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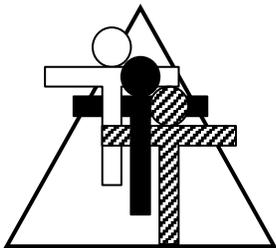
VOLCANOES

A STEM on a Shoestring **Lab**

**Model all
four types!**

**Free slide
presentation!**

**YouTube link
included!**



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Brad Fulton

Educator of the Year

- ◆ Consultant
- ◆ Educator
- ◆ Author
- ◆ Keynote presenter
- ◆ Teacher trainer
- ◆ Conference speaker

Known throughout the country for motivating and engaging teachers and students, Brad has co-authored over a dozen books that provide easy-to-teach yet mathematically rich activities for busy teachers while teaching full time for over 30 years. In addition, he has co-authored over 40 teacher training manuals full of activities and ideas that help teachers who believe mathematics must be both meaningful and powerful.

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- ◆ 2005 California League of Middle Schools Educator of the Year
- ◆ California Math Council and NCTM national featured presenter
- ◆ Lead trainer for summer teacher training institutes
- ◆ Trainer/consultant for district, county, regional, and national workshops

Author and co-author of mathematics curriculum

- ◆ Simply Great Math Activities series: six books covering all major strands
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Thanks and happy teaching,

Brad 

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- b) Affordable staff development
- c) Ongoing staff development
- d) **ALL OF THE ABOVE!**

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Volcanoes!

Building Models of the Four Types

Overview:

In this exciting and engaging activity students will blend:

- Volcanology
- Coordinate graphing
- Chemistry
- Map reading

You can also incorporate online research if you wish to make this a complete STEM activity.

Students will learn about the four types of volcanoes and see where they are located in one of our national parks. They will use coordinate graphing skills to locate each volcano on their map. Each of the four types of volcano can be modeled using the materials and procedure described.

These models can be used individually or together and can be incorporated with the available Power Point for a complete lesson in volcanoes!

Caution:

The demonstrations for the TEPHRA CONE and COMPOSITE VOLCANOES involve chemicals that can be hazardous if not handled correctly. Because these two models involve fire, flame, and hazardous fumes, they should be done outdoors, away from students, and with appropriate protection. Read all labels and follow safety guidelines. I take no responsibility for any misuse or irresponsible use of the materials.

Required Materials:

Shield volcanoes:

- Foam plates
- Foam bowls
- Small cups
- Vinegar
- Baking soda
- Red food coloring

Tephra cone volcanoes:

- Metal plate
- Ammonium dichromate

Plug dome volcanoes:

- Toothpaste
- Cookies

Composite volcanoes:

- Potassium permanganate
- Powdered sugar
- Glycerin

Optional Materials:

- Colored pencils
- Copies of outline
- Copies of Lassen National Park map

You'll find a video demonstration of all four models at:
www.youtube.com/watch?v=YTP0HEWUIcY&t=2s

You can access the FREE slide presentation at:
www.tttpress.com/volcanoes52815

Procedure:

1. Prepare all materials ahead of time. Each section will describe this.
2. You should first decide if you want to only demonstrate the four types of volcanoes or whether you want students to also complete the outline and/or map. If you plan to have them do the outline and map, pass out those materials ahead of time. You can also link to the slide presentation. **The slide presentation is provided only for those who have purchased this activity. Do not copy, modify, or forward it to anyone else. This would be a copyright violation and you would make me very rich. ☺**
3. Have the students sit in teams. Four to a team is good and will decrease the amount of materials you'll need to purchase. As you go through the slides, students can fill in the blanks. Take time to discuss points of interest as you go based on questions they ask, reading and research they have already done, or on your own knowledge.
4. This lesson was originally presented in northern California at Mistletoe STEM Institute which is near Lassen Volcanic National Park. Lassen Park contains all four types of the world's volcanoes: shield, tephra cone, plug dome, and composite. You can find a park map, pictures, and more information at

www.nps.gov/lavo/index.htm

Volcanoes Rock! Name _____

1. You may already know that there are _____ types of rocks:

- _____ — rocks are made of _____.
- _____ — means _____. These come from volcanoes.
- _____ — This _____.

