KARPAGAM ACADEMY OF HIGHER EDUCATION
(Deemed to be University, Established Under Section 3 of UGC Act, 1956)
COIMBATORE-641 021

DEPARTMENT OF CIVIL ENGINEERING

LECTURE PLAN

ENGINEERING GEOLOGY (18BECE403)

LECTURER : Dr.M. Natarajan
SEMESTER : IV (2019-2020) EVEN
NUMBER OF CREDITS : 3
COURSE TYPE : Regular Course

S.No	Hours	Topics to be Covered	Text Book	Page No.
		UNIT I- General Geology		
1.	1	Geology in Civil Engineering – Branches of geology	T1	5
2.	1	Earth Structures and composition	T1	8
3.	1	Earth processes – Weathering	T1	15
4.	1	Work of rivers	T1	32
5.	1	wind and sea and their engineering importance	T1	35
6.	1	Seismic activity	T1	85
7.	1	Seismo-tectonics of Indian plates	T1	55
8.	1	seismic zones of India	T1	57
9.	1	Ground water	T1	69
				Total 09 hours
		UNIT II- Mineralogy		
10.	1	Elementary knowledge on symmetry elements of important crystallographic systems	T1	73
11.	1	physical properties of minerals	T1	82
12.	1	study of the following rock forming minerals	T1	93
13.	1	Quartz family. Feldpar family, Augite, Hornblende, Biotite, Muscovite, Calcite	T1	99
14.	1	Garnet – properties, behaviour and engineering significance of clay minerals	T1	104
15.	1	Fundamentals of process of formation of ore minerals	T1	108
16.	1	Coal and petroleum	T1	112
17.	1	Coal and petroleum	T1	117
18.	1	Their origin and occurrence in India.	T1	130
				Total 09 hours
		UNIT III- Petrology		
19.	1	Classification of rocks	T1	158
20.	1	distinction between igneous, sedimentary and metamorphic rocks	T1	160
21.	1	Description, occurrence, engineering properties	T1	178
22.	1	distribution of following rocks. Igneous rocks	T1	183
23.	1	Granite, Syenite, Diorite, Gabbro, Pegmatite	T1	154
24.	1	Dolerite and Basalt Sedimentary rocks sandstone	T1	160
25.	1	Limestone, shale conglo,	T1	172
26.	1	Metamorphic rocks. Quartizite, Marble	T1	167
27.	1	Slate, Phyllite, Gniess and Schist.	T1	183
				Total 09 hours

UNIT IV- IV Structural Geology And Geophysical Method				
28.	1	Attitude of beds	T1	154
29.	1	Outcrops	T1	213
30.	1	Introduction to Geological maps	T1	184
31.	1	study of structures	T1	224
32.	1	Folds, faults	T1	243
33.	1	Joints	T1	167
34.	1	Seismic and Electrical methods for Civil Engineering investigations	T1	276
35.	1	Seismic and Electrical methods for Civil Engineering investigations	T1	288
36.	1	Geophysical investigation	T1	298
				Total 09 hours
UNIT V- Investigations In Civil Engineering				
37.	1	Remote sensing techniques	T1	432
38.	1	Study of air photos and satellite images	T1	463
39.	1	Interpretation for Civil Engineering projects	T1	466
40.	1	Geological conditions necessary for construction of Dams,	T1	478
41.	1	Tunnels, Buildings	T1	466
42.	1	Road cuttings	T1	474
43.	1	Landslides – Causes and preventions.	T1	476
44.	1	Sea erosion	T1	487
45.	1	coastal protection	T1	490
				Total 09 hours
				Total 45 hours

TEXT BOOKS:

1. Engineering and General Geology, Parbin Singh, 8th Edition (2010), S K Kataria& Sons.
2. Text Book of Engineering Geology, N. Chenna Kesavulu, 2ndEdition (2009), Macmillan Publishers India.
3. Geology for Geotechnical Engineers, J.C. Harvey, Cambridge University Press(1982).

KARPAGAM ACADEMY OF HIGHER EDUCATION

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Coimbatore- 641 021

(For the candidates admitted from 2017 onwards)

DEPARTMENT OF CIVIL ENGINEERING

SUBJECT CODE: 18BECE403 **SUBJECT: ENGINEERING GEOLOGY**

SEMESTER: IV **CLASS: II Civil Engineering L T P C = 3 0 0 3**

Course Outcomes:

- Identify the main and most common igneous, sedimentary and metamorphic rocks encountered by foundations and construction.
- To identify and define the main morphological and geological characteristics as shown on maps,
- Analyze geological parameters important in geotechnical studies.
- To establish and describe topographical and geological sections,
- Identify potential geological hazards and various structures and ways of preventing and dealing with them

UNIT I General Geology: Geology in Civil Engineering – Branches of geology – Earth Structures and composition –Earth processes – Weathering – Work of rivers, wind and sea and their engineering importance – Seismic activity-Seismo-tectonics of Indian plates, seismic zones of India-Ground water.

UNIT II Mineralogy: Elementary knowledge on symmetry elements of important crystallographic systems – physical properties of minerals – study of the following rock forming minerals – Quartz family. Feldpar family, Augite, Hornblende, Biotite, Muscovite, Calcite, Garnet – properties, behaviour and engineering significance of clay minerals – Fundamentals of process of formation of ore minerals – Coal and petroleum – Their origin and occurrence in India.

UNIT III Petrology: Classification of rocks – distinction between igneous, sedimentary and metamorphic rocks. Description, occurrence, engineering properties and distribution of following rocks. Igneous rocks – Granite, Syenite, Diorite, Gabbro, Pegmatite, Dolerite and Basalt Sedimentary rocks sandstone, Limestone, shale conglo, Metamorphic rocks. Quartizite, Marble, Slate, Phyllite, Gniess and Schist.

UNIT IV Structural Geology And Geophysical Method: Attitude of beds – Outcrops – Introduction to Geological maps – study of structures – Folds, faults and joints – Seismic and Electrical methods for Civil Engineering investigations- Geophysical investigation

UNIT V Investigations In Civil Engineering : Remote sensing techniques – Study of air photos and satellite images – Interpretation for Civil Engineering projects – Geological conditions necessary for construction of Dams, Tunnels, Buildings, Road cuttings, Landslides – Causes and preventions. Sea erosion and coastal protection.

Text/Reference Books:

1. Engineering and General Geology, Parbin Singh, 8th Edition (2010), S K Kataria& Sons.
2. Text Book of Engineering Geology, N. ChennaKesavulu, 2ndEdition (2009), Macmillan PublishersIndia.
3. Geology for Geotechnical Engineers, J.C.Harvey, Cambridge University Press(1982).

DEPARTMENT OF CIVIL ENGINEERING

IMPORTANT QUESTIONS AND ANSWERS

SUBJECT NAME : Engineering Geology

SUBJECT CODE : CE8392 REGULATION-2017

CLASS/SEM : II YEAR CIVIL / III

CE8392

ENGINEERING GEOLOGY **L T P C**

3 0 0 3

UNIT I PHYSICAL GEOLOGY 9

Geology in civil engineering – branches of geology – structure of earth and its composition – weathering of rocks – scale of weathering – soils - landforms and processes associated with river, wind, groundwater and sea – relevance to civil engineering. Plate tectonics – Earth quakes – Seismic zones in India.

UNIT II MINEROLOGY 9

Physical properties of minerals – Quartz group, Feldspar group, Pyroxene - hypersthene and augite, Amphibole – hornblende, Mica – muscovite and biotite, Calcite, Gypsum and Clay minerals.

UNIT III PETROLOGY 9

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.

UNIT IV STRUCTURAL GEOLOGY AND GEOPHYSICAL METHODS 9

Geological maps – attitude of beds, study of structures – folds, faults and joints – relevance to civil engineering. Geophysical methods – Seismic and electrical methods for subsurface investigations.

UNIT V APPLICATION OF GEOLOGICAL INVESTIGATIONS 9

Remote sensing for civil engineering applications; Geological conditions necessary for design and construction of Dams, Reservoirs, Tunnels, and Road cuttings - Hydrogeological investigations and mining - Coastal protection structures. Investigation of Landslides, causes and mitigation.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Varghese, P.C., Engineering Geology for Civil Engineering Prentice Hall of India Learning Private Limited, New Delhi, 2012.
2. Venkat Reddy. D. Engineering Geology, Vikas Publishing House Pvt. Lt, 2010.
3. Gokhale KVGK, "Principles of Engineering Geology", B.S. Publications, Hyderabad 2011.
4. Chenna Kesavulu N. "Textbook of Engineering Geology", Macmillan India Ltd., 2009.
5. Parbin Singh. A "Text book of Engineering and General Geology", Katson publishing house, Ludhiana 2009

TABLE OF CONTENTS

AIM

The students completing this course

- Will be able to understand the importance of geological knowledge such as earth, earthquake, volcanism and the action of various geological agencies.
- Will realize the importance of this knowledge in projects such as dams, tunnels, bridges, roads, airport and harbor
- Can choose the types of foundations and other related aspects.

OBJECTIVES:

- To gain Geological knowledge of Earth and its components.
- To impart the importance of the mineralogy of the rocks.
- To know the importance of the petrology of rocks and structural components of rocks.
- To apply this knowledge in projects such as dams, tunnels, bridges, roads, airport and harbor as well as to choose types of foundations.

DETAILED LESSON PLAN

Sl. No.	WEEK	Topics	No of Hours	Book No.
UNIT I PHYSICAL GEOLOGY				
1	WEEK I	Geology in Civil Engineering	1	T4,T5
2		Branches of geology	1	T4,T5
3		Structure of earth and its composition	1	T4,T5
4		Weathering of rocks, scale of weathering	1	T4,T5
5	WEEK II	Soils - landforms and processes associated with river, wind, groundwater and sea, relevance to civil engineering	4	T4,T5
6		Plate tectonics, Earth quakes ,Seismic zones in India	2	T4,T5
UNIT – II : MINEROLOGY				
7		Physical properties of minerals	1	T4,T5
8		Quartz group, Feldspar group	2	T4,T5
9	WEEK III	Pyroxene, hypersthene and augite	2	T4,T5
10		Amphibole, hornblende, Mica	2	T4,T5
11		Muscovite and biotite, Calcite, Gypsum and Clay minerals.	2	T4,T5
UNIT – III : PETROLOGY				
12	WEEK IV	Classification of rocks	1	T4,T5
13		Distinction between igneous, sedimentary and metamorphic rocks. Description occurrence, engineering properties and distribution of following rocks	2	T4,T5
14		Igneous rocks: Granite, Dolerite and Basalt	2	T4,T5
15		Sedimentary rocks sandstone, Limestone, shale , and Laterite	1	T4,T5
16	WEEK	Sedimentary rocks sandstone, Limestone, shale , and Laterite	1	T4,T5

Sl. No.	WEEK	Topics	No of Hours	Book No.
17	V	Metamorphic rocks. Quartzite, Marble, Slate, Gniess and Schist.	2	T4,T5
UNIT – IV : STRUCTURAL GEOLOGY AND GEOPHYSICAL METHODS				
18		Attitude of beds , Outcrops, Introduction to Geological maps	2	T4,T5
19		Study of structures, Folds, faults and joints , Their bearing on engineering construction	2	T4,T5
20	WEEK VI	Study of structures , Folds, faults and joints. Their bearing on engineering construction	3	T4,T5
21		Seismic and Electrical methods for Civil Engineering investigations	3	T4,T5
UNIT-V : APPLICATION OF GEOLOGICAL INVESTIGATIONS				
22	WEEK VII	Remote sensing for civil engineering applications	1	T4,T5
23		Geological conditions necessary for construction of Dams, Reservoirs, Tunnels, and Road cuttings	4	T4,T5
24		Hydrogeological investigations and mining	1	T4,T5
25	WEEK VIII	Coastal protection structures	1	T4,T5
26		Land slides ` Causes and mitigation	2	T4,T5

Total Hours: 50

TEXT BOOKS:

1. Varghese, P.C., Engineering Geology for Civil Engineering Prentice Hall of India Learning Private Limited, New Delhi, 2012.
2. Venkat Reddy. D. Engineering Geology, Vikas Publishing House Pvt. Lt, 2010.
3. Gokhale KVGK, "Principles of Engineering Geology", B.S. Publications, Hyderabad 2011.
4. Chenna Kesavulu N. "Textbook of Engineering Geology", Macmillan India Ltd., 2009.
5. Parbin Singh. A "Text book of Engineering and General Geology", Katson publishing house, Ludhiana 2009

UNIT-I

PART A

1. WHAT IS AN AQUIFER AND MENTION ITS TYPES?(MAY/ JUNE 2011)

- Aquifer is defined as the water-bearing formation which is porous and permeable enough to supply adequate quantity of water to wells.

TYPES OF AQUIFER

- Unconfined aquifer
- Confined aquifer
- Semi-confined or Leaky aquifer
- Perched aquifer

2. WHAT ARE THE METHODS OF WIND EROSION?(NOV/DEC 2013)

- Deflation
- Abrasion
- Attrition

3. WRITE THE TYPES OF WAVES AND CURRENTS? (NOV/DEC 2013)

Types of waves

- Oscillatory waves
- Translatory waves

Types of currents

- Littoral currents
- Rip currents
- Long shore currents

4. NAME A FEW SECONDARY TECTONIC PLATES.(NOV/DEC 2014)

Secondary tectonic plates

- The Arabian plate
- The Nazca plate
- The Caribbean plate
- The Scotia plate
- The Phillipine plate

5. WHAT IS MEANT BY SEISMIC ZONE? (MAY/ JUNE 2016)

- In is an area which refers to the frequency , type and size of earthquakes experienced over a period of time is to be named as an Seismic Zone

6. WHAT ARE BARCHANS AND SAND DUNES? (NOV/DEC 2014)

- The barchans are crescent or half moon shaped dunes of variable size. Their 'horns' point in the downward direction. Their height may vary from 15-200 mts. And width from a few to 1000s meter. They have a gentle windward slope and steeper leeward slope.
- Sand dunes are whenever the velocity of wind is arrested due to the presence of a barrier along its path, the sand particles carried by the wind will be deposited there, forming sand dunes.

7. WHAT IS MEAN BY WATER TABLE? (NOV/DEC 2014)

- The depth to upper surface of zone of saturation in free ground water is called water table. In other words, a static level of water in wells penetrating the zone of saturation is called water table

8. EXPLAIN THE TERM EXFOLIATION? (NOV/DEC 2014)- REG 2013

- Exfoliation is the process of physical weathering in which the rock mass, undergoing weathering will be peeling off into concentric shells and split up into layers, due to the influence of temperature variations in association with chemical weathering.
- The phenomenon of peeling off layer from the rocks under the influence of thermal is called as the term Exfoliation

9. DEFINE WEATHERING.(MAY/JUNE 2011)

Weathering, is a natural process of in-situ mechanical disintegration and/or chemical decomposition of the rocks of the crust of the Earth by certain physical and chemical agencies of the atmosphere.

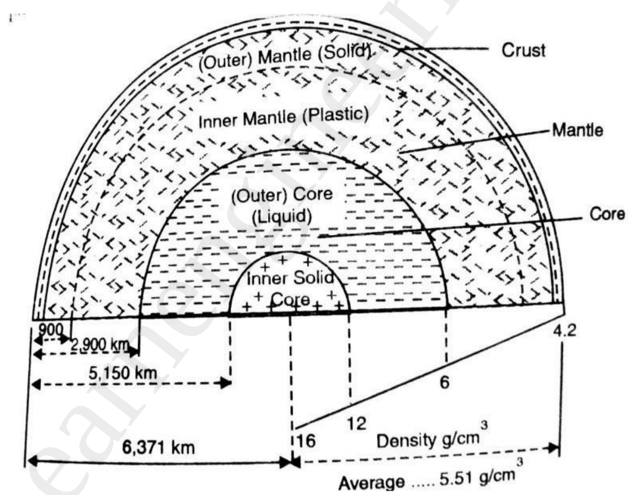
10. WHAT IS THE COMPOSITION AND NATURE OF THE INNER AND OUTER CORE OF THE EARTH (NOV/DEC 2012)

It is the third and the innermost structural shell of the earth as conclusively proved by the seismic evidence. It starts at a depth of 2900 km below the surface and extends right up to the center of the earth, at a depth of 6370 km. The liquid like core extending from a depth of 2900 km to about 4800 km is often termed as outer core. The inner core - starting from 4800 km and extending up to 6370 km is of unknown nature but definitely of solid character and with properties resembling to a metallic body. According to a widely favored view, the core may be made up of iron and nickel, alloyed in some yet unknown manner.

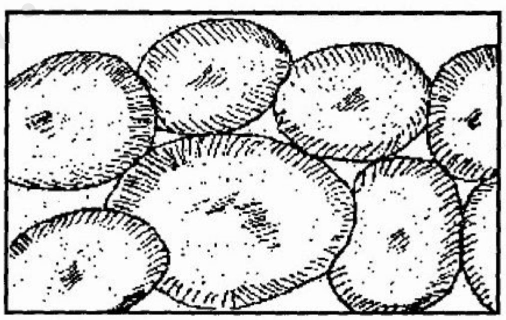
11. **DESCRIBE BRIEFLY , THE LAYERS OF THE INTERIOR OF THE EARTH.(MAY/JUNE 2012)**

The layers of the interior of the Earth is

- The Crust
- The Mantle
- The Core



12. WHAT IS SPHEROIDAL WEATHERING?(MAY/JUNE2013)



It is a complex type of weathering observed in jointed rocks and characterized with the breaking of original rock mass into spheroidal blocks.

13. HOW ARE ROCKS CLASSIFIED ACCORDING TO THE SCALE OF WEATHERING?(NOV/DEC2015)

- Highly weathered – Very intensive weathering rocks
- Fractured Rocks – High weathering
- Jointed Rocks – Low to moderate weathering
- Massive Bed rocks – No weathering

14. MENTION THE THICKNESS OF EARTH'S CRUST. (NOV/DEC2015)

(a) Under the oceans 5 - 6 km

(b) Under the continents 30 - 35 km

(c) Under the mountains : 60 - 70 km

PARTB

1. Explain in detail about branches of geology. (Nov/Dec 2015) Reg 2013

Main and Allied branches of geology:

Main Branches

- Physical geology
- Mineralogy
- Petrology
- Structural geology
- Stratigraphy
- Paleontology
- Economic geology

PHYSICAL GEOLOGY:

It deals with:

i) Different physical features of the earth, such as mountains, plateaus, valleys, rivers.lakes glaciers and volcanoes in terms of their origin and development.

ii) The different changes occurring on the earth surface like marine transgression, marine regression, formation or disappearance of rivers, springs and lakes.

iii) Geological work of wind, glaciers, rivers, oceans, and groundwater ands their role in constantly moulding the earth surface features

iv) Natural phenomena like landslides, earthquakes and weathering.

MINERALOGY:

This deals with the study of minerals. Minerals are basic units with different rocks and ores of the earth are made up of. Details of mode of formation, composition, occurrence, types, association, properties uses etc. of minerals form the subject matter of mineralogy. For example: sometimes quartzite and marble resemble one another in shine, colour and appearance while marble disintegrates and decomposes in a shorter period because of its mineral composition and properties.

PETROLOGY:

Petrology deals with the study of rocks. The earths crust also called lithosphere is made up of different types of rocks. Hence petrology deals with the mode of formation, structure, texture, composition, occurrence, and types of rocks. This is the most important branch of geology from the civil engineering point of view.

STRUCTURAL GEOLOGY:

The rocks, which from the earth's crust, undergo various deformations, dislocations and disturbances under the influence of tectonic forces. The result is the occurrence of different geological structures like folds, fault, joints and unconformities in rocks. The details of mode of formation, causes, types, classification, importance etc of these geological structures from the subject matter of structural geology.

STRATIGRAPHY:

The climatic and geological changes including tectonic events in the geological past can also be known from these investigations. This kind of study of the earth's history through the sedimentary rock is called historical geology. It is also called stratigraphy (Strata = a set of sedimementary rocks, graphy description).

ECONOMIC GEOLOGY:

Minerals can be grouped as general rock forming minerals and economic minerals. Some of the economic minerals like talc, graphite, mica, asbestos, gypsum, magnesite, diamond and gems. The details of their mode of formation, occurrence, classification. Association, varieties, concenteration, properties, uses from the subject matter of economic geology. Further based on application of geological knowledge in other fields there is many other allied branches collectively called earth science.

2. **Describe the interior Structure of the earth with neat sketch. (May/Jun 2014)reg 2008**

THE CRUST

It is the uppermost solid shell of the earth which has varying thickness in different areas as follows

(a) Under the oceans 5 - 6 km

(b) Under the continents 30 - 35 km

(c) Under the mountains : 60 - 70 km

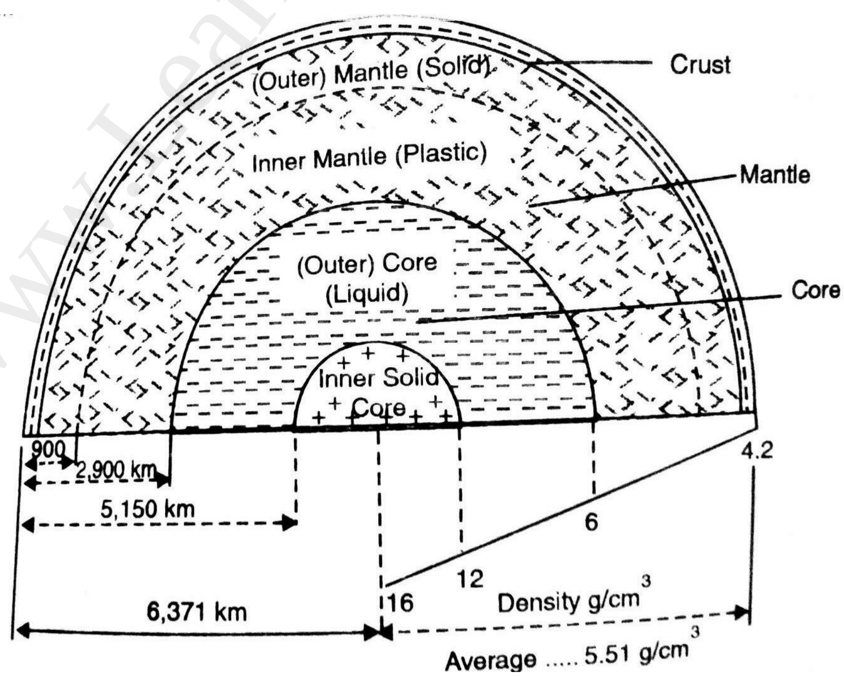
It is obvious that when compared with the radius of the Earth (6730 km. on an average), the crust makes just an insignificant part in the structure of the earth.

The chemical composition of the crust

(i) Silica - Si0 is the most dominant component; its value lies above 50% by volume in the oceanic crust and above 62% in the continental crust;

(ii) Alumina-A is the next dominant component, its value varying between 13-16 percent;

(iii) Iron Oxide (Fe Lime (CaO)-6%; Sodium Oxide-4%, Magnesium Oxide-4%, Potassium Oxide and Titanium oxide- 2% are the other components making the crust of the Earth. The solid aggregate that makes the crust of the earth is named as a rock, stone. The entire crust is made up of different types of rocks.



(B) THE MANTLE

Materials making the earth become quite different in properties at the base of the crust. This depth below the surface of the Earth at which a striking change in the properties of the materials is observed has been named as Mohorovicic discontinuity.In geological literature, it is often referred as M-discontinuity or simply as Moho. The material below Moho forms a nearly homogeneous zone till a depth of 2900 km is reached.

- At that depth, another striking change is observed in the quality of the material on the basis of the seismic waves reaching there.
- Hence, mantle is that zone within the Earth that starts from M-discontinuity and continues up to a depth of 2900 km. Mantle is made up of extremely basic material called aptly ultra basic, that is very rich in iron and magnesium but quite poor in silica
- This zone is characterized with a high density that increases with depth.
- The material of the mantle is believed to be variably viscous in nature so much so that the overlying crusted blocks can virtually float over it, of course at a very slow rate and in a broader sense of the term.

(C) THE CORE

- It is the third and the innermost structural shell of the earth as conclusively proved by the seismic evidence. It starts at a depth of 2900 km below the surface and extends right up to the center of the earth, at a depth of 6370 km.
- The core remains a mystery in many ways. Within the core, the physical nature and composition of the material is not uniform throughout its depth. Further, it has a very high density at mantle-core boundary, above lOg/cc.
- But despite such a high density, the outer core behaves like a liquid towards the seismic waves.
- The liquid like core extending from a depth of 2900 km to about 4800 km isoften termed as outer core.
- The inner core - starting from 4800 km and extending up to 6370 km is of unknown nature but definitely of solid character and with properties resembling to a metallic body.

• According to a widely favored view, the core may be made up of iron and nickel, alloyed in some yet unknown manner.

2. Briefly explain the process of weathering of rocks and its relevance to engineering geology.(April/May 2015)Reg 2008

Weathering, is a natural process of in-situ mechanical disintegration and/or chemical decomposition of the rocks of the crust of the Earth by certain physical and chemical agencies of the atmosphere.

DISINTEGRATION:

It may be defined as the process of breaking up of rocks into small pieces by the mechanical agencies of physical agents.

DECOMPOSITION:

It may be defined as the process of breaking up of mineral constituents to form new components by the chemical actions of the physical agents.

DENUDATION:

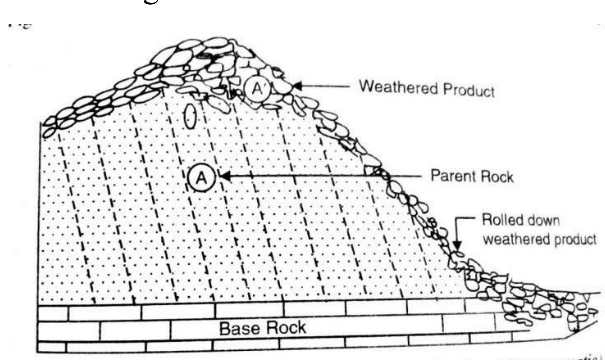
It is a general term used when the surface of the earth is worn away by the chemical as well as mechanical actions of physical agents and the lower layers are exposed.

The process of weathering depends upon the following three factors:

i) Nature of rocks
ii) Length of time
iii) Climate

Two Chief types of weathering are commonly distinguished on the basis of type of agency involved in the process and nature of the end product. They are:

i) Physical or mechanical weathering
ii) Chemical weathering



Explanation of Mechanical (Physical) Weathering (Diagrammatic)

MECHANICAL (PHYSICAL) WEATHERING

- It is a natural process of in-situ disintegration of rocks into smaller fragments and particles through essentially physical processes without a change in their composition.
- A single rock block on a hill slope or a plain, for instance, may be disintegrated gradually into numerous small irregular fragments through frost action that in turn may break up naturally into fragments and particles of still smaller dimensions.
- These loose fragments and particles may rest temporarily on the surface if it is a plain.
- On slopes, however, the end product fragments and particles may roll down under the influence of gravity and get accumulated at the base as heaps of unsorted debris.
- All these fragments and particles, however, have the same chemical composition as the parent rock.
- Mechanical weathering is one of the very common geological processes of slow natural rock disintegration in all parts of the world.
- Temperature variations and organic activity are two important factors that bring about this change under specific conditions.

(A) FROST ACTION

- As is known, water on freezing undergoes an increase in its volume by about ten per cent. This expansion is accompanied by exertion of pressure at the rate of 140 kg/cm (2000 lbs/in on the walls of the vessel containing the freezing water.
- In areas of intensive cold and humid climates, temperatures often fall below the freezing point of water repeatedly during winter months.
- In such areas freezing of water in pots and pools, water pipes and taps and in cavities and cracks in concreted roads causing their bursting and disintegration in many cases is a matter of common observation.
- This process of freezing of water when happening within the pores, cracks, fractures and cavities of rocks affects them considerably.

