Teacher Feature

VOLCA

VOLCANO LEGENDS

The word "volcano" comes from the little island of Vulcano in the Mediterranean Sea off Sicily. Centuries ago, the people living in this area believed that Vulcano was the chimney of the forge of Vulcan—the blacksmith of the Roman gods. They thought the hot lava fragments and clouds of dust erupting from Vulcano came from Vulcan's forge as he beat out thunderbolts for Jupiter, king of the gods, and weapons for Mars, the god of war. In Polynesia, people attributed eruptive activity to the beautiful but wrathful Pele, goddess of volcanoes. Today we know that volcanic eruptions are not supernatural but can be studied and interpreted by scientists.

Visible from 100 miles away, Mount Shasta is one of the highest plain-to-summit rises on earth. With an overall height of 14,162 feet, the mountain soars 11,000 feet above its surroundings. This view is to the south near Interstate 5 in Siskiyou County. *Photo by Max Flanery.*

NOES!!

Gunung Merapi (High Fire Mountain), Central Java, Indonesia. This is one of the most active and destructive volcanoes in the world. Note village at foot of volcano. *Photo by Mary C. Woods, July 1992.*

Volcanoes are mountains, but they are very different from other mountains; they are not formed by folding and crumpling or by uplift and erosion. Instead, volcanoes are built by the accumulation of their own eruptive products—lava, bombs (crusted over lava blobs), ashflows, and tephra (airborne ash and dust). A volcano is most commonly a conical hill or mountain built around a vent that connects with reservoirs of molten rock below the surface of the earth. The term "volcano" also refers to the opening or vent through which the molten rock and associated gases are expelled.

Driven by buoyancy and gas pressure, the molten rock, which is lighter than the surrounding solid rock, forces its way upward and may ultimately break through zones of weaknesses in the earth's crust. If so, an eruption begins, and the molten rock may pour from the vent as nonexplosive lava flows, or it may shoot violently into the air as dense clouds of lava fragments. Larger fragments fall back around the vent, and accumulations of fall-back fragments may move downslope as ash flows under the force of gravity. Some of the finer ejected materials may be carried by the wind and fall to the ground many miles away. The finest ash particles may be injected miles into the atmosphere and carried many times around the world by stratospheric winds before settling out.

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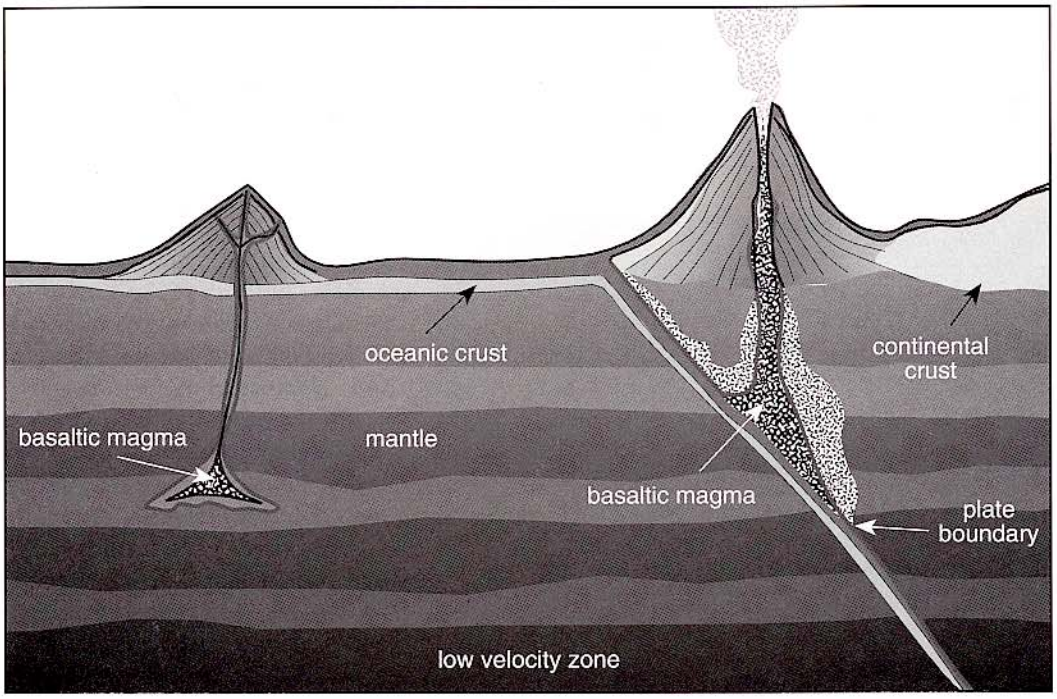
Klyuchevsky, an active volcano, Kamchatka Peninsula, Russia. *Photo by Mary C. Woods, July 1993.*



