

Volcanoes

Volcanoes are mountains from which hot, molten rock erupts. Have you ever wondered what causes them? Have you ever wondered if one could happen near where you live? Volcanoes are formed in different ways.

Most are a result of movement of the Earth's plates. Some are over "hot spots" on the Earth's surface.

Earth's curved surface is like a giant jigsaw puzzle. The pieces of the puzzle are the tectonic plates. The plates are constantly in motion. They move toward each other. They move away from each other. They slide past each other, each heading in opposite directions, scraping along each others' edge. We don't see the movement because it is very slow. We see the effects of this movement, though. Most earthquake and volcano activity takes place at the plate boundaries.

A hotspot volcano forms in the middle of a plate over a source of rising magma. Magma rises to the surface, burning its way through the crust like a blow torch. A hotspot stays still, but the plate keeps moving. Over millions of years, this process forms a string of volcanic islands like the islands of Hawaii. Hawaii's Mauna Loa and Kilauea, now active volcanoes, will become dormant (not active) as Hawaii moves off the hotspot. The Pacific plate has carried other island volcanoes in the chain far away from the magma source.

Hotspot volcanoes can also form on continents. Yellowstone National Park in Wyoming is one of the most famous hot spots found on a continent. The underlying magma is the reason for Yellowstone's famous geysers and hot springs. Underground water is heated by the magma source underneath it. The boiling water expands, making steam. Water and steam burst through the cracks in the crust, erupting as a geyser.

Volcanoes form when magma from inside earth reaches the surface. Volcanic mountains are most common at plate boundaries. At converging boundaries, where two plates are coming toward each other, heat and pressure melt rock into magma. One plate slowly dives, or subducts, beneath the other in what is called a "subduction zone." This is an area of intense earthquake and volcanic activity caused by the movement of the two plates. The area at which one plate dives beneath another creates an ocean trench, the deepest part of the ocean floor. Old crust is recycled here, pulled back into the mantle and re-melted.

As the subducted plate sinks deep into the mantle, it mixes with hot rock and melts to form magma. Under extreme heat and pressure, this new magma mixture then forces its way back upward to erupt violently at

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the surface. Subduction volcanoes are explosive and dangerous. This is due to the water present and the build-up of gases.

When magma is forced up onto Earth's surface, it becomes lava that hardens into rock. At diverging boundaries, where plates are pulling apart, magma rises through cracks and forms the mountains at mid-ocean ridges. New crust is formed where volcanoes erupt.

The ocean crust is not smooth. It has mountain ridges and deep rift valleys. When two plates with ocean crust move apart, magma from the mantle bubbles up to the surface to fill the rift. The magma cools and hardens and adds new strips of crust or ocean floor to the edges of the two plates. This forms what is called a spreading, or widening, ridge. The Atlantic Ocean is widening by about two centimeters per year.

Plates continue to move away from the spreading ridge towards other plates. When a spreading ridge breaks, earthquakes occur. Mid-ocean ridge volcanoes also form rifts, fed by the magma from below. Over millions of years, they can grow so large that the rise above the water to form islands, such as Iceland on the North Atlantic mid-ocean ridge.

A volcano begins deep below the surface of the earth in a magma chamber. These are huge pools of hot, liquid rock. The molten rock is less dense than the solid rock surrounding it. It begins to make its way to earth's surface.

Magma pushes its way through layers of rock. It works its way through cracks, parting the rocks as it moves. Some of the rocks melt and become part of the magma. Finally it breaks through the surface. A volcano is born, and the magma becomes lava. The opening in the crust where the magma breaks through is called a vent. The lava flows out the vent and surrounds it. It cools and becomes solid. Over time, a cone-shaped mountain is built up. This is the actual volcano.

Sometimes a volcano will have more than one vent. If this happens, lava will flow out all the vents. It can flow from the sides of the volcano as well as the top. A crater forms at the top of the volcano. This is a depression shaped like a bowl. The crater is connected to the magma chamber by the vent. Most volcanic craters are less than one kilometer in diameter. However, they can be as big as fifty kilometers across. These large craters are called calderas. Yellowstone National Park in the United States sits on top of three overlapping calderas.

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Calderas are formed when the top or side of a volcano collapses into the magma chamber. Steam causes explosions that blow the rocks apart. The crater widens. Eventually it can fill with water to form a lake. Crater Lake in Oregon is a famous caldera-formed lake.

Eventually the lava will form a mountain. This can happen on land or underwater. The islands of Hawaii were formed this way on the bottom of the ocean floor. Mauna Loa, if measured from the bottom of the ocean floor to the top of the mountain, is actually taller than Mount Everest!

Volcanic eruptions can be calm, with the lava just oozing out of the ground. Some explode with violence, destroying the mountain itself. A volcano's shape depends on how violent the eruption is. The material that forms the volcano also has an effect on its shape. The three basic types of volcanoes are cinder-cone, shield, and composite.

