UNIT- 2
MINERALOGY

Minerals ?-

* Inorganic substances which has more/less definite atomic structure and chemical composition.
* It has constant physical property which are used in the identification of mineral in the field.

* Minerals → Rock forming mineral

* Ore forming mineral.

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<th>Mineral Group</th>
<th>Examples</th>
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<td>Oxides</td>
<td>Quartz, magnetite, haematite, etc.</td>
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<td>Sulphates</td>
<td>Feldspar, mica, hornblende, Augite, olivine, etc.</td>
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<td>Carbonates</td>
<td>Calcite, dolomite, etc.</td>
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<td>Sulphides</td>
<td>Pyrites, galena, sphalerite, etc.</td>
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<td>Chloride</td>
<td>Rock salt, etc.</td>
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Physical Properties:

* Physical properties can be determined by inspection (or) by simple test.
* It can also be determined by hand specimen.
* The chief physical properties are colour, streak, lustre, hardness, habit, cleavage, fracture, odour, tenacity, specific gravity and crystal forms.
* Correct identification are made by using a polarizing microscope.

Colour: It occurs due to certain wavelength of light by atoms making of crystals. On a basis of colour of a mineral, may belong to anyone of three types:

→ IDIOCHROMATIC: Shows a constant constant colour appear metallic crystal. 
   Ex: Copper

→ ALLOCHROMATIC: Shows variable colours, appear non-metallic Ex: Quartz.

→ PSEUDOCHROMATIC: Shows false colour.
Some minerals viewed in different directions show irregular changes in colour.
1. **Play of colour**: Change in rapid succession on rotation
   - *Ex*: diamond.

2. **Change of colour**: Rate of change of colours on rotation and intensity is low.
   - *Ex*: labrodorite.

3. **Iridescence**: Shows rainbow colours in interior/exteriorsurface.
   - *Ex*: limonite, hematite.

4. **Tarnish**: Change of original colour due to oxidation.
   - *Ex*: bornite.

**Streak**:

*The streak of the mineral is the true colour of the mineral is quite helpful in identifying mineral.*

*The streak is obtained by rubbing a mineral against an unglazed porcelain plate.*

- *Ex*: magnetite, black in colour and give blackish brown colour as streak.

**Lustre**:

*General Appearance of a mineral surface of reflected light.*
2. Sub-Metallic: Feebly displayed metallic lustre
   Ex.: Chromite.
3. Adamantine: Hard brilliant lustre
   Ex.: Diamond.
4. Vitreous Lustre: Lustre exhibited by broken glass
   Ex.: Quartz, Gypsum.
5. Pearly Lustre: Lustre exhibited by pearls.
   Ex.: Talc, Calcite.
   Ex.: Asbestos.
7. Resinous Lustre: Exhibited by resin
   Ex.: Sphalerite, Nepheline.
8. Greasy Lustre: Lustre exhibited by grease
   Ex.: Talc.
9. Dull (or) Earthy: No lustre said to Earthy lustre
   Ex.: Kaolin.

Hardness:

Hardness of mineral depends on chemical composition.

Determined by rubbing or scratching a mineral of unknown hardness against one of known hardness.
Cleavage:
* It is defined as a tendency of mineral break more easily with smooth surface along plane of weak bonding.

* Cleavage
  → Perfect
  → Good
  → Poor
  → Indistinct

Fracture:
* The nature of the surface of the mineral is called as fracture.

* Fracture
  → Even fracture
  → Uneven fracture
  → Conchoidal fracture
  → Hacky fracture
  → Earthy fracture

Specific Gravity:
* Its number which represent the ratio of weight of the mineral to the weight of an equal volume of water.

Quartz group:

Introduction:
* It is an important rock forming mineral next to feldspor.
* It is a non-metallic refractory mineral.
* It is a silicate group.
Physical properties:

(a) Crystal system: Hexagonal.
(b) Habit: Crystalline / Amorphous.
(c) Fracture: Conchoidal
(d) Hardness: 7
(e) Specific Gravity: 2.65 - 2.66 (Low)
(f) Streak: No
(g) Transparency: Transparent / semi-transparent / opaque

Polymorphism Transformation

Quartz → Tridymite → Cristobalite → Melt.

Coloured varieties:

* Pure quartz is always colourless and transparent.
* Presence of impurities the mineral showing colours:
  (a) Amethyst: Purple / violet.
  (b) Smoky quartz: Shades of grey.
  (c) Milky quartz: Light brown, pure white, opaque.
  (d) Rose quartz: Rose.

Crypto crystalline forms of Quartz:

(a) Chalcedony: Amorphous, waxy luster.
(b) Agate: A banded, variety having different colours.
(a) Jasper: Dull red, yellow, massive.
(b) Flint: Dark grey, conchoidal fracture.
(c) Opal: Amorphous

Quartz family members:
(a) Primary: Recrystallization process (Si, Al, Fe).
(b) Secondary: Precipitation (chalcedony, opal, chert/flint).

