Lesson - 7

Earthquake and Volcanoes

Earthquake

The earth's crust constantly undergoes change due to endogenetic and exogenetic forces. Earthquake is a major sudden disaster caused due to endogenetic forces. The vibrations of the earth's crust is called Earthquake.

According to F.J. Monkhouse, the progression of devastating elastic waves in all the directions, due to the process of movement and adjustment of earth's layers is termed as 'Earthquake'. In simpler words, the earthquake can be defined as "Sudden vibrations on any part of the earth's crust caused due to endogenetic forces of the earth, is called Earthquake".

Causes of origin of earthquake : A temporary disequilibrium in any region of the earth causes earthquake. The factors that causes imbalance in this equilibrium of the earth are as follows:

1. Faulting : Due to the tension and contraction caused due to endogenetic forces, the rocks are cracked or fractured, which is called Faults. Earthquakes occur during such processes.

2. Volcanism : It is the major cause of an earthquake. During the volcanic eruption, the trapped gases pushes and gushes out with intense heat. This causes vibration on earth's surface.

A Etna, Krakatoa, Vesuvius, volcanoes caused devastating earthquake during their eruptions.

3. Water load : According to some scientists, due to the construction of dams, the accumulated water creates enormous weight, this creates disturbances in layers of earth beneath the bottom of reservoir, which causes earthquakes. In December 1947, there was a massive earthquake in Koyna district of Maharashtra, it is believed that this earthquake was caused due to 'Koyna Dam'.

4. Contraction of the Earth : Some scientists proposed that, the contraction of the earth's crust is the major cause of the earthquake. According to them due to the constant radiation of heat from the interior of the earth there is loss of heat and the earth is cooling down when this process occurs rapidly and intensely, it causes earthquakes. Dana, Jeffery supported this belief.

5. Isostatic adjustment : Generally there is a state of equilibrium maintained between different geological landforms like mountain, plateau, plains and oceanic trenches, sometimes there is momentary disturbance in this equilibrium beds, this causes earthquakes.

The earthquakes in Himalayan regions are mostly caused due to this reason.

6. Elastic Rebound Theory : According to Prof. F.S. Reed rocks are like elastic, in nature and can be stretched upto a limit, after this it breaks. The broken parts regions it previous positions, which causes earthquakes.

7. Plate tectonic : Different plates at their margins converges diverge or transform. During these processes, the movements of plates causes earthquakes.

8. Other reasons : Besides the above mentioned causes, expansion of gases, disintegration of sea cliffs on coastal areas of sea, collapsing roof of the caves, generates earthquake

which causes minor effects. Besides these man-made causes include Atomic blasts. Blasts in the mining regions, deep drilling also generates earthquakes which affect the local regions. Fig. 7.1

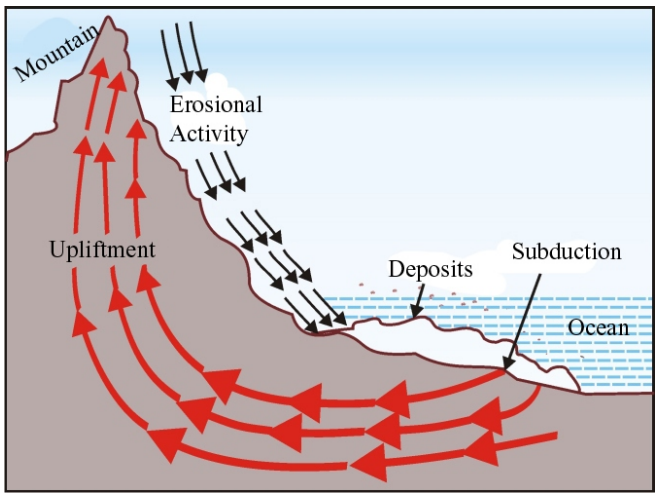


Fig. 7.1 : Isostatic Adjustment

Seismology : In seismology earthquake waves are measured through seismograph. The place of origin of an earthquake is called Focus.

