JECRC Foundation

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

Class: -	III Semester / II Year
Subject: -	Engineering Geology
Code: -	**3CE4-08**
Unit:-1	Introduction and Physical Geology
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Jaipur

VISION

- To become a role model in the field of Civil Engineering for the sustainable development of the society.

MISSION

1) To provide outcome base education.

2) To create a learning environment conducive for achieving academic excellence.

3) To prepare civil engineers for the society with high ethical values.

Course Outcomes

CO1:-To understand about weathering, physical properties of minerals and geological action of river and wind.

CO2:-To understand the different types of rocks and their properties.

CO 3:-To understand the folds, faults, joints and unconformity.

CO4:-To understand the geophysical methods and application of remote sensing and GIS.

Programme Outcomes (PO)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of 9the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage inindependent and life-long learning in the broadest context of technological change.

UNIT-1

Syllabus of Introduction and Physical Geology- Objects and scope of geology. The crust and the interior of the earth, origin and age of the earth, sub-aerial land, sub-terrain weathering, denudation and deposition, wind, river, glacial and marine erosion, volcanoes, soil, formation of soil profile ,geological classification of soil and concept of earthquake, Plate- tectonics.

GEOLOGY (in Greek, Geo means Earth, Logos means Science) is a branch of science dealing with the study of the Earth. It is also known as earth science. The study of the earth as a whole, its origin, structure, composition and the nature of the processes which have given rise to its present position is called as geology. Geology comprises the following branches:

1. Crystallography
2. Mineralogy
3. Petrology
4. Geophysics
5. Geochemistry
6. Structural Geology
7. Stratigraphy
8. Physical Geology
9. Geomorphology
10. Paleontology
11. Hydrogeology
12. Engineering Geology
13. Photo Geology
14. Economic Geology
15. Mining Geology

Crystallography: The study of the characters of crystals is known as crystallography. Crystals are bodies bounded by flat faces (surfaces), arranged on a definite plane due to internal arrangements of atoms.

Mineralogy: The study of the characters of minerals (example: quartz, pyroxene, amphibole, mica, chlorite, garnet) is known as Mineralogy. A mineral is a naturally occurring homogeneous substance, inorganically formed with a definite chemical composition, with a certain physical properties and crystalline structures.

Petrology: The study of rocks in all their aspects including their mineralogist, textures, Structures (systematic description of rocks in hand specimen and thin s e c t i o n s); origin and their relationships to other rocks.

Geophysics: The section of the earth which include the structure, physical conditions and evolutionary history of the earth as a whole.

Geochemistry: The study of chemical composition of minerals and rocks of the earth. Structural Geology is the study of rock structures such as folds that have resulted from movements and deformation of the earth's crust.

Stratigraphy: The study of the stratified rocks especially their sequence in time, the character of the rocks and correlation of beds at different localities.

Physical Geology: It deals with the geological processes which bring about changes in the crust and upon the surface of the earth. It also deals with the surface features of the earth (land forms) or its topography

Geomorphology: The description and interpretation of land forms.

Paleontology is the study of ancient life, determination of environment, evolution of organism etc.

ENGINEERING GEOLOGY: the principles and methods of geology is adopted for the purpose of civil engineering operations. Broadly speaking Engineering Geology has two divisions:

(1) The study of raw materials

(2) The study of the geological characteristics of the area where engineering operations are to be carried out such as Groundwater characteristics; the load bearing capacity of rocks; the stability of slopes; excavation; rock mechanics etc for civil engineer.

SCOPE OF GEOLOGY: In Civil Engineering

- Geology provides necessary information about the construction materials at the site used in the construction of buildings, dams, tunnels, tanks, reservoirs, highways and bridges.
- Geological information is most important in planning stage, design phase and construction phase of an engineering project.
- Geology is useful to know the method of mining of rock and mineral deposits on earth's surface and subsurface.
- Geology is useful for supply, storage and filling up of reservoirs with water.
- Before constructing roads, bridges, tunnels, tanks, reservoirs and buildings, selection of site is important from the point of stability of foundation.
- Geology provides a systematic knowledge of construction materials and their properties.
- The knowledge about the nature of the rocks in tunneling and construction of roads.
- The foundation problems of dams, bridges and buildings are directly related with geology of

the area where they are to be built.

- The knowledge of ground water is necessary in connection with excavation works, water supply, irrigation and many other purposes.
- The knowledge of Erosion, Transportation and Deposition (ETD) by surface water helps in soil conservation, river control.
- Geological maps and sections help considerably in planning many engineering projects.
- If the geological features like faults, joints, beds, folds are found, they have to be suitably treated. Hence, the stability of the rock structures is important.
- Pre-geological survey of the area concerned reduces the cost of planning work.

Minerals, Rocks and soils constitute earth materials. They play a vital role in the site evaluation and operations in civil engineering practice. Whether it is tunneling, hydro- electric projects, ground water development, foundation for structures, study of slope stability etc. A basic understanding of the earth materials is essential.

Thus, study of minerals, rocks and soils forms the first step in civil engineering point of view. Hence, a civil engineer should know the introduction of Geology and its branches and importance of a few branches such as Physical Geology, Petrology; Structural Geology and so on.

IMPORTANCE OF PHYSICAL GEOLOGY: It deals with the geological processes which bring about changes in the crust and upon the surface of the earth. It also deals with the surface features of the earth (land forms) or its topography. The earth is concentrically divided into a number of spheres.

(1) Atmosphere

(2) Hydrosphere and

(3) Lithosphere.

The outermost sphere is Atmosphere which consists of several gases and vapors and envelopes the earth. Atmosphere is essentially a mixture of N_2 and O_2 with smaller quantities of vapor, CO_2 etc. Geologically atmosphere is important as the medium of climate and weather. Hydrosphere includes the natural waters of the earth i.e., oceans, seas, lakes, rivers, streams and underground water. Lithosphere is the outer part of the earth's crust consisting of rocks and minerals.

Interior of the earth -:

Earth's interior is made up of a series of layers that sit below the surface crust. In order of depth, these layers include the solid, but flowing mantle, the liquid outer core and the solid iron outer core, which helps create Earth's protective magnetic field.

1. Crust

2. Mantle

3. Core

1. Crust-: The crust ranges from 5–70 km (~3–44 miles) in depth and is the outermost layer. The thin parts are the oceanic crust, which underlie the ocean basins (5–10 km) and are composed of dense (mafic) iron magnesium silicate igneous rocks, like basalt. The thicker crust is continental crust, which is less dense and composed of (felsic) sodium potassium aluminum silicate rocks, like granite. The rocks of the crust fall into two major categories – SIAL and SIMA (Sues, 1831–1914). It is estimated that SIMA starts about 11 km below the Conrad discontinuity (a second order discontinuity). The uppermost mantle together with the crust constitutes the lithosphere. The crust-mantle boundary occurs as two physically different events. First, there is a discontinuity in the seismic velocity, which is most commonly known as the Mohorovic discontinuity or Moho.

2. Mantle -:Earth's mantle extends to a depth of 2,890 km, making it the thickest layer of Earth. The mantle is divided into upper and lower mantle. The upper and lower mantle is separated by the transition zone. The lowest part of the mantle next to the core is known as the D″ (D prime) layer. The pressure at the bottom of the mantle is ~140 GPA. Themantle is composed of silicate rocks that are rich in iron and magnesium relative to the overlying crust. Although solid, the high temperatures within the mantle cause the silicate material to be sufficiently ductile that it can flow on very long timescales. Convection of the mantle is expressed at the surface through the motions of tectonic plates.

