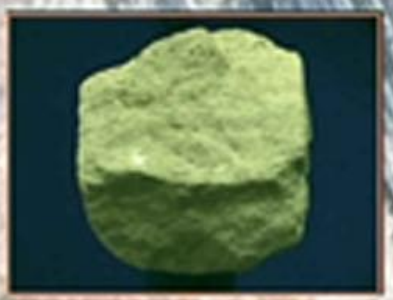
MINERALOGY *Practical*



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Lab. 1

A mineral is a naturally occurring homogeneous solid with a definite (but generally not fixed) chemical composition and an order atomic arrangement. It is usually formed by the inorganic process.

Physical Properties of Minerals

Crystal habits and aggregate:

1. Minerals in isolated crystals may be described as:

Acicular

Natrolite

Filiform

Zeolites

Bladed

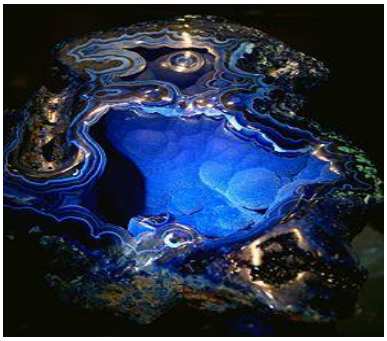
Kyanite

2. Groups of crystals the following terms are used:

Dendritic
Pyrolusite and other Mn-oxide minerals, Magnesite, native copper

Radiating
Wavellite

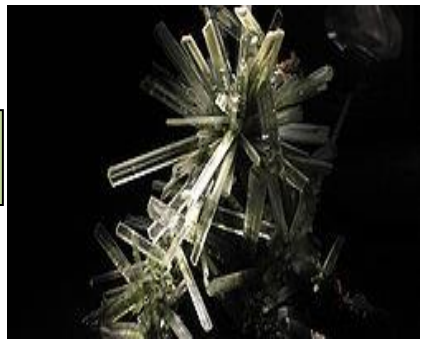
Reticulated
Cerussite



Drusy
Azurit

3. Parallel or radiating groups of individual crystals, are described as:

Columnar
Gypsum/Selenite



Bladed
Actinolite, Kyanite

Fibrous
Serpentine group

Stellate
Aragonite

Reniform or Colloform
Hematite

Mammillary
Malachite

Botryoidal or Globular
Hematite

4. Mineral aggregates composed of scales or lamellae are described as: (Foliated, Micaceous, Lamellar or Divergent scales).

5. Misellaneous terms: (Concentric, Pisolitic, Oolitic, Banded, Massive, Geode, Concretion, Amygdaloidal).

Color: when white light strikes the surface of a mineral, part of it is reflected and partly refracted. If the light suffers no absorption, the mineral is colorless, both in reflected and transmitted light. Minerals are colored because the certain wavelengths of light are absorbed, and the color results from a combination of those wavelengths that reach the eye. Some minerals show different colors when the light is transmitted along the different crystallographic directions, this selective absorption known as pleochroism.

Minerals differentiated with respect to color in to:

1. Constant color (Idiochromatic).
   e.g.: Malachite - green (without alteration)
   Azurite - blue.

2. Variation color (Allochromatic) because of inclusion impurities, chemical constituent.
   e.g.: Quartz (pure) - colorless.
   Rose Quartz - iron oxides.
   Smoky Quartz - free silicon by exposure to radioactive material.
   Amethyst - manganese oxide.
   e.g.: Calcite (pure) - colorless.
   Calcite black - manganese oxide or carbon.


Quartz (pure)

Rose Quartz


Smoky Quartz


Amethyst


Calcite (pure)


Calcite black

<u>Streak</u>: the color of a finely powdered mineral. The streak determined by rubbing the mineral on a piece of unglazed porcelain, a streak plate.

The streak plate has a hardness of about 6.5 to 7

e.g.: Hematite: black color - red streak.

Magnetite: black color - black streak.

Luster: the general appearance of a mineral surface in reflected light.