- The original openings are widened at the first stage of attack and thereby accommodate more and more water to come and freeze in subsequent cycles.

(B) THERMAL EFFECTS (INSOLATION)

- In arid, desert and semi-arid regions where summer and winter temperatures differ considerably, rocks undergo physical disintegration by another phenomenon related to temperature.
- As we know, rocks, like many other solids, expand on heating and contract on cooling. They (rocks) are, of course classed as bad conductors of heat but even then prolonged exposure to direct heating by the Sun does induce appreciable volumetric changes in them.
- Such repeated variations in temperature experienced by a body of rock gradually break it into smaller pieces, especially in the top layers, by development of tensile stresses developing from alternate expansion and contraction.

EXFOLIATION

- In a thick rock body or where the rock is layered, these are the upper layers that get affected most due to the temperature variations.
- As a result, the upper layers may virtually peal off from the underlying rock mass. In many cases such a change is also accompanied by chemical weathering, especially at margins and boundaries of the separated layers, developing curved surfaces.
- This phenomenon of pealing off of curved shells from rocks under the influence of thermal effects in association with chemical weathering is often termed as **exfoliation**.

(C) UNLOADING

- This is another process of mechanical weathering where large-scale development of fracturing in confined rock masses is attributed to removal of the overlying rock cover due to prolonged erosional work of other agencies.
- These rock masses remain confined from sides but due to relief of pressure from above, they expand upwards; consequently joints develop in them parallel to the uncovered surface dividing them into sheets.

- This rupturing or jointing in itself is a mechanical breakdown of rocks and makes them available for further weathering or decay along the joint planes.

CHEMICAL WEATHERING

- It is a process of alteration of rocks of the crust by chemical decomposition brought about by atmospheric gases and moisture.
- The chemical change in the nature of the rock takes place in the presence of moisture containing many active gases from the atmosphere such as carbon dioxide, nitrogen, hydrogen and oxygen.
- As we know, rocks are made up of minerals all of which are not in chemical equilibrium with the atmosphere around them.
- Chemical weathering is, essentially a process of chemical reactions between the surfaces of rocks and the atmospheric gases in the direction of establishing a chemical equilibrium.
- The end product of chemical weathering has a different chemical composition and poorer physical constitution as compared to the parent rock.
- Chemical weathering eats up the rocks in a number of ways depending upon theirb mineralogical composition and the nature of chemical environment surrounding
them.

(A) SOLUTION

- Some rocks contain one or more minerals that are soluble in water to some extent.

Rock salt, gypsum and calcite are few common examples.

- It is also well known that though pure water is not a good solvent of minerals in most cases, but when it (the water) is carbonated, its solvent action for many common minerals is enhanced.
- Thus, limestone is not easily soluble in pure water but carbonated water dissolves the rock effectively. Limestone gets pitted and porous due to chemical weathering.

(B) HYDRATION AND HYDROLYSIS

- These two processes indicate the direct attack of atmospheric moisture on the individual minerals of a rock that ultimately affect its structural make up.
- It is believed that though the interior of many minerals is in electric equilibrium, the surfaces of many crystals are not; they may have partially unsatisfied valences.
- When polarized water molecules come in contact with such crystals, it may cause any one of the following two reactions:
- The ions tend to hold the polarized side of the water molecule and form a hydrate.
- This process of addition of the water molecule is termed as hydration.

Examples are provided by hydration of iron oxides and **calcium sulphate crystals.** In some minerals with ferrous iron, the **Fe++** ion holds the water molecule and forms water-iron complex or a hydroxide.

Similarly, CaSO or anhydrite gets slowly converted to gypsum by hydration:

$$\underset{\text{(Anhydrite)}}{CaSO_4} + \underset{\text{(Water)}}{2H_2O} \longrightarrow \underset{\text{(Gypsum)}}{CaSO_4 2H_2O}$$

- Ions may be exchanged whereby some ions from water may enter into the crystal lattice of the mineral.
- This process of exchange of ions is called hydrolysis.
- It is a very common process of weathering of silicate minerals (which are quite abundant in rocks) and is best explained with reference to weathering of mineral Orthoclase, a feispar.

$$\underset{\text{(Orthoclase)}}{K + Al\,Si_3O_8} + \underset{\text{(Ion from water)}}{H^+} \longrightarrow \underset{\text{Silicic acid like structure}}{H\,Al\,Si_3O_8} + \underset{\text{(Pot, ion)}}{K^+}$$

(C) OXIDATION AND REDUCTION

- Iron is a chief constituent of many minerals and rocks.
- The iron bearing minerals (and hence rocks) are especially prone to chemical weathering through the process of oxidation and reduction. **Oxidation**. Ferrous iron (Fe++) of the minerals is oxidized to ferric iron (Fe+++) on exposure to air rich in moisture. Ferric iron is not stable and is further oxidized to a stable ferric hydroxide:

(*i*) $4Fe + 3\,O_2 \longrightarrow 2Fe_2O_3$

(*ii*) $Fe_2O_3 + H_2O \longrightarrow Fe_2O_3.H_2O$

Reduction. In specific types of environment, such as where soil is rich in decaying vegetation (swamps), minerals and rocks containing iron oxide may undergo a reduction

of the oxides to elemental iron. In this case the decaying vegetation supplies the carbonaceous content causing reduction.

(D) CARBONATION

- It is the process of weathering of rocks under the combined action of atmospheric carbor dioxide and moisture, which on combination form a mildly reacting carbonic acid.
- The acic so formed exerts an especially corrosive action over a number of silicate bearing rocks.
- The silicates of potassium, sodium and calcium are particularly vulnerable to decay undez conditions of carbonation.
- A typical example is that of feispar orthoclase, a very common and important constituent of many igneous, sedimentary and metamorphic rocks, which decomposes according to following reaction:

$$2KalSi_3O_8 + 2H_2O + CO_2 \longrightarrow Al_2Si_2O_5(OH)_4 + K_2CO_3 + 4SiO_2$$

(Orthoclase) + Carbonic acid ⟶ (Kaolinite) + (Pot. Carbonate) + Silica

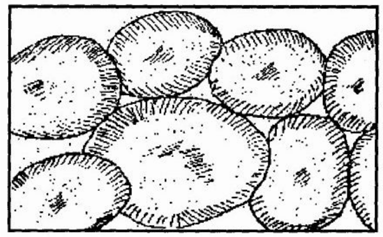
(E) COLLOID FORMATION

- The processes of hydration, hydrolysis, oxidation and reduction operating on the rocks and minerals under different atmospheric conditions may not always end in the formation of stable end products.
- Often they result in splitting of particles into smaller particles- the colloidscharacterized by atoms with only partially satisfied electrical charges. Formation of colloidal particles is especially common in the weathering of clay minerals, silica and iron oxides.

SPHEROIDAL WEATHERING

- It is a complex type of weathering observed in jointed rocks and characterized with the breaking of original rock mass into spheroidal blocks.
- Both mechanical and chemical weathering is believed to actively cooperate in causing spheroidal weathering.

- The original solid rock mass is split into small blocks by development of



parallel joints due to thermal effects (insolation).

- Simultaneously, the chemical weathering processes corrode the borders and surfaces of the blocks causing their shapes roughly into spheroidal contours.

FACTORS AFFECTING WEATHERING

(I) NATURE OF THE ROCK

- Rocks vary in chemical composition and physical constitution.
- Some rocks are easily affected by weathering processes in a particular environment whereas others may get only slightly affected and still others may remain totally unaffected under the same conditions.
- Thus of granite and sandstones exposed to atmosphere simultaneously in the same or adjoining areas having hot and humid climate, the sandstone will resist weathering to a great extent because they are made up mainly of quartz (Si0 which is highly weathering resistant mineral.

(II) CLIMATE

- The process of weathering is intimately related to the climatic conditions prevailing in an area.
- Same types of rocks exposed in three or more types of climates may show entirely different trends of weathering.
- Thus cold and humid conditions favour both chemical and mechanical types of weathering, whereas in totally dry and cold climates, neither chemical nor mechanical weathering may be quite conspicuous (due to absence of moisture).

(III) PHYSICAL ENVIRONMENT

- The topography of the area where rocks are directly exposed to the atmosphere also affects the rate of weathering to a good extent.

- Rock forming bare cliffs, mountain slopes devoid of vegetation and valley sides is more prone to weathering than same rocks exposed in level lands in similar climates and/or under vegetable cover.

3. Describe in detail how earthquakes are caused. Add a note on the earthquake prone belts of India (May/June 2016) Reg 2008

The physical forces the surfaces are rearranging rock materials by shifting magmas about altering the structures of solid rocks. The adjustment beneath the surface however involve various crystal movements, some of which because of suddenness and intensity produce tremors in the rocks and they are known as earthquake. The science dealing with the study of earthquakes in all their aspects is called seismology.

FOCUS AND EPICENTER:

The exact spot underneath the earth surface at which an earthquake originates is known as its focus. These waves first reach the point at the surface, which is immediately above the focus or origin of the earthquake. This point is called epicenter. The point which is diametrically opposite to the epicenter is called anticenter.

INTENSITY AND MAGNITUDE:

Intensity of an earthquake may be defined as the ratio of an earthquake based on actual effects produced by the quakes on the earth. Magnitude of a tectonic earthquake may be defined as the rating of an earthquake based on the total amount of energy released when the over strained rocks suddenly rebound, causing the earthquake.

CAUSES OF EARTHQUAKE:

The earthquake may be caused due to various reasons, depending upon it intensity. Following causes of earthquake are important:

1. EARTHQUAKES DUE TO SUPERFICIAL MOVEMENTS:

The feeble earthquakes are caused due to superficial movements.i.e, dynamic agencies, and operation upon surface of the earth.

- The dashing waves cause vibrations along the seashore.

- Water descending along high water falls, impinges the valley floor and causes vibrations along the neighbouring areas.
- At high altitudes the snow falling down is an avalance.also causes vibrations along the neighbouring areas.

2. EARTHQUAKE DUE TO VOLCANIC ERUPTIONS:

Most of the volcanoes erupt quietly and as consequence, initiate no vibration on the adjoining area. But a few of them when erupt, cause feeble tremors in the surface of the earth. But there may be still a volcanic eruption may cause a severe vibration on the adjoining area and have really disastrous effects.

3. EARTHQUAKE DUE TO FOLDING OR FAULTING:

The earthquakes are also caused due to folding of the layers of the earth's crust. if the earthquakes are caused due to folding or faulting then such earthquakes are more disastrous and are known as tectonic earthquakes and directly or indirectly change the structural features of the earth crust.

MAGNITUDE AND INTENSITY OF THE EARTHQUAKE.

Intensity of an earthquake may be defined as the ratio of an earthquake based on actual effects produced by the quakes on the earth.

Magnitude (M) of a tectonic earthquake may be defined as the rating of an earthquake based on the total mount of energy released when the over strained rocks suddenly rebound causing the earthquake.

CLASSIFICATION OF EARTHQUAKES:

Earthquakes are classified on a no. Of basis. Of these the depth of focus, the cause of origin and intensity are important.

A) DEPTH OF FOCUS:

Three classes of earthquakes are recognized on this basis, shallow, intermediate and deep seated. In the shallow earthquakes the depth of focus lies anywhere up to 50 km below the surface.

The intermediate earthquakes originate between 50 and 300 km depth below the surface.

B) CAUSE OF ORIGIN:

i) Tectonic earthquakes are originated due to relative movements of crystal block on faulting, commonly, earthquakes are of this type.

ii) Non tectonic earthquakes: that owes their origin to causes distinctly different from faulting, such as earthquakes arising due to volcanic eruptions or landslides.

C) INTENSITY AS BASIS:

Initially a scale of earthquakes intensity with ten divisions was given by Rossi and ferel. Which was based on the sensation of the people and the damage caused. However it was modified by Mercalli and later by wood and Neumann.

ENGINEERING CONSIDERATIONS:

The time and intensity of the earthquake can never be predicted. The only remedy that can be done at the best, it is provide additional factors in the design of structure to minimize the losses due to shocks of an earthquake. This can be done in the following way:

- To collect sufficient data, regarding the previous seismic activity in the area.
- To assess the losses, which are likely to take place in furniture due to earthquake shocks
- To provide factors of safety, to stop or minimize the loss due to sever earth shocks.

Following are the few precautions which make the building sufficiently earthquake proof.

- The foundation of a building should rest on a firm rock bed. Grillage foundations should preferably be provided.
- Excavation of the foundation should be done up to the same level, throughout the building.
- The concrete should be laid in rich mortar and continuously
- Masonry should be done with cement mortar of not les than 1:4 max.
- Flat R.CC slab should be provided.

- All the parts of building should be tied firmly with each other.
- Building should be uniform height.
- Cantilivers, projections, parapets, domes etc, should be provided.
- Best materials should be used.

4. Describe in detail, the erosional and depositional landforms formed due to the work of rivers.(November/December 2012)

Write an essay on the geological work of river. (November/December 2014)

Give a detailed account of the erosional and depositional landforms created by the action of a river. (November/December 2014) Regulation 2013

INTRODUCTION

The upper surface of ground water is called water table, may sometimes, at some places, intersect the ground surface, where a spring is originated. The spring water may also become an important source of river.

RIVER

River may be defined as a main stream into which a number of streamlets join. The term stream and river are used synonymously. In the simplest form the geological work of river is to erode the valleys, transport the material thus eroded and deposit the same in the lower reaches at favorable sites.

Types of River

Two types of rivers are distinguished:

- **Perennial River**
- **Intermittent / Non-Perennial River**

PERENNIAL RIVER

The river never gets dry. Throughout the year some water will be flowing in the river. The volume of water may be less in dry season and very high during rainy season.

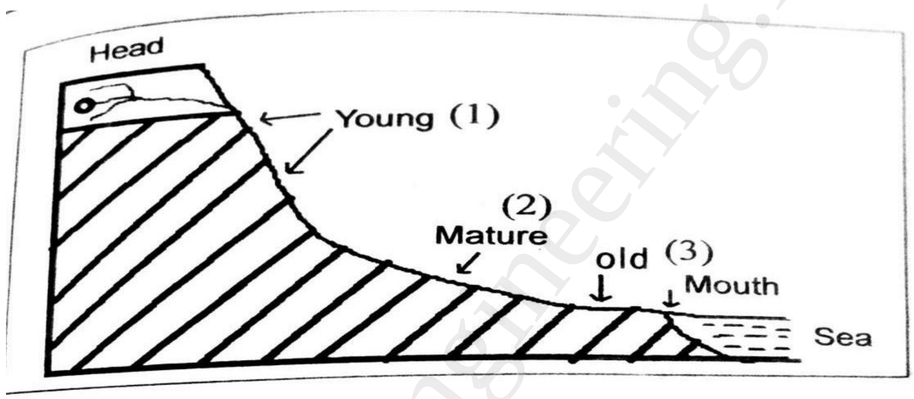
INTERMITTENT / NON-PERENNIAL RIVER

Water flows only during monsoon period in this river and the river becomes dry in summer.

RIVER PROFILE

The longitudinal section of the river starting the place of its origin (mountainous region) to is final destination to the sea is called the river profile. It has two parts.

- **The Head**
- **The Mouth**



River Profile

The mountainous region or high land where from the river originates is called the **Head** region and the place where river enters a sea is called the **Mouth.**

1. **Stages in a River System**
2. **River Erosion**
3. **River Transportation**
4. **Deposition by River**

1. STAGES IN A RIVER SYSTEM

There are **3** stages in the river profile:

- **The young stage**
- **Mature stage**
- **Old stage**

In the youth stage, the river flows along an undulating topography and the gradient is very high. Because of this the river suffers heavy headword erosion and develops valleys.

During mature stage, valley widening begins by latter cutting. A Complex branching system of the river develops and the flow is almost uniform. The reduction in gradient reduces the velocity of the river, resulting in the decrease of erosive power.

In the old stage the river gradient is very gentle and velocity is also less. During this stage, the river loses its erosive power. As a last stage the river merges into the sea forming a delta.

2. RIVER EROSION

GEOLOGICAL WORK / PROCESSES ASSOCIATED WITH RIVER

The Various processes associated with the geological work of running water can be broadly classified into:

- Hydraulic Action
- Abrasion
- Attrition
- Solution and corrosion
- Transportation
- Deposition

1. HYDRAULIC ACTION:

Hydraulic action of a river is defined as the process of breaking down of the rock masses due to the continuous impact of water moving with appreciable velocity along the channel. It is the dominating process of erosion along the upper part of the river course where the gradient is considerable.

2.ABRASION

The Large boulders and pebbles formed due to hydraulic action of the river roll down along the valley floor and move downstream while the smaller fragments travel in suspension or siltation.

Eroded materials which are moved along with the river water may exert considerable rubbing on the bed rock depending on the type of bed rock. **Three** situations may arise depending on the river bed and flowing rock materials.

- Abrasion of the bed rock is more pronounced, if the transported rock-material is hard and the river bed is soft.
- Polishing of the river bed happens if both, river bed and transported rock material are hard.
- On the contrary, if the river bed rock is hard and the moving rock fragments are soft, there will not be any appreciable instead weathered rock waste is eroded away.

3. ATTRITION

The process of mechanical breaking down of the transported rock fragments, due to the impacts and mutual collisions between themselves is described as **Attrition.**

Abrasion and Attrition always work together and produce fine rock particles, which are transported to greater distance.

4. SOLUTION AND CORROSION

A River, during its travel, traverses through a variety of country rocks along its path of travel. The readily soluble carbonate rocks (like lime stone) are attacked most conventionally by running water and are gradually removed in solution.

5. TRANSPORTATION/ RIVER TRANSPORTATION

Amount of solid material transported by a river is referred to as load. River transport comprises of three ways:

- **DISSOLVED LOAD**: It is the load acquired directly from soluble rocks which occur along the steams course. It is also brought to the river by groundwater.
- **SUSPENDED LOAD:** Major portion of the load carried by river is suspended load. Generally small-sized particles such as clay and fine silt travel in suspension.
- **BED LOAD:** Moving water with its forward force acts more directly on the larger grains at the bottom by pushing, rolling and sliding them along the bed.

6. DEPOSITION/ DEPOSITION BY RIVER

Velocity of a river is a major factor which contribute for the flow of river during all stages starting from erosion till deposition. Materials which are thus deposited by rivers are called **alluvium** or **alluvial** deposits.

Materials carried by rivers, while entering a lake, deposit all the coarse particles because of a sudden decrease in velocity. Such coarse material deposits are called **lake deposits**. But the fine grained particles move to the centre of the lake and settle when the water becomes quiet.

Alternate layers are formed with season, and such lake deposits are called **lacustrine deposits**.

Glacial soils transported by rivers from melting of glacial water create deposits of stratified glacial drift and are referred to as **glacio fluvial deposit** or stratified drift.

DEPOSITS & FEATURES / LANDFORMS OF RIVER EROSION:

1. Alluvial fans and cones
2. Flood plains

i)Convex flood plains

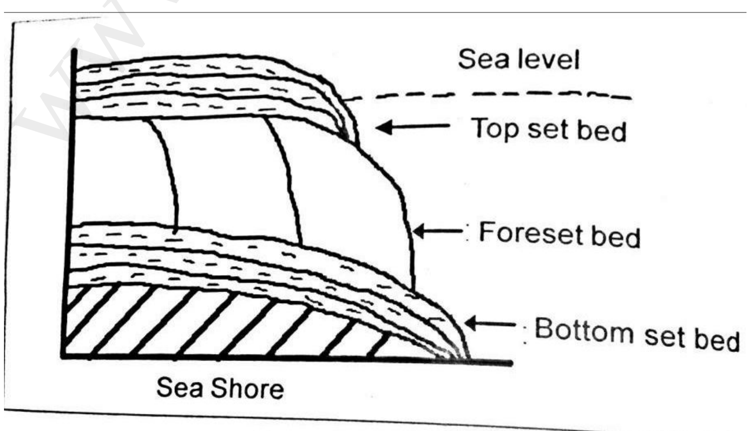
ii)Flat Flood Plains

3. Natural levees
4. Deltas

i) The bottom set beds

ii)The fore set beds

iii)The top set beds



Structure of Delta

LANDFORMS / FEATURES OF STREAM EROSION:

1. Water Falls
2. Pot holes
3. River valley
4. Escarpment
    - i)Hogs back
    - ii)Cuesta
    - iii)Mesa and Butte
5. River Meandering
6. Oxbow Lakes

ENGINEERING CONSIDERATIONS:

1. Deforestation should be stopped
2. Massive afforestation should be promoted.
3. Check dams should be constructed across streams.
4. Additional channels to be provided to the main channel of the river to divert some water.
5. Silt accumulation from river bed should be removed.
6. Future townships may be planned at places away from flood plains.

5. Write an essay on the erosional and depositional features of wind. (May/June 2013)

Describe the work of wind with sketch. (May/ June 2011)

INTRODUCTION

Atmospheric gases are collectively known as Air. Moving air is called wind. The pressure difference created in atmosphere makes the air to move from high pressure area to low pressure area in the form of winds.

The effect of wind erosion depends on wind volume, its velocity, duration of blow and nature of ground surface over which if blows. Hence strong winds blowing over loose ground, dry soils or deserts may create many new surface features.

Blowing wind generally causes erosion by 3 distinct processes known as

- Deflation
- Abrasion
- Attrition

DEFLATION

The process of lifting and removal of loose soil or rock particles during Strom, along the course of blowing wind is known as **Deflation.** Wind deflation is the main process of erosion in desert areas.

FEATURES/LAND FORMS OF WIND EROSION:

Deflation creates the following surface features in deserts

- Blow out and oasis
- Desert pavement
- Hammada
- Dreikanter

1.**BLOW OUT & OASIS:**

Wind deflation creates big depressions by removal of sand in deserts. Sometimes water table may intersect the base of such depressions. such depressions are variously called as **blowouts,** When developed on a small scale with shallow water depth and as **Oasis**, when deeper.

Oasis may be defined as much deeper and extensive depressions intersected by water table and partially filled up with water. often vegetation is found to occur around oasis.

2.DESERT PAVEMENT

Desert pavements are flat rock surfaces covered by rounded or sub rounded pebbles and are the typical features of rock deserts.

3.HAMMADA

It is a bare rock surface (found in desert) from which thin cover of sand has been blown away by strong winds.

4.DREIKANTER

A Dreikanter is a type of ventifact that typically formed in desert or periglacial environments due to the abrasive action of the blowing wind.

WIND ABRASION

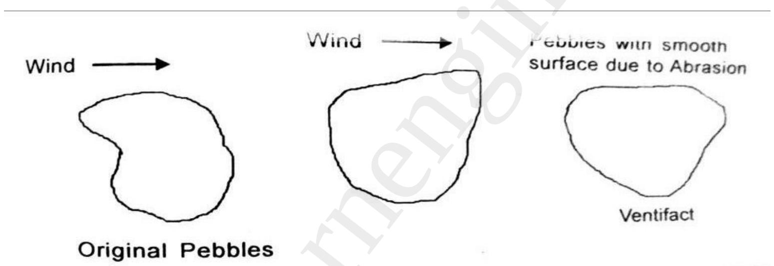
The loose rock particles, which are lifted up and transported by the blowing wind, do always, have a tendency to jump upon and collide with any rock exposures lying along their path of travel. The process of wear and tear of the exposed country-rocks as described above is known as **Abrasion**.

FEATURES OF WIND ABRASION

- Ventifacts
- Pedestal rock
- Yardangs

1. VENTIFACTS

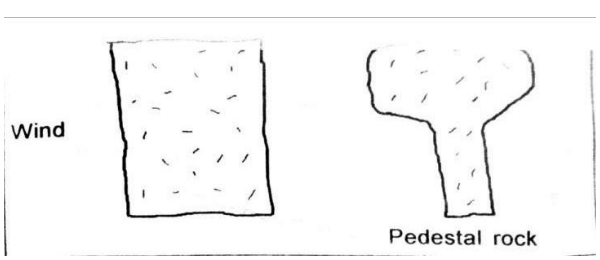
Due to wind abrasion, the exposed irregular surface of a rock mass is gradually converted into a plane, smooth and polished surface. Such pebbles of rock or minerals with smooth, plane and polished surfaces developed due to wind abrasion are called **Ventifacts.**



2.PEDESTAL ROCK/MUSHROOM ROCKS

It has been found that the heavier rock/sand particles travelling along with blowing wind are commonly more concentrated at bottom level. More so the vertical columns of rock exposures are more readily worn out towards their lower portions than at their top.

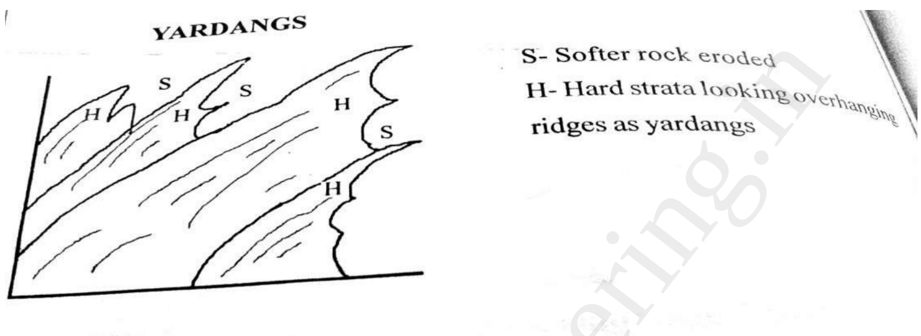
The so formed rock structures having wider tops supported on comparatively narrower bases are called **Pedestal rocks or mushroom rocks.**



3.YARDANGS

Yardangs are formed in areas where rocks of alternate hard and soft nature occur one above the other with gentle slope.

When such rock strata is attacked repeatedly by wind loaded with abrasive sand grains and blowing in the same direction, the softer layers of the strata get abraded quickly, leaving behind harder layers in the form of overhanging ridges, called **Yardangs.**



ATTRITION

The wind borne particles, travelling in suspension, do often have the chance of colliding with one another. Such mutual collision amongst themselves causes a further grinding of the particles and this process of collision between the particles themselves is described as **attrition**

TRANSPORTATION OF ERODED SEDIMENTS

The wind eroded sediments generally include heavier& courser particles such as sand, pebbles, gravels etc. and lighter and finer particles such as silt, clay and dust. These sediments are transported from one place to another by two distinct processes namely

- SUSPENSION
- SALTATION

1.SUSPENSION

The finer particles such as silt, clay, dust etc. are conveniently lifted up in air to higher elevation (level) of wind and they travel in suspension along with the blowing wind due to the turbulence of air currents. This process of transportation of particles is called **suspension**.

2.SALTATION

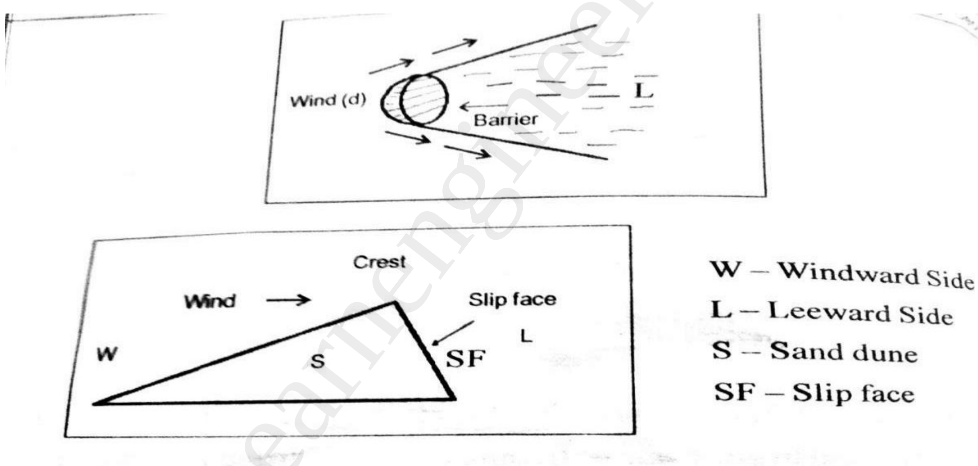
In the case of heavier particles such as sand, gravels etc. transportation takes place due to a forward movement of the grains in a series of jump sand the process is described as **saltation.**

WIND DEPOSITS

The wind borne particles are dropped down and deposited at places where the velocity of the wind is checked. This wind made deposits may ultimately take the shape of landforms. These deposits, formed due to wind erosion are described as **Aeolian deposits.**

There are **two** types of Aeolian deposits.

- SAND DUNES
- LOESS



SAND DUNES

Whenever the velocity of wind is arrested due to the presence of a barrier along its path, the sand particles carried by the wind will be deposited there, forming sand dunes.

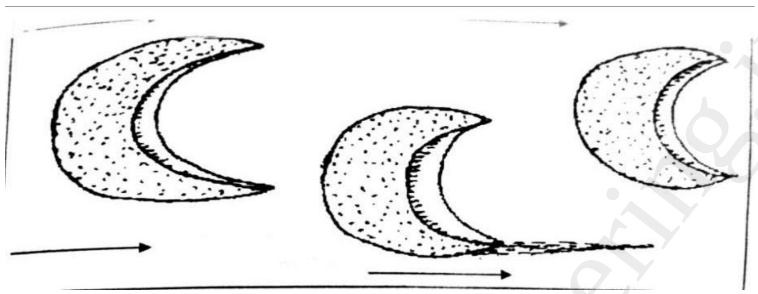
Due to this deviation of wind, a wind shadow zone is formed behind the barrier and it is called **Leeward side** where the velocity of wind is much reduced. Sand dunes are found to have a gentle slope along the wind-ward side and a comparatively steep slope along the **leeward side.**

TYPES OF SAND DUNES

1.BARCHANS

Dunes which are more or less crescent shaped are commonly described as

barchans. Barchans are convex towards the windward side and the tapering horns of the crescent point towards the direction of blow of wind.

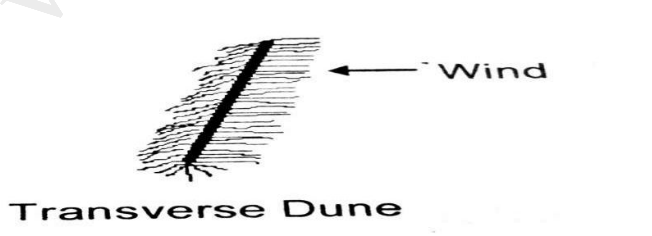


2. FORE DUNES

Fore dunes are ridge like deposits of wind borne sand particles formed along the coasts of sea and lakes.

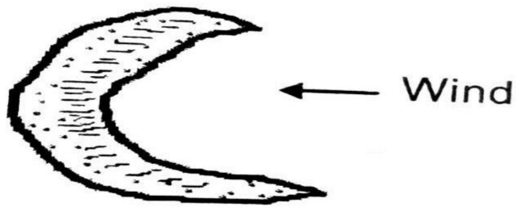
3. TRANSVERSE DUNES

Sometimes ridges of sand accumulate off from the shore line i.e.furher inland,off from the sea and orient themselves across the direction of below of wind. They are known as Transverse dunes.



4. PARABOLIC DUNE

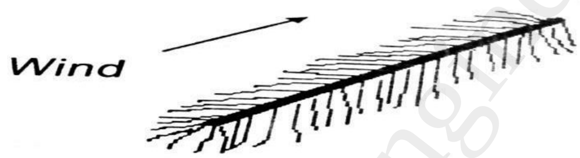
Dunes of parabolic shape are described as **Parabolic dunes.** These dunes have their horns pointing towards the direction opposite to that of the blowing wind.



Parabolic Dune

5. LONGITUDINAL DUNES

In deserts, elongated ridges of sand are sometimes found to occur parallel to the direction of blow of wind. These are known as longitudinal dunes.



Longitudinal Dune

6. SIGMOIDAL DUNE

Sigmoidal dune is having a curved or S-shaped outline with absence of horns.

- **Simple dune** : is a single dune of above types
- **Compound dune**: two or more dunes of same type
- **Complex dune**: group of dunes of different types.

LOESS

It is a wind borne deposit of silt and clay grade particles. It is unconsolidated, unstratified and porous in nature. Particles are of 0.01-0.05mm diameter.

ENGINEERING CONSIDERATIONS

As sand dunes tend to move and travel along the wind direction, they bury agricultural lands and forests. Agricultural lands can be protected by taking the following remedial measures.

- Growing belts of vegetation (coniferous trees) for checking the velocity of the wind.
- Construction of wind breaks or walls around the area
- Treating sands locally with crude oil to reduce their susceptibility of transport

Since loess is unconsolidated, it will settle down quickly and create foundation problems.

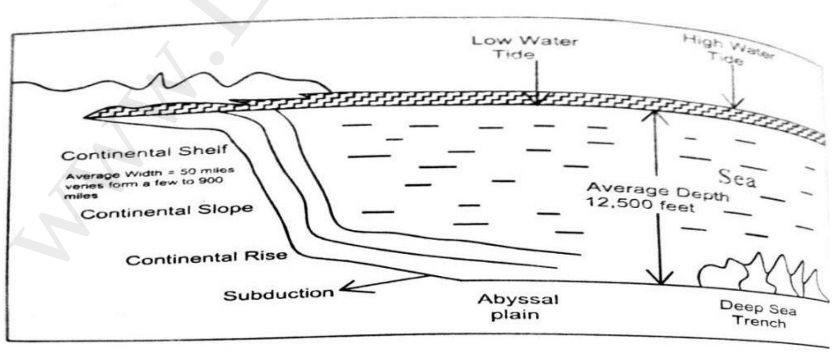
6. Explain in detail about working of sea with their engineering importance with neat sketch.(November/December 2013)

Give a detailed account of the geological work of the sea. Add a note on importance of geology in coastal engineering.(April/May2015)

INTRODUCTION

The continuous and extensive bodies of water encircling the greater part of the earth's surface, covering nearly three fourths of the landmass are described as the **oceans and seas**.

DEPTH ZONES IN SEA



GELOGICAL WORK OF OCEAN AND SEA/ (PROCESSES ASSOCIATED WITH SEA)

- **Hydraulic action**
- **Abrasion**

- **Attrition**
- **Solution**
- **Transportation and Deposition**

HYDRAULIC ACTION

The process of gradual breaking down of the rock masses, due to the hydraulic pressure of the impinging water is known as **hydraulic action.**

ABRASION

The process of wear and tear of the country rocks of the shore, due to the continuous impact of already broken fragments travelling with the advancing waves is known as **abrasion**

ATTRITION

The process of mutual collision between the rock fragments themselves is known as attrition which brings about further reduction in size of the individual rock fragments**.**

SOLUTION

The rocks having some soluble constituents attacked by waves, along the shore. This solvent action of sea water is generally much less pronounced than hydraulic action and abrasion.

TRANSPORTATION AND DEPOSITION

The products of marine erosion are transported by the waves and currents and deposited suitably upon the ocean floor.

- Long shore currents always shift the rock debris parallel to the shore line
- Marine sediments are generally well sorted.
- These sediments are collectively known as **marine sediments.**

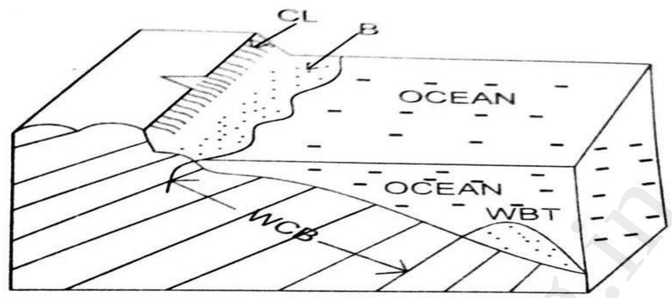
FEATURES AND LANDFORMS DEVELOPED BY MARINE EROSION

- **Shore profile**
- **Shore lines**
- **Spits and bars**
- **Oozes**
- **Islands**

- **Tombolo**

1.SHORE PROFILE

The erosional and depositional activities of waves and currents give rise to a characteristic shore profile, by grading the shore zone.



SHORE PROFILE

CL : Wave-cut cliff B : beach
WCB : Wave - cut bench WBT : Wave built terrace

The shore profile is made up of 4 erosional features.

- **Wave-cut cliff**
- **Beach**
- **Wave-cut Bench**
- **Wave Built Terrace**

I) WAVE-CUT CLIFF

The dashing waves and breakers gradually erode the land masses forming the coast, going rise to a vertical or steeply sloping strip of land features called Wave-cut cliff, showing seaward slope.

II) BEACH

With transgression of sea further inland, the cliff is worn out and the products of its decay are spread upon the shore forming a beach.

III) WAVE-CUT BENCH

The shore line shifts further inland and the adjacent stretch of shallow marine water is found to move to and fro upon a basement which is known as Wave- cut bench

IV) WAVE BUILT TERRACE

The Waves and currents move the rock debris and waste away from the beach and gradually drop them down along the sea-ward side of the beach, forming what is known as a wave built terrace.

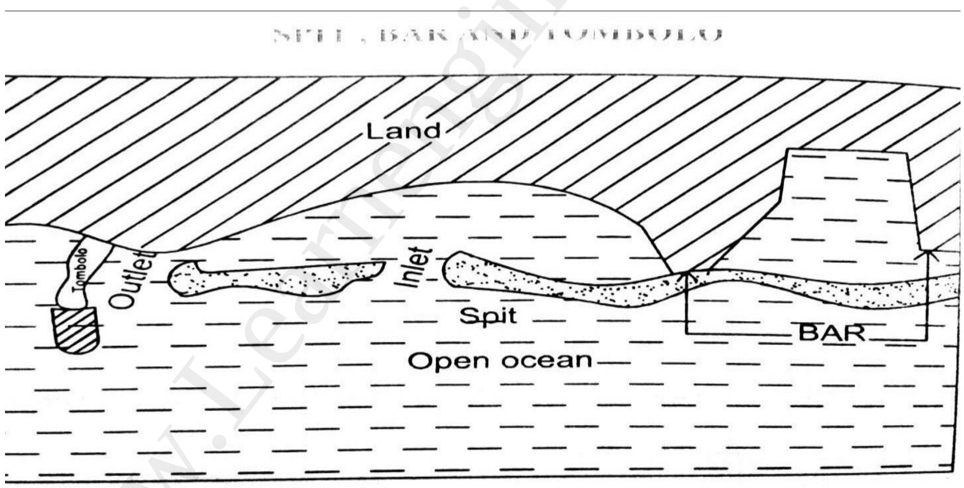
2. SHORE LINES

The border line which separates the continental land mass from the sea or ocean is called a shore line**.**

- Shore lines of emergence
- Shore lines submergence
- Compound or complex shore lines
- Neutral shore lines

3. SPITS AND BARS

The rock debris are sometimes happened up in the form of a ridge, running parallel to the shore line. These ridges visible above sea level in the long run are called **spits.** with more depositional activities, spits grow in dimension and connect themselves with coastal tracts, giving rise to **Bars** which contain a portion of marine water**.**



4. OOZES

The finest particles like silt and clay are transported by waves and under toe currents and dropped down at greater distances away from the shore, say the deep sea basin. These sediments of deep sea basin are of organic or inorganic origin and are called **oozes**.

- **Oozes of organic origin**
- **Radiolarian oozes**

- **Foraminiferal oozes**
- **Diatomaceous oozes**
- **Oozes of inorganic origin**

5. ISLANDS

The isolated land masses, occurring within the extent of oceans and seas with their all sides surrounded by sea water are described as islands

- **VOLCANIC ISLANDS**
- **CONTINENTAL ISLANDS**
- **CORAL ISLAND**

VOLCANIC ISLANDS

They are formed due to accumulation of lava upon the ocean floors, due to eruption of volcanoes.

E.g The Hawaiian Isands in Pacific Ocean

CONTINENTAL ISLANDS

The land masses which were, once, parts of the continents and have been cut off from them, due to marine erosion or crustal movements are called **continental islands.**

E.g Srilanka, Japanese and British Isands.

CORAL ISLAND

Coral islands are formed due to the accumulation of calcareous remains of marine organisms, known as Corals, upon the submarine banks or around the existing islands.

There are 3 common types of coral islands or reefs.

- **FRINGING REEFS**
- **BARRIER REEFS**
- **ATOLL**

FRINGING REEFS

The reefs which occur in contact with the fringes of the existing islands and found totally encircling them are known as **Fringing reefs.**

BARRIER REEFS

They encircle the islands, no doubt, but necessarily lie off from them, leaving a strip of marine water in between the reef and the enclosed island.
E.g Great Barrier Reef of Australia.

ATOLL

When a coral reef, occurring more or less in the form of a ring, encloses only a body of comparatively shallow marine water, it is known as an atoll.
E.g. Lakshadweep and Maldives in Arabian sea

6.TOMBOLO

Tombolo is a form of marine deposit that connects a head land and an island with another island.

ENGINEERING CONSIDERATIONS

India has longest coast line, extending over 7,000km.Erosion of coast line occurs in parts of Tamilnadu, Andhra Pradesh, Karnataka, Maharashtra, West Bengal and more severely along Kerala coast.

Hence, coastal protection measures should be necessarily taken for the safety of our nation.

There are **two** types of **coastal protection** techniques available.

- **STRUCTURAL**
- **NON- STRUCTURAL**

i) STRUCTURAL METHODS OF COASTAL PROTECTION

In this method of coastal protection, sea walls are constructed along the highly erodible sea coasts to reduce the wave action.

ii) NON-STRUCTURAL METHODS OF COASTAL PROTECTION

1.Grass Dykes- It is designed and laid along the coast. This grass dykes with stand even 30 hours of wave attack**.**

2.Beach Nourishment- This is the process of adding beach materials at the upper coast level.

3.Sand Dune Reconstruction – This is the process of storing sand in the dunes and re-bridging the dune ridge, after the strom crosses over**.**

7. Describe the geology of ground water and its importance in civil Engineering. (November/December 2014) (16 mark)

Write short notes on Ground water mode of occurrence (November/December 2014) (8 mark)

Ground water is a very powerful agent like river for creating various geological features upon or below the surface of the earth.

- **Chemical work due to corrosion**
- **Mechanical work**
- **Molecular Replacement**
- **Deposition by Precipation**

1. CHEMICAL WORK DUE TO CORROSION

When ground water comes into contact with lime stones, dolomites, gypsum, etc. during its underground flow, it becomes carbonated.

- Climate
- Geological structures
- Composition of rock and Ground water
- The porosity and Permeability of rocks
- Flow Velocity of ground water
- Temperature and Pressure
- Depth of Ground water contact.

LANDFORMS BY SOLVENT ACTION

KARST TOPOGRAPHY

Karst Topography is an important land feature developed due to the solvent action of sub surface water and was first studied in KARST region of YUGOSLAVIA.

2. MECHANICAL WORK

The ground water is subject to movement due to gravity and its hydrostatic head. But its velocity is much less than that of surface water. Due to its movement, it mechanically lubricates the surface of rocks, rendering them becoming weaker, leading to sliding and failure of slopes.

3. MOLECULAR REPLACEMENT

When ground water percolate through a wood fossil, the wood cells may be replaced by silica molecules carried by ground water, converting the wood fossil into **silicified wood**

4. DEPOSITION BY PRECIPATION

- Calcite, Silica, Fluorite, Barite, etc are some of the mineral deposits formed by precipitation from ground water.
- **Stalactites and Stalagmites** are the most common cave deposits, formed due to dripping of ground water in lime stone caverns and hence they are called **drip stones.**

DRIP STONES

Thus the various land forms and features formed due to ground water action and its dripping are:

- **KARST TOPOGRAPHY**
  - Domelins
  - Solution Cavities
  - Blind Valleys
- **LAND SUBSIDENCE**
- **SILICIFIED WOOD**
- **STALACTITES**
- **STALAGMITES**

UNIT II

PART A

1. WRITE THE MOH'S SCALE OF HARDNESS (MAY/JUNE 2016)

A numerical value is obtained by using the moh's scale of hardness.

Hardness	MINERAL
1	Talc
2	Gypsum
3	Calcite
4	Fluorite
5	Apatite
6	Orthoclase
7	Quartz
8	Topaz
9	Corundum
10	Diamond

2. DIFFERENCE BETWEEN STREAK AND COLOUR OF MINERAL (APRIL/MAY 2015)

Streak- Colour of finely powdered mineral as obtained by rubbing a mineral against an unglazed porcelain plate. Example: **Magnetite**, black in colour and give blackish brown colour as streak.

- **Colour-** Occur due to certain wavelength of light by atoms making of crystals
- **Idiochromatic**: show a constant colour appear metallic crystal ex. **Copper**
- **Allochromatic**: Show variable colors, appear non-metallic ex. **Quartz**
- **Pseudochromatic:** Shows false colour**,** when rotated

3. DIFFERENCE BETWEEN CLEAVAGE AND FRACTURE OF MINERAL (MAY/JUNE 2016)

Description	cleavage	fracture
Definition	It is defined as a tendency of mineral to break along	defined as the appearance of broken surface of mineral in a

	certain definite direction.	direction other than that of cleavage.
Types	Basal Cleavage Prismatic Cleavage Cubic cleavage	Even Fracture Uneven Fracture Conchoidal Fracture
Eg.	Muscovite Hornblende	Chert Chromite Quartz

4. LIST FOUR EXAMPLES OF CLAY MINERAL (APRIL/MAY 2015)

- Kaolinite
- Illite
- Montmorillonite
- Bentownite

5. LIST THE USES OF MICA. (NOV/DEC 2014)

- Used in paint as a pigment extender and also helps to brighten the tone.
- Its shiny and glittery appearance makes it use for cosmetics.
- Used in insulator in electronics.

6. WHAT ARE THE VARIETIES OF PLAGIOCLASE FELDSPAR? (NOV/DEC 2014)

- Albite
- Oligoclase
- Anorthite
- Andesine

7. WHAT ARE THE TYPES OF MICA (NOV/DEC 2015)

- **Light mica**- Muscovite
- **Dark mica**- Biotite

8. BRING OUT THE DIFFERENCE BETWEEN MUSCOVITE AND BIOTITE. (NOV/DEC 2014)

Physical properties	MUSCOVITE	BIOTITE
Crystal System	Monoclinic	Monoclinic
Cleavage	Eminent, basal	Perfect and basal
Streak	Colourless	Colourless
Hardness	2.5 - 3	2.5 - 3

9. WRITE THE PROPERTIES OF MICA (MAY/JUNE 2014)

- Monoclinic system
- Perfect basal cleavage
- Low hardness between 2 to 3
- Vitreous Lustre
- Platy crystal

10. DISTINGUISH BETWEEN AUGITE AND HORNBLENDE (MAY/JUNE 2014)

Physical properties	AUGITE	HORNBLENDE
Crystal System	Monoclinic	Monoclinic, crystal long, slender and prismatic
Cleavage	Prismatic	Perfect, Prismatic
Lustre	Commonly vitreous	vitreous
Hardness	5 to 6	5.5to 6

11. DEFINE MINEROLOGY.

Mineralogy is the branch of geology which deals with the formation, occurrence, properties and uses of minerals.

12. WRITE THE PROPERTIES AND USES OF CALCITE (MAY/JUNE 2012)

Properties

- Rhombohedral crystal system

- Perfect cleavage
- Hardness- 3
- Vitrous lustre

Uses

- Used in cement manufacturing
- Variety of calcite is used in optical instrument

13. WRITE THE IMPORTANT MINERALS FROM FELDSPAR GROUP AND THEIR USES. (APRIL/MAY 2015)

Important minerals

- Orthoclase
- Microcline
- Sanidine
- Plagioclase

Uses

- Used as ceramics
- Used as refractories

PART B

1. What are the various physical properties of minerals? Give example for each and explain them in detail. (may/ june 2012, nov/dec 2013)

a) COLOUR

Occur due to certain wavelength of light by atoms making of crystals. On the basic of color of a mineral may belong to anyone of three types,

- **Idiochromatic**: show a constant colour appear metallic crystal ex. **Copper**
- **Allochromatic**: Show variable colors, appear non-metallic ex. **Quartz**
- **Pseudochromatic:** Shows false colour**,** when rotated

b) LUSTRE

It is the Shine of mineral due to intensity of reflection of light from its surface.

It depends on

- The nature of reflection surface

- ➢ The light absorption capacity of minerals.
- ➢ The refractive index of mineral
- **Vitreous Lustre**: glassy shine Eg. Quartz, gypsum
- **Pearly Lustre**: Pearly shine Eg. Muscovite
- **Silky Lustre**: silky shine Eg. Asbestos
- **Metallic Lustre**: Metallic shine Eg.Magnetite

c) STREAK- Colour of finely powdered mineral as obtained by rubbing a mineral against an unglazed porcelain plate

❖ Example: **Magnetite**, black in colour and give blackish brown colour as streak

d) CLEAVAGE- It is defined as a tendency of mineral to break along certain definite direction. It is a plane of weakness with least cohesion.

Types of cleavage are

Basal Cleavage- One set of Cleavage- **Muscovite**

Prismatic Cleavage- two set of Cleavage-**Hornblende**

Cubic cleavage- three set of Cleavage at right angle to each other- **Galena**

e) FRACTURE- defined as the appearance of broken surface of mineral in a direction other than that of cleavage. The types are

- ❖ **Even Fracture**- broken surface is smooth – **Chert**
- ❖ **Uneven Fracture**- broken surface is rough – **Chromite**
- ❖ **Conchoidal Fracture**- broken surface is curved- **Quartz**

f) TENACITY- The behavior of mineral towards the force that tend to break, bend, cut or crush . The types are

- ❖ **Sectile**- cut with knife - **talc**
- ❖ **Malleable**- flatten into sheet- **silver**
- ❖ **Brittle**- crumbles to powder- **Quartz**

g) HARDNESS- Hardness of mineral depends on chemical composition. Determined by rubbing or scratching a mineral of unknown hardness against one of known hardness A numerical value is obtained by using the moh's scale of hardness.

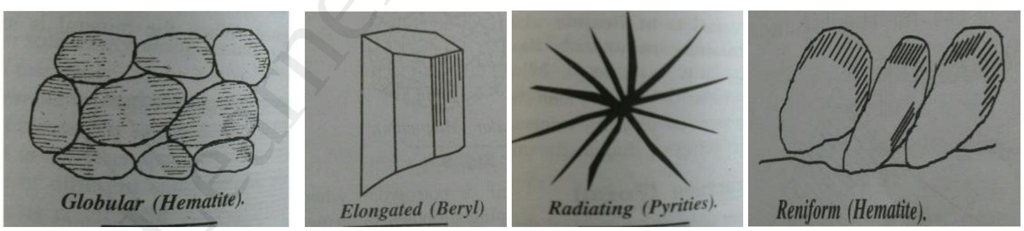
Hardness	MINERAL
1	Talc
2	Gypsum
3	Calcite
4	Fluorite
5	Apatite
6	Orthoclase
7	Quartz
8	Topaz
9	Corundum
10	Diamond

h) STRUCTURE- the physical make up of the mineral.

Tabular – mineral in flattened form. **Calcite**

Elongated – thin or thick elongated. **Quartz**

Lamellar- mineral with leaf like sheets. **Vermiculite**



2. Describe the classification and physical properties of quartz family. (may/june 2014)

QUARTZ GROUP

a)Polymorphous transformation

Quartz when heated transforms into high temperature modification as follows.

Quartz 870°c → tridymite 1470°c → cristobalite 1713°c → Melt

Quartz has two polymers

- alpha quartz
- Beta quartz

b) Right handed and left handed quartz

Classified based on typical forces such as trigonal, trapezohedron and dipyramid. In left handed quartz, these faces are located on left side of upper edge of prism. In right handed quartz these occur on right upper edge of crystal.

c) Coloured Varieties

Pure quartz is colourless transparent mineral presence of impurity give colour.

Amethyst- purple or violet

Smoky – dark to light brown

Milky – pure white

d) Cryptocrystalline Types

- **Chalcedony**- Lustre waxy
- **Agate** – opaque
- **Flint** – Dull opaque

e) Occurrence : Occur in all types of rocks like igneous, sedimentary (sandstone) and metamorphic rocks (gneisses).

Physical Properties

Crystal System	Hexagonal
Cleavage	Generally absent
Color	Colourless when pure; occurs in colored varieties red, green, blue
Fracture	Conchoidal
Lustre	White in colored varieties
Streak	Vitreous
Hardness	7
Specific Gravity	2.65 to 2.66
Composition	SiO_2
Occurrence	Igneous rock
Use	Manufacturing glass, optical instruments

3. GIVE SALIENT FEATURES AND MENTION IMPORTANT PROPERTIES OF FELDSPAR GROUP (MAY/JUNE 2016)

a) Feldspar Group

The feldspar are the most prominent group of minerals making more than 50% by weight, crust of earth upto depth of 30km.Mostly they occur in igneous rocks and metamorphic rocks. Some sedimentary rocks like arkose and greywacks.

b) Chemical Composition

Feldspar are chiefly aluminosilicate of Na, K and Ca.

WZ_4O_8, **W**= Na, K, Ca , **Z**= Si and Al, **$NaAlSi_3O_8$, $KAlSi_3O_8$**

c) Atomic Structure

Feldspar show a continuous 3D notwork type of structure in which SiO_4 tetrahedra are linked at all corners,each oxygen ion being shared by 2 adjacent teterahedra.

d) Crystallization

The crystallographic systems are monoclinic and triclinic.

e) Classification

Classified based on chemical composition and mode of crystallisation.

Chemical composition		**Mode of crystallisation**	
Types	**Eg:**	**Types**	**Eg:**
Potash Feldspar	Orthoclase	Monoclinic	Orthoclase
Sodalime Feldspar	Albite	Triclinic	Microcline

f) Physical Properties

They are generally light in colour, have low specific gravity, double cleavage and hardness varying between 6 to 6.5

Physical properties	**ORTHOCLASE**	**MICROCLINE**	**ALBITE**	**ANORTHITE**
Crystal System	Monoclinic, occur in prismatic shapes	Triclinic, resembles closely with orthoclase	Triclinic	Triclinic

Cleavage	Show cleavage in two directions. Cleavage angle is 90^0	cleavage in two directions	cleavage in two directions	Present in two direction
Colour	Various shades of red and pink	Greenish felspar	Commonly whitish or pinkish white	Generally white; also occur in reddish and light grey shade.
Lustre	Vitreous to semi-vitreous	-	Vitreous to pearly	semi-vitreous
Streak	-	Colourless	Colourless	Colourless
Hardness	6 – 6.5	6 – 6.5	6 – 6.5	-
Specific Gravity	2.56 to 2.58	2.54 to 2.57	2.60 to 2.62	-
Composition	$KAlSi_3O_8$	$KAlSi_3O_8$	$NaAlSi_3O_8$ 100 - 90 %	$CaAl_2Si_2O_8$, 100 - 90 %
Optical	Optically negative	Optically negative	Optically positive	Optically negative
Occurrence	Found in Igneous rocks, especially granite	In coarse grained igneous rock	igneous rock such as granites	Igneous rock

Economic Use	Used as ceramic material	Used as ceramic material. As a semi Precious stone	Used as ceramic material. As a ornamental stone in polished form	-
Varieties	Adularia, Sanidine	Anorthoclase	-	Plagioclase Felspar

4. EXPLAIN AMPHIBOLE GROUP OF MINERALS. (MAY/JUNE 2016)

This group of mineral is regarded as parallel to pyroxene group

a)Chemical Composition

These minerals are mete-silicates.The metallic ions present in amphiboles are Ca,Mg, Fe and Na. $[Si_4O_{11}]_2[OH]_2$.

b)Atomic Structure

In amphibole, the SiO_4tetrahedra are linked in double chain.

c)Crystallization

The amphiboles are long, slender and prismatic. The prism angle is 124^o. Crystallize in two systems orthorhombic and monoclinic.

d)Classification

Orthorhombic Amphibole	**Monoclinic Amphibole**
Anthophyllite	Tremolite Hornblende

e)Physical Properties

Most of them dark in color. Hardness between 5to 6 and specific gravity between 2.8 and 3.6. Their crystals are elongated, slender and fibrous in nature.

