Investigation 3: Rocks and Weathering

Key Question
Before you begin, first think about this key question.

How do different rock types weather?

In the last two investigations you learned that there are three major kinds of rocks. Although they are different, they are all related to each other as they pass through the rock cycle. Think about how rocks are eroded. What processes are responsible for breaking up and wearing away rocks? Do all rocks wear away at the same rate?

Share your thinking with others in your group and with your class.

Investigate
Part A: Preparing for the Investigation

1. In this investigation you will be forming your own hypotheses (plural form of hypothesis) and designing ways to test them. In your group
discuss what a hypothesis means. You may wish to read the information about hypotheses in the Inquiry box. Then answer the following questions:

a) Why is a hypothesis not the same as a guess?

b) Why do you think a hypothesis is useful in setting up a fair test?

c) Do you think that a hypothesis has to be correct? Why or why not?

2. There are several different parts to this investigation:

   Part A: Preparing for the Investigation
   Part B: Chemical Weathering
   Part C: Climate and Weathering
   Part D: Water and Weathering
   Part E: Biological Weathering
   Part F: Sharing Your Results

All groups will do Parts A and F. Your group will be assigned to do one other part. Your teacher may decide that you should do some parts as a class.

Your group will be responsible for the following:

- forming a hypothesis to test the effects of weathering on rocks;
- designing a “fair” test (a test that is objective and systematic) using the materials available;
- deciding what measurements you will make, how you will make your measurements, and when you will make measurements;
- carrying out your test and recording the data along the way.

Once you have been assigned your part of the investigation, find out which other groups are working on the same part. Work together as you form your hypothesis and conduct your tests.
Part B: Chemical Weathering

1. You will be given samples of several different kinds of rocks.
Examine the rocks closely and decide what kinds of observations to make using the materials you are provided. Be careful not to break the rocks. It is important that the rocks be roughly equal in size at the start of the experiment.

   a) Make a list of observations for each rock. Include similarities and differences among the rocks. Keep in mind that a very thorough description of the rocks will be important if you are to detect any changes as a result of your experiment.

2. On your own, think about the following questions:
   • Will these rocks weather in the same way when placed in vinegar (a mild acid)?
   • Why or why not?
   a) Write down your thinking in your journal.

3. Look at what you have written down as an answer to the first question in step 2. In your group, work together to predict what will happen to each rock sample if it is placed in vinegar and left there for 24 hours.
   Next, as a group, decide why you think this will happen.
   a) Record your group’s hypothesis (your group’s prediction and the reasons).

4. Decide what your independent and dependent variables will be and which variables you must control in your test of the hypothesis. For example, the vinegar will be one of the controls because it will be the same for every rock.
   a) Record your independent and dependent variables, and all the controlled variables in your journal.
5. Complete your design of the experiment. Decide on the steps you will take from start to finish. Be sure to include any safety precautions you will take.

Also, provide a data table in which you can record your observations. You can use a table similar to the following or make up your own to suit your test design.

   a) Include your procedure and data table in your journal.

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<thead>
<tr>
<th>Observations and Measurements</th>
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<tbody>
<tr>
<td>Rock Sample</td>
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6. With the approval of your teacher, conduct your investigation.

You are going to measure changes over a 24-hour period, so make sure that you have labeled your samples and have stored them in a safe place.

   a) Record all observations in your data table.

Part C: Climate and Weathering

1. On your own, think about the following questions:

   - Does chemical weathering happen faster in a warm climate or a cool climate? Why?
   - Does chemical weathering happen faster in a dry climate or a wet climate? Why?

Discuss your ideas with your group.

   a) Write down your thinking in your journal.
2. Next you will use a steel-wool pad, which contains iron, to model a rock containing iron. Iron is found in many sedimentary, igneous, and metamorphic rocks. When rocks containing iron undergo chemical weathering, the iron combines with oxygen to form iron oxide compounds, which are usually orange colored. Ordinary rust is an example of such a compound.

Consider the materials you are provided for this investigation. Discuss how you could use these materials in an experiment to find out more about how climate may affect the weathering of rocks.

3. Working with your group, decide upon a question to test. The question should relate to the effect of climate on chemical weathering.

As a group, agree on a prediction of what will happen to the steel wool. Decide why you think this will happen.

a) Record your group’s question and hypothesis (your prediction and the reasons).

