Volcanism

Learning Outcome

Students will be able to:

1. **Classify volcanic landforms as intrusive or extrusive**
2. **Differentiate between types of lava**
3. **Compare the structures of shield cones, composite cones, ash and lava cones and dome cones**
4. **Link the formation of hot springs and geysers to volcanic activity.**
5. **Effects of volcanic activity**

Volcanism is the eruption of magma to the surface of a planet.

Molten rock wells up through a vent in the planet's mantle, spewing lava, gases and volcanic material into the surrounding area. Over time, this material hardens and accumulates, creating cone-shaped volcanoes and other structures, such as craters.

Generally volcanic activity occurs around the edges of tectonic plates.

Volcanism can be a relatively calm event, with magma bubbling up through a vent and flowing out over the surface. In other cases, a blocked vent or particularly viscous magma can cause a buildup of pressure, creating an explosive eruption.

Volcanism means the process in which gases and molten rock are either:

(a) Poured/extruded on the earth's surface

(b) Forced/intruded into the earth's crust.

Intrusive material is the molten rock material (magma) that are injected into the crust. The features formed are called ***intrusive features***.

Extrusive material is the molten rock material (lava) that are poured out onto the surface. The features formed are called ***extrusive features***.

Magma is molten rock within the earth and **lava** is molten rock on the surface of the earth.

Materials ejected when a volcano erupts

There are three main types of materials that are ejected from an active volcano. These materials are:

1. **Lava** - Lava is molten rock that flows out of a volcano or volcanic vent. Depending on its composition and temperature, lava can be very fluid or very sticky (viscous). Fluid flows are hotter and move the fastest. Viscous flows are cooler and travel shorter distances, and can sometimes build up into lava domes or plugs.

   Most lava flows can be easily avoided by a person on foot, since they don't move much faster than walking speed, but a lava flow usually cannot be stopped or diverted.

2. **Pyroclast / pyroclastic material or tephra** - Pyroclastic falls, also known as volcanic fallout, occur when tephra - fragmented rock ranging in size from mm to tens of cm is ejected from a volcanic vent during an eruption and falls to the ground some distance away from the vent.

Tephra falls are usually not directly dangerous unless a person is close enough to an eruption to be struck by larger fragments.

Examples of tephra include:

- **Volcanic ash** - Very fine particles of molten rock measuring less than 0.06 mm in diameter.
- **pumice** - Light-colored, frothy volcanic rock
- **Cinders** - Cinders are volcanic rock having small cell or cavity. They are 1 centimeter or larger in diameter
- **Volcanic bombs** - A mass of molten rock (larger than 64 mm (2.5 inches) in diameter

(c) **Gases -** Volcanic gases are probably the least showy part of a volcanic eruption, but they can be one of an eruption's most deadly effects. Most of the gas released in an eruption is water vapor (H_2O), and relatively harmless, but volcanoes also produce carbon dioxide (CO_2), sulfur dioxide (SO_2), hydrogen sulfide (H_2S), fluorine gas (F_2), hydrogen fluoride (HF), and other gases. All of these gases can be hazardous - even deadly - in the right conditions.

Classification of Volcanoes

1. An **active volcano** is one that has erupted since the last ice age (i.e., in the past ~10,000 years).
2. A *dormant* volcano would then be one that hasn't erupted in the past 10,000 years, but which is expected to erupt again.
3. An *extinct* volcano would be one that nobody expects to ever erupt again.

N.B. There have been a number of eruptions from "extinct" volcanoes.

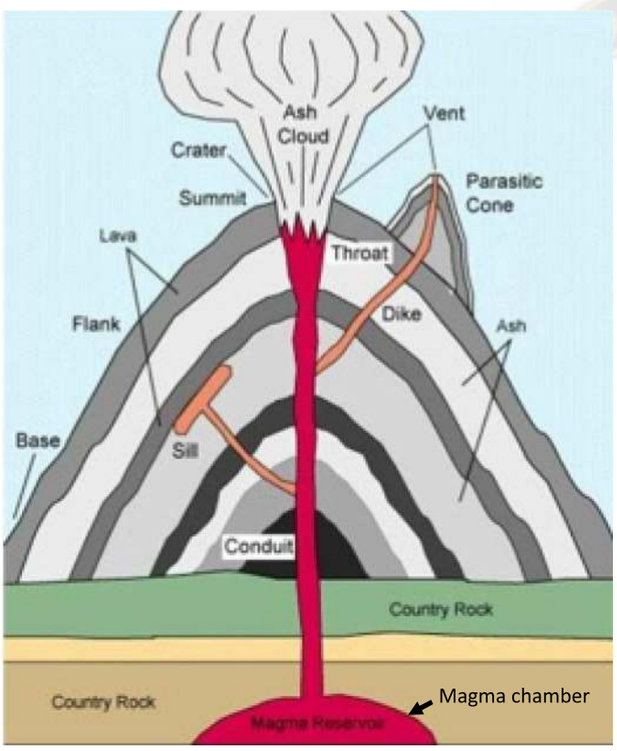
Types of lava

There are two main types of lava that a volcano ejected.

