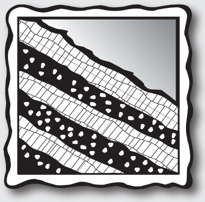
Lava Building Blocks



Grade Level: 5-10

Learner Objectives:

Students will:

- Recognize the importance of lava flows in the construction of Mount Rainier.
- Recognize that at Mount Rainier lava flows are visible as thick ridges that radiate from the volcano and as thin ledges within the volcanic cone.
- Relate the general viscosity of lava flows to a type of volcano: shield, cinder cone, or stratovolcano.
- Make some generalized comparisons of lava flow behavior at Mount Rainier, Mount St. Helens, and Kilauea Volcano

Setting: Classroom

Timeframe: 40 minutes

Lava on the Run -40 minutes

Materials:

Lava on the Run

- *"Lava on the Run"* student page
- Graphic *"Three Types of Volcanic Cones"*

USGS
science for a changing world

Living with a Volcano in Your Backyard- An Educator's Guide with Emphasis on Mount Rainier

Prepared in collaboration with the National Park Service

U.S. Department of the Interior
U.S. Geological Survey

General Information Product 19

Overview

Students investigate the influence of magma viscosity on the shape of a volcanic cone. Then, they explore the nature and motions of lava flows and learn about the importance of lava flows as the building blocks of Mount Rainier.

- Graphic *"Photographs of Lava Flows at Mount Rainier"*
- Graphic *"Volcanic Rocks of Modern Mount Rainier"*

For each student group:

- Newspaper
- Cardboard 1x1 meter (3x3 foot)
- One sample (small half-filled paper cup) each of three household products (e.g., chocolate syrup, corn syrup, shampoo, oatmeal, jelly, ketchup, rubber cement, and a tube of toothpaste.
- Specimens of lava rocks (optional)
- Paper cups
- Pencil
- Ruler
- Stopwatch
- Measuring spoon

Vocabulary: Andesite, basaltic andesite, composite volcano, cinder cone, cone, crater, dacite, eruption, eruption column, glacier, lahar, landslides, lava, lava dome, lava flow, magma, magma chamber, pyroclastic flow, rockfall, rock rubble, shield volcano, silica, stratovolcano, vent, viscosity, volcano, volcanic gases

Skills: Predicting, data collecting, recording, measuring, graphing

Benchmarks:

Science:

1 – Understands and uses scientific concepts and principles

1.1 – Use properties to identify, describe, and categorize substances, materials, and objects, and use characteristics to categorize living things

Properties of substances – use physical and chemical properties to identify and describe substances

1.2 – Recognize the components, structure, and organization of systems and the interconnections within and among them

Systems-describe how the parts of a system interact and influence each other

Components and patterns of the earth system – describe the components and relationships of the earth system, including the solid earth (crust, hot convecting mantle and dense metallic core

1.3 – Understand how interactions within and among systems cause changes in matter and energy

Processes and interactions in the earth system-describe the processes of constructive and destructive forces and how they continually change landforms on earth

2 – Knows and applies skills and processes of science and technology

2.1 – Develop abilities necessary to do scientific inquiry

Questioning-generate questions that can be answered though scientific investigations

Designing and conducting investigations – design, conduct, and evaluate scientific investigations, using appropriate equipment mathematics, and safety procedures

Explanation-use evidence from scientific investigations to think critically and logically to develop descriptions, explanations, and predictions

Communication – communicate scientific procedures, investigations, and explanations orally, in writing, with computer-based technology, and in the language of mathematics

Mathematics:

1 – Understands and applies the concepts and procedures of mathematics

1.1 – Understand and apply concepts and procedures from number sense - Computation

Teacher Background

Lava Flows—Building Blocks of Mount Rainier

Mount Rainier consists of hundreds of overlapping ***lava flow*** layers. Sandwiched between the lava flows are layers of loose rock rubble. These lava flows formed during hundreds of individual ***eruptions*** over the last 500,000 years. While the ***volcano*** has erupted frequently during this time, most ***lava*** was erupted between 500,000 to 420,000 years ago and 280,000 to 180,000 years ago. Today, chilled and hardened lava flows extend up to 22 kilometers (14 miles) from the volcano's summit. Future lava flows are more likely to be smaller and travel no more distant than 10 kilometers (6 miles) from the summit. The most recent lava flows at Mount Rainier were erupted around 1,100 to 2,200 years ago, and some of these young lava flows can be seen as raised rock ridges that bisect Emmons Glacier, and as raised areas beneath the ice. Mount Rainier lava flows consist of ***andesite*** and some low-silica ***dacites,*** with some minor lava flows containing ***basaltic andesite***. For additional information about the building of Mount Rainier, visit **A Journey Back in Time**.

