Catalog

UNIT III

PETROLOGY

3.1 CLASSIFICATION OF ROCKS

SYLLABUS

Classification of rocks, distinction between Igneous, Sedimentary and Metamorphic rocks. Engineering properties of rocks. Description, occurrence, engineering properties, distribution and uses of Granite, Dolerite, Basalt, Sandstone, Limestone, Laterite, Shale, Quartzite, Marble, Slate, Gneiss and Schist.

Introduction:

Petrology: Petrology is the branch of geology, dealing with study of rocks in respect of their origin, mode of formation, occurrence, distribution, their engineering properties and uses.

Rock : A rock is defined as an assemblage of minerals.

Mineral : A mineral is an assemblage of elements.

Element : An Element is an assemblage of atoms.

Atom : An Atom is made up of Protons, Electrons and Neutrons.

Stone : A hard, compact and tough rock is called a stone.

PETROLOGY COMPARISES OF THE FOLLOEING CHAPTERS		
Chapter 1	:	Classification of Rocks
Chapter 2	:	Textures and Structures of rocks
Chapter 3	:	Distinction between Igneous, Sedimentary and Metamorphic rocks
Chapter 4	:	Engineering properties of Rocks
Chapter 5	:	Description of Individual Rocks

Classification of Rocks

Types:

- Igneous rocks
- Sedimentary rocks
- Metamorphic rocks

1. **Igneous rocks:**

   Igneous rocks are first formed primary rock.

   Igneous rocks are formed due to the consolidation of magma.

2. **Sedimentary rocks:**

Sedimentary rocks are the secondary rocks, formed from either Igneous or Metamorphic rocks, due to weathering, erosional and depositional processes.

3. **Metamorphic rocks:**

Metamorphic rocks are formed due to Metamorphism of Igneous and or Sedimentary rocks due to the impact of temperature, pressure and chemically active fluids.

Classification of Igneous Rocks

1. Classification based on Depth of formation or origin.
2. Chemical classification.
3. Mineralogical classification.
4. Textural classification.
5. Tabular classification.

1. **Classification based on Depth of formation or origin :**

i. Plutonic rocks

ii. Hypabysaal rocks

iii. Volcanic rocks

i. Plutonic rocks :

The Igneous rocks formed at greater depths or at deep seated conditions are called Plutonic rocks. The depth may be around 10 km or more. E.g. Granite, Syenites, Gabbros, etc.

ii. Hypabysaal rocks :

The Igneous rocks formed at intermediate depth or at shallow depth (say around 3 km) are called Hypabysaal rocks. E.g. Granite Porphyry, Dolerite, etc.

iii. Volcanic rocks :

The Igneous rocks formed upon the surface of earth, due to volcanic eruption, are called volcanic rocks. E.g. Basalt, Trachyte, etc.

2. Chemical classification:

This classification is based on the chemical composition of rocks, established by Cross, Iddings, Pirson and Washington.

Classified as Salic and Fermic minerals present in rocks.

Salic / Fermic ratio and classified the rocks as follows:

S.NO	SALIC / FERMIC RATIO	CLASS
1	> 7.00	Persalic
2	7 -- 1.66	Dosalic
3	1.66 – 0.60	Salfermic
4	0.60 – 0.14	Dofermic
5	< 0.14	Perfermic

Salic Minerals (Light Colored) : Quartz, Feldspar, Nepheline, Halite, etc.

Fermic Minerals (Dark Colored): Magnetite, Haematite, Olivine, Pyrite, etc.

3. Mineralogical classification:

Based on 'Color Index' of minerals present, rocks are classified in this category. Based on mineralogical composition, Felsic and Mafic minerals are recognized.

i. **Felsic Minerals :**

They are light colored. Quartz, Feldspar, and Feldspathoid group of minerals are included in this category.

ii. **Mafic Minerals :**

They are dark colored. Ferro – magnesian minerals such as Micas, oxides of iron, Amphiboles, Pyroxenes, and Olivine etc. are included here.

S.NO	CLASS	COLOR INDEX	EXAMPLE
1	Leucocratic	1 – 30	Granite
2	Mesocratic	31 – 60	Gabbro
3	Melanocratic	61 – 100	Dolerite

4. Textural classification :

Based on texture, rocks are classified into three categories,

i. Phanerites :

The coarse grained igneous rocks with mineral grains greater than 5 mm in size, able to be identified with naked eye are called Phanerites. E.g. Granite.

ii. Aphanite :

The Igneous rocks with mineral grains less than 1 mm in size, able to be identified only under microscope are called Aphanite. E.g. Basalt.

iii. Glasses :

Rocks of zero grain size, formed due to super cooling effect are grouped under glasses. E.g. Obsidian.

5. Tabular classification :

The most important system of classification of rocks is tabular classification.

Rock class	Over Saturated	Saturated		Under Saturated
	ACID (Free silica > 66 %)	Intermediate (Free silica 55 – 66 %)	Basic (Free silica 44 – 55 %)	Ultra Basic (Free silica < 44 %)
Plutonic	Granite	Syenite	Gabbro	Peridotite
Hypabysaal	Granite Porphyry	Syenite Porphyry	Gabbro Porphyry	Limburgite
Volcanic	Rhyolite	Trachyte	Basalt	Olivine Basalt

In Tabular classification, igneous rocks are vertically classified as Plutonic, Hypabysaal and Volcanic rocks, horizontally classified as acid, Intermediate, basic and ultra basic rocks, as well as oversaturated, saturated and under saturated rocks, based on the % of free silica present.

Classification of Sedimentary Rocks:-

Sedimentary rocks are classified as

I. Clastic Rocks

II. Non – Clastic Rocks

I. Clastic Rocks :

Clastic rocks are mechanically formed rocks, due to weathering processes.

Class	Grain size
Boulders	> 256 mm
Cobbles	16 – 256 mm
Pebbles	2 – 16 mm
Sand	1 / 16 – 2 mm
Silt	1 / 256 – 1 / 16 mm
Clay	< 1 / 256 mm

II. Non – Clastic Rocks :

Non – Clastic rocks are the rocks, formed due to chemical and organic processes.

They are:

1. Chemically formed rocks
2. Organic deposits

1. Chemically formed rocks :

The Chemical processes involved in forming these rocks are precipitation, evaporation, crystallization, etc.

They are further classed as

i. Siliceous Deposits :

Silica is chief constituent of these deposits, formed due to solution and evaporation. E.g. Flint, Cherts, Jasper, etc.

ii. Carbonate Deposits :

These are formed due to precipitation of carbonate rich waters. E.g. Limestone, Magnetite, Dolomite, etc.

iii. Ferruginous Deposits :

These are formed due to chemical precipitation of oxides and hydroxide deposits of iron. E.g. Iron – ore deposits.

iv. Evaporites :

Evaporation is the formation process of some common salt and Gypsum deposits. E.g. Gypsum, rock salt, etc.

2. Organic deposits :

Sedimentary deposits formed from the remains of plants and animals. E.g. Coral Limestone.

Some types of organic deposits are listed below.

i. **Carbonaceous Deposits :**

They are carbon rich. E.g. Coal.

ii. **Phosphatic Deposits (Guano) :**

They are formed due to accumulation of excreta of some birds. E.g. Guano.

iii. **Ferruginous Deposits :**

Iron Carbonates formed, due to reduction process by bacterial action in swamps. E.g. Siderite.

iv. **Carbonate rocks :**

Sedimentary lime stones and skeletal bones of marine organisms like corals, foraminifera, etc. fall under this group. E.g. Shell limestone.

Classification of Metamorphic Rocks:-

Metamorphic rocks are classified into

i. Foliated rocks

ii. Non – Foliated rocks

i. Foliated rocks :

In some metamorphic rocks, some of the lenticular minerals are oriented and arranged themselves parallel to the least strain direction. Such direction is called foliation. E.g. Schist, Slate, Gneiss, etc.

ii. Non – Foliated rocks :

No Foliation can be seen in these rocks. Non – Foliated rocks are massive and compact. E.g. Quartzite, Marble.

3.2 TEXTURES AND STRUCTURES OF ROCKS

Texture:

Texture of a rock is defined as the mutual relationship and packing arrangement of different mineral grains and glassy matter present in a rock.

