

Portable Collections Program

# Volcanoes!



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# What's in the Case?

## Specimens



Andesite



Peridot



Sulfur



Chabazite



Basalt



Vesicular basalt



Pumice



Pumice skin scrubber



Lava



Pahoehoe lava



Cinder



Obsidian



Obsidian fragment and  
spear point



Obsidian in unidentified  
rock groundmass



Volcanic bomb

## What's in the Case?

### Specimens



Scoria



Geode



Mount Saint Helens  
dust



Mount Saint Helens  
ash



Clay brick from  
Pompeii



Agate ashtray

### Tools & Resources

[Volcanoes by Neil Morris](#)

[Volcanic Rocks \(Golden Books\) by Robert Bell](#)

[Eyewitness: Volcano & Earthquake by Susanna Van Rose](#)

[Kids Who Walk on Volcanoes by Paul Otteson](#)

DVD: "Fire Mountain: The Eruption and Rebirth of Mount St. Helens." Panorama International Productions, Inc.

## How to Handle Museum Objects and Specimens

Learning to handle cultural objects and natural history specimens from the Museum's collections with respect can be part of your students' educational experience of the case. Please share these guidelines with your class, and make sure your students follow them in handling objects and specimens in the case:

- **Students may handle the objects and specimens carefully, under your supervision.**
- **Hold objects and specimens with two hands.** Hold them by the solid part of the body or by the strongest area rather than by rims, edges or protruding parts.
- **The objects and specimens are fragile** and while they may be handled, they should be touched as little as possible. Remember that rubbing and finger oils can be damaging.
- **Do not shake objects or specimens**
- **Temperature differences, direct sunlight, and water can be very harmful to museum objects.** Please keep them away from radiators and open windows, and keep them secure.



## How to Look at Museum Objects and Specimens

Learning about volcanoes by examining rocks and other scientific specimens is much different from learning about volcanoes by reading about them in a book. Specimens have the power to tell us many things, provided we are willing to look at them in detail and think about what those details mean. Encourage your students to carefully examine the volcanic rock specimens in the case. Have them touch the specimens gently, and describe them to you. Ask them questions about what they see, and what their observations might tell them. For example:

- What do you see in this rock? Describe its shape, size, and color. (It is important that your students use visual clues based on their observations when giving their answers.)
- What do you want to know about it?
- What else can you see?

You can assist this learning process by encouraging your students to examine individual specimens in detail, and to think about what those details might mean. Ask them questions about what they see, and what that might tell them. As the conversation begins to grow, you can ask more questions about the specimen:

- How does this rock compare to the other specimens in the case?
- What type of lava or volcanic eruption created this rock? How can you tell?

Providing books and Internet access for researching these and other questions encourages students to make discoveries that further their knowledge about volcanoes and igneous rocks.

# An Introduction to Volcanoes

## To the teacher

Volcanoes are an amazing force of nature. They are exciting, disastrous, awesome, and even beautiful. They create rocks and minerals, and produce materials we use everyday. They are also the stuff of history and legend.

This Portable Collections case allows you and your students to approach the topic of volcanoes from several different angles. First and foremost, you may examine volcanoes as a natural phenomenon. Volcanoes provide dramatic evidence of natural forces going on within the Earth. Your students may learn more about Earth sciences and geology by examining the many samples of volcanic rocks, ash, and dust included in the case. This case also includes three cultural objects related to volcanic matter, which are meant to help your students connect volcanoes to things they see or use in their everyday life.

Besides connections to science curricula, wherever possible we have included suggestions for art- or literacy-based activity extensions. For example, you

and your students may also choose to explore the history and mythology of volcanoes. The Ancient Romans thought that Mount Aetna, a volcano in Sicily, was the forge of their god of fire, Vulcan. Mount Vesuvius in Italy continues to capture the imagination as the cause of one of a great historic disaster (the destruction of Pompeii). Mount Fuji is a volcano venerated in Japan; its calm, balanced silhouette is a familiar image in the art of that country. Examples of famous volcanoes and volcano mythology abound.

There are many wonderful resources for the study of volcanoes. The four books in the case are only a few of the many available, but in addition there are scores of Internet sites devoted to the subject—everything from 24-hour web camera images monitoring live volcanoes around the world to volcanic rock identification games, volcano terminology, and thumbnail essays on famous volcanoes of history. In addition, while this case is designed to be used independently, it can also coordinate with our “Rocks and Minerals,” “Crystals,” and “Fossils” cases to broaden your study of geology.

## What is all that volcano terminology about?

A volcanic eruption is quite a dramatic event, but it is usually described using very dry terms. There are terms for the parts of a volcano, the sizes and shapes of matter ejected from the volcano, and the types of eruptions, lavas, volcanic rocks, and volcanic cones. These terms often vary from one book or website to another. Clearly, these terms convey important information about volcanoes, but they can also seem overwhelming and even confusing. In this introduction, we have organized and grouped the terms (and included their variants) to make this information more accessible. Depending on how you shape your study, you should be able to select the ones you think you think will be most useful to your students.



## An Introduction to Volcanoes (continued)

### What is a volcano? How do volcanoes form?

A volcano is a place in the Earth's crust where molten rock, ash, and gas erupt. It is also the word used to describe a mountain made from volcanic material.

The Earth has a relatively thin outer **crust**, made up of the continents and the ocean floor. Just below the crust is a thick layer of rock called the **mantle**, which is so hot that in places the rock is **molten**. This hot, liquid rock is called **magma**.

The Earth's crust is not one solid, continuous entity. Instead it consists of **tectonic plates**, the size of continents or larger, which overlap or butt against each other. Geological stress occurs in the areas where these plates meet, causing rocks to split and shift. This geological action creates earthquakes (which often precede volcanic eruptions) as well as weaknesses in the Earth's crust. Wherever these weaknesses exist, volcanoes may form and magma may erupt to the surface.

The interior of a volcano consists of a reservoir of magma deep in the crust, and a **vent** or passageway to the surface with a crater or mouth at the top. The vent may have smaller vents known as **fissures**, which branch off to the sides of the volcano.

### How does a volcano erupt?

A volcano erupts because magma is propelled up and out of the Earth's crust by gases, steam, and pressure built up in the mantle. Magma is lighter than the rock around it, so it will rush up and out of the volcano with great force, releasing gases and steam as well as spewing molten rock. Once the magma is above ground, it is known as **lava**. Lava can explode from the volcano's crater, or flow from the crater and the fissures.

