ENGINEERING GEOLOGY LABORATORY

LAB MANUAL

NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

DEPARTMENT OF CIVIL ENGINEERING

VISION OF THE DEPARTMENT

To create a unique identity of the Department by achieving excellent standards of quality technical education keeping pace with the rapidly changing technologies and to produce Civil Engineers of global standards with the capability of accepting new challenges.

MISSION OF THE DEPARTMENT

M1. To promote academic growth in the field of Civil Engineering by offering state-of-the-art undergraduate and postgraduate programmers.

M2. To provide knowledge-base and consultancy services in all areas of Civil Engineering for industry and societal needs.

M3. To inculcate higher moral and ethical values among the students to become competent Civil Engineers with overall leadership qualities.

M4. To flourish as the Centre of Excellence in the emerging areas of research related to Civil Engineering and its allied fields.

PROGRAM EDUCATIONAL OBJECTIVES	
PEO1	To produce professionally competent Civil Engineers
PE02	To prepare the Civil Engineering graduates to work in industry
PE03	To inculcate among the students the sense of ethics
PE04	To impart the training in problem visualization
PE05	To impart training for development or laboratory and design skills
PE06	To inculcate in the students the ability to take up the innovative research projects and to conduct investigations of complex Civil Engineering problems using research methods

Course Outcomes (COs)	
01	To identify the minerals based on their physical properties and understand their behavior.
02	To interpret the geological maps related to civil engineering projects.
03	To learn the dip and strike, thickness of geological formation related to foundation, tunnels, reservoirs and mining.
04	To Develop a link between rocks and minerals by determining specific gravity.
05	To Have the basic understanding of various engineering properties of rocks (Rock cycle) and uses in the Civil Engineering.

List of Experiments	
Experiment No.	**Name of Experiment**
01	Study different Physical Properties of Minerals
02	Identification of minerals on the basis of their physical properties.
03	Determination of Specific Gravity by: a) Jolly’s Spring Balance b) Walkers Steel Yard Balance
04	Study and identification of different types of Rocks. (Igneous, sedimentary & metamorphic rocks)
05	Study and sketching of various types of faults (normal, reverse, dip, shake, non-plunging and plunging faults.
06	Study and sketching of various types of structure folds (anticline, syncline, symmetrical & asymmetrical.
07	Determination of Dip and Strike of geological structures with a Clinometer Compass.
08	Geological cross sections and study of geological maps

MANDATORY INSTRUCTIONS

- Students should report to the labs concerned as per the timetable.
- Record should be updated from time to time and the previous experiment must be
- Signed by the faculty in charge concerned before attending the lab.
- Students who turn up late to the labs will in no case be permitted to perform the experiment scheduled for the day.
- After completion of the experiment, certification of the staff in-charge concerned in the observation book is necessary.
- The record of observations along with the detailed experimental procedure of the experiment performed in the immediate previous session should be submitted and certified by the staff member in-charge.
- The components required pertaining to the experiment should be collected from Labin-Charge.
- When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.
- Any damage of the equipment or burnout of components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year.
- Students should be present in the labs for the total scheduled duration.
- Students are expected to prepare thoroughly to perform the experiment before coming to Laboratory.

Experiment No. 1 & 2

Aim

1. Study different Physical Properties of Minerals.
2. Identification of minerals on the basis of their physical properties.

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

The following are the physical properties identified in the laboratory

1. Form
The form represents the common mode of occurrence of a mineral in nature.

Form	Description	Example
Lamellar form	Mineral appears as thin separable layers	Different varieties of Mica
Tabular form	Mineral appears as slabs of uniform thickness.	Feldspars, Gypsum
Fibrous form	Mineral appears to be made up of fine threads.	Asbestos
Pisolitic form	Mineral appears to be made up of small spherical grains.	Bauxite
Oolitic form	Similar to Pisolitic form but rains are of still smaller size.	Lime stones
Rhombic form	Rhombic shape	Calcite
Bladed form	Mineral appears as cluster or as independent rectangular grains.	Kyanite
Granular form	Mineral appears to be made up of innumerable equidimensional grains of coarse or medium or fine size.	Chromite, Magnetite
Columnar form	Mineral appears as long slender prism.	Topaz
Prismatic form	As elongated	Apatite, quartz

Spongy form	Porous	Pyrolusite
Crystal form	Polyhedral, Geometrical shapes.	Garnets, Galena
Massive form	No definite shape for mineral.	Jasper, Graphite
Concretionary Form	Porous and appears due to accretion of small irregularly shaped masses.	Laterite
Nodular form	Irregularly shaped compact bodies with curved surfaces.	Laterite

2. Color

It is the usual body color of mineral.

Name of the Mineral	**Color**
Olivine	Olivine green
Biotite, Graphite, Magnetite	Black
Chlorite	Green
Garnet	Red
Kyanite	Blue
Amethyst	Violet
Quartz	Colorless, White, Green, Violet, Grey, yellow, Pink, etc..

Feldspar	White, Grey, Shades of Red, Green, Dirty white, etc
Calcite	Colorless, white, shades of Red, Grey, Yellow, etc

3. Streak

The color of the mineral powder is called the streak of a mineral. This is tested by rubbing the mineral on streak plate (An unglazed white porcelain plate).

Name of the Mineral	Body Color	Streak
Hematite	Steel Grey	Cherry Red
Chromite	Black	Dark Brown
Magnetite	Black	Black
Graphite	Black	Black
Molybdenite	Black	Greenish Black

4. Lustre

Lustre is the nature of shining on the surface of the mineral.

Lustre	Description	Example
Metallic Lustre	It is the type of shining that appears on the surface of a metal.	Galena, Gold, Pyrite
Sub metallic Lustre	lf the amount of shining is less when compared to metallic luster.	Hematite, Chromite, Magnetite
Vitreous Lustre	Shining like a glass sheet.	Quartz, Feldspar

Sub Vitreous Lustre	Less shining when compared to vitreous lustre	Pyroxenes
Pearly Lustre	Shining like a pearl	Talc, Muscovite mica
Silky Lustre	Shining like silk	Asbestos
Resinous Lustre	Shining like a resin	Opal, Agate
Greasy	Lustre Shining like grease	Graphite
Adamantine	Lustre Shining like a diamond	Garnet, Diamond
Earthy or Dull Lustre	No Shining	Bauxite, Magnesite

5. Fracture

Fracture is the nature of the randomly broken surface of a mineral

Fracture	**Description**	**Example**
Even fracture	If the broken surface is plain and smooth.	Magnesite, Chalk
Uneven fracture	If the broken surface is rough or irregular.	Hornblende, Bauxite
Hackly fracture	If the broken surface is very	Asbestos, Kyanite

	irregular like end of a broken stick.	
Conchoidal fracture	If the broken surface is smooth and curved	Opal
Sub Conchoidal fracture	If the curved nature is less prominent.	Agate, Flint, Jasper

6. Cleavage

The definite direction or plane along which a mineral tends to break easily is called cleavage of that mineral. It occurs as innumerable parallel planes along which the mineral is equally weak. Such parallel planes of weakness are referred to as a set.

