Fifth Through Eighth Grade:
Science

Spot the Fake

A sinister character is selling shards of pottery from an archaeological site. A historian who was asked to review the materials believes they are fake. He thinks the thief used acid to artificially age the fakes so they look like the original. Your team has been hired to investigate the situation.

Scenario

Your task is to compare the soil in which some authentic shards were found years ago with two samples: one from modern-day archaeologists and one from the sinister character. Are the shards of pottery fake? Or could they be real?

The team of archaeologists decides that a controlled test of soil samples taken near the site will help answer the team's questions regarding the authenticity of the shards of pottery. Soil is composed of weathered rock fragments, organic matter, air, and water. Soil is caked in the crevasses of each shard of pottery. It has been determined that a test of the acidity of the soil from the pottery can help identify the samples (shards) as authentic or fake. The soil in the area of the most recent finds has a relatively neutral pH. Thus, if a soil sample is acidic (having a low pH), it may indicate that the shard had been "bathed" in an acid to artificially weather it and make it look older than it is.

The archaeology team sends three soil samples to your laboratory. Each sample has been carefully lifted from crevasses in the shards of three pieces of pottery. One sample comes from a site where authentic pottery was found. The second sample comes from the latest dig site and was prepared by a team of reputable archaeologists. The third soil sample comes from the person who is suspected of trying to pass off fake pottery as authentic. You will first use the ProScope microscope to compare the soil samples and identify tiny fragments of pottery. You will check the fragments for color, texture, and aging factors. You will then test the pH of each soil sample and report your results.

Investigation

In this experiment, you will use the ProScope Digital USB Microscope to examine and capture the images of small soil samples. You will compare the soil samples and highlight any significant differences between the samples. Then, using the Vernier Go! Link and a pH Sensor, you will test the pH of water that has been poured over and through each soil sample. When you complete your experiment, you will use iPhoto to prepare a report of your results.

Objectives

In this experiment, you will:

- Use a ProScope Digital USB Microscope to record the images of three soil samples
- Use a Vernier pH Sensor and Logger Lite software to measure the pH of water that has been passed through the soil samples
- Report your test results and recommendations using iPhoto software

Materials

- Macintosh computer with Mac OS X
- iPhoto software
- Vernier Go! Link interface
- Vernier pH Sensor
- Logger Lite Software
- ProScope Digital USB Microscope with M50 lens
- Two small beakers (or other similarly-sized glass containers)
- Filter funnel
- Three pieces of filter paper
- Tap water
- Three soil samples
- One pottery shard sample
- Paper towels

Pre-lab activity

In your science journal, predict how a soil sample that came from a "fake" piece of pottery will look different from soil removed from authentic pottery. Also, predict the pH of a soil sample that contains signs of an acid.

Procedure

1 Obtain three soil samples and a pottery shard sample from your teacher. Label each sample as follows: Sample #1 is soil from the authentic pottery (the control); Sample #2 is soil from the team of archaeologists at the most recent dig site; Sample #3 is soil from a person alleging to have found authentic pottery near the most recent dig site.

2 Set up the ProScope to examine soil Sample #1.

a Spread the soil sample out in as thin and even a layer as possible.

b Connect the ProScope USB Microscope to a USB port on the computer.

c Open the USB Shot application.
You should now see an image on your computer screen.

d Focus the ProScope over the soil sample using the M50 lens. Examine the sample carefully and write down a detailed description of the soil. Examine the pottery shard sample, if necessary, to help you identify portions of pottery that may be part of the soil sample.

e When you have completed your examination of the soil sample, snap an image that best represents Sample #1.

f The image is located in the SNAP folder, which is in your Applications folder. Rename the image Soil Sample #1 and drag it into a new folder you have created for this experiment.

g Insert the image in your data table.

3 Fold a piece of filter paper and place the filter paper in a filter funnel. Place a small beaker under the funnel and pour a small amount of tap water into the funnel to wet it and keep it in place in the funnel.

4 Place soil Sample #1 on the filter paper in the funnel.

5 Use a 100 mL graduated cylinder to measure out 25-30 mL of tap water. Slowly and carefully pour the water evenly over Sample #1 and catch the water in the small beaker.

6 Connect the Go! Link interface to your computer and connect the pH Sensor to the Go! Link interface.

7 Start the Logger Lite software by double-clicking the Logger Lite icon on the desktop of your computer.

8 Pour about 50 mL of tap water into a second small beaker. You will use this beaker to store the pH Sensor between tests. Carefully remove the small plastic storage bottle and cap from the tip of the pH Sensor and place the tip of the pH Sensor in the second beaker of tap water. Allow the pH Sensor to warm up for one minute before continuing to Step 9.

9 After the pH Sensor has warmed up, move it to the beaker of water that has filtered through Sample #1. When the readings stabilize on your computer screen, record the pH for Sample #1 in your data table.

10 Place the pH Sensor back in the second beaker of tap water until you are ready to test Sample #2. Rinse out the beaker of water that filtered through the soil sample. Dispose of the filter paper containing Sample #1.

1 **11** Repeat Steps 2-10 to test Samples #2 and #3. When you have completed testing Sample #3, rinse the pH Sensor with tap water and carefully pat it dry with a paper towel. (It need not be perfectly dry.) Replace the small plastic storage bottle and cap on the tip of the pH Sensor.

Processing the data

1 Make sure that you have recorded the pH for each of the three soil samples, and copied the ProScope images of each soil sample to your data table.

2 The normal pH scale ranges from 0-14. A pH of 7 is considered neutral. Values of pH above 7 are considered basic (or alkaline) and pH values below 7 are considered acidic. Identify each of the soil samples in your data table as acidic, basic, or neutral.

