Properties of Magma

Reading Preview

Key Concepts

- Why is it helpful to know the physical and chemical properties of a substance?
- What causes some liquids to flow more easily than others?
- What factors determine the viscosity of magma?

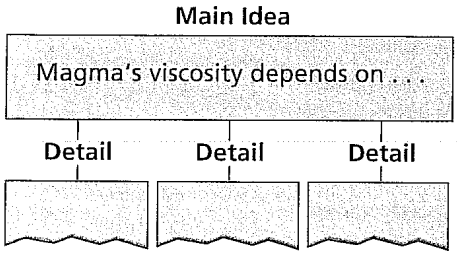
Key Terms

- element
- compound
- physical property
- chemical property
- viscosity
- silica
- pahoehoe
- aa

Target Reading Skill

Identifying Main Ideas

As you read Viscosity of Magma, write the main idea in a graphic organizer like the one below. Then write three supporting details that further explain the main idea.



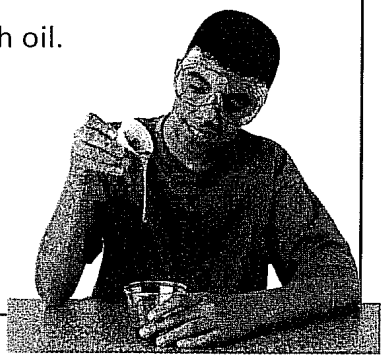
Lab zone Discover Activity

How Fast Do Liquids Flow?

1. Fill one third of a small plastic cup with honey. Fill one third of another cup with cooking oil.
2. Hold the cup containing honey over a third cup and tip it until the liquid begins to flow out of the cup. Time how long it takes from the time the cup was tipped until all the liquid drains out of the cup. Record the time.
3. Repeat Step 2 with the cup filled with oil.

Think About It

Forming Operational Definitions The tendency of a fluid to resist flowing is called viscosity. How did you measure the viscosity of honey and cooking oil? Which had a greater viscosity?



Measured from the bottom of the Pacific Ocean, the Big Island of Hawaii is the largest mountain on Earth. The island is made up of massive volcanoes. One of these volcanoes, Mount Kilauea (kee loo AY uh) erupts frequently and produces huge amounts of lava.

At a temperature of around 1,000°C, lava from Mount Kilauea is very dangerous. Yet most of the time, the lava moves slower than a person can walk—about 1 kilometer per hour. Some types of lava move much more slowly—less than the length of a football field in an entire day. How fast lava flows depends on the properties of the magma from which it formed.

Physical and Chemical Properties

Like all substances, magma and lava are made up of elements and compounds. An **element** is a substance that cannot be broken down into other substances. Carbon, hydrogen, and oxygen are examples of elements. A **compound** is a substance made of two or more elements that have been chemically combined. Water, carbon dioxide, and table salt are familiar compounds. **Each substance has a particular set of physical and chemical properties. These properties can be used to identify a substance or to predict how it will behave.**

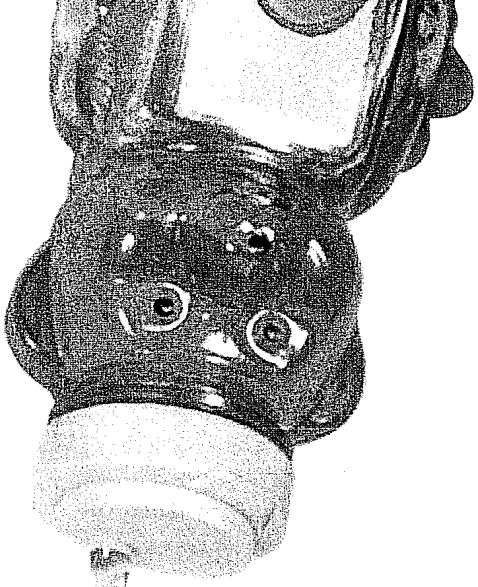


FIGURE 5
Pouring Honey
A liquid with high viscosity, such as honey, pours slowly from its container.
Predicting *If you poured water out of a similar container, how would its behavior differ from the honey? Explain your answer.*

Physical Properties A **physical property** is any characteristic of a substance that can be observed or measured without changing the composition of the substance. Examples of physical properties include density, hardness, melting point, boiling point, and whether a substance is magnetic. A substance always has the same physical properties under particular conditions. Under normal conditions at sea level, for example, water's freezing point is 0°C and its boiling point is 100°C. Between its freezing and boiling points, water is a liquid.

