



How Does Water Change Earth's Surface?

Science Vocabulary

- glacier
- minerals
- sediment
- sedimentary rock

Weathering, erosion and deposition are changing Earth's surface all around you. Water is an important cause of these changes. You will learn that water changes Earth's surface in different ways. Some of these changes are easy to observe because they happen quickly. But sometimes these changes happen over millions of years!

1. Rainwater Causes Weathering and Erosion



Rainwater flows downhill after a rainstorm, collecting into ever larger streams and rivers. The force of the water erodes previously weathered material. It also grinds down and weathers the rock it flows over.

You learned that water can weather rock and erode soil. These processes change Earth's surface and, when a lot of water is flowing, these changes can happen fast.

Think about the last time there was a storm where you live. During a storm, rainwater can erode soil very quickly. You might see splashing rain drops, moving soil on a bare spot of ground. When the rainwater hits the soil, it loosens the soil at the surface. This is the beginning of erosion. The water splashes bits of soil and small rocks and starts to flow downhill. When it rains enough, small streams start to form. Eventually, small streams join together into larger streams and then rivers. The force of this water carries bits of rock and soil along with it. So, within minutes or hours, a heavy storm can cause a lot of erosion.

Rainwater can also weather rock. Think about the stream during a heavy rainstorm again. As the water rushes over the ground, the bits of sand and soil that it carries slowly grind down the rock they flow over. Some of the rainwater also flows down into the soil and rock. Very slowly, the water mixes with some of the *minerals* in the rock and soil. **Minerals** are the chemicals that rock is made out of. Because the minerals are mixed with the water, they are carried away as the water flows. The movement of these minerals changes the structure of the rock. In these ways, rainwater weathers rock.

2. Rainwater Causes Deposition

Over time, rain weathers rock. It also erodes large amounts of material. What happens to the eroded bits of rock and soil?



When rainwater slows down or dries, it can deposit a layer of mud that can crack as it dries.

The rainwater carrying sand, rock, and soil will eventually stop moving. When the water stops moving, it deposits the sand, rock, or soil in new areas. These small pieces of sand, rock, and soil are now *sediment*. **Sediment** is any eroded material, such as weathered rock, sand, and soil, that is deposited in a new place.

As the rain slows, the rainwater flowing over the ground starts to slow down. Usually, larger pieces of material settle and are deposited first. During a heavy rainstorm, you might see a small layer of rocks on the sidewalk. As the rain turns into a drizzle or stops completely, the water deposits the smaller pieces of material such as sand or soil.

Deposition Makes Layers

Sometimes rainwater deposits sediment in more than one layer. After a storm, you might see a layer of dried mud covering some of the sidewalk or street. This mud is

made of many tiny pieces of sediment. If it rains again several days later, a new layer of sediment will be deposited on top of the first layer. The new layer might be made of a different type of sediment. So, you might see different colors or textures from the original layer of mud.



Flooding waters erode weathered material, moving it downhill. The water deposits this material as sediment in new areas, often along the banks of the stream.

3. Deposition Helps Form New Rocks



Sedimentary rock forms when layers of sediment are pressed together into one solid piece. Sedimentary rock, like this sandstone, often shows those layers.

Suppose you are at the Grand Canyon. You may notice that it is made of many layers of different colored rock. Where did these layers come from?

These layers of rock were formed by deposition. Much of this material was deposited by water at different times. Some of the rocks in the Grand Canyon are 2 billion years old!

