Demonstration #1 - PRESSURE: inflating balloons

Pressure drives volcanic eruptions. Even in small eruptions, pressure throws blobs of magma and large solid blocks hundreds of meters from the volcanic vent.

The pressure builds up below the surface; it can be caused by molten magma moving upward within the volcano, or by gas dissolved in the magma. This is an example of **positive pressure.**

Pressure also creates magma froth (like froth on boiling milk or bubbly soda). The bubbles form when magma moves from regions of high pressure (deep) to regions of low pressure (shallow). Think about taking the top off of a bottle of Coca Cola (we will use this example a lot today); this is an example of **negative pressure.**

In this activity we will generate pressure mixing baking soda with vinegar to make gas (CO_2; this is also an important gas in volcanoes). Because gas expands, it creates enough extra pressure to inflate a balloon, in the same way that gas formed from magma makes the bubbly pieces of rock.

Materials:

- Vinegar
- Baking soda or powder
- Table spoon
- Balloons
- Empty bottle
- Optional: additional bottles and balloons (depends on # of students/how many demos you want to do at once)

Instructions for Demonstration #1:

1. Ask the students if they can inflate a balloon without blowing into it.

2. Divide the group into smaller groups around each soda bottle.

3. Have them put 2 heaped tablespoons of baking powder into the balloons.

4. Add about ½ cup of vinegar into the plastic bottle.

5. Put the balloon over the top of the bottle, taking care that none of the baking soda gets into the bottle of vinegar.

6. When you are ready, hold the neck of the balloon tightly onto the bottle and dump the baking soda into the bottle from the balloon. This will cause the balloon to fill while still attached to the bottle.

Demonstration #2 - VISCOSITY: Sticky or runny lava?

Viscosity is a word that describes how liquids flow. You know from your own experience that if you spill a glass of water (or soda), the water flows quickly across the table top and ends up on the floor! If you spill a jar of honey, however, it makes more of a mess but flows much more slowly toward the floor, especially if it is cold. We say that honey has a higher *viscosity*.

In the same way, basaltic lava flows travel quicker (kilometres per hour) than obsidian (rhyolite) lava flows (a few meters per hour) because rhyolite has a higher viscosity than basalt (by a factor of more than 1,000,000! That is the same as the difference in viscosity between air and honey. Imagine how hard life would be if you had to walk through honey every day). The difference in viscosity also makes the lava flows look very different: Basalt lava flows are both small and thin. Rhyolite flows are large and thick.

In this activity you will learn more about viscosity by experimenting with different common liquids: water, dish soap, and honey. To measure the relative viscosities of these liquids you will drop a bead in each fluid and measure the time it takes to fall to the bottom of a glass. The slower the bead falls, the higher the viscosity of the liquid. In fact, we can be even more scientific about this: if the bead takes twice as long to fall in fluid number 1 than in fluid number 2 (for example), then the first fluid is twice as viscous as the second!

Materials:

- 3 large clear glasses
- 3 stopwatches
- beads
- 2 bottles of dish soap—two different colours
- water

Instructions for Demonstration #2:

1. Assemble 3 large clear glasses or cylinders on the table and fill each with a different liquid (dish soap, water, mixture of [different coloured] dish soap and water) to near the top of each glass. The glasses should be in order of increasing viscosity—the mixture of dish soap and water may need some experimenting.

2. Ask the students what they know about lava flows and how quickly they move. Hopefully they will say that some move quickly and others move slowly. Ideally, show them images of basalt and rhyolite to support the conversation.

3. Ask them if they know how to describe this difference in how they flow, and introduce the word "viscosity". Describe the concept by asking them about the three fluids on the table.

Which flows most quickly if spilled? Which flows the most slowly? Have them predict which is most viscous and which is least viscous first.

4. Introduce the notion of doing an experiment to test their guess about how fluid viscosity.

5. Hand 3 students one bead each, and have them hold the bead at the same height above each of the three glasses.

6. Give another student the timer/stopwatch, and ask that student to give a start signal for the 3 bead-holders to drop their beads into the glasses. Have the timer start the stopwatch when they drop the beads, and estimate the time that each bead hits the bottom of the glass. Even if the timer doesn't work, just ask the students which fluid allowed the bead to move quickest (this is the least viscous) and which allowed the bead to fall the slowest (this is the most viscous). You may have to move around the dish soap glass a bit to break the surface tension, allowing the bead to sink.

