Anatomy of a Volcanic Eruption:

Case Study: Mt. St. Helens

Materials Included in this Box:

- **Teacher Background Information**
- **3-D models of Mt. St. Helens (before and after eruption)**
- **Examples of stratovolcano rock products: Tuff (pyroclastic flow), pumice, rhyolite/dacite, ash**
- **Sandbox crater formation exercise**
- **Laminated photos/diagrams**

Teacher Background

There are several shapes and types of volcanoes around the world. Some volcanoes occur on the edges of tectonic plates, such as those along the 'ring of fire'. But there are also volcanoes that occur in the middle of tectonic plates like the Yellowstone volcano and Kilauea volcano in Hawaii.

When asked to draw a volcano most people will draw a steeply sided, conical mountain that has a depression (crater) at the top. This image of a 'typical' volcano is called a **stratovolcano** (a.k.a. composite volcano). While this is the often visualized image of a volcano, there are actually many different shapes volcanoes can be. A volcano's shape is mostly determined by the type of magma/lava that is created underneath it. Stratovolcanoes get their shape because of the thick, sticky (viscous) magma that forms at subduction zones. This magma/lava is layered between ash, pumice, and rock fragments. These layers of ash and magma will build into high elevation, steeply sided, conical shaped mountains and form a 'typical' volcano shape.

Stratovolcanoes are also known for their explosive and destructive eruptions. Eruptions can cause clouds of gas, ash, dust, and rock fragments to eject into the atmosphere. These clouds of ash can become so dense and heavy that they quickly fall down the side of the volcanoes as a **pyroclastic flow**. When pyroclastic flows mix with surface water (from snow, rivers, and/or lakes) it becomes a **lahar**. Lahars move down the mountain like cement, taking everything with it. **Magma** will also ooze out of the volcano but is so thick and viscous that it does not travel very far. This magma will form a **magma dome** inside the crater. As material is erupted out of the volcano, the magma chamber inside empties and can no longer support the overlying ground. This ground will collapse into the volcano creating a circular depression at the top of the volcano called a **crater**.

The second major type of volcano is called a **shield volcano**. These are the volcanoes that typically make up the Hawaiian Islands. These volcanoes have a shape that is much different from a stratovolcano. These volcanoes are broad, and gently sloped. They are so broad that they are often hard to notice. These volcanoes produce eruptions that are much gentler (non-explosive) when compared to stratovolcanoes.

Eruption of Mt. St. Helens

May 18th, 1980 the world witnessed the powerful and devastating eruption of Mt. St. Helens. While this eruption was not the largest in human history, it was unique and record setting in other ways. Mt. St. Helens is, by far one of the most famous volcanos, but is one of dozens of active composite volcanoes that make up the pacific northwest region of the United States. These volcanoes formed from the movement of the small Juan de Fuca tectonic plate beneath the North American tectonic plate. This movement has created a subduction zone. The type of volcanoes that form as a result of subduction zones are composite volcanoes (a.k.a. stratovolcanoes). Highly viscous magma creates these high relief cylindrical mountains that are made up of layers of lava, ash, pumice, and tephra (rock fragments). The magma underneath these volcanoes has a greater viscosity, this means it moves more slowly towards the surface and increasing the pressure build up. But as the magma moves up that pressure decreases. This causes the dissolved gasses to be released in a sometimes-explosive manner.

In the months leading up to its eruption, geologists were closely monitoring Mt. St. Helens. A crater had formed at the mountain's summit and had periodically emitted steam and ash. Small earthquakes and sensitive gps data showed that the north side of the mountain was bulging upwards and filling with magma. Geologists new an eruption was coming but could not predict the magnitude or volatility of such an eruption. On the morning of May 18th, 1980, the volcano was not emitting any extra warning signs, it was as it had been for the previous months. At this point the bulge was growing about 6 ft each day and ended up being so large it could be seen by anyone observing the mountain, leaving that side of the mountain quite unstable. At 8:32 AM, a magnitude 5.1 earthquake occurred approximately 1 mile below the mountain. This earthquake caused the unstable bulging land to break and slide off the mountain in the largest ever recorded landslide. The loss of the entire north side of the mountain caused the pressure on the magma to be instantaneously released. The dissolved gasses within the magma were instantly release and violently erupt sideways out of the mountain. Think of shaking a soda bottle and quickly taking the cap off. This was also unusual in that most eruptions occur upwards rather than laterally. Over 1300 ft of the mountain was gone in less than one minute. The exploding material quickly overtook the landslide and within three minutes had traveled 17 miles. The landslide and lateral blast destroyed an incredible swath of forest north of the mountain and killed 57 people.

