

# Petrology

→ Definition of Rock.

⇒ Geological classification of rocks into

(i) Igneous

(ii) Sedimentary

(iii) Metamorphic rocks.

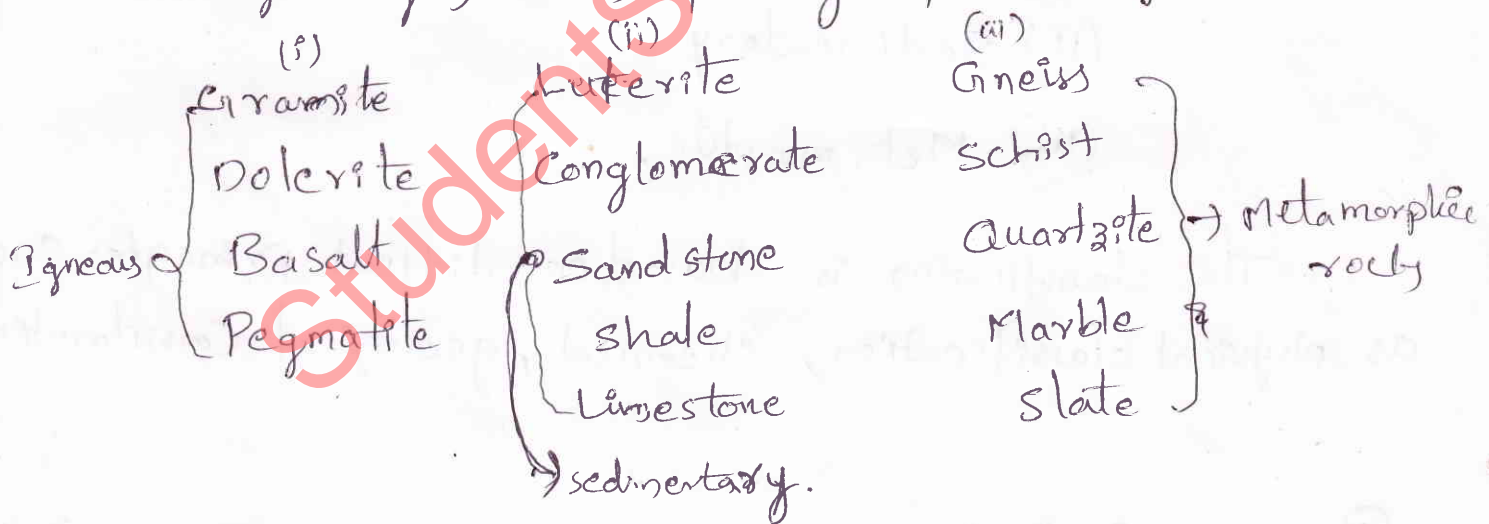
→ Common structures and textures of

(i) Igneous

(ii) Sedimentary

(iii) Metamorphic rocks

⇒ Distinguishing features & Macroscopic study of



## Definition of Rock :-

Rock :- Rock is an aggregates of minerals.

Rocks form a major part of the earth's crust. Some rocks such as quartzite ( $\text{quartz}_2$ ) and marble (calcite), are composed of mostly one mineral only.

## Classification of Rocks :-

The rocks are broadly classified into three groups

- (i) Igneous
- (ii) Sedimentary
- (iii) Metamorphic.

This classification is based on different principles such as physical classification, chemical, geological considerations.

Igneous Rocks :- They are formed by cooling & solidification of magma.

→ 90% of earth crust is composed of igneous rocks.

→ 'Magma' is a hot viscous, siliceous melt containing water vapour and gases.

The chemical composition of Igneous rocks exhibit a fairly

→ The largest oxide component is  $\text{SiO}_2$  which is common -  
Igneous rocks ranges from 40 to by weight.

On the basis of the silica percentage in the Igneous rocks are classified into following groups.

(i) Ultrabasic rocks:- These contain less than 45% silica.

E.g :- peridotite.

