

Mineralogy

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Mineral → is a homogenous, naturally occurring, solid, and generally inorganic substance with a definable chemical composition and an orderly internal arrangement of atoms.

### Homogenous:

- Consists of single substance

- Can't be broken into simpler components.

### Naturally occurring:

- result of natural geological processes

- Synthetic Minerals e.g (Industrial diamonds)

### Soil:

- Maintain a set shape nearly indefinitely.

- Liquids aren't mineral.

### definable chemical composition:

Can be described by chemical formula

Quartz →  $\text{SiO}_2$

Diamond → C

### orderly arrangement of atoms:

have a fixed atomic pattern that repeats itself over a large region ~~for~~ relative to the size of atoms  
Crystal Solid or crystal lattice: organized structure of a mineral.

- glass isn't mineral → No organized structure

### generally inorganic:

- only a few organic substances are considered mineral.

all other mineral are inorganic.

Object \_\_\_\_\_

Date / /

## Nomenclature of Minerals:

given its names on the basis of some physical properties or chemical aspects, locality, public figure, a mineralogist.

- \* Albite ( $\text{NaAlSi}_3\text{O}_8$ ) → To its Colour - From Latin (white)
- \* Rhodonite ( $\text{MnSiO}_3$ ) → From Greek (rose) - To its Colour (pink)
- \* Chromite ( $\text{FeCr}_2\text{O}_4$ ) → because the presence of Chromium in the Mineral.

\* Magnetite ( $\text{Fe}_3\text{O}_4$ ) → because of magnetic properties

\* Franklinite ( $\text{ZnFe}_2\text{O}_4$ ) → after a locality Franklin, New Jersey, where it occurs as dominant Zinc Mineral.

\* Sillimanite ( $\text{AlSiO}_3$ ) → after prof Benjamin Silliman.

## Structure of Minerals:

arrangement of atoms or ions which constitute Mineral crystal.

Such as Crystal lattice and Polymorphs

### Crystal lattice

imaginary three dimensional framework and form a network of regularly spaced points without gaps.

Two mineral that have the same composition but different crystal form.

Diamond (C)

Covalently bond

Carbon atom covalently bond in tetrahedral network

forms strong bonds that are hard to break, so diamonds are very hard

Diamonds are denser ( $3.5 \text{ g/cm}^3$ ) than graphite ( $2.1 \text{ g/cm}^3$ ) because

AL-Haramien

of formation under great pressure

graphite (C) 2 -

- Carbon atom bond in planar sheets; sheets [weakly bonded]
- Sheets are easy to break; graphite is very soft

mineral group 2

(92) naturally occurring elements - only 8 elements [O, Si, Fe, Al, Na, K, Mg, S] make up most of the mineral

Mineral, classified acc to their chemical composition

① Native elements 2 -

composed of one element

ex/ gold (Au) - Silver (Ag) - Diamond (C)

② Oxides 2 -

Consists of metal cations bonded to oxygen anion

ex/ quartz (SiO<sub>2</sub>) - magnetite (Fe<sub>3</sub>O<sub>4</sub>) - chromite (FeCr<sub>2</sub>O<sub>4</sub>)

pyrolusite (MnO<sub>2</sub>)

③ Sulfides 2 (S)

Sulfide anion, pyrite (FeS<sub>2</sub>) - sphalerite (ZnS)

galena (PbS), chalcopyrite (CuFeS<sub>2</sub>)

④ Halides

Contain halogens (Cl<sup>-</sup>, F<sup>-</sup>, I<sup>-</sup>, Br<sup>-</sup>)

Halite (NaCl), fluorite (CaF<sub>2</sub>)

⑤ Carbonates

Contain (CO<sub>3</sub><sup>2-</sup>) group - calcite (CaCO<sub>3</sub>), magnesite (MgCO<sub>3</sub>)

Siderite (FeCO<sub>3</sub>)

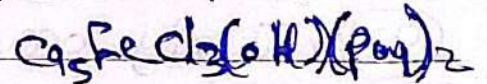
⑥ Sulfates

Contain sulfate ( $\text{SO}_4$ ) group - gyp sum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ )

Barite ( $\text{BaSO}_4$ )

⑦ phosphates

( $\text{PO}_4$ ) group - Such as Apatite [ $\text{Ca}_5(\text{Fe}, \text{Cl}, \text{OH})(\text{PO}_4)_3$ ]

⑧ Silicates

Contain Silica Tetrahedron ( $\text{SiO}_4$ )

أكبر وأبسط ذرات السيليكا

are most common mineral class in igneous rock.

five different structural of silicates

① Isolated silicates

each tetrahedron will be isolated

basic structural unit is then  $\text{SiO}_4$

Mineral held together by attraction between Silica Tetrahedron and other positive ions such as garnet

② Single chain silicates [pyroxene]

two of oxygen's are shared in a way to make long

single chain - basic structural unit is  $\text{Si}_2\text{O}_6$  or  $\text{SiO}_3$

③ Double chain silicates [Hornblende]

two chains are linked together so that each tetrahedral group shared ③ of its oxygen's

basic unit structural ( $\text{Si}_4\text{O}_{11}$ )

④ Sheet silicates

3 of oxygen's from each tetrahedral group are shared.

