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Lab Manual:

Engineering Geology Laboratory(ACEC06)

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Contents

INTRODUCTION

1.1 Introduction

Engineering Geology Laboratory provides a systematic study of the structure and properties of construction materials and their occurrence in different geographical locations. This course also addresses study and selection of different species and improvement of strength competence of the site and design considerations of constructing underground structures.

1.1.1 Student Responsibilities

The student is expected tocome prepared for each lab.Lab preparation includes understanding the labexperiment from the lab manual and reading the related textbook material.

Students have to write the allotted experiment for that particular week in the work sheets given and carry them to the Lab. In case of any questions or problems with the preparation, students can contact the Faculty Teaching the Lab course, but in a timely manner.

Students have to be in formal dress code, wear shoes and lab coat for the Laboratory Class.

After the demonstration of experiment by the faculty, student has to perform the experiment individually. They have to note down the observations in the observation Tables drawn in work sheets, do the calculations and analyze the results.

Active participation by each student in lab activities is expected. The student is expected to ask the Faculty any questions they may have related to the experiment.

The student should remain alert and use commonsense while performing the lab experiment.They are also responsible for keeping a professional and accurate record of the labexperiments in the files provided.

1.1.2 Responsibilities of Faculty Teaching the Lab Course

The Faculty shall be completely familiar with each labprior to the laboratory. He/She shall provide the students with details regarding the syllabus and safety review during the first week.Lab experiments should be checked in advance to make sure that everything is in working order.The Faculty should demonstrate and explain the experiment and answer any questions posed by the students.Faculty have to supervise the students while they perform the lab experiments. The Faculty is expected to evaluate the lab worksheets and grade them based on their practical skills and understanding of the experiment by taking Viva Voce. Evaluation of work sheets has to be done in a fair and timely manner to enable the students, for uploading them online through their CMS login within the stipulated time.

1.1.3 Laboratory In-charge Responsibilities

The Laboratory In-charge should ensure that the laboratory is properly equipped, i.e., the Faculty teaching the lab receive any equipment/components necessary to perform the experiments.He/She is responsible for ensuring that all the necessary equipment for the lab is available and in working condition. The Laboratory In-charge is responsible for resolving any problems that are identified by the teaching Faculty or the students.

1.1.4 Course Coordinator Responsibilities

The course coordinator is responsible fo rmaking any necessary corrections in Course Description and lab manual. He/She has to ensure that it is continually updated and available to the students in the CMS learning Portal.

1.2 Lab Policy and Grading

The student should understand the following policy:

ATTENDANCE: Attendance is mandatory as per the academic regulations.

LAB RECORD's: The student must:

1. Write the work sheets for the allotted experiment and keep them ready before the beginning of eachlab.
2. Keep all work in preparation of and obtained during lab.
3. Perform the experiment and record the observations in the worksheets.
4. Analyze the resultsand get the work sheets evaluated by the Faculty.
5. Upload the evaluated reports online from CMS LOGIN within the stipulated time.

Grading Policy:

The final grade of this course is awarded using the criterion detailed in the academic regulations. A large portion of the student's grade is determined in the comprehensive final exam of the Laboratory course (SEE PRACTICALS),resulting in a requirement of understanding the concepts and procedure of each lab experiment for successful completion of the lab course.

INSTRUCTIONS TO STUDENTS

• Before entering the lab the student should carry the following things (MANDATORY)
  o Identity card issued by the college.
  o Work Sheets
• Student must sign in and sign out in the register provided when attending the lab session without fail.
• Come to the laboratory in time. Students, who are late more than 15 min., will not be allowed to attend the lab.
• Students need to maintain 100% attendance in lab if not a strict action will be taken.
• All students must follow a Dress Code while in the laboratory
• Foods, drinks are NOT allowed.
• All bags must be left at the indicated place.
• Refer to the lab staff if you need any help in using the lab.
• Respect the laboratory and its other users.
• Workspace must be kept clean and tidy after experiment is completed.
• Read the Manual carefully before coming to the laboratory and be sure about what you are supposed to do.
• Do the experiments as per the instructions given in the manual.

