Program : **B.Tech**

Subject Name: **Engineering Geology and Remote Sensing**

Subject Code: **CE-405**

Semester: **4th**

UNIT I

Introduction and physical geology: branches application and scope of geology, age and parts of the earth, weathering or rocks, geological action of river, ground water, sea and oceans, Concept and causes of earthquakes and volcanoes.

Concept of geology in civil engineering: The standards and techniques of geology are adopted for the purpose of civil engineering operations. Extensively Engineering Geology has 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

1. **Geology offers vital statistics approximately the development substances on the website online used inside the construction of homes, dams, tunnels, tanks, reservoirs, highways and bridges.**
2. **Geological records are most vital in starting stage, layout segment and creation segment of an engineering venture.**
3. **Geology is beneficial to recognize the technique of mining of rock and mineral deposits on this planet's floor and subsurface.**
4. **Geology is beneficial for supply, garage and filling up of reservoirs with water.**
5. **Earlier than building roads, bridges, tunnels, tanks, reservoirs and buildings, selection of web page is vital from the point of stability of basis.**
6. **Geology gives a scientific expertise of creation materials and their properties.**
7. **The knowledge approximately the character of the rocks in tunneling and production of roads.**
8. **The foundation problems of dams, bridges and homes are directly associated with geology of the area in which they are to be built.**
9. **The information of floor water is essential in reference to excavation works, water deliver, irrigation and plenty of other purposes.**
10. **Geological maps and sections help extensively in planning many engineering projects.**
11. **If the geological capabilities like faults, joints, beds, folds are located, they should be definitely dealt with. For this reason, the stableness of the rock systems is essential.**
12. **Pre-geological survey of the place concerned reduces the fee of planning paintings.**

Minerals, Rocks and soils constitute earth materials. They play a vital role in the website evaluation and operations in civil engineering practice, whether it's miles tunneling, hydro-electric powered projects, ground water development, foundation for structures, look at of slope balance and so on. A fundamental expertise of the earth substances is essential.

Accordingly, examine of minerals, rocks and soils bureaucracy the first step in civil engineering factor of view. Consequently, a civil engineer should recognize the introduction of Geology and its branches and importance of a few branches which includes physical Geology, Petrology; Structural Geology and so on.

GEOLOGY (in Greek, Geo manner Earth) is a branch of science dealing with the have a look at of the Earth. It's also referred to as earth technology. The study of the earth as an entire, its origin, structure, composition and the character of the strategies that have given rise to its present role is called as geology.

Geology contains 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. Remote sensing

14. Economic Geology

15. Mining Geology

Crystallography: The look at of the characters of crystals is called crystallography. Crystals are our bodies bounded through flat faces (surfaces), organized on an exact plane due to inner arrangements of atoms.

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

Note: Coal, oil etc. are considered as minerals THOUGH they arise by organic matter under exceptional condition.

Petrology: The study of rocks in all their elements which include their mineralogist, textures, structures (systematic description of rocks in hand specimen and thin sections); beginning and their relationships to other rocks.

Geophysics: The segment of the earth which encompass the structure, bodily situations and evolutionary history of the earth as a whole.

Geochemistry: The have a look at of chemical composition of minerals and rocks of the earth.

Structural Geology: The study of rock systems consisting of folds that have resulted from moves and deformation of the earth's crust.

Stratigraphy: The take a look at of the stratified rocks in particular their sequence in time, the person of the rocks and correlation of beds at special localities.

Physical Geology: It deals with the geological procedures which result in adjustments inside the crust and upon the surface of the earth. It also offers with the floor functions of the earth (land bureaucracy) or its topography

Geomorphology: The description and interpretation of land bureaucracy.

Paleontology: The look at of historic lifestyles, willpower of environment, evolution of organism and so on.

Internal Structure of Earth -:

The internal structure of the Earth is layered in spherical shells: an outer silicate solid crust, a highly viscous asthenosphere and mantle, a liquid outer core that is much less viscous than the mantle, and a solid inner core.