7. Bring the conversation around to the lava flows in the images: ask the students to decide now which is least viscous (basalt) and which is most viscous (rhyolite). You can even discuss potential hazards posed by each type of flow as well (which would be easier to walk away from, for instance, which will take longest to move across a certain distance?

Demonstration #3 - Super strong bubbles drive eruptions

During volcanic eruptions, magma rises to the surface because gas bubbles form. At this station, you will learn about the power of bubbles! You will also explore differences between slow non-explosive bubble formation and rapid bubble formation; you will watch bubbles float raisins.

Basaltic eruptions have low lava fountain caused by bubble formation close to the surface and large 'Plinian" eruptions go way up in the atmosphere because of rapid bubble formation way below the surface.

In this activity you will see how strong bubbles are (did you know that bubbles were strong?). How will you do this?

First put some ginger ale in a glass. Note that the ginger ale forms bubbles (why?). Now drop a raisin in the ginger ale and watch what happens. Does the raisin float or sink? Now watch the surface of the raisin: the surface is all wrinkly, and you should see little bubbles forming on the wrinkles. Now keep watching. Are the bubbles that are attached to the raisin starting to grow?

Is the raisin dancing? Floating? If your raisin starts to float, what happens when it reaches the surface of the ginger ale? Does it start to sink again? Why do you think this happens?

Materials:

- raisins
- 2.5 L bottle of light coloured ginger ale or lemonade (fizzy)
- 1 clear glass

Instructions for Demonstration #3:

1. Ask the students what they know about bubbles (round, vary in size, can pop, etc.). Ask them if they realize bubbles are strong? Explain that you will show this to them. A bubble is strong enough to lift a raisin in a glass.

2. Pour fizzy drink in a clear glass until it is ¾ full. At this point, ask students to make note of the bubbles, and what's inside them (CO2).

3. Now have 1 student/glass pick up a raisin. Ask them whether they think the raisin will float or sink in the glass.

4. Have students drop the raisins into the fizzy drink, and encourage students to make observations about the surface of the raisin. The surface will have lots of little bubbles forming on the raisin wrinkles.

5. As the students watch the bubbles form, have them make more observations: are the bubbles on the raisins changing size? What's happening to the raisins?

6. Ask students: When a raisin gets to the surface of the liquid, what happens? You will notice that the bubbles burst and the raisin begins to sink again, until new bubbles form and begin lifting the raisin up toward the surface again.

7. Emphasize that this is the "power" of bubbles, and that this is the force driving volcanic eruptions (the expansion of gases in bubbles pushing magma up to the surface). This also represents what happens in a magma chamber—bubbles are driving movement, convection, and eruptions.

Demonstration #4 - Slow bubbles and non-explosive eruptions

In this activity, you will create a non-explosive Coke eruption. You will do this by using the rough surface of a piece of paper to create bubbles from Coke (do you know what gas forms these bubbles?). We will wrap the paper in transparency paper to make a stable conduit. Notice that the conduit sticks up above the level of the Coke, but the bubbly Coke can still travel up the conduit and out the top. This is called a siphon. It works because the **pressure** (Station A) of the air pushes down on the Coke surface and forces liquid into the conduit. Bubbles form in the conduit. Because the bubbles are as light as air, the bubbly Coke can rise higher than the non-bubbly Coke under the same air pressure.

Materials:

- paper
- transparency paper
- tape
- 2.5 L bottle of Diet Coke
- cake pan

Instructions for Demonstration #4:

Emphasize that we are now going to look at different ways bubbles can propel lava to the surface and generate different styles of eruptions, now that they have seen how "strong" a bubble can be (so strong that it can lift a raisin!). Refer to the introduction, effusive vs explosive eruptive styles, and photos of eruptive materials (lava, ash, scoria).

1. Explain that first we are going to look at effusive, or non-explosive eruptions in which lava is propelled upward in a volcanic conduit by expanding gas, but without exploding at the surface (effusive eruption).

