Volcano Models

Overview:

Shield and composite volcanoes differ in shape, largely due to underlying plate tectonics and magma types. During this activity, students learn how properties of shield and composite volcanoes differ by observing a teacher demonstration. Students also develop an understanding of how composition of lava contributes to different volcanic forms. Students conduct an experiment to demonstrate how viscosity varies with composition.

Objectives:

The student will:

- observe that composite volcanoes usually form at convergent plate boundaries, while shield volcanoes usually form at hotspots;
- observe that viscosity of magma helps determine the shape of a volcano;
- demonstrate that composition of "lava" is in partially responsible for viscosity; and
- explain that rhyolite, the normal parent material of composite volcanoes, is more viscous than basalt, the normal parent material of shield volcanoes.

Materials:

- Squeezable, thick, stone ground mustard
- Magic Shell ice cream topping
- Paper plates (thick and sturdy)
- Light corn syrup
- Honey
- Marbles (a color that will contrast with honey)
- Beakers (400 ml)
- Rulers (a slotted ruler works best)
- Spoons or stirring sticks
- Transparency: "Volcano Models"
- Student Worksheet: "Magma Composition"

Answers to Student Worksheet:

Data:

	Trial 1	Trial 2	Trial 3
Did the marble in beaker A or beaker B take longer to reach the bottom?	beaker B	beaker B	beaker B

Analysis of Data: B, The "lava" in Beaker B was more viscous.

Conclusion: High honey "lava" is more viscous than low honey "lava."

Further Questions:

1. composite 2. shield 3. rhyolite 4. basalt 5. rhyolite

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Activity Preparation:

1. Ahead of time, create a paper plate (plate A) that represents several "eruptions" over time: squirt a layer of magic shell onto a paper plate and place into a freezer for 5 minutes to allow hardening. Repeat this procedure, adding 6 or more layers, until a low, gently sloping mound emerges. This plate will be used in the demonstration described below.
2. Poke a hole in the center of 2 paper plates just large enough to fit around the opening of the mustard bottle (plate B) and the magic shell bottle (plate C).
3. Freeze plate C or chill by placing on bag of ice (plate should remain dry). If using the freezer, take the plate out just before the demonstration so that the plate is cold.

Activity Procedure:

Note: Volcanic eruptions occur when convection currents in Earth's mantle and outer core force less dense magma to rise to the surface. However, all magma is not the same: it can vary in viscosity, or resistance to flow, because of variation in both temperature and composition. These properties can affect the shape of a volcano. Low, gently sloping shield volcanoes are formed at "hotspots" in Earth's crust and ocean floor spreading centers, where magma is usually basaltic and has low viscosity. Steep-sided composite volcanoes are generally formed at convergent continental plate boundaries, where magma is higher in andesite and/or rhyolite, and has a higher viscosity.

1. Using the Transparency: "Volcano Models," show that shield volcanoes differ from composite volcanoes in the underlying plate tectonics. Shield volcanoes form at "hotspots," while composite volcanoes usually form at convergent plate boundaries. Explain that shield volcanoes also form at ocean floor spreading centers.
2. Explain that the magma that forms shield volcanoes is different than the magma that forms composite volcanoes: shield volcano magma is less viscous than composite volcano magma.
3. Ask students if they know the definition of viscosity (viscosity is a measure of resistance to flow; more viscous substances offer more resistance. For instance, it would be more difficult to swim through a bowl of honey than through a pool of water because honey is more viscous).
4. Use the transparency to illustrate how the different volcanoes build over time. Explain that volcano shape results in part from the viscosity of the magma.
5. Explain that viscosity of lava and magma will vary depending on the temperature and the composition. Explain that the parent material of the magma that forms shield volcanoes is generally basalt, while the parent material of the magma forming composite volcanoes is generally rhyolite (or andesite).
6. Write on the board that rhyolite has 69% or more silica, while basalt has about 45-54% silica.