Cleavage	**Example**
One set of cleavage	Mica, Chlorite, Talc
Two sets of cleavages	Feldspars, Pyroxenes, Amphiboles
Three sets of cleavages	Calcite, Dolomite, Galena
Four sets of cleavages	Fluorite
Six sets of cleavages	Sphalerite
No cleavage	Quartz, Olivine, Garnet

7. Hardness

Hardness may be defined as the resistance offered by the mineral to abrasion or scratching. It is determined with the help pH Moh's scale of hardness which consists of ten reference minerals arranged in increasing order of hardness and numbered accordingly.

Name of the Mineral	**Hardness**
Talc	1
Gypsum	2
Calcite	3
Fluorite	4
Apatite	5
Feldspar	6
Quartz	7
Topaz	8
Corundum	9
Diamond	10

8. Specific gravity or Density

Specific gravity or Density of minerals depends on their chemical composition and atomic structure.

Density	Range	Example
Low density	Specific gravity less than 2.5	Gypsum (2.3), Graphite (2-2.3)
Medium density	Specific gravity between 2.5 and 3.5	Quartz (2.7), Feldspar (2.5)
High density	Specific gravity greater than 3.5	Chromite (4.5- 4.8)

9. Degree of transparency

Degree of transparency is tested along the thin sharp edges of mineral keeping it against a powerful source of light. Depending upon the resistance offered by the minerals to the passage of light through them the transparency is classified.

Degree of Transparency	Example
Transparent	Thin layers of Muscovite, rock crystal
Translucent	Agate, Calcite
Opaque	Galena, Pyrite

10. Special properties

Some minerals exhibit unique characters, which enable them to be identified easily

Name of the Mineral	Special property
Talc	smooth touch or soapy feel
Graphite	Marks on a paper easily
Pyrolusite	Soils the fingers
Halite	Saline taste
Magnetite	Strongly attracted by any ordinary magnet
Chalk	Rough feeling of touch, adheres strongly to the tongue

Experiment No. 3

Aim

- Determination of Specific Gravity

a) Jolly's Spring Balance: The Jolly balance is an instrument for determining specific gravities.

it consists of a spring fastened at the top to a movable arm. At the lower end, the spring is provided with two small pans, one suspended beneath the other. The lower pan is kept immersed to the same depth in water, while the other one hangs in the air. On the upright stand behind the spring is a mirror on which is engraved or painted a scale of equal parts. The specific gravity of an object, typically a solid, is determined by noting how much the spring lengthens when the object is resting in the upper pan in air (**W**), and then when the object is moved to the lower pan and immersed in water (**w'**). The specific gravity is = **(W/ W-w')**

b) Walkers Steel Yard Balance: A steelyard balance, steelyard, or steelyard is a straight-beam balance with arms of unequal length. It incorporates a counterweight, which slides along the longer arm to counterbalance the load and indicate its weight. The steelyard comprises a balance beam which is suspended from a Lever/pivot or fulcrum which is very close to one end of the beam. The two parts of the beam which flank the pivot are the arms. The arm from which the object to be weighed (the load) is hung is short and is located close to the pivot point. The other arm is longer, is graduated and incorporates a counterweight which can be moved along the arm until the two arms are balanced about the pivot, at which time the weight of the load is indicated by the position of the counterweight.

The mineral specimen whose specific gravity is to be determined, is suspended by a very thin nylon thread from the longer arm. It is moved along the graduated arm so as to bring the end of the arm opposite the fixed index mark and the position of the specimen on the arm is noted. Let us assume that the reading is **'a'**. Now the specimen is submerged under water. This is done by placing a beaker filled with water below the specimen. This will disturb the balance. The specimen is then moved away from the fulcrum until the beam again comes opposite the index mark. Les us assume that the new reading is now **'b'** specific gravity of the mineral is calculated as follows.

Specific Gravity = b/b-a

Experiment No. 4

Aim

- Study and identification of different types of Rocks

A rock is defined as an aggregate of minerals. It is also described as unit of earth's crust. Based on their origin, geologically rocks are classified into igneous rocks, Sedimentary rocks, metamorphic rocks.

Igneous rocks:

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.

Sedimentary rocks:

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.

Metamorphic rocks:

Occurrence of alignment of minerals (lineation, foliation) and metamorphic minerals indicate the rocks under the study of metamorphic group.

IGNEOUS ROCKS

1. Texture

Phaneric	If minerals are visible to naked eye by virtue of their size.
Aphanitic	If minerals are too fine to be seen by naked eye.
Phaneric coarse	If minerals are greater than 5mm in size.
Phaneric medium	If minerals are 2mm to 5mm in size.
Phaneric tiny	If minerals are less than 2mm in size.
Equigranular	If minerals are nearly of same size.
Inequigranular	If some minerals are distinctly larger than others.
Porphyritic	If larger minerals are surrounded by smaller minerals.
Interlocking	If minerals are closely interlinked and cannot be separate

	without damaging surrounding minerals.
Graphic	If angular quartz grains occur with some orientation in feldspars.

2. Color

Leucocratic	If the rock looks pale colored or white colored, it indicates that the rock may be acidic.
Melanocratic	If the rock looks dark colored or black colored, it indicates that the rock may be basic or ultra-basic.
Mesocratic	If the rock is neither dark colored nor pale colored.

3. Structure

Vesicular	If the rock is having empty cavities
Amygdaloidal	If the rock has cavities filled with amygdales

4. Minerals

Primary	If the minerals are present from the beginning of formation of rock.
Secondary	If the minerals are present after the formation of rock.
Essential	If they are major constituents and decide the name of the rock.
Accessory	If they occur in small quantities and their presence or absence has nothing to do in naming a rock.

5. Silica Saturation

Oversaturated	If a rock has free quartz.
Under saturated	If a rock has unsaturated minerals like Olivine.
Saturated	If a rock has neither free quartz nor unsaturated minerals.