3. Core-: The average density of Earth is 5,515 kg/m^3. Because the average density of surface material is only around 3,000 kg/m^3, we must conclude that denser materials exist within Earth's core. Seismic measurements show that the core is divided into two parts, a "solid" inner core with a radius of ~1,220 km and a liquid outer core extending beyond it to a radius of ~3,400 km. The densities are between 9,900 and 12,200 kg/m^3 in the outer core and 12,600–13,000 kg/m^3 in the inner core.

Denudation: The sum of the processes which result in the general lowering of the land surfaces or when erosion takes place, fresh country rock surfaces will be exposed and this process is called DENUDATION. Denudation consists of weathering, transportation and erosion.

Weathering is the process by which rocks are broken down and decomposed by the action of external agencies such as wind, rain, temperature changes. Weathering is the initial stage in the process of denudation.

- Types of Weathering - Physical

Physical weathering is the weakening and subsequent disintegration of rock by physical forces. These physical forces include temperature fluctuation, abrasion, frost action (freezing and thawing), and salt crystal growth.

Temperature fluctuation can cause expansion or contraction of rock. When the temperature of rock increases, the rock expands.

When the temperature of rock decreases, the rock contracts. This process of expansion and contraction is a physical stress and can crack or break rock. Abrasion of rock is caused by the friction of water, wind, or ice upon the rock. The continuous exposure to these elements slowly breaks down the exposed surface of the rock.

Frost action is the repeated cycle of ice formation and ice melt in the pore spaces and fractures of rocks causing disintegration of the rock. When water in rock pores freezes, its volume increases by about 10%. This can create a significant amount of pressure on rocks. The magnitude and extent of frost action is dependent on the frequency, duration and intensity of the freezing and thawing cycles. Salt crystal growth can cause the break-up of rock materials. Crystal growth often occurs when groundwater moves into empty pores or spaces of rock by capillary action. As the water evaporates, salt crystals grow and accumulate, putting pressure on the rock and causing it to break apart. Salt crystallization is common in drier climates.

Chemical weathering :-Chemical weathering is the weakening and subsequent disintegration of rock by chemical reactions. These reactions include oxidation, hydrolysis, and carbonation. These processes either form or destroy minerals, thus altering the nature of the rock's mineral composition. Temperature and, especially, moisture are critical for chemical weathering; chemical weathering of rock minerals generally occurs more quickly in hot, humid climatic regions.

Oxidation is the reaction of rock minerals with oxygen, thus changing the mineral composition of the rock. When minerals in rock oxidize, they become less resistant to weathering. Iron, a commonly known mineral, becomes red or rust colored when oxidized. Chemical weathering is the weakening and subsequent disintegration of rock by chemical reactions. These reactions include oxidation, hydrolysis, and carbonation. These processes either form or destroy minerals, thus altering the nature of the rock's mineral composition. Temperature and, especially, moisture are critical for chemical weathering; chemical weathering of rock minerals generally occurs more quickly in hot, humid climatic regions. Oxidation is the reaction of rock minerals with oxygen, thus changing the mineral composition of the rock. When minerals in rock oxidize, they become less resistant to weathering. Iron, a commonly known mineral, becomes red or rust colored when oxidized. Carbonation is the process of rock minerals reacting with carbonic acid. Carbonic acid is formed when water combines with carbon dioxide. Carbonic acid dissolves or breaks down minerals in the rock.

CO_2 + H_2O → H_2CO_3

(carbon dioxide + water → carbonic acid)

$CaCO_3$ + $H_2CO_3 \rightarrow Ca^{2+}$ + $2HCO_{3-}$

(calcite + carbonic acid → calcium + bicarbonate)

Hydrolysis is a chemical reaction caused by water. Water changes the chemical composition and size of minerals in rock, making them less resistant to weathering. Click on the video clip below to see hydrolysis of a relatively weathering resistant mineral, feldspar. When this mineral is completely hydrolyzed, clay minerals and quartz are produced and such elements as K, Ca, or Na are released.

A hydrolysis reaction of orthoclase (alkali feldspar), a common mineral found in igneous rock, yields kaolinite, silicic acid, and potassium.

$2KAISi_3O_8 + 2H^+ + 9H_20 \rightarrow H_4Al_2Si_2O_9 + 4H_4SiO_4 + 2K^+$

(Orthoclase + water → kaolinite + silicic acid + potassium)

1. Hydration is the absorption of water into the mineral structure. A good example of hydration is the absorption of water by anhydrite, resulting in the formation of gypsum. Hydration expands volume and also results in rock deformation. Dehydration is the removal of water from rock or mineral structures. A good example of dehydration is the removal of water from limonite, resulting in the formation of hematite. Dehydration of limonite to hematite may be observed in the following experiential activity.

Biological weathering is the weakening and subsequent disintegration of rock by plants, animals and microbes. Growing plant roots can exert stress or pressure on rock. Although the process is physical, the pressure is exerted by a biological process (*i.e.*, growing roots). Biological processes can also produce chemical weathering, for example where plant roots or microorganisms produce organic acids which help to dissolve minerals. Microbialactivity breaks down rock minerals by altering the rock's chemical composition, thus making it more susceptible to weathering. One example of microbial activity is lichen; lichen is fungi and algae, living together in a symbiotic relationship. Fungi release chemicals that break down rock minerals; the minerals thus released from rock are consumed by the algae. As this process continues, holes and gaps continue to develop on the rock, exposing the rock further to physical and chemical weathering. Burrowing animals can move rock fragments to the surface, exposing the rock to more intense chemical, physical, and biological processes and so indirectly enhancing the process of rock weathering. Although physical, chemical, and biological weathering are separate processes, some or all of the processes can act together in nature.

Transportation is the main agency by which materials are moved by means of Gravity, running water (rivers, streams); Ice (glaciers); Wind etc.

Erosion: Mechanical disintegration or chemical decomposition of rocks and their subsequent displacement is called as erosion or erosion is the destructive process due to the effect of the transporting agents. The chief agents of erosion are running water, wind etc.

Deposition: The material is transported mechanically and deposit (example: sand).

Geological works of Rivers

A river is one of the major geological agent which carries out its work. The work is mainly divided into three stages, namely

1. River Erosion
2. River Transportation
3. River Deposition

River Erosion: Erosion means mechanical disintegration or chemical decomposition of rocks are transported from the site with the help of natural agencies like wind and running water (or) subsequent displacement. River is a powerful eroding agent and carries out its work in different ways such as hydraulic action, solution and abrasion / attrition etc.

- Hydraulic action: The physical breakdown of rocks take place naturally and greater the movement greater will be the erosion. In the initial and youth stages, the rivers acquire more considerable kinetic energy. When such water dashes against rock forcefully, it will break and this will be more effective if

1. The rocks are already weathered.
2. They are porous and are not well cemented.
3. Those possess fractures, cracks etc.

- Solution: This process, is a part of hydraulic action which involves only chemical decay of rocks. This is an invisible process and very effective under favorable conditions.

- Attrition: This is a mechanical weathering process. When the rock fragments hit the rocks which are already exposed, abrasion take place. Thus the rock fragments during abrasion undergo wear and tear which is called attrition.

During transportation, heavier and larger materials move slowly while finer and lighter material move fast when attrition take place the angular edges disappear and spherical, ellipsoidal stones etc are formed after a long journey.

River Transportation: A river transports its material physically as well as in a solution form. The transport system is divided into three groups.

Bed load -: comprises heavier particles of sand, pebbles, gravels etc. which are transported mainly by their rolling, and skipping, along the bottom of stream.