(ii) Basic Rocks:- These contain silica between 45%.

and 55%. E.g.:- Gabbro and Basalt.

(iii) Intermediate Rocks:- These contain silica between

55 to 65%. eg. :- Diorite.

Acid rocks:- These contain more than 65% silica.

E.g.:- Granite.

In general

Acid igneous rocks are light in colour, low in specific gravity and have proportion of mineral like quartz and alkali feldspar.

⇒ Acid rocks are also called as 'felsic rocks'

E.g :- Granite

Basic rocks are dark in colour, high specific gravity and contain mainly silica poor minerals, such as Olivine, Pyroxene, hornblende.

- Basic rocks are also called "Mafic Rocks" as they contain a high percentage of ferromagnesian minerals.

Ex:- Basalt.

Igneous rocks can also be classified as

(i) Over saturated rocks → high silica

(ii) Saturated rocks → sufficient silica

(iii) Under saturated rocks → poor silica

Based on silica percentage only.

## Sedimentary Rocks :-

Sedimentary rocks are formed by compaction and cementation of sediments deposited under

sedimentary rocks also include the rocks formed by accumulation of chemically precipitated (e.g. Org.) or organically derived material

⇒ Sedimentary rocks occur in layers and frequently contain fossils.

## Sedimentary Rocks :-

The formation of sedimentary rocks are involved in three stages (i) Weathering / erosion of pre existing rocks.

(ii) Sedimentation.

(iii) Lithification and Diagenesis.

Erosion :- During weathering the pre existing rocks and the minerals are down. The material thus produced is the "Sediment".

The sediments are usually transported and deposited in basin or down like areas

→ During transportation they become smooth and deposit according

→ The minerals which are

Sedimentation :- The process of accumulation of sediments at a site of deposition is called the "Sedimentation".

→ It is the intermediate stage in the formation of sedimentary rocks.

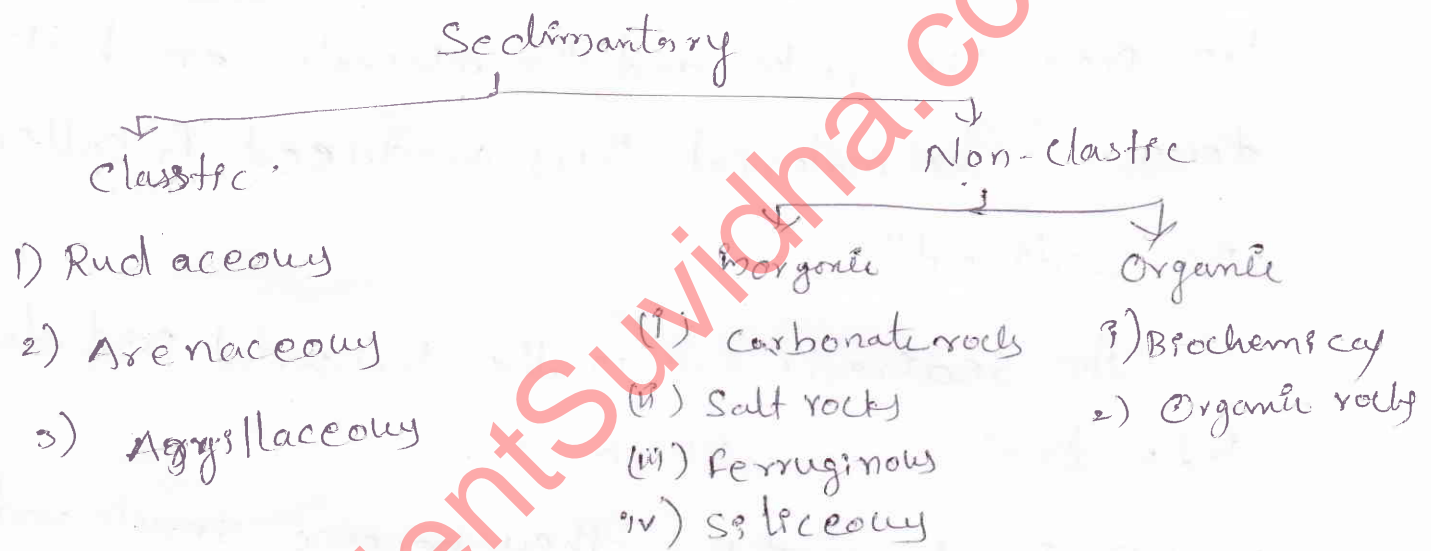
Lithification and Diagenesis :- Lithification is

