1. **Describe in detail the internal structure of the earth with neat diagram.**

The interior structure and composition of the earth cannot be directly studied because as we go deeper inside the earth, the temperature and pressure goes on increasing. The drillings also fail in this regard since using the present day technology we can drill only 10 to 15kms, which is negligible as compared to the depth of the earth, which is about 6378kms. The direct observations of the internal crustal layer of the earth are also possible to record from the petroleum and natural gas oil wells from onshore and offshore basins in addition, heat of the earth's interior can be known during the volcanic eruptions and other surface processes.

**Crust:**

The earth's crust is the outermost layer of rocks. The crust is subdivided into 2 layers based on its composition and density.

- Continental crust
- Oceanic crust

**Continental crust:**

It consists of 0.374% of the earth's mass; depth average 35km and locally it varies 60 – 70kms. It is the outermost part of the earth composed mainly crystalline Felsic rocks. These are low density minerals composed mainly quartz ($sio_2$) and feldspars (granites, synites and andisites). The crust is the coldest part of our planet. Because cold rocks are deforms slowly, this layer can be easily travelled by primary (P) and secondary (S) waves at velocity 5.8 km/sec. It mainly composed of silicon and aluminium known as SIAL. Its density varies from 2.2 to 2.9 kg/ $m^3$

**Oceanic crust**:

It consists 0.099% of earth's mass; thickness or depth at which lies is 0 – 10kms. It is mainly composed of mafic rocks, it consists of silicon and magnesium known as SIMA.

The 'mohorovicic discontinuity', which separates the crust and the mantle and this boundary marks the variation in rock composition from crust to mantle. There is a marked difference in P wave velocity across the boundary from 6.5 km/s for the crust to 8 km/s for the mantle. Its density varies from 2.9 to 3.2 kg/ $m^3$

The continental crust regions are thicker and less dense where as oceanic regions are thinner and higher in density.

**Mantle:**

The second major internal region which extends from the base of the crust to the top of the core, forming the majority of the earth's volume.

The mantle region is the source of internal heat known as geothermal energy. This region is also the source energy for all major geodynamic processes like sea floor spreading, plate tectonics, orogeny (mountain building activity), major earthquakes and continental drift.

The mantle is subdivided into the following major categories based on seismic wave characteristics:

- Upper mantle
- Transition zone
- Lower mantle

**Upper mantle:**

10.3% of earth's mass; depth of 10 – 400km in oceanic crust and 35 – 400km in continental crust side. The upper mantle is mainly consists of ultramafic rocks like peridotite, pyroxenite, and dunnite etc. part of the upper mantle called **Asthenosphere** which is partly molten or semi solid in nature and is responsible for plate tectonism. **Transition zone:**

7.5% of the earth mass; depth of 400 – 650km. This region is also called the mesosphere.

**Lower mantle:**

49.2% of the earth mass; depth of 650km – 2890km. The lower mantle contains 72.9% of the mantle-crust mass and is probably composed of silicon, magnesium and oxygen. It also contains some iron, calcium, and aluminium. Its density varies from 3.4 to 5.6 kg/ $m^3$

**Core:**

The inner most layer of the earth which got separated from mantle by Guttenberg – Weichert discontinuity. There is an increase in density from 5,500 kg/ $m^3$ to 9,900 kg/ $m^3$ across the boundary. It is again subdivided into two as the

