ENGINEERING GEOLOGY LABORATORY

ES 355 CE
Instruction: 2 periods per week **Duration : 2 hours**
CIE: 25 marks **SEE: 50 marks**
Credits : 1

Objectives:
The objectives of this course is to impart knowledge of:
- Hands-on experience to study the geological aspects of various rocks.
- Evaluate the physical and engineering properties of minerals and rocks
- Provides exposure to various geological tests.

Outcomes:
After completing this course, the student will be able to:
- Identify the physical and engineering properties of minerals and rocks
- Analyze and measure structural aspects of rocks using models
- Carry out field experiment and studies such as VES
- Perform studies such as Stereoscopic study of photographs, seismic refraction survey and Slake durability test
- Study the topographical and GSI maps

LIST OF EXPERIMENTS

1. Identification and description of physical properties of minerals
2. Identification and description of geological and geotechnical characteristics of rocks
3. Determination of apparent specific gravity, porosity and water absorption of different rocks
4. Study of structural geology models (wooden models)
5. Measurement of dip of planar feature by clinometers compass
6. Vertical electrical sounding VES field experiment
7. Stereoscopic study of aerial photographs pertaining to landforms, vegetation and water bodies
8. Seismic refraction survey to determine depth to bedrock
9. Study of topographical maps
10. Structural geology problems (strike, dip, three point problems)
11. Study of geological survey of India (GSI works) maps and reports
12. Slake durability test on soft rock

Note: At least 10 experiments should be conducted in the semester

MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY
CIVIL ENGINEERING DEPARTMENT
Engineering Geology Laboratory

Experiment No.1

Identification and description of physical properties of minerals

OBJECTIVE:-

The mineral composition is a prime consideration in the assessment of strength of the rocks by which the quality assurance can be determined for insitu rock formation for selection of dam foundations, tunnel alignment and construction materials like Building stones, Decorative stones etc.

APPARATUS:-

Moho hardness scale, magnifying lens, streak plate, pen knife, conc. Hcl etc.

DEFINITION OF MINERAL:-

A mineral is inorganic solid, homogeneous substance with definite chemical composition and fixed atomic structure.

The following methods briefly summarized

METHOD:-	**PRINCIPLE:-**
a) X ray analysis	: The study is exclusively based on atomic structure.
b) Chemical analysis	: Based on chemical composition, the mineral can be identified.
c) Optical study	: The study of mineral polished surface is deferred with optical properties with aid of microscope.
d) Physical properties	: Based on some prominent and distinctive physical properties the minerals can easily be identified with only megascopic examination.

The above mentioned methods are time consuming, destruction of minerals but the megascopic study of physical property method has got certain practical advantages like quick assessment, least expensive and repetitive study can be initiated on minerals. So, this method has been adopted in this exercise.

MEGA SCOPIC STUDY AND IDENTIFICATION OF MINERALS

Different physical properties and their important in identification:

1. **COLOUR**:- The color of mineral is inherent property, depends upon absorption some and reflection of others under ordinary light. For example:-

   The mineral quarts, composed of silicon dioxide is commonly colorless or white but it is also found with pinkish yellow, green, brown, black color because of the arrangement of different ions.

   TRUE COLOUR:- The true color of pure mineral depends on the nature and arrangement of the constituent ions. For example:- The minerals containing Al,Na,K,Ca,Mg,Ba as their main ions are generally colorless or light color. While those with those with fe,cr,mn,co,Ni,Ti,va,cu are colored.

   METHOD:- The observer is being instructed to study the uniform color of given mineral to be exposed to light with aid magnifying lens with least error.

2. **CHEMICAL COMPOSITION**:'

   The chemical composition of different ions, which constitute mineral, may only theoretical noticed which gives idea another properties

3. **FORM**:- Minerals assume definite geometrical forms of crystals. It is also good recognition property in their identification. The following general descriptive terms of crystal characters of minerals

i) Crystallized:- Denote the mineral with well developed crystals, the beautification is enhanced.
ii) Crystalline:- No definite crystals are developed but confused aggregate of imperfectly.
iii) Crypto crystalline:- The possession of more traws of crystalline structure amorphous used complete absence of crystals.
iv) Acicular:- Fine need like crystals.
v) Amypdaloidal:- Almond shaped, ex= Zeolite
vi) Bladed:- Shape like a knife-blade or lath.
vii) Botryoidal:- Spherical aggregation (resembles like bunch of grapes)
viii) Capillary:- exhibits a fine hair like form.
ix) Columnar:- Resembling slender colums.
x) Conceretionory or nodular:- forms being spherical, ellipsoidal(detached mass)
xi) Dendritic:- tree like or mass like form.

xii) Fibrous:- Fine thread like form.
xiii) Foliated:- Consists of thin and separable iamellae or leaves.
xiv) Granular:- Grains either coarse or fine.
xv) Lamellar:- Separable plates or leaves forms.
xvi) Lenticular:- Form of flattened balls or pellets.
xvii) Mammilated:- Display large mutually interfering spheroidal surface.
xviii) Radiating or divergent:- Disperson crystal or fibers around a central point.
xix) Reniform:- Kidney shaped.
xx) Reticulated:- forms of cross-mesh like net.
xxi) Sealy:- in small plates.
xxii) Stellate:- Showing fibers radiating from centre.
xxiii) Tabula:- Broad flat surfaces
xxiv) Tuberose:- Showing very irregular rounded surface
xxv) Wiry of filiform:- in this wires often twisted like the strands of a rope.

METHOD:- The observer should not the geometrical shape to conclude the specification.

4. **CRYSTAL – STRUCTURE**:- The crystal structure can be determined with the help of their symmetrical habit, the plane of symmetry, axis of symmetry and centre of symmetry is taken into account to specify structure like Cubic, tetragonal, Hexagonal, heptagonal, octagonal, triclinic monocline.

METHOD:- Regular smooth surface, can be considered in this aspect.

5. **LUSTURE**:- Lusture is defined as its appearance in reflected light, differs both in intensity and kind depending upon amount and type of light that take place

There are several kinds of lusture, those are as follows.

1) Metallic lusture:- Resembles the shine of bright metals like gold, iron, pyrite, galena.
2) Sub- metallic lusture:- Resembles the dull shine metals like chromite.
3) Vitreous:- The lusture of broken glass.
4) Sub vitreous:- Resembles feebly shine of glass ex. Calcite
5) Resinous:- The lusture of resin.
6) Silky:- The lusture of silk the mineral of fiberous form show silky lusture.
7) Adamantine:- The lusture of silk the mineral of fibrous from show silky lusture.
8) Splendent:- The lusture of mirror. Ex. Leamatite.
9) Glistening:- The lusture is less brilliant and is incapable of giving any image.
10) Glimmering:- Denotes still more feeble lusture.
11) Dull:- Earth like doesn't shine.

METHOD:- The observer may carefully identify the shining surface with respect to the degree of shining in the means of amount and its resemblance related to above mentioned.

PRECAUTIONS:- Weathered surface must be excluded for examination, mineral can be examined under light with aid magnifying lens.

6. **STREAK**:- The streak may be defined as the color of the powder of mineral fine powder produced on unglazed porcelain plate(streak plate).

METHOD:- Small quantity of mineral powder must be obtained by rubbing it on given porcelain plate(streak plate)

PRECAUTIONS:- Wipe out early deposited powder before testing.

7. **DEGREE OF TRANSPARANCY**:- A mineral is transparent when the outline of objects seen through. Ex. Rock crystal – a variety of quartz.

a) Sub-transparent:- Objects seen through them appear indistinct.
b) Translucent:- Capable of transmitting light cannot be seen through it.
c) Opaque:- When no light transmitted.

METHOD:- Out lines of mineral must be examined under light condition.

8. **HARDNESS**:- The hardness of a mineral may be defined as the resistance offered to abrasion.

OBSERVATIONS:- Hardness depends upon atomic structure increase density of packing

1) Fine cut
2) Noting the amount of powder
3) The degree of noise produced during operation. The less the powder, greater then noise. Indicates harder mineral

   A soft mineral produces much powder and little noise.

