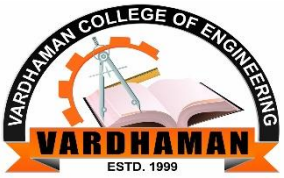


VARDHAMAN COLLEGE OF ENGINEERING
(Autonomous)
(Permanently Affiliated to JNTUH, Approved by AICTE, New Delhi & Accredited by NBA)
Shamshabad – 501218, Hyderabad.

ENGINEERING GEOLOGY LABORATORY MANUAL

DEPARTMENT OF CIVIL ENGINEERING

B. Tech. CE V SEMESTER

VARDHAMAN COLLEGE OF ENGINEERING
(AUTONOMOUS)

B. Tech. CE V Semester **VCE-R15**

ENGINEERING GEOLOGY LAB

Course Code:	**L**	**T**	**P**	**C**
	0	**0**	**3**	**2**

Course Overview:

This course emphasizes on the study of various types of rock formation and its physical properties. Topics such as rocks and minerals, soils, and earthquake activities are discussed with special reference to local geological problems. This lab course also focuses on physical properties of minerals.

Prerequisite(s):

Nil

Course Objective:

This course enables the students to understand physical properties of minerals and rocks and solve geological problems.

Course Outcomes:

Upon successful completion of this course, student will be able to:

CO 1. Identify the minerals based on their physical properties by simple tests
CO 2. Solve various geological problems.
CO 3. Classify rocks using basic geologic classification systems.
CO 4. Interpret the geological structures in the geological maps and models.

VARDHAMAN COLLEGE OF ENGINEERING
(AUTONOMOUS)

B. Tech. CE V Semester **VCE-R15**

ENGINEERING GEOLOGY LAB

Course Code:

L	T	P	C
0	0	3	2

SYLLABUS

LIST OF EXPERIMENTS

1. Study of physical properties and identification of rock forming minerals referred under theory.
2. Study of physical properties and identification of economic minerals referred under theory.
3. Megascopic and microscopic identification of rocks & minerals
4. Megascopic and microscopic description and identification of igneous rocks referred under theory.
5. Megascopic and microscopic description and identification of sedimentary rocks referred under theory.
6. Megascopic and microscopic description and identification of metamorphic rocks referred under theory.
7. Interpretation and drawing of sections for geological maps showing tilted beds, faults, unconformities etc.
8. Geological cross sections and study of geological maps
9. Simple Structural Geology problems
10. Simple strike and Dip problems
11. Study of models of geological structures and out crops patterns of different types of rocks and land forms

MINERALS

STUDY OF PHYSICAL PROPERTIES AND IDENTIFICATION OF MINERALS

STUDY OF MINERALS

Mineral

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

Common methods of study for the identification of minerals

Method	Principle
X-ray analysis	Based on the study of atomic structure, distinctive for every mineral. Its limitation is expensive, time consuming.
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).
Optical study	Based on the net effect of chemical composition and atomic structure. Its limitation is expensive.
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.

LABORATORY STUDY

In laboratories minerals are identified preferably by the method of study of physical properties.

Advantages

- The unique advantage is that the minerals can be studied in the field itself.
- It does not require any additional requirements, chemicals or equipment.
- It involves **no loss or wastage of minerals. Hence repetitive study is possible.**
- Immediate inference is possible.
- It is the cheapest and simplest method.

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.**	**Flint**

2. Colour

It is the usual body colour of mineral.

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

1. 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**

2. 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

Moh's Scale of Hardness

NAME OF MATERIAL	HARDNESS
Talc	1
Gypsum	2
Calcite	3
Fluorite	4
Apatite	5
Feldspar	6
Quartz	7
Topaz	8
Corundum	9
Diamond	10

PHYSICAL PROPERTIES OF MINERALS

OBSERVATIONS

Mineral 1

	PROPERTIES		OBSERVATION
1.	Form	:	Tabular
2.	Colour	:	Usually white, pink, grey or brown. Also colourless, yellow, orange, red, black, blue, green.
3.	Streak	:	Colourless/White
4.	Lustre	:	Vitreous. Pearly on some cleavage faces.
5.	Fracture	:	Even to uneven
6.	Cleavage	:	2 SETS
7.	Hardness	:	6 to 6.5
8.	Specific Gravity	:	2.5 to 2.8
9.	Diaphaneity	:	Usually translucent to opaque. Rarely transparent.
10.	Diagnostic Property	:	Perfect cleavage, with cleavage faces usually intersecting at or close to 90 degrees. Consistent hardness, specific gravity and pearly lustre on cleavage faces.
11.	Chemical composition	:	$KaAlSi_3O_8$
12.	Uses	:	Crushed and powdered feldspar are important raw materials for the manufacture of plate glass, container glass, ceramic products, paints, plastics and many other products. Varieties of orthoclase, labradorite, oligoclase, microcline and other feldspar minerals have been cut and used as faceted and cabochon gems.
13.	Varieties		Microcline, moon stone, orthoclase, plagioclase

Result: Based on above physical properties the given specimen is identified as *FELDSPAR*

OBSERVATIONS

Mineral 2

	PROPERTIES		OBSERVATION
1.	Form	:	MASSIVE
2.	Colour	:	Quartz occurs in virtually every color. Common colors are clear, white, gray, purple, yellow, brown, black, pink, green, red.
3.	Streak	:	Colorless (harder than the streak plate)
4.	Lustre	:	Vitreous
5.	Fracture	:	Uneven to conchoidal
6.	Cleavage	:	None - typically breaks with a conchoidal fracture
7.	Hardness	:	7
8.	Specific Gravity	:	2.6-2.7
9.	Diaphaneity	:	Translucent
10.	Diagnostic Property	:	fracture, lustre, hardness
11.	Chemical composition	:	SiO2
12.	Uses	:	Glass making, abrasive, foundry sand, hydraulic fracturing proppant, gemstones
13.	Varieties		Rose quartz, milky quartz, grey quartz etc.,
Result: Based on above physical properties the given specimen is identified as *QUARTZ*			

OBSERVATIONS

Mineral 3

1.	**Form**	**:**	**Massive**
2.	**Colour**	**:**	**Gray, black, brown, red, white and other colors due to staining**
3.	**Streak**	**:**	**Colourless**
4.	**Lustre**	**:**	**Vitreous**
5.	**Fracture**	**:**	**Conchoidal**
6.	**Cleavage**	**:**	**N/A**
7.	**Hardness**	**:**	**6.5-7**
8.	**Specific Gravity**	**:**	**2.6-2.73**
9.	**Diaphaneity**	**:**	**Opaque**
10.	**Diagnostic Property**	**:**	**Colour, Form**
11.	**Chemical composition**	**:**	**SiO_2**
12.	**Uses**	**:**	**Decorative Aggregates, Homes, Interior Decoration, Creating Artwork, Gemstone, In fire-starting tools, Manufacture of tools, Metallurgical Flux, Jewellery, To ignite fire.**
13.	**Varieties**		**Hornstone, Chert**
Result: Based on above physical properties the given specimen is identified as *FLINT*			

OBSERVATIONS

Mineral 4

1.	**Form**	**:**	**Massive**
2.	**Colour**	**:**	**Brown, yellow, orange, red, green, or blue. May also refer to any form of opaque Chalcedony in all colours. Jasper is usually multicolour or banded.**
3.	**Streak**	**:**	**White**
4.	**Lustre**	**:**	**Vitreous**
5.	**Fracture**	**:**	**Conchoidal**
6.	**Cleavage**	**:**	**N/A**
7.	**Hardness**	**:**	**6**
8.	**Specific Gravity**	**:**	**2.7**
9.	**Diaphaneity**	**:**	**Opaque**
10.	**Diagnostic Property**	**:**	**LUSTRE, CLEAVAGE**
11.	**Chemical composition**	**:**	**SiO2**
12.	**Uses**	**:**	**Ornaments, as a gem stone**
13.	**Varieties**		**-**
Result: Based on above physical properties the given specimen is identified as *Jasper*.			

OBSERVATIONS

Mineral 5

1.	**Form**	**:**	**Massive**
2.	**Colour**	**:**	**Usually olive green, but can be yellow-green to bright green; iron-rich specimens are brownish green to brown**
3.	**Streak**	**:**	**Colorless/White**
4.	**Lustre**	**:**	**Vitreous**
5.	**Fracture**	**:**	**Uneven**
6.	**Cleavage**	**:**	**N/A**
7.	**Hardness**	**:**	**6.5 to 7**
8.	**Specific Gravity**	**:**	**3.2 to 4.4**
9.	**Diaphaneity**	**:**	**OPAQUE**
10.	**Diagnostic Property**	**:**	**Green colour, vitreous lustre, conchoidal fracture, granular texture**
11.	**Chemical composition**	**:**	**(Mg, Fe)2SiO4**
12.	**Uses**	**:**	**Gemstones, a declining use in bricks and refractory sand**
13.	**Varieties**		**Forsterite, fayalite**
Result: Based on above physical properties the given specimen is identified as *OLIVINE*			

OBSERVATIONS

Mineral 6

1.	**Form**	**:**	**Massive**
2.	**Colour**	**:**	**Multicolour in banded formation. Colours include white, blue, red, green, yellow, orange, brown, pink, purple, grey, and black. Some rarer forms of Agate are iridescent.**
3.	**Streak**	**:**	**Colourless/ white**
4.	**Lustre**	**:**	**Vitreous**
5.	**Fracture**	**:**	**Conchoidal**
6.	**Cleavage**	**:**	**N/A**
7.	**Hardness**	**:**	**7**
8.	**Specific Gravity**	**:**	**2.6-2.7**
9.	**Diaphaneity**	**:**	**Opaque to Translucent**
10.	**Diagnostic Property**	**:**	**Lustre, Colour**
11.	**Chemical composition**	**:**	**SiO_2**
12.	**Uses**	**:**	**ornamental objects, Most commonly as beads in necklaces, bracelets, earrings, etc.,**
13.	**Varieties**		**Cloud Agate, Fire Agate, Eye Agate, Grape Agate**
Result: Based on above physical properties the given specimen is identified as *AGATE*			

OBSERVATIONS

Mineral 7

1.	**Form**	**:**	**Bladed**
2.	**Colour**	**:**	**Blue, white, grey, green, colorless**
3.	**Streak**	**:**	**White, colorless**
4.	**Lustre**	**:**	**Vitreous, pearly**
5.	**Fracture**	**:**	**Hackly**
6.	**Cleavage**	**:**	**2 sets**
7.	**Hardness**	**:**	**Kyanite often occurs in long, bladed crystals. These have a hardness of 4.5 to 5 along the length of the crystals and 6.5 to 7 across the width of the crystals.**
8.	**Specific Gravity**	**:**	**3.5 to 3.7**
9.	**Diaphaneity**	**:**	**Transparent to translucent**
10.	**Diagnostic Property**	**:**	**Colour, cleavage, bladed crystals**
11.	**Chemical composition**	**:**	**Al_2SiO_5**
12.	**Uses**	**:**	**Ceramics, gemstones**
13.	**Varieties**		**Orange Kyanite and Black Kyanite**
Result: Based on above physical properties the given specimen is identified as *KYANITE*			

OBSERVATIONS

Mineral 8

1.	**Form**	**:**	**Granular**
2.	**Colour**	**:**	**Usually black, dark green, dark brown**
3.	**Streak**	**:**	**White, colourless - (brittle, often leaves cleavage debris behind instead of a streak)**
4.	**Lustre**	**:**	**Vitreous**
5.	**Fracture**	**:**	**Uneven**
6.	**Cleavage**	**:**	**2 sets**
7.	**Hardness**	**:**	**5 to 6**
8.	**Specific Gravity**	**:**	**2.6-2.73**
9.	**Diaphaneity**	**:**	**Opaque**
10.	**Diagnostic Property**	**:**	**Cleavage, colour**
11.	**Chemical composition**	**:**	**$(Ca,Na)_{2-3}(Mg,Fe,Al)_5(Al,Si)_8O_{22}(OH,F)_2$**
12.	**Uses**	**:**	**Decoration**
13.	**Varieties**		**Magnesio-hornblende, Hornblende-asbestos**
Result: Based on above physical properties the given specimen is identified as *HORNBLENDE*			

