

# MINERALOGY

## Define Mineralogy

This deals with the study of **minerals**.

Mineralogy deals with the detailed mode of formation, composition, occurrence, types, association properties uses etc .



# MINERALOGY

## Define Minerals

A mineral is a **naturally-occurring, homogeneous, solid** with a definite, but generally not fixed, **chemical composition** and an **ordered atomic arrangement**. It is usually formed by inorganic processes.



# MINERALOGY

## Define Minerals

### 1. Natural

- occurs naturally
- NOT manmade

# MINERALOGY

## Define Minerals

1. Natural

**2.Homogeneous**

- Something that is the same throughout.
- Cannot be broken into simpler components

# MINERALOGY

## Define Minerals

1. Natural
2. Homogeneous
3. **Solid**
  - Minerals must be able to maintain a set shape nearly indefinitely
  - liquids are not minerals.

# **MINERALOGY**

## **Define Minerals**

1. Natural
2. Homogeneous
3. Solid

## **4. Chemical Composition**

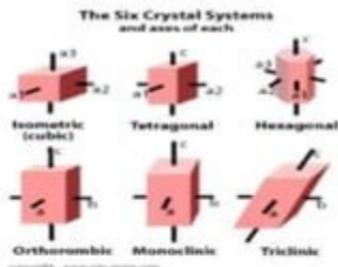
- A mineral can be described by a chemical formula
  - -Quartz: SiO<sub>2</sub>
  - -Biotite: K(Mg, Fe)<sub>3</sub> (AlSi<sub>3</sub>O<sub>10</sub>)(OH)<sub>2</sub>
  - -Diamond: C

# MINERALOGY

## Define Minerals

### 5. Orderly Arrangement of Atoms

- Minerals have a fixed atomic pattern that repeats itself over a large region relative to the size of atoms
- –Crystal solid, or crystal lattice: The organized structure of a mineral
- –A glass is not a mineral; no organized structure



# MINERALOGY

## Define Minerals

### 6. Generally Inorganic

- ***Organic:*** A substance composed of C bonded to H, with varying amounts of O, N and other elements. C, alone, is not organic!
- Only a few organic substances are considered minerals, all other minerals are inorganic

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## Mineral Identification

Since we can't all have x-ray diffraction machines and electron microscopes, we identify minerals by visual and chemical properties called ***physical properties***.

# **MINERALOGY**

## **Mineral Identification**

### **Physical Properties of Minerals**

1. Forms and Habits
2. Colour
3. Streak
4. Lustre
5. Fracture
6. Cleavage
7. Hardness
8. Specific Gravity
9. Degree of Transparency
10. Special Properties

# **MINERALOGY**

## **Forms and Habits**

The form represents the common mode of occurrence of a mineral in nature. It is also called Habit or Structure of minerals. To some extent this is the function of the atomic structure of minerals.

