

## Section 1

# Weathering

**Key Concept** Rock is broken down into smaller pieces by mechanical and chemical weathering.

### What You Will Learn

- Ice, water, wind, gravity, plants, and animals can cause mechanical weathering by breaking rock into pieces.
- Water, acids, and air can cause chemical weathering of rocks.

### Why It Matters

Weathering is the process that allows soil to form and that shapes much of Earth's surface.

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If you have ever walked along a trail, you may have noticed small rocks lying around. Where did these small rocks come from? These small rocks came from larger rocks that were broken down. The process by which rock materials are broken down by physical or chemical processes is called **weathering**.

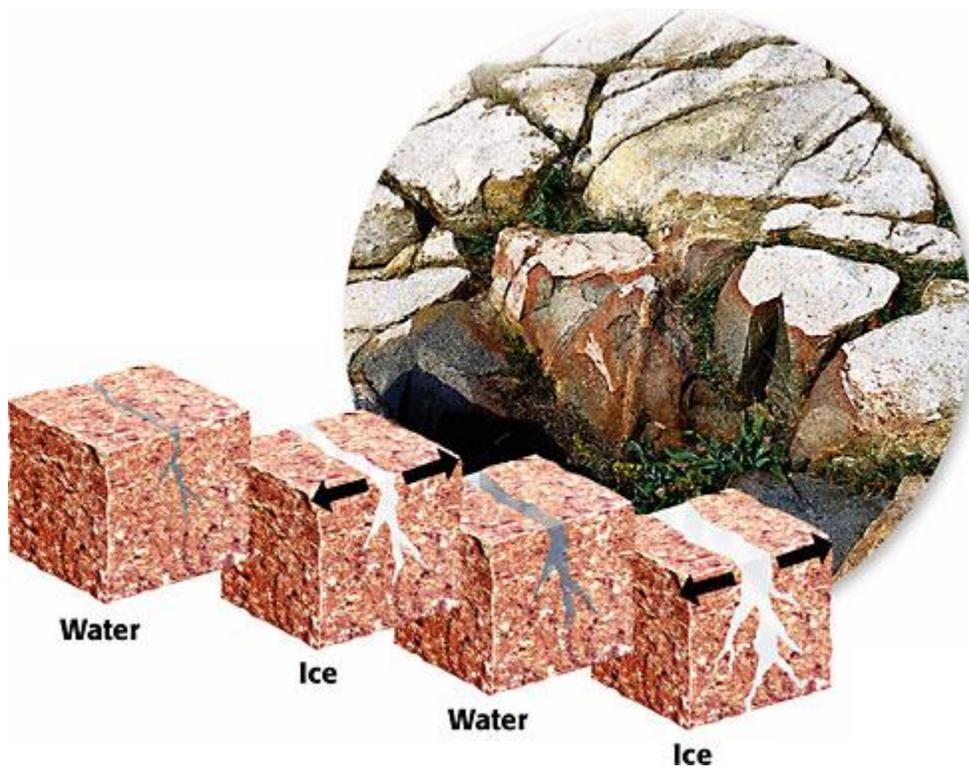
## Mechanical Weathering

If you were to crush one rock with another rock, you would be practicing one kind of mechanical weathering. **Mechanical weathering** is the breakdown of rock into smaller pieces by physical means. Agents of mechanical weathering include ice, wind, water, gravity, plants, and even animals.

### Ice Wedging

One cause of mechanical weathering is *frost action*, the alternate freezing and thawing of soil and rock. *Ice wedging*, one kind of frost action, is shown in **Figure 1**. Ice wedging starts when water seeps into cracks in rock during warm weather. When temperatures drop, the water freezes and expands. The ice then pushes against the sides of the cracks. This action causes the cracks to widen. As the cycle repeats, the cracks get bigger until the rock finally breaks apart.

**Figure 1** The granite in the photo has been broken down by repeated ice wedging, which is illustrated below.



### **Abrasion**

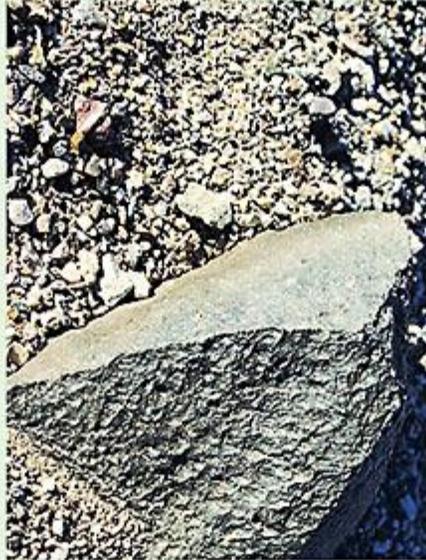
As you scrape a piece of chalk against a board, particles of the chalk rub off on the board. The piece of chalk wears down and becomes smaller. The same process, called *abrasion*, happens with rocks. **Abrasion** is the grinding and wearing away of rock surfaces through the mechanical action of other rock or sand particles.

