VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELGAUM

ENGINEERING GEOLOGY

(Subject Code: BCV303)

LECTURE NOTES

(MODULE-2)

III-SEMESTER

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MODULE- 2
INTRODUCTION AND MINEROLOGY

Minerals -Industrial, rock forming and ore minerals. Physical properties, composition and uses Rocks as a construction materials- physical properties, texture, composition, applications for aggregate, decorative (facing/polishing), railway ballast, rocks for masonry work, monumental/architecture, rocks as aquifers, water bearing properties igneous, sedimentary

MINERALOGY

Minerals - have been defined as naturally occurring substances, mostly in organic, that are characterized by a definite chemical composition and a definite atomic structure. Since Rock make up the earth is simply natural aggregates of minerals, a study of Minerals are of fundamental importance understands the elements of science of geology. The branch of geology dealing with the study of minerals is designated as **Mineralogy.**

Each mineral is generally characterized with a set of qualities some of which are always distinctive and differentiate it from other minerals. Some of these qualities or properties may be studied from the body of the minerals, its shape, color, shine, hardness etc. these are termed physical properties. Some other qualities like the behavior towards light require externally thin sheet or section of the mineral and are best studied with the help of a microscope. These are termed optical or microscopic properties. A third group of properties involving.

These are the physical properties most useful for mineral identification:

Habit

A mineral may sometimes show a definite and characteristic arrangement in its outer appearance or physical shape. This shape is expressed by the term Habit and is typical in the case of many minerals. A few common habits with examples are given below.

Fibrous habit – when the mineral is made up of fibers, generally separable, e.g. in Asbestos.

Columnar habit:- When the mineral is composed of thin or thick columns, sometimes flattened, e.g. in Hornblende.

Bladed habit:- The minerals appears as if composed of thin, blade like structure, e.g. in Kyanite.

Lamellar habit: - The plates or leaves are separable, e.g. Vermiculite.

Granular habit: - The mineral shows numerous grains packed together, e.g. in Chromite.

Acicular habit:- When a mineral surface is covered by large, conspicuous, overlapping prominences, e.g. in Malachite.

Mammillary habit :- when a mineral surface is covered by large, conspicuous overlapping prominences, e.g. in malachite.

Reniform habit:- The rounded prominences exhibit a resemblance to a kidney shape, e.g. in Hematite.

Foliated habit: -When the mineral consists of thin and separable leaves, e.g. in Mica.

Radiating habit:-When the fibers or needles are arranged around a central point, e.g. in Iron Pyrites.

Tabular habit: -The mineral is flat and elongated e.g. in Calcite, Orthoclase.

Globular habit: - or botryoidally, when the minerals is in the form of bulbous overlapping projections, e.g. in hematite.

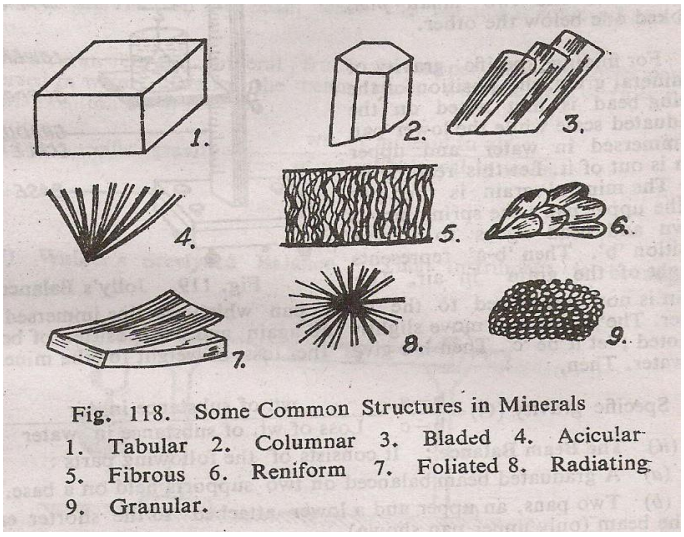

Fig. 118. Some Common Structures in Minerals
1. Tabular 2. Columnar 3. Bladed 4. Acicular
5. Fibrous 6. Reniform 7. Foliated 8. Radiating
9. Granular.

Fig; Common Structure of Minerals

Colour

Minerals show great variety of colors. The color of a substance is its appearance in light and depends upon the composition and structure of the substance is its appearance in light and depends upon the composition and structure of the substance. In minerals, colors may be either of inherent of an exotic nature, the former is related to the chemical composition and is more diagnostic where as exotic colors are due to small traces of impurities and may vary within wide limits. Metallic minerals commonly show greater consistency in color than the

non-metallic minerals

Some minerals show peculiar phenomena connected with color. of these, the following are interesting and important.