Cinder-cone volcanoes form from violent eruptions. Cinders and rocks explode high into the air. They rain back down to the surface and pile loosely around the vent. They form a cone with a narrow base and steep sides. Cinder-cone volcanoes are usually not more than 500 meters high. They can form on or near larger volcanoes. This is the most common type of volcano.

The lava that forms a cinder-cone volcano has a low viscosity. This means it is very runny. It contains a high volume of water. It also contains large amounts of gases. This makes cinder-cone volcanoes more explosive than other types.

Shield volcanoes are the largest volcanoes. They have gentle slopes and a wide, circular base. These volcanoes form when thin, running lava flows over a large area. Each time the volcano quietly erupts, the layers of cooled lava build up. The lava that forms shield volcanoes contains a large volume of basalt. It has a very low viscosity. Basaltic lava contains few gases, resulting in quiet, flowing eruptions. Mauna Loa in Hawaii is an example of a shield volcano.

The third type of volcano is called a composite volcano. A violent eruption occurs, forcing cinders and ash from the vent. This material settles around the vent, much like a cinder-cone volcano. This event is followed by a quiet eruption. The lava flows over the cinders. It eventually cools and hardens. After many of these alternating eruptions, a tall cone-shaped mountain forms.

Volcanoes (cont'd)

The lava that forms composite volcanoes also has a low viscosity. It contains large amounts of silica, water, and gases. These violent volcanoes can be very dangerous. Mount Etna in Italy and Mount Saint Helens in the state of Washington are two examples of composite volcanoes. When Mount Saint Helens erupted in 1980, the eruption was so violent it blew over one thousand feet off the top of the mountain!

There are several types of material that spill from a volcano. Solid particles are called tephra. This material is made of rock fragments. It can come from several sources. Tephra can be pieces of hardened lava. It can be mineral grains or pieces of the cone. These particles are classified by size.

The smallest pieces are called volcanic dust. It is a very fine material, almost like powder. Another type of tephra is called ash. Most ash is about the size of grains of rice. Ash may fall to the surface and form small rocks.

Both dust and ash are easily seen during violent volcanic eruptions. They can be blown high into the air and carried away by the wind. They eventually land, either near the volcano, or as far away as the other side of the earth! The clouds of tephra can block the sun and cause long-term changes in the weather.

Larger rock particles of tephra measure a few centimeters up to several meters in diameter. These are called volcanic bombs. These particles are molten blobs of lava when they leave the vent. As they travel through the air, they become solid. Smaller volcanic bombs are called cinders. These are about the size of golf balls. But others can be as large as boulders. They can weigh several tons!

A soupy mixture of gas, ash, and other tephra is called a pyroclastic flow. This material can be very dangerous. It is very hot! Temperatures of pyroclastic flows can reach over 700 degrees Celsius. They can travel at speeds of more than 200 kilometers per hour. Pyroclastic flows can contain poisonous gases. They move rapidly down the slope of the volcano. Everything in their path is destroyed.

Lava is another type of material that erupts from a volcano. Lava can be viscous (thick like honey) or thin and watery. It can be light-colored, or dark. Dark-colored lava is usually thin and runny. It contains large amounts of iron and magnesium. This kind of lava usually flows quietly down the sides of the volcano.

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Light-colored lava is very thick. It contains large amounts of silica. This lava is responsible for eruptions that are more explosive. Because it is so thick, it sometimes is stuck in the vent. It hardens into rocks that form a kind of plug. Steam and new lava build up below the plug. When the pressure becomes too great, an explosion occurs.

Not all traveling magma reaches the earth's surface. What happens to magma that does not erupt? As magma travels up toward the surface, it comes in contact with the rock that surrounds it. Magma forces its way into the rocks around it. This process is called intrusion. Many of the interesting mountains and rock formations found on earth's surface are a result of intrusive activity.

When magma intrudes, several things can happen. It can force the rocks of the crust apart. Small cracks called fissures will form in the rocks. The magma can seep slowly into them. The temperature is extremely hot. Some of the overlying rock may melt as the magma moves through it. When magma moves up toward the surface of the earth, there can be great pressure. Large chunks of overlying rock can be broken off. They then become part of the magma. Eventually they might melt also. Rock that has been changed by heat or pressure is called metamorphic rock.

Sometimes the magma begins to cool as it lies in the rocks under earth's surface. It forms minerals. Over time, these minerals combine to form rock bodies. These intrusive rock bodies are called plutons.

Plutons can be very long and thin like a ribbon. These are only a few centimeters thick, but they can be several hundred meters long. Other plutons can be very large, measuring hundreds of cubic kilometers. Over time, the forces of erosion and uplift can expose plutons on the surface. Plutons create some interesting landforms on the earth's crust.

There are several kinds of plutons. They are classified by their size and shape. They are also classified by whether they cut across or run parallel to the rock layers they intrude.

Batholiths are the largest plutons. They can form over millions of years. Batholiths have an irregular shape. They are made of coarse-grained igneous rocks such as granite and gabbro. Batholiths are often found in the interiors of many large mountains. The Sierra Nevada Mountains are an example of a batholith in the United States. The batholith has been exposed by years of erosion and uplift.