1. Suspended load consists of silt, fine sands, clay etc... And such load is carried by river in its body of water in suspension. As the river is moved, the load is also carried along with it. Thus load is transported continuously without break till conditions are favorable. This type of natural suspension and separation of sediments account to their size is called Sorting.
2. Dissolved load: Material is transported in a solution condition. The ability to transport the sediments is influenced by river velocity, density etc...

River Deposition is the last phase of geological work of a river. Among the different kinds of river deposits, a few are listed below:

Alluvial cones and fans: River sediment is known as alluvium. If the deposit is spread over a small area but has a relatively steep slope, it is called an alluvial cone. On the other hand, if the deposit is spread over a large area and has a gentle slope, it is called an alluvial fan.

Placer deposits: The placer deposits are characteristically composed of heavier metals such as Gold, Platinum, Chromite, magnetite, Rutile, Ilmenite, Monazite etc. which are commonly economic minerals.

Example Rand placer deposit of South Africa is famous for gold.
Delta deposits: Most of the rivers reach this stage just before they merge with the sea. Rivers Ganga and Brahmaputra have built up the best deltaic regions of the world. Deltas are very fertile and valuable for agriculture.

Natural levees. During the time of floods, the river carries a very large scale of river dumps along its course on either side which are known as natural levees example silt, clay .

MEANDER DEVELOPMENT

A meander in general is a bend in a (moving with smooth twists & turns) water coarse. A meander bend is formed when the moving water in a stream erodes the out banks and widens its valley. If the river encounters any obstacle, it shall not have the capacity to uproot it and therefore it takes a diversion and continues its downward coarse.. This is responsible for the formation of deposits known as placer deposits.

By virtue of its relatively weak condition the river compulsorily undergoes a number of curves or bends which makes its path zigzag. These bends are called meanders and the phenomenon is known as Meandering. Meandering is therefore a characteristic feature of the mature stage.

In due course of time these bends become more and more acute due to deposition of sediments along the inner curve and erosion along the outer curve. Ultimately under favorable conditions such as floods, these loops are cut off from the main course of the river. Such cut off bodies of water which are curved in plan are called cut off lakes or horse shoe lakes or ox bow lakes.

Delta: A delta is a land-form that is formed at the mouth of a river where the river flows into an ocean, or sea. Deltas are formed from the deposition of the sediment carried by the river as the flow leaves the mouth of the river. Over long periods of time, this deposition builds the characteristic geographic pattern of river delta.

Development of delta: The favorable conditions for the formation of delta are:

1. The river should have large amount of load.The river should have totally exhausted its energy at the time of its merger with the sea.
2. The oceans at the mouth of the river should not be turbulent otherwise as & when loose sediments are deposited they are washed away by the waves and currents of the sea.

During delta formation the prevailing conditions will be such that the river will be shallow and will change its direction and velocity frequently. Under such conditions deltas develop a typical structure known as cross bedding.

The delta will have gently incline bottom layers of fine sediments known as bottom set beds. These are overlain by steeply inclined middle layers of coarse sediments known as forest beds. Above these again gently dipping layers of the mixture of finer and coarser sediments occur. They are known as top set beds. Though all these three sets of beds are inclined towards the sea, they differ in the amount of inclination and hence they are not parallel. Such a peculiar bedding phenomenon is known as cross bedding.

VALLEYS: In geology, a valley is a depression with predominant extent in one direction. A very deep river valley may be called a canyon or gorge. The terms U-shaped and V-shaped are descriptive terms of geography to characterize the form of valley. Most valleys belong to one of these two main types or a mixture of them, at least with respect of the cross section of the slopes or hills.

FORMATION AND DEVELOPMENT: A valley is an extended depression in the Earth's surface that is usually bounded by hills or mountains and is normally occupied by a river or stream. Valleys are one of the most common landforms on the Earth and they are formed through erosion or the gradual wearing down of the land by wind and water. In river valleys for example, the river acts as an erosional agent by grinding down the rock or soil and creating a valley. The shape of valleys varies but they are typically steep-sided canyons or broad plains, however their form depends on what is eroding it, the slope of the land, the type of rock or soil and the amount of time the land has been eroded. There are three common types of valleys which include V-shaped valleys, U-shaped valleys and flat floored valleys. V-SHAPED VALLEYS/ RIVER VALLEYS: A V-shaped valley, sometimes called a river valley, is a narrow valley with steeply sloped sides that appear similar to the letter "V" from a cross-section. They are formed by strong streams, which over time have cut down into the rock through a process called down cutting. These valleys form in mountainous and/or highland areas with streams in their "youthful" stage. At this stage, streams flow rapidly down.

- An example of a V-shaped valley is the Grand Canyon in the Southwestern United States. After millions of years of erosion, the Colorado River cut through rock of the Colorado Plateau and formed a steep sided canyon V-shaped canyon known today as the Grand Canyon.
- The original natural large river valleys of the world such as Nile, Ganges, Amazon, Mississippi etc.

U-SHAPED VALLEYS/ GLACIAL VALLEYS: A U-shaped valley is a valley with a profile similar to the letter "U." They are characterized by steep sides that curve in at the base of the valley wall. They also have broad, flat valley floors. U-shaped valleys are formed by glacial erosion. U-shaped valleys are found in areas with high elevation and in high latitudes, where the most glaciation has occurred. Large glaciers that have formed in high latitudes are called continental glaciers or ice sheets, while those forming in mountain ranges are called alpine or mountain glaciers.

Due to their large size and weight, glaciers are able to completely alter topography. This is because they flowed down pre-existing river or V-shaped valleys during the last glaciations and caused the bottom of the "V" to level out into a "U" shape as the ice erode the valley walls, resulting in a wider, deeper valley. For this reason, U-shaped valleys are sometimes referred to as glacial troughs.

One of the world's most famous U-shaped valleys is Yosemite Valley in California. It has a broad plain that now consists of the Merced River along with granite walls that were eroded by glaciers during the last glaciations.

Geological work of wind

Wind is the moving air. Wind blowing over the solid surface of the lands is also an active agent of landform development. Its activity is particularly intensive in the deserts and semi deserts which constitute about 20% of the surface of continents.

The geological action of wind is particularly effective in areas that lack plant cover, have a considerable diurnal and seasonal temperature variation, and low precipitation. The geological action of wind can conveniently be divided in to three stages viz. Erosion, Transportation and Deposition. As a whole, the geological action of wind is largely governed by its velocity. But wind alone has little influence on shaping the surface of the ground, because it is only able to move small dry particles. In humid climatic regions, the surface of the earth is protected by a solid cover of vegetation and also by the cohesive effects of moisture in the soil from sharp temperature fluctuations causing physical weathering and the deflation work of the wind.

Erosion Wind erosion manifests itself in three forms viz. (i) deflation, (ii) abrasion or corrosion and (iii) attrition. Wind uses sand as the agent of erosion. Wind and running water are in many respect similar in the ways in which they erode and transport sediment particles.

1. Deflation :A strong wind can transport very coarse sand, lifting it from the ground and carry it for great distances. This process of removal of loose soil of rock particles, along the course of the blowing wind is known as 'deflation' (from the Latin de flare=to blow off).

The wind picks up and removes loose particles from the earth's surface, and thus helps to lower the general level. This process operates well in dry regions with little or no rainfall. The rate of deflation depends on the force of the wind, the nature of the rock and the degree of weathering it has suffered etc.

Features Produced by Deflation

(i) Hamada: When the loose particles are swept away the hard mantle left behind is known as 'hamada'. The term has been applied to the stone-strewn surface in the Sahara desert, left after the finer materials are removed by wind. This is a form of lag-deposits.