# MINERALOGY

## Forms and Habits

### Lamellar Form



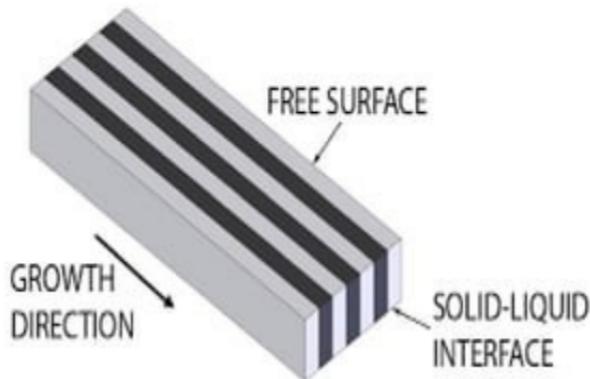
**Mica**

Minerals appears as Thin  
separable Layer

# MINERALOGY

## Forms and Habits

### Tabular Form



### Feldspar

Minerals appears as slab of uniform Thickness

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## Forms and Habits

### Fibrous Form



alamy stock photo



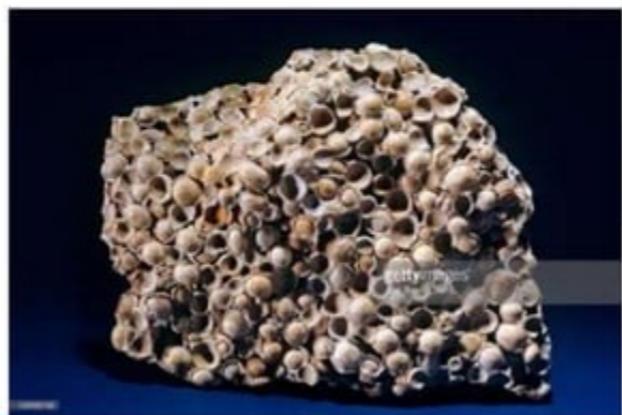
### Asbestos

Minerals appears to be made of  
Thin Thread

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## Forms and Habits

### Pisolitic Form



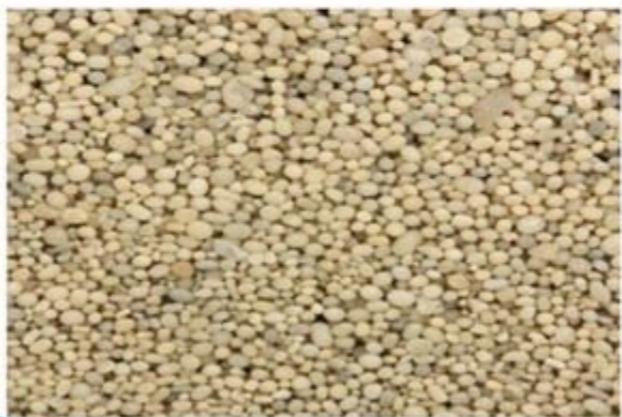
**Bauxite**

Minerals appears to be made of small spherical grain

# MINERALOGY

## Forms and Habits

### Oolitic Form



**Lime stone**

Minerals appears to be made of  
still small spherical grain

# MINERALOGY

## Forms and Habits

### Rhombic Form



**Calcite**

Minerals appears to be made of  
Rhombic Shape

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## Forms and Habits

### Granular Form



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### **Magnetite, Chromite**

Minerals appear to be made of innumerable equidimensional grain of coarse or medium of grain

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## Forms and Habits

### Bladed Form



**Kyanite**

Minerals appears as a cluster or independent lath shaped grains

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## Forms and Habits

### Botryoidal Form



### Hematite, Chalcedony

Minerals appears as made up of smaller curved faces like bunch of grapes.

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## Forms and Habits

### Acicular Form



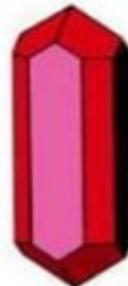
**Natrolite , Actinolite**

Minerals appears as made up of thin needles.

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## Forms and Habits

### Columnar Form



Columnar



Quartz, Apatite

Minerals appears as Long slender prism.

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## Forms and Habits

### Prismatic Form



### Quartz, Apatite

Minerals appear as elongated independent crystals.

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## Forms and Habits

### Spongy Form



© Dakota Matrix

**Pyrolusite, Bauxite, pumice**  
Minerals appears as porous

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## Forms and Habits

### Crystal Form



**Quartz, Amethyst, Pyrite, Galena**

Minerals appears as Polyhedral Geometrical shapes

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## Forms and Habits

### Massive Form



**Graphite, Olivine, Jasper**  
No Definite shape for minerals

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## Forms and Habits

### Nodular Form



**Flint, Lime stone**

Irregular shaped compacted body  
With curved surface

# MINERALOGY

## Mineral Identification

### Physical Properties of Minerals

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# MINERALOGY



## Colour

Colour is due to the composition. In some others it is imparted by the presence of trace element, inclusions, atomic structure.

Great consistency in ore forming minerals. [Idiochromatic]

Less consistency in Rock forming minerals.

[Allochromatic]

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## Colour



Graphite  
Shining Black



Hematite  
Dark steel Gray



Amethyst  
Violet

# MINERALOGY

## Colour



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Calcite  
White



Jasper  
Red



Olivine  
Olive Green

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## Colour



Quartz  
Colour less or White



Asbestos  
White, less commonly  
green, Yellow, gray



Pyrolusite  
Dark gray, nearly black

# MINERALOGY

## Colour



Galena  
Dark Lead Grey



Barytes  
White or Pale grey



Pyrolusite  
Dark gray, nearly black

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## Colour

Determined by the chemical composition of the mineral

Minerals rich in Al, Ca, Na, Mg are often light coloured.

