JORHAT ENGINEERING COLLEGE

DEPARTMENT OF CIVIL ENGINEERING

ENGINEERING GEOLOGY LAB MANUAL

EXPERIMENT (1to 5)

Interpretation and drawing of sections for geological maps

AIM:

The aim of this unit is to draw a geological section along X-Y axis and interpret the geological map.

OBJECTIVES:

After drawing the profile students will be able to

- Describe the geology of the area
- Explain the structure of the area
- Describe the topography
- Explain the succession of the beds
- List out the beds

EQUIPMENTS REQUIRED:

Maps, Scale, Set Square, Papers, Pencils etc.

THEORY:-

A cross section should be consistent with all the available data, although there are often several viable interpretations of the same data. Most cross sections are drawn to true scale, that is, where the horizontal scale is the same as the vertical scale. This means the true dip of the rock units are shown. Vertical exaggeration, where the vertical scale is increased relative to the horizontal, is sometimes used to make a cross section clearer. However, it also increases the dips of the rock units exaggerating the geological structures.

PROCEDURE:

Step 1: Determine the line along which to draw the section. The line of section should be representative of the study area, be perpendicular to the major structural feature of the area (e.g. large scale folds or faults), cross as many structural features as possible and run through areas with the most data readings.

<u>Step 2</u>: Draw a straight line (Strike line) along the points of intersection of bedding plane and contour line. Draw another strike line for the same bedding plane with consecutive contour to calculate the dip of the bed and direction. Determine true dip and apparent dip along the section.

Note: Never draw one straight line for one bedding plane and a second straight line for another Bedding plane for calculation of dip

<u>Step 3</u>: Transfer the topographic information from the map to the section. Project the height of each topographic contour, where it crosses the line of section, on to the section and draw in the topography

<u>Step 4</u>: Transfer the lithological boundaries, faults etc onto cross section in the same way.

<u>Step 5</u>: Transfer bedding readings on to the section, correcting for apparent dip if necessary. Plot the readings at the height at which they occur, so where a reading is extrapolated from a greater or lesser height than the topography of the cross section plot it above or below the topography as appropriate.

<u>Step 6</u>: Using the bedding readings as a guide, draw in the Lithological boundaries both above and below the surface. Geology extended above the topography is shown by dashed lines. When drawing the section always consider what is geologically reasonable behavior for the layers, e.g. sudden changes in a unit's thickness or dip should be justifiable.

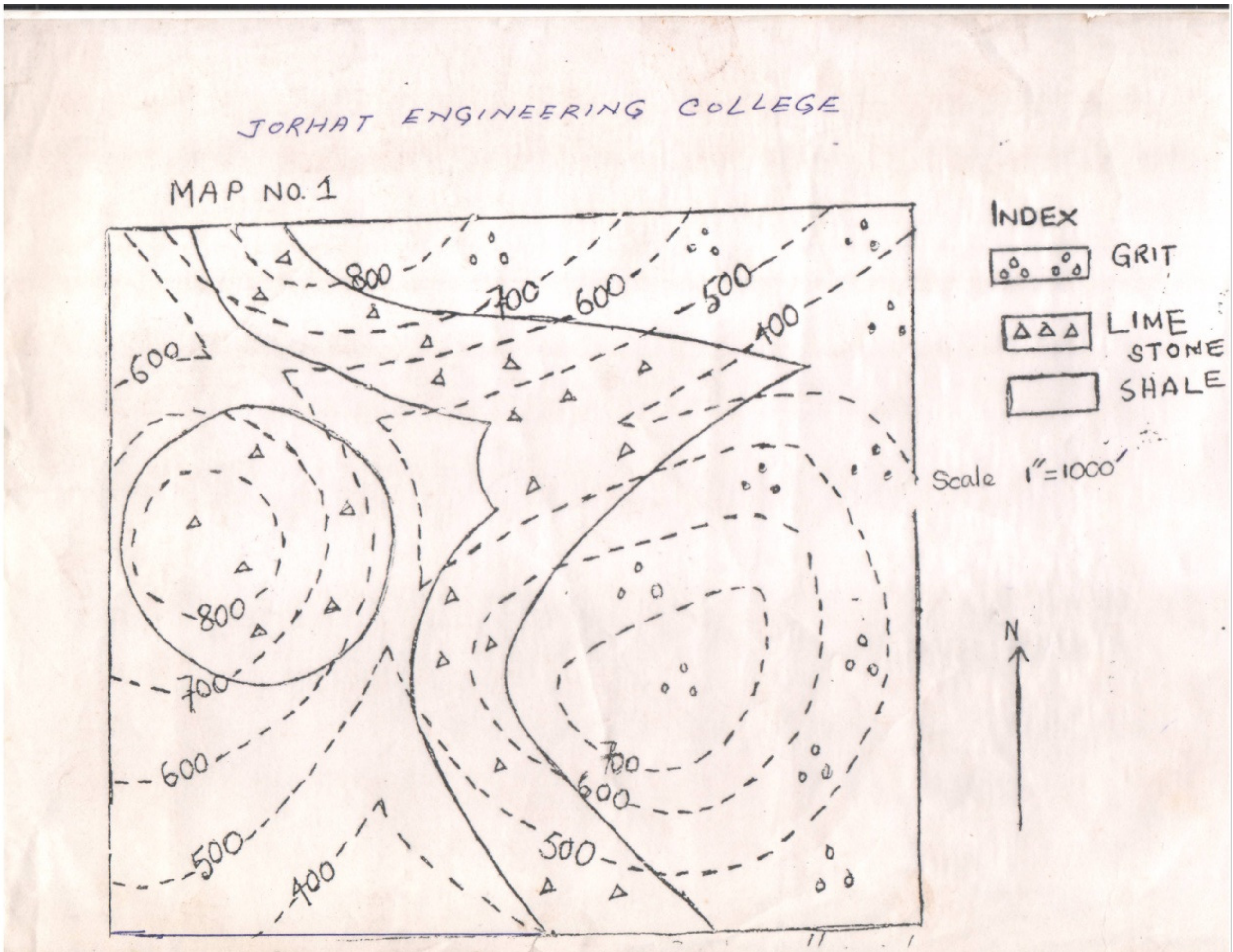
PRECAUTION

Draw two straight lines for the same bedding plain to calculate the dip of the bed
Note: Never draw on straight line for one bedding plane and a second straight line for another Bedding plane for calculation of dip

QUESTIONS FOR VIVA-VOCE

1. **What is strike of a formation**
2. **What is apparent dip and true dip ?**
3. **What are the advantages of drawing section from Geological Map**

EXPERIMENT - 1 : Draw a geological section along X-Y axis and interpret the geological map. (**GEOLOGICAL MAP -1)**

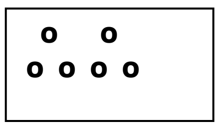


GEOLOGICAL INTERPRETATION

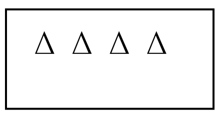
1) TOPOGRAPHY OF THE AREA
   The area represented on the map is a hilly one. A hill of 700 feet is found to the south eastern part of the area. Another hill of 800 feet height is found on the western side of the area. The two hills are separated by the valley. One more hill of 800 feet is partially visible in the north western direction.
   One valley of 400 feet depth is found in the north eastern part. Another one of 400 feet depth in the south western side and third valley of 600 feet depth is found in the north western side of the area.

2) LITHOLOGY OF THE AREA
   There are three types of rocks existing in the area. They are as follows:

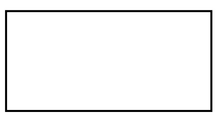
GRIT-



LIMESTONE -



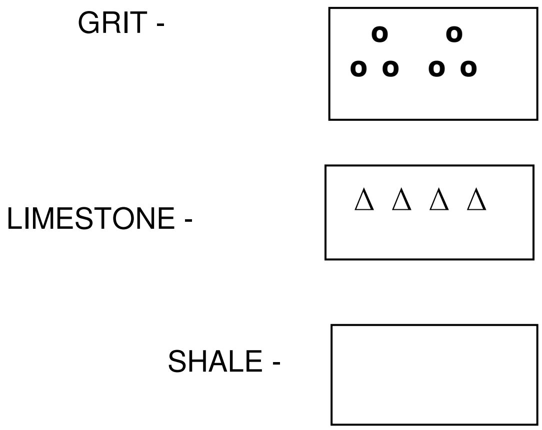
SHALE -



3) GEOLOGICAL STRUCTURES
   The area represented on the map is very simple one. The area has not been subjected to any folding or faulting. The area is also devoid of many major joints or fractures. The beds are striking in north-south direction and the true dip of the bed is equal to 6.5° towards east and apparent dip is about 5.5° towards east.

