

## Glossary:

This glossary includes definitions of key words relating to volcanology and the science done at volcanoes. Where appropriate we have included some context of these words in relation to the 2021 Eruption in La Palma.

### Scientific Terms

**Ash** – In volcanism, ash refers to any volcanic particles less than 2 mm in diameter. Read more about volcanic ash during the 2021 La Palma eruption [here](#).

**Ash plume** – The rising cloud of very fine particles of ash that is emitted by a volcano during an eruption. In general, the more explosive the eruption, the larger and higher the ash plume. Find out more about ash plumes [here](#).

**Conduit** – A volcanic conduit is a pipe that transports magma from the subsurface to the surface, where it is erupted. Read more about them [here](#).

**Deformation** – In relation to volcanic activity, deformation refers to small movements of the ground caused by the subsurface movement of magma. Deformation can either be measured from the ground, through [continuous GPS \(cGPS\) stations](#), or from planes or satellites using [Interferometric Synthetic Aperture Radar \(InSAR\)](#). The intrusion of magma underground will generally cause the inflation of the ground above it, and the emptying of a magma during a volcanic eruption is likely to cause deflation of the ground. However, because not all of the magma injected underground will be erupted on the surface, the deflation is often smaller than the associated inflation for a given eruption. Deformation can also be caused by the movement on faults during earthquakes associated with volcanic activity. In the 8 days before the La Palma eruption, inflation was measured near the eruption site, with a peak of 30 cm being recorded a few days into the eruption. Throughout October and November, slow deflation was seen around the eruption site.

**Degassing** – The process by which gases trapped in liquids escape. In volcanism, this relates to the gases trapped within magma, which escape as the magma rises to shallower depths and the pressure decreases. The main three gases degassed from magma, in order of abundance, are water vapour (H<sub>2</sub>O), Carbon Dioxide (CO<sub>2</sub>), and Sulfur Dioxide (SO<sub>2</sub>).

**Dike** – The name given to an intrusion of magma that cuts through existing rock layers, generally upwards close to vertical although they can be found at a range of angles. In the 2021 La Palma eruption, it is thought to be a series of dikes that transported magma from the shallow magma chamber at around 10 km depth to the surface. Examples of ancient dikes that are now exposed on the surface can be seen [here](#).

**Earthquake Intensity** – The intensity of an earthquake differs from the earthquake magnitude as it is an estimate of the intensity of shaking and damage caused on the surface due to an earthquake. As well as earthquake magnitude, the depth of an earthquake and the type of subsurface material the seismic waves travel through. The estimates of earthquake intensity come from information about these properties as well as ‘felt’ reports submitted by citizens who felt the earthquake. In the 2021 La Palma eruption, the [European Macroseismic Scale \(EMS\)](#), a 1 (weakest) to 12 scale (strongest), was used to measure the intensity of the earthquakes, with the most intense earthquakes measuring a 5 on this scale.

**Earthquake Magnitude** – The magnitude of an earthquake is a quantitative measurement of the energy released during an earthquake. There are many [different scales](#) that are used to measure earthquake magnitude, based upon their strength and the location of the earthquake as well as the location of recording equipment. The different scales can both measure [different seismic waves](#), and measure seismic waves in different ways (for more information see [here](#)). IGN Spain who recorded earthquakes during the 2021 La Palma eruption, used the [mBLg scale](#), which measures the [body wave magnitude](#), and is similar to the well-known Richter scale in that it uses a logarithmic scale. This scale is used because it is suited for measuring earthquakes close to their epicentre.

**Effusive** – In volcanic terms, this is used when describing a certain type of eruption or style of activity. Effusive activity. Effusive activity is characterised by the steady emission of lava out of a volcanic cone, as opposed to explosive activity, the other main classification for eruption styles, which is characterised by more discrete and violent explosions. Effusive activity is usually associated with basaltic eruptions, although other compositions of magma can also show effusive activity, and a single eruption can show both effusive and explosive activity at different times. To learn more about the difference between effusive and explosive activity and eruption styles, check out this guide [here](#).

