Democratic and People's Republic of Algeria

Ministry of Higher Education and Scientific Research

Adlehafid boussouf university center of MILA

Faculty Natural and life sciences

Department: Department: science of the earth and the university

Practical works Mineralogy

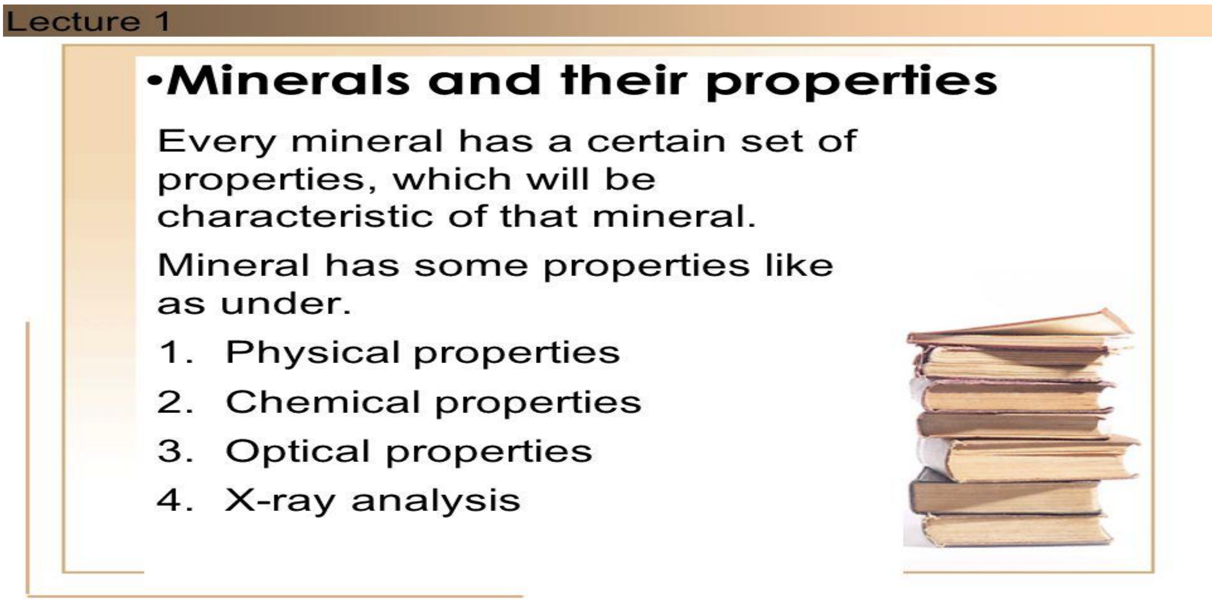
BOUFEDAH BADISSI Mohamed Salah

2024-2025

1- Definition of a mineral

Natural inorganic solid, characterized by an ordered atomic structure and a precise chemical composition, and constituting the rocks of the earth's crust.

2- Mineral classification systems



1) Classification according to chemical composition
2) Classification according to internal atomic structure
3) Classification according to physical, chemical and optical properties