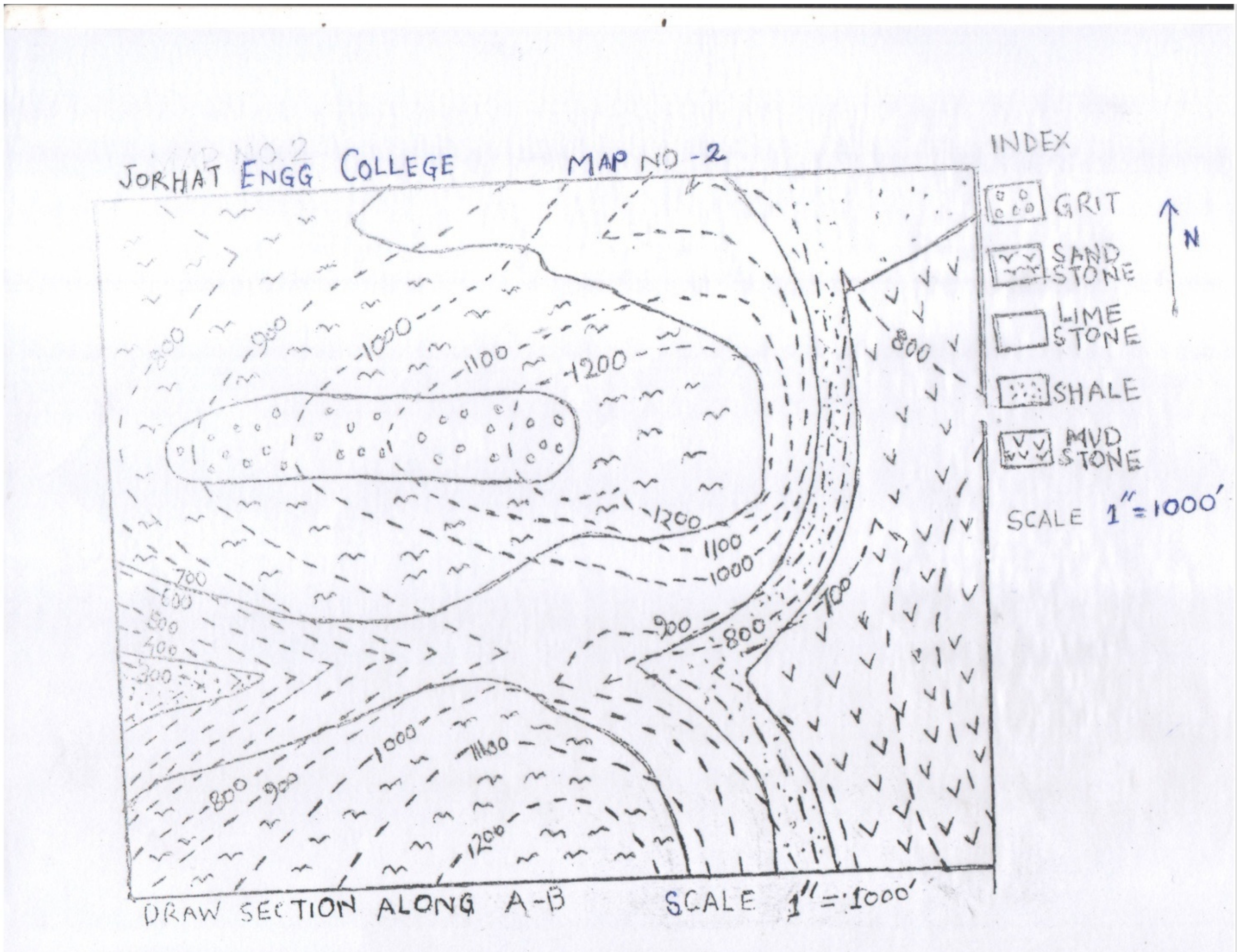
4) GEOLOGICAL HISTORY
   The area representing the maps is composed of sedimentary rocks. The rocks were deposited in a sedimentary environment. Shale was first deposited in the area, then limestone was deposited above shale and finally grit was deposited in the area. After the deposition and compaction entire area is uplifted and subsequently eroded to give rise to present configuration.

The sequence of deposition are as follows:



5) IGNEOUS ACTIVITY
There is no igneous activity found in the area.

EXPERIMENT - 2 : Draw a geological section along X-Y axis and interpret the geological map. (**GEOLOGICAL MAP -2)**



GEOLOGICAL INTERPRETATION

GEOLOGICAL INTERPRETATION

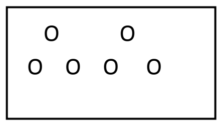
1) TOPOGRAPHY OF THE AREA
   The area represented on the map is a hilly one. A hill of 1200 feet is found on the north eastern part of the area. Another hill of 1200 feet is partially visible on the southern part of the area.

A valley of 400 feet depth is present on the south western part of the area. Another valley of 700 feet depth is present on the south eastern part of the area. The two hills are separated by the valley.

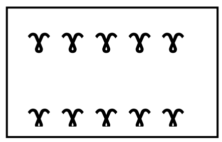
2) LITHOLOGY OF THE AREA

There are five different types of rocks present in the area. They are- Mudstone, Shale, Limestone, Sandstone, and Grit.

GRIT -

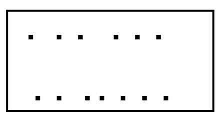


SANDSTONE -

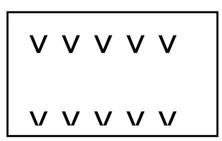


LIMESTONE -

SHALE -



MUD STONE -



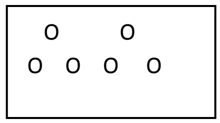
3) GEOLOGICAL STRUCTURE

The area represented in this map is a simple one. The area has not been subjected to any folding, faulting, joint fracture, etc. The loads are striking north-south and are dipping towards the west. The true dip of the beds is 6.5° west and apparent dip is 5.5° towards west.

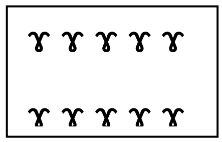
4) GEOLOGICAL HISTORY

The rock beds comprising the area were deposited in a sedimentary environment (basin). Mudstone was deposited first which is followed by shale, limestone, sandstone and then grit. Mudstone is the oldest rock and grit is the youngest rock. After deposition and compaction, the entire area has been uplifted and subsequently eroded, giving this present configuration. The sequences of deposition are as follows:

