

Orthosilicates or Nesosilicates

1- Phenacite group:-

Phenacite : $\text{Be}_2 \text{SiO}_4$.

Willemite : $\text{Zn}_2 \text{SiO}_4$.

2- Olivine group:two end member:-

Forsterite : $\text{Mg}_2 \text{SiO}_4$.

Tephroite : $\text{Mn}_2 \text{SiO}_4$.

Monticellite : Ca Mg SiO_4 .

Glaucocroite : Ca Mn SiO_4 .

Kirschsteinite : Ca Fe SiO_4 .

Larsenite : Pb Zn SiO_4 .

fayalite : $\text{Fe}_2 \text{SiO}_4$.

3-Garnet group:-

Andradite : $\text{Ca}_3 \text{Fe}_2 (\text{SiO}_4)_3$.

Almandine : $\text{Fe}_3 \text{Al}_2 (\text{SiO}_4)_3$.

Grossularite : $\text{Ca}_3 \text{Al}_2 (\text{SiO}_4)_3$.

Pyrope : $\text{Mg}_3 \text{Al}_2 (\text{SiO}_4)_3$.

Soessartite : $\text{Mn}_3 \text{Al}_2 (\text{SiO}_4)_3$.

Uvarovite : $\text{Ca}_3 \text{Cr}_2 (\text{SiO}_4)_3$.

4-Zircon group :-

Zircon : Zr SiO_4 .

5- Humite group:-

Chloritoid : $(\text{Fe,Mg})_2 \text{Al}_4 \text{O}_4 (\text{SiO}_4)_2 (\text{OH})_4$.

Chondrodite : $\text{Mg}_5 (\text{SiO}_4)_2 (\text{OH,F})_2$.

Sphene = Titanite : Ca TiO SiO_4 .

Datolite : $\text{CA B SiO}_4 (\text{OH})$.

6- Andalusite group:-

Sillimanite : $\text{Al}_2 \text{SiO}_5$.

Andalusite : $\text{Al}_2 \text{SiO}_5$.

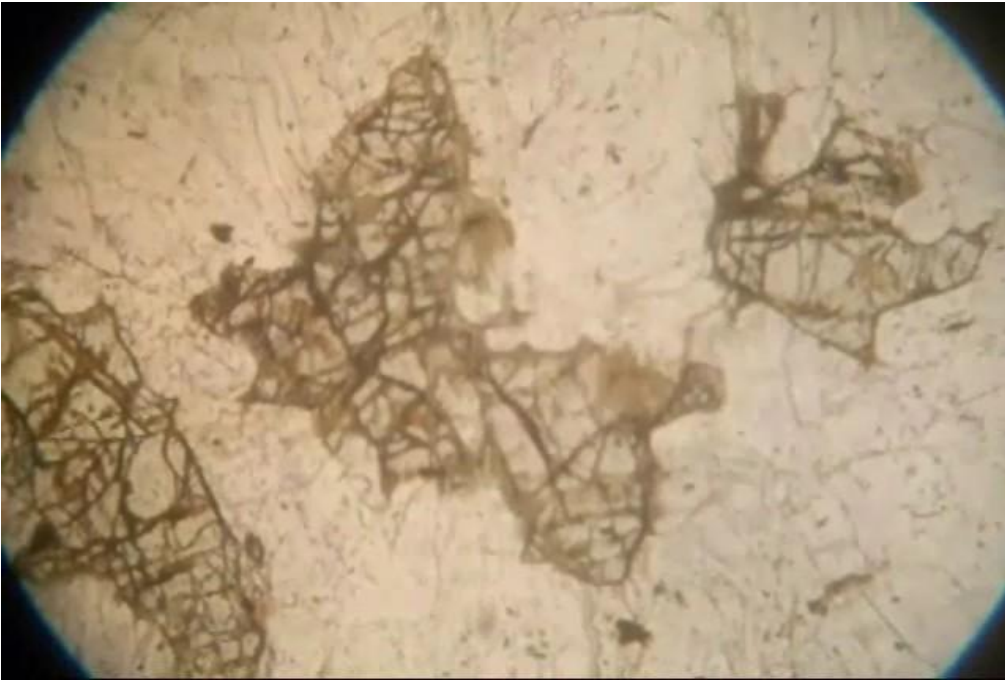
Kyanite : $\text{Al}_2 \text{SiO}_5$.

Chiastolite : $\text{Al}_2 \text{SiO}_5$.

- 1- **Topaz** : $\text{Al}_2 \text{SiO}_4 (\text{F}, \text{OH})_2$.
- 2- **Dumortierite** : $\text{Al}_7 \text{B}_3 (\text{SiO}_4)_3 \text{O}_3$.
- 3- **Gadolinite** : $\text{Be}_2 \text{Fe Y}_2 \text{Si}_2 \text{O}_{10}$.
- 4- **Staurolite** : $\text{Fe Al}_9 \text{O}_6 (\text{SiO}_4)_4 (\text{OH}, \text{O})_2$.

Mineral name: **Olivine group.**

- 1-colorless or olive green.
- 2-high relief.
- 3-highly interference color.
- 4-y-cracks cleavage.



Chemical composition: **Forsterite** ($Mg_2 Si O_4$) / **Fayalite** ($Fe_2 SiO_4$)

Alteration: Olivine alters to distinctive products visible in thin section. As like { iddingsite }.

Occurrence: Common in mafic and ultramafic igneous rocks. Associated with Ca- rich plagioclase and Ca- clinopyroxene.

Mineral name: **Almandine - Andradite** (Garnet group).

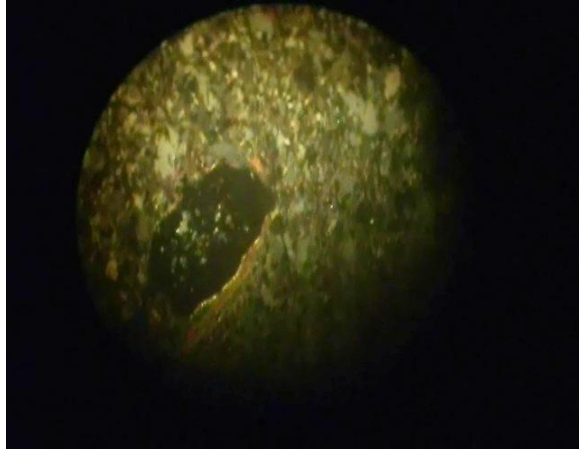
-:(**Almandine**)

1-polygonal crystals or equidimensional crystals. 2-colorless.

3-isotropic mineral. 4-irregular fractures. 5-dark brown.

1-Rhombicdodica hedron.-:(**Andradite**)

2-Trapeza hedron.



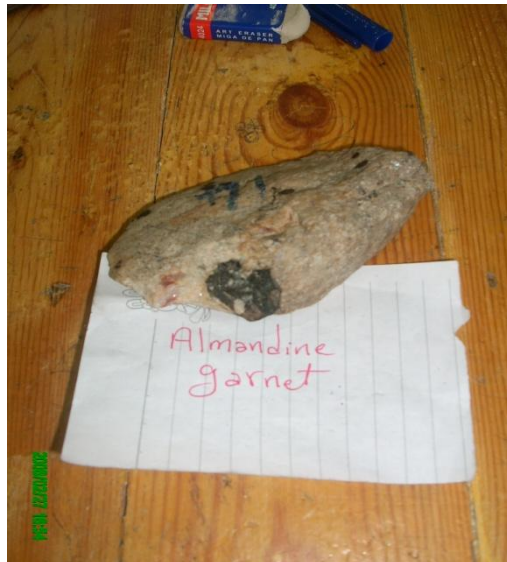
Chemical composition: Almandine: $\text{Fe}_3 \text{Al}_2 (\text{SiO}_4)_3$.

Andradite: $\text{Ca}_3 \text{Fe}_2 (\text{SiO}_4)_3$.

Alteration: Garnet may alter to Chlorite or other minerals as like Hornblende - Epidote or iron oxides.

Occurrence: Almandine: in mica schist.

