1. Details of Module and its structure

Module Detail	
Subject Name	Geography
Course Name	Geography 01 (Class XI, Semester - 1)
Module Name/Title	Volcano and Volcanic Landforms – Part 2
Module Id	kegy_10302
Pre-requisites	Basic knowledge about volcano and volcanic landforms
Objectives	After going through this module, the learners will be able to; • Explain the volcano and the types of volcano • Describe the Volcanic Features • Understand the volcanic landforms
Keywords	Volcanoes, Magma, Earthquakes, Shield Volcanoes, Composite Volcanoes

2. Development Team

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Table of Content :

Introduction

The earth crust is dynamic. The earth surface is being continuously subjected to external forces (exogenic) induced basically by energy (sunlight) and internal forces (endogenic) are active though with different intensities Some changes are fast and some are slow. Earthquakes and volcanoes are endogenic forces which cause sudden changes on the earth. Weathering and agents of sculpture are exogenic forces which bring about slow changes. . Exogenic as well as endogenic processes are constantly shaping the landscape. Volcanic eruption and volcanic features are an important source of obtaining direct information of earth

Volcano

The molten material coming out from inside the earth through a pipe or *vent* and accumulating around the pipe in the form of a mound is called a *volcano.* All volcanoes result from *magma*, molten material below the earth's surface, which is brought to the surface as *lava* or volcanic fragments. Volcanoes show considerable variation in size, shape and the kind of material ejected. Most volcanoes produce lava. Lava is at very high temperatures,
between 800° and 13,000° Celsius and it contains steam and many other gases. Magma, originating inside the earth comes to the surface as lava.

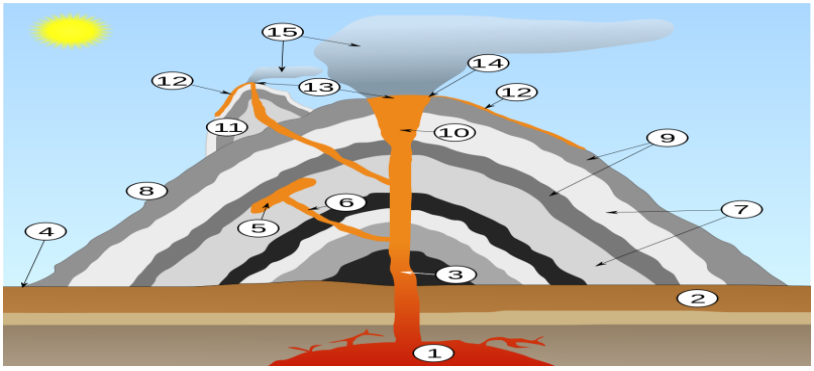

Fig 1 Cross –Section of a volcano

1. Large Magma Chamber
2. Bedrock
3. Conduit (pipe)
4. Base
5. Sill
6. Branch pipe
7. Layers of ash emitted by the volcano
8. Flank
9. Layers of lava emitted by the volcano
10. Throat
11. Parasitic cone
12. Lava flow
13. Vent
14. Crate
15. Ash cloud

Source; https://en.wikipedia.org/wiki/Volcano#/media/File:Volcano_scheme.svg

Towards the base of the earth's crust, hot rock maintains its solid state because of the pressure from rock above it. When pressure is reduced by a crack in the earth or rock that lies above, the hot rock can change to a liquid in small chambers known as magma chambers. Zones of weakness, regions of lessened pressure or already existing fissures are perfect paths for the passage of magma. Gas pressure in pockets in the earth forces the magma to move. Sometimes as magma moves, it melts overlying rocks or forces them aside

A volcano is a place where gases, ashes and/or molten rock material – lava – escape to the ground. A volcano is called an active volcano if the materials mentioned are being released or have been released out in the recent past. The layer below the solid crust is mantle. It has higher density than that of the crust. The mantle contains a weaker zone called *asthenosphere*. It is from this that the molten rock materials find their way to the surface. The material in the upper mantle portion is called *magma*. Once it starts moving towards the crust or it reaches the surface, it is referred to as *lava*. The material that reaches the ground includes lava flows, pyroclastic debris, volcanic bombs, ash and dust and gases such as nitrogen compounds, sulphur compounds and minor amounts of chlorine, hydrogen and argon.