Physical properties	HORNBLENDE
Crystal System	Monoclinic, crystal long, slender and prismatic
Cleavage	Perfect, Prismatic
Colour	Dark green, Dark brown, black
Lustre	vitreous
Streak	White with greenish tint
Hardness	5.5to 6
Specific Gravity	3 to 3.47
Composition	Highly variable and complex; broadly an aluminous amphibole
Optical	Optically negative
Occurrence	Rock forming mineral found in Igneous and metamorphic rocks like andesite.
Varieties	About half a dozen varieties of hornblende depending on chemical composition

5. GIVE AN DETAILED ACCOUNT OF THE MINERALOGICAL COMPOSITION, ENGINEERING PROPERTIES, BEHAVIOUR AND USES OF CLAY MINERALS (NOV/DEC 2012)

CLAY MINERAL:

- Clay mineral are mainly formed due to alterations or decomposition of pre-existing silicate minerals.

- Eg: Kaolinite clay mineral is formed by the breakdown of feldspar by the action of Water and CO_2
- Clay are also formed by hypothermal activity.

Varieties of clay material and their Chemical compositions:

- All clay minerals are basically hydrous silicates.
- Some may have little potassium, magnesium, sodium, iron etc.

Clay Minerals are

1.Kaolinite

2. Illite

3. Montmorillonite

4.Bentownite

ENGINEERING PROPERTIES OF CLAY

i)Porosity

It is defined as the ratio of pore spaces present in the sample to the total volume of sample.

n=v/V *100

ii)Permeability

The capacity of strata to transmit water through it is called permeability.

iii)Consistency of soil

Consistency denotes degree of firmness of soil and it is related to water content.

It is described under

a)Liquid limit

b)Plastic Limit

c)Shrinkage Limit

d)Plasticity Index

iv) Activity of clay

It is defined as the ratio of plasticity index to percentage weight of soil particles of diameter less than 2 microns.

v) Shear strength

It is the resistance to deformationby continuous shear displacement of soil particles.

BEHAVIOUR OF CLAY

Swelling property during rainy season.

Shrinkage during hot season

PHYSICAL PROPERTIES

(i)Bentonite Clay: Formed by alteration of volcanic ash. Mainly has montmorillonite. Used in drilling wells and cosmetic preparation

(ii)China clay: Variety of kaoline clay does not swell with addition of water. White in colour. Useed in the manufacture of crockery.

(iii)Ball Clay: Has large Silica Content. Has high Plasticity. Used in ceramic.

(iv) Fire clay:It has good plasticity, color is white, grey or black. Used in manufacture of acid refractory bricks

Physical properties	**Clay minerals**
Crystal System	Monoclinic and triclinic
Colour	Colorless, grey, brown
Lustre	Dull and earthy
Streak	White
Hardness	2
Specific Gravity	2.6
Composition	Hydrous aluminium silicate
Form	Massive earthy
Occurrence	Alternate products of alkali feldspar
Uses	Used in the manufacture of bricks, tiles and ceramics etc

ATOMIC STRUCTURE IN CLAY MINERALS/ MINEROLOGICAL COMPOSITION

- The clay Minerals possess sheet structure and crystallize under the monoclinic crystal system
- The basic structural units of most of the clay minerals consists of silica tetrahedron
- Various clay minerals are formed by stacking of combination of the basic sheet structures with different forms of loading between the combined sheets
- In kaolinite clay, mineral limited isomorphism substitution take place and the combined silica are held together fairly tightly by hydrogen bonding.
- A Kaolinite particle consists of 100 stacks of silica and alumina sheet.
- In an Illite clay mineral one alumina sheet is combined with two silica sheet
- In the montmorillonite clay the basic structure is same as illite in which alumina sheet is partial substitution of aluminium by magnesium. The spare between the combined sheet is occupied by water.
- Swelling of Montmorillonite occurs.

USES OF CLAY MINERALS

- Used in making bricks.
- Used in ceramics.
- Used as filtering and deodorizing agents in the refining of petroleum
- Used in purifying sewage.

6. EXPLAIN IN DETAIL ABOUT PYROXENE AND MICA GROUP

a) Pyroxene Group

Important rock forming minerals. They occur in good abundance in dark coloured igneous and metamorphic rocks.

b)Chemical Composition:

Pyroxene are ferro-magnesion silicates.

$RSiO_3$ where R= Ca, Na, Al and Li

c)Atomic Structure

Single chain structure of silicates. The silicon-oxygen tetrahedron are linked together at one of oxygen atoms.

d) Crystallization

Crystallize in two system such as orthorhombic and monoclinic. The prism angle is 87° and 93°.

e)Classification

Orthorhombic pyroxene		Monoclinic pyroxene	
Types	**Eg:**	**Types**	**Eg:**
Enstatite	$MgSiO_3$	Diopside	$FeSiO_3$
Hypersthene	$MgSiO_3$	Augite	-

f) Physical Properties

They are generally dark in colour, their hardness varies between 5 and 6. Specific gravity from 3 to 3.3. Pismatic cleavage is possible.

Physical properties	HYPERSTHENE	AUGITE
Crystal System	Orthorhombic	Monoclinic
Cleavage	Prismatic	Prismatic
Colour	Green, Olive green to greenish black	Occurs in shades of grayish, green and black
Lustre	Pearly to vitreous	Commonly vitreous
Streak	grey	-
Hardness	5 - 6	5 to 6
Specific Gravity	3.4 - 3.5	3.25 to 3.55
Composition	$MgSiO_3$	A complex Fe-Mg silicate
Optical	Optically negative	Optically positive

Occurrence	Found in valconic Igneous rocks like andesite.	Ferro-magnesium mineral of igneous rock.

MICA GROUP

The structure is micaceous and it can be split into very thin sheets along one direction. It consist of SiO_4 tetrahedron linked at three of their corners and extending in two dimension. The sheets are held together in pain bimetallic ions. The cleavage present is eminent. Mica are beside feldspar, pyroxene and amphibole and forms 4 percent of crust of earth.

Chemical composition

They are silicates of aluminium and potassium containing one or more of hydroxyl group, magnesium, iron etc.

Atomic Structure

Sheet structure in atomic constitution. The basic unit of silicates, SiO_4 tetrahedron are linked at their three corners resulting in Si:O ratio of2:5, when extend in 2 direction results in sheet of SiO_4-tetrahedra.

Crystallization

Monoclinic System.

Classification

Light mica	**Dark Mica**
Muscovite	Biotite
Paragonite	Zinwaldite

Physical properties

- Perfect basal cleavage
- Low hardness between 2 to 3
- Vitreous Lustre
- Platy crystal

Physical properties	MUSCOVITE	BIOTITE
Crystal System	Monoclinic	Monoclinic
Cleavage	Eminent, basal	Perfect and basal
Colour	Colourless in thin sheet; as a mass appear pale yellow	Black and deep green
Lustre	Vitreous; pearly on cleavage face	-
Streak	Colourless	Colourless
Hardness	2.5 - 3	2.5 - 3
Specific Gravity	2.7 – 3.1	2.7 – 3.1
Optical	negative	negative
Occurrence	Commonly present in sedimentary rocks	Commonly found in igneous and metamorphic rocks
Economic Use & Varieties	Good electrical insulator and used in electrical industry as a fire proof	-

7. GIVE AN DETAILED ACCOUNT ON GYPSUM AND CALCITE

It is a sedimentary rock. The composition is $CaSO_4.2H_2O$. Its color is white but may also occur in other shades such as yellow, red or dark grey due to impurities. Gypsum is forms as a result of evaporation from sea water rich in sulphate salts. Hydration of anhydrite results in gypsum. Anhydrite is a granular aggregate of mineral anhydrite $CaSO_4$. The uses are

- ✓ Used as a raw material in the manufacture of fertilizer.
- ✓ Used as an essential ingredient in the manufacture of cement.
- ✓ in the manufacture of plaster of paris.
- ✓ As fire proofing component of gypsum board.

Physical properties	**GYPSUM**	**CALCITE**
Crystal System	Monoclinic	Hexagonal-Rhombohedral
Cleavage	Perfect	Highly Perfect
Lustre	pearly	Vitreous
Hardness	2	3
Specific Gravity	2.3	2.71
Tenacity	Sectile	Brittle
Form	Fibrous; Foliated	Pure calcite is white and transparent.

UNIT III

PART-A

1. DISTINGUISH BETWEEN GRANITE AND MARBLE ROCK (AUC APRIL/MAY 2010)

Rock may be defined as plutonic light colored igneous rocks. These are among the most common igneous rocks. The work granite is derived from Latin word geranium meaning a grain and obviously refers is the equigranular texture of the Marble is a Essentially a granular metamorphic rock composed Chiefly of recrystallized calcite. It is a Characterized by a Granular Structure but the Grain Size shows

2. LIST THE VARIOUS TYPES OF SEDIMENTARY AND METAMORPHIC GROUP.(AUC APRIL/MAY 2010)

Sedimentary group3

- Sandstone
- limestone
- Shale Congo
- Ganglomerate

Metamorphic group

- Quartzite
- Marble
- Slate
- Phyllite

3. WRITE ABOUT THE MINERAL COMPOSITION, ORIGIN AND PROPERTIES AND USES OF BASALT (AUC NOV/DEC 2009)

Basalts are volcanic igneous rocks formed by rapid coding from lava flows from volcanoes either over the surface (or) under water on oceanic floors.

COMPOSITION:

Basalts are commonly made up of calcic plagioclase feldspars and a number of Ferro – magnesium minerals like Augite, hornblende. In fact many types of basalts are distinguished on the basis of the type and proportion of Ferro magnesia minerals in them.

OCCURRENCE:

The basaltic rocks form extensive lava flows on the continents and also on the oceanic floors in almost all the regions of the world.

4. BRING A SHORT NOTE ON DOLERITE (AUCNOV/DEC2009)

It is an intermediate type of igneous rock of plutonic origin with silica percentage generally lying between 52 – 66 %.

COMPOSITION: There are typically rich in feldspar plagiocose of zodiac group, diorites also contain accessory minerals like hornblende, biotite and some pyroxenes.

TEXTURE: In texture, diorites show close resemblance to granites and other plutonic rocks. They are coarse to medium grained and holo-crystalline.

OCCURRENCE: Diorite commonly occurs as small intrusive bodies like dikes, sills, stocks and other irregular masses.

5. GIVE A BRIEF DESCRIPTION OF LIMESTONE (AUC NOV/DEC 2011)

These are the most common sedimentary rocks from the non clastic group and are composed chiefly of carbonate of calcium with subordinate proportions of carbonate of magnesium.

TEXTURE:

- Fossiliterous nature
- Dense and compact texture

TYPES:

Following are common types of limestone’s:

1. Chalk:

2.Shelly limestone:

3.Argillaceous limestone:

4.Lithographic limestone:

6. DIFFERENCE BETWEEN THE CONGLOMERATE AND BRECCIAS (AUC NOV/DEC 2011)

BRECCIAS:

It is a mechanically formed sedimentary rock. It consists of angular fragments of heterogenic composition embedded in a fine matrix of clayed material.

The angularity of the fragments indicates that these have suffered very little or even no transport after their disintegration from the parent rocks.

CONGLOMERATES :

These are clastic nature and also belong to rudaceous group. They consist mostly of rounded fragments of various sizes but generally above 2 mm.The roundness of gravels making the rock is a useful characteristic to differentiate it from Breccias in which the fragments are essentially angular.

7. DIFFERENTIATE BETWEEN BLACK GRANITE (DIORITE) (AUCNOV/DEC 2009)

DIORITE: It is an intermediate type of igneous rock of plutonic origin with silica percentage generally lying between 52 – 66 %.

COMPOSITION: There are typically rich in feldspar plagiocose of sodic group, diorites also contain accessory minerals like hornblende, biotite and some pyroxenes.

TEXTURE:coarse to medium grained and hole crystalline.

OCCURRENCE: Diorite commonly occurs as small intrusive bodies like dikes, sills, stocks and other irregular masses

8. DEFINE THE TERM METAMORPHISM . GIVE EXAMPLES (AUC MAY/ JUNE 2010)

It may define as metamorphic process involving essentially formation of new minerals by the mechanism of chemical replacement of pre-existing minerals under the influence of chemically active fluids.Three major kinds of Metamorphism differentiated on the basis of dominant factors are thermal metamorphism, dynamic metamorphism and Dynamo thermal metamorphism

9. LIST THE FEW TEXTURE OF IGNEOUS ROCKS (AUC MAY/ JUNE 2012)

The term texture has been defined as the mutual relationship of different mineralogical constituents in a rock. It is determine by size, shape and arrangement of these constituents within the body of rock.

- Aphaeretic
- Glassy or vitreous
- Pyroclastic
- Phaneritic
- Pagmatite

10. DISTINGUISH BETWEEN LIMESTONE AND SHALE (AUC MAY/ JUNE 2012)

These are the most common sedimentary rocks from the non clastic group and are composed chiefly of carbonate of calcium with subordinate proportions of carbonate of magnesium.

It is fine-Grained sedimentary rocks of argillary, composition, these are made up of very particle of slit and clay

11. DEFINE PETROLOGY?

The branch of geology dealing with various aspects of rocks such as their formation, classification and occurrence is called petrology.

12. DISTINGUISH BETWEEN MONOMINERALIC ROCK AND POLYMINERALIC ROCK WITH EXAMPLES?

MONOMINERALIC ROCK:

Rocks composed by a single mineral (e.g.) pyroxenes which is composed at pyroxene only.

POLYMINERALIC:

Rocks composed at more than one mineral and polymineralized rock (e.g.) Granite.

13. DIFFERENTIATE: PLUTONIC ROCK AND VOLCANIC ROCK?

Igneous rocks which have formed at a depth are known as plutonic igneous rock. (e.g. granite) and those formed from lava and formed mainly at the surface are known as volcanic igneous rock (e.g Basalt)

PART-B

1. What do you understand by the terms texture is igneous rocks? (AUC NOV/DEC 2014)

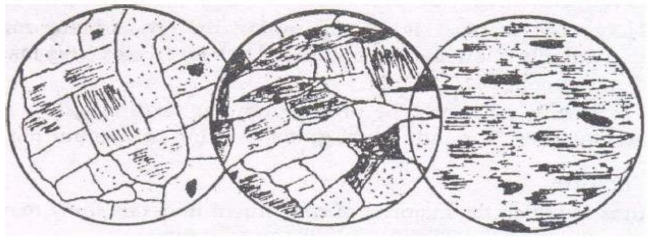
It is defined as the mutual relationship of different mineralogical constituents in a rock. It is determined by the size, shape and arrangement of these constituents within the body of the rock.

FACTORS EXPLAINING TEXTURE:

The three factors are,

A. DEGREE OF CRYSTALLIZATION:

All the constituent minerals may be present in distinctly crystallized forms and easily recognized by unaided eye in non-crystallized form.



1.holocrystaline 2.merocrystaline 3. holohyaline

I. HOLOCRYSTALINE:

When all the constituent minerals are distinctly crystallized.

II. HOLOHYALINE:

When all the constituents are very fine is size and glassy or non crystalline in nature.

B. GRANULARITY:

This defines the grain size of the various components of a rock. Thus the rock texture is described as:

I. COARSE GRAINED – when the average grain size is above 5 mm the constituent minerals are then easily identified with naked eye.

II. MEDIUM GRAINED: When the average grains size lies between 5 mm and 1mm use of magnifying less after becomes necessary for identifying all the constituent mineral components diagram.

III. FINE GRAINED: When the average grain size is less than 1mm. In such rocks identification of the constituent mineral grains is possible only with the help of microscope for which very this rock sections have to be prepared.

C. FABRIC:

This is a composite term expressing the relative grain size of different mineral constituents in a rock and well as degree of perfection in the form of the crystals. Fabric will be defined by three terms.

I. PANDO MORPHIC:

When majority of the components are in fully developed shapes.

II. HYPIDIOMORPHIC:

The rock contains crystals of all the categories:

III. ALLOTRIMORPHIC:

When most of the crystals are of anhedral or irregular shapes.

Types of Texture:

These can be broadly divided into five categories.

- Equigranular texture
- In equigranular texture
- Directive texture
- Intergrowth texture
- Inter granular texture

EQUIGRANULAR TEXTURE:

All these textures in which majority of consistent crystals of a rock are broadly equal in size. In igneous rocks these textures are shown by granites and felsites are often named as granitic and felsitic textures.

In granitic texture, the constituents are either all coarse grained or all medium grained and the crystals show ethereal to subhedral outlines. In the felsitic texture the rock is micro granular the grains being mostly microscopic crystals but these invariably show perfect outlines.

IN EQUIGRANULAR TEXTURE:

The constituent minerals show marked difference in their relative grain size are grouped as in equigranular texture.Porphyritic and policlinic textures are important examples of such textures.

DIRECTIVE TEXTURES:

These textures that indicate the result of flow of magma during the formation of rock are known as directive texture.

The exhibit perfect parallism of crystals or crystallites in the direction of the flow of magma. Frachytic textures are common examples.

INTERGROWTH TEXTURE:

During the formation of the igneous rocks two or more minerals may crystallize out simultaneously in a limited space. So that the resulting crystals are mixed up or intergroup. Graphic and granophyres texture is example.

INTER GRANULAR TEXTURE:

In certain igneous rock crystals formed at earlier stages may get to arranged that polygonal or trigonal spaces are left in between them. This texture so produced is called an intergranular structure.

2. Explain briefly about structure and forms of an igneous rock? (NOV/DEC 2013)

1. STRUCTURE OF IGNEOUS ROCKS

These rocks are developed on a large scale in the body of an extrusion or intrusion giving rise to conspicuous shapes or forms are included under the term structures.

TYPES

Igneous rocks can be broadly grouped under three headings.

A. STRUCTURE DUE TO MOBILITY OF MAGMA (OR) LAVA:

The mobility of Magma is responsible for a variety of structures that will acquire.

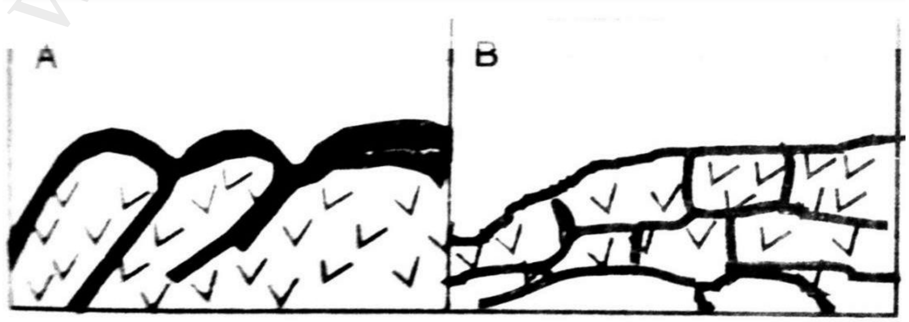
- Flow structure
- Pillow structure
- ropy and blocky lava
- Spherulitic structure
- Orbicular structure.

FLOW STRUCTURE:

It is defined by the development of parallel or nearly parallel layers or bands in the body of an igneous rock.

PILLOW STRUCTURE:

This is characterized by the development of bulbous, over lapping, pillow like surfaces in the body of igneous mass. It is typical structure at rocks formed form mobile basaltic lava.



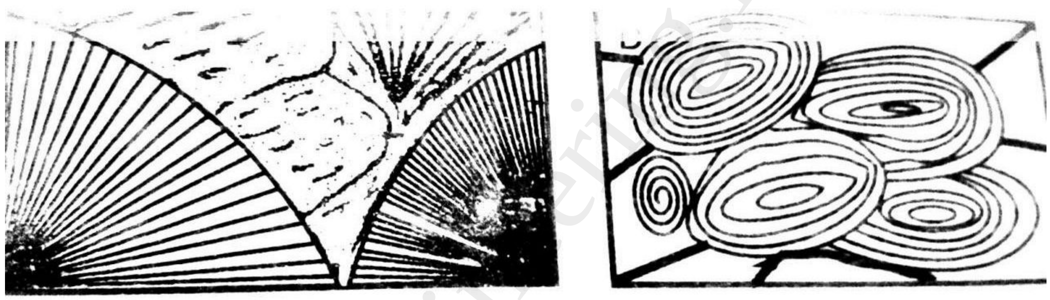
1.pillow structure **2. Blocy lava**

ROBY AND BLOCKY LAVA:

Highly viscas dry lavas undergo very little movement after their eruption and before cooling. Their surfaces show broken and fragmented appearance. These are called blocky lag .The upper surface is smoothly wrinkled rather than actually broken. The surface structure is then referred as nosy lava.

SPHERULITIC STRUCTURE:

It is distinguished by the presence of this mineral fibers of various sizes arranged in perfect or semi perfect radial manner about a common centre.



a C. Spherulitic Lava D. Orbicular Lava

ORBICULAR STRUCTURE:

It is a range type of structure of igneous rocks in this a rock mass appears as if composed of ball like aggregations.

JOINING STRUCTURE:

Cooling of magma or lava is very often accompanied by development of cracks or joints in the rocks formed form these sources.

VESICULAR STRUCTURE:

The process of cooling and crystallization is generally accompanied by the escape of these gases. This leads commonly to the formation of cavities of various sizes and shapes in the cooled mass.

2. FORMS OF IGNEOUS ROCKS

The cooled igneous masses occur is nature in a variety of shapes (or) forms. The igneous mass will acquire on cooling depends on a number of factor such as

a. The structural disposition of the host rock b. The Viscosity of the magma

c. The composition of the magma

d. The environment of which injection of magma

CONCORDANT BODIES: All those nitrogen in which the magma has been injected and cooled along or parallel to the structural planes of the host rocks are grouped as concordant bodies. Most important concordant forms are sills, batholiths, laccoliths and laccoliths

SILLS:

These igneous intrusions that have been injected along or between the bedding plane or sedimentary sequence are known as sills. It is typical of sills that their thickness is much small than their width and length.

Sills are commonly subdivided into following types:

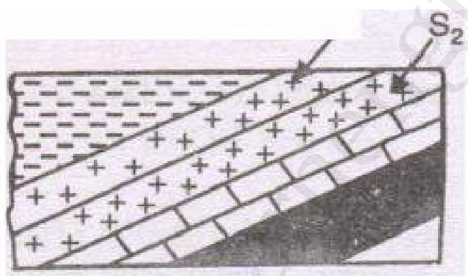
a. Simple sills

b. Multiples sills

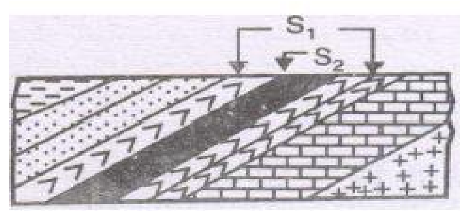
c. Composite sills

d. Differentiated sills

e. Inter formational sheets



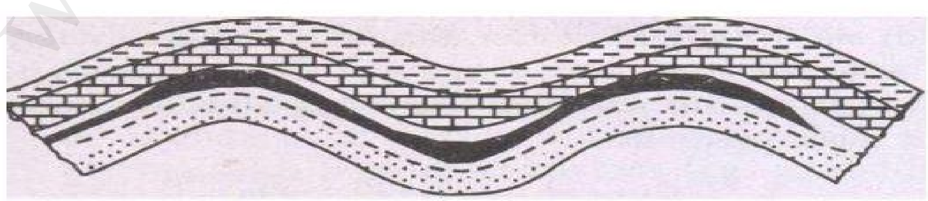
Composite Sills



Multiple Sills

PHACOLITHS

These are concordant, small sized intrusive that occupy positions in the through and crests of bends called folds.



LOPOLITHS:

These igneous intrusions which are associated with structural basins, that are sedimentary beds inclined towards a common center are termed or Lopoliths. They may from huge bodies of consolidated magma, often many kilometers long and thousands of meters thick. Lopoliths like sills may be simple, complex or differentiated in character the terms having same connotations.

LACCOLITHS:

These are concordant intrusion due to which the invaded strata have been arched up or deformed into a dome. Laccoliths are formed when the magma being injected is considerably viscous so that it is unable to flow and spread for greater distances. Extreme types of laccoliths are called bysmaliths and in these the overlying strata get ultimately fractured at the top of the dome because of continuous injections.

DISCORDANT BODIES :

Important types of discordant intrusion are dykes, volcanic necks, and batholiths.

DYKES (DIKES):

These may be defined as columnar bodies of igneous rocks that across the bedding plane (or) unconformities or cleavage planes and similar structures.

Dykes show great variations in their thickness, length texture and composition. They may be only few centimeters or many hundred of meters thick.

It is customary to classify dykes as simple dykes, multiple dykes, composite dykes, differentiated dykes.

TYPES OF DYKES

1. **Radiation Dyke**
2. **Ring Dyke**
3. **Cone Sheet Dyke**

VOLCANIC NECKS:

In such congealed intrusions are termed volcanic necks or volcanic plugs. In outline these masses may be circular, semicircular, or irregular and show considerable variation is their diameter.

BATHOLITHS:

These are huge bodies of igneous masses that show both concordant and discordant relations with the country rock.

In composition batholiths may be made of any type igneous rock. They also exhibit many types of textures and structures.

IGNEOUS EXTRUSIONS:

The igneous extrusions do not show much complexity in their form. They generally occur as widely speed, extensive flows covering enormous area and the existing toposcraphy. These may be layers other sedimentary materials deposited during the volcanic intermissions which are called inter trapped layers.

3. Write short notes on: i. Granite ii. Diorite iii. Syerite iv. Basalt v. Gabbro. (MAY/JUNE 2014)(NOV/DEC 2013)

GRANITE

It may be defined as plutonic light color igneous rock. The word granite is derived from Latin word granum meaning a grain and refers to the equigranular texture of the rock.

COMPOSITION:

Two most common and essential mineral constituents of granites are;

Quartz and Feldspar. Quartz is always recognized by its glassy luxture, high hardness, and cleavage less transparent. Feldspar may be of two varieties. The potash feldspar and soda bearing feldspar.

TEXTURE:

Granites are generally coarse to medium grained, Holocrystaline and equigranular rocks. Granites, graphic, porphyritic and intergrowth texture are the most common types of textures, met with is granites of different varieties.

TYPES:

Many types of granites are distinguished on the basis of relative abundance is them of some particular accessory mineral.

White mica, muscovite is present as a prominent accessory mineral. The granite may be distinguished as muscovite granite.

USE:

Granite finds extensive use in architectural and massive construction where they are finding in abundance. These rocks have been used extensively in monuments and memorials as columns and steps and as theoring in buildings.

DIORITE

DEFINITION:

It is an intermediate type of igneous rock of plutonic origin with silica percentage generally lying between 52 – 66 %.

COMPOSITION:

There are typically rich in feldspar plagiocose of sodic group, diorites also contain accessory minerals like hornblende, biotite and some pyroxenes. **Texture:**

In texture, diorites show close resemblance to granites and other plutonic rocks. They are coarse to medium grained and holo crystalline.

OCCURRENCE:

Diorite commonly occurs as small intrusive bodies like dikes, sills, stocks and other irregular masses.

SYENITES

DEFINITION:

These are volcanic rocks in which plagioclase feldspar are the predominant constituents making the potash feldspar only a subordinate member.

COMPOSITION:

The most common feldspars of Syenites are orthoclase and alite microcline, Oligoclase and anorthite are also present is then is subordinate amounts.

TEXTURE:

Syenites show textures broadly similar to those of granites, that is they are coarse to medium grained Holocrystaline is nature.

TYPES:

Few – Well known types of syenites as follows

I.)NORDMARKITE:

a syenite that contains some amount of quarts in then.

II)MONAZITE :

Feldspar become almost equal to the potash feldspar as essential minerals.

LARVIKITE:

It is also sometimes known as blue granite, it is however actually a syenite that contains feldspar laboratories as a predominant constituent.

NEPHELINE:

These are a group of syenite rocks in which nepheline becomes an important constituent.

GABBRO

DEFINITION:

These are coarse, grained plutonic rocks of basic character. Plagioclase feldspars, of lime – soda composition are the chief constituents of gabbro's.

TEXTURE:

Gabbro shows variable texture, generally coarse to medium grained, reaction rim structure is seen in some gabbro's.

TYPES:

I. NORITE:

Contains orthomorphic pyroxene like hypersthenes and enstatite in addition to labradorite.

II. GABBRO

It contains monoclinic pyroxenes as the dominant mafic mineral besides the typical feldspars.

III. ANORTHOSITE:

It is a typical monomineralllic rock containing generally feldspar labrodorite.

IV. EUCRITE:

It is a gabbroic rock in which feldspar bytwonite or anorthite dominates.

V. TROCTOLITE:

It is that gabbroic rock which contains mainly feldspars and oliumie.

VI. DUNITE:

This gabbroic rock is characterized with the typical absence of felspars and dominance of oliuise and pyroxenes.

BASALTS

DEFINITION:

Basalts are volcanic igneous rocks formed by rapid coding from lava flows from volcanoes either over the surface (or) under water on oceanic floors.

COMPOSITION:

Basalts are commonly made up of calcic plagioclase felspars and a number of ferro – magnesian minerals like augite, horn blende. In fact many types of basalts are distinguished on the basis of the type and proportion of Ferro magnesian minerals in them.

OCCURRENCE:

The basaltic rocks form extensive lava flows on the continents and also on the oceanic floors in almost all the regions of the world.

4. Explain briefly about Formation and Texture of sedimentary rocks? (MAY/JUNE 2014)(NOV/DEC 2013)

Sedimentary rocks are also called as secondary rocks. This group includes a wide variety of rocks formed by accumulation, compaction and consolidation of sediments.

FORMATION:

The process of formation of sedimentary rocks is ever prevailing. The sediments so produced are transported to the settling basins such as sea floors where they are deposited, get compacted and consolidated and finally transformed into a cohesive solid mass.

Sedimentary rocks are broadly grouped into three classes on the basis of their mode of formation.

Mechanically formed (or) clastic rocks Organically formed rocks

Chemically formed rocks.

1.CLASTIC (MECHANICALLY) FORMED ROCKS:

A. DECAY AND DISINTEGRATION:

The rocks existing on the surface of the earth are exposed to decay and disintegration by the action of natural agencies like atmosphere, water and ice on them.

The original hand and weren't rock bodies are gradually broken down into smaller fragments grains and particles. The disintegrated, loosened material so formed and accumulated near the source is called as detritus. Hence classic rocks are often also called as detrital rocks.

B. TRANSPORT OF SEDIMENTS:

The detritus produced from the decay and disintegration of the pro existing rocks forms the source of the sedimentary rocks but it has to be transported to a suitable place for transformation again into a rock mass. The running water bodies transport the sediment load as bed-load, suspended load and dissolved load al dumped at the setting basins.

C. GRADUAL DEPOSITION:

The sediments as produced through weathering and erosion are transported to setting basins. These basins may be located in different environments such as on the continents, along the seashores or in deep or in deep – sea environments. In the continental environments may be included the glacis deposits the fluvial deposit, the glacio fluvial deposits and the eolian deposits each type giving rise to a definite type of sediment accumulation.

D. DIGENESIS:

The process of transformation of loose sediments deposited in the settlement basins to solid cohesive rock masses either under pressure a. This cementation is collecting known as Diagnosis.

2. CHEMICALLY FORMED (NON- CLASTIC) ROCKS:

Water is a great solvent. Water from rains, springs streams, rivers, lakes and underground water bodies dissolves many compounds from the rocks with which it comes into contact.

In all cases a stage may be reached when the dissolved salts get crystallized out either through evaporation or through precipitation.

Rock salt may be formed form sodium chloride rich seawater merely by the process of continued evaporation in bays and lagoons.

C. ORGANICALLY FORMED ROCKS:

These extensive water bodies sustain a great variety of animal and plant life. The hard parts of many sea organisms are constituted chiefly of calcium and magnesium. Limestone's are the best examples of organically formed sedimentary rocks.

ENVIRONMENT OF FORMATION:

FACIES:

The concept of formation of a sedimentary rock in a particular type of environment is explained by the term facies. There are three main facies a sedimentary rock. **a. CONTINENTAL FACIES:**

Sedimentary rocks formed on the continents such as in lakes, rivers, streams, and alluvial fans are said to belong to the continental facies. Coarse grained rocks like breccia, Conglomerates and soft sand stone are typical examples of rocks of continental facies.The rocks of continental facies are, in general relatively less dense, loosely packed, and often cemented.

B. TRANSITIONAL FACIES:

Some sedimentary rocks may be formed by accumulation and composition of sediments along the seashore or on the continental shelt that remains partly submerged under sea such an beaches and deltas. These sediments and rocks developed from the represent the transitional facie

C .MARINE FACIES:

All sedimentary rocks formed at sea floor and ocean floors are covered under marine facies. These may be further subdivided in shallow sea deposits and deep marine deposits formed on ocean floors.

TEXTURES OF SEDIMENTARY ROCKS:

This texture is determined by at least six contributing factors.

I. ORIGIN OF GRAINS:

A sedimentary rock may be partially or wholly composed of clastic grains, or of chemically formed or organically contributed parts. Thus the rock may show a clastic texture or an on clastic texture.

II. SIZE OF GRAINS

The grain size in the sedimentary rock varies within wide limits. Three textures recognized on the basis of grain size are:

Coarse grained rock - average grain size > 5 mm.

Medium grained rock - average grain size between 5 and 1 mm Fine grained rock - average grain size < 1mm.

III. SHAPE OF GRAINS

The sediments making the rocks may be of various shapes, rounded surrounded, angular and sub angular.

IV. PACKING OF GRAINS:

Sedimentary rocks may be open packed or porous in textures or densely packed depending upon their environment of formation. The degree of ___ is generally related to the load of the overlying sediments during the process of deposition.

V. FABRIC OF GRAINS:

It may contain many elongate particles. Their orientation is studies and described in terms of orientation of their longer axes

5.Write short notes on:

1. **Breccias**
2. **Conglomerate**
3. **Sand stone**
4. **Lime stone (MAY/JUNE 2014)**

BRECCIAS:

It is a mechanically formed sedimentary rock. It consists of angular fragments of heterogenic composition embedded in a fine matrix of clayed material.

The angularity of the fragments indicates that these have suffered very little or even no transport after their disintegration from the parent rocks.

TYPES:

A. BASAL BRECCIAS:

This rock is formed by the sea waters advancing over a coastal region covered with fragments of cherty and other similar rocks .Once seawater retreats, the loose chert fragments get cemented together as breccias rocks.

B. FAULT BRECCIAS:

These rocks are made up of angular fragments that have been produced during the process of faulting.

CONGLOMERATES :

These are clastic nature and also belong to rudaceous group. They consist mostly of rounded fragments of various sizes but generally above 2 mm.

The roundness of gravels making the rock is a useful characteristic to differentiate it from breccias in which the fragments are essentially angular.

TYPES:

There are three types:

I. BASAL CONGLOMERATES:

Having gravels derived from advancing sea –waves over subsiding land masses.

II. GLACIAL CONGLOMERATE:

In which gravel making the conglomerate are distinctly of glacid origin.

III. VOLCANIC CONGLOMERATE:

These are distinct volcanic origins but have subsequently subjected to lot of transport resulting in their smothering and polishing on litho logical basis conglomerates are grouped in two classes.

a. OLIGOMICITIC:

Simple in composition, these gravels are made up of quarts, chert and calate.

b. POLYMICTIC:

In this constituent gravels re derived from rocks a all sorts. Igneous, sedimentary, metamorphic all cemented together.

SAND STORES:

These are mostly composed at sand grade particles that have been compacted and consolidated together in the form of beds in basins of sedimentation. **Composition:** Quartz (SiO2) is the most common mineral making the sand stones. Beside, quartz, minerals like feldspars, micas, garret and magnetite may also be found is small proportions in much sandstone.

TEXTURE:

Sand stones are in general medium to fine gravised in texture. The individual grains may be round or angular in outline, loosely packed or densely passed and in sample or interlocking arrangement.

COLOUR:

Stones naturally occur in a variety of colors, red, brown, grey and white being the most common colors.

TYPES:

Following types are of common occurrence.

i. SILICEOUS SAND STONES:

Silica (SiO2) is the cementing material in these sand stones. Tis is named Quartzite.

ii. CALCAREOUS SAND STONES:

Those varieties of sandstones in which carbonates of calcium and magnesium are the centering materials.

iii. ARGILLACEOUS SANDSTONES:

These are among the soft varieties of sandstone because the cementing material is clay that has not much inherent strength.

LIME STONES

DEFINITION: These are the most common sedimentary rocks from the non clastic group and are composed chiefly of carbonate of calcium with subordinate proportions of carbonate of magnesium.

COMPOSITION:

Pune limestone is invariably made up of mineral calcite (CaCO3). In the limestone rock formations, however, presence of dolomite CaMg (CO3)2, quartz, (SiO2) feslpar minerals and Iron Oxide is rather a common feature.

TEXTURE:

The most important textural feature of limestone's in their fossiliterous nature. Other varieties of limestone's show dense and compact texture. Some may be loosely packed and highly porous. Others may be compact and homogenous.

TYPES:

Following are common types of limestone's:

1. CHALK:

It is the purest form of limestone characterized by fine grained earthly texture.

2. SHELLY LIMESTONE:

It has a rich assemblage of fossils that are fully or partly preserved.

3. ARGILLACEOUS LIMESTONE:

It contains clay as a significant constituent and are clearly of alocathonous origin.

4. LITHOGRAPIC LIMESTONE:

These are compact massive homogenous varieties of pure limestone's that find extensive use of in litho printing.

6. List the various field and laboratory tests carried out to determine the engineering properties of rocks (AUC MAY/JUNE 2015)

(A)Laboratory Test

(i) Uniaxial laboratory test

Test carried out on cylinder core sample length diameter ratio of 2 .The results are reduced to length:diameter ratio of 1 using the relationship

$$Co=Cs\ (0.8 + 0.2/L/D)$$

Co is the observed compressive strength , L and D are the length and diameter of the specimen actually used in the test

Compressive strength of rocks can be found out.

(ii) Tensile Strength

Can be determined by directly or indirectly.

Direct method is complicated which requires fixing the plate specimen using strong epoxy resin.

Indirect method is done and calculated using the relation .

$$Ts= 2P/\pi DL$$

L and D are the length and diameter of the specimen

It consist of loading a test cylinder diametrically in such a way that the applied loads would develop tensile rupturing along the diametrical plane of specimen. Loading is increased gradually till the test specimen fractures.

(iii)Shear Strength

In lab testing, Bar shaped specimen held with grips supported on both the ends is loaded slowly at constant rate. Rupture occurs as shear strength of the specimen is exceeded and is indicated by failure along two planes. The shear strength is found using the relation

$$S= \{1/2P\}/A$$

P – Load at failure

A – Area of cross section

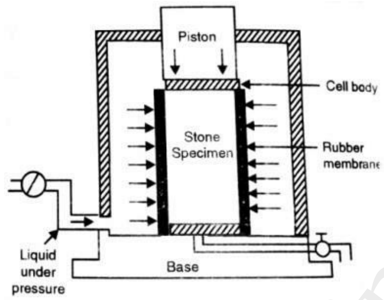
(iv) Modulus of elasticity

Indicates the property of undergoing deformation when loaded. The deformation is recovered when load is removed. Determined with reference to Hook's law. Test carried out on cylinder core sample length diameter ratio of 2. The E value depends upon composition, texture and structure. Rock is grouped into three classes Quasi-elastic rock, Semi-elastic and non-elastic rocks

E= stress/strain (or) modulus of elasticity

(v) Triaxial test

Assess the behavior of rocks to confining pressure. Cells or jackets have to be used to perform this test. Consist of metallic container into which oil or liquid is filled at pressure. Test carried out on cylinder core sample length diameter ratio of 1. Inserted in the cell and placed under vertical load. Horizontal stress by injecting the fluid. Deformation at different axial and confining load recorded till failure.

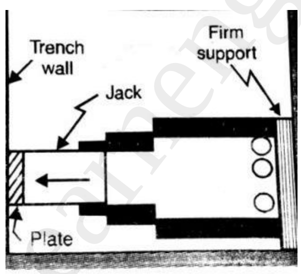


(B)Field Test

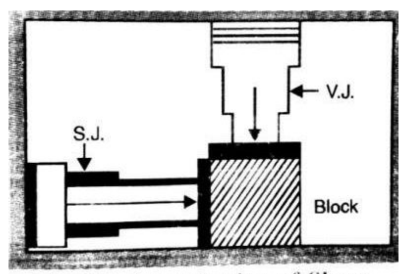
(i)Jack Test

It is a Static test conducted to determine the in-situ deformation characteristics of rocks. A hydraulic is made to rest on one side of the excavation on a base plate or on a concrete platform cast in-situ.After firmly adjusting the jack ,load is applied through the jack on the rock wall .Resulting deflections with increasing loads are recorded by strain gauges.

$$\varepsilon = 4P\,(1-\nu^2)/\Pi d^2 E$$



Jack Test arrangements



In-situ determination of Shear

(ii)Shear test

The in-situ shear strength of rock is also determined by applying jack test in a slightly modified manner.it is required that rock exposed for testing should be at least $1m^2$ at the base and should have sufficient height to impose sufficient vertical load at the proposed vertical shearing plane. Each of these blocks is then loaded, one by one, from side by a jack. Any displacement of the block under such conditions gives an assessment of the shearing resistance of the rock once applied shearing force and the vertical load are known.

(iii)Seismic test

In an artificial shock, elastic waves originate from the point of shock similar in the earth quake. The P waves and S waves are taken into consideration while studying the elastic characteristics of rock.

7. Write the description, composition, texture and occurrence of Dolerite, Limestone, Quartzite and Sandstone (AUC MAY/JUNE 2015)

Terms	Dolerite	Limestone	Quartzite	Sandstone
Description	Igneous rocks of hypabyssal origin forms as shallow sill and dyke	Sedimentary rocks from non-clastic group.	Granular metamorphic rocks of intersutured grains of quartz	Sandstones are mechanically formed sedimentary rocks of Arenaceous group
Composition	Made up of calcic plagioclase	Made of mineral calcite	Beside quartz it contains mica, feldspar,garnets	Quartz is the most common mineral making sandstone
Texture	Medium to fine grained.Ophitic and porphyritic texture	Fosilliferous texture	Porphyroblastic and granoblastic texture	Medium to fine grained in texture
Occurrence	Sills and dykes have been recorded with magmatic activity	Form mountains and hills extending over several hundred kilometers	Recrystallization of pure sandstone under influence of contact and dynamic metamorphism	Found in upper 15 km of the crust

UNIT IV

PART A

1. WHAT IS MEANT BY ANTICLINE AND SYNCLINE? (MAY/JUNE 2012)REG 2008

When the beds are unfolded in an arch-like structure, it is called an anticline. When the beds are down folded in trough like structure, it is called a Syncline. It may be noted that in an anticline the oldest rock is in the centre, where as in a syncline the youngest rocks is in the centre.

2. EXPLAIN 'TRUE DIP' AND 'APPARENT DIP' (NOV/DEC 2012) REG 2008

It is the maximum inclination of bedding planes with the horizontal, or in other wards it is the inclination of the direction of which water would flow, if poured on the upper surface of the bed.

The inclination of the bedding planes, with the horizontal, in any other direction, other than the direction of the true dip, is known as the apparent dip. The value of apparent dip is always less than the true dip.

3. DEFINE 'DIP' AND 'STRIKE' OF THE ROCK (MAY/JUNE 2011) REG 2008

The inclination of the bedding planes, with the horizontal, is called dip and is always expressed in degrees.

It is the direction, measured on a Horizontal surface, of a line formed by the intersection of dipping bed with the horizontal plan. It is always expressed in terms of main direction ie, is North, South, East or West.

4. DEFINE OUT CROP (NOV/DEC 2013) REG 2008

A little consideration will show that the out crop of a rock is affected by the angle of dip also. If a rock has a vertical dip then the outcrop will be less, than that when the same rock is dipping at some angles.

5. WHAT IS MEANT BY MASTER JOINTS?

The joints always occur in sets and groups. A set of joints means, joint occurring in the same dip or strike. A group of joints means a few sets of joints having almost the same trend. If a few sets or groups of joints appear for a considerable length in a rock, such joints are called major joints or master joints.

6. DEFINE FAULTS? (NOV/DEC 2012)REG 2008

Faults are fractures, along which the movement of one block with respect to other, has taken place. This movement may vary from a few centimeters to many kilometers depending upon the magnitude of the stresses, and the resistance offered by the rocks.

7. WHAT IS A GEOLOGICAL MAP? (NOV/DEC 2009)

A geologic map or geological map is a special-purpose map made to show geological features. Rock units or geologic strata are shown by color or symbols to indicate where they are exposed at the surface.

8. WHAT IS MEAN BY JOINTS? (APRIL/MAY 2015)REG 2013

When sufficient tensile stress in developed between two successive points, a crack is Developed at right angle to the direction of the stress, such cracks are called joints.

9. EXPLAIN THE EFFECTS OF JOINTS WHERE A TUNNEL IS TO BE CONSTRUCTED. (MAY/JUNE 2012)REG 2012

1. There will be percolation of water through the joints during heavy raining, which may render the rocks becoming weaker and hence the tunnel may lose the support from the rocks.

2. The vibrations caused due to heavy traffic through tunnelling will transfer the forces to the jointed rocks of the tunnel and its sides, widening of joint may reduce the life of the tunnel.

10. DEFINE CROSS BEDDING? (May/June 2009)Reg 2008

Sedimentary beds or layers are generally parallel to one another. But, sometimes, it has been observed that the beds lie slightly oblique to the major bedding planes.

PART B

1. Describe the different types of folds with neat diagram. Add a note on their engineering significance. (May/June 2013)

DEFINITION

FOLDS may be defined as undulations or bends or curvatures developed in the rocks of the crust as a result of stresses to which these rocks have been subjected from time to time in the past history of the Earth.

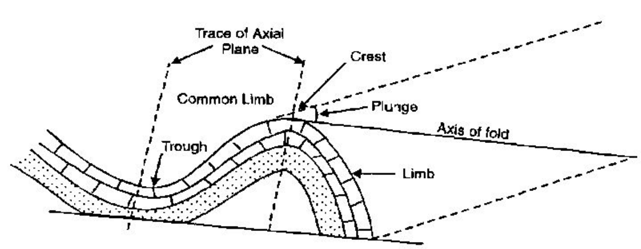
DEVELOPMENT OF FOLDS

1. The folds may develop in any type of rock and may be of any shape and geometry ranging from simple up arched bends or downward curvatures to completely overturned flexures.
2. The shape and extent of a fold depends upon a number of factors like the nature, magnitude and the direction of and duration for which these forces act upon the rocks
3. The process of development of folds in the rocks is called Folding.
4. Folding is a ductile type of deformation experienced by the rocks compared to the brittle deformation where the rocks actually get broken and displaced when stressed.

PARTS OF A FOLD

LIMBS

These are the sides or flanks of a fold. An individual fold will have a minimum of two limbs.



HINGE

- In a folded layer, a point can be found where curvature is maximum and one limb ends and the other limb starts from that point. This is the hinge point.
- When rocks occur in a sequence and their all hinge points are joined together, they make a line, called the hinge line.

AXIAL SURFACE

- When the hinge line is traced throughout the depth of a folded sequence a surface is obtained which may be planar or non-planar. It is referred to as axial surface

AXIAL PLANE

- Axial plane is the imaginary plane that passes through all the points of maximum curvature inclined or horizontal in nature.
- A fold surface is planar in nature; otherwise it in a folded sequence.
- It may be vertical, is sometimes called a planar fold if the axial is a non-planar fold.

AXIS OF A FOLD

- It is simply defined as a line drawn parallel to the hinge line of a fold.
- A more precise definition of an axis of a fold would be the line representing the intersection of the axial plane of a fold with any bed of the fold.

PLUNGE OF A FOLD

- The angle of inclination of the fold axis with the horizontal as measured in a vertical plane is termed the plunge of the fold.

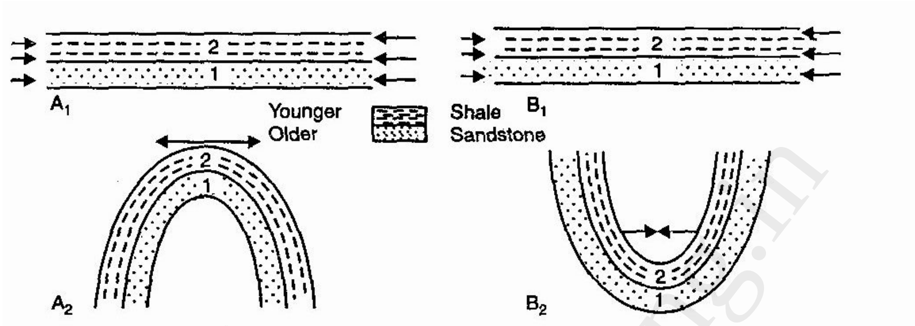
CREST AND TROUGH

- Most folds are variations of two general forms; uparched and downarched bends. The line running through the highest points in an uparched fold defines its crest.
- A corresponding line running through the lowest point in a downarched fold makes its trough. The crest and trough may or may not coincide with the axis of the fold.

CLASSIFICATION OF FOLDS

- Anticlines are defined as those folds in which

- The strata are uparched, that is, these become CONVEX UPWARDS;
- The geologically older rocks occupy a position in the interior of the fold, oldest being positioned at the core of the fold and the youngest forming the outermost flank,
- The limbs dip away from each other at the crest in the simplest cases.



SYNCLINES

- The strata are down arched, that is, these become CONVEX DOWNWARDS;
- The geologically younger rocks occupy a position in the core of the fold and the older rocks form the outer flanks, provided the normal order of superposition is not disturbed,
- In the simplest cases in synclines, the limbs dip towards a common center.

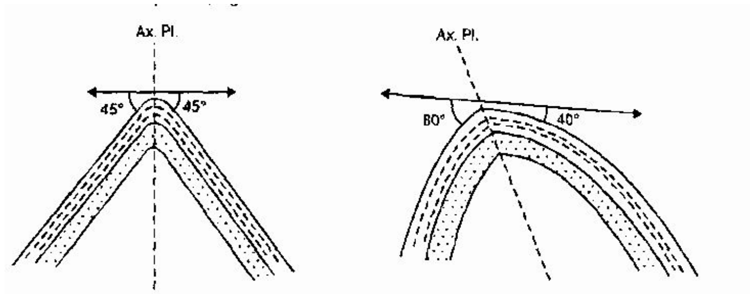
POSITION OF AXIAL PLANE

- Depending upon the nature and direction of the stresses the axial plane in a resulting fold may acquire any position in space, that is, it may be vertical, inclined or even horizontal.

Following main types are recognized on the basis of position of the axial plane in the resulting fold

SYMMETRICAL FOLDS

- These are also called normal or upright folds. In such a fold, the axial plane is essentially vertical.
- The limbs are equal in length and dip equally in opposite directions.



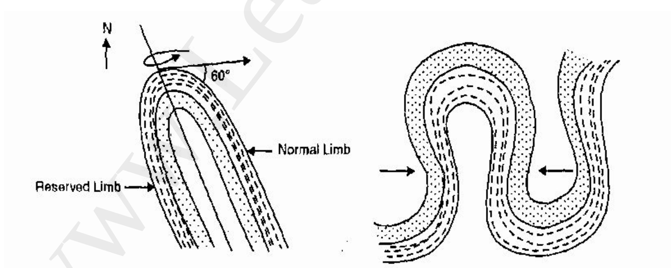
- It may be an anticline or syncline and when classified, may be described as symmetrical anticline/ syncline as the case may be.

ASYMMETRICAL FOLDS

All those folds, anticlines or synclines, in which the limbs are unequal in length and these dip unequally on either side from the hinge line are termed as asymmetrical folds.

OVERTURNED FOLDS

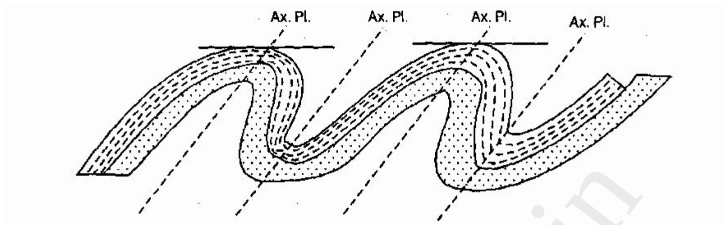
- These are folds with inclined axial planes in which both the limbs are dipping essentially in the same general direction.
- The amount of dip of the two limbs may or may not be the same.
- Overfolding indicates very severe degree of folding.
- One of the two limbs (the reversed limb) comes to occupy the present position after having suffered a rotation through more than 90 degrees.
- The other limb is known as the normal limb.



- In certain cases, both the limbs of a fold may get overturned because of very high lateral compression.
- Such a type of fold is commonly referred to as a fan fold
- In such folds, the anticlinal tops are said to have opened up into a broad, fan-shaped outline due to intense compression in the lower region.

ISOCLINAL FOLDS

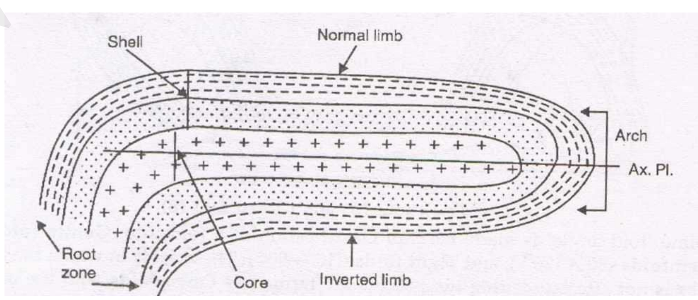
- These are group of folds in which all the axial planes are essentially parallel, meaning that all the component limbs are dipping at equal amounts.
- They may be made up of series of anticlines and synclines



RECUMBENT FOLDS

- These may be described as extreme types of overturned folds in which the axial plane acquires an almost horizontal attitude.
- In such folds, one limb comes to lie exactly under the other limb so that a drill hole dug at the surface in the upper limb passes through the lower limb also.
- The lower limb is often called the inverted limb or the reversed limb.
- Other parts of a recumbent fold are sometimes named as follows:
- The arch, which is zone of curvature corresponding to crest and trough in the upright folds;
- The shell, which is the outer zone made up mostly of sedimentary formations;

The core, which is the innermost part of the fold and maybe made mostly of crystalline igneous or metamorphic rocks;

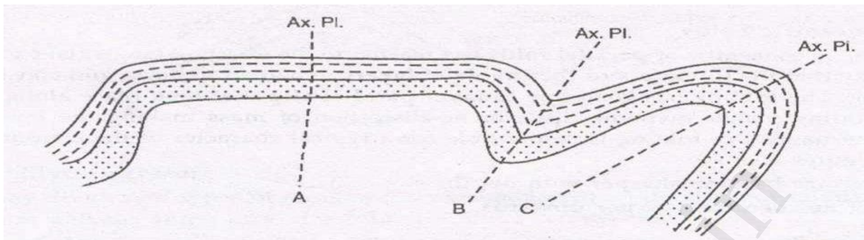


The root or the root zone, which is the basal part of the fold and may or may not be easily traceable; Once traced it can throw light whether the fold was originally an anticline or syncline that has suffered further inversion.

