

Water Tube Tiltmeters

Overview:

In addition to changing the distance across a caldera located at the top of a volcano, magma chamber inflation and deflation changes the shape of the volcano surface in three dimensions. For example, Mauna Loa is experiencing deformation on the side of the volcano. Tiltmeters can be used to measure the amount of change in slope on the volcano surface. In this lesson, students will build a simple water tube tiltmeter to measure changes in slope.

Objectives:

The student will:

- build a water tube tiltmeter;
- calibrate a tiltmeter;
- measure slope using a tiltmeter; and
- understand how tiltmeters are used to monitor volcanoes.

Materials:

- Carpenter's level
- Balloon
- Meter stick
- Clear tape
- Cardboard
- Ruler
- Protractor
- Washer
- String
- Clear flexible tubing (5/16" diameter, cut to 16 1/2" of tubing per tiltmeter)
- Small funnel (optional)
- Food coloring (optional)
- Student Information Sheet: "Build a Tiltmeter"
- Student Information Sheet: "Tiltmeter Template"
- Student Worksheet: "Water Tube Tiltmeters"

Answers to Student Worksheet:

Data table answers will vary

1. a) slope
2. c) to find how changes in magma chamber volume affect the volcano surface

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Activity Procedure:

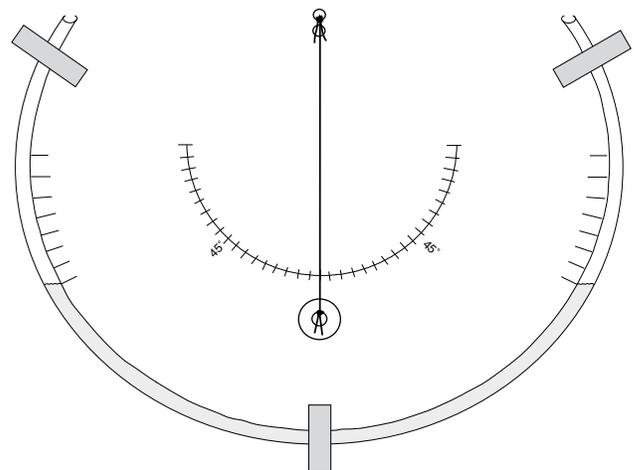
1. Build a tiltmeter so students can see what the final product looks like before they begin this activity. Cut plastic tubing for all tiltmeters to appropriate lengths if necessary.
2. Show students a carpenter's level and ask how it works. Secure the carpenter's level to a meter stick. Place one end of the meter stick on a stack of books and place a partially inflated balloon under the other end. Inflate and deflate the balloon. Ask students to observe what happens to the carpenter's level when the volume of the balloon changes. Explain that the level is measuring tilt. When the volume of magma in a magma chamber changes, the elevation on the surface of the volcano also changes. A tiltmeter can be used to measure change in elevation around a volcano.

Note: Water tube tiltmeters are able to detect changes of less than one microradian, which is approximately the change in slope of a 1 kilometer-long bar if it is raised the width of a dime at one end. Tiltmeter measurements can be taken regularly over long periods of time to determine the change in tilt around a volcano.

3. Explain that students will build a simple water tube tiltmeter and calibrate it using a protractor. Distribute the Student Information Sheets: "Build A Tiltmeter" and review the instructions. Distribute all materials and ask students to build, calibrate, and use their tiltmeters to find the degree of tilt (slope) of surfaces around the classroom. Add food coloring so the water will be easier to see.
4. After students are finished, ask how accurate they think their tiltmeters were. Explain that the ones used at volcano observatories work on the same principle, but are able to detect very small changes in the water level. Distribute the Student Worksheet: "Water Tube Tiltmeters" and ask students to answer all questions.

Follow-up Class Discussion Questions:

- a) What problems exist with the water tube tiltmeter?
 - b) What would happen if the tiltmeter were perpendicular to the magma chamber? Demonstrate this with the carpenter's level and books.
 - c) How could this problem be solved?
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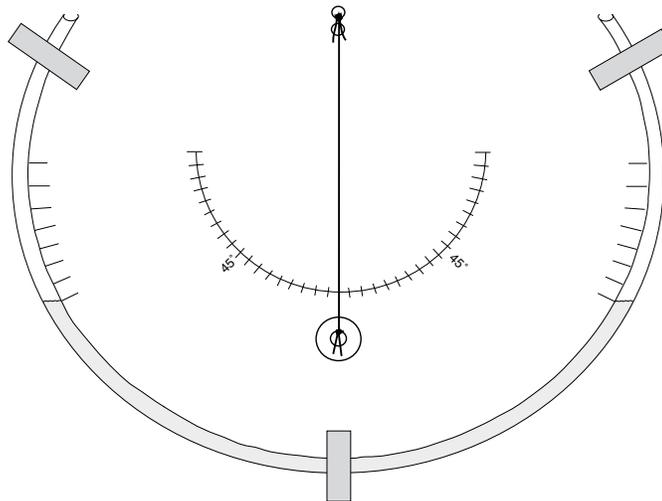