Structure:

Structure refers the form are shape of the rock, developed during its formation.

Texture of Igneous rock / Textural classification:

1. **Crystallinity:** It refers the amount of crystal or glassy matter on both present in a rock.

It is further classified into

i. **Holocrystalline**: When a rock is completely made up of crystals. (.E.g.) Granite.

ii. **Holohyaline**: When a rock is completely made up of glass. (.E.g.) Obsidian.

iii. **Hemi / Merocrystalline:** When a rock is partly made up of crystals and partly of glass. (E.g.) Granite porphyry.

2. **Granularity :** It refers the grain size and dimension of grains present in a rock (visible to naked eye or not)

Granularity is classified into:

i. **Phaneric or phanerocrystyalline:** When mineral grains areable to be identified with naked eye. E.g. Granite.

- **Coarse grained** : When grain size > 5mm
- **Medium grained** : When grain size 1mm –5mm
- **Fine grained** : When grain size < 5mm

ii. **Aphanitic**: When crystal grains are unable to be identified with naked eye. E.g. Basalt.

iii. **Microcrystalline**: When crystal grains are able to be identified only under microscope. E.g. Slate.

iv. **Crypto crystalline**: When even under microscope, very difficult to identify mineral grains. E.g. Flint, Cherts, etc.

3. **Shape of crystals :** It refers grain size of crystals present (bigger / smaller) in a rock (whether equal or unequal in size)

It is studied under,

i. **Euhedral**: Crystal faces perfectly developed. When a rock is totally made up of Euhedral crystals, the texture is termed Pan Idiomorphic. E.g. Granite.

ii. **Subhedral**: Crystal faces partially developed. When a rock is totally made up of Subhedral crystals, the texture is termed Hypidiomorphic.

iii. **Anhedral**: Crystal's faces undeveloped. When a rock is fully made up of anhedral crystals, the texture is called Allotriomorphic.

4. **Mutual Relations of crystals:** It refers the presence of smaller and larger grains and their relationships.

This texture is classified into:

i. **Porphyritic**: When larger grains surrounded by smaller ones in a rock. E.g. Granite, Syenites, etc.

ii. **Poikilitic**: When smaller grains surrounded by or enclosed in larger ones. E.g. Dolerite.

Structure of igneous Rocks:

1. **Extrusive forms:** the forms developed upon the surface of earth (eg) volcanic rocks
2. **Intrusive forms:** the forms developed below the surface of earth (eg) Silt, Dykes, etc.
3. **The block and ropy lava:** (When magma comes out of the surface of earth, it becomes lava.)

Block lava: The surface is rough & irregular with broken & fragmental appearance, due to highly viscous lava undergoing little movement

Ropy lava: Smooth surface of structure, due to very mobile lave, moving considerable distance.

4. **Flow structure:** Development of parallel or nearly parallel layers of minerals, due to flow of lava.
5. **Pillow structure:** Overlapping pillow like structure.

Spherulitic structure: Made up of thin minerals fibres.

6. **Orbicular structure:** Concentric shell like.
7. **Columnar:** column like –rhombic, square, hexagonal shapes (eg) Columnar Basalt
8. **Sheet structure:** Made up of separable sheets, due to weathering (eg) Granite
10. **Vesicular structure:** Escape of gases within the lava gives rise to several empty cavities on cooling within the consolidated rock. This structure is termed vesicular structure.
11. **Rift and grain:** this structure indicates two separate directions, along which when quarrying, the rock will split.(Eg) granite can be broken with a comparative ease, due to rift and grain. The directions of rift and grain are at right angles to each other.

Other structures of igneous rocks:

1. **Concordant forms:** eg sill

The igneous intrusion that has been injected parallel to the bedding planes of host rocks are called concordant forms Eg sills

2. **Discordant form:** eg Dyke

The intrusion that cut across the bedding planes is called discordant forms. Dykes is a discordant plane.

3. **Batholiths:**

The extensive body of igneous intrusion (generally more than 100 Km^2 in area) which is discordant in nature and unable to trace its depth is known as batholiths.