Minerals rich in Fe, Ti, Ni, Cr are often dark in colour



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## Colour

Determined by the atomic structure of the mineral

Atomic structure controls which components of white light are absorbed or reflected

White minerals reflect all components of white light

Black minerals absorb all components of white light

Green minerals reflect green light and absorb the others

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## Colour

- Colour is not particularly useful as a diagnostic property
- Some minerals show a wide variety of colours
- Quartz can be transparent, white, pink, brown, purple, yellow, orange and even black
- Many minerals show very similar colours
- Calcite, gypsum, Barytes, fluorite, plagioclase feldspar and halite are commonly grey or white in colour

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## Colour



Examples of colour variation in Fluorite

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## Colour



All these minerals are grey or white in colour

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## Mineral Identification

### Physical Properties of Minerals

1. Forms and Habits
2. Colour
3. **Streak**
4. Lustre
5. Fracture
6. Cleavage
7. Hardness
8. Specific Gravity
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## Streak

The colour of a mineral's powder obtained by rubbing a mineral specimen on an unglazed white porcelain tile.

Useful for identifying metallic ore minerals.

Silicates generally do not mark the tile and have no streak.

White minerals streaked on a white tile will have a white streak

Any minerals harder than the tile (6) no streak.

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## Streak

Haematite gives a  
cherry red streak

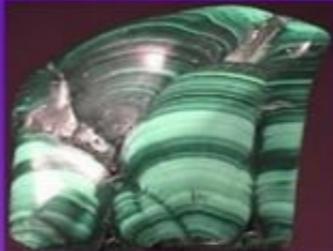


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## Streak



# MINERALOGY



Malachite – pale green



Haematite – cherry red



Iron Pyrite – greenish black



Galena – lead grey



Sphalerite – pale brown



Limonite – yellowish brown

## Streak

# MINERALOGY

## Metallic Ore Minerals – Characteristic Streaks

	Pyrite
	Haematite
	Orpiment
	Sphalerite
	Sulphur
	Graphite
	Azurite
	Malachite

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**Streak** [Streak...can help identify quartz]



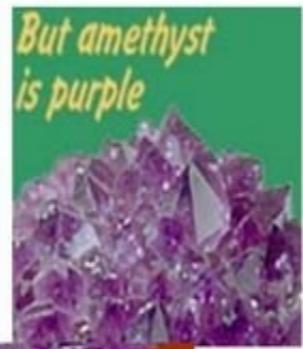
Pure  
quartz  
is clear



Smoky quartz  
is black



and  
adventurine  
is green!



But amethyst  
is purple

**BUT**



Quartz always  
leaves a white  
streak

# MINERALOGY

## Mineral Identification

### Physical Properties of Minerals

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# MINERALOGY

## LUSTRE

The way in which a mineral reflects light and it is Controlled by the atomic structure of the mineral.

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

Based on quality or type of shining, lustres are grouped as **metallic** and **non metallic**.

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## LUSTRE

### Metalic Lustre



**Pyrite**



**Gelena**



**Gold**

It is the type of shining that appears on the surface of metals.

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## LUSTRE

### Sub Metallic Lustre



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Hematite



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Magnetite



Chromite

The amount of shining is less compare to metallic lustre.

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## LUSTRE

### Vitreous Lustre



**Quartz**



**Dolomite**



**Calcite**

The non metallic minerals  
shining like a glass sheet

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## LUSTRE

### Pearly Lustre



Talc



Muscovite Mica



Gypsum

The non metallic minerals  
shining like a Pearls

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## LUSTRE

### Silky Luster



**Asbestos**



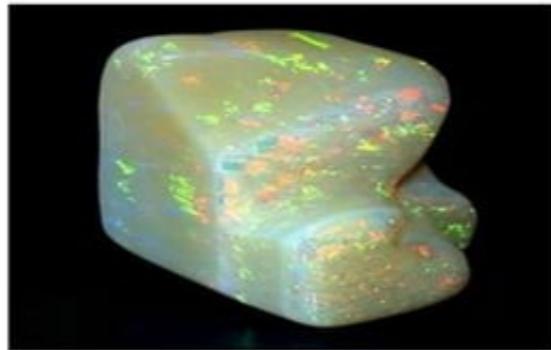
**Satinspar**

The non metallic minerals  
shining like a silk.

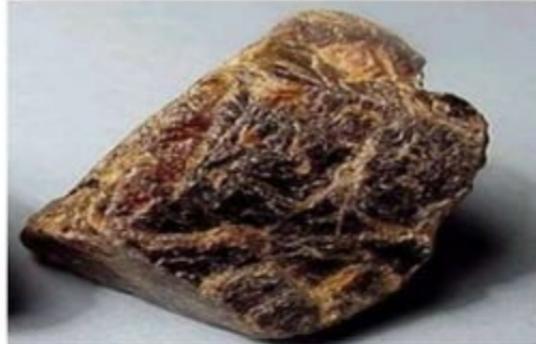
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## LUSTRE

### Resinous Luster



Opal



Chalcedony

The non metallic minerals shining like a Resin.