GRIT -

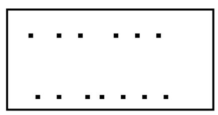


SANDSTONE -

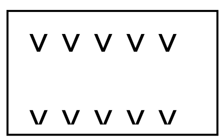


LIMESTONE -

SHALE -

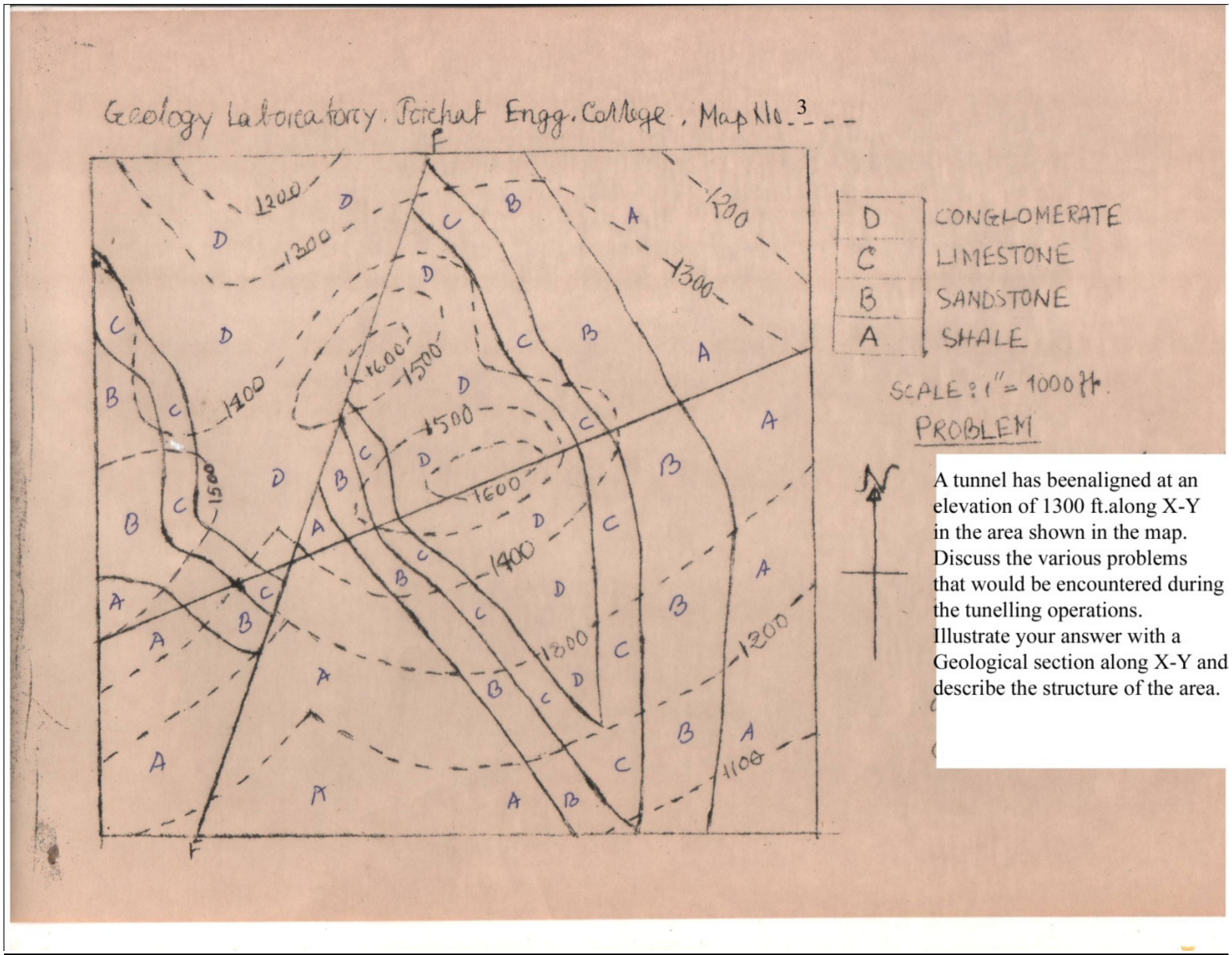


MUD STONE -

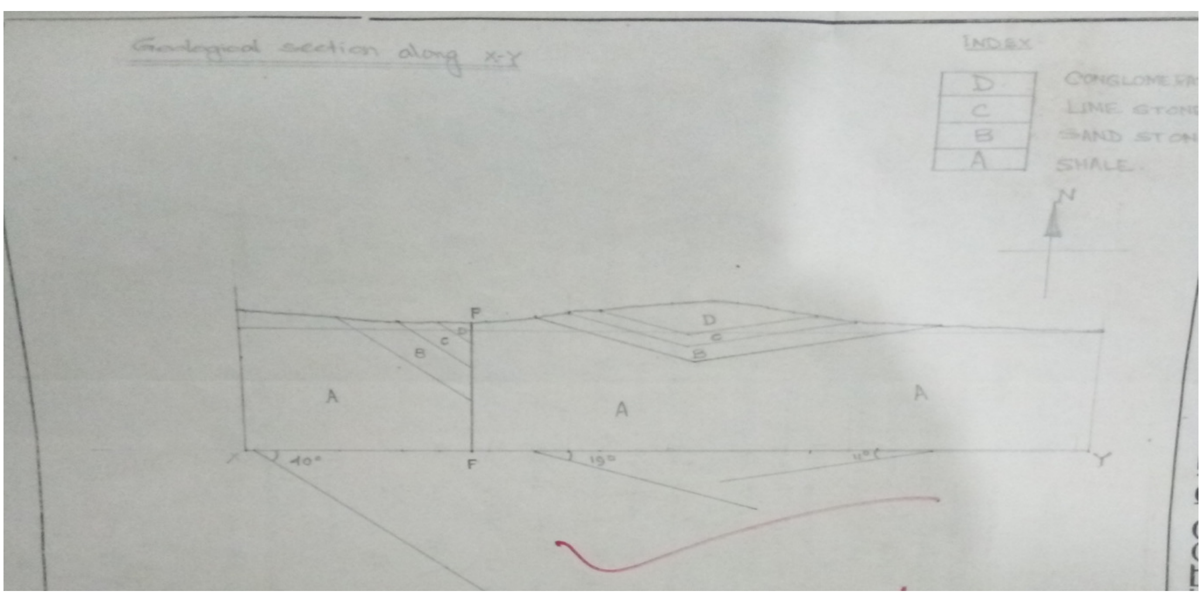


5) IGNEOUS ACTIVITY
There is no igneous activity found in the area.

EXPERIMENT - 3 : Draw a geological section along X-Y axis and interpret the geological map. (**GEOLOGICAL MAP -3)**



A tunnel has beenaligned at an elevation of 1300 ft.along X-Y in the area shown in the map. Discuss the various problems that would be encountered during the tunelling operations. Illustrate your answer with a Geological section along X-Y and describe the structure of the area.



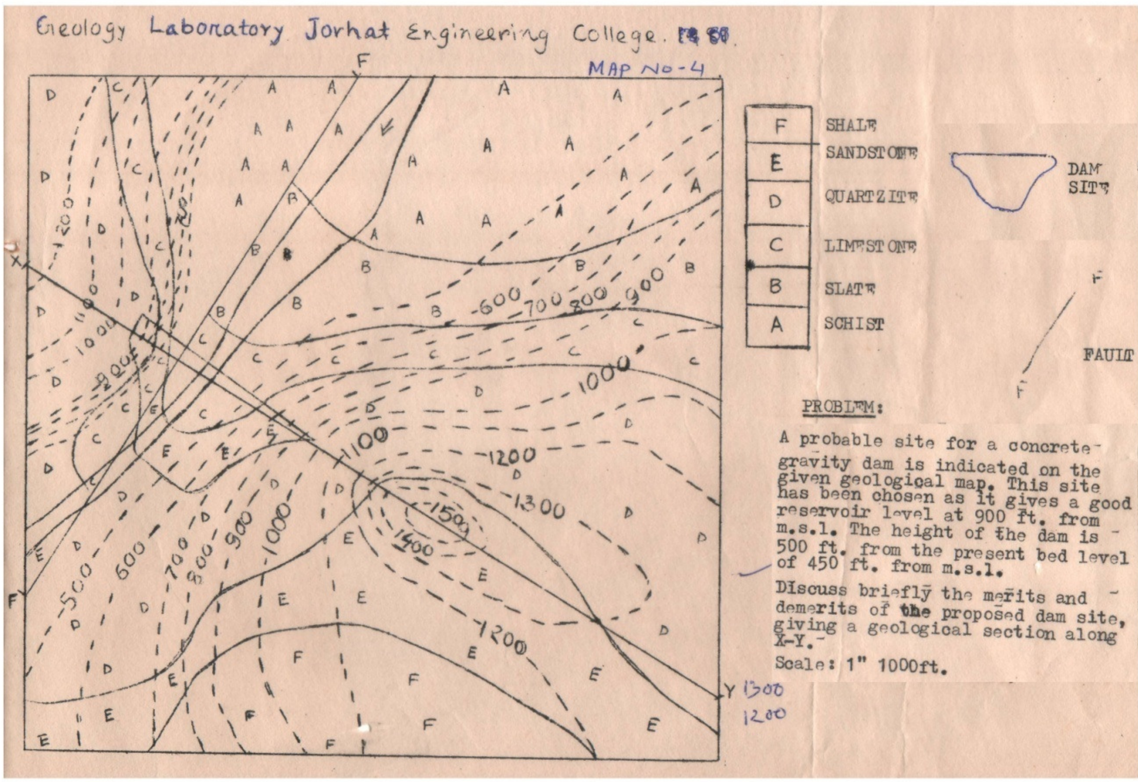
GEOLOGICAL INTERPRETATION

Geological Description:

1. **Lithological Character of the area**:- The proposed tunnel site is situated at 1300feet above the mean sea level (MSL). The area is composed of sedimentary rocks like - Shale, Sandstone, Limestone and Conglomerate which are permeable in nature. Though excavation of tunnel through these rocks is less expensive yet they require major support in tunneling operation. Permanent lining should be made for safety of the tunnel. So the lithology is not favourable for tunneling in this region.
2. **Structures of the region**: The area has been folded and faulted. The proposed tunnel should be excavated through synclinal zone and through the fault of the region. The axial region of folds has suffered maximum bending, for which the rock become weak and unsafe to be trusted as the roof or floor in tunnels.

A fault FF is passed through the tunnel site which may cause dislocation of the rock beds and leakage of water which are most unsafe for tunnel.

EXPERIMENT - 4 : Draw a geological section along X-Y axis and interpret the geological map. (**GEOLOGICAL MAP -4)**



GEOLOGICAL INTERPRETATION

The dam site is situated at 900' elevation above m.s.l which is suitable level for reservoir. The merits and demerits of the proposed gravity dam that indicated on the given geological map is given below:-

Merits:

(i) The topography of the dam site is favourable, because the reservoir is situated in between 500' and 600' contours and hence there is gradual increase in height on the both sides of the proposed dam site.

(ii) The possibility of the sliding of the dam is less because it will be constructed in Sandstone and Quartzite.

(iii) The river is narrow, so the cost of construction will be less.

(iv) The lithology is favourable for dam site.

(v) The horizontal nature of the bed in both side of the proposed dam will prevent extra leakage.