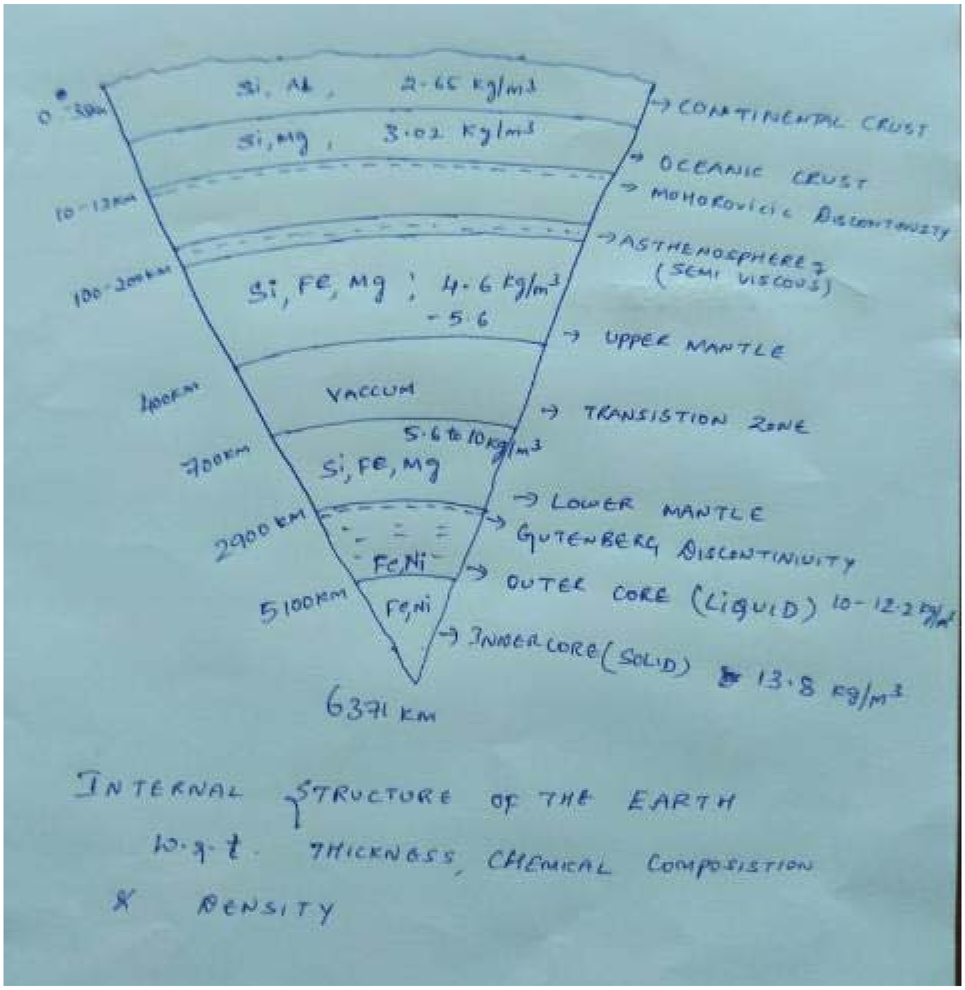
- Outer core
- Inner core

**Outer core:**

30.8% of the earth's mass; depth of 2890km – 5150km. The outer core is a hot, electrically conductive liquid within which convective motion occurs. It is composed of Fe,Ni. Its density varies from 5.6 to 12.2 kg/ $m^3$

**Inner core:**

1.7% of the earth's mass, depth of 5150km – 6370km. The inner core is solid and unattached to the mantle, suspended in the molten outer core. It is believed to have solidified as a result of pressure freezing which happens to most liquids when temperature decreases or pressure increases. Its density varies from 12.2 to 13.1 kg/ $m^3$




**2. What is Mineral? Describe the physical properties of the following minerals.**
**Rose Quartz b) Opal**

Minerals have been defined as naturally occurring homogenous substances, mostly inorganic, that are characterized by a definite chemical composition and a definite atomic structure

| | | |
|---|---|---|
| Habit | Crystalline | Amorphous |
| Colour | Pale pink, pink | Shades of blue, green, yellow |
| Streak | absent | absent |
| Lustre | vitreous | vitreous |
| Diaphaneity | transparent | translucent |
| Cleavage | absent | absent |
| Fracture | Conchoidal to Uneven | Conchoidal to Uneven |
| Hardness | 7 | 7 |
| Specific Gravity | medium | medium |
| Diagnostic Property | Colour, fracture, hardness | Colour, fracture, hardness |
| Occurance | Magmatic process, Found as rock forming mineral in all the rock units | Magmatic process, marine volcanic sedimentation process, Found as rock forming mineral in all the rock units |
| Chemical Composition | $SiO_2$ | $SiO_2$ |
| Uses | Used in electronic gadgets, precious and semi precious stone, sand paper, abrasive mineral, glass | Used in electronic gadgets, precious and semi precious stone, sand paper, abrasive mineral, glass |
| Name of the mineral | **ROSE QUARTZ** | **OPAL** |