Play of Colors:- It is the development of a series of prismatic colours shown by some minerals on turning about in light. The colors change in rapid succession on rotation, example: Diamond.

Change of colours:- it is similar to play of colours except that rate of change of colours on rotation is rather slow, each colour continues over a larger space in the mineral, e.g. labradorite.

Iridescence: - some minerals show rainbow colours either in their interior or on their surface. This are termed as Iridescence.

Tarnish: - sometimes the surface colour is different, rather dull, than the colour of the mineral as seen on f freshly fractured surface, e.g. chalcopyrite, an ore of copper.

Streak

The streak of a mineral is the color of its powder. This becomes important in the sense that for some minerals, the color is entirely different from that of their powder. This has been found true in certain or minerals, while most of the other minerals exhibit a white streak and, streak does not help in distinguishing those minerals. The important minerals offering characteristic color-streak combinations are given in table.

Some minerals with their characteristic color-streak combinations

Mineral Name	Original Color	Streak Color
Pyrite	Brass-Yellow	Greenish Black
Chromite	Greenish-Black	Greenish Brown
Hematie	Black	Cherry red

The streak of mineral can be readily observed by scratching it on a streak plate, which is made up of unglazed porcelain or roughened glass. While determining streak for a mineral, care should be taken to scratch it from its obscure part, and to give only small scratch, producing a small quantity of its powder.

Luster

The shining surface of a mineral is called as luster. The different types of luster and their

examples are given in a tabular column.

Sl.No..	Type Of Luster	Description	Example
1	Vitereous Luster	A mineral having a glassy shine	Quartz and Calcite
2	Pearly Luster	A mineral having a pearly shine	Muscovite Mica
3	Metallic Luster	A mineral having a metallic shine	Magnetite
4	Silky Luster	A mineral having a silky shine	Asbestos
5	Resinous Luster	A mineral having a greasy, oil shine	Talc
6	Adamantine Luster	A mineral having a diamond like shine	Diamond

Diaphaneity

Diaphaneity of a mineral may be defined as its capability to pass light through it .Hence, if an object can be seen fully and easily through a mineral, it may be called as diaphaneity. Depending upon the extent to which light can pass through a mineral, they may be classified as follows.

Type of Transparenc	Description	Example
Transparent	Mineral which allows the light to pass fully, and objects on Other sides are seen clearly Through the mineral.	Quart, Calcite
Translucent	A mineral which allows only some diffused light to pass through edges.	Jasper
Opaque	A mineral which does not pass any light and hence through which nothing can be seen.	Orthoclase, Hornblende

Fracture

The fracture of a mineral may be defined as the appearance of its broken surface, when the mineral is hammered and broken. It is a characteristics feature of certain mineral which help us their identification. The different types of fracture seen in various minerals are:

Type of Fracture	Description	Example
Even Fracture	When the broken surfaces of a mineral are smooth	Chert
Uneven Fracture	When the mineral breaks with very rough and coarse surface	Chromite

Conchoidal Fracture	When a mineral breaks with curved surfaces. Infact, there will be concentric grooves and ridges resembling with the concentric lines of growth on a shell (Conch)	Quartzite
Hackly Fracture	When a mineral breaks with irregular surfaces having sharp edges	Copper
Earthy Fracture	When a broken surface is soft and almost smooth	Chalk

Hardness

Hardness is another property of a mineral, which can be used as a handy tool in the field, to differentiate between the different minerals or to recognize particular minerals.
hardness of the mineral may be defined as the resistance, which the mineral offer to scratch.

This property of a mineral is generally determined by scratching a given mineral with a mineral of known hardness, so as to obtain the comparative figure for the hardness of the given mineral. Thus for example, if a given mineral gets scratched by a mineral or metal of hardness say 6, but does not gets cratched by that of hardness 5, then evidently we can conclude that the hardness of a given mineral lies between 5 and 6. Moreover, the intensity of scratch procured, will help us to judge whether the hardness determined is nearer to 5 or to 6. The hardness of mineral is generally expressed on **mohs scale of hardness,** which incorporate ten minerals assigned with standard hardness.

Table : Showing Hardness Number of Minerals

Mineral	Hardness	
Talc	1	can be scratch even by finger nail
Gypsum	2	can be scratch even by finger nail
Calcite	3	can be scratch even by finger nail
Fluorite	4	can be scratch by pen or knife
Apatite	5	can be scratch by pen or knife
Orthoclase	6	can be scratch by pen or knife
Quartz	7	cannot be scratch by pen or knife
Topaz	8	cannot be scratch by pen or knife
Corundum	9	cannot be scratch by pen or knife
Diamond	10	it can be scratch by another diamond

Miscellaneous

Besides the above properties, minerals may show some specific and rare qualities that often become helpful in their identification. some of these special properties are explained below:

Magnetism: -Some minerals have natural magnetism in them to an Appreciable Extent. Example

is magnetite.