OBSERVATIONS

Mineral 9

1.	**Form**	**:**	**Foliated**
2.	**Colour**	**:**	**Various shades of green. Rarely yellow, white, pink, black**
3.	**Streak**	**:**	**Greenish to greenish gray**
4.	**Lustre**	**:**	**Vitreous, pearly, dull**
5.	**Fracture**	**:**	**Uneven**
6.	**Cleavage**	**:**	**1 set**
7.	**Hardness**	**:**	**2 to 3**
8.	**Specific Gravity**	**:**	**2.6 to 3.3**
9.	**Diaphaneity**	**:**	**Opaque**
10.	**Diagnostic Property**	**:**	**Color, hardness, foliated appearance, feels slightly greasy**
11.	**Chemical composition**	**:**	**A generalized formula: $(X,Y)_{4-6}(Si,Al)_4O_{10}(OH,O)_8$ The "X" and "Y" in the formula represent ions, which might include: Fe^{+2}, Fe^{+3}, Mg^{+2}, Mn^{+2}, Ni^{+2}, Zn^{+2}, Al^{+3}, Li^{+1}, or Ti^{+4}. The composition and physical properties of chlorites vary as these ions substitute for one another in solid solution.**
12.	**Uses**	**:**	**Very few industrial uses. Used as a filler and as a constituent of clay.**
13.	**Varieties**		**Chanosite, Ritidolite**
Result: Based on above physical properties the given specimen is identified as *CHLORITE*			

OBSERVATIONS

Mineral 10

1.	**Form**	**:**	**Fibrous**
2.	**Colour**	**:**	**White pale colour**
3.	**Streak**	**:**	**White**
4.	**Lustre**	**:**	**Silky**
5.	**Fracture**	**:**	**Uneven to hackly**
6.	**Cleavage**	**:**	**1 set**
7.	**Hardness**	**:**	**5-6**
8.	**Specific Gravity**	**:**	**2.9-3.2**
9.	**Diaphaneity**	**:**	**Opaque**
10.	**Diagnostic Property**	**:**	**Form, Colour**
11.	**Chemical composition**	**:**	**$CA_2(MgFe)_5Si_8O_{22}(OH)_2$**
12.	**Uses**	**:**	**Fire proof bricks**
13.	**Varieties**		**Mountain Paper, Pilolite.**
Result: Based on above physical properties the given specimen is identified as *ASBESTOS*			

OBSERVATIONS

Mineral 11

1.	**Form**	**:**	**Lamellar**
2.	**Colour**	**:**	**Thick specimens often appear to be black, brown, or silver in colour; however, when split into thin sheets muscovite is colourless, sometimes with a tint of brown, yellow, green, or rose**
3.	**Streak**	**:**	**White, often sheds tiny flakes**
4.	**Lustre**	**:**	**Pearly to vitreous**
5.	**Fracture**	**:**	**Uneven to Hackly**
6.	**Cleavage**	**:**	**1 Set**
7.	**Hardness**	**:**	**2.5 to 3**
8.	**Specific Gravity**	**:**	**2.8 to 2.9**
9.	**Diaphaneity**	**:**	**Transparent to translucent**
10.	**Diagnostic Property**	**:**	**Cleavage, colour, transparency**
11.	**Chemical composition**	**:**	**$KAl_2(Si_3AlO_{10})(OH)_2$**
12.	**Uses**	**:**	**Used in the manufacturing of paint, joint compound, plastics rubber, asphalt roofing, cosmetics, drilling mud.**
13.	**Varieties**		**Sodium mica, lithium mica**
Result: Based on above physical properties the given specimen is identified as *MUSCOVITE*			

OBSERVATIONS

Mineral 12

1.	**Form**	**:**	**Lamellar**
2.	**Colour**	**:**	**Brown**
3.	**Streak**	**:**	**Brownish**
4.	**Lustre**	**:**	**Pearly**
5.	**Fracture**	**:**	**Uneven**
6.	**Cleavage**	**:**	**1 Set**
7.	**Hardness**	**:**	**2-3**
8.	**Specific Gravity**	**:**	**2.7-3.1**
9.	**Diaphaneity**	**:**	**Transparent to Translucent**
10.	**Diagnostic Property**	**:**	**Form, Lustre**
11.	**Chemical composition**	**:**	**$K(MgFe)_3(Si3Al)O_{10}(OH,F)_2$**
12.	**Uses**	**:**	**Used in the manufacturing of insulating materials**
13.	**Varieties**		**Lepidolite, Biotite**
Result: Based on above physical properties the given specimen is identified as *MICA*			

OBSERVATIONS

Mineral 13

1.	**Form**	**:**	**Massive**
2.	**Colour**	**:**	**Typically red, but can be orange, green, yellow, purple, black, or brown. Blue garnets are extremely rare.**
3.	**Streak**	**:**	**Colourless**
4.	**Lustre**	**:**	**Vitreous**
5.	**Fracture**	**:**	**Uneven to conchoidal**
6.	**Cleavage**	**:**	**N/A**
7.	**Hardness**	**:**	**6.5 to 7.5**
8.	**Specific Gravity**	**:**	**3.5 to 4.3**
9.	**Diaphaneity**	**:**	**Transparent to translucent**
10.	**Diagnostic Property**	**:**	**Hardness, specific gravity, isometric crystal form, lack of cleavage**
11.	**Chemical composition**	**:**	**$X_3Y_2(SiO_4)_3$**
12.	**Uses**	**:**	**Waterjet cutting granules, abrasive blasting granules, filtration granules, abrasive grits and powders, gemstones**
13.	**Varieties**		**Pyrope**
Result: Based on above physical properties the given specimen is identified as *GARNET*			

OBSERVATIONS

Mineral 14

1.	**Form**	**:**	**Foliated**
2.	**Colour**	**:**	**Green, white, grey, brown, colourless**
3.	**Streak**	**:**	**White to pale green**
4.	**Lustre**	**:**	**Pearly**
5.	**Fracture**	**:**	**Uneven to Hackly**
6.	**Cleavage**	**:**	**1 set**
7.	**Hardness**	**:**	**1**
8.	**Specific Gravity**	**:**	**2.7 to 2.8**
9.	**Diaphaneity**	**:**	**Translucent**
10.	**Diagnostic Property**	**:**	**Soapy feel, colour, softness, cleavage**
11.	**Chemical composition**	**:**	**$Mg_3Si_4O_{10}(OH)_2$**
12.	**Uses**	**:**	**Used as a filler and anti-stick coating in plastics, ceramics, paint, paper, roofing, rubber, cosmetics**
13.	**Varieties**		**Stealite, Soap stone**
Result: Based on above physical properties the given specimen is identified as *TALC*			

OBSERVATIONS

Mineral 15

1.	**Form**	**:**	**Rohmbic**
2.	**Colour**	**:**	**Usually white but also colorless, gray, red, green, blue, yellow, brown, orange**
3.	**Streak**	**:**	**White**
4.	**Lustre**	**:**	**vitreous**
5.	**Fracture**	**:**	**Even**
6.	**Cleavage**	**:**	**3 sets**
7.	**Hardness**	**:**	**3**
8.	**Specific Gravity**	**:**	**2.7**
9.	**Diaphaneity**	**:**	**Translucent**
10.	**Diagnostic Property**	**:**	**Rhombohedral cleavage, powdered form effervesces weakly in dilute HCl, curved crystal faces and frequent twinning**
11.	**Chemical composition**	**:**	**$KAl_2(Si_3AlO_{10})(OH)_2$**
12.	**Uses**	**:**	**Acid neutralization, a low-hardness abrasive, soil conditioner, heated for the production of lime**
13.	**Varieties**		**Island spar**

Result: Based on above physical properties the given specimen is identified as *CALCITE*

OBSERVATIONS

Economic Mineral 1

1.	**Form**	**:**	**Cubic, Granular**
2.	**Colour**	**:**	**Brass yellow - often tarnished to dull brass**
3.	**Streak**	**:**	**Greenish black to brownish black**
4.	**Lustre**	**:**	**Metallic**
5.	**Fracture**	**:**	**Uneven**
6.	**Cleavage**	**:**	**3 sets**
7.	**Hardness**	**:**	**6 to 6.5**
8.	**Specific Gravity**	**:**	**4.9 to 5.2**
9.	**Diaphaneity**	**:**	**Opaque**
10.	**Diagnostic Property**	**:**	**Colour, hardness, brittle, greenish black streak, specific gravity**
11.	**Chemical composition**	**:**	**Iron sulphide, FeS_2**
12.	**Uses**	**:**	**Ore of gold**
13.	**Varieties**		**Marcasite**
Result: Based on above physical properties the given specimen is identified as *PYRITE*			

OBSERVATIONS

Economic Mineral 2

1.	**Form**	**:**	**Massive**
2.	**Colour**	**:**	**Black to steel-gray to silver; red to reddish brown to black**
3.	**Streak**	**:**	**Red to reddish brown**
4.	**Lustre**	**:**	**Metallic, submetallic, earthy**
5.	**Fracture**	**:**	**Uneven**
6.	**Cleavage**	**:**	**N/A**
7.	**Hardness**	**:**	**5 to 6.5**
8.	**Specific Gravity**	**:**	**5.0 to 5.3**
9.	**Diaphaneity**	**:**	**Opaque**
10.	**Diagnostic Property**	**:**	**Red streak, specific gravity**
11.	**Chemical composition**	**:**	**Fe_2O_3**
12.	**Uses**	**:**	**The most important ore of iron. Pigment, heavy media separation, radiation shielding, ballast, polishing compounds, a minor gemstone**
13.	**Varieties**		**Ironore**
Result: Based on above physical properties the given specimen is identified as *HEMATITE*			

OBSERVATIONS

Economic Mineral 3

1.	**Form**	**:**	**Granular**
2.	**Colour**	**:**	**Black to silvery grey**
3.	**Streak**	**:**	**Black**
4.	**Lustre**	**:**	**Metallic, submetallic**
5.	**Fracture**	**:**	**Uneven**
6.	**Cleavage**	**:**	**N/A**
7.	**Hardness**	**:**	**5 to 6.5**
8.	**Specific Gravity**	**:**	**5.2**
9.	**Diaphaneity**	**:**	**Opaque**
10.	**Diagnostic Property**	**:**	**Strongly magnetic, colour, streak.**
11.	**Chemical composition**	**:**	**Fe_2O_4**
12.	**Uses**	**:**	**The most important ore of iron. Heavy media separation. Studies of Earth's magnetic field.**
13.	**Varieties**		**-**
Result: Based on above physical properties the given specimen is identified as *MAGNETITE*			

OBSERVATIONS

Economic Mineral 4

1.	**Form**	**:**	**Massive/Spongy**
2.	**Colour**	**:**	**White, grey, sometimes stained yellow, orange, red, pink, or brown by iron or included iron minerals**
3.	**Streak**	**:**	**Usually white, but iron stain can discolor**
4.	**Lustre**	**:**	**Dull, earthy**
5.	**Fracture**	**:**	**Uneven**
6.	**Cleavage**	**:**	**N/A**
7.	**Hardness**	**:**	**1 to 3**
8.	**Specific Gravity**	**:**	**2 to 2.5**
9.	**Diaphaneity**	**:**	**Opaque**
10.	**Diagnostic Property**	**:**	**Soft, low specific gravity, colour**
11.	**Chemical composition**	**:**	**$AlO(OH)$, $Al(OH)_3$**
12.	**Uses**	**:**	**The primary ore of aluminum. Synthetic bauxite is used as an abrasive and as a fracking proppant**
13.	**Varieties**		**Corundum, Spinel**
Result: Based on above physical properties the given specimen is identified as *BAUXITE*			