The volume of lava on Mount Rainier is approximately 150 cubic kilometers (36 cubic miles), an amount sufficient to fill Seattle's Safeco Stadium 100,000 times! Lava flows from each new eruption accumulate on top of older flows, building the ***cone*** taller and broader. Lava flows on the upper cone are relatively thin, commonly 30 meters (100 feet) or less in thickness. However, lava flows that pooled along the base of the cone formed layers hundreds of meters in thickness. When the eruption ends, many processes begin to destroy the cone, including ***glacier*** erosion, flowing water, ***rockfall***, and ***landslides***. A volcano will grow in size if the volume of lava erupted exceeds the amount lost to erosion.

How Do Lava Flows Form on Steep-Sided Volcanoes?

Volcanic eruptions often begin with the release of steam and other ***volcanic gases*** that have been trapped within the ***magma*** during its long ascent from the ***magma chamber.*** The real mountain building begins after most volcanic gases have escaped. Inside the ***vent,*** molten lava rises and subsides repeatedly. The lava within the vent eventually rises high enough to spill over the ***crater*** rim as a glowing lava flow, often with temperatures that range between 900-1100 degrees C (1,650 to 2,000 degrees F). The outside of the lava flow cools and hardens into a rubbly crust within minutes, while the interior of the flow remains hot and gooey and continues to spill downhill. But, that is not the end of the story.

Pyroclastic Flows, Avalanches of Hot Rock and Gas

Many lava flows that issue from steep-sided volcanoes break up into blocks and rubble that avalanche down valley accompanied by a billowing cloud of rock dust and steam. ***Pyroclastic flows*** can also form from the collapse of ***eruption columns***. The swift melting of snow and ice by pyroclastic flows has the potential to create ***lahars*** that travel great distances beyond the slope of the mountain and threaten nearby communities. Geologists speculate that, at steep-sided Cascade volcanoes, some of the ***rock rubble*** found sandwiched between lava flows originated as pyroclastic flows. Learn more about lava flows, pyroclastic flows and associated hazards in the **Rock Stars, Volcanic Processes,** and **Understanding Volcano Hazard Video** activity.

Where Are the Lava Flows at Mount Rainier?

Lava flows are visible in two general arrangements at Mount Rainier—as thin rock ledges that protrude from the cone of the volcano, and as the immense ridges that radiate from the volcano in every direction. The rock ledge lava flows, commonly 30 meters (100 feet) in thickness, are all that remain of longer flows that during the eruptions disintegrated into pyroclastic flows, or after the eruption were eroded away by glacial action. The great lava flow ridges, exemplified as Paradise Ridge, Ricksecker Point, Mazama Ridge, and Rampart Ridge, rise hundreds of meters (hundreds of feet) above the valley floors. Their rock-rubble tops can be difficult to observe because of dense meadow and forest vegetation. Almost every step taken on these ridges is made upon hardened lava flows. From valley bottoms, the educated observer can view multiple lava flows that have built the ridge. The lava rocks usually appear gray, and in some places form columns. See examples of thin and thick lava flow types in the graphic ***"Photographs of Lava Flows at Mount Rainier."***

Silica Influences Lava Viscosity and Overall Shape of the Volcano

Silica content is the principal control upon the ***viscosity*** of magma. Silica molecules form a strong bond that permits entrapment of volcanic gases and promotes explosive volcanic eruptions. Low-silica magmas allow rapid escape of gases and low-explosivity eruptions. Other factors that control magma viscosity include the magma's temperature, gas and water content, and the amount of crystals in the magma. The massive ***shield volcanoes*** of Kilauea and Mauna Loa, in Hawai'i, contains 50 percent silica in its magma, whereas the ***stratovolcano*** of Mount Rainier has silica content of nearly 60 percent. Mount St. Helens has the highest average silica content at 64 percent. For more information about magma, visit the **Magma Mash** activity and the **Internet Resources Page**.

