathers over time.

The process that slowly breaks down natural materials, such as rocks and boulders, into smaller pieces is called **weathering.** Weathering also breaks down human-made structures, such as roads and buildings. Weathering can be caused by physical forces or by chemical reactions.

The term "weathering" indicates that the changes to the rock material are caused by the weather. Weather includes changing temperature, wind, rainfall, and snowfall. Weathering slowly breaks down all rock materials in contact with the air.

There are three kinds of weathering: mechanical, chemical, and biological.

Mechanical Weathering

Weathering that is caused by a physical force is called **mechanical weathering.** Many different physical forces can cause weathering.

Have you ever left a full bottle of water or pop in the freezer? The container either swells or breaks as the water expands from freezing. Rocks often have cracks in them. During colder months, rainwater is caught in the cracks and then freezes. As the water expands, it puts pressure on the walls of the cracks, forcing them to widen. This is called **ice wedging.** Eventually, as ice wedging occurs again and again, the cracks may widen or pieces of rock may break off (**Figure 2**).

LEARNING TIP

Compare what you are learning with what you already know. How do the examples of mechanical weathering fit with what you already know?

Figure 2
Ice wedging has weathered this rock face. Notice the pieces of rock that have fallen off and collected below.

Mechanical weathering may be caused by the wind as well. Sand particles and small rocks carried by the wind have the same effect as sandpaper as they rub the surface of the rock. The sand and small rocks slowly wear down exposed surfaces into small pieces or particles of rock.

Figure 3
These rocks have been rounded as they tumbled in a fast-flowing river.

Similarly, rocks carried by fast-flowing water rub against each other. This action gradually wears away and smoothes the outer surfaces of the rocks (**Figure 3**). The force of pounding waves on a seashore can break large rocks into smaller fragments.

One of the most dramatic causes of mechanical weathering is glaciers. Although glaciers seem to stay in one place, they actually move very slowly downhill due to their immense weight. As they move, the rocks that are trapped in the ice scrape the ground below (**Figure 4**). This type of mechanical weathering is easily identified by the long scratches, called striations, it leaves on rocks.

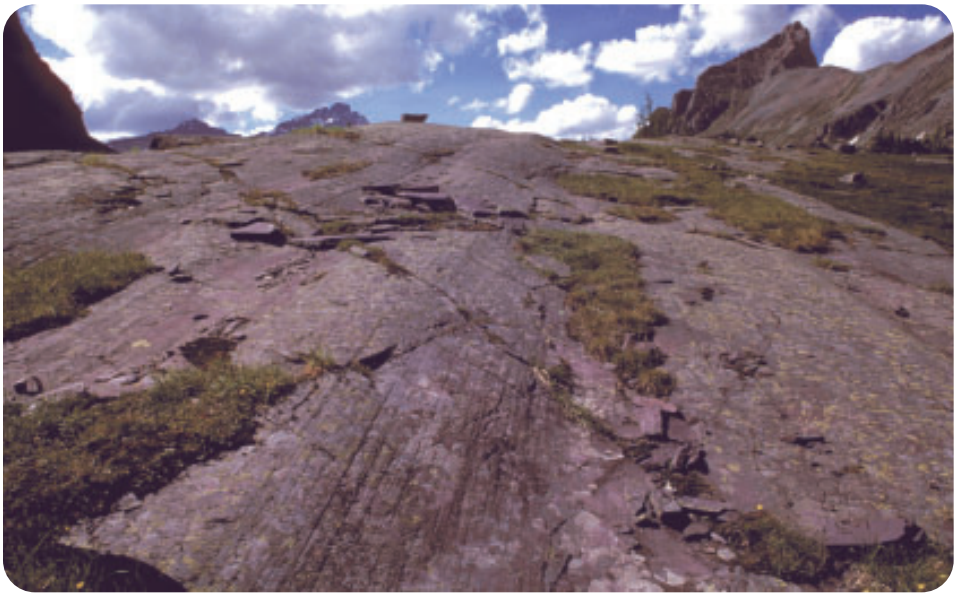

Figure 4
During the last ice age, a huge glacier covered most of North America. You may find a rock like this, with marks that have been cut into it by rocks in the moving ice.