Chemical Properties A **chemical property** is any property that produces a change in the composition of matter. Examples of chemical properties include a substance's ability to burn and its ability to combine, or react, with other substances. You can often tell that one substance has reacted with another if it changes color, produces a gas, or forms a new, solid substance. For example, a piece of silver jewelry darkens when exposed to air. This change indicates that silver has reacted with oxygen to form tarnish. The ability to react with oxygen is a chemical property of silver.

Reading Checkpoint **Is the boiling point of a substance a physical property or a chemical property?**

What Is Viscosity?

When you pour yourself a glass of milk, you are making use of a familiar physical property of liquids. Because particles in a liquid are free to move around one another, a liquid can flow from place to place. The physical property of liquids called **viscosity** (vis KAHS uh tee) is the resistance of a liquid to flowing. **Because liquids differ in viscosity, some liquids flow more easily than others.**

The greater the viscosity of a liquid, the slower it flows. For example, honey is a thick, sticky liquid with high viscosity. Honey flows slowly. The lower the viscosity, the more easily a liquid flows. Water, rubbing alcohol, and vinegar are thin, runny liquids with low viscosities.

Why do different liquids have different viscosities? The answer lies in the movement of the particles that make up each type of liquid. In some liquids, there is a greater degree of friction among the liquid's particles. These liquids have higher viscosity.

Reading Checkpoint **Why do liquids differ in viscosity?**

Go Online
SCILINKS NSTA
For: Links on volcanic eruptions
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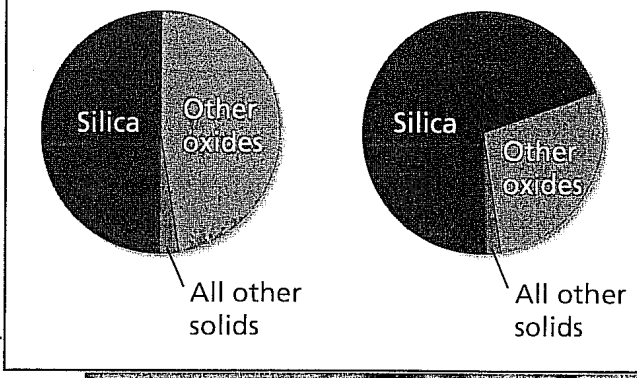
Math Analyzing Data

Magma Composition

Magma varies in composition and is classified according to the amount of silica it contains. The graphs show the average composition of two types of magma. Use the graphs to answer the questions.

1. **Reading Graphs** Study both graphs. What materials make up both types of magma?
2. **Reading Graphs** Which type of magma has more silica? About how much silica does this type of magma contain?
3. **Estimating** A third type of magma has a silica content that is halfway between that of the other two types. About how much silica does this magma contain?
4. **Predicting** What type of magma would have a higher viscosity? Explain.

Types of Magma



Viscosity of Magma

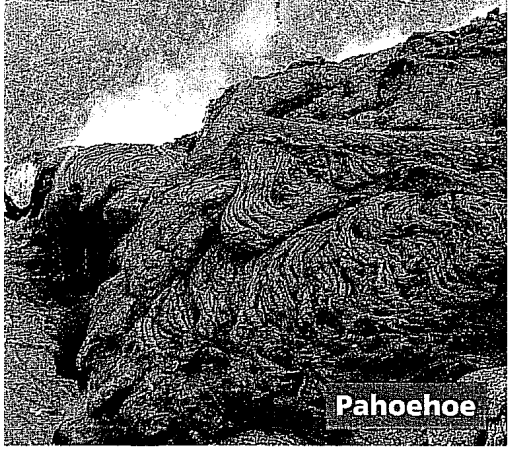
At the extremely high temperatures and pressures inside Earth, mantle rock sometimes melts to form magma. Surprisingly, the properties of magma can vary. For example, not all types of magma have the same viscosity. **The viscosity of magma depends upon its silica content and temperature.**

Silica Content Magma is a complex mixture, but its major ingredient is silica. The compound **silica** is made up of particles of the elements oxygen and silicon. Silica is one of the most abundant materials in Earth's crust. The silica content of magma ranges from about 50 percent to 70 percent.