There are different types of volcanic eruptions. Some are truly explosive! Volcanic explosions occur when the magma has met resistance from the dense crust,



or because its rock composition is dense and has trapped gas inside, or because water from above has come in contact with hot magma and has turned to steam that expands and presses upwards. Other volcanoes, while never peaceful, erupt with flows of lava rather than explosions. When eruptions occur under the ocean, islands can appear and disappear, and tsunamis can be set in motion. There are names for different types of eruptions, which vary depending on their force and their underlying architecture. (You can read more about Plinian, Pelean, Strombolian, and other types of eruptions in the books included in this Portable Collections case.)

### What happens in the aftermath of a volcanic eruption?

Often, a volcanic eruption creates a volcanic cone (also known simply as a volcano). If an eruption occurs in a pre-existing cone, it can substantially alter the shape of the cone, cause it to collapse into a crater, or even destroy the cone altogether. The different shapes of volcanic cones have different names, some of them corresponding to variations in the types of eruption. Mt. Fuji in Japan, with its high cone and sloping sides, is quite logically called "cone-shaped." It was created by a number of lava flows hardening before they had time to flow very far, thus building up the cone's height with layer upon layer of lava. Another type of cone, called a **shield** volcano, has lower sloping sides; this shape is formed when lava cools slowly, and therefore flows a long distance.

An Introduction to Volcanoes (continued)

**How do volcanoes fit into the study of basic geology?**

Volcanoes come from rocks and spew out rocks, so in learning about them it is useful to understand a little about how they relate to basic geology. (You may also want to consider renting the “Rocks and Minerals” and “Crystals” Portable Collections cases to supplement your study of geology.)

All **rocks** are classified into igneous, sedimentary, and metamorphic types. These terms refer to how the rock was formed. **Igneous** rocks are also known as volcanic rocks because they are formed from the hot magma and lava spewed by volcanic eruptions (*igneous* comes from the Latin word for fire, *ignis*).

Igneous rocks can be further subdivided into two types: **extrusive** and **intrusive** rocks. These terms

refer to *where* and *how quickly* these rocks formed, as well as their *chemical composition*. In general, rocks formed below ground cool more slowly and the **mineral** crystals in them are consequently larger. Rocks that form underground also usually include a greater variety of minerals in their composition. This is because lava cools quickly when it hits the Earth’s atmosphere or ocean water. There may be no time for crystals to develop, or only enough time for a few small ones to appear.

In examining at the rocks in the case with hand lenses, students will find that extrusive (or volcanic) rocks have finer-grained texture and fewer mineral crystals. They look like they are uniform in composition, and have only small crystals (if any). Intrusive (or plutonic) rocks have a coarser-grained texture. They look like they contain different types of matter, often of different colors or textures, as well as large crystals. □

Type of igneous rock	Where magma cools	Speed of cooling	Crystal structure	Varieties of mineral formed
Intrusive rock; also known as plutonic rock	Magma cools underground	Slower	Larger crystals and more of them within the rock	Numerous varieties
Extrusive rock; also known as volcanic or basaltic rock	Magma extruded above ground as lava	Faster than plutonic rock; sometimes so fast that no crystals form	Smaller crystals, if any; and fewer of them	Fewer

*Words in boldface have been included in the Vocabulary Words section on page 23.*

## Information About the Objects and Specimens in the Case

### ANDESITE



Andesite is a silica-bearing volcanic rock. Its name comes from the Andes Mountains in South America, where andesite is common. Andesite is gray to black in color, and has a scattering of crystals in it. This specimen contains crystals of amphibole crystals, a silicate mineral that form prismatic or needle-like crystals. Andesite does not flow as easily as other silicates (like basalt) and usually erupts from stratovolcanoes (which have a steep profile), often in large explosions.

### SULFUR



Volcanoes spew sulfur in its gaseous state (when it smells like rotten eggs). When sulfur cools, it turns into a yellowish crystalline rock. This specimen has relatively small crystals, which means that it probably formed in lava above the Earth's surface, where it cooled quickly. (Sulfur that forms in magma below the surface cools more slowly and may have larger crystals.) Sulfur is used to create gunpowder, vulcanized rubber, insecticides, pharmaceuticals, and sulfur compounds like sulfuric acid. It is also a disinfectant in winemaking, and is even used to nourish African violets.

### CHABAZITE



Chabazite is one of a group of minerals called zeolites (a term referring to any porous mineral). Zeolites form over a long period of time due to chemical reactions between volcanic rock and ash and groundwater that is alkaline (salty).

Naturally-occurring zeolites are used in pet litter, animal feed, soil conditioners, and wastewater treatment.

### PERIDOT



Peridot is a deep green gemstone (these specimens are rough and unpolished, though). Most gemstones (including diamonds) are formed by the slow crystallization of minerals inside gas bubbles or other cavities in volcanic rock. Peridot is the birthstone for the month of August, and is said to have been favored by Cleopatra. It continues to be popular in modern times.

### BASALT



Basalt is the most common volcanic rock, and the most common rock type in the Earth's crust. It underlies most of the ocean as well as large portions of the continents. It erupts directly from the Earth's mantle, just beneath the crust. It is very hard, and tends to be dark or black due to its high iron content. Basalt is relatively thin and flows easily. Because of this, it tends not to be accompanied by explosive eruptions. Volcanoes with shield cones are generally formed by basaltic flows.

### VESICULAR BASALT



This specimen has the same chemical composition as the other piece of basalt. However, it has a unique, vesicular texture that comes from the small holes (vesicles) left behind when gas escapes the molten rock while it is hardening.



Information About the Objects and Specimens in the Case (continued)

**PUMICE**



Pumice is so lightweight and full of holes that it floats. The holes are the remains of gas bubbles trapped inside lava as it hardens. Compare erupting lava to soda escaping from a bottle. The gases inside the bottle and a volcano create

foam when released, but in the case of the volcano the lava then hardens around the gas bubbles to create pumice. People rub pumice on their feet and elbows to smooth rough skin. Pumice is also used as an environmentally-friendly abrasive in household cleansers, and in construction materials such as concrete, plaster, and insulation.

**PUMICE SKIN SCRUBBER**



This scrubber from Democratic Republic of Congo illustrates how people around the world have found pumice useful for scrubbing their skin to clean and smooth it.

**LAVA**



This is a piece of hardened lava. We do not know what type of volcano ejected it. The holes are the remains of gases emitted with the lava, which escaped out of this specimen and into the air as it hardened. This lava is probably a cinder, which means it hardened on the ground.

**PAHOEHOE LAVA**



Pahoehoe (pronounced pa-hoy-hoy) lava is the type of lava ejected by the volcanoes that formed the Hawaiian Islands (hence its Hawaiian name). It is usually made up of basalt. Pahoehoe lava flows slowly, with the top crusting

over smoothly and small “toes” of hot lava creeping out at the front. This process can sometimes create bizarre shapes on the surface of the lava, similar to the twisted, rope-like specimen in the case. In contrast to pahoehoe, there is another type of Hawaiian lava called a’ā (pronounced ah-ah). A’ā lava is hotter than pahoehoe and typically advances in surges, carrying along large chunks of cooled lava and flattening everything in its path. Pahoehoe lava rarely gets more than three feet thick, but a’ā lava can be over 300 feet thick.