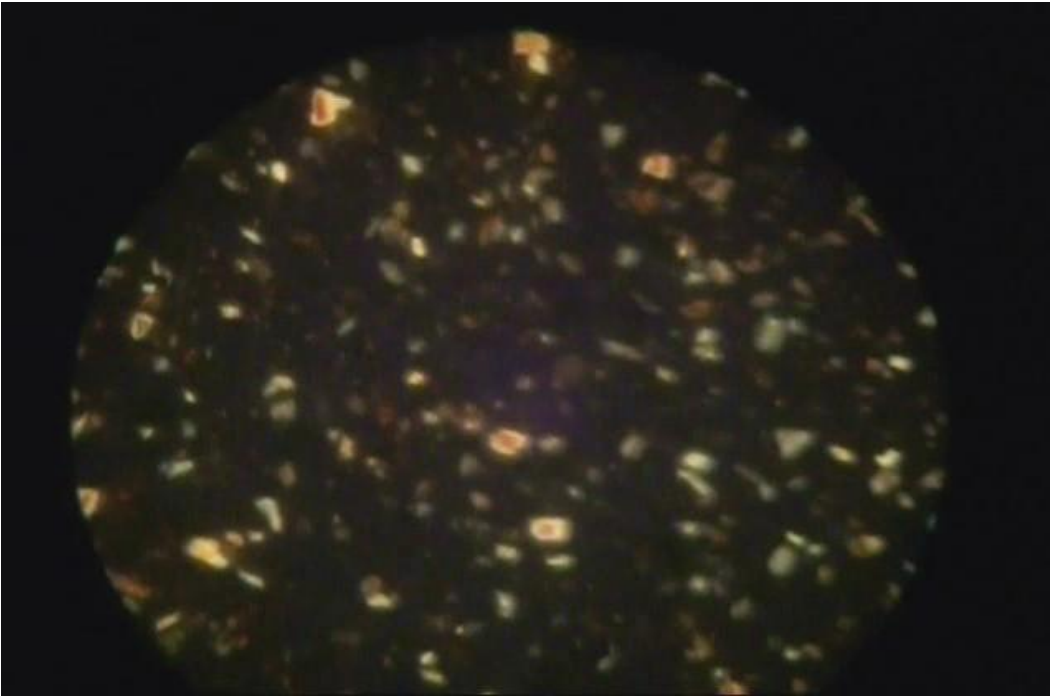
Andradite: found in metamorphosed carbonate-rich.



Mineral name: Zircon (Zircon group).

1-colorless. 2-minute crystals of short prismatic habit.

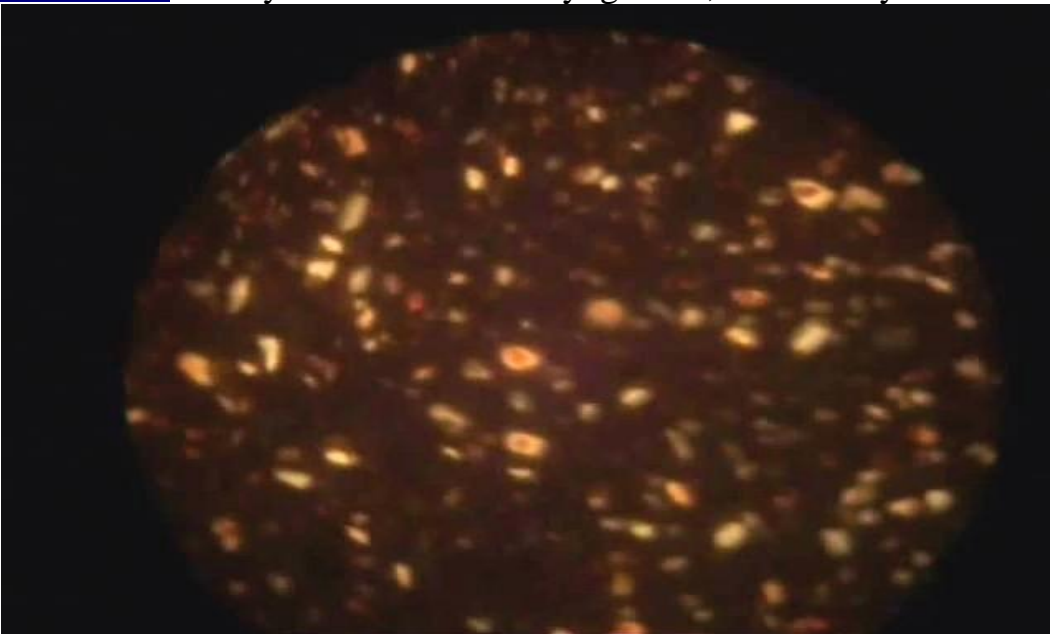
3-low relief. 4-radioactive mineral.



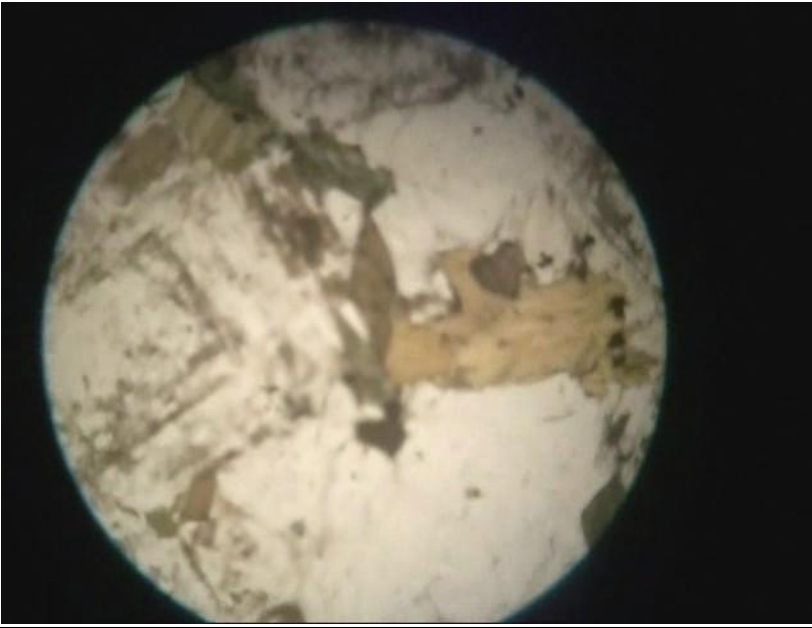
Chemical composition: Zr SiO_4 .

Alteration: zircon is quite stable and neither weathers nor alters to other minerals.

Occurrence: widely distributed in many igneous, sedimentary and metamorphic rocks.



Mineral name: Sphene = Titanite (Humite group).



1-yellowish color. 2-high relief. 3-Acute Rhombic crystals.
4-irregular fracture. 5-sphenoidal shape.

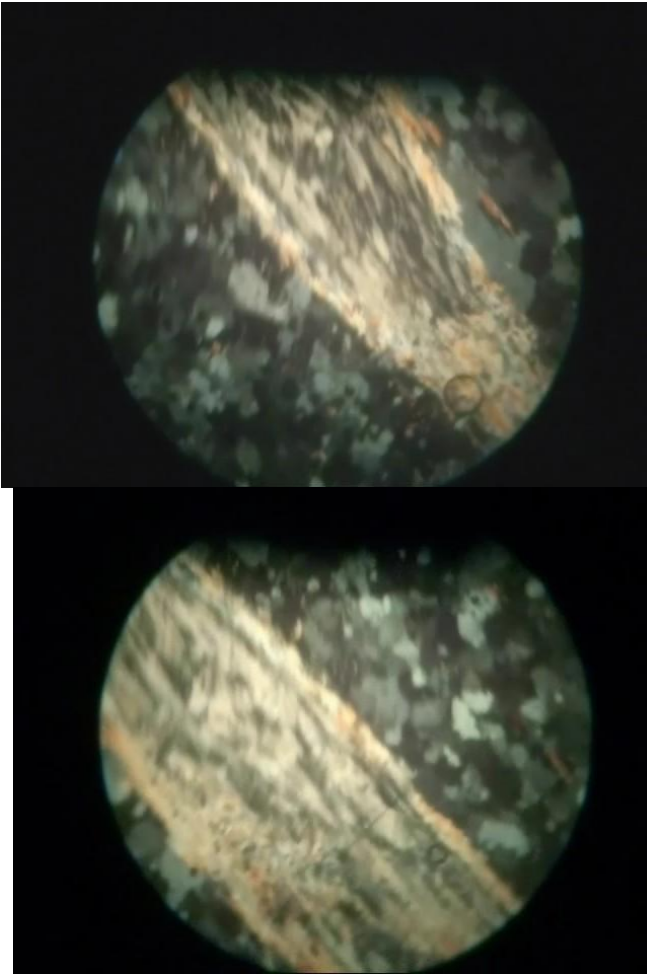


Chemical composition: Ca TiO SiO_4 .