OBSERVATIONS

Economic Mineral 5

1.	**Form**	**:**	**Massive**
2.	**Colour**	**:**	**Steel grey to black**
3.	**Streak**	:	**Black**
4.	**Lustre**	**:**	**Metallic, sometimes earthy**
5.	**Fracture**	**:**	**Uneven**
6.	**Cleavage**	**:**	**1 SET**
7.	**Hardness**	**:**	**1 to 2**
8.	**Specific Gravity**	**:**	**2.1 to 2.3**
9.	**Diaphaneity**	**:**	**Opaque**
10.	**Diagnostic Property**	**:**	**Color, streak, slippery feel, specific gravity**
11.	**Chemical composition**	**:**	**C**
12.	**Uses**	**:**	**Used to manufacture heat and chemical resistant containers and other objects. Battery anodes. A dry lubricant. The "lead" in pencils.**
13.	**Varieties**		**-**
Result: Based on above physical properties the given specimen is identified as *GRAPHITE*			

OBSERVATIONS

Economic Mineral 6

1.	**Form**	**:**	**Granular**
2.	**Colour**	**:**	**Dark gray to black, rarely brownish black**
3.	**Streak**	**:**	**Dark brown**
4.	**Lustre**	**:**	**Metallic to submetallic**
5.	**Fracture**	**:**	**Uneven**
6.	**Cleavage**	**:**	**N/A**
7.	**Hardness**	**:**	**5.5 to 6**
8.	**Specific Gravity**	**:**	**4.0 to 5.1**
9.	**Diaphaneity**	**:**	**Opaque**
10.	**Diagnostic Property**	**:**	**Luster, streak**
11.	**Chemical composition**	**:**	**$FeCr_2O_4$**
12.	**Uses**	**:**	**An ore of chromium**
13.	**Varieties**		**-**
Result: Based on above physical properties the given specimen is identified as *CHROMITE*			

OBSERVATIONS

Economic Mineral 7

1.	**Form**	**:**	**Cubic**
2.	**Colour**	**:**	**Fresh surfaces are bright silver in colour**
3.	**Streak**	**:**	**Dark brown**
4.	**Lustre**	**:**	**Metallic to submetallic**
5.	**Fracture**	**:**	**Uneven**
6.	**Cleavage**	**:**	**3 sets**
7.	**Hardness**	**:**	**2.5**
8.	**Specific Gravity**	**:**	**7.4 to 7.6**
9.	**Diaphaneity**	**:**	**Opaque**
10.	**Diagnostic Property**	**:**	**Colour, lustre, specific gravity, streak, cleavage**
11.	**Chemical composition**	**:**	**PbS**
12.	**Uses**	**:**	**An ore of lead**
13.	**Varieties**		**-**
Result: Based on above physical properties the given specimen is identified as *GALENA*			

OBSERVATIONS

Economic Mineral 8

1.	**Form**	**:**	**Massive**
2.	**Colour**	**:**	**White, greyish, yellowish, brownish, rarely colourless**
3.	**Streak**	**:**	**White**
4.	**Lustre**	**:**	**Dull, earthy, chalky, rarely vitreous**
5.	**Fracture**	**:**	**Even to Uneven**
6.	**Cleavage**	**:**	**N/A**
7.	**Hardness**	**:**	**3.5 to 5.0**
8.	**Specific Gravity**	**:**	**3.0 to 3.2**
9.	**Diaphaneity**	**:**	**Opaque**
10.	**Diagnostic Property**	**:**	**Colour, Fracture**
11.	**Chemical composition**	**:**	**$MgCO_3$**
12.	**Uses**	**:**	**Heated to produce MgO which is used to produce refractory bricks, refractory cements, and magnesium metal. High-quality pieces of magnesite are used to cut beads, cabochons, tumbled stones, and other lapidary projects**
13.	**Varieties**		**Epsomite**
Result: Based on above physical properties the given specimen is identified as *MAGNESITE*			

ROCKS

MEGASCOPIC AND MICROSCOPIC DESCRIPTION AND IDENTIFICATION OF ROCKS REFERRED UNDER THEORY

STUDY 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

Terminology related for the description of 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 tine	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. Colour

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

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.**

IGNEOUS ROCK -1			
1.	Colour	:	Mesocratic
2.	Texture		
	A) Crystallinity	:	Holocrystalline
	B) Granularity	:	Coarse grained
	C) Mutual relationship of minerals	:	Inequigranular
	D) Shape of the mineral	:	-
3.	Mineral Composition		
	a) Essential Minerals	:	Quartz
	b) Accessory Minerals	:	Mica, magnetite
4.	Structure	:	Compact, massive
5	Mode of Origin	:	Greater depths under high pressure
6	Distribution in India	:	Tamilnadu, Karnataka
7	Engineering Properties & Uses	:	Charnockites are massive & compact, hence can be used for road material
Result: Based on above physical properties the given specimen is identified as *CHARNOCKITE*			

IGNEOUS ROCK -2			
1.	Colour	:	Leucocratic
2.	Texture		
	A) Crystallinity	:	Holocrystalline
	B) Granularity	:	Coarse grained
	C) Mutual relationship of minerals	:	Interlocking
	D) Shape of the mineral	:	Subhedral
3.	Mineral Composition		
	a) Essential Minerals	:	Alkali feldspar, quartz
	b) Accessory Minerals	:	Cassiterite, Spodumene
4.	Structure	:	-
5	Mode of Origin	:	Intrusive igneous rock
6	Distribution in India	:	Bihar, Rajasthan
7	Engineering Properties & Uses	:	Nil
Result: Based on above physical properties the given specimen is identified as *PEGMATITE*			

IGNEOUS ROCK -3			
1.	Colour	:	Leucocratic
2.	Texture		
	A) Crystallinity	:	Holohyaline
	B) Granularity	:	Medium to fine grained
	C) Mutual relationship of minerals	:	Equigranular
	D) Shape of the mineral	:	Subhedral
3.	Mineral Composition		
	a) Essential Minerals	:	Plagioclase feldspar
	b) Accessory Minerals	:	Hornblende, iron oxide
4.	Structure	:	Vesicular or amygdaloidal
5	Mode of Origin	:	Volcanic extrusive rock
6	Distribution in India	:	Maharashtra, Kutch, Gujarat, Madhya Pradesh
7	Engineering Properties & Uses	:	Massive basalts are highly durable and strong with highest load bearing capacity. It is used as building stone and also suitable in tunnelling since it doesn't require lining.
8	Varieties	:	-
Result: Based on above physical properties the given specimen is identified as *BASALT*			

IGNEOUS ROCK -4			
1.	Colour	:	Leucocratic
2.	Texture		
	A) Crystallinity	:	Holo crystalline
	B) Granularity	:	Coarse or medium grained
	C) Mutual relationship of minerals	:	Equigranular
	D) Shape of the mineral	:	Subhedral
3.	Mineral Composition		
	a) Essential Minerals	:	Alkali feldspar, plagioclase, quartz
	b) Accessory Minerals	:	Hornblende, pyroxenes, emphiboles
4.	Structure	:	-
5	Mode of Origin	:	Intrusive igneous rock
6	Distribution in India	:	AP, TS, Rajasthan, Karnataka
7	Engineering Properties & Uses	:	Granite can be used as foundation rock, building stone, it doesn't require lining in tunnels.
Result: Based on above physical properties the given specimen is identified as *GRANITE*			

IGNEOUS ROCK -5			
1.	Colour	:	Melenocratic
2.	Texture		
	A) Crystallinity	:	Holo crystalline
	B) Granularity	:	Fine grained
	C) Mutual relationship of minerals	:	Equigranular
	D) Shape of the mineral	:	-
3.	Mineral Composition		
	a) Essential Minerals	:	Ferro magnesium, small amounts of quartz.
	b) Accessory Minerals	:	pyroxenes, iron oxide
4.	Structure	:	Massive, Compact
5	Mode of Origin	:	Intrusive igneous rock (DYKES)
6	Distribution in India	:	Jharkhand, all over south India
7	Engineering Properties & Uses	:	It is suitable as railway ballast, bitumen aggregate, and concrete structures.
Result: Based on above physical properties the given specimen is identified as ***DOLORITE***			

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 lime stones.

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.

SEDIMENTARY ROCK -1			
1.	Colour	:	Reddish brown
2.	Texture		
	A) Grain size	:	Medium to fine grained
	B) Sorting	:	Loose , sometimes compact
	C) Cementing material	:	siliceous material
	D) Shape of grains	:	Rounded
	E) Roundness of grains	:	Poor
3.	Mineral Composition		
	c) Essential Minerals	:	Aluminium silicate
	d) Accessory Minerals	:	-
4.	Structure	:	Bladed bedding
5	Mode of Origin	:	Argillaceous sedimentary rocks
6	Distribution in India	:	Mangalore, Tamilanadu
7	Engineering Properties & Uses	:	As road material and can't be used in construction
Result: Based on above physical properties the given specimen is identified as *Lateriate*			

SEDIMENTARY ROCK -2			
1.	Colour	:	Reddish brown
2.	Texture		
	A) Grain size	:	Medium to fine grained
	B) Sorting	:	Poorly sorted
	C) Cementing material	:	siliceous material
	D) Shape of grains	:	Rounded
	E) Roundness of grains	:	Good
3.	Mineral Composition		
	a) Essential Minerals	:	Flint, Quartz, Jasper
	b) Accessory Minerals	:	-
4.	Structure	:	Bladed bedding
5	Mode of Origin	:	Mechanically formed
6	Distribution in India	:	Rajasthan
7	Engineering Properties & Uses	:	Can be used as building material, however it is undesirable for major construction works.
Result: Based on above physical properties the given specimen is identified as *COGLEMERATE*			

SEDIMENTARY ROCK -3			
1.	Colour	:	Reddish, yellow , white
2.	Texture		
	A) Grain size	:	Medium to Coarse grained
	B) Sorting	:	Well sorted
	C) Cementing material	:	siliceous material
	D) Shape of grains	:	Rounded
	E) Roundness of grains	:	Poor
3.	Mineral Composition		
	a) Essential Minerals	:	Quartz
	b) Accessory Minerals	:	Muscovite
4.	Structure	:	Bedding
5	Mode of Origin	:	Arenaceous sedimentary rock
6	Distribution in India	:	AP, Assam, Gujarat, Harayana
7	Engineering Properties & Uses	:	Due to less permeability sand stone is best for all civil engg. Projects.
Result: Based on above physical properties the given specimen is identified as *SANDSTONE*			

SEDIMENTARY ROCK -4			
1.	Colour	:	Reddish, brown, grey , white
2.	Texture		
	A) Grain size	:	Fine grained
	B) Sorting	:	Compact
	C) Cementing material	:	Absent
	D) Shape of grains	:	Undefined
	E) Roundness of grains	:	Undefined
3.	Mineral Composition		
	a) Essential Minerals	:	Silt & Clay
	b) Accessory Minerals	:	-
4.	Structure	:	Sheet like
5	Mode of Origin	:	Argilaceous sedimentary rock
6	Distribution in India	:	AP, Assam, Maharashtra
7	Engineering Properties & Uses	:	Undesirable at site or foundation or civil structures like Dams and tunnels.
Result: Based on above physical properties the given specimen is identified as *SHALE*			

SEDIMENTARY ROCK -5			
1.	Colour	:	White, pink, green , blue
2.	Texture		
	A) Grain size	:	Fine grained
	B) Sorting	:	Absent
	C) Cementing material	:	Absent
	D) Shape of grains	:	Undefined
	E) Roundness of grains	:	Undefined
3.	Mineral Composition		
	a) Essential Minerals	:	Calcite
	b) Accessory Minerals	:	Magnesium
4.	Structure	:	Laminated
5	Mode of Origin	:	Inorganic sedimentary deposits
6	Distribution in India	:	AP, Assam, Maharashtra
7	Engineering Properties & Uses	:	Compact and massive limestones may be used for construction
Result: Based on above physical properties the given specimen is identified as *LIMESTONE*			

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) colour bands appear.

