Planetary Volcanoes: Not So Alien Geology

OVERVIEW
Take a geology field trip to another planet and learn about volcanoes on Mars, Venus, Io, and Titan. Learn how volcanoes form and realize that they are not so different than the ones in our backyard. It can take hundreds of thousands of years for volcanoes to develop and they are not all the same. Even of Earth, several different volcanoes can form depending on many factors. The same can be said for volcanoes on other planetary bodies. These massive and awe-inspiring features can shape whole landscapes, create life-sustaining environments, and even cause colossal destruction. This lesson will discuss the similarities and differences of volcanoes on Earth and others found around our solar system. Learners will be able to create models of these volcanoes using Playdoh and other household materials. Is geology really so alien on other planets?

LEARNING OBJECTIVE
- Learners will explore the geological process of volcanoes and how they form, on Earth, and other planets.
- Learners will use playdoh in order to demonstrate and model the different types of volcanoes.
- Learners will be able to explain similarities and differences of volcanoes found on Earth and other planets.

VOCABULARY
- **VOLCANO** – A break in a planet's surface that allows lava, gases, and ash to escape from the molten core of the planet. Usually, this lava hardens and adds up over time, creating volcanic features such as mountains or islands.
- **MAGMA** – Molten or liquid rock that sits within a chamber below a volcano.
- **LAVA** – Liquid rock that has erupted from the vent and is running down the sides of a volcano.
- **ERUPTION** – A geological event where lava, ash, and gas escapes from the volcano in a forceful event. This eruption can be very destructive like Mount St. Helen or slow and steady like the Kilauea eruption on Hawai'i.
- **CONVERGENT BOUNDARIES** – An area on a planet where two tectonic plates collide, and one of the plates slides under the other. The plate sliding underneath starts to melt as it reaches the mantle, this liquid rock can be pushed up threw smaller cracks in the crust of the Earth and starts the formation of a volcano as the lava builds up.
- **DIVERGENT BOUNDARIES** – An area on a planet where two tectonic plates pull apart from each other, causing a rift or valley to form. As the plates pull apart gaps form between the planet’s crust and mantle, lava fills in the gaps and adds up to create a volcano.
- **COMPOSITE VOLCANO** – A type of volcano that is created by different layers of volcanic rock adding up over time, these volcanoes are usually very steep, have the ability for explosive eruptions, and have thick lava. (Ex. Mount Rainier or Mt. St. Helens)
- **SHIELD VOLCANO** – A type of volcano that is created by layers of oozing liquid lava, these volcanoes are usually wide and have a gentler incline, have steady eruptions without a lot of explosive power and thin, runny lava. (Ex. The Hawaiian Islands)
- **CALDERA** – A type of volcano that became too unstable and collapsed in on itself, these volcanoes cannot release the magma, gasses, and pressure building up inside of them because of the damaged structure and can be extremely destructive if they ever erupt. (Ex. Crater Lake or Yellowstone)
- **PANCAKE DOMES** – A type of volcano found of the planet Venus. This volcano is thought to form over a period of one long eruption and an area of several cracks in the planet’s surface. This volcano is not very tall and wide like a pancake.
- **PIT CRATER** – The collapse of an empty volcanic chamber these pits can sometimes fill back up with magma but usually create visible craters from the planet’s surface.
- **CRYOVOLCANO** – A type of volcano that erupts plumes of ice, methane, and ammonia instead of molten lava, these gases eventually freeze and add to the layering of the cryovolcano.

MATERIALS
- Playdoh
- Plate or tray to work on
- Small cup
- Toothpick
- Baking Soda (Optional)
- Vinegar (Optional)
SET-UP

→ Prepare the classroom by setting up plates or trays with one container of playdoh, a toothpick, and one small cup for each participant.
→ If using baking soda and vinegar for your own demonstration, it is suggested that the educator measure out a few tablespoons of each beforehand and creating the five different kinds of volcanoes as models. Make sure to leave the inside of your volcanoes hollow or with a large enough divot on the top to mix your ingredients. Run this experiment only as a demo, not with each learner, as it will get quite messy.
→ Print out some pictures of different volcanoes like Mt. Rainier, Hawai‘i, Olympus Mons, and Maat Mons to show the physical similarities and differences of volcanoes on different planets.