Types of luster

A. Metallic: opaque mineral (black or very dark streak).
B. Submetallic: intermediate luster. A submetallic luster often occurs in near-opaque minerals.
C. Nonmetallic: light color (colorless or very light streak).
   1. Vitreous (Quartz)
   2. Resinous (Sulfur)
   3. Pearly (Celestite)
   4. Greasy (Talc)
   5. Silky (Fibrous Gypsum)
   6. Adamantine (Diamond)
   7. Earthy (Kaolinite)


Metallic \ Graphite


Submetallic \ Sphalerite

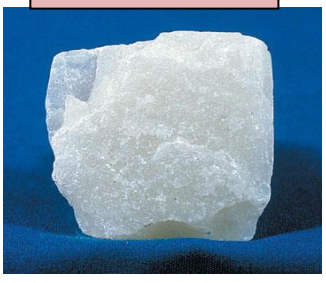
Nonmetallic

Vitreous \ Quartz

Resinous \ Sulfur

Pearly \ Celestite

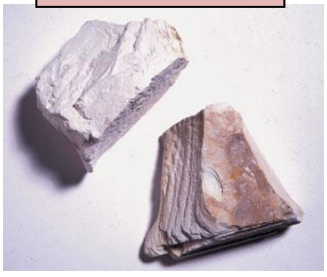
Greasy \ Talc



Silky \ Fibrous Gypsum

Adamantine \ Diamond

Earthy \ Kaolinite



Transparency: transmitted light within the mineral.

Divide to:

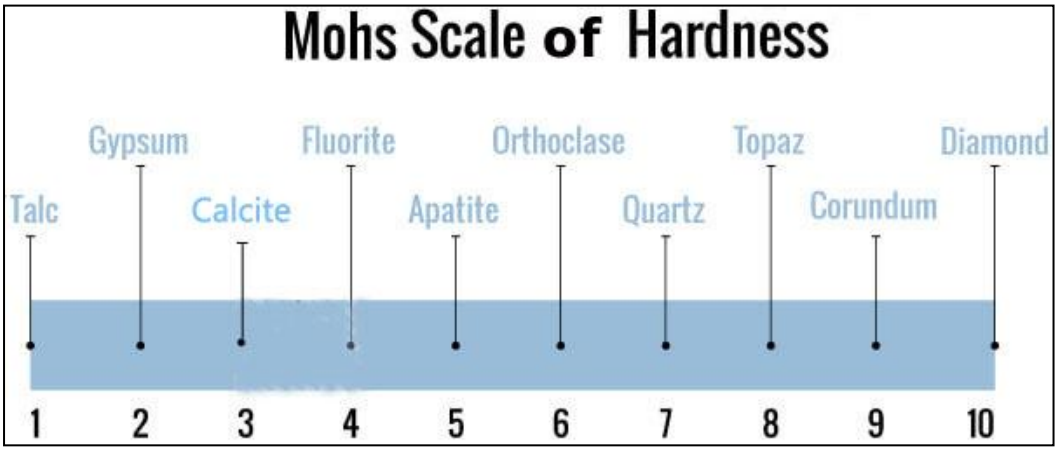
1. Transparent (Quartz, Gypsum)
2. Translucent (Smoky Quartz)
3. Opaque (Galena, Graphite)

Cohesive Properties of Minerals:

Hardness (H): the resistance that a smooth surface of a mineral offers to scratch.

The degree of hardness is determined by:

1. The observing the comparative with which mineral is scratched by another.
2. Using the Mohs scale of hardness (F. Mohs., 1824), Mohs scale is relative of hardness.



3. Using some simple tools:

	Tools	Hardness
1	Pencil	1.5
2	Fingernail	2.5
3	Copper coin	3.5
4	Steel knife	5.0-5.5
5	Window glass	5.5
6	Steel nail	6.5
7	Steel file	6.7
8	Streak plate	6.5-7.0
9	Masonry drill bit	8.5

Cleavage: a mineral has cleavage if it breaks along definite plane surfaces (parallel to crystal faces).

Cleavage described as:

1. Perfect
2. Distinct or good
3. Imperfect
4. Difficult or poor

Fracture: the way a mineral breaks when it does not yield along cleavage or parting surface.