The point of earthquake, which is perpendicular to the 'Focus is where the earthquake tremors are felt first is called 'Epicenter'. (Fig. 7.2)

Earthquake Waves : Due to the shock, at the focus of the earthquake, rocks vibrate which generate tremors. According to the progression pattern and the speed of the waves, its divided into three parts- P-Waves, S-Waves and L-Waves.

1. P-Waves : These are also called Primary Waves. These waves travel from the earthquake focus to the earth's surface, and are first to reach. The speed of these waves varies between 6-13 km per second when these waves pass through rocks. Vibrations in the rock particles is to and fro in direction of wave progression. These waves can pass through all the these mediums solid, liquid and gas.

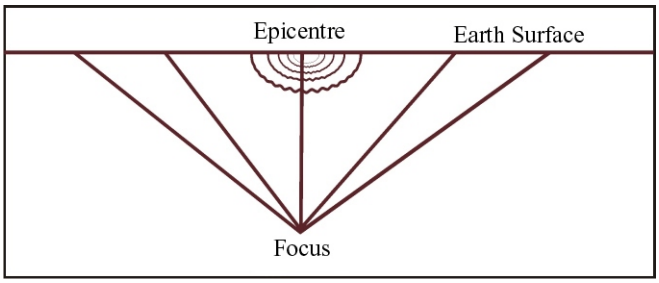


Fig. 7.2 : Focus and Epicentre

2. S-Waves : These are called Secondary Waves. The average speed of these waves is between 4 to 7 km per second. When these waves passes through rock particles, the direction of the movement of the particles is perpendicular to the progression of the waves. These waves can only pass through solids. They disappear in liquids.

3. L-Waves : These waves travel longest distances on earth's surface and progress only around the epicenter on the earth's surface. This is the reason why its called Longitudinal or Surface Waves. These waves travel at the speed of 3 kms per second. They causes enormous damage in the earthquake region. All the three waves are recorded at the Epicenter. Therefore the difference between them is not much known. But as the speed of these waves is different, the time for them to reach the epicenter is also different. Therefore these waves reach one after another, whereby can be clearly differentiated. (Fig. 7.3)

Pg and Sg Waves : They are similar to the P and S in property. But their speed is lesser. These waves progress near the earth's surface.

P* and S* Waves : The speed of these waves are more than Pg and Sg. These waves progresses in the middle region of the earth.

Types of Earthquake : Many types of earthquake affect different areas of the earth. On the basis of nature and causes of earthquake. They are classified under different categories -

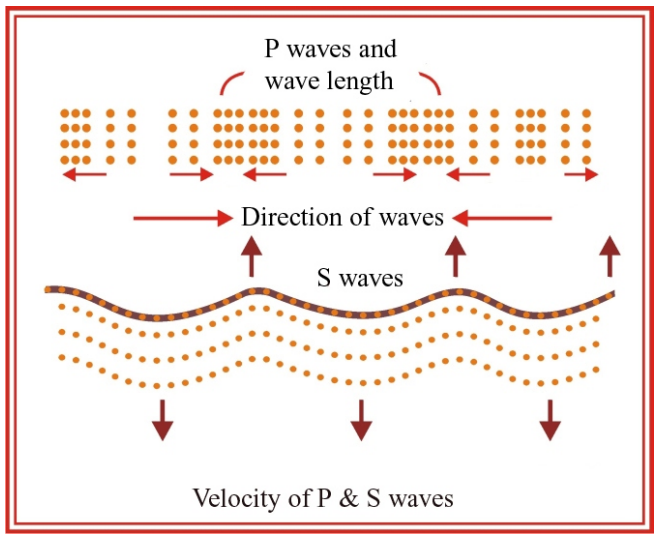


Fig. 7.3 : Seismic waves

1. Artificial Earthquake : These earthquakes are caused due to human activities. These earthquakes affect the local area and are less intense. For example - Mining, Atomic blast, Underground Atomic Experiments.