a process by which soft and loose sediments are

Converted into hard and firm rocks. This process is also called 'Consolidation'. During this time many physical & chemical changes take place within the sediment. Such changes are called as diagenesis.

The diagenesis includes three processes.

- (i) Compaction
- (ii) Cementation
- (iii) Recrystallization



## Metamorphic Rocks :-

Metamorphic rocks are formed from the older rocks when they are subjected to high pressure & temperature conditions under the earth crust.

## Agents of Metamorphism :-

The agents which bring about metamorphic changes in the rocks are

- (i) heat (ii) pressure (iii) stress
- (iv) chemically active fluids & gases.

Processes of Metamorphism :- The processes which operate together in the effected rock to bring ~~that the~~ rock are partially melted about metamorphism

- (i) Granulation
- (ii) plastic deformation
- (iii) Recrystallization
- (iv) Metasomatism.

Granulation :- This process where crushing of rocks take place without loss of coherence is called the granulation.

plastic deformation :- When a solid is subjected to stresses, its shape changes. On the removal of stresses if the solid does not regain its original shape, it is said to be plastically deformed.

Recrystallization :- Formation of new crystals of the pre-existing minerals is called as Recrystallization.

metasomatism :- Is the process in which the original composition of rocks are changed primarily by the addition or removal of material. This changes is caused by the movement of hydrothermal fluids through rocks usually under high temperatures and pressure.

All the above said processes usually operate in combination to produce metamorphic rocks.

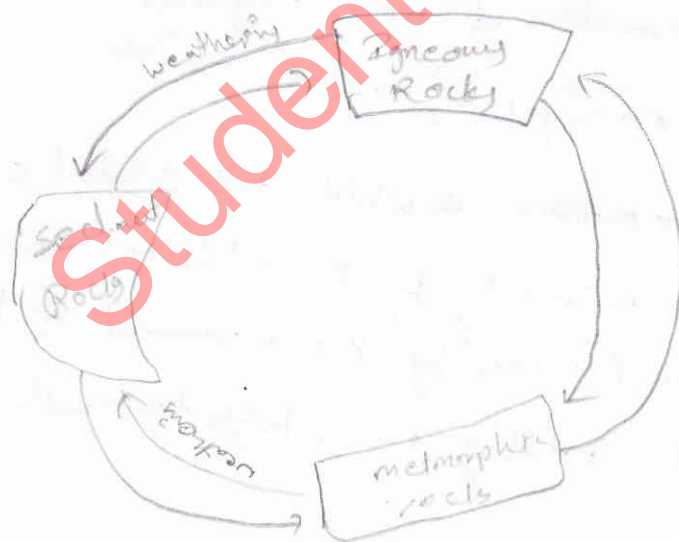
Ex:- Quartzite, Schist, slate, Marble, Gneiss, phyllite,

are example of metamorphic rocks.

Rock Cycle :- The rock cycle shows the relationship between the three types of rocks, that is the igneous, sedimentary, metamorphic rocks.

One type of rock changes slowly to another type.

Erosion produces sediments which is transported and deposited into deep basins under the sea. Then it hardens to form "Sedimentary rocks". If these rocks are deeply buried the temperature and pressure turn them into "metamorphic rocks". Intense heat at great up and reach the earth's surface where it cools to form "Igneous rocks". At the surface, igneous rocks are exposed to weathering and erosion, and the cycle begins again.