Occurrence: common in many acid and intermediate igneous rocks.
and in mica schist and amphibolites.

Mineral name: **Sillimanite** (Andalusite group).

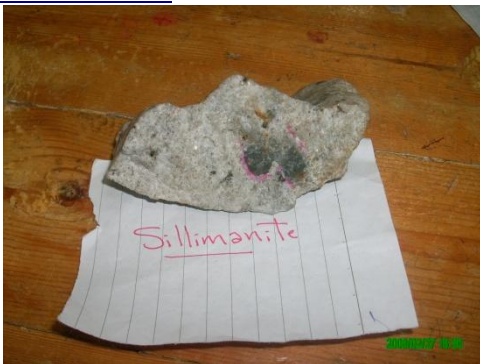
1-colorless to yellowish color. 2-one set of cleavage.
3-slender prismatic crystals or hair-like shape fibres.



Chemical composition: Al_2SiO_5 .

Alteration: sillimanite may alter to sericite and may show reaction relation with associated minerals.

Occurrence: found in medium and high grade pelitic metamorphic rocks.



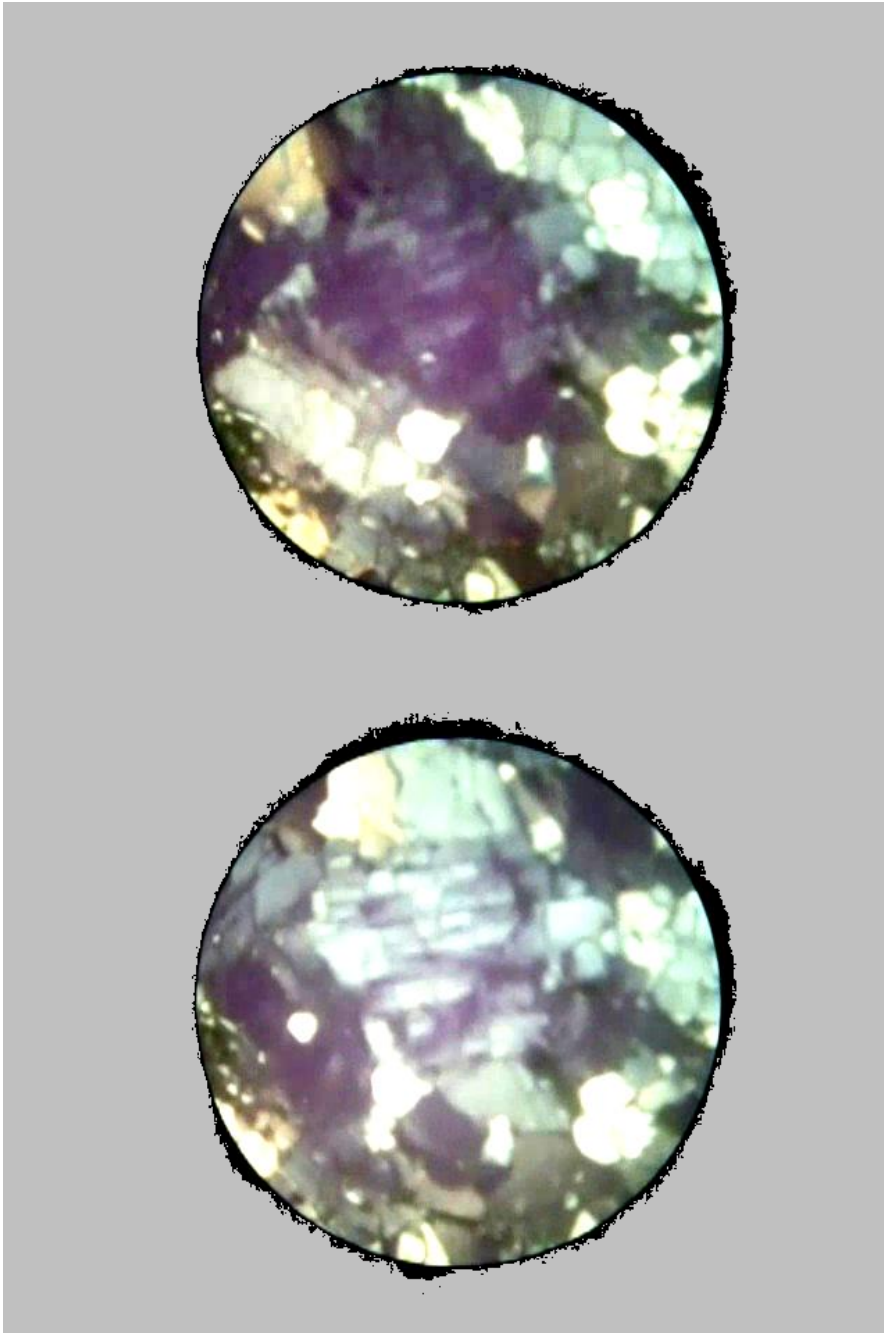
Mineral name: **Kyanite** (Andalusite group).

1-colorless.

2-broad elongate tabular crystals.

3- 30° extinction angle.

4-two sets of cleavage.

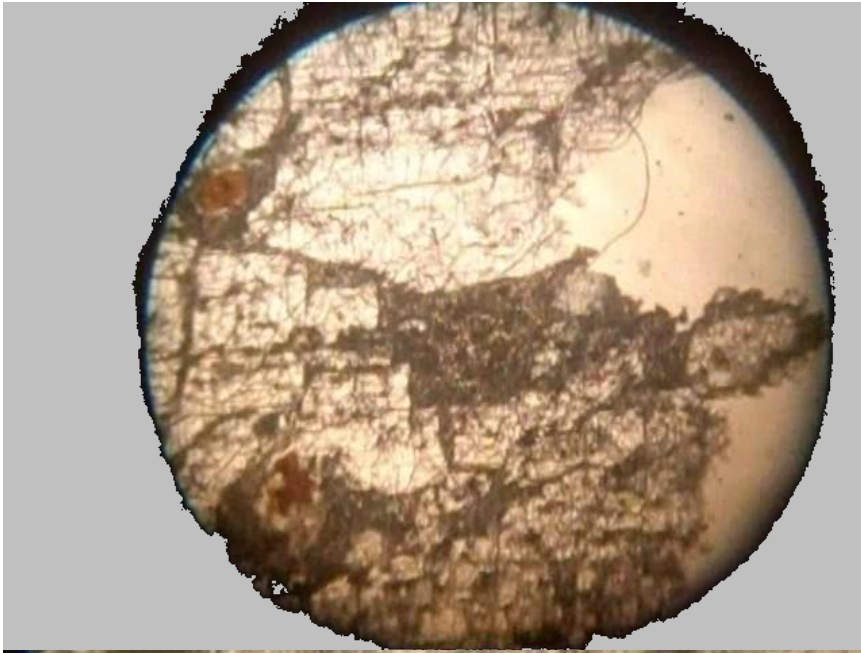


Chemical composition: Al_2SiO_5 .

Alteration: Kyanite may alter to sericite or to chlorite or to other phyllosilicates.

Occurrence: as a result of metamorphism or pelitic rocks.

Mineral name: **Chiastolite** (Andalusite group).