Type of Volcanoes

Volcanoes are classified on the basis of nature of eruption and the form developed at the surface. On the basis of frequency of eruption, there are three types of volcanoes:-**Active, Dormant and Extinct Volcanoes.** The volcanoes that erupt frequently as compared to others are called Active Volcanoes.Examples of Active Volcanoes are Kīlauea, Mount Nyiragongo, Mount Etna, Mount Merapi and Mount Yasur, in Vanuatu. The Volcanoes that erupt intermittently are known as Dormant volcano or sleeping volcanoes. The Barren Island of Andamans in India is an example of dormant volcano. It is difficult to distinguish an extinct volcano from a dormant (inactive) one. Volcanoes are often considered to be extinct if there are no written records of its activity. Nevertheless, volcanoes may remain dormant for a long period of time. For example, Yellowstone has a repose/recharge period of around 700,000 years, and Toba of around 380,000 year

Fig. 02 Aerial view of the Barren Island, Andaman Islands, India, during an eruption in 1995. It is the only active volcano in South Asia.

Source:- https://en.wikipedia.org/wiki/Volcano#/media/File:Ile_Barren,_1995.jpg

Extinct volcanoes are those that scientists consider unlikely to erupt again because the volcano no longer has a magma supply The volcanoes that have not erupted for a very long times and have record of eruption in historic times are known as extinct or dead volcanoes. The extinct volcanoes may get activated suddenly and are therefore dangerous. Krakatao in Indonesia erupted in 1883(world's greatest recorded explosion). Examples of extinct volcanoes are many volcanoes on the Hawaiian – Emperor seamount chain in the Pacific Ocean (although some volcanoes at the eastern end of the chain are active), Hohentwiel in Germany, Shiprock in New Mexico, and Zuidwal volcano in the Netherlands.

Classification of Volcanoes on the basis of nature of eruption and the form developed at the surface are as follows:

Shield Volcanoes

Barring the basalt flows, the shield volcanoes are the largest of all the volcanoes on the earth. The Hawaiian volcanoes are the most famous examples. These volcanoes are mostly made up of basalt,

a type of lava that is very fluid when erupted. For this reason, these volcanoes are not steep. They become explosive if somehow water gets into the vent; otherwise, they are characterized by low-explosivity. The upcoming lava moves in the form of a fountain and throws out the cone at the top of the vent and develops into cinder cone.

Fig. 03; Shield Volcanoes

Source:https://upload.wikimedia.org/wikipedia/commons/0/0d/Kilauea_Shield_Volcano_Hawaii_20071209A.jpg

Shield volcanoes, so named for their broad, shield-like profiles, are formed by the eruption of low-viscosity lava that can flow a great distance from a vent. They generally do not explode catastrophically. Since low-viscosity magma is typically low in silica, shield volcanoes are more common in oceanic than continental settings. The Hawaiian volcanic chain is a series of shield cones, and they are common in Iceland, as well.

Fig. 04:Skjaldbreiður, a shield volcano whose name means "broad shield"

Source : https://en.wikipedia.org/wiki/Volcano#/media/File:Skjaldbreidur_Herbst_2004.jpg

Composite Volcanoes

These volcanoes are characterized by eruptions of cooler and more viscous lavas than basalt. These volcanoes often result in explosive eruptions. Along with lava, large quantities of pyroclastic material and ashes find their way to the ground. This material accumulates in the vicinity of the vent openings leading to formation of layers, and this makes the mounts appear as composite volcanoes.

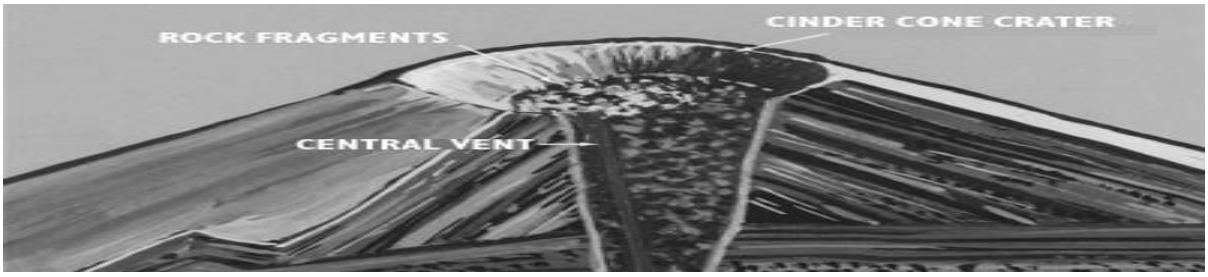

Fig. 05; Schematic representation of the internal structure of a typical cinder cone

