Geography

Volcanoes and volcanic eruptions

Volcanoes form when magma reaches the Earth's surface, causing eruptions of lava and ash. They occur at destructive (compressional) and constructive (tensional) plate boundaries.

The immediate effects of volcanic eruptions can be devastating, but they may be beneficial in the long term.

Key facts

A volcano is formed by eruptions of lava and ash.
Volcanoes are usually **cone shaped** mountains or hills.
When *magma* [**magma**: *Magma is molten rock.*] reaches the Earth's surface it is called lava. When the lava cools, it forms rock.
Volcanic eruptions can happen at *destructive* [**destructive boundaries**: *The boundary of two plates which are moving towards each other.*] and *constructive* [**constructive boundaries**: *Areas between two crustal plates that are moving away from each other, causing new crustal rocks to form. May also be referred to as divergent plate boundaries.*] boundaries, but not at *conservative boundaries* [**conservative boundaries**: *Areas between two crustal plates that are moving past each other in opposite directions.*].
Some volcanoes happen underwater, along the seabed or ocean floor.

The formation of volcanoes

1. Magma rises through cracks or weaknesses in the Earth's crust.
2. Pressure builds up inside the Earth.
3. When this pressure is released, eg as a result of plate

movement, magma explodes to the surface causing a volcanic eruption.
4. The lava from the eruption cools to form new crust.
5. Over time, after several eruptions, the rock builds up and a volcano forms.