Whenever one rock hits another, abrasion takes place. As **Figure 2** shows, abrasion can happen in many ways. Water can cause abrasion as rocks bump into and scrape each other as they are moved by waves and rivers. Wind causes abrasion by blowing sand and silt against exposed rock. Gravity causes abrasion by causing rocks to grind against one another as they slide downhill.

### **Figure 2 Three Forms of Abrasion**



These river rocks are rounded because they have been tumbled in the riverbed by fast-moving water for many years.



This rock has been shaped by blowing sand. Such rocks are called *ventifacts*.



As rocks gather together in a mass, they may break into fragments.

**Standards Check** How can sediment transported in a stream cause abrasion?

**Exfoliation**

As overlying surface material is eroded, some pressure on underlying rocks is removed. This decrease in pressure on the body of rock allows the rock to expand. Sheets of rock may peel away from the main body of rock. **Exfoliation** is the process by which sheets of rock peel away from a large body of rock because pressure is removed.

### Plant Growth

You may not think that plants are strong, but some plants can easily break rocks. Have you ever seen sidewalks and streets that are cracked because of tree roots? The roots of a plant commonly grow into existing cracks in rocks. As the plant grows, the force of its expanding roots becomes so strong that the cracks widen. Roots don't grow fast, but they certainly are powerful! In time, the whole rock can split apart, as **Figure 3** shows.



**Figure 3** Although they grow slowly, tree roots are strong enough to break solid rock.

### Animal Actions

Believe it or not, earthworms cause a lot of weathering. They tunnel through the soil and move soil particles around. This motion breaks some particles into smaller particles. It also exposes fresh surfaces to continued weathering. Some kinds of tropical worms move an estimated 100 metric tons of soil per acre every year! Almost any animal that burrows causes mechanical weathering. Ants, worms, mice, coyotes, and rabbits are just a few of the animals that contribute to weathering. **Figure 4** shows some of these animals in action. The mixing and digging that animals do also contribute to chemical weathering, another kind of weathering.

**Figure 4 Weathering Caused by Animals**



◀ Harvester ants cause weathering as they build tunnels and chambers underground.



As earthworms burrow through the ground, they move rock and soil particles and expose new particles to water and air. ▶



◀ When prairie dogs (right) and moles (left) burrow in the ground, they break up soil and loosen rocks to be exposed to further weathering. ▶