Sidebar 1

Get A Sense About Lava Flows

Color

Color and texture of lava vary considerably depending on cooling conditions. Lava rocks at high temperatures appear red to orange in color but cool quickly to shades of red (due to oxidation) and gray.

Sound

Witnesses of slow-moving, partially cooled lava flows report sounds similar to breaking of glass and pottery, caused by the splintering of the cooled outer skin of the lava flow. In contrast, the passing of a pyroclastic flow is eerily quiet. Some people say this is because its sound energy is absorbed within the billowing ash cloud.

Smell

Observers of lava flows report a slight sulfur smell in the air and the odor of burning vegetation.

Texture

Lava at Mount Rainier is not as fluid as lava at the volcanoes on Hawai'i, where lava flows sometimes resemble hot molasses, nor is it as viscous as lava at Mount St. Helens.

Not All Volcanoes Are Created Equal

While there are many ways to classify volcano types, one very simplistic and common classification system separates all volcanoes into three types based upon overall shape—shield volcanoes, ***cinder cones,*** and stratovolcanoes, sometimes known as ***composite volcanoes***. The overall shape of a volcano provides clues about the texture and chemical content of the lava that formed it. Magma erupted from shield volcanoes produces fluid lava that spreads quickly and thinly for great distances across the surface. This produces a gentle slope, similar in shape to the round shields used by Roman soldiers. Shield volcanoes have large foundations that cover massive areas. A stratovolcano consists of accumulations of viscous lava flows and rock rubble. Their slopes are much steeper than slopes of shield volcanoes. The type of magma that creates a cinder cone is similar to that producing shield volcanoes. During an eruption, expanding gases inflate small pieces of rock called cinders, which accumulate into a pile forming a rubbly cone. Many cinder cones also contain small lava flows. The graphic ***"Three Types of Volcanic Cones"*** depicts examples of these volcanic cones.

Mount Rainier and Mount St. Helens—Some Comparisons

Mount Rainier and Mount St. Helens have very different ages (oldest rocks 500,000 years ago and 40,000 years ago, respectively) and eruption styles, which explains their difference in shape and size. Mount Rainier's tendency to erupt more lava than tephra is one reason why it has been able to grow to such a great height. On the other hand, Mount St. Helens produces a tremendous amount of tephra that is blown away from the volcano and does not contribute to the volcano's cone. Lava at Mount St. Helens can be so viscous that it appears to squeeze out of the ground like toothpaste from a tube. This creates a muffin-shaped feature called a ***lava dome*** that grows over the vent. Later explosive eruptions will destroy earlier lava domes and prevent the volcano from growing to great heights.

Sidebar 1 Viscosity

This is the resistance of a material (usually a fluid) to flow. Examples higher and lower viscosity would be the higher resistance to flow of cake batter compared to water.

Procedure

What to do Before Class Begins:

- Choose three products to represent lava samples. Products should have different compositions and textures and viscosities (chocolate syrup, corn syrup, shampoo, oatmeal, jelly, ketchup, rubber cement, etc.). Place each of these materials in small containers to give to each lab group. Use paper cups or other containers.

Introducing Viscosity

1. Briefly review the different types of volcanoes. Use the ***"Three Types of Volcanoes"*** graphic to compare the shapes and sizes of shield, cinder cones, and stratovolcanoes.

2. Introduce the term viscosity and describe how the viscosity of lava will determine eruptive style and the type of volcano produced.

Lava On The Run

Students test the viscosity of three "lava samples" and draw conclusions about the type of volcano that might result.

Provide each student with a ***"Lava on the Run"*** student page.

1. Divide the class into groups of three or four persons. Each team member should have at least one role in the experiment, such as recorder, timekeeper, marker and measurer, and sample pourer.