Krakatoa in the Sunda Strait, Indonesia

Inside a volcano

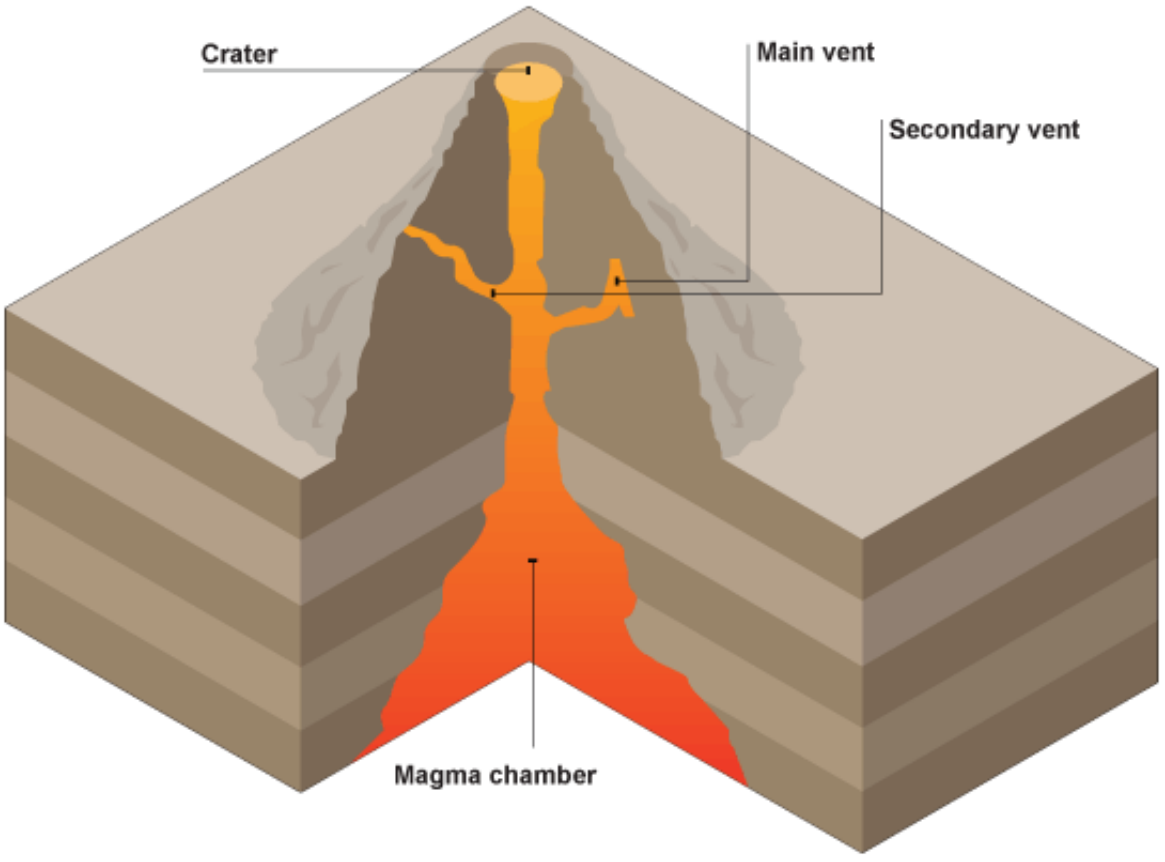


Diagram of a volcano

The **magma chamber** is a collection of magma inside the Earth, below the volcano.
The **main vent** is the main outlet for the magma to escape.
Secondary vents are smaller outlets through which magma escapes.
The **crater** is created after an eruption blows the top off the volcano.

An eruption occurs when pressure in the magma chamber forces magma up the main vent, towards the crater at the top of the volcano. Some magma will also be forced out of the secondary vent at the side of the volcano.

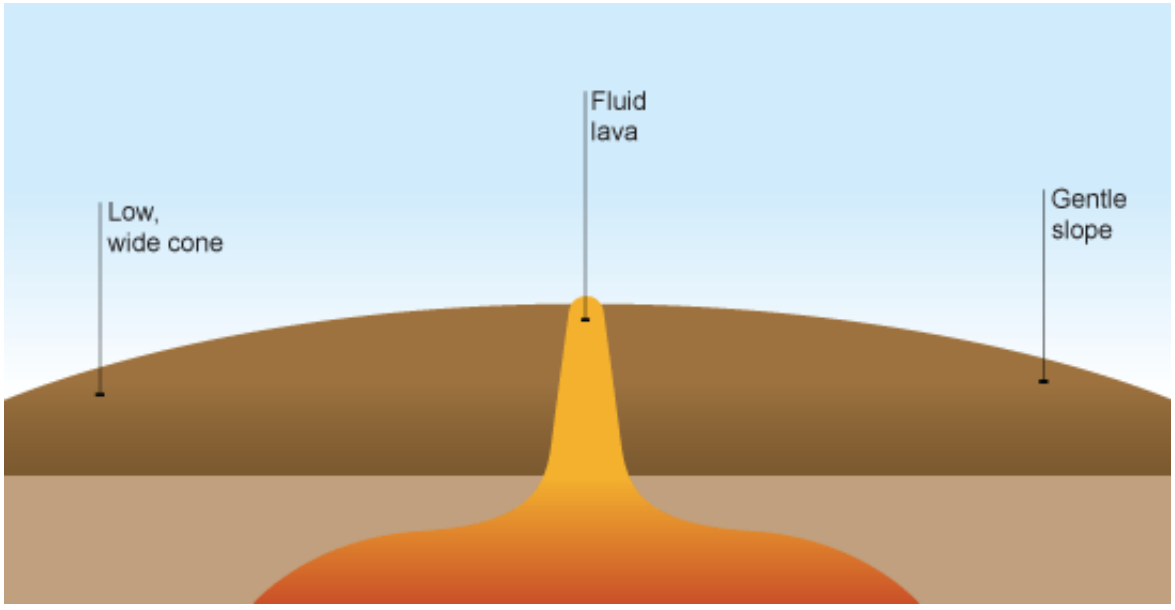
Different types of volcano

Volcanoes can be described in terms of activity and can be:

still **active** and erupt frequently
dormant (temporarily inactive but not fully extinct)
extinct (never likely to erupt again)

Volcanoes can also be described by their shape or type - shield or composite.