**3 Describe all the properties which are helpful to identify the minerals.**

1. Physical properties – properties which are studied based on external features or outer appearance. Habit, cleavage, hardness, specific gravity, tenacity.
2. Chemical properties – properties which are studied based on composition and mineral crystallization system. Chemical composition, crystal system.
3. Optical properties – properties which are studied based on light. Colour, streak, diaphaneity, Lustre.
4. Diagnostic properties – Highlighting properties of a mineral among above mentioned properties

**HABIT**

A mineral may sometimes show a definite and characteristic arrangement in its outer appearance or physical shape. This shape is expressed by the term Habit and is typical in the case of many minerals.

**COLOUR**

It is depends up on the absorption and reflection of colours vibration rays by the minerals . the colour of the mineral is depends upon the amount of light is absorbed and reflected back by the mineral.

**STREAK**

The streak of a mineral is the color of its powder. This becomes important in the sense

that for some minerals, the color is entirely different from that of their powder.

**LUSTRE**

The shining surface of a mineral is called as Lustre. When light incident on any mineral surface and the reflection phenomena is known as Lustre. The different types of Lustre and their examples are given in a tabular column.

**DIAPHENITY**

Diaphaneity of a mineral may be defined as its capability to pass light through it. Hence, if an object can be seen fully and easily through a mineral, it may be called as diaphaneity.

**FRACTURE**

The fracture of a mineral may be defined as the appearance of its broken surface, when the mineral is hammered and broken. It is a characteristic feature of certain minerals, which help us in their identification.

**HARDNESS**

Hardness is another property of a mineral, which can be used as a handy tool in the field,

to differentiate between the different minerals or to recognize particular minerals.

**SPECIFIC GRAVITY**

It is defined as the ratio of its weight to the weight of an equal volume of water.

**CLEAVAGE**

Any deformed plane which can be removed by hitting by a hammer, without loss of cohesion

**MISCELLANEOUS**

Besides the above properties, minerals may show some specific and rare qualities that often become helpful in their identification. Some of these special properties are explained below:

**Magnetism: -** Some minerals have natural magnetism in them to an Appreciable Extent. Example is magnetite.

**Acid tests:** Few minerals readily react with acids (dilute or concentrated) and few are susceptible. Example: calcite reacts with dilute HCl and liberates $CO_2$ with effervescence.

bonding). Cleavages can be determined as perfect, absent in a mineral.

4. What are Carbonate Minerals? Describe any two examples of carbonate minerals. [10]

In nature, carbon atoms join with oxygen to form the **carbonate** ion, CO3. These ions combine with metal cations to form **carbonate minerals**. These **minerals** are commonly formed in sedimentary and oxidizing environments. The **carbonates** fall into three groups: the calcite group, the dolomite group, and the Magnasite group

| | | |
|---|---|---|
| Habit | Crystalline, Rhombohedral, hexagonal, prismatic | Crystalline, Rhombohedral, hexagonal, prismatic |
| Colour | Milky white, greyish white. | Shades of grey and white, grey, milky white. |
| Streak | white | white |
| Lustre | vitreous | vitreous |
| Diaphaneity | Transparent to translucent | translucent |
| Cleavage | Perfect | Perfect |
| Fracture | uneven | uneven |
| Hardness | Easily scratchable by pen knife | Easily scratchable by pen knife |
| Specific Gravity | medium | medium |
| Diagnostic Property | Habit, colour, hardness, cleavage, Readily reacts with dilute HCl, giving effervescence sound | Habit, Colour, Cleavage, Produces a very weak reaction to cold, HCL |
| Geological occurance | Magmatic process, sedimentation process, Found as one of the rock forming mineral in mafic and ultramafic rocks as carbonate rocks, sedimentary rocks. | Magmatic process, sedimentation process, Found as one of the rock forming mineral in mafic and ultramafic rocks as carbonate rocks, sedimentary rocks. Associated with calcite deposits |
| Chemical Composition | $CaCO_3$ | $CaMg(CO_3)_2$ |
| Uses | Construction material, cement, paints, dyes, CaO is also know as lime used in quick solidification cement. | Construction material, cement, paints, dyes. |
| **Name of the mineral** | **CALCITE** | **DOLOMITE** |

