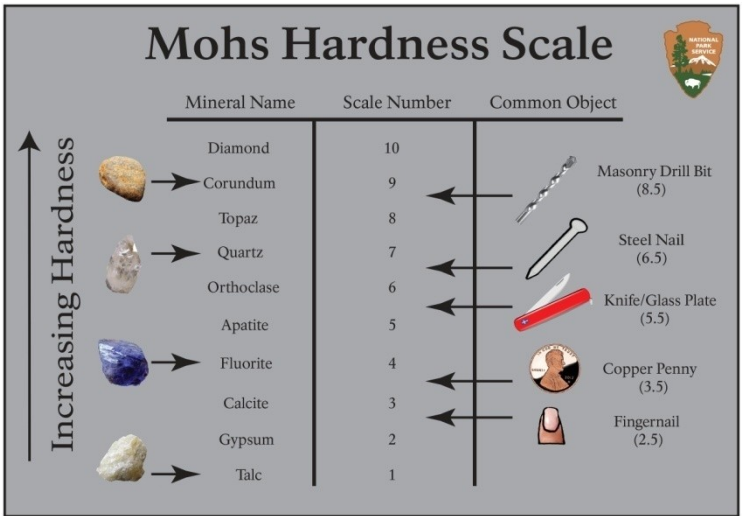
UNIT-II MINEROLOGY

Mineral: a naturally occurring crystalline, inorganic, homogenous solid with a chemical composition that is either fixed or varies within certain fixed limits, and a characteristic internal structure manifested in its exterior form and physical properties.

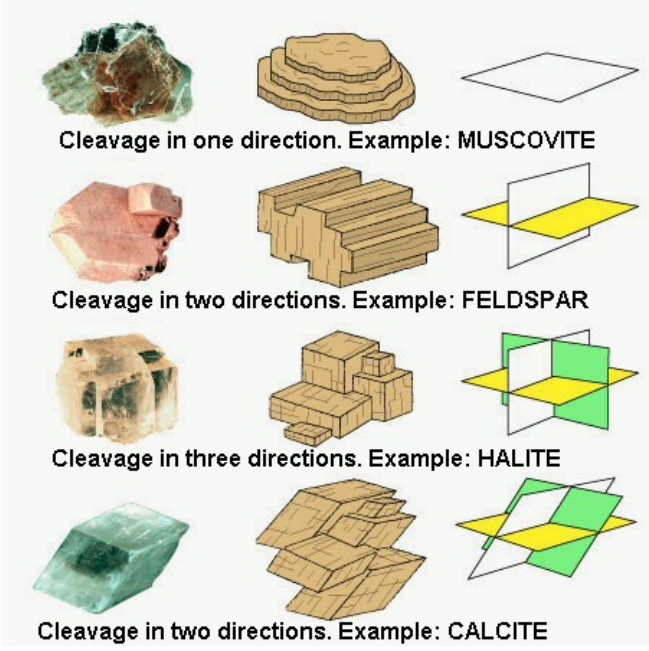
2.1.Physical Properties of Minerals

Colour
- on a fresh surface in reflected light
- The colour or lack of colour may be diagnostic
- Be careful- it can vary due to small differences in chemical composition!
- Small impurities may also change the colour

Hardness is the resistance to abrasion (scratchability)
- Determined by either trying to scratch a mineral of unknown hardness with a substance of known hardness or by using the unknown mineral to scratch a substance of known hardness.
- Mohs Scale of hardness: 10 minerals arranged by hardness



Cleavage
- Defined as the tendency of a mineral to break along definite planes of weakness that exist in the internal structure
- It is almost impossible to break some minerals in such a way that cleavage planes do not develop. Calcite and pyrite are great examples
- A well defined cleavage plane will reflect light off of it's very smooth surface
- Look for repetitions in the breaks of the crystal
- Do not be confused with mineral growth faces, such as quartz!



