

Reflect



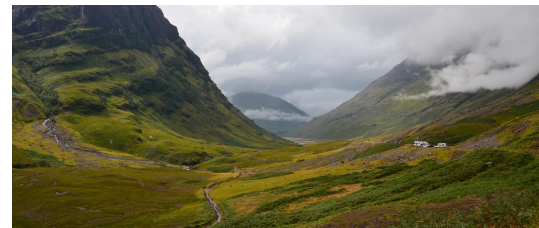
Have you ever seen a sculpture that has been outside for many years? If the sculpture is of a person, the nose and mouth might be worn down. The face might have cracks in some places. The way the sculpture looks now is probably not how it looked when the artist made it. Think of the famous Sphinx in Egypt. This sculpture was made more than 4,500 years ago. Over thousands of years, some parts of the Sphinx have worn away.

landforms – features on Earth’s surface, such as mountains, plains, hills, dunes, and valleys

Just like structures that humans build, Earth’s **landforms** change over time. Take mountains, for example. Some mountains are tall with steep slopes. They have sharp, jagged peaks. Over time, however, their slopes will become gentler. Their peaks will become more rounded and smoother, just like the face of the Sphinx. These changes happen when rocks break down and move to new places.



Jagged peaks (above) indicate younger mountains; rounded peaks (below) indicate older mountains



Forces of Nature

What forces in nature cause landforms to change? There are three forces in nature that slowly, but persistently, cause landforms to change: **weathering**, **erosion**, and **deposition**.

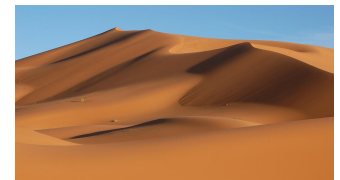
- **weathering** – the process of wearing away, dissolving, or breaking down rock
- **erosion** – the process of moving sediment (by agents such as water, wind, ice, and gravity) after it has been weathered
- **deposition** – the process of placing sediment in a new location after it has been moved by water, wind, ice, or gravity



This rock has been weathered by wind, water, and ice.



This coastline is being eroded by ocean waves.



Sediment is deposited by the wind to form sand dunes.

Weathering

Weathering happens when forces in nature break down rocks into smaller pieces. Think of the tiny grains of sand on a beach. Those grains of sand used to be parts of larger rocks or shells. Over time, pieces of the larger rocks or shells broke off. The pieces became smaller and smaller. Now they are just tiny grains.

Weathering can occur two different ways: mechanical (physical) weathering and chemical weathering. Mechanical weathering happens when physical forces break apart rocks without changing the composition of the rocks. Chemical weathering happens when chemicals act on the rocks.

Different things cause weathering. Wind is one way that weathering happens. Wind carries tiny particles of soil and rock, called *sediment*. As wind blows against a mountain, the sediment grinds against it. This grinding action breaks off pieces of the mountain. Liquid water can also cause weathering. Rivers carry sediment that grinds against rocks in the riverbed. Over time, large formations, such as canyons, can form. Waves crash against rocks over and over again, breaking off little bits. Ice can also cause weathering. Water expands when it freezes. If water seeps into cracks in rocks and then freezes, the ice pushes the cracks a little wider. After melting and refreezing many times, the ice will split the rock into pieces. Gravity causes weathering when rocks fall and split or when they land on other rocks and break them apart. Plants also weather rocks. Plant roots grow and wedge rocks apart. In addition, plants release chemicals that weather rocks. Weathering by plants is sometimes called *biological weathering*, because it is caused by a living organism. Animals can also weather rocks by digging, burrowing, climbing, and releasing chemicals from bodily functions.



Weathering from water, ice, and wind helped create these natural arches in Utah. Over many years, parts of the rocks were worn away, leaving empty spaces.



Plant roots weather rocks by breaking rocks apart as they grow.



Gravity causes rocks to fall, breaking and splitting rocks they land on.

Erosion

What causes erosion? Weathering is not the only way landforms change. When rocks break down into smaller pieces, those pieces often get moved. This movement of rock particles to a new place is called *erosion*.

Weathering and erosion work together to change Earth's surface. In fact, many things that cause weathering also cause erosion. Wind causes erosion by carrying away loose sediment from landforms, such as cliffs or sand dunes. In fact, sand dunes are constantly shifting positions because of wind erosion. In a similar way, running water carries away loose rock particles in a riverbed. The Colorado River, for example, has carried away enough rock material to nearly fill the Grand Canyon! Rainwater from storms also causes erosion when it washes away soil from hillsides. Ice can also cause erosion. As a **glacier** flows downhill, it breaks off pieces of rock. The glacier then carries the rock pieces with it. Gravity also moves sediment. Landslides, rockfalls, and mudflows are examples of erosion through gravity.

glacier – a slow-moving mass of ice



These towering rock formations are called *hoodoos*. Short, intense rainfalls are one agent that weathered and eroded the rock to form these structures.

Deposition

Eventually, wind, water, ice, and gravity put down the sediment they carry. This process is called *deposition*. (If you deposit something, you put it down.) Over time, this sediment can build up and create new landforms. For example, when wind stops blowing, the particles in the air fall to the ground. As more particles collect, they may build new beaches and sand dunes. Rivers may deposit sediment as they enter larger bodies of water, because the water slows down. This sediment creates new land at the mouth of a river (called a *delta*). Glaciers also deposit rock and soil as they melt and retreat.