Rock cycle

# Structures and textures of Rocks:-

structures and textures of 1) Igneous

2) sedimentary

3) metamorphic rocks.

## 1) Igneous structures & Textures :-

→ Texture :- Texture means the size, shape and arrangement of mineral grains in a rock.

The grain size of an igneous rock depends on the rate of cooling of magma.

Slower is the rate of cooling → Coarser the grain.

In the study of texture four points are considered. These points are:

i) degree of crystallization

ii) Size of grains

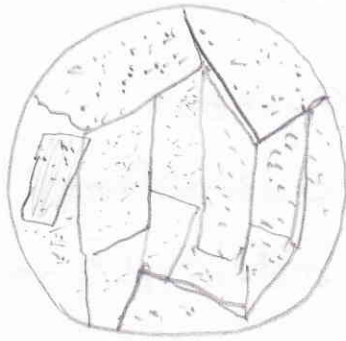
iii) shape of crystals.

iv) Mutual relationship between mineral grains.

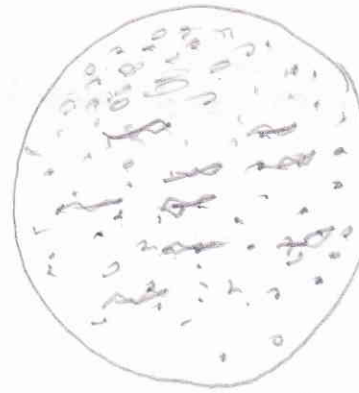
### (i) Degree of Crystallization :-

On the basis of degree of crystallization, textures of igneous rocks can be divided into

(a) Holocrystalline Texture :- When a rock is made up entirely of crystals, its texture is described as



Holocrystalline texture



Holohyaline texture

- (b) Holohyaline texture:- When a rock is composed entirely of glassy material, its texture is called "holohyaline".
- (c) Microcrystalline texture:- When a rock is composed partly of crystals and partly of glass, the texture is called microcrystalline.

(ii) Size of Grains:- The size of grains in an igneous rock varies considerably. Grains are,

If, Slow cooling -  $> 5 \text{ mm.}$  → Phaneritic.

Rapid cooling - Glassy texture. → Aphanitic.

Phaneritic further subdivided as

(i) Coarse grained texture =  $> 5 \text{ mm.}$

(ii) Medium grained texture =  $1 - 5 \text{ mm.}$

(iii) Fine grained texture =  $< 1 \text{ mm.}$

(iv) Microcrystalline texture - Under microscope only

(v) Cryptocrystalline - Very small. not even seen in microscope.

iii) Shape of Crystals :- The grains of an igneous rocks are called "euhedral" if they show well developed crystal face  
Subhedral - if they partly developed crystal face  
anhedral - if they are not <sup>fully</sup> developed crystal face.

iv) Mutual Relation of Grains :-

Depending on mutual relation of grains it may be classified into four sub groups

- Equigranular texture
- Inequigranular texture
- Directive texture.
- Inter growth texture.

① Equigranular texture :- Igneous rocks containing minerals grains of more or less equal size are shaped to have an equigranular texture. They are