2. Natural Earthquake : These earthquakes are caused naturally and are active. Its different types are as follows :

(A) Volcanic Earthquake : Those earthquakes which are caused during volcanic eruptions are called Volcanic Earthquakes. Earthquakes occurred during Etna, Vesuvius, Krakatoa Volcanic eruptions are examples of Volcanic Earthquakes.

(B) Tectonic Earthquake : These earthquakes are structural, which are originated due to plate tectonics tension and contraction. These types of earthquakes are not generated at greater depths.

(C) Isostatic Earthquake : These earthquakes are caused due to imbalance in the isostatic balance of the earth. These types of earthquakes occur in the areas of young fold mountains like Himalayan Region, earthquakes in Hindukush and Nepal in 2015.

(D) Plutonic Earthquake : The earthquakes that occur very deep inside the earth are called Plutonic Earthquake. Not much is known about the origin and intensity of these Earthquakes.

3. Types of Earthquakes on the basis of Location.

(A) Land Earthquake : Earthquakes occurring on land are called Land earthquake. Most of the earthquakes of Mid Continental Plate are of this category.

(B) Marine Earthquake : The earthquake that occurs in the marine regions are called Marine earthquakes. These earthquake cause huge oceanic waves which are called 'Tsunami' in Japanese language. Due to massive earthquake in 2011 near. Honshu island of Japan. Fukushima city was completely destroyed.

World Distribution of Earthquake :

Most of the earthquakes occur in new fold mountain region, volcanic regions and coastal margins. These are those places, where isostatic balance is disturbed or the crust is weaker. Earthquakes occur at the plate margins. The major earthquake belts of the world are as follows :