**Standards Check** How can animals cause mechanical weathering?

□

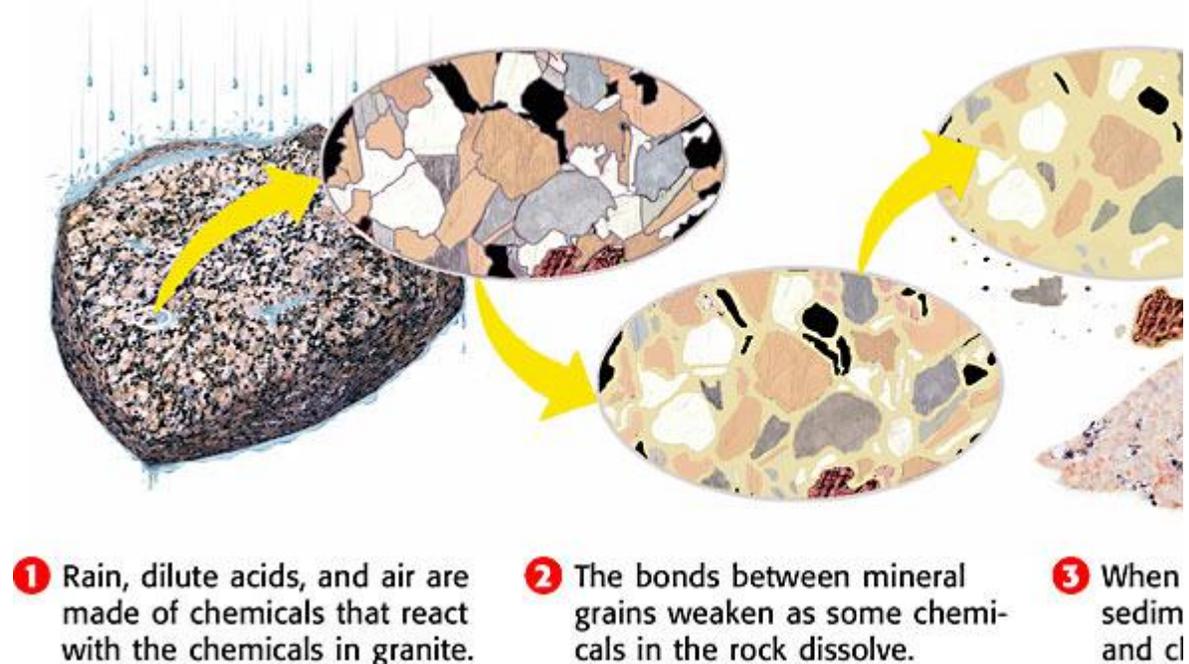
## Chemical Weathering

The process by which rocks break down as a result of chemical reactions is called **chemical weathering**. Common agents of chemical weathering are water, acids, and air. These agents chemically break down rocks by reacting with the chemicals that form the rock. These reactions weaken or destroy the bonds between elements in the minerals in the rock.

### How Water Chemically Breaks Down Rock

If you drop a sugar cube into a glass of water, the sugar cube will dissolve after a few minutes. In a similar way, water dissolves some of the chemicals that make up rock. Even hard rock, such as granite, can be broken down by water. But this process may take thousands of years or more. **Figure 5** shows how granite is chemically weathered.

**Figure 5 Chemical Weathering of Granite**



### Acid Precipitation

Precipitation is naturally acidic. However, rain, sleet, or snow that contains a higher concentration of acid than normal is called **acid precipitation**. Natural sources, such as volcanoes, produce small amounts of sulfuric and nitric acids. Air pollution from the burning of fossil fuels, such as coal and oil, also produces these chemical compounds. These compounds combine with water in the atmosphere to form acids. These acids then fall back to the ground in rain and snow. Because acids are more reactive than regular water is, acid precipitation can cause very rapid weathering of rock.

### How Acids in Groundwater Weather Rock

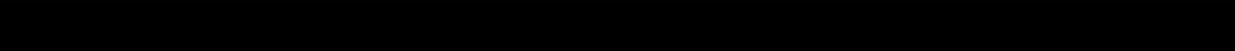
In certain places, water flows through rock underground. This water, called *groundwater*, commonly contains dilute acids, such as carbonic or sulfuric acid. When this groundwater comes into contact with limestone, a chemical reaction takes place. This chemical reaction dissolves the rock. Over a long period of time, the dissolving of limestone may form caverns, such as the one shown in **Figure 6**.



**Figure 6** Acid in groundwater has weathered limestone to form Carlsbad Caverns in New Mexico.

### How Acids in Living Things Weather Rock

All living things make dilute acids in their bodies. When these living things come into contact with rock, some of the acids are transferred to the rock's surface. The acids react with chemicals in the rock and produce areas of weakness in the rock. The weakened areas are more easily weathered. The rock may also crack in these weakened areas. Even the smallest crack can expose more of the rock to agents of both mechanical weathering and chemical weathering.



### How Air Chemically Weathers Rock

The rocks in **Figure 7** are undergoing chemical weathering. The rocks are orange because oxygen in the air reacts with the iron in the rocks. This process is called *oxidation*.



**Figure 7** The color of these rocks in Chaco Canyon, New Mexico, is the result of chemical weathering.

Oxidation is a chemical reaction in which an element, such as iron, combines with oxygen to form an oxide. This common form of chemical weathering is what causes rust. Cars, bicycles, and other metal objects can experience oxidation if they are exposed to air and rain for a long time. Exposure to rain and other water speeds the process. But the iron would react with oxygen even if no water were present.

**Standards Check** What is oxidation?



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## Section Summary

- Ice wedging is a form of mechanical weathering in which water seeps into cracks in rock and then freezes and expands.

- Wind, water, and gravity cause mechanical weathering by abrasion.
- Animals and plants cause mechanical weathering by mixing the soil and breaking apart rocks.
- Water, acids, and oxygen in the air chemically weather rock by reacting chemically with elements in the rock.
- Oxidation is the process by which oxygen from the air reacts with iron in rocks.