6. Depth of Formation

Plutonic/Hypabyssal	If a rock is Phaneric and has interlocking texture.
Volcanic	If a rock is vesicular or amygdaloidal and Aphanitic.

SEDIMENTARY ROCKS

Details relevant for the study of sedimentary rocks

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.

2. Cementing Material

Calcareous	It imparts white colour and pale colour to sand stones and can be known by acid test.
Feriginous	Imparts shades of brown, red, or yellow colour to sand stone
Argillaceous	It provides only weak cohesion for sand particles, which fall of rubbing the sand stone
Siliceous	Resembles calcareous cementing material but provides competence and durability to sand stone.
Glaucontic	It provides green colour to sand stone.

3. Fossils

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

4. Ripple Marks

Rare, may appear in sandstones, shales and lime stones. These appear as ware undulations on rock surface.

5. Peculiar forms

Concretionary, nodular	Laterites, Lime stones
Pisolotic	Lime stones, Laterites
Oolitic	Lime stones
Solution cavities	Lime stones
Lamination	Shales

6. Flaggy

Tendency to break in to slab, due to parallel fractures. Sometimes these are noticed in lime stones and sand stones.

7. Fissility

Tendency to split along bedding planes. Some shale has this character.

8. Conchoidal fracture

In dense compact Lime stones, less distinctly in shales

9. Composition

Argillaceous	Shales
Arinaceous	Sand stones
Calcareous	Lime stones

10. Grain Size

Too fine to be seen as separate particles in shales and lime stones.

11. Surface touch

Gritty or rough in sand stones, smooth in shales and lime stones.

12. Appearance
Panels of colors for laterites, dense very fine grained for lime stone.

Metamorphic Rocks

Details relevant for the study of metamorphic rocks

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

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

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

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

5. Schistose structure
They have predominantly lamellar (mica, tale, chlorite) or prismatic (hornblende, Kyanite etc) minerals. These do not have any alternating color bands.

Experiment No. 5

Aim

- Study and sketching of various types of faults (normal, reverse, dip, shake, non- plunging and plunging faults

How does rock respond to stress?

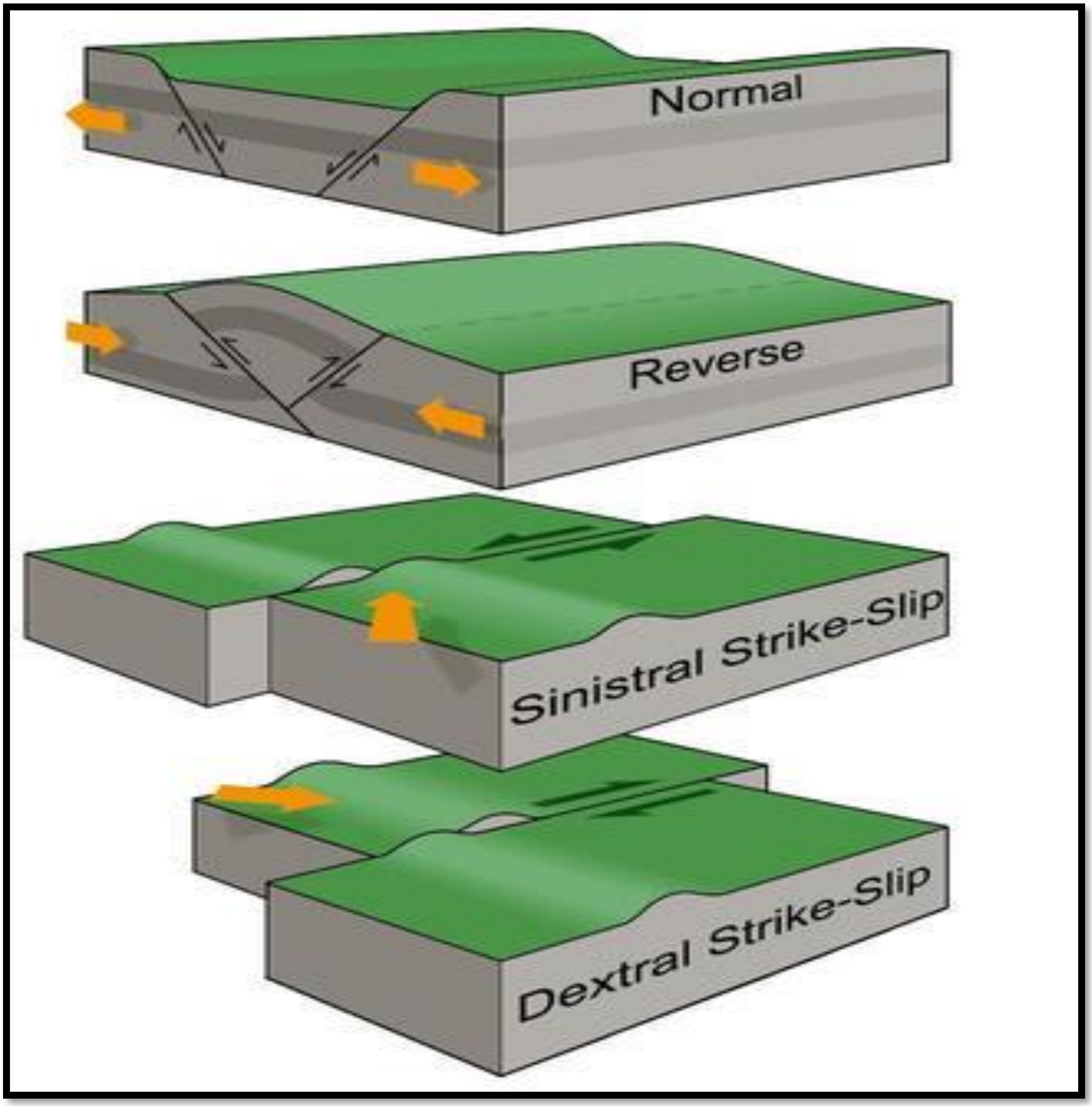
A fault is a rock fracture where the two sides have been displaced relative to each other. Faults are categorized into three general groups based on the sense of slip or movement.

for stand-alone versions of each fault type.

Normal fault—the block above the inclined fault moves down relative to the block below the fault. This fault motion is caused by extensional forces and results in extension. [Other names: normal-slip fault, tensional fault or gravity fault] Examples include Basin & Range faults.

Reverse fault—the block above the inclined fault moves up relative to the block below the fault. This fault motion is caused by compressional forces and results in shortening. A reverse fault is called a thrust fault if the dip of the fault plane is small. [Other names: reverse-slip fault or compressional fault.] Examples include the Rocky Mountains and the Himalayan Mountains.

Strike-slip fault—movement of blocks along a fault is horizontal and the fault plane is nearly vertical. If the block on the far side of the fault moves to the left, as shown in this animation, the fault is called left-lateral (Figure 2). If it moves to the right, the fault is called right-lateral. The fault motion of a strike-slip fault is caused by shearing forces. [Other names: trans current fault, lateral fault, tear fault or wrench fault.] Examples include the San Andreas Fault, California; Anatolian Fault, Turkey.


Normal
Reverse
Sinistral Strike-Slip
Dextral Strike-Slip

Experiment No. 6

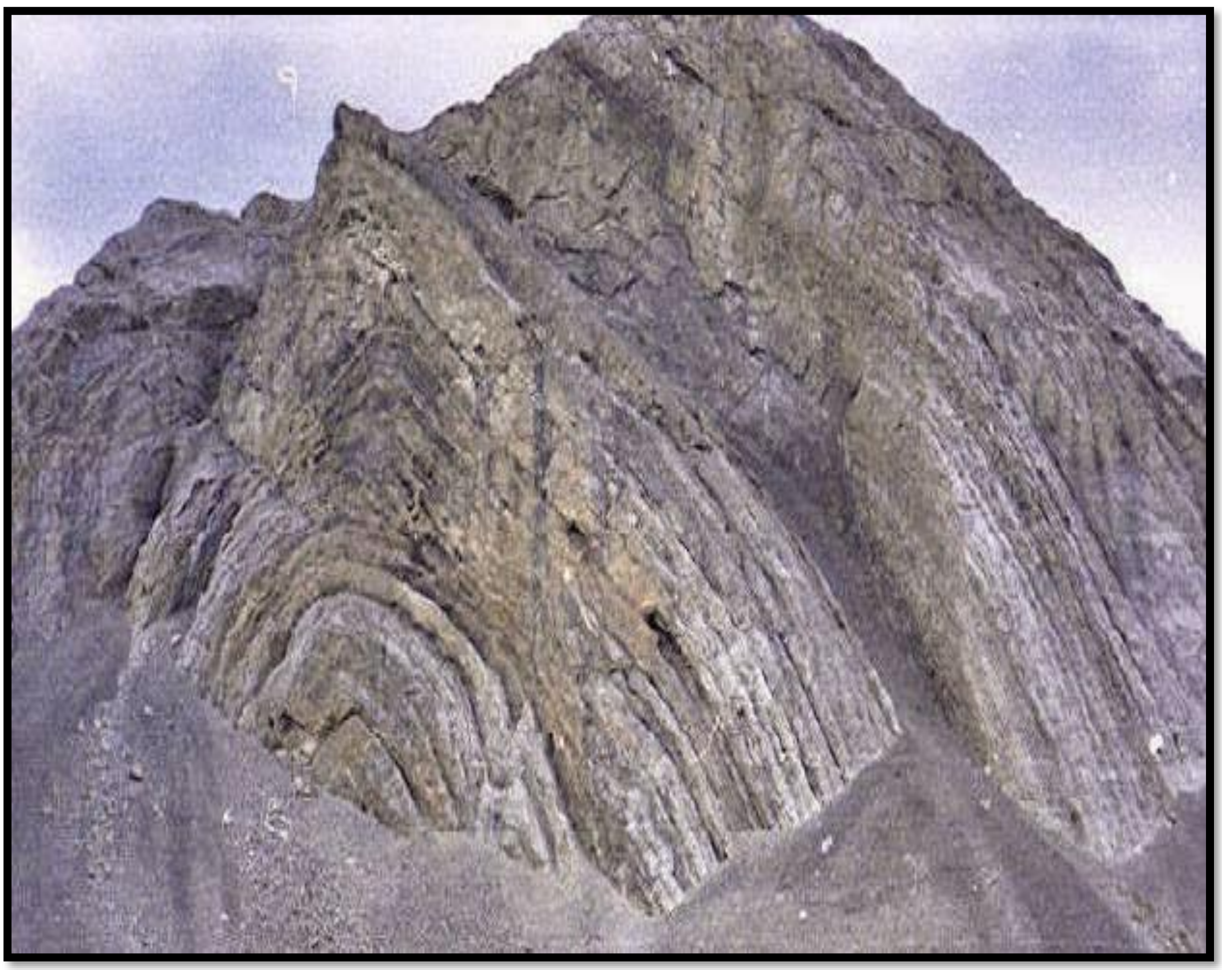
Aim

- Study and sketching of various types of structure folds (anticline, syncline, symmetrical & asymmetrical

