

Cleavage: 2 sets (Perfect).

Diagnostic features: Crystal form (prismatic) and cleavage angle.

Occurrence: In igneous rocks (syenite and diorite), also in metamorphic rocks (amphibolite).

2) Tremolite – $\text{Ca}_2 \text{Mg}_5 \text{Si}_8 \text{O}_{22}(\text{OH})_2$

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

Crystallography: Monoclinic.

Color: White to green.

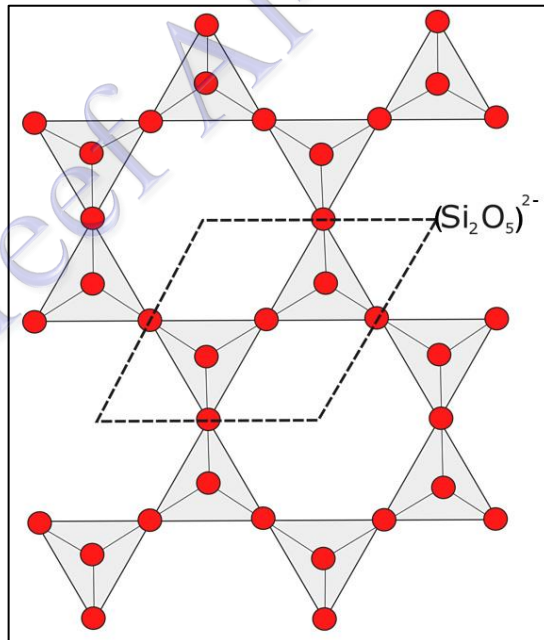
Cleavage: 2 sets (Perfect).

Diagnostic features: Color, prismatic, and cleavage.

Occurrence: Tremolite and actinolite found in metamorphic rocks.

5) Phyllosilicates

In the phyllosilicates, three of the 4 oxygens from each tetrahedra are shared with other tetrahedral, this leads to a basic structural unit of $(\text{Si}_2\text{O}_5)^{2-}$. with a ratio of Si:O = 2:5.



Characteristics of Phyllosilicates:

- 1- Hydrous minerals.
- 2- Soft minerals.
- 3- Platy or flaky habit.
- 4- Prominent cleavage.
- 5- Relatively low specific gravity.
- 6- The ratio of Si:O = 2:5.

Classification of Phyllosilicates

- 1) Serpentine group $\left\{ \begin{array}{l} \text{Antigorite} \\ \text{Chrysotile} \end{array} \right. \rightarrow \text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$
- 2) Clay mineral group $\left\{ \begin{array}{l} \text{Kaolinite} - \text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 \\ \text{Talc} - \text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2 \end{array} \right.$
- 3) Mica group $\left\{ \begin{array}{l} \text{Muscovite} - \text{KAl}_3\text{Si}_3\text{O}_{10}(\text{OH})_2 \\ \text{Phlogopite} - \text{KMg}_3(\text{AlSi}_3\text{O}_{10})(\text{OH})_2 \\ \text{Biotite} - \text{K}(\text{Mg, Fe})_3(\text{AlSi}_3\text{O}_{10})(\text{OH})_2 \end{array} \right.$
- 4) Chlorite Group: Chlorite – $(\text{Mg, Fe})_3(\text{Si, Al})_4\text{O}_{10}(\text{OH})_2 \cdot (\text{Mg, Fe})_3(\text{OH})_6$

1) Serpentine group – $\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$

Crystallography: Monoclinic.

Color: Olive to dark green.

Luster: greasy in antigorite and silky in chrysotile.

Diagnostic features: Color and luster.

Occurrence: Found in both igneous and metamorphic rocks.

Uses: Fibrous serpentine (chrysotile) is source of asbestos. Massive serpentine (antigorite) is used as an ornamental stone.

2) Clay mineral group

a. Kaolinite – $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$

Crystallography: Triclinic.

Color: White.

Diagnostic features: Claylike character.

Occurrence: In sedimentary rocks (kaolin).

Uses: Ceramic products.

b. Talc – $\text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2$

Crystallography: Monoclinic.

Color: White, apple-green, or gray.

Cleavage: One (001) perfect.

Hardness: 1

Diagnostic features: Hardness, softness, and greasy feel.

Occurrence: In metamorphic rocks (talc-schist)

Uses: Powder is used in pain, ceramics, rubber, and paper.

3) Mica group**a. Muscovite – $\text{KAl}_3\text{Si}_3\text{O}_{10}(\text{OH})_2$**

Crystallography: Monoclinic.

Color: Colorless.

Cleavage: One (001) perfect.

Diagnostic features: Color and cleavage.

Occurrence: In igneous rocks (e.g., granite), in metamorphic rocks (e.g., mica-schist), also in sedimentary rocks (e.g., sandstone).