**OBSIDIAN**



Obsidian is a dense volcanic glass that occurs when lava cools aboveground so fast that crystals do not have time to form. It fractures in smooth, slightly curved shapes, and can have very sharp edges. Obsidian is often black, but it

can often have red and green tones or be banded, depending on how much hematite or iron it has in it.

**OBSIDIAN IN UNIDENTIFIED ROCK MATRIX**



In this specimen, layers of obsidian alternate with another type of unidentified rock. Although obsidian can be found in large nodules and chunks, it is often found in small deposits like this one.

Information About the Objects and Specimens in the Case (continued)

**OBSIDIAN FRAGMENT AND  
OBSIDIAN SPEAR POINT**



Ancient peoples all over the world discovered that they could chip obsidian into sharp pieces that were small but strong. When hafted to a wooden shaft, these obsidian chips made excellent spear and arrow points for hunting

and killing animals. This obsidian spear point was made by a Native American between 1000 and 1900 C.E.

**GEODE**



A geode is a hollow rock nodule that can form in a bubble hole in cooled lava. Over time, the center fills in with crystals of silica or other minerals. When broken open, the geode reveals beautiful quartz crystals and colored banding inside.

**VOLCANIC BOMB**



After the initial gases and steam escape from a volcano, it may shoot larger pieces of magma high into the air. These pieces cool as they fly through the air, taking on the aerodynamic shape of missiles. They are known as "bombs."

If volcanic bombs land before they are completely cool, they may also be flattened like a pancake; this one has a slightly flattened end, so perhaps it smashed against something when it was almost hard. Some volcanic bomb types have very descriptive names, like breadcrust bombs, ribbon bombs, spindle bombs, spheroidal bombs, and "cow-dung" bombs.

**CINDER**



A volcanic cinder is a small piece of lava that was shot out of a volcano but hardened on the ground rather than in the air, like a bomb. Cinders have vesicles (holes) and are larger than one centimeter in diameter.

**SCORIA**



Some varieties of lava bubble out of the volcano and down its sides, where they harden into a type of rock called scoria. Scoria has a lot of holes like pumice, although the holes are usually larger and the rock is not lightweight.

Sometimes scoria is used to make barbecue grills.

**MOUNT SAINT HELENS DUST**



Mount Saint Helens, a volcano in Oregon, erupted on May 18, 1980, after lying dormant for more than 100 years. There was a series of earthquakes in the preceding months, but a column of ash from the top of the mountain was the first

official sign of the eruption. The ash rolled down the mountain, and then began to rise into the air. Eventually it fell on 212 square miles of ground all around the mountain. Finer ash and dust traveled the farthest. The fine-grained volcanic dust in this jar was collected about 75 miles northeast of Mount St. Helens. Volcanic ash is very destructive. Since it travels widely in the atmosphere, it can change the world's climate by obscuring the sun. Some huge volcanic eruptions have produced ash that has blocked the sun all around the globe for as much as year. When deposited in thick blankets all around the volcano, volcanic ash can also smother plants and animals.

Information About the Objects and Specimens in the Case (continued)

**MOUNT SAINT HELENS ASH**



This coarse-grained volcanic ash fell to Earth about 40 miles west of Mount Saint Helens. Volcanic ash is the finest form of lava. It is graded according to size (from smallest to largest) into dust, ash, and lapilla (larger pieces of ash).

*You and your students can learn more about these specimens and other objects from around the world by visiting our Collections Central Online database at [www.brooklynkids.org/emuseum](http://www.brooklynkids.org/emuseum).*

**CLAY BRICK FROM POMPEII**



Mount Vesuvius, a volcano on the southern shore of Italy, erupted on August 24 in the year 79 C.E. Over the next several days, it spewed so much volcanic dust, ash, and pumice that it buried the nearby city of Pompeii under a blanket of volcanic matter up to 30 feet deep. While this eruption killed many of the citizens of Pompeii, it preserved their Roman Empire-era city so well that almost two centuries later, one can still see the frescoes decorating the walls. This clay brick is said to be from one of the buildings excavated at Pompeii. (See the Web Resources section on page 29 for links to more information and activities about Pompeii.)

**AGATE ASHTRAY**



This modern stone ashtray is made of polished agate, a banded and colorful form of quartz that is called a gemstone because of its beauty. It is hard to imagine, but stones like this show that volcanoes may produce beauty as well as destruction. Agates come in many colors, and are made into a variety of jewelry and decorative objects, both today and in the past. In ancient times, agate was also highly valued as a talisman or amulet. It was believed to quench thirst and protect people from fevers.

## ACTIVITY 1

# Introductory Activity: Inside a Volcano

Grades 3–5

Related Specimen: Volcanic bomb

In this activity, your students will learn about the Earth's layers and how volcanoes are formed. Completing the volcano cross-section worksheet at the end of the activity will help them develop a working vocabulary of volcano-related terms.

### Materials:

- Eyewitness: Volcano & Earthquake by Susanna Van Rose (in the case)
- Volcanoes by Neil Morris (in the case)
- Blackboard OR chart paper
- An apple
- A knife
- "Inside a Volcano" worksheets, one per student (see following page)
- Colored pencils, markers, or crayons

### What To Do:

- 1 Introduce the topic of volcanoes by asking your students what they know about volcanoes already, and what questions they have about volcanoes. Use the Discussion Questions below to probe students' ideas or reveal areas where they have questions. Write their responses on the blackboard or chart paper, without correcting wrong information (the students will correct themselves as they learn more).
- 2 Start a lesson about what a volcano is and how it is created. Hold up the apple and tell the students to imagine it is the Earth. Cut the apple in half from top to bottom and explain that it has layers, just like our planet.
  - Compare its skin to the Earth's **crust**, which is just beneath the Earth's surface (the continents and oceans). The apple's skin is about the same relative thickness as the Earth's surface and crust compared to their interiors.
  - The flesh of the apple is equivalent to the two layers of molten material beneath the Earth's crust: the **mantle**, which consists of white-hot molten rock (this molten rock is called **magma** when it is underground, and **lava** when it issues above ground); and the **outer core**, which is made up of liquid metal.
  - Point out the apple's core, which is made up of seeds. The Earth's **inner core** is made up of very dense, solid metal.