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## LUSTRE

### Adamantine Lustre



**Adamantine minerals**

The non metallic minerals  
shining like a Diamond.

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## LUSTRE

Earthy or Dull Lustre



Kaolin



Bauxite



Magnesite

The non metallic minerals shining like a Earth or Chalk.

# MINERALOGY

## Mineral Identification

### Physical Properties of Minerals

1. Forms and Habits
2. Colour
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4. Lustre
5. **Fracture**
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# MINERALOGY

## FRACTURE

The tendency of minerals to break along a flat surface or to break unevenly along a curved surface or irregular surface.

Fracture is a mineral property where the atomic bonding between atoms in crystal structure is perfect with no weakness. When these minerals are stressed they shatter making no two pieces truly the same.

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## FRACTURE

Fracture occurs in the minerals where bond strength is generally the same in all direction.

Minerals that have fracture do not exhibits cleavage.

Fracture is the Uneven breakage of minerals.



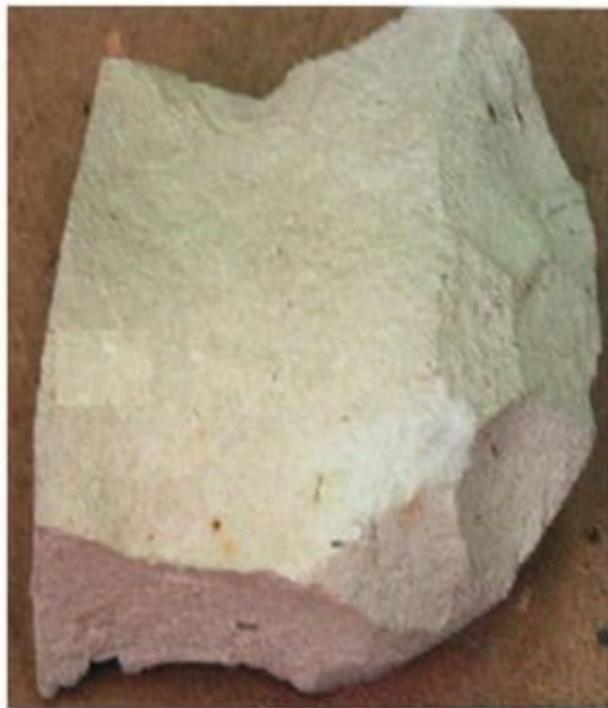
# MINERALOGY

## FRACTURE

### Even Fracture



**Magnasite**



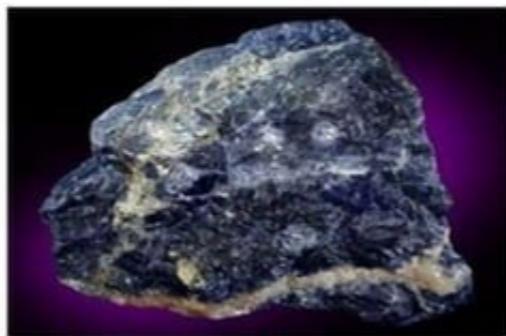
**Chalk**

The Broken surface of the minerals is plain and smooth.

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## FRACTURE

### Uneven Fracture



**Sodalite**

The Broken surface of the minerals is rough or irregular .

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## FRACTURE

### Hackly Fracture



Kyanite



Asbestos



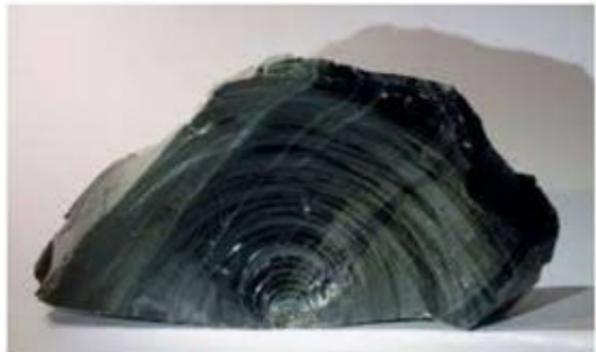
Tremolite

The Broken surface of the minerals is very irregular like broken stick.