2.1- Classification according to chemical composition

GROUPE	MINÉRAL	FORMULE	USAGE
ÉLÉMENTS NATIFS	Or	Au	Échange, joaillerie
	Argent	Ag	joaillerie, photographie
	Cuivre	Cu	conducteurs électriques
	Diamant	C	gemmes, abrasifs
	Graphite	C	mines à crayons, lubrifiants
	Soufre	S	médicaments, produits chimiques
	Platine	Pt	catalyseurs, alliages
OXYDES	Hématite	Fe_2O_3	minerai de fer
	Magnétite	Fe_3O_4	minerai de fer
	Corindon	Al_2O_3	gemme, abrasif
SULFURES	Galène	PbS	minerai de plomb
	Sphalérite	ZnS	minerai de zinc
	Pyrite	FeS_2	"or des fous"
	Chalcopyrite	$CuFeS_2$	minerai de cuivre
	Bornite	Cu_5FeS_4	minerai de cuivre
	Cinabre	HgS	minerai de mercure
SULFATES	Gypse	$CaSO_4.H_2O$	plâtre et panneaux
	Anhydrite	$CaSO_4$	plâtre et panneaux
	Barite	$BaSO_4$	boue de forage
CARBONATES	Calcite	$CaCO_3$	ciment Portland
	Dolomite	$CaMg(CO_3)_2$	ciment Portland
	Malachite	$Cu_2(OH)_2CO_3$	minerai de cuivre, joaillerie
	Azurite	$Cu_3(OH)_2(CO_3)_2$	minerai de cuivre, joaillerie
	Rhodochrosite	$MnCO_3$	joaillerie
SILICATES	quartz	SiO_2	verre, horlogerie, calculatrices
	talc	$Mg_3Si_4O_{10}(OH)_2$	poudre pour bébés
	amiante	$Mg_6Si_4O_{10}(OH)_8$	isolant
	kaolinite	$Al_4Si_4O_{10}(OH)_8$	céramique
HALOGÉNURES	Halite	$NaCl$	sel commun
	Fluorite	CaF_2	fabrication des aciers
	Sylvite	KCl	fertilisants
HYDROXYDES	Limonite	$FeO(OH).nH_2O$	minerai de fer, pigment
	Bauxite	$Al(OH)_3.\ nH_2O$	minerai d'aluminium

2.2- Classification according to internal atomic structure: there are Seven cristalline systems.

2.3- Classification according to physical, chemical and optical properties

Physical Property	Definition	Method of Examination
Colour	Reflection or absorption of light from a mineral	Observe the specimen and determine its colour such as pink, blue, green, yellow, red, white, black, etc.
Streak	Colour of a mineral in its powdered form	Rub/scratch the specimen on the streak plate and determine colour of the powder. Note that it is not recommended for mineral having hardness >7 as it would scratch the streak plate itself
Luster	Amount and type of reflection of light by a mineral from its surface	Observe the specimen and determine if the mineral is metallic or non-metallic in appearance
Transparency or diaphaneity	Capability of a mineral to transmit light through itself	Put the specimen on a piece of newspaper and determine how sharp and distinct outline of the texts/ objects are
Crystal Form/ Habit	General shape or appearance of a mineral	Generally, it is not seen in most of the laboratory samples. However, determine it by examining the shape of a specimen
Cleavage	Breakage of a mineral along its crystallographic planes	Examine the broken surfaces of the specimen and where light reflects
Fracture	Breakage of a mineral other than along planes of cleavage	Examine the broken surfaces of the specimen and describe the breakage either irregular or conchoidal
Hardness	Resistance of a mineral to scratching	You can determine relative hardness of a specimen by scratching it with objects/ minerals of known hardness
Magnetism	Electromagnetic force generated by a mineral	Use a magnet to check if it is attracted by the specimen
Specific Gravity	It determines relative density of minerals. It is a ratio of the mass of a mineral to the mass of an equal volume of water	Check the relative weight of a specimen by holding it in hand
Reaction to acid	Chemical interaction of dilute hydrochloric acid and calcium carbonate	This is to be done only for carbonate samples like calcite. Determine it by placing a small drop of dilute HCl on a specimen and check for a reaction - effervesces (bubbles). Do not forget to clean the acid from the sample with flowing water

3. The use of minerals

- ❖ *Nutrition*
- ❖ *Industry*
- ❖ *Jewelry, art and decoration*

I. OPTICAL AND PHYSICAL PROPERTIES OF MINERALS

I.1 Definition of a mineral:

Homogeneous natural solid, characterized by an ordered atomic structure and a precise chemical composition, and constituting the rocks of the crust terrestrial. (Dict. Larousse)

The classification of minerals is based on their chemical characters and crystallographic and includes the following main classes: 1.Elements natives; 2. Sulphides; 3. oxides and hydroxides; 4. halides; 5.Carbonates; 6. Phosphates; 7. Sulfates; 8. Silicates.