• If there is no cleavage, there is fracture. ex: conchoidal fracture patterns in obsidian or the fibrous fracture of asbestos.

Streak

• The colour of a mineral powder, produced from rubbing the mineral against a porcelain streak plate, either black or white

• Some minerals have a very unique streak colour ex: hematite(cherry red)

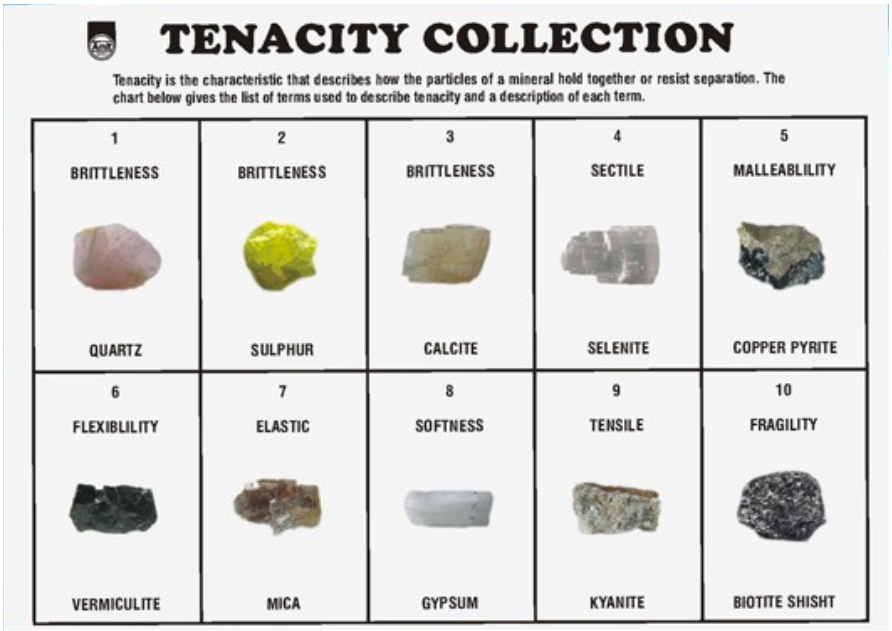
• In general, metallic minerals have a unique streak colour

• Limitation: the streak plate hardness is ~7

Tenacity

• An index of a mineral's resistance to be broken…or bent..

• Many terms are used to describe tenacity, some examples in your lab manual are brittle, elastic, flexible



Diaphaneity

• The ability of a mineral to transmit light.

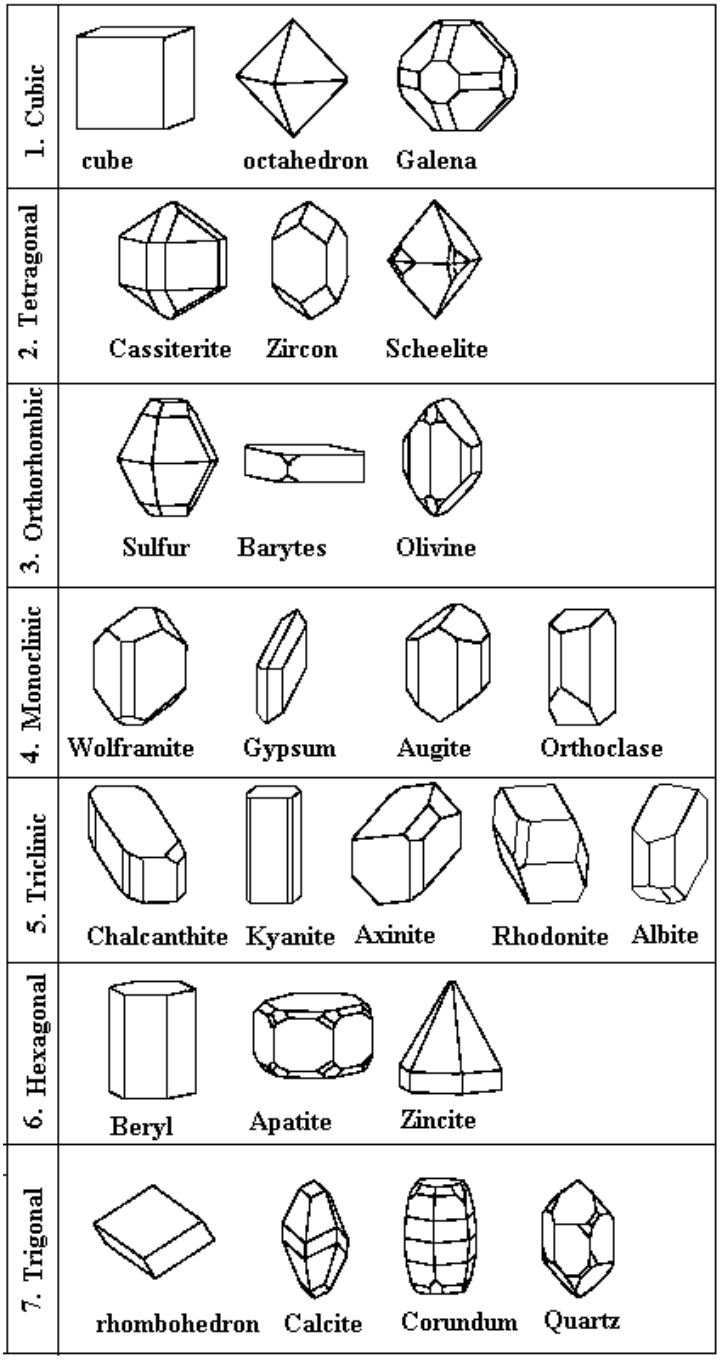
• Transparent, translucent, opaque.

• Limitation: some minerals change properties with differing thicknesses.

Crystal Form

• The assemblage of crystal faces that constitute the exterior surface of the crystal
• Crystal Symmetry is the geometric relationship between the crystal faces
• Opposite: Amorphous
• 7 crystal systems: Cubic (or isometric),trigonal, tetragonal, hexagonal, orthorhombic, monoclinic, triclinic.

Crystal form of the seven crystal systems



Other physical Properties

• Magnetism Lodestone compasses
• Double refraction
• Taste (Rock Salt, NaCl)
• Odor (Sulfur, Sphalerite ZnS)

• Feel (talc is greasy,hornblende is rough)
• Chemical reaction with HCL

2.2.Table for Identification of Mineral:

S. No	Physical Property	Mineral No.	Mineral No.	Mineral No.
1	**Color**	Olive green, yellow to bright green and brownish green to brown	white, gray, flesh pink, reddish, yellow, green etc.	Typically red, but can be orange, green, yellow, purple, black or brown.
2	**Streak**	colorless/white	white	colorless
3	**Luster**	Vitreous	Vitreous	Vitreous
4	**Diaphanity (Transperency)**	Translucent/opaque	Translucent	Translucent
5	**Cleavage**	Poor	Perfect	Absent
6	**Fracture**	Conchoidal	Uneven	Uneven
7	**Hardness**	6.5-7	6	7-8
8	**Tenacity**	Brittle	Brittle	Brittle
9	**Specific Gravity**	3.2 - 4.4	2.5-2.6	3.5-4.3
10	**Form**	Massive/granular		Cubic, Massive
11	**Diagnostic property if (reaction/Mgnetism/Electric Conductivity etc.)**	Olive green color,dull luster,Medium density	Tabular Form	Cleavage absent,red color.
12	**Name of the Mineral**	Olivine	Feldspar	Garnet
13	**Chemical Composition**	$(Mg, Fe)_2 SiO_4$	$KAlSi_3O_8$, $NaAlSi_3O_8$ – $CaAl_2Si_2O_8$	$X_3Y_2(SiO_4)_3$
14	**Mode of origin/occurence**	Most olivine found at Earth's surface in dark-colored igneous rocks.	Found in Intrusive and extrusive igneous, and metamorphic rocks.	Garnets are found in metamorphic, igneous, and sedimentary rocks.
1	**Uses**		Used as	Used as Abrasives,

5			decorative stone, moon stone, ceramics.	Blasting, Water jet Cutting, , and Gemstone.

