Do rocks dissolve?

Teaching and Learning Focus

In the last investigation, students began thinking about how rocks change through time. Students were introduced to the concept of weathering and looked at abrasion as one of several physical weathering processes. In this investigation, students explore how rocks weather chemically. **Chemical weathering** is the process that breaks down rock through chemical changes. The most common agents of chemical weathering include water, oxygen, carbon dioxide, and living organisms. Chemical weathering creates holes or soft spots in rock, so the rock breaks apart more easily. Chemical and mechanical weathering often go hand in hand; mechanical weathering breaks rock into pieces, exposing more surface area to chemical weathering. In this investigation, students examine the effects of naturally formed acids on the breakdown of rock. When water (e.g. rainwater) mixes with carbon dioxide gas in the air or in air pockets in soil, a weak acid solution, called carbonic acid, is produced. When carbonic acid flows through the cracks of some rocks, it chemically reacts with the rock causing some of it to dissolve. Carbonic acid is especially reactive with calcite, which is the main mineral that makes up limestone. Over many thousands of years, the dissolving action of carbonic acid on limestone sometimes produces underground caves.
In this investigation, students will simulate the effect of carbonic acid on limestone. Pieces of chalk represent limestone and vinegar represents carbonic acid. Students place the chalk into the acid and observe how it changes over time.

Materials Needed

For each student group:

- 2 clear plastic cups
- vinegar
- water
- 2 small pieces of chalk
- masking tape
- marker or pen
- magnifying glass
- paper towels
- observation sheet
- paper (e.g. newsprint) to cover desktops
- safety goggles and apron

For instructional purposes:

- images of Chemical Weathering
- overhead projector and blank transparency sheet, flip chart or white board for recording student responses

Safety

This investigation is generally considered safe to do with students. Students should be reminded not to drink the water or vinegar. Also, review the investigation for your specific setting, materials, students, and conventional safety precautions. Be sure to remind students to wash their hands when they finish.

Setting the Scene

Begin the investigation by reminding students of the abrasion activity they did in the last investigation. Continue with the following questions:

1. **What caused the rocks to break apart?**
2. **What other processes are responsible for breaking up rocks? How do they work?**

Have your students discuss these questions, first in pairs, then groups and then as a whole class. Record their answers on a flipchart that you can refer to throughout the investigation.

Presenting the Investigation Question

After the scene is set, introduce your students to the investigation question:

1. **Do rocks dissolve?**

Have your students discuss the question in pairs, then in groups, and then as a whole class. Record their answers on a flipchart.
Have your students brainstorm ideas about how this investigation question could be investigated.

2. **How would you design an experiment that could be used to test the investigation question?**
3. **What materials would be needed?**
4. **What would you have to do?**
5. **What would be measured?**
6. **How long would the experiment take?**

Tell your students that they will be investigating this question and at the end of their study they will be able to provide reliable answers.

Assessing What Your Students Already Know

Students will have had some experiences with solids dissolving in liquid, e.g. mixing salt, sugar, or a drink mix in water. Students will probably not recognize that rocks can dissolve in water. They will also not know that rainwater is naturally slightly acidic.
Here are some initial questions that your students can discuss, in pairs, then in groups:

1. **What happens when you mix salt, sugar, or a drink mix in water?**
2. **If you mixed rock in water, could the same thing happen? Why or why not?**
3. **What causes solids to dissolve in water?**

Have your students share their ideas with the class and record them as a list on a flipchart.
Have students think about what they would like to learn about how rocks dissolve. Record their ideas on the flipchart as a list called “Questions we have about how rocks dissolve.” This list will provide further insights into what your students know, and also what they would like to know. By the end of the investigation, some of these questions will probably be answered.