| | |
|---|---|
| 5 | Describe the physical properties of following minerals with uses.<br>a) Hematite b) Asbestos c) Kaolin |

| | | | |
|---|---|---|---|
| Habit | Claylike masses | Fibrous | Crystalline, botryoidal to Reniform shapes with radiating structure |
| Colour | white | Greenish/White | Black, brownish black |
| Streak | white | White | Cherry red, brick red, blood red |
| Lustre | Dull | Greasy/Vitreous | Metallic |
| Diaphaneity | Opaque. Rarely translucent. | Opaque | Opaque |
| Cleavage | Absent | Absent | None |
| Fracture | Earthy | Uneven | Uneven |
| Hardness | 2—2.5 | 3 | 5.5 |
| Specific Gravity | 2.6 (Medium) | 2-3 | High |
| Diagnostic Property | Habit, colour, hardness, cleavage, Kaolin is very friable, and can be cut and molded, especially when wet, Soapy feel | Habit , Colour | Hardness, specific gravity, Colour. streak |
| Occurrence | Occurs as an alteration product of granites an gneisses | **Asbestos** is most commonly found in three rock types: serpentinites, altered ultramafic rocks, and some mafic rocks | magmatic process. Marine volcanic sedimentation process |
| Chemical Composition | $Al_2Si_2O_5$ (OH)4 | $Mg_3Si_2O_5(OH)_4$ | $Fe_2O_3$ |
| Uses | Used in the manufacture of potteries, earthenware, sanitary ware, rubber and paints | Refractory, heat and fire resistant, cement Sheets, acid resistant | Used as construction material, industrial material, utensils, electrical appliances, paints, impurities in gem stones, glass, locomotive parts. |
| **Name of the mineral** | **Kaloin** | **Asbestos** | **Hematite** |

6. **Explain the role of Geology in civil engineering.**

- In any civil engineering construction geology plays a vital role. Because every civil engineering structure constructed on or in the ground. In this regard a civil engineer should understand and analyze a detailed investigation should be carried out by using geology as a tool. They are as follows:
- Foundation Problem: The foundation problems of dams , bridges and buildings are directly related with geology of the area where they are built.
- Construction material: Geology provides a systematic knowledge of construction material there structures , stability quality and properties of stones.
- Infrastructure Engineering: In tunneling, construction roads and bridges and in determining the stability of cuts and slopes , the knowledge about the nature of rock is very necessary.
- Water resource engineering:
  The knowledge of ground water is necessary in connection with excavation works, source an quality of water, desilting of reservoir, water supply, irrigation, navigation channels etc.
- Geological map and Section helps considerably in planning man engineering projects. In geological mapping rock deformation such as faults, folds, joints etc has to be treated for assuring the stability of structures .
- Pre geological Survey of the area concerned reduces the cost of engineering projects.
  Thus in civil engineering geology provides necessary information about the site , construction materials for buildings, dams, tanks, reservoirs, highways and bridges. It is most important in Planning phase, Design phase and construction phase o a civil engineering project

7. **What are Igneous Rocks? Explain the Classification of Igneous Rocks based on mode of occurrence**

Igneous rocks are primary rocks formed due to consolidation of parent magma or lava".

Approximately 90% of the earth crust is composed of igneous rocks but their great abundance is hidden inside the earth.Magma is a hot viscous rock melt containing water vapour and gases. Classification of Igneous Rocks based on Mode of Occurrence:

1. **EXTRUSIVE FORMS:**

**Blocky Lava:**

It is a lava flow where the upper surface is flooded with angular solid pieces that have sharp edges. On consolidation its surface is divided into blocks and hence the name blocky lava. These blocks often contain large vesicles.

