Volcanoville: Predicting Eruptions

In the workshop Volcanoville: Predicting Eruptions, your students investigated some of the variables that influence volcanic eruptions and considered their potential effects on nearby communities. Continue students’ explorations into the processes involved in volcanic eruptions and the techniques used to monitor active volcanoes with the following discussions and activities.

### Discussion: Effects of Volcanic Eruptions

**TIME:** 10-20 minutes

**GOAL:** Review concepts encountered during the museum visit.

Discuss with the class their experiences in the workshop and the exhibit.
- What new things did they learn about volcanoes and eruptions?
- What are some of the hazards from volcanoes? What effects do they have on people?
- What are some of the ways we can study and predict the behavior of volcanoes?
- What questions do the students still have about volcanoes and volcano monitoring?
- What could they do to find out more information about those questions?

### Investigation: Variables in Lava Flow

**TIME:** 30–45 minutes for introduction and experimental design, plus time to carry out investigations

**GOAL:** Design and carry out an experiment investigating the effects of a changing variable on lava flow patterns.

In the Volcanoville workshop, students explored the effects of varying slope and lava type (viscosity) on the rate of lava flow. In this investigation they will generate other possible variables involved in volcanic eruptions and design an experiment to collect further data on the effects of one of the variables.
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**INVESTIGATION:** VARIABLES IN LAVA FLOW

**MATERIALS:**
Materials may vary depending on students’ experimental design, but may include:
- Dish soap
- Disposable pipettes (preferably with graduated markings for volume measurement)
- Plastic lunch trays or other similar trays
- 1-cm grid paper, laminated (downloadable here: https://www.hand2mind.com/pdf/gridpaper.pdf)
- Stopwatches or other timing devices

**PROCEDURE:**
1. Remind students of their investigations in the workshop. How did slope affect lava flow? What about type of lava? If you have previously completed the Dough Lava activity (see Volcanoville Pre-Visit Resources), encourage students to make connections to their observations from that activity.

2. Brainstorm other variables that might affect how lava flows. Some possibilities include:
   - Volume of lava
   - Force/how fast lava is ejected
   - Shape of landscape (rounded or bumpy rather than flat)
   - Temperature

3. The experiment in the workshop measured the speed of lava flow from an eruption. Are there any other factors that might be important or useful to measure (e.g. the area covered)? Make a list of possible measurable outcomes.

4. Divide students into groups of 2-4, and explain that they will be using the same model that they used in the workshop (dish soap) to investigate further how lava flows.

5. Challenge each group to choose one variable to explore and to create an experimental design for their investigation. The following questions might serve as guidelines for planning the investigation:
   - What question do we want to answer? How could we answer it?
   - What variable(s) will we change? What needs to stay the same?
   - What will we measure or observe? How will we record the results?
   - What materials will we need?

6. Supply needed materials to each group—or allow time for students to bring in supplies—and provide class time for setting up and carrying out investigations.

7. Ask groups to create a graph of their results. Invite them present their findings, summarizing what they did, what they discovered, and what other questions they now have about their subject.
REFLECTION:
Discuss the results of the class’s investigations.
- Were there any patterns in how lava flow is affected by these variables?
- If more than one group tested the same variable, how did their results compare to one another? What might account for any differences?
- Assuming this model is a good predictor for actual lava flow, what conclusions can students draw from their investigations about the behavior of lava during volcanic eruptions?
- How might their results be used to help people living near volcanoes plan for future eruptions?

EXTENSION:
Challenge groups to choose a second variable and carry out another investigation. Ask them to compare and contrast the effects of the two variables, and then explore the interaction between them. Which combination of conditions maximizes the outcome, and which minimizes it? (For example: Which combination of slope and lava volume covers the largest area? The smallest area?) How big is the difference between the maximum and minimum?
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**RESEARCH PROJECT:** Eruption News Report or Volcanologist Interview

**TIME:** 15–30 minutes to introduce the project, plus time for individual presentations

**GOAL:** Research an active volcano or a volcano monitoring technique and create a television segment based on the research.

**MATERIALS:**
- Video recording and playback capability (optional)

**PROCEDURE:**

1. This project could be done individually or in pairs. Prepare lists of active volcanoes and volcano monitoring techniques and encourage students to choose a topic from the lists. (See the links to the Smithsonian Global Volcanism Program and USGS Volcano Hazards websites in the Online Resources section below for ideas.)

2. Introduce the activity with a discussion of the effects of volcanic eruption on people. As students saw in the Volcanoville workshop, many volcanoes are located near populated areas. What kinds of problems and damage can volcanoes cause to places where people live? What kinds of things can people do to prevent or minimize these dangers?

