

# Volcanoes Erupt

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**Science Content Standards:** Grade 6, 1d *Students know* that earthquakes are sudden motions along breaks in the crust called faults and that volcanoes and fissures are locations where magma reaches the surface; and 1e *Students know* major geologic events, such as earthquakes, volcanic eruptions, and mountain building, result from plate motions.

**Lesson Concept:** Volcanoes occur as a result of hot molten rock and extreme pressure.

## Conceptual Flow:

- ▶ Plate Tectonics – the Earth’s plates are in constant motion. Convection currents drive plate tectonics. The tectonic plates of the lithosphere move in relation to each other.
- ▶ Heat creates pressure and pressure creates heat in an enclosed space. The magma of molten rocks and gases pushes upward and is forced out forming a volcano.
- ▶ Volcanoes occur as a result of hot molten rock and extreme pressure.
- ▶ Where do volcanoes occur? Volcanoes occur around plate boundaries. Earthquakes and volcanic eruptions are a result of plate movement.
- ▶ How are volcanoes formed?
  - As matter is heated, it expands and becomes relatively less dense than the same matter that is cooler.
  - In an enclosed space that contains high pressure matter, the matter will rapidly exit the space; the higher the pressure the faster the exit.
  - The high pressure environment of the Earth’s interior will result in the rapid escape of molten rock if a crack occurs in the Earth’s crust.
  - Convection currents in the Earth bring hot molten rock to just beneath the Earth’s crust.
  - If matter is heated in an enclosed space, pressure in that space will increase.
  - Increasing pressure inside an enclosed space will make matter inside the space hotter.
  - As liquid matter under high pressure escapes from a high pressure situation, it will expand, cool and then solidify.

**» Parts of the Volcano**

- Magma, vent/side vent, magma chamber crater, pipe

**» Shapes of Volcanoes**

- There are four basic shapes of volcanoes: island arcs, cinder cone, composite cone, and shield cone.

**Teacher Background:**

Much of the magma in Earth is produced 100-200 kilometers below the surface. Earth's heat comes from (1) radioactive decay and (2) residual heat which is gravitational energy left over from Earth's formation. The hot, moving mantle, consisting of melted rocks and minerals, is responsible for many geologic events, including most seismic and volcanic activity. As a result of the relative motion of the lithospheric plates, the boundaries of the plates are subjected to stresses. Volcanic phenomena, including explosive eruptions and lava flows, may also result from interactions at the boundaries between plates. Molten gas-charged magma generated in the crust or mantle rises buoyantly and exerts an upward force on Earth's surface. If these rocks and gases punch through the surface, they result in a variety of volcanic phenomena.

Most (but not all) volcanic eruptions occur along plate boundaries where the plates are moving relative to one another. Volcanic eruptions may occur along faults in which one plate slides under another and sinks deep enough to melt part of the descending material. This process of one plate sliding under another is called subduction. (Adapted and excerpted from the *Science Framework for California Public Schools: Kindergarten Through Grade Twelve*.)

**Materials Needed for the Lesson:****Teacher Materials**

- Pictures of volcanoes (check student texts)
- Video clip on "Volcanoes" from *The Earth Inside and Out* produced by Discovery School for grades 6-12 (Elements of Earth Science series) ISBN 1-59527-398-0.
- Microwave to heat up the model magma
- How to make the magma for the model magma: Use 7 cups of hot water, add glue, paint, and borax. Stir well.
  - 40% white glue
  - 53% water
  - 6% red acrylic (or tempera) paint
  - 1% borax/ascorbic acid (optional)

Note: The model magma containers for each group of students are made up of two sets of two round plastic containers (e.g., Gladware, Tupperware), one slightly larger than the other. One set is for the cool magma and one set is for the heated magma. The smaller

containers should each have a hole drilled into the bottom. The larger container will be  $\frac{1}{4}$  full with the model magma. Students will place the smaller container (with the hole) on top of the magma and place a 2 cm layer of soil into it. Then they will force the smaller container down into the “magma.” Since the soil container has a hole drilled into it at the bottom, when the two are squeezed together the “magma” comes through the soil. This demonstration works best, when the magma is heated.

### Student Hands-on Materials

For each pair of students

- Sticky notes

For each group of four students

- Two small containers for the model magma; one should fit easily into the other with less than one-half inch space between the two; make a pencil sized hole in the bottom of the smaller container
- $\frac{1}{4}$  cup of soil for model magma
- Tube of red colored toothpaste (check Dollar Stores)
- Compass with sharp point or a large nail
- Paper towels

### Student Handouts

- Toothpaste Eruption (one per student)

## 5E Lesson: Volcanoes Erupt

Teacher Does	Student Does	Concept
<p><b><u>ENGAGE:</u></b></p> <p>▶ <i>Hold your breath. What happens after you hold it awhile? Why do you have to let it out? Your lungs are kind of like a volcano in that when too much pressure builds up, you explode the air (carbon dioxide) out of your lungs.</i></p> <p><b>Show picture of an exploding volcano.</b></p> <p>▶ <i>Discuss with a partner “What causes a volcano to erupt?” With your partner, write an explanation explaining what causes a volcano to erupt on a sticky note.</i></p> <p><b>Choose several sticky notes to share with the class.</b></p>	<p>You have to let it out.</p> <p>There gets to be too much pressure inside your lungs.</p> <p><b>Expected Student Response (ESR):</b> Earthquakes, fire comes out of the Earth; plate tectonics</p>	<p>Plate Tectonics – the Earth’s plates are in constant motion. Convection currents drive plate tectonics</p>