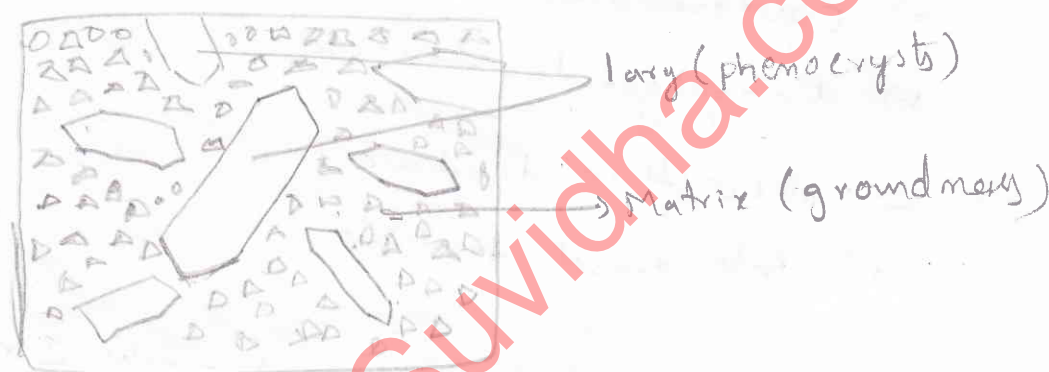
- Peridiomorphic Texture :- Most grains are euhedral  
Ex: Lamprophyres.
- Hypidiomorphic :- Most of the crystals are subhedral, the texture is called "hypidiomorphic"  
Ex: Granites & Syenites.
- Alotriomorphic texture :- anhedral crystals  
Ex: Aplites.
- Microgranular Texture :- Fine, micro grains.

- Orthophyric Texture :- fine grained peridotomorph texture
- Pelsitic Texture :- containing uniform mass of cryptocrystalline matter.

## Inequigranular Texture :-

— variation in grain sizes.

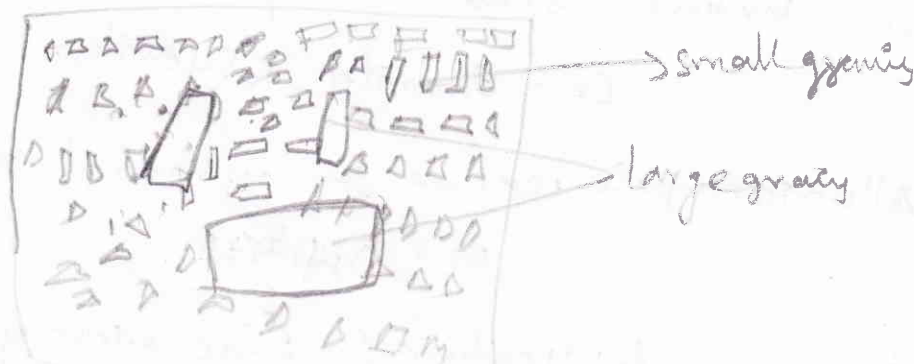
- \* Porphyritic texture :- In igneous rocks large grains are surrounded by matrix or fine grains.



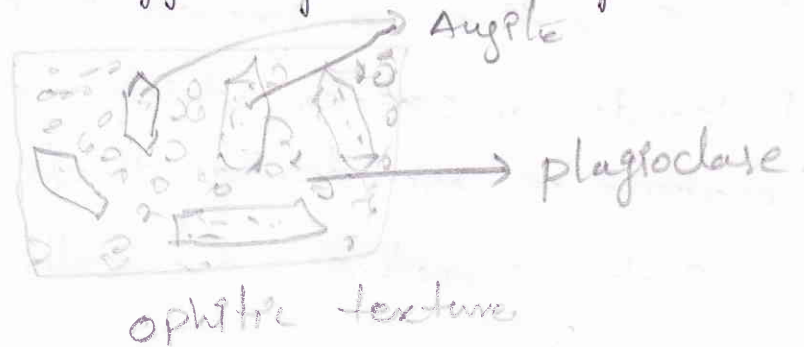
Porphyritic texture.

Granite - Granite porphyry  
 Diorite - Diorite porphyry  
 Rhyolite - Rhyolite porphyry

- \* Poikilitic Texture :- When in a rock smaller crystals are enclosed by larger crystals the texture is called poikilitic texture.



\* Ophitic texture :- It is a special type of polikrystic texture in which bigger crystals of Augite enclose smaller laths of plagioclase.



\* Intergranular texture :- In many basalts, plagioclase laths occur in such a way that they form a network with triangular or polygonal interspaces.

Directive Texture :- They produce as a result of convection during their consolidation. are called 'directive textures'. They are as

(i) Trachytic texture :- Certain volcanic rocks such as trachyte, contain feldspar laths arranged in lines parallel to the direction of flow of lava. Such a texture is called the trachytic texture.