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7. Using plates B and C, show how "magma" of different viscosities creates different types of volcanoes:
   a. Poke the mustard bottle through the hole in plate B and squeeze. A large mound should form, representing a composite volcano.
   b. Remove plate C from the freezer or ice, poke the magic shell bottle through the hole, and squeeze (results are better if plate is very cold). The substance should spread out and harden, making a rather flat mound that represents a shield volcano.
8. Ask students why the substances formed different shapes (different viscosities). Ask what each "volcano" might look like after numerous "eruptions." Show plate A to illustrate what might happen over time.
9. Distribute the Student Worksheet "Magma Composition." Ask students to complete the activity.

Extension Idea: Instead of simply observing which marble reaches the bottom of the beaker first, students could time how long it takes the marbles to reach the bottom of each beaker and create a bar graph of the results.

Name:_____ **Student Worksheet**

Magma Composition

Testable Question:

Which "lava" is more viscous: high honey "lava" or low honey "lava"? _____

Background Information:

Magma from shield volcanoes is different in viscosity than magma from composite volcanoes. This is due in part because of temperature differences, but also because of differences in magma composition: magma from composite volcanoes has more silica than magma from shield volcanoes. In this experiment, the syrup represents the magma, and the honey represents the silica.

Hypothesis:

____ High honey lava is more viscous than low honey lava.

____ Low honey lava is more viscous than high honey lava.

Materials:

- Corn syrup
- Honey
- 6 marbles
- 2 beakers
- Ruler
- 2 spoons or stir sticks

Procedure:

1. Using a permanent marker, label one beaker with letter "A" and one with the letter "B."
2. Beaker A will be the low honey beaker. Fill the beaker to 300 milliliters, using 50% honey and 50% syrup. Stir well with a spoon or stir stick.

   To calculate the number of milliliters of honey and syrup needed, multiply:

   300 milliliters x 0.50 = _____
3. Beaker B will be the high honey beaker. Fill the beaker to 300 milliliters, using 80% honey and 20% syrup.

   To calculate the number of milliliters of honey needed, multiply:

   300 milliliters x 0.80 = _____

   To calculate the number of milliliters of syrup needed, multiply:

   300 milliliters x 0.20 = _____

Magma Composition

4. If a slotted ruler is available, rest a ruler across the tops of both beakers. Place a marble in a slot directly over each beaker. Flip the ruler over so that the marbles fall into the beakers at the same time.
5. Observe which marble reaches the bottom of the beaker first. Record results in the Data Chart.
6. If no slotted ruler is available, drop a marble into each beaker at the same time by hand. Be sure that both marbles are dropped from the same height. Resting a hand on the edge of the beaker will help ensure that the marbles are dropped from the same height. Observe which marble reaches the bottom of the beaker first. Record results in the Data Chart below.
7. Repeat the marble dropping procedure three times.

Data:

	Trial 1	Trial 2	Trial 3
Did the marble in beaker A or beaker B take longer to reach the bottom?			

Analysis of Data:

The marble will take longer to reach the bottom in more viscous "lava". Circle the correct answer:

a. The "lava" in Beaker A was more viscous.
b. The "lava" in Beaker B was more viscous.

Conclusion:

Check the correct statement:

____ High honey "lava" is more viscous than low honey "lava."

____ Low honey "lava" is more viscous than high honey "lava."

Was your hypothesis proved or disproved? Use a complete sentence.

_____

_____

Explain what evidence supports your conclusion. Use complete sentences.

_____

_____

_____

_____

Name:_____ **Student Worksheet**

Magma Composition

Further Questions:

1. Does the high honey "lava" represent magma from a shield volcano or a composite volcano?

   _____

2. Does the low honey "lava" represent magma from a shield volcano or a composite volcano?

   _____

3. Does the high honey "lava" represent rhyolite or basalt? _____

4. Does the low honey "lava" represent rhyolite or basalt?_____

5. Which is more viscous, rhyolite or basalt? _____

