Exploring Volcanic Hazards: Gas and Vog

Overview:

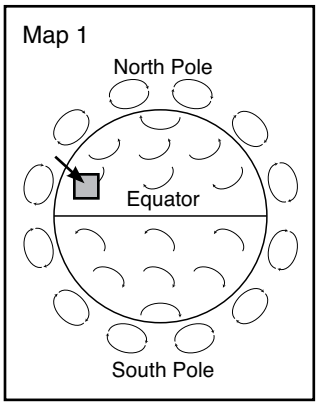
Convection currents can form in the mantle, in the ocean, or in the atmosphere. In the atmosphere, convection currents arise when dense, cold air takes the place of rising warm air. This cycling of warm and cool air produces global and local winds (wind is simply the horizontal movement of air in a convection current). In this activity, students learn about atmospheric convection and explore how global and local wind patterns affect the dispersion of volcanic gas in Hawai'i.

Objectives:

The student will:

- observe that atmospheric convection currents result from a difference in density between warm and cool air;
- observe how convection currents give rise to global and local wind patterns;
- describe how local wind patterns on Hawai'i affect risk from sulfur dioxide gas; and
- calculate how long it will take for gas to reach a town under given conditions.

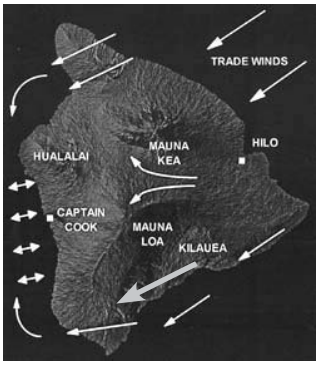
Map 1



Materials:

- 2 Cotton balls
- 2 empty film canisters
- Peppermint extract
- Almond extract (or other extract)
- World globe
- Desk fan
- Transparency: "Atmospheric Convection"
- Student Worksheet: "Tracing the Path of Volcanic Gas"

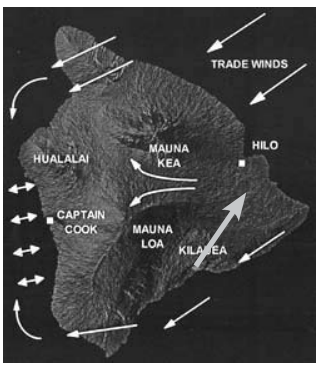
Map 2



Answers to Student Worksheet:

1. see map 1 at right
2. a. Northeast to Southwest
3. see map 2 at right
4. b. Captain Cook
5. see map 3 at right
6. a. Hilo
7. The wind will blow gas towards the island in the day and away from the island at night.
8. Answers will vary, but should include the concept of temperature changing air density.
9. it will take 1/2 hour

Map 3



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Activity Preparation:

Soak a cotton ball with peppermint extract, place it in an empty film canister and close tightly. Repeat this procedure with the almond extract. (Note: some students may be allergic to nut extracts. If this is the case, replace almond extract with another extract: orange, etc.)

Activity Procedure:

1. Ask students how wind might affect the trajectory of ash or poisonous gases emitted from a volcano. Write answers on the blackboard.
2. Use the Transparency: "Atmospheric Convection" to show how convection currents in the air form when temperature changes the density of the air. Explain that, at the global level, the sun heats the Equator more than the poles, which causes warm air to rise at the Equator. Cooler air then rushes from the poles towards the Equator. This causes predictable patterns in wind at the global level.
3. Explain that smaller convection currents can arise at places such as the coasts because the sun heats water and air unequally. This can lead to local wind patterns that differ from global wind patterns.
4. Have students demonstrate how wind can move gases towards populated areas. Ask students to stand in a line that extends across the classroom. Open the canister containing the peppermint extract and hold it one or two feet away from the first student in line. Ask students to raise their hand when they smell the scent. Time how long it takes for the scent to reach the front, middle, and end of the line (Note: the scent may not travel to the end of the line; end the activity after 5 minutes or so.)
5. Repeat this procedure with the almond extract, but first turn on a fan that blows directly towards the line of students. Hold the canister in front of the fan. Time the travel of the scent as above.
6. Ask students which scent reached the last students in line more quickly. Ask what would happen if the odor was gas from a volcano? Would there be more time to flee with wind or no wind? (Note: This demonstration could be done with sticks of incense if a more visual effect is desired.)
7. Distribute the Student Worksheet: "Tracing the Path of Volcanic Gas." Ask students to explore how wind patterns affect the trajectory of volcanic gases.

Name:_____ **Student Worksheet**

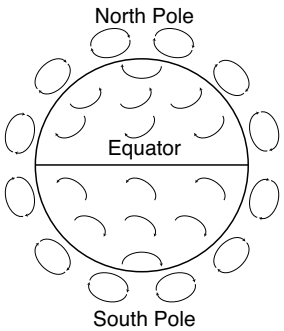
Tracing the Path of Volcanic Gas

Directions: Use the information given by the teacher and in this worksheet to answer the questions.