Type of fracture:

1. Even
2. Uneven
3. Hackly
4. Earthy
5. Conchoidal

Specific gravity (G) or relative density: is a number that expresses the ratio between the weight of a substance and the weight of an equal volume of water at 4 ^{o}C.

Traditionalism method to determine specific gravity is using your hand, therefore, minerals divided to:

Heavy minerals (G > 2.9)

Light minerals (G < 2.9).

Other Properties of Minerals:

1. Magnetism (Magnetite)
2. Sense properties:

a. Taste (Halite - salty taste) and (Epsomite - bitter taste)

b. Feel (Talc - soapy feel)

c. Odor (Pyrite - corrupt eggs odor) and (Arsenopyrite - garlic odor)

d. Electricity (Copper)

e. Radioactivity (Uraninite)

Lab. 2

Mineral classification

Chemical composition has been the basis for the classification of minerals:

1. Native elements
2. Sulfides
3. Oxides and Hydroxides
4. Halides
5. Carbonate
6. Nitrates
7. Borates
8. Phosphates
9. Sulfates
10. Silicates

Native elements

1. Copper: Cu , Isometric

Diagnostic features: red color on fresh surfaces, hackly fracture, high specific gravity, and malleability.

Occurrence: associated with basaltic lava, resulting from the reaction of the hydrothermal solution with Iron oxide minerals.

Used for electrical purposes mostly as a wire.

2. Sulfur: S , Orthorhombic

Yellow color, resinous luster, the absence of a good cleavage distinguishes it from Orpiment.

Occur at or near the crater rim of active volcanoes, it is also formed from sulfates by the action of Sulfur-forming bacteria.

3. Graphite: C , Hexagonal

Graphite is recognized by its black color and streak, foliated nature or scaly masses but may be radiated or granular, it is greasy feeling.

Occurrence: in metamorphic rocks and hydrothermal veins.

Name derived from the Greek word meaning to write, in allusion to its use in pencils.

Sulfides

1. Galena: PbS , Isometric

Recognized by its good cleavage, lead-gray streak, high specific gravity, and softness.

Occurrence: it is a very common metallic sulfide, found in veins, and in hydrothermal veins and in contact metamorphic deposits.

2. Pyrite: FeS_2 , Isometric

Pale brass-yellow color, greater hardness (6 - 6.5). conchoidal fracture.

Distinguished from Chalcopyrite by its paler color and greater hardness and from Marcasite by its deeper color and crystal form.

Occurrence: in contact metamorphic deposits, hydrothermal veins, igneous rocks, and sedimentary rocks.

3. Pyrrhotite: (Magnetic Pyrite): $Fe_{1-X}S$, Monoclinic

Recognized by its massive nature, brownish bronze color, and magnetism.

Occurrence: basic igneous rocks, contact metamorphic deposits, veins deposits, and pegmatite.

4. Chalcopyrite: $CuFeS_2$, Tetragonal

Brass-yellow color, greenish-black streak.

Distinguished from Pyrite by lower hardness (3.5 - 4) and from Gold by being brittle.

Occurrence: in igneous rocks, pegmatite dykes, and contact metamorphic deposits.

5. Orpiment: As_2S_3 , Monoclinic

Characterized by its lemon-yellow color, foliated structure or columnar masses.

Distinguished from Sulfur by its perfect cleavage.

Occurrence: Orpiment is a rare mineral found in veins of Lead, Silver, and Gold ores.

6. Realgar: AsS , Monoclinic

Recognized by its red color, orange-red streak, and resinous luster.

Occurrence: it is found in veins of Lead, Silver, and Gold ores.

7. Marcasite: FeS_2 , Orthorhombic

Pale bronze-yellow to white (on the fresh surface).

Distinguished from Pyrite by its pale-yellow color and by its fibrous habit.

Occurrence: it is found in metallic ferrous veins and sedimentary rocks as a replacement.

8. Cinnabar: HgS , Hexagonal

Recognized by its red color and scarlet streak, high specific gravity, perfect cleavage.

Occurrence: it is found in veins near recent volcanic rocks and hot springs.