**Ropy Lava:**

It is a surfacial feature seen in lava flows which are mobile. The surface of the solid lava is thrown into lenticular wrinkles. As it resembles the twisted wrinkled surface of the rope, it is known as ropy lava.

**Pillow Structure or Ellipsoidal Structure:**

The term pillow structure or simply pillow lava refers to bulbous (spherical or swollen or rounded) masses of lava heaped together one above the other arranged lenticularly connected by small necks. As they resemble pillows the **'pillow lava'** is given to them.

**2.INTRUSIVE FORMS:**

The magma when forcibly injected into the surrounding rocks gives rise to intrusive forms. If the intrusion takes place in large scale then it is termed as subjacent bodies.

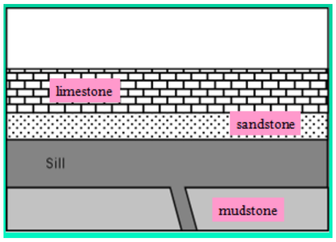
The injected bodies are broadly divided into 2 types, namely concordant injections and discordant injections depending on the relationship of the intrusions to the intruded rocks.

Concordant injections are those injected igneous bodies which lies parallel to the strata / rock beds. Examples are sill, lacolith, lopolith and phacolith. Whereas discordant injections are those injected igneous bodies which cut through the overlying strata or rock beds. Examples are Dyke.

***1.Intrusive – Injected - concordant igneous rock bodies:***

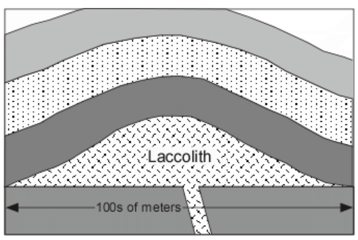
**Sill:**

A sill is a sheet of magmatic material which has been injected along the bedding plane or other similar structure of the country rocks. Sills are relatively thin tabular sheet like body that penetrates parallel to the bedding planes.



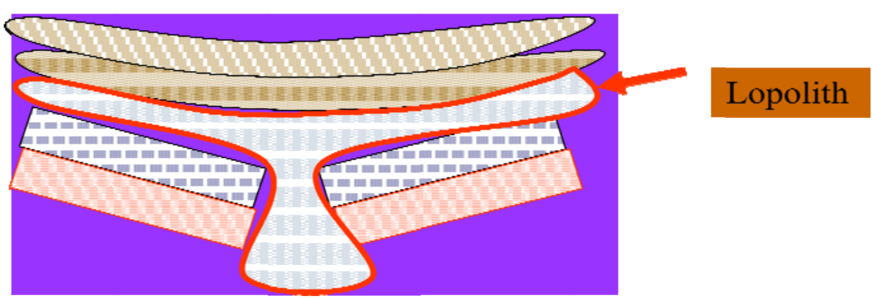

**Laccolith:**

It is a bun shaped igneous intrusion which is formed when the injected magma is highly viscous and tends to accumulate around the orifice (mouth). As a result the overlying strata is domed up.



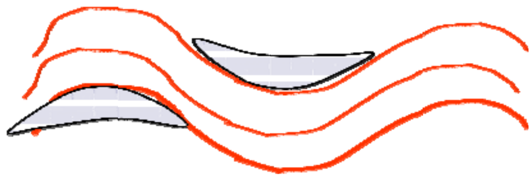

## Lopolith:

These are basin or saucer-shaped concordant bodies with top nearly flat and convex bottom




## Phacoliths:

They are isolated igneous intrusions, crescent shaped, seen in highly folded strata. In structurally affected beds of such a nature the crest and troughs experience relief in stress conditions .