METHOD:- Hardness is determined by mono's scale of hardness. Hardness classified 1-10 based on above observations.

MOHS' SCALE OF HARDNESS

HARDNESS	**STANDARD MINERAL**
1.	Talc
2	Rock salt, Gypsum
3	Calcite
4	Flurospar
5	Appetite
6	Orthoclase feldspar
7	Quartz

8	TOPAZ
9	Corundum
10	Diamond

TEST:-

1) Scratching the mineral with known hardness mineral scratch one mineral to another group of mineral in which the scratch crates, lines are distinctive, the degree of depression along the line.
2) Hardness may be tested by means of pen knife or even finger-nail former stretch upon 6 ½ and latter 2 ½. After starching and nail-penknife testing all minerals must be sequentially placed in moho's hardness scale.

9. **TENACITY**:- Behavior of the mineral is expressed interms like brittleness, flexibility, elasticity, sectility and malleability.

a) **SECTILITY**:- A mineral is said to be sectile when it can be cut by knife resulting slice break up under a hammer.
b) **MALLEABILITY**:- If it is cut from it flattens out under a hammer. Ex. Silver, copper, gold.
c) **FLEXIBILITY**:- A property of bending in some minerals it can be observed by experimenting with thin plates laminae. A flexibility remains bent after pressure is removed.
d) **ELASTICITY**:- Flexibility that brings back original position
e) **BRITTLENESS**:- It is shown by cumbling or fiying to powder.

10. **SPECIFIC GRAVITY**:- The specific gravity of a body is the ratio of the body that of an equal volume of water specific gravity depends upon atomic weight and their orientation in crystal structure

$$\text{Specific gravity} = \frac{W_a}{W_a - W_w}$$

Where Wa,Ww are weights of the body in air and weight in water respectively.

METHOD OF DETERMINING SPECIFIC GRAVITY:-

1) Walker's steel yard for large specimen.
2) Jolly's spring balance for very small specimen.
3) Pycno meter or specific gravity bottle etc.

11. **CLEVAGE**:- The tendency to split along certain definite planes are called cleavage plane. Related to crystalline form and the internal structure.

METHODOLOGY:-

1) The planes appears on mineral surface that are possibility break in definite plane may thoroughly be studied with out destruction of mineral.
2) Sets of cleavage may also be noticed in some minerals.

12. **FRACTURE**:- Nature of the broken surface of the mineral.

a) Even:- The fracture surface is smooth is called even.
b) Uneven:-The fracture surface is rough by reasons of minute elevation and depression is called uneven
c) Conchoidal:- Curved concave or convex surface in often shows concentric shapes.
d) Hackly:- The surface is studied with sharp and jagged elevation.
e) Earthy:- As in the fracture of chalk.

METHOD:- The broken surfaces should easily be examined by observer to the above mentioned characters.

13. **SPECIAL PROPERTY**:- There are some cases of some minerals which are unique in some respects. For example.

1) Magnet:- Strongly attracted by even ordinary magnets;
2) Realgarl orpiment:- Have strong garlic smell.
3) Graphite:- Mark on paper.
4) Calcite:- Reacts with Hcl(cons) gives effervance.
5) Pyrolusite:- Soils the fingers.
6) Talc:- Soapy feel.

14. **DIAGNOSTIC PROPERTIES:**- There are set of some physical properties which are distinctive for mineral can be seen in some only. Ex. Quartz:- Diagnostic properties:- vitreouls lusture, elevage absent, H – 7, medium density not opaque. There properties can be formed in quartz only.
15. **USES**:- The general use of the mineral should be studied.
16. **NAME OF THE MINERAL**:- After examining above all physical properties the observer must conclude the name of the mineral

PRECAUTION:-

1) All minerals of fresh surface must be taken for study of the physical character.
2) The exercised information must be written in format being enclosed.

NOTE:-

1) Rock forming mineral are prime consideration and plays role on strength of rock in Civil Engineering.
2) A format is enclosed for observation of mineral study.

MEGASOPIC STUDY AND IDENTIFICATION OF ROCK FORMING MINERALS

COLOUR:-

CHEMICAL COMPOSITION

FORM:-

CRYSTAL STRUCTURE:-

LUSTURE:-

STREAK:-

DEGREE OF TRANSPARENCY:-

HARDNESS:-

TENACITY:-

SPECIFIC GRAVITY:-

CLEVAGE:-

FRACTURE:-

SPECIAL PROPERTY:-

DIAGNOSTIC PROPERTY:-

USE:-

NAME OF THE MATERIAL:-

MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY
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Experiment No.2a

Identification and description of geological and geotechnical characteristics of rocks

DEFINATION OF ROCK:- A rock may be defined as an aggregate of minerals.

GEOLOGICAL CLASSIFICATION:- Based on their origin, the rocks are igneous, sedimentary, metamorphic rocks.

MEGASCOPIC STUDY OF IGNEOUS ROCKS:-

1) **COLOUR**:- The presence of minerals give a certain colour in rock. The overall colour of a rock should be assessed by reference of colour chart,(the colour chart of geological society of America).

METHOD:- The observer should read the colour megascopically when a rock is imagined to be kept at some distance. The colour can be written in terms as follows.

i) **LEUCOCRATIC**:- If the rock looks pale or white coloured, indicated rocky be acidic. The colour index 1-30, light col. Ex: granite
ii) **MELANOCRATIC**:- If the rocks like dark coloured or black coloured, it indicated that rock may be basic or ultra basic. Colour index 61-100 Ex:Gabbro.
iii) **MESOORRATIC**:- If the rock is neither dark nor pale colour. Colour index 31-60 dark cilour Ex. Peridotites.

2) **MINERAL COMPOSITIONS**:-The mineral composition and colour of rocks are related to their chemical composition. The presence of mineral in a rock has variable proportion during crystallization.

a) Primary minerals: The present of minerals in dominant proportion and these has been formed during crystallization.
b) Secondary minerals:- The minerals are [resent after the formation of rock.
c) Essential minerals:- The major mineral constituents and decide the name of the rocks.
d) Accessory:- If they occur in small quantities and their presence or absence has nothing to do in naming a rock.

3) **TEXTURE**:- The size, shape and arrangement of grain defines texture of rock.

SIZE:-

I) Coarse grained – if grain size diameter is < 2 mm
II) Medium grained – size of grain is between 0.006 to 2 mm
III) Fine grained – size of grain is < 0.06 mm

SHAPE:-

i) Euhedral:- The term denotes if grains in rock shows roundness.
ii) Subheral:- If the grain is partly irregular and partly irregular in shape called subhedral.
iii) Anhedral:- The grain's line out shows completely irregular is called anhedral.

The observer should megascopically, identify any of these.

Instructions:- The observer should carefully study grain size and shape of grain to determine the appropriate terms as mentioned above.

ARRANGEMENT OF THE GRAINS:- The orientation of grain's pattern directly depends upon crystallization. The common arrangements are

i) Regular arrangement:- A series of grains are arranged in regular fashion.
ii) Random arrangement:- If grains are randomly disturbed.

4) **DEGREE OF CRYSTALLINITY**:- The rocks may have all of its mineral constituents distinctly crystallized, some may be poorly crystallized depends upon the factor during cooling process of magma.

i) Holo crystalline:- Entirely composed of crystals with ground mass(cooled-slowly)
ii) Hypo crystalline:- Composed of partly crystals and partly glassy.
iii) Hyalo crystalline:- No crystals but glass(cooled quickly)

5) **GRANULARITY**:- The arrangements of major constituent minerals and size in a particular rock granularity is as follows

i) Equi-granular:- All those rocks in which majority of the constituent grains are roughly equal size are described as equigranular.
ii) Inequi-granular:- All those texture in which the majority of the constituent minerals show marked differences in their grain size are grouped under inequigranularity.

