Weathering and Erosion

Reflect

Have you ever looked at the land around you and wondered how it was shaped? The geologic features that help define the world are still being shaped by the natural processes of weathering, erosion, and deposition. These processes affect land differently, depending on the types of soil, rocks, and vegetation found in an ecoregion.

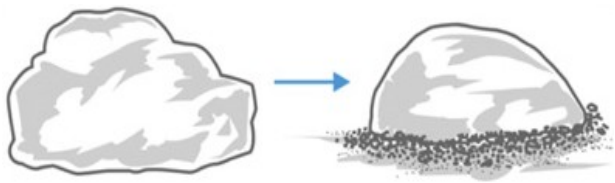
climate: a region's typical weather conditions over a long period of time

These processes can also be affected by other natural features, such as **climate** and **topography**. Later in this companion, you will learn how human activities can also affect how weathering, erosion, and deposition shape the land.

topography: the surface features of a region, including how the land rises to form mountains and falls to form valleys

Weathering

Weathering is the process by which rocks are broken down into sediments slowly over time. There are two major types of weathering: mechanical (or physical) and chemical.



Mechanical weathering breaks down rocks into smaller pieces—called **sediments**—through physical processes. Mechanical weathering changes the shape and size of a rock, but it doesn't change the rock's chemical composition. Wind and water are two of the main agents that cause mechanical weathering. Other agents include living things and changing temperatures. (An **agent** is something that causes something else.)

For example, winds can pick up small particles and blast them against rock, slowly scraping away at the rock over time. Moving water can weather rocks in a similar way; water often carries larger particles that scrape away at the rock more quickly. Millions of years ago, the Colorado River flowed over relatively flat land in what would become the southwestern United States. Slowly, over time, the river carved away the rocks and carried the sediments downstream. This process created a depression in the flat land that gradually became a deep, wide canyon that we call the Grand Canyon today.

Like many canyons, the Grand Canyon was created through mechanical weathering by water flowing in the Colorado River.

Reflect

Water can also weather rocks by getting into cracks and freezing. When water freezes, it expands. When the water freezes in the cracks, it pushes the rocks apart. Plants growing in the cracks of a rock can also push apart the rock in a similar manner. Drastic changes in temperature, from fires or volcanic activity, can also cause rocks to crack and break down as they expand and contract from heating and cooling.

Chemical weathering breaks down rocks through chemical processes that change the rocks' chemical composition. For example, when carbon dioxide in air dissolves in rain water, carbonic acid is formed. This can dissolve some rocks, including limestone. Oxygen can also cause chemical reactions that weather rocks. Many rocks contain minerals that are composed of the element iron. Oxygen in the air or dissolved in water can cause the iron in these minerals to rust or **oxidize**. Rusting changes the iron (Fe) into iron oxide (Fe_2O_3), a different kind of chemical.

Some rocks are better able to withstand weathering agents than others. Rocks made of quartz, a very hard mineral, are highly resistant to mechanical weathering. Limestone, made of the mineral calcite, is the opposite of quartz. It is very easy to dissolve through chemical weathering. When a region contains many rock types, those that are more resistant to weathering will take longer to break down. This is called **differential weathering**. Differential weathering can shape the landscape by leaving peaks of highly resistant rocks and holes or depressions where less-resistant rocks have been broken down.

Many caves are formed as a result of chemical weathering, when large areas of limestone are dissolved by acidic water.

Differential weathering can create unique landforms like the one shown above. Weathering by wind created this rock formation. The less resistant rock weathered away, while the more resistant rock remained.

Reflect

Erosion

Weathering breaks rocks down into sediments, and the process of **erosion** moves these sediments to other locations. Water—liquid and frozen—is an important agent for erosion. Flowing water can carry rocks, sediments, and soil downstream. The faster the water flows, the larger the particles it can carry. These particles may scrape against each other or nearby rocks, causing mechanical weathering at the same time as erosion. Glaciers—large sheets of moving ice—can also cause mechanical weathering, ripping chunks of rock out of the ground as they move across the land. The rocks and sediments caught up in a glacier are carried along the glacier's path, causing erosion.

Wind is another agent of erosion. Compared to water, winds usually carry smaller sediments. As these sediments scrape against rock in the wind's path, they can cause mechanical weathering at the same time as erosion. Animals are agents of erosion as they burrow into the ground, moving sediments out of their way.

Another erosional agent is gravity, which constantly pulls rocks downhill. Many rocks break as they erode downhill, causing additional mechanical weathering.

Because weathering and erosion tend to occur at the same time, rocks that are carried long distances by erosion tend to be more weathered. These rocks tend to be broken into smaller pieces and become more rounded. Rocks that are carried shorter distances, particularly through gravity, tend to have larger pieces with more angular edges. Differential weathering also plays a role. For example, if many different types of rocks are carried downstream for the same amount of time, those that are more resistant to weathering tend to be larger and less rounded than those that are less resistant.

As water laps against the shore, it erodes bits of rock. Blowing winds and the force of gravity also carry sediments into the sea.

Look Out!