(ii) Blow-outs or deflation-hollows: Deflation sometimes leads to the formation of depression or hollows on the land surface. At few places, deflation may continue to deepen a blow-out in fine-grained sediment until it reaches the water-table. These depressions may range from a few meters to a kilometer or more in diameter, but it is usually only a few meters deep. Such depressions, when deepen until '.he water-table and gets filled with water, create shallow ponds or lakes known as 'Oases'. The position of the oasis is quickly stabilized by the growth of vegetation-commonly palm trees. Some oases are very small with only a few trees, whilst others are large enough to support moderate-sized townships surrounded by gardens and date palms. The pans of

South Africa, the so-called lakes of west and central Australia etc. are probably the results of long-continued deflation.

(iii) Lag deposits*:* Sometimes a layer of residual pebbles and cobbles are strewn upon the surface while intervening finer particles have been removed as a result of deflation. These accumulation of pebbles and boulders have been designated by the general term lag- deposits.

By rolling or jostling about, as the finer particles are removed, the pebbles become closely fitted together forming what is known as a desert pavement. This layer protects the underlying sediment from further deflation. Its widespread occurrence is emphasized by the variety of names applied to it: reg in Algeria; rig in Iran, serer in Libya; the gibbers in Australia.

2. Abrasion

The loose particles that are blown away by the wind serve as tools of destruction, wearing away the surface with which it comes in contact. This process is also known as corrosion. Abrasion is mainly effective as part of saltation (a mode of wind transport) and can operate only near the ground because of the inability of wind to lift sand more than a few feet. Its main effect is mostly seen in under cutting and fluting at the base of upstanding rock masses. Depending on the hardness of the rock and the character of the material bomb by the wind, the surface of rocks is polished, covered with striations, furrows or grooves, and so on.For effective abrasion, sand-blasting must continue for a long time and the wind must have a long fetch across a source area of suitably-sized particles.

Features Produced by Abrasion :-

Yardang: It is a grooved or furrowed topographic form produced by wind abrasion. The grooves are elongated in the direction of prevailing winds and are separated by sharp ridges. The yardangs commonly develop, where the exposed rocks have vertical layers, consisting of alternations of hard and soft strata, and when the winds are steady and blow in one direc- tion, the softer strata are scoured away more rapidly than the hard and resistant strata. Thus, there develops a topographic feature consisting of elongated ridges and furrows, depending on the original rock characteristics. These are also usually under-cut. These are common in parts of the Asiatic deserts. -

(i) Ventifacts: These are the pebbles faceted by the abrasive effects of wind-blown sand. These are developed when sand has been blown over pebbles for a longtime, so that they become worn from the repeated abrasion and smooth polished surfaces result. Ventifacts with one smooth surface is called Einkanters, with two abraded surfaces as Zweikanter and with three smooth faces as Dreikanters.

(ii) *Pedestal rock* : It is a wide rock-cap standing on a slender rock column, produced because of wind abrasion. As we know, the sand-blast action is most effective just above the surface of the ground where the drift is thickest and it decreases rapidly upwards as a result of which rocks which projects upwards are under-cut. When soft rocks capped with harder and resistant rocks are exposed to wind abrasion, the softer rocks being more deeply worn, produce a mushroom-shaped form in which the upper widened part of the rock rests upon a relatively thin and short rock-column.

(iii) Zeugen These are tabular masses of more resistant rock resting on under-cut pillars of softer material and are very often elongated in the direction of prevailing wind; besides the strata are horizontal.

3. Attrition: While on transit, wind born particles often collide with one another and such mutual collision brings about some degree of grinding of the particles. Thus rounding of grains become perfect to a great extent and the grains are reduced to smaller dimensions. The more the length of transit and velocity, the greater is the degree ofrounding

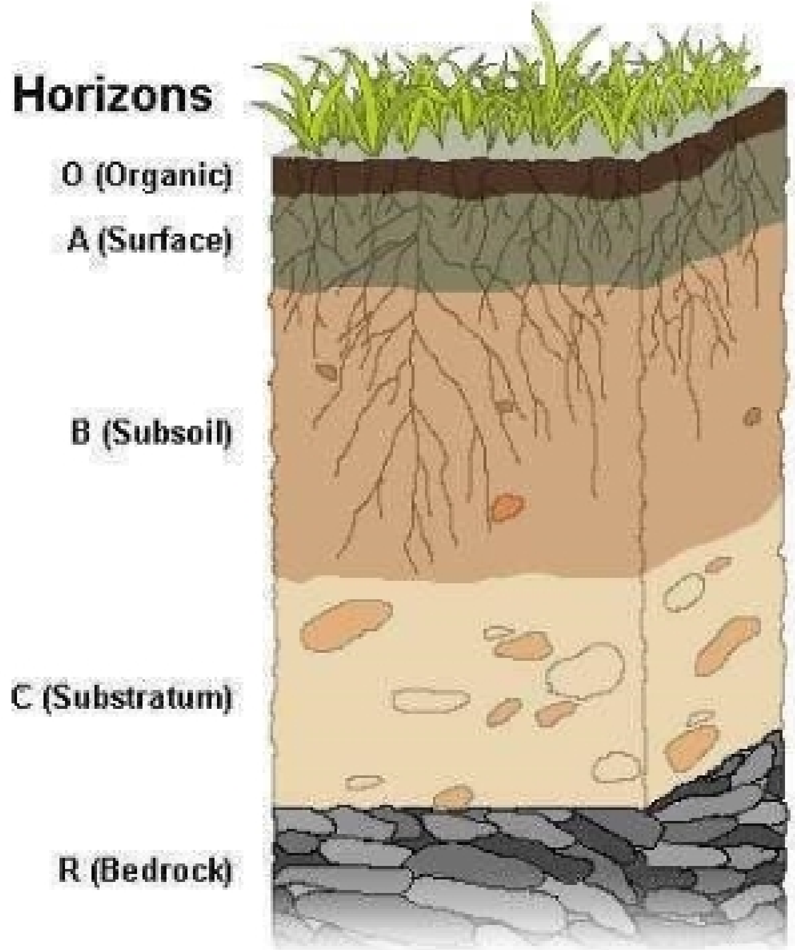
Depositional features

Soil formation and soil profile-: The development of a soil from inorganic and organic materials is a complex process. Intimate interactions of the rock and hydrologic cycles produce the weathered rock materials that are basic ingredients of soils. Weathering is the physical and chemical breakdown of rocks and the first step in soil development. Weathered rock is further modified by the activity of soil organisms into soil, which is called either residual or transported, depending on where and when it has been modified. A soil can be considered an open system that interacts with other components of the geologic cycle. The characteristics of a particular soil are a function of climate, topography, parent material (the rock or alluvium from which the soil is formed), time (age of the soil), and organic processes (activity of soil organisms). Vertical and horizontal movements of the materials in a soil system create a distinct layering, parallel to the surface, collectively called a soil profile. The layers are called zones or soil horizons. Our discussion of soil profiles will mention only the horizons most commonly present in soils Soil generally consists of visually and texturally distinct layers, also called profiles, which can be summarized as follows from top to bottom:Surface soil: Organics mixed with mineral matter. This layer of mineral soil contains the most organic matter accumulation and soil life. This layer eluviates (is depleted of) iron, clay, aluminum, organic compounds, and other soluble constituents. When eluviations is pronounced, a lighter colored "E" subsurface soil horizon is apparent at the base of the "A" horizon. A-horizons may also be the result of a combination of soil bioturbation and surface processes that winnow fine particles from biologically mounded topsoil. In this case, the A- horizon is regarded as a "bio mantle".