S. No	**Physical Property**	**Mineral No.**	**Mineral No.**	**Mineral No.**
1	**Color**	Black, dark green, dark brown	white	black, dark green, dark brown
2	**Streak**	white to gray	white	White
3	**Luster**	Pearly	Pearly	Vitreous
4	**Diaphanity (Transperency)**	Translucent	Translucent	Opaque
5	**Cleavage**	Perfect	Perfect	Perfect
6	**Fracture**	Uneven	Even	Uneven
7	**Hardness**	2-3	2-3	5-6
8	**Tenacity**	Malleable	Malleable	Brittle
9	**Specific Gravity**	2.7-3.4	2.8-2.9	2.9-3.5
10	**Form**	Lamellar	Lamellar	Prismstic
11	**Diagnostic property if (reaction/Mgnetism/Electric Conductivity etc.)**	Pearly luster	Pearly luster	Dark green color
12	**Name of the Mineral**	Biotite Mica	Muscovite Mica	Hornblende
13	**Chemical Composition**	$K(Mg,Fe)_{2-3}Al_{1-2}Si_{2-3}O_{10}(OH,F)_2$	$K\ Al_2(AlSi_3O_{10})(OH)_2$	$(Ca,Na)_{2-3}(Mg,Fe,Al)_5(Al,Si)_8O_{22}(OH,F)_2$
14	**Mode of origin/occurence**	Biotite is a primary mineral found in a wide range of crystalline igneous rocks such as granite, diorite, gabbro, peridotite and pegmatite. It also forms under metamorphic	Muscovite is found in igneous, metamorphic and sedimentary rocks.	Hornblende is an important constituent in acid and intermediate igneous rocks such as granite, diorite, syenite, andesite and rhyolite

		conditions when argillaceous rocks are exposed to heat and pressure to form schist and gneiss.		
15	**Uses**	Ground mica is used as a filler and extender in paints, as an additive to drilling muds, as an inert filler and mold-release agent in rubber products, and as a non-stick surface coating on asphalt shingles and rolled roofing	Muscovite mica is used to manufacture a variety of products such as joint compound, paint, drilling mud, plastics, rubber, asphalt roofing and cosmetics.	cut, polished hotrnblende sold under the name "black granite" for use as building facing, floor tiles, countertops and other architectural uses
S. No	**Physical Property**	Mineral No.	Mineral No.	Mineral No.
1	**Color**	Dark greenish black	White,gray, red, green, blue, yellow, brown, orange	White
2	**Streak**	White	White	Pale green
3	**Luster**	Vitreous	vitreous	Pearly
4	**Diaphanity (Transperency)**	Opaque	Transparent to Translucent	Translucent to opaque
5	**Cleavage**	Present	Perfect (rhombohedral)	Perfect
6	**Fracture**	Uneven	Even	Even
7	**Hardness**	5-6	3	1
8	**Tenacity**	Brittle	Brittle	Brittle
9	**Specific Gravity**	Medium	2.7	2.7-2.8
10	**Form**	Prismatic	Rhombohedral or Hexagonal	Massive
11	**Diagnostic property if (reaction/Mgnetism/Electric Conductivity etc.)**		React with acid	Soapy feel
12	**Name of the Mineral**	Augite	Calcite	Talc
13	**Chemical Composition**		$CaCO_3$	$Mg_3Si_4O_{10}(OH)_2$

14	**Mode of origin/occurence**		Calcite is the principal constituent of limestone and marble	Talc is most often found in the metamorphic rocks of convergent plate boundaries.
15	**Uses**		Calcite used as a construction material, abrasive, agricultural soil treatment, construction aggregate, pigment, pharmaceutical and more	Used as a filler and anti-stick coating in plastics, ceramics, paint, paper, roofing, rubber, cosmetics.