**Fissure eruption** – An effusive volcanic eruption which takes place through multiple vents along a linear fracture or crack along the ground, which could be hundreds of metres or even kilometres long. Soon after starting, a fissure eruption typically concentrates around on or more certain vents, which dictates where a main cone for an eruption may form. [This summary](#) of the 2021 La Palma eruption can show the evolution of the fissure and building of a main cone, whilst [this timelapse](#) of the 2021 Fagradalsfjall eruption in Iceland shows a similar process.

**Fumarole** – Vents that emit only gas (such as CO<sub>2</sub> or SO<sub>2</sub>) or steam. In the 2021 La Palma eruption, [‘fields’ of multiple fumaroles](#) were observed on the flanks of the cone.

**Gas plume** - The rising cloud of gas that is emitted by a volcano during an eruption. The three most abundant gases in these plumes are water vapour (H<sub>2</sub>O), Carbon Dioxide (CO<sub>2</sub>), and Sulfur Dioxide (SO<sub>2</sub>). The gas plume may rise to a different height than the ash plume due to differing densities in each plume, and this was seen in the [2021 La Palma eruption](#).

**Geochemical monitoring** – The monitoring of a volcano by observing levels of gases or other chemicals associated with volcanic processes. Examples of some geochemical parameters that were measured during the 2021 La Palma eruption include CO<sub>2</sub> emissions, SO<sub>2</sub> emissions, and the [<sup>3</sup>He/<sup>4</sup>He ratio](#).

**Hawaiian activity** – A style of volcanic eruption characterised by gentle effusion of lava from vents with minimal ash, that produces lava flows. The style is seen in eruptions of basaltic magma with a poor gas content, as a higher gas content leads to more explosive eruption styles such as Strombolian activity. The type of activity is named after the islands of Hawaii, whose eruptions are known for this style of activity. This type of activity was seen during the 2021 La Palma eruption particularly during the start of October and was concentrating in vents that opened up on the flanks of the main cone, below the main vents (which largely showed Strombolian activity). Hawaiian activity was mostly seen in these lower vents because the magma erupted from these vents had

degassed more so had a lower gas content when they erupted. An example of Hawaiian activity during the 2021 La Palma eruption can be seen [here](#).

**Hydromagmatic explosions** – Explosions caused by the interaction of magma and water. These are similar to those seen in phreatomagmatic activity but can also happen when lava flows meet the sea or other water bodies. More information on the distinction between hydromagmatic and phreatomagmatic activity is available [here](#).

**Hydrothermal** – Referring to water being heated by an external source. Many volcanoes, including Cumbre Vieja on La Palma, have extensive hydrothermal systems beneath them, where aquifers or other bodies of water are heated by the magma below the volcano.

**Intrusion (magmatic)** – A magmatic intrusion, often just referred to as an intrusion when talking about volcanoes, is an injection of magma into the earth's crust from depth. The 2021 La Palma earthquake started with an intrusion of magma roughly 10 km depth before the eruption, and was estimated by [INVOLCAN](#) to have a volume of 11 million m<sup>3</sup>.

**Jameo(s)** – A Canarian word for sunken terrain area where a volcanic conduit opens to the surface. It is also used to describe a hole that is produced by the partial collapse of the roof of a volcanic tube. An example of a Jameo produced during the 2021 La Palma eruption can be seen [here](#).

**Lapilli** – A size classification for volcanic particles between 2 mm and 64 mm in diameter. Have a closer look at lapilli from the 2021 La Palma eruption [here](#).

**Lava** – Lava is the term given to molten or partially molten rock when it is above the surface. In a volcanic eruption, magma rises upwards from the subsurface and becomes lava when it erupts onto the surface.