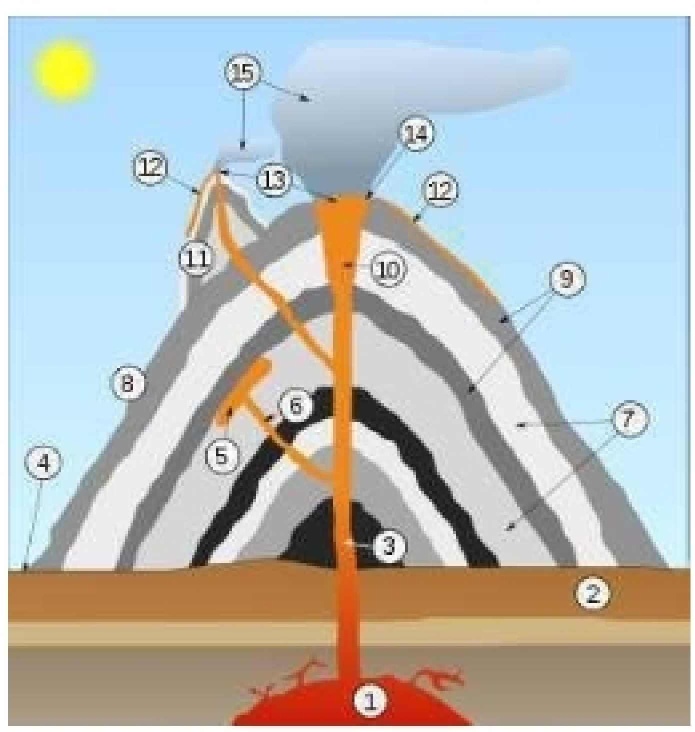
A) Subsoil: Subsurface layer reflecting chemical or physical alteration of parent material. This layer accumulates iron, clay, aluminum and organic compounds, a process referred to as illuviation.

B) Parent rock, also known as substratum: The parent material in sedimentary deposits. Layer of large unbroken rocks. This layer may accumulate the more soluble compounds.

R) Bedrock: The parent material in bedrock landscapes. This layer denotes the layer of partially weathered bedrock at the base of the soil profile. Unlike the above layers, R horizons largely comprise continuous masses of hard rock that cannot be excavated by hand. Soils formed in situ will exhibit strong similarities to this bedrock layer. These areas of bedrock are under 50 feet of the other profiles.



Volcano -: A volcano is a rupture in the crust of a planetary-mass object, such as Earth, that allows hot lava, volcanic ash, and gases to escape from a magma chamber below the surface. The word volcano is derived from the name of Volcano, a volcanic island in the Aeolian Islands of Italy whose name in turn comes from Vulcan, the god of fire in Roman mythology.[3] The study of volcanoes is called volcanology, sometimes spelled Volcanology



1. Large magma chamber 2. Bedrock 3. Conduit (pipe) 4. Base 5. Sill 6. Dike 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. Crater 15. Ash cloud

Volcanic features

The most common perception of a volcano is of a conical mountain, spewing lava and poisonous gases from a crater at its summit; however, this describes just one of the many types of volcano. The features of volcanoes are much more complicated and their structure and behavior depends on a number of factors. Some volcanoes have rugged peaks formed by lava domes rather than a summit crater while others have landscape features such as massive plateaus. Vents that issue volcanic material (including lava and ash) and gases (mainly steam and magmatic gases) can develop anywhere on the landform

Volcanic cones (cinder cones).

Volcanic cones or cinder cones result from eruptions of mostly small pieces of scoria and pyroclastic (both resemble cinders, hence the name of this volcano type) that build up around the vent. These can be relatively short-lived eruptions that produce a cone- shaped hill perhaps 30 to 400 meters high. Most cinder cones erupt only once. Cinder cones may form as flank vents on larger volcanoes, or occur on their own. Paricutin in Mexico and Sunset Crater in Arizona are examples of cinder cones. In New Mexico, Ceja del Rio is a volcanic field of over 60 cinder cones.

Stratovolcanoes or composite volcanoes are tall conical mountains composed of lava flows and other eject in alternate layers, the strata that gives rise to the name. Stratovolcanoes are also known as composite volcanoes because they are created from multiple structures during different kinds of eruptions. Strato/composite volcanoes are made of cinders, ash, and lava. Cinders and ash pile on top of each other, lava flows on top of the ash, where it cools and hardens, and then the process repeats. Classic examples include Mount Fuji in Japan, Mayon Volcano in the Philippines, and Mount Vesuvius and Stromboli in Italy. Throughout recorded history, ash produced by the explosive eruption of stratovolcanoes has posed the greatest volcanic hazard to civilizations. Not only do stratovolcanoes have greater pressure build up from the underlying lava flow than shield volcanoes, but their fissure vents and monogenetic volcanic fields (volcanic cones) have more powerful eruptions, as they are many times under extension. They are also steeper than shield volcanoes, with slopes of 30–35° compared to slopes of generally 5–10°, and their loose tephra are material for dangerous lahars.[8] Large pieces of tephra are called volcanic bombs. Big bombs can measure more than 4 feet (1.2 meters) across and weigh several tons.

Supervolcanoe: A Supervolcanoe usually has a large caldera and can produce devastation on an enormous, sometimes continental, scale. Such volcanoes are able to severely cool global temperatures for many years after the eruption due to the huge volumes of sulfur and ash released into the atmosphere. They are the most dangerous type of volcano. Examples include: Yellowstone Caldera in Yellowstone National Park and Valles Caldera in New Mexico (both western United States); Lake Taupe in New Zealand; Lake Toba in Sumatra, Indonesia; and Ngoro Ngoro Crater in Tanzania. Because of the enormous area they may cover, super volcanoes are hard to identify centuries after an eruption. Similarly, large igneous provinces are also considered super volcanoes because of the vast amount of basalt lava erupted (even though the lava flow is non-explosive).

Types of volcano

A popular way of classifying magmatic volcanoes is by their frequency of eruption, with those that erupt regularly called active, those that have erupted in historical times but are now quiet called dormant or inactive, and those that have not erupted in historical times called extinct. However, these popular classifications—extinct in particular—are practically meaningless to scientists. They use classifications which refer to a particular volcano's formative and eruptive processes and resulting shapes, which was explained above.

1. Active :There is no consensus among volcanologists on how to define an "active" volcano. The lifespan of a volcano can vary from months to several million years, making such a distinction sometimes meaningless when compared to the lifespans of humans or even civilizations. For example, many of Earth's volcanoes have erupted dozens of times in the past few thousand years but are not currently showing signs of eruption. Given the long lifespan of such volcanoes, they are very active.

Mount Etna and nearby Stromboli, two Mediterranean volcanoes in "almost continuous eruption" since antiquity

2. Extinct : Fourpeaked volcano, Alaska, in September 2006 after being thought extinct for over 10,000 years Mount Rinjani eruption in 1994, in Lombok, Indonesia Extinct volcanoes are those that scientists consider unlikely to erupt again because the volcano no longer has a magma supply. Examples of extinct volcanoes are many volcanoes on the Hawaiian – Emperor Seamount chain in the Pacific Ocean,

3. Dormant: 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 years.

Volcanic products

Volcanoes usually produce three types of materials viz. solid, liquid and gaseous.