Teacher Does	Student Does	Concept
<p><b>“Model Magma”</b>  <i>We are going to show two models of magma flow.</i></p> <p>Put the soil container into the Model Magma container. Then hold the container in both hands. Slowly press down for only a few seconds. Show students what has happened.</p> <ul style="list-style-type: none"> <li>▶ <i>What do you observe?</i></li> </ul> <p>Have few students share their observations.</p> <p>In small containers provide model magma (one per four students) for students to press and observe. Make a picture of the model magma under pressure.</p> <ul style="list-style-type: none"> <li>▶ <i>Continue to push the container of soil down into the container of Model Magma until you cannot press down any more. What do you observe?</i></li> <li>▶ <i>On a sticky note write what you observe.</i></li> <li>▶ <i>What caused the magma to break through the surface of the Earth?</i></li> </ul> <p><b>Collect the “cooler magma” and distribute hot magma (heated in the microwave) for the students to observe.</b></p> <ul style="list-style-type: none"> <li>▶ <i>Repeat the above process with the hot Model Magma. What do you observe?</i></li> <li>▶ Discuss student observations.</li> </ul>	<p><b>ESR:</b> A big bulge in the dirt.</p> <p><b>ESR:</b> the magma is coming up through the dirt.</p> <p><b>ESR:</b> The pressure and the heat.</p> <p><b>ESR:</b> When I was pushing down, that created pressure and pushed the magma up. The heated magma was able to break through the soil. The heated magma was more runny and was able to spread into the thin cracks in the soil.</p>	

Teacher Does	Student Does	Concept
<p><b><u>EXPLORE:</u></b></p> <ul style="list-style-type: none"> <li>▶ <i>Now we are going to have you investigate the effects of heat and pressure on any substances including molten rock.</i></li> <li>▶ <i>What are some ways to put pressure on things?</i></li> <li>▶ <i>What happens to things when they are heated?</i></li> </ul> <p><b>After the Model Magma; do the toothpaste activity.</b></p> <p>Give each set of four students a tube of red colored toothpaste and paper towels.</p> <ul style="list-style-type: none"> <li>▶ <i>The tube represents the lithosphere of the Earth and the toothpaste inside represents the molten magma under the lithosphere.</i></li> <li>▶ <i>Press all the toothpaste to one end, causing great pressure on the “magma” inside the tube. While applying great pressure, use the sharp point on your compass or nail to poke a hole in the “lithosphere” (the tube) and observe what happens.</i></li> <li>▶ <i>The toothpaste container is compared to the Earth, the erupting toothpaste can be compared to hot magma. Magma is moved by strong heat and pressure. If the magma finds a crack or a fault line in the crust, it erupts through the surface and releases the pressure.</i></li> </ul> <p>Distribute the “Student Handout” and ask students to complete it.</p>	<p><b>ESR:</b> Squeezing it, put something heavy over it in a closed area.</p> <p><b>ESR:</b> Water evaporates; metal melts into molten; it gets hot</p> <p>Press on the toothpaste. Poke with a sharp point of the compass.</p> <p>Complete the “Student Handout.”</p>	<p>Heat creates pressure and pressure creates heat in an enclosed space.</p>
<p><b><u>EXPLAIN:</u></b></p> <p>Show video clip.</p> <ul style="list-style-type: none"> <li>▶ <i>How do these experiments help you explain what causes volcanoes to erupt?</i></li> </ul>	<p><b>ESR:</b> Hot molten rock is forced up through the Earth due to heat and pressure and that pressure is released through cracks in the Earth’s crust.</p>	<p>Volcanoes occur as a result of hot molten rock and extreme pressure.</p>

Teacher Does	Student Does	Concept
<p><b><u>EXTEND:</u></b>                      Volcanoes are like cans of soda. Some erupt violently; others more gently.                      Volcanoes form over a weak spot in the Earth’s crust.                      Volcanoes occur along subduction zones.                      Volcanoes occur at spreading centers.</p> <p><b><u>EVALUATE:</u></b>                      Review student responses in “Student Handout” and assess each student’s answer to the last question, “How is this exploding toothpaste tube like a volcano?”</p>		

**Input Question:** What do you observe? (in “Engage” section) List or describe your observations.

**Process Question:** How do these experiments help you explain what causes volcanoes to erupt? (in “Explain” section)

**Output Question:** From what we have learned about how matter acts under pressure, what other examples can you share?

**STUDENT HANDOUT**

# **Toothpaste Eruption**

What happens to a tube of toothpaste when it is under pressure?

**Hypothesis:**

**Procedure:**

- 1.
- 2.

**Conclusion:**

Illustrate what happened:

**Before**

**After**

How is this exploding toothpaste tube like a volcano?