I.2 THE OPTICAL AND PHYSICAL PROPERTIES OF MINERALS

We will only describe here the optical properties of minerals whose effects are perceptible to the naked eye and we will not discuss optics crystalline which involves the use of various devices, in particular the polarizing microscope.

A) TRANSPARENCY

First of all, we distinguish transparent minerals from those which are opaque. The former allow the light to pass through while the latter stop it more or less completely. The limit is not clear. There m ost of the minerals constituting rocks are transparent when observed under a microscope in thin section (0.03 mm), while most of them appear opaque to the naked eye. We also say that a mineral is translucent when it allows light while masking the outline of objects observed through it. It is among the sulphides and metal oxides that we find the truly opaque minerals, while most other minerals classes are transparent. It is the more or less selective absorption of light by minerals which determines their transparency, opacity andtheir color.

B) THE COLOR IS MISLEADING

Color is one of the characters used primarily in description of minerals. However, minerals which always have the same color are few frequent. We must therefore be careful and be aware that the color of most minerals is essentially variable and that it can be due to various very different causes:

1. One of the chemical elements constituting the mineral is chromatophore. The mineral then still has its own color. Thus copper colors minerals green or blue, manganese in purple red, lithium in pink red and magnesium associated with iron gives a yellow-green color.
2. Tiny traces of a chromatophore element are dispersed within of a usually colorless mineral. The same mineral species can therefore present different colors depending on the nature of impurity.
3. 3. Fine inclusions modify the coloring of a mineral usually colorless. Quartz tinted green by fine inclusions chlorite or dark red by hematite inclusions.
4. 4. Disruption of the crystal lattice by natural radioactivity rock can cause unusual hues to appear. The best known example is that of smoky quartz whose brown tint more or less dark was caused by the very weak radioactivity granite in which it has remained for several million years.

C) LINE COLOR

The degree to which a mineral is divided into small particles plays a role important on the appearance of its color. If divided finely - into powder.