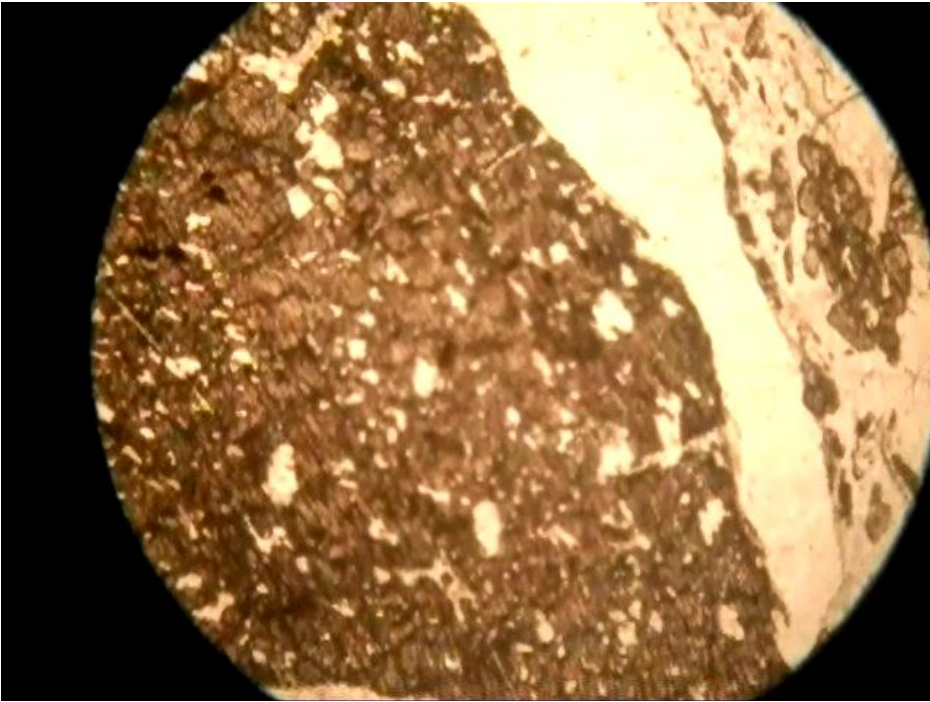
Mineral name: **Staurolite.**

1-colorless to yellowish brown.

3-highly interference color.

2-two sets of cleavage.

4-H.S : golden brwon.



Chemical composition: $\text{Fe Al}_9 \text{O}_6 (\text{Si O}_4)_4 (\text{OH},\text{O})_2$.

Occurrence: A metamorphic mineral typical of medium-temperature conditions of the upper part of the amphibolite facies.



2

Sorosilicates or Disilicates

(Double of tetrahedron)

1-Epidote group:-

Epidote : $\text{Ca}_2 \text{Al}_3 \text{O} (\text{SiO}_4) (\text{Si}_2\text{O}_7) (\text{OH}) .$

Zoisite : $4\text{CaO} . 3\text{Al}_2\text{O}_3 . 6\text{SiO}_2 . \text{H}_2\text{O} .$

Clinozoisite : $4\text{CaO} . 3\text{Al}_2\text{O}_3 . 6\text{SiO}_2 . \text{H}_2\text{O} .$

Allanite : $\text{X}_2\text{Y}_3 \text{O} (\text{SiO}_4) (\text{Si}_2\text{O}_7) (\text{OH}) .$

. Sorosilicates

Idocrase : $\text{Ca}_{10} (\text{Mg,Fe})_2 \text{Al}_4 (\text{SiO}_4)_5 (\text{Si}_2\text{O}_7)_2 (\text{OH}) .$

Akermanite : $\text{Ca}_2 \text{Mg Si}_2\text{O}_7 .$

Piemotite : $\text{Ca}_2 (\text{Mn,Fe,Al})_3 \text{O} . \text{OH} (\text{Si}_2\text{O}_7) (\text{SiO}_4) .$

Hemimorphite : $\text{Zn}_4 (\text{Si}_2\text{O}_7) (\text{OH}) . \text{H}_2\text{O} .$

Ilvaite : $\text{Ca Al}_2 (\text{OH})_2 (\text{Si}_2\text{O}_7) \text{H}_2\text{O} .$

Prehnite : $\text{Ca}_2 \text{Al}_2 (\text{Al}_3\text{O}_{10}) (\text{OH})_2 .$

Mineral name: **Epidote** (Epidote group).

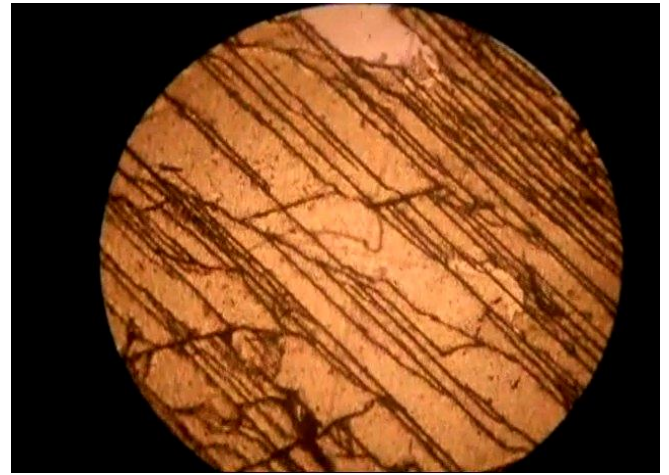
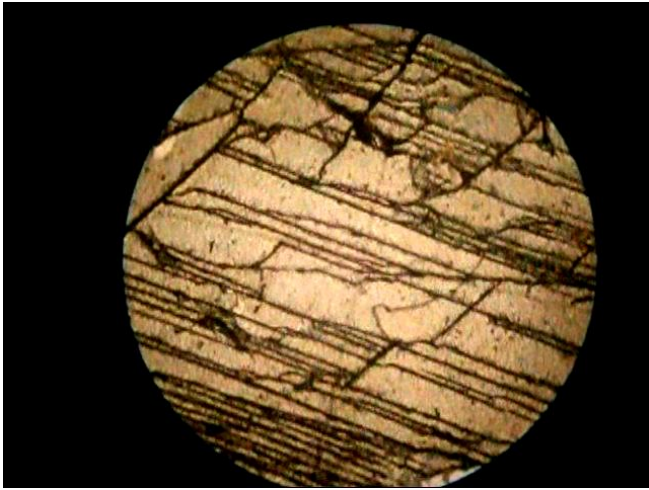
1-colorless to yellowish green.

2-grnular to columnar aggregates.

3-highly interference color.

4-two sets of cleavage.

5-high relief.



Chemical composition: $\text{Ca}_2 \text{Al}_3 \text{O}(\text{SiO}_4)(\text{Si}_2\text{O}_7)(\text{OH})$.

Alteration: Not commonly altered.

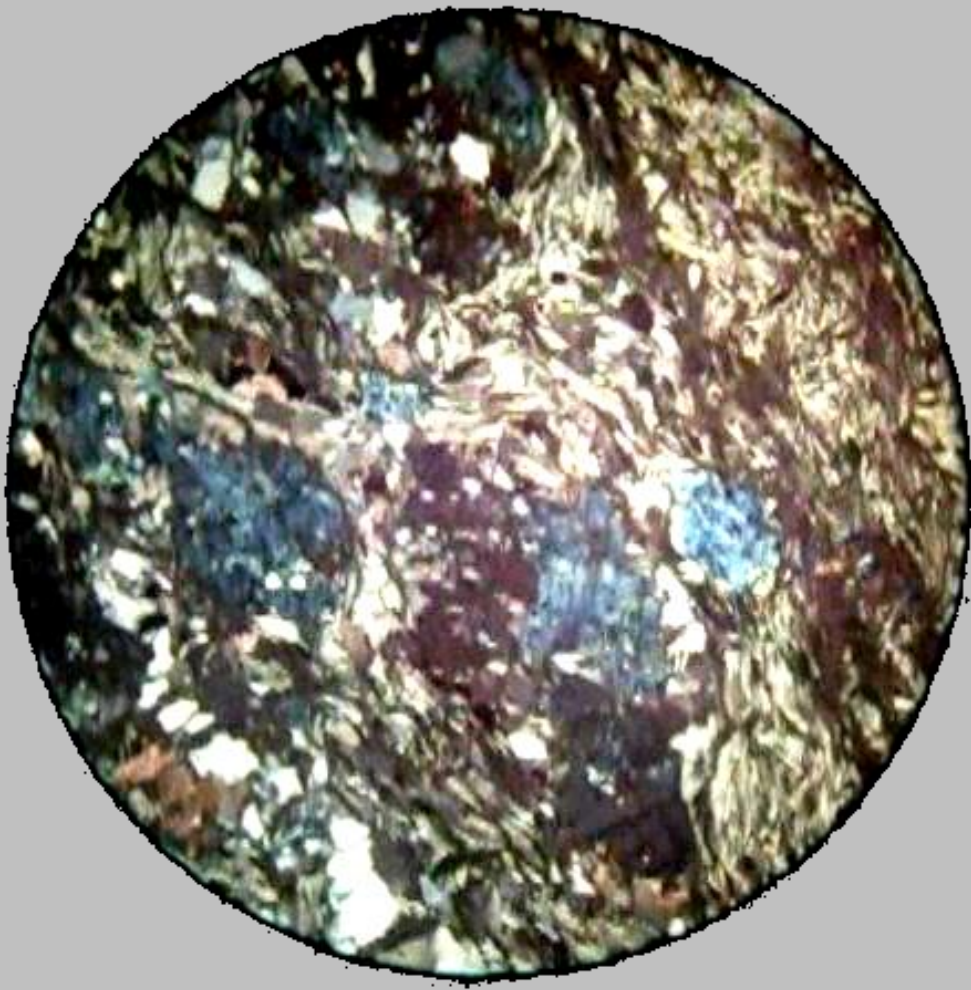
Occurrence: common in a wide variety of regional and contact metamorphic rocks
And mafic igneous.