CONJUGATE FOLDS

- In certain cases a pair of folds that are apparently related to each other may have mutually inclined axial planes.

BOX FOLD



Flattened top and steeply inclined limbs almost forming three sides of a rectangle

- .

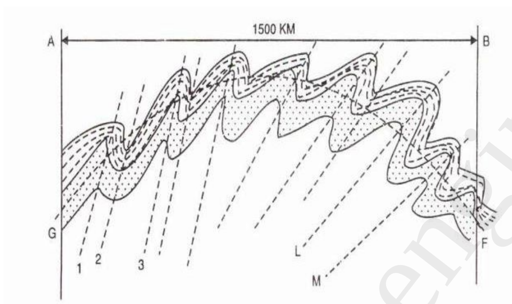


Fig. 6.23. A-B Anticlinorium

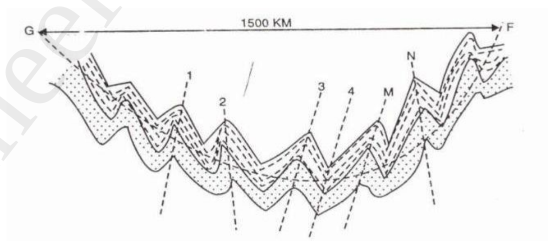


Fig. 6.23. G–F Synclinorium

ANTICLINORIUM: It is the anticline fold, which is large in size occupying several 100s of square kilometre also various types of minor folds can be seen on the limbs.

SYCLINORIUM: It is the syclined quite large in size to anticlinorium with minor folds on the limbs.

GEOSYCLINORIUM: It is bigger in size than syclinorium. EXAMPLE:gangetic valley.

GEOANTICLINORIUM: It is bigger in size than anticlinorium. EXAMPLE: Himalayan hill range.

ENGINEERING CONSIDERATIONS

- Folds developed in the areas of work are important for a civil engineer in that these make his work more complicated.
- If these structures are not thoroughly investigated and properly interpreted,

any civil engineering project standing on or driven through the folded rocks may prove to be uneconomical and unsafe.

- Due consideration is, therefore, always to be given to the presence of folds in deciding about the designing and construction of such structures as driving of traffic and hydropower tunnels, selection of sites for dams and reservoirs and in fixing the alignments of roads, bridges and highways.

CHANGE IN ATTITUDE

- Folding of any type would cause a change in the attitude (dip and strike) of the same strata in the aerial extent and also in depth.
- Hence same layers may be repeated along an alignment or one or more different layers may be unexpectedly encountered.
- If it happens so and the unexpectedly repeated or encountered layers are of undesirable nature, the project costs may be effected as also the time schedule and safety of the project.

SHATTERING OF ROCKS.

- The stresses are often strong enough to break or shatter the rocks, especially in the axial zones, which are the places of maximum concentration of these forces.
- hence, in folded rocks, axial regions are likely to be the areas containing fractured zones.
- This effect is of utmost importance because shattered rocks become:

1. weak in strength parameters of all types;
2. porous and pervious in character;

- Axial regions avoided for other better alignments or sites as the case may be.

STRAINED NATURE

- In essence, the folded rocks are considerably strained, the magnitude of strain varying from point to point in the folded sequence.
- Strain energy is released as soon as (or soon after) the excavations are made and huge blocks of rocks start caving in or falling with great force called the rock bursts.
- This often involves fatal accidents besides causing considerable delay in the

progress of the work.

➢ A proper planning of the work in folded areas is, avoid these possible hazards in construction work.

2. Explain various types of fault with neat diagram

- Those fractures along which there has been relative movement of the blocks past each are termed as **FAULTS**.
- The entire process of development of fractures and displacement the blocks against each other is termed as **FAULTING**

CLASSIFICATION OF FAULTS

Following factors are more commonly considered important in classification of faults:

- ❖ The apparent movement of the disrupted blocks along the fault plane;
- ❖ The direction of slip;
- ❖ The relation of fault attitude with the attitude of the displaced beds;
- ❖ The amount of dip of the fault;
- ❖ Mode of Occurrence.

TERMINOLOGY:

FAULT PLANE: The fracture surface along which relative movements has taken place is called a fault plane.

DIP: The dip is the angle, the fault makes with the horizontal surface.

STRIKE: The strike of a fault is a direction of its continuity on the ground surface.

THROW: The vertical displacement of fractured rock blocks is called throw of fault.

HEAVE: The horizontal displacement of is called heave.

NET SLIP: The total displacement measured along the fault plane is called the net

SLIP HADE: The angle inclination of fault plane measured from vertical

STRIKE SLIP: The movement which is parallel to the strike of the fault plane is called strike slip

DIP SLIP: The movement which is parallel to the direction of dip of the fault plane.

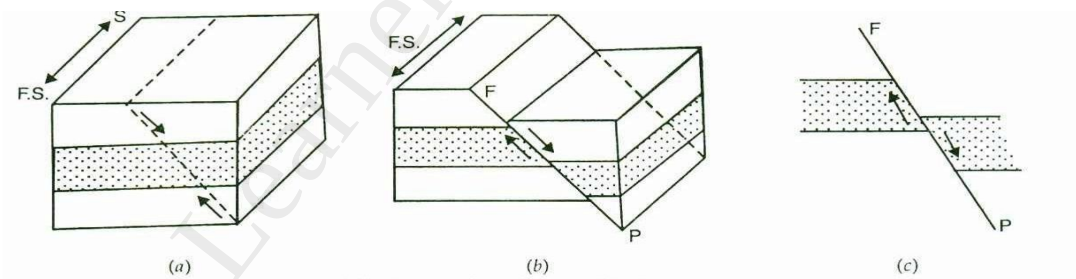
HANGING WALL: The term hanging wall is used for that faulted block which lies on the upper surface of the fault plane.

FOOT WALL: The term foot wall is used for that faulted blocks which lies on the under surface of the fault plane.

Three fundamental types of faults are commonly distinguished on the basis of apparent movement: normal faults, reverse faults and strike slip faults.

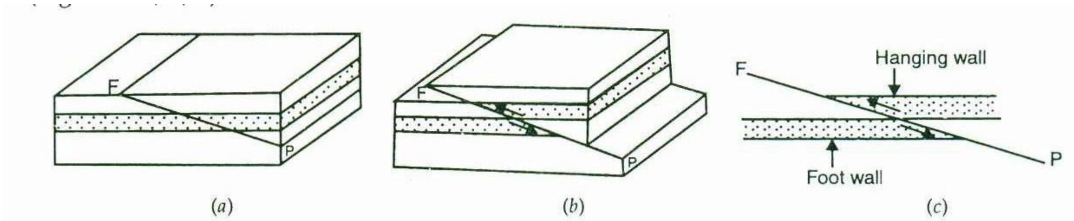
NORMAL FAULTS

- Such a fault in which hanging wall has apparently moved down with respect to footwall is classified as a Normal Fault.
- In this definition it is clearly implied that nothing can be said with certainty whether it was the hanging wall which moved down or the foot wall which moved up or both the walls moved down, the hanging wall moving more than the foot wall and hence the appearance.
- when the fault satisfies the definition of hanging wall standing at a lower position with respect to the footwall it may be classed as a normal fault.
- In normal faults, the fault plane may be inclined at any angle between horizontal and vertical, but most commonly, the fault angles are between 45 and vertical.
- further, due to the inclined nature of the fault plane and downward displacement of a part of the strata, normal faults cause an extension in the crust wherever they occur.



REVERSE FAULTS

- It is such a type of fault in which the hanging wall appears to have moved up with respect to the footwall.
- In reverse faults, the fault plane is generally inclined between horizontal and 45 degrees although reverse faults with steeply inclined fault surface have been also encountered.
- By virtue of their inclination and direction of movement, reverse faulting involves shortening of the crust of the Earth (compare with normal faults).

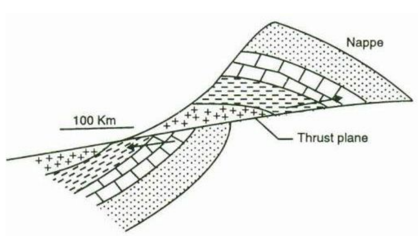


THRUST FAULTS

- These are, broadly speaking, such varieties of reverse faults in which the hanging wall has moved up relative to the footwall and the faults dip at angles below 45 degrees.
- The thrust faults or simply thrusts are of very common occurrence in folded mountains and seem to have originated as a further step in the process of adjustment of rocks to the imposed stresses.
- Thrusts are sometimes further distinguished into two sub-types: the over thrusts and the under thrusts.

NAPPES

- This term is used for extensive blocks of rocks that have been translated to great distances, often ranging to several hundred kilometers, along a thrust plane.
- The large-scale movement maybe attributed to a major over thrusting or a recumbent folding followed by thrust faulting.
- When a series of thrust faults occur in close proximity, thrust blocks are piled up one above another and all fault surfaces dip in the same direction, the resulting interesting structure is known as an imbricate Structure.

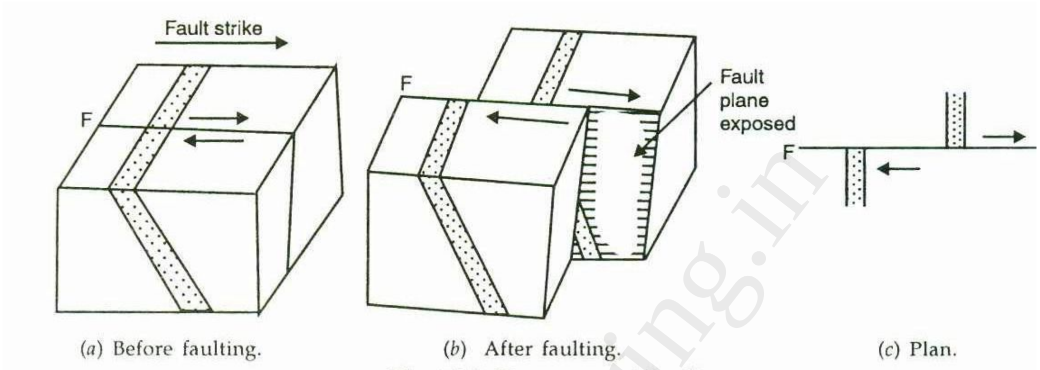


STRIKE-SLIP FAULTS

- These may be defined as faults in which faulted blocks have been moved against each other in an essentially horizontal direction.
- The fault plane is almost vertical and the net slip may be measured in great

distances.

- There are some other terms used for strike slip faults such as lateral faults, transverse faults, wrench faults and transform faults.
- Of these, the transform faults are very common and denote strike slip faults specially developed in oceanic ridges.



ENGINEERING CONSIDERATIONS

1. Presence of faults creates the heterogeneity in the geological rock layers making the design of structure complicated and also differential settlements in foundation.
2. Fault create abrupt changes or variation in ground water table.
3. The fault zone reduces the strength of rocks.
4. The presence of rocks initiates the landslide activity.
5. Fault zone act as huge reservoir of ground water and petroleum.

3. Describe different types of joints and their engineering significance (NOV/DEC 2011)REG 2008

A joint are fracture along which no displacements are occurs.

JOINT SET:

A group of joints that are parallel is called joint set. A joint system is a group of more joint set.

BASED ON SPATIAL RELATIONSHIP:

- SYSTAMATIC JOINTS: Joint planes are parallel or sub parallel.
- NON- SYSTAMATIC JOINTS: Joint planes are not parallel.

BASED ON GEOMENTRY:

- STRIKE JOINT: Strike of joint is parallel to strike of adjacent beds
- D

IP JOINT: Strike of joint is parallel to the dip of adjacent beds

- OBLIQUE JOINTS: The strike of joint is oblique to the strike of adjacent beds

BASED ON THE NATURE OF JOINT

- **OPEN JOINT:** The joint which divides the rock mass into two blocks
- **CLOSED JOINTS:** The joint which tappers out at depth and fail to divides

the rocks.

JOINT IN ROCKS

IGNEOUS ROCK

1. Sheet joint
2. Columnar joint
3. Mural joint

SHEET JOINT: A horizontal set of joint divides the rockmass in such a way as to give it an appearance of layers sedimentary rocks

COLUMNAR JOINT: These are formed in tabular igneous rock such as dykes , sills, and lava flows. These joint divide the rock mass into hexagonal, square and triangular

MURAL JOINTING: It may occur 3 sets of joints in such a way that 1 set is horizontal and other 2 sets are vertical all three sets being mutually at right angles to each other. This joint dividing the rock mass into cubical mass.

SEDIMENTARY ROCKS:

1. Mud cracks 2. Tensile shear joints

METAMORPHIC ROCKS:

1. Mural joints

2. Sheet joints

3. Shear joints

One set of joint are dominant then they are called primary joints,

ENGINEERING SIGNIFICANCE OF JOINTS:

- Spacing of joints
- Length of joints
- Block size
- Width of joints
- Seepage of water through joints
- Filled materials and its nature

➢ The presence of more number of joint set increase porosity and permeability of rock layer leading to excessive seepage

➢ Joint reduce the stability of rocks

➢ Presence of joints enhances the possibility of landslide on hill slopes

➢ Joint in sub surface rock layer create favorable condition to develop groundwater resources

4. Explain in details the electrical methods of geophysical survey for engineering investigations. (MAY/JUNE 2012)REG 2008

A. **ELECTRICAL METHODS PRINCIPLE**.

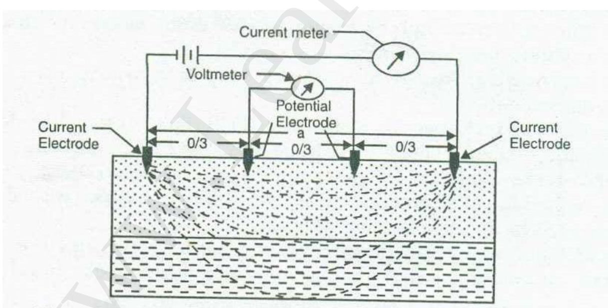
- All electrical method is based on the fundamental fact that different materials of earth's crust possess widely different electrical properties.
- Resistivity, electrochemical activity and dielectrical constant are some of

these properties that are generally studied through these methods

- Potential-drop methods: the natural potential may be due to electrochemical reactions between the solutions and the surrounding - subsurface rocks.
- Elongated ore bodies of magnetite and pyrite etc. are easily delineated by this method.
- Natural electrical potential is measured with the help of non polarising electrodes along definite directions and results are plotted in terms of potential gradient along horizontal distances which are then interpreted.

POTENTIAL DROP METHODS.

- These include a variety of methods in which electrical current is artificially introduced from an external source at certain points and then its flow through subsurface materials recorded at different distances.
- In the Equipotential Method two primary electrodes are inserted into the ground, 6-7 meters apart from each other, across which current is introduced.
- The position of these primary electrodes remains fixed in the subsequent investigations.
- Potential between these primary electrodes is determined with the help of two search electrodes and points of equal potential found out along the entire region under investigations, which are jointed to get equipotential lines.



- Under normal conditions, that is, when the material below is of uniform nature, electrically the ec lines would be regular in character.
- But in cases when the material is not of uniform character (that is, it contains patches of high or low conductivity), equipotential lines would show clear distortions or irregularities which would include probable location of rock masses of different characteristics.
- The Resistivity Method is similar to equipotential method but in this case it is

the resistivity of the material of the subsurface which is determined and from which important interpretations are made

- Here also, a known current is introduced through two electrodes- current electrodes, which are inserted at some distances apart from each other.,

$$\rho = 2\pi \frac{d.v}{I}$$

INVESTIGATION

- The depth of penetration of electrical current in these investigations is broadly equal to although there are many conditions attached to this generalization.
- The resistivity method envisages interpretation of the qualitative as well as quantitative characters of the subsurface materials which are governed by two basic principles

(i) If material below is of uniform nature, the resistivity values would be of regular character.

(ii) If the material is non-uniform, that is, it consists of layers or masses of different character, and then these would be indicated by irregularities or anomalies in the resistivity values.

(iii) The depths at which these anomalies occur can be calculated and also the nature of the subsurface material broadly understood.

APPLICATIONS:

(a) **IN PROSPECTING**: The electrical methods have been successfully employed in delineation of ore bodies occurring at shallower depths. For such surveys at great depths, these are not of much help.

As may be seen, rocks exhibit a great variation.

IN CIVIL ENGINEERING: Resistivity methods have been widely used in engineering investigation for determination of

DEPTH TO THE BED ROCK —as for instance, in important projects like dams, buildings and bridge foundations, where it would be desirable that the structure should rest on sound hard rocks rather than on overburden or soil

LOCATION OF GEOLOGICAL STRUCTURES —like folds, buried valleys, crushed and fractured zones due to shearing and faulting.

LOCATION OF AQUIFERS —and other water bearing zones which could be easily interpreted on the basis of known resistivity values of moisture rich rocks and dry rocks.

5. Explain in detail, the seismic methods used in the civil engineering investigations (NOV/DEC 2012)REG 2008

PRINCIPLE.

- Shocks or explosions within the earth' s crust are always accompanied by generation of elastic waves, which travel in all directions from the point or place of shock, the focus.
- Velocity of these shock waves is related to the nature of the medium through which they travel. In nature these waves are produced during earthquakes. The seismic waves reveal a great deal of information about the internal constitution of the earth.
- Although different types of waves are generated when a shock occurs, these are the P waves (longitudinal waves), which are the fastest and strongest. Their velocity, Vp, is related broadly to the medium (rocks) through the following equation:

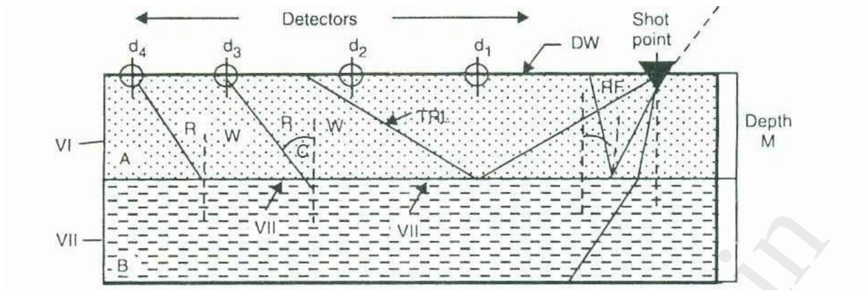
$$Vp = \left[E \cdot \frac{(1-v)}{e(1+v)(1-2v)} \right]^{1/2}$$

- where E is Modulus of elasticity, e is density and v is the Poisson' s Ratio of the medium.
- The controlling factor is, obviously, the modulus of elasticity which itself is dependent upon nature of rock, its chemical and mineralogical composition, degree of freedom from structural discontinuities and degree of saturation with water and other fluids.
- From experimental investigations, characteristic velocity values for P waves have been broadly established for different rock types.
- As such, if the velocity of seismic waves travelling through a section of the ground is known, nature of the ground can be fairly assessed.
- This is the underlying principle of all the seismic methods.

METHOD.

The fundamental procedure in all seismic investigations for subsurface explorations is the same: a shock is created at a chosen point or location either by exploding a charge, of dynamite;

The waves so produced are recorded at different distances from the shot point with the help of geophones or special detectors.



- The instant of shot, that is the shot time and the first arrival are recorded very carefully from which time –distance plots are prepared in a selected manner.
- A proper interpretation of these time-distance plots may reveal presence of unusually high or low velocity media at certain depths.
- Reflection methods have been found especially useful for subsurface studies under bodies of water (e.g. lakes, rivers, and estuaries) because in such surveys signals from surface and shear waves are obliterated by water and arrival times of only longitudinal waves are recorded clearly and easily.
- It may be pointed out that for correct inferences, it is imperative that reflection and refraction records are properly distinguished.
- These demand considerable skill and expertise.

UNIT V

PART A

1. WHAT IS MOSAIC? (MAY/JUNE 2013)

An assemblage of aerial photographs whose edges have usually been cut & matched to form a continuous photographic representation of a particular area is mosaic.

2. DEFINE FLOWAGE?(MAY/JUNE 2016), (NOV/DEC 2014), (MAY/JUNE 2013)

It is defined as a downward movement of unconsolidated superficial landmass along no definite surface of failure in a highly irregular manner.

3. HOW FAULTS IDENTIFIED IN AERIAL PHOTO? (NOV/DEC 2012)

- As linear features
- As presence of fault scraps
- By omission of strata

4. EXPLAIN STANDUP TIME (NOV/DEC 2012)

It is defined as the time elapsed after excavation that an unsupported tunnel face will remain stable.

5. EXPLAIN OVER BREAK? (NOV/DEC 2012)

Blasting in tunneling leads to overbreak.Overbreak is defined as excess and unwanted excavation (or) removal of rocks more than what is required in design of tunneling.

6. EXPLAIN THE AFFECT OF JOINTS IN ROCK WHERE A TUNNEL IS TO BE CONSTRUCTED? (MAY/JUNE 2012)

There will be percolation of water through the joints during heavy raining which may render the rocks becoming weaker and hence the tunnel may lose the support from the rocks.

The vibrations caused due to heavy traffic through tunneling will create transfer roof and its sides.It will cause widening of joints which may reduce the life of the tunnel.

7. LIST SOME METHODS TO PREVENT COASTAL EROSION. (NOV/DEC 2014), (MAY/JUNE 2012)

a. By constructing sea walls

b. By laying grass dykes along the coast.

c. By beach nourishment

d. By sand dune reconstruction.

8. DEFINE REMOTE SENSING. (MAY/JUNE 2016),(NOV/DEC 2013)

Remote Sensing is defined as the technique of acquiring information about an object, earth surface (or) phenomena, without coming into contact with them through sensing & recording of reflected (or) EMR energy from the targets of interest & processing , analyzing & applying that information to solve any specific problem.

9. LIST OUT THE CAUSES OF LAND SLIDING.(APR/MAY2015), (NOV/DEC 2013)

- Slope Failure
- Movement of tectonic platos
- Earthquake
- Heavy Rainfall
- Artificial causes like mining , over exploitation of oil & gas ,ground water etc.,

10. DEFINE LANDSLIDE (MAY/JUNE 2014)

A Landslide is a slow or sudden down hill movement of slope forming rock and soil materials under the force of gravity.

11. DEFINE THE TERM DEAD STORAGE RESERVOIR. (MAY/JUNE 2016)

Volume of water which is not available for use and is represented by the water stored in the reservoir below the minimum pool level.

12. WHAT IS MEANT BY ROCK BOLTING? (MAY/JUNE 2016)

Rock Bolting is perhaps the most popular and prevalent method for keeping the fractured rocks together in and around tunnel openings.

13. WHAT ARE THE GEOLOGICAL CONDITIONS STUDIED DURING THE ROAD CUTTINGS FOR ROAD SAFETY? (MAY/JUNE 2011)

- Lithological Character
- Topography
- Weathering
- Geological Structure

- Ground water condition.

PART B

1. Explain the geological consideration for the construction of tunnels (MAY/JUN 2011) REG 2008

- Lithology
- Structural characteristics of rocks
- Ground water conditions

LITHOLOGY

The mineal composition, texture and structure of rocks are needed to decide the method and alignment of tunnels

Blasting Required

Total cost of tunnelling

- ✓ Hard, compact, crystalline rocks like granites, quartzite, gneisses will be most suitable, but require blasting.
- ✓ Soft rocks like limestone, shale etc will not be self supporting and hence temporary or permanent lining may be required.

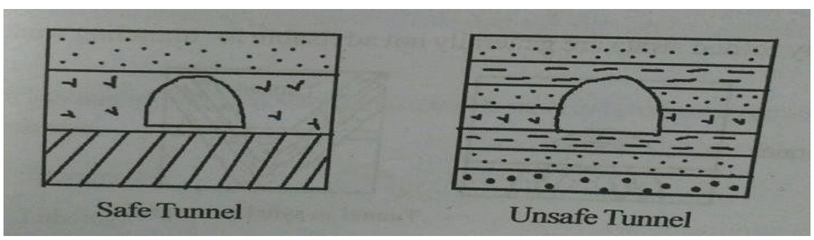
STRUCTURAL CHARACTERISTICS OF ROCKS

i) HORIZONTAL STRATA:

They are quite favourable, but they are rare in occurrence and suitable for small tunnels.

In the first case, the tunnel is driven through a single layer and each layer is sufficiently thick. The top layer will act as a natural beam, applying same and uniform load. Hence this situation is safe and favourable.

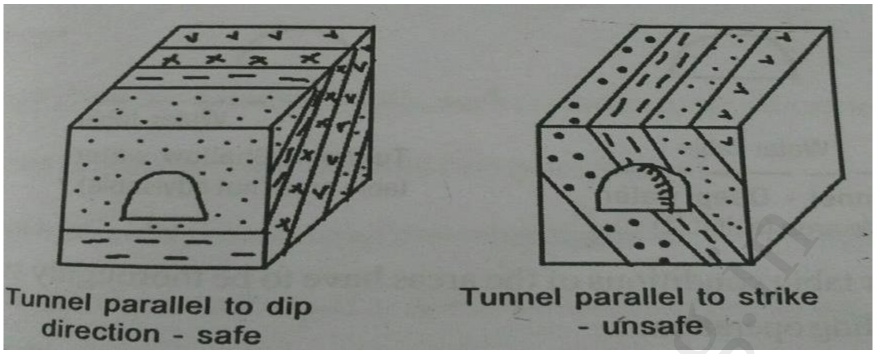
In the second case, there are heterogeneous multi layer of rocks through which the tunnel is aligned. Hence differential load will be exerted by the strata and hence unsafe.



ii) DIP AND STRIKE

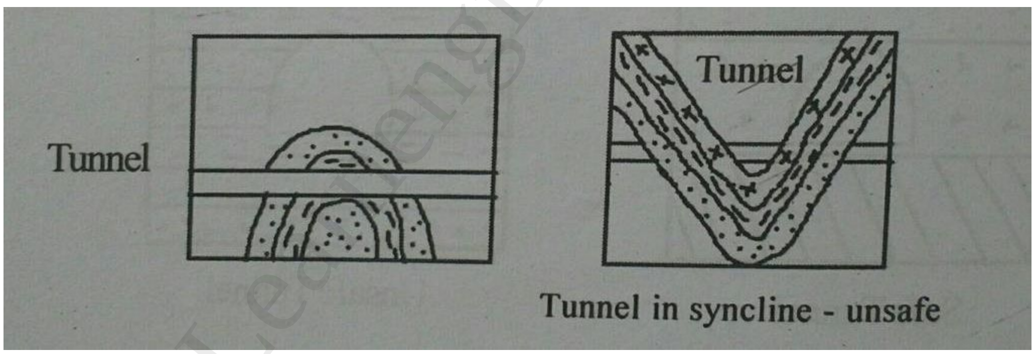
When tunnel axis is parallel to the dip direction the strata will apply uniformly distributed load and hence it is favourable situation.