Basaltic, or basic lava	Andesitic, or acidic lava
Hot (1 ,200°C)	Less hot (800°C)
Lower silica content	Higher silica content
Low viscosity, so flows quickly and far	Viscous, so flows slowly, and less far
Takes longer to cool and solidify, so flows considerable distances	Cools and solidifies quickly, so flows over shorter distances
Retains gas, so is very mobile	Loses gas quickly, so becomes very viscous
Produces large-scale landforms of gentle slope angles	Produces localised features, with steeper slope angles
Eruptions are frequent, but relatively gentle	Eruptions less frequent, but violent due to viscous lava and build up of gases.
Ejecta: lava and steam	Ejecta: ash (tephra), rocks (pyroclasts), lava and steam
Found at constructive plate boundaries where magma rises from the mantle	Found at destructive plate boundaries where oceanic crust subducts, melts and rises

What is volcano?

A volcano is an opening or fissure in the Earth's surface, which molten rock, pyroclastic materials and gases to escape from deep below the surface.



Magma chamber/reservoir - a large underground pool of liquid rock found beneath the surface of the Earth.

Parasitic Cone/secondary cone/conelet - A small cone-shaped volcano formed by an accumulation of volcanic debris.

Vent - An opening in Earth's surface through which volcanic materials escape.

Flank - The side of a volcano.

Crater - Mouth of a volcano - surrounds a volcanic vent.

Conduit - An underground passage magma travels through.

Throat - Entrance of a volcano. The part of the conduit that ejects lava and volcanic ash.

Ash Cloud - A cloud of ash formed by volcanic explosions.

Geographical distribution of volcano

Volcanic activity is widespread over the earth. Volcanoes are most likely to occur along the margins of subduction zones and along the ocean ridge systems.

Most of the worlds volcanoes are found around the basin of the Pacific Ocean. Two-thirds of the world volcano are located around the basin of the Pacific Ocean, (the Pacific Ring of Fire).

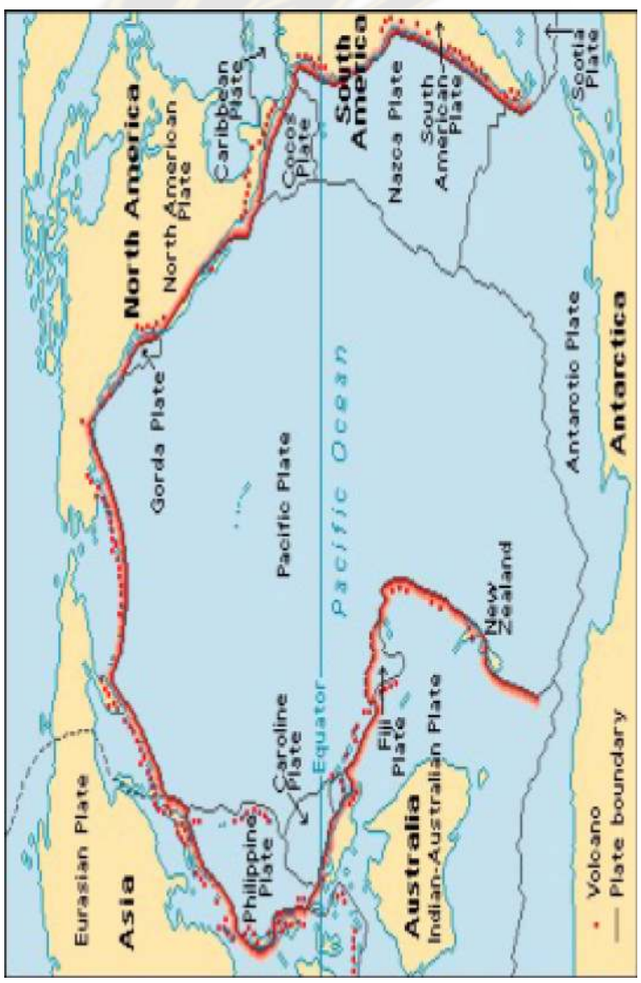
- Starting in South America all the way through Central America most of the highest peaks are volcanic. In North America a chain of volcanoes can be traced through the Cascade Mountain Range. Another chain nearly 3200km long can be traced through southern Alaska.
- On the Asiatic (eastern) side of the Pacific Ocean volcanoes can be found along the island arcs (e.g. Japan Islands), through the East Indies (e.g. Indonesia) towards New Zealand.