• Copy all the programs to observation which are taught in class before attending the lab session.
• Students are not supposed to use floppy disks, pen drives without permission of lab- incharge.
• Lab records need to be submitted on or before the date of submission.
• Computer labs are established with sophisticated and high end branded systems, which should be utilized properly.
• Students / Faculty must keep their mobile phones in SWITCHED OFF mode during the lab sessions. Misuse of the equipment, misbehaviors with the staff and systems etc., will attract severe punishment.
• Students must take the permission of the faculty in case of any urgency to go out; if anybody found loitering outside the lab / class without permission during working hours will be treated seriously and punished appropriately.
• Students should LOG OFF/ SHUT DOWN the computer system before he/she leaves the lab after completing the task (experiment) in all aspects. He/she must ensure the system / seat is kept properly.

1.3 Course Goals and Objectives

The engineering geologist's main objective is to protect life and property from damage caused by different geological conditions. The practice of engineering geology is also very closely linked to the practice of geological engineering and geotechnical engineering.

Students will try to learn:

1. To understand the role of geology in the design and construction process of underground openings in rock.
2. To apply geologic concepts and approaches on rock engineering projects.
3. To identify and classify rock using basic geologic classification systems.

1.4 Use of Laboratory Instruments

One of the major goals of this lab is to familiarize the student with the proper equipment andtechniques for conducting experiments. Some understanding of the lab instruments is necessaryto avoid personal or equipment damage.By understanding the device's purpose and following a fewsimple rules, costly mistakes can be avoided.

The following rules provide a guideline for instrument protection.

1.4.1 Instrument Protection Rules

1. New students must receive an orientation on lab operating procedures before working in a lab.
2. Students shall publish a safety checklist for equipment for which they are responsible.
3. Students must read the safety checklist for each piece of equipment before operating it.
4. Ensure you know the location of the emergency stop button before starting equipment.
5. Always depressurize accumulators or pneumatic reservoirs before working on fluid power apparatus.
6. Check the application pressure, system pressure, and component pressure before connecting a system to a pump or pressure source. The maximum operating pressures are listed on equipment labels or published on manufacturer websites.

7. Periodically check hoses for leakage, cracks, kinks, or breaks.
8. Test your equipment for leaks at low pressure before raising the pressure to the operating pressure.
9. All components shall operate within manufacturer's specifications.
10. Equipment shall incorporate an emergency stop or emergency return control, whichever provides maximum safety.
11. Emergency stops shall be readily accessible under all conditions of working and shall operate immediately.
12. Equipment shall be designed so that loss of electrical, pneumatic and/or hydraulic power shall not cause a hazard.
13. Pump inlet temperatures should not exceed 600C when maximum ambient temperatures exist.
14. Rotating parts shall be guarded to provide adequate protection against hazard.
15. Flexible hoses shall only be used where necessary. Their length shall be minimized and they shall be protected from abrasion. If failure causes a hazard, the hose shall be restrained or shielded.

1.5 Data Recording and Reports

1.5.1 The Laboratory Notebook:

Students must record their experimental values in the provided tables in this laboratory manual and reproduce them in the lab reports. Reports are integral to recording the methodology and results of an experiment. In engineering practice, the laboratory notebook serves as an invaluable reference to the technique used in the lab and is essential when trying to duplicate a result or write a report. Therefore, it is important to learn to keep accurate data. Make plots of data and sketches when these are appropriate in the recording and analysis of observations. Note that the data collected will be an accurate and permanent record of the data obtained during the experiment and the analysis of the results. You will need this record when you are ready to prepare a lab report.

