

Measuring Magma Chamber Changes

Overview:

Scientists often measure the width of a caldera on top of a volcano to determine changes in the magma chamber beneath it. This width can be measured with EDM (electronic distance measurement), which uses laser light to measure the distance between two points. The distance between points on a volcano becomes larger with inflation and smaller with deflation. Using a balloon, students learn how inflation and deflation of a magma chamber causes ground movement, which can affect the surface of a volcano.

Objectives:

The student will:

- hypothesize how magma chamber changes will impact the distance between two points across a caldera;
- understand how magma pressure affects the area around a volcano;
- understand how EDM (electronic distance measurement) works; and
- understand why distance measurements are taken across calderas.

Materials:

- Balloons (light colored) or weather balloon
- String
- Rulers
- Markers
- Carpenter's electronic ruler or Calculator Based Ranger (CBR) (optional)
- Student Worksheet: "Volcano Measurements"

Answers to Student Worksheet:

Analysis of Data:

1. As the balloon is inflated, the distance across it becomes greater. This increase in volume causes the lines to spread apart. This is an example of how a volcano inflates when magma moves into a magma chamber.
2. True

Conclusion:

If the volume of magma in a volcano's magma chamber increases, then distance across the volcano's caldera will increase. Other answers will vary.

Further Questions:

1. c) The level of magma is decreasing.
2. Electronic Distance Measurement (EDM)

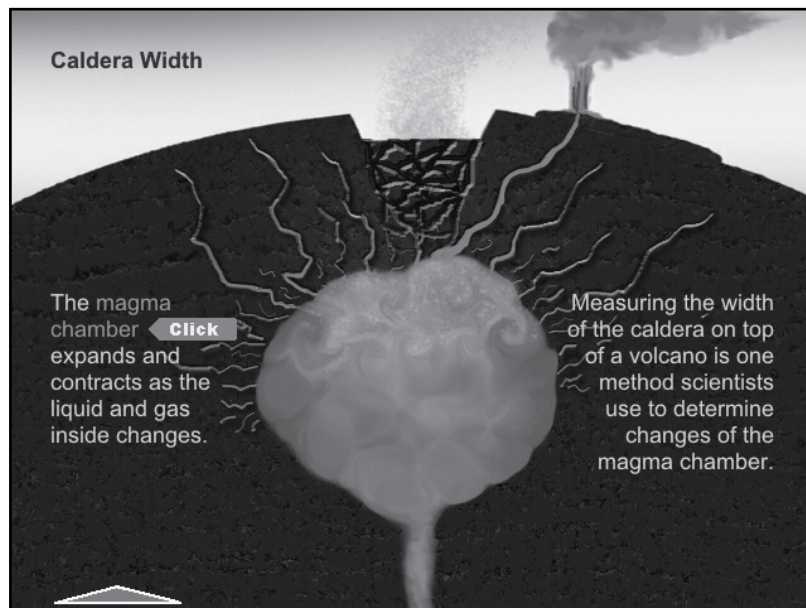
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Activity Procedure:

1. Remind students that a caldera is a large crater formed when the top of a volcano collapses. The amount of magma inside a magma chamber can rise and fall. When magma increases, the chamber inflates. Ask students how this might affect the distance across a caldera. After an eruption, the magma chamber deflates. Ask students how this might affect the distance across a caldera. Measuring caldera width is one method scientists use to monitor volcanic activity.
2. Distribute the Student Worksheets: “Volcano Measurements” to each student. Ask students to read the Testable Question and Background Information then compete their hypotheses.
3. Ask students to divide into groups. Distribute a balloon, marker, ruler and string to each group. Ask one student in the group to inflate the balloon (to reduce the spread of germs). Ask another student to use a marker to draw on the balloon, a third student to make the measurements described on the Student Worksheet and a fourth student to record data. Ask students to complete the experiment described on the worksheet, and answer the questions.
4. Follow up class discussion questions:
 - a) What happened to the distances between the lines when the balloon was inflated?
 - b) What would happen to the distances between the lines if the balloon was deflated to 3/4 of its largest volume?

Optional Demonstration:

Demonstrate an electronic carpenter’s ruler or CBR. Carpenter’s rulers and CBRs use ultrasound and have limited ranges. EDMs use a laser light to measure distance and can measure great distances.



Volcano Measurements

Testable Question:

How does a change in the volume of magma in a magma chamber affect the distance between two points across a caldera?

Background Information:

A caldera is a large crater formed when the top of a volcano collapses. Caldera width changes as the volume of magma in the volcano's magma chamber changes. When magma increases, the chamber inflates. After an eruption, the magma chamber deflates. Measuring caldera width is one method scientists use to monitor volcanic activity. Scientists often use an Electronic Distance Measurement (EDM) to measure caldera width. This instrument measures the time it takes for a laser to travel across a caldera and be reflected back.

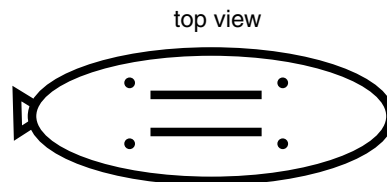
Hypothesis:

In this activity you will determine how an increase in the volume of magma in a magma chamber affects the distance between two points across a caldera. A balloon will be used as a model for the magma chamber and volcano surface. Complete the hypothesis below.

If the volume of magma in a volcano's magma chamber increases, then the distance between two points across the volcano's caldera will _____.

Materials:

- Balloon
- String
- Ruler
- Marker



Procedure:

1. Inflate a balloon *halfway*. Keep the neck of the balloon pinched closed so that air does not escape.
2. With a marker, draw two closely spaced lines and four dots on the balloon as shown in the diagram. These lines and dots represent the edges of a caldera. Ensure the marks are not too close to the neck of the balloon.
3. Measure (a) the length of the lines, (b) the distance between the lines at the center, (c) the distance between the dots near the end of the balloon, and (d) the distance between the dots near the opening.
4. Record this data in the table.
5. Inflate the balloon *fully* then repeat steps 3 and 4.

Volcano Measurements

Data:

Record your measurements in the data table below.

Measurement	Partially Inflated	Fully Inflated
(a) Length of lines		
(b) Distance between lines (at center of balloon)		
(c) Distance between dots nearest the end		
(d) Distance between dots nearest the balloon opening		

Analysis of Data:

1. Did the lines increase or decrease in length as the balloon was inflated? Why?

2. True or False: A magma chamber can inflate or deflate, somewhat like a balloon.

Conclusion:

Write your conclusion as a complete sentence on the lines below.

Was your hypothesis proved or disproved? Explain your answer.

Further Questions:

1. When the distance between two points across a caldera decreases, what does it reveal about the level of magma in the magma chamber below the caldera?
 - a) The level of magma is remaining constant.
 - b) The level of magma is increasing.
 - c) The level of magma is decreasing.
2. _____ is an instrument used to measure caldera width by measuring the time it takes for a laser to travel across a caldera and be reflected back.