Types of fold

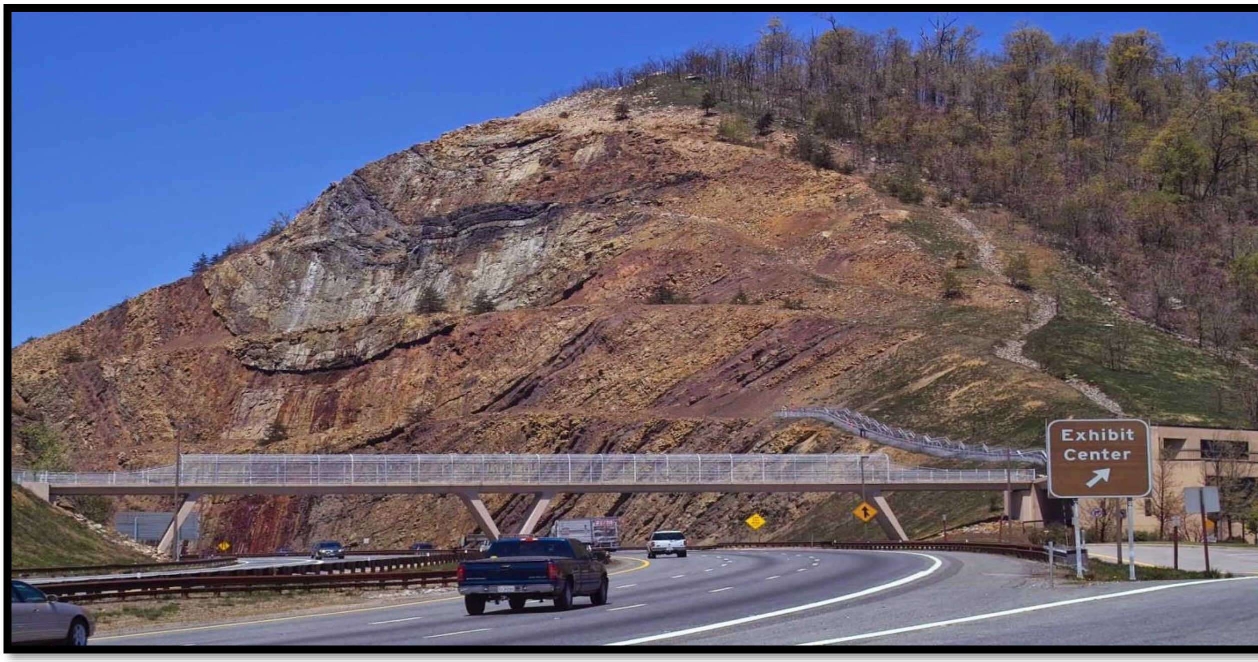
Anticline

Anticline is a fold that is convex up and has its oldest beds at its core. The term is not to be confused with antiform, which is a purely descriptive term for any fold that is convex up. Therefore if age relationships between various strata are unknown, the term antiform should be used.



Syncline

A syncline is a fold with younger layers closer to the center of the structure. Synclines are typically a downward fold, termed a synformal syncline (i.e. a trough); but synclines that point upwards, or perched, can be found when strata have been overturned and folded (an antiformal syncline).



Monocline

local warping in horizontal strata. Rock beds lying at two level separated by steep inclined limbs. It is form by vertical movement and generally found fault below monocline. a step-like fold in rock strata consisting of a zone of steeper dip within an otherwise horizontal or gently-dipping sequence.

Chevron fold

Chevron folds are a structural feature characterized by repeated well behaved folded beds with straight limbs and sharp hinges. Well developed, these folds develop repeated set of V-shaped beds. They develop in response to regional or local compressive stress. Inter-limb angles are generally 60 degrees or less. Chevron folding preferentially occurs when the bedding regularly alternates between contrasting competences.

Recumbent fold

Recumbent fold has an essentially horizontal axial plane. linear, fold axial plane oriented at low angle resulting in overturned strata in one limb of the fold.

Isoclinal fold

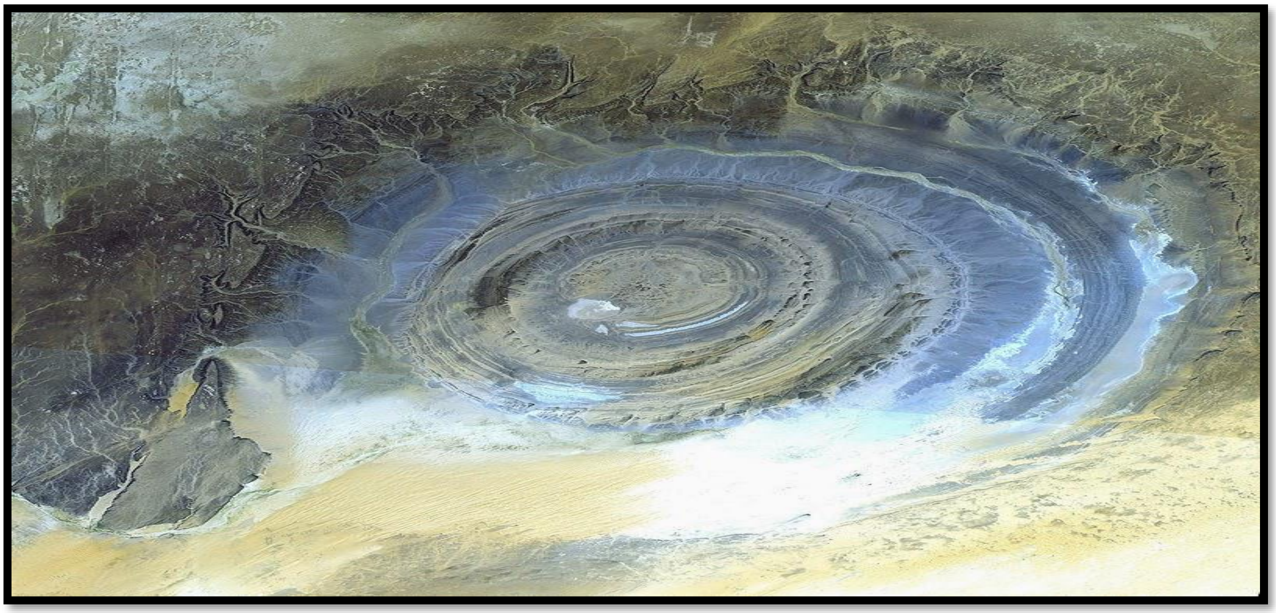
Isoclinal folds are similar to symmetrical folds, but these folds both have the same angle and are parallel to each other. 'Iso' means 'the same' (symmetrical), and 'cline' means 'angle,' so this name literally means 'same angle.' So isoclinal folds are both symmetrical and aligned in a parallel fashion.

Plunging fold

A fold whose axis plane is not horizontal (not Parallel to sea level). Direction of plunge - the direction in which the axis is inclined nose - indicate the direction of plunge. In anticline, plunge is directed towards nose and in syncline it is directed away from nose.