1.5.2 The Laboratory Worksheets:

Reports are the primary means of communicating your experience and conclusions to other professionals. In this course you will use the lab report to inform your LTA about what you did and what you have learned from the experience. Engineering results are meaningless unless they can be communicated to others. You will be directed by your LTA to prepare a lab report on a few selected lab experiments during the semester. Your assignment might be different from your lab partner's assignment.

Your laboratory report should be clear and concise. The lab report shall be typed on a word processor. As a guide, use the format on the next page. Use tables, diagrams, sketches, and plots, as necessary to show what you did, what was observed, and what conclusions you can draw from this. Even though you will work with one or more lab partners, your report will be the result of your individual effort in order to provide you with practice in technical communication.

CONCLUSIONS - The conclusion section should provide a take-home message summing up what has been learned from the experiment:

1. Briefly restate the purpose of the experiment (the question it was seeking to answer)
2. Identify the main findings (answer to the research question)
3. Note the main limitations that are relevant to the interpretation of the results
4. Summarise what the experiment has contributed to your understanding of the problem.

LAB-1 Lab -1 Physical Properties Of Minerals

2.1 Mineral

A mineral may be defined as a natural, inorganic, homogenous, solid substance having a definite chemical composition and regular atomic structure.

2.2 Common methods of study for the identification of minerals

2.2.1 X-ray analysis

Based on the study of atomic structure, distinctive for every mineral. Its limitation is expensive, time consuming.

2.2.2 Chemical analysis

Based on the study of chemical composition. Its limitation is expensive, time consuming and not suitable for minerals exhibiting polymorphism (two or more minerals exhibit different physical properties in spite of possessing the same chemical composition).

2.2.3 Optical study

Based on the net effect of chemical composition and atomic structure. Its limitation is expensive.

2.2.4 Study of physical properties

Based on the consistency in physical properties which are due to the definite chemical composition and regular atomic structure. Its limitation is liable for erroneous inference, sometimes

LAB-2 GROUP OF MINERALS

3.1 Introduction

Minerals are grouped by their chemical composition. Silicates, oxides, sulfates, sulfides, carbonates, native elements, and halides are all major mineral groups.
1. Silicates
2. Oxides
3. Sulfates
4. Sulfides
5. Carbonates
6. Native Elements
7. Halides

3.2 Crystalline Solid

Minerals are crystalline solids. A crystal is a solid in which the atoms are arranged in a regular, repeating pattern. The pattern of atoms in different samples of the same mineral is the same. Is glass a mineral? Without a crystalline structure, even natural glass is not a mineral.

3.3 Inorganic Substances

Organic substances are the carbon-based compounds made by living creatures and include proteins, carbohydrates, and oils. Inorganic substances have a structure that is not characteristic of living bodies. Coal is made of plant and animal remains. Is it a mineral? Coal is a classified as a edimentary rock but is not a mineral.

3.4 Natural Processes

Minerals are made by natural processes, those that occur in or on Earth. A diamond created deep in Earth's crust is a mineral. Is a diamond created in a laboratory by placing carbon under high pressures a mineral? No. Do not buy a laboratory-made "diamond" for jewelry without realizing it is not technically a mineral.

3.5 Chemical Composition

Nearly all (98.5% of Earth's crust is made up of only eight elements – oxygen, silicon, aluminum, iron, calcium, sodium, potassium, and magnesium – and these are the elements that make up most minerals

LAB-3 IDENTIFICATION OF SILICA GROUP MINERALS

4.1 Introduction

Silica mineral, any of the forms of silicon dioxide (SiO2), including quartz, tridymite, cristobalite, coesite, stishovite, lechatelierite, and chalcedony. Various kinds of silica minerals have been produced synthetically; one is keatite.

4.2 General considerations

Silica minerals make up approximately 26 percent of Earth's crust by weight and are second only to the feldspars in mineral abundance. Free silica occurs in many crystalline forms with a composition very close to that of silicon dioxide, 46.75 percent by weight being silicon and 53.25 percent oxygen. Quartz is by far the most commonly occurring form. Tridymite, cristobalite, and the hydrous silica mineral opal are uncommon, and vitreous (glassy) silica, coesite, and stishovite have been reported from only a few localities. Several other forms have been produced in the laboratory but have not been found in nature.

