MODULE

CHEMICAL CLASSIFICATION OF GEMS

Chemical Groups of Gems

In addition to categorizing gems by their three dimensional structures, *we can also view them as belonging to various chemical groups.* Due to their related chemistries, some quite different looking gems share some of their basic properties, while other gems which look rather similar, differ markedly, due to their unlike chemistries

Chemical Groups of Gems

In the world of minerals, certain groupings occur quite commonly. For example, oxygen frequently occurs bonded to atoms of a metal (like iron or aluminum). We call such compounds oxides, and oxide gems have some characteristics in common. There are dozens of chemical groups which could be listed if all gem species were taken into account, but *in this course, you will be required to recognize, and recall, only five major groups, the: silicates, oxides, carbonates, phosphates and native elements.*

Chemical Groups of Gems

Accounting for nearly 60% of gem species, silicates are the most important group, closely followed in prominence by the oxides. These two groups have in common, that their member species tend to be relatively hard and stable, while the carbonates and phosphates are generally softer, and susceptible to attack by acids.

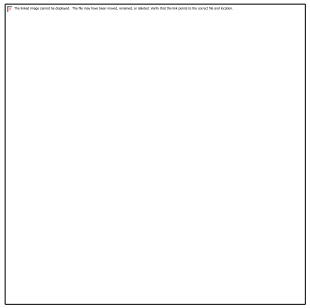
Silicates

Regardless of what other atoms are present (usually one or more metals), gems of this category will have in their chemical formulas some number of Si and O (silicon and oxygen) atoms listed together as a group . For example, as in the polymorphic species from above: Al_2SiO_5. Here we see the group of one silicon atom and five oxygen atoms, which identify the polymorphs Andalusite/kyanite as silicate gems. The numbers of Si and O will vary, depending on the species, but will always appear as a unified group.

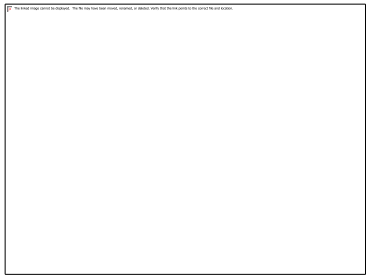
In general they tend to be hard, transparent to translucent, and of medium density.,

Examples of Silicate gems

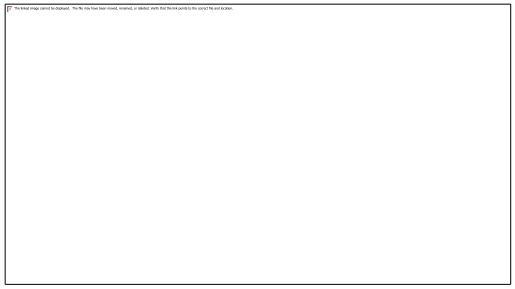
- **All the beryls (aquamarine, emerald, etc.)**
- **All the quartzes (amethyst, rose quartz, agate, etc.)**
- **All the feldspars (sunstone, moonstone, etc.)**
- **All the garnets.** The different species are pyrope, almandine, spessartine, grossular (varieties of which are hessonite or cinnamon-stone and tsavorite), uvarovite and andradite**).**
- **Topaz, tourmaline, zircon, and many other lesser known species.**



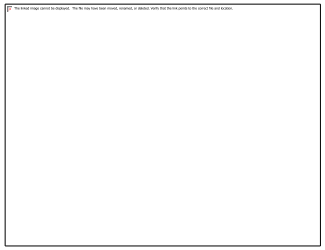
Emerald



amethyst

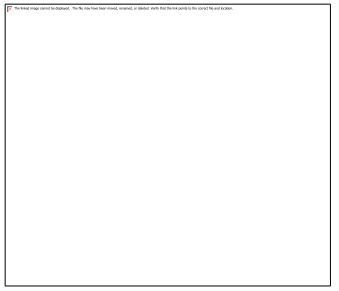


tiger'seye quartz

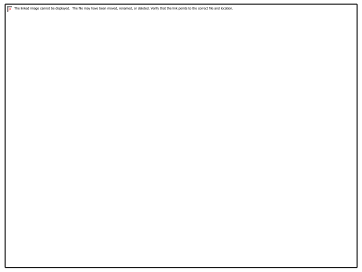


Moonstone

white zircon



Blue topaz



rhodolite garnet

Oxides

This group will have one or more oxygen atoms *(not grouped with silicon, phosphorus or carbon) in their formulas*. Many oxides are important ores of metals or valuable gemstones and tend to be quite hard and rather dense.

