

Earth Science

Chapter 6: Volcanoes

Lecture Notes

- I. Volcanoes
 - A. Formation of a Volcano
 - i. Magma: molten rock not yet reaching the Earth's surface
 - ii. Lava: molten rock that has reached the Earth's surface
 - iii. Volcano: place on the surface where magma reaches the surface
 - iv. Vent: The opening from which lava erupts
 - v. Crater: funnel shaped pit at the top of a volcano
 - vi. Caldera: crater walls collapse in forming very large crater: Crater Lake in Oregon
 - B. Volcanic Eruptions
 - i. Four main types of lava
 1. Dark-colored
 - a. Contains a lot of water
 - b. Rich in iron and magnesium
 - c. Cools and forms rocks like basalt
 - d. Usually thin and runny: Hawaiian
 2. Light-color
 - a. Contains only a little water
 - b. Rich in silicon and aluminum
 - c. Cools and forms rhyolite
 - d. Thick and explosive: Mt. St. Helens
 3. Combination
 - a. Chemical composition similar to both light and dark
 - b. Cools to form andesite
 4. Contains > Gases
 - a. Steam and CO₂
 - b. Forms rocks w/ many holes when cooled
 - c. Pumice and scoria
 - ii. Volcanic Particles
 1. Volcanic Dust
 - a. < .25 mm
 - b. Consistency of flour grains
 2. Volcanic Ash
 - a. .25mm – 5mm in size
 - b. Rice grain in size
 3. Cinders
 - a. small volcanic bombs about golf ball size
 4. Volcanic bombs
 - a. A few centimeters to several meters in diameter
 - iii. Types of Volcanoes
 1. Cinder Cone
 - a. Made mostly of cinders and other rock particle
 - b. Little or no lava flows
 - c. Formed from explosive type volcanoes
 - d. Narrow base and steep sides

2. Shield Volcanoes
 - a. Composed mainly of runny lava flows
 - b. Largest volcanoes in the world
 - c. An example: Hawaiian Islands
 - d. Gentle slopes & domed shaped
3. Composite Volcanoes
 - a. Built up of alternating layers of cinders and lava
 - b. Mt. Vesuvius in Italy

6-1 Volcanoes and Plate Tectonics

A **volcano** is a weak spot in the crust where molten material, or magma, comes to the surface. **Magma** is a molten mixture of rock-forming substances, gases, and water from the mantle. When magma reaches the surface, it is called **lava**. When lava has cooled, it forms solid rock. Lava released during volcanic activity builds up Earth's surface.

Volcanoes occur in belts that extend across continents and oceans. One major volcanic belt is the **Ring of Fire**, formed by the many volcanoes that rim the Pacific Ocean. **Volcanic belts form along the boundaries of Earth's plates.** At plate boundaries, huge pieces of the crust spread apart or collide. As a result, the crust often fractures, allowing magma to reach the surface. Most volcanoes form along spreading plate boundaries such as mid-ocean ridges and along colliding plate boundaries where subduction takes place. Along the rift valley, lava pours out of cracks in the ocean floor, gradually building new mountains.

Many volcanoes form near colliding plate boundaries where oceanic plates return to the mantle. Volcanoes may form where two oceanic plates collide or where an oceanic plate collides with a continental plate. Many volcanoes occur near boundaries where two oceanic plates collide. Through subduction, the older, denser plate sinks into a deep-ocean trench down into the mantle. Some of the rock above the subducting plate melts and forms magma. Because the magma is less dense than the surrounding rock, it rises toward the surface. Eventually, the magma breaks through the ocean floor, creating volcanoes. The resulting volcanoes create a string of islands called an **island arc**. Volcanoes also occur where an oceanic plate is subducted beneath a continental plate.

Some volcanoes result from "hot spots" in Earth's mantle. A **hot spot** is an area where material from within the mantle rises and then melts, forming magma. **A volcano forms above a hot spot when magma erupts through the crust and reaches the surface.** A hot spot on the ocean floor can gradually form a series of volcanic mountains. The Hawaiian Islands formed one by one over millions of years as the Pacific plate drifted over a hot spot. Hot spots can also form under the continents. Yellowstone National Park in Wyoming marks a hot spot under the North American plate.

6-2 Volcanic Eruptions

Lava begins as magma deep beneath Earth's surface. Magma flows upward through cracks in the rock until it becomes trapped or reaches the surface to form a volcano.

