Hawai'i Space Grant College, Hawai'i Institute of Geophysics and Planetology, University of Hawai'i, 1996

Gelatin Volcanoes

Teacher Page

Purpose

To understand how and why magma moves inside volcanoes.

Background

Magma is molten rock, including crystals and dissolved gases, found at depth in a planetary interior. When magma ***erupts*** onto the surface, the volcanic products make distinctive landforms including lava plains and ***volcanoes***, depending on the details of the eruption. One of the most interesting things to consider about magma is how it moves up from underground reservoirs, called magma chambers, to erupt as ***lava*** on planetary surfaces. Does it travel in natural tubes or pipes? Or along fractures? This experiment strikingly reveals the answer.

Magma leaves underground reservoirs through fractures in the surrounding rock. The fractures are either pre-existing or are created by the erupting magma. An active ***dike*** is a body of magma moving through a sheet-like, vertical or nearly vertical fracture.

An important aspect of magma flow not dealt with in the gelatin activity is the heat lost during eruption. Magma, ascending as a dike begins to cool and solidify and the flow may become localized in the dike. Such localized eruption of magma over a long period of time produces a volcano.

Stresses in the planet affect the orientation of dikes. Dikes open (widen) in the direction of least resistance. They propagate (grow longer and taller) perpendicular to the direction of opening.

Hawaiian shield volcanoes are characterized by concentrated regions of dike injections, called ***rift zones***. A series of experiments using gelatin models was conducted by researchers in 1972 to explain the growth and orientation of Hawaiian rift zones. The "Gelatin Volcanoes" classroom activity was inspired by this work.

This Activity

Gelatin, molded in bowls or bread pans, is used as transparent models of volcanic landforms. Colored water is used as the dike-forming magma. In this activity, dikes tend to propagate radially from the center of bowl-shaped casts of gelatin because the resistance to opening is the same in every direction. Dikes tend to parallel the long-axis of ridge-shaped (bread pan) casts of gelatin because the narrow dimension provides less resistance to opening than the long dimension. The dike opens in the narrow dimension and we see propagation in the long dimemsion. With a slow, steady injection rate, the colored water creates a dike and generally erupts from the flanks or ends of the gelatin casts.

Edge-on, a dike appears as a line. When the gelatin cast is sliced through with a knife, dikes appear as red lines in the vertical, cut edges.

Preparation

Follow the directions listed on the student sheet for preparing the gelatin. Gelatin requires at least three hours of refrigeration to set. Use a warm water bath to free the gelatin from the bowl without getting water on the gelatin itself.

Unflavored gelatin is ideal for this experiment because of its transparency. Sweetened gelatin desserts also work. If you prefer the dessert variety, then use a flavor that is easy to see through, such as lemon. Another alternative is agar. Agar hardens at room temperature, eliminating the need for refrigeration, but it must be made so it is easy to see through.

Two-liter (or two-quart) capacity bowls work very well because the diameter allows enough space for multiple dike injections. This size is large enough for demonstration purposes. Smaller bowls, down to the size of margarine containers, have also been used successfully.

In Class

Make sure a drip tray is placed under the gelatin to catch the colored water that drains out of the fractures. They will remain visible.

Wear protective gloves to keep stains off hands.

The colored water should not be injected too fast. Rapid injection drives the fluid straight up and creats an eruption but ruins the simulation of dike formation.

When slicing the gelatin, choose a direction perpendicular to a dike to show its "line" shape on edge.

Extension

Prepare gelatin in a bread pan and repeat the experiment. The original research by Fiske and Jackson used elongate models with triangular cross-sections.

Reference

Fiske R. S. and Jackson, E. D., 1972, Orientation and growth of Hawaiian volcanic rifts: the effect of regional structure and gravitational stresses, *Proc. R. Soc. London, Ser. A, vol. 329*,

299-326.

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Procedure

1. Prepare gelatin for the volcano model by mixing two cups of cool water with four packages of unflavored gelatin in a large bowl. Stir for 30 seconds. Add six cups of boiling water and stir until gelatin is dissolved. Transfer mixture to a 2-liter bowl, smaller bowls, or bread pans. Refrigerate gelatin at least three hours or until set.

2. Prepare "magma" by mixing water in a glass with enough red food coloring to make a very dark liquid.

Key Words

magma

dike

eruption

volcano

lava

rift zone

Materials

Unflavored gelatin, 28 gm (one-ounce) box containing four packages

Spoon

Bowls or bread pans, either one 2-liter (or 2-quart) capacity, or smaller sizes

Red food coloring, to mix with water in a glass to make "magma"

Syringe for injecting magma, best to use a plastic variety found at pet stores for feeding

3. Loosen the gelatin by dipping the bowl briefly in a larger bowl of hot water.

4. Transfer the gelatin upsidedown to the center of the peg board and lift off the bowl. The gelatin cast will settle somewhat after being removed from the bowl. It should resemble a colorless to milky, shimmering volcano. There should be no cracks in the gelatin, but it's OK to proceed if one develops during unmolding.

5. Place the peg board on top of the two bricks.

6. Fill a syringe with red water. Remove air bubbles from the syringe by holding it upright and squirting out a small amount of water. Air tends to fracture the gelatin.

7. Predict what will happen when red water is injected into the gelatin cast. What direction will it go? What

Peg board, 40 x 60 cm, with 5-mm-diameter holes spaced 2.5 cm apart

Two bricks, 30 cm high

Large knife to cut through the gelatin model

Tray, for collecting drips

Rubber gloves (optional) for protecting hands from food coloring

shape will it take? Will it erupt through the surface of the gelatin? If so, where?

8. Insert the syringe through a hole in the peg board into the center of the gelatin cast. Inject the red water slowly, at a rate of about 20 cc/minute, and watch carefully.

9. Describe how the experimental results compare with your predictions.

10. Refill and insert the syringe as many times as possible. Compare magma migration each time. Are there differences in the direction the magma takes when the syringe is inserted in different parts of the gelatin cast? Describe and explain what you see.

11. Looking directly down on the gelatin cast, sketch the positions and shapes of the magma bodies. Label your drawing "Map View."

12. Use a sharp knife to cut through the gelatin cast. Separate the pieces and examine the cut surfaces. Note the traces made by the magma bodies; these are similar to what we see in highway road cuts or cliff faces.

13. Sketch the positions and shapes of the magma bodies on a cut face. Lable your drawing "Cross-sectional View."

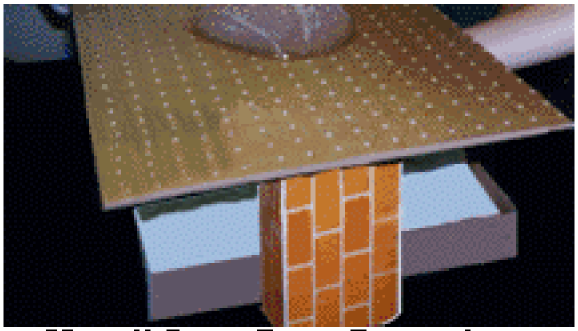
14. Compare what you see in two dimensions on the cut face with what you see in three dimensions looking into the gelatin cast. Which view gives you more information. Why?

15. How and why does magma move through volcanoes?

Extension

1. Repeat the experiment with an elongated model such as a bread pan. Before injecting the magma, try to predict what will happen. What effect does gelatin shape have on magma movement?

Experimental Setup



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