Write all of the boldface terms on the board

- 3 Use the illustrations in Eyewitness: Volcano & Earthquake (pages 9, 12–13) and Volcanoes by Neil Morris (pages 6–7) to show a cross-section of the Earth. Explain that volcanoes occur where the tectonic plates that comprise the Earth's crust shift and push against each other. (The Morris book has a particularly good map showing the "Ring of Fire"—the plate lines around the Pacific Ocean, along which volcanoes proliferate.)
- 4 Hand out the "Inside a Volcano" worksheets and explain that this is what a volcano might look like if they sliced through it and the ground underneath. Ask students to describe what features of the cross-section they can identify, and list them on the board. With this image in front of them, how do they think the volcano works? Have them write the names of each feature on the worksheet.
- 5 Discuss the features that the students don't know. Divide students into small groups, and have each one research the unknown features of the volcano cross-section using the books in the case, or resources from their school or local library or the Internet. For younger students, you can add the terms that you have not defined to the list on the board, and have the students decide which term goes with which feature.
- 6 (Optional) Have students color in their volcano cross-sections.

### Discussion Questions:

Students will not know the answers to all of these questions, but simply asking them may inspire students to look at books or search the Internet for answers.

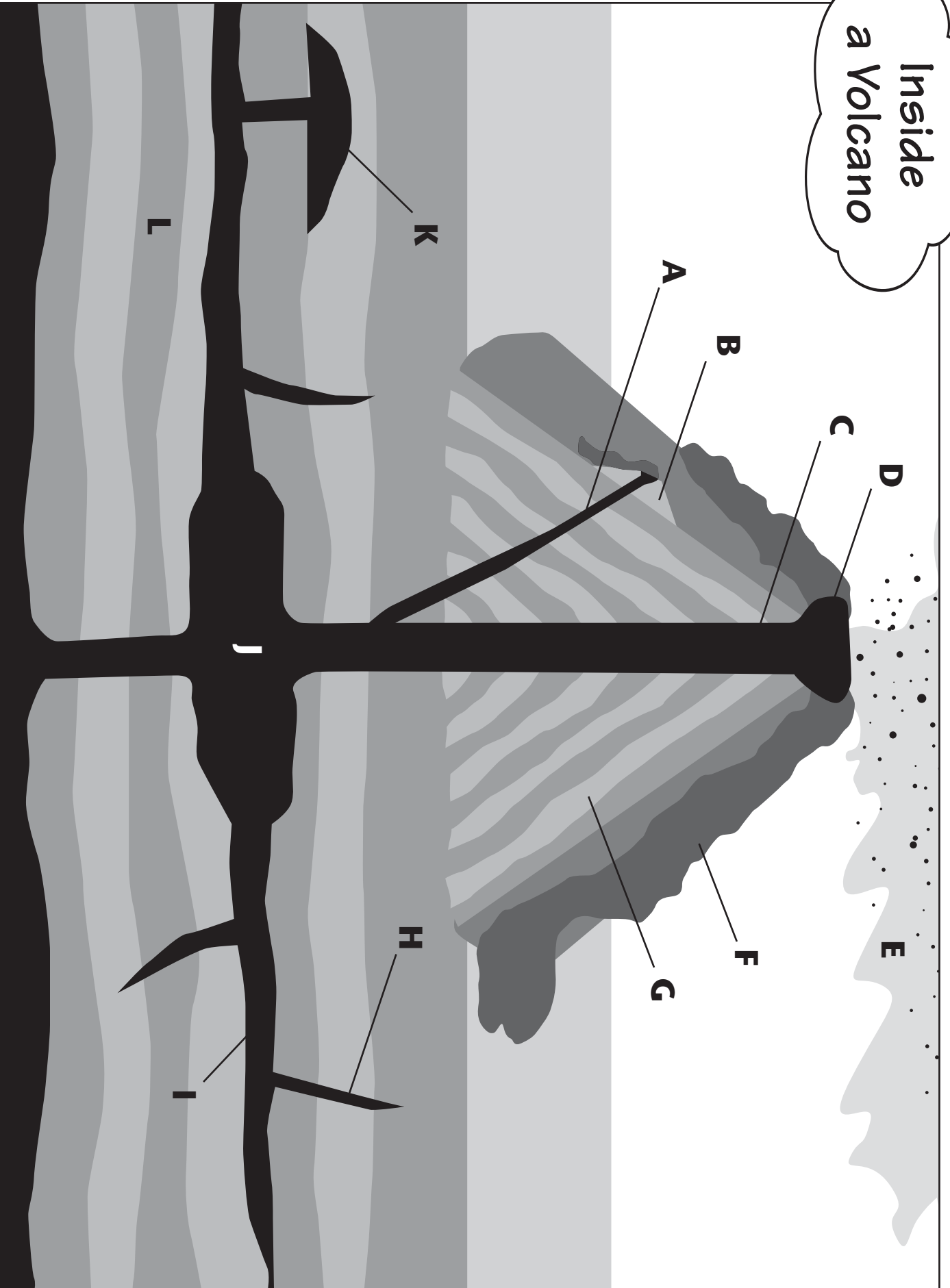
- What is a volcano? Why do they occur?
- Where do volcanoes occur—on land? In the ocean?
- Are volcanoes dangerous? What happens when they explode? What happens to the land and people when a volcano occurs? How long does it take for nature to recover?
- How can volcanoes affect the whole world? (They affect the weather.)
- Are all volcanoes explosive? What do you think a sleeping (**dormant**) volcano is?
- How fast does a volcanic eruption happen? What warning signs might there be?
- What comes out of a volcano when it explodes?
- Where does lava come from? What is it made of?
- How far can lava from a volcano travel, and how fast?

Worksheet Answer Key:

Leave room for a box containing answers to the worksheet on the following page.

**See page 25 for details on how this activity meets New York State Learning Standards.**

Inside  
a Volcano



## ACTIVITY 2

# What Can Specimens Tell Me?

**Grades 3–5**

**Related Specimens: All rock specimens**

This activity gives your students a chance to look at examples of **igneous** rocks very closely, and examine features like surface color and texture. Even if students cannot come up with definite answers to their questions just from looking at the rock specimens, they will still find significant clues about what kind of volcanic activity created each specimen.

### Materials:

- Hand lenses
- Copies of the “What Can Specimens Tell Me?” chart for each student OR, for a whole class exercise, a transparency of the chart and an overhead projector
- Blackboard OR chart paper for recording group observation

### What To Do:

- 1 Depending on the age and interests of your students and the amount of time you would like to spend, you can do this activity using a handful of specimens or every specimen in the case. It can be done in small groups or as a class, looking at the specimens in turn and filling out the chart using an overhead projector or large chart paper.
- 2 For small groups, prior to the presentation of the lesson, set the classroom up into stations (make sure there are enough stations that you have only 3–4 students working at each one). Place one or more specimens and a hand lens on the table at each station.
- 3 Distribute the “What Can Objects Tell Me?” chart and go over it with the students. Ask them to pay special attention to the physical properties of each of the specimens, such as color and texture. You may want to practice with the class by using one of the specimens to model the activity.
- 4 Have the students fill in their charts as they look at the specimens. After a few minutes, the groups should rotate to a new station. Repeat this step as many times as you like.