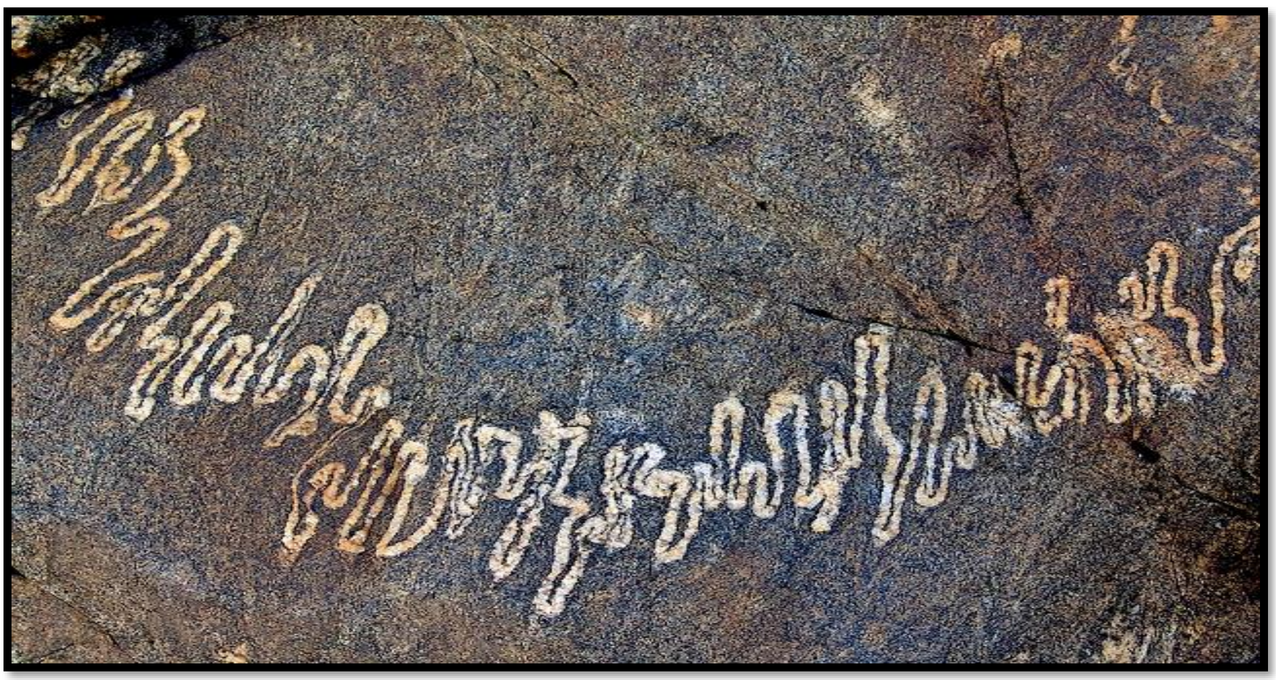
Dome and Basin

We also have domes, which are like anticlines but instead of an arch, the fold is in a dome shape, like an inverted bowl. Similarly, there are also basins, which are like synclines but again, instead of a sinking arch, the fold is in a shape of a bowl sinking down into the ground. Dome: nonlinear, strata dip away from center in all directions, oldest strata in center. Basin: nonlinear, strata dip toward center in all directions, youngest strata in center.



Ptygmatic fold

Folds are chaotic, random and disconnected. Typical of sedimentary slump folding, migmatites and decollement detachment zones. Ptygmatic folds generally represent conditions where the folded material is of a much greater viscosity than the surrounding. medium



Experiment No. 7

Aim

- Determination of Dip and Strike of geological structures with a Clinometer Compass

Geologists take great pains to measure and record geological structures because they are critically important to understanding the geological history of a region. One of the key features to measure is the orientation, or attitude, of bedding. We know that sedimentary beds are deposited in horizontal layers, so if the layers are no longer horizontal, then we can infer that they have been affected by tectonic forces and have become either tilted, or folded. We can express the orientation of a bed (or any other planar feature) with two values: first, the compass orientation of a horizontal line on the surface—the strike—and second, the angle at which the surface dips from the horizontal, (perpendicular to the strike)— the dip (Figure 1).

It may help to imagine a vertical surface, such as a wall in your house. The strike is the compass orientation of the wall and the dip is 90˚ from horizontal. If you could push the wall so it's leaning over, but still attached to the floor, the strike direction would be the same, but the dip angle would be less than 90˚. If you pushed the wall over completely so it was lying on the floor, it would no longer have a strike direction and its dip would be 0˚. When describing the dip it is important to include the direction. In other words. if the strike is 0˚ (i.e., north) and the dip is 30˚, it would be necessary to say "to the west" or "to the east." Similarly if the strike is 45˚ (i.e., northeast) and the dip is 60˚, it would be necessary to say "to the northwest" or "to the southeast."

Measurement of geological features is done with a special compass that has a built-in clinometer, which is a device for measuring vertical angles. An example of how this is done is shown on Figure 2.

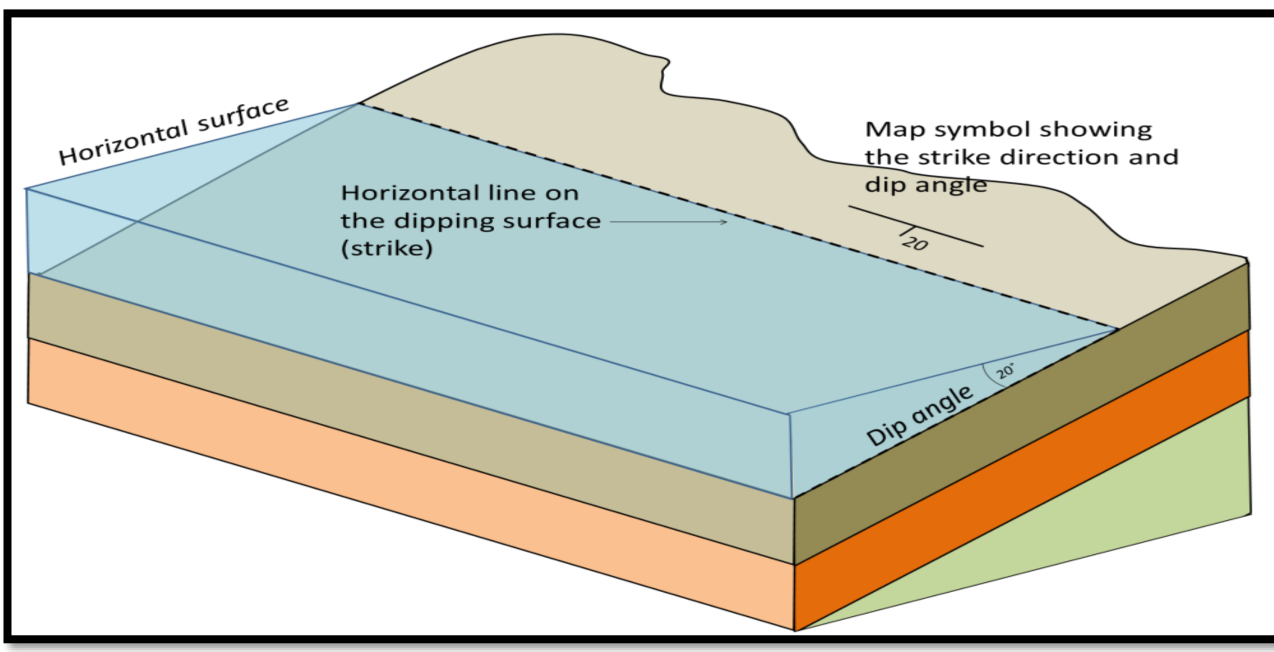


Figure 1 A depiction of the strike and dip of some tilted sedimentary beds partially covered with water. The notation for expressing strike and dip on a map is shown. [SE]

Figure 2 Measurement of strike (left) and dip (right) using a geological compass with a clinometer. [SE]

Strike and dip are also used to describe any other planar features, including joints, faults, dykes, sills, and even the foliation planes in metamorphic rocks. Figure 3 shows an example of how we would depict the beds that make up an anticline on a map.