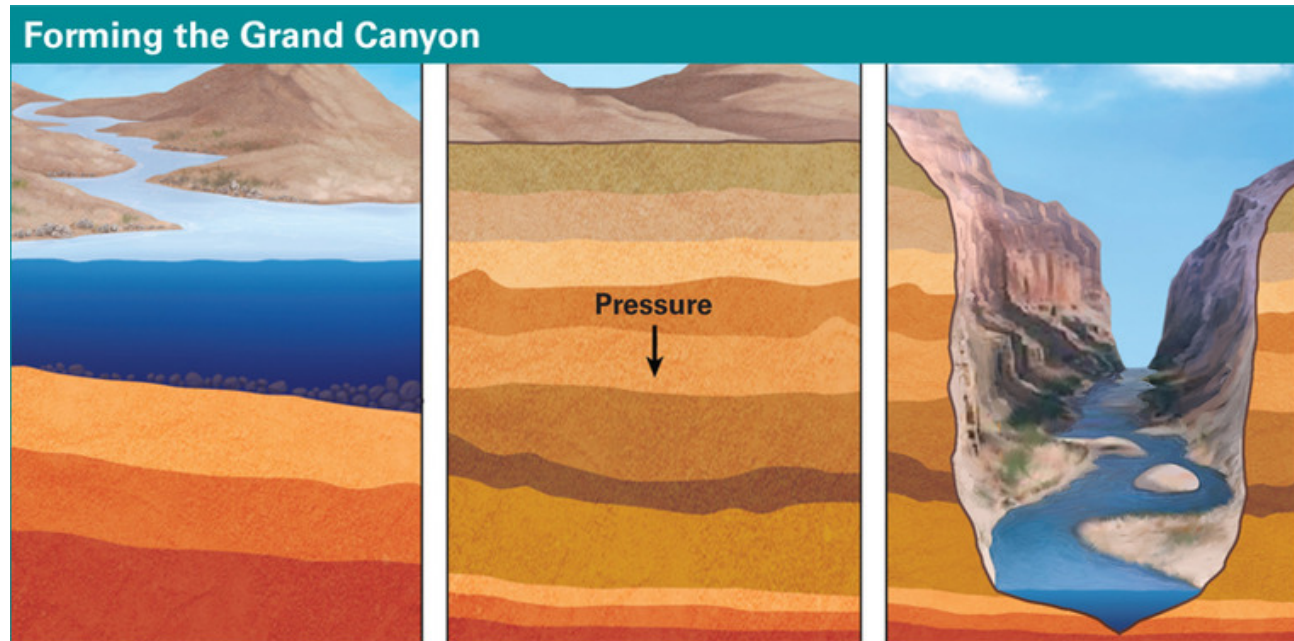
Remember how rainwater can deposit layers of sediment along the sidewalk? On some places on Earth, the same thing happens on a much larger scale. Many large rivers deposit huge amounts of sediment where they slow down or reach the sea. After many years, these sediments can add up to form a deep layer. Sometimes the environment changes, and a new kind of sediment starts being deposited. This forms a different layer. New layers always form on top of the older layers.

As more sediment is deposited, the sediment is buried and changes over time. Sediment is heavier than water. The layers on top push down on the layers beneath them, and the pieces of rock and soil get smashed together. Minerals from the water can act like glue to help the pieces stick together. Eventually, the material can become solid rock. Rock that is formed from deposited sediment is called **sedimentary rock**. Many of Earth's surface rocks are sedimentary rocks.



Over time, deposited sediment can add up to form deep layers. As these layers are buried, they very slowly turn into a type of stone called sedimentary rock. Many layers of sedimentary rock can be seen in the Grand Canyon.

4. River Water Weathers and Erodes



The Grand Canyon was formed over millions of years. First, sediment was deposited in layers. The layers pushed on each other and formed sedimentary rock with the pressure. Then the Colorado River weathered and eroded the rock to form a canyon.

Weathering, erosion, and deposition can happen very quickly, but it usually takes a long time for them to change a whole landscape. The Grand Canyon was carved by these processes, but it took millions of years.

A *canyon* is a deep valley carved by water in an area of rock. The Grand Canyon is one of the deepest canyons in the world. At the bottom of the Grand Canyon flows the Colorado River. Millions of years ago, this river started flowing and weathering the rock in the area.

Weathering alone cannot carve a canyon. Erosion must also happen. As the Colorado River carried huge amounts of sediment from the canyon to the ocean, the water eroded the rock. Most scientists think it took about 6 million years for the river to weather and erode the whole Grand Canyon. Recently, other scientists found new evidence that the canyon might be over 17 million years old. Scientific explanations can change and improve with new evidence.

Erosion and weathering can make an area look completely different. The Colorado River still runs through the Grand Canyon, deepening it over time.

5. Ice Causes Weathering and Erosion



Over time, freezing and thawing ice can break apart even very strong rocks, like this one in Antarctica. Liquid water, wind, and gravity help erode the weathered materials.

You learned how liquid water can cause material on Earth's surface to weather, erode, and be deposited. Frozen water can also cause these changes on Earth's surface.

One way ice can weather rocks is with *ice wedging*. Ice wedging is a process in which cracks in a rock get bigger from water inside them freezing. Ice wedging happens because water takes up more space as it freezes into ice.