Volcanoes (cont'd)

A laccolith is a mushroom-shaped pluton. It is formed when magma moves horizontally between sedimentary rock layers. Magma that forms laccoliths is very viscous (thick). The pressure causes the rocks to bow upward. When the magma cools, it has a domed top and a flat bottom. Laccoliths are much smaller than batholiths. Most are less than fifteen kilometers wide. They form at shallow depths beneath the surface of the earth. Laccoliths are found in the Black Hills of South Dakota.

Another type of pluton is called a dike. These form when magma flows upward into fissures in the surrounding rocks. It cuts across the layers of rocks. The magma cools slowly and forms coarse-grained minerals. Dikes are usually very narrow, up to several meters wide. But they can be tens of kilometers long. They form almost vertically. They are common in areas where there is volcanic activity.

A sill is formed when magma intrudes between rock layers. It is similar to a laccolith. However, the intrusion that forms a sill does not force the rocks to bend upward. A sill can be very thin or very thick. The position of a sill is almost horizontal, like a window sill.

When people think about igneous activity, they mostly think of volcanoes. Volcanoes give us only a hint of the amount and movement of magma. Most of this activity takes place below the surface. Magma moves, cools, and forms plutons. These plutons can only be seen on the surface after years of uplifting and erosion.

Volcanoes are one of the most spectacular events that occur on earth. Scientists have learned a lot about the interior of the earth from studying volcanoes. By learning more about them, scientists can better predict when and where a volcano will erupt. This helps warn people to leave the area and protects people and property from destruction.

Volcanoes Questions

1. Where do most volcanoes form?
 - a. over a hot spot
 - b. at plate boundaries
 - c. in the middle of continents
 - d. in the ocean

2. Where do hotspot volcanoes form?
 - a. at plate boundaries
 - b. in the middle of continents
 - c. in the ocean
 - d. in the middle of a plate over a magma source

3. A subduction zone is where one plate:
 - a. dives beneath another plate
 - b. moves away from the plate next to it
 - c. slides past the plate next to it
 - d. pushes forward against the plate next to it

4. At a subduction zone:
 - a. new crust is made
 - b. old crust is re-melted, making new magma
 - c. geysers and hot springs are made
 - d. plates are pushed apart

5. What happens at a mid-ocean ridge?
 - a. new crust is made
 - b. old crust is re-melted, making new magma
 - c. geysers and hot springs are made
 - d. plates are pushed together

6. Why does magma flow upward toward the earth's surface?
 - a. It is less dense than the solid rock that surrounds it.
 - b. It is denser than the solid rock that surrounds it.
 - c. It is hotter.
 - d. It has less pressure.

7. When magma reaches the earth's surface, it is called:
 - a. rock
 - b. lava
 - c. caldera
 - d. magma

Volcanoes Questions (cont'd)

8. What is the opening in the crust called where magma breaks through?
 - a. a volcano
 - b. a vent
 - c. a subduction zone
 - d. a magma chamber

9. The very large, bowl-shaped depression on top of a volcano is called a:
 - a. vent
 - b. crater lake
 - c. caldera
 - d. mid-ocean ridge

10. What two things affect a volcano's shape?
 - a. the material that forms the volcano, and how violent the eruption is
 - b. the number of eruptions, and how many years apart they are
 - c. the temperature outside, and the temperature of the magma
 - d. the size of the magma chamber beneath, and the pressure of the magma

11. The three types of volcanoes are cinder-cone, shield, and:
 - a. vent
 - b. caldera
 - c. composite
 - d. viscosity

12. A volcano formed from a violent eruption, with a narrow base and steep sides, is called a:
 - a. shield volcano
 - b. cinder-cone volcano
 - c. composite volcano
 - d. caldera volcano

13. The largest volcanoes, which usually have quiet eruptions, are:
 - a. cinder-cone
 - b. shield
 - c. composite
 - d. vent

14. Solid particles that spew from a volcano are called:
 - a. pyroclastic flows
 - b. plutons
 - c. lava
 - d. tephra

Volcanoes Questions (cont'd)

15. The largest plutons are called:
- batholiths
 - laccoliths
 - dikes
 - sills
16. Mushroom-shaped plutons are called:
- batholiths
 - laccoliths
 - dikes
 - sills
17. A soupy mixture of gas, ash, and other tephra is called:
- pyroclastic flow
 - lava
 - iron
 - silica
18. Magma forces its way into the overlying rock. This process is called:
- eruption
 - intrusion
 - fissures
 - a volcano
19. Rock bodies that are formed from intrusive activities are called:
- plutons
 - volcanoes
 - fissures
 - magma
20. Dikes form almost vertically, while sills form:
- horizontally
 - mushroom-shaped
 - at shallow depths
 - on the surface

Name _____

Date _____

Volcanoes Answers

1. b
2. d
3. a
4. b
5. a
6. a
7. b
8. b
9. c
10. a
11. c
12. b
13. b
14. d
15. a
16. b
17. a
18. b
19. a
20. a