2. This is a demonstration, but have a student help with it.

3. Roll up a piece of paper in a transparency, so that the plastic is on the outside of the paper, and the paper forms the inside surface of a cylinder. Tape this together.

4. Place an open 2.5 L bottle of Diet Coke in a cake pan/bin, and, in a quick motion, stick about an inch of the transparency/paper cylinder into the opening, so that it breaks the surface of the soda fast.

5. Now watch carefully and have the students make observations. The "lava" (which is Diet Coke) will slowly get moved upward by expanding bubbles of CO_2 as they come out of solution from the soda. In the process, they push the lava upward and out of the bottle.

6. While watching, you can ask the students what kind of gas is in soda (carbon dioxide), and have them realize that when they drink a soda and it's "fizzy", that's the CO_2 coming out as gas bubbles as they drink it.

7. Have the students make the observation that the lava is flowing slowly, because the gas is coming out of the Diet Coke slowly as well. This is like an effusive, or gentle eruption that produces lava flows.

Demonstration #5 - *Rapid bubbles and explosive eruptions*

In this activity, you will create an explosive water eruption. Does water usually explode? What do we need to add to water to make it explode? BUBBLES! You will do this by using Alka Seltzer to create a chemical reaction that produces gas. To make the water explode, you need to use those bubbles to create a lot of pressure. We will do this by using a plastic container ... what do you think will happen when the gas pressure is higher than the strength of the lid? What do you think would happen if we put Alka-Seltzer in a liquid with a higher *viscosity* than water (dish soap, for example)?

Materials:

- Alka-Seltzer tablets
- Film canisters
- Water
- cake pan

Instructions for Demonstration #5:

Summarize for students that we've now seen the power of bubbles (lifting raisins), and how it can drive a gentle or effusive volcanic eruption and lava flow (Coke and siphon). Now we are going to see how water and gas can make an explosive eruption.

1. Ask students some leading questions: Does water usually explode? What would we need to add to water to make it explode? (we're looking for them to say bubbles, given the previous experiments)

2. Have a student drop ½ of an Alka-Seltzer tablet into a clear plastic container. Now pour some water over it, and have students observe what is happening. They will see bubbles forming and a foam, but it just fizzes, no explosion.

3. Ask students: now that we have bubbles, why didn't it explode? It's because there wasn't much pressure inside those bubbles. To make bubbles cause water to explode, we have to find a way to make those bubbles contain a lot of pressure. Explain that one way to do this is to put the bubbles in a contained space.

4. Pass out film canisters to every student. Have them pull the lids on and off so that they can see that the seal is quite strong.

5. Now have them put ½ of an Alka-Seltzer tablet into the bottom of the canister, then fill the canister about ½ full with water, and put the cap on quickly. Sit back and watch, as within a few seconds, the pressure inside the container will expand enough to propel the top off of it (sometimes it will hit the ceiling, even).

6. Now ask students what happened and why it exploded. You want them to conclude that it's from allowing pressure to build up in the bubbles with the top of the canister in place, then the pressure inside the bubbles exceeds the strength of the cap on the canister, and it explodes. Make the connection to explosive style eruptions and even to ash (fragmented lava= little water droplets thrown all over in the eruption).

7. Let students do a few more experiments (change amounts of water, change amounts of Alka-Seltzer). Ask them to draw any conclusions from their experiments (more gas=more explosive, etc.).

Demonstration #6 - OUTSIDE - Coke volcano

How high do you think it will go?

Drop Mentos candy into a 2 litre bottle of Diet Coke all at once using the Geyser Tube and watch the soda erupt!

Each Mentos candy has thousands of tiny pits all over its surface. These tiny pits are called nucleation sites - perfect places for carbon dioxide bubbles to form.

As Mentos hit soda, bubbles form all over the surface of the candy. And, the fact that the Mentos candies sink to the bottom of the bottle gives a double-whammy. When all the gas is released, it pushes the liquid up and out of the bottle in an incredible soda blast.

Shows the power of bubbles to cause eruptions.

Materials:

- Peppermint Mentos
- 2 L bottle of Diet Coke
- Geyser Tube

Instructions for Demonstration #6:

1. Open the Diet Coke and screw on the Geyser Tube.
2. Holding the pin in place, dump a tube of Mentos into the Tube.
3. When everyone is standing a good distance away from the Diet Coke bottle, and ready, pull the pin and watch the Diet Coke erupt high into the air!