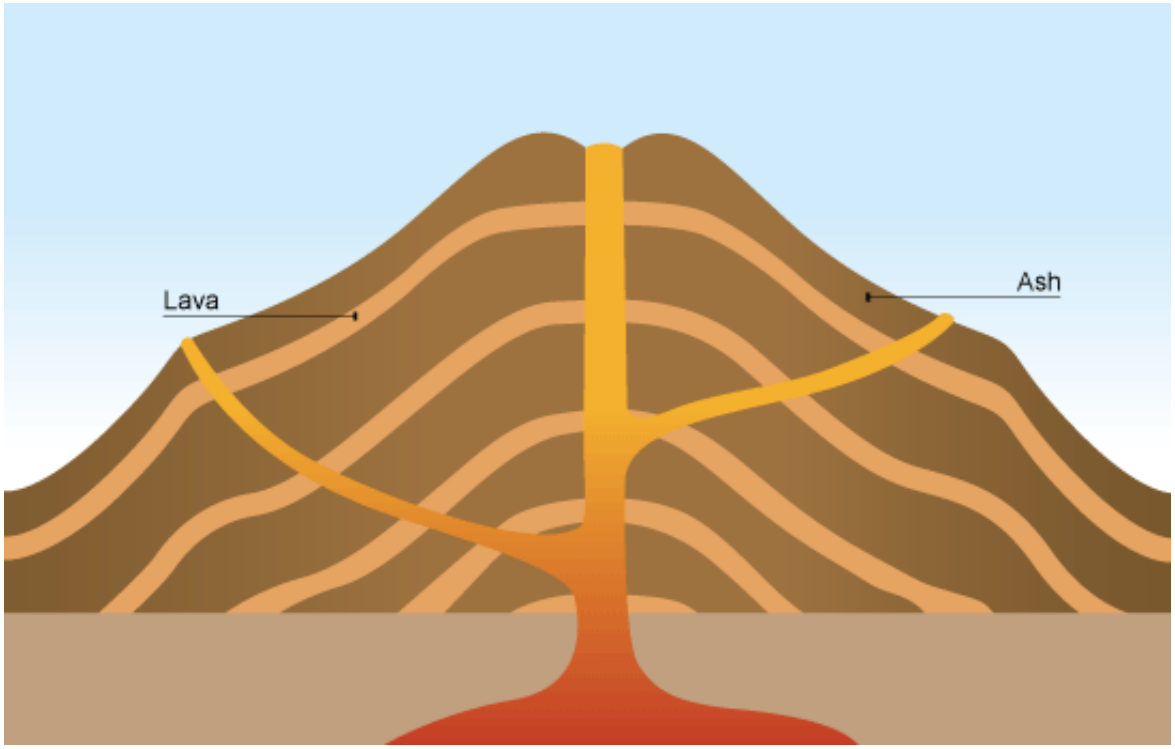
Shield volcanoes



The characteristics of a shield volcano

Shield volcanoes are usually found at *constructive* [**constructive boundaries**: *Areas between two crustal plates that are moving away from each other, causing new crustal rocks to form. May also be referred to as divergent plate boundaries.*] or tensional boundaries.
They are low, with gently sloping sides.
They are formed by eruptions of thin, runny lava.
Eruptions tend to be frequent but relatively gentle.

Composite volcanoes



Characteristics of a composite volcano

Composite volcanoes are made up of alternating layers of lava and ash (other volcanoes just consist of lava). They are usually found at *destructive* [**destructive boundaries**: *The boundary of two plates which are moving towards each other.*] or compressional boundaries.

The eruptions from these volcanoes may be a pyroclastic flow rather than a lava flow. A **pyroclastic** flow is a mixture of hot steam, ash, rock and dust.

A pyroclastic flow can roll down the sides of a volcano at very high speeds and with temperatures of over 400°C.

Supervolcanoes

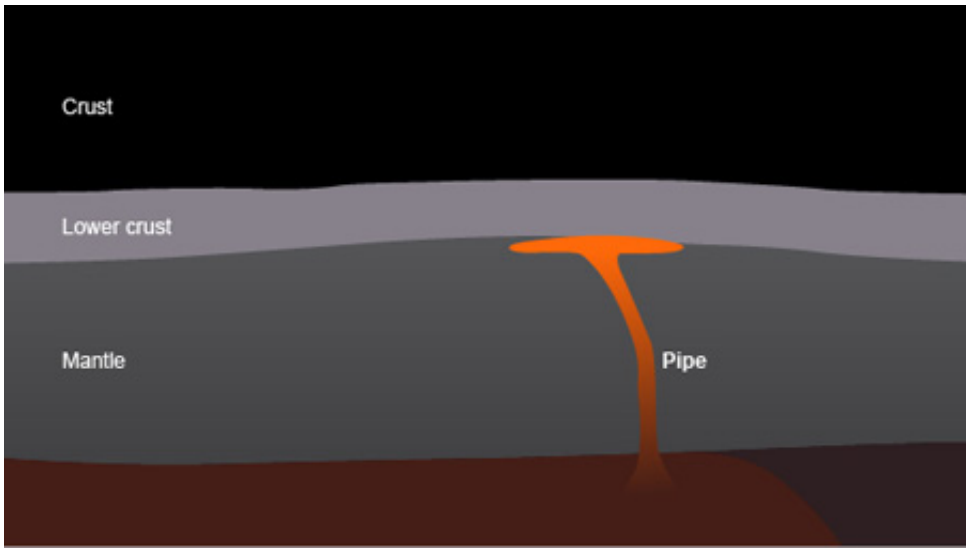
A supervolcano is a volcano on a **massive scale**. It is different from a volcano because:

it erupts at least 1,000 km^3 of material (a large volcano erupts around 1 km^3)

it forms a depression, called a *caldera* [**caldera**: *A*

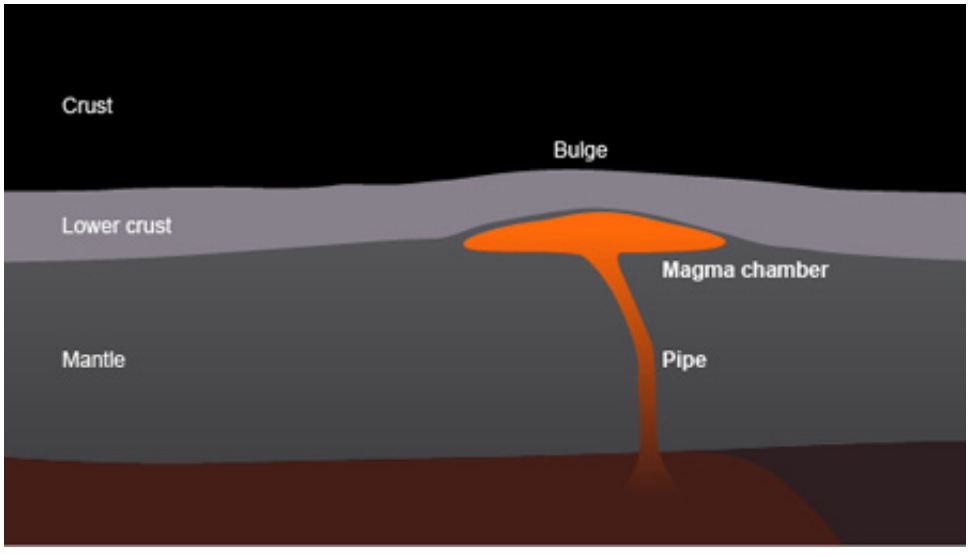
cauldron / depression shaped tectonic feature usually formed from the collapse of a magma chamber.] (a volcano forms a cone shape)
a supervolcano often has a ridge of higher land around it
a supervolcano erupts less frequently - eruptions are hundreds of thousands of years apart