2. Students spread newspaper or plastic sheeting over activity areas to ensure easy cleanup.

3. Students use a marker to draw a start line at the top of the cardboard and then prop the cardboard against an object at a steep angle.

4. Provide the lava flow samples to each group.

5. Instruct students to examine the lava samples.

6. On the student page, students write their prediction about which sample is the most viscous (slowest flowing) and least viscous (fastest flowing).

7. Instruct students to measure one tablespoon of sample and hold it above the start line ready to pour when the *timekeeper* says go. Pour the sample onto the cardboard. After ten seconds, the timekeeper will say stop, and the *marker* will draw a line where the "lava" was at that time. The *measurer* will determine the distance traveled during that time. The *recorder* writes the distance on the student page.

8. Students repeat the process with all samples. Average the results of each "lava" sample for all groups.

9. Instruct each group to graph the results showing which sample is more viscous or resistant to flow in the experiment.

Concluding the Experiment

1. Discuss results with the class. Address similarities and differences among group results. Did each group mark the same specimen as most or least viscous? Instruct students to explain their answers. Which specimen might represent each type of volcano? How did slope play a role in the results? How would shape or slope of a volcano and changes in silica content affect the volcano? Discuss how each consecutive lava flow adds height to the volcano.

2. Display the graphics ***"Three Types of Volcanic Cones," "Photographs of Lava Flows at Mount Rainier,"*** and ***"Volcanic Rocks of Modern Mount Rainier"*** Ask students to identify the samples that would build a shield and stratovolcano. Note the presence of thin flows on Success Cleaver, and thick flows in the Ricksecker Point Lava Flow. Explain how thin lava flows form high on the volcano while lava pools along the base of the volcano, forming thick flows and ridges that radiate from the volcano.

Adaptations

- Conduct ***"Lava on the Run"*** as a classroom demonstration.

Extensions

- For older students, assign Internet or library research concerning volcano growth rates. Instruct students to examine the life histories of other Cascade volcanoes.

Assessment

For assessment, instruct students to show results on the student page and on the graph. Students should demonstrate ability to follow instructions on the student page, record results and graph their data. Look for evidence that students understand the following concepts: that the type of lava material erupted from a volcano influences the volcano's shape; that Mount Rainier is a stratovolcano; that lava flows are the principal building blocks of Mount Rainier; that lava flows are visible as thick ridges that radiate from the volcano and as thin ledges within the volcanic cone. Assess application to real-world situations by assigning further class interpretation of photographs of volcanoes on the graphics pages and of photographs in books and websites. Ask questions about how viscosity of magma affects the shape of volcanoes near your community.

Resources

Sisson, T. W.; Vallance, J. W.; Pringle, P. T., 2001, Progress made in understanding Mount Rainier's hazards: EOS (American Geophysical Union Transactions), v. 82, no. 9, p. 113, 118-120.

Refer to **Internet Resources Page** for a list of resources available as a supplement to this activity.

Photo Credits

Photographs of Lava flows at Mount Rainier

Thin Lava Flow Layers on the south flank of Mount Rainier stratovolcano. (U.S. Geological Survey photograph by Carolyn Driedger during February 2003.)

Thick lava layers that accumulated as Ricksecker Point lava flow. (U.S. Geological Survey photograph by Carolyn Driedger during September 2006.)

Three Types of Volcanic Cones

Shield Volcano View of the northwest flank of Mauna Loa Volcano from the south side of Mauna Kea Volcano. (U.S. Geological Survey photograph by D. Little, date unknown)

Lava Butte Cinder Cone, Oregon, taken from Highway 97. (National Park Service photograph.)

Mount Rainier stratovolcano. (U.S. Geological Survey photograph by Carolyn Driedger during July 2004.)

Team Names ______________________________

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Lava on the Run

During this activity, you will test the viscosity of three lava-like products and draw conclusions about the type of volcano they might form.

1. Choose roles for each team member— recorder, timekeeper, marker and measurer, and sample pourer.

2. Spread newspaper or plastic sheeting over activity areas for easier cleanup.

3. Use a marker to draw a start line at the top of the cardboard and, then prop the cardboard against an object at a steep angle.

