

OXIDES AND HYDROXIDES

Oxides

When oxygen combines directly with one or more metallic cations an oxide is formed. The major types are: XO , X_2O , X_2O_3 , XO_2 , XY_2O_4 , and XY_2O_6 where X and Y are metal cations and O is oxygen. As a group oxides are dense, relatively hard, and refractory (melt at a high temperature). They are often found as accessory minerals in igneous and metamorphic rocks and, because of their hardness, as resistant grains detrital grains in sediments and sedimentary rocks.

Oxides are characterized by highly ionic bonds. The bonding may be resonant, but the dominant bond type is ionic. Water ice is an oxide mineral. Hydrogen bonding is important in ice.

XO

Zincite ZnO

X₂O

* CUPRITE Cu₂O
WATER ICE H₂O

X₂O₃

CORUNDUM Al₂O₃
HEMATITE Fe₂O₃
ILMENITE FeTiO₃

XO₂

RUTILE TiO₂
PYROLUSITE MnO₂
CASSITERITE SnO₂
URANINITE UO₂

XY₂O₄

Gahnite ZnAl₂O₄
MAGNETITE Fe₃O₄ (Fe²⁺Fe³⁺O₄)
Franklinite (Zn,Fe,Mn)(Fe,Mn)₂O₄
The (Zn,Fe,Mn) are divalent
The (Fe,Mn) are trivalent
CHROMITE FeCr₂O₄

XY₂O₆

Columbite (Fe,Mn)Nb₂O₆
Tantalite (Fe,Mn)Ta₂O₆
Complete solid solution series - found together

NOTES: There are four types of hematite - oolitic, fossiliferous, micaceous, and red ocher. Be sure to look at all four types.
The uraninite is black.
Cassiterite is brown to black, but the streak is white.
Franklinite is black and is often found associated with zincite (deep red to orange-yellow).

Hydroxides

Hydroxide minerals contain $(-\text{OH})^{-1}$ groups. They are usually soft to moderate hardness and have lower densities than oxides. Typically they are alteration products formed by weathering. Hydrogen bonding often links layers together. These bonds are relatively weak, and thus the minerals are soft. Hydroxides are necessarily low-temperature minerals. High temperatures would cause dehydration and would destroy the crystal structure.

Brucite	$\text{Mg}(\text{OH})_2$
Manganite	$\text{MnO}(\text{OH})$
Romanechite	$(\text{Ba}, \text{Mn}^{2+})_3(\text{O}, \text{OH})_6 \text{Mn}_8^{4+} \text{O}_{16}$
*Diaspore	$\alpha\text{AlO}\cdot\text{OH}$
GOETHITE	$\alpha\text{FeO}\cdot\text{OH}$

BAUXITE Although often used as a mineral name, bauxite is really a rock name and is a mixture of diaspore, gibbsite ($\text{Al}(\text{OH})_3$), and boehmite ($\gamma\text{AlO}\cdot\text{OH}$).

Limonite A mixture of hydrous iron oxides, mainly goethite.

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