4.3 Physical and chemical properties

The crystallographic structures of the silica minerals, except stishovite, are three-dimensional arrays of linked tetrahedrons, each consisting of a silicon atom coordinated by four oxygen atoms. The tetrahedrons are usually quite regular, and the silicon-oxygen bond distances are 1.61 ± 0.02 A. Principal differences are related to the geometry of the tetrahedral linkages, which may cause small distortions within the silica tetrahedrons. High pressure forces silicon atoms to coordinate with six oxygen atoms, producing nearly regular octahedrons in the stishovite structure.

4.4 Individual silica minerals

Quartz Quartz occurs in many varieties in almost all types of igneous, sedimentary, and metamorphic rocks. It has also been found in meteorites and in some lunar rocks.

High quartz High quartz, is the more symmetrical form quartz takes at sufficiently high temperatures (about 573 °C at one atmosphere of pressure), but the relationship is pressure-sensitive. High quartz may be either left- or right-handed, and its c axis is one of sixfold symmetry rather than threefold; thus, many twin laws of ordinary quartz cannot occur. High quartz twins typically involve inclined sets of axes. High quartz can form directly from silicate magma or from high-temperature gases or solutions.

LAB-4 IDENTIFICATION OF FELDSPAR GROUP MINERALS

5.1 Introduction

Introduction Feldspars are a group of closely related minerals that together are the most abundant mineral in the Earth's crust. A thorough knowledge of the feldspars is what separates geologists from the rest of us.

5.2 How to Tell Feldspar:

Feldspars are hard minerals, all of them with a hardness of 6 on the Mohs scale. This lies between the hardness of a steel knife (5.5) and the hardness of quartz (7). In fact, feldspar is the standard for hardness 6 in the Mohs scale. Feldspars usually are white or nearly white, though they may be clear or light shades of orange or buff. They usually have a glassy luster. Feldspar is called a rock-forming mineral, very common, and usually makes up a large part of the rock. In sum, any glassy mineral that's slightly softer than quartz is very likely considered a feldspar. The main mineral that might be confused with feldspar is quartz. Besides hardness, the biggest difference is how the two minerals break. Quartz breaks in curvy and irregular shapes (conchoidal fracture). Feldspar, however, breaks readily along flat faces, a property called cleavage. As you turn a piece of rock in the light, quartz glitters and feldspar flashes. Other differences: quartz is usually clear and feldspar is usually cloudy. Quartz appears in crystals more commonly than feldspar, and the six-sided spears of quartz are very different from the generally blocky crystals of feldspar.

5.3 Feldspar Formulas and Structure:

The basic feldspar recipe is X(Al,Si)4O8, where X stands for Na, K, or Ca. The exact composition of the various feldspar minerals depends on what elements balance the oxygen, which has two bonds to fill (remember H2O?). Silicon makes four chemical bonds with oxygen; that is, it's tetravalent. Aluminum makes three bonds (trivalent), calcium makes two (divalent) and sodium and potassium make one (monovalent). So the identity of X depends on how many bonds are needed to make up the total of 16.

LAB-5 IDENTIFICATION OF MINERALS

6.1 Introduction

A mineral may be defined as a natural, inorganic, homogenous, solid substance having a definite chemical composition and regular atomic structure.