Mineral name: **Zoisite** (Epidote group).

1-colorless.

2-columnar aggregates.

3-Blue interference color.



Chemical composition: $4\text{CaO} \cdot 3\text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2 \cdot \text{H}_2\text{O}$.

Alteration: Not commonly altered.

Occurrence: found in medium-grade metamorphic rocks derived from Ca-rich sedimentary rocks. Such as calcareous shale.

3

Cyclosilicates or Ring silicates

- 1- Benitoite : $\text{Ba Ti Si}_3\text{O}_9$.
- 2- Beryl : $\text{Al}_2 \text{Be}_3 \text{Si}_6\text{O}_{18}$.
- 3- Cordierite : $\text{Mg}_2 \text{Al}_4 \text{Si}_6\text{O}_{18}$.
- 4- Tourmaline : $\text{M}_7 \text{Al}_6 (\text{OH},\text{F})_4 (\text{BO}_3)_3 \text{Si}_6\text{O}_{18}$.
- 5- Axinite : 1-Ferroaxinite : $\text{Fe Bo}_3 \text{Si}_4\text{O}_{12} (\text{OH})$.
2-Manganoaxinite : $\text{Mn Bo}_3 \text{Si}_4\text{O}_{12} (\text{OH})$.
- 6- Chrysocolla : $\text{Cu SiO}_3.n\text{H}_2\text{O}$.
- 7- Milarite .
- 8- Diopase .

Mineral name: Beryl.

Chemical composition: $\text{Al}_2 \text{Be}_3 \text{Si}_6\text{O}_{18}$.

Alteration: the usual alteration products of Beryl are clay mineral or sericite.

Occurrence: found in granitic pegmatite associated with
Quartz, Feldspar, Muscovite and Biotite.



Mineral name: Tourmaline.

Chemical composition: $M_7Al_6(OH,F)_4(BO_3)_3Si_6O_{18}$.

Alteration: its present in all types of rocks alteration is rare.

Occurrence: found in igneous rocks – metamorphic rocks
–sedimentary rocks and pegmatites.



Inosilicates or Chain silicates

1-Single chain:-

Pyroxene group:-

- 1- Orthopyroxene : Bronzite .
- 2- Clinopyroxene : Aegirine .
- 3- Pyroxenoid .

2-Double chain:-

Amphibole group:-

- 1- Hornblende .
- 2- Tremolite – Actinolite .
- 3- Glaucofanite .

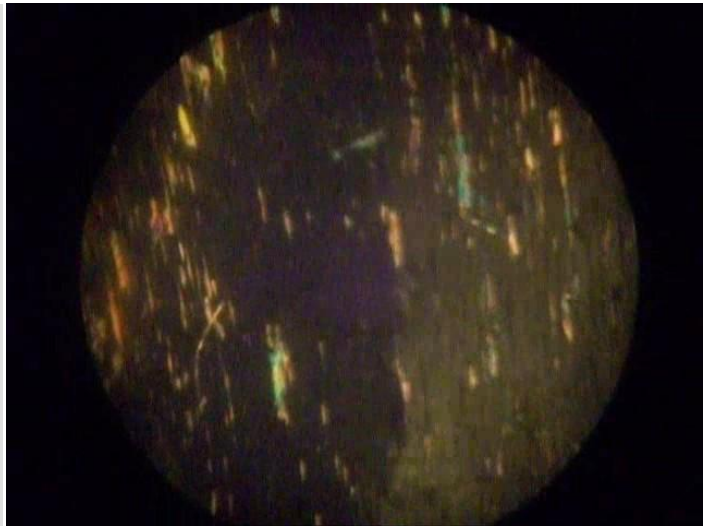
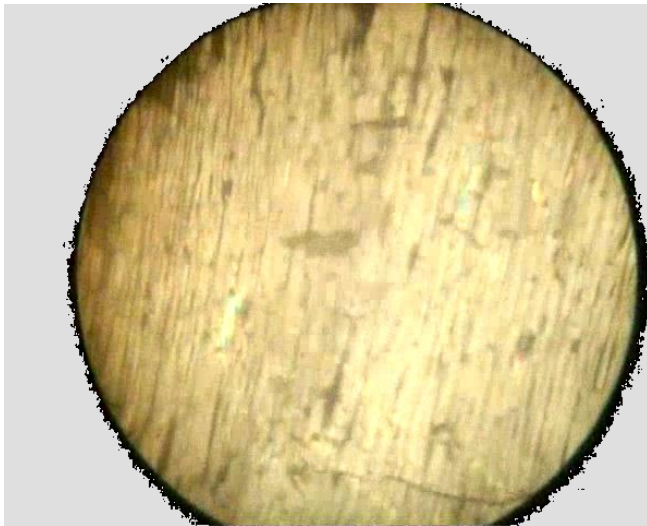
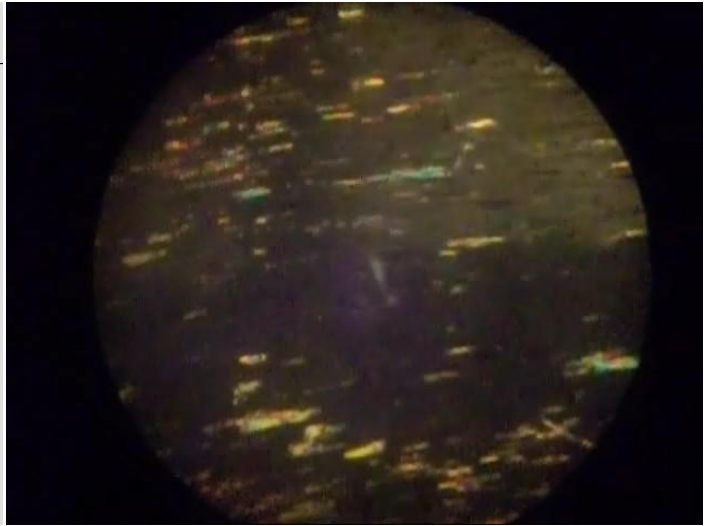
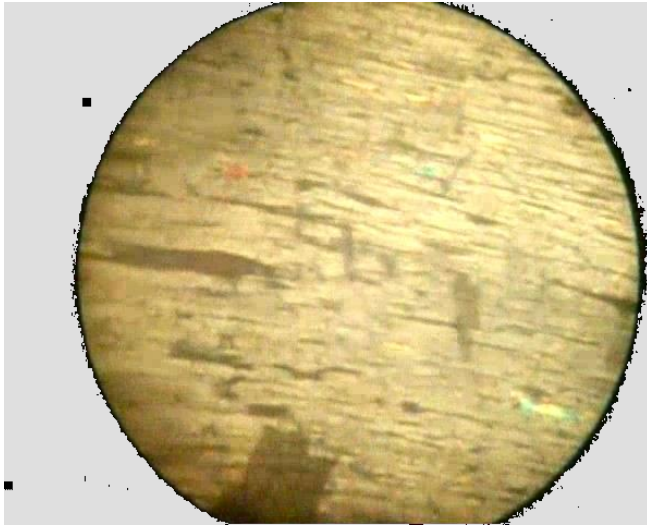
Mineral name:**Bronzite.**

(Single chain: pyroxene group: orthopyroxene).