6) **TYPES OF TEXTURE**:- Based on crystals size and ground mass(glassy)texture are classified as follows.

i) Phaneric:- if minerals are visible to naked eye by virtue of their size.
ii) Aphanitic:- if minerals are too fine to be seen by naked eye.
iii) Phaneric coarse:- if minerals are > 5 mm in size.
iv) Phaneric medium:- if minerals are 2 to 5 mm in size.
v) Phaneric fine:- if minerals are < 2 mm in size.
vi) Equigranular:- if minerals are nearly of same size.
vii) Inequigranular:- if some minerals are distinctly large than others.
viii) Porphyritic:- if large minerals surrounded by smaller minerals.
ix) Inter locking:- if minerals are closely inter linked can be separated without damaging surrounding minerals.
x) Graphic:- if angular quartz grain occur with some orientation in feldspare.

INSTRUCTION TO OBERERVER:- The observer should examine the one of properties of given rock and note particulars to conclude the type of texture in rock.

i) Vasicular structure:- Generally lava is rich in gases at the time eruption. During the process if cooling and crystallization the gases are escaped through molten stage magma leaving remants of its passages called vesicles or cavities, this structure is called vasicular structure.
ii) Amygdaloidal structure:- The vesicles are subsequently get filled with secondary minerals(almond shaped) gibing rise the so known amygdaloidal structure (almond shapes) Ex. Scoria, pumice, Basalt.
iii) Flow structure:- It is defined by the development if parallel or nearby parallel layers or bands or streaks in the body of igneous rock. The parallelism is caused by the flow of magma or lava during the process of crystallization.
iv) Spherulitic structure:- It is defined by the presence of this mineral fibers of varies sizes arranged in a perfect or semi perfect radial manner about common centre.
v) Orbicular:- Rare type in which rock appears ball like segregation each ball is turn composed concentric shells of different minerals.

7) **JOINTS**:- Joints are defined as divisional planes alone which there is no relative displacement.

IGNEOUS ROCKS SHOWING JOINTS:- Less regular arrangement of joints is exhibited in igneous rocks.

TYPES OF JOINTS IN IGNEOUS ROCKS:-

i) Sheet joints:- If joints are parallel to each other with notable spacing is called sheet joints. Ex. Granite
ii) Mural joints:- If two vertical and one horizontal so that the rock can divide into sub circles of minerals.
iii) Columnar joints:- The pattern of joints in such rock when splits to give exact polygon columns.

JOINTS IN SEDIMENTARY ROCKS & METAMORPHIC ROCKS:-

Heavily jointed pattern can be seen in sedimentary rocks.
Regular joints arrangement can be seen in metamorphic rocks.

INSTRUCTION TO OBSERVER:-

1) All above mentioned joints are seen in rock formation in the field
2) The observer should identify the joints planes if present in given rock.
3) Discuss the strength of the rock by considering its orientation and grain size distribution and maturity should also taken into account.

8) **FRACUTRE**:- Broken surface of rock weaker plane presence in a rock is fracture. The observer should the relate between the direction of fracture and grain size arrangement.

For example

i) Fracture along grains: if fracture and grain arrangement in same direction.
ii) Across the grains: if fracture orientation other than grain arrangement.

9) **ENGINEERING PROPERTIES**:-

1) Compressive strength.
2) Crushing strength
3) Tensile strength
4) Porosity
5) Density
6) Abrasive strength
7) Fire and frost resistance

Note:- The theoretical values must be compared with carefully referring with each engineering property and try to conclude like, High-Medium-Low.

10) **DEGREE OF WEATHERING**:- The rate of weathering in the given rock indicated discoloration due to water action.

i) Fresh:- if rock is free from weathering.
ii) Moderately weathered:- if nearly 50% of the rock is weathered.
iii) Highly weathered:- if rock is discoloured from its original.

11) **CLASSIFICATION:-** The igneous rocks may be classified based on grain size.

i) Plutonic:- Deep seated cock shows grained coarse because of slow cooling process.
ii) Hypabassyal:- Presence of rock at intermediate depths with medium grained because of its rate of cooling moderate.
iii) Volcanic:- Fine grained rocks formed due to rapid cooling on the surface of the earth.

12) **OCCURANCE**:- Occurrence of the given in a igneous intrusive and extrusive forms like, sills, loccolith, dukes, batholiths, etc

13) **USER:-** The uses of rock in the Civil Engineering practice. Ex. Building stone, Decorative stone, Flooring, Roofing stone, aggregates, Road metals etc.

14) **NAME OF THE ROCK**:- After studying above all megascopic properties the student should conclude the name of the rock and type .Ex. Granite, Igneous.

SOME IDENTICAL PROPERTIES OF IGNEOUS ROCKS:-

1) Consists of silicate minerals which make them durable and pleasant coloured (incase of acidic rock).
2) Inter locking of grains is high, provides good internal cohesion.
3) Porosity and permeability is negligible which contribute strength and durability
4) Can take high degree of polishing.

The above mentioned character are helpful in identification as igneous rocks and differentiate from sedimentary and metamorphic rocks.

Note:- The enclosed format must be followed during the study of Geo-technical aspects.

GEOTECHNICL DESCRIPTION OF IGNEOUS ROCK

COLOUR:-

MINERAL COMPOSITION
a) Primary minerals
b) Secondary minerals
c) Essential minerals
d) Accessory minerals

TEXTURE:- (1) SIZE (2) SHAPE (3) ARRANGEMENT OF GRAINS

DEGREE OF CRYSTALLINITY

GRANULANITY

STRUCTURE:-

JOINTS
(i) Sheet joints
(ii) Mural joints
(iii) Columnar joints
(iv) A joint plane

FRACTURE:-

ENGINEERING PROPERTIES:-

DEGREE OF WEATHERING:-

CLASSIFICATION:-

OCCURRENCE:-

USES:-

NAME OF ROCK:-

MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY
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Experiment No.2b

Identification and description of geological and geotechnical characteristics of Sedimentary rocks

1) **COLOUR**:- The presence of minerals give a certain colour in rock. The overall colour of a rock should be assessed by referring of colour chart the (colour chart of geological society of America) .

METHOD:- The observer should read the colour megascopically when a rock is imagined to be kept at some distance. The colour can be written in terms as follows.

i) **LEUCOCRATIC**:- Of the rock looks pale or white coloured, indicates the rock looks pale or white coloured, indicates the rock may be acidic.
ii) **MELANOCRATIC:**- If the rock looks dark in coloured or black coloured, it indicates the rock may be basic or ultra basic. Colour index 61-100 Ex.
iii) **MESOORRATIC**:- If the rock is neither dark nor pale coloured. Colour index 31-60 dark colour Ex.

2) MINERAL COMPOSITION

I) The mineral composition and colour of rocks are related to their chemical composition. The presences of mineral in a rock have variable proportion during simple consolidation or cementation, it's highly heterogenic in nature.
II) Primary minerals: The presence of minerals in dominant proportion and these have been formed.
III) Secondary minerals:- If the minerals are present after the formation of rock.
IV) Essential minerals:- The major mineral constituents are decide the name of the rock

3) **TEXTURE:**- Sedimentary rock made up gravel, fragments which are coarser than grave. Sedimentary textural classification play important role describing a structure of sedimentary rocks.

i) Size:- Size of the grains of sedimentary rocks into certain grades, coarse medium/fine/ most of the sedimentary rocks are hetrogenetic in nature.

Instructions:- The observer should note the size of the grade like coarse/medium/fine.

ii) Shape of sedimentary:- The mineral like Quartz, garnet will remain angular shape even it has under gone long transportation. Heavier mineral becomes more rounded whilst smaller remain angular unaffected by transportation.

Instruction:- The shape in terms of Euheral/subhedral/anhedral should be observed by observer.

iii) Arrangement of grains:- The sedimentary rocks are normally hetrogenetic in composition and shape of grain changes one to other. Based upon the rate of consolidation some rock also show regular arrangement, fine grained rocks normally show regular orientation in grains arrangement.

Instruction:- The observer should note down the grain size arrangement like preferred orientation/random orientation.

Shape:-

Euhedral:- The term denotes if grains in rock shows roundness.
Subhedral:- if the grain is partly irregular and partly regular in shape called subhedral.
Anhedral:- The grain's out line shows completely irregular is called anhedral. The observer should megascopically, identify any of these characters the rock posses.

Arrangement of the grains:- The orientation of grain's pattern directly depends upon the minerals of parent rock, intensity and magnitude of weathering. There re few types are common.

