

Activity Overview

Students explore evidence for past volcanism in their community and region by examining local rock samples and geologic maps. The activity is an extension of their initial search for volcanoes. Recall that in **Activity 1** students found some limitations to the maps they had examined. **Activity 6** gives students an opportunity to explore new kinds of geologic data—rock samples and geologic maps.

Preparation and Materials Needed

Become familiar with the geologic map and determine whether or not there is any evidence of past volcanic activity in your region. This might be a good time to invite a geologist into the classroom to explain how geologic maps are made and interpreted.

You will need to obtain sets of volcanic rocks and also collect rock samples from your region for students to use in this activity. Try to note the location of the samples you collect on either the regional (AAPG) or state geologic map that students use in the investigation. This will help students to see how the map records the distribution of rocks on the surface. You can also ask students to bring in rocks from around their home. Be sure to tell them to bring in rocks that came from an exposed rock formation or were found along a stream bed, shoreline, or gravel quarry rather than rocks they happen to have in their home (such rocks may not be local).

Field guides to rock identification are helpful, but not absolutely necessary for this investigation. You can use the guides from your school or local library, university geology lab manuals, or Earth science textbooks. If students are given the locations of the local rock samples, they can read the key of the geologic map. The list of rock types will help students to determine whether or not there are any volcanic rocks in their region.

Take time to become familiar with the illustrations in the student pages, including the contrast between dacite and basalt. If you have additional photographs or videos of Hawaiian lava erupting or Mt. St. Helens exploding, this is a good time to include those in the lesson.

Materials

- 8–10 varied rock samples (some local rocks and some volcanic rocks): basalt, rhyolite, pumice, scoria, obsidian, and andesite/dacite
- Chart of rock types and names of common rocks (see chart in **Activity 5** in this module)
- Local, state, or regional geologic maps. (See the *EarthComm* web site)
- Hand lens or magnifying glass
- Copy of the cross section of a composite volcano shown on page 51—See **Blackline Master Volcanoes 6.1**

Think about It

Student Conceptions

This investigation provides an opportunity for students to make a very important conceptual leap from viewing rocks as “things” to viewing rocks as “evidence that can be used to understand Earth history.” Students may be familiar with examining boxes of rocks and minerals, devoid of any context. They are often simply asked to learn how to identify them. Geology is all about context—understanding why certain rocks are found where they are and what this reveals about how our planet has changed over time. Depending upon where you live, students may be very surprised to learn in this investigation that volcanoes erupted in or near their community millions of years ago. *EarthComm* provides students with an opportunity to learn about rocks in context—to come to understand rocks as evidence of past events on Earth. Take some time to review students’ responses to the **Think about It** question in this light and consider how the inquiry provides an opportunity for students to learn some basic concepts about igneous rocks and about rock interpretation.

Encourage students to write down as many ideas as they can. If your community once had a volcanic eruption long ago, what evidence would be left behind? Select a few students to share their ideas. Record their ideas on the board. Use some of the ideas on the list to introduce the investigation. For example, if someone says volcanic ash deposits or volcanic rocks, you can tell the class that this investigation will focus on an examination of rocks found in their community and rocks from a volcanic region. If a volcano has erupted in the past in their community, there might be some evidence left behind on the surface.

Answer for the Teacher Only

This is a challenging question, with many different angles that could be explored. Answers hinge partly on what is meant by “long ago” and even what “your community” means.

In some places, there has been volcanic activity that happened long ago by human standards but in fairly recent geologic times—more recently than some millions of years ago. Students are likely to be aware of the kinds of evidence left by such volcanic activity. Cinder cones or lava domes might still show the recognizable outlines of their original shape. Basalt flows might rest on the present land surface over a sharply defined area, although such flows are likely to have had their surfaces degraded to some extent by weathering of the basalt to the extent that the original surface features might have been partly or even entirely obliterated. Large volcanic edifices, like the volcanic mountains in the Pacific Northwest (Rainier, Baker, Shasta, etc.) or Hawaii (Mauna Kea, Mauna Loa, Kilauea, etc.) record ongoing volcanism through the latter part of geologic time up to, or almost up to, the present. The presence of a layer of volcanic ash is an indication of very recent volcanic activity, but the volcano itself might have been far away. Because volcanic ash is susceptible to rapid weathering in most climates, the volcano that produced the ash layer would

very likely have been recent, not “long ago,” although careful study of even strongly weathered ash is likely to reveal its origin.