(a) Solid products: Enormous quantities of solid materials are thrown out by volcanoes during an eruption. They consist of fragments of rocks or pieces of already cooled lava. The ejection of the solid materials is usually accompanied by violent explosions. The solid materials, during the initial stages of volcanism, mostly contain the fragments of the crustal rocks.through which the pipe of the volcano passes; but at later stages they consist mostly the fragments of solidified lava, resulted from the partial solidification in the molten reservoir beneath the surface as well as the solidified lava of earlier eruptions. The rock fragments ejected during volcanic-eruptions are called pyroclasts or tephra. Generally, larger fragments fall at the edge of the crater and slide down its inner and outer slopes, while smaller ones are thrown into the surrounding plains or pile up at the foot of the cone.

According to their size and shape the Pyroclastic materials are classified as follows:

(i) Volcanic blocks: These are the largest masses of rock blown out. These are either the masses of the solidified lava of earlier eruptions or those of the pre-existing rocks. They are usually angular and the diameter of the fragments is always above 32 millimeter. Thus they are the huge solid fragments ejected during a volcanic activity.

(ii) Volcanic bombs: These are rounded or spindle-shaped masses of hardened lava, which may develop when clots of lava are blown into the air and get solidified before reaching the ground.

Their ends are twisted, indicating rapid rotation in the air while the material was plastic. Because of their somewhat rounded appearance, they are known as volcanic bombs. The diameter of these fragments are always above 32 millimeter. Bread-crust bombs are those volcanic bombs which present a cracked surface, may be due to the approximately solid state of the material from which they have been formed, which gives the appearance of the crust of a bread.

***(iii) Cinders or lapilli*: The size of the fragments is between 4 mm to 32 mm, and is shaped very much like bombs. The term 'lapilli' is used when the fragments are not conspicuously vesicular; and in case of vesicular fragments they are known as cinders. Still smaller fragments are called volcanic-sand.**

(iv) Ash: These particles range in size from 0.25 mm to 4mm and as such, are the fine particles of lava.

(v) Fine-ash or volcanic dust*:* These are the minute pyroclastic- tic materials, and their diameter is always less than 0.25 mm. In many instances volcanic dust was carried by wind to enormous distances and scattered over a vast territory forming volcanic dust layers.

Pyroclastic materials accumulating on the slopes and adjoining areas of a volcano with gradual compaction and cementation gives rise to rocks called Volcanic-tuffs. These tuffs when consist of angular fragmental materials, they are known as Volcanic- breccia; when volcanic bombs are predominant in the tuffs, they are referred to as Volcanic-agglomerates. The diameter of these fragments are always larger than 20 mm. The welded tuffs are commonly known as Ignimbrites. In certain instances, a great cloud of superheated vapors and incandescent rock material and volcanic ash are violently emitted during the eruption. These are called Nueces andantes and are sometimes referred to as glowing avalanches.

(b) Liquid products : Lava's are the major and the most important liquid product of a volcano. As we know, the magma that has flowed out on to the surface is called lava. All lava's contain gases, but because of the high pressure that prevails in the interior of the earth the content of gases and vapors in the magma is more.According to the composition and the gas content, the temperature of lava's during eruptions usually ranges between 900°C to 1200°C. Like magma, lava is also divided in to three types viz. acidic, medium and basic, depending on the silica content

Acid lavas contain a high proportion of silica, have a high melting point and are usually very viscous and therefore their mobility is low. They cool very slowly and contain many gases in a dissolved state.

They congeal at relatively short distances from the crater. Rhyolites, composed of orthoclase feldspar and quartz are the examples of acid lavas.

The lavas of intermediate or medium composition have the silica content between 55 to 60%. Andesite lavas are the best examples of the lavas of intermediate nature and they mostly characterize extrusions around the margins of the Pacific.

The basic lavas contain low percentage of silica, which is usually 50% or less. These lavas melt at lower temperature, and have a high density as well as liquid consistency. They cool quickly and contain little gas.

These lavas are highly mobile and spread over large distances, forming flows or sheets. Basalts are the best examples of the basic lava.

Since the lava behave differently depending on their chemical composition they give rise to different configurations when consolidated, as described below:

(i) Lava tunnels: Sometimes the outer surface of the lava flows; cools and solidifies first forming a crust while the lava is still in a liquid state inside. This enclosed liquid may drain out through some weak spots of the solidified flow forming a tunnel called a lava-tunnel.

(ii) Block lava: It is also known as aa-lava. In this case, the gases escape explosively from the partly crystallized flows thus break the congealing crust in to an assemblage of rough and uneven blocks. The escape of gases increase the viscosity of the lava and helps in rapid cooling, giving rise to a solidified lava flow with spiny, rubble surface. It is therefore the Hawaiian name, aa (pronounced ah-ah meaning rough or spiny) is applied to this type of lavas.

(iii) Ropy-lava*:* Lavas with low-viscosity remain mobile for a longer period. These lavas usually contain much entrapped gas and cool very slowly. The lava spreads out in thin sheets and congeals with a smooth surface which wrinkles or twisted into ropy form like that of a stream of flowing pitch. It is also called Pahoehoe-structure.

(iv) Pillow lava*:* Lava erupted under water-logged sediments in sea-water, beneath ice-sheets, or in to rain soaked air, characteristically emerges as a pile of rounded bulbous blobs or pillows. Basic lava of spilitic type often presents pillow structure.

(v) Vesicular or Scoriaceous structure *:* When lavas heavily charged with gases and other volatiles are erupted on the surface, the gaseous constituents escape from the lava, due to the decrease of pressure, giving rise to a large number of empty cavities of variable dimensions on the surface of the lava-flows.

Due to the presence of vesicles or cavities, the resulting structure is known as structure. These cavities when filled up subsequently with secondary minerals, the is called amygdaloidal structure and the infillings as amygdales.

A highly vesicular rock, which contains more gas space than rock, is known as 'Scoria'. In more viscous lavas, when the gases cannot escape easily and the lava quickly congeals, it forms Pumice or 'Rock -froth', which contains so much void space that it can float in water.

(vi) *Jointing*

As a consequence of contraction due to cooling joints are developed in the lava flows, which may be manifested in the form of sheet, platy or columnar structures,

(c) Gaseous Products-: Volcanic activity is invariably associated with emanation of steam and various gases from the volcanoes.

Water vapor constitutes about 60 to 90% of the total content of the volcanic gases. Second in abundance to steam among volcanic gases is Co_2.

Amongst other gases which have been detected in considerable quantities, hydrochloric acid, sulphureted hydrogen, Sulphur-dioxide, hydrogen, nitrogen, boric-acid pours, phosphorous, arsenic vapor, argon, hydrofluoric acid etc. are the most important

Earthquake

An earthquake is what happens when two blocks of the earth suddenly slip past one another. The surface where they slip is called the fault or fault plane. The location below the earth's surface where the earthquake starts is called the hypo center, and the location directly above it on the surface of the earth is called the epicenter.

Sometimes an earthquake has *fore shocks*. These are smaller earthquakes that happen in the same place as the larger earthquake that follows. Scientists can't tell that an earthquake is a fore shock until the larger earthquake happens. The largest, main earthquake is called the *main shock*.

Main shocks always have *aftershocks* that follow. These are smaller earthquakes that occur afterwards in the same place as the main shock. Depending on the size of the main shock, aftershocks can continue for weeks, months, and even years after the main shock.