Demerits:

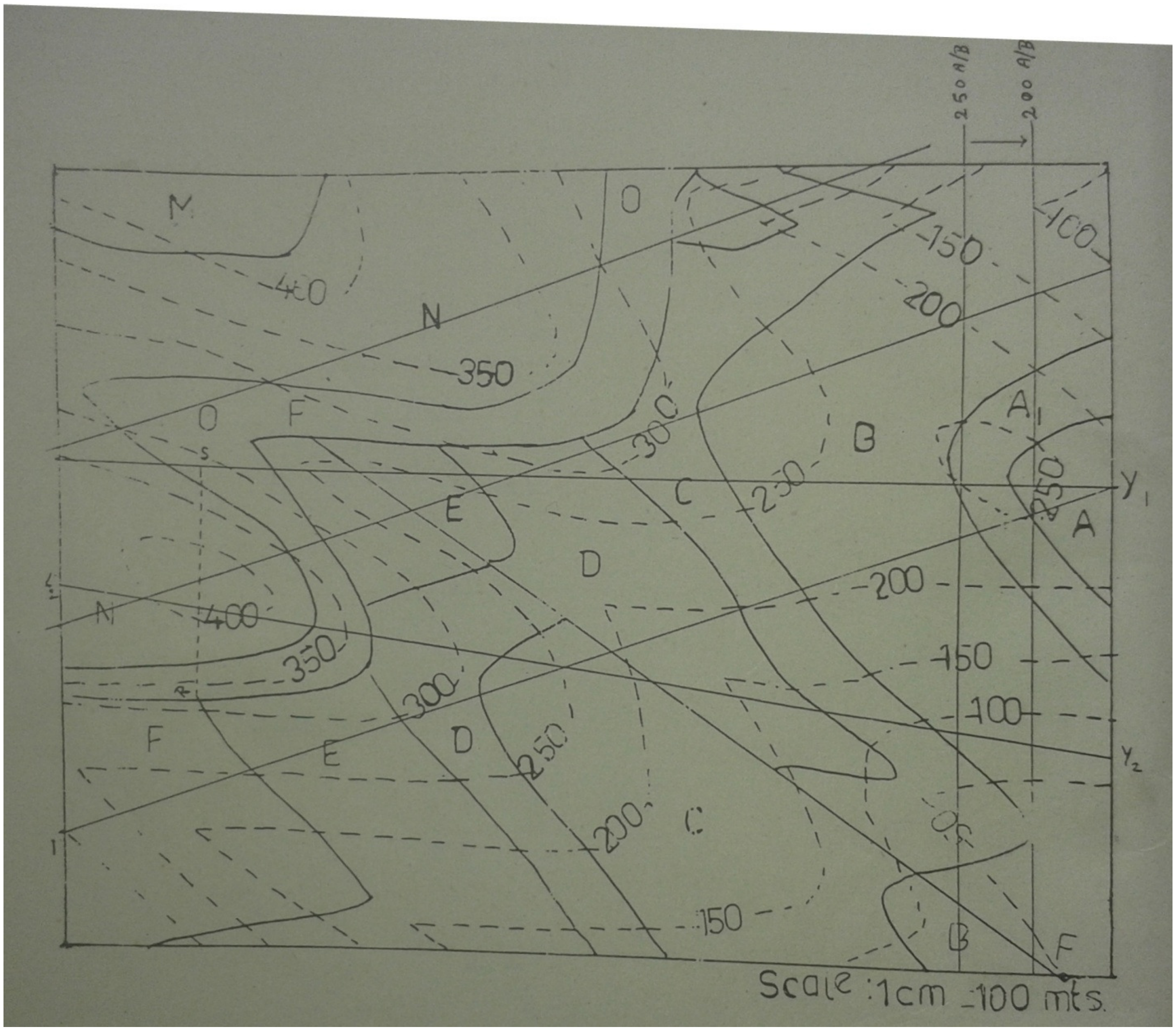
(i) The fault FF is passed through the reservoir site which may cause leakage of water.

(ii) Considering the lithology of the reservoir site, it is situated above Limestone and Schist, so there is possibility of developing fissures within Limestone by the process of solution and it may cause leakage of water.

Conclusion:

For preparing for a good dam site in the proposed area, the appropriate grouting should be provided for prevention of leakage through fault and Limestone bed. Appropriate measure against the silting from upstream side of the dam should be taken.

EXPERIMENT - 5 : Draw a geological section along X-Y axis and interpret the geological map. (**GEOLOGICAL MAP -5)**



SECTION ALONG X-Y

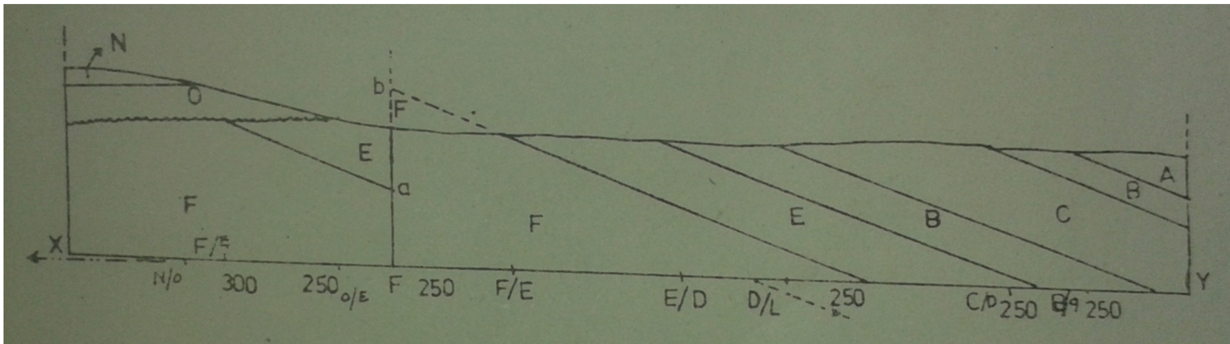


Fig. 16.1

OLDER SERIES
strike Interval - 135 mts. Dip 20^0 towards 'Y'
YOUNGER SERIES
strike Interval - 1000 mts. Dip 3^0 towards 'X'

GEOLOGICAL INTERPRETATION

Topography

In the given map the highest contour is of 400 mts. In the eastern region and the lowest contour is of 50 mts SE corner. There is a valley in the direction NW-SW there is also a ' small amount having a height of 250 mts.

General Geology

In the given map the older beds strike NS and dip towards east (towards Y) with an amount of 200 whereas the younger group of rocks strike NE-SW and dip 30 towards NW (towards X). The two series of unconformable. There are two important structures one is an unconformity and the other being a fault in older series. The fault strike NW-SE and has a vertical dip.

Geological Succession

In the area the beds F-E-D-C-B-A are deposited conformably in a normal marine conditions. Later on they were uplifted and titled to attain the attitude. Then they were subjected to faulting resulting in a displacement of about 190 mts. After faulting they were eroded and submerged under the sea. Then there was deposition of younger series O-N-M unconformably over the older series.

EXPERIMENT – 6

Study of physical properties and Identification of minerals referred Under theory

AIM:

The aim of this unit is to study and identify some important minerals.

OBJECTIVES

After completing this unit students should be able to:

• Identify the important rock forming minerals.

• Recognize the minerals of rocks

Apparatus: Unglazed porcelain plate (known as a streak plate),hardness scale

Theory

Mineral : Mineral are defined as naturally occurring, inorganic, solids with a definite chemical composition and a regular, internal crystalline structure. Different chemical composition results in different minerals. Mineral are the building blocks of rocks.

Mineral Physical Property chart		
Physical Property	**Definition**	**Testing Method**
Cleavage	Breakage of a mineral along planes of weakness in the crystal structure	Examine the mineral for area where the mineral is broken. Look for area where the light reflects from planar surfaces. This can be easily confused with a crystal face and is the most difficult properties for student to master
Color	Visible light spectrum radiation reflected from a mineral.	look at the sample and determine its color white, green, black, clear etc.
crystal forms	Geometric shape of a crystal or mineral	examine and describe the geometric shape of the mineral, cubic, hexagonal, etc. Not commonly seen in most lab samples
Fractures	Breakage of a mineral, not along planes of weakness in the crystal structure	Examine the mineral for area where the mineral is broken. Describe the breakage as either irregular or conchoidal (has the appearance of broken glass)
Hardness	Resistance to scratching or abrasion	Use mineral of know hardness from the Mohs hardness Kits. Scratch the unknown mineral with a know hardness to determine which is harder. Continue doing this with harder or softer minerals from the kit until the hardness is determined.
luster	Character of the light reflected by a mineral	Look at the samples to determine if the mineral is metallic in appearance or non metallic. Vitreous, like glass and earthy (like dirt, or other Powderly material)
Magnetism	Electromagnetic force generated by an object or electric field.	Use of magnet to determined in an introductory lab.
Specific	Ratio of the mass of a	Generally not determined in an introductory lab.

gravity	mineral to the mass of an equal volume of water	
Streak	Color of the mineral when it is powdered	Grind a small amount of a mineral into a powder on a porcelain streak plate and determine the color of the powder.
Transparent	Stages of transparency of mineral	

Table -2 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

Table - 3) Specific Gravity of the Impotant Minerals	
Mineral	**Specific Gravity**
Graphite	2.23
Quartz	2.65
Feldspars	2.6- 2.75
Fluorite	3.18
Topaz	3.53
Corundum	4.02
Barite	4.45
Pyrite	5.02
Galena	7.5
Cinnabar	8.1
Copper	8.9
Silver	10.5

PRECAUTIONS:

1. Handle carefully the soft and flaky minerals.

2. After using the minerals from hardness box put them in proper space assigned for the particular mineral of the hardness scale.

