Modeling an Active Explosive Volcano

Grades 3–6, estimated time 30 minutes

Anticipated Learning Outcomes

- Students will explain how the build-up of gas from dissolving an Alka-Seltzer tablet causes the lid of a medicine vial to blow off.
- Students will explain that build-up of gas pressure causes eruption of explosive volcanoes and that the pressure comes from heating of dissolved gases in the magma.
- Students will discuss the similarities and differences between the model and an actual volcano.
- Students will verbalize excitement of learning about volcanoes.

Introduction

This activity is an active simulation of an explosive volcanic eruption. The “volcano” (use non-childproof prescription medicine vials) erupts (the lid blows off) when gas pressure generated by dissolving an Alka-Seltzer tablet is sufficiently high. It is realistic in that the timing of the eruption is difficult to predict precisely and in that the eruption occurs when the pressure of the gas exceeds the confining pressure of the lid. The experiment can be modified to show that an eruption will not occur if there is not enough gas pressure generated (small piece of Alka-Seltzer) or if gas is allowed to escape gradually through holes punched in lid of medicine vial.

Caution: Allow students a clear view of the volcano, but make sure they stand a bit away to avoid anyone being hit by the volcano’s exploding top.

Background

Not all volcanoes erupt explosively and unpredictably. The eruptive style (quiet streams of lava versus violent blasts of gases, ash, and debris) and eruption frequency and predictability are related to the viscosity (resistance to flow) and amount of dissolved gas in the magma (molten lava prior to eruption). Hot, runny magmas with little dissolved gas tend to flow smoothly out of vents and produce a volcano that is broad and not steep, such as the Hawaiian volcanoes. On the other hand, slightly cooler magma with a higher dissolved gas content is much more viscous. Instead of running out smoothly, the magma may ooze out like toothpaste, clogging the vent. These volcanoes are steeper and have the typical “volcano shape” of famous volcanoes such as Mt. Fuji in Japan. Under this type of volcano, gases dissolved in magma can separate as the pressure decreases when the magma rises closer to the Earth’s surface. If the gases separate rapidly and cannot escape immediately, they can build up pressure greater than that of the overlying rock. When this happens, they break the rock suddenly as a violent explosion occurs sending a plume of gas and ash upwards to heights as great as 20 miles. Commonly there is little if any lava extruded. The ejecta may consist primarily of ash, pumice (instantaneously cooled magma containing abundant trapped air), and debris blown off the volcano by the eruption. The force of the eruption can blast material tens of miles from the volcano, causing extensive loss of life and damage.

It may take thousands of years for sufficient pressure to build to cause an eruption, and it is difficult to predict when a volcano that has long been dormant will become active. If the pressure were released gradually it would not build up to the point where it could cause an explosive eruption. Because they erupt infrequently, unpredictably, and violently, and because they occur in populated areas (e.g., Japan, Indonesia, Philippines, Pacific Northwest of the United States, Central and South America), these explosive volcanoes pose the greatest danger to humans.

Materials

- Non-childproof prescription medicine vial
- Water
- Graduated cylinders (small)
- Alka-Seltzer (regular strength) tablets, cut into halves and quarters
- Lots of paper towels for clean up

Procedures

1. Put about 20 ml (about 1/8 cup) of water into vial.
2. Add a quarter of an Alka-Seltzer tablet and quickly put on cap.
3. Observe what happens for about 2 minutes.
4. Repeat using a half of an Alka-Seltzer tablet (Watch out!).
5. Repeat using half of a tablet and lid with perforations that allow gas to escape.

Results and Discussion

1. *What happens?* The lid on the vial containing a quarter tablet will balloon upwards as the pressure increases, then deflate as it decreases, or it may possibly pop off gently. The lid on the vial containing a half of a tablet will bulge and then blow off violently, rising several feet in the air or travelling laterally 5 or 6 feet. The perforated lids will not blow off.

2. *Why?* There is not enough gas generated by one quarter of a tablet of Alka-Seltzer to build sufficient pressure to blow the lid off. However, the gas generated by a half of an Alka-Seltzer tablet is plenty to blow the lid part way across the room, as long as the lid is put on quickly and firmly so that no gas escapes.

Students can use the ballooning of the lid prior to its blowing off to predict when the lid will blow off. This is analogous to volcanologists predicting when an eruption will occur based on the measurable bulging of a volcano. If the gas is allowed to escape gradually through holes in the lid, the gas pressure from the dissolving Alka-Seltzer will not build up to the point where it exceeds the confining pressure of the lid, and the lid will not blow off.

Additional Activities

Repeat each experiment several times. Using a second hand on a clock, time how long it takes the lid to blow off with the half tablet. Measure the distance that the lid goes. Data from several groups can be pooled and tabulated and histograms made.

Older students could research the eruptive history of a particular volcano, the effects it has had on humankind, and its potential for future destruction. Some famous volcanoes: Kilauea and Mauna Loa (both “nonviolent” volcanoes on the island of Hawaii), Mt. Vesuvius, Mt. Pinatubo (erupted 1991), Mt. Rainier, Mt. Lassen, Mt. St. Helens, Tambora, Krakatoa, El Chichon, Nevado del Ruiz (erupted 1985, causing 23,000 deaths in Columbia).

Locate these volcanoes on a world map (geography) and have students discover some dramatic story or event for their assigned volcano.

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