3. Explain that students will research one of the topics and create a 3–5 minute segment for a television program. This may be filmed and played for the class in video format, or presented as a live-action skit. Like all good television, the segment should be interesting and engaging to keep people watching, but it should also be realistic and based on the results of their research. As students plan, they should consider graphics, props, or other elements they might include to add interest to their segment.

4. **Option 1, Eruption News Report:** Choose an active volcano that is located in an inhabited area of the world and research its features, behavior and history. Imagine that this volcano has a major eruption sometime in the near future, and create a news broadcast covering the eruption. The broadcast should answer the following questions:
   - Where is the volcano located? What cities or inhabited areas are affected?
   - What type of volcano is it, and what type of eruption is occurring?
   - What kinds of damage are being caused?
   - What is the volcano’s history? How was it formed, and when did it erupt in the past?
   - Was the volcano being monitored? Was there any warning that the volcano was about to erupt?
   - How are people reacting to the eruption? What are governments or other organizations doing to ensure people’s safety?
5. **Option 2. Volcanologist Interview:** Choose one of the techniques used to monitor volcanic activity and research how it works and how it is used. Imagine that you are a volcanologist being interviewed about how people can be warned before eruptions happen. Your interview should answer the following questions:

- What is the technique called? What does it measure?
- How does it help to warn of possible eruptions?
- What are its limitations? (What can’t it tell us?)
- What kind of equipment does it use, and how does the equipment work?
- What does an average day in your job look like? What things do you do?
- What happens if the data indicate a potential eruption?

6. Invite students to present their TV segments to the class.

**REFLECTION:**
- Based on the information in these presentations, what are some of the challenges for governments and other organizations trying to prepare communities for and protect them from volcanic eruptions?
- What are some of the ways they are trying to address those challenges?
- What ideas do the students have for other ways to solve these problems?

**EXTENSION:**
Divide students into small groups and assign each group an active volcano located near a populated area; use the volcanoes from the students’ news report presentations if possible. Each group has been designated the Volcano Hazard Management Commission for the area around their volcano. **Their task is to create a plan for how the community should prepare for and respond to the volcano's eruption.** The plan should include:

- How the volcano’s activity will be monitored
- How (and to whom) warnings will be communicated in the event of an eruption
- A plan and procedure for how residents will be evacuated
- Any recommendations for construction projects or other changes to city design and planning that might help to minimize damage from the eruption

Encourage groups to include existing strategies as well as their own ideas for future technologies. Each group should prepare a poster or digital presentation detailing their plan, including charts, maps, or diagrams where appropriate, and explaining why this is the best plan for their community.
Online Resources:

- U.S. Geological Survey—Extensive educational resources for middle and high school:
  - Topical resource list: http://education.usgs.gov/secondary.html
  - Volcano hazards resources: http://volcanoes.usgs.gov/about/index.php
  - Predict an Eruption online interactive: http://volcanoes.usgs.gov/about/edu/predict/index.php
- Volcano World—Information, activities, and other resources for students and teachers from Oregon State University: http://volcano.oregonstate.edu/
- Smithsonian Global Volcanism Program—Facts and up-to-date monitoring of all the world’s known active volcanoes: http://www.volcano.si.edu/
- Build a Volcano—An online interactive which allows students to adjust magma variables and see the resulting eruption: http://www.mnh.si.edu/earth/main_frames.html

Standards:
The Volcanoville workshop and these accompanying resources support the following elements of the Next Generation Science Standards (http://www.nextgenscience.org/):

Core Ideas:
- Earth’s Materials and Systems: The planet’s systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth’s history and will determine its future. (MS-ESS2-2)

- Natural Hazards: Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.

- Biogeology: Living things affect the physical characteristics of their regions. (4-ESS2-1)

- Designing Solutions to Engineering Problems: Testing a solution involves investigating how well it performs under a range of likely conditions. (ETS1-B)
Science and Engineering Practices:
• Asking Questions and Defining Problems:
  Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.

• Planning and Carrying Out Investigations:
  Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

• Analyzing and Interpreting Data: Analyze and interpret data to determine similarities and differences in findings, or to provide evidence for phenomena.

Crosscutting Concepts
• Patterns:
  Patterns in rates of change and other numerical relationships can provide information about natural systems.

• Stability and Change:
  Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales; small changes in one part of a system might cause large changes in another part.

• Cause and Effect:
  Cause and effect relationships may be used to predict phenomena in natural systems.

• Systems and System Models:
  Models can be used to represent systems and their interactions.