2. There are _____ types of volcanoes in the world, and Lassen National Park contains examples of all of them.

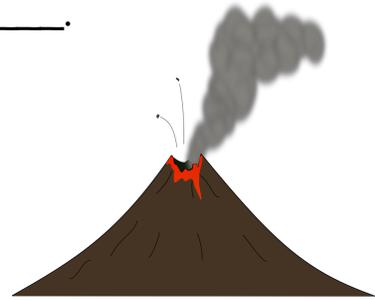
3. _____ volcanoes are also called Hawaiian volcanoes.

- They have runny lava that flows over a wide area like _____.
- The largest known shield volcano is named _____.
- It is found on _____ and is as wide as California!
- Examples in Lassen are:
 - a. (15, 2) Mt. Harkness
 - b. (9, 1) Sifford Peak
 - c. (13, 10) Prospect Peak



4. _____ volcanoes are also called _____ volcanoes.

- They are made of little pieces of lava tossed in the air.
- They look like _____.
- Examples in Lassen are:
 - a. (14, 9) Cinder Cone
 - b. (12, 7) Fairfield Peak
 - c. (8, 7) Hat Mountain



5. _____ are made up of very stiff blocky lava.

- They are the most dangerous.
- Examples in Lassen are:
 - a. (4, 5) Lassen Peak
 - b. (6, 4) Reading Peak
 - c. (3, 7) Chaos Crags



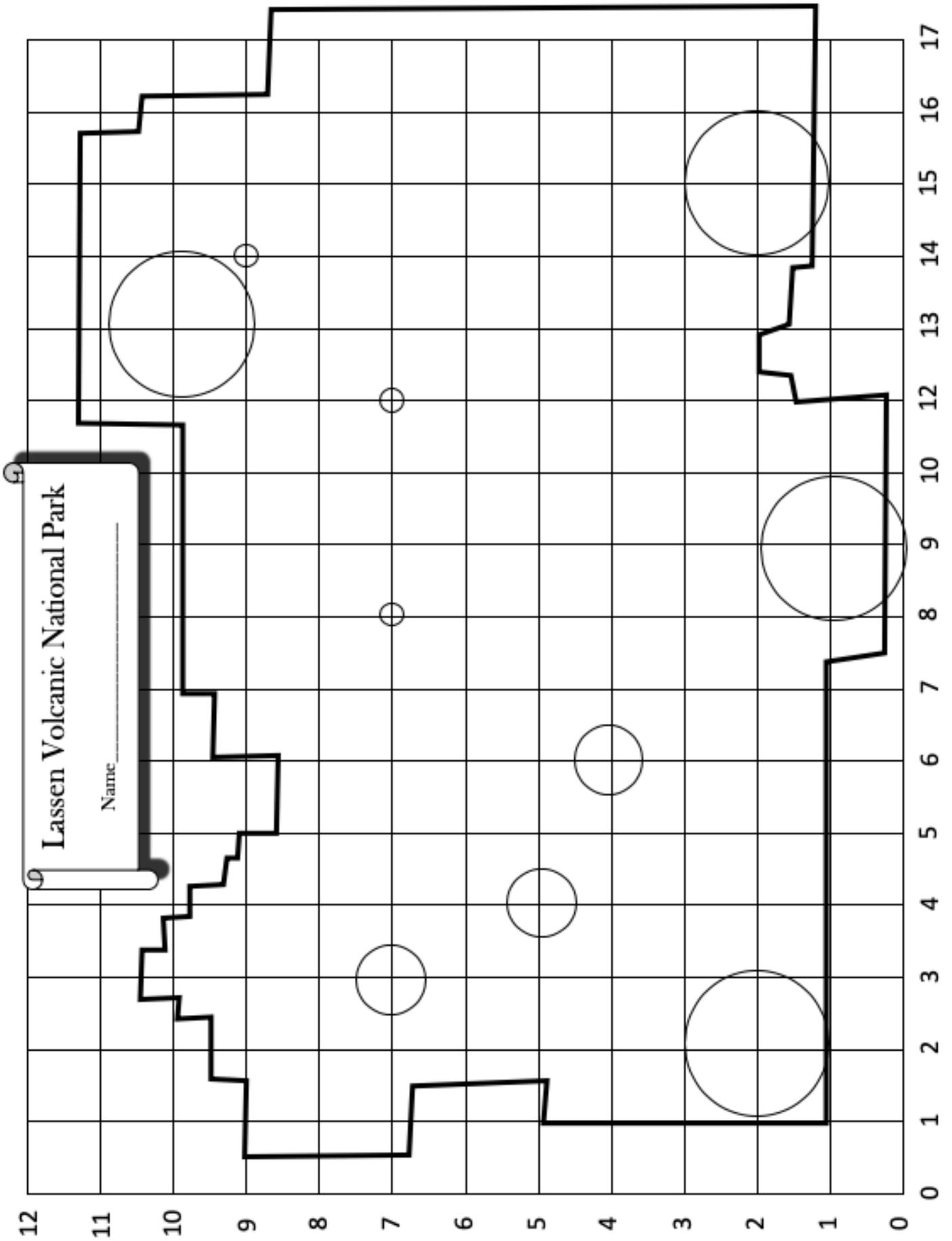
6. _____ volcanoes are made of many different eruptions.

- They are the world's largest volcanoes.
- They are also called stratovolcanoes. "Strato" means "_____".
 - a. The only one in Lassen is (2, 2) Brokeoff Peak.

Volcanoes Rock!

ANSWER KEY

1. You may already know that there are three types of rocks:
 - Sedimentary — rocks are made of layers.
 - Igneous — means fire. These come from volcanoes.
 - Metamorphic — This means changed form.
2. There are four types of volcanoes in the world, and Lassen National Park contains examples of all of them.
3. Shield volcanoes are also called Hawaiian volcanoes.
 - They have runny lava that flows over a wide area like syrup.
 - The largest known shield volcano is named Olympus Mons.
 - It is found on Mars and is as wide as California!
 - Examples in Lassen are:
 - a. (15,2) Harkness Peak
 - b. (9, 1) Sifford Peak
 - c. (13, 10) Prospect Peak
4. Cinder cone volcanoes are also called tephra cone volcanoes.
 - They are made up of little pieces of lava tossed in the air.
 - They look like ant hills.
 - Examples in Lassen are:
 - a. (14, 9) Cinder Cone
 - b. (12, 7) Fairfield Peak
 - c. (8, 7) Hat Mountain
5. Plug domes are made up of very stiff blocky lava.
 - They are the most dangerous.
 - Examples in Lassen are:
 - a. (4, 5) Lassen Peak
 - b. (6, 4) Reading Peak
 - c. (3, 7) Chaos Crags
6. Composite volcanoes are made of many different eruptions.
 - They are the world's largest volcanoes.
 - They are also called stratovolcanoes. "Strato" means "layer".
 - a. The only one in Lassen is (2, 2) Brokeoff Peak.



Shield volcano demonstration:

1. I used small plastic cups for the crater in my volcano. These are the types often used in restaurants for salsa and other condiments.
2. I cut a hole in the center of the foam bowl slightly smaller than the diameter of the condiment cup.
3. Set the foam plate on the table. It is there to contain the eruption and prevent a mess.
4. Place the foam bowl upside down on the plate.
5. Each group should put one spoonful of baking powder in the condiment cup (crater).
6. Give each group a small amount (about a quarter cup) of vinegar dyed red.
7. At your cue, they can pour the vinegar into the crater and watch it erupt. The red “lava” will flow down the sides of the volcano.



Discussion points:

- a) How is this model similar to a real shield volcano? (The lava is red. It flows or oozes fairly slowly.)
- b) How is it different? (There are many obvious differences, such as the fact that it is not hot, but one of the most significant observations might be that the shield volcanoes shown in the presentation are not nearly as steep as the bowl. Because this lava is so fluid and runny, it spreads out over a wide area with shallow slopes.)
- c) The reason that vinegar and baking soda do this is because we are mixing an acid with a base. Vinegar is composed of 1% acetic acid and 99% water. Baking soda is a base. Interestingly, the vinegar and baking soda actually cool off a bit. This is an example of an *endothermic* chemical reaction; it absorbs energy making it a bit colder.
- d) Shield volcanoes can be very destructive – wiping out homes and highways – but they are usually not dangerous. The lava flows about as slowly as a person walks, so it is not difficult to escape.
- e) Olympus Mons, a shield volcano on the surface of Mars is five times higher than Mt. Everest! It is 300 miles (500 km.) across at the base or about the width of California.
- f) Have the students locate the three shield volcanoes in Lassen Park: Mt. Harkness, Sifford Peak, Prospect Peak. They will notice these are very large. Have them color them red to signify the red flowing lava.

Tephra cone demonstration:

1. **This demonstration uses AMMONIUM DICHROMATE, a known carcinogen. Read all labels and follow all safety procedures. Do this outdoors away from students. Wear appropriate safety equipment.**

2. Explain that the lava in a tephra or cinder cone eruption is composed of small bits of hot lava (tephra) that are blasted into the air.
3. Put a small amount of ammonium dichromate in a metal pan. A quarter cup will be sufficient but a bit more or less is fine. Do not use the measuring cup for any food item afterwards.
4. Light the top of the mound with a match, and then move away.
5. As the ammonium dichromate burns, the orange crystals will produce a dark green ash. It will also throw sparks into the air above the pan. The ashes will begin to form a cone of debris in the pan. As it continues to burn, a crater will form in the top.
6. When it has finished burning and has cooled off, dispose of the materials per the safety guidelines on the product.



The crater is beginning to form. Note the eruption of sparks (cinders) at the top of the cone and the formation of the characteristically sloped sides.

Because of the fumes, do this experiment outdoors and in a well-ventilated area away from students.

Discussion points:

- a) How is this model similar to a real tephra cone eruption? (Glowing material is ejected into the air and lands back on the flanks of the volcano. It also forms flanks that measure 30° to the base. This is called the *angle of repose* and matches the angle of the flanks of these actual volcanoes. It also forms a crater in the top.)
- b) Why might this type of volcano be more dangerous than a shield volcano eruption? (The material can be ejected with great force through the air. It is difficult to outrun. Fortunately, most volcanoes give ample warning prior to major eruptions. These are often in the form of earthquake clusters. Most, but not all, injuries and deaths are caused when people assume the warnings are over and the volcano is safe.)
- c) Have the students locate the cinder cone volcanoes in Lassen Park: Cinder Cone, Fairfield Peak, and Hat Mountains. They can color these orange to signify the glowing orange cinders that are ejected. They will notice that they are less massive than shield volcanoes.

Plug dome demonstration:

1. Give each team one tube of toothpaste.
2. Explain that a plug dome has very thick and pasty lava – not really a liquid, but not very solid either. As the force of the magma chamber pushes out lava, it rises higher and higher. These volcanoes can build tall jagged cliffs in just a few years.
3. Have them point their tube of toothpaste upward as they slowly squeeze. As the toothpaste rises higher and higher, it will eventually collapse under its own weight.
4. **A second and more engaging model involves stacking cookies. Here the tower is built by adding new cookies to the *bottom* of the stack to represent the lava pushing up from the bottom. How high can your students stack the “lava” before a sudden avalanche happens?**
5. You can incorporate some math into the second model if you wish:
 - a) Find the range: what was the greatest number and least number of cookies stacked?
 - b) What was the mode? The median? The mean (average)?
 - c) These can be graphed on a line plot, a box plot, or made into a histogram. Online graphing software can be used if you wish. ([desmos.com](https://www.desmos.com))



The plug is erupting!