Occurrence:
*It occurs in all types of rocks like igneous, metamorphic and sedimentary rocks.

Uses:
(i) Used as semi-precious stone.
(ii) Form of sand in construction.
(iii) Used as abrasive in industries.
(iv) Used for making watches.
(v) Piezoelectric crystal for frequency control.

Felspar Group:
(i) It is most abundant of all minerals.
(ii) It is used for making more than 50% by weight crust of earth.
(iii) It is non-metallic and silicate minerals.

Chemical Composition:
(i) Potash feldspar: $K_2AlSi_3O_8$
(ii) Soda lime feldspar: $NaAlSi_3O_8$ / $CaAl_2Si_2O_8$
Varieties of Potash Feldspar:

1. Orthoclase
2. Sanidine
3. Natroline

Soda lime Feldspar:

1. Albite
2. Oligoclase
3. Anorthine
4. Amathitite
5. Labrodorite

Crystal System: Monoclinic/Triclinic

(a) Habit: Tabular (Crystalline)
(b) Cleavage: Perfect (2 directional)
(c) Fracture: Conchoidal/Uneven
(d) Colour: White/grey/pink/green/red
(e) Lustre: Vitreous
(f) Hardness: 6 - 6.5
(g) Specific Gravity: 2.55 - 2.58 (Low)
(h) Streak: No
(i) Occurrence: Igneous rock
(j) Uses: Ceramics, glass, tableware, enamels, electric porcelain & false teeth.
POTASH FELDSPAR :-

a) ORTHoclase :-

b) CRYSTAL SYSTEM :- Monoclinic

c) COLOUR :- Flesh red

d) CHEMICAL COMPOSITION :- K\textsubscript{2}Al\textsubscript{2}Si\textsubscript{5}O\textsubscript{8}

e) USES :- Ceramic semiprecious.

SODA KURIE FELDSPAR :-

MICROLINE :-

a) CRYSTAL SYSTEM :- Triclinic

b) COLOUR :- White / Pinkish white

c) CHEMICAL COMPOSITION :- K\textsubscript{2}Al\textsubscript{2}Si\textsubscript{5}O\textsubscript{8}

d) USES :- Ceramic semiprecious.

e) SODA LINAE FELDSPAR :-

ALBITE :-

a) CRYSTAL SYSTEM :- Triclinic

b) COLOUR :- White / Pinkish white

c) CHEMICAL COMPOSITION :- Na\textsubscript{2}Al\textsubscript{2}Si\textsubscript{5}O\textsubscript{8}

d) USES :- Ceramic / Ornamental Stone.
ANDROTHITE :-
(a) CRYSTAL SYSTEM :- Triclinic
(b) COLOUR :- White
(c) COMPOSITION :- Ca Al₂Si₂O₈ (90%), Na Al₂Si₂O₈ (10%)
(d) USES :- Ceramic / Ornamental stone
(e) OCCURRENCE :- All types of rocks

PYROXENES GROUP

ORTHOPYROXENE :
(i) ENSTATITE (MgSiO₃)
(ii) HYPERTHENE [(Mg, Fe)SiO₃]

CLINOPYROXENE :
(i) AUGITE [(Ca, Na) (Mg, Fe, Al) (Al, Si)₂O₆]
(ii) DIOPSIDE [Ca Na₂Si₂O₆]
(iii) HEDENBERGITE [Ca Fe₂Si₂O₆]

AUGITE :-
(a) CRYSTAL SYSTEM :- Monoclinic
(b) HABIT :- Crystalline
(c) CLEAVAGE :- Good (Prismatic cleavage)
(d) FRACTURE :- Conchoidal
(e) COLOUR :- Shades of greyish green and black
(f) LUSTRE :- Vitreous
(g) HARDNESS :- 5-6
(h) SPECIFIC GRAVITY :- Medium
STREAK : white

OCCURRENCE : Ferromagnesiam mineral of igneous rock (dusty)

USES : Rock forming mineral

COMPOSITION : 

\[ (Ca,Na)(Mg,Fe,Al)(Al,Si,O_6) \]

TRANSPARENCY : Translucent/opaque

AMPHIBOLE GROUP

* These are closely related to pyroxene group.
* It shows double chain silicate structure.
* Rich in calcium, magnesium, iron oxide and KNa, K and H.

Classification :

(a) Orthorhombic

(b) Monoclinic

(i) Hornblende
(ii) Tremolite
(iii) Actinolite

MICA GROUP :

(i) Form sheet like structure.
(ii) Can be split into very thin sheets along one direction.
(iii) Aluminium and magnesium are rich.
(iv) Occupy 4 - 1% of earth crust.
(v) shows basal cleavage.