5. Schistose structure

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

METAMORPHIC ROCK 1			
1.	Colour	:	Black or Grey
2.	Texture		
	A) Grain size	:	Fine grained
	B) Foliation / Lineation	:	Foliation
3.	Mineral Composition		
	a) Essential Minerals	:	Mica, quartz
	b) Accessory Minerals	:	Biotite, muscovite, talc, chlorite, feldspar, calcite, pyrite
4.	Structure	:	Schistos
5	Mode of Origin	:	Formed due to dynamic metamorphism of shale
6	Distribution in India	:	Rajasthan, A.P
7	Engineering Properties & Uses	:	These are not suitable for site as foundation rocks, but may be used as building stone.
Result: Based on above physical properties the given specimen is identified as *CHLORITE SCHIST.*			

METAMORPHIC ROCK 2			
1.	Colour	:	Reddish brown
2.	Texture		
	A) Grain size	:	Fine grained to medium grained
	B) Foliation / Lineation	:	Lineation
3.	Mineral Composition		
	a) Essential Minerals	:	Quartz
	b) Accessory Minerals	:	Mica, Garnet, Feldspar, Pyroxine, Chlorite, Magnetite
4.	Structure	:	Granular
5	Mode of Origin	:	Formed due to dynamo-thermal metamorphism of quartzite.
6	Distribution in India	:	Andhra Pradesh, Bihar, Delhi, Haryana, Karnataka, Kerala, Madhya Pradesh, Rajasthan, Tamil Nadu, Uttar Pradesh
7	Engineering Properties & Uses	:	These rocks are used as railway ballast and roadway metal.
Result: Based on above physical properties the given specimen is identified as *QUARTZITE.*			

METAMORPHIC ROCK 3			
1.	Colour	:	White or milky white
2.	Texture		
	A) Grain size	:	Fine grained to medium grained
	B) Foliation / Lineation	:	Lineation
3.	Mineral Composition		
	a) Essential Minerals	:	Calcite
	b) Accessory Minerals	:	serpentine
4.	Structure	:	Granular
5	Mode of Origin	:	Formed due thermal metamorphism of LimeStone.
6	Distribution in India	:	Rajasthan, Gujarat
7	Engineering Properties & Uses	:	These rocks are used as decorative, face stone, statues etc.
Result: Based on above physical properties the given specimen is identified as *MARBLE.*			

METAMORPHIC ROCK 4			
1.	Colour	:	White , Grey
2.	Texture		
	C) Grain size	:	Coarse grained
	D) Foliation / Lineation	:	Both
3.	Mineral Composition		
	c) Essential Minerals	:	Feldspar, Quartz
	d) Accessory Minerals	:	Hornblende, Mica, Talc, Pyroxenes, Kyanite, Garnet
4.	Structure	:	Equigranular
5	Mode of Origin	:	Formed due dynamo-thermal metamorphism of Granite.
6	Distribution in India	:	Rajasthan, A.P, Karnataka
7	Engineering Properties & Uses	:	As building stone, Road metal and railway ballast.
Result: Based on above physical properties the given specimen is identified as *GNEISS.*			

METAMORPHIC ROCK 5			
1.	Colour	:	Black/Grey
2.	Texture		
	E) Grain size	:	Fine grained
	F) Foliation / Lineation	:	Foliation
3.	Mineral Composition		
	e) Essential Minerals	:	Mica, Quartz
	f) Accessory Minerals	:	Biotite, Muscovite, Talc, Chlorite, Feldspar, Calcite, Pyrite
4.	Structure	:	-
5	Mode of Origin	:	Formed due dynamic metamorphism of shale.
6	Distribution in India	:	Rajasthan, A.P, Karnataka
7	Engineering Properties & Uses	:	As building stone. But not as foundation rock.
Result: Based on above physical properties the given specimen is identified as *SLATE.*			

GEOLOGICAL MAPS

INTERPRETATION AND DRAWING OF SECTIONS FOR GEOLOGICAL MAPS SHOWING TITLED BEDS, FAULTS, UNIFORMITIES, ETC.

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, 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.

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, litho logy, structure and geological history.

Interpretation of Topography

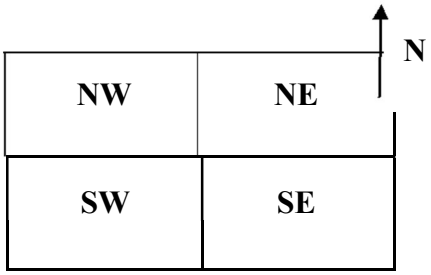
From the study of contour the information noted is about

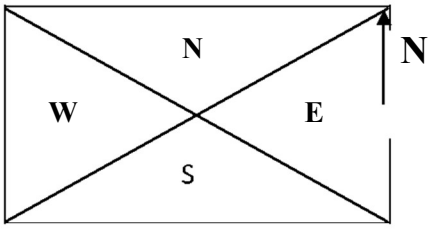
1. Maximum height, Minimum height, Surface relief

2. Number of Hills, Valleys, ridges, etc

3. Nature of slope, whether it is uniform or irregular and steep or gentle Relevant details

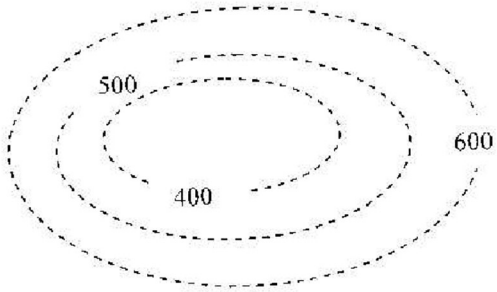
1. **Area in the map indicated as below**



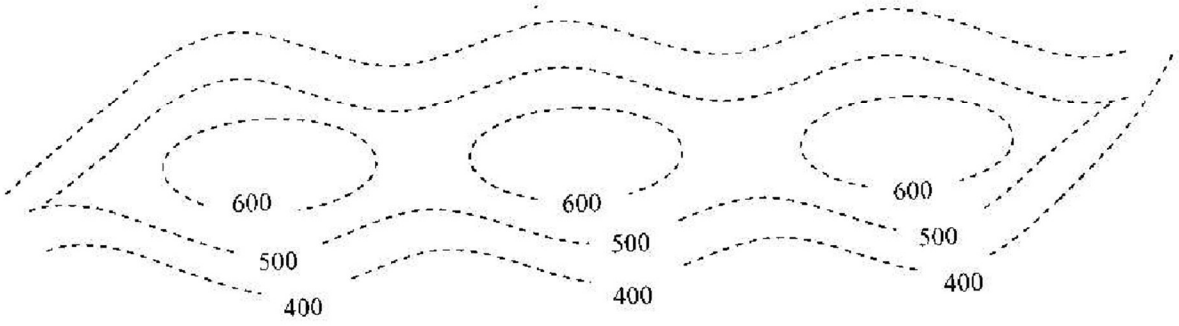


2. Hills or Hill ranges

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



Hill



Hill Range

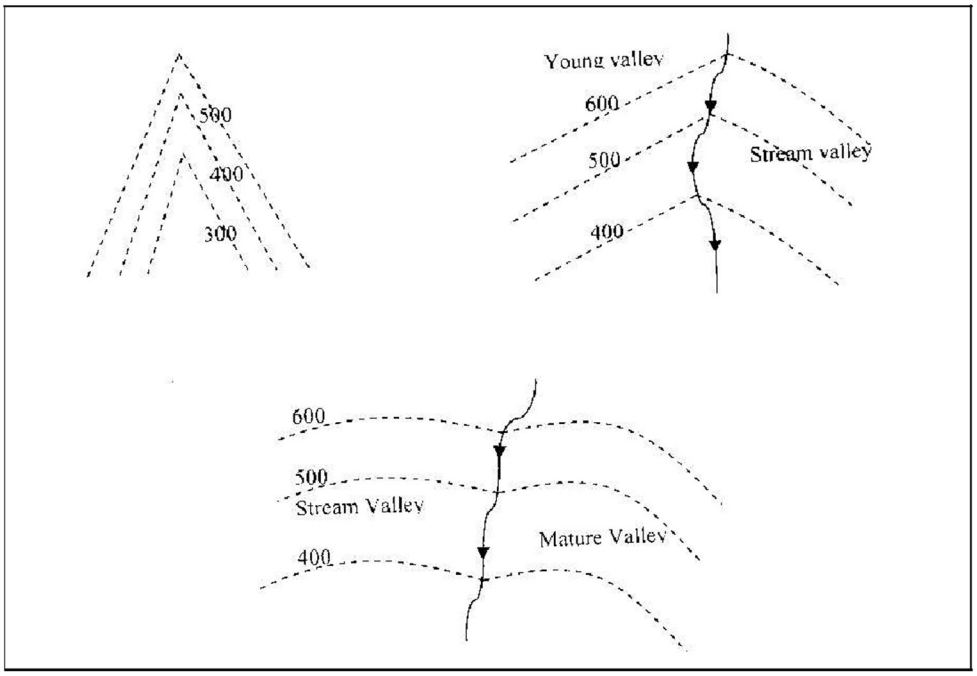
3. (a) Maximum height is the elevation which is more than the highest contour marked in the map.

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

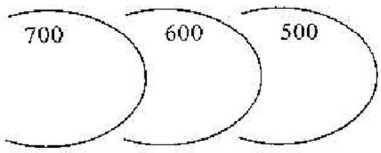
(c) Surface relief is the difference between the maximum height and the minimum height.

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 valley development**
- Young valleys have sharply contours but mature valleys have bluntly curve **contours**

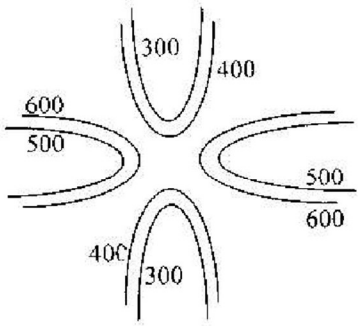


(b) Ridges: These resemble valleys but in these towards the convex side of the contours, successively lower elevations appear.



Ridges

(c) Saddle like structures:



Saddle like structure

SIMPLE STRUCTURAL GEOLOGY PROBLEMS

1. **Problem:**
   The width of an outcrop of shale formation measured in east-west direction is 750m. The straight direction of shale. Formation is North-South dipping with an angle 25º towards East. Determine true and vertical thickness of formation**.**

Aim : To determine true and vertical thickness of the shale formation.
Objective(s): After solving the problem the student should be able to
1) Determine the true thickness of formation
2) Determine the vertical thickness of formation

Material : Set squares, Protractor, scale, Pencil.
Method :

i) **Assume scale as 1cm=100m**
ii) **Draw a horizontal line AB which represents the East-West direction.**
iii) **Draw one more vertical line on AB line and note it as OP which represents the North-South direction.**
iv) **Take point "C" on line AB with a distance 7.5 cm from 1cm away from point A, make a point and note it as "D". CD is the width of outcrop**
v) **From point "C" draw a line CE at an angle of 25º with respect to line AB towards east direction.**
vi) **From the point D draw line parallel to CE**
vii) **Draw a line DI from point D at right angles to the horizontal line to get the vertical thickness and formation.**
viii) **Draw a perpendicular line GH from line DF to CE, this is the true thickness of formation.**

Result : True thickness of formation = 310m
Vertical thickness of formation=350m

2. **Problem:**
   The width of an outcrop of a rock formation dipping towards east 200m on ground level. Its vertical thickness is 350m. Determine the amount of its dip and also find true thickness of formation.