Lab. 3

Oxides

1. Corundum: Al_2O_3 , Hexagonal

Various color (colorless, gray, brown, pink, blue), great hardness (9), adamantine to vitreous luster.

Occurrence: igneous, metamorphic rocks.

2. Hematite: Fe_2O_3 , Hexagonal

Reddish-brown to black color, red streak, usually Botryoidal to reniform, massive and radiating shape.

Occurrence: contact metamorphic rocks, igneous and sedimentary rocks.

3. Ilmenite: $FeTiO_3$, Hexagonal

Massive granular to platy crystals, iron-black color, brownish-red streak, slightly magnetic.

Distinguished from Hematite by its streak and from Magnetite by its lack of strong magnetism.

Occurrence: igneous rocks, pegmatite, black sand.

4. Rutile: TiO_2 , Tetragonal

Red, reddish-brown to black color, pale-brown streak, adamantine to submetallic luster.

Occurrence: igneous, metamorphic, dolostone.

5. Pyrolusite: MnO_2 , Tetragonal

Iron-black color and streak, low hardness (1-2) (often soiling the fingers), usually splintery or radiating fibrous aggregates.

Occurrence: manganese ores.

6. Magnetite: Fe3O4 , Isometric

Strongly magnetic, black color and streak, great hardness (6)

Occurrence: igneous, metamorphic, sedimentary rocks.

7. Cassiterite: SnO_2 , Tetragonal

Brown to black color, high specific gravity (6-7), adamantine to submetallic luster, light streak (white).

Occurrence: igneous, metamorphic, pegmatite.

8. Gahnite: $ZnAl_2O_4$, Isometric

Dark green color, grayish streak, vitreous luster, great hardness (7.5-8).

Occurrence: pegmatite, contact metamorphic rocks.

Lab. 4

Hydroxides

1. Bauxite: Al-hydroxides

The mixture of Diaspore, Gibbsite and Boehmite, various color (yellow, brown, white), usually pisolitic in rounded grains and earthy masses, dull to the earthy luster.

Occurrence: produced by prolonged weathering of Al-bearing rocks.

2. Goethite: FeO.OH , Orthorhombic

Yellowish-brown to dark brown color, yellowish-brown streak, hardness (5-5.5), radiating coliform to mammillary form.

Distinguished from Hematite by its streak.

Occurrence: weathering product of iron-bearing minerals.

Note: similar species:

Limonite: $FeO.OH.nH_2O$

Is used mainly as a field term to refer to natural hydrous iron oxides of uncertain identity.

Halides

1. Halite: NaCl , Isometric

Characterized by its perfect cubic cleavage, colorless or white color, cubic crystals or granular masses, salty taste.

Distinguished from Sylvite by less bitter taste.

Occurrence: precipitated by evaporation with Gypsum, Sylvite, Anhydrite, Calcite, Clay and Sand.

2. Sylvite: KCl , Isometric

Colorless or white, perfect cleavage.

Resembles Halite, but distinguished from it by more bitter taste and lesser hardness.

3. Fluorite: CaF_2 , Isometric

Color varies widely, most commonly (light-green, yellow, bluish-green, pink), perfect cleavage (octahedral cleavage) = 4 cleavage direction, hardness (4), vitreous luster.

Usually determined by its cubic crystals and octahedral cleavage.

Occurrence: it is found in hydrothermal veins, igneous rocks and pegmatite.

Lab. 5

Carbonates

Calcite Group:

1. Calcite: $CaCO_3$, Trigonal

Characterized by its hardness (3), perfect rhombohedral cleavage, color usually white to colorless, vitreous luster.

Effervesces in cold HCl acid.

Occurrence: sedimentary rocks (Limestone) and metamorphosed limestone (Marble).

2. Siderite: $FeCO_3$, Trigonal

Distinguished from other carbonates by its color (light to dark brown) and high specific gravity (3.96), perfect cleavage, vitreous luster.

Occurrence: it is found iron-stone (in concretions with concentric layers).

3. Rhodochrosite: $MnCO_3$, Trigonal

Characterized by its pink color, perfect cleavage, white streak and vitreous luster.