Regular arrangement:- A series of grains are arranged in regular fashion
Random arrangement:- If grains are randomly disturbed.

The observer should carefully study in all corners and sides to determine this pattern.

4) **NATURE OF BOND**:- The rock which have been formed by mechanically process shows good cementation in which matrix(fine material) acts as binding, the matrix is usually from mineral like silica, calcium, carbonate, clay, or ferruginous materials.

The other sedimentary rocks are chemically formed soluble constituents are leached and carried away in form of solution by precipitation and chemical feeble acid activity plays role in the formation of the rocks, chemical deposits and with incorporates of dead organic shells are called organic deposits.

Instruction:- The nature of binding material (matrix) will help observer to study of various aspects, the student should note that the bond in the sedimentary rock whether of its king mechanical or chemical organic.

Structure:- The structure includes some large-scale features in sedimentary rocks.

1) Mechanical structure:- Developed because of some physical process during the time of deposition.
2) Stratification:- Layered arrangement each bed is separated by bedding plane.(stratum = bed) starta (series of beds).
3) Cross bending:- Change in velocity and direction the sediments get deposited in irregular types.
4) Linticular:- In which layers show extreme irregularity in their shape and deposition.
5) Ripple marks:- Rare, may appear in sand stones, shale, and line stones, they
6) appear as undulation in rock.

2) Chemical structure:-

i) Concretionary, nodular – Nodular or irregular shaped grains Ex. Laetrite.
ii) Oolitic:- Presence of small, spherical and pisolitic or grains. Ex. Limestone.
iii) Solution cavities:- Cavities or pores can be found due to acid activity. Ex. Lime stone.

CLASSIFICATION:- Clastic(mechanically formed) Non clastic (chemically formed)

SOME IDENTICAL CHARACTER OF SEDIMENTARTY ROCK:-

i) Stratification can be seen in sedimentary rocks.
ii) The segmentation and compaction can be observed in the rock of poor in sense of durability.
iii) Size, shape, assessment is normally different with other rocks.

Note:- The enclosed format must be followed during the study of Geotechnical aspects.

GEOTECHNICAL DESCRIPTION OF SEDIMENTARY ROCKS

COLOUR

MINERAL COMPOSITION:-
- i) Primary minerals
- ii) Essential minerals
- iii) Secondary minerals
- iv) Accessory minerals

TEXTURE:- I) SIZE: II) SHAPE: III) ARRANGEMENT OF GRAINS:

NATURE OF BOND:-

STRUCTURE:-

JOINTS:-

FRACTURE:-

ENGINEERING PROPERTIES:-

CLASSIFICATION:-

OCCURRENCE:-

USES:-

NAME OF THE ROCK:-

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Experiment No.2C

Identification and description of geological and geotechnical characteristics of metamorphic rocks

Definition of Metamorphic rock:- Primary rock or secondary rock is subjected to temp, pressure, stresses and chemical action will show partial or complete change in colour, mineral composition and textural properties. The process in which these changes takes place is called metamorphism..

MEGASCOPIC STUDY OF METAMORPHIC ROCKS

1) **COLOUR:**- The presence of minerals give a certain colour in rock. The overall colour of a rock should be assessed by reference of colour chart the (colour chart of geological society of America).

METHOD:- The observer should read the colour megascopically when a rock is imagined to be kept at some distance. The colour can be written in terms as follows.

i) **LEUCOCRATIC:**- If the rock looks pale or white coloured, indicated the rock looks pale or white coloured, indicates the rock may be acidic. The colour index 1-30, light col. Ex.
ii) **MELANOCRATIC**:- If the rocks looks dark coloured or black coloured, it indicated the rock may be basic or ultra basic. Colour index 61-100 Ex. Gabbro.
iii) **MESOORRATIC**:- If the rock is neither dark nor pale coloured. Colour index 31-60 dark colour Ex.

2) **MINERAL COMPOSITION**:- The mineral composition and colour of rocks are related to their chemical composition. The presence of mineral in a rock has variable proportion during crystallization.

a) Primary minerals:- The present of minerals in dominant proportion and these have been found.
b) Secondary minerals:- The minerals are present after the formation of rock.
c) Essential minerals:- The major mineral constituents and decide the name of the rocks.

d) Accessory:- They occur in small quantities and their presence or absence has nothing to do in naming a rock.

3) **TEXTURE**:- The size, shape and arrangement of grain defines texture.

Size:-
i) Coarse grained – if grain size diameter is < 2mm
ii) Medium grained – size of grain is between 0.06 to 2 mm
iii) Fine grained – size of grain < 0.06mm.
Shape:-

Euhedral:- The term denotes if grains in rock shows roundness.

Subhedral:- if the grain is partly irregular and partly irregular in shape called subhedral.

Anhedral:- The grain's out line shows completely irregular is called anhedral. The observer should megascopically identify any of these characters the rock posses.

INSTRUCTIONS:- The observer should carefully study grain size and shape of grain to determine the appropriate terms as mentioned above.

Arrangement of the grains:- The orientation of grain's pattern directly depends upon recrystallization. These are two types are common.

Regular arrangement:- A series of grain's are arranged in regular fashion.
Random arrangement:- If grains are randomly disturbed.

The observer should carefully study in all corners and sides to determine this pattern.

4) **DEGREE OF CRYSTALLINITY**:- The rocks may have all of its mineral constituents distinctly recrystallized, some may be poorly crystallized depends upon the factors of metamorphism.

Holo crystalline:- Entirely composed of crystals with ground mass.

Hypo crystalline:- Composed of partly crystals and partly glassy.

Hyalo crystalline:- No crystals but glassy.

5) **GRANULARITY**:- The arrangements of major constituent minerals are size in a particular rock granularity is as follows.

Equigranular:- All those rocks in which majority of the constituent grains are roughly equal size are described as equigranular.

Inequigranular:- All those texture in which the majority of the constituent minerals shows difference in their grain size are grouped under inequigranularity.

STRUCTURES:-

I) **GNEISSOSE STRUCTURE**:- It is generally observed in granite gneiss where in alternate black (hornblende, biotite) and white (feldspar and quartz bearing) colour bonds appear feldspar in important mineral in these rocks.

II) **SCHISTOSE STRUCTURE**:- Metamorphic rocks show this structure and it is called schistose. They have predominantly lamellar (mica, talc, chlorite) and or prismatic (hornblende, kyanite, tourmaline etc.) mineral along with small quantities of magnetic, quartz, garnet like mineral. They do not have any alternate colour bands in gneiss-felspar is rare or absent in schist.

III) **CATACLASTIC STRUCTURE**:- It is charaterstied by the development of extremely fine rocks. This is produced under the influence of several crushing and shearing effects of metamorphism.

IV) **MACULOSE STRUCTURE**:- It is characterized by spotted appearance of the rock which may be due to development of large crystals. This structure can be formed due to incomplete recrystallization of rock a typical thermal or contact metamorphism. Ex Hornfels.

V) **GRANULOSE STRUCTURE**:- It is characterized by an essentially "granular" charter, the individual grains irregular in out line but mutually interlocking. The rocks with granulose structure are granutites. Ex. Marble.

7) **JOINTS**:- Joints are defined as divisional planes along which there is no relative displacement.

Joints in metamorphic rocks:- Regular arrangement can be seen in metamorphic rocks.

Instruction to observer:- The above mentioned joints are seen in rock formation in the field. The observer should identify the joints planes if present in given rock.
Discuss the strength of the rock by considering its orientation and grain size distribution and maturity should also taken into account.

8) **FRACTURE**:- Broken surface of rock/wear plane presence in a rock is called fracture. The observer should note the relationship between the direction of fracture and grain size arrangement. For example.

i) Fracture along grains: Of fracture and grain arrange in same direction.
ii) Across the grains:- If fracture orientation other than grain arrangement.

9) **ENGINEERING PROPERTIES**:-

Compressive strength
Crushing strength
Tensile strength

Porosity
Density
Abrasive strength
Fire and frost resistance

Note:- The theoretical values must be compared with carefully refer with each physical property and try to conclude like , High-Medium,Low.