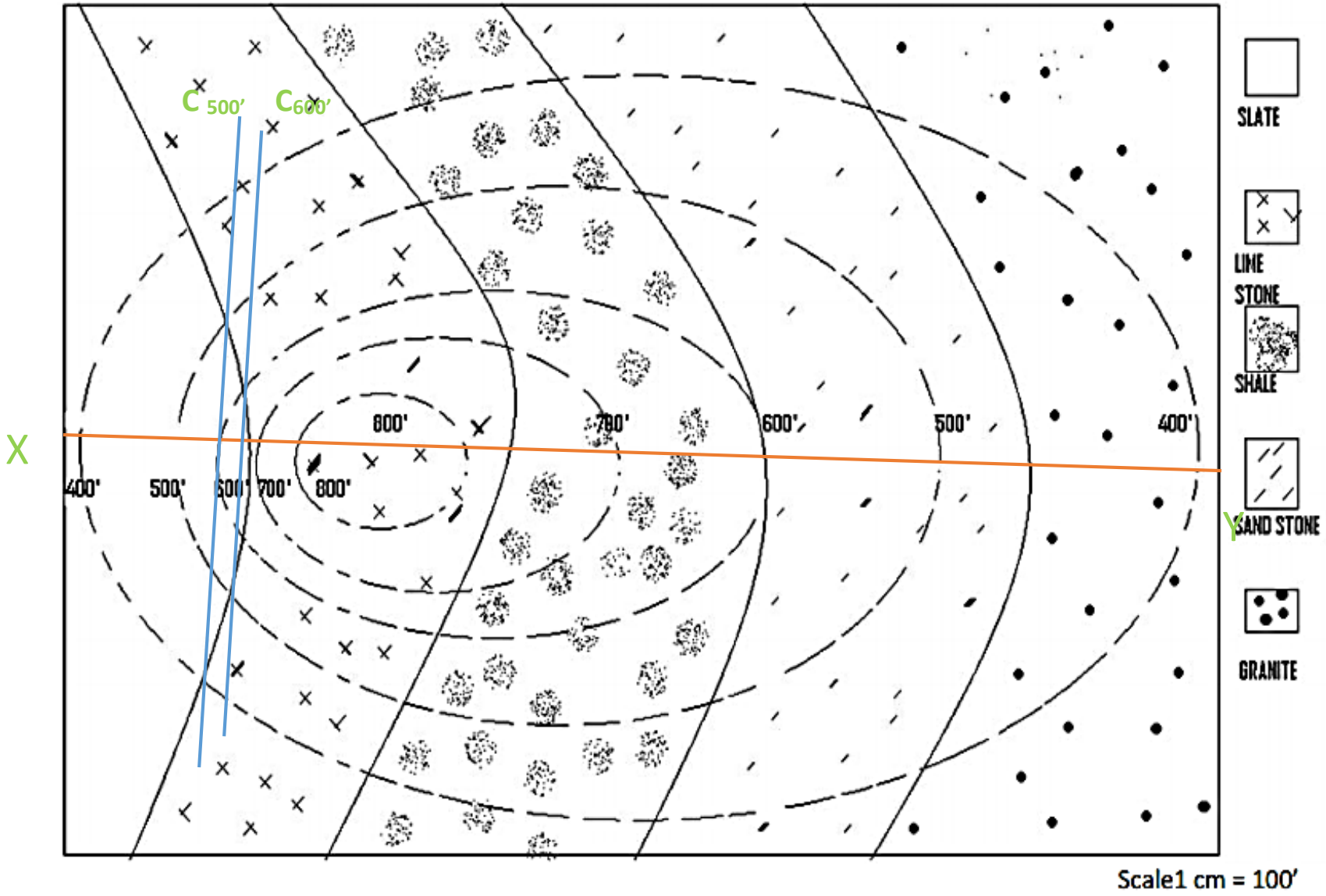
Aim : To determine the dip amount and true thickness of formation.
Objective(s): After solving the problem the student should be able to
3) Determine the true thickness of formation
4) Determine the dip amount of formation

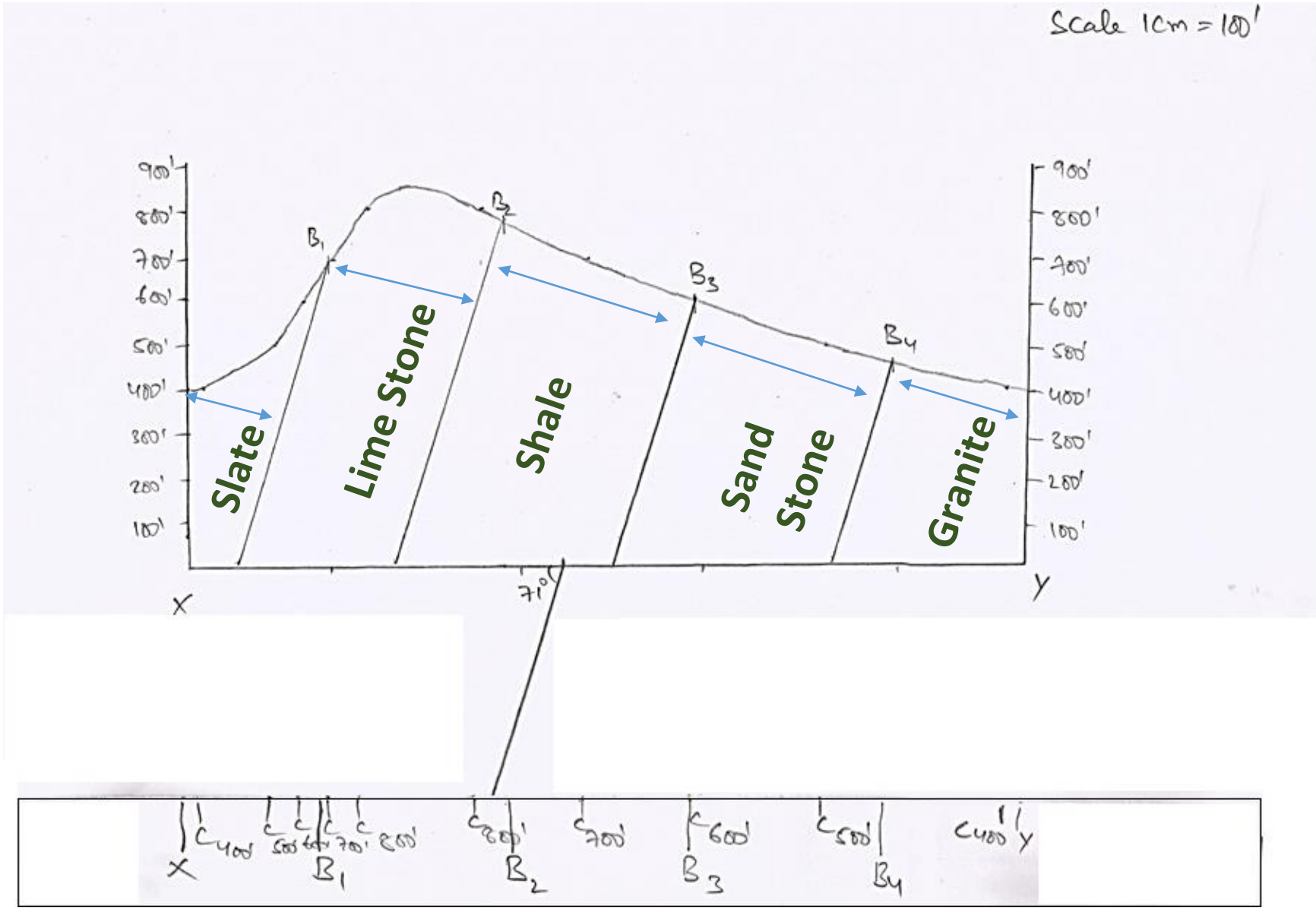
Method :

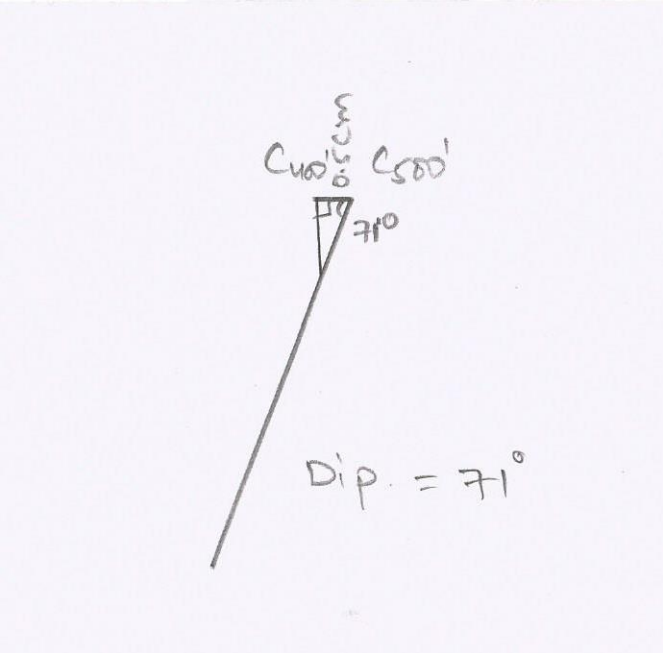
i) **Assume scale as 1cm=100m**
ii) **Draw a horizontal line AB which represents ground level and East-West direction.**
iii) **Draw a vertical line OP on line AB which represents North-South direction.**
iv) **Take a point "C" on line AB, 1 cm away from "C", from point C measure the out crop as 2cm and mark the point as D. now line CD is the width of outcrop.**
v) **From point D, draw a perpendicular line with a distance of 3.5cm, mark a point and note it as E.**
vi) **Join the point C and E with a line CE, representing the bottom of bed.**
vii) **Draw a line DG parallel to CE, line DG is the top of bed.**
viii) **Draw a perpendicular line HI on CG line and extend towards DG line. This HI is the true thickness of the formation.**
ix) **Measure the angle DCE or BDG, this angle give the dip amount of the bed.**

Result : True thickness of formation =
Dip angle of rock =

Q. Draw a neat cross-section of given map and write a brief description?

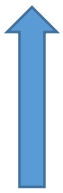



Scale 1cm = 100'
Slate
Lime Stone
Shale
Sand Stone
Granite
B1
B2
B3
B4
X
Y
71°



Map Interpretation

Order of Superpostion:



Slate
Lime Stone
Shale
Sand Stone
Granite

Thickness of beds:

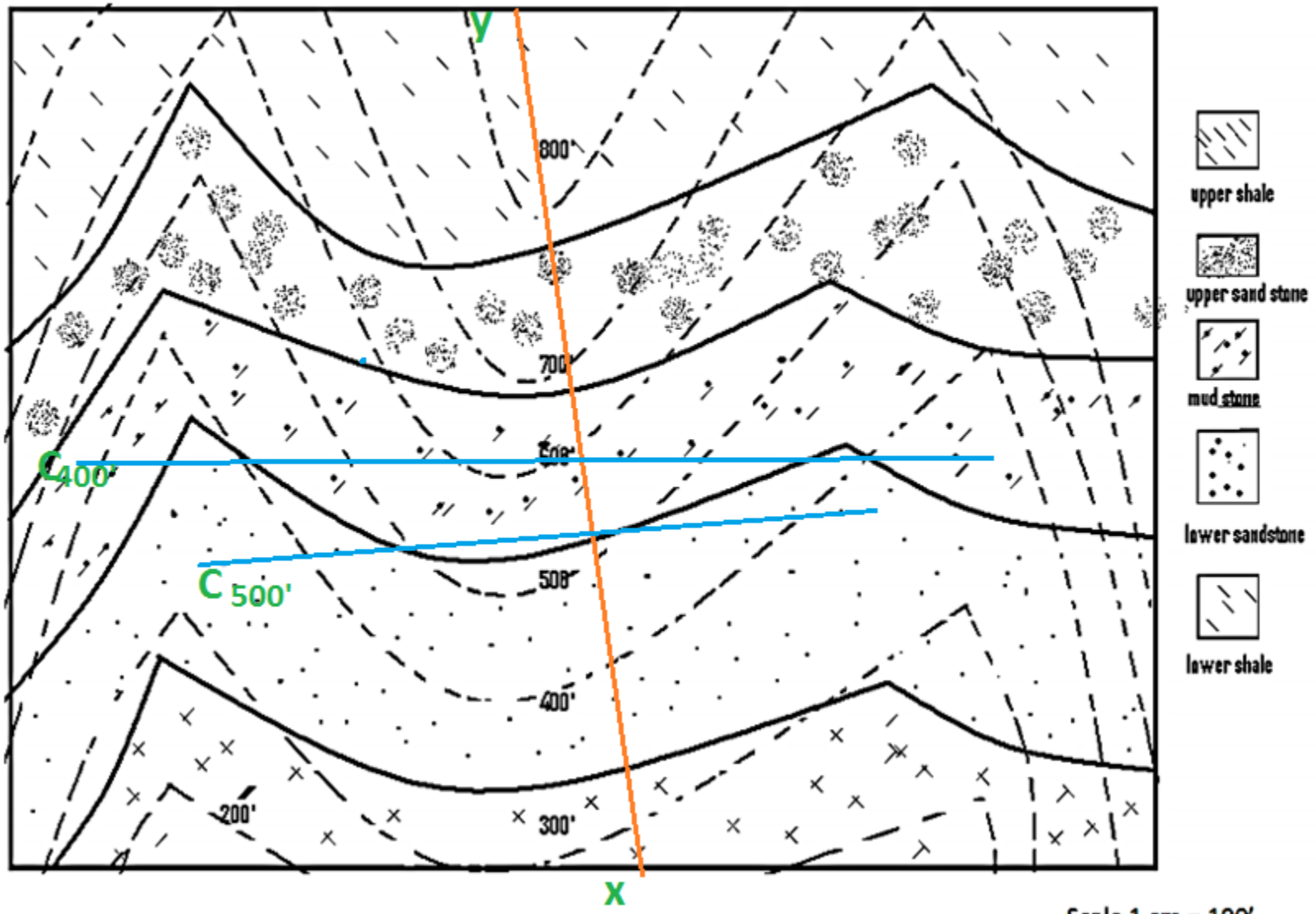
Slate	: Approximately 2.2 cms	= 220'
Lime Stone	: 3.5 cms	= 350'
Shale	: 4.7 cms	= 470'
Sand Stone	: 4.7 cms	= 470'
Granite	: Approximately 4 cms	= 400'

