

## Identification of Rock Minerals under a Polarizing Microscope

Igneous rocks contain a wide variety of minerals, but the predominance of basalts and granites has led geologists to establish a classification system that takes into account a few minerals, which are classified into four groups:

- **Cardinal minerals:** These determine the major groups of the classification. These are quartz, feldspars, and feldspathoids.
- **Essential minerals:** These complete the definition of the rock and determine second-order divisions. These are generally ferromagnesian elements.
- **Accessory minerals:** These are not included in the classification but are consistently present in the rock, most often in small quantities (apatite, zircon, etc.). □ **Accidental minerals:** They are only present in certain particular types of rocks (garnets, corundum, etc.).

Minéral	Formule chimique	Roches magmatiques
<b>Silice</b> Quartz, tridymite, cristobalite	SiO <sub>2</sub>	Roches acides
<b>Feldspaths</b> Sanidine, orthose, microcline	KAlSi <sub>3</sub> O <sub>8</sub>	Volcaniques (sanidine) et plutoniques
Plagioclases <i>Albite</i> <i>Anorthite</i>	NaAlSi <sub>3</sub> O <sub>8</sub> CaAlSi <sub>3</sub> O <sub>8</sub>	Roches volcaniques et plutoniques, acides et basiques.
<b>Feldspathoïdes</b> Népheline Leucite Sodalite	Na <sub>3</sub> K[AlSi <sub>4</sub> ] KAlSi <sub>2</sub> O <sub>6</sub> Na <sub>8</sub> Al <sub>6</sub> Si <sub>6</sub> O <sub>24</sub> Cl <sub>2</sub>	Roches alcalines pauvres en SiO <sub>2</sub>
<b>Olivines</b> Fayalite Forstérite	Fe <sub>2</sub> SiO <sub>4</sub> Mg <sub>2</sub> SiO <sub>4</sub>	Roches acides Roches basiques et ultrabasiques
<b>Pyroxènes</b> Enstatite Hypersthène Augite Aegyrine Spodumène	Mg <sub>2</sub> Si <sub>2</sub> O <sub>6</sub> (Mg,Fe) <sub>2</sub> Si <sub>2</sub> O <sub>6</sub> Ca(Mg,Fe)Si <sub>2</sub> O <sub>6</sub> Fe <sup>3+</sup> NaSi <sub>2</sub> O <sub>6</sub> LiAlSi <sub>2</sub> O <sub>6</sub>	Roches volcaniques et plutoniques // // // // // //
<b>Amphiboles</b> Hornblende Riébeckite	(Ca,Na,K) <sub>3</sub> (Mg,Fe,Al) <sub>2</sub> Si <sub>6</sub> (Si,Al) <sub>2</sub> O <sub>22</sub> (OH,F) <sub>2</sub> Na <sub>2</sub> Fe <sup>2+</sup> <sub>2</sub> Fe <sup>3+</sup> <sub>3</sub> Si <sub>8</sub> O <sub>22</sub> (OH) <sub>2</sub>	Roches plutoniques calcoalcalines Roches plutoniques alcalines
<b>Micas</b> Muscovite Biotite Lépidolite	KAl <sub>2</sub> (AlSi <sub>3</sub> O <sub>10</sub> )(OH) <sub>2</sub> K(Mg,Fe) <sub>3</sub> (AlSi <sub>3</sub> O <sub>10</sub> )(OH) <sub>2</sub> KLi <sub>2</sub> Al(Si <sub>4</sub> O <sub>10</sub> )(OH) <sub>2</sub>	Roches plutoniques acides Roches magmatiques acides et inter. Pegmatites
<b>Minéraux accessoires</b> Apatite Corindon Sphène Fluorine Zircon Magnétite Ilménite Pyrite	Ca <sub>5</sub> (PO <sub>4</sub> ) <sub>3</sub> (OH,F,Cl) Al <sub>2</sub> O <sub>3</sub> CaTiSiO <sub>5</sub> CaF <sub>2</sub> ZrSiO <sub>4</sub> FeFe <sub>2</sub> O <sub>4</sub> FeTiO <sub>3</sub> FeS <sub>2</sub>	Roches magmatiques alcalines Roches magmatiques riches en Al Roches magmatiques alcalines Roches magmatiques alcalines Roches magmatiques siliceuses Grande variété de roches magmatiques

**Tableau 1 : Principaux minéraux des roches magmatiques.**

## I-Cardinal Minerals

### 1-Quartz (SiO<sub>2</sub>)

#### 1.1- Plane Polarized Light (UPL) or Natural Light

1.1.1- **Shapes:** Varied, hexagonal for autochreme sections

1.1.2- **Relief:** Very low, refractive index is close to that of feldspars.

