| Review: Mineral Groups |
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| **Group** | **Examples** |
| Oxides | Hematite (iron oxide Fe2O3), corundum (aluminum oxide Al2O3), water ice (H2O) |
| Sulphides | Galena (lead sulphide PbS), pyrite (iron sulphide FeS2), chalcopyrite (copper-iron sulphide CuFeS2) |
| Sulphates | Gypsum (calcium sulphate CaSO4·H2O), barite (barium sulphate BaSO4) *(Note that sulphates are different from sulphides. Sulphates have the SO4–2 ion while sulphides have the S–2 ion)* |
| Halides | Fluorite (calcium flouride CaF2), halite (sodium chloride NaCl) *(Halide minerals have halogen elements as their anion — the minerals in the second last column on the right side of the periodic table, including F, Cl, Br,etc.* |
| Carbonates | Calcite (calcium carbonate CaCO3), dolomite (calcium-magnesium carbonate (Ca,Mg)CO3) |
| Phosphates | Apatite (Ca5(PO4)3(OH)), Turquoise (CuAl6(PO4)4(OH)8**·**5H2O) |
| Silicates | Quartz (SiO2), feldspar (sodium-aluminum silicate NaAlSi3O8), olivine (iron or magnesium silicate (Mg,Fe)2SiO4) *(Note that in quartz the anion is oxygen, and while it could be argued, therefore, that quartz is an oxide, it is always classed with the silicates.)* |
| Native minerals | Gold (Au), diamond (C), graphite (C), sulphur (S), copper (Cu) |

**Oxide** minerals have oxygen (O2–) as their anion, but they exclude those with oxygen complexes such as carbonate (CO32–), sulphate (SO42–), and silicate (SiO44–). The most important oxides are the iron oxides hematite and magnetite (Fe2O3 and Fe3O4, respectively). Both of these are important ores of iron. Corundum (Al2O3) is an abrasive, but can also be a gemstone in its ruby and sapphire varieties. If the oxygen is also combined with hydrogen to form the hydroxyl anion (OH–) the mineral is known as a **hydroxide**. Some important hydroxides are limonite and bauxite, which are ores of iron and aluminium respectively. Frozen water (H2O) is a mineral (an oxide), but liquid water is not because it doesn’t have a regular lattice.

**Sulphides** are minerals with the S–2 anion, and they include galena (PbS), sphalerite (ZnS), chalcopyrite (CuFeS2), and molybdenite (MoS2), which are the most important ores of lead, zinc, copper, and molybdenum respectively. Some other sulphide minerals are pyrite (FeS2), bornite (Cu5FeS4), stibnite (Sb2S3), and arsenopyrite (FeAsS).

**Sulphates** are minerals with the SO4–2 anion, and these include anhydrite (CaSO4) and its cousin gypsum (CaSO4.2H2O) and the sulphates of barium and strontium: barite (BaSO4) and celestite (SrSO4). In all of these minerals, the cation has a +2 charge, which balances the –2 charge on the sulphate ion.

The **halides** are so named because the anions include the **halogen** elements chlorine, fluorine, bromine, etc. Examples are halite (NaCl), cryolite (Na3AlF6), and fluorite (CaF2).

The **carbonates** include minerals in which the anion is the CO3–2 complex. The carbonate combines with +2 cations to form minerals such as calcite (CaCO3), magnesite (MgCO3), dolomite ((Ca,Mg)CO3), and siderite (FeCO3). The copper minerals malachite and azurite are also carbonates.

In **phosphate** minerals, the anion is the PO4–3 complex. An important phosphate mineral is apatite (Ca5(PO4)3(OH)), which is what your teeth are made of.

The **silicate** minerals include the elements silicon and oxygen in varying proportions ranging from Si : O2 to Si : O4. These are discussed at length in Section 2.4.

**Native minerals** are single-element minerals, such as gold, copper, sulphur, and graphite.

We classify minerals according to the anion part of the mineral formula, and mineral formulas are always written with the anion part on the right. For example, for pyrite (FeS2), Fe2+ is the cation and S– is the anion. This helps us to know that it’s a sulphide, but it is not always that obvious. Hematite (Fe2O3) is an oxide; that’s easy, but anhydrite (CaSO4) is a sulphate because SO42– is the anion, not O. Along the same lines, calcite (CaCO3) is a carbonate, and olivine (Mg2SiO4) is a silicate. Minerals with only one element (such as S) are native minerals, while those with an anion from the halogen column of the periodic table (Cl, F, Br, etc.) are halides.

Provide group names for the following minerals:

| **Name** | **Formula** | **Group** |
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| sphalerite | ZnS | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| magnetite | Fe3O4 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| pyroxene | MgSiO3 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| anglesite | PbSO4 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| sylvite | KCl | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| silver | Ag | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| fluorite | CaF2 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| ilmenite | FeTiO3 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| siderite | FeCO3 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| feldspar | KAlSi3O8 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| sulphur | S | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| xenotime | YPO4 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |