



6. CARBONATES, NITRATES, BORATES

Carbonates (around 100 species) include very important minerals: calcite, aragonite, dolomite. The anionic unit is CO_3^{--} . These are minerals corresponding to the formula XCO_3 where **X** represents a bivalent metallic element: Ca, Mg, Zn, Mn, Fe^{2+} , Co, Sr, Ba, Pb, Cu.

There are 3 groups of carbonates: calcite group, aragonite group and basic carbonates.

Calcite group basic

(Rhombohedral)

Aragonite group

(Orthorhombic)

Carbonates

(Monoclinic)

Calcite	CaCO_3	Aragonite	CaCO_3	Azurite	$\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$
Dolomite	$(\text{Ca},\text{Mg})(\text{CO}_3)_2$	Cerussite	PbCO_3	Malachite	$\text{Cu}_2\text{CO}_3(\text{OH})_2$
Ankerite	$(\text{Ca},\text{Fe})(\text{CO}_3)_2$	Strontianite	SrCO_3		
Siderite	FeCO_3	Witherite	BaCO_3		
Magnesite	MgCO_3				
Rhodochrosite	MnCO_3				
Smithsonite	ZnCO_3				

Carbonates are colorless, white or faintly colored with the exception of those of copper, cobalt or manganese. Their hardness is less than 5. They generally effervesce with acids.

Nitrates are rare (less than 10 species). Two important minerals, Nitronatrite (NaNO_3) and Nitrite (KNO_3), often result from the evaporation of water circulating in desert soils.

Borates (around 100 species) have a structure with BO_3 groups -- or BO_4 tetrahedra. Glassy, colorless to white fragments, they have low hardness and are not very dense. They are found in water evaporation basins that have leached volcanic rocks.

Some well-known species: Ulexite $\text{NaCaB}_5\text{O}_9 \cdot 8\text{H}_2\text{O}$ (Triclinic, $D = 2 / H = 2.5$), Borax $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ (monoclinic; $D = 1.7 / H = 2$); Colemanite $\text{Ca}_2\text{B}_6\text{O}_{11} \cdot 5\text{H}_2\text{O}$ (monoclinic; $D = 2.4 / H = 4.5$) and Kernite $\text{Na}_2\text{B}_4\text{O}_7 \cdot 4\text{H}_2\text{O}$ (monoclinic, $D = 2.4 / H = 4$)



CALCITE



Rhombohedral

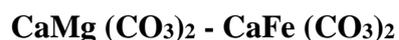
Automorphic crystals presenting very varied shapes (several hundred). The most common are: elongated or flattened rhombohedral prisms; scalenohedra. Often massive, sometimes fibrous and stalactitic. Very easy rhombohedral cleavages (determining rhombohedra).

D = 2.7 / H = 3. Colorless, white, pale shades. Sometimes fluorescent under UV light. Soluble cold with effervescence in even diluted acids.



One of the most widespread minerals. Essential constituent of certain sedimentary (limestone, marl) or metamorphic (cipolin) rocks. Accessory constituent of certain altered calcic eruptive rocks. Very common as gangue in hydrothermal deposits. Stalactitic concretions in caves.

DOLOMITE - ANKERITE



Rhombohedral

Solid solution series between the two minerals.

Usual shape: rhombohedron. Sometimes assemblies of small crystals with curved faces. Compact or rough granular masses. Perfect rhombohedral cleavages.

D = 2.9 = H = 3.5 to 4. Transparent to translucent. Bright glassy shine. Colorless, white, pale shades, brown (or browning by oxidation in iron-bearing varieties). Lively effervescence, hot only, in diluted acids.

Essential constituent of sedimentary or metamorphic dolomites. Gangue of hydrothermal veins or substitute deposits.



Dolomite



Magnesium ore.



SIDERITE (Siderosis)



Rhombohedral

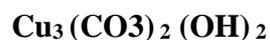
Automorphic crystals in rhombohedra, often lenticular, with curved faces, sometimes grouped in rosettes. Cleavable or finely granular crystalline masses. Globular concretions. Perfect cleavages.

D = 3.9 / H = 4. Translucent to opaque. Bright glassy shine. Blonde to brown. White dust. Hot acid effervescence only. Becomes brown to black by oxidation to limonite, goethite.

Common mineral. Sedimentary layers; substitution masses in limestones or dolomites, Concretions in various sediments; in veins, alone or as gangue of various ores



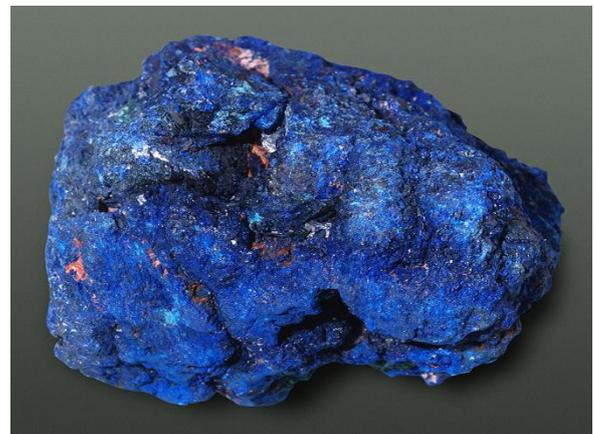
AZURITE



Monoclinic

Crystals with very varied, complex facies: prisms or tablets, fibro-radiated aggregates.

Often in coatings or earthy masses. Density 3.8 / H = 3.5 to 4. Conchoidal break; fragile. Cleavage interrupted. Transparent to translucent. Glassy shine. Bright azure blue to midnight blue color. Light blue dust. Alteration in malachite and native copper. Acid effervescence.





Mineral from the oxidation zone of copper deposits. Less common than malachite, with which it is associated as well as limonite, cuprite (Cu_2O).

MALACHITE



Rare, small crystals, generally acicular, grouped in clumps. Most often in coatings or concrete masses with a fibrous structure.

$D = 4 / H = 3.5$ to 4. Irregular breakage. Translucent to opaque. Vitreous, earthy luster in compact varieties. True green color, pale green for coatings. Pale green dust. Makes acids effervescent.

Mineral typical of the oxidation zone of copper deposits, associated with azurite, cuprite, limonite. Use: Copper ore. Ornamental material.

Monoclinic

