

Forces That Shape the Earth: Wind, Water and Erosion

The earth is in a constant state of motion, both as a planet in the solar system and as a body of interactive systems. Many of these systems create forces that change the face of the planet. The term weathering refers to any force that breaks down rocks and other objects in nature into smaller pieces. Erosion refers to the movement of the parts that were broken off through the weathering process.

The Origin of Sand

Have you ever looked at the patterns in the sand as you walked along a streambed or on the beach? They are evidence of other forces at work. These ridges and dips in the sand are most likely caused by either moving water or wind.

The tiny grains of sand were once a part of a larger rock. If wind and water are able to shape tiny particles of sand, what forces are needed to reduce a rock? A rock is exposed to the forces of weather including freezing, thawing, rain, wind, and heat.

Freezing and Thawing

Some types of rocks are porous, or able to absorb water. If the temperature drops while the rock is wet, the water inside the pores expands. You may recall that a soda explodes when it freezes because the liquid inside expands, or gets larger, to the point there the container can no longer hold the outward force.

Just as in the soda can, the rock cannot withstand the outward force of the ice crystals. It will break at the weakest points into two or more pieces. For many rocks, the water remains near the surface so only small pieces are removed by this process. However, over many years, this process is repeated enough times to change the appearance of the rock and, over thousands or millions of years, can change the appearance of mountains.

Moving Water

Water is responsible for other types of changes. Moving water is a very powerful force, capable of tumbling large boulders. As boulders crash together, pieces may be broken off and rough edges are smoothed. When you look at streams, you might observe that most rocks have rounded edges. This is a result of the tumbling action as currents move the rocks as well as the constant friction of moving water running over the rocks' surfaces. Another form of moving water, waves are responsible for eroding beaches by loosening and carrying away the sand. The constant friction of moving water wears away the surface of rocks as well as sand and soil. Just as sugar dissolves in water, some minerals contained in rocks may also dissolve and are swept away in the water.

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Glaciers

We have learned how the freezing and thawing of water can fracture a rock and that moving water can change rocks by friction, dissolving, and tumbling. Glaciers, gigantic sheets of ice, have moved over many parts of the earth thousands of years ago during an ice age.

Have you ever made a snowman? If so, when you rolled the snowballs that gathered the snow, you may remember how they also gathered and grass, debris, and gravel that was under the snow. Once your snowman melts, you may find this debris in a pile where the snowman once stood.

As glaciers moved, they gathered and carried huge boulders, smaller rocks, and debris. Their motion caused a grinding action between the surface and the rocks they carried. When they melted, they deposited piles of debris far away and that was not normally found in that area. Glaciers also carved into the sides of mountains and scooped out large areas and shaped valleys.

Wind

In the sand example, we mentioned wind as a possible cause. Winds sculpt the beaches and deserts of the world. They also are very effective at wearing away soft rocks such as sandstone. Wind alone can lift loose particles, thus causing erosion from a site. However, as the wind carries the fine particles of sand and other particles, its “sand blasting” action will wear away whatever it hits.

Erosion by Gravity

Erosion by gravity is a form of erosion that many people overlook. Consider a large boulder that is embedded into the side of a mountain. It is exposed to the weather and, during the winter, often experiences freezing and thawing while wet.

Over time, chips and chunks of the rock face are loosened and break completely away. Because it is located at a height, these small rocks and particles fall away from their original location because of gravity. Over hundreds or thousands of years, the shape of the mountain or cliff may change completely as parts fall away.

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Check Your Understanding

1. We have talked about many forces that act on the surfaces of the earth and change them over time. Some are considered to be weathering while others are classified as erosion. What is weathering and how is it different from erosion?

2. You are walking through the woods and find a large pile of boulders out in the middle of nowhere. There are no mountains or other places from which these could fall and there is no obvious explanation. As a science student, use what you have learned in this exercise and write up a possible explanation of how this rock pile got here.

3. When visiting Bryce Canyon National Park, you see some formations called Hoodoos. These types of formations are common through out the park and look like columns of dirt or stone left standing after all the surrounding material has been removed. They almost look like statues or chimneys after a house has burned. They are a product of erosion over millions of years. Using what we have learned, write a possible explanation as to why these towers of stone remain when all of the ground/dirt/stone that once surrounded them is gone.

4. On a walk through a section of Yellowstone National Park, you notice that a lot of smaller boulders have cracks in them and some are fractured completely into several smaller rocks. What may have caused something as hard as a rock to break?

Suggested Responses

1. Weathering is the breaking down of things such as by freezing and thawing. Weathering is a stationary process in that the newly broken pieces remain in place or the immediate area. Anything that breaks something large into smaller pieces is weathering.

Erosion is the movement of fragments. It may be water (liquid or frozen) moving over or carrying along rocks, stones, pebbles, etc. Movement causes any breakdown into smaller pieces and movement is responsible for rounding stones and smoothing of sharp edges or points.

2. When a pile of rocks is found in a place where they are not expected (didn't fall from a higher place, most likely not placed there by man as in mining or construction, etc.) it is reasonable to consider that a glacier may have deposited them there. This is particularly true if, after examining the rocks, they are found to be a type of rock that is not common to that area and would have had to be brought there from their native region.
3. Any answer that involves erosion may be reasonable since the real causes were not identified. Water or wind would be the primary answers expected. As to why these remain when other material has been carried away, a student should identify that the remaining material had some quality that made it less susceptible to erosion (harder rock).
4. The simple answer, based on this lesson, is weathering. The broken rock remains in place. The most likely cause would be freezing and thawing. As an additional learning opportunity, you may discuss the wild fires that hit Yellowstone in 1988 and how extreme heat followed by rapid cooling can also fracture rocks and did in Yellowstone. Additionally you can add the climate extremes of severe winters while hot springs abound throughout that park with frequent geyser eruptions so the extreme heat/extreme cold are available to break rocks much of the year.