4. **Stock and boss:**

   When the surface area of batholiths is less than 100 Km^2, it is said to be a stock and stock with circular outline is termed boss

Texture of sedimentary rocks:

The texture of sedimentary rocks is broadly classified as

i. **Texture based on origin:**

1. Clastic texture and
2. Non Clastic texture

Clastic texture: it is mechanically formed texture.

Non clastic texture: it is chiefly found in rocks that have precipitated chemically from water (chemical sedimentary rocks).

i. Texture based on shape:

1. Angular, sub angular (Eg) Breccias.
2. Rounded, sub rounded (Eg) conglomerates.

ii. Texture based on Grain size:

1. Coarse grained : average grain size > 5mm
2. Medium grained : average grain size 1mm to 5mm
3. Fine grained : average grain size < 1mm

Structure of sedimentary rocks

i. **Stratification:** The layered arrangement of strata in sedimentary rocks is called stratification. Each layer may be few cm to several meters thick and may extend for several maters or kilometers.

ii. **Lamination:** In a layered structure, if the individual layer is less than 1 cm thick and appears to be very thin, then it is called lamination.

iii. **Graded bedding:** In a stratified rock, the component grains of bedding are sorted and symmetrically arranged, coarsest to finest from top layer to bottom layer, then it is termed as graded bedding.

If the beddings show cross-cutting relationship with each other, not showing parallelism & gradation of grains, then the graded beddings becomes cross bedding.

If gradation of particles is followed in a cross bedding, it becomes torrential bedding.

iv. Concretionary structure:

If the sedimentary rock made up of concretions of various shape, like, rounded or sub rounded, quite small or quite large, like fish egg or walnut, then the structure is termed as concretionary structure.

v. Oolitic & Pisolitic structure:

These are examples of concretionary structures.

In oolitic structures, the concretions are of the size range 0.1 to 1.00 mm.

In Pisolitic structure, the individual size of the concretion is like that of a peanut, greater than 1mm. Eg: oolitic and Pisolitic limestones.

Texture of Metamorphic rocks

i. **Crystalloblastic:** This is a metamorphic texture equivalent to Holocrystalline texture of igneous rocks.

ii. **Porphyroblastic:** Equivalent to Porphyritic texture of igneous rocks.

iii. **Palymsest texture:** This is the remnant of igneous texture, after metamorphism. To indicate this, ‘blast’ is used as prefix.

Blastophitic: Remnant of ophitic texture is left over, after metamorphism.

iv. **Granoblastic:** Equivalent to equigranular texture, made up to equidimensional grains.

v. **Xenoblastic:** Crystal faces well developed (equivalent to Panidiomorphic)

vi. **Idioblastic:** Crystal faces not fully developed.

Metamorphic Structure

i. **Cataclastic Structure:** Characterized by extreme fineness of grains. Eg. Slate, crush breccias.
ii. **Schistose structure:** Parallel arrangement of platy/flaky minerals. Eg. Schist.
iii. **Gneissose structure:** Alternate color bands of dark colored and light colored minerals. Eg. Gneiss.
iv. **Granulose structure:** Minerals- granular in characters. Eg. Marble, quartzite.

Metamorphism

Metamorphism is defined as the process of alteration & recrystallization of rocks due to the impact of temperature, pressure and chemically active environment.

Agents of Metamorphism: Temperature, pressure (stress & directed pressure) and chemically active fluids.

Types of Metamorphism:

1. **Thermal metamorphism / contact metamorphism:** Temperature is the dominating agent.
2. **Plutonic metamorphism:** High temperature and high pressure dominating.
3. **Dynamic metamorphism (load metamorphism):** pressure dominates.
4. **Dynamothermal or regional metamorphism:** Temperature, pressure and chemically active fluids dominate.

3.3 ENGINEERING PROPERTIES OF ROCKS

The engineering properties of rocks to be tested in laboratory, to find their suitability to be used as building stones, road metal or concrete aggregate are listed by below:

1. Uniaxial compressive strength
2. Tensile strength
3. Hardness
4. Water absorption capacity
5. Porosity
6. Abrasion coefficient
7. Toughness index
8. Specific gravity
9. Weathering resistance index, etc.