Uses: As an electrical insulator, ground mica is used in the manufacture of wallpapers.

b. Phlogopite – $\text{KMg}_3(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$

Crystallography: Monoclinic.

Color: Yellowish-brown.

Cleavage: One (001) perfect.

Diagnostic features: Color and cleavage.

Occurrence: Found in metamorphosed Mg-rich limestones, dolomites, and ultrabasic rocks (kimberlite).

Uses: Electrical insulator.

c. Biotite – $\text{K}(\text{Mg, Fe})_3(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$

Crystallography: Monoclinic.

Color: Dark green, brown to black.

Cleavage: One (001) perfect.

Diagnostic features: Color and cleavage.

Occurrence: Found in igneous rocks (e.g. granite) and in metamorphic rocks (e.g. schist).

4) Chlorite Group: Chlorite – $(\text{Mg, Fe})_3(\text{Si, Al})_4\text{O}_{10}(\text{OH})_2 \cdot (\text{Mg, Fe})_3(\text{OH})_6$

Crystallography: Monoclinic.

Color: Pale-green.

Cleavage: One (001) perfect.

Diagnostic features: Color and cleavage.

Occurrence: It's a common mineral in metamorphic rocks (e.g., schist). Also, in igneous rocks as an accessory mineral from alteration of biotite, pyroxene, or amphibole.

6) Tectosilicates

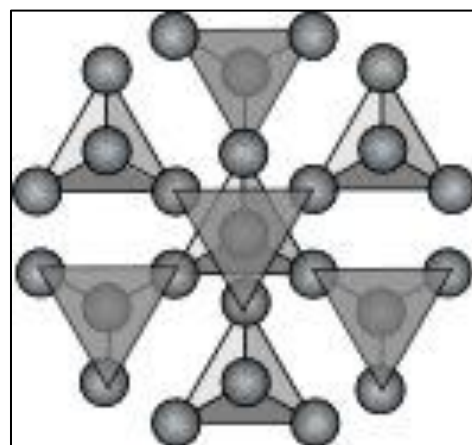
In the tectosilicates or framework silicate, all of the 4 oxygens of $(\text{SiO}_4)^{4-}$ tetrahedron are shared with other tetrahedra. The ratio of Si to O is thus 1:2.

Characteristics of Tectosilicates:

- 1- All oxygens in each SiO_4 tetrahedron are shared.
- 2- Tectosilicates are stable minerals.
- 3- Have a strongly bonded structure.
- 4- The ratio of Si:O = 1:2.

Classification of Tectosilicates

- 1) SiO_2 group: (quartz)
- 2) Feldspar group: Divided into:
 - a. K – Feldspar (orthoclase, microcline, and sanidine).
 - b. Plagioclase (albite, oligoclase, andesine, labradorite, bytownite, and anorthite).
- 3) Feldspathoid group: (nepheline and leucite).



1) SiO_2 group – Quartz

Crystallography: Hexagonal.

Color: Colorless or white and may be colored due to impurities.

Hardness: 7.

Fracture: Conchoidal.

Diagnostic features: Hardness and fracture.

Occurrence: in igneous rocks (e.g., granite), in metamorphic rocks (e.g., schist, gneiss), and in sedimentary rocks (sandstone).

Uses: Gemstones and ornamental material.

2) Feldspar group

a. Orthoclase, microcline, and sanidine – KAlSi_3O_8

Crystallography: Orthoclase (monoclinic), microcline (triclinic), and sanidine (monoclinic).

Color: Orthoclase (gray, flesh-red), microcline (white to pale yellow), and sanidine (colorless).

Diagnostic features: Color.

Occurrence: Orthoclase (in plutonic igneous rocks, e.g., granite), microcline (similar to orthoclase, e.g., granite), and sanidine (in volcanic igneous rocks, e.g., rhyolite).

b. Plagioclase: Albite, $\text{NaAlSi}_3\text{O}_8$ -----Anorthite, $\text{CaAl}_2\text{Si}_2\text{O}_8$

Crystallography: Triclinic.

Color: Colorless, white, or gray.

Diagnostic features: Albite twin striations {001}.

Occurrence: in igneous rocks (e.g., granite) and in metamorphic rocks (amphibolite).

3) Feldspathoid group

The feldspathoids are a group of tectosilicate minerals which resemble feldspars but have lower silica content. They are not found in rocks containing primary quartz.

Nepheline – $(\text{Na}, \text{K})\text{AlSiO}_4$

Leucite – KAlSi_2O_6

Crystallography: Nepheline (hexagonal) and leucite (tetragonal).

Color: Nepheline (colorless, white, or gray) and leucite (white to gray).

Occurrence: Leucite found in the K rich volcanic rocks (leucitite) and nepheline found the in intrusive (nepheline-syenite) and extrusive rocks (nephelinite).

Uses: Leucite as a minor source of potassium and aluminum and nepheline is used material for special kinds of glass and ceramics.