What do you think causes the red color in this sandstone?
4. Decide what your independent and dependent variables will be and which variables you must control in your test of the hypothesis. For example, if you decide to test cold versus warm, then temperature will be your independent variable.
   a) Record your independent and dependent variables, and all the controlled variables in your journal.

5. Examine the steel wool closely and decide what kinds of observations to make using the materials you are provided. Because your goal is to measure change over time, your first observations are important.
   a) Make a data table to keep track of your observations. You can use a data table similar to the following, or you can make up your own to suit your test design. You may wish to add other categories.

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<thead>
<tr>
<th>Title</th>
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<td>Time</td>
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   b) Record your initial observations.

6. Complete your design of the experiment. Decide on the steps you will take from start to finish. Be sure to include any safety precautions you will take.
   a) Include your procedure in your journal.

7. With the approval of your teacher, conduct your investigation.
   You are going to measure changes over a period of about a week, so make sure that you have labeled your samples, and have stored them in a safe place.
   a) Record all your observations in your data table. You may also wish to record observations that you did not expect.
Part D: Water and Weathering

1. On your own, think about the following questions:
   - How can water break rocks into small pieces?
   - When water enters a crack in a rock, what happens if the water freezes?
   Discuss your ideas with your group.
   a) Write your thoughts in your journal.

2. In this investigation you will use plaster of Paris blocks to model rocks.
   Consider the materials you are provided for this investigation. Think about and discuss how you could use these materials in an experiment to find out more about how freezing water can weather a rock.

3. In your group, work together to agree on a prediction of what will happen to a plaster of Paris block if a water balloon placed inside freezes.
   Next, as a group, decide why you think this will happen.
   a) Record your group’s hypothesis (your group’s prediction and the reasons).

4. Decide what your independent and dependent variables will be and which variables you must control in your test of the hypothesis. For example, the amount of plaster of Paris you use should be the same for both milk cartons, and therefore is a controlled variable.
   a) Record your independent and dependent variables, and all the controlled variables in your journal.
5. Complete your design of the experiment. Decide on the steps you will take from start to finish. Be sure to include any safety precautions you will take.
   a) Include your procedure in your journal.

6. With the approval of your teacher, conduct your investigation.
   You are going to observe the changes the following day. Make sure that you have labeled your samples, so that others know what they are.
   a) Record all your observations.

Part E: Biological Weathering

1. On your own, think about the following question:
   • How can the roots of plants cause rocks to weather?
   Discuss your ideas with your group.
   a) Write down your thinking in your journal.

2. In this investigation you will use a plaster of Paris model of a rock. Some small crevices have been made in your model rock.
   Consider the materials you are provided for this investigation. Think about and discuss how you could use these materials in an experiment to find out more about how plant roots can weather a rock.

3. In your group, work together to agree on a prediction of what will happen to a plaster of Paris rock if mustard seeds are allowed to sprout in the crevices.
Next, as a group, decide why you think this will happen.

a) Record your group’s hypothesis (your group’s prediction and the reasons).

4. Decide what your independent and dependent variables will be and which variables you must control in your test of the hypothesis. For example, the size and shape of the plaster of Paris rocks you use should be the same, and therefore they are controlled variables.

a) Record your independent and dependent variables, and all the controlled variables in your journal.

5. Complete your design of the experiment. Decide on the steps you will take from start to finish. Be sure to include any safety precautions you will take.

a) Include your procedure in your journal.

6. With the approval of your teacher, conduct your investigation.

You are going to observe the changes for several days. Make sure that you have labeled your samples, so that others know what they are.

a) Record all your observations.

Part F: Sharing Your Results

1. When you have finished your test, examine your data. As a group discuss and answer the following questions:

a) Does the evidence you have gathered support the hypothesis?

b) Which data in particular support your hypothesis?

c) Are there any data that are not clear? Why do you think this is so?

d) Has anything occurred during your test that raises new questions? If so, what new hypothesis can you form?

2. Put all your information together into a form that others can see and understand.

Prepare to share your findings with other groups.
Digging Deeper

Weathering

If you were to sit and watch a rock surface for a day, or a month, or even a year, it might seem to you that rocks do not change. Yet rocks exposed at the Earth’s surface do not stay the way they are forever. Over tens to hundreds of years, many processes that act in the surface environment of the Earth cause solid rocks to be broken down into loose pieces of minerals and rocks. These processes, taken together, are called physical weathering.