1. Compressive strength:

Uniaxial compressive strength is defined as the maximum load per unit area, which a stone can withstand without failure. It is expressed as C_0.

C_0 = load at failure / load bearing surface area = P/A

Where,

P = load at failure

A = area of cross section of sample.

Eg

Rock name	**:**	**compressive strength**
Granite	:	1000-2500 kg / cm^2
Sand stone	:	200-2000 kg / cm^2
Gneiss	:	500-2500 kg / cm^2

2. Tensile strength:

The resistance offered by a rock specimen to tension is called its tensile strength. Tensile strength is indirectly determined by Brazilian test.

Tensile strength = 2 x load at failure / π x diameter of the specimen x length of the specimen

(or)

$T_s = 2P/\pi DL$

Eg:

Rock name : Tensile strength

Granite : 7-25 MPa

Sand stone : 4-25 MPa

Marble : 15 MPa

Quartzite : 10-30 MPa

3. Hardness:

Hardness is defined as the resistance offered by a stone specimen to any external force that tries to scratch it.

MOH'S SCALE OF HARDNESS	
Mineral Name	**Hardness No.**
TALC	1
GYPSUM	2
CALCITE	3
FLOURITE	4
APATITE	5
FELDSPAR (ORTHOCLASE)	6
QUARTZ	7
TOPAZ	8
CORUNDUM	9
DIAMOND	10

In this scale, higher hardness minerals will scratch lower hardness minerals, but the lower hardness minerals will not scratch higher hardness one.

4. Water absorption capacity:

Water absorption capacity of a rock specimen refers the ability of that rock to absorb water at a given time and temperature.

Eg

Rock sample	**:**	**water absorption capacity**
Sand stone & limestone	:	10%
I class Brick	:	20% (max)

5. Porosity:

Porosity of soil or rock is defined as the ratio of volume of pore spaces to the total volume of the rock or soil.

It is given by, $\alpha = (v/V) \times 100$

Where, α = porosity of specimen

v = volume of pore spaces present in specimen

V = total volume of specimen

Eg

Building stones	**:**	**porosity**
Granite	:	0.1-0.5%
Sand stone	:	5-25%
Marble	:	0.5-2%

6. Abrasion coefficient:

Abrasion coefficient is defined as the resistance offered by a stone against rubbing action. The sand loaded winds blown will produce rubbing action upon the stones used in pacing along roads, buildings, tunnels, dams, etc. hence, abrasion coefficient is a significant property to be studied and tested by an equipment called Dorry's abrasion testing machine.

The safe value of abrasion coefficient = 2%

7. Toughness index:

Toughness index refers the resistance offered to No. of blows of load from a constant height, applied to the stone specimen, without undergoing failure.

8. Specific gravity:

Specific gravity of a material is defined as the ratio of weight of the sample in air to that of an equal volume of water.

Specific gravity = (weight of stone sample in air/ weight of equal volume of water) x density of the water

Where, density of water = 1

Specific gravity of any material can be obtained, using pycnometer.

9. Weathering resistance index:

It is the resistance offered by the stone sample to weathering impact. It is indirectly known by doing acid test.

3.4 DESCRIPTION OF INDIVIDUAL ROCKS – IGNEOUS ROCKS

GRANITE	
Description	Hard and resistant acid igneous rock, having free silica greater than 66% composition
Origin	Plutonic igneous in origin
Texture	Holocrystalline, Phaneric, Panidiomorphic, medium to coarse grained, Porphyritic, graphic texture, etc.
Mineralogy	Essential minerals : Quartz, feldspar and micas Accessory minerals : Hornblende, tourmaline, augite, garnet, hypersthenes
Occurrence	Occurs as massive batholyths
Varieties	i. Biolite granite : Biolite dominant ii. Hornblende granite : hornblende dominant iii. Tourmaline granite : tourmaline dominant iv. Graphic granite : shows graphic texture v. Porphyritic granite : Porphyritic texture
Distribution	Distributed mostly in the crust of the earth. Occurs as intrusive form like sills and as extrusive forms like batholyths, exposed upon the surface after prolonged erosion.
Engg Properties	Compressive strength : 1000 – 2500 kg / cm^2 Density : 2550 – 2650 kg / m^3 Water absorption capacity : 0.5 – 1.2%
Uses	Used as i. Building stone for foundation of major structures. ii. Road metal iii. Coarse aggregate for concrete iv. Stone masonry v. Ornamental & monumental stones