6.2 Experimental

1. Form :
2. Colour :
3. Streak :
4. Lustre :
5. Fracture:
6. Cleavage :
7. Hardness :
8. Specific Gravity :
9. Degree of Transparency :
10. Special Property :

6.3 INFERENCE

1. Chemical Composition :
2. Crystal System :
3. Nature of Origin :
4. Occurrence :
5. Uses :
6. Remarks :

LAB-6 IDENTIFICATION OF AMPHIBOLE GROUP MINERALS

7.1 Introduction

Amphibole is an crucial institution of usually darkish-colored, inosilicate minerals, forming prism or needlelike crystals, composed of double chain SiO4 tetrahedra, connected at the vertices and normally containing ions of iron and/or magnesium in their systems. Amphiboles may be inexperienced, black, colorless, white, yellow, blue, or brown. The International Mineralogical association presently classifies amphiboles as a mineral supergroup, inside which might be businesses and several subgroups.

7.2 Amphibole Origin and Occurrence

Exhibiting an extensive range of possible cation substitutions, amphiboles crystallize in both igneous and metamorphic rocks with a broad range of bulk chemical compositions. Because of their relative instability to chemical weathering at the Earth's surface, amphiboles make up only a minor constituent in most sedimentary rocks.

7.3 Amphibole Origin and Occurrence

Types of Amphibole

LAB-7 IDENTIFICATION OF IGNEOUS ROCKS

8.1 Introduction

These are characterized by vesicular structure, amygdaloidal structure and Aphanitic structure if they are volcanic. If they are Hypabyssal or plutonic, they are dense, compact and exhibit interlocking texture.

8.2 IGNEOUS ROCKS:

Terminology related for the description of igneous rocks

8.3 Texture

8.4 Structure

8.5 Colour

8.6 Minerals

8.7 Silica saturation

8.8 Depth of formation

1. Colour :
2. Grain :
3. Texture or Structure :
4. Mineral Present :

8.9 INFERENCE:

1. Essential Minerals :
2. Accessories :
3. Mode of Origin :

LAB-8 IDENTIFICATION OF SEDIMENTARY ROCKS

9.1 Introduction

Occurrence of normal or cross bedding, cementing material, fossils, ripple marks, mud cracks, tracks and trails and peculiar forms such as modular, concretionary, Pisolitic, Oolitic, etc indicate that the rocks under study of sedimentary rocks. Details relevant for the study of sedimentary rocks

9.1.1 Bedding or stratification

a) Different beds can be recognized based on colour, grain size, texture, hardness and other physical properties.
b) In case of cross bedding sets of layers will not be parallel but mutually inclined.

9.1.2 Cementing Material

Get complete discussion of Slider crank and Geneva Mechanism

9.1.3 Fossils

May be plant (leaf) fossils or shells (complete or broken) - common in shales and lime stones.

9.1.4 Ripple Marks

9.2 INFERENCE:

1. Essential Minerals :
2. Accessories :
3. Mode of Origin :

Lab 9 – IDENTIFICATION OF METAMORPHIC ROCKS

10.1 Introduction

Occurrence of alignment of minerals (lineation, foliation) and metamorphic minerals indicate the rocks under the study of metamorphic group in the lab. Details relevant for the study of metamorphic rocks

10.1.1 Foliation

It refers to the parallel alignment of platy or lamellar minerals in metamorphic rocks.

10.1.2 Lineation

It refers to the parallel alignment of prismatic or columnar minerals in metamorphic rocks.

10.1.3 Metamorphic minerals

Minerals like garnet, tale, chlorite, graphite are suggestive of metamorphic origin of a rock.

10.1.4 Gneissose structure

It is generally observed in granite gneisses where in alternating black (hornblende) and white (feldspars and quartz) colour bands appear.