Occurrence: it is found in hydrothermal veins with ores of Silver, Lead, Copper and other manganese minerals.

4. Smithsonite: $ZnCO_3$, Trigonal

Color usually dirty brown but it may be colorless, white, green, blue or pink, white streak and vitreous luster.

Occurrence: usually found with zinc-deposits in limestone.

Aragonite Group:

5. Aragonite: $CaCO_3$, Orthorhombic

Color: colorless, white, pale-yellow, distinct to poor cleavage, vitreous luster.

Distinguished from Calcite by its higher specific gravity, lack of rhombohedral cleavage and more harder (3.5-4).

Effervesces in cold HCl acid.

Occurrence: it is less stable than Calcite under atmospheric conditions, deposited by hot springs associated with Gypsum and iron ores.

6. Witherite: $BaCO_3$, Orthorhombic

Color: colorless, white, gray, vitreous luster, distinct to poor cleavage, high specific gravity (4.3).

Occurrence: it is rare mineral found in veins associated with Galena.

Dolomite Group:

7. Dolomite: $CaMg(CO_3)_2$, Hexagonal

Color: colorless, white, gray or pink, vitreous to pearly luster, perfect cleavage, harder than (3).

Powdered minerals will effervesce in cold HCl acid.

Occurrence: in dolostone sedimentary rocks.

Monoclinic Carbonate with (OH^-):

8. Malachite: $Cu_2CO_3(OH)_2$, Monoclinic

Color and streak bright-green, Botryoidal form, radiating or mammillary shape, adamantine, vitreous, silky or earthy luster.

Effervesces in cold HCl acid.

Occurrence: in veins with Copper deposits and associated with Azurite and maybe alter to it

9. Azurite: $Cu_3(CO_3)_2(OH)_2$, Monoclinic

Characterized by its azure-blue color and light-blue streak, vitreous luster, radiating fibrous.

Effervesces in HCl acid.

Occurrence: in veins with Copper deposits and usual alteration from Malachite.

Lab. 6

Phosphates

1. Apatite: $Ca_5(PO_4)_3$ (F, Cl, OH) , Hexagonal

Usually in the hexagonal prism with a pyramid, green, blue, brown, violet or colorless, poor cleavage, hardness (5), vitreous to a subresinous luster.

- *Collophane*: the name collophane has been given to the massive, cryptocrystalline types of Apatite that constitute the bulk phosphate rock and fossil bone.

- *Phosphorite*: you can use this term when you can't identification Apatite.

Occurrence: Apatite is widely disseminated as an accessory constituent in all types of rocks (igneous, metamorphic and sedimentary rocks).

2. Pyromorphite: $Pb_5(PO_4)Cl$, Hexagonal

Various color (green, brown, gray, yellow), resinous to adamantine luster, high specific gravity, globular or botryoidal shape.

Occurrence: veins associated with lead and zinc minerals.

Tungstates and Molybdates

1. Wolframite: $(Fe, Mn)WO_4$, Monoclinic

Black to brown color, perfect cleavage (one direction), high specific gravity, submetallic to the resinous luster.

Occurrence: rare mineral found usually in pegmatite and veins.

Sulfates

1. Barite: $BaSO_4$, Orthorhombic

Colorless, white, blue, red, usually in an aggregate of platy crystals, vitreous to pearly luster, perfect cleavage and high specific gravity.

Occurrence: it is a common mineral, occurs in hydrothermal veins in sedimentary rocks.

2. Anhydrite: $CaSO_4$, Orthorhombic

Colorless, white, blue, gray, red, perfect cleavage in three directions perpendicular to each other, commonly in massive (without cleavage) , vitreous to pearly luster.

Distinguished from Calcite by its higher specific gravity (2.9) and from Gypsum by its greater hardness (3-3.5).

Occurrence: sedimentary rocks.

3. Gypsum: $CaSO_4.2H_2O$, Monoclinic

Colorless to white color, perfect to good cleavage, massive (without cleavage) , hardness (2), vitreous or pearly and silky luster.