Also, some of the minerals in rocks at the surface can be easily changed into other chemicals. Rocks form deep in the Earth, at much higher temperatures and pressures, and in a very different chemical environment. When these rocks are brought near the surface, the change in conditions makes some of their minerals chemically unstable. This chemical breakdown of some minerals when they are exposed at the Earth’s surface is called chemical weathering. Physical weathering and chemical weathering act together, but they are easier to understand by considering them separately.

Physical Weathering

Physical weathering breaks rocks apart without changing their mineral composition. Here are some examples of processes that are important in physical weathering:

Ice Wedging

Water seeps into cracks in rocks near the surface. When the temperature drops below freezing, the water freezes. As it freezes, it expands. The expansion puts enormous pressures on the surrounding rocks. The frozen water acts like a wedge, making cracks wider. After repeated freezing and thawing, the rock breaks apart. This expansion and contraction is also a major cause of potholes in streets.
Plants can take root in cracks in rock. As the plant grows, the root becomes larger. The pressure exerted by a confined growing root can be very great. These pressures make the cracks in the rocks larger. As the roots continue to grow, they can break rocks apart.

**Chemical Weathering**

As you may have found in your investigations, water is important to chemical weathering. Water dissolves the minerals in rock (just like when you put salt into water; but much more slowly). Water can also dissolve gases, like the gas that is dissolved in your soda pop. When gases in the atmosphere dissolve in water (for example, in rain), they form a weak acid. The acidic water makes some rocks dissolve even faster. Rocks made of the mineral calcite (like limestone) are the most easily dissolved by
acidic water: Without water; chemical reactions that cause rocks to weather happen much more slowly. You probably know that a piece of iron or steel stays the same for long times in dry air but rusts rapidly when it is in contact with water.

Biological Processes in Weathering

Lichens are among the first living things that establish themselves on bare rock. Lichens produce a diluted acidic solution that causes some minerals in rock to break down slowly.

Once rock is weathered into soil, microorganisms (very small plants and animals) begin to establish themselves there. They are present in the soil in amazingly large numbers. Larger animals like earthworms and rodents also live in the soil. As the plants and animals die, they add organic matter to the soil. As this organic matter decays, it is converted into carbon dioxide. The carbon dioxide dissolves in water making a weak acid called carbonic acid. This promotes further weathering of the mineral material of the soil.
The formation of karst landforms by chemical weathering is an excellent example of the Earth systems in action. Animals exhale carbon dioxide into the atmosphere. Humans also burn fossil fuels to power cars, heat buildings, and run machinery. The burning of fossil fuels also releases carbon dioxide into the atmosphere. As organic matter decays in the soil, it also releases carbon dioxide. Some of this carbon dioxide is dissolved in surface waters, making the water more acidic and more capable of dissolving limestone. In areas with pure limestone bedrock and lots of rainfall, a kind of topography called karst topography often develops. This happens both on rock surfaces and in cracks and fractures in the limestone, as acidic groundwater percolates downward. This often leads to large underground networks of caverns. Now and then a cavern will collapse, forming a sinkhole. Sometimes whole blocks of homes will fall into a sinkhole. The atmosphere, the hydrosphere, the biosphere, and the geosphere all interact to produce karst topography.

Investigation 3: Rocks and Weathering

Karst topography is clearly seen in Monroe County, Illinois.
INVESTIGATING ROCKS AND LANDFORMS

**Review and Reflect**

**Review**
1. What are ways in which rocks can weather?
2. What effects can climate have on weathering?
3. Do all rocks weather the same way? Explain your answer.

**Reflect**
4. Why is weathering an important part of the rock cycle?
5. Explain two ways that weathering affects your life.

**Thinking about the Earth System**
6. How does the weathering of rocks affect landforms?
7. Explain how the hydrosphere is connected to the weathering of rocks.
8. How is the biosphere connected to the weathering of rocks?
9. Acid rain can have an effect similar to vinegar on rocks. How does this type of weathering relate to the atmosphere?
10. Write any connection that you have discovered in this investigation to connect rocks to the geosphere, hydrosphere, atmosphere, and biosphere. You can record this information on your *Earth System Connection* sheet.

**Thinking about Scientific Inquiry**
11. How did you form a testable hypothesis for your investigation?
12. Use an example to explain what a dependent variable, an independent variable, and a controlled variable are.
13. How did you use mathematics in your inquiry?