Sources; https://upload.wikimedia.org/wikipedia/commons/1/10/Cinder_cone_diagram.gif

Fig. 06:Holocene cinder cone near Veyo, Utah

https://en.wikipedia.org/wiki/Cinder_cone#/media/File:VeyoVolcano.jpg

Fig. 07 : Pu'uO'o, an active cinder cone in Hawaii and also part of Kilauea

https://upload.wikimedia.org/wikipedia/commons/6/6d/Puu_Oo_cropped.jpg

Caldera

These are the most explosive of the earth's volcanoes. They are usually so explosive that when they erupt they tend to collapse on themselves rather than building any tall structure. The collapsed depressions are called calderas. Their explosiveness indicates that the magma chamber supplying the lava is not only huge but is also in close vicinity.

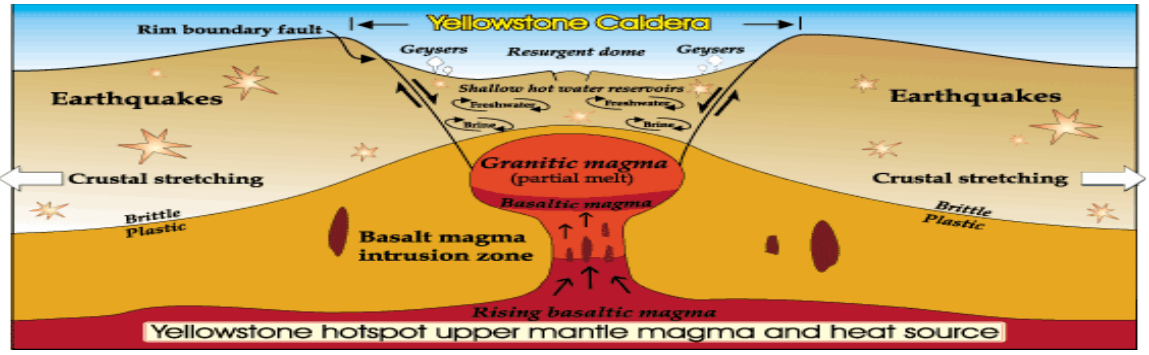

Fig. 08 Caldera

Fig. 09 Mount Pinatubo, Philippines

Sources:https://upload.wikimedia.org/wikipedia/commons/8/8f/Pinatubo92pinatubo_caldera_crater_lake.jpg

Flood Basalt Provinces

These volcanoes outpour highly fluid lava that flows for long distances. Some parts of the world are covered by thousands of sq. km of thick basalt lava flows. There can be a series of flows with some flows attaining thickness of more than 50 m. Individual flows may extend for hundreds of km. The Deccan Traps from India, presently covering most of the Maharashtra plateau, are a much larger flood basalt province. It is believed that initially the trap formations covered a much larger area than the present.

Fig. 10: Moses Coulee in the US showing multiple flood basalt flows of the Columbia River Basalt Group. The upper basalt is Roza Member, while the lower canyon exposes Frenchmen Springs Member basalt

Source:https://en.wikipedia.org/wiki/Flood_basalt#/media/File:3-Devils-grade-Moses-Coulee-Cattle-Feed-Lot-PB110016.JPG

Mid-Ocean Ridge Volcanoes: These volcanoes occur in the oceanic areas. There is a system of mid-ocean ridges more than 70,000 km long that stretches through all the ocean basins. The central portion of this ridge experiences frequent eruptions.