QUESTIONS FOR VIVA-VOCE

1. Questions may be asked from the physical properties of minerals and their uses and importance

(i) FELDSPAR

1.Form : Tabular

2. Colour: Pale Pink

3.Streak : White

4. Luster : Vitreous

5.Fracture : Uneven

6.Cleavage : Absent

7. Transparency: Opaque

8. Hardness : 6-7

9. Specific Gravity: Medium

10. Uses : Tiles

11. Name of the Specimen : Feldspar

12. Chemical Composition : $KAlSi_3O_8$

(ii) QUARTZ

1. FORM : Crystalline
2. Colour : Colourless
3. Streak: Colourless
4. Luster : Vitreous
5. Fracture : Uneven
6. Cleavage : Absent
7. Transparency : Transparent
8. Hardness : 7
9. Specific Gravity: High
10. Name of the Specimen : Quartz
11. Uses : Used as gemstone and in watch industries etc
12. Chemical Composition : SiO_2

(iii) <u>Gypsum</u>

1. FORM : Crystalline

2. Colour : White

3. Streak: White

4. Luster : Sub-Vitreous

5. Fracture : Even

6. Cleavage : 2 sets

7. Transparency : Opaque

8. Hardness : 2

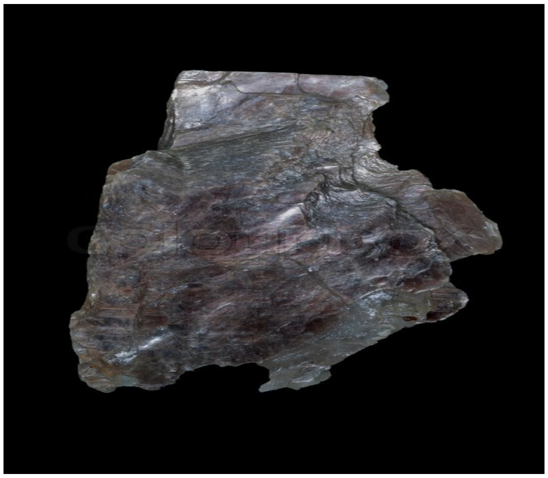
9. Specific Gravity: Medium

10. Name of the Specimen : Gypsum

11. Uses : Used as Fertilizer, manufacturing of cement and plaster of Paris

12. Chemical Composition : SiO_2

(iv) MUSCOVITE



1. Form : Lamellar/Flaky
2. Colour : White
3. Streak : White
4. Luster : Vitreous
5. Fracture : Uneven
6. Cleavage : One set Basal Cleavage
7. Transparency : Transparent in individual layer & opaque as whole
8. Hardness : 2 to 3
9. Specific Gravity : Medium (2.5)
10. Uses : Poor conductor of heat
11. Name of the Specimen : Muscovite
12. Chemical Composition : $KAl_2(Al\ Si_3)\ O_{10}\ (OH, F)_2$

(v) **ASBESTOS**

1. Form : Fibrous
2. Colour : Green and White
3. Streak : white
4. Luster : Silky
5. Fracture : Hackly
6. Cleavage : Absent
7. Transparency : Opaque
8. Hardness : 4 to 6
9. Specific Gravity : High (3 to 4.5)
10. Uses : It is used to make sheets
11. Name of the Specimen : Asbestos
12. Chemical Composition: Hydrous silicate of Mg, Al.

(vi) CALCITE

1. Form : Bladed
2. Colour : Honey Yellow
3. Streak : White
4. Lustre : Vitrous
5. Fracture : Uneven
6. Cleavage : Absent
7. Diaphaneity : Opaque
8. Hardness : 5
9. Specific : 2.5 to 3
10. Name of the Specimen: Calcite
11. Uses : Bombs, gun powders, anti – air craft
12. Chemical Composition: $Caco_3$

(vii) GALENA

1. Form : Massive
2. Colour : Gray and black
3. Streak : Black
4. Lustre : Metallic
5. Fracture : Absent
6. Cleavage : Absent
7. Transparency : Opaque
8. Hardness : 2-3
9. Specific : High (5.5)
10. Name of the Specimen : Galena
11. Uses : Ornamental and atomic purposes
12. Chemical Composition : PbS

(viii) HAEMETITE

1. Form : Massive
2. Colour : Reddish Black
3. Streak : Cherry red
4. Luster : Metallic
5. Fracture : Absent
6. Cleavage : Absent
7. Transparency : Opaque
8. Hardness : 2-3
9. Specific : High
10. Name of the Specimen: Hematite
11. Uses : Steel, and iron industries

13.Chemical Composition: Fe_2O_3

(ix) BAUXITE

1. Form : Concretionary (Pisolitic)
2. Colour : Reddish Brown
3. Streak : Brown
4. Lustre : Earthy
5. Fracture : Uneven
6. Cleavage : Absent
7. Transparency : Opaque
8. Hardness : 3-4
9. Specific : High (3)
10. Name of the Specimen : Bauxite
11. Uses : Aluminum ore
12. Chemical Composition : Al_2O_3, $2H_2O$

(x) <u>GRAPHITE</u>

1. Form : Massive
2. Colour : Black
3. Streak : Black
4. Lustre : Sub-metallic
5. Fracture : Uneven
6. Cleavage : Absent
7. Transparency : Opaque
8. Hardness : 2-3
9. Specific : Medium
10. Name of the Specimen : Graphite
11. Uses : In pencils ,as a lubricant. It has many electrical **uses**, primarily because it is the only common nonmetal that is a good conductor of electricity.
12. Chemical Composition : C

(xi) CHROMITE

1. Form : Granular
2. Colour : Black
3. Streak : Light brown
4. Lustre : Sub-metallic
5. Fracture : Absent
6. Cleavage : Absent
7. Transparency : Opaque
8. Hardness : 6-7
9. Specific : High (4.5-4.7)
10. Name of the Specimen : Chromite
11. Uses : Ore of Chromium, refractory
12. Chemical Composition : $FeCr_2O_4$

(Xii) CHALCO PYRITE

1. Form : Massive
2. Colour : Golden yellow
3. Streak : black
4. Lustre : Sub-metallic
5. Fracture : Absent
6. Cleavage : Absent
7. Transparency : Opaque
8. Hardness : 3-4
9. Specific : High (4.1-4.3)
10. Name of the Specimen : Chalco Pyrite
11. Uses : Ore of copper
12. Chemical Composition : $CuFeS_2$

EXPERIMENT – 7,8 and 9

Megascopic description and identification of rocks referred Under theory

<u>OBJECTIVE</u>: Megascopic description and identification of rocks referred Under theory .

EXPERIMENT 7: IDENTIFICATION OF IGNEOUS ROCKS

AIM : The aim of this unit is to study and identify different types of Igneous rocks

OBJECTIVES:

After completing this Unit, students should be able to Describe the

- Different types of Igenous rocks (volcanic, Hypabasal and plutonic rocks).
- Main factors used in the classification of igneous rocks.
- Order of crytallisation in which minerals are formed.
- Petrogenesis.

QUESTIONS FOR VIVA-VOCE

1. How Igneous, sedimentary and Metamorphic rocks are formed?
2. Why some rocks are fine grained where as some are coarse grained?
3. What are the uses of various rocks?
4. What controls the colour of rocks?

GRANITES

Granites are of two types, based on their coulour (a) pink granite, in which the Kfeldspars are more predominant than the plagioclase feldspars. (b) Grey granite, in which the lagioclase feldspars are more predominant than the k-feldspars. They exhibit two distinct types of a) Equigranular b) Inequigranular (porphyritic). They are the most abundant rock types among other igneous rocks. In hand specimen, granite is a light colored coarse grained granular rock. It is mainly composed of quartz, feldspars, and micas. Apatite, magnetite, zircon and sphene are found as accessories. The coarse grained texture indicates that the rock is formed under the plutonic conditions.

1. Colour : Leucocratic

2. Mineralogy

a) essential minerals : quartz, alkali feldspar and micas

b) accessory : apatite, magnetite, zircon, sphene, and Hornblende.