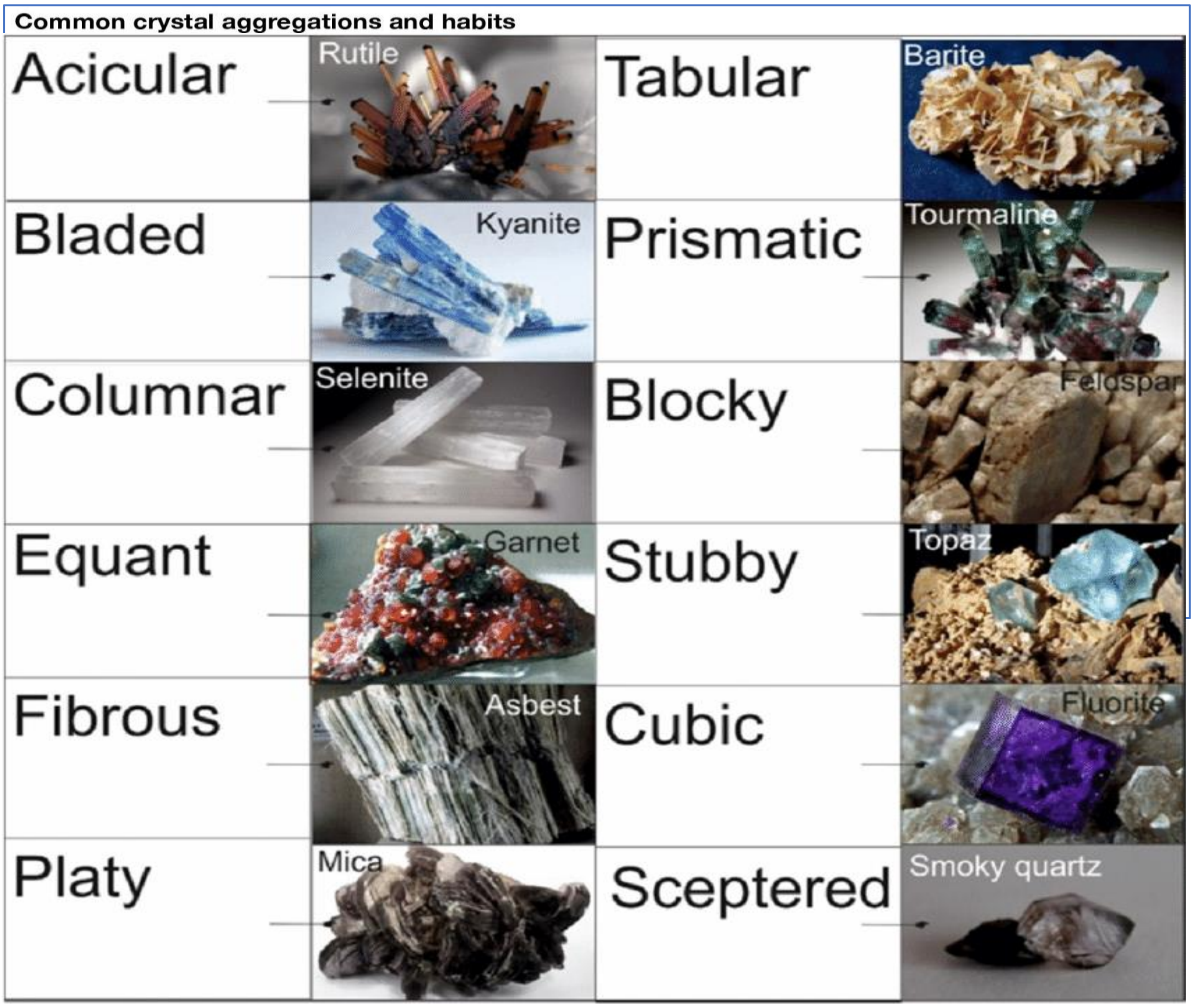
for example - its color becomes lighter. Hematite which appears gray-black gives a brownish red color when powdered. To observe this coloring simply rub the mineral onto a hard rough surface. We generally uses an unglazed porcelain plate on which the mineral leaves a colored line. The color of the line features prominently in works describing minerals.

D) THE HABITUS DESCRIBES THE EXTERNAL FORM

The habitus describes the various forms that minerals can take. To describe them, we use qualifiers specifying the geometric shape. linked to the crystal system or a tendency towards flattening, elongation, or sometimes even, a particular form linked to the mode of training. We then speak of octahedral, pyramidal, prismatic habitus, or still of isometric habitus, elongated, prismatic, acicular, tabular.

In nature, the same mineral species can appear with a habitus different depending on the pressure and temperature conditions in which it was formed, or because of the influence of a very slight modification of its chemical composition.