S. No	**Physical Property**	Mineral No.	Mineral No.	Mineral No.
1	**Color**	pale blue	white, gray, yellow, red, brown.	Grey,green
2	**Streak**	White	White	White
3	**Luster**	Vitreous,Pearly	vitreous, silky, sugary	Silky
4	**Diaphanity (Transperency)**	Translucent	Transparent-Translucent	Opaque
5	**Cleavage**	Perfect	Perfect	Perfect
6	**Fracture**	Hackly	Even	Hackly
7	**Hardness**	4-6	2	2.5
8	**Tenacity**	Brittle	Brittle	Flexible
9	**Specific Gravity**	3.6-3.7	2.3	3-3.2
10	**Form**	Bladed	Monoclinic	Fibrous
11	**Diagnostic property if (reaction/Mgnetism/Electric Conductivity etc.)**	Bladed Form	Less Hardness	Fibrous form, Silky luster
12	**Name of the Mineral**	Kyanite	Gypsum	Asbestos

13	**Chemical Composition**	Al_2Sio_5	$CaSO_4{\cdot}2H_2O$	$Mg_3Si_2O_5(OH)_4$
14	**Mode of origin/occurence**	Kyanite is a mineral found mainly in metamorphic rocks. It is found in the schists and gneisses of regionally metamorphosed areas and less often in quartzite or eclogite.	Gypsum is found in layered sedimentary deposits in association with halite, anhydrite, sulfur, calcite and dolomite	It occurs chiefly in association with massive serpentine.
15	**Uses**	It used in the manufacture of refractory products such as the bricks, mortars and kiln furniture used in high temperature furnaces. For foundries, the molds that are used for casting high temperature metals are often made with kyanite.	Gypsum uses include manufacture of wallboard, cement, plaster of Paris, soil conditioning, a hardening retarder in Portland cement.	Due to its resistance to the effects of heat and fire it is widely used in roofing, ceiling tiles, cement pipes and other building materials. Asbestos fabrics were used for safety apparel and for such items as theatre curtains and fire stop hangings in public buildings.
S. No	**Physical Property**	Mineral No.	Mineral No.	Mineral No.
1	**Color**	Black to silvery gray	Red- reddish brown- black	lead grey
2	**Streak**	Black	Red, Cherry red.	Black
3	**Luster**	Metallic-Submetallic	Sub-metallic	Sub-metallic
4	**Diaphanity (Transperency)**	Opaque	Opaque	Opaque
5	**Cleavage**	Absent	Absent	Perfect(Cubic)
6	**Fracture**	Uneven	Uneven	Uneven
7	**Hardness**	5-6.5	5-6.5	2-3
8	**Tenacity**	Brittle	Brittle	Brittle
9	**Specific Gravity**	5.2	5-5.3	7.4-7.6
10	**Form**	Massive	Massive	Cubic
11	**Diagnostic property if (reaction/Mgnetism/Electric**	Strongly Magnetic	Streak is cherry red.	Black streak, High specific gravity

	Conductivity etc.)			
12	**Name of the Mineral**	Magnetite	Hematite	Galena
13	**Chemical Composition**	Fe_3O_4	Fe_2O_3	PbS
14	**Mode of origin/occurence**	It found in igneous, metamorphic and sedimentary rocks.	It is a common rock-forming mineral found in sedimentary, metamorphic, and igneous rocks at locations throughout the world	It is found in igneous and metamorphic rocks in medium- to low-temperature hydrothermal veins.
15	**Uses**	As Iron ore and powdered magnetite is often mixed with a liquid to produce a thick, high density slurry. The abrasive known as "emery" is a natural mixture of magnetite and corundum. Small amounts of magnetite used as a micronutrient in fertilizers, pigment in paints, and as an aggregate in high-density concrete.	Used as Iron ore, and to produce pigments, heavy media separation, radiation shielding, ballast, and many other products.	Galena is a very important mineral because it serves as an ore for most of the world's lead production. It is also a significant ore of silver.