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## FRACTURE

### Conchoidal Fracture



**Volcanic Glass**



**Opal**



**Volcanic Glass**

The Broken surface of the minerals is smooth and curved surface.

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## FRACTURE

### Sub Conchoidal Fracture



**Flint**



**Agate**



**Jasper**

The Broken surface of the minerals is smooth and curved nature is less predominate.

# MINERALOGY

## Mineral Identification

### Physical Properties of Minerals

1. Forms and Habits
2. Colour
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6. **Cleavage**
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# MINERALOGY

## Cleavage

The definite direction or plane along which a minerals tend to break easily.

It is related to crystallinity only crystalline minerals have cleavage.

Cleavage represents the plane of weakness in atomic structure of minerals.

# MINERALOGY

## Cleavage

### Basal-One direction



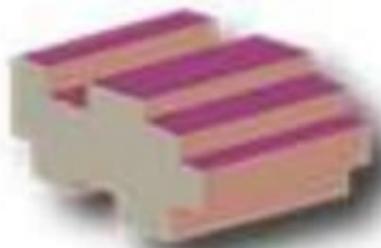
**Muscovite mica**

These minerals can be split into a very thin sheet along horizontal plane

# MINERALOGY

## Cleavage

### Prismatic-Two direction



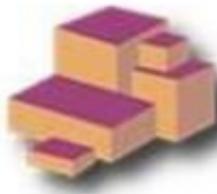
### Orthoclash

These minerals exhibits two mutually perpendicular sets of cleavage.

# MINERALOGY

## Cleavage

### Cubic-Three direction



### Halite

These minerals exhibits three mutually perpendicular sets of cleavage.

# MINERALOGY

## Cleavage

### Cubic-Three direction



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**Calcite**

These minerals exhibits three mutually perpendicular sets of cleavage with some angles.

# MINERALOGY

## Mineral Identification

### Physical Properties of Minerals

1. Forms and Habits
2. Colour
3. Streak
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5. Fracture
6. Cleavage
7. **Hardness**
8. Specific Gravity
9. Degree of Transparency
10. Special Properties

# **MINERALOGY**

## **Hardness**

Hardness may be defined as the resistance offered by minerals to abrasion or scratching.

It is also related to Atomic structure of Minerals.

The chemical composition of mineral appear to have a less influence over hardness.

# MINERALOGY

## Hardness

Hardness minerals is studied either as **Absolute hardness** and **Relative hardness**.

Absolute hardness means Total hardness.

Relative hardness means comparative hardness.

# **MINERALOGY**

## **Hardness**

The relative hardness of unknown minerals is determined by scratching it with the minerals of Mohs scale of hardness, starting with the talc and followed by minerals.

# MINERALOGY

## Hardness

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

RATING	DESCRIPTION	MINE RAL EXAMPLE
<b>1: VERY SOFT</b>	EASILY CRUMBLES. CAN BE SCRATCHED WITH A FINGERNAIL (2.2)	TALC 
<b>2: SOFT</b>	CAN BE SCRATCHED WITH A FINGERNAIL (2.2)	GYPSUM 
<b>3: SOFT</b>	CAN BE SCRATCHED WITH A COPPER PENNY (3.5)	CALCITE 
<b>4: SEMI-HARD</b>	CAN BE SCRATCHED WITH A NAIL (5.2)	FLUORITE 
<b>5: HARD</b>	CAN BE SCRATCHED WITH A NAIL (5.2)	APATITE 
<b>6: HARD</b>	MINERAL WITH HARDNESS OF 6 OR MORE CAN SCRATCH GLASS	FELDSPAR 
<b>7: VERY HARD</b>	CAN BE SCRATCHED WITH A CONCRETE NAIL (7.5)	QUARTZ 
<b>8: VERY HARD</b>		TOPAZ 
<b>9: EXTREMELY HARD</b>	USED IN INDUSTRIAL TOOLS FOR CUTTING AND GRINDING	CORUNDUM 
<b>10: THE HARDEST</b>	DIAMOND IS USED TO CUT ALL MINERALS	DIAMOND 

# MINERALOGY

## Mineral Identification

### Physical Properties of Minerals

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# **MINERALOGY**

## **Specific Gravity (Density)**

It is the ratio of the mass of a substance to the mass of a reference substance for the same given volume.

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

Specific gravity of minerals is determined by using either Walker's steel yard or jolly's spring.