3. Texture : Coarse grained, equigranular.

4. Specific gravity : Medium

5. Type : Plutonic

6.. Mode of formation : Formed at great depth due to slow cooling of magma at high pressure and high temperature

7.. Name of the rock : Granite

PORPHYRITIC GRANITE

1. Colour : Leucocratic
2. Mineralogy
   a) essential minerals : quartz, alkali feldspar and micas
   b) accessory : apatite, magnetite, zircon, sphene, and Hornblende.
3. Texture : Coarse grained, inequigranular (Porhyritic texture).
4. Specific gravity : Medium
5. Type : Plutonic
6.. Mode of formation : Formed at great depth due to slow cooling of magma at high pressure and high temperature
7. Mode of Occurrence : Big batholiths to small pluton
8. Name of the rock : Porphyritic Granite
9. Use: As building stones, Road metals, Railway ballast, Ornamentation

BASALT

BASALT
Basalt is a dark-ash coloured fine grained rock. It is mainly composed of labradorite Plagioclase augite pyroxene. Magnetite, olivine and apatite are found as accessories. Quartz,calcite and zeolities are found as secondary minerals in cavities and vesicles of the rock. The fine grained texture indicates that the rock is formed under volcanic conditions

1. Colour : Melnocratic

2. Mineralogy

a) essential minerals : Plagioclase Feldspar, Pyroxene (Augite)

b) accessory : Hornblende, magnetite and apatite

3. Texture : Fine grained

4. Specific gravity : High

5. Type : Volcanic

6.. Mode of formation : Due to fast cooling of lava as surface intrusive and extrusive

7. Mode of Occurrence : Sills, flows, and dykes

8.. Name of the rock : Compact Basalt

9.. Use: As building stones, Road metals, Railway ballast,

VESICULAR BASALT

1. Colour : Melnocratic

2. Mineralogy

a) essential minerals : Plagioclase Feldspar, Pyroxene (Augite)

b) accessory : Hornblende, magnetite and apatite

3. Texture : Fine grained

4. Structure: Partly vesicular and partly amygdaloidal

5. Specific gravity : High

6. Type : Volcanic

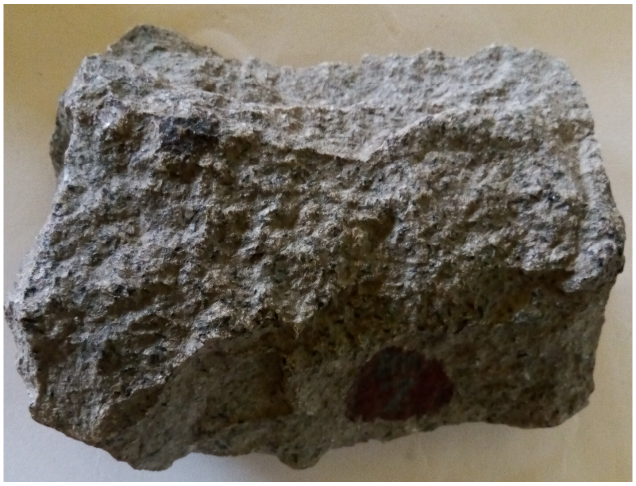
7.. Mode of formation : Due to fast cooling of lava as surface intrusive and extrusive

8. Mode of Occurrence : Sills, flows, and dykes

9.. Name of the rock : Vesicular Basalt

10. Use: Due to presence of vesicles, less use

SYENITE



1. Colour : Mesocratic
2. Mineralogy

a) essential minerals : Alkali Feldspar, Plagioclase Feldspar, Mica

b) accessory : Hornblende, magnetite and apatite

3. Texture : Medium grained

4. Specific gravity : Medium

5. Type : Plutonic

6.. Mode of formation : Due to slow cooling of magma

7. Mode of Occurrence : As intrusive rock

8.. Name of the rock : Syenite

9.. Use: As building stones, Road metals, Railway ballast,

RHYOLITE

1. Colour : Leucocratic

2. Mineralogy

a) essential minerals : Alkali Feldspar, Quartz, Mica

b) accessory : Hornblende, magnetite and apatite

3. Texture : Fine grained

4. Structure: Flow structure

5. Specific gravity : High

6. Type : Plutonic

7.. Mode of formation : Due to slow cooling of magma

8. Mode of Occurrence : Sills, flows, and dykes

9.. Name of the rock : Rhyolite

10. Use: As building stones, Road metals, Railway ballast,

EXPERIMENT-8: IDENTIFICATION OF SEDIMENTARY ROCKS

AIM:

The aim of this unit is to provide students the description of some important sedimentary rocks.

OBJECTIVES

After completing this unit you should be able to:

• Identify the sedimentary rocks
• Recognize the minerals of sedimentary rocks
• Describe the textures & formation of sedimentary rocks.

SANDSTONE

It is most common clastic rock founded in basinal environments such as river, lakes and marginal seas. It is formed due to consolidation of sand particles. The sand particles are mainly made up of rounded quartz grains. In hand specimen, it is in brown or yellow or grey or buff colour, and exhibits medium grained texture. Sometimes size grading and rippling features are seen in it. Well sorting of grains is a characteristic feature of many sandstones. If a sandstone is completely composed of quartz, it is termed as orthoquarzite. If a sandstone contains 75% of quartz and 25% of feldspar, it terms as arkose. If a sandstone has more than 30% of matrix of clay, chlorite and glauconite, it terms as greywacks. A fine grained greywake (sandstone) terms into shale.


1. Colour: Grey white
2. Mineralogy : Quartz with little amount of feldspar
3. Cementing materials: Siliceous or ferruginous or both
4. Texture:
    a) Grain size : Medium grained
    b)Grain shape : Rounded to sub rounded
5. Type: Arenaceous
6. Clastic / Nonclastic : Clastic (mechanically formed)
7. Name: sandstone
8. Use: As building stones, Road metals, Railway ballast

LIMESTONE

It is a fine grained non clastic sedimentary rock that has been formed by the precipitation of calcium carbonate solutions which are derived from seawater. In handspecimen. It looks grey and exhibits fine grained texture. It is made up of mainly calcite. There are many varieties of limestone. It is a limestone is porous with full of foramineral shells, it terms as chalk. If a limestone contains shells of brachiopods or Lamellibranchs, it terms as shelly limestone. If a limestone contains high volums percentage of dolomite, it grades into dolomite.

1. Colour: Grey
2. Mineralogy : Calcite
3. Cementing materials: Calcareous
4. Texture:
   a) Grain size : Coarse grained
   b)Grain shape : Rounded to sub rounded
5. Type: Calcareous
6. Clastic / Nonclastic : Non-Clastic (Chemically formed)
7. Name: Lime stone
8. Use: In cement factories

SHALE

It is a fine grained argillaceous sedimentary rock that have been formed by the consolidation of beds of mud, clay or silt. The mud and clay are in chlorite, muscovite nd quartz. In handspecimen, it has varied colours like grey, brown black or yellow and exhibits fine grained texure and thin layering.

1. Colour: Black
2. Mineralogy : Clay
3. Cementing materials: Siliceous or ferruginous
4. Texture:
    a) Grain size : Fine grained
    b)Grain shape : Variable
5. Type: Argillaceous
6. Clastic / Nonclastic : Clastic (Mechanically formed)
7. Name: Shale
8. Use: Building materials

Laterite

Laterite is a soil and rock type rich in **iron and aluminium**, and is commonly considered to have formed in hot and wet tropical areas. Nearly all laterites are of rusty-red coloration, because of high iron oxide content. They develop by intensive and long-lasting weathering of the underlying parent rock. Tropical weathering (laterization) is a prolonged process of chemical weathering which produces a wide variety in the thickness, grade, chemistry and ore mineralogy of the resulting soils.

1. Colour: Red
2. Mineralogy : Clay minerals, Fe_2O_3, Al_2O_3
3. Cementing materials: Self cemented
4. Texture:
    a) Grain size : Fine grained (Concretionary)
    b)Grain shape : Variable
5. Type: Argillaceous
6. Clastic / Nonclastic : Clastic (Mechanically formed)
7. Name: Laterite
8. Use: Building stone, road metal, ore of iron, bauxite.

CONGLOMERATE

It is a common rudaceous rock formed under continental environment. It is mainly consolidated with rounded and subrounded pebbles and gravels. These pebbles and gravels are made up of quartz, feldspars and rock fragments. Ferrugeneous and siliceous cementing materials envelop the pebbles and gravels.

In handspecimen, the rock is easily distinguished from breccias by its characteristic rounded pebbles and gravels. The systematic description of the rock is given below.

1. Clastic/ Nonclastic : Clastic

2. Colour : shades of grey, brown

3. Mineralogy : Quartz feldspars, clay, hematite and limonite (goethite)

4. Structure : Rounded rudite

5. Texture

(a) Grain size : Coarse grained

(b) Grain shape : Rounded to subrounded

(c) Sorting : Poorly sorted

6. Nature of matric : Ferrugeneous and siliceous

7. Name : Conglomerate

EXPERIMENT9: IDENTIFICATION OF METAMORPHIC ROCKS

AIM

The aim of this unit, is to provide students about description of metamorphic rocks.

OBJECTIVES

After completing this unit, you should be able to

- Describe the different types of metamorphic rocks
- Describe the mineralogy of different types of rocks

SLATE

Slate is a fine grained lowgrade regional metamorphism rock; which is transformed from shale by regional metamorphism. It is characterized by slaty cleavage, along which it splits into thin sheets or layers. State is variable in its colour from grey to black.