So tunnel axis parallel to strike direction is an unsafe situation, due to layering.



iii) FOLDED STRATA

In folded strata, a lot of strain energy will be stored within the rocks. when excavations are made in folded strata, there may be a sudden release of strain energy, leading to rock bursting.



iv) JOINTED STRATA

Joined strata, whether slightly, moderately or severly may be taken into consideration for tunnelling work, provided proper lining should be done along the wall and roof of tunnel to avoid seepage of water during rainy season.

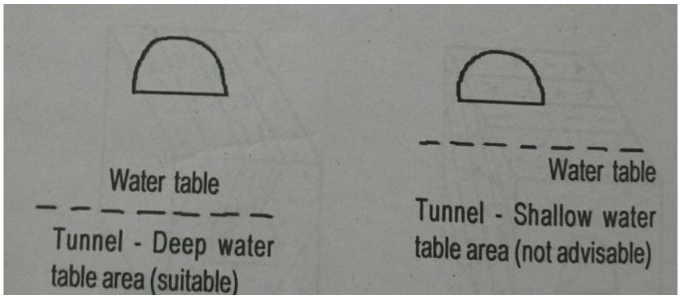
GROUND WATER CONDITIONS

i) WATER TABLE DEPTH

Where the water table is deep, such a site is best suited for tunnelling work in terms of ground water consideration.

ii) SHALLOW WATER TABLE

In shallow water table areas, ground water will be entering into tunnel. Hence it is not advisable.



2. Explain in detail about geological consideration for the design and construction of road cuttings (NOV/DEC 2013) REG 2008

The following are the factors to be considered while selecting site for roadways

- ❖ Topogyaphy
- ❖ Lithology
- ❖ Structural characteristics of rocks
- ❖ Weathering condition
- ❖ Ground water conditions`

1. TOPOGRAPHY

It refers land features or land forms such as valley, hilly terrain, plains, plateau etc. The topography of an area plays a significant role in the alignment of roadways. Proper L.S and C.S surveying should be carried out to know reduced level to arrive the decision on quantity of cutting and fitting for road alignment.

2. LITHOLOGY

It gives the details of rock such as their composition, texture, origin etc.

The terrain is classified into

- Hard rock terrain: Made up of consolidated, massive and hard bed rock.
- Soft rock terrain: made up of soft and unconsolidated strata.

3. STRUCTURAL CHARACTERISTICS OF ROCKS

The factors to be considered

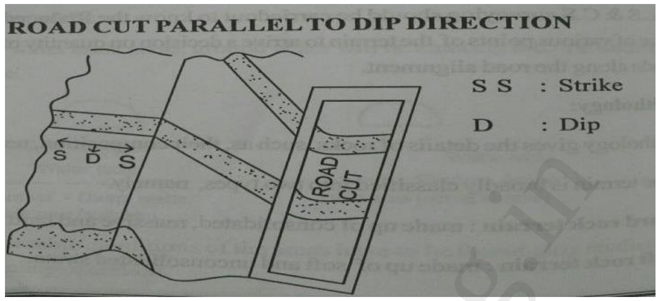
- ▪ Dip and strike
- ▪ Joints and
- ▪ Faults

DIP AND STRIKE

Three cases are considered

a) Road cut parallel to dip direction

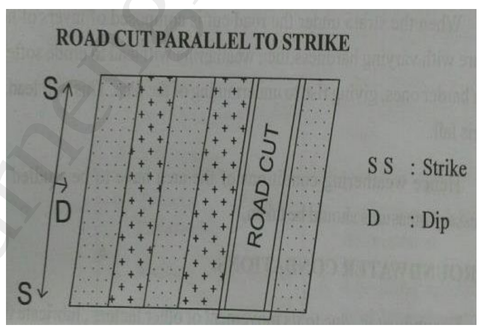
In this case the strata will offer an uniform behaviour on either side of roadcut and hence the risk of failure is minimal in this case.



b) Road cut parallel to strike

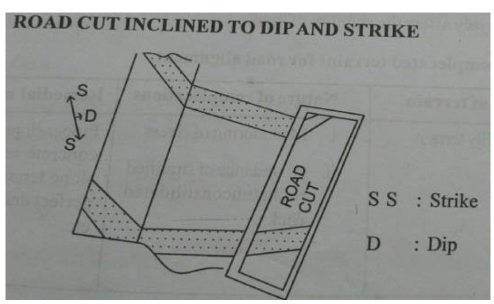
When **dip inside the road cut**, there is likely to have slip or fall of materials if the rocks are lubricated with rain or ground water.

When **strata dipping into hill,** the slope of roadcut will be equal on both sides. This situation would result in similar difficulties as dip.



c) Road cut inclined to dip and strike

In this case the slope of the roadcut will be unequal on both side.



4. WEATHERING CONDITION

When the strata under the road cut is composed of layers of heterogeneous nature with varying hardness, the weathering will lead to erode soft layers faster than harder ones, giving rise to undermining of face. This lead to rock fall or debris fall.

5. GROUNDWATER CONDITION

Groundwater due to its movement or other factors lubricates the rock strata and their bearing capacity. Hence the water table should be studied thoroughly in the proposed site.

Deeper the water table, safer the roadcut and vice versa. Shallow water table condition will lead to intersect the slope or base of road alignment. This situation is quite dangerous and unable to bear the designed loads leading to adversely affect the stability of road.

3. Describe the causes of sea erosion and methods of coastal protection. (MAY/JUNE 2011 Regulation 2008)

COASTAL EROSION

Coastal erosion is the wearing away of land and the removal of beach or dune sediments by wave action, tidal currents, wave currents, drainage or high winds. Waves, generated by storms, wind, or fast moving motor craft, cause coastal erosion, which may take the form of long-term losses of sediment and rocks, or merely the temporary redistribution of coastal sediments; erosion in one location may result in accretion nearby. The study of erosion and sediment redistribution is called 'coastal morphodynamics'. It may be caused by hydraulic action, abrasion, impact and corrosion.

On non-rocky coasts, coastal erosion results in dramatic (or non-dramatic) rock formations in areas where the coastline contains rock layers or fracture zones with varying resistance to erosion. Softer areas become eroded much faster than harder ones, which typically result in landforms such as tunnels, bridges, columns, and pillars. Also abrasion commonly happens in areas where there are strong winds, loose sand, and soft rocks. The blowing of millions of sharp sand grains creates a sandblasting effect. This effect helps to erode, smooth and polish rocks. The definition of abrasion is grinding and wearing away of rock surfaces through the mechanical action of other rock or sand particles.

WAVE ACTION

HYDRAULIC ACTION

Hydraulic action occurs when waves striking a cliff face compress air in cracks on the cliff face. This exerts pressure on the surrounding rock, and can progressively splinter and remove pieces. Over time, the cracks can grow, sometimes forming a cave. The splinters fall to the sea bed where they are subjected to further wave action.

ATTRITION

Attrition occurs when waves causes loose pieces of rock debris (scree) to collide with each other, grinding and chipping each other, progressively becoming smaller, smoother and rounder. Scree also collides with the base of the cliff face, chipping small pieces of rock from the cliff or have a corrasion (abrasion) effect, similar to sandpapering.

SOLUTION

Acids contained in sea water will dissolve some types of rock such as chalk or limestone.

CORRASION

Corrasion or otherwise known as abrasion occurs when waves break on cliff faces and slowly erode it. As the sea pounds cliff faces it also uses the scree from other wave actions to batter and break off pieces of rock from higher up the cliff face which can be used for this same wave action and attrition.

CORROSION

Corrosion or solution/chemical weathering occurs when the sea's pH (anything below pH 7.0) corrodes rocks on a cliff face. Limestone cliff faces, which have a moderately high pH, are particularly affected in this way. Wave action also increases the rate of reaction by removing the reacted material.

FACTORS THAT INFLUENCE EROSION RATES

PRIMARY FACTORS

The ability of waves to cause erosion of the cliff face depends on many factors.The hardness (or inversely, the erodibility) of sea-facing rocks is controlled by the rock strength and the presence of fissures, fractures, and beds of non-cohesive materials such as silt and fine sand.

The rate at which cliff fall debris is removed from the foreshore depends on the power of the waves crossing the beach. This energy must reach a critical level to remove material from the debris lobe. Debris lobes can be very persistent and can take many years to completely disappear.

Beaches dissipate wave energy on the foreshore and provide a measure of protection to the adjoining land.

The stability of the foreshore, or its resistance to lowering. Once stable, the foreshore should widen and become more effective at dissipating the wave energy, so that fewer and less powerful waves reach beyond it. The provision of updrift material coming onto the foreshore beneath the cliff helps to ensure a stable beach.

The adjacent bathymetry, or configuration of the seafloor, controls the wave energy arriving at the coast, and can have an important influence on the rate of cliff erosion. Shoals and bars offer protection from wave erosion by causing storm waves to break and dissipate their energy before reaching the shore. Given the dynamic nature of the seafloor, changes in the location of shoals and bars may cause the locus of beach or cliff erosion to change position along the shore.

SECONDARY FACTORS

- Weathering and transport slope processes
- Slope hydrology
- Vegetation
- Cliff foot erosion
- Cliff foot sediment accumulation
- Resistance of cliff foot sediment to attrition and transport
- Human Activity

TERTIARY FACTORS

1. Resource extraction 2. Coastal management

COASTAL EROSION CONTROL STRATEGIES

There are three common forms of coastal erosion control methods. These three include: soft-erosion controls, hard-erosion controls, and relocation.

HARD-EROSION CONTROLS

Hard-erosion control methods provide a more permanent solution than soft-erosion control methods. Seawalls and groynes serve as semi-permanent infrastructure. These structures are not immune from normal wear-and-tear and will have to be refurbished or rebuilt. It is estimated the average life span of a seawall is 50–100 years and the average for a groyne is 30–40 years. Because of their relative permanence, it is assumed that these structures can be a final solution to erosion. Seawalls can also deprive public access to the beach and drastically alter the natural state of the beach. Groynes also drastically alter the natural state of the beach. Some claim that groynes could reduce the interval between beach nourishment projects though they are not seen as a solution to beach nourishment.

Natural forms of hard-erosion control include planting or maintaining native vegetation, such as mangrove forests and coral reefs.

SOFT-EROSION CONTROLS

Soft erosion strategies refer to temporary options of slowing the effects of erosion. These options, including Sandbag and beach nourishment, are not intended to be long term solutions or permanent solutions. Another method, beach scraping or beach bulldozing allows for the creation of an artificial dune in front of a building or as means of preserving a building foundation. However, there is a U.S. federal moratorium on beach bulldozing during turtle nesting season, 1 May – 15 November. One of the most common methods of soft erosion control is beach nourishment projects. These projects involve dredging sand and moving it to the beaches as a means of reestablishing the sand lost due to erosion.

RELOCATION

Under this response, humans move from the coast and surrender the coast to the natural processes of both absolute and relative sea level rise and erosion. This solution is eco-centric meaning that the focus is on forcing humans to adapt to the natural processes rather than the opposite. By removing structures along the oceanfront, the beach is surrendered to the natural forces of the ocean. In this case, property owners and coastal communities are essentially "retreating" from the sea. Typically, there has been low public support for "retreating. However, this would be most effective in reducing the impacts of erosion on human society.

TRACKING

Storms can cause erosion hundreds of times faster than normal weather. Before-and-after comparisons can be made using data gathered by manual surveying, laser altimeter, or even a GPS unit mounted on an ATV. Remote sensing data such as Landsat scenes can be used for large scale and multiyear assessments of coastal erosion.

METHODS OF COASTAL PROTECTION

HARD ENGINEERING METHODS

GROYNES

Groynes are barriers or walls perpendicular to the sea, often made of greenharts, concrete, rock or wood. Beach material builds up on the downdrift side, where littoral drift is predominantly in one direction, creating a wider and a more plentiful beach, therefore enhancing the protection for the coast because the sand material filters and absorbs the wave energy. However, there is a corresponding loss of beach material on the updrift side, requiring that another groyne to be built there. Moreover, groynes do not protect the beach against storm-driven waves and if placed too close together will create currents, which will carry sand material offshore.

Groynes are extremely cost-effective coastal defence measures, requiring little maintenance, and are one of the most common coastal defence structures.

SEA WALLS

Walls of concrete or rock, built at the base of a cliff or at the back of a beach, are used to protect a settlement against erosion or flooding. They are usually about 3–5 metres (10–16 ft) high. Older-style vertical seawalls reflected all the energy of the waves back out to sea, and for this purpose were often given recurved crest walls which also increase the local turbulence, and thus increasing entrainment of sand and sediment. During storms, sea walls help longshore drift.

Modern seawalls aim to re-direct most of the incident energy, resulting in low reflected waves and much reduced turbulence and thus take the form of sloping revetments. Current designs use porous designs of rock, concrete armour

(Seabees, SHEDs, Xblocs) with intermediate flights of steps for beach access, whilst in places where high rates of pedestrian access are required, the steps take over the whole of the frontage, but at a flatter slope if the same crest levels are to be achieved.

Sea walls can cause beaches to dissipate, rendering them useless for beach goers. Their presence also scars the very landscape that they are trying to save.

REVETMENTS

Wooden slanted or upright blockades, built parallel to the sea on the coast, usually towards the back of the beach to protect the cliff or settlement beyond. The most basic revetments consist of timber slants with a possible rock infill. Waves break against the revetments, which dissipate and absorb the energy. The cliff base is protected by the beach material held behind the barriers, as the revetments trap some of the material. They may be watertight, covering the slope completely, or porous, to allow water to filter through after the wave energy has been dissipated. Most revetments do not significantly interfere with transport of longshore drift. Since the wall greatly absorbs the energy instead of reflecting, it erodes and destroys the revetment structure; therefore, major maintenance will be needed within a moderate time of being built, this will be greatly determined by the material the structure was built with and the quality of the product.

GABIONS

Boulders and rocks are wired into mesh cages and usually placed in front of areas vulnerable to heavy erosion: sometimes at cliffs edges or jag out at a right angle to the beach like a large groyne. When the seawater breaks on the gabion, the water drains through leaving sediments, also the rocks and boulders absorb a moderate amount of the wave energy.

Gabions need to be securely tied to prevent abrasion of wire by rocks, or detachment of plastic

CLIFF STABILIZATION

Cliff stabilization can be accomplished through drainage of excess rainwater of through terracing, planting, and wiring to hold cliffs in place. Cliff drainage is used to hold a cliff together using plants, fences and terracing, this is used to help prevent landslides and other localized damage.

ENTRANCE TRAINING WALLS

Rock or concrete walls built to constrain a river or creek discharging across a sandy coastline. The walls help to stabilise and deepen the channel which benefits navigation, flood management, river erosion and water quality but can cause coastal erosion due to the interruption of longshore drift.

FLOODGATES

Storm surge barriers, or floodgates, were introduced after the North Sea Flood of 1953 and are a prophylactic method to prevent damage from storm surges or any other type of natural disaster that could harm the area they "protect". The Thames Barrier is an example of such a structure.

SOFT ENGINEERING METHODS

BEACH REPLENISHMENT

Beach replenishment or nourishment is one of the most popular soft engineering techniques of coastal defence management schemes. This involves importing sand off the beach and piling it on top of the existing sand. The imported sand must be of a similar quality to the existing beach material so it can integrate with the natural processes occurring there, without causing any adverse effects. Beach nourishment can be used alongside the groyne schemes.

SAND DUNE MANAGEMENT

Sand dune stabilisation or sand dune management works using a number of different methods in order to prevent the loss of sediment on the beach. Firstly the introduction of public amenities such as car parks, footpaths, Dutch Ladders and boardwalks, stop the removal of sediment by humans. Secondly, education of visitors with noticeboards, leaflets and beach wardens explain to visitors how to avoid damaging the area. Thirdly, by using fences constructed of simple materials such as wood, sand traps can create Blowouts.

Beach drainage

Beach drainage or beach face dewatering lowers the water table locally beneath the beach face. This causes accretion of sand above the drainage system.

4. Explain the causes and prevention of Landslides(May/June 2011) Reg 2008

The causes of landslides are usually related to instabilities in slopes. It is usually possible to identify one or more landslide causes and one landslide trigger. The difference between these two concepts is subtle but important. The landslide causes are the reasons that a landslide occurred in that location and at that time. Landslide causes are listed in the following table, and include geological factors, morphological factors, physical factors and factors associated with human activity.

GEOLOGICAL CAUSES

- Weathered materials
- Sheared materials
- Jointed or fissured materials
- Adversely orientated discontinuities
- Permeability contrasts
- Material contrasts
- Rainfall and snow fall
- Earthquakes

MORPHOLOGICAL CAUSES

- Slope angle
- Uplift
- Rebound
- Fluvial erosion
- Wave erosion
- Glacial erosion
- Erosion of lateral margins

- Subterranean erosion
- Slope loading
- Vegetation change
- Erosion

PHYSICAL CAUSES

TOPOGRAPHY

- Slope Aspect and Gradient

GEOLOGICAL FACTORS

- Discontinuity Factors (Dip Spacing, Asparity, Dip and length)
- Physical Characteristics of the Rock (Rock Strength etc.)

TECTONIC ACTIVITY

- Seismic activity (Earthquakes)
- Volcanic eruption

PHYSICAL WEATHERING

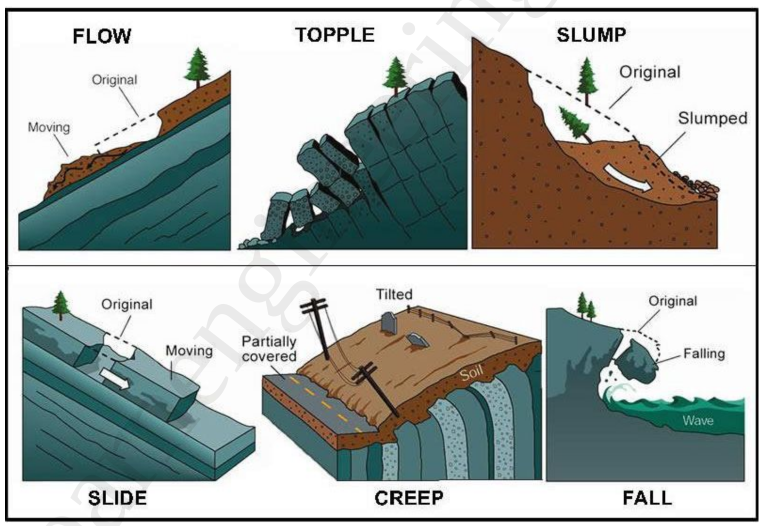
- Thawing
- Freeze-thaw
- Soil erosion

HYDROGEOLOGICAL FACTORS

- Intense rainfall
- Rapid snow melt
- Prolonged precipitation
- Ground water changes (Rapid drawdown)
- Soil pore water pressure
- Surface runoff

HUMAN CAUSES

- Deforestation
- Excavation
- Loading
- Water management (Groundwater Draw-down and Water leakage)
- Land use (e.g. construction of roads, houses etc.)
- Mining and Quarrying
- Vibration
- Pollution



LANDSLIDE CLASSIFICATION

Types of Landslides

- fall (by undercutting)
- fall (by toppling)
- slump
- rockslide
- earth flow
- rockslide that develops into rock avalanche

a. TYPE OF MOVEMENT

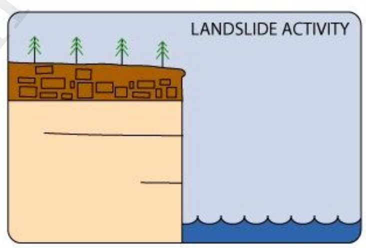
This is the most important criteria, even if uncertainties and difficulties can arise in the identification of movements, being the mechanisms of some landslides often particularly complex. The main movements are falls, slides and flows, but usually topples, lateral spreading and complex movements are added to these.

b. INVOLVED MATERIAL

Rock, earth and debris are the terms generally used to distinguish the materials involved in the landslide process. For example, the distinction between earth and debris is usually made by comparing the percentage of coarse grain size fractions. If the weight of the particles with a diameter greater than 2 mm is less than 20%, the material will be defined as earth; in the opposite case, it is debris.

c. ACTIVITY

The classification of a landslide based on its activity is particularly relevant in the evaluation of future events. The recommendations of the WP/WLI (1993) define the concept of activity with reference to the spatial and temporal conditions, defining the state,



the distribution and the style. The first term describes the information regarding the time in which the movement took place, permitting information to be available on future evolution, the second term describes, in a general way, where the landslide is moving and the third term indicates how it is moving.

d. MOVEMENT VELOCITY

This factor has a great importance in the hazard evaluation. A velocity range is connected to the different type of landslides, on the basis of observation of case history or site observations.

e. THE AGE OF THE MOVEMENT

Landslide dating is an interesting topic in the evaluation of hazard. The knowledge of the Landslide frequency is a fundamental element for any kind of probabilistic evaluation. Furthermore, the evaluation of the age of the landslide permits to correlate the trigger to specific conditions, as earthquakes or periods of intense rains. It should be noted that, it is possible that phenomena could be occurred in past geological times, under specific environmental conditions which no longer act as agents today. For example, in some Alpine areas, landslides of the Pleistocene age are connected with particular tectonic, geomorphological and climatic conditions.

f. GEOLOGICAL CONDITIONS

This represents a fundamental factor of the morphological evolution of a slope. Bedding attitude and the presence of discontinuities or faults control the slope morphogenesis.

g. MORPHOLOGICAL CHARACTERISTICS

As the landslide is a geological volume with a hidden side, morphological characteristics are extremely important in the reconstruction of the technical model.

h. GEOGRAPHICAL LOCATION

This criterion describes, in a general way, the location of landsides in the physiographic context of the area. Some authors have therefore identified landslides according to their geographical position so that it is possible to describe "alpine landslides", "landslides in plains", "hilly landslides" or "cliff landslides". As a consequence, specific morphological contexts are referred characterised by slope evolution processes.

PREVENTION AND REMEDIATION OF LANDSLIDES

Many methods are used to remedy landslide problems. The best solution, of course, is to avoid landslide-prone areas altogether. Before purchasing land or an existing structure or building a new structure, the buyer should consult an engineering geologist or a geotechnical engineer to evaluate the potential for landslides and other geology-related problems.

Listed below are some common remedial methods used when landslide-prone slopes cannot be avoided. There is no guarantee that any one method or combination thereof will completely stabilize a moving hillside.

Improving surface and subsurface drainage:

Because water is a main factor in landslides, improving surface and subsurface drainage at the site can increase the stability of a landslide-prone slope. Surface water should be diverted away from the landslide-prone region by channeling water in a lined drainage ditch or sewer pipe to the base of the slope. The water should be diverted in such a way as to avoid triggering a landslide adjacent to the site. Surface water should not be allowed to pond on the landslide-prone slope.

Ground water can be drained from the soil using trenches filled with gravel and perforated pipes or pumped water wells. Swimming pools, water lines, and sewers should be maintained to prevent leakage, and the watering of lawns and vegetation should be kept to a minimum. Clayey soils and shales have low hydraulic conductivity and can be difficult to drain.

EXCAVATING THE HEAD:

Removing the soil and rock at the head of the landslide decreases the driving pressure and can slow or stop a landslide. Additional soil and rock above the landslide will need to be removed to prevent a new landslide from forming upslope. Flattening the slope angle at the top of the hill can help stabilize landslide-prone slopes.

BUTTRESSING THE TOE:

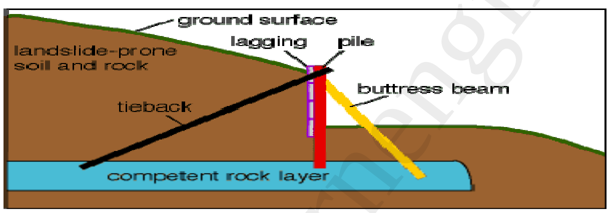
If the toe of the landslide is at the base of the slope, fill can be placed over the toe and along the base of the slope. The fill increases the resisting forces along the failure surface in the toe area. This, in turn, blocks the material in the head from moving toward the toe. However, if the toe is higher on the slope, adding fill would overload the soil and rock below the toe, thus causing a landslide to form downslope of the fill.

CONSTRUCTING PILES AND RETAINING WALLS:

Piles are metal beams that are either driven into the soil or placed in drill holes. Properly placed piles should extend into a competent rock layer below the landslide. Wooden beams and telephone poles are not recommended for use as piles because they lack strength and can rot.

Because landslides can ooze through the gaps between the piles, retaining walls are often constructed. Retaining walls can be constructed by adding lagging (metal, concrete, or wooden beams) horizontally between the piles. Such walls can be further strengthened by adding tiebacks and buttressing beams. Tiebacks are long rods that attach to the piles and to a competent rock layer below the ground surface. Buttressing beams are placed at an angle down slope of the piles to prevent the piles from toppling or tilting. Retaining walls also are constructed of concrete, cinder blocks, rock, railroad ties, or logs, but these may not be strong enough to resist landslide movement and could topple.

Diagram of a retaining wall with tiebacks and buttress beams. Tiebacks are metal rods that extend from the piles to a competent rock layer below the ground surface. Buttress beams are metal beams that are inclined downslope from the piles that prevent the piles from toppling. Lagging consists of wooden, metal, or concrete beams placed upslope and between the piles to fill in the gaps.



REMOVAL AND REPLACEMENT:

Landslide-prone soil and rock can be removed and replaced with stronger materials, such as silty or sandy soils. Because weathering of shales can form landslide-prone soils, the removal and replacement procedure must include measures to prevent continued weathering of the remaining rock. Landslide material should never be pushed back up the slope. This will simply lead to continued motion of the landslide.

PRESERVING VEGETATION:

Trees, grasses, and vegetation can minimize the amount of water infiltrating into the soil, slow the erosion caused by surface-water flow, and remove water from the soil.

ROCK FALL PROTECTION:

Rock falls are contained by

(1) ditches at the base of the rock exposure,

(2) heavy-duty fences, and

(3) concrete catch walls that slow errant boulders that have broken free from the rock outcrop.

In some cases, loose blocks of rock are attached to bedrock with rock bolts, long metal rods that are anchored in competent bedrock and are threaded on the outside for large nuts. A metal plate with a center hole, like a very large washer, is placed over the end of the rod where it extends from the loose block, and the nut is then added and tightened. Once constructed, remedial measures must be inspected and maintained. Lack of maintenance can cause renewed landslide movement

5. Describe how remote sensing is utilized for civil engineering projects

(May/June 2013)

Radar Imaging Satellite 1, or RISAT-1, is an Indian remote sensing satellite which was built and is operated by the Indian Space Research Organisation (ISRO). The second RISAT satellite to be launched, it uses C-band 5.35 GHz Synthetic Aperture Radar for earth observation irrespective of the light and weather conditions of the area being imaged.

The launch of RISAT-1 came several years after that of RISAT-2, which carried an Israeli-built x-band radar. The RISAT-2 mission was prioritised over RISAT-1 following the 2008 Mumbai attacks, resulting in RISAT-1 being delayed by several years.

Spacecraft

RISAT-1 had a mass at liftoff of 1,858 kilograms (4,096 lb), making it the heaviest earth observation satellite to be launched by India, and the heaviest satellite to be launched using a Polar Satellite Launch Vehicle. has the capability to take images of Earth during day and night, as well as in cloudy conditions.