Types of volcanic eruptions

Eruptive Styles

Magma may cool enough to solidity before it reaches the surface of the earth, or it may cool after it flows down the side of a volcano. If eruption is violent lava is hurled high into the air with solid rocks. Volcanoes may remain dormant for thousands of years and then suddenly burst into violence when the pressure has built up beneath the ground. Eruption takes place in two ways – fissure eruption and central eruption.

Fissure Eruption

The lava or pyroclastic material emanates from long, narrow fissures or a group of such fissures. The fluid lava flows away from the fissures and does not build cones. Deccan Plateau in India is an example of the fissure lava eruption that took place about 60-62 million years ago.

Central Eruption

The central eruptions are much like point source eruption unlike the linear sources of fissure eruption. The lava or pyroclastic material erupts from a central vent or pipe and gives rise to cone. Viscous lava can barely flow and produce volcanic domes.

Volcanic landforms/ Volcanic features

Extrusion of lava takes place from an opening called *volcanic vent.* A saucer shaped depression is created around the vent, which is known as *crater.* On occasion, the explosive eruption of a volcano blows out an enormous mass of magma and previously solidified *lava* from a considerable depth. Such explosion is associated with the collapse or subsidence of the central part of the crater. A steep sided crater is formed by the destruction of the crater formed by the gradual construction of volcanic matter. This steep-sided crater is known as *caldera.* Besides the lava that flows out from a volcano, rock and mineral fragments are also blown out from a volcano known as *pyroclastic* material. The pyroclastic material ranges in size from solid blocks to fine dust. Spindle or spherical shaped masses are known as *volcanic bombs.* Sometimes fluid or plastic lava falls close to the vent

after being thrown in the air to form *spatter cone*. Smaller particles of lam, ranging from 4 to 25 mm, are called *volcanic lapilli* whereas particles under 4 mm constitute *volcanic dust* ash. Volcanic ash, when thrown up in air, remains in suspension for a long period of time. It is either drifted away by wind or falls down with rainfall and is transported by running water to be deposited as sedimentary layers called *tuff*.

Intrusive Forms: The lava that is released during volcanic eruptions on cooling develops into igneous rocks. The cooling may take place either on reaching the surface or also while the lava is still in the crustal portion. Depending on the location of the cooling of the lava, igneous rocks are classified as volcanic rocks (cooling at the surface) and plutonic rocks (cooling in the crust). The lava that cools within the crustal portions assumes different forms. These forms are called intrusive forms. Some of the forms are shown in the figure..

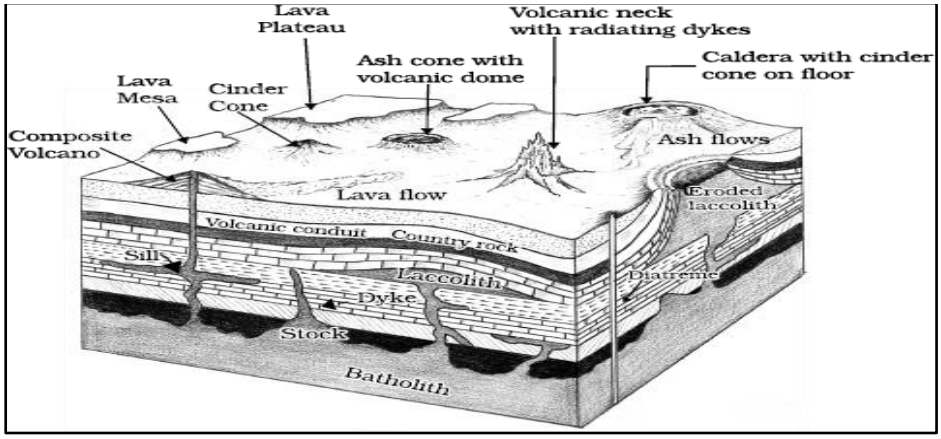

Fig. 11; Volcanic Landforms

Batholiths

A large body of magmatic material that cools in the deeper depth of the crust develops in the form of large domes. They appear on the surface only after the denudational processes remove the overlying materials. They cover large areas, and at times, assume depth that may be several km. These are granitic bodies. Batholiths are the cooled portion of magma chambers.