Note: New experiments have shown that warm Diet Coke fountains much higher than cold Diet Coke and it expels much more coke out of the bottle, while cold Diet Coke erupts for a much longer time with apparently much smaller bubbles. Source: Naomi Caplan-Auerbach

Demonstration #7 - Plate Tectonics and Volcanoes – Oreos

Use an Oreo and the flyer on the next page (available on the shared drive) to demonstrate plate tectonics and to explain the various settings where volcanoes form. The demonstration runs better when the Oreos are warm, but that may not be possible.

Materials:

- Enough Oreos for everyone
- Napkins

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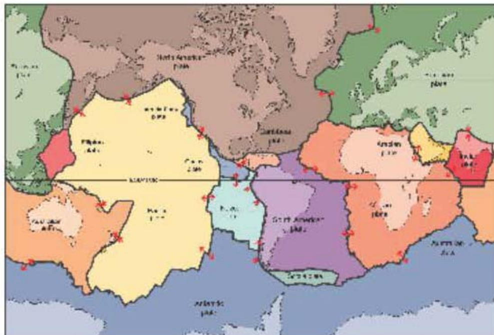
Te Whare Wānanga o Tāmaki Makaurau

OREO PLATE TECTONICS

Our Earth's crust is made up of tectonic plates that pull apart, slide past, and collide against one another. Many natural hazards like earthquakes and volcanic eruptions occur at the edges of these plates.



Major tectonic plates of the Earth.

Let's pretend the Earth's layers are like an Oreo cookie:

Top layer = hard, breakable crust and upper mantle ("lithosphere")
Creamy centre = plasticky asthenosphere (part of the mantle)
Bottom layer = lower mantle

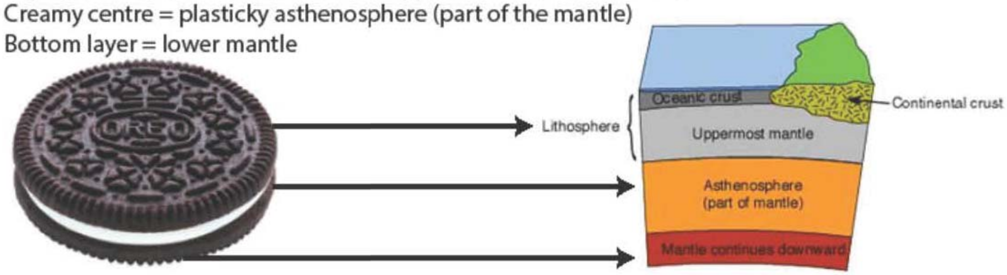
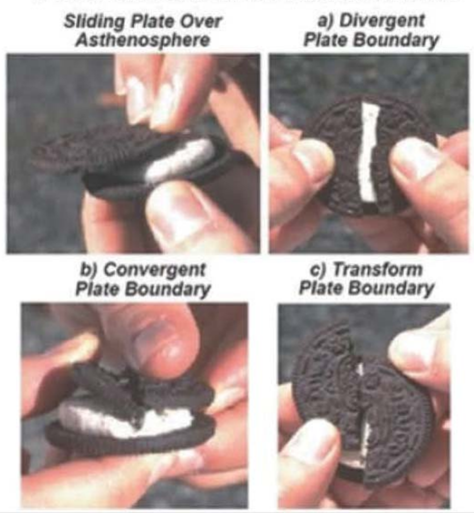
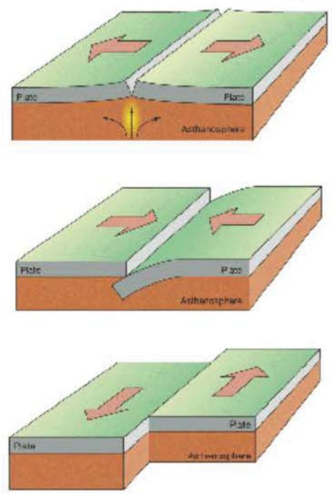


Plate Movement Demonstrations



Types of Volcanoes at Each Boundary



a) Magma rises to create volcanoes at divergent plate boundaries, such as in Iceland.

b) Volcanoes like Ruapehu form at convergent plate boundaries.

c) No volcanism is associated with transform plate boundaries.