The amount of silica in magma helps to determine its viscosity. The more silica magma contains, the higher its viscosity. Magma that is high in silica produces light-colored lava that is too sticky to flow very far. When this type of lava cools, it forms the rock rhyolite, which has the same composition as granite.

The less silica magma contains, the lower its viscosity. Low-silica magma flows readily and produces dark-colored lava. When this kind of lava cools, it forms rocks like basalt.

FIGURE 6
Sampling Magma
A geologist samples magma from a lava flow in Hawaii.



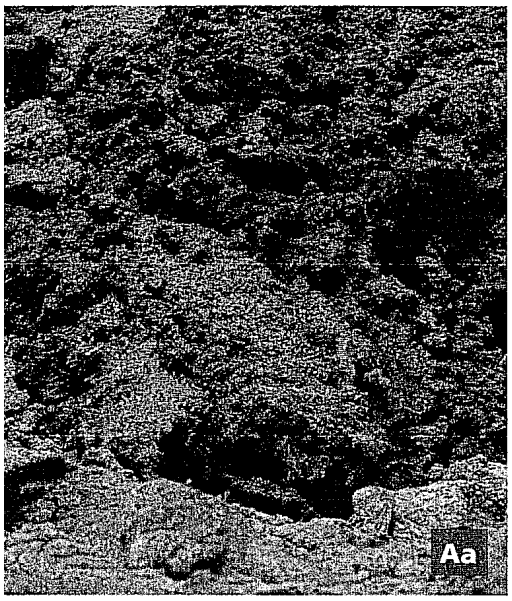


FIGURE 7
Pahoehoe and Aa
Both pahoehoe and aa can come from the same volcano. Pahoehoe flows easily and hardens into a rippled surface. Aa hardens into rough chunks. **Inferring** *Which type of lava has lower viscosity?*

Temperature How does temperature affect viscosity? Viscosity increases as temperature decreases. On a hot day, honey pours easily. But if you put the honey in the refrigerator, its viscosity increases. The cold honey flows very slowly.

The temperature of magma and lava can range from about 750°C to 1,175°C. The hotter the magma is, the lower its viscosity and the more rapidly it flows. Cooler types of magma have high viscosity and flow very slowly.

In Figure 7, you can see how temperature differences produce two different types of lava: pahoehoe and aa. **Pahoehoe** (pah HOH ee hoh ee) is fast-moving, hot lava that has low viscosity. The surface of a lava flow formed from pahoehoe looks like a solid mass of wrinkles, billows, and ropelike coils. Lava that is cooler and slower-moving is called **aa** (AH ah). Aa has higher viscosity than pahoehoe. When aa hardens, it forms a rough surface consisting of jagged lava chunks.

Reading Checkpoint **How hot are magma and lava?**

Section 2 Assessment

Target Reading Skill **Identifying Main Ideas** Use your graphic organizer to help you answer Question 3 below.

Reviewing Key Concepts

1. a. **Defining** What is a physical property?
   b. **Defining** What is a chemical property?
   c. **Classifying** Magma is a hot, liquid mixture that changes to solid rock when it cools and hardens. Which of these characteristics are physical properties?
2. a. **Identifying** What is viscosity?
   b. **Applying Concepts** Which has a higher viscosity, a fast-flowing liquid or a slow-flowing liquid?
   c. **Inferring** What can you infer about the amount of friction among the particles of a liquid that has low viscosity?
3. a. **Reviewing** What two main factors affect magma's viscosity?
   b. **Predicting** A lava flow cools as it moves away from the vent. How would this affect the surface appearance of the lava flow?

Lab zone **At-Home Activity**

Cooling Lava Place cold water in one cup and hot tap water in another. Ask members of your family to predict what will happen when melted candle wax drops into each cup of water. Have an adult family member drip melted wax from a candle into each cup. **CAUTION:** *Handle the lit candle carefully.* Explain how this models what happens when lava cools quickly or slowly.