(ii) Hyalopilitic texture :- In a volcanic rock if feldspar laths are intermixed with colour the texture is called 'Hyalopilitic'.

\* Inter growth texture :- The intergrowth of quartz and orthoclase may take place when they crystallize simultaneously that is called inter growth texture.

## Structures of Igneous rocks:-

Flow structures:- Sometimes an igneous rock shows parallel or sub parallel bands or streaks which are caused by the flow of magma or lava during their cooling and crystallization. Such structures are called the "flow structures".

Reaction Rims:- During the formation of igneous rocks, reaction takes place between early forming minerals and the magma. This zone of reaction products which occurs near the boundary of the mineral grains is called the 'reaction rims'.

Xenolithic Structures:- Foreign rock fragments are included into the magma when it rises up towards the earth's surface. Such entrapped fragments of foreign rocks are called the 'xenoliths', and the structure is called the 'xenolithic structure'.

Vesicular texture:- Most lavas contain large amount of gas and volatiles. If they escape vesicles form, this structure is known as 'vesicular structure'.

Amygdaloidal structure: The vesicles of volcanic rocks may subsequently filled by secondary minerals such as calcite & zeolites. this structure is called "Amygdaloidal structure".

Pegmatitic structure: If the constituent mineral grains exceed several centimeters in size, the rock is said to have a 'pegmatite structure'.

It may be said that the texture and structure of an igneous rock provide numerous clues that suggest the circumstances of formation of rocks.

## 2) Structures & Textures of Sedimentary Rocks

Texture:- Texture means size, shape and arrangement of grains in a rock. As sediments contain particles of various size, grain size is an important factor for description of sedimentary rocks. Depending upon the size of particles sediments are classified as.

Grade	Grain Size	Rock Type.
Pebble Gravel	1 mm and above 2 mm to 10 mm } ①	Conglomerate
Sand	0.1 mm to 2 mm - ②	Sandstone
Silt	0.01 to 0.1 mm - ③	Siltstone
clay	Less than 0.01 mm - ④	shale.

① → very coarse grained

② coarse grained / sand

③ medium grained

④ fine grained.

The shapes of the constituent grains of sedimentary rocks of considerable significance in the study of texture.

The grains of a rock may be rounded  
partially rounded  
angular.

→ If the grains are in pinhead (1 mm) the texture is 'oolitic'

→ If less than that 'pisolitic texture'

# Structural features :- The important structure of sediment

- any rocks are
- (i) Stratification
  - (ii) lamination
  - (iii) graded bedding.
  - (iv) Current bedding.
  - v) Ripple marks.

Stratification :- Deposition of sedimentary into layers or beds is called the stratification.

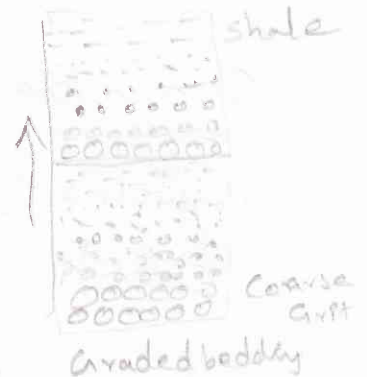
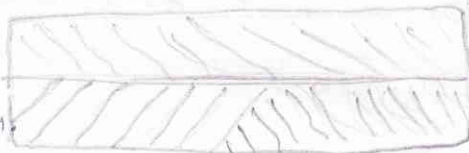
→ The planes dividing into different beds are called the bedding planes.

Lamination :- This bedding, less than one centimeter in thickness are called lamination.

Graded bedding :- In this each bed shows a gradation in grain size from coarse below to fine above.

Current bedding :- It is also called as 'Cross bedding'.

in this structure minor beds lie at an angle to the planes of general stratification.



Ripple Marks :- Are the wavy undulations seen on the surface of bedding planes. They are produced by the action of waves and currents in shallow water.