DOLERITE	
Description	Traditionally called 'Black Granite'.
Origin	Hypabysaal igneous in origin
Texture	Ophitic texture, some varieties are Porphyritic in texture.
Mineralogy	Essential minerals : augite, plagioclase feldspar & iron oxide. Accessory minerals : quartz Minor minerals : olivine & hypersthenes.
Occurrence	Occurs as sills and dykes
Distribution	In Tamilnadu, it is found in Kunnam (Tindivanam), Villapuram Dist. In North India, it is found in Singhbhum region of Bihar
Engg Properties	Uniaxial compressive strength : 1500 – 3500 kg / cm^2
Uses	Used as i. Building stones ii. Monumental stones iii. Ornamental & decorative stones

BASALT	
Description	They are volcanic igneous rocks, formed due to volcanic eruption & rapid cooling from lava flows.
Origin	Volcanic igneous in origin
Texture	Fine grained texture
Mineralogy	Plagioclase feldspar (anorthite & labradorite) and ferromagnesian minerals (augite, hornblende, hypersthenes, olivine, biotite, etc) in equal proportion.
Occurrence	Occurs as Deccan traps in central India, and also as columnar basalts in Maharashtra.
Varieties	i. Basanite : olivine-rich basalt ii. Tholeiites : olivine free basalt iii. Nepheline basalt : Nepheline free accessory mineral iv. Leucite : leucite as accessory mineral
Distribution	It is distributed in central India as Deccan traps in Madhya Pradesh & Gujarat and as columnar basalt in Maharashtra.
Engg Properties	Compressive strength : 1500 – 3500 kg / cm^2 Porosity : 0.1 – 1.0 %
Uses	Used as i. Road metal ii. Coarse aggregate in concrete

3.5 DESCRIPTION OF INDIVIDUAL ROCKS – SEDIMENTARY ROCKS

SANDSTONE	
Description	Mechanically formed clastic sedimentary rocks, made up of sand grade particles of size range $^1/_{16}$ mm to 2mm.
Origin	Sedimentary in origin.
Texture	Clastic texture : mostly medium to fine grained, rarely coarse grained. i. Coarse grained : $^1/_2$ mm to 2mm ii. Medium grained : $^1/_4$ mm to $^1/_2$mm iii. Fine grained : $^1/_{16}$mm to $^1/_4$mm The individual grains are rounded or angular to sub angular in outline. Colour : depending upon the composition and cementing materials present, the color varies. Eg : presence of iron oxide gives red, brown or yellow shades.
Occurrence	It is abundant in the upper crust of the earth and it forms 15% of the total sedimentary rocks of earth.
Varietie	**(based on cement)** i. Siliceous sandstone : SiO_2 is the cementing material. ii. Calcarieous sandstone : $CaCO_3$ & $MgCO_3$ are the cementing materials. iii. Argillaceous sandstone : Cay as cementing materials. iv. Ferruginous sandstone : Iron oxide as cementing materials **(based on mineral composition)** i. Arkose : quartz and feldsparrich variety ii. Grey wackes : grey colored sandstone with fine grained quartz, feldspar with clay iii. Flagstone : extremely rich in micas. iv. Free stone : massive variety of sandstone, rich in quartz with high crushing strength.
Distribution	They are distributed in Vindhyans and Gondwanas. Most calcareous and arenaceous sandstones belong to gondwana system.
Engg Properties	Uniaxial Compressive strength : 200 – 2000 kg / cm^2 Porosity : 5 – 25%

Uses	Used as i. Building stone (New Delhi Red Fort is built with

	sandstone) ii. Road metal iii. Coarse aggregate iv. For construction of concrete pavements v. Reservoir rock for oil and gas