Three variety types:

- ✓ *Satin spar:* is fibrous Gypsum with the silky luster.
- ✓ *Alabaster:* is the fine-grained massive variety, pearly luster.
- ✓ *Selenite:* is a variety that yields broad colorless and transparent, cleavage folia.

Occurrence: it is common mineral in sedimentary rocks.

Lab. 7

Silicate minerals

Nesosilicates:

1. Olivine: $(Mg, Fe)_2SiO_4$, Orthorhombic

Olive-green color, distinguished by its vitreous luster and conchoidal fracture, granular nature and great hardness (6.5-7).

Occurrence: igneous rocks.

2. Garnet: $A_3 B_2 (SiO_4)_3$, Isometric

Usually in dodecahedrons or trapezohedrons crystals or combination of the tow, brown to red color, white streak, vitreous to resinous luster, hardness (6.5-7).

Occurrence: commonly in metamorphic rocks and accessory in igneous rocks.

3. Zircon: $ZrSiO_4$, Tetragonal

Usually is small prisms truncated by the pyramid, color (brown, red, gray, green or colorless), adamantine luster, poor cleavage, hardness (7.5), high specific gravity.

Occurrence: it is a common accessory mineral in igneous rocks, found also in some metamorphic rocks (gneisses, schist) and Zircon is a common accessory mineral in many sediments as rolled grains in the sand.

4. Kyanite: Al_2SiO_5 , Triclinic

Bladed aggregates with perfect cleavage, hardness (5) parallel to the length of crystals, (7) at right angles to this direction, usually blue color, vitreous to pearly luster.

Occurrence: in metamorphic rocks (the result of regional metamorphism).

Sorosilicates:

1. Epidote: $Ca_2(Al, Fe)Al_2O(SiO_4)(Si_2O_7)(OH)$, Monoclinic

Color (pistachio-green to yellowish-green to black), hardness (6-7), high specific gravity, cleavage in one direction, vitreous luster, usually in prismatic crystals.

Occurrence: metamorphic rocks.

Cyclosilicates:

1. Beryl: $Be_3Al_2(Si_6O_{18})$, Hexagonal

Usually hexagonal prisms, bluish-green or light-yellow color. imperfect cleavage, hardness (7.5-8), vitreous luster.

Occurrence: in granitic rocks, pegmatite, mica schist and bituminous limestone.

2. Tourmaline: $(Na, Ca)(Li, Mg, Al)(Al, Fe, Mn)_6(BO_3)_3(Si_6O_{18})(OH)_4$

Hexagonal

Slender prismatic crystals with a triangular cross-section or an radiating groups of crystals, color: varied but mostly black, conchoidal fracture, vitreous to resinous luster, the absence of cleavage.

Occurrence: found in pegmatite and an accessory mineral in igneous and metamorphic rocks.

Lab. 8
Inosilicates:

A- Single chain:

1. Augite: (Ca, Na)(Mg, Fe, Al)(Si, Al)$_2$O$_6$, Monoclinic

Imperfect prismatic cleavage at 87° and 93°, black color, vitreous luster, translucent, hardness (5-6).

Occurrence: it is most common pyroxene found in the dark color igneous rocks such as basalt, gabbro and Peridotite.

2. Diopside: CaMgSi$_2$O$_6$, Monoclinic

White to light green color, imperfect cleavage, vitreous luster, transparent to translucent, hardness (6.5).

Occurrence: common in metamorphic and igneous rocks.

3. Enstatite: MgSiO$_3$, Orthorhombic

Crystals usually prismatic but rare, commonly massive, fibrous or lamellar, color: gray, brown to black, cleavage: good in two directions at nearly 90°, vitreous to pearly luster, hardness (5-6).

Occurrence: common mineral in peridotite, gabbro and basalt.

B- Double chain:

1. Hornblende: (Ca, Na)$_{2-3}$(Mg, Fe, Al)$_5$Si$_6$(Si, Al)$_2$O$_{22}$(OH)$_2$ Monoclinic

Perfect prismatic cleavage at the angle of 56°-124°, dark green to black color, vitreous luster but fibrous varieties often silky, translucent, hardness (5-6).

Occurrence: in both igneous and metamorphic rocks.

2. Anthophyllite: (Mg, Fe)$_7$Si$_8$O$_{22}$(OH)$_2$, Orthorhombic

Perfect cleavage at angles 54° and 126° (two directions), gray to green and clove brown color, commonly in aggregates and fibrous massive crystals, vitreous luster, hardness (5.5-6).

Occurrence: it is a metamorphic product of Mg-rich rocks such as ultrabasic igneous rocks and impure dolomitic shale.

3. Riebeckite: Na$_2$Fe$_3^{2+}$Fe$_2^{3+}$Si$_8$O$_{22}$(OH)$_2$, Monoclinic

Slender acicular crystals or as aggregate or sometimes asbesti form, blue to lavender-blue to black color, white to light blue streak, translucent, hardness (6).

Occurrence: commonly in igneous rocks such as granite and syenite and in some schist of regional metamorphic origin.

Lab. 9

Phyllosilicates:

Serpentine Group:

1. Serpentine: $Mg_3Si_2O_5(OH)_4$, Monoclinic

Serpentine occurs in two distinct form:

a) Platy variety, massive (Antigorite).

b) Fibrous variety (Chrysotile).

Frequently mottled green in the massive variety, fibrous in the asbestos variety Chrysotile.

Color: olive to blackish green.

Luster: greasy or waxlike in the massive varieties, silky in the fibrous.

Hardness: 3-5.

Occurrence: found in both igneous and metamorphic rocks.

Clay Mineral Group:

2. Kaolinite: $Al_2Si_2O_5(OH)_4$, Triclinic

White color, cleavage perfect but seldom seen, luster usually dull earthy, hardness (2-2.5), an argillaceous odor with adhering to the dry tongue.

Occurrence: in clay and kaolin, it is formed by weathering or hydrothermal alteration of aluminum silicates particularly Feldspar.

3. Talc: $Mg_3Si_4O_{10}(OH)_2$, Monoclinic

Usually foliated and radiating foliated groups, color: white, apple-green, gray or silver-white, perfect cleavage, pearly to greasy luster, translucent, hardness (1) (will make a mark on cloth), softness and greasy feel.

Occurrence: in low-grade metamorphic rocks.

Mica Group:

4. Muscovite: $KAl_2(AlSi_3O_{10})(OH)_2$, Monoclinic

Foliated masses and scales, cleavage: perfect allowing the mineral to be split into very thin sheets, color: colorless to pale brown or green, yellow or white, luster: vitreous to pearly or silky, hardness (2-2.5), transparent to translucent.

Occurrence: in igneous granites and metamorphic rocks.

5. Phlogopite: $KMg_3(AlSi_3O_{10})(OH)_2$, Monoclinic

Irregular foliated masses, color: yellowish-brown, green, white, perfect cleavage, vitreous to pearly luster, hardness (2.5-3), may show copper like reflections from cleavage surface.

Occurrence: found in metamorphosed Mg-rich limestones, dolomites and ultrabasic rocks.

6. Biotite: $K(Mg, Fe)_3(AlSi_3O_{10})(OH)_2$, Monoclinic

Irregular foliated masses, color: dark green, brown to black, more rarely light yellow, thin sheets usually have a smoky color (differing from the almost colorless Muscovite), perfect cleavage, splendent luster, hardness (2.5-3).

Occurrence: in igneous and metamorphic rocks.

Chlorite Group:

7. Chlorite: $(Mg, Fe)_3(Si, Al)_4O_{10}(OH)_2.(Mg, Fe)_3(OH)_6$, Monoclinic

Irregular foliated masses may be in compact masses of minute scales, thin sheets flexible but not elastic (like mica group minerals), green color, perfect cleavage, vitreous to pearly luster, transparent to translucent, hardness (2-2.5).

Occurrence: it is a common mineral in metamorphic rocks.

Lab. 10
Tectosilicates:
SiO_2 Group:

1. Quartz: SiO_2 , Hexagonal

Crystals usually show horizontal striated prism with rhombohedral termination,

Color: usually colorless or white but frequently colored by impurities and may then be any color (**Coarsely crystalline varieties**) such as:

- *Amethyst:* Quartz colored various shades of violet, often in crystals. The color apparently results from small amounts of Fe^{3+}.