10) **DEGREE OF WEATHERING**:- The rate of weathering in the given rock for ex. Fresh:- if rock is free from weathering.
    Moderately weathered:- if nearly 50% of the rock is weathered.
    Completely weathered:- if rock is discolored from its original.

11) **TYPE OF METAMORPHISM**:-

Thermal metamorphism
Contact metamorphism
Dynamic metamorphism
Phutonic metamorphism

Instructions:- The observer may note the degree of recrystallinity, grain size character to know type of morphism

12) **OCCURRENCE**:- Occurrence of the given in rock should be discussed.

13) **USER**:- The uses of rock in the Civil Engineering practice Ex building stone, decorative stone, flooring, roofing stone, aggregates, road metals etc.

14) **NAME OF THE ROCK**: - After studying above all megascopic properties the student should conclude the name of the rock and type Ex. Marble, metamorphic.

Some identical properties of metaporphic rocks:- Metamorphic rocks can be identified as follows.

1) Foliation, Schistose plane can be seen
2) Mineral assemblage in regular.

The above mentioned character are helpful in identification as metamorphic rocks and differentiate from sedimentary and igneous rocks.

Note:- The enclosed format must be followed during the study of Geotechnical aspects.

GEOTECHNICAL DESCRIPTION OF METAMORPHIC ROCKS

COLOUR

MINERAL COMPOSITION:-
- i) Primary minerals
- ii) Essential minerals
- iii) Secondary minerals
- iv) Accessory minerals

TEXTURE:- I) SIZE: II) SHAPE: III) ARRANGEMENT OF GRAINS:

DEGREE OF CRYSTALLINITY:-

GRANULARITY:-

STRUCTURE:-

JOINTS:-

FRACTURE:-

ENGINEERING PROPERTIES:-

DEGREE OF WEATHERING:-

TYPE OF METAMORPHISM:-

OCCURANCE:-

USES:-

NAME OF THE ROCK:-

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Experiment No.3

Determination of apparent specific gravity, porosity and water absorption of different rocks

Aim: to determine the water absorption , porosity and apparent specific of building stone (granite) used for construction purpose.

Apparatus:

i. 1000ml and 100ml cylindrical measuring glass jars. 100ml capacity jar must have a graduation on mark of 1ml .

ii. 1.5 litres capacity glass vessel.

iii. 2 dry clothes.

iv. Balance of capacity 3kg with an accyracy of 1gm.

Selection of sample:

i. The sample must be selected from a quarry, preferably the stones should not be seen with weathering effect.

ii. Approximately 500-600gms of stone sanples are required for conducting the tests.

iii. The size of the stone pieces must be retained in the 10mm sieve after passing through 20mm sieve.

Procedure:

1. The test piece weighing about 1kg shall be washed to remove particles of dust and immersed in distilled water in a glass vessel at room temperature 20 to 30 degree Celsius for 2 hours. So on after Immersion and again at the end of soaking period, entrapped air shall be removed by gentle agitation achieved by rapid clockwise and clockwise and anticlockwise rotation of vessel. The vessel shall then be emptied and the test piece be allowed to drain. The test piece shall than be placed on a dry cloth and gently surface dried with cloth. It shall ne transferred to second dry cloth when the first one removes no further moisture. It shall be spread cloth and left exposed to atmosphere away from direct sunlight or any other source of heat for not less than 10min. until it appears to be completely surface dry. The sample than shall be weighed(B).

2. The sample shall then be carefully introduced in the 1000ml capacity measuring cylinder and distilled water shall be poured by means of 100ml capacity measuring cylinder .in the larger cylinder while taking care to remove entrapped air,until the level of water in the larger cylinder reaches 100ml mark. The quantity of water thus added shall be recorded in ml or expressed in grain weight(C).

3. The water in the larger cylinder shall be dried and the sample shall be carefully taken out and dried in an oven at 100-110 degree celsius for not less than 25hrs. it shall then be

cooled in a dessicator to room temperature and weighed (A) . the room temp. during the test shall be recorded.

rmulae:

i. Apparent specific gravity = A/(1000-C).

ii. Water absorption =B-A/A *100

iii. Apparent porosity =B-A (100)/(1000-C).

Results and calculation:

B=500gms

C=250mls=350gms

A=497.075gms

Apparent sp. Gravity = 497.075/(1000-350)=.765

Water absorption=B-A/A *100 => 500-497.075/650 *100 =.5

App. Porosity = B-A/1000-c *100 = 500 -497.075/650 *100 =.45

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Experiment No.4

Study of structural geology models (wooden models)

The structures which are developed in the body of a rock during its formation stage are termed as primary structures, where as all modification of the original shape and arrangement and development of new forms in the rock body subsequent to its formation are grouped as secondary structures.

Secondary structure are controlled by operative forces than by the rocks in which they are developed. The forces most commonly responsible for the development of secondary structure are tectonic in nature, they are associated with certain disturbances believed to originate below the crust. Non-tectonic causes such as intrusion of magma or loading of parts of the crust under sediments are also responsible for secondary structures.

The attitude of the bed such as strike, apparent dip and true dip are shown in wooden models.

The prominent geological structures like, normal fault, reverse fault, step fault, dome fold, and unconfirmites are also shown in other wooden model.

INSTRUCTIONS:- The student should carefully study each geological structure in exhibited in wooden model, describe the type of geological structure and mechanism is involved in the development of that structure.

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Experiment No.5

Measurement of dip of planar feature by clinometers compass

MEASUREMENT OF DIP OF BEDS
(Assuming Drawing Board as Bed)

OBJECTIVES:- The attitude of the beds is important component the rock stability is concerned. The important components of attitude of bed are dip and strike.

STRIKE:- It is a geographic direction of extension of bed, may be explained as the direction of intersection of bedding plane with horizontal plane.

DIP:- It is defined as the maximum angle of slope of a bed or layer or rock with horizontal. The amount of dip is the angle between the bedding plane and horizontal plane.

APPARATUS:- Drawing board, clinometer compass etc.

PROCEDURE:-
1) The observer should select good quality drawing (Drawing board can be assumed as a bed).
2) Place the drawing board inclined position by taking suitable support.
3) Take a clinometer which is in good condition, as the arm of clinometer can be rotatable, perfection in the scale divisions, and ideal condition of deflection of its needle.
4) Set the pointer such that it coincides with north direction, and clamp the screw.
5) Rest the arm of clinometer in one of the direction dip or at a given selected point by the examiner.
6) Unclamp the screw so that deflection is found in the clinometer.
7) Measure the direction and amount of the dip. (The direction like NE,SE,SW,NW with amount should be noted.

INSTRUCTIONS:- The observer should read the dip (both components) at least 3-4 readings by rotating the table in different direction, the recorded values must be written in observation book.

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Experiment No.6

Vertical electrical sounding VES field experiment

ELECTRICAL EARTH RESISTIVITY METHOD

OBJECTIVE:- This geophysical method is based on some different electrical properties of subsurface materials. To find depth of bed rock and weathered mantle depth for constructional works of foundations for multi storied building, damsites investigation and to locate the zones of ground water presence.

PRINCIPLE:- The electrical resistivity of medium is the resistance offered by a unit cube of it when a unit current passes to normal to surface of cross-sectional area A. it is given by Ohm's law.

P = RA/L   ohem m^2/m = ohem - mt

Where P= resistivity
R= Resistance offer by medium of length L and Cross sectional area A.

A known current I (direct current or low frequency alternate current) is sent into ground through a pair of current electrode P_1 and P_2 and potential difference (ΔV) created in medium another pair of potential electrodes M and N. The resistivity of formation is given by $A=(\Delta V)/I$.

Geometric factor of electrode arrangement

AM, BM, AN, BN are electrode spacing from either one of this electrode configuration.

(1) Wenner Configuration

Where all 4 electrode equidistant.

(2) Schlumberger configuration:- Where electrodes maintained 1:3 or 1:5 of potential and current electrodes. In present method schlumberger configuration is adopted because its more practical advantages Digital display resistivity is recently designed with high degree of precision and accuracy and have contain practical advantages like, the direct resistance can be measured.