- 5 Have the students reconvene as a class to discuss their findings. You may want to use the blackboard or chart paper to make notes about their observations. When you feel they have gone as far as they can with what they observed, you can introduce information from your own knowledge, from this guide, or from other library or Internet resources.






### Discussion Questions:

- What could make a rock light in weight? What might make it heavy? Compare the specimens of basalt and pumice. How are they different? (Hint: Have students look at the pockets formed by gas bubbles.)
- Take a close look at a specimen with a hand lens. Is it the same color or texture all over? Are there different colors, materials, or crystals in it? Are they few and far between or all clumped together?
- How do you think rocks get their colors? (Hint: Although the answer to this ultimately is chemical, and students cannot be expected to know this, getting them to think about it is a way of opening their eyes and their minds to rocks and minerals.)
- Can you imagine how hot would it have to be for rocks to melt? Could you make them melt on the stove? Ask if students are familiar with blacksmiths (as portrayed in Western movies)—how do they mold or bend metal into different shapes, like horseshoes?
- Are the rocks we find on the ground the same ones that come from inside a volcano?
- Which rocks are most closely related to the ashtray, the scrubber, and the projectile point in the case?

**See page 25 for details on how this activity meets New York State Learning Standards.**






# What can specimens tell me?

Use your senses to observe each rock or mineral carefully, using a hand lens if necessary. What can you tell about a specimen just by looking at it in detail? Use this chart to record what you discover.

	What is the specimen's surface texture like?	What is the main color of the specimen?	Does the specimen have any other textures or colors?	Is the specimen solid, filled with holes, or in between?
				
				
				
				
				






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## ACTIVITY 3 Make a Volcano

### All Grades

#### Related Specimens: Cinder, scoria, pumice

This is a dramatic, messy activity that is not only fun but also instructive. It can be a very simple demonstration using just a plastic soda bottle, or a complicated, multi-stage activity that involves the whole class building a volcanic landscape. Our version is in the middle, with some options for making it more elaborate or re-usable for several experiments. You can find many similar activities by entering “Make a volcano” in your Internet search browser.

#### Materials:

- A large cookie sheet or square of plywood on which to build your volcano model (about twice as large as the diameter of the volcano cone you plan to make)
- Newspaper
- Masking tape
- Baking soda
- White vinegar
- Dishwashing liquid
- Plastic soda bottle, 20 oz. or 2 liter (Note: The bigger the bottle, the more you will need to increase the ingredients in proportion. This is not an exact science, so feel free to experiment.)
- Modeling clay, plaster, OR materials for papier-mâché
- Funnel
- Measuring spoon and cup
- Food coloring
- (Optional) Paint and/or spray sealant (such as Krylon)

#### What To Do:

- 1** Put a clean, empty bottle in the center of the cookie sheet or plywood.
- 2** Build the volcano around the bottle, using wadded newspaper fixed with masking tape to create a mountain shape. Build up layers of clay, plaster, or papier-mâché on top of the newspaper. Create a cone at the top of the bottle and have the volcano slope down to the ground from there. Leave the top of the bottle clear.
- 3** (Optional) Depending on how elaborate your volcano is, you may want to make channels down the sides for the “lava” to flow.
- 4** Let the plaster or papier-mâché dry.
- 5** (Optional) Paint the volcano and let it dry.
- 6** (Optional) If you want to use the volcano several times, spray it with a clear sealant and let it dry.

- 7** Get ready for an eruption! Mix 1 tablespoon of dishwashing liquid together with 1 tablespoon of baking soda and a few drops of red food coloring and pour the mixture carefully into the bottle with a clean, dry funnel.
- 8** Have students stand away from the volcano, and clear any desks or other materials around it. Then carefully but quickly pour  $\frac{1}{2}$  cup of vinegar into the bottle, stand back, and watch the “lava” flow! (Note: If the lava is too thick, add a tablespoon or more of water to the soap mix.)
- 9** If you made a reusable volcano, wipe it with a damp cloth and try again! You might experiment by altering the lava color, or by putting fake or real plants or twigs on the volcano’s slopes to see what happens to them during the eruption.
- 10** (Optional) Have older students write a short description of what happened during the experiment, and how their model volcano simulated a real volcanic eruption. Encourage them to use proper volcano terminology.

#### Discussion Questions:

- What happened during the eruption?
- What did the lava do? What effect did it have on the slopes?
- Our explosion was caused by gas. (The vinegar and baking soda mix creates carbon dioxide gas just like the fizz that bubbles over when a soda is opened after being shaken.) Is there gas in actual volcanoes? Do any of the rocks in the case tell you the answer? How? (Hint: Have students examine the pumice or vesicular basalt specimens.)
- How was our explosion different than an actual volcanic explosion?
- Can we make a bigger explosion? A runnier explosion? What happens if we put more dishwashing liquid in the mix? What happens if we partially fill in the mouth of the bottle? (Note: These changes mimic such differences as the density of the magma or the constrictions of the cone that determine the type of eruption.)

See page 25 for details on how this activity meets New York State Learning Standards.

## ACTIVITY 4 Edible Rocks

**Grades 3–5**

**Related Objects or Specimens: All**

Fudge is a lot like lava—stirring it too much (or not enough) as it cools affects its texture and consistency by altering the way sugar crystallizes within it. This is similar to how minerals form within cooling lava. The resulting textures make the fudge resemble either ‘a’a (pronounced ah-ah) lava, which is rough-surfaced but smooth inside, or pahoehoe (pronounced pah-HOY-hoy) lava, which is smooth on the outside but gritty and coarse inside. This activity gives your students the opportunity to conduct a science experiment and enjoy a sweet treat at the same time!