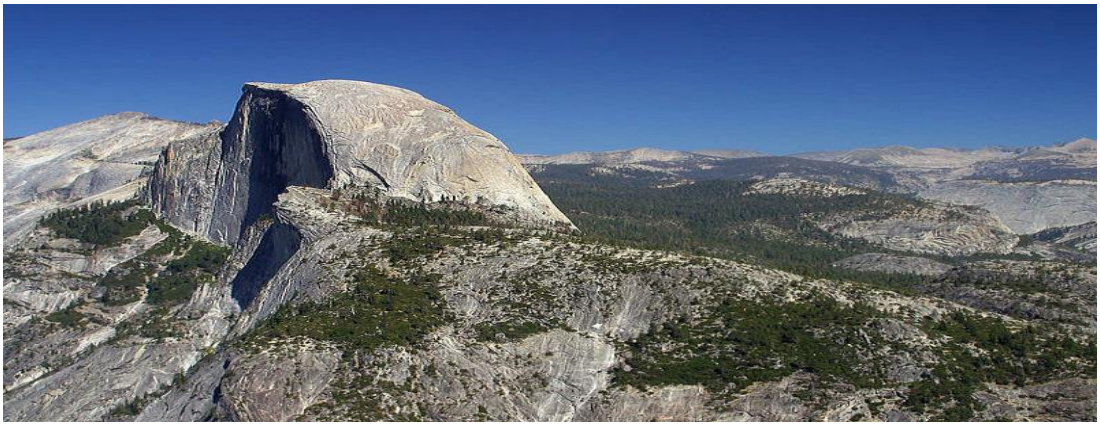

Fig. 12 ; Half Dome, a granite monolith in Yosemite National Park and part of the Sierra Nevada Batholith

Source https://en.wikipedia.org/wiki/Batholith#/media/File:Yosemite_20_bg_090404.jpg

Lacoliths

These are large dome-shaped intrusive bodies with a level base and connected by a pipe-like conduit from below. It resembles the surface volcanic domes of composite volcano, only these are located at deeper depths. It can be regarded as the localised source of lava that finds its way to the surface. The Karnataka plateau is spotted with domal hills of granite rocks. Most of these, now exfoliated, are examples of lacoliths or batholiths.

Lapolith, Phacolith and Sills

As and when the lava moves upwards, a portion of the same may tend to move in a horizontal direction wherever it finds a weak plane. It may get rested in different forms. In case it develops into a saucer shape, concave to the sky body, it is called lapolith.

Fig. 13 Laccolith exposed by erosion of overlying strata in Montana

Source:https://en.wikipedia.org/wiki/Laccolith#/media/File:Limestone_Butte_Montana_Laccolith.jpg

A wavy mass of intrusive rocks, at times, is found at the base of synclines or at the top of anticline in folded igneous country. Such wavy materials have a definite conduit to source beneath in the form of magma chambers (subsequently developed as batholiths). These are called the phacoliths.

The near horizontal bodies of the intrusive igneous rocks are called sill or sheet, depending on the thickness of the material. The thinner ones are called sheets while the thick horizontal deposits are called sills.

Dykes

When the lava makes its way through cracks and the fissures developed in the land, it solidifies almost perpendicular to the ground. It gets cooled in the same position to develop a wall-like structure. Such structures are called dykes. These are the most commonly found intrusive forms in the western Maharashtra area. These are considered the feeders for the eruptions that led to the development of the Deccan traps.

Distribution of Volcanic Zones of the World

Volcanic Zones are found high temperature (700-1400 °C) where magma is created by partial melting of solid material in the Earth's crust and upper mantle. These areas usually form along tectonic plate boundaries at depths of 10–50 km. For example, volcanoes in Chains are always associated with places where the crust of the earth is actively changing. The longest chain surrounds the Pacific Ocean and is called the 'Rings of Fire'. Another group exists in the area of Mediterranean and in the Rift Valley In eastern Africa. Whole groups and chains of islands are sometimes formed in the ocean by volcanoes that erupt time and again. This is how the Hawaiian and Aleutian Islands were created. The effects of volcanic activity are not all bad. The ejected material that comes from inside the volcano is unbelievably fertile. Another important product of volcanic activity is geothermal heat, a source of alternate power.