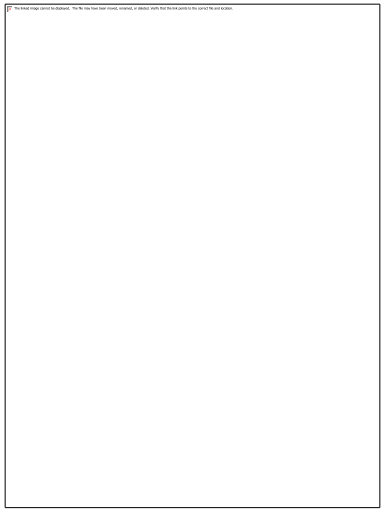
Examples of Oxide gems

Amongst the members of this group of gems are:

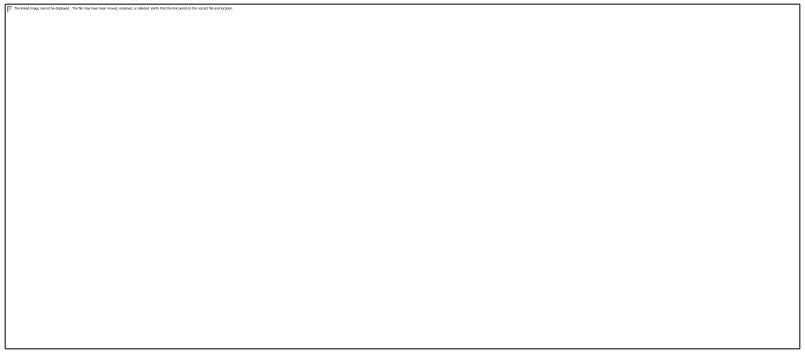
- **Corundum Al_2O_3 (ruby and sapphire)**
- **Spinel** is the magnesium aluminium member of the larger **spinel** group of minerals. It has the formula $MgAl_2O_4$
- **Chrysoberyl** is an aluminate of beryllium with the formula $BeAl_2O_4$**.**

Examples of oxide gems

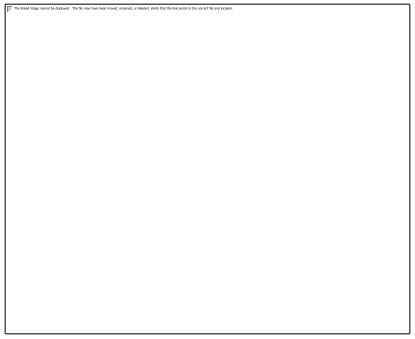
- **Haematite** is the mineral form of iron(III) oxide (Fe_2O_3), one of several iron oxides.