First, a rock with a crack in it fills up with liquid water from rain or some other source. Then the temperature drops below freezing. The water starts to freeze and expand. Ice takes up more space than liquid water. The expanding ice pushes against the inside of the crack. It spreads the sides of the rock apart and makes the crack bigger. When the weather warms up, the ice melts. Since the crack is now larger, more water can get in and freeze. This pattern repeats. Each time the water freezes, it expands, and the crack gets bigger.

Erosion also happens with ice wedging. The ice wedging causes bits of rock to break off. These pieces that the ice breaks off do not always stay in the crack. Often the melted ice, rain, or other sources of water carry these bits of rock away from the crack. Gravity can make the pieces fall out too. In these ways, the weathered rock erodes.

6. Glaciers Cause Weathering, Erosion, and Deposition



Glaciers are huge rivers of ice. They move very slowly, slower than you can see. But their force scrapes off huge amounts of rock and moves it to new places.

Glaciers are another way ice weathers and erodes rock. They also move weathered rock and deposit it as sediment. This happens in high mountain valleys and in cold places like Antarctica.

Ice from glaciers starts out as snow. A **glacier** is a slowly moving river of ice. Glaciers form where it is so cold that not

all of the snow melts in the summer. Over time, so much snow piles up that it gets pressed and sticks together. This forms a glacier.

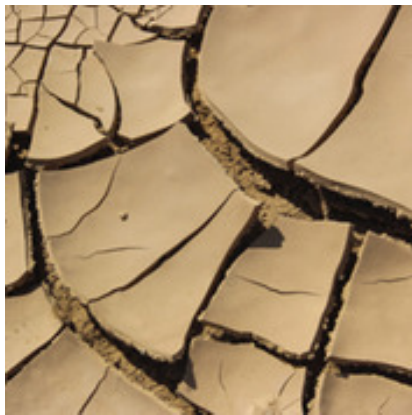
Very slowly, the glacier flows down the mountain. Glaciers weather and erode rock as they flow down valleys. Glaciers are slow, but they are so large that they create a lot of force. The weight of the ice scraping along the ground grinds off large amounts of rock underneath them. This weathered material moves downhill with the glacier. Large glaciers carve out whole valleys and change the V-shape of river valleys to a U-shape. A U-shaped valley is evidence there once was a glacier flowing through the valley.

Glaciers deposit large amounts of rock, sand, and mud at their bases. The glacier carries its sediment down the valley to lower elevations, where it is warmer. This part of the glacier starts to break off and melt. Here, it deposits the soil and rocks that it carried. This is usually many kilometers from where the glacier started.

Summary: How Does Water Change Earth's Surface?



1. Rainwater Causes Weathering and Erosion A storm can cause erosion quickly. Raindrops loosen and move soil, eroding it. As the rain forms larger streams, the force of the water increases. The sediment in the water flows over rocks, wearing it down.



2. Rainwater Causes Deposition When flowing water slows down or stops, the soil and sand it carries eventually stop moving. These small pieces of rock are then deposited as sediment. Over time, different layers of this sediment form on top of one another.



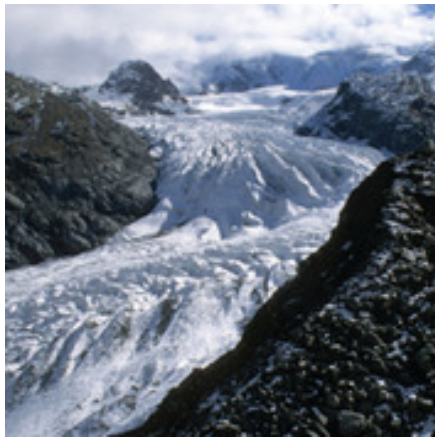
3. Deposition Helps Form New Rocks Where a lot of sediment is deposited, the lower layers are squeezed by the weight of the layers above. Eventually they turn into sedimentary rock. Most of Earth's surface rocks on its continents are sedimentary rocks.



4. River Water Weathers and Erodes As rivers flow, they weather and erode the rock they move over. Millions of years of this can produce large canyons, like the Grand Canyon in the southwestern United States.



5. Ice Causes Weathering and Erosion Ice wedging happens when water gets in the cracks of a rock and freezes. The freezing water pushes the sides of the rock apart. Over many cycles of freezing and melting, ice wedging can crack rocks apart.



6. Glaciers Cause Weathering, Erosion, and Deposition Glaciers are huge rivers of ice. The weight and power of the slow-moving ice scrapes off rock, erodes it, and deposits the pieces as sediment further downhill. This erosion carves U-shaped valleys.