### Materials:

- Hot plate and saucepan OR microwave and microwave-safe bowl
- Basic ingredients: Sugar, chocolate chips, evaporated milk, vanilla extract
- “Rock” ingredients: Small marshmallows or nuts (check to make sure no students have nut allergies)
- Experimental ingredients: Corn syrup, cornstarch, applesauce
- Baking pans, 8x8” or smaller
- Spatula or large spoon
- Knife
- Hand lenses OR a microscope
- Napkins

### What To Do:

- 1 Remind the students that when they first examined the volcanic rocks from the case, they saw that the rocks have different textures. In some cases, they have smaller units of rock called mineral crystals within them.
- 2 Explain that in order to learn more about how lava cools and forms volcanic rocks, the class will be making fudge. Fudge can act like lava and has crystals within it. In fudge, the crystals are made of sugar, but they form the same way, as the lava or fudge cools.
- 3 Introduce the different types of lava, ‘a’a and pahoehoe lava. (These unusual names are Hawaiian. Hawaii was formed by volcanoes and still has many active ones.) Show students the lava sample from the case and pictures from books to highlight the differences between these two types of lava.
- 4 As a class, prepare several batches of fudge, following the recipe below or another of your choosing. Divide the class in three or more groups. One group should stir its fudge constantly, another should stir its fudge very little, and a third stirs its fudge to a thick but still “molten” consistency.
- 5 (Optional) Have another group add corn syrup, corn starch, or applesauce to their batch. These ingredients will prevent crystals from forming at all and make the candy smoother and more like taffy (or obsidian, in volcanic terms).
- 6 Stirring the fudge different amounts (or adding experimental ingredients) will suggest how crystal formation of minerals changes with different chemical reactions in the heated interior of the Earth. Have students compare the textures of each group’s fudge or “magma.” Which group’s fudge is lumpy? Which is runny? Have students keep track of the time and observe what stirring does to the fudge/lava.
- 7 (Optional) Add nuts and marshmallows to the fudge to simulate rocks caught up in the lava.
- 8 Pour the fudge into pans and chill or let cool.
- 9 When the fudge is firm, cut thin slices from each batch and have students compare the slices with hand lenses (or even better, under a microscope). Which batch of fudge has the smoothest texture and the least crystallization? Which has the most crystallization? Have students record their observations on paper, either individually or as a group. You may wish to have them make a simple chart for comparing the color, surface texture, and amount of crystallization of each batch of fudge.
- 10 Ultimately the class should come to the conclusion that the more stirring there is, the more lumpy and crystallized the fudge is.
- 11 Eat up! (You can share with another class, too.)

### Discussion Questions:

- How does the hot fudge look? What is its texture like?
- Lift a spoon and let the hot fudge fall. Does it run off the spoon or drop off in globs? What makes the difference? How does this compare to the different kinds of lava? (Compare the pahoehoe lava to the other lava specimen in the case, and study images in books and on the Internet.)

## ACTIVITY 4

### Edible Rocks (continued)

- Which fudge most resembles 'a' lava, the under-stirred or the over-stirred fudge? Which one most resembles pahoehoe?
- How do the fudge slices compare to the rocks? Which ones have large crystals and which ones have small crystals?

#### MICROWAVE FUDGE RECIPE

##### Ingredients:

- 1 12-oz. bag semisweet chocolate chips
- 6 oz. butterscotch chips (or just use more chocolate chips)
- 1 14 oz. can of sweetened condensed milk
- 1-1/2 tsp. vanilla extract
- Microwave-safe bowl and stirrer
- 8 or 9-inch square pan
- Corn syrup (optional)
- Nuts and/or marshmallows (optional)

##### Directions:

Combine all ingredients in the bowl. Microwave for 2 minutes. Stir. Pour into 8 x 8 inch pan and chill for 2 hours or let cool until firm.

#### HOT PLATE FUDGE RECIPE

##### Ingredients:

- 3 cups semisweet chocolate chips
- 1 can (14 oz.) sweetened condensed milk
- Dash of salt
- 1 1/2 tsp. Vanilla extract
- 8 or 9-inch square baking pan
- Aluminum foil
- Bowl and stirrer
- Corn syrup (optional)
- Nuts and/or marshmallows (optional)

##### Directions:

In heavy saucepan over low heat, melt chips with sweetened condensed milk and salt. Remove from heat; stir in vanilla. Spread evenly into aluminum foil lined pan. Chill two hours or until firm. Turn fudge onto cutting board; peel off foil and cut into squares. Store loosely covered at room temperature.

See page 25 for details on how this activity meets New York State Learning Standards.

## ACTIVITY 5

# Tell a Story and Paint a Volcano

### All Grades

### Related Objects and Specimens: All

Volcanoes are a good inspiration for making up stories in which a dramatic event presents a life-or-death challenge, changes lives, creates heroes and heroines, leads to adventure, and ends happily. These stories can be written, illustrated, or both.

In conducting this activity, use your judgment about how much to feed the children's imaginations without frightening them. Disasters are fascinating, but they are also the stuff of nightmares. Remember, too, that some children have lived through disasters of which they may not wish to be reminded.

### Materials:

- Kids Who Walk on Volcanoes by Paul Otteson (included in the case)
- Paper
- Paint, markers, colored pencils, crayons or other art materials

### What To Do:

- 1 Discussion 1. Open up the students' imaginations by reading Kids Who Walk on Volcanoes or another book about a real or imaginary volcanic eruption.
- 2 Help students create their own volcano stories, either individually or as a class. Offer them a starting point by having them imagine that they live on the shore of a volcanic island. Make sure to add some drama to your delivery—after all, this is a life-or-death situation! For example: "One day while you are walking to school, you feel hear rumbling and feel shaking under-foot. Rocks and soil begin to roll down the mountain. You look up and see smoke rising from the top of the volcano and one part of its solid flank starting to bulge up...."
- 3 Have students think about how to build their story. How does their day start? When and how do they realize something is happening? What do they do to help others escape? What obstacles to their escape (such as evil characters) do they encounter?
- 4 Add more elements to the students' story repertoire, such as where their family members are and what they are doing, what kinds of escape transportation might be available, how far from other islands their island is, what kinds of trees are on the island, how the houses are built, and so forth. Students may make themselves the hero or heroine of their story.
- 5 Have students write down their stories and illustrate them with a picture of the volcano as it appeared in one scene in their story. Younger children may simply paint or draw a volcano.

### Discussion Questions:

- In the story, describe how you learn there will be a volcanic eruption. Will you evacuate with your family? How?
- In the story, how do you feel when you hear the rumbling and see the smoke? Have you experienced a volcano before or is this your first time?
- In the story, how are the people around you reacting?
- In the story, are there tools or equipment that you can use to help? Would you strap on your roller blades or grab your scooter? Could getting on the Internet help?
- In the story, are there rescuers? Who are they and where do they come from? Are you one of them?

See page 25 for details on how this activity meets New York State Learning Standards.

## ACTIVITY 6

# Additional Activities and Curricular Connections

### **Research and Literacy: Make a Mini Museum** **Grades 3–5**

Give students a research assignment. Have them pick one (or more) of the specimens and perform library or Internet research to find out more about it and where it fits in the story of a volcano. Have them write a report or create a poster about their specimen. Students' reports can be displayed along with the specimens to make a "mini museum" in the classroom.

### **Research and Literacy: Famous Eruptions** **Grades 3–5**

Create a class book of actual volcanoes and their eruptions. Have each child or team of children research one volcano using book and Internet resources and then write the story of the volcano and its explosion and what happened. There are many good candidates for "volcano biographies," such as Mount Vesuvius, Mount Etna, Krakatoa, Kilauea, Mount Saint Helens, Mount Lassen, and Stromboli.