APPARATUS:- Digital display resistivity meter (consists of both current and potential meter). Power pack (capacity to tap 90 volts), 2 current electrodes (crow bars) 2 potential electrodes (porcelean made), wire which is wounded to winch, nylone rope, hammers, gloves.

PROCEDURES:-

(1) Choose the alignment of investigation with help of nylone rope.
(2) Setup instrument at centre point'0'.
(3) Insert potential and current electrode as per the data sheet enclosed as the next page (K is calculated as per AB/2 and MN/2 of furnished in data sheet).
(4) Pour water near contact of current and potential electrodes.
(5) Complete circuit by connecting the terminals of
P_1, P_2 - potential unit to potential electrodes.
C_1, C_2 – Current electrodes to current unit. Power pack of positive and negatives to – positive and negative terminals of current units.
(6) Switch on current and potential units.
(7) Check voltage setting red pointer of selected multi ohm knob at 'V'.
(8) Check the continuity of circuit setting knob at "C".
(9) Select the 1 of multi ohms and 0.5 of potential range.
(10) Press for current by pressing RED BUTTON of current unit.
(11) The readings displayed on Digital screen must be equalized by quickly rotating Head Scale Knob.
(12) Note down the head and vernier scale when both of readings of Digital Display Resistivity meter.
(13) Prolong by investigation by extending AB/2 and MN/2 as per the data sheet.
(14) Complete the investigation as per the requirement depth.

Electrical circuit of resistivity method

The readings must be multiplied by the K given against AB/2 and MN/2 of data sheet.

Please note an enclosed data sheet for entering data.

SI.No.	AB/2	MN/2	K	Resistance R	Apparent Resistivity (pa)	Interpreted Value
1	2	3	4	5	6	7
1	1.5	0.5	6.3			
2	2.0	0.5	11.8			
3	3.0	0.5	27.5			
4	5.0	0.5	77.5			
5	7.0	0.5	153.2			
6	10.0	0.5	313.3			
7	10.0	2.0	75.4			
8	12.0	2.0	110.5			
9	15.0	2.0	173.5			
10	20.0	2.0	311.0			
11	25.0	2.0	487.9			
12	30.0	2.0	704.0			
13	30.0	5.0	275.0			
14	35.0	5.0	377.1			
15	40.0	5.0	495.0			
16	45.0	10.0	628.0			
17	45.0	10.0	302.5			
18	50.0	10.0	377.1			
19	60..0	10.0	550.0			
20	70.0	10.0	754.2			
21	80.0	10.0	990.0			
22	90.0	10.0	1257.0			
23	100.0	10.0	1555.7			

INTERPRETATION:- The value of AB/2 and pa should be plotted on log – log graph, further the obtained curve should match with master curve. Recent developed inverse slope method has got ease interpretational results in which the AB/2 and pa can be plotted on graph.

An example of graph is given below in which 2-3 layer are shown

C – current electrode spacing

A – 1st layer thickness	L1	Resistivity dy/dx
B – 2nd layer thickness	L2	Resistivity dy1/dx1
C – 3rd layer thickness	L3	Resistivity dy3/dx3
D – 4th layer thickness	L4	Resistivity dy4/dx4

The thickness of the layers L1,L2,L3,L4 A,B,C,D can be noted the corresponding AB/2 distance and the resistives ρ_1,ρ_2,ρ_3,ρ_4 can be read by inverse slope method values showing different values.

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Experiment No.7

Stereoscopic study of aerial photographs pertaining to landforms, vegetation and water bodies

Aerial photography is a the branch of Remote Sensing. These are Platforms of remote sensing observations studies of aircraft and satellites imageries . Aerial photography is useful in topographical mapping, engineering studies, environmental science studies and in exploration for oil and natural gas etc. In the early stages of development, 1903 aircrafts are being used widely for

An aerial photograph is taken from an airborne vehicle aircraft, drones, satellites. The aerial photograph has many uses in defence fields and in natural resources studies .

Types of Film:

Based on different purpose and unique situations variety of films are available that are used. Panchromatic and natural color films are the two most commonly used. These two films along with infrared and false colour.

Panchromatic:

Panchromatic, more often termed black and white, is the most commonly used photogrammetry.

Colour:

Natural colour also known as true colour film

Colour Infrared:

Colour Infrared film is commonly termed as false colour. A false colour image contains red/pink hues in vegetative areas, with the colour depends on the degree to which the photosynthetic process .

Stereoscopic Coverage:

The Earth's surface in three dimensions, aerial photography is with a 60 % forward overlap and a 25 % side lap, to provide full coverage of the area .This is a requirement from the photogrammetric mapping point of view to gather data interpretation and the model is viewed in three dimensions.

Classification of Aerial Photograph:

Scale:

Large scale: between 1:5,000 and 1:20,000

Medium scale: between 1:20,000 and 1:50,000

Small scale: smaller than 1:50,000

Oblique:

a. Low oblique:

Low oblique has the following characteristics:

(1) It covers a relatively small area.

(2) The ground areas covered is a trapezoid, even though the photo is square or rectangular.

(3) The objects have a more familiar view, comparing to view from the top of a high hill or tall building.

(4) Relief is discernible but distorted.

(5) It does not show the horizon.

High oblique:

The high oblique is a photograph taken with the camera inclined about 60° from the vertical. it is used in the making of aeronautical maps. However, . A high oblique has the following characteristics:

(a) It covers a very large area

(b) The ground area covered is a trapezoid, but the photograph is square or rectangular.

(c) The view varies depending on the height at which the photograph is taken.

(d) Distances and directions are not measured on this photograph for the same reasons

(e) Relief may be distorted as in any oblique view. The relief is not apparent in a high altitude, high oblique.

(f) The horizon is always visible.

Film

Black and white panchromatic: This is most broadly used type of film for photogrammetric, mapping and interpretation.

Black and white infrared: itis used interpretation and intelligence and in hazy environment as IR can penetrate through haze.

Colour: It is used for interpretation and mapping.

Colour infrared/ false colour: It is used for vegetation studies, water pollution, and crop studies.

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Experiment No.8

Seismic refraction survey to determine depth to bedrock

SEISMIC REFRACTION METHOD

INTRODUCTION:

Seismic refraction method is one of the most powerful geophysical techniques deployed for delineation of weathered layer configuration – a vital information necessary for several types of applications including Engineering geology, ground water exploration etc. In this technique the Seismic waves generated through a seismic source at a point near the ground surface travel down towards the basement and after getting refracted along the velocity discontinuity between the soft weathered layer and the harder basement, travel back towards the surface to be picked up by a receiver (geophone) placed on the ground surface. The time taken by these refracted seismic waves (usually referred to as first arrivals) to travel from the source to the receivers (geophones) located at specified points along a profile is accurately measured and forms the basis for computation of the geometrical as well as velocity structure of the subsurface.

The Seismic timer is an elegant single channel seismic instrument that could be deployed in shallow seismic surveys and thus finds extensive application in several types of shallow geological/geophysical exploration problems particularly in Engineering geology.

The Seismic timer utilises a sledge hammer throw device for the generation of Seismic waves and the incoming seismic waves are picked up by a geophone. The instant, the hammer blow is made, a timer circuit is triggered through a mechanical contact between the attached to the sledge and hammer. The timing circuit is immediately closed when the geophones respond to first arrival. The time so record represents the time of travel of seismic waves from sources to receiver. This time interval is measured to a high degree of accuracy of up to 0.1m.sec and is displayed in digital form on the LCD display.

SEISMIC TIMER:
PANEL DESCRIPTION:

1.	HAMMER	Socket for receiving the cable, coming from the hammer switch.
2.	SIGNAL	Sockets for receiving the cables from geophones.
3.	POWER 'ON'	Toggle switch to switch 'ON' the power.
4.	DISPLAY 'ON'	Toggle switch to switch on the display.
5.	GAIN	Controls for adjusting the amplifier gain.
6.	RESET	Push switch to reset the displays to zero.
7.	DIRECT/REVERSE	Switches to select the phase of Seismic signals – for monitoring the receiver of first arrivals.
8.	TRAVEL TIME DISPLAY	LCD display windows for displaying the travel time of first arrivals for each channel.

The equipment is highly portable, simple to operate and yield extremely useful data when measurements are carried out in a systematic way. Following is a brief description of the operational procedure to carry out a shallow seismic refraction survey using the Seismic timer.

The principle of the surveying technique using the Seismic timer basically involves the generation of a Seismic disturbance at a selected point by striking a hammer blow on the head of a sledge planted in the ground. The time of travel of the first arrival reaching the geophone is automatically measured and displayed.

Field Operation:

OPERATIONAL STEPS:

i) Connect the cable from hammer switch to socket (1) of the seismic timer.

ii) Connect he cable from Geophone to the socket (2) of the seismic timer.

iii) Place the sledge on the ground firmly.

iv) Put the power switch(3) and display switch (4) in 'ON' position.

v) Observe the LCD display. It should read '000' otherwise set it to read '000' by pressing the '**RESET** ' button switch(6).

vi) Set the Toggle switch 7 in 'Direct' position.

vii) Adjust the Gain Control knob (4) in such a way that the gain is maximum with out picking up noise.
At this stage if the digit '1' flickers on the most significant digit of the displays, even after resetting, it indicates that the background noise level is high. Reduce the gain control (4) such that '1' on the display (8) just disappears. The instrument is now ready for taking measurements.

viii) After making sure that the above steps are completed strike a hammer blow on the flat top of the sledge and observe the display (8). Note the read out on the display (say R_1).

ix) Set the Toggle switch(7) in 'Reverse' position. Repeat steps (v) to (viii). Note the read out on (8) say R_2. Compare the read outs R_1 & R_2. Note the lesser value as time of first arrivals.
Keep the geophone fixed at the same point at the end of the profile. Move the sledge to the next point on the traverse. (See Fig.2 for the fieldlayout). Repeat step (v) to (ix) and so on till the profile is completed. Then repeat the field measurements in the reverse direction along the profile i.e., keep the geophone at the other end of the traverse and repeat the measurements from opposite end.

x) The travel time Vs distance graph is plotted to obtain the thickness, velocity information using the conventional formula described in Appendix 1.

Note: The depth of the investigation depends on the distance between the hammering point and geophone and the seismic wave velocities in the subsurface formation. Generally with the hammer seismic timer units the depth of investigation is limited to about 10 to 12m which means the maximum distance between the source and receiver that could be set would be about 30 to 40m. if we increase this distance further, the energy of the hammer source may not be sufficient to penetrate to greater depth and this results in a considerable scatter in the time distance plot making the interpretation of the plot more difficult and ambiguous.

If the signal is too weak (for large hammer- geophone separations) the timer may get triggered by the second or third zero crossing of the wave instead of the first. In such cases there will be a fixed time difference in the displayed time of arrivals.

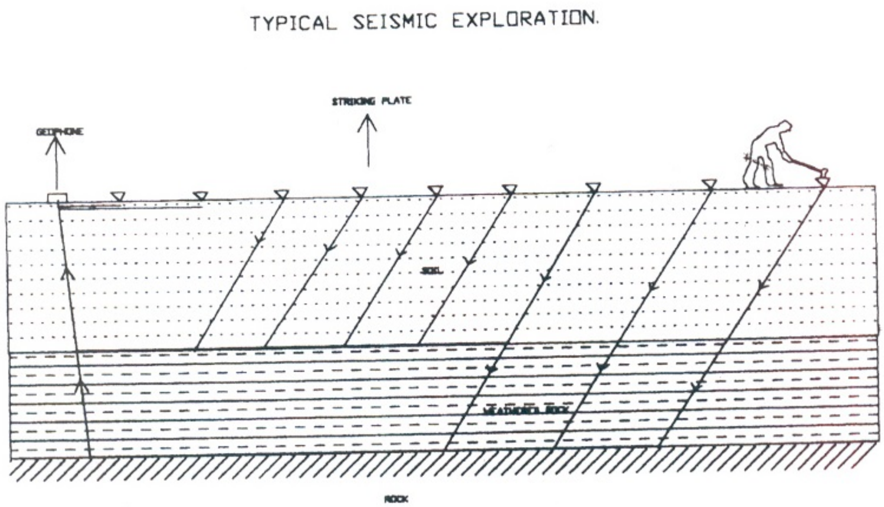

Fig.: 1 Experiment of seismic refraction

APPENDIX

Analysis of data:

The travel times are plotted against the distance (Geophone – shot distance) as shown in Fig.3. The data points fall on straight lines (except for large distance where there is scatter due to dissipation of energy) corresponding to distinct subsurface layers. Best fitting straight lines are drawn through these points. For example three lines could be drawn through the data points in fig.3a,b, indicating three layered structure. (The data points beyond 30mts are scattered in this example). The Inverse slope of these straight lines gives the velocity of the seismic wave in the corresponding layer.

The velocity of the first layer

$$V_1 = \frac{X'_2 - X'_1}{Y'_2 - Y'_1}$$

Where x'_1, x'_2, y'_1, y'_2 is abscissa and ordinates of any two points on the first segment. Its thickness can be computed from

$$Z_1 = \frac{T_{i1}}{2} \frac{V_2 \ V_1}{\sqrt{V_2^2 - V_1^2}}$$

From $z_1 = \frac{X_c}{2} \sqrt{\frac{V_2 - V_1}{V_2 + V_1}}$

Where T_{i1} is the ordinate of the point of intersection of second segment when it is extended backward, with the y-axis and x cross is the abscissa of the point of intersection of second segment with the first one.

Similarly the velocity of the second and third layers can be computed from

$V2 = \frac{X''_2 - X''_1}{Y''_2 - Y''_1}$ $V3 = \frac{X'''_2 - X'''_1}{Y'''_2 - Y'''_1}$

Where x''_2, x''_1, y_2'', y_1'' and x_2''', x_1''', y_2''', y_1''' are abscissa and ordinate values of any two points on second and third segments respectively.
The thickness of the second layer can be computed from

$$Z_2 = \frac{1}{2} \left[T_{i2} - 2z_1 \sqrt{\frac{V_3^2 - V_1^2}{V_3 \; V_1}} \right] \sqrt{\frac{V_3 \; V_2}{V_3^2 - V_2^2}}$$

Where T_{i2} is the ordinate of the point of intersection of third segment, when it is extended backward, with the y-axis.