S. No	**Physical Property**	**Mineral No.**	**Mineral No.**	Mineral No.
1	**Color**	Brass yellow	white, brown or yellow	White
2	**Streak**	Greenish black	usually white but iron stain can discolor	colorless
3	**Luster**	Metallic	dull, earthy	Vitreous
4	**Diaphanity (Transperency)**	Opaque	Opaque	Transparent-Translucent

5	**Cleavage**	Poor	Absent	Absent
6	**Fracture**	Uneven	Uneven	Uneven-Conchoidal
7	**Hardness**	3.5-4	1-3	7
8	**Tenacity**	Malleable	Brittle	Brittle
9	**Specific Gravity**	4.1-4.3	2-2.5	Medium
10	**Form**	Massive	Pisolitic	Massive,Drusy,Crystals
11	**Diagnostic property if (reaction/Mgnetism/Electric Conductivity etc.)**	Greenish black streak		
12	**Name of the Mineral**	Chalcopyrite	Bauxite	Quartz
13	**Chemical Composition**	$CuFeS_2$	$Al_2O_3.2H_2O$	SiO_2
14	**Mode of origin/occurence**	Chalcopyrite deposits are found in hydrothermal veins, void fillings and replacements in limestones, contact metamorphic deposits and magmatic separations	Formed from a laterite soil that has been severely leached of silica and other soluble materials in a wet tropical or	Found in Igneous roks mainly granites,pegmatites and diorites.
15				

METALLIC TO SUBMETALLIC MINERALS

FRACTURE CLEAVAGE	STREAK	COLOR	HARDNESS	FRACTURE CLEAVAGE	LUSTER	DIAPHANEITY	OTHER PROPERTIES	SPECIFIC GRAVITY	MINERAL NAME
CLEAVAGE	yellow or brown	yellow, brown, black	5 - 5.5	one direction indistinct	submetallic	translucent	silky, fibrous appearance	3.3 -4.3	GOETHITE
	white, yellow, or brown	white, red yellow, brown, green, black	3.5 - 4	perfect cleavage in 6 directions	submetallic	translucent	brittle, looks like resin	3.9 - 4.1	SPHALERITE
	colorless	dark green, dark brown, or black	2.5 - 3	perfect cleavage in one direction	submetallic	translucent	thin flakes, tough, flexible	2.8 - 3.2	BIOTITE
	black	black, silver, or gray	1 - 2	cleavage sometimes indistinct	metallic or submetallic	opaque	marks paper, soils fingers, slippery	2.23	GRAPHITE
FRACTURE	black	brassy yellow	6 - 6.5	conchoidal fracture	metallic	opaque	sometimes in crystal shapes	5.02	PYRITE
	reddish	red -brown, black, silver	5 - 6.5	fracture	metallic or submetallic	opaque	sometimes oolitic or magnetic	5.56	HEMATITE
	black	black or silver	6	fracture	metallic or submetallic	opaque	strongly magnetic	5.18	MAGNETITE
	black	brownish	4	fracture	metallic	opaque	weakly magnetic	4.58 - 4.65	PYRRHOTITE
	greenish black	brassy yellow	3.5 - 4	fracture	metallic	opaque	brittle	4.1 - 4.3	CHALCOPYRITE
	black	brassy with iridescent colors	3	indistinct cleavage	metallic	opaque	iridescent peacock colors	5.0 -5.1	BORNITE