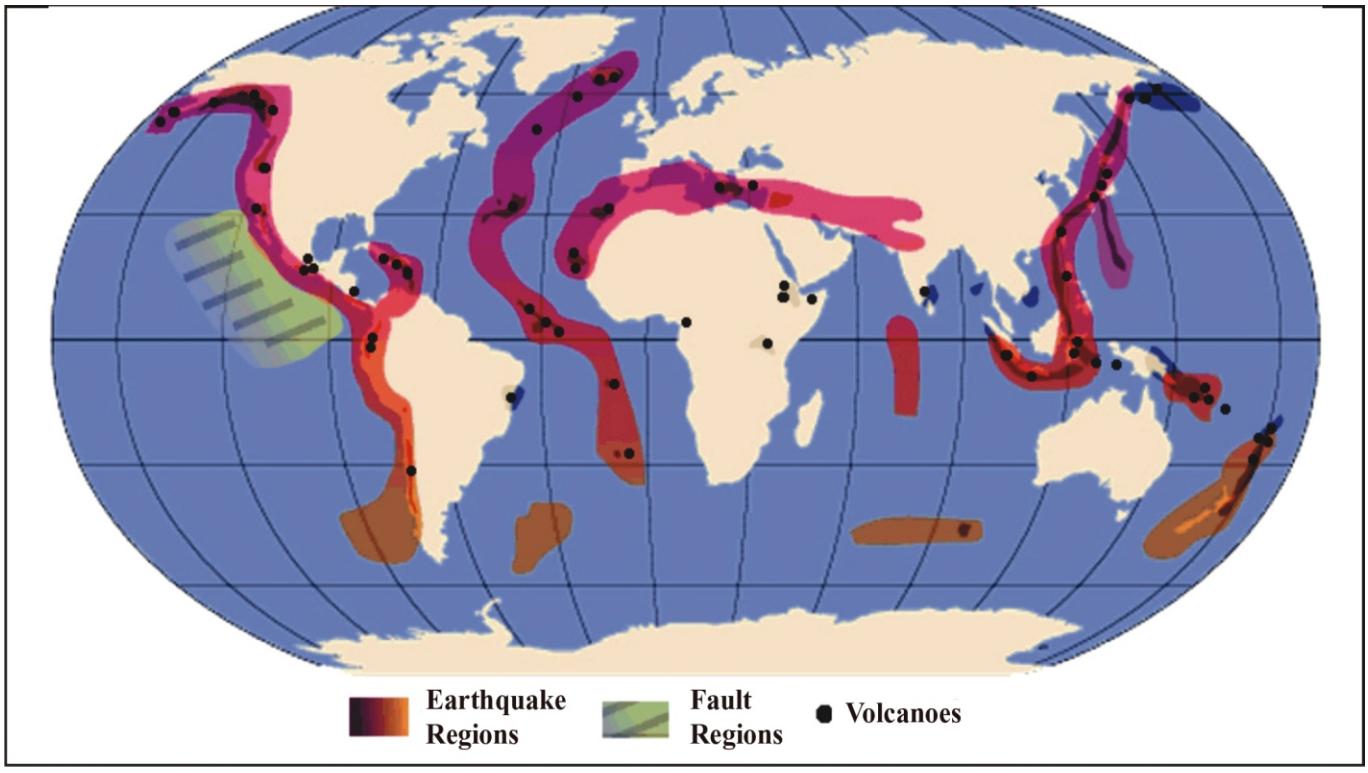


Fig. 7.4 : World distribution of Earthquake and Volcano

(1) Circum Pacific Belt :

This is the most extensive earthquake region of earthquake in the world 2/3rd of the entire earthquakes of the world occur in this region. This belt in form of arc, is situated in Pacific Ocean around continents and Oceans. The four major conditions of occurrence of the earthquakes are present here ie. ground bounding waters, new fold mountains, volcanic regions, divergence of plate boundaries. These include the western margins of North and South America. From Kamchatka peninsula of Asia to eastern Asian islands and Japan, Taiwan Philippines.

(2) Mid Atlantic Ridge Belt : This belt is situated near the Mid Atlantic Ridge in Atlantic Ocean which extends from western Island group of Atlantic Ocean to Bouvet island in the south. One of its branch extends from Nile valley to Great Rift Valley of Africa. Most of the earthquake occur in these regions due to metamorphism, formation of faults and volcanic eruptions Maximum earthquake occur near equator.

(3) Mid-Continental Belt : Its also called Mid-Equatorial belt. Earthquake occur in this region due to fault formation and isostatic balance. 21% of the entire earthquakes of the world occur in this region. This belt include from Portugal to Himalaya, Tibet and Southern, eastern islands groups. Indian earthquake region is part of this belt. The major regions are Italy, China, Asia Minor, Hindukush, Himalaya, Alps, Myanmar.

Effects of Earthquakes :

Earthquake is a natural disaster, which cause devastating effects on the earth's crust. The intensity of the earthquake is measured on Richter scale. It has 0 to 9 points. Each point ahead produces 10 times more intensity and 31.6 times more energy than the previous point. This system is, experience oriented system. It is seen in the context of the effects on human beings, which is from 1 to 12. Earthquakes bring devastating effects for humans. It has more harmful effects than benefit. So its a curse for humans.

Loss due to Earthquake

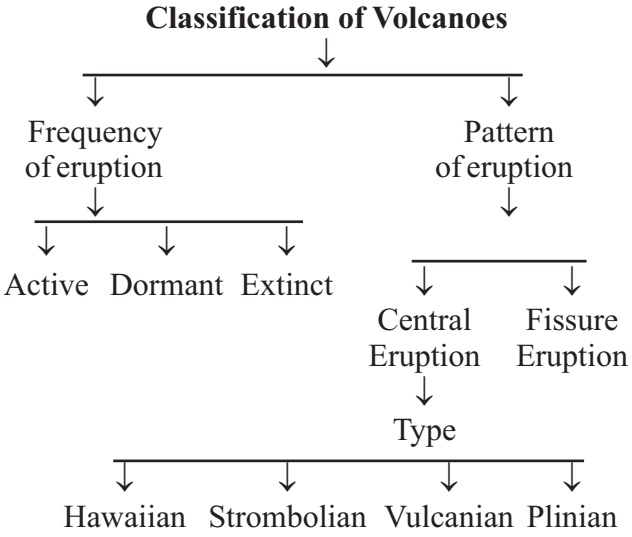
1. There is enormous loss of life and property due to earthquakes. Lot of people die, houses, dams, reservoirs gets destroyed.
2. Earthquakes breaks the rocks of the earth the course of the rivers change, the transport system get damaged. High intensity earthquakes destroys the entire city.
3. Earthquake cause Tsunami waves in sea, which submerge the coastal regions.