Electricity:- In some minerals heating may develop an electric charge. These are called pyro electric minerals. Examples quartz.

Fluorescence: - A few minerals have the property of glowing or emitting light when they are exposed radiation. This property Is called Fluorescence and mineral. Fluorite shows this Property.

Fusibility: - Minerals behave differently on heating to elevated temperature. Some Melt easily at lower temperatures where as other require very high Temperature.

Classifications of minerals

1. **Silicate minerals (Rock forming minerals)**
   i. Quartz minerals
   ii. Feldspar mineral
   iii. Mica mineral
   iv. Amphibole mineral
   v. Garnet mineral

2. **Non-Silicate minerals (Rock forming minerals)**
   i. Carbonate group
   Ex. Calcite, Dolomite, Magnesite

3. **Non-Silicate minerals (Ore forming minerals)**
   i. Sulphide group. Ex. Galena, Pyrite, Chalcopyrite
   ii. Oxide group. Ex. Hematite, Magnetite, Bauxite, Corundum
   iii. Sulphate group. Ex. Gypsum, Barytes

PHYSICAL PROPERTIES OF MINERALS

Name ↓ / Physical Properties	Quartz Group	Feldspar Group		
		Orthoclase	Microclase	Plagioclase
Form	Massive / granular	Tabular	Tabular / massive	Tabular / massive
Colour	Variable	Pink	White / greenish	White / grayish
Streak	Colourless	Colourless	Colourless	Colourless
Luster	Vitreous	Vitreous	Vitreous	Vitreous
Cleavage	Absent	Perfect	Perfect	Perfect
Fracture	Conchoidal to uneven	Uneven	Uneven	Uneven
Hardness	7 (high)	6	6 - 6.5	6
Diaphenity	Transparent to opaqaue	Translucent to opaque	Translucent to opaque	Translucent to opaque
Sp Gravity	2.7 (low to medium)	2.6	2.6	2.6
Composition	SiO_2, Silicon oxide	$KAlSi_3O_8$	$KAlSi_3O_8$	$NaCaAlSio_2$
Occurrence	Ig, sed. and Met. Rocks, **RFM**	Acid igneous rock, granite and pegmatite, **RFM**		
Uses	Glass making, abrasive cloth, flux, electronic industry, radio circuits, refractories, agates are used as ornaments ceramics and papers	Sanitary ware, Earthenware, porcelain items, glazed tiles, flux enamel, binders		

Name	Mica Group		Amphibole Group		Garnet group
Physical Properties	**Biotite**	**Muscovite**	**Hornblende**	**Asbestos**	**Garnet**
Form	Flaky	Flaky	Crystal tabular	Fibrous/massive	Crystal
Colour	Black	Colourless	Green / brown	Greenish/white	Red, Brown
Streak	White	White	White	White	Colourless
Luster	Vitreous	Vitreous	Vitreous	Greasy/vitreous	Vitreous
Cleavage	Perfect	Perfect	Perfect	None	Imperfect/none
Fracture	Uneven	Uneven	Uneven	Uneven	Uneven
Hardness	2-3	2-3	5.5-6	3	6- 7.5
Diaphaneity	Translucent	Transparent	Translucent-opaque	Opaque	Translucent-opaque
Sp Gravity	2.5	2.5	3.0	2-3	3.5
Composition	KMgFeAlSi-OH	KAlSi-OH	Ca,Na,Mg,Fe,Al,Si – OH	MgSi – OH	Mg,Fe,Ca,Al,Si-O
Occurrence	Ig, Met rocks, **RFM**	Ig, Met rocks, **RFM**	Intrusive, Met. **RFM**	Ultra basic Ig, rocks	Met. rock
Uses	Electrcal Insulator, furnace window.	Electrical Insulator, furnace window,		Refractory, heat and fire resistant, cement, acid resistant	Gem stones, abrasives