In Africa most of the volcanoes can be found along the East Africa Rift Valley. Volcanoes are also located in and around the Mediterranean Sea.

Several Volcanoes can also be found along the Mid-Atlantic Ridge.

In the Caribbean the lesser Antilles have several active volcanoes.

The only fold mountain range without any volcanoes is the Himalayas.



Features formed by intrusive volcanic activity

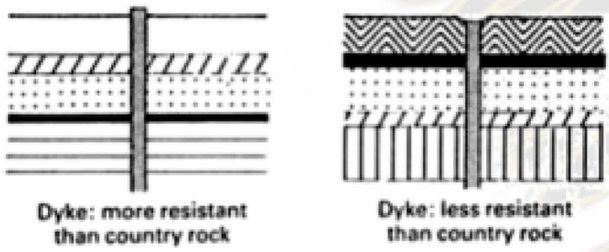
The features formed by intrusive volcanic activities result from the intrusion of molten magma into the crust. The form (shape) the features take depends on how fluid or how sticky the magma is. Fluid magma flows as a thin sheet while viscous magma solidifies rapidly.

These landform form within the Earth's crust and may become visible at the Earth's surface due to erosion and weathering. When molten rock is forced up through the crust, it may solidify in a number of forms.

The main intrusive features are:

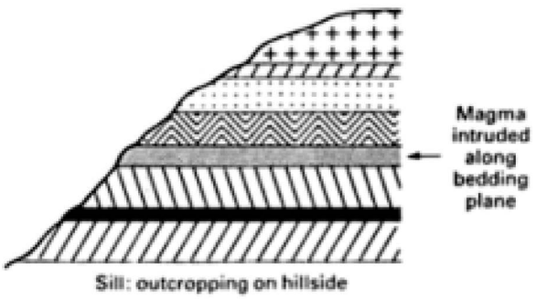
Dyke - a mass of vertical or highly inclined intrusive rock that cuts across the bedding planes (layers) of rocks.

They are formed when magma forces its way through a fissure, crack or fault where it cools and solidifies. When affected by denudation a dyke may stand up as a ridge or be worn away to form a depression.



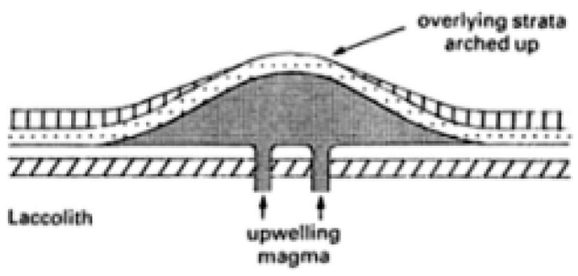
Sill - a sheet igneous rock that has intruded (forced) between older layers of sedimentary rock.

They are formed when magma forces its way between layers of sedimentary rock where is cools and solidifies. Sills can be of any thickness and extends over many square km.

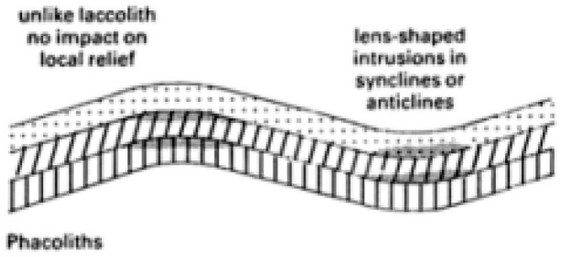


Laccolith - these are domes or lens of igneous rocks which have been injected between two layer of sedimentary rock.

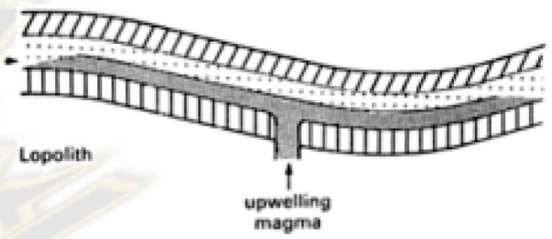
They are formed when magma forces its way between two layer of sedimentary rock causing the upper surface of the rocks to arch up into a dome shaped mass. Well formed laccoliths have flat bottoms and a irregular upper surface. They are sometimes eroded to form hills or mountains.