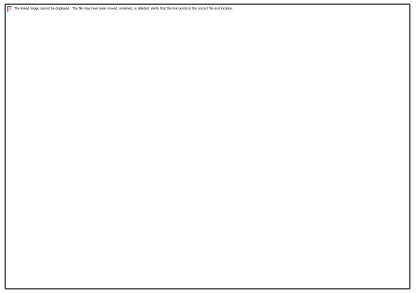
Ruby



Spinel



Hematite



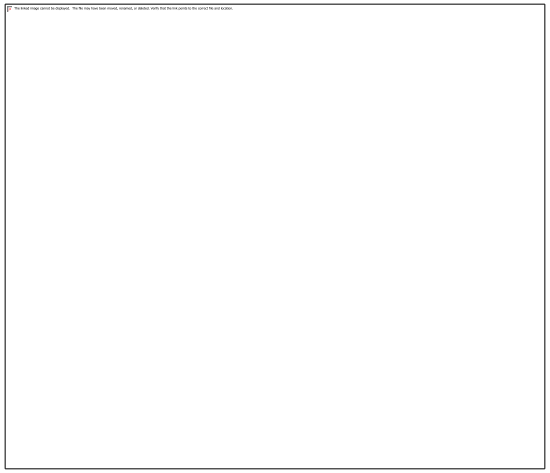
Chrysoberyl

Carbonates

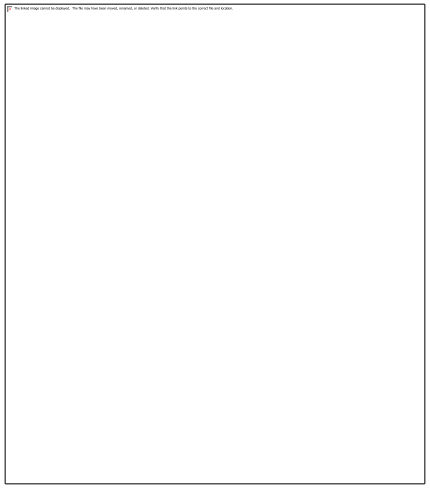
The grouping CO_3 identifies the carbonate gems such as rhodocrosite, malachite, calcite ($CaCO_3$), and azurite. They are generally soft and often brightly colored. They dissolve readily in hydrochloric acid.

Examples of Carbonate gems

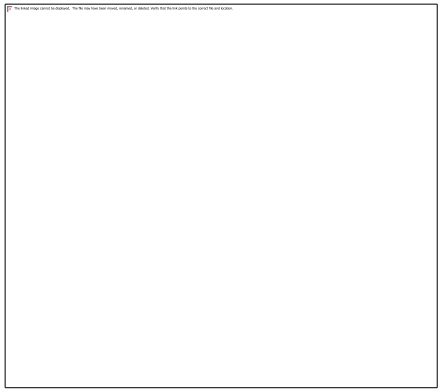
- **Rhodochrosite** is a manganese carbonate mineral with chemical composition $MnCO_3$. In its (rare) pure form, it is typically a rose-red color
- **Malachite** is a copper carbonate hydroxide mineral, with the formula Cu_2CO_3
- **Calcite** is a carbonate mineral and the most stable polymorph of calcium carbonate Ca_2CO_3.
- Azurite is one of the two basic copper(II) carbonate minerals, the other being bright green malachite. Azurite has the formula $Cu_3(CO_3)_2(OH)_2$



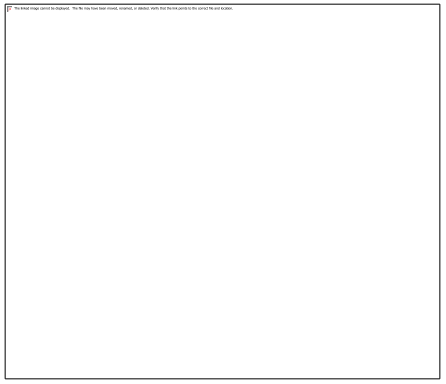
Rhodocrosite



malachite



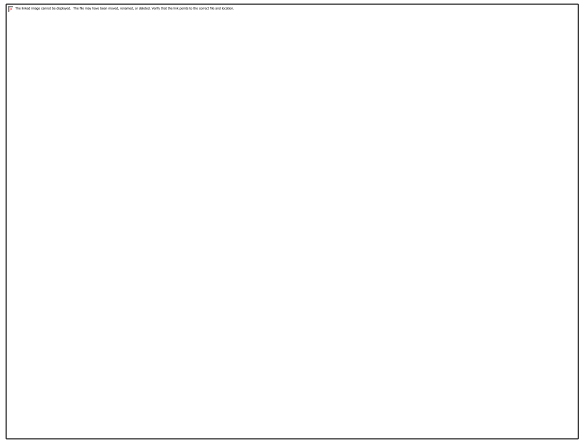
Calcite



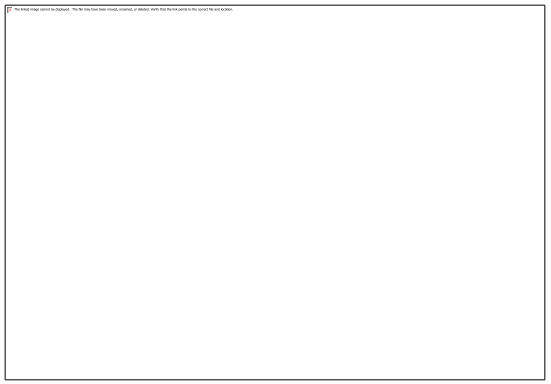
Azurite

Phosphates

A PO_4 group is the identifying chemical landmark for gems of this class. Many of these gems have very complex formulas, but you can still see the phosphate group in there! A highly variable group, in general they are soft, fragile, and brightly colored. *Turquoise, and apatite are notable phosphate gems*.