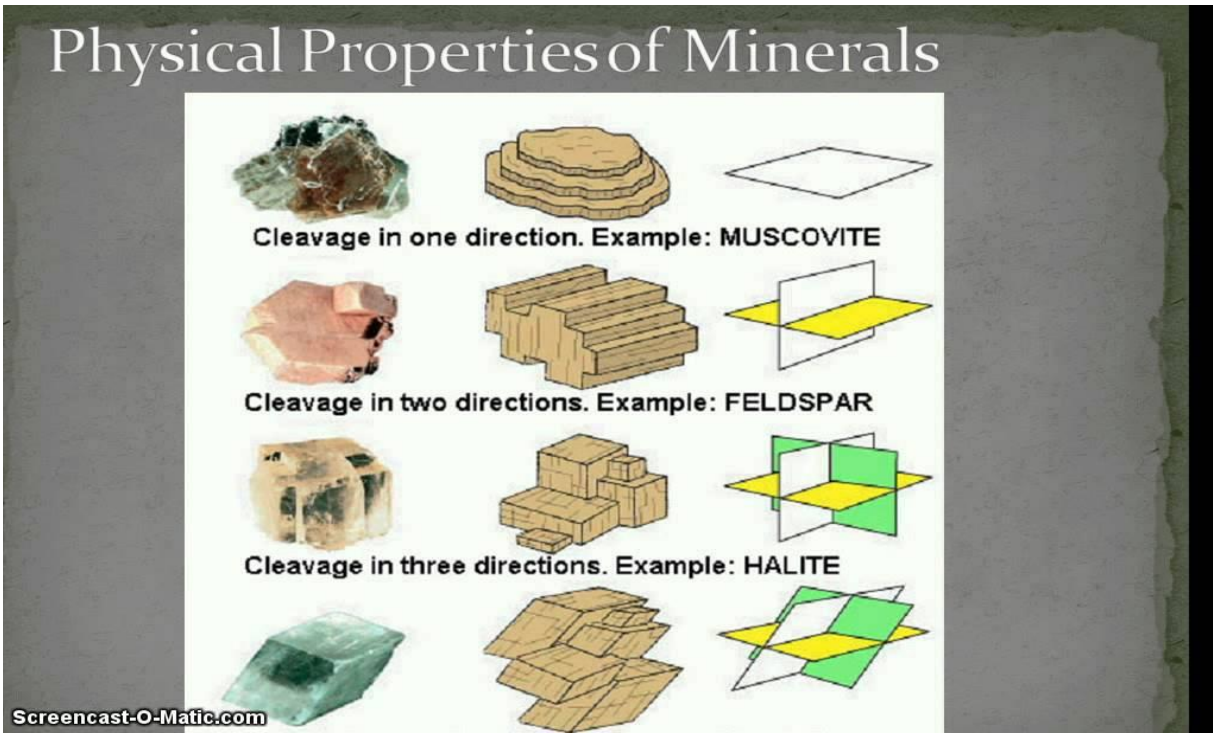
When minerals are grouped other than in crystals individualized, we attribute evocative qualifiers to them: massive**, granular, fibrous, fibro-radiated, foliaceous, dendritic, stalactitic, globular...**



E) CLEAVAGE, A SIGN OF STRUCTURAL WEAKNESS

Many minerals have the property of being debited along preferential planes when mechanical pressure is exerted on them. This phenomenon is particularly marked for calcite crystals which are cut into rhombohedra, for micas which are cut into sheets and for fluorite cubes whose vertices can easily be truncated.

A cleavage is said to be easy or difficult depending on the importance of the mechanical effort that it took practice to obtain it. We also speak of perfect cleavage if the The surface obtained is very smooth and reflective like a mirror. It is said imperfect when the plan obtained only imperfectly reflects a signal bright.



F) THE SPECIFIC WEIGHT

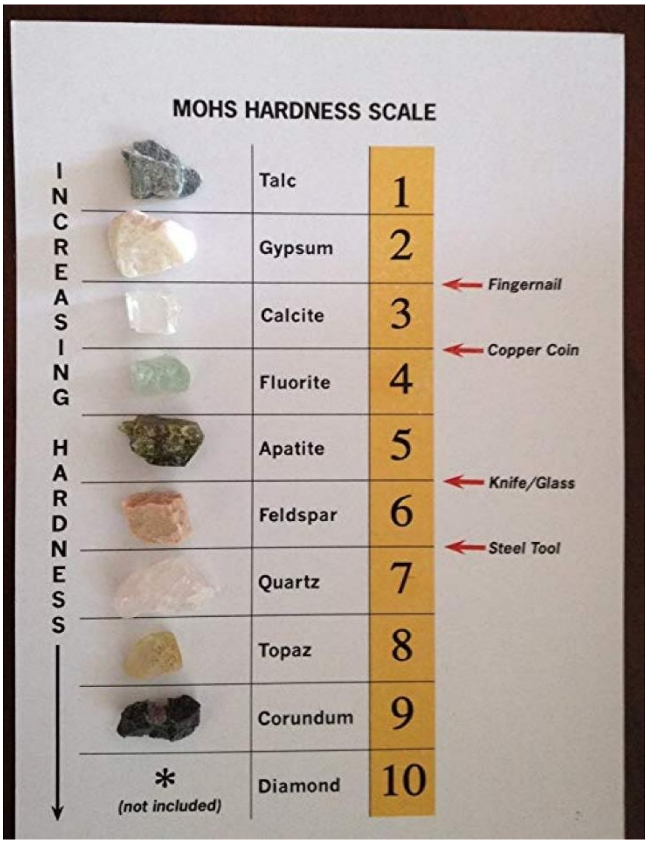
It is the weight of a unit of volume. It is expressed in grams by cubic centimeter [g/cm3]. As for the density of a mineral, it is the ratio of its specific weight to that of water. The two values are the same, except except that density is expressed as a unitless number.

