Minerals

Definition and calculation of mineral chemistry

Lab. No. 1

Second semester

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Outlines:

- Definition and concept
- Naming of Mineral
- Mineral chemistry calculations

Minerals: Are inorganic, naturally occurring substances that have a characteristics chemical composition, distinctive physical properties, and crystalline structure.

- ***According to our earlier definition, three conditions must be satisfied for a substance to be a mineral:***

1. It must be crystalline solid
2. It must have formed through geologic processes
3. It must have a specific chemical composition

Mineralogy: Is the science that dealing with minerals.

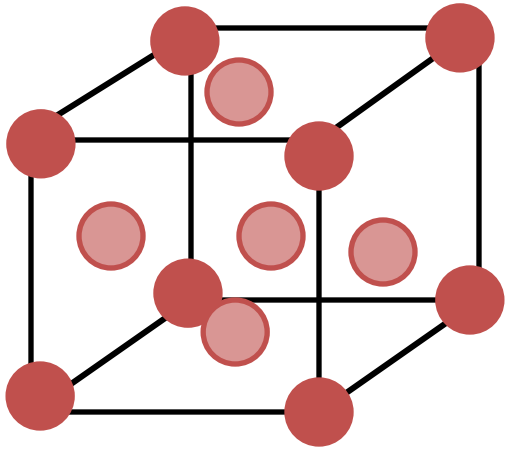
Mineraloids: A few materials such as limonite (rust) and opal do not have crystalline structure and never form crystals.

Rocks – aggregates of one or more minerals.

How element arrangement and mineral form?

- Elemental minerals are those naturally occurring minerals that are made up entirely of single elements from periodic table, such as cupper

Cu

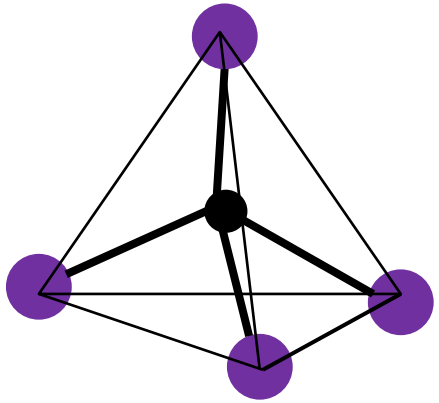


Cupper mineral

- Compound minerals are naturally occurring crystalline substance, which are formed by the chemical combination of two or more elements, such as silicate minerals

O

Si



Quartz

Cupper

Quartz

Naming of Minerals

✓ Minerals may be given names on the basis of some:

❖ physical property or chemical aspect

❖ They may be named after a locality

❖ A public figure, a mineralogist

❖ Almost any other subject considered appropriate

Some examples of mineral names and their derivation are as follows:

- Albite: from the Latin , albus (white) from its color
- Rhodonite: from the Greek, rhodon (a rose) from its characteristic pink color
- Chromite: because of the presence of a large amount of chromium element in the mineral.
- Magnetite: cause of its magnetic properties
- Frankilite: after locality, Franklin, New Jersey, where it occurs as dominant zinc mineral
- Sillminite: after Professor Benjamin Silliman of Yale University.

Albite

Rhodonite

Chromite

Magnetite

Franklinite

Sillimanite

Mineral chemistry calculations

- The chemical compositions of minerals as reported in their chemical formulas are really Ideal compositions, based only on the proportions of their **Major Element** constituents.

- [**Major elements are defined as any element occurring at >1% wt. in a mineral, and/or any element which predominantly fills a structural site in a mineral**].

- However, minerals include both **Minor Elements (1.0 - 0.1% wt. abundance)** and **Trace Elements (<0.1% wt in abundance)** in their structures.

- Unfortunately, when mineral compositions are analyzed chemically and reported, the values are traditionally reported in wt.% oxides and in ppm **(parts per million, = µg/g: 10,000 ppm = 1% wt.)**

- We will study the calculation of weight percent of elements in minerals and the determination of the chemical formula of a mineral.

- Also, we will determine the same for the element oxide composition of a mineral which is quite different than what you did in your chemistry course but very important in geology.

1. Determination of weight % of elements in a mineral

- need chemical formula of mineral.
- need atomic weights of individual elements comprising mineral formula.
- chemical formulas are traditionally written with **cations preceding anions**; **cations appear in order from left to right according to increasing valence.**
- if the same valence exists for two or more cations, they can be written left to right according to alphabetic order of their chemical symbols; the following is an example of the determination of weight %.

Q1: Calculate the weight % of the elements in the mineral, chalcopyrite ($CuFeS_2$):

element	atomic weight	# atoms/formula	molecular weight contribution	weight % of element
Cu	63.54	1	63.54	(63.5/183.51)x100=34.62
Fe	55.85	1	55.85	(55.9/183.51)x100=30.43
S	32.06	2	64.12	(64.1/183.51)x100=34.94
			183.51	

2. Determination of the chemical formula of a mineral

- need weight % of each element in the mineral.
- need atomic weights of elements in the mineral.

Q: the following is an example of the determination of the formula of the mineral, chalcopyrite:

- calculate the **subscripts** (no. of atoms) of Cu, Fe, and S in the mineral.

- the atomic proportions must be normalized dividing by the smallest number and rounded off to obtain the whole number.

element	atomic weights	weight %	atomic proportion	subscript
Cu	63.54	34.62	(34.62/63.54)=0.54	(0.54/0.54)=1
Fe	55.85	30.43	(30.43/55.85)=0.54	(0.54/0.54)=1
S	32.06	34.94	(34.94/32.06)=1.08	(1.08/0.54)=2

-placing each appropriate subscript below the corresponding element in the formula will result in the chemical formula of the mineral, **$CuFeS_2$.**

Q1: Calculate the percentage composition by weight of mineral Marcasite from the following data :

elements	atomic weight
Fe	55.85
S	32.07

- Note: chemical formula of Marcasite is FeS_2

Q2: From the following data determine the formula of Sphalerite mineral:

element	weight %	atomic weights
Fe	18.36	55.84
Mn	2.68	54.93
Cd	0.28	112.41
Zn	44.92	65.38
S	33.76	32.06

NEXT LAB

CALCULATION OF CHEMICAL COMPOSITION IN OXIDE MINERALS