



V - PHYLLOSILICATES:

MICAS GROUP:

MUSCOVITE



Monoclinic

In general, only the (001) face is clear and sometimes has a pseudo-hexagonal outline. The lateral faces are irregular, dull and marked by cleavage. Sometimes association of small blades in divergent sheaves. In pegmatites, crystals sometimes of large dimensions (decimetric to metric).



$D = 2.8 / H = 2$ on (001), 3 to 4 on the other faces. Cleavage (001) extraordinarily easy. Flexible and elastic cleaving blades. Transparent to translucent. Bright pearly shine on (001), matte on the other sides. Colorless to light yellowish.

Varieties:

- **Lepidolite** (lithiniferous), pink, purple or purplish gray.
- **Fuschite** (chromiferous); green
- **Sericite**, finely fibrous or scaly coming from the alteration of silicates (feldspars). Unalterable.

Very widespread. Constitutive element of acidic eruptive rocks (2-mica granites, leucogranites, greisens) and metamorphic (gneiss, mica schists, sericite schists). Pegmatite veins.

Detrital mineral in tiny flakes in sedimentary rocks (psammite sandstone from the Tunisian Triassic).

Uses: electrical and thermal insulation, lubricant, refractory materials. Lepidolite is a source of lithium.



BIOTITE - PHLOGOPITE $K(Mg,Fe)_3(OH,F)_2[AlSi_3O_{10}]$

Continuous series of minerals with $Mg/Fe < 2/1$ for biotite, $Mg/Fe > 2/1$ for phlogopite.

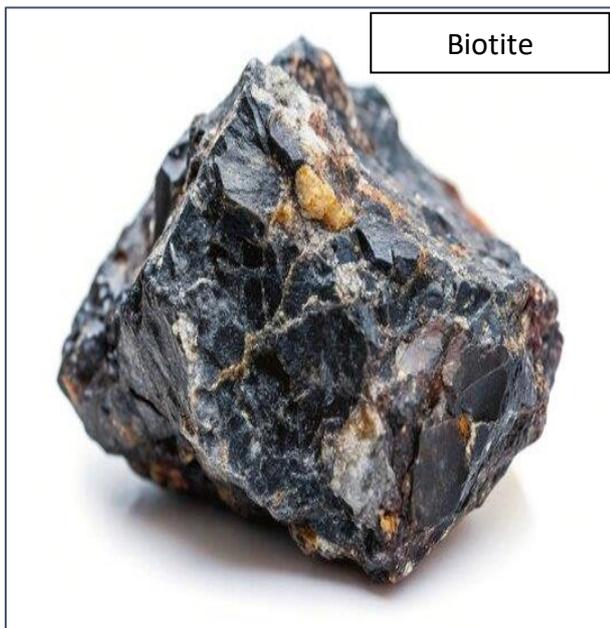
Forms and cleavage of muscovite.

$D = 2.7$ to 3.3 : $H = 2$ on (001), 3 to 4 on the other faces.

Brown to black color, sometimes with reddish or greenish nuances, colorless dust (biotite) or golden-brown yellow to almost colorless (phlogopite). Transparent to translucent. Bright shine on (001), sometimes pearly.

Hydrothermal alteration in chlorite or muscovite with exudation of iron and titanium oxides. Surface alteration into brownish hydromicas or vermiculite.

Biotite is the most widespread micas, frequently associated with muscovite. Constitutive element of eruptive and metamorphic rocks. Pegmatite veins.



Phlogopite appears in magnesian rocks (dolomites), metamorphosed in contact with granites.

Uses: phlogopite is used in the electrical industry (capacitors, etc.). Etymology: phlogopite, from the Greek “phlogopos”: inflamed (color).



CHLORITES GROUP: $Mg_3 Si_4 O_{10} (OH)_2 Mg_3 (OH)_6$ Monoclinic

These are hydrated Al, Mg, Fe silicates which form a group of monoclinic minerals resembling micas but which are distinguished by structural characters, by less easy cleavage, giving flexible but not elastic lamellae, and having a color usually dark green.

Substitutions result in the following formula: $(Mg,Fe,Al)_3(AlSi_3)O_{10}(OH)_2 Mg_3(OH)_6$

Magnesian chlorites: Pennine, Clinocllore and Ripidolite

Rarely in pseudo-hexagonal lamellar automorphic crystals; generally only face (001) is clear, the side faces are irregular. Often vermiculated piles of very small blades or leafy aggregates.

Very easy basal cleavage. Cleaving blades flexible but not elastic, unlike micas. $D = 2.6$ to $3 / H = 2$ to 2.5 . Bottle green color more or less dark to colorless. Translucent to opaque. Glassy shine.

Low temperature minerals. In metamorphic rocks (chloritoschists) with talc, serpentine. Characteristics of the "green schist" metamorphism facies (actinote-epidote-chlorite-albite association). In eruptive rocks where it forms by alteration of biotites, pyroxenes, amphiboles, garnets.



Etymology of the Greek "chloros" = green.



SERPENTINE $Mg_6[(OH)_5Si_4O_{10}]$

(Antigorite or lamellar serpentine. Chrysotile or fibrous serpentine)

Monoclinic but distinct crystals are due to pseudomorphoses. Aggregates mainly massive, sometimes scaly, acicular, fibrous, silky.



Serpentine



$d = 2.5$ to 2.6 . $D = 3$ to 4 . Tenacious. Conchoidal to fibrous breakage. Color generally green, blackish green, yellow green, sometimes brown, whitish yellow, reddish. Translucent to opaque. Oily shine. White dust.

Varieties: The noble, massive serpentine. Chrysolite (asbestos), acicular and fibrous masses, with a silky luster, yellow to light green in color. The fibers can reach 15 cm Garnierite would be a nickeliferous antigorite, it appears in collomorphic masses, apple green to greenish yellow in color and containing 4 to 30% nickel (very important source of nickel).

Deposits: Serpentine comes from the transformation of basic rocks, with chromite, magnetite. In limestone rocks, in nodules and lenses. Garnierite is linked to the alteration of olivine rocks in the tropical climate of New Caledonia.

TALC $Mg_3(OH)_2[Si_4O_{10}]$ Monoclinic

In compact powdery microcrystalline masses, rarely in crystals with clear shapes, or in laminated aggregates. Cleavage (001) perfect.

$D = 2.8$ / $H = 1$. Creamy touch. Colors: white, green, gray; pearly shine.

Silicate linked to the transformation of dolomite by siliceous solutions (French deposits) or to the hydrothermal alteration of magnesium basic rocks (Italian deposits).



CLAYS (Kaolinite, Montmorillonite, Illite)

Aluminum silicates, sometimes Mg, Fe, K, hydrated

Monoclinic

We distinguish:

- Silico-aluminous clays: **Kaolinite** $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$
- Ferro-magnesian silico-aluminous clays: **Montmorillonite** $(\text{Al,Fe,Mg})_4(\text{Si}_4\text{O}_{10}(\text{OH})_2 \cdot n\text{H}_2\text{O})$.
- Potassic silico-aluminous clays: **Illite** $\text{K}(\text{Al,Mg,Fe})_2(\text{SiAl})_4\text{O}_{10}(\text{OH})_2$

Clays appear in very small crystallites ($<500\text{\AA}$) and only the electron microscope has made it possible to specify their shape, generally in platelets with a hexagonal outline. Color: white to gray, yellow, green.

Macroscopically, clays constitute earthy masses characterized by their plasticity (ability to make paste with water), their ability to absorb polar molecules (water, etc.) (montmorillonite), their hardening during cooking (brick manufacturing).

The exact determination of the mineralogical composition of a clay is based on physical analyses: thermal analyzes and X-ray diffraction.

Principal silicate alteration minerals, particularly feldspars

Deposits: In altered feldspathic rocks. In sedimentary series: clays form layers that are sometimes very thick. These are very fine products transported after erosion of continental masses.

Use: making bricks, porcelain and pottery.



VI – TECTOSILICATES

FELDSPATHOIDS

In rocks less rich in silica, feldspars are replaced by minerals poor in silica, called feldspathoids. Quartz can never be found at the same time as these minerals.

LEUCITE



Quadratic

Generally included pseudo-cubic crystals up to 5 cm, showing the faces of the trapezohedron; faces often streaked. Sometimes grainy or massive. $D = 2.5 / H = 5.5$ to

6. Conchoidal breakage. Color: milky white to gray. Opaque, sometimes translucent. Glassy shine. White dust.

In lavas (leucitites, phonolites, leucite basalts, etc.). More rarely in deep rocks. Italy (lavas from Vesuvius).





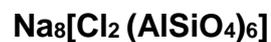
NEPHELINE (K,Na₃)[AlSiO₄]₄ Hexagonal

Rarely well crystallized in stubby prisms. Often grainy or massive. Color: white, yellowish, sometimes greenish, reddish. Transparent to translucent. Vitreous to greasy sheen. Colorless dust.

Important mineral, essential constituent of nepheline syenites, phonolites, sometimes in free crystals in the cavities of volcanic rocks. Associated with zircon, sphene and apatite.



SODALITE



Cubique.

Rare in dodecahedral crystals sometimes centimetric with the faces of the cube and the octahedron, sometimes and rarely those of the hexagonal prism (male), massive grained. D = 2.2. H = 5.5. Glassy to oily sheen, colorless, gray, greenish, yellowish, sometimes blue. Colorless dust.

In alkaline rocks and in recent eruptive rocks. Often associated with nepheline.

LAZURITE



Cubique

Very rarely in centimetric, dodecahedral crystals. Grainy to cryptocrystalline aggregates. D = 2.4. H = 5 to 5.5. Uneven breakage. Color: dark azure blue, sometimes light blue. Opaque to translucent. Vitreous to greasy sheen. Azure blue dust. Frequent pyrite inclusions.

Rare. Contact deposits between alkaline rocks (alkaline granites, alkaline syenites) and carbonate rocks...

Varieties: the **most beautiful** varieties colored blue are sought after in jewelry (**Lapis lazuli**).

FELDSPATHS GROUP

The feldspar group includes silicate minerals with several common properties. They constitute more than 60% of the upper part of the earth's crust. They undoubtedly owe their name to their vast distribution (in each field, in German "Feld"), and to the word "Fels", meaning rock.



- **Potassium feldspars:** Orthoclase, Microcline
- **Sodi-calcium feldspars or plagioclase:** Albite, Oligoclase, Andesine, Labrador, Bytownite, Anorthite

ORTHOCLASIS

(Orthoclase) $K [AlSi_3 O_8]$

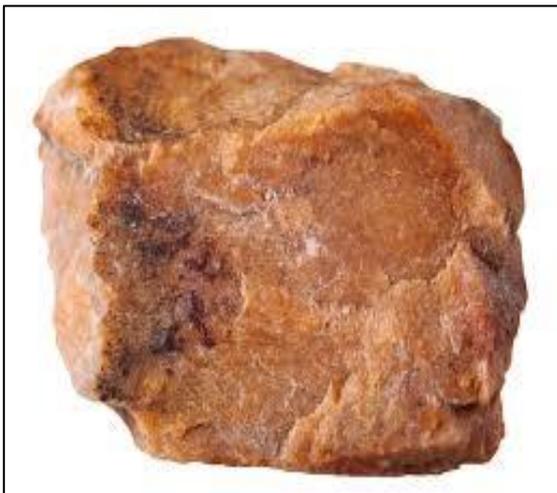
Monoclinic

Common well-formed crystals, sometimes large, flattened or elongated. Frequently massive. Frequent simple twin of rotation and adjoining plane (Carlsbad twin).

Etymology of the Greek "orthoclase": right; "clasis": cleavage (right angle cleavages)

Perfect orthogonal cleavages. $D = 2.57$. $H = 6$. Transparent to translucent. Glassy shine. Colorless, white, flesh red, pink)

Alterable (kaolinization).



Varieties:

- **Sanidine:** cracked, vitreous, found in trachyte volcanic rocks);
- **Adularia:** of hydrothermal origin, in colorless and transparent crystals.