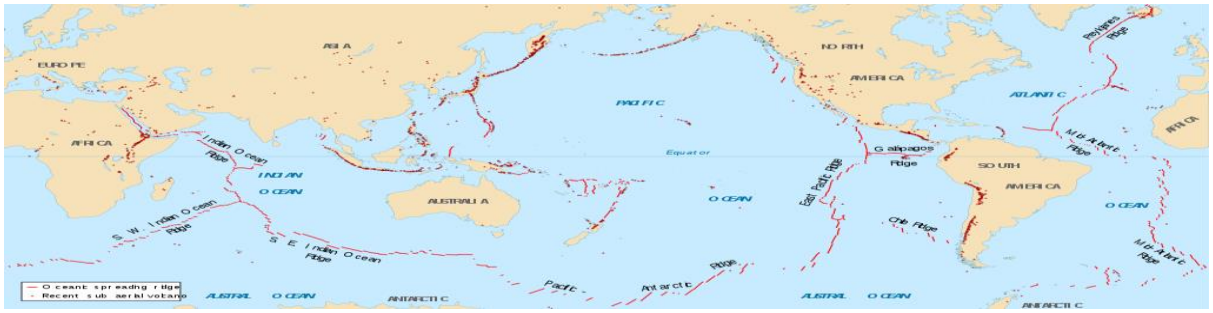

Fig. 12 Map showing the divergent plate boundaries (oceanic spreading ridges) and recent sub-aerial volcanoes

Source:https://en.wikipedia.org/wiki/Volcano#/media/File:Spreading_ridges_volcanoes_map-en.svg

Effects of volcanoes

There are many different types of volcanic eruptions and associated activity: phreatic eruptions (steam-generated eruptions), explosive eruption of high-silica lava (e.g., rhyolite), effusive eruption of low-silica lava (e.g., basalt), pyroclastic flows, lahars (debris flow) and carbon dioxide emission. All of these activities can pose a hazard to humans. Earthquakes, hot springs, fumaroles, mud pots and geysers often accompany volcanic activity.

Volcanic gase

The concentrations of different volcanic gases can vary considerably from one volcano to the next. Water vapour is typically the most abundant volcanic gas, followed by carbon dioxide and Sulfur dioxide. Other principal volcanic gases include hydrogen Sulfide, hydrogen chloride, and hydrogen fluoride. A large number of minor and trace gases are also found in volcanic emissions, for example hydrogen, carbon monoxide, halocarbons, organic compounds, and volatile metal chlorides.

Large, explosive volcanic eruptions inject water vapour (H_2O), carbon dioxide (CO_2), sulfur dioxide (SO_2), hydrogen chloride (HCl), hydrogen fluoride (HF) and ash (pulverized rock and pumice) into the stratosphere to heights of 16–32 kilometres (10–20 mi) above the Earth's surface. The most significant impacts from these injections come from the conversion of sulfur dioxide to sulfuric acid (H_2SO_4), which condenses rapidly in the stratosphere to form fine sulfateaerosols. The SO_2 emissions alone of two different eruptions are sufficient to compare their potential climatic impact. The aerosols increase the Earth's albedo—its reflection of radiation from the Sun back into space—and thus cool the Earth's lower atmosphere or troposphere; however, they also absorb heat radiated up from the Earth, thereby warming the stratosphere. Several eruptions during the past century have caused a decline in the average temperature at the Earth's surface of up to half a degree (Fahrenheit scale) for periods of one to three years; sulfur dioxide from the eruption of Huaynaputina probably caused the Russian famine of 1601–1603.

Source : https://en.wikipedia.org/wiki/Volcano

Conclusion

Volcanic eruptions can cause earthquakes ,floods, rock fall. They damage everything which comes in its path. The large amount of dust and ash can cause difficulty in breathing. The effects of volcanic activity are not all bad. Whole groups and chains of islands are sometimes formed in the ocean by volcanoes that erupt time and again. This is how the Hawaiian and Aleutian Islands were

created. The ejected material that comes from inside the volcano is unbelievably fertile which is very beneficial for plants . Another important product of volcanic activity is geothermal heat ,a source of alternate power. Volcanic very fine ash provides nutrients to the surrounding soil. Volcanic gases are one of the source of water in atmosphere. Volcanoes help in cooling off the earth removing heat from its interior.