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DO ROCKS LAST FOREVER?

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We think rocks last forever. The boulder we played on in our parents' front yard when we were children is still there for our grandchildren to enjoy. The rock steps to the church are still in use a hundred years later, and the gravestones in the cemetery still mark where our ancestors were laid to rest. These rocks, to us, have lasted forever. But, if you look closely, change is taking place.

This change is called weathering. The term weathering refers to the destructive processes that change the character of rock at or near the Earth's surface. There are two main types of weathering, mechanical and chemical. Processes of mechanical weathering (or physical disintegration) break up rock into smaller pieces but do not change the chemical composition. The most common mechanical weathering processes are frost action and abrasion. The processes of chemical weathering (or rock decomposition) transform rocks and minerals exposed to water and atmospheric gases into new chemical compounds (different rocks and minerals), some of which can be dissolved away. The physical removal of weathered rock by water, ice, or wind is called erosion.

Weathering is a long, slow process, which is why we think rocks last forever. In nature, mechanical and chemical weathering typically occur together. Commonly, fractures in rocks are enlarged slowly by frost action or plant growth (as roots pry into the fractures). This action causes more surface area to be exposed to chemical agents. Chemical weathering works along contacts between mineral grains. Crystals that are tightly bound together become looser as weathering products form at their contacts. Mechanical weathering continues until the rock slowly falls apart into individual grains.

We often think of weathering as destructive and a bad thing because it ruins buildings and statues. However, as rock is destroyed, valuable products are created. The major component of soil is weathered rock. The growth of plants and the production of food is dependent on weathering. Some metallic ores, such as copper and aluminum, are concentrated into economic deposits by weathering. Dissolved products of weathering are carried in solution to the sea, where they nourish marine organisms. And finally, as rocks weather and erode, the sediment eventually becomes rock again—a sedimentary rock.

Four experiments that illustrate the effects of mechanical and chemical weathering are presented below.

PLASTER AND ICE (MECHANICAL WEATHERING)

What you need: plaster of paris, water, a small balloon, two empty pint milk cartons (bottom halves only), a freezer.

What to do: (1) Fill the balloon with water until it is the size of a ping-pong ball. Tie a knot at the end. (2) Mix water with plaster of paris until the mixture is as thick as yogurt. Pour half of the plaster in one milk carton and the other half in the other. (3) Push the balloon down into the plaster in one carton until it is about $^{1}/_{4}$ inch under the surface. Hold the balloon there until the plaster sets enough so that the balloon doesn't rise to the surface. (4) Let the plaster harden for about 1 hour. (5) Put both milk cartons in the freezer overnight. 6) Remove the containers the next day to see what happened.

What to think about: What happened to the plaster that contained the balloon? What happened to the plaster that had no balloon? Why is there a difference? Which carton acted as the control? Why? How does this experiment show what happens when water seeps into a crack in a rock and freezes?

What should have happened: The plaster containing the balloon should have cracked as the water in the balloon froze and expanded. Explain that when water seeps into cracks in rocks and freezes, it can eventually break rocks apart.

A SOUR TRICK (CHEMICAL WEATHERING)

What you need: lemon juice, vinegar, medicine droppers, two pieces each of limestone, calcite, chalk, and quartz.

What to do: (1) Put a few drops of lemon juice on one of each of the four rock samples. (2) Put a few drops of vinegar on each of the other four samples. (3) Look and listen carefully each time you add the lemon juice or the vinegar.

What to think about: What happens when you put lemon juice on each rock? What happens when you put vinegar on each rock? Did the lemon juice and vinegar act the same way on each rock? Why did some of the rocks react differently? What does this experiment have to do with weathering?

What should have happened: Lemon juice and vinegar are both weak acids. The lemon juice contains citric acid and the vinegar contains acetic acid. These mild acids can dissolve rocks that contain calcium carbonate. The lemon juice and vinegar should have bubbled or fizzed on the limestone, calcite, and chalk, which all contain calcium carbonate. There should not have been a reaction on the quartz, which does not contain calcium carbonate. Explain that water commonly contains weak acids that dissolve rocks containing calcium carbonate and other minerals.

SHAKE IT UP (MECHANICAL WEATHERING)

What you need: 15 rough, jagged stones that are all about the same size, three containers with lids (like coffee cans), three clear jars, a pen, paper, masking tape.

What to do: (1) Separate the stones into three piles of five. Put each pile on a sheet of paper. (2) Label each pile A, B, or C. Label each can and jar A, B, or C. (3) Fill Can A halfway with water and put in the stones from Pile A. Do the same with Can B and Pile B and Can C and Pile C. Let the stones stand in the water overnight. (4) The next day, hold Can A in both hands and shake it hard 100 times. (5) Remove the stones from Can A with your hands and pour the water into Jar A. Observe the stones and the water. (6) Give Can B 1,000 shakes (you can rest between shakes). Remove these stones and pour the water into Jar B. Observe the stones and the water. (7) Do not shake Can C. Remove the stones and pour the water into Jar C. Observe the stones and the water. (8) Compare the three piles of stones and the three jars of water.

What to think about: How do the piles of stones differ? Why? Which pile acted as the control? Why? How do the jars of water differ? How does this show what happens to stones that are knocked about in a fast-moving river?

What should have happened: The stones that were shaken should have more rounded edges than the stones that weren't shaken, and the stones in Can B should have rounder edges than the ones in Can A. Both jars should have some sediment in the bottom, but Jar B should have more sediment because more shakes would have broken off more bits of rock. The same thing happens to rocks that are carried along in rivers or are tumbled about by waves.

STEEL WOOL AND WATER (CHEMICAL WEATHERING)

What you need: Three shallow dishes, three pieces of steel wool, salt, water, gloves.

What to do: (1) Place each piece of steel wool in a shallow dish (wear gloves because steel wool can give splinters). (2) Pour equal amounts of water over two of the pieces of steel wool. Leave the third piece dry. (3) Sprinkle one of these wet pieces with plenty of salt. (4) Observe and compare the pieces every day for a week.

What to think about: What happened to each piece of steel wool? Which piece changed the most? Why do you think the steel wool changed? Which piece of steel wool acted as the control? What does this experiment have to do with weathering?

What should have happened: When iron gets wet, the water acts as an agent to speed up oxidation (oxidation occurs when oxygen combines with another substance). In this case, oxygen in the water combined with the iron in the steel wool to form an iron oxide, or rust. Rust is a weaker material than the original metal and erodes quickly. When salt is added to the water, it speeds up the oxidation of iron. So, the steel wool in the salt water should have changed the most. The same thing happens to rocks that contain iron as happens to cars during northern winters when salt is put on the roads.

SOURCE: *Ranger Rick's Nature Scope: Geology: the Active Earth*, National Wildlife Federation, 1988.