Benefits of Earthquake :

1. The Earthquake uplift the regions which positively impacts the climate of the region.
2. Fertile grounds emerges out of marine areas, which is useful for agricultural work. When the coastal areas subsides down, the harbours becomes deeper.
3. Earthquake helps to know more about internal structure of the earth.

Vulcanism :

Volcano is a sudden geological activity originated due to geological forces, in which gas, rock material and hot molten lava erupts out from fracture or a ridge. According to Wooldridge and Morgan. **"Volcanicity is an action which includes all the processes of earth's interior and exterior".**



In simple words vulcanicity is a very wide term which includes, the process of rock material formation, its flow, deposition and its solidification.

Causes of Vulcanicity :

(1) Isostatic Disequilibrium : Due to isostatic disequilibrium structural changes occur in geological areas, which causes volcanic activity.

(2) Formation of Gases : The water seeps into the earth's interior from cracks and fractures, this water is converted into steam and works as a propelling force during eruption.

(3) Increase in temperature in earth's interior : The radioactive minerals present in earth's interior constantly undergoes fission and releases enormous energy resulting in high temperature. Due to high temperature, rocks gets weaker and increases in volume, later volcano erupts from weaker margins.

(4) Decrease in Pressure : The upper layers of the interior of the earth remains in the solid state because of extensive pressure, as soon as pressure is released the rocks melts. This causes volcanicity.

(5) Plate Tectonic : The movement of plates, on earth's crust also causes eruption of volcano. When the plates are colliding, this process of vulcanicity is more probable.

Types of Volcanoes : Volcanoes are classified on two basis :

(1) Frequency of Eruption (2) Nature of Eruption.

The classification on the basis of frequency of eruption is given in the following table.

(a) Active Volcano : In these types of volcanoes, eruptions occur frequently. Etna and Strombolian of Italy are the example of active volcano.

(b) Dormant Volcano : In these types of volcanoes. The volcanic eruptions occurs after dormant period. Vesuvius volcano of Italy is dormant type volcano in which the volcanic eruption occurred in 1631, 1812, 1906 & 1943.

(c) Extinct Volcano : The volcanoes in which there have been no eruption since very long period of time and its vent is filled with water, its called as extinct volcano. Mt. Popa of Myanmar, Koh-i-Sultan of Iran are the example of Extinct volcano.

(2) Classification of Volcanoes on the basis of pattern of volcanic eruption.

(a) Central Eruption Type Volcanoes : The volcanic eruptions in which the eruption is through a vent and a creator, its called central Eruption Volcano.

On the basis of emergence the central eruption type of volcanoes are classified as follows :

(i) Hawaiian Types of Volcano :

In this type of volcano, explosion is lesser and eruption is of silent type. The main reason behind this is thickness of lava and lesser intensity of gases. The example of these type of volcanoes are

