VOLCANOES

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2017 YEAR OF RISK

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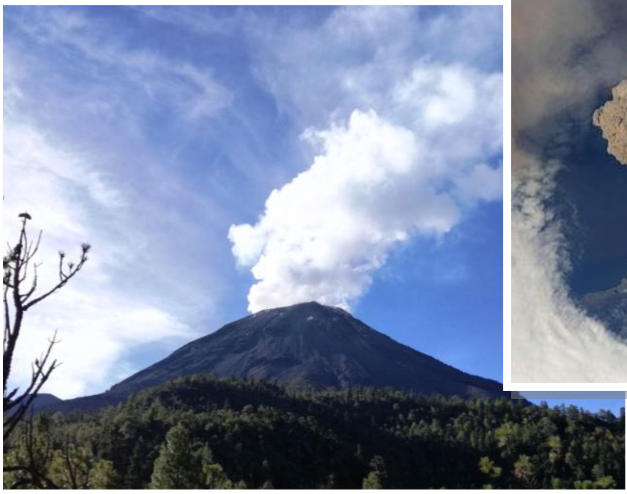

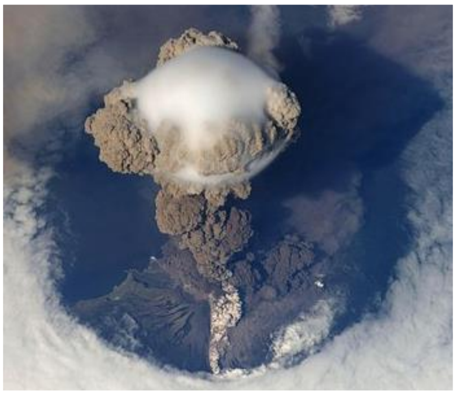

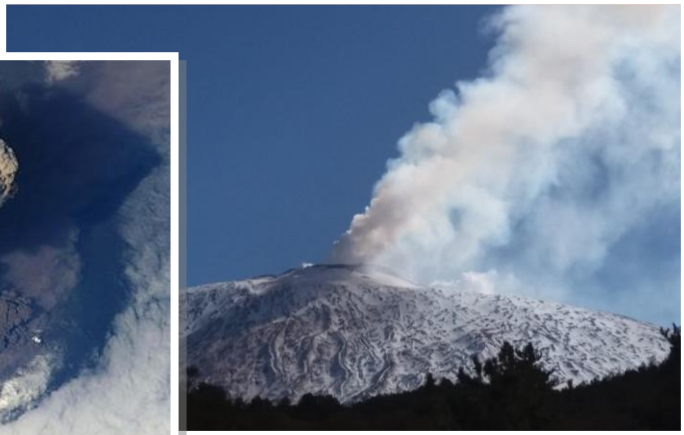

Image left: degassing of Colima, Mexico. Tom Hodgkinson
Image center: eruption of Sarychev, Russia
Image right: Etna, Italy. Alastair Hodgetts

A volcano is a rupture in the Earth's crust which allows magma and gas to escape from beneath the surface. When magma reaches the surface of the Earth, it is called lava. Over many eruptions, the layers of volcanic materials, like lava, ash and pumice, build up, forming a volcano.

How do volcanoes form?

Volcanoes can form in a number of different ways but in all cases, they form where there is partially molten rock, **magma**, below the surface of the Earth. This magma then either rises through natural cracks in the crust or gets stuck underground where the pressure rises until it erupts explosively.

At **convergent plate boundaries,** plates move towards each other. The denser of the two plates then sinks under the other. Inside the Earth, the denser plate becomes incredibly hot and loses of all its water. The water enters the mantle, lowering the melting temperature of the mantle rocks. This allows the rocks to melt, producing magma.

At **divergent plate boundaries,** plates move away from each other. As they move apart, a crack is created and pressure is lowered. This decrease in pressure lowers the melting temperature of mantle rocks. This newly molten magma is then erupted at the surface, most commonly under the sea.

In the middle of plates, we can sometimes find volcanoes, like Kilauea in Hawaii. These volcanic areas are called **hot spots** and are fed by **plumes** of hot, partially molten rock that rises from the mantle.

Fissure eruption of mantle plume material at the Hawaiian hot spot.

Types of eruption

How explosive an eruption is depends on two main factors: how much **silica** (SiO_2) and how many bubbles of **gas** there is in the magma. Silica increases the **viscosity** of magma (makes it less runny) which traps bubbles of gas in the magma, increasing pressure and therefore leading to a more explosive eruption.

Effusive

Effusive eruptions occur when magma has low silica content and therefore low viscosity. They usually cause few hazards the gas emissions from larger eruptions can affect climate. Effusive eruptions form **shield volcanoes**, which are typically large, round, low lying structures. Effusive volcanoes do not produce ash so the volcano is just made of lava. These eruptions take place at divergent plate boundaries and in the middle of plates.