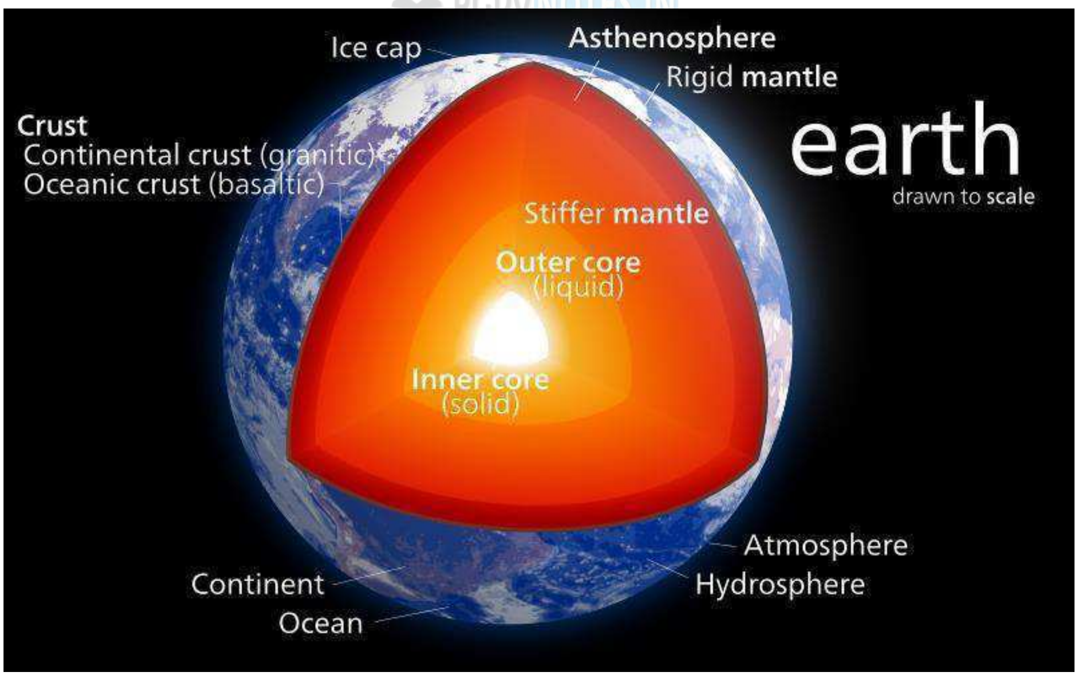


Fig. 1 Internal Structure of Earth

The structure of Earth can be defined in two ways: by mechanical properties such as rheology (Is the study of the flow of matter, primarily in a liquid state, but also as "soft solids" or solids under conditions in which they respond with plastic flow rather than deforming elastically in response to an applied force. It is a branch of physics which deals with the deformation and flow of materials, both solids and liquids), or chemically.

Mechanically, it can be divided into lithosphere, asthenosphere, mesospheric mantle, outer core, and the inner core. Chemically, Earth can be divided into the crust, upper mantle, lower mantle, outer core, and inner core.

Earth's interior is made of a sequence of layers that sit down below the floor crust. in order of depth, those layers encompass the stable, however flowing mantle, the liquid outer middle and the solid iron outer middle, which allows create Earth's shielding magnetic field.