The stages in the creation of a supervolcano caldera



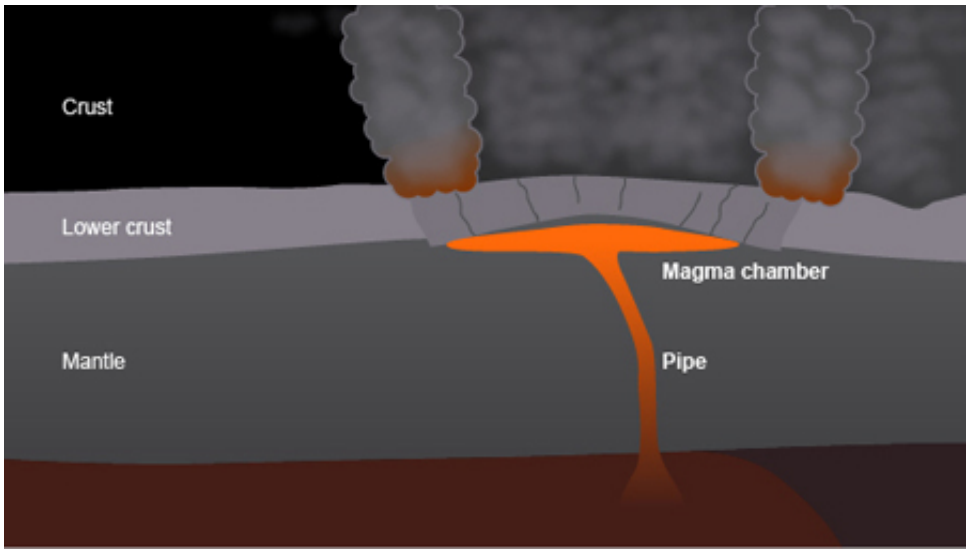
Magma cannot escape to the surface and collects under the lower crust.

The stages in the creation of a supervolcano caldera



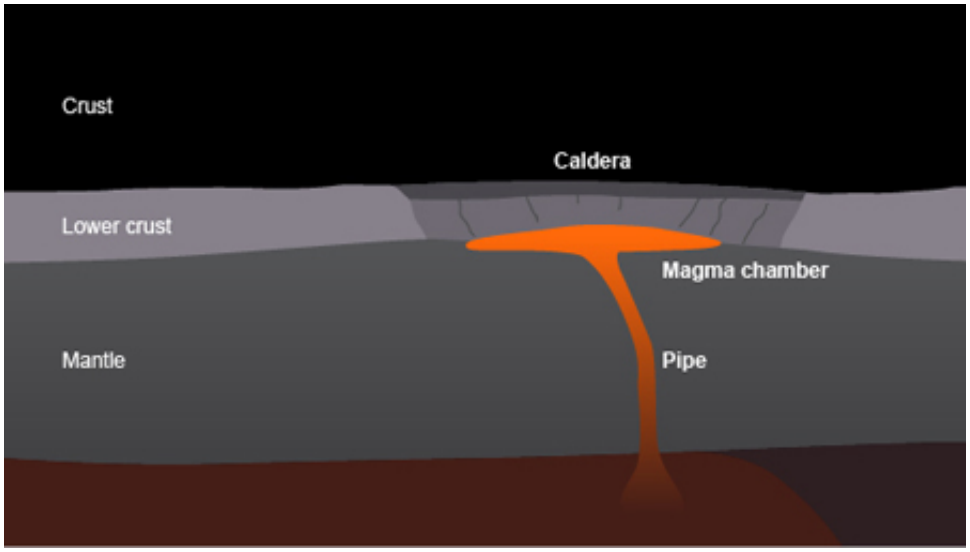
An 'uplifted bulge' begins to form under the lower crust as the magma chamber enlarges.

The stages in the creation of a supervolcano caldera



Cracks appear on the surface. Gas and ash erupt from the magma chamber through these cracks.

The stages in the creation of a supervolcano caldera



The magma chamber collapses and a depression is formed. This is called a caldera.

Yellowstone

Yellowstone is one example of a supervolcano. Three huge eruptions have happened in the last 3 million years. the last eruption was 630,000 years ago, and was 1,000 times bigger

than the Mount St Helens eruption in 1980.

A hydrothermal feature at Yellowstone

The large volume of material from the last Yellowstone eruption caused the ground to collapse, creating a depression called a *caldera* [**caldera**: *A cauldron / depression shaped tectonic feature usually formed from the collapse of a magma chamber.*]. The caldera is 55 km by 80 km wide. The next eruption is predicted to have catastrophic worldwide effects.

The supervolcano at Yellowstone is formed because of a volcanic *hotspot* [**hotspot**: *An area of the Earth's crust where an unusually high amount of heat flow is causing volcanic activity.*].

Every year millions of visitors come to see the related features, such as *geysers* [**geyser**: *A spring of water which has been heated geothermally which erupts intermittently.*] and hot springs. Old Faithful is one example of a geyser.