LIMESTONE	
Description	They are non clastic sedimentary rocks, formed by bio mechanical and biochemical processes. They are made up of $CaCO_3$ with $MgCO_3$ and siliceous matter.
Origin	Non clastic sedimentary in origin, crystalline variety-inorganic origin, shell limestone : organic origin.
Texture	Crystalline – dense and compact, concretionary fossiliferous.
Composition	Chiefly made up of $CaCO_3$ with magnesia as common impurity, impurities present : SiO_2, Al_2O_3, Fe_2O_3., etc.
Occurrence	Occurs as a crystalline variety of the archaeans and shell limestone of the tertiary age.
Varieties	1. Chalk : earthy nature 2. Shell limestone : rich in fossils 3. Argillaceous limestone : rich in clay 4. Kankar : concretionary form of limestone 5. Calc-sinter : precipitation of the carbonate rich spring water forms Calc-sinter.
Distribution	It is distributed in many states of India and in Tamilnadu. Crystalline limestones occur in Tirunelveli, Coimbatore, Madurai, Virudhunagar Districts and shell limestones are found in Ariyalur area.
Uses	Used i. As the raw material for manufacturing Portland cement. ii. In metallurgical and chemical industries as flux.

SHALE	
Description	It is an argillaceous, fine grained sedimentary rock, composed of clayey and silt grade particles with dominant quartz and clay minerals.
Origin	Sedimentary in origin, formed under marine environment. Clastic or non clastic.
Texture	Fine grained texture
Mineralogy	Essential minerals : quartz, clay minerals and feldspar Accessory minerals : iron oxides, carbonates and organics.
Occurrence	Occurs as massive deposits.
Varieties	Based on organic origin:

	1. Residual : formed in situ with pre-existing rocks, without much mixing. 2. Transported : transported and deposited somewhere away from the origin of the parent rock and they are clastic in nature. 3. Hybrid : they are non clastic and organic in origin. The other varieties are named quartz shales, feldspathic shales, Chloritic shales, Micaceous shales, etc., based on the dominant mineral constituents.
Distribution	It is found in Cuddapah system of rocks, covering south Indian regions. Also distributed in some parts of central and western India (M.P, Maharashtra, Gujarat)
Uses	Used i. For manufacturing bricks & tiles ii. As source rock for alumina, paraffin and oil.

LATERITE	
Description	It is a residual deposit, formed due to weathering in humid climatic conditions, made up of clay minerals and iron oxides. Red, brown, or yellow in colour.
Origin	Residual sedimentary in origin.
Texture	Porous and concretionary texture
Mineralogy	Essential minerals : clay minerals, and iron oxides. Minor minerals : silica,
Occurrence	Laterite occurs as the residual deposits as mantle over bed rock. Bauxite occurs in hills of Ooty, Kothagiri, Cunnore, Shervarai, and Palani hills.
Varieties	1. Laterite : When iron rich 2. Bauxite : When alumina rich
Distribution	i. Laterites are found to occur in many parts of south Tamilnadu, such as Sivaganga, Puthukottai, Virudhunagar, Ramnad, etc.,
Uses	1. Bauxite is used as raw material for manufacture of aluminium metal 2. Used as electrical and chemical industries.

3.6 DESCRIPTION OF INDIVIDUAL ROCKS – SEDIMENTARY ROCKS

SANDSTONE	
Description	Mechanically formed clastic sedimentary rocks, made up of sand grade particles of size range $^1/_{16}$ mm to 2mm.
Origin	Sedimentary in origin.
Texture	Clastic texture : mostly medium to fine grained, rarely coarse grained. i. Coarse grained : $^1/_2$ mm to 2mm ii. Medium grained : $^1/_4$ mm to $^1/_2$mm iii. Fine grained : $^1/_{16}$mm to $^1/_4$mm The individual grains are rounded or angular to sub angular in outline. Colour : depending upon the composition and cementing materials present, the color varies. Eg : presence of iron oxide gives red, brown or yellow shades.
Occurrence	It is abundant in the upper crust of the earth and it forms 15% of the total sedimentary rocks of earth.
Varieties	**(based on cement)** i. Siliceous sandstone : SiO_2 is the cementing material. ii. Calcarieous sandstone : $CaCO_3$ & $MgCO_3$ are the cementing materials. iii. Argillaceous sandstone : Cay as cementing materials. iv. Ferruginous sandstone : Iron oxide as cementing materials **(based on mineral composition** i. Arkose : quartz and feldspar rich variety ii. Grey wackes : grey colored sandstone with fine grained quartz, feldspar with clay iii. Flagstone : extremely rich in micas. iv. Free stone : massive variety of sandstone, rich in quartz with high crushing strength.
Distribution	They are distributed in Vindhyans and Gondwanas. Most calcareous and arenaceous sandstones belong to gondwana system.
Engg Properties	Uniaxial Compressive strength : 200 – 2000 kg / cm^2 Porosity : 5 – 25%
Uses	Used as i. Building stone (New Delhi Red Fort is built with