Another type of volcanism occurs in the middle of the plates: intraplate volcanism. Hawai'i and the Auckland Volcanic Field are this type.

IMAGE SOURCES:
–Tectonic Plates by USGS [Public domain], http://pubs.usgs.gov/publications/text/slabs.html via Wikimedia Commons
–Oreo from http://www.americansoda.uk
–Earth's layers from http://www.classroomatsea.net/general_science/plate_tectonics/tectonics_intro.html
–Plate Movements from Robert J. Lillie's article: 'Fun with food! Plate tectonics and our national parks,' March 11, 2004.
–Boundary diagrams from http://earthsci8.wikispaces.com/1b+Ch.+12+-+Earth's+Intern+Proc http://creativecommons.org/licenses/by-sa/3.0/
–Intraplate diagram from Dr Jack Share http://written-in-stone-seen-through-my-lens.blogspot.co.nz/2012/09/hiking-mount-humphreys-of-san-francisco.html

Demonstration #8 - Effusive eruption (aka lava flows!)

(AKA Elephant's toothpaste)

Lava flows are associated with effusive eruptions. These are more common at basaltic volcanoes, where the lava has low viscosity. Bubbles are STILL the focus of this experiment. We will show what happens when magma and gases are not under pressure, but still cause magma to expand, rise to the surface, and ooze out of the volcano in the form of a lava flow.

In this activity you will learn more about buoyancy, effusive eruptions, and how bubbles can expand and move 'magma' foam in a non-explosive (effusive) eruption.

Materials:

- 2 teaspoons dry yeast
- Cup (at least 100 mls)
- Warm water – 50 – 75 mls.
- ½ cup (125 mls) 6% hydrogen pyroxide (H_2O_2).
- Measuring cup (1 cup)
- Measuring spoon (teaspoon)
- Dish soap – a squirt
- Red food colouring – 10 – 20 drops (you can experiment with this to find a good colour)
- Spoon
- funnel
- Clear plastic bottle, ~500 mls or smaller (300 mL works well), empty. E.g. an empty Coke bottle.
- Large bowl or tray with sides to catch the "lava"

Safety: Safety goggles on kids, audience a bit back from the table. Try not to get the H_2O_2 on your hands but not a crisis if you do.

Instructions for Demonstration #9:

1. Show the students the lava flow pictures and ask some leading questions: Do you know what kind of eruption lava flows happen in? Is it explosive or calm? How do you think magma rises to the surface of the Earth? Do you want to create a lava flow that you can touch?
2. Make sure everyone has safety goggles on.
3. Ask a volunteer to heap two teaspoons of yeast into the water. Have the volunteer stir the mix of yeast and water in the cup really well while you are preparing the rest of the experiment. The mixture should be reasonably liquid-y; if not, add a bit more water. Explain that these are fungi (the same you make bread with), and that the fungi needs to be 'woken up' with warm water.
4. Put the plastic bottle into the bowl/tray with the funnel over top.
5. Pour ½ cup H_2O_2 into the plastic bottle. This is just water with an extra oxygen, but is more dangerous. However, the fungi will eat this up and transform it. (CAP the bottle to preserve the solution, otherwise it will become WATER and your lava will not 'flow.')
6. Have a 'tall' kid add the food colouring to the bottle. Swirl the bottle to mix up the color.
7. Add a squirt of the dish soap to the bottle.
8. Make sure the yeast mixture is not clumpy, otherwise it will clog the funnel.
9. Explain that once the fungi is added, it will eat up the hydrogen peroxide and turn it into water, oxygen gas and heat (you will notice that the foam produced feels warm), and a foam will be

created. This foam will slowly expand as more and more oxygen bubbles from the yeast are added. In just the same way, as magma rises, more bubbles form, and these bubbles expand and help to push magma toward the surface of the earth, creating a calm lava flow.
10. Pour in the yeast mixture.
11. Lava flow!
12. Contrast these processes with explosive eruptions (Demonstration #5) where the gas builds up, creating an explosion.
13. Kids may play with the lava foam but their hands will get colored from the dye.