Effects of volcanic eruptions

Volcanic eruptions can have a devastating effect on people and the environment.

Helgafjell Volcano, Iceland

However, unlike earthquakes, volcanoes can also have a positive impact on an area. These positive impacts can help to explain why people choose to live near volcanoes.

Positive and negative effects of an eruption

Positive	Negative

The dramatic scenery created by volcanic eruptions attracts tourists. This brings income to an area.	Many lives can be lost as a result of a volcanic eruption.
The lava and ash deposited during an eruption breaks down to provide valuable nutrients for the soil. This creates very fertile soil which is good for agriculture	If the ash and mud from a volcanic eruption mix with rain water or melting snow, fast moving mudflows are created. These flows are called *lahars* [**lahar**: *A destructive volcanic landslide or mudflow, consisting of a mixture of volcanic debris, mud, rock and water.*].
The high level of heat and activity inside the Earth, close to a volcano, can provide opportunities for generating geothermal energy.	Lava flows and lahars can destroy settlements and clear areas of woodland or agriculture.
	Human and natural landscapes can be destroyed and changed forever.

Case study: Chances Peak, Montserrat, 1995-97 - an LEDC

Montserrat is a small island in the Caribbean. There is a volcanic area located in the south of the island on Soufriere Hills called **Chances Peak**. Before 1995 it had been *dormant* [**dormant**: *A volcano is classed as dormant when it is temporarily inactive but not fully extinct.*] for over 300 years. In

1995 the volcano began to give off **warning signs** of an eruption (small earthquakes and eruptions of dust and ash). Once Chances Peak had **woken up** it then remained active for five years. The most intense eruptions occurred in 1997.

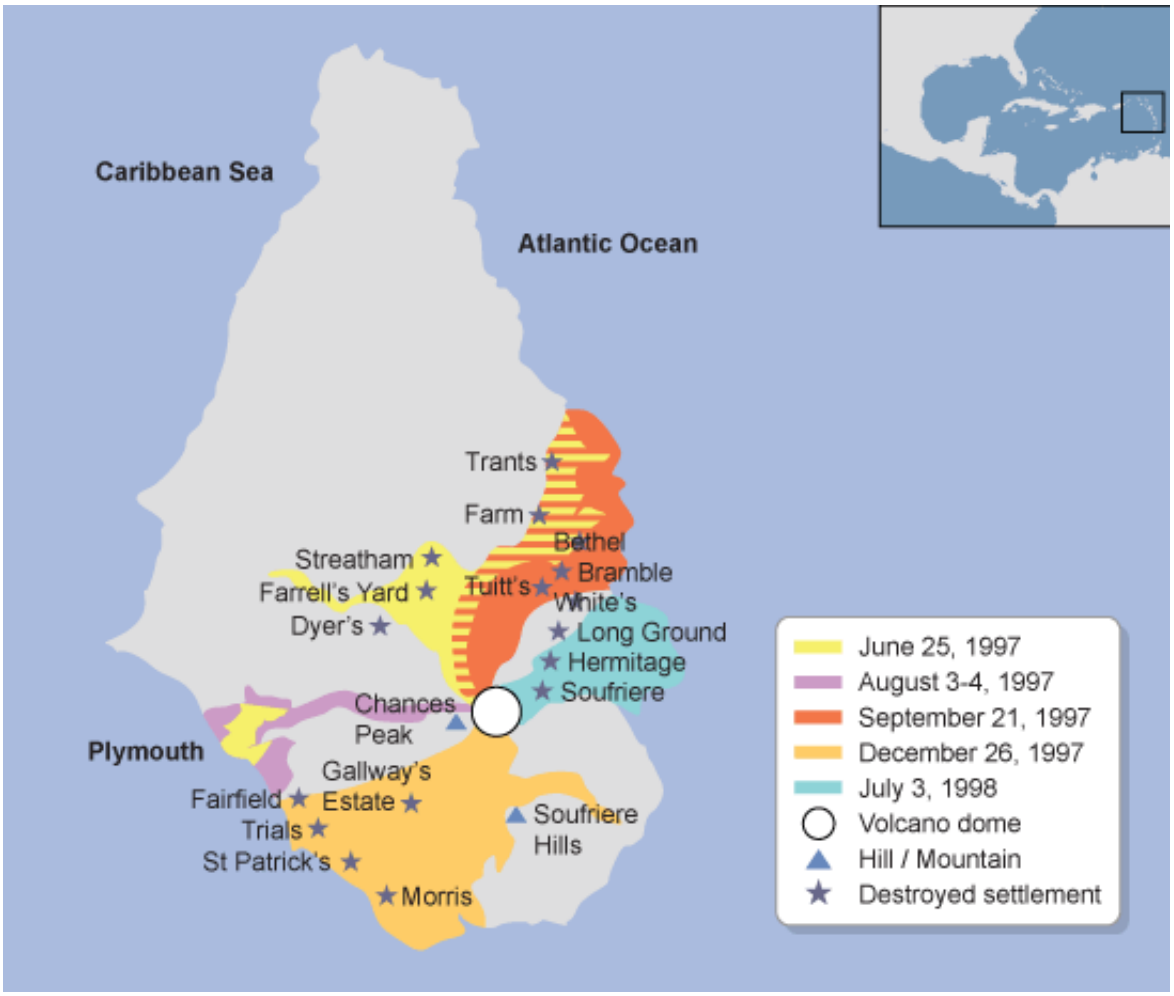
Plymouth covered in ash from volcanic eruptions on Montserrat