Very widespread mineral. Essential constituent of eruptive rocks (granites and syenites), metamorphic rocks (gneiss). Pegmatite veins. Sometimes oriented associations with quartz (graphic pegmatites) or albite (perthites). In sedimentary rocks: arkoses.

Industrial uses: ceramics, porcelain, glass.

MICROCLINE

$K [AlSi_3 O_8]$

Triclinic

Rare automorphic crystals; rather in cleavable, compact or grainy masses. Same physical properties as orthoclase, from which it is indistinguishable macroscopically. Variety: **green Amazonite**.



Deposits comparable to those of orthoclase but lower temperature formation conditions. Almost constant association with albite: perthites, often visible to the naked eye.

Etymology of the Greek "micros": little, "elino": to incline. The angle of the cleavages is very close to 90°.



PLAGIOCLASES Na [AlSi₃O₈] to Ca [Al₂Si₂O₈] **Triclinics.**

Continuous series of minerals between albite (sodium term) and anorthite (calcic term).

Tabular crystals, quite rarely well formed only in albite. Generally in grains, aggregates, grainy masses, or laminar. Frequent and varied twins, particularly of the polysynthetic type.

D = 2.62 to 2.76 (from albite to anorthite). H = 6 to 6.5. Transparent to translucent glassy sheen. Variable colors, generally pale: pink-white, grayish, bluish. Colorless dust. Labradors often exhibit a characteristic shimmer.

Easier alteration for calcic plagioclases giving epidote, scapolite, chlorite, calcite, zeolites, than for sodiums which give kaolinite.

- Widespread minerals. Essential constituents of igneous rocks: their calcium content increases with the basicity of the rock and its richness in ferromagnesian silicates.
- Metamorphic rocks: (gneiss, metamorphic limestones)
- Pegmatite veins.

Etymology: from the Greek "plagios": oblique, "clasis": cleavage.

Intermediate minerals are classified according to their percentages of Albite (Ab) and Anorthite (An).

- **ALBITE** (Ab 100 - 90 / Year 0 -10%). Tabular crystals. Cleavelandite is a variety with lamellar facies. Aventurine is an albite with red internal reflections due to hematite inclusions. In alkaline granites and syenites. In pegmatites and pneumatolytes with lepidolite, beryl, cassiterite.



- **ANDESINE** - (Ab 90 - 70). Especially in laminar masses. In granites, syenites, andesites, gneisses...
- **ANDESITE** (Ab 70 - 50). Crystals rich in faces. In cordierite gneisses. In eruptive rocks.
- **LABRADOR** (Ab 50 - 30). Lamellar masses. In gabbros, they often exhibit colored internal reflections, giving highlights “butterfly wings”. In anorthosites.
- **BYTOWNITE** (Ab 30 - 10). Looks like a Labrador. In diorites, certain volcanic rocks and meteorites.
- **ANORTHITE** (Ab 10 - 0). Rare prismatic crystals. Cleavable or grained masses. In basic igneous rocks (diorite, andesite, gabbro, norite). In contact metamorphic limestones. Alteration: in kaolin.

QUARTZ

SiO₂

Rhombohedral.

Prismatic automorphic crystals (generally a six-sided prism) are terminated by two pyramids (bipyramid prisms). When facets appear truncating the vertices of the prism, they highlight the reduced rhombohedral symmetry and sometimes the existence of twins. The faces of the prism are generally horizontally ridged.

D = 2.65. H = 7. Fragile upon impact. No clear divide. Conchoidal breakage. Transparent to translucent. Vitreous shine, greasy in the break. Variable color: colorless, white, brown, pink, purple). Frequent gaseous, liquid or crystalline inclusions (rutile, micas, chlorites, etc.). There are huge crystals, the size of a man.

Quartz is very common because it is very mechanically resistant and difficult to attack chemically (soluble only in hydrofluoric acid).

Quartz is, after feldspars, the most common mineral in the upper part of the earth's crust. It is the main component of silica-rich igneous and metamorphic rocks, as well as most sands.

In mineral assemblages, quartz generally appears colorless or milky.

