Halides group

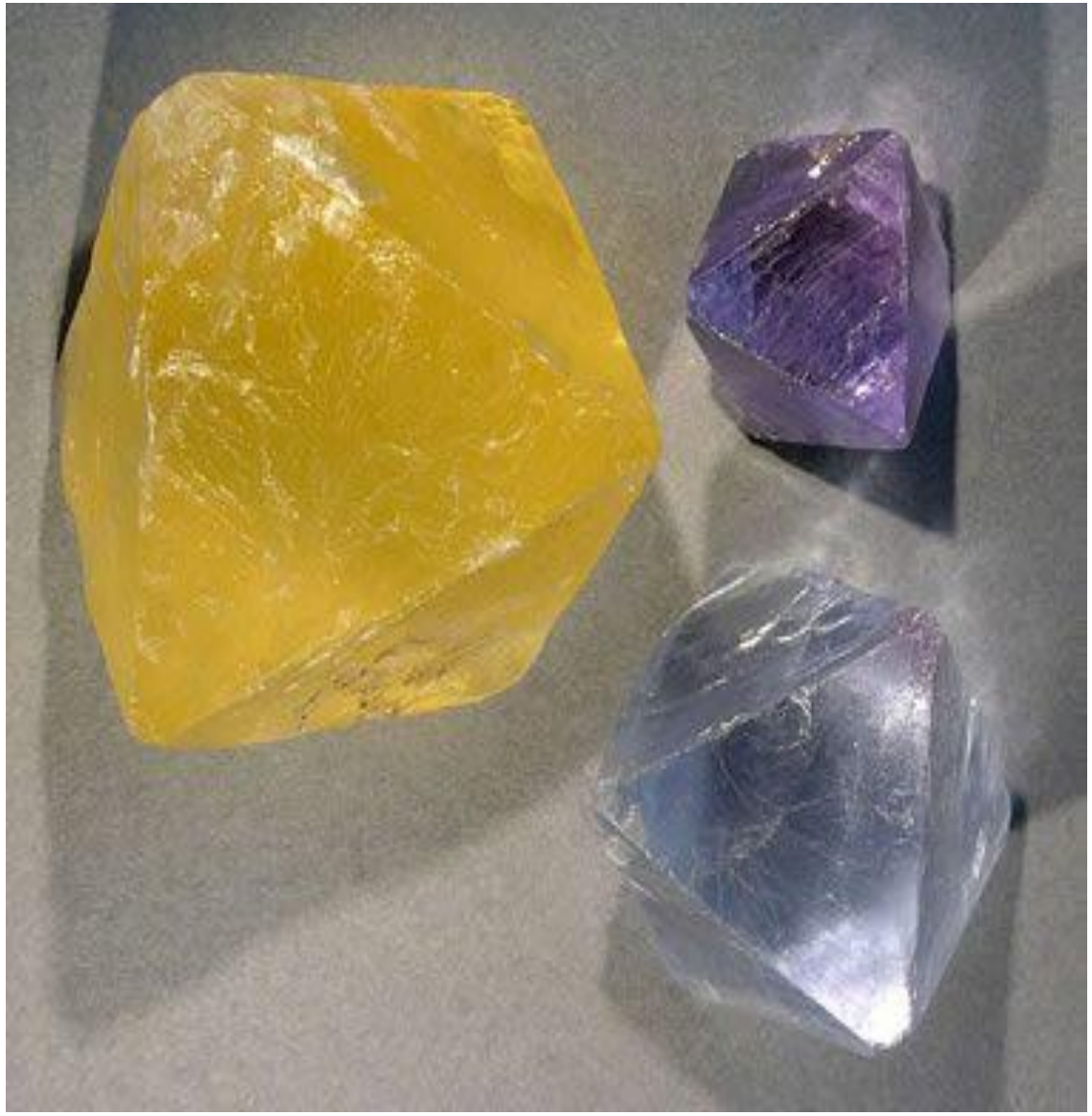
The Halides *are a group of minerals whose principle anions are halogens. Halogens are a special group of elements that usually have a charge of negative one when chemically combined.*

The halogens that are found commonly in nature include Fluorine, Chlorine, Iodine and Bromine. Halides tend to have rather simply ordered structures and therefore a high degree of symmetry. The most famous halide mineral, halite (NaCl) or rock salt has the highest symmetry 4/m bar 3 2/m. The colorful mineral fluorite (CaF) also has 4/m bar 3 2/m symmetry and its cubic crystals are very popular mineral specimens. There are only a few common halide minerals. The typical halide mineral is soft, can be transparent, is generally not very dense, has good cleavage, and often has bright colors.