During this time, Montserrat was devastated by *pyroclastic flows* [**pyroclastic flow**: *A very hot mixture of volcanic debris that flows downhill at high speeds.*]. The small population of the island (11,000 people) was *evacuated* [**evacuated**: *When people have been removed or sent away from an area, usually for their own safety.*] in 1995 to the north of Montserrat as well as to neighbouring islands and the UK.

Despite the evacuations, 19 people were killed by the eruptions as a small group of people chose to stay behind to watch over their crops.

Volcanic eruptions and *lahars* [**lahar**: *A destructive volcanic landslide or mudflow, consisting of a mixture of volcanic debris, mud, rock and water.*] have destroyed large areas of Montserrat. The capital, Plymouth, has been covered in layers of ash and mud. Many homes and buildings have been destroyed, including the only hospital, the airport and many roads.

The graphic shows the progress of the eruption and its impact on the island.



Montserrat - eruption progress and impact

Short-term responses and results

Evacuation.

Abandonment of the capital city.

The British government gave money for compensation and redevelopment.

Unemployment rose due to the collapse of the tourist industry.

Long-term responses and results

An exclusion zone was set up in the volcanic region.

A volcanic observatory was built to monitor the volcano.

New roads and a new airport were built.

Services in the north of the island were expanded.

The presence of the volcano resulted in a growth in tourism.

Volcanic activity has calmed down in recent years and people

have begun to return to the island.

You might be asked to consider the values and attitudes or opinions of people involved in the eruption, such as refugees or aid workers for example.

Case study: Mount St Helens 1980 (MEDC)

Mount St Helens is on the plate boundary between the Juan de Fuca plate and North American plate. When it erupted it permanently changed the surrounding landscape.

Map showing location of Mount St Helens

Effects of the eruption

Primary effects	Secondary effects
Nuée ardente [**nuee ardente**: *A French phrase, literally meaning 'glowing cloud', which describes the cloud of volcanic debris formed by the collapse of a volcanic dome.*] (hot ash and gas) destroyed forests and logging camps.	Ash blocked rivers destroying popular fishing sites and causing flooding. This in turn destroyed crops and livestock.
63 people were killed, mainly by poisonous gases.	Flooding destroyed communications such as road and railway bridges.
Lahars [**lahar**: *A destructive volcanic landslide or mudflow, consisting of a mixture of volcanic debris, mud, rock and water.*] (mudflows of ash and water) covered an extensive area	Sediment carried downstream ruined

surrounding the volcano.

barge transport on the Columbia River.

Short-term responses and results

Communications such as roads and bridges were repaired.

People were rehoused.

Long-term responses and results

Soil fertility improved due to the ash deposits.

The volcano is now more carefully monitored.

Tourism has increased, boosting the local economy.

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