Exploring the Concept

1. Explain to students that rainwater is not the same as the water they drink. Rainwater is a weak acid. Tell them that they will be looking at the effects of rainwater on the weathering (breakdown) of rocks. They will be putting chalk, which is similar in composition to limestone, into vinegar, which is a weak acid, much like rainwater. They will observe the chalk over time to see whether or not the acid has any effect on the chalk. They will also be putting chalk in water for comparison.
2. Break students into groups of 3 or 4.
3. Provide the materials to the groups.
   Observation Sheet Word Document (30 KB) | Observation Sheet Adobe PDF (12 KB)
4. Instruct groups to cover their desktops with paper.
5. Provide the following instructions to groups:
   a. Use the magnifying glass to examine each piece of chalk. Draw or describe what each piece of chalk looks like on the observation sheet.
   b. Pour vinegar into one clear plastic cup until it is about 2/3 of the way full. Use the masking tape to write “acid” and put the label on the cup.
   c. Pour water into one clear plastic cup until it is about 2/3 of the way full. Use the masking tape to write “water” and put the label on the cup.

d. Predict what will happen to the chalk after it sits in the vinegar for one hour. Record your prediction on the observation sheet.
e. Place one piece of chalk in each plastic cup.
f. Store the cups in a safe place.
g. After 1 hour, examine the chalk with the magnifying glass. Draw or describe on the observation sheet what each piece of chalk looks like.
h. Predict what will happen to the chalk after it sits in the vinegar for a total of 24 hours. Record your prediction on the observation sheet.
i. After 24 hours, examine the chalk with the magnifying glass. Draw or describe on the observation sheet what each piece of chalk looks like.
j. On the observation sheet, write a conclusion that explains your observations.

6. Discuss students' findings as a class. Prompt them with the following questions:
   a. **Which piece of chalk changed the most, the one soaking in water or the one soaking in vinegar? Why?**
   b. **How did the chalk change after soaking in vinegar for 1 hour? After 24 hours? What may have caused these changes?**
   c. **Was there more of a change after 24 hours? Why?**
   d. **How did your predictions compare with your results?**
   e. **How does what you observed compare to what happens when rainwater falls on rocks?**
   f. **How long does it take to dissolve rocks in nature?**
7. Help students to understand that when rainwater mixes with carbon dioxide in the air or carbon dioxide in air pockets in soil, a weak acid called carbonic acid is produced. When carbonic acid flows through the cracks of some rocks, it chemically reacts with the rock causing some of the rock to be dissolved. Over many thousands of years, much rock can be dissolved.

Applying Students' Understanding

Show students the *Images of Chemical Weathering* pictures. Have students answer the following questions related to the pictures:

1. **Describe the rocks in each picture.**
2. **What evidence would suggest that these rocks are undergoing chemical weathering?**

- Images of Chemical Weathering Word Document (6.65 MB)
- Images of Chemilcal Weathering Adobe PDF (349 KB)

Revisiting Investigation Question 4

Complete this investigation by asking your students the following:

1. **Do rocks dissolve?**

As a result of this investigation, students should be able to state that certain rocks can dissolve when exposed to rainwater, which is slightly acidic. This exposure increases the breakdown of rocks into smaller and smaller pieces.

Digging Deeper

The following passage provides more detailed information related to this investigation that you may choose to explain to your students.

Chemical Weathering Processes

Chemical weathering is the decomposition of rocks due to chemical reactions occurring between the minerals in rocks and the environment. Following are examples of the chemical weathering processes.

Water

Water, and many chemical compounds found in water, is the main agent of chemical weathering. Feldspar, one of the most abundant rock-forming minerals, chemically reacts with water and water-soluble compounds to form clay.

Acids

Water contains many weak acids, such as carbonic acid. This weak, but abundant, acid is formed when carbon dioxide gas from

the atmosphere mixes with rainwater. Sulfur dioxide and nitrogen gases create other types of acids that act as chemical weathering agents. Some sources of sulfur dioxide are power plants that burn coal; as well as volcanoes and coastal marshes. Sulfur gases react with oxygen and rainwater to form sulfuric acid. Although relatively weak, this acid's abundance and long term effects produce noticeable damage to vegetation, fabrics, paints and rocks.

Oxidation

Oxidation is another kind of chemical weathering that occurs when oxygen combines with another substance and creates compounds called oxides. Rust, for example, is iron oxide. When rocks, particularly those with iron in them, are exposed to air and water, the iron undergoes oxidation, which can weaken the rocks and make them crumble.

Rocks Unit Sections