TRY THIS: *MODEL MECHANICAL WEATHERING*

Skills Focus: observing, inferring, creating models

Make a model to show how glaciers carrying rocks cause mechanical weathering. Fill an ice-cube tray with water. Sprinkle some sand in half of the sections. Freeze the water. Pop out a regular ice cube, and rub it along on a piece of foil. Then do the same with a sand cube. As you rub the sand cube along the foil, what do you observe (**Figure 5**)?

Figure 5

Chemical Weathering

As you have learned, rocks are made up of many different materials. Chemicals can weaken and break down some of these materials. **Chemical weathering** occurs when there is a chemical reaction between water, air, or another substance and the materials in rocks.

Water can dissolve some rock materials. If the water contains natural or human-made acids, the dissolving process will occur much more quickly. In nature, carbon dioxide gas in the air dissolves in rainwater to form a weak acid. When the rainwater passes over or through limestone, it dissolves some of the rock. Holes form in the rock. Over very long periods of time, these holes grow larger to form caves (**Figure 6**). In British Columbia, there are caves that were formed like this on Vancouver Island, in Glacier National Park, and near Mount Robson.

Figure 6
Rainwater dissolves the mineral calcite in limestone, sometimes forming large underground tunnels. The cave above is in Fernie, in the Southern Rockies of British Columbia.

LEARNING TIP

Check your understanding of how this cave formed by explaining it in your own words to a partner.

Pollutants in the air can create acid precipitation (either rain or snow). Acid rain dissolves more minerals than normal rain. The limestone that is used to make statues and other monuments and buildings can be severely damaged by acid rain (**Figure 7**). Over many years, the mineral calcite in the limestone dissolves as acid rain pours over it, causing the limestone to crumble.

Air can also cause chemical weathering. The oxygen in air can rust any iron in minerals found in rocks.

Figure 7
The chemical weathering of ancient statues has been speeded up by the modern pollutants in acid rain.

TRY THIS: MODEL CHEMICAL WEATHERING

Skills Focus: creating models, observing, inferring

Create a model of chemical weathering by acid rain using chalk, water, and vinegar. Chalk is made of a compound called calcium carbonate. Calcium carbonate is found in the marble and limestone that are often used to make statues and buildings. Use a model to compare the effects of normal rain and acid rain on chalk. Put one piece of chalk in a glass or cup of tap water (rain). Put another piece of chalk in a glass or cup of vinegar (acid rain). Label the cups and leave the cups overnight. The next day, observe and compare the two pieces of chalk.

Biological Weathering

Sometimes living things cause mechanical or chemical weathering. This is called **biological weathering.**

Lichen grows on rocks and uses some of the materials in the rocks as a source of nutrients (**Figure 8**). It produces an acid that dissolves and wears down the rocks. When the lichen dies, it leaves a thin layer of weathered rock materials in which other plants can grow.

Figure 8
Lichen can wear down rocks.

Plants that grow in the cracks in rocks help to split the rocks. Wind and water deposit soil particles in the cracks caused by ice wedging. Roots grow in the cracks, splitting the rocks even more (**Figure 9**).

a) Trees grow very slowly where there is little soil. As the tree's roots grow, they split the rock.

b) This small tree may be hundreds of years old.

Figure 9

The roots of trees and other plants cause biological weathering.

TRY THIS: OBSERVE BIOLOGICAL WEATHERING

Skills Focus: observing, classifying

Take a walk around your schoolyard. Find and sketch examples of biological weathering. Look for lichen on rocks and weeds growing in cracks in the sidewalk. Post sketches in your classroom. Did other students find similar examples of biological weathering? Different examples?

CHECK YOUR UNDERSTANDING

1. Draw a Venn diagram to show the relationships among mechanical, chemical, and biological weathering. On your diagram, define each type of weathering and give examples.
2. Explain how water can be involved in both mechanical and chemical weathering.
3. Old gravestones are sometimes so weathered that the writing is worn away. What types of weathering could act on a gravestone?
4. What human activities can increase the rate of weathering?

LEARNING TIP

To review how to use a Venn diagram, see "Using Graphic Organizers" in the Skills Handbook.