Reading Further

Dripping Water Did That!

Weathering and erosion can create deep canyons and huge caves. Water also causes special kinds of deposition in caves deep underground. These look like delicate works of art. How does water create sculptures out of rock?



This room inside Carlsbad Caverns, New Mexico, is called the Chinese Theater.

Each year, thousands of people visit huge caves. They travel from all over the world for a chance to adventure through maze-like passages. Jewel Cave in South Dakota and Mammoth Cave in Kentucky are two of the longest caves in the world. You could walk for more than a hundred kilometers in each! But people do not visit these underground worlds to see how far they can walk. Believe it or not, they are there to see deposition.

These huge caves and others like them, such as Oregon Caves in Oregon and Carlsbad Cavern in New Mexico, are no where near one another. And they are found in very different climates. Even so, they are all formed of the same material—limestone. Deposition in limestone caves is more than just layers of clay or sand. Cone-shaped rocks stick up from the floor. Some cones hang from the ceiling. There is also stone shaped like curtains, columns, icicles, or drinking straws. All of these forms are created by water, one drop at a time. Visitors of the caves want to learn exactly how dripping water could form such amazing stone shapes. But how did the caves form in the first place?

Water in Caves

Some caves form through weathering and erosion at Earth's surface. Wind and water may carve a cave from the side of a cliff. This kind of cave might be home to animals such as bears.



Some caves form when water flows underground. Water might drip from the ceiling, hang in the air, and form pools and streams.

Other kinds of caves form when water flows underground. It moves through spaces in the soil and down through cracks in solid rock. If this rock is limestone, water mixes with and carries away the rock. Minerals that make up the limestone are completely mixed in with the water that moves over it. The rooms and passages of a limestone cave form as water mixes with the rock and carries it away.

As water continues to drip into the open cave spaces, it carries more minerals with it. The water deposits minerals on the floor or ceiling of the cave. Drip by drip, these minerals build up for thousands of years. This dripping and depositing creates all the different and amazing stone shapes that you find in a cave.

If you ever visit a limestone cave, you will probably feel lots of moisture in the air. You will usually hear water dripping. This means the cave is still forming. As long as there is water in a cave, it will keep shaping the cave and its rock formations. A cave that is still growing and changing is called an *active cave*. In active caves, water can also form cave ponds and streams.

Cave Cones



A stalactite and a stalagmite can grow so long that they might meet in the middle of the cave.

If you want to experience what a cave is like, go to a room and turn off the lights! Without human-made light, a cave is completely dark. You cannot see anything. But with lights, beautiful formations may be revealed.

You might see cones hanging down toward the floor. *Stalactites* are long cave formations that grow down from the ceiling. Stalactites look like icicles. Water seeping into a limestone cave drips from the ceiling. The water leaves minerals that form thin, hollow tubes. These stalactites look like soda straws, which is what they are called. Over time, water can flow along the outer edge of the soda straw, depositing more minerals. These minerals eventually make the icicle shape.

In a cave, you might also see cones reaching up to the cave top. These are called *stalagmites*. They are formed because water dripping from the ceiling of a cave can deposit minerals on the floor. Stalagmites are often found directly beneath a stalactite. Stalagmites can be wide or narrow, tall or short. A stalactite and a stalagmite can grow so long that they meet. When they do, they become one very large structure called a column.

Cave Textures

If you visit a cave, you should not touch any of its surfaces. Some formations can break very easily. So, even just touching others can damage them. This is because the oils in your skin can change the minerals. To satisfy curious visitors and still keep caves safe, guides often have samples that visitors are allowed to feel. If you could touch a cave, you would feel many different textures.

Pieces of rock that fall off the walls and ceiling feel very rough. So do the eroded surfaces of limestone. Another cave formation occurs where water splashes and leaves behind minerals. It is called cave popcorn. Just like the food, cave popcorn has a very bumpy and rough surface.

Other surfaces in a limestone cave are very smooth. Flow stone looks like a liquid and is often described as a frozen waterfall. Other surfaces called “curtains” look like soft, folded fabric. Curtains with brown and tan stripes are called “cave bacon.”

With ceilings hung with bacon and floors covered in popcorn, it is a wonder tour guides can keep visitors from tasting cave formations! Of course, if they did, all they would get is a mouthful of rocks.



A cave can have smooth and rough textures. “Cave bacon” curtains hang from the ceiling of this cave.