**Lava delta** – This refers to the new, low-lying land created when a lava flow meets and flows out into the sea. In reporting of the 2021 La Palma eruption, the word 'Fajana' was used to describe these features, which is a Canarian word derived from the Portuguese word for an area of low-lying land next to the coast. Detailed views of the lava deltas created by the eruption can be seen [here](#).

**Lava flow field** – Refers to an area comprising multiple individual lava flows from the same volcanic eruption. It is useful when differentiating between the impacts of single active lava flows and the broader impression of all the lava flows produced by an eruption. With the 2021 La Palma eruption, the overall flow field was broken down into 11 individual lava flows, which were active and took different paths during different phases of the eruption. A map of those lava flows can be seen [here](#).

**Lava fountains** – Vertical jets of magma emitted from an erupting volcano caused by the thrusting of material upwards due to the rapid expansion of gas bubbles in the magma as it gets closer to the surface and depressurises. They can be anywhere from 10s to many 100s of metres tall. A video of lava fountaining during the 2021 La Palma eruption can be seen [here](#).

**Lava tube** – A landform which is formed where cooling at the margins of the lava channel causes a 'roof' of cooled lava to cover the channel, so that the surface of the lava flow appears cooled, whilst lava continues to flow in the 'tube' formed within the lava flow. Lava tubes are very efficient for transporting lava flows long distances because the flowing lava is very well insulated and takes longer to cool than lava flowing in open channels.

After the first few weeks of the 2021 La Palma eruption, a complex network of lava tubes began to form beneath the lava flow field. For more information on lava tubes, see [this US National Park Service Guide](#).

**Long period earthquake** – One of three main types of earthquakes recorded at volcanoes (tremor and volcano-tectonic earthquakes are the others), these are named because of their characteristic low frequency (i.e. long period) vibrations relative to other types of earthquakes, which can be seen on seismograms. They are also known as LP (long period) or LF (low frequency) earthquakes. These types of earthquakes can be caused by the movement of fluids (water or magma) through cracks in the ground. These earthquakes are most commonly recorded between eruptions at volcanoes with subsurface hydrothermal systems, such as the post-eruptive seismic swarm on [La Palma in March 2022](#).

**Magma** – Magma is the term given to molten or [partially molten](#) rock when it is below the surface.

**Phreatic activity** – An explosive steam eruption at a volcano, which does not emit any magmatic material. This can occur where a hydrothermal system beneath a volcano is heated up and pressurised, causing an explosion. A recent example of a phreatic eruption is the [2019 eruption at Whaakari/White Island eruption](#) in New Zealand that killed 22 people.

**Phreatomagmatic activity** – This is a type of explosive eruptive activity that occurs when rising magma interacts explosively with subsurface water. The activity is characterised by thick ash and steam plumes that are light in colour due to the abundant white steam generated. In the 2021 La Palma eruption, phases of phreatomagmatic activity were seen when rising magma interacted with the ground water beneath the island. Some of these phases came after heavy rainfall, when the water table rose. More information on phreatomagmatic activity is available [here](#).

**Pyroclasts** – Rocks ejected by explosive volcanic activity containing fragments of magma broken apart by explosions. Pyroclasts cover an extremely wide range of sizes from ash particles to volcanic bombs that could be on the order of metres in size. The various cones formed during the 2021 La Palma eruption were comprised of pyroclasts that built up over time around erupting vents.

**Seismic swarm** – A group of earthquakes that occur as a cluster around a certain area within a short period of time. Swarms may last anywhere from days to years, but are different from major earthquake events that are associated a series of foreshocks or aftershocks. Prior to the 2021 La Palma eruption, there were 9 different seismic swarms, starting in October 2017. An animation of each of these swarms can be seen [here](#).