- *Rose Quartz:* when containing small amounts of Ti^{4+}.

- *Smoky Quartz:* Smoky yellow to brown to almost black and this dark color attributed to free silicon formed by exposure to radioactive material.

Luster: vitreous, some Quartz samples give greasy or splendent luster.

Fracture: conchoidal.

Transparency: transparent to translucent.

Hardness: 7.

Specific gravity: light.

Occurrence: Quartz found in all types of rocks.

Microcrystalline varieties:

- *Chalcedony:* is a general term applied to a fibrous variety of Quartz, brown to gray color, waxy luster, translucent, it is deposited from aqueous solutions and is frequently found lining or filling cavities in rocks.

Color and banding give rise to other varieties such as:

- *Agate*
- *Jasper*
- *Flint and Chert*

2. Opal: $SiO_2.nH2O$

Color: colorless, white, pale shades of yellow, red, brown, green, gray, and blue, conchoidal fracture, hardness (5-6), specific gravity (light).

Distinguished from microcrystalline varieties of Quartz by lesser hardness and specific gravity and by the presence of water.

Occurrence: Opal may be deposited by hot spring at shallow depths and from the siliceous tests of the silica-secreting organism.

Feldspar Group:

K - Feldspar

3. Microcline: $KAlSi_3O_8$, Triclinic

Color: white to pale yellow, rarely red or green.
Luster: vitreous.
Cleavage: perfect to good at the angle of 89°30´.
Hardness: 6.
Transparency: transparent to translucent.
Distinguished by twinning which determined by the aid of the microscope.
Occurrence: in igneous rocks such as granite and syenite, in sedimentary rocks (arkose sandstone and conglomerate), and in metamorphic rocks in gneiss.

4. Orthoclase: $KAlSi_3O_8$, Monoclinic

Color: colorless, white, gray, flesh-red, rarely yellow or green.
Streak: white.
Luster: vitreous
Cleavage: perfect, good-imperfect.
Hardness: 6.
Distinguished from other feldspars by color and its right-angle cleavage.
Occurrence: Orthoclase is a major constituent of granite and syenite igneous rocks.

5. Sanidine: $(K, Na)AlSi_3O_8$, Monoclinic

Crystals are often tabular to elongated.
Color: colorless.
Streak: white.
Luster: vitreous.
Transparency: transparent.
Cleavage: perfect to good.
Hardness: 6.
Occurrence: it is found as phenocrysts in extrusive igneous rocks such as rhyolite and trachyte.

Plagioclase Feldspar Series

6. Plagioclase: **Albite $NaAlSi_3O_8$-----Anorthite $CaAl_2Si_2O_8$** , Triclinic

Crystals commonly tabular to elongate and frequently twinned.
Color: colorless, white and gray and rarely greenish, yellowish or flesh-red.
Luster: vitreous to pearly.
Transparency: transparent to translucent.
Cleavage: perfect to good.

Hardness: 6.
Distinguished from other feldspars by the presence of albite twin striations {001}.
Occurrence: in igneous and metamorphic rocks, and rarely in sedimentary rocks.

Feldspathoid Group

7. Leucite: $KAlSi_2O_6$, Tetragonal (Pseudo isometric)
White to gray color, vitreous to dull luster, translucent, hardness(5.5-6), usually embedded in a fine-grained matrix.
Occurrence: it is rare mineral found in recent lavas, rarely observed in deep-seated rocks, Leucite is found only in silica-deficient rocks and thus never in rocks containing Quartz.

8. Nepheline: $(Na, K)AlSiO_4$, Hexagonal
Mostly massive and compact, and in embedded grains.
Color: colorless, white, yellowish, gray, greenish, reddish.
Luster: vitreous in clear crystals; greasy in the massive variety.
Transparency: transparent to translucent.
Cleavage: distinct.
Hardness: 5.5-6.
Occurrence: Nepheline found in silica-deficient intrusive and extrusive rocks.