### **Research and Literacy:** **Volcano Myths and Legends** **Grades 3–5**

Have students research volcano myths and legends. For example, the Romans had Vulcan, the Roman god of fire, for whom volcanoes were named. The Greeks had Hephaestus, the Greek god of fire. The ancient peoples of Mexico, Central and South America made sacrifices to volcano gods. In Africa, Hawaii, and Japan—indeed wherever there are volcanoes—people have sought to appeal to the spirits of the volcano. Working individually or in teams, have students research volcano legends using library or Internet resources. They may present their findings to the class in an oral or written report, or on a poster. Alternatively, you have students perform research and then write their own volcano myths and legends.

### **Geography: Mapping Volcanoes** **Grades 4–5**

Using the books in the case, from your school or local library, or Internet resources, have students research where in the world volcanoes are located. Then they should find and mark the volcanoes' locations on a map, working either individually or as a small group (using a world map worksheet), or as a class (using a large world map). As a class, discuss the patterns of volcanoes' location (such as the Ring of Fire around the Pacific Ocean), and talk about how it relates to the Earth's tectonic plates.

### **Science and Literacy:** **Observation and Recording** **Grades 2–5**

If you have access to the Internet in the classroom, have each student or group of students adopt a live volcano that has a web camera on it. Search the Internet for examples, or look at the University of Wisconsin-Madison Volcano Watch site at [www.ssec.wisc.edu/data/volcano.html](http://www.ssec.wisc.edu/data/volcano.html) for satellite images of the world's ten most active volcanoes. Students should check on their volcanoes daily, and keep an observation journal describing the volcano's appearance and any volcanic activity it may be experiencing.

### **Science Extension: Volcanology** **Grades 4–5**

Have students complete volcano-themed crossword puzzles to learn volcano terminology. There are many examples on the Internet (type "volcano crossword puzzle" into your browser's search field). These games can be played online, or you can print out and copy one of the puzzles for your students. It is also possible to create your own puzzle using the terms you have introduced and adapting for your students. Some examples of crossword puzzles (and other games) can be found at:

[www.volcano.und.nodak.edu/vwdocs/kids/fun/crossword/crossword.html](http://www.volcano.und.nodak.edu/vwdocs/kids/fun/crossword/crossword.html)

[www.ngdc.noaa.gov/seg/hazard/stratoguide/word/Crossword.html](http://www.ngdc.noaa.gov/seg/hazard/stratoguide/word/Crossword.html)

[www.vulcan.wr.usgs.gov/Outreach/FunStuff/crossword.html](http://www.vulcan.wr.usgs.gov/Outreach/FunStuff/crossword.html) (2 puzzles of different complexity).

[www.edhelper.com/volcanoes.htm](http://www.edhelper.com/volcanoes.htm)

See page 25 for details on how these activities meet New York State Learning Standards.

## Vocabulary Words

**chimney:**

another term for vent.

**crust:**

the relatively thin outer layer of the Earth. The crust is about 30 miles deep, and thicker beneath the continents than under the ocean.

**dormant:**

a volcano is said to be dormant (or “sleeping”) if it has not erupted for hundreds of years, but is known to have erupted in the past; see also extinct.

**erupt:**

to break out suddenly or abruptly and with force; to spew forth lava, gases, and steam.

**extinct:**

a volcano is said to be extinct if it has not erupted in thousands of years and shows no evidence of current volcanic activity. However, extinct volcanoes have surprised people in the past.

**extrusive igneous rock:**

see volcanic rock.

**feeder pipe:**

see vent.

**fissures:**

see vent; fissures are cracks in the ground from which lava flows.

**igneous rock:**

rocks solidified from molten magma at or below the surface of the Earth. The word igneous has its root in the Latin word for “fiery.”

**intrusive igneous rock:**

intrusive igneous rocks are formed from magma that has not reached the earth’s surface. They are also called plutonic rocks.

**inner core:**

the center of the Earth, which is thought to be solid iron and nickel. The inner core is under such intense pressure that, although it is as hot as the surface of the sun, it remains solid. It is about 780 miles thick and over 3000 miles deep inside the Earth. The heat radiates outwards and circles back just beneath the crust in a series of convection currents whose power moves the tectonic plates.

**lava:**

molten rock (also known as magma) expelled by a volcano. There are four types: basalt, andesite, dacite, and rhyolite.

**magma:**

molten rock found underground, within the Earth’s mantle.

**mantle:**

the thick layer of the Earth’s interior that lies just below the crust. The mantle is about 1800 miles thick. It consists of very hot rock material with pockets of molten rock called magma. Below the mantle is the outer core, consisting of liquid metals.

**mineral:**

a mineral is a solid, nonliving material that has a particular chemical composition, crystal structure, hardness, and color.

**molten:**

in a hot, viscous (thick liquid) state.

**outer core:**

the layer of the Earth found below the mantle, encircling the inner core. Like the inner core, it is made of metals, but they are under less pressure and therefore molten. The outer core is 2000 to 3000 miles below the Earth’s surface.

**plutonic rocks:**

see intrusive igneous rock. A common example is granite.

**rock:**

solid matter made up of one or more minerals. Rocks may be *igneous* (formed when hot liquid rock or magma cools and becomes solid), *sedimentary* (when fragments of rock are washed away, settle on top of each other, and are gradually compressed into a solid), or *metamorphic* (an igneous or sedimentary rock that is changed by heat, pressure, or chemical action into a new rock).

**tectonic plates:**

huge blocks of the Earth’s crust on which the continents and oceans rest. Tectonic plates are about 70 miles thick. There are seven major ones and a number of smaller ones encircling the globe. The term “tectonics” refers to the structural forms and processes of the Earth’s crust.

## Vocabulary Words

**vent:**

a passageway from the volcanic reservoir or chamber in which magma is held to the surface; also called the feeder pipe. The vent may have smaller vents branching off of it to the surface, which are also known as **fissures**.

**vesicles:**

pockets or holes formed in lava when bubbles of gas evaporate while the lava is cooling.

**volcano:**

an eruption onto the surface of the Earth of hot, molten and gaseous matter called magma from below the crust; also the name for the mountain formed by the eruption.

**volcanic rocks:**

extrusive igneous rocks that are formed when magma that erupts to the surface of the Earth has cooled.