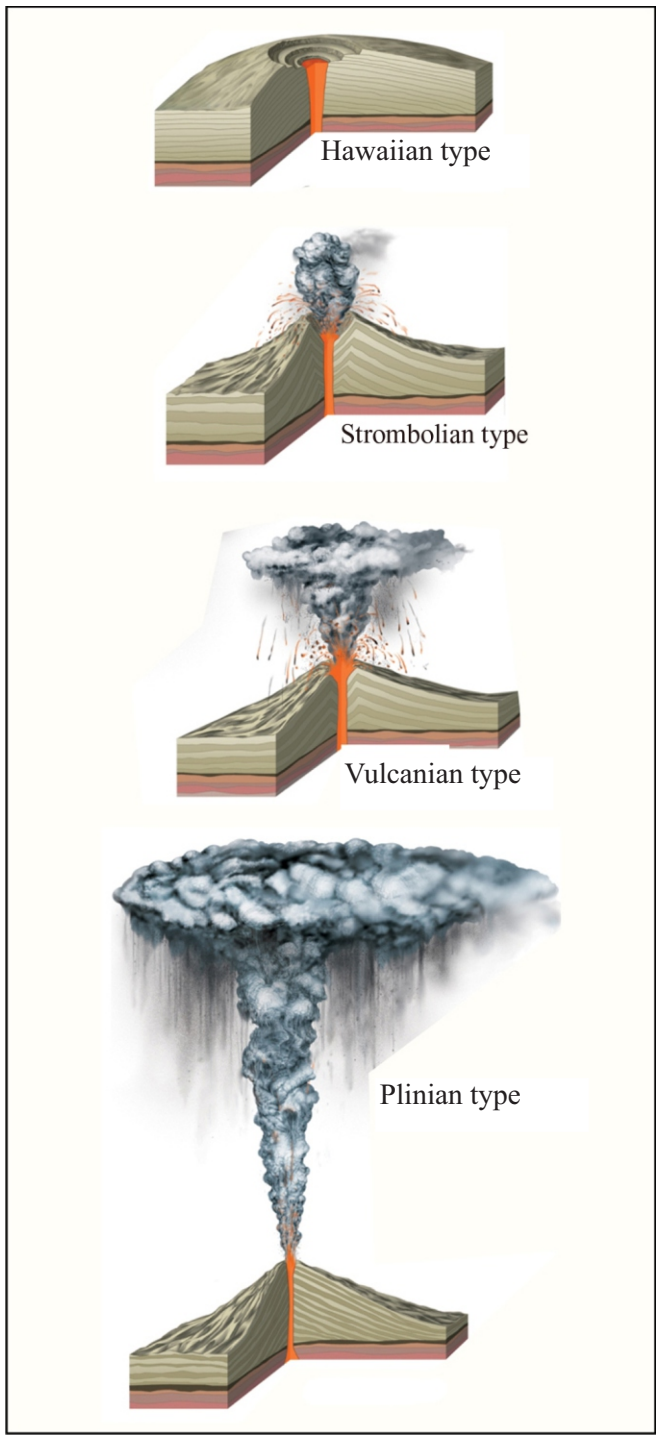


Fig. 7.5 : Types of Volcano

more in Hawaiian Islands. Therefore these types of volcano are name Hawaiian type of volcano.

(ii) Strombolian type of Volcanoes : The lava, in the these types of volcano is much thicker and erupt with greater intensity. Sometimes the eruption is explosive thus the volcano having this type of eruption and the volcanic eruption similar to this type is named strombolian type volcanoes.

(iii) Volcanic type of Volcanoes : The eruptions in these volcanoes is with huge explosion and eruption is of very great intensity and after the explosion, gases ashes, gases with dust, are emitted out in form of huge block cloud. It resembles the shape of a cauliflowers from a distance.

These types of volcanoes are named after the 'Volcano (the name of a volcano) which is located in the Lepari Island Group.

(iv) Plinian Type : In these types of volcanoes, the lava eruptions are most explosive and fierce and its also most devastating. In Martinique group of islands. The explosive volcano named 'Pelee' is located and the volcanoes with similar eruption type is named after this volcano.

(B) Volcanoes with Fissure Eruptions : In these type of volcanoes, the lava erupts selently from the fissures. The lava is mostly thinner resulting into formation of lava plateau. Columbian Plateau, Deccan Plateau are made up of Volcanic eruptions from fissures.

Material ejected out of Volcanoes :

1. Gases and water Vapour : Along with the eruption of earthquake, Carbon-di-oxide, water vapour, Sulphur-di-oxide, carbon-monoxide, Hydrochloric Acid, Amonia Chloride etc. gases are emitted out. Fumaroles are the sources of hot water, through which hot vapours and water are ejected out. Gases, acids and sulphur gushes out in form of jet. 'Solftara' is the name of one such fumarole.

2. Solid Material : The volcanic eruptions include eruptions like dust particles, ashes to huge bolders.

3. Liquid Material : The liquid rocks beneath the earth's surface is called Magma and when it comes out on earth's surface, it is called lava.