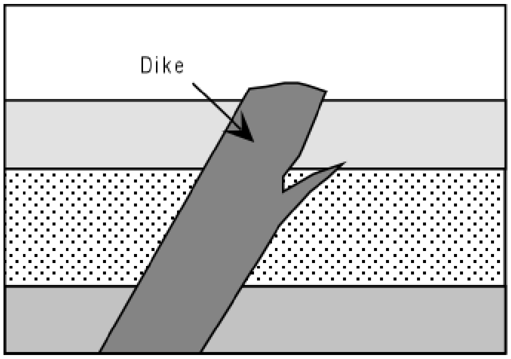
## *2.Intrusive – Injected – Discordant Igneous bodies:*

**Discordant Injections:**

Discordant injections are those injected igneous bodies whose form bear a cross cutting relationship to the major structural features of the country rocks. They are Dykes, ring dykes, cone sheets and volcanic necks.

**Dyke:**

A wall like igneous intrusion which is seen to cut across the bedding plane and other similar structures of the country rocks is called a dyke. Their thickness varies from a few cm to a 100m or more. Undesirable at the sites of foundations of dams because they introduce heterogeneity in the region and turn out to be weak planes. Dykes are like walls and act as barriers for the flow of underground water. Thus, like quartz veins, they interrupt the ground water movement which is good or bad potential of ground water in a region




**Volcanic Plug:**

A volcanic plug is a vertical cylindrically shaped igneous body which has a roughly oval or circular cross-section. It represents the vent of an extinct volcano. Volcanic plugs range in diameter from few 100m to a km or more.

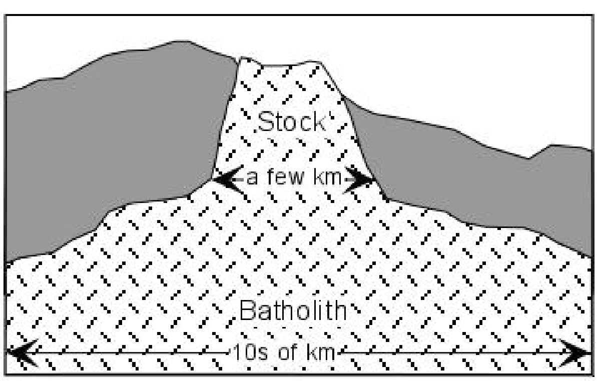
**Intrusive – Subjacent- igneous Bodies:**

Igneous bodies which have been emplaced on a very large scale so much so that they do not have any visible relationship to the surrounding rocks are grouped under the subjacent bodies. The forms are batholiths, stocks and bosses.

**Batholiths:**

It is a very huge igneous body. The batholiths have steep walls and are said to be bottomless. Because the floor of these bodies are not identifiable. They are also known as bathyliths, which means ‘rocks of the depths’. Usually they founded in folded regions.

**Stock**: A small batholiths is called a stock.




8. **What are Sedimentary Rocks? Describe any two examples of Sedimentary Rocks**

Sedimentary rocks are those, which are formed by the accumulation, compaction and consolidation of sediments. The sediments are the particles produced from the disintegration of pre-existing rocks (Igneous/metamorphic rocks).

The formation of sediments involves the following processes.

- There must be pre-existing rocks
- These rocks must be weathered
- The product of weathering must be transported to the place of accumulation
- They must be dropped particle by particle giving rise to sediments.

| Properties of rocks | Sand Stone | Shale |
|---|---|---|
| Colour: | Dull white, reddish, brown, brick red, pink | Reddish brown, brick red, chocolate brown |
| Texture & grain size; | Clastic Arenaceous (sandy) medium grained 1/10 mm to 2 mm | Clastic fine grained (clayey) |
| Mineral composition: | Quartz (Sand particles) Orthoclase (little) little muscovite & mica | Clays, mud, silts fine, sediments |
| Cementing Material: | $Fe_2O_3$, $SiO_2$, $CaCo_3$ | $Fe_2O_3$ |
| Crushing strength: | Medium | Low to Medium |
| Specific gravity: | 2.8 | 2.6 |
| Classification: | Mechanically formed arenaceous group of sedimentary rocks. | Mechanically formed argillaceous sedimentary rocks. |
| Special Features: | Sp. /Current bedding ripple marks. Bedded and granular. | Laminated structure soft, Sun cracks, Rain prints |
| Uses: | Building, Ornamental, structural, road, metal, rail road, Ballast, paving set, concrete aggregates | Bricks, Tiles, cement Manufacture |