3 Examine your observations of each soil sample and add any descriptive detail that you may now consider to be important. Your teacher will have extra portions of each soil sample, if you wish to examine a sample again.

Data table

	Soil Sample #1	Soil Sample #2	Soil Sample #3
pH			
Observations			
ProScope Image			

Analyzing your data

1 Compare the images of the three soil samples. How are they similar? How are they different? How did the ProScope images help you compare the samples?

2 Describe and compare the pottery shards in each soil sample.

3 How did the pH values of the three soil samples compare with each other?

4 Soil Sample #1 is from an authentic pot. Compare your test results for Samples #2 and #3 to Sample #1. Can you say with confidence that Samples #2 and #3 are also from authentic pots? Explain.

5 Prepare a report of your results using iPhoto software to incorporate your digital images and data tables into your report.

Teacher Information

In this experiment, your students will examine and describe the various components of soil as they search for shards of pottery and evidence of the presence of an acid. You may want to take the opportunity to encourage your students to learn more about the types of organic and inorganic matter found in soil.

As an extended math or chemistry activity, instruct your students to add a precise volume of water to the soil. Your students may then use the measured pH of the filtered water to calculate molar concentration of H^+ (or H^3O^+) ions.

Students can use their data table file in their iPhoto presentation. You may want to explain the steps involved in exporting their files to iPhoto. To export a data table from a word-processing document or spreadsheet into iPhoto, follow these steps:

1. Take a screen shot of the information you want to include. Hold down the Command-Shift-4 keys and drag to highlight the area you want to select.

   A numbered file named Picture is created, such as "Picture 1."

2. Open the Preview application from the Dock or in the Applications folder. (Preview is included on every new Macintosh computer.)

3. Choose Open from the File menu, then locate and open your Picture screen shot file.

4. Choose Export from the File menu, name the file, and save it as a JPG file.

5. Open iPhoto and drag the JPG file into your Photo Library.

Materials

The success of this experiment will depend upon preparing good soil samples for your students to test. The pottery shards can come from any ceramic piece. A good, inexpensive piece is a small flower pot. Wrap the piece securely in a thick towel and crush it with a hammer so that you have a fairly large amount of tiny pieces of pottery.

A mixture of beach sand and any other soil makes a good sample with a lot of variety for the students to examine with the ProScope. Mix a small amount of pottery shards in with the soil. The shards should be small enough that they are not easily seen with the naked eye.

The best way to treat Sample #3 with acid is to add a small amount of citric acid or any dry lemonade drink. Citric acid is sold in drug stores and some grocery stores as dry crystals resembling sugar.

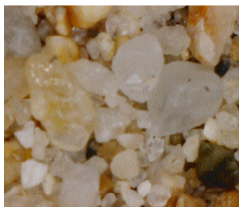
Prepare a sample of pottery shards for the students to examine with the ProScope. This will be an important step in their process of identifying the components of the soil samples. Also, set aside a set of soil samples so that your students may examine a sample with the ProScope a second time.

Do not use distilled water for any part of the experiment. Depending on how it is processed, distilled water can have a pH as low as 5. It is okay to rinse the pH Sensor with tap water.

If you do not have circular filters and filter funnels, coffee filters will work.

Each soil sample should be fairly small so that it is easy to spread into a thin and even layer. Also, it will take less time to run water through a small soil sample. One to two tablespoons of soil per sample works well.

Sample data table

	Soil Sample #1	Soil Sample #2	Soil Sample #3
pH			
Observations	Granular in appearance, there seem to be many different components in the soil.	Granular in appearance, there seem to be many different components in the soil.	Granular in appearance, there seem to be many different components in the soil. The components appear the same as the other two samples.
ProScope Image			

Answers to analyzing your data questions

1 Answers will vary. However, students may note that Sample #3 contains some different materials from Samples #1 and #2, depending on how you prepared the samples. These materials could be different types of pottery shards and/or bits of solid acidic substances. In the sample data pictured, there are no noticeable visual differences. If the same is true of your data, students should conclude that the specimens are visually identical, but vary in pH.

2 Answers will vary, depending on how you have prepared the shards. Unless you used a different type of pottery in Sample #3, the students should not note significant differences.

3 Based on the sinister character in the scenario indeed being a charlatan, the pH of the water filtered through Sample #3 should be acidic, and significantly different from Samples #1 and #2.

4 Answers will vary. The answers to this question will evaluate how your students used the information they gathered to describe the samples and judge whether or not one of the samples could have contained a fake shard of pottery.

National Science Standards

This experiment provides direct alignment to national standards by allowing students to observe and measure heat energy and transfer. The design of the experiment also emphasizes alignment with measurement, inquiry, and investigative standards by having students use technology to practice and gain insight into these skills.

Content Standard A: Science as Inquiry: B. 5-8

As a result of their activities in grades 5-8, all students should develop an understanding of

1 Abilities necessary to do scientific inquiry,

2 Understandings about scientific inquiry.

Content Standard B: Physical Science: B. 5-8

As a result of their activities in grades 5-8, all students should develop an understanding of

2 Properties and changes of properties in matter,

Content Standard D: Earth and Space Science: B. 5-8

As a result of their activities in grades 5-8, all students should develop an understanding of

1 Structure of the Earth system.

Content Standard G: History and Nature of Science: B. 5-8

As a result of their activities in grades 5-8, all students should develop an understanding of

2 Nature of Science.

Special thanks

This lesson was written by Linda Trawick, Science Coordinator and National Board Certified Teacher, Smitha Middle School, Marietta, GA, and edited by Vernier Software & Technology.