World distribution of Volcano :

World distribution of volcanoes is presented in form of belts :

1. Circum Pacific Belt : More than 2/3rd of world's volcanic eruptions are found in this belt. This belt is extended all around in Pacific Ocean in coastal regions. The extension of this belt starts from Erebus of Antarctica including Rockies Andes mountains, turns from Alaska towards south eastern coastal regions and merges with Continental Plate. This belt include Fujiyama of Japan. Mt. Taal of Philippines, Mt. Shasta of Mt.Rainier USA.

2. Mid-Continental Belt : This belt is extended in Alps and Himalayan ranges. Mediterranean volcanic eruptions come under this belt. Mt. Varnon, Mt. Elbruz, Mt. Etna, Mt. Vesuvius, Stromboli are all included in this belt.

3. Mid Atlantic Ridge Belt : This belt is extended in Atlantic Ocean is form of English Alphabet 's'. This belt extends from Iceland in the north including Mid Atlantic Ridge to Antarctic in the south. Hekla, Katla, Ascension St. Helena, volcanoes are included in this belt.

4. East African Belt : This belt extends from Israel in the north. Red Sea in the south and from Rift valley in the east till Madagascar. Volcanoes of Elgon and Kilimanjaro are included in this belt.

5. Other Volcanoes : Besides these belts, some volcanoes are also extended in singular form, it includes the volcanoes on Hawai Islands in Pacific Ocean. Mauritius, Comoro, Reunion Islands in Indian ocean.

Effects of Volcanoes

Positive or Constructive Effects- The volcanic eruption after scattering of lava, gives birth to highly fertile soil. The black soil of Indian Peninsula is an example of the beneficial side of volcanic eruption. The volcanic process has an important role in the development of various types of mineral belts.

Destructive Effects- The erupted lava along with other substances like gases, ashes result in loss of human lives as well as cultural landscape. There is mass destruction of life due to volcanic eruption, flooding of coastal areas and there is loss of marine acquatic plants and animals.

Important Points

1. Sudden vibrations on the earth's surface caused due to endogenetic forces of the earth's

interior is called earthquake.

2. Faults, Volcanoes, Construction of earth's crust, water load causes of earthquake.
3. Seismic waves are of three types- P-waves, S-waves and L-waves.
4. Volcanoe is a sudden activity caused due to endogenetic forces of the earth's interior, during which gases, rock materials and magma erupts out.,
5. Active, Dormant, Extinct, Central Erupting and Eruption from Fractures are some of the types of Volcanoes.

Exercises

Multiple type questions-

1. The Etnavolcanoe of Italy is which type of volcanoe from the following types ?
   (a) Active (b) Silent
   (c) Extinct (d) Dormant

2. The Vesuvius volcano, falls under which category of volcano?
   (a) Active (b) Silent
   (c) Extinct (d) Dormant

3. Mt. Popa of Myanmar is which category of volcanoes?
   (a) Active (b) Silent
   (c) Extinct (d) Dormant

4. The volcanoes which have a vent is kept under which category of volcanic types?
   (a) Fissure Volcano (b) Central Eruption
   (c) Extinct (d)Dormant

5. The 'Deccan Trap Region' of India is made up of which volcanic type eruption ?
   (a) Fissure Eruption (b) Central Eruption
   (c) Extinct (d) Dormant

Very Short Type :

6. Define Earthquake.
7. Name the materials emitted during volcanic eruptions.
8. What are Secondary Waves?
9. Give the names of two active volcanoes.
10. Give the names of two extinct volcanoes.

Short Type :

11. Explain Elastic Rebound Theory.
12. Vulcanism causes earthquakes. Explain.
13. Explain waterlod.
14. Give the types of volcanoes.
15. Give the examples of active volcanoes.

Essay Type :

16. Describe the major causes of origin of the earthquakes and different types of seismic waves.
17. Classify earthquakes and give their world distribution.
18. Describe the causes of volcano and explain its classification.

Answer Key

1. A 2. D 3. D 4. B 5. A