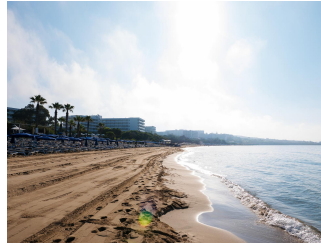


Sediment piles up at the mouth of this river to form a delta.

Try Now

Take some time to observe weathering, erosion, and deposition in action.

1. To complete this activity, you will need the following materials:
 - A rectangular baking pan
 - Sand
 - Tap water
 - Two small, wooden blocks
2. Place one wooden block under the edge of one side of the pan. The pan should be slightly tilted.
3. Add sand to the raised end of the pan. Make your sand like a mini beach. To do this, make sure your sand covers only half of the pan (the higher part).
4. Pour water into the lower end of the pan until it just reaches the edge of the beach. Do not let the water spill over the edge of the pan. If necessary, add more sand to the beach.
5. Dip the second wooden block in the water at the lower end of the pan. Gently move it up and down to create waves.
6. Watch what happens to the sand. What signs of erosion and deposition do you see?



How do waves affect the sand on a beach?

Look Out!

Looking to the Future: Threats to Forests

Human actions can change the land. In many cases, human actions lead to erosion. For example, in recent decades humans have cut down many large forests. People clear the land to build homes and businesses. When trees are cut down, their roots no longer hold the soil in place. As a result, the soil washes away more easily. This can be harmful for the environment. As soil erodes, nutrients that help plants grow also wash away. Fewer plants result in less food for the animals that live in the area, including humans! Also, loose soil can wash away suddenly in a landslide, which can harm other living things.

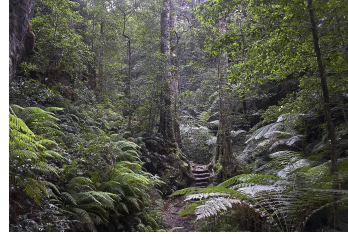
People in many areas want to make laws that protect forests. Some organizations are fighting companies around the world that are destroying forests. However, other laws are making it easier to cut down forests. For example, Brazil's government recently passed a law that allows farmers to clear some protected forests for farmland. The removal of forests continues to threaten the planet. Erosion can remove nutrients and important soil from areas that cannot get it back. How do you think we can prevent erosion from happening?

Reflect

Rainfall

Weathering, erosion, and deposition are not the only forces that shape the land. Water, in the form of rain, is a major factor in shaping an area. The amount of rainfall determines the type of plants that live in a region. Think of the contrast between the amount of precipitation a desert and a rain forest receive. Then, think of the types of vegetation you find in each location. The types of plants a region has also determines the types of animals that live in a region, since food webs are dependent upon the producers (plants) to supply energy to all the organisms.

A desert receives less than 35 cm of rain annually. Desert plants must be hardy and drought resistant.



A tropical rain forest receives at least 200 cm of rain per year. Plants of all kinds grow, and there is high **biodiversity**.

biodiversity – variety of life in an ecosystem

Plants

Plants play a major role in shaping an environment. Some plants help preserve an environment, while others can be harmful and damaging to it.



Helpful: Beach grasses can help hold sand dunes and soil in place to protect a beach area. Beach grasses have a large underground root system that creates a stable area where sand dunes form and grow. Over time, other plants will take root, such as bearberry, cottonwood trees, sand cherry, and junipers.

Harmful: Kudzu (Japanese arrowroot) is a harmful plant. Kudzu was introduced at the 1876 Centennial Exhibition in Philadelphia as an ornamental shrub. Kudzu is in interference competition with native plants in the area. It grows so fast, it overgrows other plants, preventing them from getting sunlight and causing them to die. It can grow up to 1 foot per day! In the 1930s and 1940s, Southern farmers were paid to plant kudzu to stop soil erosion. Over 1 million acres were planted. Today, kudzu is spreading so fast that it covers 150,000 new acres a year.



Methods used to remove kudzu are close mowing every week, burning, and herbicides. In some states, farmers keep goats and llamas to graze on the kudzu.

What Do You Think?

Did you know that some plants are able to remove toxins and poisons from soil and improve the water quality in streams? Did you know that some plants are used to clean the soil at old mining sites? Conduct an internet search for the Hubbard Brook Ecosystem Study. The Hubbard Brook Experimental Forest is in the White Mountain National Forest in central New Hampshire. At its website, you can take a virtual watershed walking tour, observe areas via their webcams, and read about some of their studies and lesson activities.

Can you think of any other plants that shape the land they inhabit (whether helpful or harmful)?

Reflect

Animals

Plants are not the only living organisms to affect the land. Animals can also change the land in the regions where they live.



Beavers create habitats that are great resting places for migrating birds.

Beavers are called “busy beavers” and “eager beavers” for a reason. With their powerful jaws, these large rodents spend much time chewing down trees and building lodges and dams. Dams reroute rivers and streams, changing landscapes dramatically. In fact, only people have done more to change the land in North America than beavers.



Before prairie dogs were exterminated as pests, dens were often 10 miles long!

Prairie dogs are small rodents that once inhabited much of the prairie. They dig big burrows with many branching tunnels and inhabit them with large families. Because of their destructive landscaping habits, about 95% of the prairie dog population has been exterminated by farmers as the Great Plains have been converted to farmland.

Can you think of any other animals that have shaped or affected the land where they live?