Properties of Common Minerals

LUSTER	HARDNESS	CLEAVAGE	FRACTURE	COMMON COLORS	DISTINGUISHING CHARACTERISTICS	USE(S)	MINERAL NAME	COMPOSITION*
Metallic Luster	1–2	✔		silver to gray	black streak, greasy feel	pencil lead, lubricants	**Graphite**	C
	2.5	✔		metallic silver	very dense (7.6 g/cm^3), gray-black streak 	ore of lead	**Galena**	PbS
	5.5–6.5		✔	black to silver	attracted by magnet, black streak	ore of iron	**Magnetite**	Fe_3O_4
	6.5		✔	brassy yellow	green-black streak, cubic crystals 	ore of sulfur	**Pyrite**	FeS_2
Either	1–6.5		✔	metallic silver or earthy red	red-brown streak	ore of iron	**Hematite**	Fe_2O_3
Nonmetallic Luster	1	✔		white to green	greasy feel	talcum powder, soapstone	**Talc**	$Mg_3Si_4O_{10}(OH)_2$
	2		✔	yellow to amber	easily melted, may smell	vulcanize rubber, sulfuric acid	**Sulfur**	S
	2	✔		white to pink or gray	easily scratched by fingernail	plaster of paris and drywall	**Gypsum** (Selenite)	$CaSO_4 \cdot 2H_2O$
	2–2.5	✔		colorless to yellow	flexible in thin sheets 	electrical insulator	**Muscovite Mica**	$KAl_3Si_3O_{10}(OH)_2$
	2.5	✔		colorless to white	cubic cleavage, salty taste 	food additive, melts ice	**Halite**	NaCl
	2.5–3	✔		black to dark brown	flexible in thin sheets 	electrical insulator	**Biotite Mica**	$K(Mg,Fe)_3 AlSi_3O_{10}(OH)_2$
	3	✔		colorless or variable	bubbles with acid 	cement, polarizing prisms	**Calcite**	$CaCO_3$
	3.5	✔		colorless or variable	bubbles with acid when powdered	source of magnesium	**Dolomite**	$CaMg(CO_3)_2$
	4	✔		colorless or variable	cleaves in 4 directions	hydrofluoric acid	**Fluorite**	CaF_2
	5–6	✔		black to dark green	cleaves in 2 directions at 90° 	mineral collections	**Pyroxene** (commonly Augite)	$(Ca,Na)(Mg,Fe,Al)(Si,Al)_2O_6$
	5.5	✔		black to dark green	cleaves at 56° and 124° 	mineral collections	**Amphiboles** (commonly Hornblende)	$CaNa(Mg,Fe)_4(Al,Fe,Ti)_3Si_6O_{22}(O,OH)_2$
	6	✔		white to pink	cleaves in 2 directions at 90°	ceramics and glass	**Potassium Feldspar** (Orthoclase)	$KAlSi_3O_8$
	6	✔		white to gray	cleaves in 2 directions, striations visible	ceramics and glass	**Plagioclase Feldspar** (Na-Ca Feldspar)	$(Na,Ca)AlSi_3O_8$
	6.5		✔	green to gray or brown	commonly light green and granular	furnace bricks and jewelry	**Olivine**	$(Fe,Mg)_2SiO_4$
	7		✔	colorless or variable	glassy luster, may form hexagonal crystals 	glass, jewelry, and electronics	**Quartz**	SiO_2
	7		✔	dark red to green	glassy luster, often seen as red grains in NYS metamorphic rocks	jewelry and abrasives	**Garnet** (commonly Almandine)	$Fe_3Al_2Si_3O_{12}$

*Chemical Symbols: Al = aluminum, C = carbon, Ca = calcium, Cl = chlorine, F = fluorine, Fe = iron, H = hydrogen, K = potassium, Mg = magnesium, Na = sodium, O = oxygen, Pb = lead, S = sulfur, Si = silicon, Ti = titanium

✔ = dominant form of breakage