Varieties:

- **Rock crystal** (clear and colorless),
- **Silky quartz** (translucent white),
- **Smoky quartz** (more or less dark brown),
- **Amethyst** (purple),
- **Aventurine** (mica or hematite inclusions)
- **Citrine:** lemon yellow to honeyed (heated amethyst)

Types of deposits: one of the most widespread minerals. Eruptive rocks: granites, rhyolites, diorites, quartzites. Metamorphic rocks: gneiss, mica schists, quartzites...



Sedimentary rocks: sands, sandstones, conglomerates...Pegmatitic and hydrothermal veins.



Use: Used as a raw material in the glass and ceramic industry, in technology in the adjustment of transmitters and watches, in optics (UV premiums)...

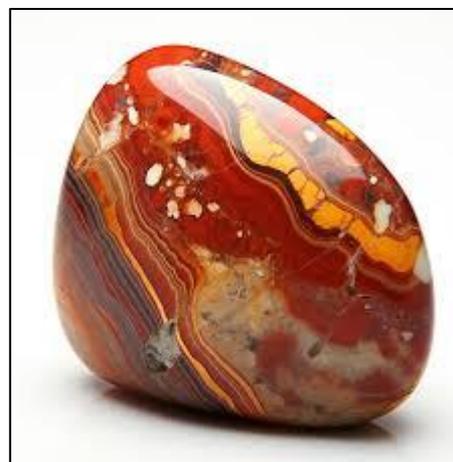
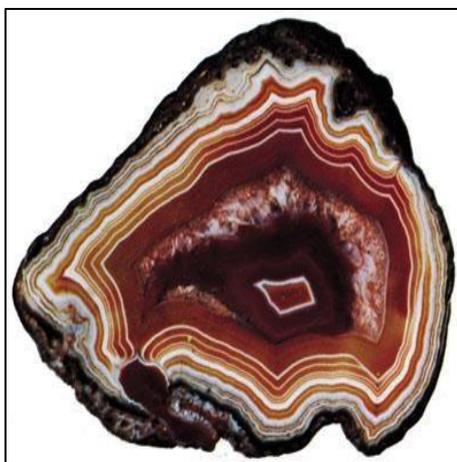
Colorful varieties are valued as **gems and decorative stones**.

The word quartz comes from the language of German miners in the Middle Ages. Its original meaning remains unknown.

CHALCEDONY (Agate) SiO₂

Chalcedony is a finely fibrous variety of quartz, forming concretionary masses with nipped surfaces.

Conchoidal breakage. Transparent to translucent. Glassy shine. Variable color (white, gray, pale blue, brown.....)





Varieties:

- **Agates:** finely zoned concentrically chalcedony, often with contrasting hues.
- **Jaspers:** microcrystalline varieties brightly colored brown, red or green, notably by iron oxides.
- **Lydians:** black jaspers of organic origin, rich in carbonaceous inclusions.
- **Silex** concretions of yellowish, grayish to blackish color formed by concentration of silica in limestone sediments.

Very common mineral, of secondary origin at low temperature, often associated with opal and forming at the expense of quartz at shallow depth. Eruptive rock cavities. “Iron hats” or wall walls of the veins. Sedimentary rocks.

OPAL

$\text{SiO}_2, n\text{H}_2\text{O}$

Amorphous

Concrete, nipple-like masses, sometimes powdery. Form of masses mixed with chalcedony, or alternately zoned with it.

D = 2 to 2.5. H = 5 to 6. Conchoidal breakage. Transparent to almost opaque. Vitreous or resinous sheen. Colorless when pure. Metallic oxides can color it brightly yellow, brown, red green, etc.

Unalterable.





Varieties:

- **Noble opal**, with iridescent reflections due to internal reflections.
- **Geyselite**, concretions of geyser deposits, porous, grayish, opaque
- **Tripoli**: very fine-grained earth formed from remains of diatoms or of infusoria in sedimentary deposits.

Mineral of secondary origin, low temperature. In the cavities and fissures of volcanic rocks. Silicate meteoric alteration mineral. Of organic origin in sediments.

SILICIFIED WOOD

Formed by the action of groundwater which, while circulating, dissolves the organic matter buried in the sediments and replaces it with mineral substances (mainly chalcedony). It is therefore chalcedony in pseudomorphosis of wood.