# MINERALOGY

## Specific Gravity (Density)

**Quartz** with silicon dioxide has **higher specific gravity** of 2.7.

**Opal** with Amorphous variety has **lesser specific gravity** 2.2 .

**Amber** as specific gravity nearly **equal to water** 1.

**Platiniridium** is the **heaviest specific gravity** of 22.84.

**Rock forming** minerals have **specific gravity** of 2.5 – 3.5.

**Ore forming** minerals have **specific gravity** of over 3.5.

# MINERALOGY

## Specific Gravity (Density)

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# MINERALOGY

## Specific Gravity (Density)

Most sulfides are 4.5 to 6.0

Iron metal is ~8

Lead is ~13

Gold and platinum are 19-22.

# **MINERALOGY**

## **Specific Gravity (Density)**

Most sulfides are 4.5 to 6.0

Iron metal is ~8

Lead is ~13

Gold and platinum are 19-22.

# MINERALOGY

## Mineral Identification

### Physical Properties of Minerals

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# **MINERALOGY**

## **Degree of Transparency**

The resistance offered by materials to the passage of light through them.

Transparency depends on chemical composition.

Ore minerals exhibits opaque.

Degree of transparency is mainly depends on thickness.

# MINERALOGY

Degree of Transparency

Transparent



Quartz

Muscovite Mica



# MINERALOGY

Degree of Transparency

Translucent



Calcite



Agate

# MINERALOGY

Degree of Transparency

Opaque



Calcite



Galena

# **MINERALOGY**

## **Mineral Identification**

### **Physical Properties of Minerals**

1. — Forms and Habits
2. — Colour
3. — Streak
4. — Lustre
5. — Fracture
6. — Cleavage
7. — Hardness
8. — Specific Gravity
9. — Degree of Transparency
- 10. Special Properties**

# **MINERALOGY**

## **Special Properties**

Some minerals exhibits peculiar characters which enable them to identify easily.

# MINERALOGY

## Special Properties

Its very soft ( $h=1$ )

It exhibits smooth touch  
or soapy feel



Talc

# MINERALOGY

## Special Properties

Its low hardness ( $h=1$ )

It exhibits black colour

Mark easily on paper.



Graphite

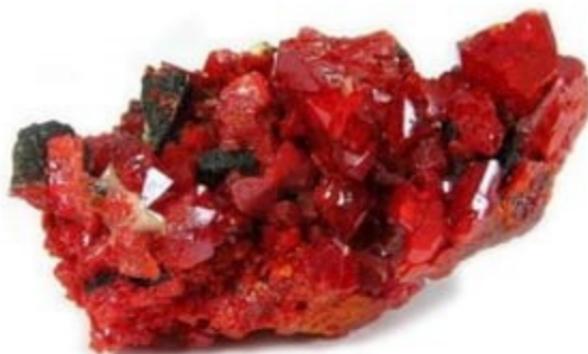
# MINERALOGY

## Special Properties

It gives garlic smell

When struck or heated

and freshly broken surface



Realgar



Orpiment

# MINERALOGY

## Special Properties

It gives a clayey smell  
And adheres strongly to the  
Tongue.



Kaolin

# MINERALOGY

## Special Properties

Halite has a saline taste



Halite

# MINERALOGY

## Special Properties

It strongly attracts by an Ordinary magnet.



Halite

# **MINERALOGY**

## **Importance of Mineral**

The solid Earth consists of rocks. Rocks are made of minerals. Understanding minerals helps in understanding rocks.

The civil engineers needs to know the properties of rock precisely to enable them to consider different rocks for various purpose such as foundation rocks, road metals, building stone.

### **Halite**

# **MINERALOGY**

## **Importance of Mineral**

Study of minerals heavily used in manufacturing of plastics, cloths, pencil lead, glass, chalk board and the chalk, Salts.

Minerals serve as the raw material for manufacturing of chemicals, dimension stone, aggregate for road and concrete.

# **MINERALOGY**

## **ROCK FORMING MINERALS**

Based on the nature and economic importance all minerals are grouped into Rock forming and Economic forming minerals. Some economic minerals serve as a source of extraction of valuable metals and other become useful by virtue of their physical properties.

# **MINERALOGY**

## **ROCK FORMING MINERALS**

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# **MINERALOGY**

## **ROCK FORMING MINERALS**

99% of the earth crust made up of 20- 25 rock forming minerals.

Earth crust consists of 1600 species of minerals but are very rare.