1-pale yellow → reddish brown.

2-two sets of cleavage.

3-schiller structure.



Mineral name: Aegirine.

(Single chain: pyroxene group: clinopyroxene).

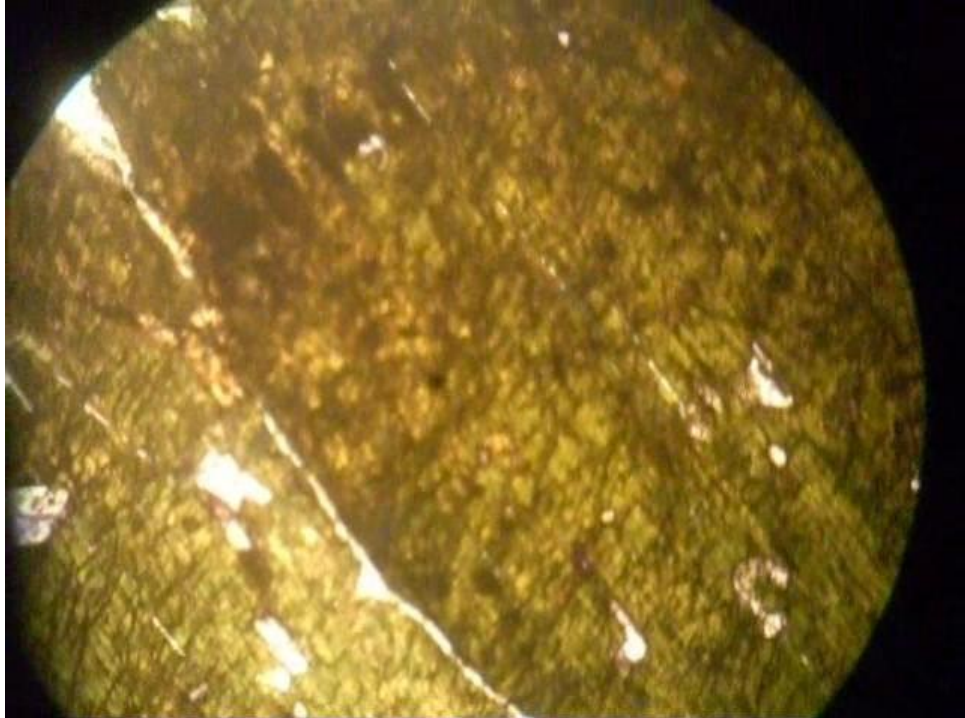
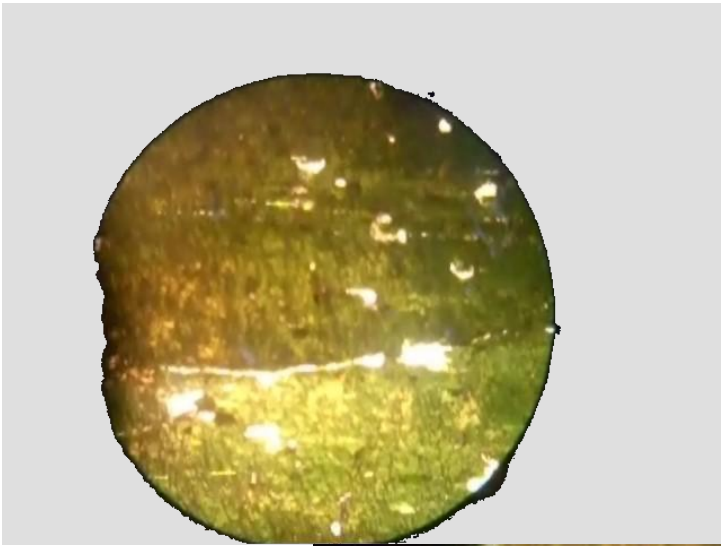
Chemical composition: Na,Fe,Si₂O₆.

1- Dark green.

2-Long prismatic crystals which bladed.

3-Two sets of cleavage 78°-93°.

4-Tripleochroic:dark green→light green→yellow.



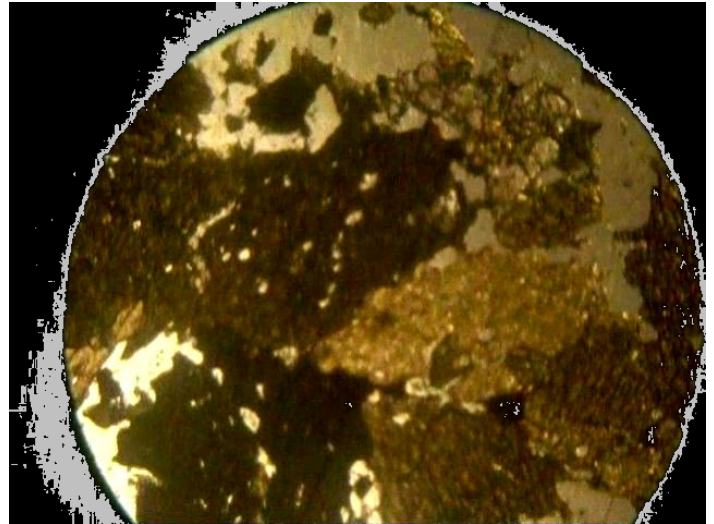
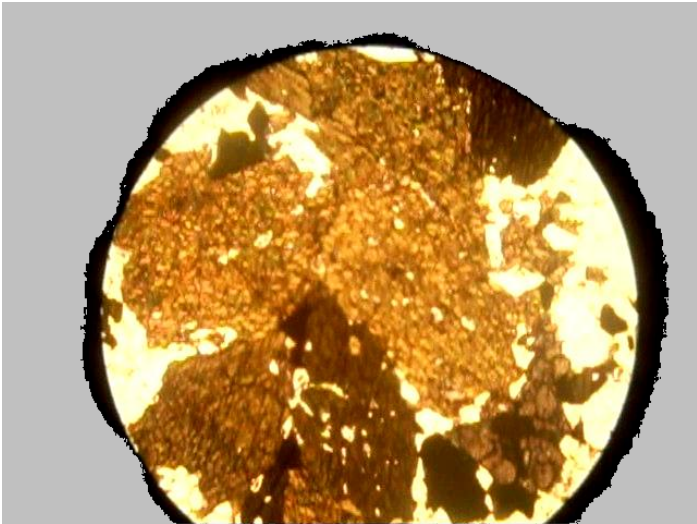
Mineral name: **Hornblend** (Double chain: Amphibole group).

1-Prismatic habit crystals.

2-Dark brown or green.

3-Two sets of cleavage.

4-Tripleochroic: dark brown → light brown → yellow.



Chemical composition: $\text{Ca}_2 (\text{Mg,Fe})_5 \text{Al}_8 \text{Si}_8 \text{O}_{22} (\text{OH})_2$.

Alteration: Hornblend may be altered to Biotite or Chlorite.

Occurrence: Found in igneous and metamorphic rocks.