Causes of earthquake:-

The earth has four major layers: the *inner core, outer core, mantle* and *crust*. (Figure 2) The crust and the top of the mantle make up a thin skin on the surface of our planet. But this skin is not all in one piece – it is made up of many pieces like a puzzle covering the surface of the earth. (Figure 3) Not only that, but these puzzle pieces keep slowly moving around, sliding past one another and bumping into each other. We call these puzzle pieces *tectonic plates*, and the edges of the plates are called the *plate boundaries*. The plate boundaries are made up of many faults, and most of the earthquakes around the world occur on these faults. Since the edges of the plates are rough, they get stuck while the rest of the plate keeps moving. Finally, when the plate has moved far enough, the edges unstick on one of the faults and there is an earthquake.

While the edges of faults are stuck together, and the rest of the block is moving, the energy that would normally cause the blocks to slide past one another is being stored up. When the force of the moving blocks finally overcomes the *friction* of the jagged edges of the fault and it unsticks, all that stored up energy is released. The energy radiates outward from the fault in all directions in the form of *seismic waves* like ripples on a pond.

Earthquakes are recorded by instruments called *seismographs*. The recording they make is called a *seismogram*. The seismograph has a base that sets firmly in the ground, and a heavy weight that hangs free. When an earthquake causes the ground to shake, the base of the seismograph shakes too, but the hanging weight does not. Instead the spring or string that it is hanging from absorbs all the movement. The difference in position between the shaking part of the seismograph and the motionless part is what is recorded.

The size of an earthquake depends on the size of the fault and the amount of slip on the fault, but that's not something scientists can simply measure with a measuring tape since faults are many kilometers deep beneath the earth's surface. So how do they measure an earthquake? They use the *seismogram* recordings made on the *seismographs* at the surface of the earth to determine how large the earthquake was (figure 5). A short wiggly line that doesn't wiggle very much means a small earthquake, and a long wiggly line that wiggles a lot means a large earthquake. The length of the wiggle depends on the size of the fault, and the size of the wiggle depends on the amount of slip.

The size of the earthquake is called its magnitude. There is one magnitude for each earthquake. Scientists also talk about the *intensity* of shaking from an earthquake, and this varies depending on where you are during the earthquake.

Seismogram come in handy for locating earthquakes too, and being able to see the *P wave* and the *S wave* is important. You learned how P & S waves each shake the ground in different ways as they travel through it. P waves are also faster than S waves, and this fact is what allows us to tell where an earthquake was. To understand how this works, let's compare P and S waves to lightning and thunder. Light travels faster than sound, so during a thunderstorm you will first see the lightning and then you will hear the thunder. If you are close to the lightning, the thunder will boom right after the lightning, but if you are far away from the lightning, you can count several seconds before you hear the thunder. The further you are from the storm, the longer it will take between the lightning and the thunder.

P waves are like the lightning, and S waves are like the thunder. The P waves travel faster and shake the ground where you are first. Then the S waves follow and shake the ground also. If you are close to the earthquake, the P and S wave will come one right after the other, but if you are far away, there will be more time between the two. By looking at the amount of time between the P and S wave on a seismogram recorded on a seismograph, scientists can tell how far away the earthquake was from that location.

Earthquake waves

Seismic waves are waves of energy that travel through the Earth's layers, and are a result of earthquakes, volcanic eruptions, magma movement, large landslides and large man- made explosions that give out low-frequency acoustic energy. Many other natural and anthropogenic sources create low-amplitude waves commonly referred to as ambient vibrations. Seismic waves are studied by geophysicists called seismologists. Seismic wave fields are recorded by a seismometer, hydrophone (in water), or accelerometer.

Body waves

Body waves travel through the interior of the Earth along paths controlled by the material properties in terms of density and modulus (stiffness). The density and modulus, in turn, vary according to temperature, composition, and material phase. This effect resembles there fraction of light waves. Two types of particle motion result in two types of body waves: Primary and Secondary waves.

Primary waves

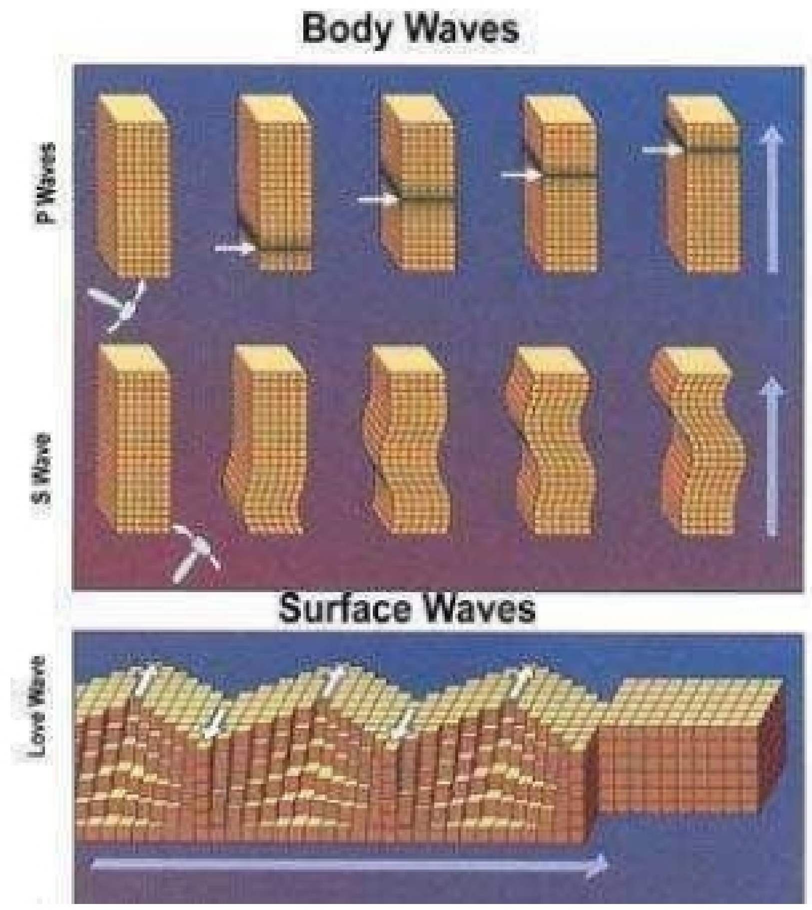
Primary waves (P-waves) are compression waves that are longitudinal in nature. P waves are pressure waves that travel faster than other waves through the earth to arrive at seismograph stations firstly, hence the name "Primary". These waves can travel through any type of material, including fluids, and can travel at nearly twice the speed of S waves. In air, they take the form of sound waves, hence they travel at the speed of sound. Typical speeds are 330 m/s in air, 1450 m/s in water and about 5000 m/s in granite.

Secondary waves

Secondary waves (S-waves) are shear waves that are transverse in nature. Following an earthquake event, S-waves arrive at seismograph stations after the faster-moving P-waves and displace the ground perpendicular to the direction of propagation. Depending on the propagation direction, the wave can take on different surface characteristics; for example, in the case of horizontally polarized S waves, the ground moves alternately to one side and then the other. S-waves can travel only through solids, as fluids (liquids and gases) do not support shear stresses. S-waves are slower than P-waves, and speeds are typically around 60% of that of P-waves in any given material.

Surface waves

Seismic surface waves travel along the Earth's surface. They can be classified as a form of mechanical surface waves. They are called surface waves, as they diminish as they get further from the surface. They travel more slowly than seismic body waves (P and S). In large earthquakes, surface waves can have an amplitude of several centimeters.



Terminology of earthquake

1. Focus
2. Epicenter
3. Iso-seismal lines

GEOLOGICAL WORK OF EARTHQUAKE

An earthquake is a sudden vibration of earth surface by rapid release of energy this energy released when two parts of rock mass move suddenly in relation of to each other along a fault

EFFECTS OF EARTHQUAKE:

Buildings are damaged

Roads are fissured, railway lines are twisted and bridges are destroyed

Rivers change their course

Landslides may occur in hilly region.