1. Crust

2. Mantle

3. Core

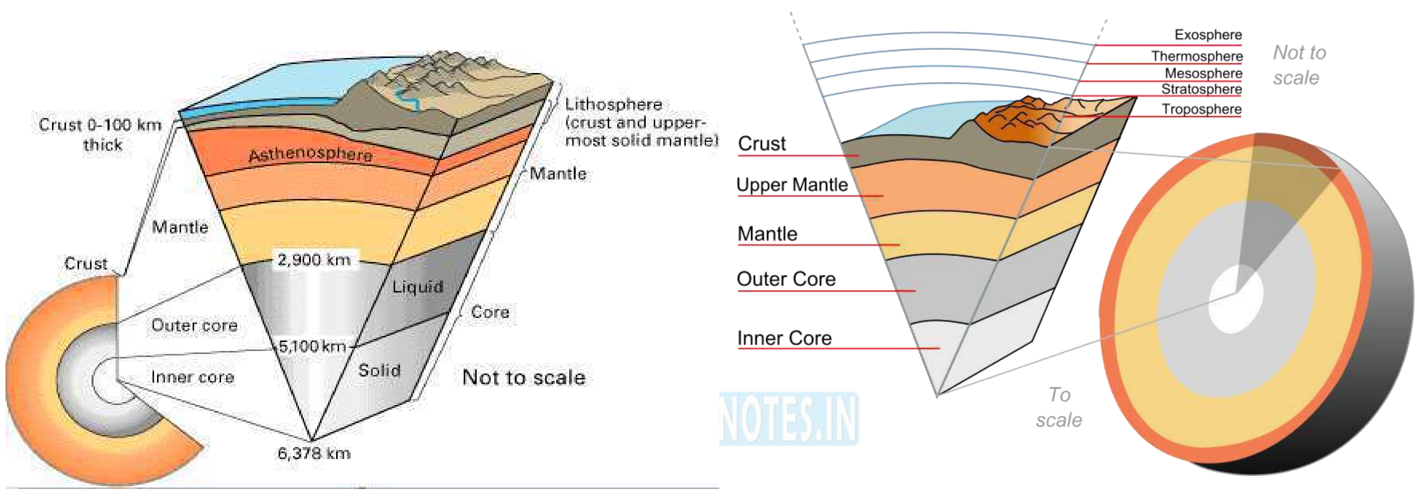


Fig. 2 Internal Structure of Earth

1. Crust-: The crust stages from 5–70 km (~3–44 miles) intensive and is the outermost layer. The skinny components are the oceanic crust, which underlie the sea basins (5–10 km) and are composed of dense (mafic) iron magnesium silicate igneous rocks, like basalt. The thicker crust is continental crust that is much less dense and composed of (felsic) sodium potassium aluminum silicate rocks, like granite. The rocks of the crust fall into two essential classes – SIAL and SIMA (Sues, 1831–1914). Its miles predicted that SIMA starts off evolved about 11 km under the Conrad discontinuity (a 2nd order discontinuity). The uppermost mantle together with the crust constitutes the lithosphere. The crust-mantle boundary takes place as bodily exclusive activities. First, there is a discontinuity within the seismic speed, that's maximum commonly referred to as the Mohorovic discontinuity or Moho.

2. Mantle -: Earth's mantle extends to a depth of two, 890 km, making it the thickest layer of Earth. The mantle is divided into higher and lower mantle. The upper and decrease mantle are separated with the aid of the transition region. The bottom part of the mantle subsequent to the center is referred to as the D" (D high prime) layer. The stress at the bottom of the mantle is a hundred and forty GPA. The mantle consists of silicate rocks that are wealthy in iron and magnesium relative to the overlying crust. Even though solid, the high temperatures within the mantle cause the silicate fabric to be sufficiently ductile that it could drift on very long timescales. Convection of the mantle is expressed at the floor via the motions of tectonic plates.

The two most important things about the mantle are: (1) It is made of solid rock, and (2) It is hot. Scientists know that the mantle is made of rock based on evidence from seismic waves, heat flow, and meteorites. The properties fit the ultramafic rock peridotite, which is made of the iron- and magnesium-rich silicate minerals. Peridotite is rarely found at Earth's surface due to high heat in mantle heat flows in two different ways within the Earth: conduction and convection. Conduction is defined as the heat transfer that occurs through rapid collisions of atoms, which can only happen if the material is solid. Heat flows from warmer to cooler places until all are the same temperature. The mantle is hot mostly because of heat conducted from the core. Convection is the process of a material that can move and flow may develop convection currents.

3. Core-: The average density of Earth is 5,515 kg/m^3 due to the fact the average density of floor material is most effective around 3,000 kg/m^3, we have to conclude that denser materials exist inside Earth's center. Seismic measurements show that the center is divided into two components, a "stable" inner middle with a radius of ~1,220 km and a liquid outer core extending past it to a radius of ~3, 400 km. The densities are among 9,900 and 12,200 kg/m^3 within the outer core and 12,600–13,000 kg/m^3 inside the internal middle.

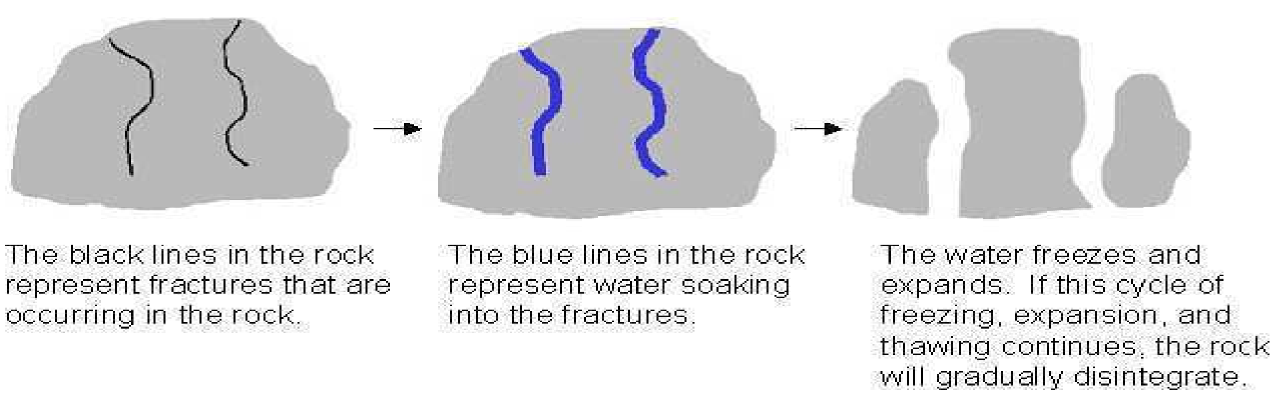
Weathering

Weathering is the technique with the aid of which rocks are broken down and decomposed by the movement of external businesses which include wind, rain, temperature adjustments. Weathering is the preliminary level in the system of denudation.

Types of Weathering

1. Physical Weathering
2. Chemical Weathering
3. Biological Weathering

Physical weathering is the weakening and subsequent disintegration of rock by bodily forces. These physical forces consist of temperature fluctuation, abrasion, frost motion (freezing and thawing), and salt crystal growth. Temperature fluctuation can motive expansion or contraction of rock. While the temperature of rock increases, the rock expands. Whilst the temperature of rock decreases, the rock contracts. This technique of growth and contraction is a bodily pressure and may crack or wreck rock. Abrasion of rock is as a result of the friction of water, wind, or ice upon the rock. The continuous publicity to these elements slowly breaks down the uncovered surface of the rock.



Frost motion is the repeated cycle of ice formation and ice soften within the pore areas and fractures of rocks causing disintegration of the rock. whilst water in rock pores freezes, its extent increases by using about 10% this will create a huge amount of strain on rocks. The significance and volume of frost movement is depending on the frequency, duration and depth of the freezing and thawing cycles.

Salt crystal increase can cause the wreck-up of rock materials. Crystal increase frequently takes place when groundwater moves into empty pores or spaces of rock by means of capillary action as the water evaporates, salt crystals develop and gather, setting strain at the rock and inflicting it to interrupt aside. Salt crystallization is not unusual in drier climates.

Chemical weathering

Chemical weathering is the weakening and subsequent disintegration of rock by means of chemical reactions these reactions consist of oxidation, hydrolysis, and carbonation those techniques both shape or break minerals, hence altering the nature of the rock's mineral composition. Temperature and, specially, moisture are essential for chemical weathering; chemical weathering of rock minerals generally happens extra fast in warm, humid climatic regions.

Oxidation is the response of rock minerals with oxygen, accordingly converting the mineral composition of the rock whilst minerals in rock oxidize, they turn out to be much less proof against weathering. Iron, a commonly known mineral, turns into crimson or rust colored whilst oxidized.

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Oxidation is the reaction of rock minerals with oxygen, accordingly changing the mineral composition of the rock whilst minerals in rock oxidize; they grow to be much less proof against weathering. Iron, a usually regarded mineral, will become crimson or rust colored while oxidized. Carbonation is the process of rock minerals reacting with carbonic acid. Carbonic acid is formed whilst water combines with carbon dioxide. Carbonic acid dissolves or breaks down minerals inside the rock.

$CO_2 + H_2O \rightarrow H_2CO_3$

(Carbon dioxide + water → carbonic acid)

$CaCO_3 + H_2CO_3 \rightarrow Ca^{2+} + 2HCO_3^-$

(Calcite + carbonic acid → calcium + bicarbonate)

Hydrolysis is a chemical response as a result of water. Water modifications the chemical composition and size of minerals in rock, making them less proof against weathering.

Biological weathering

It is the weakening and subsequent disintegration of rock with the aid of plants, animals and microbes. Growing plant roots can exert stress or strain on rock although the system is bodily, the stress is exerted via a organic technique (i.e., growing roots) biological methods can also produce chemical weathering, for example wherein plant roots or microorganisms produce natural acids which help to dissolve minerals. Microbial activity breaks down rock minerals by changing the rock's chemical composition, therefore making it extra vulnerable to weathering. One instance of microbial interest is lichen; lichen is fungi and algae, residing together in a symbiotic relationship. Fungi release chemical substances that wreck down rock minerals; the minerals as a consequence launched from rock are consumed by using the algae. As this process maintains, holes and gaps preserve to broaden on the rock, exposing the rock similarly to bodily and chemical weathering. Burrowing animals can pass rock fragments to the surface, exposing the rock to extra excessive chemical, bodily, and organic methods and so not directly enhancing the procedure of rock weathering.

Geological work 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.

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

2. Suspended load consists of silt, fine sands, clay 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.

3. 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.

2. The river should have totally exhausted its energy at the time of its merger with the sea.

3. 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.

Fig. 3 Youth Stage of River

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 glaciations 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 much 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 accumulations 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.

Features Produced by Abrasion

(I) 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 direction, 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.

(II) 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 are called Einkanters, with two abraded surfaces as Zweikanter and with three smooth faces as Dreikanters.

(III) 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.

(IV) 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 of rounding

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:

A) 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 are 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".

B) 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.

C) 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 less than 50 feet of the other profiles.

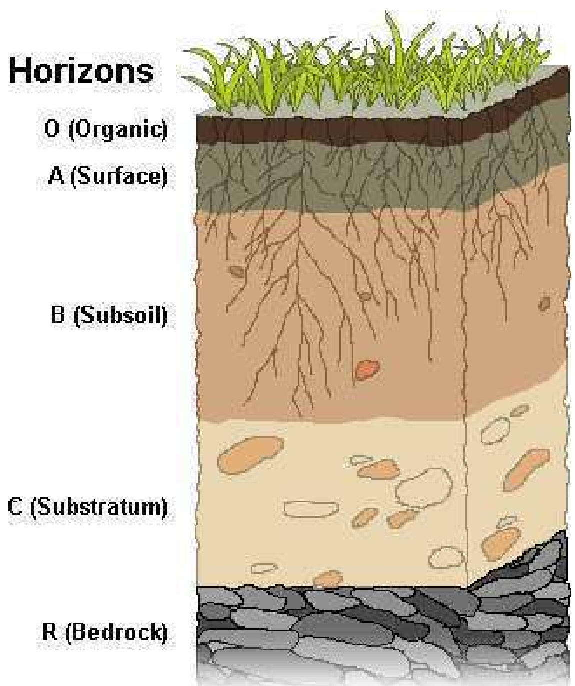

Fig. 4 Soil Profile

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.

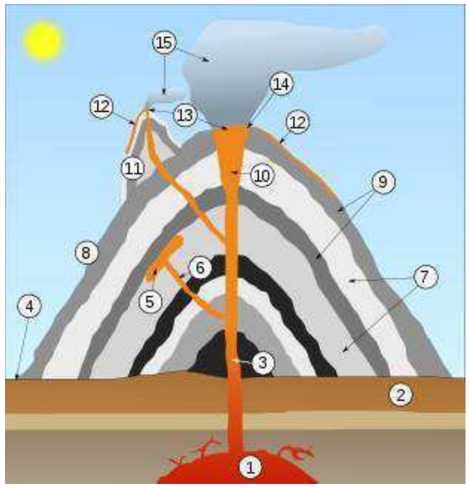

Fig. 5 Volcano

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
9. Throat
10. Parasitic cone
11. Lava flow
12. Vent
13. Crater
14. 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.