4. Examine the three samples provided to your group (chocolate syrup, corn syrup, shampoo, oatmeal, jelly, ketchup, rubber cement, etc.)

5. On the student page, write your prediction about which sample is more viscous and will flow downhill the slowest, and which sample is least viscous and will flow fastest.

6. Measure 1 tablespoon of sample and hold it above the start line ready to pour when the *timekeeper* says go. Pour the sample onto the cardboard. After 10 seconds, the timekeeper will say stop, and the *marker* will draw a line where the "lava" was at that time. The *measurer* will determine the distance traveled during that time. The *recorder* writes the distance on the student page.

7. Perform each lava run twice. Average the results of each sample and record it.

8. On the back of this page, draw a graph of your results. Write on your graph which lava-like samples are more viscous (resistant to flow).

Student Page

Team Names ____

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Lava on the Run - continued

Predictions:

Which sample will travel the greatest distance in 10 seconds? _________________

Which sample will travel the shortest distance in 10 seconds? _________________

Sample #	Distance (mm) 1st time	Distance (mm) 2nd time	Average

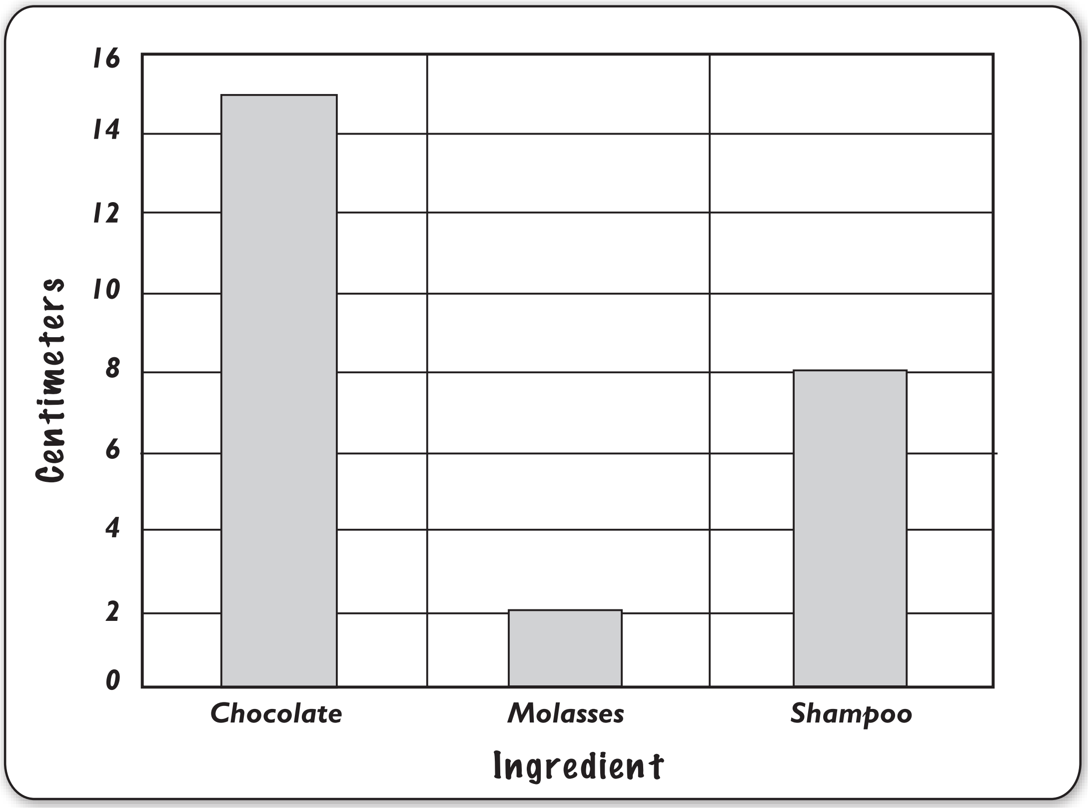
1. List factor(s)which control distances traveled by your lava-like flows.