( $\text{Si}_2\text{O}_6$ ) A.S. kaolinite

### ⑤ Framework silicates :-

- All of  $O_2$  are shared with another  $SiO_4$  Tetrahedron
- basic structural unit  $SiO_2$
- AS Quartz

### ← physical properties of minerals :-

#### ① Colour :-

mineral Coloured because, certain wave lengths of light are absorbed, The colour results from a combination of those wave lengths that reach the eye.

|                       |   |                |                             |
|-----------------------|---|----------------|-----------------------------|
| malachite & olivine   | → | always green   | } Constant Coloured mineral |
| azurite               | → | " blue         |                             |
| pyrite & chalcopyrite | → | " brass yellow |                             |

#### varied Coloured minerals

اللون الناتج عن الشوائب

depends on impurities within mineral.

Quartz →

Pure :- Colourless - rose → Contains small amount of red iron oxide (hematite)  
violet → includes tin oxide

#### ② luster :-

appearance of mineral surface in reflected light.

types of luster :-

① metallic :- have a brilliant appearance

ex :- galena - pyrite - magnetite.

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\* non metallic luster

Vitreous: Quartz / Calcite

Resinous: Sulphur

pearly: Talc "iridescence pearl like"

Greasy: Covered with oil (graphite)

Silky: Actinolite

Adamantine: brilliant due to unusual high refractive index

Dull: Limonite & kaolinite (Diamond)

### ③ Streak

Colour of a mineral powder

Sulphur → yellow colour [~~white streak~~] yellow streak

pyrite → black [brass ~~yellow~~ streak]

Hematite → red brown streak

\* more reliable than colour for identification of mineral

### ④ Transparency

ability of mineral to pass light

transparent: as: Calcite - muscovite - pure quartz, gypsum

translucent: talc, limonite, orthoclase, barite

opaque: Galena

### Miscellaneous Features

① play of colour: example: opal

② iridescence: play of colours due to thin coating on mineral surface or because of partially opened cleavages

Ex: geothite

AL-Haramien

Opalescence : milky or pearly reflections from the interior of the specimen  
ex → opal

Chatoyancy :  
Silky appearance on reflected light "parallel"  
ex → tiger's eye quartz

Asterism :  
Similar to chatoyancy, but inclusions arranged in  
③ directions. at 120°  
ex → star rose quartz

Pleochroism :  
Specimen appears various colour  
Ex → tourmaline

Tarnish :  
Chemical reactions between the mineral and air, often  
produced thin coatings → usually dull  
→ occasionally brilliant

Ex → (Copper) - bornite non-luminescent

Luminescence : emission of light from non incandescent mineral

Luminescence : emission of light from non incandescent mineral

Fluorescent : exposing to UV or X ray or Cathode ray

Phosphorescent : luminescence continuous after  
cut off exciting ray

Thermoluminescence : when it heating x / apatite calcite

Triboluminescence : when scratched, rubbed or crushed  
ex / Fluorite / Sphalerite

Object lec 5 ges (Minerology)

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## Cohesive properties

Crystal Habit: The characteristic external shape of an individual or crystal group

Complete faces → euhedral

UnComplete faces → Subhedral

no faces → anhedral

\* name of crystal derived from predominant crystal faces

(prism - prismatic, pyramid - pyramidal, pinacoid - platy)

## Cohesive properties

① Hardness is a measure of mineral resistance to abrasion process.

|            |    |                    |
|------------|----|--------------------|
| Talc       | 1  | يدخل في الحصى      |
| Cypsur     | 2  | يدخل في الحصى      |
| Calcite    | 3  | * Fingernail 2.5   |
| Fluorite   | 4  | * Copper penny 3   |
| Apatite    | 5  | * knife blade 5    |
| Orthoclase | 6  | * Glass 5.5        |
| Quartz     | 7  | * Steel nail 6     |
| Topaz      | 8  | * Steel plates 6.5 |
| Corundum   | 9  | يدخل في الحصى      |
| Diamond    | 10 | يدخل في الحصى      |

## ② Cleavage (parting)

Tendency of mineral to split along planes of weak bonding

\* Cleavage planes produce flat & shiny surface.