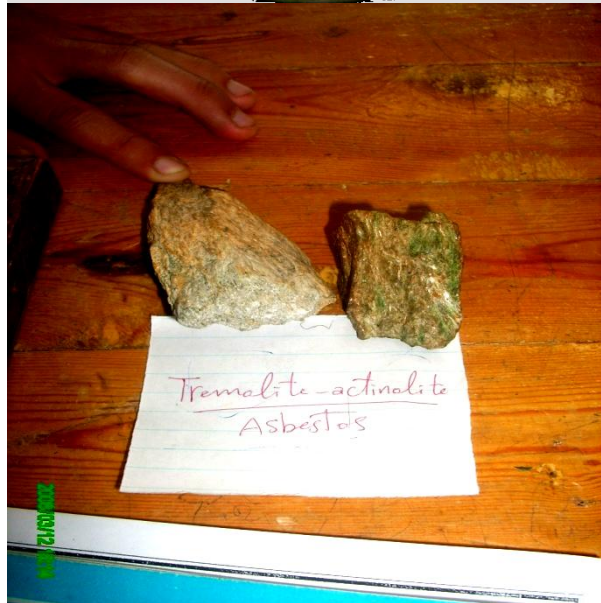
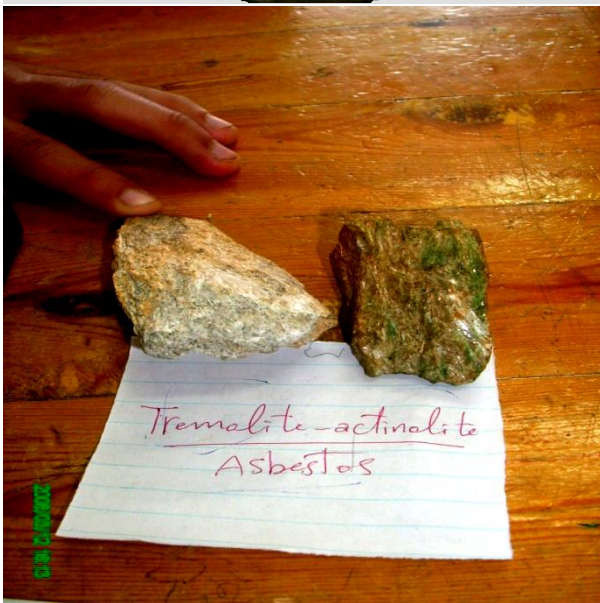
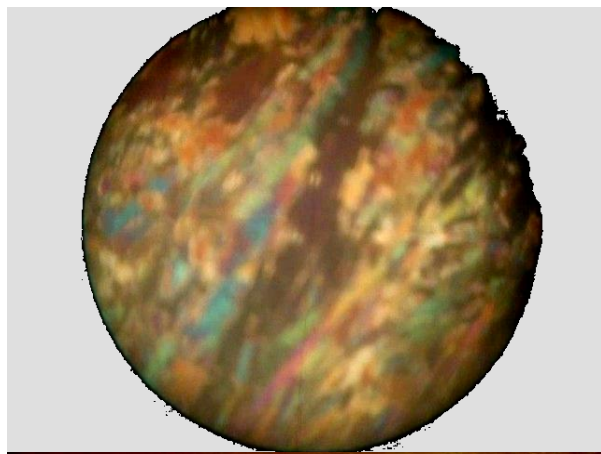
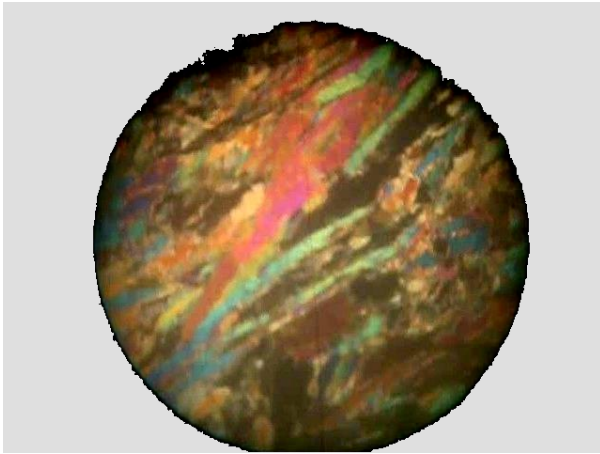
Mineral name: **Trimolite - Actinolite** (Double chain: Amphibole group).

1-Colorless to pale green.

3-Two sets of cleavage 124° - 56° .

2-Fibrous to columnar aggregates.

4-Highly interference color.



Chemical composition: Tremolite: $\text{Ca}_2 \text{Mg}_5 \text{Si}_8 \text{O}_{22} (\text{OH})_2$.

Actinolite: $\text{Ca}_2 (\text{Mg,Fe})_5 \text{Si}_8 \text{O}_{22} (\text{OH})_2$.

Alteration: Chlorite – Talc – Carbonates are common alteration products.

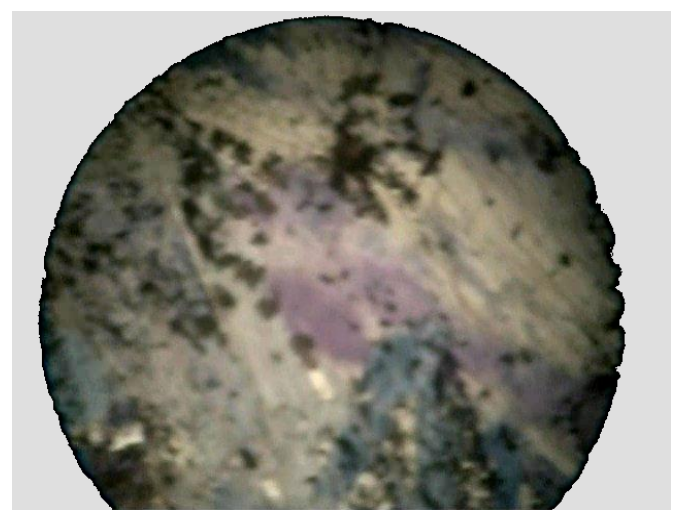
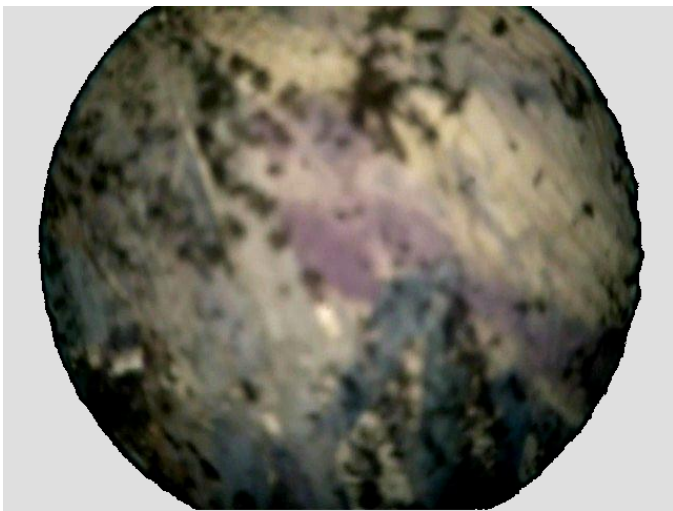
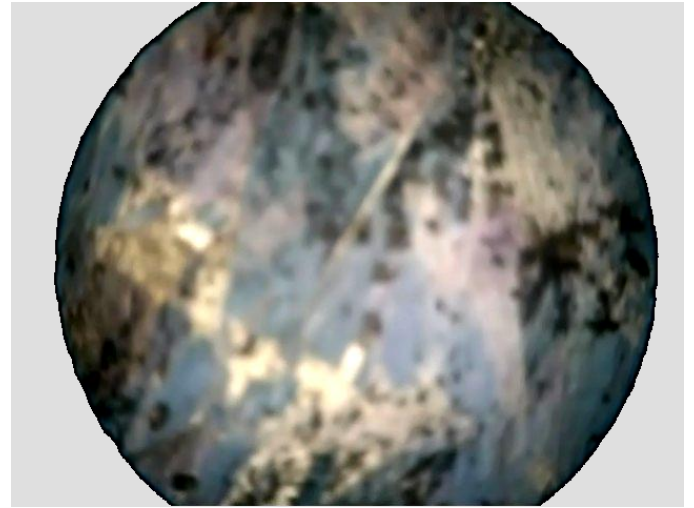
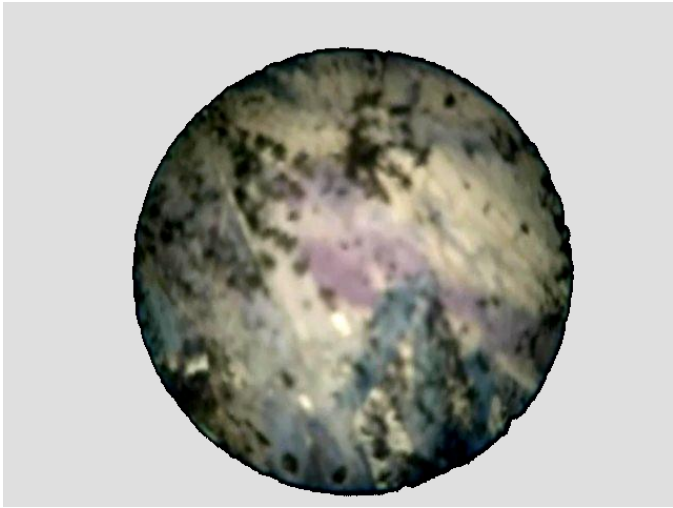
Occurrence: Found in metamorphosed dolomitic limestones.