An idealized diagram of a volcano in an oceanic environment (left) and in a continental environment (right). *Modified from U.S. Department of the Interior, U.S. Geological Survey.*

Molten rock below the surface of the earth that rises in volcanic vents is known as *magma*, but after it erupts from a volcano it is called *lava*. Originating many tens of miles beneath the ground, the ascending magma commonly contains some crystals, fragments of surrounding (unmelted) rocks, and dissolved gases. However, it is mostly a liquid made principally of oxygen, silicon, aluminum, iron, magnesium, calcium, sodium, potassium, titanium, and manganese. Magmas also contain many other chemical elements in trace quantities. Upon cooling, the liquid magma may precipitate crystals of various minerals until they are solidified, thus forming an *igneous* or *magmatic rock*.

The diagram above shows that heat concentrated in the earth's upper *mantle* raises temperatures sufficiently to melt the rock locally by fusing the materials with the lowest melting temperatures. This results in small, isolated blobs of magma. These blobs then collect, rise through conduits and fractures, and some ultimately may re-collect in larger pockets or reservoirs (holding tanks) a few miles beneath the earth's surface. Mounting pressure within the reservoir may drive the magma farther upward through structurally weak zones to erupt as lava at the surface. In a continental environment, magmas are generated in the earth's crust as well as at varying depths in the upper mantle. The variety of molten rocks in the crust, plus the possibility of mixing with molten materials from the underlying mantle, leads to the production of magmas with widely different chemical compositions.

If magmas cool rapidly, as might be expected near or on the earth's surface, they solidify to form igneous rocks that are finely crystalline or glassy with few crystals. Accordingly, lavas, which are very rapidly cooled, form volcanic rocks typically characterized by a small percentage of crystals or fragments set in a matrix of *glass* (quenched or supercooled magma) or finer grained crystalline materials. If magmas remain deep underground and never break the surface, they cool much more slowly. This allows enough time to sustain crystal precipitation and growth, resulting in the formation of coarser grained, nearly completely crystalline, igneous rocks. After final crystallization and solidification, these rocks can be exposed by erosion many thousands or millions of years later as granitic rocks. Some of the most spectacular rocks at Yosemite National Park and other parts of the majestic Sierra Nevada are granitic rocks.

Lava is red-hot when it pours or blasts out of a vent but soon changes to dark red, gray, black, or some other color as it cools and solidifies. Very hot, gas-rich lava containing abundant iron and magnesium is fluid and flows like hot tar; cooler, gas-poor lava high in silicon, sodium, and potassium flows sluggishly, like thick honey in some cases or in others like pasty, blocky masses.

All magmas contain dissolved gases, and as they rise to the surface to erupt, the confining pressures are reduced and the dissolved gases are released either quietly or

explosively. If the lava is a thin fluid (not viscous), the gases may escape easily. But if the lava is thick and pasty (highly viscous), the gases will not move freely but will build up tremendous pressure, and ultimately escape with explosive violence. Gases in lava may be compared with the gas in a bottle of carbonated soft drink. If you put your thumb over the top of the bottle and shake it vigorously, the gas separates from the drink and forms bubbles. When you remove your thumb abruptly, there is a miniature explosion of gas and liquid. The gases in lava behave in somewhat the same way. Their sudden expansion causes the terrible explosions that throw out great masses of solid rock as well as lava, dust, and ash.

The violent separation of gas from lava may produce rock froth called *pumice*. Some of this froth is so light—because of the many gas bubbles—that it floats on water.

In many eruptions, the froth is shattered explosively into small fragments that are hurled high into the air in the form of volcanic cinders (red or black), volcanic ash (commonly tan or gray), and volcanic dust.

Information taken from Volcanoes *by Robert I. Tilling, a publication of the U.S. Department of the Interior, U.S. Geological Survey.*