

# **Earth Science**

## **Chapter 13 - Volcanoes**

### **Section 2 – Volcanic Eruptions**

***E.Q.: What are the major types of pyroclastic material and the main types of volcanoes?***

#### **STANDARDS:**

**SES2. Students will understand how plate tectonics creates certain geologic features, materials, and hazards.**

- a. Distinguish among types of plate tectonic settings produced by plates diverging, converging, and sliding past each other.
- b. Relate modern and ancient geologic features to each kind of plate tectonic setting.
- c. Relate certain geologic hazards to specific plate tectonic settings.
- d. Associate specific plate tectonic settings with the production of particular groups of igneous and metamorphic rocks and mineral resources.
- e. Explain how plate tectonics creates and destroys sedimentary basins through time.

**SES5. Students will investigate the interaction of insolation and Earth systems to produce weather and climate.**

- a. Explain how latitudinal variations in solar heating create atmospheric and ocean currents that redistribute heat globally.
- b. Explain the relationship between air masses and the surfaces over which they form.
- c. Relate weather patterns to interactions among ocean currents, air masses, and topography.
- d. Describe how temperature and precipitation produce the pattern of climate regions (classes) on Earth.
- e. Describe the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming).
- f. Relate changes in global climate to variation in Earth/Sun relationships and to natural and anthropogenic modification of atmospheric composition.

#### **Objectives:**

- **Explain how the composition of magma affects volcanic eruptions and lava flow.**
- **Describe the five major types of pyroclastic material.**
- **Identify the three main types of volcanic cones.**
- **Describe how a caldera forms.**

- **List three events that may signal a volcanic eruption.**

### **Volcanic Eruptions**

**mafic - describes magma or igneous rock that is rich in magnesium and iron and that is generally dark in color**

**felsic describes magma or igneous rock that is rich in feldspar and silica and that is generally light in color**

- **Mafic rock commonly makes up the oceanic crust, where as felsic and mafic rock commonly make up the continental crust.**

### **Types of Eruptions**

- **The *viscosity*, or resistance to flow, of magma affects the force with which a particular volcano will erupt.**
- **Magma that contains large amounts of trapped, dissolved gases is more likely to produce explosive eruptions than is magma that contains small amounts of dissolved gases.**
- **Oceanic volcanoes commonly form from mafic magma.**
- **Because of mafic magma's low viscosity, gases can easily escape from mafic magma.**
- **Eruptions from oceanic volcanoes, such as those in Hawaii, are usually quiet.**

### **Lava Flows**

- **When mafic lava cools rapidly, a crust forms on the surface of the flow.**
- **If the lava continues to flow after the crust forms, the crust wrinkles to form a volcanic rock called *pahoehoe*.**
- **Pahoehoe forms from hot, fluid lava. As it cools, it forms a smooth, ropy texture.**

- If the crust deforms rapidly or grows too thick to form wrinkles, the surface breaks into jagged chunks to form *aa*.
- Aa forms from lava that has the same composition as pahoehoe lava.
- Aa lava's texture results from the differences in gas content and the rate and slope of the lava flow.
- *Blocky lava* has a higher silica content than aa lava does, which makes blocky lava more viscous than aa lava.
- The high viscosity causes the cooled lava at the surface to break into large chunks, while the hot lava underneath continues to flow.

### Reading Check

How do flow rate and gas content affect the appearance of lavas?

*The faster the rate of flow is and the higher the gas content is, the more broken up and rough the resulting cooled lava will be.*

### Types of Eruptions

#### **Explosive Eruptions**

pyroclastic - material fragments of rock that form during a volcanic eruption

- Unlike the fluid lavas produced by oceanic volcanoes, the felsic lavas of continental volcanoes, such as Mount St. Helens, tend to be cooler and stickier.
- Felsic lava also contains large amounts of trapped gases, such as water vapor and carbon dioxide.

- So, felsic lava tends to explode and throw pyroclastic material into the air.