Many people confuse weathering and erosion or use the terms interchangeably. While weathering and erosion often happen at the same time, they are not the same processes. Weathering is the process by which rocks are broken down. Erosion is the process by which rocks, sediments, or soil are moved or carried away.

Look Out!

Deposition

Sediments, rocks, and soil cannot keep moving forever. Eventually, the particles stop moving and settle where the erosional agents have carried them. This process is called **deposition**. When sediments are eroded by wind, flowing water, ice or gravity, they are deposited in horizontal layers. The oldest layer of sediments is positioned at the bottom, and the more recently deposited layers are at the top. Depending on which agents caused the erosion, the sediments may be deposited in different ways.

Sediments are deposited in horizontal layers.

As a river flows into the ocean, sediments carried by the flowing water begin to pile up around the river's mouth. These sediments create rich deposits of land, called deltas. Deltas are excellent places to farm because their soil contains many nutrients picked up along the river's path to the sea.

What Do You Think?

Can you think of some other landforms caused by weathering, erosion or deposition?

Human Activities

Weathering, erosion, and deposition are natural processes. However, human activities can affect how these processes shape the land. Humans can cause mechanical weathering and erosion by digging into the ground and moving rocks, sediments, and soil to other places during construction. The roots of trees and other plants help hold soil in place. When humans cut down trees, the soil loses its support and becomes more vulnerable to erosion.

What Do You Think?

Pollution from cars, factories, and other human activities can also put more chemicals in the air and water. This makes it easier for chemical weathering to occur. For example, pollution can mix with water vapor in the atmosphere and fall as acid rain. Acid rain can easily dissolve limestone, as you can see in the photograph to the right.

Discover Science: Galveston Barrier Island System

Galveston, Texas lies on a special type of island called a barrier island. A **barrier island** is a long, narrow island that stretches along a coastline. A typical barrier island is separated from the mainland by a small, shallow stretch of water such as a bay or lagoon. Barrier islands help protect the shoreline from weathering and erosion by waves and storms.

Residents of Galveston, Texas, reenter the city two weeks after Hurricane Ike made landfall.

Barrier islands are made of small, fine-grained sediments. Scientists are not entirely certain how barrier islands formed. One hypothesis is that barrier islands formed through erosion and deposition caused by flooding after the last Ice Age. Thousands of years ago, glaciers on land began to melt. As water from the melting glaciers flowed downhill to the sea, they weathered and eroded sediment. As the water flowed into the ocean, it slowed down, depositing larger, heavier sediment further inland, and smaller, fine-grained sediment further into the ocean. This process continued until the glaciers had finished retreating (leading to a rise in sea level) and the piles of sediment were high enough to rise above sea level, creating a barrier island.

Today, many people have built homes and other structures on barrier islands. People enjoy living near the beach, so barrier islands are popular places for resorts and summer homes; however, this is not always safe. Barrier islands are exposed to ocean waves and erode easily. This is especially dangerous during violent storms like hurricanes, which cause powerful winds and waves that sweep sediments from the island into the ocean. This can damage or collapse buildings along the shoreline, as well as increase the risk of flooding as the ground is washed away. In 2008, Hurricane Ike made landfall over Galveston, killing 17 people and causing billions of dollars worth of damage.

Try Now

What Do You Know?

Several processes can cause changes to the land. Read some characteristics of these processes in the box below. Then, study the photographs on the next page. Decide which characteristics in the box describe what you see in each photograph, and then write each characteristic in the appropriate space below. Some characteristics will describe more than one photograph.

Characteristics of Processes	
• Grains have been eroded a great distance • Grains have been eroded a short distance • Differential weathering	• Sediments deposited in horizontal layers • Likely deposited after being eroded by flowing water • Well-sorted sediment

Try Now

Rounded Pebbles	Angular Pebbles
	

Grooves in a Cliff	Layers of Different-Sized Grains
	

Outcrop with Ridges


Connecting With Your Child

Exploring Rock Cycle Processes at Home

First, review with your child the processes of weathering, erosion, and deposition:

- **Weathering** is the process by which rocks are broken down through mechanical (physical) or chemical means.
- **Erosion** is the process by which rocks, sediments or soil particles are carried from one location to another.
- **Deposition** is the process by which rocks, sediments or soil particles settle in horizontal layers in a new location after being eroded.
- Take your child on a walk outside. Pick up some of the rocks you find along the way. Take a close look at the rocks.
- Discuss any observations your child makes about the rocks, paying particular attention to the textures, layers, grain sizes or other features.
- Have your child explain how each rock may have been affected by weathering and erosion. Your child should also explain the features of the rock that support this hypothesis.

If there is a graveyard nearby, take a look at the older headstones. Many headstones are made of limestone or marble. These rocks are highly susceptible to chemical weathering. Pollution has resulted in acid rain in many areas, which makes limestone and marble dissolve more quickly.

Have your child observe the differences between newer and older headstones. Ask whether the headstones show evidence of chemical weathering.

Here are some questions to discuss with your child:

- How big are the grains in this rock? Are the grains all about the same size or are they many different sizes?
- Are the grains mostly rounded or mostly angular?
- Which agents of weathering and erosion do you think shaped the grains in this rock?
- How do you think this rock came to be deposited here?