Activity Overview

Students learn to interpret topographic contour maps and are introduced to the variety of the topographic features in volcanic regions. Magma composition is an important factor that controls the type of volcanic landform that develops in a region. After students use models to explore topography, content reading explains the relationship between magma chemistry and volcanic landforms. These ideas are building blocks for understanding the nature of volcanic eruptions explored in later activities. Questions explore students' understanding of topography, magma chemistry, and volcanic landforms. Students also learn that the ability to read a topographic map is helpful in predicting the flow of hazardous material on a volcano.

Preparation and Materials Needed

This is an inexpensive alternative to the "plastic volcano contour models" sold by commercial vendors. The commercial model works by having students place a plastic model volcano into a watertight container. Students then mark 1-cm increments in height on the side of the container, pour in water to the 1-cm mark, and use a grease pencil to trace the "shoreline" (where the water touches the plastic volcano). They then place the lid on the box, look down on the model, and trace the outline of the water onto the box top. The lid is removed, another centimeter of water added, and the process continues until the water reaches the top of the volcano. The lines are labeled and a legend is added, yielding a two-dimensional representation of a three-dimensional surface (contour map).

In this inexpensive version, students use tape and paper to make a paper volcano. They trace horizontal lines onto the paper model, put the model into the box, place a lid on the box, and trace the outlines on the box top.

If you prefer the wet method, simply substitute modeling clay for the plastic volcano, but have students mold the clay into the shape of a volcano. Adding food coloring to the water makes it easier to construct the contour map.

Materials

- Plastic shoebox
- Clear plastic clipboards (or clear, flat, box lids)
- Sheet of paper (for volcano models)
- Tape
- Metric ruler (30 cm)
- Transparency
- Transparency marker or grease pencil (for drawing contour lines)
- Copy of the map of Mt. St. Helens on page 18 — see the **Blackline Master Volcanoes 2.1**

Think about It

Student Conceptions

Expect a variety of responses to this question. Students may have the following conceptions about why different volcanoes have different shapes:

- Volcanoes that have recently erupted will have more jagged peaks.
- Older volcanoes may be taller because more lava has erupted over time.
- Older volcanoes would be more worn down and smoother due to erosion.
- Some volcanoes erupt molten lava while others explode or erupt ash and cinders.

Answer for the Teacher Only

Differences in the shapes of volcanoes stem from differences in the chemistry of the magma from which they form, their recent eruptive history, and the effects of erosion. Silica-rich magmas are more viscous, and form steep-sided domes. Silica-rich magmas tend to have a high content of volatile compounds like water, and therefore they often erupt explosively.

Assessment Tool

Think about It Evaluation Sheet

Refer students to the **Think about It Evaluation Sheet** to help students understand and internalize basic expectations for the warm-up activity.

Investigate

Teaching Tips

Steps 1 – 6:
Students can make a paper model of a volcano by rolling a piece of paper into a cone and taping it to the table. The paper model needs to be lower than the height of the box so that the box lid or clipboard can be placed over it. A felt-tipped marker works best for drawing the lines.

When students have completed their maps, consider displaying those contour maps on an overhead projector and discussing some of the important features (steep slope, or gentle slope, contour interval). Pick a point on the contour map and ask students to predict the direction in which lava would flow if it erupted at that point. You might ask students to prepare a final copy of their topographic map by tracing it onto a sheet of notebook paper and including it in their *EarthComm* notebook.

Step 7:
Make overhead transparencies (or a class set of photocopies) of the map on page 18 (see **Blackline Masters**). This will make it easier for students to respond to the questions.

As you circulate around the room while students are working, or when you review the results of the activity, make sure that students understand the similarity between the movement of mountain glaciers (which flowed down the slope of Mt. St. Helens under the force of gravity) and lava (which also flows downhill).

Assessment Opportunity

As you circulate during the investigation, check students' contour maps. Maps should have a scale, elevations should be marked, maps should be consistent with the shape of the model, and contour lines should not be broken (i.e., lines should be continuous and closed except for where they pass off the map). You may consider developing an assessment rubric with these criteria that students can use as a checklist and you can use for evaluation any time students are asked to develop a contour map.

7. a) The contour lines on both maps are approximately in the form of circles. The values of the lines increase toward the center of the map.
   b) Check student work for clear map legends.
   c) According to the legend or map key, the shaded areas represent glaciers.
   d) The shaded areas cross the contour lines at right angles because glaciers flow downhill. The most direct path downhill is perpendicular to the lines of equal elevation.
   e) The map shows that the slope between 2000 and 2500 m is steeper because the contour lines are spaced more closely together (the same change in elevation as between 1500 m and 2000 m, but over a shorter horizontal distance).
   f) The lowest elevation is below 1300 m. The highest elevation is at 2800 m. The difference in elevation between the highest and lowest points on Mt. St. Helens is about 1500 m (2800 m minus 1300 m).
   g) Lava that erupted at point A would flow to point D because point D is directly downhill from point A.