Inside a volcano, magma collects in a pocket called a **magma chamber**. The magma moves through a **pipe**, a long tube that connects the magma chamber to Earth's surface. There, the magma leaves the volcano through an opening called a **vent**. The area covered by lava as it pours out of a vent is called a **lava flow**. Lava may collect in a **crater**, a bowl-shaped area around a volcano's central vent. As magma rises toward the surface, the pressure decreases and the dissolved gases begin to expand and exert an enormous force. **When a volcano erupts, the force of the expanding gases pushes magma from the magma chamber through the pipe until it flows or explodes out of the vent.**

Geologists classify volcanic eruptions as quiet or explosive. Silica is a material found in magma that is made of oxygen and silicon. If the magma has a low silica content, it flows easily and the volcano erupts quietly. The gases bubble out gently and the lava oozes quietly. Quiet eruptions can produce both fast-moving, hot lava that is thin and runny (pahoehoe) and slower-moving, cool, thicker lava (aa). A volcano erupts explosively if its magma is high in silica. The thick magma does not flow out of the chamber, but builds up in the pipe. The trapped gases build up pressure until they explode with incredible force. A **pyroclastic flow** occurs when an explosive eruption hurls out ash, cinders, and bombs. Volcano hazards include lava flows, clouds of ash and deadly gases, landslides, and avalanches of mud, snow, or rock.

Geologists often use the terms *active, dormant, or extinct* to describe a volcano's stage of activity. An active volcano is one that is erupting or has shown signs that it may erupt in the near future. A **dormant** volcano is not active now but may become active in the future. An **extinct** volcano is unlikely to erupt again. Geologists monitor changes in and around volcanoes to try to predict eruptions. But geologists cannot be certain about the type of eruption or how powerful it will be.

Hot springs and geysers are often found in areas of present or past volcanic activity. Hot springs collect in a natural pool. A **geyser** is a fountain of water and steam that erupts from the ground.

6-3 Volcanic Landforms

Some volcanic landforms are formed when lava flows build up mountains and plateaus on Earth's surface. **Volcanic eruptions create landforms made of lava, ash, and other materials. These landforms include shield volcanoes, cinder cone volcanoes, composite volcanoes, and lava plateaus.**

At some places on Earth's surface, thin layers of lava pour out of a vent. More layers of such lava harden on top of previous layers. The layers gradually build a wide, gently sloping mountain called a **shield volcano**. If a volcano's lava is thick, the lava may explode into the air and harden into ash, cinders, and bombs. These materials pile up around the vent, forming a steep, cone-shaped hill or mountain called a **cinder cone**. Sometimes lava flows alternate with explosive eruptions of ash, cinders, and bombs. The alternating layers form a tall, cone-shaped mountain called a **composite volcano**. Some eruptions of thin, runny lava flow out of cracks and travel a long distance before cooling and hardening. Over millions of years, these layers of lava build up over a large area to form a lava plateau.

An enormous eruption may empty a volcano's main vent and magma chamber. With nothing to support it, the top of the mountain collapses inward. The huge hole left by the collapse of a volcanic mountain is called a **caldera**.

Over time, the hard surface of a lava flow breaks down to form soil. Some volcanic soils are among the most fertile soils in the world. People have settled close to volcanoes to take advantage of the fertile soil.

Sometimes magma rises upward through cracks in the crust but does not reach Earth's surface. The magma cools and hardens into rock beneath the surface. **Features formed by magma include volcanic necks, dikes, sills, and batholiths.** A **volcanic neck** forms when magma hardens in a volcano's pipe. The softer rock around the pipe wears away, exposing the hard rock of the volcanic neck. A **dike** forms when magma forces itself across rock layers and hardens. A **sill** forms when magma squeezes between layers of rock and hardens. Dikes and sills are examples of igneous intrusions. An **intrusion** forms when magma hardens underground to form igneous rock. When a large body of magma cools inside the crust, a mass of rock called a **batholith** forms. Smaller bodies of hardened magma can form dome mountains.

6-4 California Geology

The movements of the Pacific and North American plates produced California's major geological features. These features include faults, volcanoes, mountain ranges, and basins. The large fault

system that runs along California's coast was formed as a result of movement along two plate boundaries. The North American plate and the Pacific plate grind past each other with great force. This movement has created many faults that make up the San Andreas fault system.

As oceanic plates get subducted beneath Earth's crust, they melt, forming magma. The magma rises to the surface, forming volcanoes. The volcanoes that have formed along California's coast are the result of active subduction of the Juan de Fuca plate. Mount Shasta and Lassen Peak formed in this way.

California has several mountain ranges. Some of them formed as the result of plate motion. As the Pacific plate and the North American plate collided, some of the crust crumpled and was pushed upward. This formed mountain ranges such as the Sierra Nevada and the Coast and Transverse ranges. Erosion has since shaped them into the peaks we see today.

Sometimes, plate movements cause the crust to warp downward. This forms large bowl-shaped valleys, or **basins**. These valleys often form between mountain ranges in response to the uplifting in the area next to them. Erosion of the surrounding mountains produces the sediment that fills these valleys. The **Central Valley** of California formed in this way.