Dip: The beds are dipping toward X-direction with the angle of 71^0

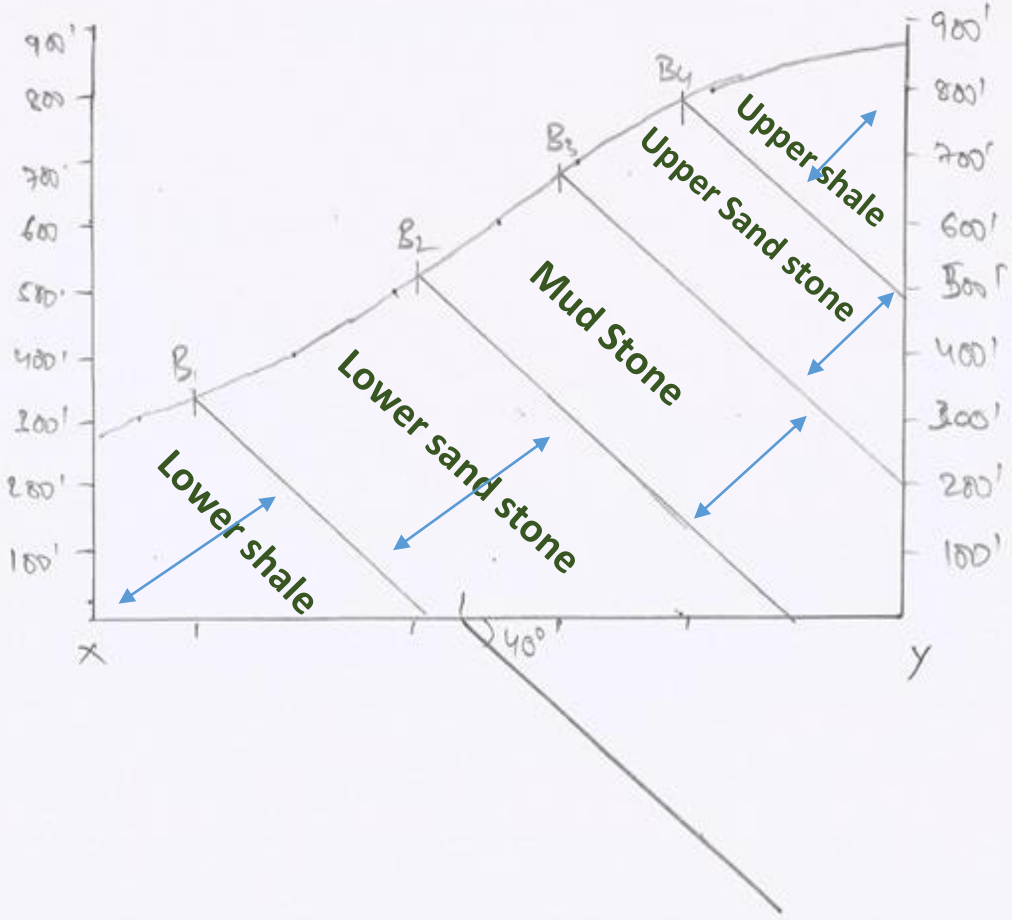
Structure: The given map is showing simple bedding structure where the beds are dipping towards X-Direction.

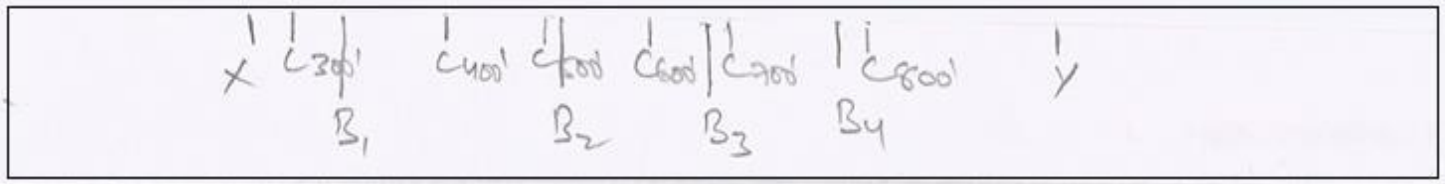
Elevation: Highest Contour is 800' towards X-direction and Lowest Contour is 400'

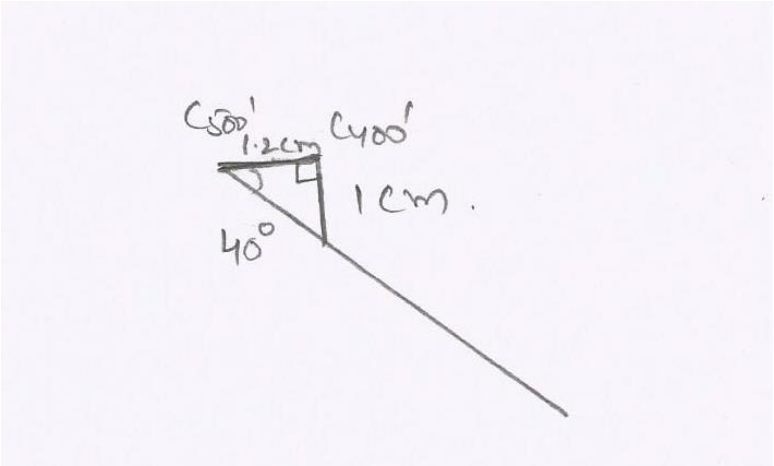
Q. Draw a neat cross-section of given map and write a brief description?



Scale 1 cm = 100'

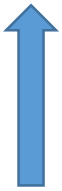

Scale 1cm = 100'
900'
800'
700'
600'
500'
400'
300'
200'
100'
B1
B2
B3
B4
Upper shale
Upper Sand stone
Mud Stone
Lower sand stone
Lower shale
40°
X
Y


X
300'
400'
600'
700'
800'
Y
B1
B2
B3
B4



Map Interpretation

Order of Superposition:



Upper shale
Upper Sand Stone
Mud Stone
Lower Sand Stone
Lower Shale

Thickness of beds:

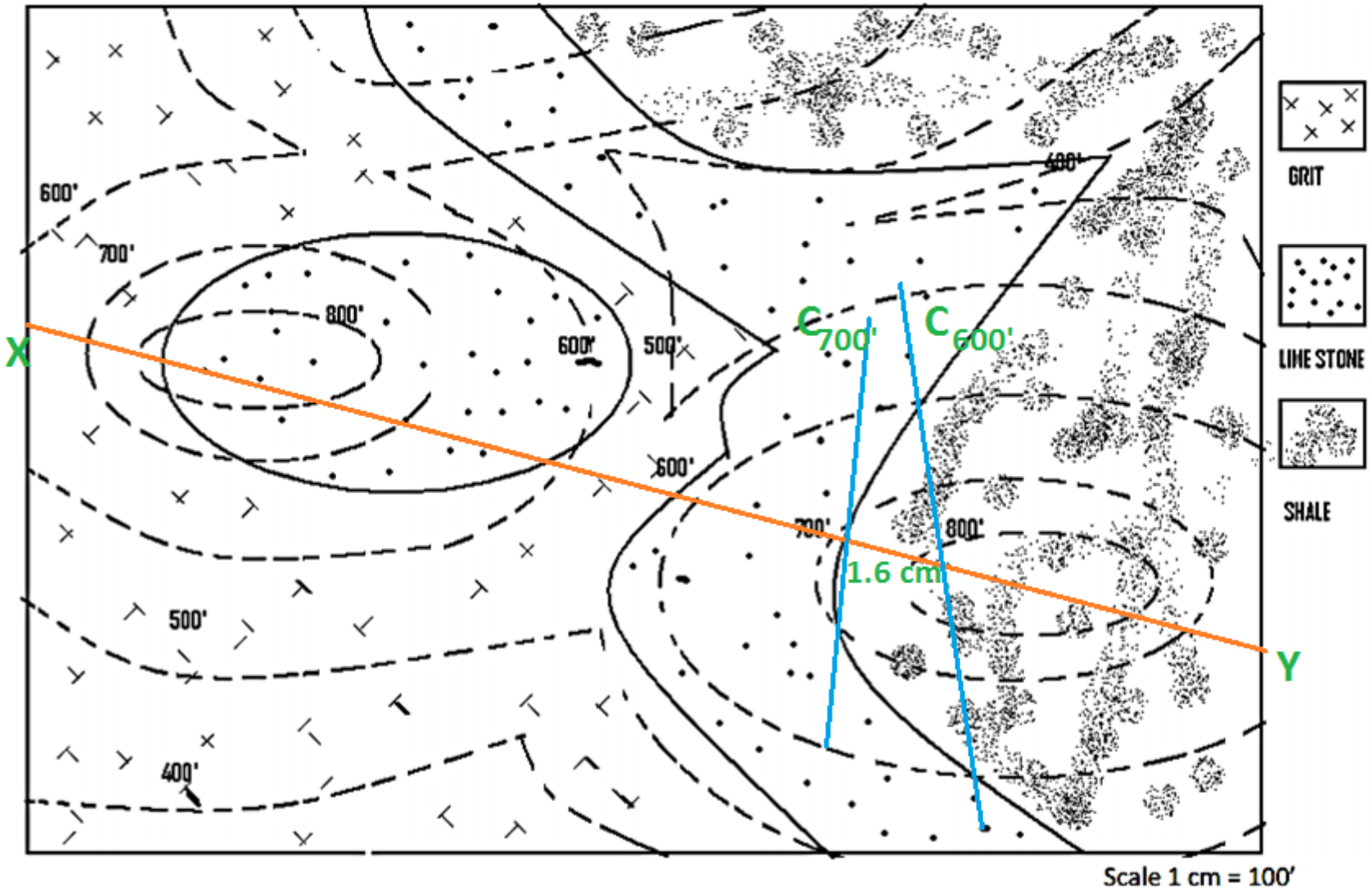
Upper Shale	: Approximately 3 cms	= 300'
Upper Sand Stone	: 2.2 cms	= 220'
Mud Stone	: 2.7 cms	= 270'
Lower Sand Stone	: 3.8 cms	= 380'
Lower Shale	: Approximately 3.6 cms	= 360'

