

## Surface Changes on Earth

The Earth is a constantly changing planet. Many of those changes happen on the surface where we can see and measure them. Earth has been changing for a very long time. Some of the changes happen fairly quickly. Some changes happen slowly over millions of years. Scientists believe that the processes that have changed the Earth in the past still happen today. This idea is known as the **principle of uniformity**. In other words, the same changes we can see happening on Earth today also happened in the past. This helps us understand why the Earth is the way it is today.

Weathering is a very important process of surface change. Weathering can be defined as the breaking down of the lithosphere by the action of wind, water, ice, plants, animals, and chemical changes. Remember that the lithosphere is the solid part of Earth. Weathering is a very slow process. It is also a continuous process. It affects all substances that are exposed to the atmosphere.

There are two kinds of weathering: mechanical and chemical. There are five different ways mechanical weathering can happen. The first way is caused by temperature changes. During the day, the sun's energy heats rock surfaces. At night the surface will cool. The next day, it will heat again. This changing temperature can cause rocks to peel or flake. This process is called **exfoliation**. It breaks rock down into smaller pieces.

A second type of mechanical weathering may be caused by frost. Water may enter a small crack or hole in a rock. As the temperature drops to freezing, the water freezes in the rock and expands. As the water expands, it will make a larger crack or hole in the rock. When the water melts, it may move deeper into the rock and refreeze. After a while, the rock will break into pieces. This is called **ice wedging**. We see this type of weathering on our roads. It makes cracks and potholes.

The third type of weathering is caused by plants and animals. This is called **organic weathering**. Tree roots can grow into rock. As the tree grows and the roots expand, they will cause the rock to crack. Burrowing animals, such as ants, worms, and woodchucks also cause organic weathering. People may also be responsible for organic weathering by digging, plowing, or cutting stone.

**Gravity** is the fourth type of mechanical weathering. Landslides move rock and soil materials downhill due to the force of gravity. As rocks fall down, they hit each other and break into smaller pieces.

The last type of mechanical weathering is called **abrasion**. This is the wearing away by solid particles carried by wind, water, or other forces. Wind-blown sand is an abrasive that will weather even the hardest rocks.

Chemical weathering changes the chemical makeup of rocks. The five different types of mechanical weathering only change the size of the rock. The first type of chemical weathering is called **oxidation**. Oxidation is a process combining oxygen with another substance. This results in a new substance. A good example that you are probably familiar with is rusting. Iron and oxygen combine chemically to form rust; this is a form of oxidation. If a material is colored differently on the inside than the outside, it is a clue that oxidation may be taking place. Iron atoms are also found in rocks. Rocks can also rust. When this happens, it gives the rock a rusty-red color.

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The second type of chemical weathering is **carbonation**. When carbon dioxide dissolves in water, carbonic acid is formed. This acid reacts chemically with other substances, creating chemical changes. An example is acid rain. This is created when carbon dioxide dissolves in rainwater. Acid rain will dissolve some kinds of rocks. Caves are formed by this process when rainwater seeps underground.

The last type of chemical weathering is caused by plant acids. Mosses and lichens grow on rocks. They produce acids called humic acids. The acids break down the minerals in the rocks.

Weathering is a slow process. There are several factors that affect the rate of weathering. The first factor is the type of rock that is exposed to the atmosphere. Sandstone, for example, is a rock that can weather quickly. Granite rock is very resistant to weathering. This type of rock will weather very slowly. The condition of the exposed rock is an important factor, too. Rocks that have cracks or holes in them to begin with will weather at a faster rate than rocks that are solid. Of course, smaller rocks usually weather more quickly, while big boulders take more time.

The area's climate is another important factor. Climate is determined by the amount of precipitation, the temperature, and the geographical location of an area. An area with a lot of moisture will see the effects of weathering, both mechanical and chemical, faster than a dry area.

Pollution is another factor affecting the rate of weathering. Burning fossil fuels releases carbon dioxide into the air, polluting the environment. As more carbon dioxide is released into the air, more carbonation can occur. This creates more acids to weather the areas' rocks. Remember that many buildings are covered with rocks. Carbonation also affects buildings, statues, and cemetery markers that are made of stone.

Tropical climates will have the fastest rate of weathering. The temperatures are high, the air is very moist, and there are a lot of plants growing. Deserts will have one of the slowest rates because of the lack of humidity, or water in the air. In temperate climates, summer is a time of faster weathering because of higher temperatures. However, alternate freezing and thawing in the winter and early spring can also cause a larger amount of weathering.

Once the weathering process has happened, other processes cause changes on the surface of the Earth, too. **Erosion** is the wearing away of Earth's surface materials by moving water, ice, waves, and wind. Transportation is the carrying away of weathered materials. **Deposition** is the process of laying the weathered material down in a new location. For example, you have probably been outside after a heavy rain and seen water running down a slope and noticed how muddy it was. It was muddy because the water's movement had eroded soil along the sides of the slope. The water will carry the soil with it until it slows down. Then it will deposit the soil where it slowed. This erosion and deposition happens with soil and small pieces of rock as well.

Most of the time, erosion is a gradual process. It may take millions of years for the agents of erosion to make noticeable differences on the Earth's surface. The Grand Canyon in Arizona is the result of about three million years of erosion.

Erosion can also happen quickly. An unusually rainy spring can cause rivers to overflow their banks and flood areas nearby. The erosion caused by the rapid rivers and their flooding can have very quick results on the Earth's surface and its inhabitants.

Deposition by a river can cause a delta. When the moving water of a river flows into the standing water of a lake or ocean, it slows down rapidly. It deposits the sediment it was carrying. Sediments may be soil, sand, pebbles, or even small rocks. These sediments build up to form a delta, often spreading out into the lake or ocean.