On the other hand, past volcanism might be recorded by the presence, in your community, of typically much older volcanic rocks that are not associated with volcanoes in any obvious way. Geologic processes acting through geologic time do things like fragmenting originally connected rock bodies like volcanic flows and volcanic edifices by faulting and moving the pieces from place to place, often for long distances, and burying older rocks under deposits of younger rocks. The presence of volcanic bedrock in your community tells you that volcanic activity produced that rock sometime in the geologic past and somewhere on Earth, but was it “in your community”? That’s partly a matter of semantics.

Metamorphism acts to convert volcanic rocks into schists or gneisses, whose volcanic origin becomes difficult or impossible to recognize as the intensity of metamorphism increases. A perceptive or argumentative student might assert that such a metamorphic rock started out as a volcanic rock, and it would not be easy to disprove such an assertion.

Many sandstones and conglomerates contain evidence of past volcanism, in the form of clasts of volcanic rock. (Clasts are pieces of preexisting rock, of sand or gravel size, that were transported, commonly for long distances, from a source area to a site of deposition.) Conglomerates often contain pebbles or cobbles that are obviously volcanic. That tells you that there was volcanic activity somewhere and sometime in the geologic past, but knowing where and when is usually a challenge that calls upon many lines of geologic study to decipher.

Here’s a fundamental point, which is usually not at all obvious to nongeologists: commonly, there is little or no relationship between the presence of volcanic rocks in the bedrock geology of your community, on the one hand, and the present lay of the land in your community, on the other hand, because of the vicissitudes of erosion, deposition, and faulting. It would take careful geological fieldwork to demonstrate such a relationship.

Finally, the students should beware of assuming that there was volcanism in their community just because they have found loose pieces of volcanic rock, like pebbles from stream beds, gravel pits, or the seashore, that are not from the bedrock underlying the community. Usually there is no way of knowing exactly the location of the bedrock exposures that supplied those pieces: perhaps far from the community.

Assessment Tool

Think about It Evaluation Sheet

Think about It Evaluation Sheet can be used to assess the extent to which students have met the basic expectations for the warm-up activity.

Investigate

Collecting rock samples in your community may or may not be easy. If you live in a paved-over urban area, there may be no exposed bedrock at all, or, if it is, you may not be able to obtain pieces of it. In suburban and rural areas there is a better chance of finding natural or man-made exposures of local bedrock. Places to look are hillslopes, stream beds, seacliffs, highway cuts, building foundations, or rock quarries. Highway cuts are especially good, but collecting there can be especially dangerous and in many places is illegal. It is likely to be easier to find loose rocks in the soil, in stream beds, at the seashore, and in sand and gravel quarries, but keep in mind that such rocks may have been transported from far away. In regions of the United States with warm and humid climates, like the southeast, where weathering is intense and deep, it may be difficult to find rocks of any kind near the surface.

Teaching Tip

If you do not have any previous experience with local rock collecting, do not hesitate to try to contact local amateur geologists or geology faculty at nearby colleges or universities for advice on where to look and what to look for.

Part A: Rock Samples

The goal of this investigation is for students to understand that volcanoes leave a record of their eruptive history.

- Encourage students to make and record careful observations of the rock samples, and to note how they categorized samples into different groups.
 - Depending upon the rocks that you have available, students might prepare the following groups:
 - Light color: rhyolite, pumice
 - Medium color: andesite, dacite
 - Dark color: basalt, obsidian, and scoria
 - Glassy: obsidian
 - Fine-grained: rhyolite, basalt
 - Coarse-grained: None of these rocks are predominantly coarse-grained, because they formed at or near the Earth's surface. The more rapid cooling results in small crystal size. Rhyolite and andesite (and occasionally basalt) sometimes contain coarser crystals
 - Frothy/vesicular/have holes: pumice, scoria
- Answers will vary.

Part B: Geologic Maps

This will likely be the first time your students have worked with a geologic map. Indeed, it might be the first time that you have worked with a geologic map, or at least a local geologic map. Take some time to familiarize them with the map key and scale. Point out two or three examples of rock units and their colors and symbols on the map using places that are likely to be familiar to most students.

Geologic maps vary greatly in scale, and therefore in area covered. Think about the area you want the students' maps to cover. Most states have good geologic maps, and most are readily obtainable, but the geology of your community is likely to be very generalized on a state map. Much, but by no means all, of the United States is covered by geologic quadrangle maps, which cover areas much smaller than entire states. If your community is covered by such a map, the geology of would be shown in much more detail. Maps at intermediate scales are not nearly as common. If you live in an area with relatively simple geology (for example, flat-lying sedimentary rocks), you might want to choose a state map, which shows greater geologic variety. If, on the other hand, you live in an area with more varied and complicated geology, a map that covers a smaller area might be more useful and interesting.