### 3) Textures & Structures of Metamorphic rocks:-

Textures:-

- (i) Crystalloblastic
- (ii) Porphyroblastic
- (iii) Granoblastic
- (iv) Palimpsest Texture.

Crystalloblastic texture:- The holocrystalline texture of metamorphic rocks is called the "Crystalloblastic texture".

- The crystals show perfect outline - Idio blastic.
- The crystals which do not have definite shape - Xenoblasts.

Porphyroblastic Texture:- When idio blastic texture occurs as large crystals embedded in a fine grained ground mass, the texture is called "Porphyroblastic".

Granoblastic:- In a metamorphic rock if the major constituents are granular or equidimensional, the texture is called "granoblastic".

Palimpsest texture:- The remnant texture of a parent rock found preserved in the metamorphic rock is called -  
'palimpsest texture'

## Structures :-

a) Cataclastic structure :- is found in breccias and mylonites. These structures formed mainly due to shearing stresses.

b) Maculose structure :- When argillaceous rocks are subjected to contact metamorphism, spotted rock is formed in areas where incomplete recrystallization takes place. This structure is called the 'maculose structure'.

Slaty structure :- This structure is caused due to the parallel orientation / arrangement of flaky minerals like mica.

Schistose structure :- If a rock consists of only prismatic or platy minerals, then no segregation takes place, but only foliation. Such a texture is called Schistose structure.

Gneissose structure :- A coarse grained metamorphic rock showing banded and or streaked appearance is called 'gneiss' and its structure is called the 'gneissose structure'.

Granulose structure :- It is formed due to equidimensional minerals such as quartz, feldspar, pyroxene, calcite.

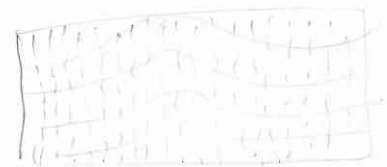
Ex: Marble & Quartzites.



Schistose structure



Gneissose structure



Slaty structure



Granulose structure

# Megascopic study of Rocks:-

## Granite :-

Nature :- Plutonic, Acid, Light coloured.

Mineral Composition :-

- i) Essential minerals :- K-feldspar and quartz.
- ii) accessory minerals :- mica & hornblende.

Texture :- Fine to coarse grain.

Equigranular.

(but porphyrys sometimes shows.)

Structure :- Compact / dense / massive hard rock

Occurrence :- Granites are commonly occur as major intrusive bodies, such as batholiths and stocks.

Types of Granites :-

- a) Biotite-granite
- b) Hornblende granite
- c) Rhyolite
- d) pink granite
- e) gray granite.

Uses :- It is used as building stones.

Ex:- O.U Arts college building is built with pink granite.

## Dolerite :-

Nature :- Dark Coloured rock of fine grained texture.

Mineral Composition :-

i) Essential minerals :- Calcic plagioclase and Augite.

Texture :- Medium to fine grained

Inequigranular porphyritic.

Structure :- Massive, dense & non-vesicular

Occurrence :- Dolerites occur mainly as dykes and sills.

Uses :- Building stones.

\*Economically Dolerite is also called as "Black Granite"

## Basalt :-

Nature :- Volcanic rock, basic to ultra basic, Dark coloured.

Mineral Composition :- Augite, calcic-plagioclase. (Labradorite)

Textures :- Fine grained to glassy.

Porphyritic texture is common

Vesicular texture.

Structure :- Lava flow structure

Occurrence :- They are abundant of the volcanic rocks.

Ex :- Deccan Traps.

## Pegmatites :-

Nature :- Extremely coarse grained.

Mineral Composition :- Granitic composition but coarse grained crystals.

E. Minerals :- Quartz, feldspar and mica.

Accessories :- Tourmaline, beryl, topaz, apatite, monazite, and fluorite.

Texture :- Extremely coarse grained and irregular.

Structure :- Not having any specific structure.

Occurrence :- Pegmatites are closely related genetically to large masses of plutonic rocks.

## Sedimentary rocks

### Laterite :-

Nature :- Red colour, brown/yellow.

It is a residual product of weathering in hot humid climate.

Mineral Composition :- Laterites are essentially clays rich in aluminium and iron hydroxides.

Texture :- Porous and Concretionary

Varieties :- Laterites rich in aluminium hydroxides are called "bauxites".

Uses :- (i) Bauxites are aluminum ores.

(ii) Laterite soils are famous for cotton.

### Conglomerate :-

Nature :- Consolidated gravels. Colour variable

Mineral Composition :-

- Rounded pebbles are set in a fine grained matrix.
- Matrix consists of sand or silt.

Texture :- Very Coarse grained.

Varieties :- Angular Conglomerate called Breccia.

Uses :- Some of the conglomerates are containing Diamonds.

### Sand Stone :-

Nature :- Arenaceous (sandy), Colour variable.

Mineral Composition :- Quartz is chief mineral.

Mica, feldspar, etc ...

Texture :- Coarse grained,  
medium grained  
fine grained

Structure:- Stratification, Current bedding, ripple marks.

Varieties:- Arkose

Graywackes are some varieties.

Uses:- Construction material / building stones.

## Shale:-

Nature:- Argillaceous variable colour.

They are often soft and can be scratched by a knife.

Mineral Composition:-

Major → kaolinite, illite etc.

minor → quartz, mica and chlorite.

Texture:- very fine grained size.

Structure:- Lamination, ripple marks

Varieties:- Calcareous shale

Perrugineous shale

Carbonaceous shale

Silt stone

Mud stone.

Uses:-

## Limestone :-

Nature :- Calcareous rock

Formed chemically or organically.

White / grey / cream coloured.

Mineral Composition :-

→ Calcium Carbonate ( $\text{CaCO}_3$ )

→ Magnesium Carbonate ( $\text{MgCO}_3$ )

Texture :- Fine grained rock.

Compact / massive.

Varieties :- chalk,  
marl.

Uses :- Cement industry.  
Paper industry.

## Metamorphic rocks

### Slate :-

Nature :- dark coloured  
Slaty cleavage.

Mineral composition :- Mixture of micas & chlorites

Texture :- Very fine grained texture.

Structure :- Slaty cleavage

Origin :-

Shales  $\xrightarrow[\text{High P \& T}]{\text{Metamorphism}}$  Slates.  
(Sed. Rock) (Met. rock)

### Schist :-

Nature :- Schists are Coarse grained,  
foliation / schistosity  
varies of colour

Mineral composition :-

Mica schist - mica mineral

Kyanite " - kyanite "

Texture :- Coarse grained.

Structure :- Schistose structure

Origin :- Schist are generally the product of  
regional metamorphism.

## Gneiss :-

Nature :- Coarse grained.  
light colour / dark colour bands

Mineral Composition :-

- Quartz and feldspar occur light colour
- biotite and Hornblende dark colour.

varieties :-

Biotite - gneiss  
Hornblende - gneiss.  
granite - gneiss

Structure :- Gneissose structure

Texture :- Coarse grained.

Origin :- Gneisses are more commonly derived by the high grade regional metamorphism.

## Marble :-

Nature :- Crystalline rock,  
pink / yellow / grey / green / black / white colour.

Mineral composition :- Calcite  
Dolomite (rare)

Texture :- Crystalline texture.

Origin :- Limestone metamorph Marble

Uses :- ex) Ajmal.

## Quartzite ↗

Nature :- Hard, dense, siliceous rock  
light in colour.

Mineral composition :-

Essential :- Quartz

Small amount :- mica, tourmaline,

Texture :- interlocking quartz grains / granular texture

Structure :- Granulose.

Origin :- Quartzites are derived from sandstones by  
high grade metamorphism.

Sandstone  $\xrightarrow[\text{high grade}]{\text{metamorphism}}$  Quartzite