Reflecting on the Activity and the Challenge

Have students read this brief passage and share their thoughts about the main point of the activity in their own words. You might ask students how a topographic map could be used to identify a volcanic region. What might the contour map look like?

Digging Deeper

Assign the reading for homework. The questions in **Check Your Understanding** (page 23) can be provided as a homework assignment.

Assessment Opportunity

Use (or rephrase) the questions in **Check Your Understanding** for a brief quiz to check students' 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.

Assessment Opportunity

Provide students with a sketch of a simple contour map and ask them to determine:

- the contour interval
- highest elevation on the map
- lowest elevation
- overall map relief
- regions of high and low slope

Check Your Understanding

1. A contour line is a line on a map that shows points of equal elevation above the Earth's surface. Contour interval is the difference in elevation between adjacent contour lines. A topographic map shows the elevation of the surface in an area.

2. Corn syrup is more viscous than vegetable oil, and vegetable oil is more viscous than water.

3. Magmas with low silica content have low viscosity.

4. Silica-poor magmas produce broad volcanoes with gentle slopes because low-silica magma has low viscosity and flows very easily. Because of the ease of flow, only gentle slopes are needed to keep the magma flowing.

5. Silica-rich magmas have high viscosity, which means that they do not flow easily. Steep slopes are needed to keep the magma flowing. The magma tends to pile up around the vent, producing steep slopes.

6. A caldera is a large hole or depression on a volcano, formed when a very large volume of magma is erupted, or when magma beneath the volcano drains back downward.

Understanding and Applying What You Have Learned

1. The contour interval is 100 m.

2. Answers will vary, but contour map "a" should have widely spaced contours, map "b" should have closely spaced contours, map "c" should have contours extremely closely spaced, and map "d" should have circular contours that have hatches to indicate the circular depression at the crater (or contour values actually decreasing at the top of the volcano).

3. Students may have to transfer their contour map from the clipboard to a sheet of paper. Check students' maps to make sure that the lava is flowing downhill, and everywhere locally perpendicular to contour lines from the top of the volcano down the slope.

4. Check students' maps to determine the extent to which they understand how to represent a broad shield volcano shown in *Figure 2* (widely spaced contours to indicate more gentle slopes) and a composite cone (fairly symmetrical, nearly circular contours). The maps should also have a legend that indicates a contour interval. Contour lines should be labeled.

5. Note: Try to provide a topographic map of your state or community. You could post one map on a bulletin board for students to view, or photocopy the scale and a portion of the topographic map onto an 11 x 17 sheet of paper and give each student or group a copy. Answers below pertain to the topographic map of Mt. Rainier provided on page 24. If possible, enlarge a photocopy of this map and provide copies to students.

- **a**) The contour interval is 50 meters. The highest elevation is 4392 meters (on top of Mt. Rainier) and the lowest elevation is about 950 meters (near Stevens Ridge). Therefore, the relief is 3442 (4392 – 950) meters.
- **b**) The paths of potential lava flows should move away from the top of the volcano and down the slope.

Teaching Tips

Question 5:
Make an overhead transparency (or a class set of photocopies) of the map on page 24 (see **Blackline Master Volcanoes 2.2**). This will make it easier for students to respond to the questions. Visit the *EarthComm* web site to find out how to obtain a topographic map of your community (this map can be used in **Inquiring Further**, and in other chapters in this module).

Preparing for the Chapter Challenge

This provides an opportunity for students to work on the **Chapter Challenge**. Remind students of the basic scenario of the challenge—writing a story or play that is thrilling yet informative. If students have access to photocopies of local or state topographic maps, they can include an interpretation of topography in their story. They can also sketch contour maps of volcanic regions to demonstrate explosive versus non-explosive volcanic landforms and the paths that lava might take on a volcano.

Inquiring Further

1. Cascade volcano in your community

Comparing a Cascade volcano to local topography provides an opportunity for students to gain a sense of the scale of volcanoes. Comparison puts the volcano in perspective. This is particularly helpful if you live in a small community and/or relatively flat area. It works best if you enlarge the topographic maps of the volcano and your community. The map on page 24 is a Cascade volcano called Mt. Rainier. Make about five copies. Students can place the model of the volcano right onto the map of their community, or make a similar 3-D model of their community and place them side by side.

Teaching Tip

Visit the *EarthComm* web site www.agiweb.org/earthcomm to find out how to obtain topographic maps of your community and of Cascade volcanoes for the **Inquiring Further** portion of this activity.

Assessment Opportunity

Constructing scaled physical models from topographic maps of the community and of a Cascade volcano is very challenging and provides a unique opportunity to assess students' understanding of topography and the concept of scale. Placing the two physical models side by side also provides an opportunity for students to gain a better sense of the true scale of a Cascade volcano.