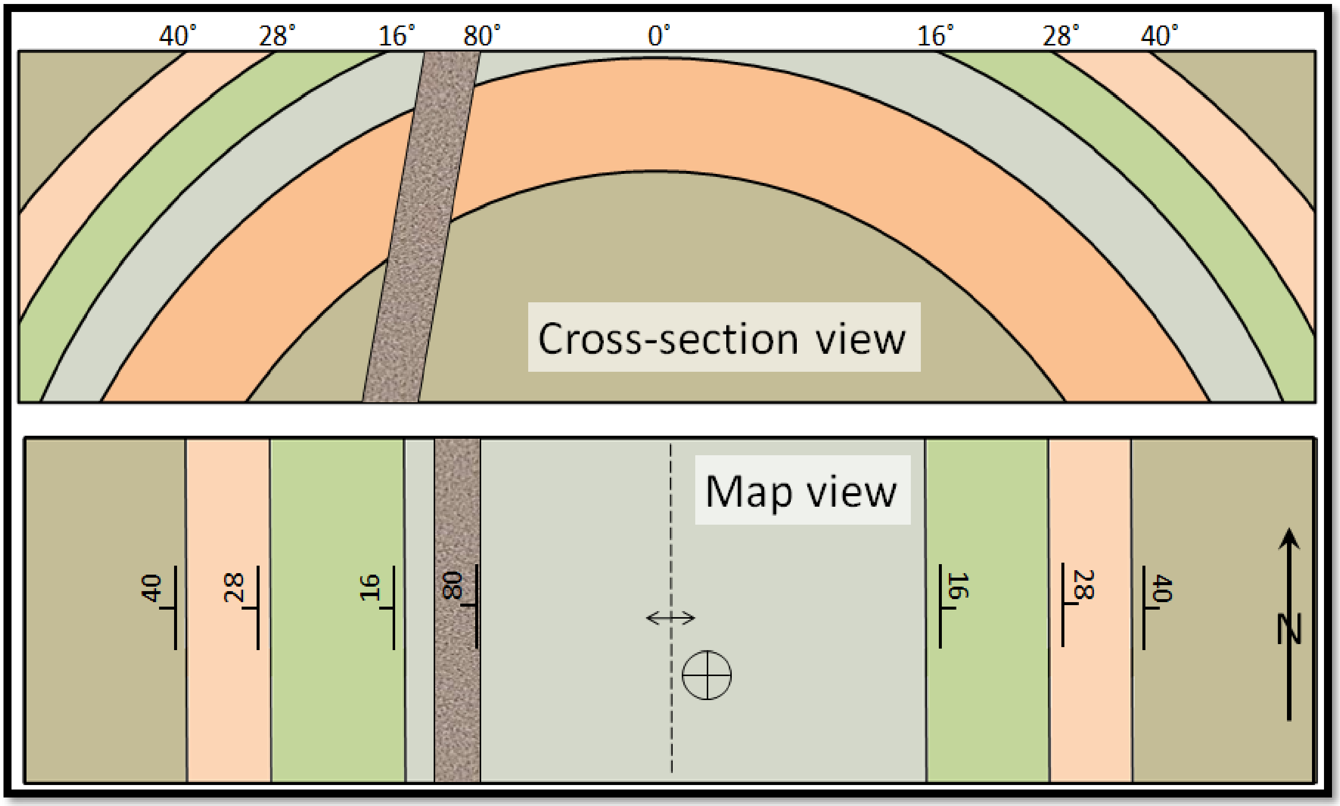


Figure 3 A depiction of an anticline and a dyke in cross-section (looking from the side) and in map view (a.k.a. plan view) with the appropriate strike-dip and anticline symbols. [SE]

The beds on the west (left) side of the map are dipping at various angles to the west. The beds on the east side are dipping to the east. The middle bed (light grey) is horizontal; this is denoted by a cross within a circle. The dyke is dipping at 80˚ to the west. The hinge of the fold is denoted with a dashed line with two arrows point away from it. If it were a syncline, the arrows would point towards the line.

Experiment No. 8

Aim

- Geological cross sections and study of geological maps

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, lithology, 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.

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.

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.

Interpretation

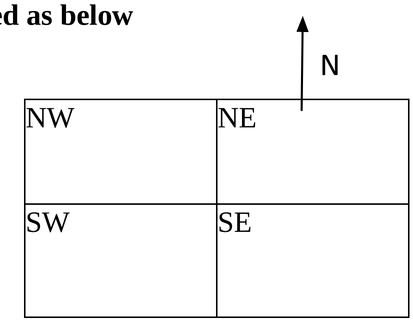
In a geological map, normally contours are marked as dotted lines with elevation value and bedding planes, fault planes etc. are marked as continuous lines. The interpretation comprises of details of topography, lithology, structure and geological history.