DATA SHEET

Distance (Mt)	Time (Milliseconds)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
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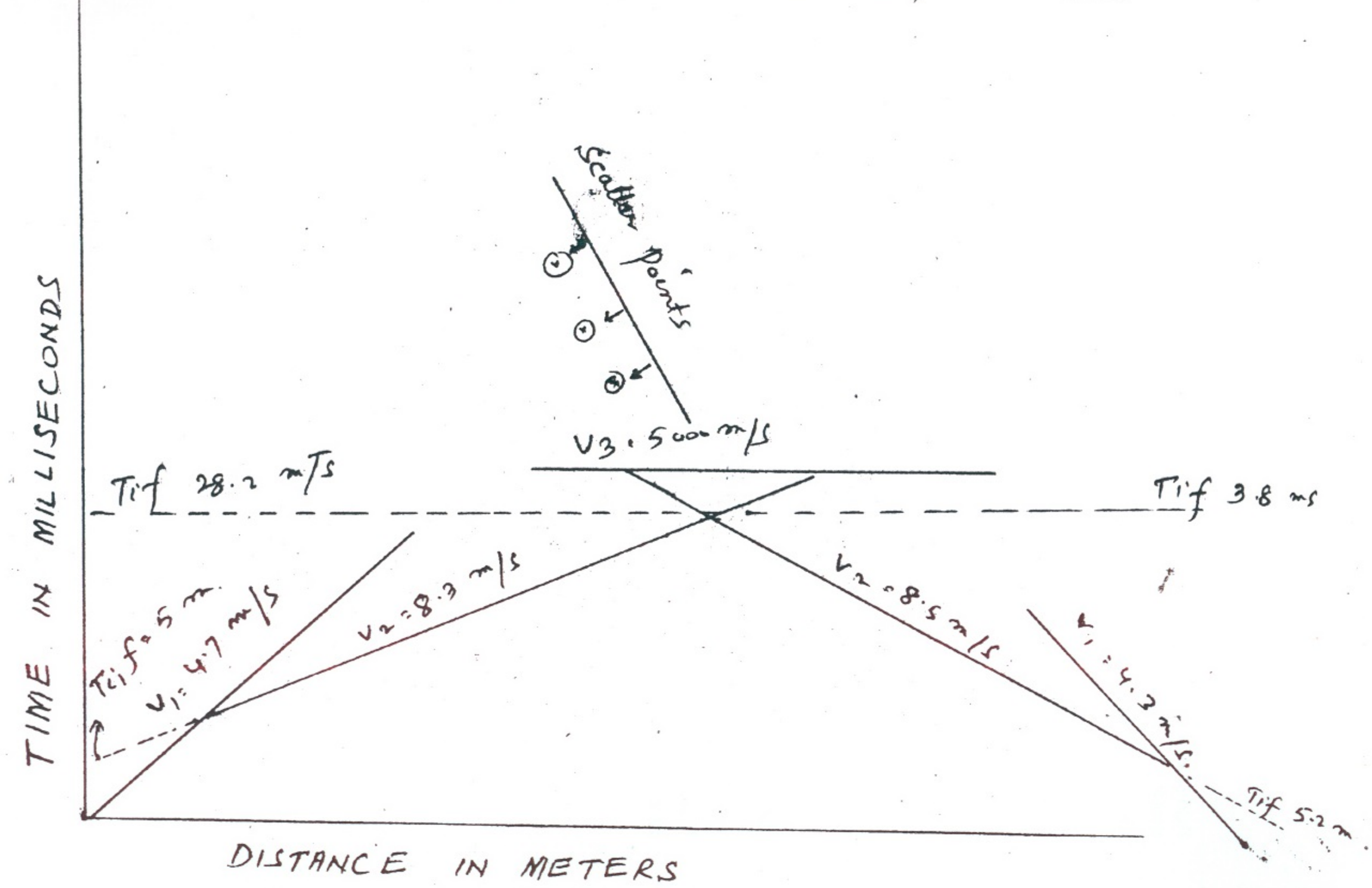
28	
29	
30	

Travel time Vs Distance plot



Experiment No.9

Study of topographical maps

Topographic Map:

These maps will show the location and will also explain the detailed features of that forest or mountain region. You'll be able to find accurate information such as the height of the mountains, various routes around there, the boundary of the forest and any particular species found there, etc. These maps fulfil all your requirements. These detailed maps of the geographic features are known as topographic maps. Here,.
The study about the surface of the land. It can contain various things such a s mountains, valleys, rivers and other things that exist on this very on land, the whole study has detailed characteristics. The contour lines which can be called as lines of equal elevation. Topography can be in the shape of the land surface and the map that usually see to understand the given area represents the land surface . Basically the topographic map explains or represents the land surface. These can be called as tools used in geologic studies because they help us to configure the earth surface and read them and their characteristics properly. The cartographers who solve the problem of representing the 3-D land surface by copying it on a flat piece of paper through the usage of contour lines which also has horizontal distances and vertical elevations which can be measured from a topographic map.
Maps are different but all maps do have a horizontal scale but along with the horizontal scale topographic maps also have a vertical scale to allow the determination of a point in three-dimensional space.
Contour lines pose a very important term when defining topographic maps contour lines are basically used to determine elevations and can be evaluated as lines on a map that are produced from connecting points of equal elevation. These lines are marked with their

elevations and a general target so that it can represent its characteristic features evidently. In contrast lighter contour lines do not have such elevations but they can be determined by counting up or down from the nearest index contour line and by multiplying the contour interval. Contour lines can be traced in any topographic map located below the scale and so does the contour interval.

The topographic maps represent a view of the landscape as we see it from above, so in order to perform or produce a detailed study of the landscape it is very important to construct a topographic profile or a cross-sectional design through a particular interval. A topographic profile can be defined as a cross-sectional view of a long line drawn through a portion of a topographic map. A profile may be constructed quickly and accurately across any given state line but in order to do so we need to follow a procedure.

Stream Gradient: The gradient of a stream or river is determined by measuring a section of a stream or river and dividing the distance (in miles) into the vertical difference (in feet) between the two points.

"Topographic Map is a map showing topographic features, usually using contour lines."Vegetation, Elevation and Glaciers

The variation of the leaves or contours of a reason are often shown as brown lines that connect points of equal elevation on a map. With these lines we can easily measure and show mountain heights, steep slopes and ocean depths in a flat map. Topographic maps and the studies conducted may also include vegetation such as forests at each level of a mountain. Different forests such as large and sparse vegetation can be represented by dark shades of green and light green accordingly. Similarly larger and deeper bodies of water are outlined in darker shades of blue and the lighter shades of blue indicate smaller lakes and ponds. For glaciers and snow fields which are snow covered almost all year round can be outlined in white called as wide areas along the same contour lines.

Uses of Topographic Map

It can have several uses which are mentioned below:

These maps can be used for any kind of geographic planning or architecture purposes.

It can be used in matters of Earth Science and Geography.

It can be used in mining and other such purposes like the construction of ponds etc.

It can be used for recreational purposes as well. For example, hiking or mountaineering, etc.

It can be used to get any detailed description of any area or any geographical feature. For example, drainage, landforms, forests, communication or transportation routes, etc.

It can be used to get detailed information on any man-made features as well.

It can be used in civil engineering as well.

It can be used by the government for planning or administrative purposes or can be used by the private Industrial players as well.

Structure

These maps have a very comprehensive and detailed structure of any feature that occurs on the surface of the Earth and this structure provides all the information about that particular feature with the help of contour lines and graphical representation. This structure can include the following aspects in the maps:

MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY
CIVIL ENGINEERING DEPARTMENT
Engineering Geology Laboratory

Experiment No.10

Structural geology problems (strike, dip, three point problems

Introduction :

The three-point problem is one of the classic laboratory problems of the undergraduate geology curriculum. In three points on a geologic surface such as a formation contact, attitude (strike and dip) of bed In fact that the three-point problem arises in real-world applications. The problem of strike and dip of beds and coal seams can be sloved.
The three-point problem is also a gateway to some useful mathematics. In this manual the solutions of the three-point problem using Cramer's Rule, an important technique for solving a small number of simultaneous equations. Geology students generally do see an application of simultaneous equations in geological data analysis or geophysics algebra.

The Problem
It shows a common presentation of the three-point problem. This example is very similar to the three-point problem discussed in a standard textbook in structural geology. The surface of interest is an unconformity. The elevation of the unconformity is known at three locations (A, B, and C). The horizontal scale is provided. We want to find the strike and dip of the unconformity.
Graphical Solution
The standard approach is graphical. The elevation at B is between the elevations at A and C, so a contour passing through B (i.e., the 2700-ft contour) must cross the line segment AC. By the definition of strike, the direction of this contour is the strike of the unconformity surface. Thus the first step is to draw this contour (Fig. 2).
We can locate the contour by dividing line segment AC into proportional parts according to the elevation differentials. Specifically, the unconformity surface drops 1000 ft between A and C; 700 ft between A and B', and 300 ft between B' and C. Therefore, B' must be 70% of the
distance from A to C. This locates B'. So, we draw the line segment BB' (Figure 2) and measure the azimuth of the strike with a protractor.

Map showing the location of the line of strike from data
The second step is to find the dip. To use a fully graphical way of doing this (Davis and Reynolds, 1996), draw a cross-section perpendicular to BB', the line of strike (Figure 3). Then, using a vertical scale equal to the horizontal scale, lay out elevations on the cross section; project the locations of A, B, and C onto the cross-section at the appropriate elevations; and connect the dots. The resulting line segment shows the unconformity in cross-section. Because the cross- section is perpendicular to strike, the included angle is the true dip. So, we measure the angle with a protractor.

Experiment No.11

Study of geological survey of India (GSI works) maps and reports

1. Foundation geology of Nagarjuna sagar dam
2. Foundation geology of Srisailam dam
3. Geological characteristics of Bhakra nangal dam

   Instruction: The students should study the above dams through given maps