### types of cleavage:

- ① perfect 2 cleavage planes are clear (mica)
- ② imperfect cleavage planes are present but less obscure (apatite, beryl)
- ③ poor 2 cleavage planes are absent.

cleavage can be classified as the following:

- ① one sets of cleavage: mica
- ② two sets of cleavage:
  - pyroxene  $\rightarrow$  at  $90^\circ$
  - Amphibole  $\rightarrow$  at  $120^\circ$
- ③ three sets of cleavage:
  - Calcite (Rhombohedral cleavage)
- ④ four sets of cleavage:
  - (Fluorite) (octahedrons) طبعاً يتكسر على أربع اتجاهات
- ⑤ six sets of cleavage:
  - Sphalerite (dodechedron) طبعاً يتكسر على 6 اتجاهات

~~parting~~

it is also a plane of weakness in crystal structure.

هو مستوى لا تكونه ذرات بل هي نقاط فقط

~~may appear when mined~~

قد تظهر فقط عندما يتم الحفر

لأنه عندما يتم الحفر لا يكون له اتجاه

Corundum: Show parting due to twinning

Pyroxene / xpatite: due to weakness.

~~fracture~~

is the description of the way that mineral tend to break.

(طبعاً يتكسر على 6 مستويات الاتجاه)

Conchoidal: (قوسية) Smooth (quartz)

Earthy: (تربة) looks like freshly broken soil

(limonite / kaolin)

يكون السطح خشن

Hackly: Jagged surface with sharp edges.

(copper and silver)

\* uneven - Rough surface has random regularities  
(pyrite, arsenopyrite)

\* Fibrous - Fibers or splinters  
(asbestos - chrysotile)

### \* Additional Characteristic Features

\* Specific gravity - The weight of that mineral divided by the weight of an equal volume of water.

الخاصة بوزن الكتلة - 3.4 = 2.6 = specific gravity  
يكون أثقل وأقل في specific gravity

low specific gravity → Magnetite - kaoline - limonite (S)  
high specific gravity → chromite - galena - barite

### Sense properties (Taste, odor, Touch)

Halite → Saline taste

Talc → has Soap Touch

kaolin → astringent taste

graphite → greasy Touch

gold → Cool Touch

By heating → (Sulfur: Match odor - Sulfides:  $H_2S$  odor)

Breathing up → (kaolin: mud odor)

Rubbing → (phosphate: garlic odor)

### \* Magnetism

meas its affinity to be attracted by magnet

paramagnetic - attract to magnet

تجذب عندما يكون اقتراب من مغناطيس قريب منها بغير احتكاك فيقد قدرتها

Ferrimagnetic - لا يمكن اقترابها من مغناطيس

Ex/ magnetite - pyrrhotite

origin of minerals

### (a) Magmatic origin

Mineral crystallize from Melted rock (Magma)

Slow Cooling  $\rightarrow$  Coarse crystals

Fast Cooling  $\rightarrow$  fine crystal

Sudden Cooling  $\rightarrow$  glassy or skeletal form

\* The mineral composition depend on magma type

Acidic - rich in (Si, O, Na, K, Al) - quartz - feldspar - muscovite

Basic - rich in (Si, O, Fe, Mg, Ca) - olivine - pyroxene - amphibole - biotite

Alkaline Magma - (rich in Na, K, poor in Si, O)  
produce - feldspathoids like (nepheline)

### (b) Hydrothermal origin

Formed from hot, mineral rich water moving through cracks and pores.

Classified based on Temp and pressure

$\uparrow$  Hypothermal (500 - 300°C) - wolframite - molybdenite  
Mesothermal (300 - 100°C) - barite - calcite - galena  
Epithermal (100 - 50°C) - calcite - fluorite - marcasite  
Sillite

### (c) Metamorphic origin

Formed when existing rocks are subjected to change in Temp and pressure

(1) Metamorphosed minerals - result from alteration

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of primary mineral [kaolinite from Fiedspar]

Metamorphic minerals :-

from chemical reactions [garnet - sphene - talc - graphite]

olivine + Anorthite  $\rightarrow$  garnet  
Ilmenite + Anorthite  $\rightarrow$  Sphene

(d) Sedimentary origin

① Chemical ppt - from saturated water  
[siderite - bauxite - hematite]

② evaporation :-  
first - carbonate [calcite]

then - magnesite

Followed - sulfates [gypsum]

last - halides [halite]

③ bio chemical processes :-  
involving microorganisms.

Bacteria help from mineral like

Sulfur - Ilmenite - goethite.

especially sulphur fixation