10.1.5 Schistose structure

They have predominantly lamellar (mica, tale, chlorite) or prismatic (hornblende, Kyanite etc) minerals. These do not have any alternating colour bands. 1. Colour :
2. Grain :
3. Texture or Structure :
4. Mineral Present :

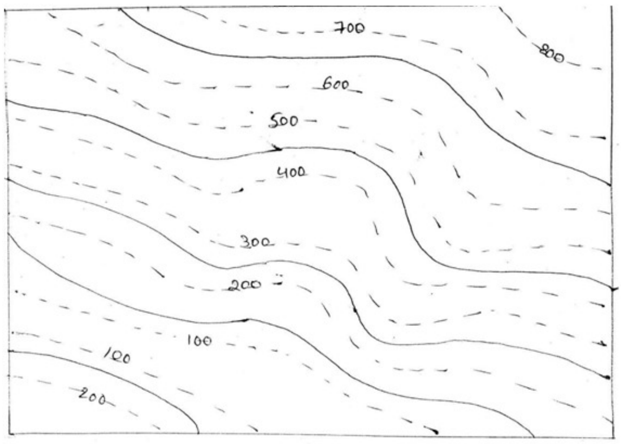
10.2 INFERENCE:

1. Essential Minerals :
2. Accessories :
3. Mode of Origin :

LAB-10 TOPOGRAPHICAL FEATURES

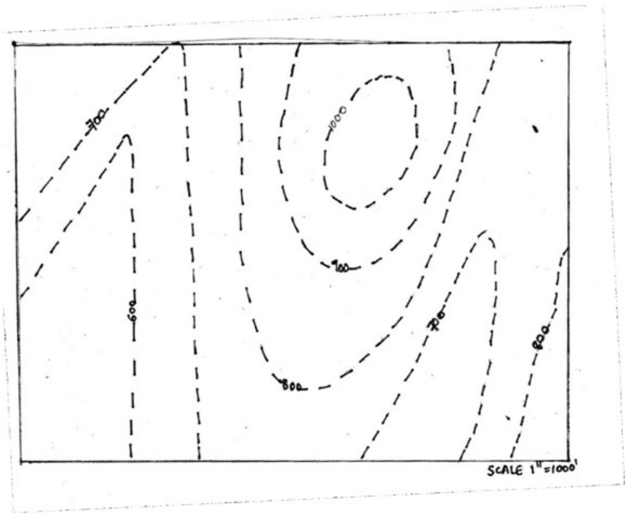
11.1 MAP I:

A CASE OF HORIZONTAL BEDS



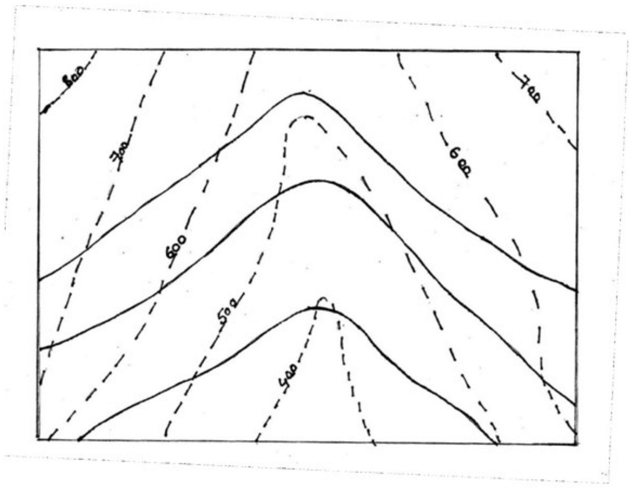
11.2 MAP II:

A CASE OF VERTICAL BEDS



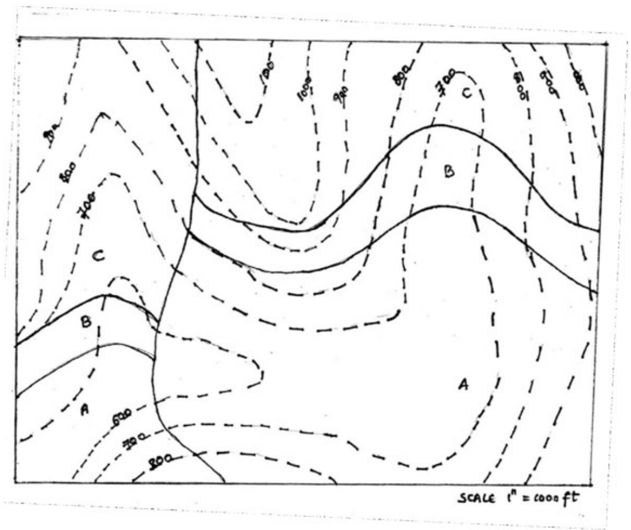
11.3 MAP III:

A CASE OF INCLINED BEDS



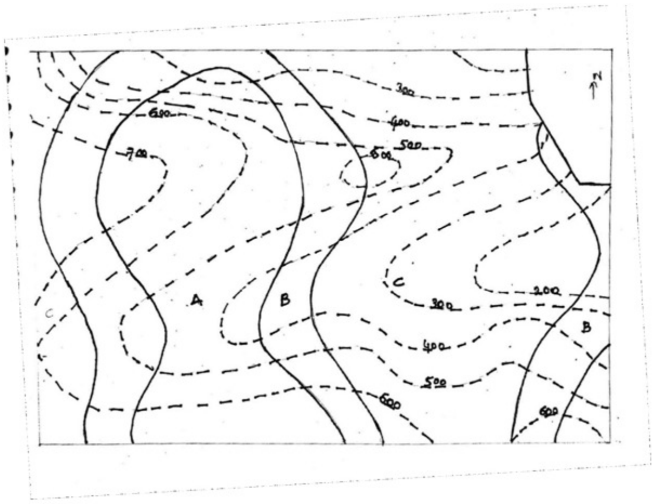
11.4 MAP IV:

A CASE OF FAULTED BEDS



11.5 MAP V:

A CASE OF FOLDED BEDS



LAB-11 GEOLOGICAL PROBLEMS

Interpretation of Lithology and Structure

12.1 1. Horizontal Beds:

If the bedding planes and associating contours are mutually parallel it indicates beds are Horizontal.

a) Highest elevation is the youngest
b) Can't have Strike and Dip

12.2 2. Vertical Beds:

If the bedding planes appear as straight lines and also cuts across the associating contours, it indicates beds are vertical.

a) Bedding plane itself is their strike direction
b) No dip direction but dip amount is 90°

12.3 3. Inclined Beds:

If the bedding planes are curved and cut across the associating contours, it indicates beds are inclined.

a) Choose any bedding plane which cuts across the same contour minimum at two places. Draw a line passing through. It gives the strike direction of beds.

b) Next check where the bedding planes cut next contour, draw a parallel line passing through this point.
c) If the bedding plane refers to A/B contact and contour passes at the intersection point (where bedding plane, strike line, contour line intersect) is 500 and is called A/B 500. Second value is either A/B 600 or A/B 400.

d) A short line perpendicular to the strike line in the decreasing side is the Dip direction.
i) Dip amount = (contour interval*60)/strike interval.
e) Since the arrow head of the dip direction points to successively younger Beds, Order of Superposition is known
f) Strike direction is expressed both with N or S, but dip direction is expressed only either N or S. For example if N 10° E is dip direction, then strike direction is N 80 ° W or S 80 ° E

LAB 12 - GEOLOGICAL MAPS

13.1 Geological Map

A map is described as representation of an area on a plain paper to a scale. The geological map is one which reveals the geological information in terms of topography, litho logy, and geological structure, order of superposition, thickness of beds and geological history of that region. A geological map is a contour map over which geological formations, structures etc are marked.

13.2 Civil Engineering Importance

For safe, stable, successful and economical Civil Engineering constructions such as dams, reservoirs, tunnels, etc., detailed geological information is essential. Proper interpretation of a geological map provides all details which a Civil Engineer requires. This study of geological maps is of great importance.

13.3 Aim

The purpose of interpretation of the following maps is not to tackle any specific Civil Engineering project but to equip with all necessary geological information, so as to enable the concerned to utilize the same as the required by the context.