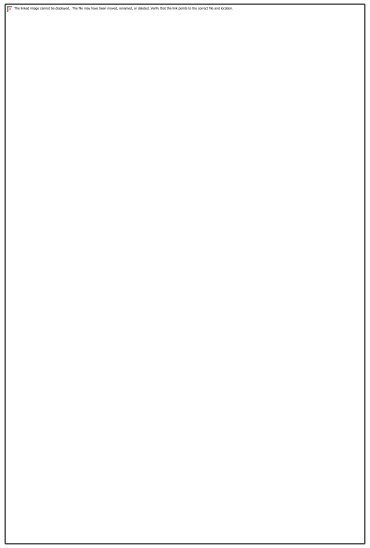
Turquoise



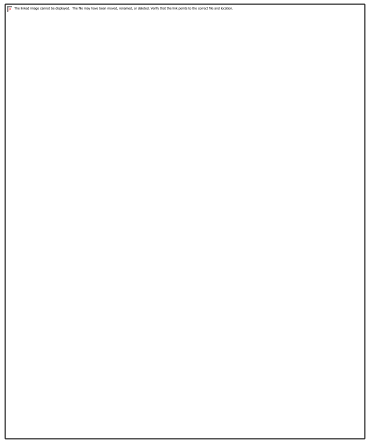
Apatite

Native Elements

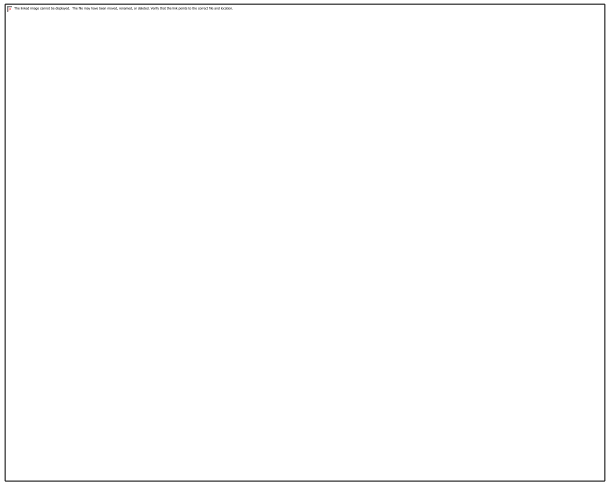
This is the easiest group of all to recognize, as it consists of one and only one element. All the precious jewelry metals such as gold, silver and platinum belong to this group, as does diamond.



Native gold



platinum nugget

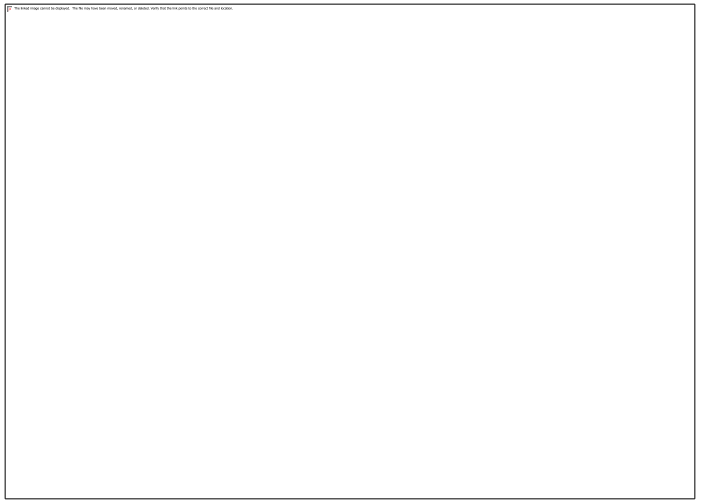


[Diamonds

Native Elements

Two interesting native element examples, not used as gems, but often sought by collectors are sulfur and mercury. Pure sulfur occurs in bright yellow crystals which would tempt the faceter if they were not so heat sensitive that just holding them in the hand causes them to crack, and rare native mercury has the distinction of being the only metal found in a liquid form at normal ambient temperatures.

Crystals of pure sulfur: beautiful to look at but too fragile to touch



Droplets of liquid native mercury in matrix rock