LESSON PLAN

1) Start by asking the learners if they have ever seen a volcano before, or what do you think of when you hear the word volcano? Talk about how volcanoes form, bringing up the Earth’s crust, mantel, plates. Explain how Convergent and Divergent Boundaries help create most volcanoes on Earth. Ask the class to use their hands as the plates of the Earth and have them make the two different boundaries with the motion of coming together or pulling apart. Finally, talk about how volcanoes can be active, dormant, or extinct.

2) Next, talk about how volcanoes can form on other plants and can be very similar or different, ask them what other planets they think have volcanoes. Talk about volcanoes only forming on solid planets. Bring out the pictures of volcanoes from different planets and have them explain what they see. Explain that depending on the lava and many various factors, the volcanoes can look very different, even on other planets. Have them head to their workstation.

3) The first volcano they will make with Playdoh is a Composite Volcano, explain that these volcanoes are found on Earth and are very steep/pointy. They can be very explosive and have thick lava, like syrup. Use the toothpick to create a crater or vent at the top of the volcano, explaining this is where lava would come out.

4) The second volcano is a Shield Volcano. This volcano is found all over the solar system, but depending on the planet can be created by plate movement, radiation, or even tidal movement under the surface. Shield Volcanos are found on Earth, Mars, Venus, and Io (moon of Jupiter), to name a few. These volcanoes have liquid lava, like water, and are not very steep but very large and tall. Olympus Mons on Mars is a shield volcano and is two and a half times taller than Mount Everest (not a volcano).

5) The third volcano is a Caldera, which is a volcano that collapsed in on itself because it was unstable, and the force of eruptions made it weak and can be found on planets like Earth, Mars, Venus, and Io.
6) The fourth volcano is a Pancake Dome; these volcanoes are found on Venus and are flat, round, and not very tall. These Volcanoes are made from one slow eruption, are high in silica (main factor for making lava thick) content like the Composite Volcano. (Look at vocab).

7) The final volcanic feature you will make is called a Pit Crater; this is an empty chamber of a volcano that has collapsed. These craters usually have steep sides to them but are not very deep. These are very common on Mars as a lot of the volcanoes on Mars are expected to be extinct. (Use the cup as the mold for your pit crater.

8) The final volcano you will talk about is a Cryovolcano and cannot be made using playdoh. This type of volcano is found on cold planetary bodies with liquid seas found under a layer of ice. Instead of erupting hot lava, these volcanoes act like giant geysers erupting gas, ice, and liquids into the atmosphere. Titan (a moon of Saturn) is very famous for its Cryovolcanoes, whose eruptions have been captured by the Cassini space probe. We still don’t know a lot about Cryovolcanoes, but they are something not found on Earth.

9) Finally, go over everything thing you did today and ask them about something they found interesting about the lesion, did they learn anything new?

FURTHER EXTENSION

In the Museum
During your visit to The Museum of Flight, visit the Simonyi Space Gallery to learn more about our solar system and the technology that is allowing us to explore it.

SUGGESTED READING/ ADDITIONAL RESOURCES
-Database by the International Astronomical Union that looks at geology of planetary bodies.
https://iau.org/

-In depth presentation on planetary volcanism
https://www2.mps.mpg.de/solar-system-school/lectures/planetary_interiors_surfaces/markiewicz.pdf

-NASA Image database
https://photojournal.jpl.nasa.gov/
Reference Images

Mount Rainier – Composite Volcano (Earth)

Mauna Kea - Shield Volcano (Earth)
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Grade: 5+
Time: 1 hour

Olympus Mons – Shield Volcano (Mars)

Maat Mons - Shield Volcano (Venus)
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Pancake Domes (Venus)

Titan

Encelades Cryo plumes from space (Moon of Saturn)
Picture Credit

Pictures by Logan Wegmeyer
- Figure 1
- Figure 2
- Playduh Volcano examples 1-5
- Mount Rainier

NASA/JPL
- Cryovolcano Diagram: https://photojournal.jpl.nasa.gov/jpeg/PIA19059.jpg
- Olympus Mons: https://nssdc.gsfc.nasa.gov/photo_gallery/photogallery-mars.html#features
- Maat Mons: https://photojournal.jpl.nasa.gov/catalog/pia00254
- Pancake Domes: https://photojournal.jpl.nasa.gov/catalog/PIA00084
- Titan: https://photojournal.jpl.nasa.gov/jpeg/PIA20016.jpg
- Encelades Cyra: https://photojournal.jpl.nasa.gov/catalog/PIA07758