Explosive

Volcanoes with high silica and gas content are explosive. They are very hazardous, producing **ash** (small fragments of broken rock), **pyroclastic density currents** (hot clouds of gas and rocks that flow down the sides of the volcano) and **lahars** (cement-like mixtures of water and hot ash). Explosive eruptions create **composite volcanoes**, built up of repeated layers of ash and lava over multiple eruptions. These eruptions take place at convergent plate boundaries.

DID YOU KNOW?

The 1815 eruption of Tambora, Indonesia, was one of the largest in recorded history. One of the main products of the eruption was Sulphur dioxide (SO_2), which acts as a short term global coolant. So many millions of tons of SO_2 were released during the eruption that global temperatures fell by 0.5°C. This led to 1816 being known as the 'Year without Summer'.

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Explosivity

Volcanic eruptions are classified on a logarithmic scale called the Volcanic Explosivity Index (VEI), which is scaled from 0 to 8.

VEI	Volume of erupted material (km^3)	Height of ash cloud (km)	Example
0	< 0.0001	< 0.1	Kilauea, Hawaii (ongoing since 1975)
1	> 0.0001	0.1 - 1	Nyiragongo, Democratic Republic of Congo (2002)
2	> 0.001	1 - 5	Stromboli, Italy (ongoing since Roman times)
3	> 0.01	3 - 15	Nevado del Ruiz, Colombia (1985)
4	> 0.1	> 10	Eyjafjallajökull, Iceland (2010)
5	> 1	> 10	Mount St Helens, USA (1980)
6	> 10	> 20	Pinatubo, Indonesia (1991)
7	> 100	> 20	Tambora, Indonesia (1815)
8	> 1000	> 20	Yellowstone, USA (630,000 years ago)

Can we predict an eruption?

An eruption is caused by the movement of magma underground. All methods of prediction, therefore, are designed to detect magma movement.

Rising magma can cause **ground deformation**, where parts of the volcano bulge or recede. **Global Positioning Systems** and **tilt meters**, which measure the angle of slope on a volcano's flank, can both pick up changes in ground level.

Movements underground can cause minor **earthquakes** as space is made to accommodate new material. Earthquakes are measured using **seismometers**; an increase in the frequency of quakes may mean that an eruption is imminent!

All magma contains gas. When magma rises, the pressure on it decreases, allowing more gas to escape. By measuring changing gas emissions at volcanic vents, volcanologists can tell when magma has risen.

A common cosmetic tool, pumice stone comes from the top of volcanoes; the holes are empty gas bubbles.

Volcanic Hazards

Lava the molten rock that flows from volcanoes isn't a particularly dangerous hazard. Generally speaking, even low viscosity, basaltic magma will only travel at 1 km/h on a gentle slope.

Ash: fragments of broken lava are thrown high into the air and can travel around the globe. Ash particles are toxic and sharp; breathing in ash can kill animals and humans. When mixed with water, ash becomes very heavy and collapses roofs.

Pyroclastic Density Currents: dense clouds of hot gas and rock that can reach 900°C and travel at 700 km/h on steep slopes. They are a major hazard that poses serious risk to people.

Lahars: when ash mixes with water, it creates a cement-like slurry that flows downhill. Lahars can be up to 70°C and can be activated by heavy rainfall months after an eruption. They can ruin fertile land and destroy villages.

Earthquakes: as magma rises through the Earth's surface, it can cause the ground to deform. This movement can cause earthquakes and, if underwater, **tsunamis**.

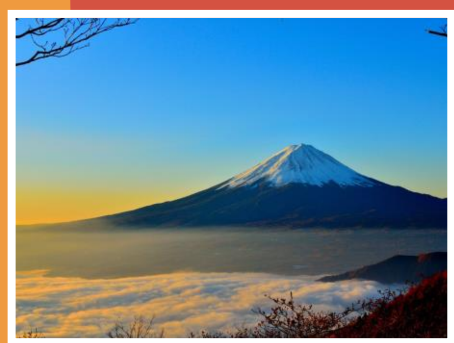
Gas: volcanoes produce large quantities of gas, such as SO_2 and CO_2, which can cause suffocation.

Volcanoes and people

Around the world, many millions of people live on or near volcanoes. Many do so because they have no choice, and the hazard posed by a dormant volcano is negligible, until it reawakens. Although prediction has improved greatly in recent years, volcanoes can still erupt with little to no warning. When a volcano starts to ramp up to an eruption, evacuation may be the only way to save the lives of those in harm's way; but evacuation may disrupt communities, damage livelihoods and cause misery to those affected.

A volcanologist measures gas release from an effusive volcanic eruption

There are some reasons why people might choose to live near volcanoes: volcanic materials such as ash are full of nutrients and, once broken down, they can act as a natural fertilizer (the land around Naples is intensively cultivated because of the rich soils produced by Mount Vesuvius); lava is also a good building material; the heat produced by volcanoes can be used to produce geothermal energy and the beauty of volcanic landscapes can create a great deal of wealth through tourism.



Mount Fuji, Japan. A famously stunning volcano, it attracts 300,000 climbers every summer.