■ RESOURCES AND REFERENCE MATERIALS ■

## Correlations with New York State Learning Standards

The activities included in this guide meet the following New York State Learning Standard Performance Indicators for elementary students (K–5):

New York State Learning Standard Performance Indicators (Elementary Level)					Activity					
Standard Area	Standard #	Subject	Letter	Students will	1	2	3	4	5	6
Arts	1	Visual Arts	a	Experiment and create art works, in a variety of mediums (drawing, painting, sculpture, ceramics, printmaking, video, and computer graphics), based on a range of individual and collective experiences			•		•	
English Language Arts	1	Listening & Reading		Gather and interpret information from children's reference books, magazines, textbooks, electronic bulletin boards, audio and media presentations, oral interviews, and from such forms as charts, graphs, maps, and diagrams	•					•
ELA	1	Listening & Reading		Ask specific questions to clarify and extend meaning	•	•	•	•	•	•
ELA	1	Speaking & Writing		Present information clearly in a variety of oral and written forms such as summaries, paraphrases, brief reports, stories, posters, and charts		•	•	•	•	•
ELA	1	Speaking & Writing		Use details, examples, anecdotes, or personal experiences to explain or clarify information		•	•	•	•	•
ELA	1	Speaking & Writing		Observe basic writing conventions, such as correct spelling, punctuation, and capitalization, as well as sentence and paragraph structures appropriate to written forms		•	•	•	•	•
ELA	2	Speaking & Writing		Create their own stories, poems, and songs using the elements of the literature they have read and appropriate vocabulary					•	•
ELA	2	Speaking & Writing		Observe the conventions of grammar and usage, spelling, and punctuation		•	•	•	•	•
ELA	4	Speaking & Writing		Listen attentively and recognize when it is appropriate for them to speak	•	•	•	•	•	•
ELA	4	Speaking & Writing		Take turns speaking and respond to other's ideas in conversations on familiar topics	•	•	•	•	•	•
Social Studies	3	Geography		Draw maps and diagrams that serve as representations of places, physical features, and objects						•
Social Studies Social Studies	3	Geography		Ask geographic questions about where places are located; why they are located where they are; what is important about their locations; and how their locations are related to the location of other people and places						•
Math, Science, & Technology	1	Scientific Inquiry		Ask "why" questions in attempts to seek greater understanding concerning objects and events they have observed and heard about	•	•	•	•	•	•
MST	1	Scientific Inquiry		Question the explanations they hear from others and read about, seeking clarification and comparing them with their own observations and understandings	•	•	•	•		•

■ RESOURCES AND REFERENCE MATERIALS ■

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New York State Learning Standard Performance Indicators (Elementary Level)					Activity					
Standard Area	Standard #	Subject	Letter	Students will	1	2	3	4	5	6
MST	1	Scientific Inquiry		Develop relationships among observations to construct descriptions of objects and events and to form their own tentative explanations of what they have observed		•	•	•		•
MST	1	Scientific Inquiry		Carry out their plans for exploring phenomena through direct observation and through the use of simple instruments that permit measurements of quantities (e.g., length, mass, volume, temperature, and time)		•	•	•		•
MST	1	Scientific Inquiry		Organize observations and measurements of objects and events through classification and the preparation of simple charts and tables		•				
MST	1	Scientific Inquiry		Share their findings with others and actively seek their interpretations and ideas		•	•	•		•
MST	4	Physical Setting		Describe the relationships among air, water, and land on Earth	•		•			
MST	4	Physical Setting		Observe and describe properties of materials using appropriate tools		•	•	•		
MST	4	Physical Setting		Describe chemical and physical changes, including changes in states of matter			•	•		
MST	6	Models		Analyze, construct, and operate models in order to discover attributes of the real thing			•			
MST	6	Models		Discover that a model of something is different from the real thing but can be used to study the real thing			•			
MST	7	Strategies		Work effectively-Contributing to the work of a brainstorming group, laboratory partnership, cooperative learning group, or project team; planning procedures; identify and managing responsibilities of team members; and staying on task, whether working alone or as part of a group	•	•		•		•

## Corresponding Field Trips

Perhaps we are fortunate that there are no volcanoes to visit in the New York City area. However, geological exhibits and programs are available. Check with the organizations below for details, and look for special National Earth Science Week activities held annually in October.

### **American Museum of Natural History**

79th and Central Park West, Manhattan  
(212) 769-5200  
[www.amnh.org](http://www.amnh.org)

### **Staten Island Museum**

75 Stuyvesant Place  
(2 blocks from the Ferry Terminal), Staten Island  
(718) 727-1135, extension 24  
[www.statenislandmuseum.org](http://www.statenislandmuseum.org)

The Brooklyn Children's Museum also offers programs on a variety of natural history topics. For a listing of programs currently available, please see our website at [www.brooklynkids.org](http://www.brooklynkids.org), or contact the Scheduling Assistant at 718-735-4400, extension 118.



## Bibliography and Web Resources

The following books and websites may help you to enrich your experience with the objects in the case.

**Lauber, Patricia. Volcano: The Eruption and Healing of Mount St. Helens.** New York, New York: Scholastic, 1986.

**McGlone, Catherine. Visiting Volcanoes with a Scientist.** Berkeley Heights, New Jersey: Enslow Publishers, 2004.

**Martin, Linda. Eruption: The Story of Volcanoes.** New York, New York: Dorling-Kindersley, 2001.

**Simon, Seymour. Volcanoes.** New York, New York: HarperCollins Children's Books, 1988

### **Edhelper's Volcano Theme Unit:**

Many volcano activities, printable worksheets, quizzes, and links. This site is for teachers, by teachers.  
[www.edhelper.com/volcanoes.htm](http://www.edhelper.com/volcanoes.htm)

### **Igneous Rock—Wikipedia:**

This site includes a map of where intrusive (plutonic) and extrusive ("true" volcanic) igneous rock is found in North America.  
[www.en.wikipedia.org/wiki/Igneous](http://www.en.wikipedia.org/wiki/Igneous)

### **Planet Diary**

This educational site contains information about the eruption of Mount Vesuvius, including a short animated clip about the eruption and activities about the buried city of Pompeii.  
[www.harcourtschool.com/activity/pompeii/](http://www.harcourtschool.com/activity/pompeii/)

### **Smithsonian Institution:**

Daily activity reports on volcanic activity around the world.  
[www.volcano.si.edu](http://www.volcano.si.edu)

### **U.S. Geological Survey:**

Includes an educator's page.  
[www.volcanoes.usgs.gov](http://www.volcanoes.usgs.gov)

### **Volcano World:**

Has images of current and past eruptions, good information about volcanoes around the world, virtual field trips including "Kids Door," and updates on actual field trips.  
[www.volcano.und.nodak.edu](http://www.volcano.und.nodak.edu)

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Brooklyn Children's Museum  
145 Brooklyn Avenue  
Brooklyn, New York 11213  
718-735-4400 ext. 170  
[www.brooklynkids.org](http://www.brooklynkids.org)

For information about renting this or other Portable Collections Program cases,  
please contact the Scheduling Assistant at 718-735-4400 ext. 118.