COMPOSITIONS OF MINERALS

This part of the exercise cannot be concerned with how you can know the compositions of minerals – you just have to learn them. However, it is concerned with how to read those names and what the various terms in the names mean.

Minerals have two names. One is the name by which it is known, such as quartz, calcite, crocoite and over 7000 others. These names tell us nothing about a mineral except what to call it. The second name is the vital one. It tells us the chemical composition of the mineral in terms of the names of the 92 elements listed in the periodic table.

1 Elements

There are 27 elements that occur as minerals. The composition of each of those minerals is 100% of the element, and here are six that you most likely know. They are listed with the AN so you can find them easily.

Mineral	**AN**	**composition**		
Diamond	6	C	carbon	
Graphite	6	C	carbon	
Copper	29	Cu	copper	Latin name - cuprum
Silver	47	Ag	silver	Latin name - argentum
Gold	70	Au	gold	Latin name - aurum
Mercury	80	Hg	mercury (liquid)	Latin name - hydrargyrum

Here are the others: aluminium 13, silicon 14, sulphur 16, chromium 24, iron 26, nickel 28, zinc 30, arsenic 33, selenium 34, rhodium 45, palladium 46, cadmium 48, indium 49, tin 50, antimony 51, tellurium 52, rhenium 75, osmium 76, iridium 77, platinum 78, lead 82 and bismuth 83. All occur naturally as minerals.

The compositions of these minerals are obvious. The compositions of the other more than 7000 minerals, which are all compounds, are not so obvious.

2 Compounds

The chemical names of the simple mineral compounds most usually have two parts. The first part is usually a metal or metals (cationic or +ve) and the second is non-metallic, (anionic or -ve). The first part has the name of the metal(s) and should be easy once you know the elements The second part has the name ascribed to the combination of non-metallic atoms. You are expected to know many of these and how to speak them.
So, for the mineral paracelsian the composition is: $BaAl_2Si_2O_8$. Decomposing it is easy. The first part is $BaAl_2$ and means that a molecule of the mineral contains 1 atom of Ba and 2 atoms of Al (showing that numbers more than 1 are represented

as subscripts). It is spoken as “barium, aluminium”. The second part is Si_2O_8 meaning it contains 2 atoms of Si and 8 of O. This is one of several combinations of Si and O that is called a silicate and “silicate” is the name of the second part. Thus, $BaAl_2Si_2O_8$ is correctly spoken: “barium, aluminium silicate”. It really is simple.

The various forms of the second part of the name are also reasonably simple.

a Names ending in “ide” refer to a single element. We have seen 2 of these - NaCl is sodium chloride (chlorine only) and CaF_2 (fluorine only). Others are

cuprite	CuO	copper oxide, (only O) and
niccolite	NiAs	nickel arsenide, (only As),

and others such as boride, carbide, phosphide, iodide and stannide. Here is another – SiC called silicon (the Si) carbide (the C only). Silicon carbide is the mineral moissanite, commonly known as carborundum and has a hardness of 9.5.

b Many minerals have compositions ending in a small group of atoms such as CO_3 and SO_4. These groups have special names ending in “ate” as follows
CO_3 is a carbonate
SO_4 is a sulphate
PO_4 is a phosphate
SiO_3 is one form of silicate (other forms are SiO_4, Si_2O_8, Si_4O_5 - S and O is silicate)
Others include “borate”, “nitrate”, “fluorate”, “chlorate”, “arsenate” and “selenate”.
In some minerals one of these groups contains one less oxygen atom than usual and this is indicated by a special name. Sulphate is SO_4 and so, SO_3 having one less O atom, is sulphite and similarly for other groups.

c Some minerals contain the group of two atoms (OH). This means ‘hydroxide” and the terms “hydroxy” or “hydroxyl” as a prefix indicates it is in the composition. So the mineral kapellasite $Cu_3Zn(OH)_6Cl_2$ is copper zinc hydroxy-chloride, whereas the mineral clinoclase $Cu_3(AsO_4)(OH)$ is copper arsenate hydroxide.

d Other minerals contain H_2O as part of the composition as in ferristrunzite which is $Fe_3(PO_4)_2(OH)_3.5H_2O$ – hydrated iron phosphate hydroxide. Note the dot (.) before the $5H_2O$. That is how the H_2O part of a composition is always written.

3 Complicated minerals

Many, probably most, of the thousands of mineral compositions are complicated. You are not expected to know these compositions but you are expected to know that they are written using the same symbols used in writing the simpler compositions. Those symbols of course, are the one letter and two letter symbols for the elements. You will need to know most of these.

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