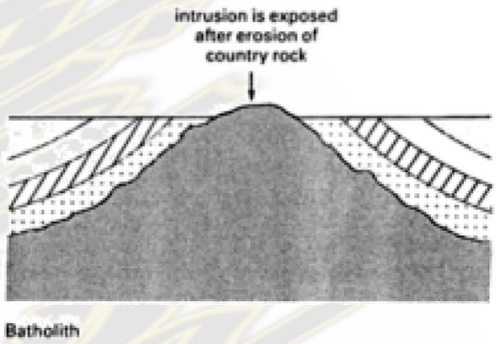
Phacolith - these are lens-shaped mass of igneous rock which are formed on top of anticlines or the bottom of synclines in folded strata/layers.



Lopolith - a basin-shaped body of igneous rock formed by the penetration of magma between existing layers of rock .



Batholith - a massive, dome-shaped formation of intrusive igneous rock, usually granite, that is thought to have originated far beneath the earth's surface, forms the base of mountain ranges.



Features formed by extrusive volcanic activity

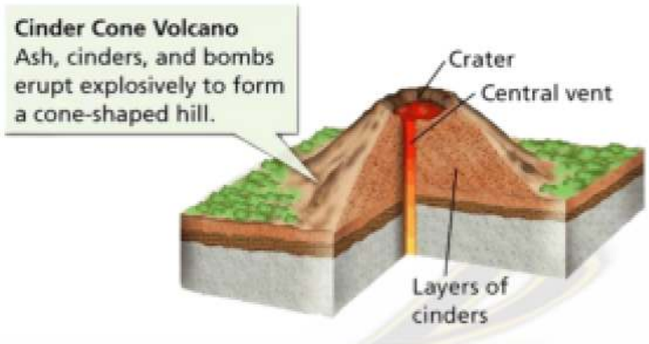
Materials ejected onto the earth's crust may form a number of features or landforms. The shape of the landforms depend on the nature of the material ejected. These landforms includes:

Cinder Cone volcano -

A cinder cone or scoria cone is a steep conical hill of loose pyroclastic fragments (volcanic clinkers, cinders, volcanic ash, or scoria) that has been built around a volcanic vent.

In a cinder cone, lava erupts from a small vent in the crust and 'sprays' melted rock fragments (pyroclatic fragments) into the air where they then fall back to earth in a pile. These rock fragments are glassy, gas-filled chunks of lava called cinders or scoria that cool rapidly as they sail through the air and land next to the vent opening, slowly accumulating in the shape of a cone. Most cinder cones have a bowl-shaped crater at the summit.

Sunset Crater, California



Examples of Cinder cone volcanoes

Paricutin - Mexico

Sunset Crater - California, USA

Wizard Island - Oregon, USA

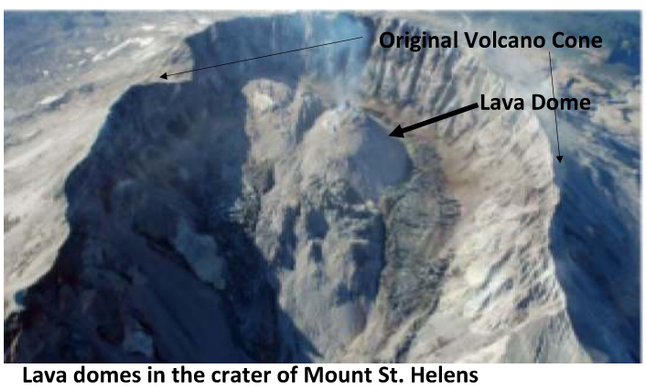
Cerro Negro - Nicaragua

Dome volcano / Lava Dome -

Lava Dome is mound of viscous lava that has been forced out (extruded) from a volcanic vent.

A dome volcano is small and often forms inside the caldera of a stratovolcano. After a large eruption when large amount of magma has emptied out of the magma chamber the summit of the composite volcano collapses forming a depression. Inside the depression magma oozes out to begin forming a small lava dome.

Lava domes also form on the steep sides of volcanoes where they can become dislodged during an eruption. These are the most dangerous type of lava domes because they can expose molten rock beneath the dome that become pyroclastic flows as the gases inside the volcano are released.