Classification:

Light Mica:

(a) Muscovite - $K\text{Al}_2(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$ - Potash Mica
(b) Paragonite - $Na\text{Al}_2(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$ - Soda Mica
(c) Lepidolite - $K\text{LiAl}(\text{Si}_4\text{O}_{16})(\text{OH})_2$ - Lithium Mica.

Dark Mica:

(a) Biotite - $K(\text{MgFe})_3(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$ (Fe Mg Mica)
(b) Phlogopite - $K\text{Mg}_3(\text{Al}_2\text{Si}_3\text{O}_{10})(\text{OH})_2$ (Mg Mica)
(c) Zinnwaldite - Complex U - Fe Mica.

Iron Oxide Minerals:

Magnetite:

(a) Crystal system: Cubic
(b) Habit: Crystalline, massive / granular
(c) Fracture: Uneven
(d) Cleavage: Absent
(e) Lustre: Metallic
(f) Hardness: 6 - 7
(g) Sp. gravity: 5.18 (high)
(h) Streak: Brown
(i) Composition: Fe$_3$O$_4$
Transparency :- Translucent

Occurrence :- As necessary in igneous rocks

Uses :- It is important ore of iron.

HEMATITE :-

(a) Crystal system :- Hexagonal

(b) Habit :- Massive

(c) Cleavage :- Absent

(d) Fracture :- Uneven

(e) Colour :- Reddish brown to black.

(f) Lustre :- Metallic

(g) Hardness :- 5-6

(h) Sp. Gravity :- 5.26 (high)

(i) Streak :- dark red

(j) Composition :- Fe₂O₃

(k) Varieties :- Red other

(l) Transparency :- Translucent

(m) Occurrence :- Thick beds of sedimentary rocks

(n) Uses :- As iron ore and pigments.
PYRITE:

- Crystal System: Cubic
- Habit: Cube / Granular
- Cleavage: Absent
- Fracture: Conchoidal
- Colour: Brass / Yellow
- Lustre: Vitreous
- Hardness: 6-6.5
- Specific Gravity: 5.02
- Streak: Greenish / Brownish Black
- Transparency: Translucent
- Occurrence: Common sulphide minerals found in hydrothermal veins of metamorphic rock.
- Uses: Used in manufacture of sulphuric acid.

SIDERITE:

- Crystal System: Hexagonal
- Habit: Crystalline, fibrous also granular
- Cleavage: Perfect
- Colour: Light to dark brown
- Lustre: Vitreous
- Hardness: 3.5-4
- Specific Gravity: 3.96 (medium)
- Composition: FeCO₃
- Transparency: Translucent
- Uses: In steel industries.
CARBONATE MINERAL :-

CALCITE :-

(1) Crystal System :- Hexagonal

(2) Habit :- Tabular

(3) Cleavage :- Perfect

(4) Fracture :- Even

(5) Colour :- Milky white, grey, green, yellow, etc

(6) Lustre :- Vitreous

(7) Hardness :- 3

(8) Sp. Grav. :- 2.71 (low)

(9) Streak :- Colourless

(10) Composition :- CaCO₃

(11) Transparency :- Transparent

(12) Uses :- Used for manufacture of cement and lime. It is also used as a fertilizer.

(13) Occurrence :- Rock forming mineral in sedimentary rocks.

CLAY MINERAL GROUP :-

(i) These are phyllosilicates minerals.

(ii) Essentially hydrous aluminium silicates.

(iii) These are common weathering products.

(iv) Very common in sedimentary rocks.
CLASSIFICATION:

There are four groups:

1. Kaolin
   a. Kaolinite
   b. Biotite
   c. Nacrite
   d. Halloysite

2. Smectite
   a. Montmorillonite
   b. Nontronite
   c. Hectorite

3. Illite
4. Chlorite

Kaolinite:

* It is formed by weathering of aluminate-silicate minerals. The feldspar rocks are commonly weathered to kaolinite.

a. Crystal system: - Triclinic
b. Habit: - Massive
c. Colour: - White sometimes brown
d. Cleavage: - Perfect
E. Fracture: - Even
ILLITE:

* The illite clay have a structure similar to that of muscovite. They form by alternate minerals like muscovite and feldspar.

* Chemical composition: \((K, H)\cdot Al_2(SiAl)_4O_{10}(OH)_2\cdot xH_2O\)

* Uses: Oil Industry.

CHLORIDE:

* Crystal system: Foliated monoclinc
* Habit: Foliated
* Colour: Grey, Green
* Streak: White
* Cleavage: Good
* Fracture: Even
* Lustre: Vitreous.
(b) Sp. Gravity: Low
(c) Hardness: 2-8