Once the initial blast occurred, the eruption continued upwards as normal. The mountain continued to erupt for months, these included more ash and steam eruptions a well as lava eruptions that created an 800 ft tall lava dome inside the newly formed crater.

Lesson Instructions

1. Ask the class if they can think of the name of any volcanoes that they have heard of. They may say Mt. St. Helens, Hawaii, Mt. Rainier, or Yellowstone. If not, you can go over some of the more famous volcanoes with them.
2. After discussing some of theses famous volcanoes, ask them what these volcanoes look like? Have them describe or draw the shape and size of them. You can show them the diagram of different volcano shapes while discussing.
3. Review the two main types of volcanoes and their shapes: Shield Volcanoes and Composite Volcanoes.
4. Show the class the 3-D model of Mt. St. Helens **BEFORE** it's eruption. Ask them to identify the type of volcano.
5. Discuss stratovolcanoes and their parts. Use diagram provided.
6. Show students examples of the different products of these volcanoes (tuff, rhyolite, pumice, and ash) and discuss them.
7. Now tell them that the model is a real model of Mt. St. Helens located in the US and begin to discuss the eruption that took place.
8. Show class the 3-D model of Mt. St. Helens **AFTER** its eruption. As them to identify the differences between the two models.
9. Explain what happened during the eruption and how this was an eruption that has never been seen before or again. Show them the before and after images.
10. Show the class this composite video of the massive landslide: https://www.youtube.com/watch?v=bgRnVhbfIKQ
11. After discussing the eruption of Mt. St. Helens. Discuss in more detail the idea of a caldera.
12. Perform the activity/demonstration showing how a caldera forms. See the instructions on the following page.

Crater/Caldera Class Activity

When a magma chamber fills up with magma it pushes the ground upward. Just like the bulge on the side of Mount St. Helens in the months leading up to its eruption. When the volcano erupts and the magma chamber empties, the ground above is no longer supported and collapses into the now empty space.

Materials Needed:

- Balloon
- Bin filled with sand
- Bicycle tire pump

Procedure:

1. Unscrew the end of the tire pump.
2. Affix the balloon over the end of the pump.
3. Dig a hole in the sand and place the empty balloon inside.
4. Cover balloon completely with sand. You should have several inches of sand over the balloon.
5. Slowly inflate the balloon until you see the sand is push upwards.
6. Once you stop pumping the bicycle tire the air should slowly leak out of the balloon and deflate your magma chamber.
7. Class Discussion:

   Discuss how this crater formation is different than the eruption that took place on Mt. St. Helens. Mt. St. Helens erupted after a massive landslide. The crater that formed is mostly due to the landslide and lateral explosion. Can your students think of other famous craters (a.k.a calderas)? Here are some others you can talk about: Crater Lake, Yellowstone Caldera, Halema'uma'u (Kilauea Volcano).

Extensions:

Exploring Mt. St. Helens on Google Earth

- If you do not already have it, download the Google Earth desktop version onto classroom computers. Make sure this is the 'Google Earth Pro' desktop version. Link Here: https://www.google.com/earth/versions/#earth-pro
- Open Google Earth and search for Mt. St. Helens in the upper left search bar.
  - You can explore the image by holding the left click on the mouse and dragging the picture in the direction you wish to move. You can also use the tools on the right side of the picture to adjust your view.
  - The top circle will change the view angle.
  - The circle below that will also move the picture left, right, up, or down.

    - Clicking and dragging the person to a location will put you in ground-level view, the image will appear as though you are standing on the ground in that location.
    - The slide zoom beneath that will zoom in and out of the image, you can also do this using the roller on the mouse.
- Zooming into the volcano, observe some of the different parts to the volcano. You can see and explore the caldera, lava dome (inside the crater). Look for lahars (volcanic mud flows) that flowed off the mountain during it's eruption.
- You can search some of the other volcanoes that you discussed in the class and see if they do or don't have calderas!