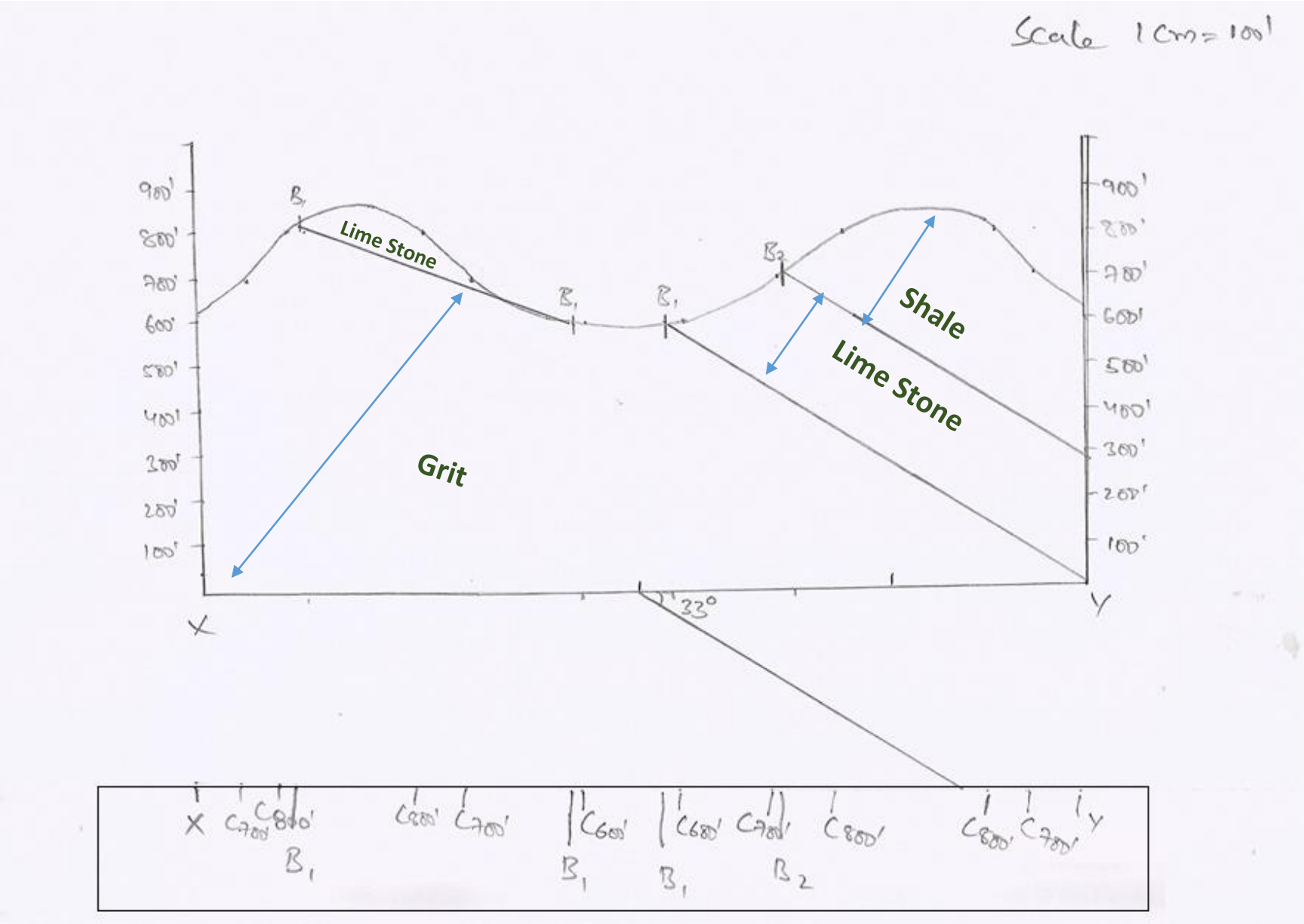
Dip: The beds are dipping toward Y-direction with the angle of 40^0

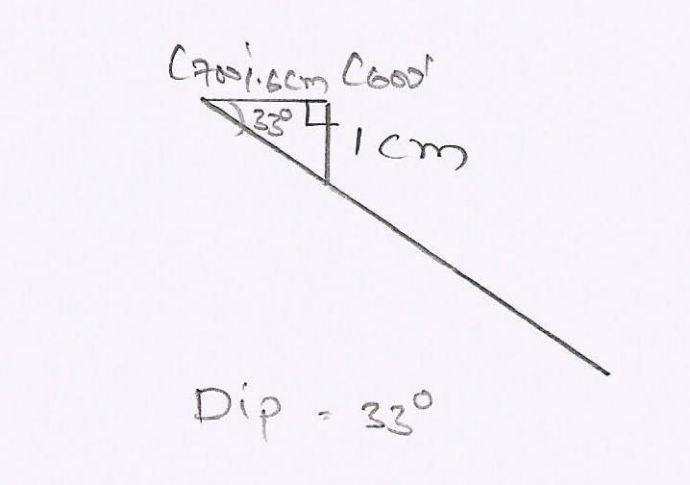
Structure: The given map is showing simple bedding structure where the beds are dipping towards Y-Direction. The repetition of rock indicated that the beds rocks are overturned.

Elevation: Highest Contour is 800' towards Y-direction and Lowest Contour is 300' towards X-direction.

Q. Draw a neat cross-section of given map and write a brief description?

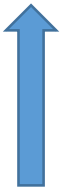



Scale 1 Cm = 100'
Lime Stone
Grit
Shale
Lime Stone
33°
X
Y
B1
B2



Map Interpretation

Order of Superposition:



Shale
Lime Stone
Grit

Thickness of beds:

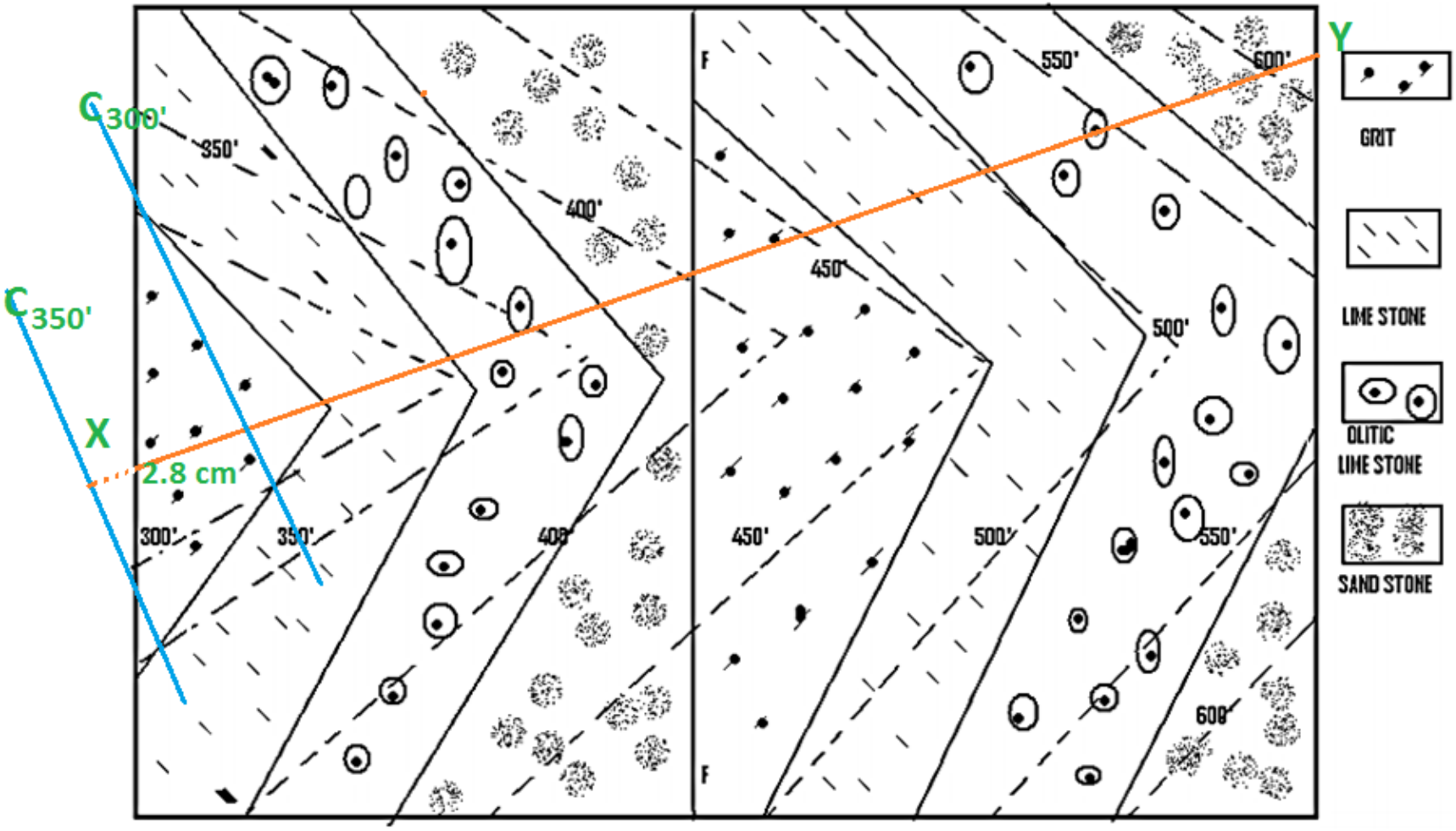
Shale	: Approximately 3.4 cms	= 340'
Lime Stone	: 2.3 cms	= 230'
Grit	: Approximately 8 cms	= 800'

Dip: The beds are dipping toward Y-direction with the angle of 33^0

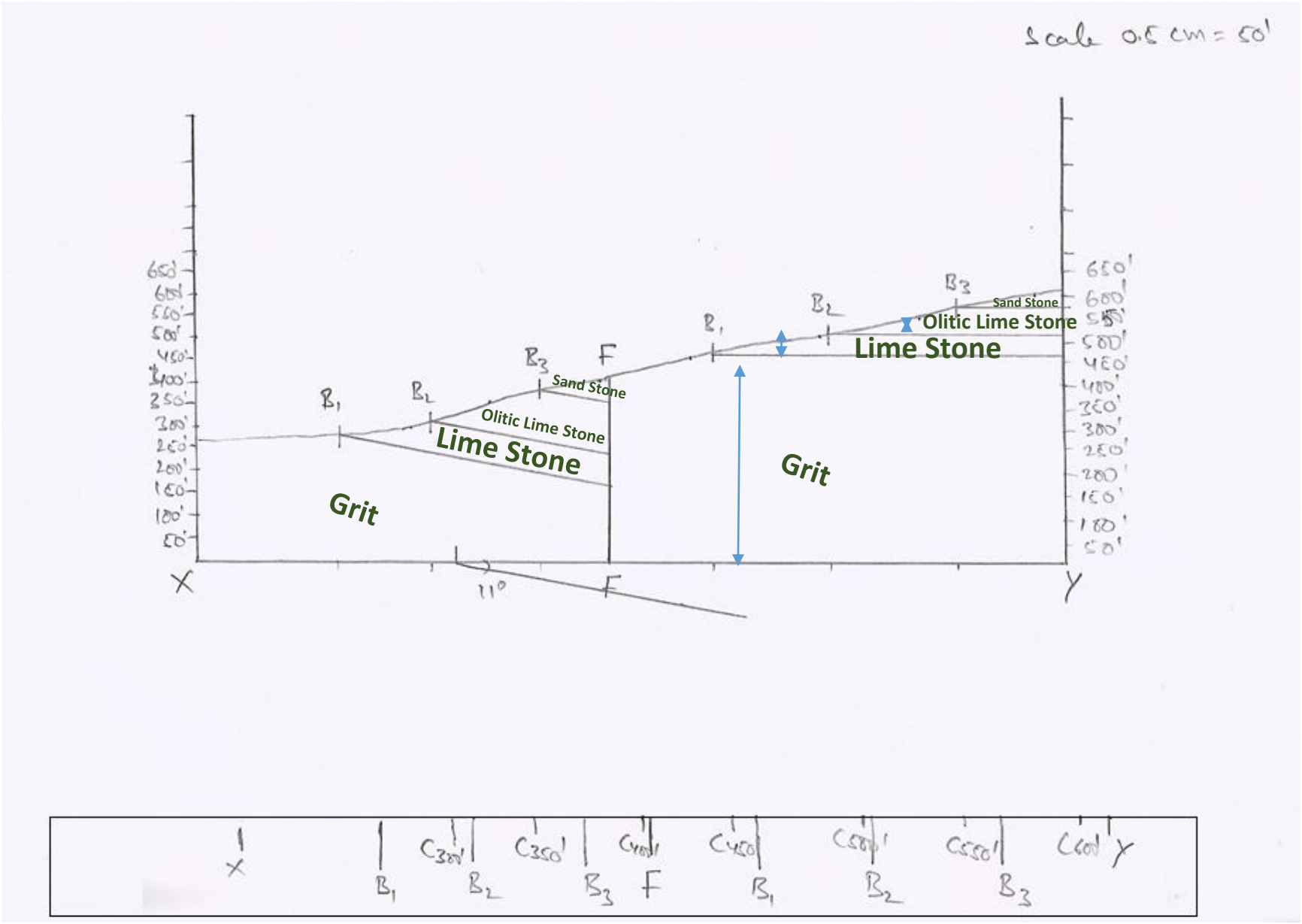
Structure: The given map is showing simple bedding structure where the beds are dipping towards Y-Direction. The repetition of rock indicated that the beds rocks are overturned.