The specific weight of a mineral directly depends on its composition chemical and, to a lesser extent, its structure. It corresponds to the weight of all the atoms contained in the unit cell, divided by its volume.

The principle of measuring specific weight is simple: we divide the weight of the mineral by its volume. The volume is obtained by double weighing of the mineral, in the air then in the water, the difference corresponding to the weight of the volume of water displaced.

In the field, it is possible to approximately determine the density of a mineral by weighing it. We thus distinguish:

- ❖ Light minerals (density 1 to 2),
- ❖ Moderately heavy minerals (density of 2 to 4) such as gypsum (d=2.3), quartz (d=2.65 to 2.7), calcite (d=2.7), amphiboles (d=2.9 to 3.45), pyroxenes (d=3.1 to 3.6),
- ❖ Heavy minerals (d=4 to 6) such as blende (d=4.2), barite (d=4.48) or pyrite (d=5 to 5.2),
- ❖ Very heavy minerals (d>6) such as galena (d=7.4 to 7.6), cassiterite (d=6.8 to 7) or uraninite (d=8) and native metals: gold (d=15 to 16), platinum (d=14 to 20)...



G) HARDNESS REFLECTS THE COHESION OF THE STRUCTURE

Hardness reflects the resistance offered by the crystal structure to mechanical efforts that are made to it. Practically, it is the resistance tostripe. A mineral is said to be harder than another mineral when it scratches this last. The measurement of hardness is empirical and is done by comparison with 10 reference minerals which constitute the so-called Mohs hardness scale.

Measuring hardness is easy. When we say that pyrite has a hardness of 6.5, this means that it scratches the orthoclase but is scratched by the quartz. Hardness depends on the structure of the mineral, the size of the atoms, and the connecting forces that unite them.

Hardness benchmarks

2.5	**Nail**
3	**Copper coin**
5	**Pocket knife blade**
5.5	**Window glass**
6.5	**Steel file**