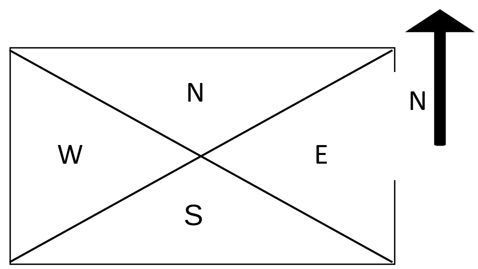
Interpretation of Topography

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

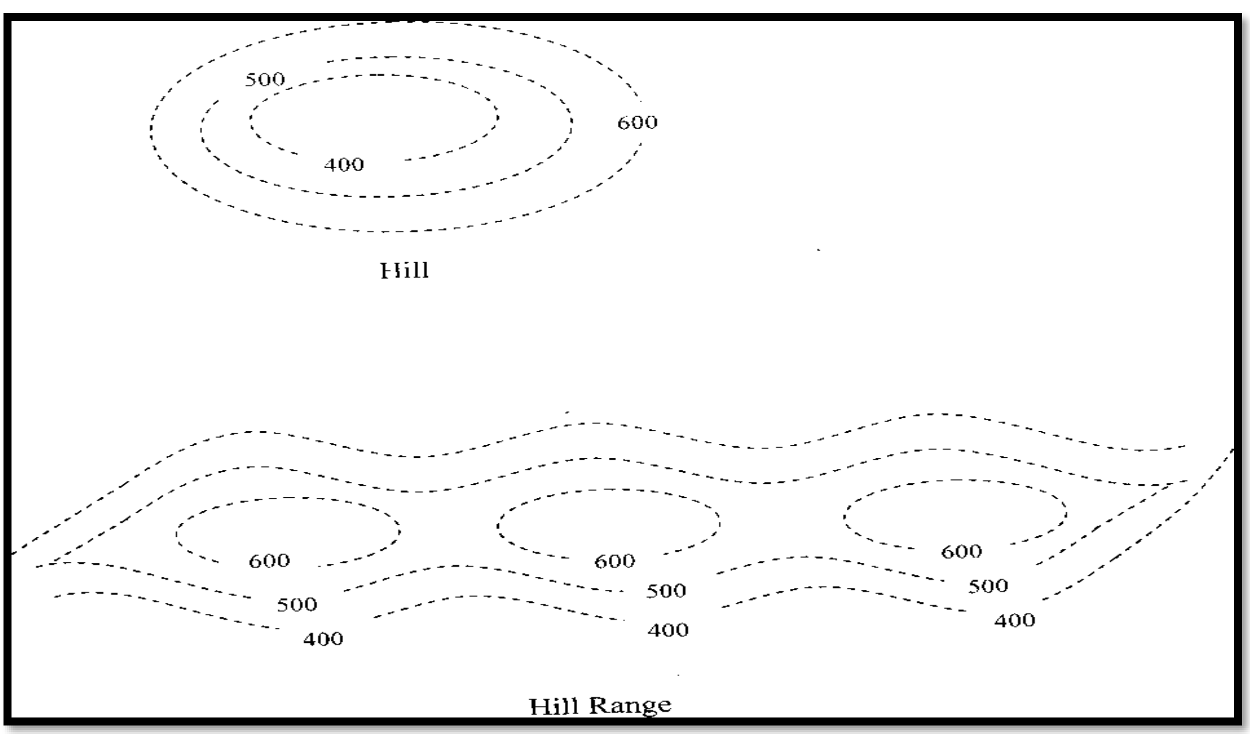
1. Area in the map indicated as below





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

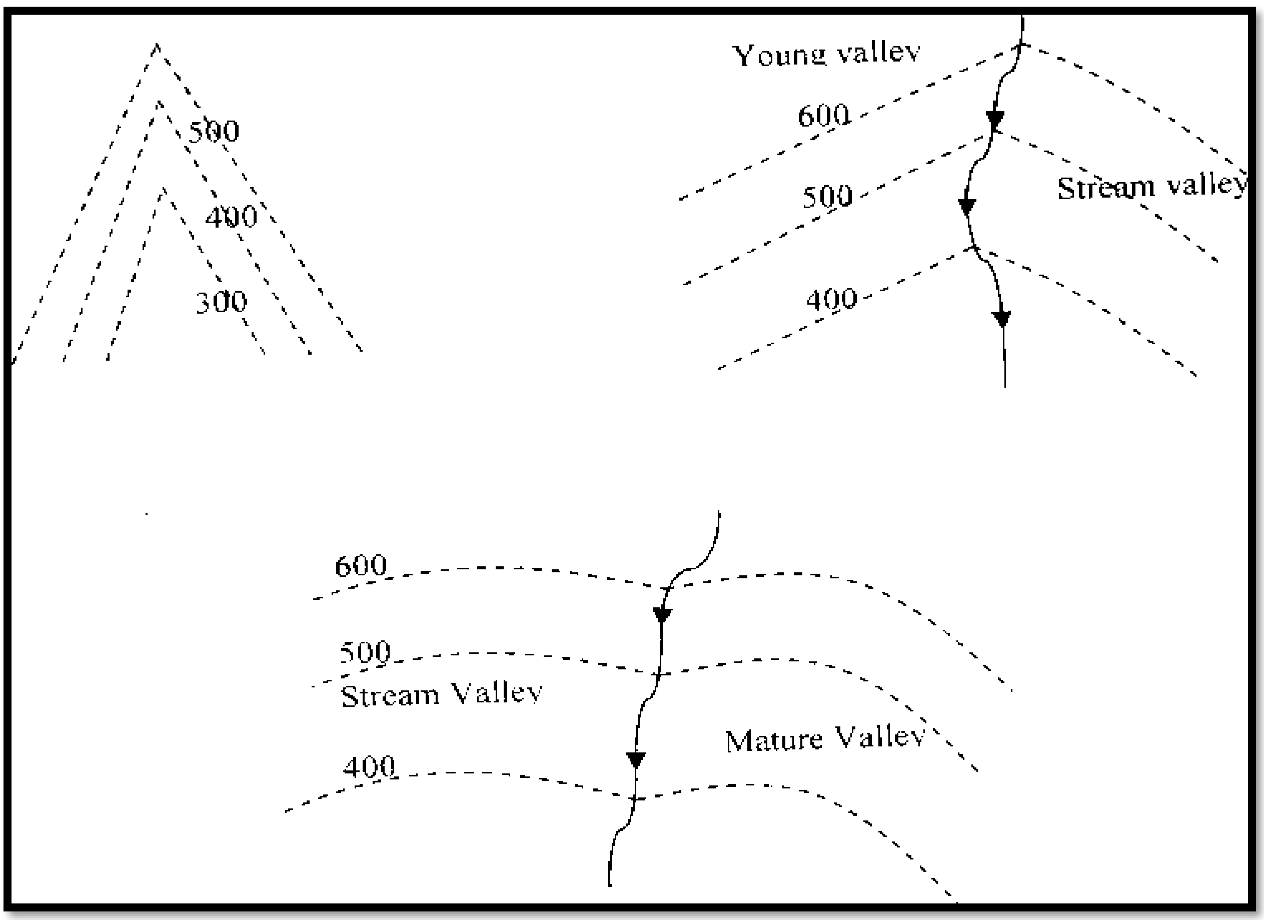


3. Height

- Maximum height is the elevation which is more than the highest contour marked in the map.
- Minimum height is the elevation which is less than the lowest contour marked in the map.
- Surface relief is the difference between the maximum height and the minimum height.

4. 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 valley development
- Young valleys have sharp contours but mature valleys have blunt curve contours



Interpretation of Lithology and Structure

1. **Horizontal Beds**: If the bedding planes and associating contours are mutually parallel it indicates beds are Horizontal.

   - Highest elevation is the youngest
   - Can't have Strike and Dip

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°

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 intersects) 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.

   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