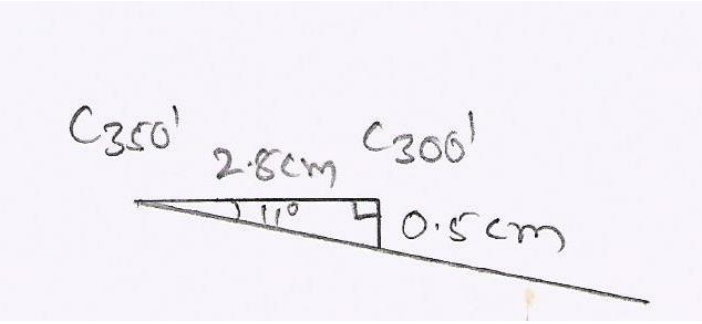
Elevation: Highest Contour is 800' towards Y-direction and X-Directions, Lowest Contour is 600' in center of profile.

Q. Draw a neat cross-section of given map and write a brief description?



Scale 0.5 cm = 50'


Scale 0.5 cm = 50'
650'
600'
550'
500'
450'
400'
350'
300'
250'
200'
150'
100'
50'
X
Y
F
11°
B1
B2
B3
Sand Stone
Olitic Lime Stone
Lime Stone
Grit
C300'
C350'
C400'
C450'
C500'
C550'
C600'



Map Interpretation

Order of Superposition:

Sand Stone
Olitic Lime Stone
Lime Stone
Grit

Thickness of beds:

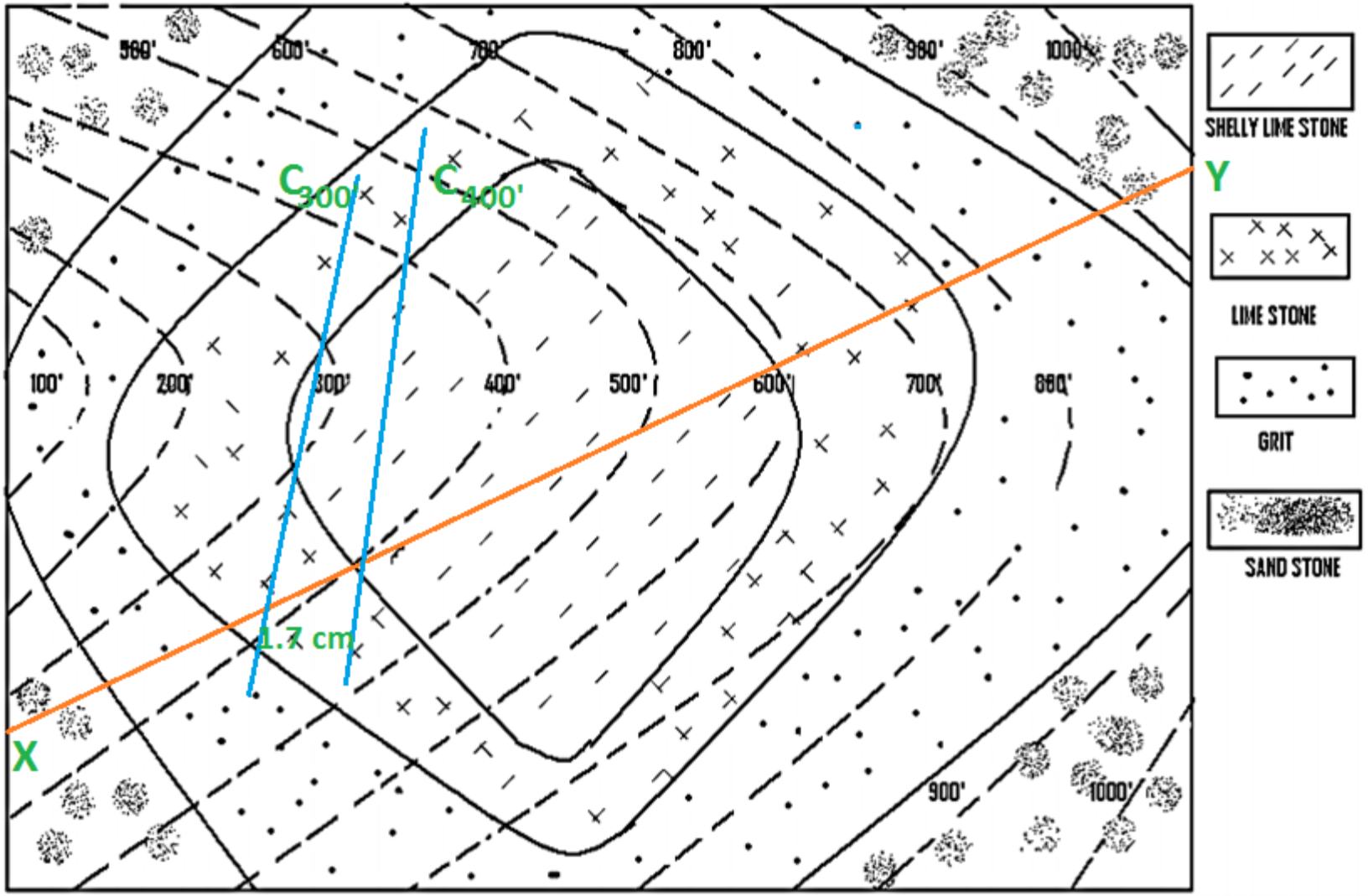
Sand Stone	: Approximately 0.3 cms	= 30'
Olitic Lime Stone	: 0.6 cms	= 60'
Lime Stone	: 0.5 cms	= 50'
Grit	: Approximately 4.6 cms	= 460'

Dip: The beds are dipping toward Y-direction with the angle of 11^0 at left side and 0^0 at right side of the profile section.

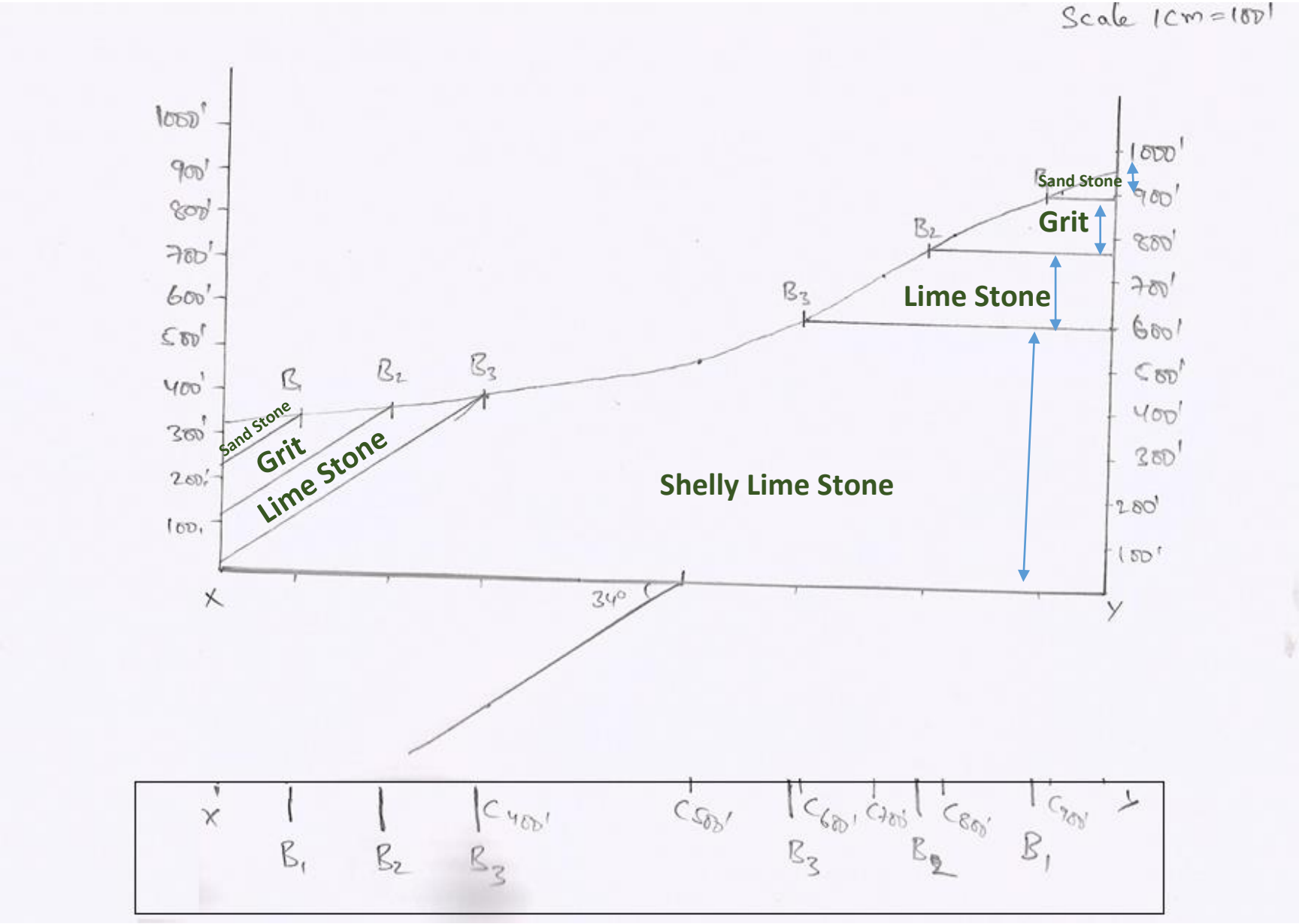
Structure: The given map is showing Faulted structure followed bedding structure where the beds are dipping towards Y-Direction.

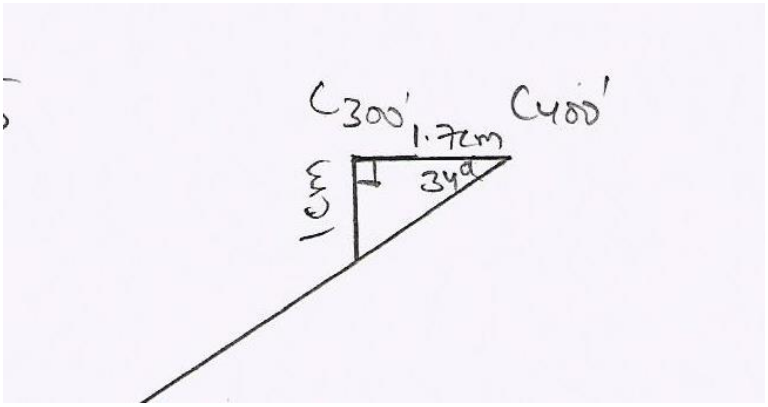
Elevation: Highest Contour is 650' towards Y-direction and Lowest Contour is 300' towards X-direction.

Q. Draw a neat cross-section of given map and write a brief description?



Scale 1 cm = 100'


Scale 1cm = 100'
1000'
900'
800'
700'
600'
500'
400'
300'
200'
100'
B
B2
B3
Sand Stone
Grit
Lime Stone
Shelly Lime Stone
X
Y
34°
C400'
C500'
C600'
C700'
C800'
C900'
C1000'



Map Interpretation

Order of Superposition:

Sand Stone
Grit
Lime stone
Shelly Lime Stone

Thickness of beds:

Sand Stone	: Approximately 0.6 cms	= 60'
Grit	: 1.2 cms	= 120'
Lime Stone	: 1.7 cms	= 170'
Shelly Lime Stone	: Approximately 6 cms	= 600'

Dip: The beds are dipping toward X-direction with the angle of 34^0 at left side and 0^0 at right side of the profile section.

Structure: The given map is showing Folding structure followed bedding structure where the beds are dipping towards Y-Direction.

Elevation: Highest Contour is 900' towards Y-direction and Lowest Contour is 400' towards X-direction.