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## Chemical Composition of Earth Crust

ELEMENTS	PERCENTAGE
Oxygen	46.71
Silicon	27.69
Aluminium	8.07
Iron	5.05
Calcium	3.65
Sodium	2.75
Potassium	2.58
Magnesium	2.08
Titanium	0.62
Others	0.80

# MINERALOGY

99.2% of the earth crust made of these 9 elements.

Oxygen and silicate together constitute 74.4%.

The rock forming minerals are mainly silicates.

All precious and useful minerals such as platinum, gold, silver etc are together represents only 0.436%. That why economic minerals are scarce.

# **MINERALOGY**

## **Rock Forming Minerals**

The rock forming minerals are mainly composed of silicates, oxides and carbonates.

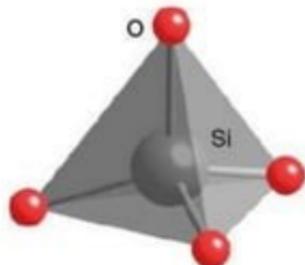
Since silicate are the most common rock forming minerals.

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## Rock Forming Minerals

### Structure of Silicates

Silicate **Tetrahedron** is the fundamental unit of all silicate minerals. This unit has the nature of either occurring alone or in different combination in mineral structure.

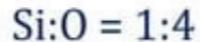


# MINERALOGY

## Rock Forming Minerals

### Nesosilicates Structure

In this group  $\text{SiO}_4$  tetrahedra occur as independent unit in mineral structure.



Olivine



# MINERALOGY

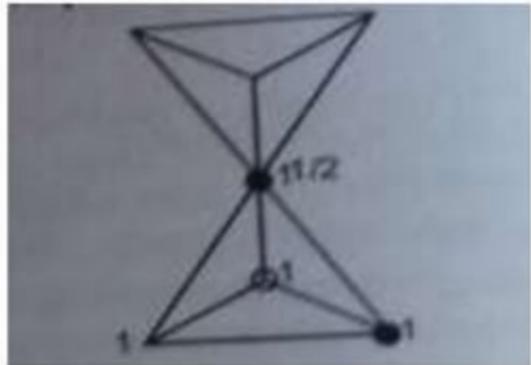
## Rock Forming Minerals

### Sorosilicates Structure

In this Group of minerals  $\text{SiO}_4$  tetrahedra occurs in **pairs**.

$\text{Si}:\text{O} = 1:3.5$

Melilite



# MINERALOGY

## Rock Forming Minerals

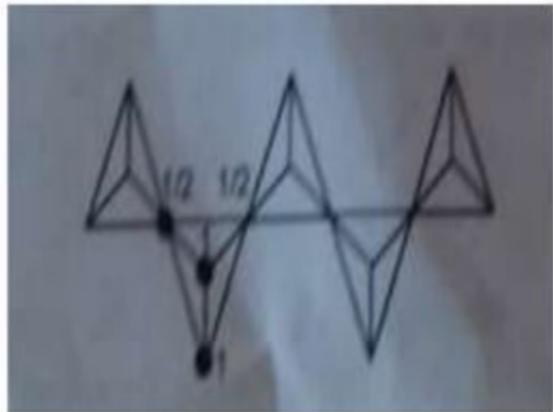
### Inosilicates Structure

In this Group of minerals  $\text{SiO}_4$  tetrahedra occurs in **Chain**.

#### Single Chain Silicate

$\text{Si}:\text{O} = 1:3$

Pyroxenes.



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## Rock Forming Minerals

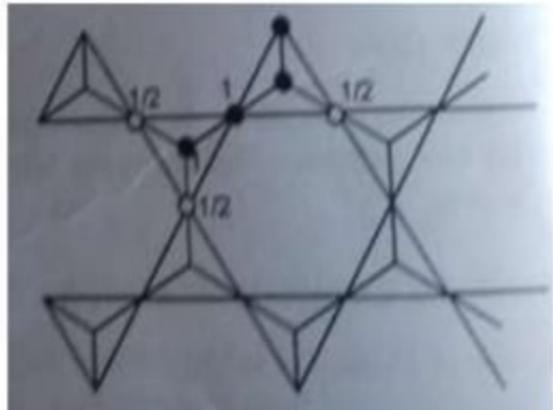
### Inosilicates Structure

In this Group of minerals  $\text{SiO}_4$  tetrahedra occurs in **double Chain**.

### Double Chain Silicate

$\text{Si}:\text{O} = 2:3$

Amphiboles.