	sandstone) ii. Road metal iii. Coarse aggregate iv. For construction of concrete pavements v. Reservoir rock for oil and gas

LIMESTONE	
Description	They are non clastic sedimentary rocks, formed by bio mechanical and biochemical processes. They are made up of $CaCO_3$ with $MgCO_3$ and siliceous matter.
Origin	Non clastic sedimentary in origin, crystalline variety-inorganic origin, shell limestone : organic origin.
Texture	Crystalline – dense and compact, concretionary fossiliferous.
Composition	Chiefly made up of $CaCO_3$ with magnesia as common impurity, impurities present : SiO_2, Al_2O_3, Fe_2O_3., etc.
Occurrence	Occurs as a crystalline variety of the archaeans and shell limestone of the tertiary age.
Varieties	1. Chalk : earthy nature 2. Shell limestone : rich in fossils 3. Argillaceous limestone : rich in clay 4. Kankar : concretionary form of limestone 5. Calc-sinter : precipitation of the carbonate rich spring water forms Calc-sinter.
Distribution	It is distributed in many states of India and in Tamilnadu. Crystalline limestones occur in Tirunelveli, Coimbatore, Madurai, Virudhunagar Districts and shell limestones are found in Ariyalur area.
Uses	Used i. As the raw material for manufacturing Portland cement. ii. In metallurgical and chemical industries as flux.

SHALE	
Description	It is an argillaceous, fine grained sedimentary rock, composed of clayey and silt grade particles with dominant quartz and clay minerals.
Origin	Sedimentary in origin, formed under marine environment. Clastic or non clastic.
Texture	Fine grained texture
Mineralogy	Essential minerals : quartz, clay minerals and feldspar Accessory minerals : iron oxides, carbonates and organics.
Occurrence	Occurs as massive deposits.
Varieties	Based on organic origin:

	1. Residual : formed in situ with pre-existing rocks, without much mixing. 2. Transported : transported and deposited somewhere away from the origin of the parent rock and they are clastic in nature. 3. Hybrid : they are non clastic and organic in origin. The other varieties are named quartz shales, feldspathic shales, Chloritic shales, Micaceous shales, etc., based on the dominant mineral constituents.
Distribution	It is found in Cuddapah system of rocks, covering south Indian regions. Also distributed in some parts of central and western India (M.P, Maharashtra, Gujarat)
Uses	Used i. For manufacturing bricks & tiles ii. As source rock for alumina, paraffin and oil.

LATERITE	
Description	It is a residual deposit, formed due to weathering in humid climatic conditions, made up of clay minerals and iron oxides. Red, brown, or yellow in colour.
Origin	Residual sedimentary in origin.
Texture	Porous and concretionary texture
Mineralogy	Essential minerals : clay minerals, and iron oxides. Minor minerals : silica,
Occurrence	Laterite occurs as the residual deposits as mantle over bed rock. Bauxite occurs in hills of Ooty, Kothagiri, Cunnore, Shervarai, and Palani hills.
Varieties	1. Laterite : When iron rich 2. Bauxite : When alumina rich
Distribution	i. Laterites are found to occur in many parts of south Tamilnadu, such as Sivaganga, Puthukottai, Virudhunagar, Ramnad, etc.,
Uses	1. Bauxite is used as raw material for manufacture of aluminium metal 2. Used as electrical and chemical industries.