

# Caldera: GS-1 Notes for UPSC

A caldera is a depression formed after a volcano releases the bulk of its magma in an explosive eruption. Without any structural backing underneath, the land around the erupting volcanic vent or vents downfalls inwardly, constructing the bowl-shaped caldera.

The topic regarding calderas is important in the GS-1 section of the UPSC Mains Exam.

## How is a Caldera formed?

When the magma chamber of a volcano is discharged, a collapse is triggered. The emptying of a magma chamber is the result of a large volcanic explosion, along with effusive eruption on the sides of a volcano and connected fissure systems. If and when a large amount of magma is expelled, the now empty chamber will be unable to support the entire weight of the mountain structure above it. Thus a roughly circular fracture, the "ring fault", develops around the edge of the chamber.

This "ring fault" serves as a feeder for fault intrusions which are also known as ring dykes. The centre of the volcano located within the ring structure will begin to collapse as the magma chamber begins to be emptied. The collapse might happen at once due to cataclysmic eruption or in stages as a result of many explosions. The total area that collapses may be hundreds or thousands of square kilometres.

## What are the different types of Calderas?

Due to the unpredictable nature of a volcanic explosion and the topography of the area in which the explosions happen, there are different types of calderas. Some of them are as follows:

**Crater-lake Calderas:** A Crater-lake caldera is the result of collapse after a high-explosive eruption known as Plinian eruption that releases massive amounts of lava, volcanic ash, and rocks.

When a magma chamber is emptied the off collapse then forms the caldera and as a result, water is filled through rain, flooding by rivers or oceans and in case of the frigid regions, snow. Thus a lake is formed in the centre. An example of this type of a caldera is Deception Island off the coast of Antarctica.

### **Shield Volcano Calderas:**

Shield volcanoes are formed as a result of a series of explosions over the years. These explosions subside in gradual stages due to the periodic release of lava. This less-explosive release of lava, known as lava fountaining, is characteristic of shield volcanoes. As a shield

volcano periodically releases lava, it produces nested or terraced depressions rather than a large bowl-shaped caldera.

The Galápagos Islands are an example of a series of shield volcanic landforms with some summit calderas.

### **Resurgent Calderas:**

Resurgent calderas are the largest volcanic structures on Earth, ranging from 15 to 100 kilometres in diameter. They are not associated with one particular volcano but instead result from the widespread collapse of vast magma chambers. This caldera collapse is produced by incredibly destructive eruptions known as pyroclastic sheet flows, the likes of which have not occurred in historic times.

The Toba Caldera on the Indonesian island of Sumatra is the example of a newest resurgent caldera, created roughly 74,000 years ago by the largest volcanic eruption in the last 25 million years. This massive eruption ejected 2,800 cubic kilometres of debris, enough to block the sun for centuries to come. It resulted in a nuclear winter-like situation that almost brought about the extinction of all life on earth.

**Extraterrestrial Calderas:** Through high-powered telescopes, it has been known that volcanism has occurred on other planets and moons in the Solar System. Through the use of manned and unmanned spacecraft, volcanism has been discovered on Venus, Mars, the Moon, and Io, a satellite of Jupiter. None of these worlds has plate tectonics, which contributes approximately 60% of the Earth's volcanic activity (the other 40% is attributed to hotspot volcanism).

Caldera structure is similar on all of these planetary bodies, though the size varies considerably. The average caldera diameter on Venus is 68 km. The average caldera diameter on Io is close to 40 km, and the mode is 6 km. The average caldera diameter on Mars is 48 km, smaller than Venus. Calderas on Earth are the smallest of all planetary bodies and vary from 1.6–80 km as a maximum.

**Explosive Calderas:** Explosive calderas are formed when very large magma chambers filled with silica-rich melt and abundant gas move upwards from depth. Silica-rich magmas have a very high viscosity that enables them to hold gas bubbles under very high pressures. As they rise to the surface, the reduction of pressure causes the gases to expand. When break-through occurs the result can be an enormous explosion which blasts away large volumes of rock to form the caldera. Some of these blasts eject many cubic kilometres of magma and rock.