Background Information: Volcanoes spew not only lava and tephra, but also poisonous gases. Three commonly emitted volcanic gases pose threats to human health: sulfur dioxide, carbon dioxide, and hydrogen fluoride. The effects of these gases can range from respiratory irritation to death, depending on the concentration of gas and local weather patterns such as wind speed and direction.

Kilauea volcano is one of the most active on Earth, emitting up to 2,000 tons of sulfur dioxide gas each day. The gas reacts with sunlight, oxygen, dust, and water to form volcanic smog, or "vog." This activity explores the connection between wind patterns and areas that are at risk from sulfur dioxide released by Kilauea.

Map 1

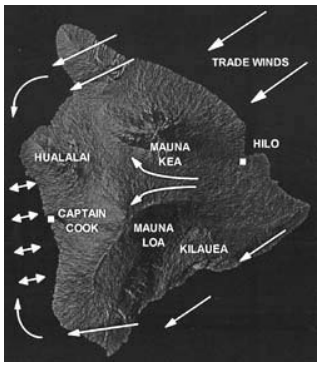


1. Use a world globe to find the location of Hawai'i. Mark the approximate location of Hawai'i on Map 1 (use the Tropic of Cancer and the International Date Line as guides).

2. Look at Map 1 again. The arrows on the map indicate the normal direction of global winds. What is the normal direction of the winds that blow across Hawai'i?

   a. Northeast to Southwest
   b. Southeast to Northeast
   c. Northwest to Southeast

Map 2

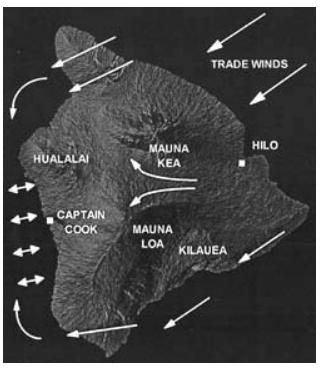


3. The winds on Hawai'i usually blow in the direction shown by the arrows in Map 2. The prevailing global winds are diverted when they hit the landmass of the island, causing the circular pattern shown on the map. Draw the path of gases emitted from Kilauea on Map 2.

4. Look at Map 2 again. Which city or town on Hawai'i will be most affected by the path of the gas?

   a. Hilo b. Captain Cook c. Waimea

Map 3



5. Sometimes the prevailing winds do not blow, and the wind comes from the south (Kona winds). On Map 3, draw the path of the gas under Kona wind conditions.

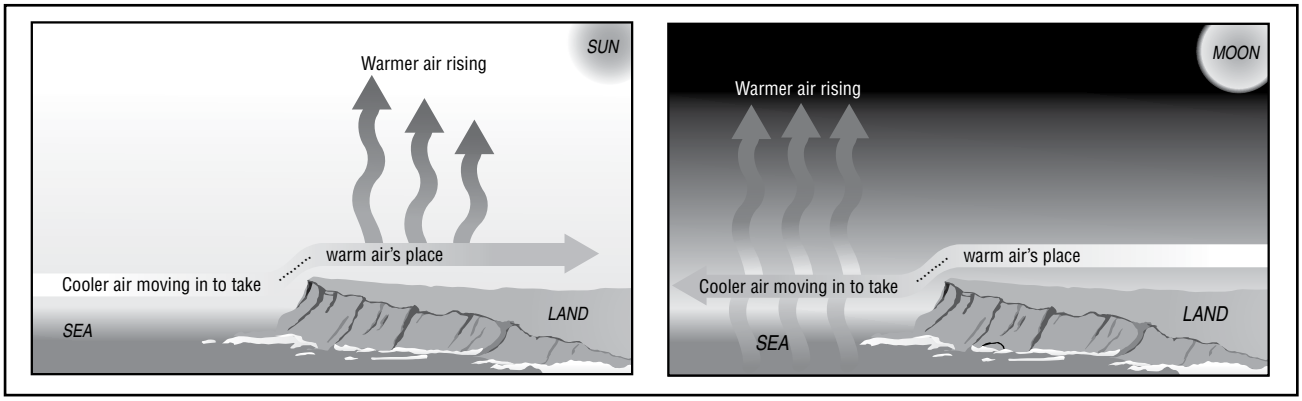
6. Look at Map 3 again. Under Kona wind conditions, which city or town on Hawai'i will be most affected by the path of the gas?

   a. Hilo b. Captain Cook c. Waimea

Name:_____ **Student Worksheet**

Tracing the Path of Volcanic Gas

Figure 1



7. Wind is the horizontal movement of air in a convection current. Look at the differences in air movement during the night vs. the day in Figure 1. Will the wind blow the gases towards or away from the island during the day? How about at night?

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8. Describe why the wind direction is different during the day than in the night.

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9. Imagine that a new volcano on Oahu starts emitting gas. The volcano is located 15 miles NE of the town of Wai'anae. The prevailing winds are blowing at a speed of 30 miles per hour. How long will it take for the gas to reach Wai'anae?

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Show work below.