Name	**Carbonates**			**Sulphates**	
Physical Properties	**Calcite**	**Dolomite**	**Magnesite**	**Gypsum**	**Baryte**
`Form	Crystal / rhomb	Crystal/massive	Massive	Crystal/fibrous	Crystal/tabular
Colour	Colourless / white	Black	white	White/yellowish	White/grey
Streak	White	White	White	White	White
Luster	Vitreous	Vitreous	Dull	Vitreous	Vitreous/perly
Cleavage	Perfect	Perfect	None	Perfect	Perfect
Fracture	Uneven	Uneven	Uneven	Uneven	Uneven
Hardness	**3**	3-4	3-4	1.5	3-3.5
Diaphaneity	Transparent	Opaque	Opaque	Opaque	Opaque
Sp Gravity	3	3	3	2.3	**4.5**
Composition	CaCO3	Ca,Mg(CO3)2	MgCO3	CaSO4 – 2H2O	BaSO4
Occurrence	Hydro thermal/ weathering, **RFM**	Hydro thermal/ weathering	Hydro thermal/ weathering,	Oxidation of sulphides	Hydro thermal/ weathering,
Uses	Optics, building material (reacts with dil. acid)	building material, cement	Refractory, building material	Cement, Metullargy	Metullary, x-ray exam,

Name	**Sulphide group**		
Physical Properties	**Gelena**	**Pyrite (fools gold)**	**Chalcopyrite**
Form	Crystal/granular	Crystal/granular	Massive/granular
Colour	Lead grey	Brass yellow	Yellow/dark yellow
Streak	Black	Black	Black
Luster	Metallic	Metallic	Metallic
Cleavage	Perfect	Indistinct	Imperfect
Fracture	Uneven	Uneven	uneven
Hardness	2 - 3	6	3
Diaphaneity	Opaque	Opaque	opaque
Sp Gravity	**7.5**	5	4.3
Composition	PbS	FeS_2	$CuFeS_2$
Occurrence	Hydro thermal	Weathering / hydro thermal	Weathering / hydro thermal
Uses	Ore of lead	Ore of iron	Ore of Copper and Iron

Name ↓ / Physical Properties	Oxide group			
	Hematite	**Magnetite**	**Bauxite**	**Corundum**
Form	Massive/granular	Massive/granular	Massive/cryptocry	Crystal/tabular
Colour	Black	Black	White/yellowish	Grey/blue/black
Streak	Cherry red	Black	White	None
Luster	Sub - metallic	Sub - metallic	Dull	Vitreous
Cleavage	None	None	None	Indistinct
Fracture	Uneven	Uneven	Uneven	Uneven
Hardness	5.5 - 6	5.5 - 6	3.5	9
Diaphaneity	Opaque	Opaque	Opaque	Opaque
Sp Gravity	5	5	3	4
Composition	Fe_2O_3	Fe_3O_4	$Al_2O_3 – H_2O$	Al_2O_3
Occurrence	Weathering hydro thermal	Magmatic, hydro thermal	Hydro thermal/ weathering	Pegmatite, Met. rocks
Uses	Iron ore, dye	Iron ore	Aluminum ore, refractory, paper making, dying, ceramics	Gem/ abrasive

DESCRIPTIVE MINERALOGY

Name / **Physical Properties**	**Olivine**	**Serpentine**	**Talc**	**Kaoline (china clay)**
Form	Granular/massive	Massive/fibrous	Massive	Earthy/granular
Colour	Olive green/ black	Green/yellow	Pale green/white	White/yellowish
Streak	colourless	White	White	White
Luster	Vitreous	Greasy	Perly/vitreous	Dull
Cleavage	Imperfect	None	None	None
Fracture	Uneven	Uneven	Uneven	Uneven
Hardness	6-7	3	**1**	1
Diaphaneity	Opaque	Opaque	Opaque	Opaque
Sp Gravity	3-4	2-3	2-3	2.5
Composition	MgFeSi – O	MgSi – OH	MgSi – OH	Al,Si-OH
Occurrence	Basic Ig. rocks, **RFM**	Ultra basic Ig, rocks	Ultra basic Ig, rocks	Weathered product of Ig, Met rock
Uses	Refractory, spark plug insulator, ornamental	Decorative, furnace repair	Fillers, paper, cosmetics, furnace lining, toilet powder	Ceramic, paper industry, pottery, bricks, pesticide

Name / **Physical Properties**	**Limonite**	**Pyrolsite**	**Chromite**
Form	Earthy/massive	Granular	Granular/ massive
Colour	Brown/yellowish	Black	Black
Streak	Reddish	Black	Brown
Luster	Dull	Sub metallic	Sub metallic
Cleavage	None	none	none
Fracture	Uneven	Uneven	Uneven
Hardness	4	5 - 6	5.5
Diaphaneity	Opaque	opaque	opaque
Sp Gravity	3	5	4.5
Composition	Fe_2O_3- H_2O	MnO_2	$FeCr2O_3$
Occurrence	Hydro thermal/ weathering	Hydro thermal	Weathering / hydro thermal
Uses	Iron ore, dye, filler	Ore of manganese, battery cells	Ore of Chromium, refractory