Sulfosalts

- There are approximately 100 species constituting the rather large and very diverse sulfosalt class of minerals. The sulfosalts differ notably from the sulfides and sulfarsenides with regard to the role of semimetals, such as arsenic (As) and antimony (Sb), in their structures. In the sulfarsenides, the semimetals substitute for some of the sulfur in the structure, while in the sulfosalts they are found instead in the metal site. For example, in the sulfarsenide arsenopyrite (FeAsS), the arsenic replaces sulfur in a marcasite- (FeS_2-) type structure. In contrast, the sulfosalt enargite (Cu_3AsS_4) contains arsenic in the metal position, coordinated to four sulfur atoms. A sulfosalt such as Cu_3AsS_4 may also be thought of as a double sulfide, $3Cu_2S \cdot As_2S_5$.

Physical Properties of Fluorite	
Chemical Classification	Halide
Color	Typically purple, green, and yellow. Also colorless, blue, red, and black.
Streak	White
Luster	Vitreous
Diaphaneity	Transparent to translucent
Cleavage	Four directions of perfect cleavage
Mohs Hardness	4
Specific Gravity	3.2
Diagnostic Properties	Cleavage, hardness, specific gravity, color
Chemical Composition	CaF_2
Crystal System	Isometric(Cubic)
Uses	Numerous uses in the metallurgical, ceramics, and chemical industries. A source of fluorine, hydrofluoric acid, metallurgical flux. High-clarity pieces are used to make lenses for microscopes, telescopes, and cameras.



Physical Properties of Halite	
Chemical Classification	Halide
Color	Colorless or white when pure; impurities produce any color but usually yellow, gray, black, brown, red
Streak	White
Luster	Vitreous
Diaphaneity	Transparent to translucent
Cleavage	Perfect, cubic, three directions at right angles
Mohs Hardness	2.5
Specific Gravity	2
Diagnostic Properties	Cleavage, solubility, salty taste (The taste test is discouraged. Some minerals are toxic or contaminated by other people tasting them.)
Chemical Composition	NaCl
Crystal System	Isometric
Uses	Winter road treatment, a source of sodium and chlorine for chemical processes, food preservation, seasoning

Phosphate group

- *Naturally occurring inorganic salts of phosphoric acid, $H_3(PO_4)$. More than 200 species of phosphate minerals are recognized, and structurally they all have isolated (PO_4) tetrahedral units. Phosphates can be grouped as: (1) primary phosphates that have crystallized from a liquid; (2) secondary phosphates formed by the alteration of primary phosphates; and (3) fine-grained rock phosphates formed at low temperatures from phosphorus-bearing organic material, primarily underwater.*

Physical Properties of Apatite

Chemical Classification	Phosphate
Color	Green, brown, blue, yellow, violet, pink, colorless. Transparent specimens with excellent clarity and vivid color are used as gemstones.
Streak	White
Luster	Vitreous to subresinous
Diaphaneity	Transparent to translucent
Cleavage	Poor to indistinct
Mohs Hardness	5
Specific Gravity	3.1 to 3.3
Diagnostic Properties	Color, crystal form, and hardness. Brittle, often highly fractured. Can be scratched with a steel knife blade.
Chemical Composition	A group of calcium phosphates. Fluorapatite: $Ca_5(PO_4)_3F$ Hydroxylapatite: $Ca_5(PO_4)_3(OH)$ Chlorapatite: $Ca_5(PO_4)_3Cl$ Carbonate-rich apatite/francolite: $Ca_5(PO_4,CO_3)_3(F,O)$
Crystal System	Hexagonal
Uses	Fertilizer, phosphoric acid, hydrofluoric acid, gemstones, ore of rare earth elements, pigments, gemstone. Serves as a hardness of 5 on the Mohs Hardness Scale.

Carbonates group

- Carbonates
- In nature, carbon atoms join with oxygen to form the carbonate ion, CO_3. These ions combine with metal cations to form carbonate minerals. These minerals are commonly formed in sedimentary and oxidizing environments.
- The carbonates fall into three groups: the **calcite** group, the **dolomite** group, and the **aragonite** group. The copper carbonate minerals, azurite and malachite, are the only important economic carbonates.