13.4 Interpretation

In a geological map, normally contours are marked as dotted lines with elevation value and bedding planes, fault planes etc are marked as continuous lines. The interpretation comprises of details of topography, litho logy, structure and geological history.

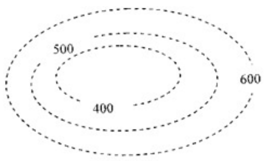
13.5 Interpretation of Topography

From the study of contour the information noted is about

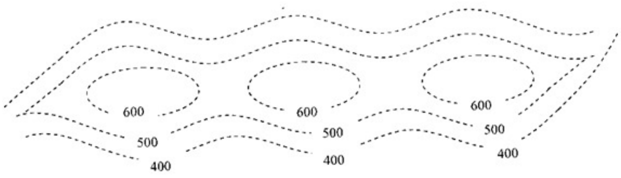
1. Maximum height, Minimum height, Surface relief
2. Number of Hills, Valleys, ridges, etc
3. Nature of slope, whether it is uniform or irregular and steep or gentle Relevant details 1. Area in the map indicated as below

13.6 2. Hills or Hill ranges

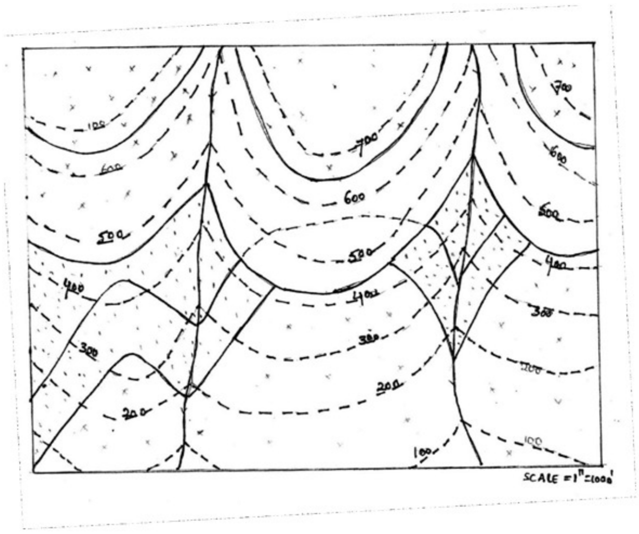
- Closed contour with contour values increasing inwards
  - Repeated appearance of the same in a row is Hill Range
  - Contours also indicate shape of Hills



Hill



Hill Range



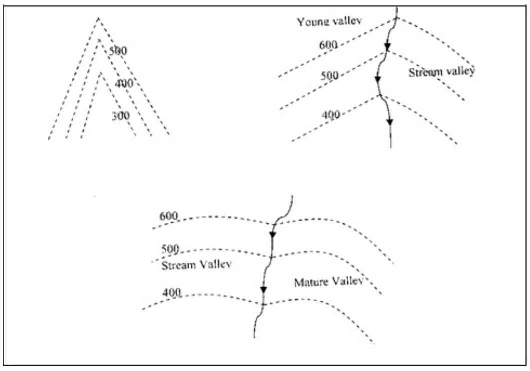
3. (a) Maximum height is the elevation which is more than the highest contour marked in the map.

(b) Minimum height is the elevation which is less than the lowest contour marked in the map.

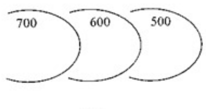
(c) Surface relief is the difference between the maximum height and the minimum height.

4. (a) Valleys: These are a series of V shaped (sharply bent) contours with successively higher elevation towards the pointed ends (convex side) of the contours.

- The sharpness of bends indicates the stage of valleydevelopment
- Young valleys have sharply contours but mature valleys have bluntlycurve contours

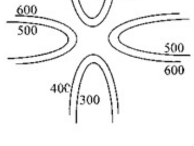


(b) Ridges: These resemble valleys but in these towards the convex side of the contours, successively lower elevations appear.



Ridges

(c) Saddle like structures:



Saddle like structure