Mohs hardness scale

1 talc, crumbly under the nail

2 gypsum, scratchable with a nail

3 calcite, scratchable with a copper coin

4 fluorite, scratchable (lightly) with a knife

5 apatite, scratchable with a knife

6 orthoclase, scratchable with file, by sand

7 quartz, scratches a window

8 topaz, scratchable by tungsten carbide

9 corundum, scratchable with silicon carbide

10 diamond, scratchable with another diamond

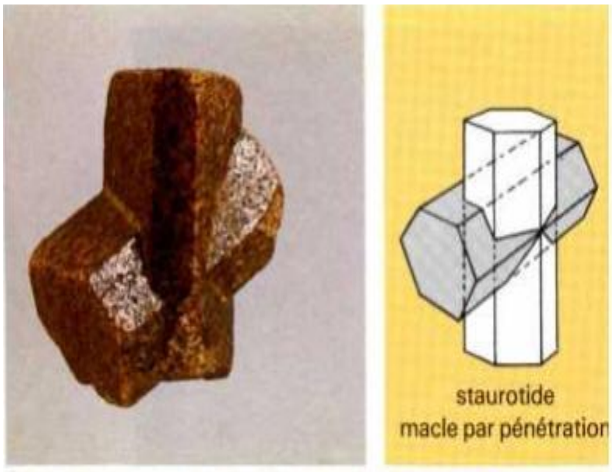
H) SHINE ALLOWS YOU TO SHINE

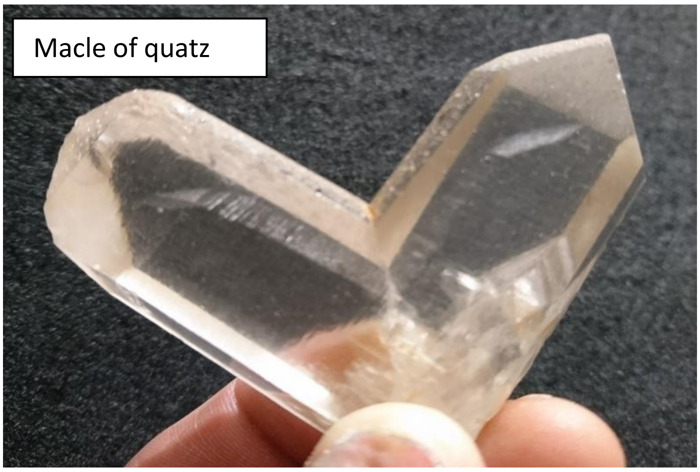
Brilliance is a somewhat subjective assessment that directly depends reflective power. The latter is defined as the proportion of light reflected in relation to the quantity of light received. The greasy or glassy sheen characterizes low-index transparent minerals of refraction (quartz, fluorite, tourmaline), the adamantine radiance characterizes the transparent minerals with a high refractive index (Cassiterite, Rutile, Diamond).

As for opaque minerals, their luster is more or less metallic depending on the importance of their reflective power. The nature of the surface of the mineral or the presence of inclusions microscopic can modify the brightness, and there is a whole series of qualifiers which characterize these aspects: resinous, milky, earthy, silky, dull, etc...

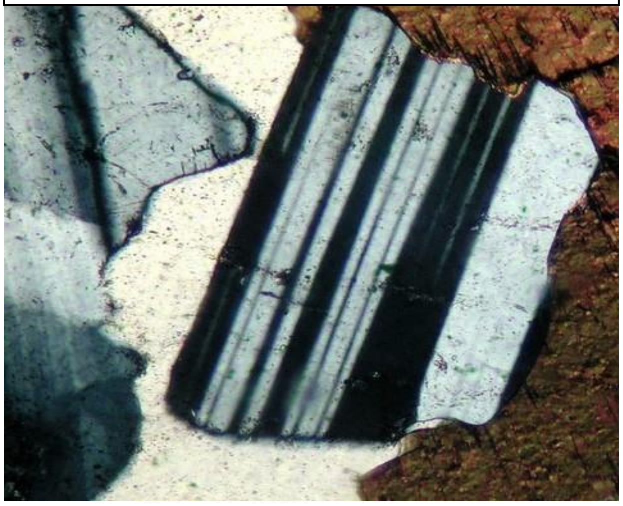
I) Twinnings (Fr. les Macles)

Certain minerals are easily characterized when they present twins. It is in fact the association of crystals of the same composition which puts in common an element of symmetry, either by joining along a defined face, or by interpenetration of crystalsThere can be single twins (association of two crystals) or multiple twins (several crystals). Some twins are very characteristic: the iron twin of lance of gypsum, the knee twin of rutile, the cross twin of Saint-André of staurolite, polysynthetic plagioclase twins, Carlsbad twin orthoclase...





Macle of Labradorite (with microscope)



J) SOLOBILITY

Some minerals may be soluble in water and others in acid. This characteristic can be interesting to identify certain minerals. For example: sylvite (KCl) and halite (NaCl) dissolve in cold water, the gypsum($CaSO_4 2H_2O$) in hot water. Calcite ($CaCO_3$), it dissolves very well, causing strong effervescence in cold hydrochloric acid, which allows it to be differentiated from dolomite (Ca,Mg)CO3.

K) TASTE AND SMELL

It may also be interesting to "taste" and "smell" some minerals. Thus, sylvite and halite taste salty and some sulphides slightly heated, or crushed by a hammer blow, (pyrite, marcasite) release a smell of sulfur (rotten egg).