The satellite is equipped with a 160 × 4 Mbps data handling system, 50 Newton-metre-second reaction wheels, and a phased array antenna with dual polarisation. Its synthetic aperture radar has a resolution of 3m-50m. It also supports a spotlight mode for prolonged focus on a given geographical area at a resolution of 1m. Most of the design and the installation of basic instrument subsystems for the satellite was conducted in 2010.

The mission has an approximate cost of 4.9 billion (US$73 million)the spacecraft itself cost 3.78 billion (US$56 million) to develop, and a further 1.1 billion (US$16 million) to launch. The satellite has a design life of five years.

Synthetic aperture radar allows RISAT-1 to collect data during both day and night and in all weather conditions. The satellite is intended to be used for natural resources management, primarily agriculture planning and forestry surveys, as well as to predict and prevent flooding. It will be used for monitoring paddy plantations and yields in the kharif season and to assist India's food security planning. Pictures from RISAT-1 will be used to estimate the number of hectares being farmed in India, to assess crop health and predict total yield. They can also be used to identify wreckage from aircraft which go down in forested areas. RISAT-1 was not designed as a surveillance satellite, given its reliance on the C-band.

RISAT-1

Radar Satellite-1 (RISAT-1) is a state of the art Microwave Remote Sensing Satellite carrying a Synthetic Aperture Radar (SAR) Payload operating in C-band (5.35 GHz), which enables imaging of the surface features during both day and night under all weather conditions.

Application

Active Microwave Remote Sensing provides cloud penetration and day-night imaging capability. These unique characteristics of C-band (5.35GHz) Synthetic Aperture Radar enable applications in agriculture, particularly paddy monitoring in kharif season and management of natural disasters like flood and cyclone.

Mass	1858 kg
Orbit	Circular Polar Sun Synchronous
Orbit Altitude	536 km
Orbit Inclination	97.552
Orbit Period	95.49 min

Number of Orbits per day	14
Local Time of Equator Crossing	6:00 am / 6:00 pm
Power	Solar Array generating 2200 W and one 70 AH Ni-H2 battery
Repetivity	25 days
Attitude and Orbit Control	3-axis body stabilised using Reaction Wheels, Magnetic Torquers and Hydrazine Thrusters
Nominal Mission Life	5 years
Launch date	April 26, 2012
Launch site	SDSC SHAR Centre, Sriharikota, India
Launch vehicle	PSLV- C19

APPLICATION OF REMOTE SENSING

Various applications of remote sensing may be grouped into the following:

1. Resource exploration
2. Environmental study
3. Land use
4. Site investigation
5. Archaeological investigation and
6. Natural hazards study.
7. Landslide Studies
8. Transportation Network Analysis
9. Town Planning And Urban Development

10.Water Resources Engineering

1. **Resource Exploration:** Geologists use remote sensing to study the formation of sedimentary rocks and identify deposits of various minerals, detect oil fields and identify underground storage of water. Remote sensing is used for identifying potential fishing zone, coral reef mapping and to find other wealth from ocean.

2. **Environmental Study:** Remote sensing is used to study cloud motion and predict rains. With satellite data it is possible to study water discharge from various industries to find out dispersion and harmful effects, if any, on living animals. Oil spillage and oil slicks can be studied using remote sensing.

3. **Land Use**: By remote sensing, mapping of larger areas is possible in short time. Forest area, agricultural area, residential and industrial area can be measured regularly and monitored. It is possible to find out areas of different crops.

4**. Site Investigation**: Remote sensing is used extensively in site investigations for dams, bridges, pipelines. It can be used to locate construction materials like sand and gravel for the new projects.

5. **Archaeological Investigation:** Many structures of old era are now buried under the ground and are not known. But by studying changes in moisture content and other characteristics of the buried objects and upper new layer, remote sensors are able to recognise the buried structutures of archaeological importance.

6. **Natural Hazard Study:** Using remote sensing the following natural hazards can be predicted to some extent and hazards minimised:

1. Earthquake 2. Volcanoes

3.Landslides 4.Floods and

5.Hurricane and cyclones.

7.Landslide Studies

Landslides are the most common and recurring hazards in mountainous areas causing enormous loss of life and property every year. The parameters that contribute directly or indirectly include litho logy and structure, landform, slope, aspect, relief, vegetation cover, climatic and human activities. Information on these aspects can be collected and integrated for preparing a landslide hazard zone map that can be done through RS and GIS.

8.Transportation Network Analysis

With the help of high spatial resolution data, mapping of road and rail network can be accomplished. This facilitates in deciding optimal routing for transport of construction materials. Even, identification of village roads is possible in certain cases.

9. Town Planning And Urban Development

The unprecedented growth of urbanization in India has given rise to problems of housing, sanitation, power, water supply, disposal of effluents and environmental pollution. Systematic mapping and periodic monitoring of urban land use is therefore necessary for proper planning, management and policy making (with the help of RS and GIS optimal master plan for development and management of urban settlements can be prepared).

For sustainable development of urban agglomeration, optimal urban land use plans and resources development models need to be generated by integrating the information on natural resources, demographic and socio – economic data in a GIS domain with the currently available satellite data.

10. Water Resources Engineering

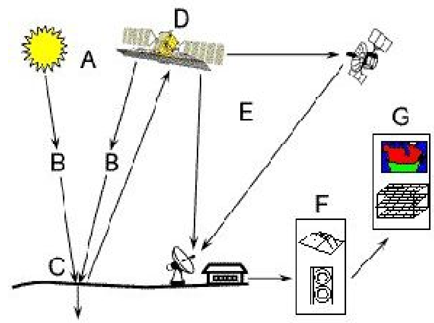
By analyzing multidate RS data, it would be possible to monitor the effects of dam construction. Remotely sensed data of pre and post dam construction can reveal the forest and other land at different water levels. This would also help in preliminary investigation of finding suitable areas for human resettlement.

Explain in detail about process of remote sensing(Nov/Dec 2013)

REMOTE SENSING

Remote sensing is the science (and to some extent, art) of acquiring information about the Earth's surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information."

In much of remote sensing, the process involves an interaction between incident radiation and the targets of interest. This is exemplified by the use of imaging systems where the following seven elements are involved. Note, however that remote sensing also involves the sensing of emitted energy and the use of non-imaging sensors.



1. **Energy Source or Illumination (A)** - the first requirement for remote sensing is to have an energy source which illuminates or provides electromagnetic energy to the target of interest.

2. **Radiation and the Atmosphere (B) -** as the energy travels from its source to the target, it will come in contact with and interact with the atmosphere it passes through. This interaction may take place a second time as the energy travels from the target to the sensor.

3. **Interaction with the Target (C)** - once the energy makes its way to the target through the atmosphere, it interacts with the target depending on the properties of both the target and the radiation.

4. **Recording of Energy by the Sensor (D)** - after the energy has been scattered by, or emitted from the target, we require a sensor (remote - not in contact with the target) to collect and record the electromagnetic radiation.

5. **Transmission, Reception, and Processing (E) -** the energy recorded by the sensor has to be transmitted, often in electronic form, to a receiving and processing station where the data are processed into an image (hardcopy and/or digital).

6. **Interpretation and Analysis (F)** - the processed image is interpreted, visually and/or digitally or electronically, to extract information about the target which was illuminated.

7. **Application (G) -** the final element of the remote sensing process is achieved when we apply the information we have been able to extract from the imagery about the target in order to better understand it.

INDUSTRIAL / PRACTICAL CONNECTIVITY OF THE SUBJECT

The methods used by engineering geologists in their studies include

- **Geologic field mapping** of geologic structures, geologic formations, soil units and hazards,
- The **review of geologic literature,** geologic maps, geotechnical reports, engineering plans, environmental reports, stereoscopic aerial photographs, remote sensing data, Global Positioning System (GPS) data, topographic maps and satellite imagery,
- **The excavation, sampling and logging of earth/rock materials in** drilled borings, backhoe test pits and trenches, fault trenching, and bulldozer pits;
- **Deformation monitoring** as the systematic measurement and tracking of the alteration in the shape or dimensions of an object as a result of the application of stress to it manually or with an automatic deformation monitoring system.

Reg. No. :

H 0679

B.E./B.TECH. DEGREE EXAMINATION, MAY/JUNE 2011

THIRD SEMESTER

CIVIL ENGINEERING

CE1201 APPLIED GEOLOGY

(REGULATION 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define weathering. Pg.no 8
2. What is an aquifer? Pg.no 7
3. Differentiate between cleavage and fracture. Pg.no 44
4. List out the places of Indian occurrences of coal.
5. How will you differentiate between igneous rock and sedimentary rock? Pg.no 64
6. What is the texture and mineralogical composition of gneiss?
7. What is strike of a bed? Pg.no 84
8. Differentiae between fan shooting and profile shooting.
9. Differentiate between radiometric resolution and temporal resolution.
10. What are the geological conditions studied during the road cuttings for road safety? Pg.no 104

PART B — (5 × 16 = 80 marks)

11. (a) Describe the work of wind with sketch. (8) Pg.no 29

(b) Explain the earthquake belts of India. (8) Pg.no 21

Or

12. (a) Describe the branches of geology and their importance in civil engineering. (8)

(b) Explain theory of plate tectonics, names of plates, and evidence of plate tectonics. Pg.no 21 (8)

13. (a) Describe the physical properties studied in the identification of minerals in hand specimen. Pg.no 47 (8)

(b) Explain various process of ore formation. (8)

Or

14. (a) Describe the physical properties, chemical composition and uses of feldspar family minerals. Pg.no 51 (8)

(b) Write the origin and geological occurrence of petroleum. Write the Indian occurrence of petroleum. (8)

15. (a) Describe the textures and structures of igneous rocks. Pg.no 64 (8)

(b) Write the description, distribution, occurrence and engineering properties of syenite, basalt and schist. Pg.no 62 (8)

Or

16. (a) Describe various structures, classification and distribution of sedimentary rocks. (8)

(b) Write the description, distribution, occurrence and engineering properties of gabbro, shale and slate. (8)

17. (a) Describe vaious classification of faults with sketch. Pg.no 93 (8)

(b) How are faults recognized in field? Add a note on importance of faults. (8) Pg.no 93

Or

18. (a) Describe the seismic survey for subsurface investigation. Pg.no 101 (8)

(b) Describe the effect of fold and joints on civil engineering projects. Pg.no 101 (8)

19. (a) Describe the characteristics of any one Indian remote sensing satellite with its civil engineering applications. Pg.no 123 (8)

(b) Explain the geological conditions necessary for driving tunnels. Pg.no 105 (8)

Or

20. (a) Describe the causes of sea erosion and methods of coastal protection. (8) Pg.no 109

(b) Explain the causes and prevention of landslides. Pg.no 116 (8)

Reg. No. :

Question Paper Code : 10122

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2012.

Third Semester

Civil Engineering

AG 2211/187301/AG 33/CE 1201/10111 CE 303/080100009 — APPLIED GEOLOGY

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Use neat sketches wherever necessary.

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Describe briefly, the layers of the interior of the earth. Pg.no 8
2. What is meant by a seismic zone? Pg.no 8
3. List the properties of calcite. Pg.no 46
4. Describe the Moh's scale of hardness of minerals. Pg.no 44
5. List a few textures of igneous rocks. Pg.no 64
6. Distinguish between limestone and shale. Pg.no 65
7. List the major differences between anticlines and synclines. Pg.no 54
8. What is a normal fault? Pg.no 85
9. Explain the effect of joints in rocks where a tunnel is to be constructed. Pg.no 103
10. List some methods to prevent coastal erosion. Pg.no 103

PART B — (5 × 16 = 80 marks)

11. (a) Give a detailed account of groundwater occurrence in rocks. Add a note on the porosity and permeability of rocks. Pg.no 42

Or

(b) Describe in detail how earthquakes are caused. Add a note on the earthquake prone belts of India. Pg.no 21

12. (a) What are the various physical properties of minerals. Give examples for each property and describe them in detail. Pg.no 47

Or

(b) Describe how coal and petroleum originate. Give a detailed account of their occurrence in India.

13. (a) Describe the petrological and engineering properties of the following rocks : Pg.no 72

(i) Schist (ii) Marble

(iii) Sandstone (iv) Gneiss.

Or

(b) Bring out the distinguishing characters and properties of Igneous, Sedimentary and Metamorphic rocks.

14. (a) What are folds in rocks? Classify them and describe each in detail. Pg.no 86

Or

(b) Explain the Electrical methods of geophysical surveys for civil engineering investigations. Pg.no 98

15. (a) Give an elaborate account of the various geological factors to be considered for the construction of dams and reservoirs.

Or

(b) Explain how remote sensing can help in planning, design and execution of civil engineering projects. Pg.no 123

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 31038

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Third Semester

Civil Engineering

AG 2211/ AG 33/ CE 1201/10111 CE 303/080100009 — APPLIED GEOLOGY

(Common to Geoinformatics Engineering)

(Regulation 2008/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write the types of waves and currents. Pg no 7
2. What are the methods of wind erosion? Pg no 7
3. Write any four structural forms of minerals.
4. List the minerals formation process. Pg no 62
5. Define Hypabyssal rocks.
6. Write the types of metamorphism. Pg no 64
7. What is an OUTCROP? Pg no 84
8. Write the causes of folding.
9. Define remote sensing. Pg no 104
10. List out the causes of landsliding. Pg no 104

PART B — (5 × 16 = 80 marks)

11. (a) Explain in detail about working of sea with their engineering Importance with neat sketch. Pg no 36 (16)

Or

(b) Write short notes on :

(i) Groundwater mode of occurrence Pg no 42 (8)

(ii) Earthquake belts in India. Pg no 21 (8)

12. (a) Discuss about physical properties of minerals with suitable examples. (16)
Pg no 47

Or

(b) Write the Physical properties of following minerals : Pg no 49

(i) Quartz

(ii) Garnet

(iii) Hornblende

(iv) Mica. (4 × 4 = 16)

13. (a) Explain the distinction between Igeneous, sedimentary and metamorphic rocks. Pg no 68, 75 (16)

Or

(b) Write the engineering properties of following rocks Pg no 72

(i) Granite

(ii) Limestone

(iii) marble

(iv) Gabbro. (4 × 4 = 16)

14. (a) Explain in detail about the types of faults and joints with neat sketch.
Pg no 93, 96

Or

(b) Discuss about the seismic and electric method of Geological Investigation. Pg no 98 (16)

15. (a) Write a short notes on following :

(i) Costal erosion and its protection Pg no 109 (4)

(ii) Aerial photography Pg no 123 (4)

(iii) Process of Remote Sensing. Pg no 123 (8)

Or

(b) Explain in detail about Geological condition necessary for construction of Tunnels, bridges and Road cuttings. Pg no 105, 107 (16)

Reg. No. :

Question Paper Code : 97025

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Third Semester

Civil Engineering

CE 6301 — ENGINEERING GEOLOGY

(Regulation 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is meant by exfoliation? Pgno 8
2. Name a few secondary tectonic plates. Pgno 7
3. What are the varieties of plagioclase feldspar? Pgno 45
4. Bring out the differences between muscovite and biotite. Pgno 45
5. What is meant by RMR? What is its significance?
6. Differentiate between Gneiss and Schist.
7. How do joints influence the strength of rocks?
8. Using a diagram, explain the Dip and Strike of rock layers. Pgno 84
9. What is meant by "stand-up time" in tunelling? Pgno 103
10. List at least four measures to prevent coastal erosion. Pgno 103

PART B — (5 × 16 = 80 marks)

11. (a) Describe in detail, the process of weathering of rocks. Add a note on the effect of weathering on the strength of rocks. Pgno 14

Or

(b) Give a detailed account of the erosional and depositional landforms created by the action of a river. Pgno 24

12. (a) Discuss about the chemical composition, physical properties, origin, varieties and uses of quartz. Pg.no 49

Or

(b) Give a detailed account of the chemical composition, physical properties, origin, varieties and uses of clay minerals. Pg.no 54

13. (a) How are rocks classified? Describe the major distinguishing properties of the major rock types.

Or

(b) List the various engineering properties of rocks and describe the field and laboratory tests to be conducted to determine these properties. Pg.no 80

14. (a) Explain how faults and folds affect the choice of locations for dams and tunnels. Pg.no 86

Or

(b) Elaborate on the electrical methods used for sub-surface investigations. Pg.no 98

15. (a) Using case studies, give a detailed account of the application of remote sensing in civil engineering. Pg.no 125

Or

(b) Classify landslides and discuss about the causative factors of landslides. Also, add a note on the measures for mitigation of landslides. Pg.no 116

Reg. No. :

Question Paper Code : 91041

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Third Semester

Civil Engineering

AG 2211/CE 1201/AG 33/080100009/10111 CE 303 — APPLIED GEOLOGY

(Regulation 2008/2010)

Time : Three hours Maximum : 100 marks

Use neat sketches wherever necessary.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are Sand dunes? & Barchans Pg no 8
2. Define "Water table". Pg no 8
3. Write the axial position of the normal classs of tetragonal system.
4. Write the uses of mica. Pg no 45
5. Define 'Metamorphism". Pg no 64
6. Give a brief note on stratification.
7. What is anticlinal fold? Pg no 84
8. Name the device used to measure dip and strike.
9. Define "flowage". Pg no 103
10. What is remote sensing? Pg no 104

PART B — (5 × 16 = 80 marks)

11. (a) Write an essay on the geological work of river. Pg no 24

Or

(b) Describe the geology of groundwater and its importance in civil engineering. Pg no 42

12. (a) Explain in detail about the physical properties of minerals and give two mineral examples for each property. Pg.no 47

Or

(b) Describe the physical properties and uses of the following minerals. Pg.no 60

(i) Rock crystal (4)

(ii) Orthoclase (4)

(iii) Calcite (4)

(iv) Magnetite. (4)

13. (a) Describe the distinguishing features of Igneous, Sedimentary and Metamorphic rocks based on various criteria.

Or

(b) Give the mode of occurrence, mineral composition, engineering properties and uses of the following rocks. Pg.no 72

(i) Granite (4)

(ii) Basalt (4)

(iii) Sandstone (4)

(iv) Marble. (4)

14. (a) What are folds? How are they classified? And write its engineering significance. Pg.no 86

Or

(b) Explain in detail the seismic and electrical method in civil engineering investigation. Pg.no 98, 101

15. (a) Define the term tunnel. Explain the geology of tunneling with sketches to show how tunnels can be located in highly disturbed area. Pg.no 105

Or

(b) Write an essay on landslide, its causes and prevention. Pg.no 116

CIVIL SET

Reg. No. : [ ]

Question Paper Code : 51038

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2014.

Third Semester

Civil Engineering

AG 2211/CE 1201/AG 33/080100009/10111 CE 303 — APPLIED GEOLOGY

(Regulation 2008/2010)

Time : Three hours Maximum : 100 marks

Use neat sketches wherever necessary.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is Base level of erosion?
2. What is an aquifer? Pg no 7
3. List the properties of mica. Pg no 46
4. Distinguish between Augite and Hornblende. Pg no 46
5. How are metamorphic rocks formed? Pg no 64
6. How are sedimentary rocks identified in the field?
7. Define strike and Dip of a sedimentary formation. Pg no 84
8. List a few applications of Geophysical surveys.
9. What is Landslide?
10. What is the common shape of tunnels in rocks?

PART B — (5 × 16 = 80 marks)

11. (a) Discuss the landforms produced by erosion and deposition of rivers. Pg no 24

Or

(b) Explain with a neat diagram the interior of the Earth. Pg no 12

571

12. (a) Describe the classification and physical properties of Quartz family. Pg.no 49

Or

(b) Describe the physical and engineering properties of clay minerals. Pg.no 54

13. (a) Describe the mode of formation classifications and structures of sedimentary rocks. Pg.no 75

Or

(b) Describe the petrological and engineering properties of following rocks. Pg.no 78

(i) Granite

(ii) Limestone

(iii) Gneiss

(iv) Conglomerate.

14. (a) Describe with neat diagram the various classifications of faults. Add a note on civil engineering significance of faults. Pg.no 93

Or

(b) Explain the seismic refraction survey for the determination of the depth to bed rock. Pg.no 101

15. (a) Discuss on the causes, classifications and prevention of landslides.. Pg.no 116

Or

(b) Discuss on the geological conditions essential for tunnel construction. Pg.no 105

Reg. No.

Question Paper Code : 51040

B.E/B.Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Third Semester

Civil Engineering

AG 2211 / AG 33/CE 1201/10111 CE 303/080100009 – APPLIED GEOLOGY

(Common to Geoinformatics Engineering)

(Regulations 2008/2010)

Time : Three Hours **Maximum : 100 Marks**

Use neat sketches wherever necessary.

Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

1. Brief on the layers of the interior of the earth. Pg.no 11
2. What is meant by a seismic zone ? Pg.no 8
3. Bring out the difference between streak and colour of a mineral. Pg.no 44
4. Name few common clay minerals. Pg.no 45
5. Define Hypabyssal rocks.
6. Write the types of metamorphism. Pg.no 64
7. Define strike and dip of a sedimentary formation. Pg.no 84
8. List a few applications of Geophysical surveys.
9. Define "Flowage". Pg.no 103
10. What is remote sensing ? Pg.no 104

PART – B (5 × 16 = 80 Marks)

11. (a) Give a detailed account of groundwater occurrence in rocks. Add a note on the porosity and permeability of rocks. Pg.no 42

OR

(b) Describe in detail how earthquakes are caused. Add a note on the earthquake prone belts of India. Pg.no 21

12. (a) Using examples list and describe the important physical properties of minerals. Pg.no 47

OR

(b) Write in detail about the origin and occurrence of petroleum and natural gas in India.

13. (a) Describe the mode of formation, classification and structures of sedimentary rocks. Pg.no 75

OR

(b) Describe the petrological and engineering properties of following rocks : Pg.no 78

(i) Granite

(ii) Limestone

(iii) Gneiss

(iv) Conglomerate

14. (a) Explain in detail about the types of faults and joints with neat sketch. Pg.no 93 96

OR

(b) Discuss about the seismic and electric method of Geological Investigation. Pg.no 98 101

15. (a) Define the term tunnel. Explain the geology of tunnelling with sketches to show how tunnels can be located in highly disturbed area. Pg.no 105

OR

(b) Write an essay on landslide, its causes and prevention. Pg.no 116

Question Paper Code : 77050

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Third Semester

Civil Engineering

CE 6301 — ENGINEERING GEOLOGY

(Regulation 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is spheroidal weathering? Pg.no 9
2. Draw the internal structure of the Earth. Pg.no 8
3. Write the important minerals from Feldspar group and their uses. Pg.no 47
4. List the names of clay group of minerals. Pg.no 45
5. Define crushing strength of a rock.
6. Write short note on the importance of texture and structure of a building stone.
7. What are Joints and Joint sets? Pg.no 85
8. Define the term 'Rock Quality Designation' (RQD).
9. Write the factors that cause landslides. Pg.no 104
10. What are aerial photo interpretation elements?

PART B — (5 × 16 = 80 marks)

11. (a) Write elaborately on Physical and chemical weathering of rocks. What is the significance of weathering of rocks in Civil Engineering? Pg.no 14

Or

Pg.no 36

(b) Describe the geological work of sea and its engineering considerations.

Or

(b) Explain in detail about the Pyroxene group of minerals.

13. (a) (i) Write elaborately on textural classification of Igneous rocks. Pg.no 65

(ii) Write notes on engineering importance of Igneous rocks. Pg.no 65

Or

(b) Explain the characteristics and engineering properties of Granite, Sandstone, Marble and Dolerite. Pg.no 83

14. (a) What are faults? Explain in detail with sketches on (i) Normal faults (ii) Reverse faults (iii) Strike slip fault (iv) Oblique fault. Pg.no 93

Or

(b) Explain in detail about Resistivity methods and Wenner configuration. Add a note on its Civil Engineering applications. Pg.no 98

15. (a) Illustrate with neat sketches about landslides and their types. What are the various measures to control landslides? Pg.no 116

Or

(b) Explain how remote sensing is done? Discuss in detail on remote sensing applications in Civil Engineering. Pg.no 123

Reg. No. :

Question Paper Code : 71543

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Third Semester

Civil Engineering

CE 6301 — ENGINEERING GEOLOGY

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Draw the internal structure of earth.
2. What is Exfoliation?
3. List the name of clay group of minerals.
4. Bring out the differences between muscovite and biotite.
5. How do you classify rocks? Give examples.
6. Differentiate between Gneiss and Schist.
7. Differentiate between True dip and apparent dip of rock formation.
8. What are joints and joint sets?
9. Define remote sensing.
10. List at least four measures to prevent coastal erosion.

PART B — (5 × 13 = 65 marks)

11. (a) Explain the concept of plate tectonics and describe how earthquakes occur. Add a note on the distribution of earthquake in the world and in India.

Or

(b) Illustrate and explain the erosion and depositional features formed by flow of river and add a note on the significance in civil engineering projects.

12\. (a) List the physical properties of minerals and describe each property with examples from the mineral kingdom.

Or

(b) Describe the composition, properties, varieties and uses of Gypsum, Quartz, and Feldspar.

13\. (a) What are the engineering properties of rocks to be tested for constructions of dams and tunnels and how will you determine the engineering properties of rocks at site and laboratory?

Or

(b) Write briefly about the classification of rocks? Describe the origin, texture, structure and occurrence of granite, dolerite, marble and sandstone rocks.

14\. (a) Explain folding in rocks and describe the various types of folds.

Or

(b) Explain how the geophysical methods help in knowing about sub-surface features during civil engineering investigations.

15\. (a) What are landslides? How do they occur? Describe the types of landslides with a sketch and enumerate the geological investigation required for mitigation of landslides.

Or

(b) Explain in detail the various causes and effects of sea erosion. Add a detailed note on coastal protection measures.

PART C — (1 × 15 = 15 marks)

16\. (a) Using case study write a detailed account of the application of remote sensing in civil engineering?

Or

(b) Write the geological considerations to be taken into account during tunneling.

Reg. No. :

Question Paper Code : 80193

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Third Semester

Civil Engineering

CE 6301 — ENGINEERING GEOLOGY

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate between Physical and chemical weathering.
2. Mention about the seismic zones of India.
3. Differentiate between colour and streak of minerals.
4. Differentiate between muscovite and biotite.
5. Write briefly about attrition test.
6. Compare the relative strengths of shale, sandstone and quartzite.
7. What are joints in rocks? How do they influence the strength of rocks?
8. What is meant by Wenner Configuration?
9. What is over break in tunelling? How can it he controlled?
10. Mention a few coastal protection structures.

PART B — (5 × 13 = 65 marks)

11. (a) Using diagrams and explanations, describe the internal structure and composition of the Earth.

Or

(b) Write in detail about the tectonic plates and their role in generation of earthquakes.

12. (a) Using appropriate examples from the mineral kingdom, describe the physical properties of minerals.

Or

(b) Describe in detail, the properties, composition and uses of Feldspar and Calcite.

13. (a) Outline the various engineering properties of rocks, and give a detailed account of the laboratory and field tests to be carried out to estimate such properties.

Or

(b) Write detailed notes on the mineral composition, texture, origin, engineering properties and uses of (i) Granite (ii) Dolerite, (iii) Sandstone and (iv) Marble.

14. (a) Write in detail about the types of faults and their influence on dams and tunnels.

Or

(b) Discuss the operating principle of the seismic methods of subsurface investigation.

15. (a) What are the effects of the action of sea waves on the coastal zones? Add a note on the various coastal protection structures.

Or

(b) List the causes of landslides. Also, classify landslides and give a detailed account of the methods of preventing them.

PART C — ($1 \times 15 = 15$ marks)

16. (a) Using case studies of structural failures, discuss the importance of geological investigations for the design and construction of large civil structures.

Or

(b) Natural disasters in India can be understood better and controlled well, if geology is understood well. Give your opinion about this statement using appropriate case studies.