Lava domes in the crater of Mount St. Helens

Examples of Dome Volcanoes: Lassen Peak - California

Puy de Dome - France, Mount St. Catherine Lava Domes - Grenada, Novarupta - Alaska

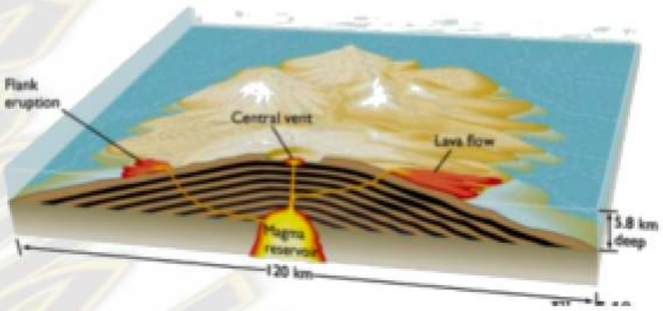
Shield Volcano -

Shield volcano a broad, domed volcano with gently sloping sides, characteristic of the eruption of fluid, basaltic lava.

Shield volcanoes are huge, gently sloping volcanoes built of very thin lava spreading out in all directions from a central vent. They have wide bases several miles in diameter with steeper middle slopes and a flatter summit. The gentle convex slopes give them an outline like a shield.

Mauna Kea in Hawaii

Shield Volcano



Examples of Shield Volcano: Mauna Loa - Hawaii, Kilauea - Hawaii, Medicine Lake Volcano - California Erta Ale - Ethiopia

Stratovolcano/Composite Volcano

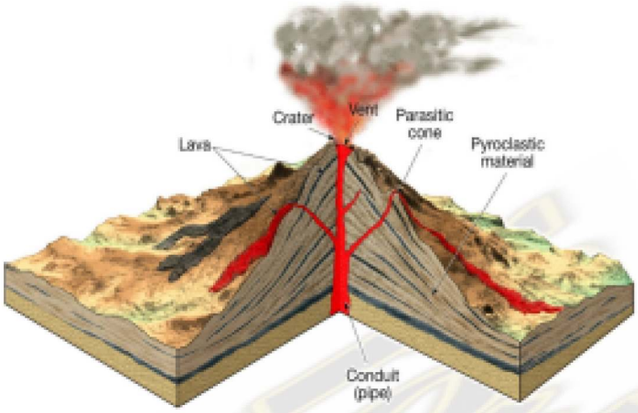
A stratovolcano is a tall, conical volcano composed of one layer of hardened lava, tephra, and volcanic ash. These volcanoes are characterized by a steep profile and periodic, explosive eruptions. The lava that flows from them is highly viscous, and cools and hardens before spreading very far.

Composite volcanoes are constructed from multiple eruptions, sometimes recurring over hundreds of thousands of years, sometimes over a few hundred.

Lava issued sideways from the main vent to form dykes which strengthened the cone. Sometimes active conelets known as parasitic or secondary cone are formed on the sides of the main of the main volcano.

Examples of composite volcano: Mount St. Helens and Mount Rainier (Washington State, USA), Mount Vesuvius (Italy), Mayon Volcano (Luzon Island, Philippines), Mount Fuji (Japan) and Mount Cotopaxi (Ecuador).

Mayon, Philippines

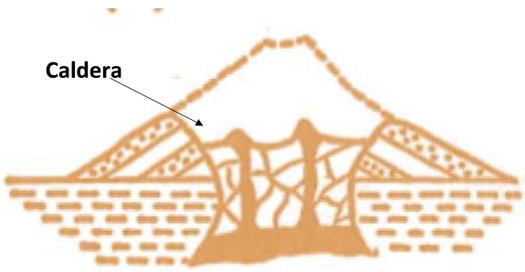


Caldera - This is a a large, basin- like depression resulting from the explosion or collapse of the center of a volcano.

When such a large volume of magma is removed from beneath a volcano, the ground subsides or collapses into the emptied space, to form a huge depression called a **caldera**.

Calderas are among the most spectacular and active volcanic features on Earth. Earthquakes, ground cracks, uplift or subsidence of the ground, and thermal activity such as hot springs, geysers, and boiling mud pots are common at many calderas.