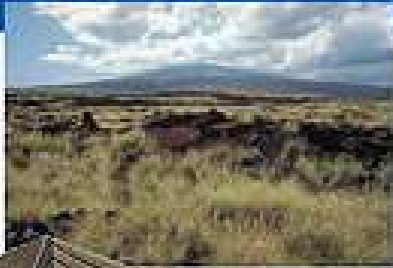


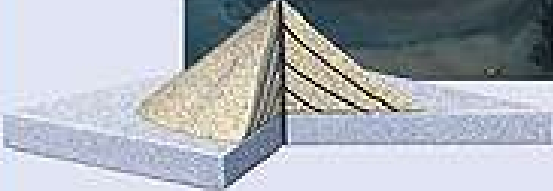
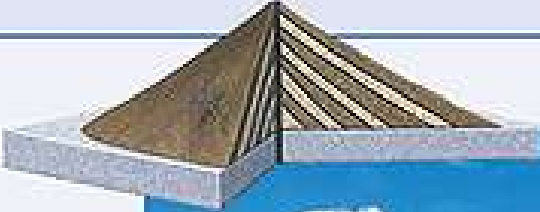

### Types of Pyroclastic Material

- Some pyroclastic materials form when magma breaks into fragments during an eruption because of the rapidly expanding gases in the magma.
- Other pyroclastic materials form when fragments of erupting lava cool and solidify as they fly through the air.
- Scientists classify pyroclastic materials according to the sizes of the particles.
- Pyroclastic particles that are less than 2 mm in diameter are called *volcanic ash*.
- Volcanic ash that is less than 0.25 mm in diameter is called *volcanic dust*.
- Large pyroclastic particles that are less than 64 mm in diameter are called *lapilli*.
- Large clots of lava may be thrown out of an erupting volcano while they are red-hot.
- As they spin through the air, they cool and develop a round or spindle shape. These pyroclastic particles are called *volcanic bombs*.
- The largest pyroclastic materials, known as *volcanic blocks*, form from solid rock that is blasted from the vent.

### Types of Volcanoes

- The lava and pyroclastic material that are ejected during volcanic eruptions build up around the vent and form volcanic cones.
- The funnel-shaped pit at the top of a volcanic vent is known as a *crater*.
- A crater usually becomes wider as weathering and erosion break down the walls of the crater and allow loose materials to collapse into the vent.

The diagram below shows the three types of volcanoes.

Types of Volcanoes	
<p><b>Shield Volcanoes</b> Volcanic cones that are broad at the base and have gently sloping sides are called <i>shield volcanoes</i>. A shield volcano covers a wide area and generally forms from quiet eruptions. Layers of hot, mafic lava flow out around the vent, harden, and slowly build up to form the cone. The Hawaiian Islands form a chain of shield volcanoes that built up from the ocean floor at a hot spot.</p>	 
 	<p><b>Cinder Cones</b> A type of volcano that has very steep slopes is a cinder cone. The slope angles of the cinder cones can be close to 40°, and the slopes are rarely more than a few hundred meters high. Cinder cones form from explosive eruptions and are made of pyroclastic material.</p>
<p><b>Composite Volcanoes</b> Composite volcanoes are made of alternating layers of hardened lava flows and pyroclastic material. During a quiet eruption, lava flows cover the sides of the cone. Then, when an explosive eruption occurs, large amounts of pyroclastic material are deposited around the vent. The explosive eruption is followed again by quiet lava flows. Composite volcanoes, also known as <i>stratovolcanoes</i>, commonly develop to form large volcanic mountains.</p>	 

## **Calderas**

**caldera** - a large, circular depression that forms when the magma chamber below a volcano partially empties and causes the ground above to sink

- Eruptions that discharge large amounts of magma can also cause a caldera to form.
- Calderas may later fill with water to form lakes.

## **Reading Check**

**Describe two ways that calderas form.**

***A caldera may form when a magma chamber empties or when large amounts of magma are discharged, causing the ground to collapse.***

## **PREDICTING VOLCANIC ERUPTIONS**

### **Earthquake Activity**

- One of the most important warning signals of volcanic eruptions is changes in earthquake activity around the volcano.

### **Earthquakes Occurring**

- An increase in the strength and frequency of earthquakes may be a signal that an eruption is about to occur.

### **Temperature Changes**

- Temperature changes within the rock and fracturing of the rock around a volcano can cause small earthquakes and signal the beginning of an eruption.

## **Gases Emitted**

- **A change in the amount and types of gases that are expelled from the volcano area is another sign that the volcano is going to change.**

## **Patterns in Activity**

- **Before an eruption, the upward movement of magma beneath the surface may cause the surface of the volcano to bulge outward.**
- **Predicting the eruption of a particular volcano also requires some knowledge of its previous eruptions.**
- **Unfortunately, only a few of the active volcanoes in the world have been studied by scientists long enough to establish any activity patterns.**