1. Colour : Black
2. Mineralogy : Muscovite, chlorite, feldspar, quartz
3. Structure : Sheet or layers with slaty cleavage
4. Type of metamorphism : Regional metamorphism
5. Conditions of metamorphism : Low pressure and low temperature
6. Nature of parent rock : Pelitic (shale)
7. Name of the rock : Slate
8. Use: Building stone. Road Materials

MARBLE

Marble is either contact (thermal) or regional metamorphic rock transformed from a metamorphosed limestone. It is a coarse grained granular rock commonly exhibits white colour (but some marbles may be in different colours due to impurities). Its colour, texture, soft and smooth surfaces promote the rock into commercial grade in building industry.

1. Colour : White
2. Mineralogy : Calcite
3. Structure : Granulose
4. Type of metamorphism : Contact (thermal) metamorphism
5. Conditions of metamorphism : High temperature and low pressure
6. Nature of parent rock : Limestone
7. Name of the rock : Marble
8. Use: Building stone, ornamentation

QUARTZITE

It is a metamorphosed sandstone formed under either contact or regional metamorphism. In hand specimen, it is rather earthy white to brown in colour and exhibits granular form. It is mainly composed of recrystallized quartz. Its colour. Texture, hard and toughness promote the rock into commercial grade in building industry.

1. Colour : White
2. Mineralogy : Quartz
3. Structure : Granulose
4. Type of metamorphism : Contact (Thermal) metamorphism
5. Conditions of metamorphism : High temperature and low pressure
6. Nature of parent rock : **Sandstone**
7. Name of the rock : **Quartzite**
8. Use: Building materials, Road metals etc.

SCHISTS

Schists of many kinds (or varieties) depending upon their colour and composition. All of them have a unique character i.e. Schistosity or foliation. They are common rock type of the Precambrian terrains. Inhandspecimen they are coarse grained rocks and are in different shades of colours from dark green to brown and also exhibit characteristic foliation. They are mainly composed of phyllosilicates and double chain silicates. They are derived from either sedimentary or igneous rocks by the regional metamorphism.

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1. Colour : Black
2. Mineralogy : Bioite, garnet, quartz
3. Structure : Schistose or foliation
4. Type of metamorphism : Medium grade regional metamorphism
5. Conditions of metamorphism : Moderate pressure and temperature
6. Nature of parent rock : Pelitic (shale)
7. Name of the rock : Mica schist

GNEISSES

Gneisses are of many kinds (or varieties) depending upon their colour and composition. All of them have a unique character i.e. gneissosity or banding (or lineation). They are common on rock types of the Precambrian terrains. In handspecimen, they are coarse grained rocks with alternate dark and white (light) bands. Each band its own colour and composition. Generally, the white bands is mainly composed of felsic minerals such as quartz and feldspars, while dark band is rich in mafic minerals, such as puroxenes, amphiboles, epidotes, garnets and biotite micas. They are derived from either sedimentary or igneous rocks by high grade regional metamorphism.

1. Colour : Shades of grayish white
2. Mineralogy : Quartz, feldspar, biotite, hornblende
3. Structure : Gneissose or banding (felsic and mafic bands)
4. Type of metamorphism : High grade regional metamorphism
5. Conditions of metamorphism : Moderte pressure and high temperature
6. Nature of parent rock : Granite
7. Name of the rock : Gneiss
8. Use: Building materials, Road metals , concrete aggregate etc.

EXPERIMENT NO 10

DIP AND STRIKE PROBLEM

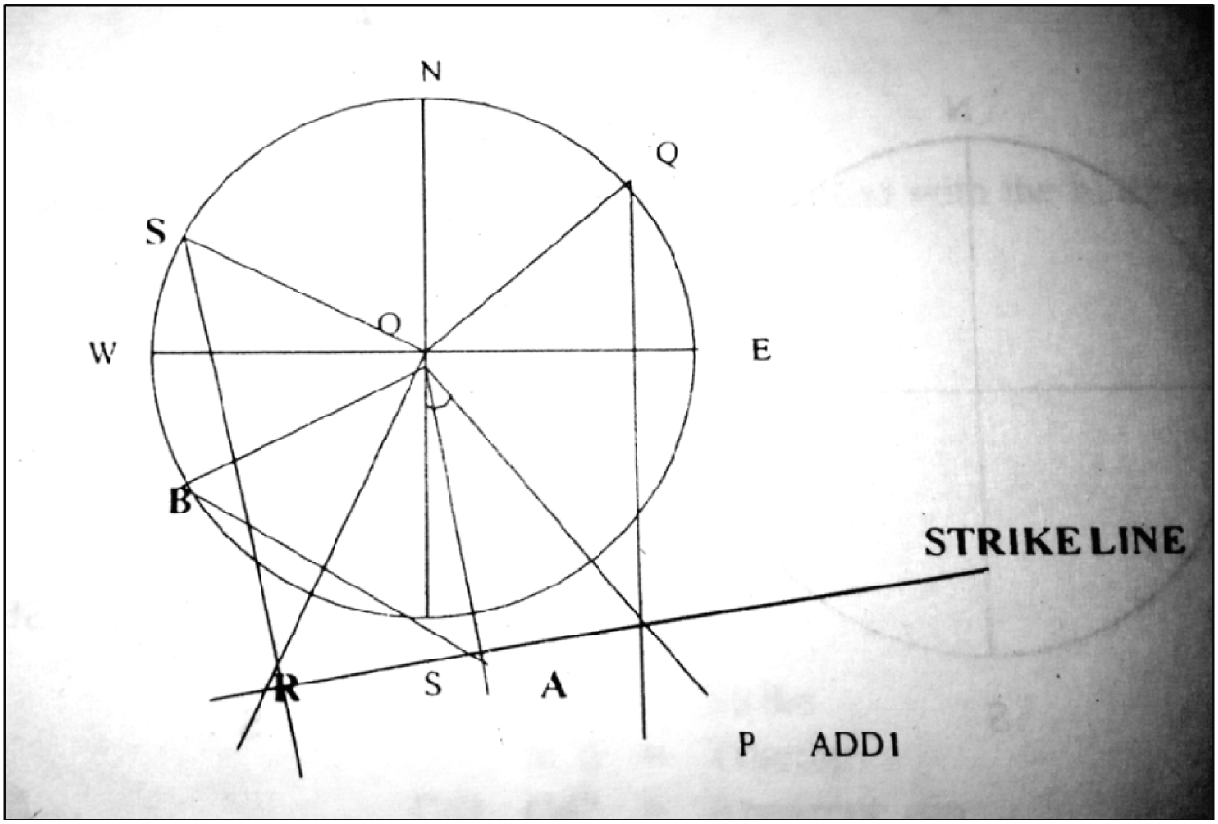
AIM
The aim of this unit is to determine the direction and amount of dip of the geological formation.
OBJECTIVES
After solving the problem students should will be able to:
• Determine the dip amount and dip direction of the geological formations
• Determine the true thickness of the formations

QUESTIONS FOR VIVA-VOCE:

1. Why it is important to determine the dip and strike of beds?

(I) DETERMINATION OF TRUE DIP DIRECTION [T.D.D.] AND TRUE DIP

Problem : A bed of sandstone dips at an angle of 30° in a direction of S 30°E and 30° along S15°W. Find the amount of true dip?



Procedure :

1. Draw a circle by convenient radius and mark N.S.E.W directions with O as center.
2. Draw the line OP = S30°E and OR = S15°W.
3. Draw a perpendicular to the line OP from P point O which cuts the circle at Q.Now at Q draw a complementary angle [90° - 30° = 60°] which cuts the line OP at point P. Join PQ.
4. Similarly draw a perpendicular to the line OR from point O which cuts the circle at S. Draw a complementary angle [90° - 30° = 60°] which cuts the line OR at point R. Join RS.
5. Now join the points P and R, which is the strike direction.
6. For finding amount of true dip draw a perpendicular from O to the line PR which meets the line PR at A. Join OA.

Draw a perpendicular to the line OA from point O, which cuts the cirlcle at B. Join AB. Now angle OAB will give the amount of true dip and OA is the direction of true dip.