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 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 life spans 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: Four peaked 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 is 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 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- breccias; when volcanic bombs are predominant in the tuffs, they are referred to as Volcanic-agglomerates. The diameter of these fragments is 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. Rhyolite, 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 behaves 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 breaks the congealing crust in to an assemblage of rough and uneven blocks. The escape of gases increases 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 vesicular- structure. These cavities when filled up subsequently with secondary minerals, the structure 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 Co2.

Amongst other gases which have been detected in considerable quantities, hydrochloric acid, Sulphurdioxide, 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.

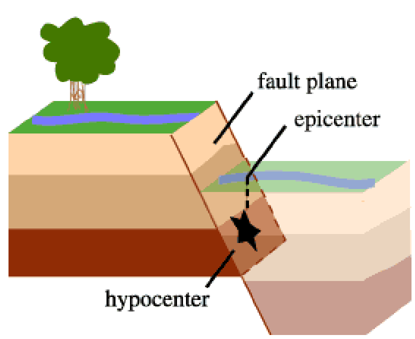

Fig. 6 Basic Structure for Earthquake

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

An earthquake basically is an outcome of the movements of tectonic plates beneath the Earth's surface. However, these are also caused due to certain other reasons. These are mostly natural reasons however sometimes these can even be man-made. Given below are the various causes of earthquakes:

Volcanic Eruptions

Volcanic eruptions are a common cause of earthquake. Areas that are faced with frequent volcanic activities are more prone to earthquakes.

Geological Fault

It occurs because of the displacement of plates from their original position. As the rocks move alongside these planes, it brings about tectonic earthquakes.

Human Activities

Man is known to influence various natural activities and earthquakes are no exception. Nuclear bombing, building of dams and mining are few such human activities that can cause earthquake.

Effects of Earthquake

The effects of an earthquake are terrible and devastating. Many building, hospitals, schools, etc are destroyed due to it. A lot of people get killed and injured. Many people lose their money and property. It affects the mental health and emotional health of people.

The environmental effects of it are that including surface faulting, tectonic uplift and subsidence, tsunamis, soil liquefaction, ground resonance, landslides and ground failure, either directly linked to a quake source or provoked by the ground shaking.

Types of Earthquake

There are different types of earthquakes that have been experienced on our planet. Here is a look at the main types of earthquakes:

Tectonic Earthquake

A tectonic earthquake is an outcome of the breakage of Earth's crust because of exertion of pressure on rocks and tectonic plates.

Aftershock

This is often a mild earthquake that takes place in the same area that has been hit by a severe earthquake few hours, days or weeks before.

Foreshock

A small earthquake that takes place before a severe earthquake is referred to as a foreshock.

Explosion Earthquake

This type of earthquake occurs because of explosion of a chemical and nuclear device.

Volcanic Earthquake

It is an earthquake that occurs due to the combination of tectonic forces and volcanic activities.

Collapse Earthquake

This type of earthquake is caused due to the explosion of rocks. These are generally mild earthquakes that occur due to mining activities.

Submarine Earthquake

It is an earthquake that takes place underwater particularly at the bottom of an ocean. It is commonly referred to as Tsunami.

Volcano

Volcano, vent in the crust of the Earth or another planet or satellite, from which issue eruptions of molten rock, hot rock fragments, and hot gases. A volcanic eruption is an awesome display of the Earth's power. Yet while eruptions are spectacular to watch, they can cause disastrous loss of life and property, especially in densely populated regions of the world. Sometimes beginning with an accumulation of gas-rich magma (molten underground rock) in reservoirs near the surface of the Earth, they can be preceded by emissions of steam and gas from small vents in the ground.

Volcanoes are closely associated with plate tectonic activity. Most volcanoes, such as those of Japan and Iceland, occur on the margins of the enormous solid rocky plates that make up the Earth's surface. Other volcanoes, such as those of the Hawaiian Islands, occur in the middle of a plate, providing important evidence as to the direction and rate of plate motion.

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