Physical Properties of Calcite	
Chemical Classification	Carbonate
Color	Usually white but also colorless, gray, red, green, blue, yellow, brown, orange
Streak	White
Luster	Vitreous
Diaphaneity	Transparent to translucent
Cleavage	Perfect, rhombohedral, three directions
Mohs Hardness	3
Specific Gravity	2.7
Diagnostic Properties	Rhombohedral cleavage, powdered form effervesces weakly in dilute HCl, curved crystal faces and frequent twinning
Chemical Composition	$CaCO_3$
Crystal System	Hexagonal
Uses	Acid neutralization, a low-hardness abrasive, soil conditioner, heated for the production of lime

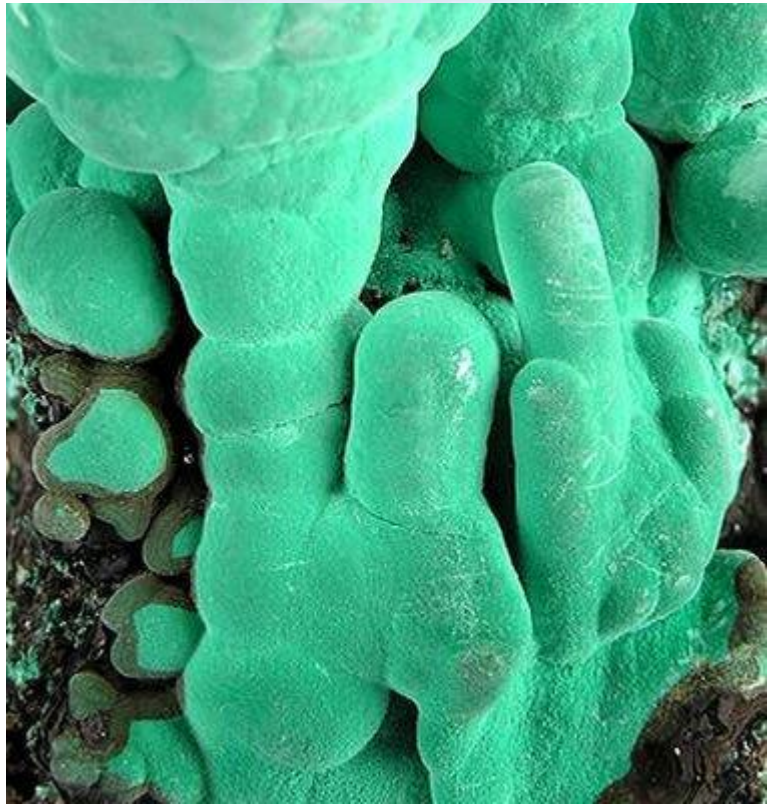
Physical Properties of Dolomite

Chemical Classification	Carbonate
Color	Colorless, white, pink, green, gray, brown, black
Streak	White
Luster	Vitreous, pearly
Diaphaneity	Transparent to translucent
Cleavage	Perfect, rhombohedral, three directions
Mohs Hardness	3.5 to 4
Specific Gravity	2.8 to 2.9
Diagnostic Properties	Rhombohedral cleavage, powdered form effervesces weakly in dilute HCl, hardness
Chemical Composition	$CaMg(CO_3)_2$
Crystal System	Hexagonal
Uses	Construction aggregate, cement manufacture, dimension stone, calcined to produce lime, sometimes an oil and gas reservoir, a source of magnesia for the chemical industry, agricultural soil treatments, metallurgical flux

Aragonite

Category	Carbonate mineral
Formula (repeating unit)	$CaCO_3$
Crystal system	Orthorhombic
Color	White, red, yellow, orange, green, purple, grey, blue and brown
Cleavage	Distinct on {010}, imperfect {110} and {011}
Fracture	Subconchoidal
Tenacity	Brittle
Mohs scale hardness	٤-٣,٥
Luster	Vitreous, resinous on fracture surfaces
Streak	White
Diaphaneity	Translucent to transparent
Specific gravity	٢,٩٥

Physical Properties of Malachite	
Chemical Classification	Carbonate
Color	Green
Streak	Green
Luster	Rare crystals are vitreous to adamantine. Fibrous specimens are silky. Massive specimens are dull to earthy. Polishes to a very bright luster.
Diaphaneity	Most specimens are opaque. Crystals are translucent.
Cleavage	Perfect in one direction. Fair in a second direction.
Mohs Hardness	3.5 to 4.0
Specific Gravity	3.6 to 4.0
Diagnostic Properties	Green color, soft, effervesces with dilute HCl to produce a green liquid.
Chemical Composition	$Cu_2(CO_3)(OH)_2$
Crystal System	Monoclinic
Uses	A minor ore of copper. Gemstones, small sculptures, pigment.



Physical Properties of Azurite	
Category	Carbonate mineral
Formula	$Cu_3(CO_3)_2(OH)_2$
Crystal system	Monoclinic
Color	Azure-blue, dark to pale blue; pale blue in transmitted light
Fracture	Conchoidal
Tenacity	brittle
Mohs scale hardness	3.5 to 4
Luster	Vitreous
Streak	Light blue
Diaphaneity	Transparent to translucent
Specific gravity	3.773 (measured), 3.78 (calculated)