2. List which products most closely resemble the behavior of lava flows on a shield volcano and a stratovolcano.

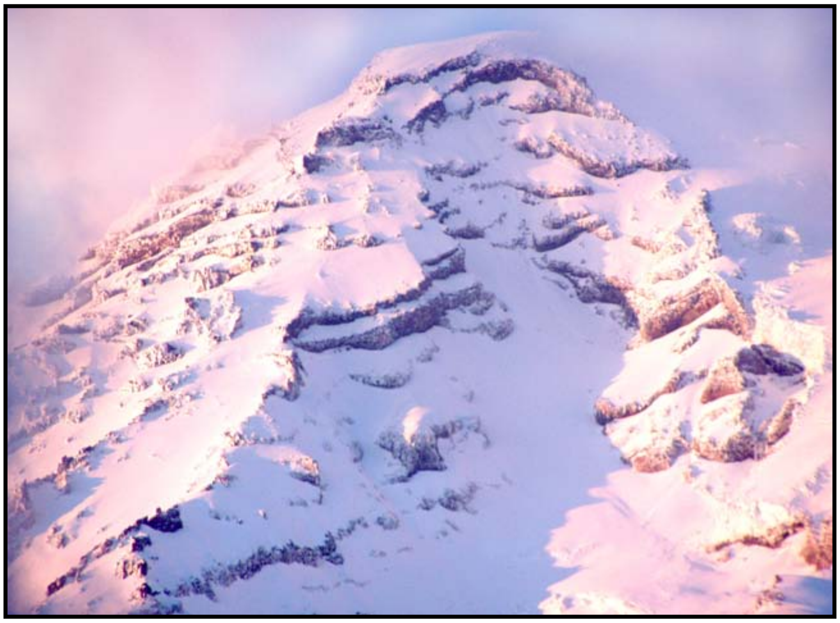
Teacher Page

Lava on the Run - Sample Graph

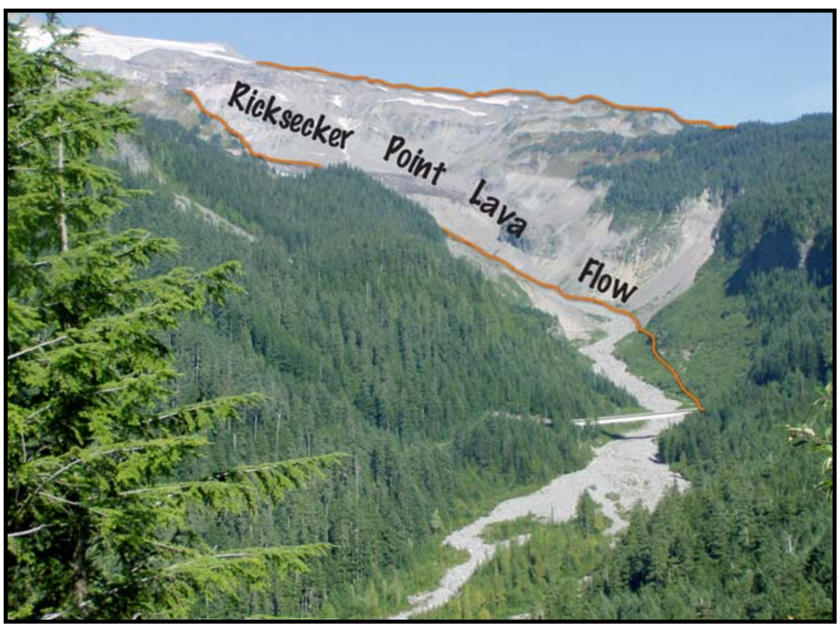
Lava on the Run



Photographs of Lava Flows at Mount Rainier



Layers of thin lava flows, each about 30 meters (100 feet) thick on Success Cleaver.



Thick lava flows (300 meters (1,000 feet) thick). Ricksecker Point lava flow.

Three Types of Volcanic Cones

Shield Volcano

View of the northwest flank of Mauna Loa Volcano from the south side of Mauna Kea Volcano, Hawaii.

Cinder Cone

Lava Butte Cinder Cone, Oregon, from Highway 97

Stratovolcano (Composite Cone)

South side of Mount Rainier from Paradise Ridge

Volcanic Rocks of Modern Mount Rainier