1.1.3- **Color:** Colorless, quartz has clear sections.

1.1.4- **Pleochroism:** No pleochroism

1.1.5- **Cleavages:** No cleavages

1.1.6- **Alterations:** No alterations.



#### 1.2. Cross Polarized Light

1.2.1- **Birefringence:** Low. Quartz polarizes in the light gray to white range of the first order. Exceptionally, sections cut perpendicular to the 6th-order axis exhibit polarization hues in the dark and produce good axis patterns (centered cross) in converging light.

1.2.2- **Extinction:** Straight for sections elongated along c. Quartz also exhibits undulating or rolling extinction when subjected to tectonic effects.

1.2.3- **Elongation:** positive

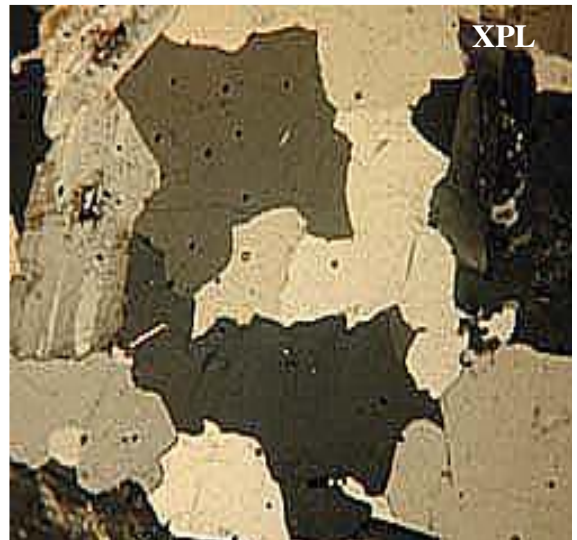
These last two characteristics are rarely determinable.

1.2.4- **Twins:** no twins.

1.3- **Converging light:** positive uniaxial.

1.4- **Deposit mode:** In igneous rocks, it is a mineral characteristic of silica-saturated rocks (granites, granodiorites, quartz diorites, rhyolites, etc.).

1.5- **Confusions:** Quartz can be confused with feldspars and feldspathoids. Feldspars are biaxial, feldspathoids are negative uniaxial.





## 2.1- Plane polarized light (PPL) or natural light

**2.1.1- Shapes:** Potassium feldspars (orthoclase and albite) have more or less elongated to squat prisms. Sanidine has elongated rods.

**2.1.2- Relief:** low, refractive index is close to that of quartz.

**1.2.3- Color:** colorless, sections are less clear than those of quartz.

**2.1.4- Pleochroism:** no pleochroism

**2.1.5- Cleavages:** presence of cleavages except for sanidine which shows cracks.

**2.1.6- Alterations:** kaolinization, saussuritization, muscovitization.

## 2.2. Cross Polarized Light (XPL)

**2.2.1- Birefringence:** weak. Like quartz, feldspars polarize in the light gray to white range of the first order.

**2.2.2-Extinction:** Substraight to oblique for **Orthoclase** and **Sanidine**

**2.2.3-Elongation:** Negative elongation for Orthoclase and Sanidine.

**2.2.4-Twinning:** Carlsbad twinning for orthoclase and sanidine, polysynthetic twinning for plagioclase, and fine gridding for microcline. Plagioclase can also be zoned.

## 2.3- Convergent light:

- **Orthoclase, Microcline, and Sanidine:** Biaxes of negative sign

- **Plagioclase:** Biaxes of variable sign

## 2.4-Deposit mode:

In igneous rocks, feldspars are characteristic of acidic, intermediate, and basic rocks (granites, rhyolites, granodiorites, quartz diorites, diorites, andesites, gabbros, and basalts).

## 2.5- Confusion:

Feldspars can be confused with quartz and feldspathoids.

Feldspars are biaxial, while feldspathoids are negative uniaxial.

## 1. Orthoclase



### PPL or Natural light View:

**Shape:** Elongated, sub-rectangular sections.

**Cleavages:** (001) and (010) often difficult to see.

**Color:** Colorless, more or less dirty

**Refractive index:** Low (~1.53 nm)

**Alteration:** Often with small, non-birefringent brownish minerals (clays, etc.). Rare for sanidine.

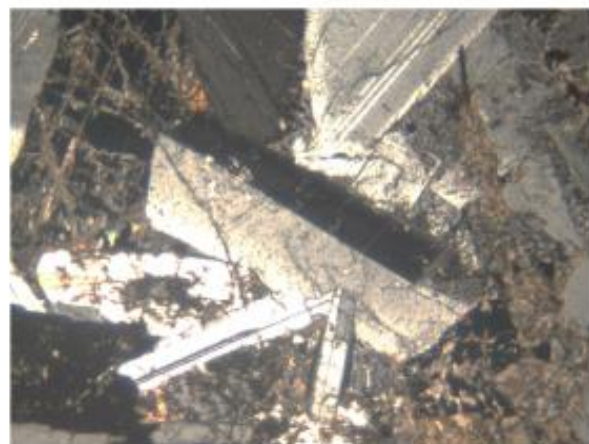
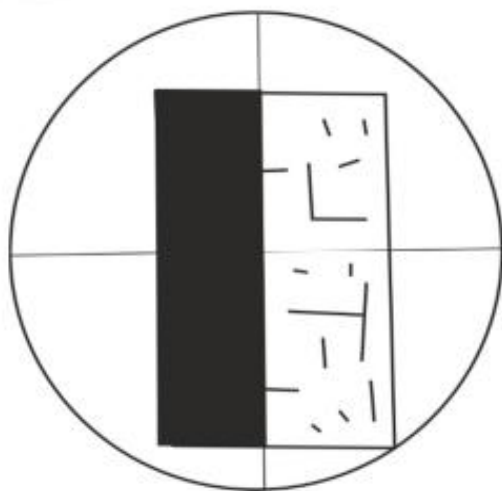


### XPL View

**Polarization tint:** first-order light gray

**Twins:** simple Carlsbad, very common

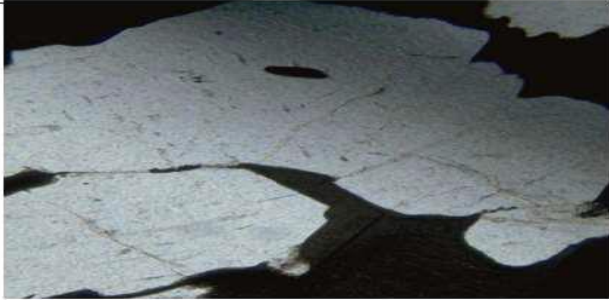
**Extraction:** oblique



**Figure:** Carlsbad twinning: a) Sketch; and b) Photomicrograph of orthoclase showing Carlsbad twinning (simple banding).

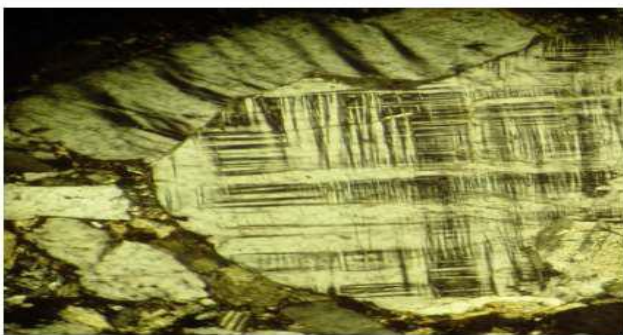
## 2. Microcline

### Le Microcline



#### PPL View

**Same Orthoclase**



#### XPL View

**same character except**

**Twin:** The Carlsbad twin is common, but less so than the association of two orthogonal polysynthetic twins, which gives it a grid-like appearance.

**Weathering:**

**Same Orthoclase**

### Plagioclase



#### PPL View

**Color:** Colorless

**Shape:** Subautomorphic to automorphic

**Relief:** Low

**Pleochroism:** Absent

**Cleavage:** Two suborthogonal cleavages (fine and regular)



#### XPL View

**Polarization tint:** Weak birefringence polarizes in the first-order gray, sometimes pale yellow.

**Twin:** A characteristic polysynthetic material that forms parallel bands, giving off a zebra-like appearance

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### 3-Feldspathoids

According to their chemical composition, two groups are distinguished:

- Potassium feldspathoids (Leucite):  $\text{KAlSi}_2\text{O}_6$
- Sodium feldspathoids (Nepheline):  $\text{NaAlSiO}_4$

#### 3.1- Unanalyzed polarized light (UPL) or natural light

**3.1.1- Shapes:** Leucite exhibits sections with subcircular polygonal contours.

Nepheline generally exhibits xenomorphic sections. However, the latter can exhibit hexagonal or square sections.

**3.1.2- Relief:** Slight.

**3.1.3- Color:** Colorless

**3.1.4- Pleochroism:** No pleochroism

**3.1.5- Alterations:** Nepheline readily alters into micaceous products (damourite) and zeolites.

#### 3.2. Analyzed Polarized Light (APL)

**3.2.1-Birefringence:** Very weak. Leucite sections are almost extinguished and should not be confused with voids in thin sections. Nepheline polarizes in the first-order gray range.

**3.2.2-Twins:** Very fine polysynthetic twins for leucite.

#### 3.3- Converging Light

- Leucite: No axial pattern, rarely a positive biaxial sign

- Nepheline: Negative biaxial sign.

#### 3.4-Deposit Mode

- **Leucite:** In silica-deficient volcanic rocks (leucophonolites, leukotephrites, leucitites)

- **Nepheline:** In silica-deficient sodic rocks (nepheline syenites and phonolites)

#### 3.5-Confusions

- Leucite can be confused with Analcime.

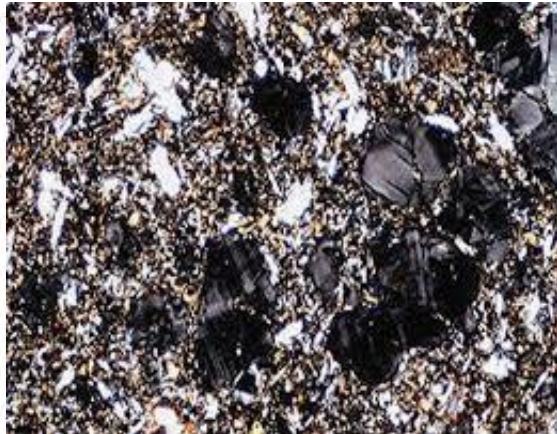
-Nepheline can be confused with quartz, alkali feldspars and apatite.

**Leucite K (Si<sub>2</sub> Al O<sub>6</sub>)** du système quadratique pseudo-cubique à température ordinaire (rigoureusement cubique à partir de 600°C). elle cristallise généralement en trapézoèdre



**LPNA**

- **Couleur** : Incolore
- **Forme** : section à contour polygonal sub-circulaire
- **Relief** : très faible,
- **Pléochroïsme** : absent.



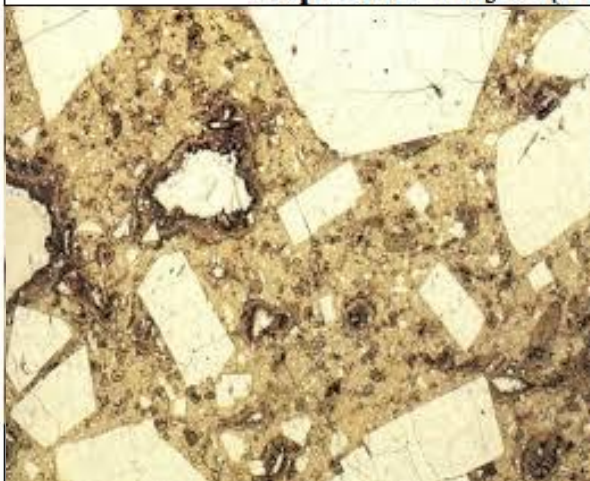
**LPA**

- **Teintes de polarisation** : biréfringence très faible. Les sections sont pratiquement éteintes.
- **Macle** : polysynthétiques difficilement visible en lame mince
- **Extinction** : presque isotrope

**Weathering :**


**easily alters in Sericite**

**Néphéline Na<sub>3</sub> K (Si<sub>2</sub> Al O<sub>4</sub>)<sub>4</sub>** du système hexagonal



**LPNA**

- **Couleur** : Incolore, toutefois, les altérations lui confèrent parfois un aspect trouble
- **Forme** : sections rarement automorphe, sauf dans les roches volcaniques (très petites sections carrées ou hexagonal). En général, plage xénomorphes moulant les autres cristaux.
- **Relief** : faible,
- **Pléochroïsme** : absent.

	<p><b><u>LPA</u></b></p> <ul style="list-style-type: none"> <li>○ <b><u>Teintes de polarisation</u></b> : biréfringence faible. Polarise dans les gris du 1<sup>er</sup> ordre.</li> <li>○ <b><u>Macle</u></b> : pas de macle</li> <li>○ <b><u>Extinction</u></b> droite</li> </ul>
<p><b>Que nous apprend-il sur la roche?</b></p>	<p>La néphéline se rencontre seulement dans les roches sous saturés riches en Na. Rechercher dans les roches à amphiboles ou pyroxènes sodiques (syénites néphéliniques, phonolites)</p>
<p><b>Altérations</b></p>	<p>La néphéline se transforme en général, en produits micacés, zéolites (Famille de tectosilicates alumino-silicatés, calciques ou alcalins) et fréquemment en cancrinite (feldspathoïdes incolore à biréfringence variable, parfois élevée)</p>

## **References**

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