Mineral name: Glaucophane (Double chain: Amphibole group).

1-Blue to violet color.

2-Prismatic tubular crystals.

3-Two sets of cleavage 124° - 56° .



5

Phyllosilicates or Sheet silicates

1- Serpentine group:-

Antigorite : $\text{Mg}_3 \text{Si}_2\text{O}_5 (\text{OH})_4$.

Lizardite : $\text{Mg}_3 \text{Si}_2\text{O}_5 (\text{OH})_4$.

Chrysotile : $\text{Mg}_3 \text{Si}_2\text{O}_5 (\text{OH})_4$.

2- Clay mineral group:-

Talc : $Mg_3 Si_4 O_{10} (OH)_2$. (White)
 Montmorillonite (Bentonite) : $Mg Al (OH) H_2O$. (Yellowish green)
 Kaolinite : $Al_2 Si_2 O_5 (OH)_4$. (Silver)
 Vermiculite : $Mg Fe Al (OH) H_2O$. (Green)
 Glauconite . (Golden brown)

3- Mica group:-

Muscovite : $K Al_2 (Al Si_3 O_{10}) (OH)_2$.
 Biotite : $K (Mg,Fe)_3 (Al Si_3 O_{10}) (OH)_2$.

4- Brittle mica:-

Margarite : $Ca Al_2 (Al_2 Si_2 O_{10}) (OH)_2$.
 Ottrellite : $Fe,Al,Mn (OH)$.

5- Chlorite group:-

Clinochlore : $(Mg,Fe)_3 (Al,Si)_4 O_{10} (OH)_2$.
 Penninite : $(Mg,Fe)_3 (Al,Si)_4 O_{10} (OH)_2$.
 Corundophylite : $(Mg,Fe)_3 (Al,Si)_4 O_{10} (OH)_2$.
 Prochlorite : $(Mg,Fe)_3 (Al,Si)_4 O_{10} (OH)_2$.

Mineral name:Serpentine group.

1-Pale yellowish color.

2-Mixture of Antigorite and Chrysotile seive of mesh texture.





Chemical composition: $Mg_3 Si_2O_5 (OH)_4$.

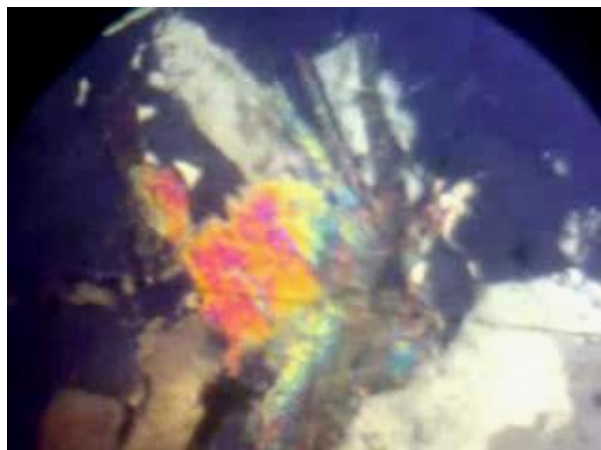
Occurrence: Formed by hydrothermal alteration of mafic and ultramafic rocks.

Mineral name: **Muscovite** (Mica group – white mica).

1-Color less.

2-One set of cleavage.

3-Highly interference color.





Chemical composition: $K Al_2 (Al Si_3 O_{10}) (OH, F, Cl)_2$.

Alteration: Not readily altered, but may be converted to clay mineral by weathering.

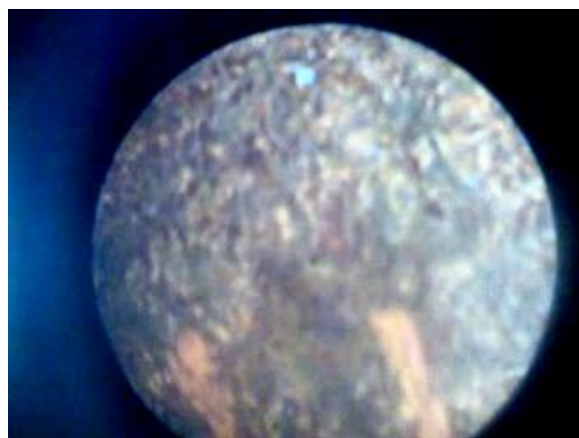
Occurrence: Found in igneous – metamorphic and sedimentary rocks.

Mineral name: **Biotite** (Mica group – black mica).

1-Dark brown or yellowish.

2-One set of cleavage.

3-Masking of interference color.





Chemical composition: $K (Mg,Fe)_3 Al Si_3O_{10} (OH)_2$.

Alteration: Biotite alters to Chlorite and clay mineral.

Occurrence: Found in igneous and metamorphic rocks.

Mineral name: Chlorite group.

1-Dark green. 2-One set of cleavage.

3-Pleochrism: yellowish green – dark green.



Chemical composition: $(Mg,Fe)_3 (Al,Si)_4 O_{10} (OH)_2$.

Occurrence: Product of hydrothermal alteration or low-grade metamorphism of Magnesium and Silicates.

Mineral name: **Talc** (Clay mineral group).



Chemical composition: $Mg_3 Si_4 O_{10} (OH)_2$.

Alteration: Talc may be altered to Chlorite.

Occurrence: Found in hydrothermally altered mafic and ultramafic rocks.

Mineral name: **Montmorillonite** or **Bentonite**
(Clay mineral group).



Chemical composition: $Mg Al (OH) H_2O$.

Occurrence: In a sedimentary environment in a tropical climate through alteration of feldspar in rocks poor in silica.

Mineral name: **Kaolinite** (Clay mineral group).



Chemical composition: $\text{Al}_2 \text{Si}_2\text{O}_5 (\text{OH})_4$.

Occurrence: Formed by alteration. The largest deposits are beds of clay formed in lakes.

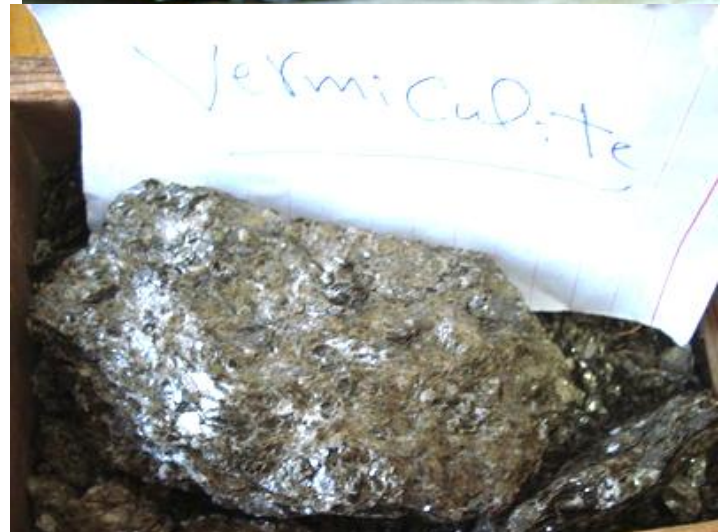
Mineral name: **Glaucosite** (Clay mineral group).



Alteration: Reddish or yellowish limonite staining due to weathering is common in Glaucosite.

Occurrence: Glaucosite small rounded pellets in clastic sediments deposits in marine conditions.

Mineral name: **Vermiculite** (Clay mineral group).



Chemical composition: $Mg, Fe, Al (OH) H_2O Si_2O_5 (OH)_4$.

Occurrence: A hydrothermal alteration product of Biotite and Phlogopite, especially at the contact between felsic rocks and ultramafic rocks.