The avalanche begins!

Discussion points:

- a) What happens when the toothpaste gets too high? (It collapses. This occurs with plug dome volcanoes as well. Rock avalanches are not uncommon. Sometimes these collapse so suddenly that air is trapped beneath them in what is called a *steam cushion avalanche*. These can race down a mountainside at over 100 miles per hour!)
- b) How is this demonstration similar to an actual plug dome eruption? (The toothpaste is much like the stiff, pasty lava of a plug dome. The cookies are a better model for the sudden and dangerous collapse that can occur with these eruptions.)
- c) Why might plug dome volcanoes be extremely dangerous? (The crumbling lava travels very fast.)

Have the students locate the three plug dome volcanoes on their Lassen Park map: Lassen Peak, Reading Peak, Chaos Crags. They can color these gray to match the gray rocks of the volcano. Lassen Peak, at 10,500 feet high, last erupted in 1915. Chaos Crags erupted about 350 years ago and a steam cushion avalanche rolled to the northwest. To this day, the resulting landscape looks like waves of rock. The rocks dammed up Manzanita Creek forming Manzanita and Reflection Lakes. The trees in this area are stunted due to a lack of soil and formed the Dwarf Forest of Lassen Park.

Composite volcano or stratovolcano:

1. For this, you may wish to build a model of the volcano as I did.
 - a. I began by cutting out a base with a hole in the middle. The middle hole makes it much easier to load the volcano with the erupting chemical fuel.



- b. Then I set a can in the center and stretched a window screen over it. The screen was stapled to the base.



- c. I mixed some plaster of Paris and began to coat the window screen leaving the “crater” uncoated.



- d. Once it dried, I painted it to make it look more realistic and removed the window screen that was blocking the crater.
 - e. Lastly, I cut the top off the can and began mixing the fuel for the eruption.



2. To make the fuel I used this recipe: **Do this eruption outdoors in a well ventilated area away from students and with appropriate protective gear.**
 - a. Combine 2 tsp. potassium permanganate with 2 tsp. powdered sugar in the can. Mix well.
 - b. Add 1 tsp. potassium permanganate on top of the mixture.
 - c. Set the can into the volcano. The opening on the base makes this easier and also helps prevent the base from catching on fire.
 - d. Add a few drops of glycerin onto the top tsp. of potassium permanganate and move away.

3. It will take a few seconds and the students will likely become lulled into thinking that the experiment is a dud. Then smoke will begin to erupt from the crater. Very soon flames will erupt. You may even see some ejected material, so be sure to stand back. **DO NOT LOOK INTO THE CRATER TO SEE WHY THE ERUPTION HASN'T STARTED!**

Discussion points:

- a. Why might this type of eruption be dangerous? (It can involve hot lava, a violent eruption, landslides, and ejected material. Anything can happen.)
- b. Have the students color the one remaining circle on their map. This is Brokeoff Peak and is one part of the flank of an old composite volcano that has eroded away (not broken off as originally thought when it was named). If you drive through the southern part of Lassen Volcanic National Park, you will pass the smelly steam of the Sulfur Works. This is the vent of the old volcano and shows that it is not extinct, but merely dormant. In its heyday, Brokeoff would have been taller than Lassen by 1,000 feet.

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- *Petroglyphs Lab* - Learn about petroglyphs and make your own using the included recipe for stone dough. A great tie-in to language arts!
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Feel free to contact me if you have questions or comments or would like to discuss a staff development training or keynote address at your site.

Happy teaching,

Brad