Result : True Dip Amount TDA = 30°

True Dip Direction : TDD = S8°E

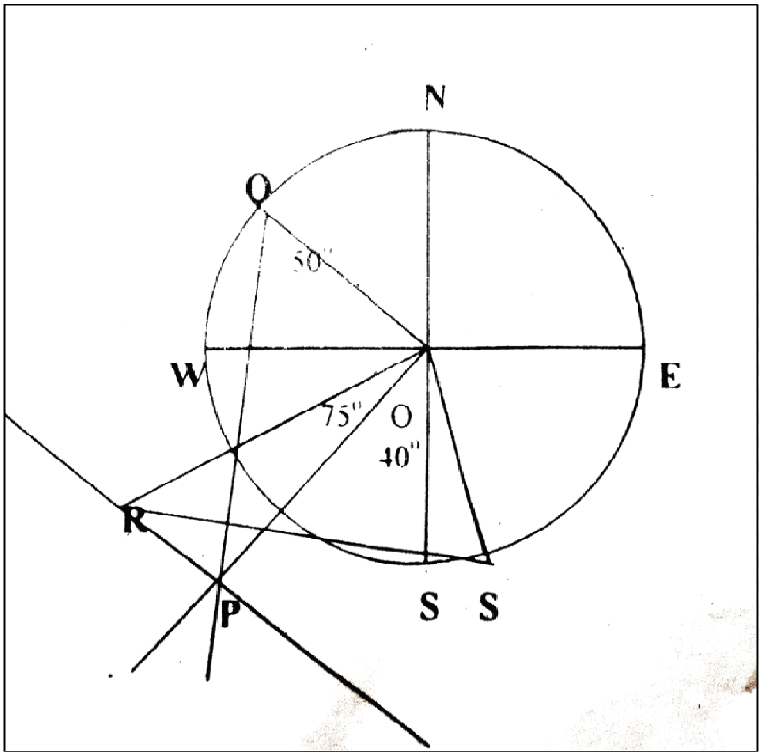
EXERCISE

1. The apparent dip of a coal bed is 30° in a direction of S30°E and in a direction of S58°W with an apparent dip of 45°. Find the direction and amount of true dip.
   Result : TDA = OAB = 49°
   TDD = OA = S8°E
2. A limestone bed dips 30° along S25E and dips 33° along N85°E. Determine its true dip.
   Result : TDA = OAB = 36°
   TDD = OA = N8°E
3. In a dam site a bed of limestone dips 25° along NW and 20° along NEE. Determine its true dip.
   Result : TDA = OAB = 36°
   TDD = OA = N6°E
4. A coal bed dips 30° along S30°W and 38° along N60°W. Determine its true dip.
   Result : TDA = OAB = 42°
   TDD = OA = S85°W
5. At a dam site a bed of Quartzite dips 28° along N20°E and 34° along S80°E. Determine its true dip.
   Result : TDA = OAB = 38°
   TDD = OA = N68°E

(II) METHOD : DETERMINATION OF APPARENT DIP AMOUNT [A.D.A]

PROBLEM: Coal seam dips 35° along S40°W. Detremine the amount of apparent dip in the direction of S75°W.

T.D.A. = 35°
A.D.A = ?
T.D.D. = S40°W
A.D.D. = S75°W



PROCEDURE :

1. Draw a circle by convenient radius and mark N.S.E.W. directions with O as center.
2. Draw a line OP = S40°W. Draw a perpendicular to the line OP from point O which cuts the circle at Q. Now at Q draw a complementary angle 90° - 35° = 55° which cuts the line OP at point P. Join PQ.
3. From the intersection point P draw a parallel line to the line OQ that is the strike line.
4. Let a line equal to S75°W , which cuts the strike line at point R. Join OR-OR line.
5. Draw a perpendicular to the line OR from point O, which cuts the circle at S. Join R and S. Measure angle ORS, which is the amount of apparent dip.

NOTE : ORS should be less than the true dip. Amount given in the problem.

Result : ADA along N70°W = ORS = 30°.

EXERCISE

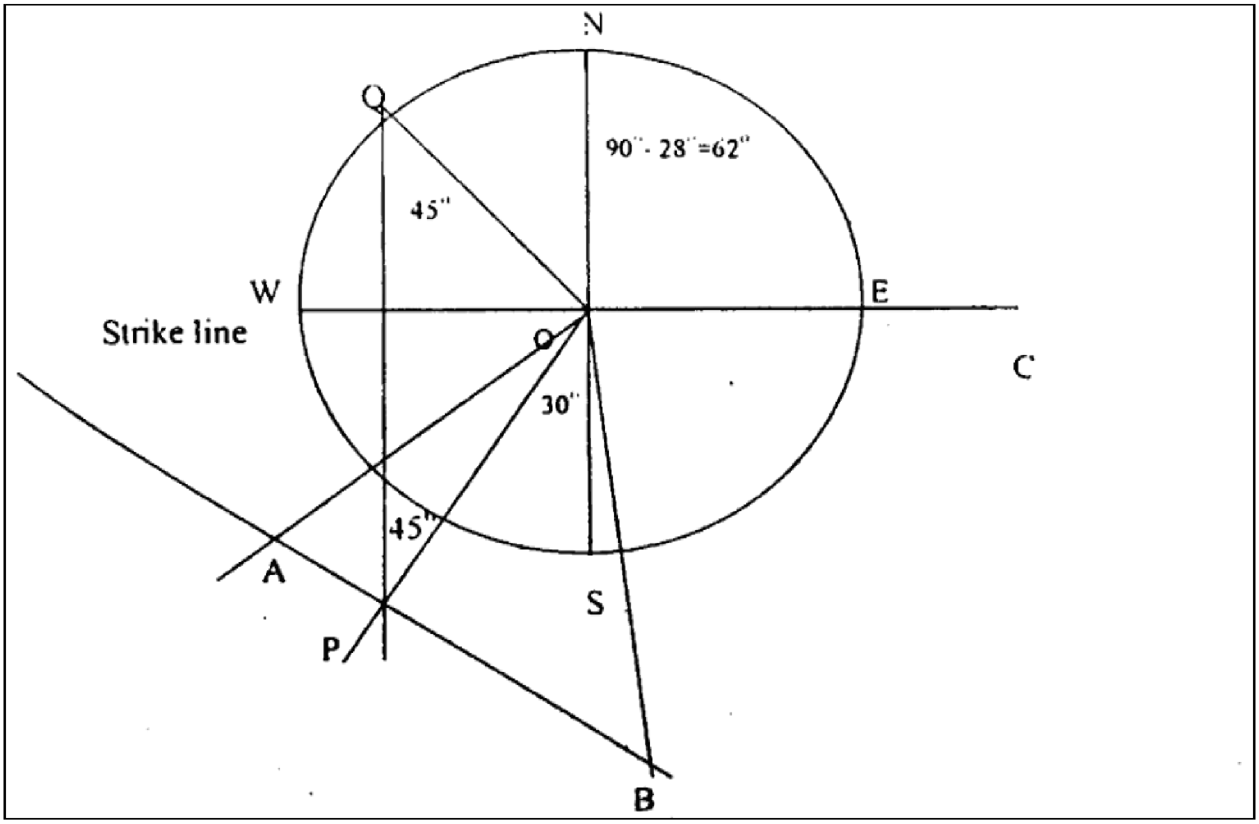
1. A bed of sandstone dips 40° along east. Determine the amount of dip along N60°E and SE.
   Result : Apparent dip amount along SE = 3°
   Apparent dip amount along N60°E = 32°

2. A bed of sandstone dips 40° along N60°E. Determine the amount of apparent dip along S80°E and N27.5°E.
   Result : Apparent dip along S80°E = 32°
   Apparent dip along N27.5°E = 36°
3. A coal seam is exposed around a colliery. It shows a true dip of 48° along S30°W. Determine the amount of inclination along S10°E and S60°W.
   Result : Apparent dip along S10°E = 40°
   Apparent dip along S60°W = 43°
4. In a reservoir site a bed of Quartzite has maximum inclination of 40° along N40°W. Find its inclination along North and N60°W.
   Result : Apparent dip along North = 23°
   Apparent dip along N60°W = 43°

(III) METHOD:DETERMINATION OF APPARENT DIP DIRECTIONS (ADD)

PROBLEM : Coal seam dips 45° along S30°W. Two inclined tunnels are proposed to have a dip of 28°. Determine the directions of tunnels. (On direction of apparent dip).

T.D.A. = 45° **T.D.D. = S30°W**
A.D.A. = 28° **A.D.D. = ?**



PROCEDURE :

1. Draw a circle by convenient radius and mark N.S.E.W. directions with O as center.
2. Draw a line OP = S40°W. Draw a perpendicular to the line OP from point O which cuts the circle at Q. Now at Q draw a complementary angle 90° - 35° = 55° which cuts the line OP at point P. Join PQ.
3. From the intersection point P draw a parallel line to the line OQ that is the strike line.
4. Select any arbitrary line (Direction) says north. From point N draw a complementary angle 90° - 28° = 62° that cuts the east lien at point C.

   Now with O as centre OC as radius drw=aw two arcs. So that it cuts the strike line on both the directions at points AB respectively.Join OA and OB.

NOTE : OA and OB are the directions of apparent dip.

RESULT: ADD_1, OA = S30°E ADD_2, OB = S35°W.

EXERCISE

1. A bed of Shale is found to have a true dip of 45° in the direction of N80°E. Find the direction along which the bed will have an apparent dip of 36°
   Result : ADD_1, OA = N50°E
   ADD_2, OB = S34°E
2. A coal seam dips 45° along S50°W. Two inclined tunnels are proposed to have a dip of 28°.Determine the direction of tunnels.
   Result : ADD_1, OA = 28° along S85°W
   ADD_2, OB = 28° along S33°W