TERMINOLOGY:

a) FOCUS
b) Epicentre

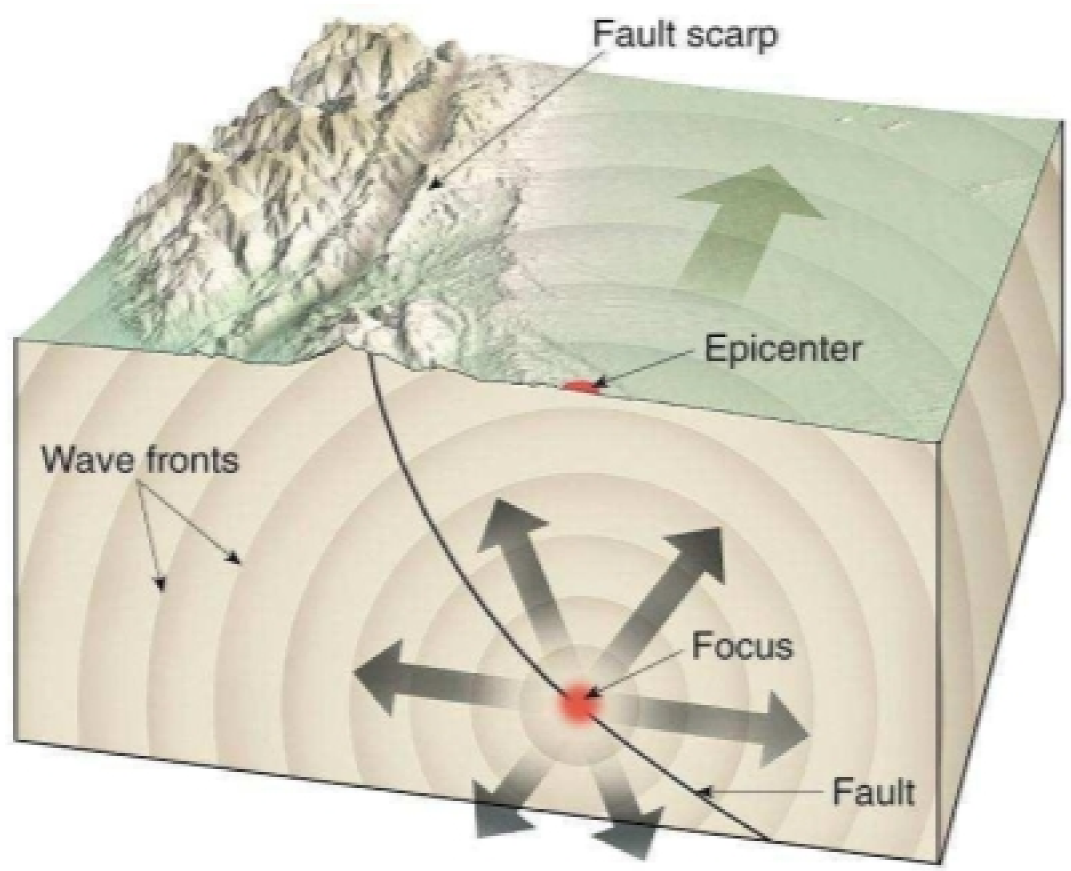
It is the point on the (free) surface of the earth vertically above the place of origin (hypocenter) of an earthquake. This point is expressed by its geographical latitude and longitude.

1. Hypocenter or Focus:

It is the point within the earth from where seismic waves originate. Focal depth is the vertical distance between the hypocenter and Epicentre

2. Iso-seismal lines

The lines joins the same intensity of waves are called the Iso-seismal lines.



Magnitude:

It is the quantity to measure the size of an earthquake in terms of its energy and is independent of the place of the observation.

Richter scale: Magnitude is measured on the basis of ground motion recorded by an instrument and applying standard correction for the Epicentre distance from recording station. It is linearly related to the logarithm of amount of energy released by an earthquake and expressed in Richter scale.

Intensity: It is the rating of the effects of an earthquake at a particular place based on the observations of the affected areas, using a descriptive scale like Modified Mercalli Scale.

Classification of earthquakes	
Slight	Magnitude upto 4.9 on the Richter Scale.
Moderate	Magnitude 5.0 to 6.9
Great	Magnitude 7.0 to 7.9
Very Great	Magnitude 8.0 and more

Earthquake types

1. On the basis of origin

A. Landslide

B. Volcanic

C. Tectonic

2. On the basis of depth

A. Shallow

B. Intermediate

C. Deep

CLASSIFICATION OF EARTHQUAKE:

CLASSIFICATION –I: Depending on mode of origin

1. DUE TO SURFACE CAUSES: Generated by land slopes and collapse of root of underground waves

2. DUE TO VOLACANIC CAUSES: It may also produce earthquake but very feeble.

3. DUE TO TECTONIC PLATES: Most numerous and disastrous and caused by shocks originated in

Earth crust due to sudden movement of faults.

CLASSIFICATION-II: Depending on depth of focus

1. SHALLOW FOCUS: Depth of focus up to 55kms.

2. INTERMEDIATE FOCUS: Depth between 55-300kms.

3. DEEP FOCUS; Depth from 300-600kms.

The shallow earthquake are more violent at the surface but affect smaller area.

EARTHQUAKE INTENSITY SCALE:

ROSSI FOREL SCALE: It has 9

divisions INTENSITY-I: Weakest

earthquake INTENSITY-IV: Cause

damage to property

INTENSITY-IX: Strongest earthquake that cause massive destruction to manmade Structure and natural objects.

RICTHER SCALE: Devised by Charles .F. Richter an American seismologist

MAGNITUDEEFFECTS

2.5Not felt but recorded 4.5Local damage

6.0Can be destructive in popular region 7.0Major earthquake inflict series damage

>8.0Great earthquake cause total destruction

DISTRIBUTION OF EARTHQUAKE:

The zones where earthquake occurs are known as seismic belts.

1. CIRCUM PACIFIC BELT: (PACIFIC OCEAN): 80%of the world earthquake occur in this belt
2. ALPINE HIMALAYAN BELT: Europe to East Indies
3. RIFT VALLEY REGION: East and Central Africa MAGNITUDE:

The total amount of energy release during an earthquake.

ENGINEERING CONSIDERATION:

SEISMIC HISTORY:

Study of seismic events in particular region to know the intensity and magnitude By seismic zoning, area are classified on their varying earthquake and also geological setting of areas

PROBLEMS:

1. To know the seismic history of area
2. To access the magnitude and probable loss or damage in quality or quantity due to likely seismic shocks in the period of the structure
3. To introduce safety factors in new construction and possible to safeguard early structure

ASSESMENT OF SEISMIC RISK:

Seismic risk is the probability of occurrence of a critical earthquake during the projected life period

CRITICAL EARTHQUAKE:

An earthquake occurred in area as past T- yans and has recorded the magnitude capable of producing horizontal and accelerate greater than a minimum value at that particular locality.

Earthquake-resistant structures are structures designed to withstand earthquakes. While no structure can be entirely immune to damage from earthquakes, the goal of earthquake- resistant construction is to erect structures that fare better during seismic activity than their conventional counterparts.

According to building codes, earthquake-resistant structures are intended to withstand the largest earthquake of a certain probability that is likely to occur at their location. This means the loss of life should be minimized by preventing collapse of the buildings for rare earthquakes while the loss of functionality should be limited for more frequent ones.