**Strombolian activity** – A style of volcanic eruption characterised by cyclical or continuous (relatively) mild explosions and lava fountaining emitting ash, lapilli, and volcanic bombs anywhere from tens to hundreds of m high. The style is seen in eruptions of basaltic magma with a moderate gas content. The style is named after Stromboli volcano in the Aeolian Islands just north of Sicily, which commonly displays this type of activity. Strombolian activity was the predominant eruption style seen during the 2021 La Palma eruption from the most active vents, although phases of Hawaiian and Phreatomagmatic eruptive activity were also seen. An example of Strombolian activity during the 2021 La Palma eruption can be seen [here](#).

**Tephra** – A general term given to volcanic material that is ejected through the air by an erupting volcano.

**VEI** – An acronym for Volcanic Explosivity Index, which is a scheme for classifying volcanic eruptions by size. The scheme is based on a scale from 0 (least explosive/smallest) to 8 (most explosive/largest), with one of two possible criteria needed to be met to meet a certain VEI number, ash plume height, or total erupted tephra volume (not including lava flow volume). The scheme was [developed in 1982](#) by volcanologists Christopher Newell and Steven Self, and a breakdown of the scheme can be seen [here](#). The 2021 La Palma eruption was a VEI 3 eruption, based on the total erupted tephra volume of greater than 10 million m<sup>3</sup>. It was initially estimated as a VEI 2 eruption, before being upgraded to a VEI 3 eruption in late November. This change caused some confusion, but it was purely due to the increase in the cumulative erupted tephra volume and did not imply any changes to the characteristics or explosivity of the eruption.

**Vent** – A vent in a volcanic sense is an opening in the earth's surface where gas or magma is emitted. The 2021 La Palma eruption had [multiple vents active](#) at the same time throughout the eruption, with different vents opening and closing with many times.

**Volcanic bombs** – Also known as volcanic blocks or lava bombs, a size classification for volcanic particles greater than 64 mm in diameter. Watch a spectacular video of a volcanic bomb from the 2021 La Palma eruption [here](#).

**Volcanic Edifice** – A synonym of volcanic cone, the main surface impression of a volcano. A picture of the cone after the eruption can be seen [here](#).

**Volcanic Tremor** – Also sometimes just referred to as tremor, volcanic tremor is the name given to continuous earthquakes within a specific range of frequencies associated with volcanic eruptions and the movement of magma. They can be detected by seismometers, and the amplitude and frequency of the signals can be used to interpret underground magmatic processes. In the 2021 La Palma eruption, near continuous volcanic tremor was recorded from a few hours before the eruption until the eruption ended on the evening of the 13<sup>th</sup> December. You can learn more about volcanic tremor from this [article](#), this USGS [definition](#), or this University of Oregon [article](#).

**Volcano-tectonic earthquake** – Also known as VT earthquakes, earthquakes that are caused by slip on faults close to a volcano, that may be triggered by the movement of magma in the subsurface. These types of earthquakes may occur both before and during an eruption and are distinguishable from the other types of volcanic earthquakes (tremor and long-period earthquakes) by their waveform. More information about VT earthquakes is available [here](#).

**Xenolith** – A rock which contains a fragment of a different type of rock from another origin. They are mostly found where lava at an erupting volcano contains blocks of the crust from other rocks that have been broken off and incorporated into the magma. In the 2011 El Hierro underwater eruption in the Canary Islands, basalts containing sedimentary xenoliths were erupted and were termed '[Restingolites](#)' after the town of La Restinga, the closest town to the eruption. Similar xenoliths have also been found in lavas from the 2021 La Palma eruption.

**Organisations:**

**PEVOLCA** - Plan de Emergencias Volcánicas de Canarias (Volcanic emergency plan of the Canary Islands)

**IGN Spain** - Instituto Geográfico Nacional (National Geographic Institute of Spain)

**INVOLCAN** - Instituto Volcanológico de Canarias (Volcanological Institute of the Canary Islands)

**CSIC** - Consejo Superior de Investigaciones Científicas (Spanish National Research Council)