Build a Tiltmeter

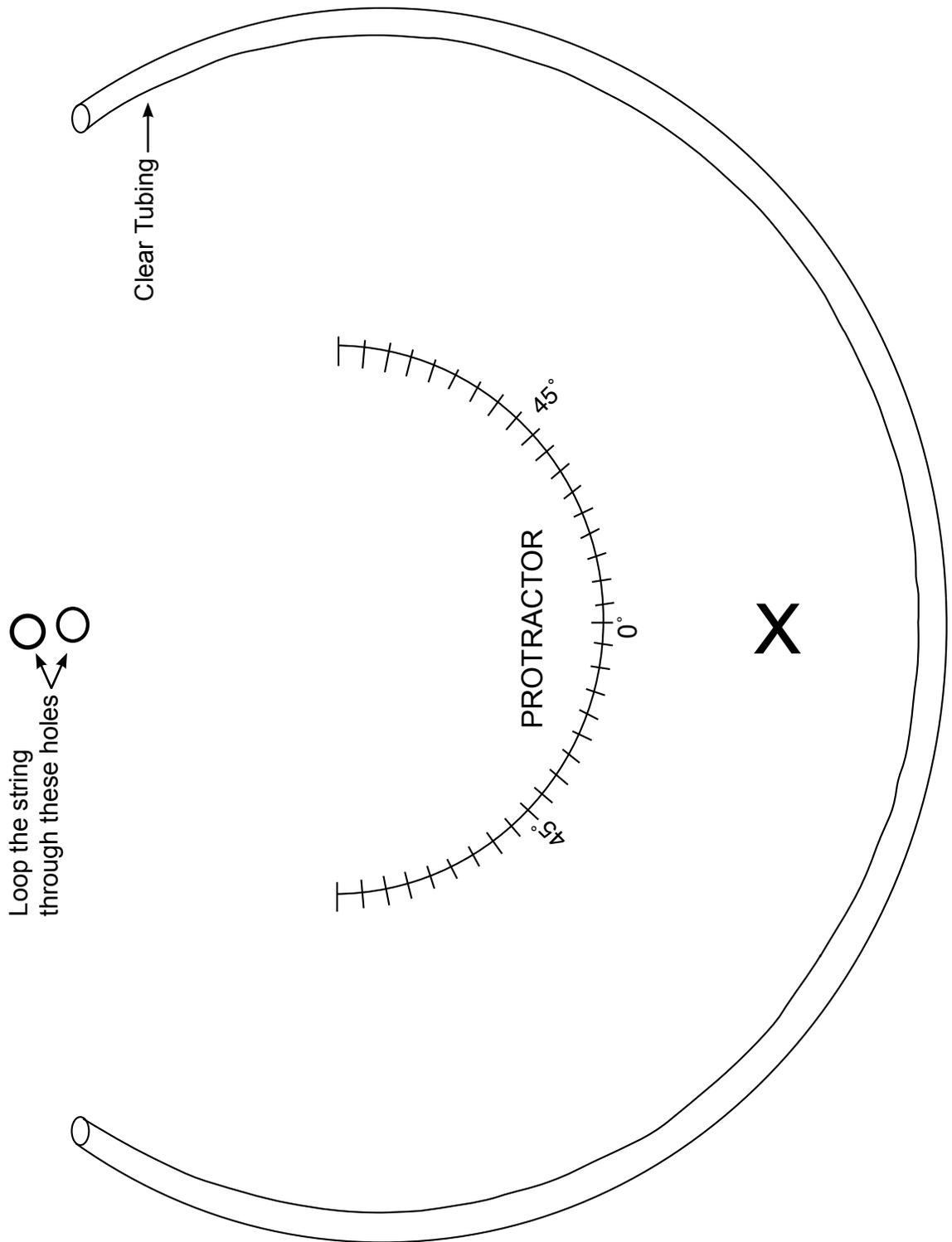
Directions: Measuring the change in elevation around a volcano can help scientists determine if there is a change in the amount of magma in the magma chamber. Tiltmeters are instruments used to measure the change in elevation or slope on the surface of a volcano. Use these directions and the Tiltmeter Template to build and calibrate a simple water tube tiltmeter.

Procedure:

1. Tape the Tiltmeter Template to an 8.5" x 11" piece of cardboard.
2. Tie one end of a string to a washer and the other end of the string to the cardboard. Loop the string through the top holes and let the washer extend to the X marked on the template.
3. Tape the clear tubing to the cardboard at one end and the middle. Fill the tubing with water so it is 3 to 4 inches below the top, then tape the free end down.
4. Let the washer hang straight down to 0 degrees on the protractor. Mark a point on the scale next to the water level in the tube on both sides to show where the tiltmeter is level.
5. Use the protractor to calibrate the tiltmeter by marking points on the water tube scale that correspond to 5, 10, 15, 20 and 25 degrees in both directions.
6. Remove the string and washer.



Tiltmeter Template



Name: _____

<h2>Water Tube Tiltmeters</h2>

Using the Tiltmeter: Use the tiltmeter to find slopes around the classroom. Record where measurements were taken and the degree of tilt in the data table below.

Data Table:

Location	Degree of tilt

After completing the activity, answer the questions below.

1. What does a tiltmeter measure?
 - a) slope
 - b) circumference
 - c) distance
 - d) lava temperature

2. Why would a scientist studying eruptions use a tiltmeter?
 - a) to find the depth of a caldera
 - b) to find the temperature of lava as it erupts from the volcano
 - c) to find how changes in magma chamber volume affect the volcano surface
 - d) to find the distance between two points on the volcano surface