Caldera with Crater Lake, Oregon



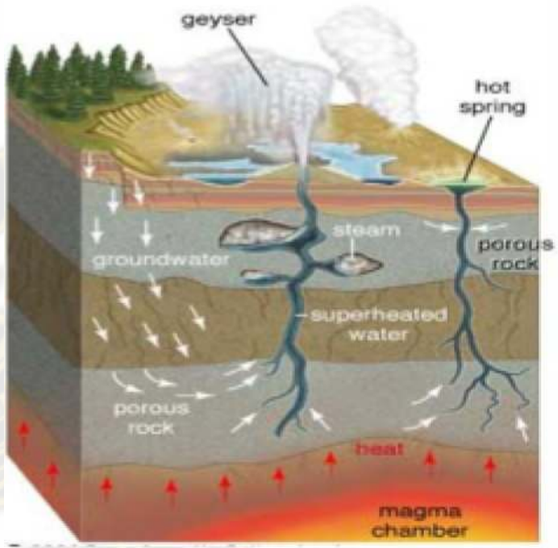
A **crater lake** is a lake that forms in a volcanic crater or caldera.

Fumaroles

These are small volcanic vents through which hot gases and steam are continuously emitted at low pressure. If the gas is rich in sulphur, yellow sulphurous deposits may form around the vent, which becomes known as a **solfatara.**

Mud Volcano -

Mud volcano a small vent or fissure in the ground discharging hot mud.



Minor volcanic forms

Hot Spring -

A hot spring is a spring that is produced by the emergence of heated groundwater from the earth's crust. These are formed when superheated water flows gently out of the rocks.

Geyser -

A **geyser** is a vent in Earth's surface that periodically ejects a column of hot water and steam. Even a small **geyser** is an amazing phenomenon; however, some **geysers** have eruptions that blast thousands of gallons of boiling-hot water up to a few hundred feet in the air. Old Faithful is the world's best-known **geyser**.

Lahar -

A lahar is a type of mudflow or debris flow composed of a slurry of pyroclastic material, rocky debris, and water. The material flows down from a volcano, typically along a river valley.

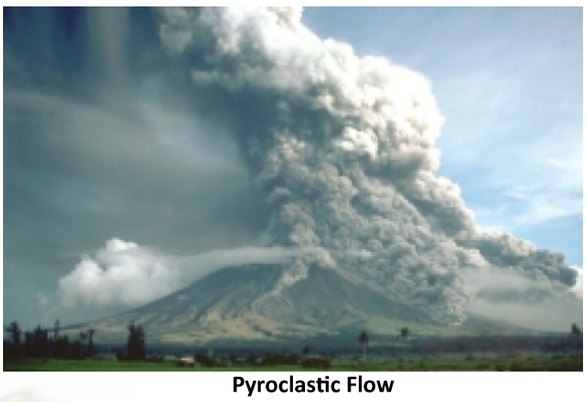
Lahars are extremely destructive: they can flow tens of metres per second (22 mph or more), and destroy any structures in their path.

Pyroclastic Flow

A pyroclastic flow/pyroclastic density current is a fast-moving current of hot gas and tephra, which reaches speeds moving away from a volcano of up to 700 km/h. The gas can reach temperatures of about 1,000 °C. Pyroclastic flows normally hug the ground and travel downhill, or spread laterally. They are a

common and devastating result of certain explosive volcanic eruptions.

Lahar



Pyroclastic Flow

Negative impacts of volcanoes

1) Buildings and roads are destroyed by lava flows and pyroclastic flows — buildings also collapse if enough ash falls on them.
2) People and animals are injured or killed, mainly by pyroclastic flows but also by lava flows and falling rocks.
3) Crops are damaged and water supplies are contaminated when ash falls on them.
4) People, animals and plants are suffocated by carbon dioxide.
5) lahars flows cause loads more destruction, deaths and injuries
6) Fires are started by lava flows and pyroclastic flows, which then spread
7) People are left homeless
8) There's a shortage of food because crops are damaged.
9) There's a shortage of clean water
10) Roads are blocked or destroyed so aid and emergency vehicles can't get through,
11) Businesses are damaged or destroyed, causing unemployment.
12) Sulphur dioxide released into the atmosphere causes acid rain.

Positive impact of volcanic activities

1) Rich volcanic soils form by alteration of volcanic products.
2) Geothermal power
3) Health spas and hot springs for recreation and health.
4) Hydroelectric power from rivers flowing off large volcanoes.
5) Recreation: skiing, hiking, tourism, and learning about volcanoes first-hand
6) Source for precious gems -- diamonds. Semi-precious gems -
7) Source for metals -- gold, silver, molybdenum, copper, zinc, lead, and mercury.
8) Construction materials: Naturally-broken aggregate for road construction and cinder athletic tracks; cut blocks from hardened volcanic ash for buildings and walls; water-resistant concrete from volcanic ash.