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### Phyllosilicate Structure

In this Group of minerals  $\text{SiO}_4$  tetrahedra occurs as **Sheet**

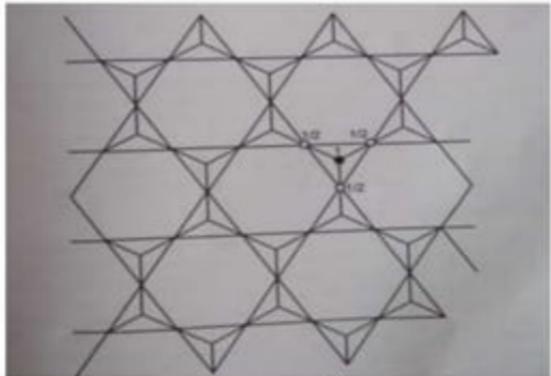
**Resulting in more growth in**

**Two direction of a minerals.**

**Sheet silicate Silicate**

$\text{Si}: \text{O} = 1:2.5$

Amphiboles.



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## Rock Forming Minerals

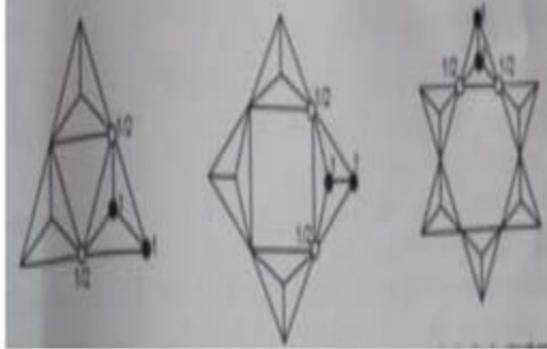
### Tectosilicates Structure

In this Group of minerals  $\text{SiO}_4$  tetrahedra occurs in **Three dimensional frame work**

Resulting equidimensional growth.

$\text{Si}:\text{O} = 1:3$

Muscovite Mica.



# MINERALOGY

## Rock Forming Minerals Groups

Feldspar	Quartz
Pyroxene	Olivine
Amphibole	Mica
Garnet	Kyanite
Chlorite	Talc
Calcite	Bauxite

# MINERALOGY

## Rock Forming Minerals Groups

### Feldspar Group

Feldspar is not a single minerals.

Aluminium silicates of sodium, potassium and calcium rarely barium. ***Alkali and lime feldspar.***

All feldspar are **Tectosilicates.**

Occurs more commonly in Metamorphic Rocks

# MINERALOGY

## Rock Forming Minerals Groups

### Quartz Group

Quartz is the most common rock forming minerals.

Silica composition

Silica occurs in **crystalline** nature.

All Quartz are **Tectosilicates**.

Occurs more commonly in Igneous Rocks

# **MINERALOGY**

## **Rock Forming Minerals Groups**

### **Pyroxene Group**

Pyroxene are related to both feldspar and mafic minerals.

Silicates of calcium, magnesium and ferrous iron.

Pyroxene are **Single Chain Silicate**.

Occurs more commonly in Igneous Rocks

# MINERALOGY

## Rock Forming Minerals Groups

### Olivine Group

Olivine are related to mafic minerals.

Silicates of magnesium and ferrous iron.

Olivine are **Nesosilicates**.

Occurs more commonly in Igneous Rocks

# **MINERALOGY**

## **Rock Forming Minerals Groups**

### **Amphibole Group**

Amphibole are related to Ferro magnesium minerals.

Silicates of calcium, magnesium, sodium and ferrous iron.

Amphibole are **Inosilicates** but have a double chain silicates.

Occurs more commonly in Igneous Rocks

# **MINERALOGY**

## **Rock Forming Minerals Groups**

### **Mica Group**

Mica are related to Silicate minerals.

Silicates of aluminium, magnesium, and Potassium.

Mica are **Phyllosilicates**.

Occurs more commonly in Igneous Rocks .

# **MINERALOGY**

## **Rock Forming Minerals Groups**

### **Kyanite Group**

Kyanite are related to Metamorphic minerals.

Silicates of aluminium, magnesium, and Potassium.

Kyanite are **Nesosilicates**.

Occurs more commonly in Metamorphic Rocks

# **MINERALOGY**

## **Rock Forming Minerals Groups**

### **Talc Group**

Talc is an extremely soft, non metallic economic mineral.

Hydrous magnesium silicates.

Talc are **Phyllosilicates**.

Occurs more commonly in Metamorphic Rocks