For additional information about reading geologic maps, visit the *EarthComm* web site. This site will also provide you with information on how to obtain geologic maps of your community.

Reflecting on the Activity and the Challenge

Encourage students to think about the **Chapter Challenge**. Ask them to consider how their work in this activity (the search for evidence of past volcanic activity) relates to earlier investigations (volcanic flows and airborne volcanic materials). Now is also a good time to point out that they were asked to compare their region to a volcanic region.

Digging Deeper

Assign the reading for homework. The questions in **Check Your Understanding** (page 50) can be provided as a homework assignment.

Check Your Understanding

1. Intrusive igneous rocks typically consist of coarse, interlocking crystals. Extrusive igneous rocks typically have fine crystals—crystals too small to be seen without magnification. They also have holes commonly formed from the escape of gas.
2. Intrusive igneous rock cools and crystallizes within the Earth. Extrusive igneous rocks cool and crystallize at or near the Earth's surface.
3. The major dark-colored minerals in igneous rocks tend to contain abundant iron and magnesium.

Assessment Opportunity

Use (or rephrase) the questions in **Check Your Understanding** for a brief quiz to check comprehension of key ideas and skills. Use the quiz (or a class discussion about the questions in the textbook) to assess your students' understanding of the main ideas in the reading and the activity.

If rock identification is an element of your state or local science content standards, this might be a good time to assess your students' ability to identify and/or describe igneous rock samples. Depending upon the extent to which you incorporate local rock samples into the activity (which may include sedimentary or metamorphic rocks), you can add these to your assessment.

Understanding and Applying What You Have Learned

1. a) The intrusive igneous rocks are those that appear as the nearly vertical intrusive bodies (dikes) on the cross section.
b) Extrusive igneous rocks make up the sloping layers on the flanks of the volcano.
2. a) Rocks provide evidence of past volcanic activity. They reveal the history of the volcano and can point to the possibility of future volcanic activity and hazards in a region.
b) You can learn whether or not a volcano erupted in the region. If you learn the type of volcanic rock (silica-rich or silica-poor), you can learn something about how explosively the volcano erupted.

Preparing for the Chapter Challenge

Encourage students to discuss the evidence they have examined and what it reveals about the possibility of a volcanic eruption in their region. Students should also discuss the main concepts learned in the activity about intrusive versus extrusive igneous rocks, and the use of geologic maps as a source of evidence.

Teaching Tip

Provide Students with a copy of **Blackline Master 6.1, Cross Section of a Composite Volcano** to label when answering **Understanding and Applying Question 1**.

Inquiring Further

1. Volcanoes as natural resources

The suggestions for further inquiry provided here give students an opportunity to examine how volcanoes benefit society by providing a source of energy to some communities, and by providing mineral resources.

Useful energy is derived from volcanic areas in the form of geothermal energy. The basic process involves pumping cool water through deep piping systems that extend downward into rocks that are heated from below by magma that is close to the Earth's surface. The water is heated under pressure, and when it returns to the surface, it boils as pressure is released, making steam. The steam then drives turbines to generate electrical energy. Geysers are natural counterparts to the same process. In some places, the geothermal heat is used directly for space heating as well.

In many volcanic areas, hydrothermal processes form economic deposits of various minerals. Magmas cooling below the surface tend to become more and more concentrated in water and also minor chemical constituents that do not fit into the major minerals and are left over to either crystallize into certain low-temperature minerals or remain in solution in the leftover water-rich residuum of the magma. The hot solutions rise upward, to feed hot springs or simply merge with deep groundwater, and as they cool they deposit a great variety of minerals in the form of veins in near-surface bedrock. Many of these minerals, especially metal sulfides, and such things as native gold, are economically valuable.

Teaching Tip

At this stage of the chapter, students are likely to be very curious as to why anyone would want to live near a volcano. **Inquiring Further Part 1** provides an important opportunity for students to realize the benefits of volcanic activity because of its focus on volcanoes as natural resources. A third inquiry that you might offer to students is to examine the importance of volcanoes within the history of various cultures.

2. Simulating gases in igneous rock

This “at home” investigation provides a concrete way to further develop students’ understanding of how volcanic rocks are formed. The generation of gas bubbles is different, but the physical nature of the bubbles is similar. In the lava, much as in the bread dough, the bubbles tend to rise upward, but because the lava is of such high viscosity, the bubbles cannot move far before being frozen into the solidified volcanic rock. In a newly opened container of a carbonated beverage, on the other hand, the process of generation of the gas bubbles is just the same as in lavas, but because the viscosity of the beverage is so much lower, the bubbles rise rapidly upward in the liquid.