Alfred Buranek

MINERAL TABLES

MINERAL TABLES

FOR THE DETERMINATION OF MINERALS BY THEIR PHYSICAL PROPERTIES.

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SECOND EDITION, REVISED

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PREFACE TO SECOND EDITION.

In this new edition of the Tables, no change has been made in the arrangement of the minerals primarily by their streak, color and hardness, as it has been well demonstrated, in the years since the tables were first issued, that such an arrangement gives the student the surest and quickest means of identifying minerals. Tables depending wholly upon physical properties as a means of identification have their limitations; it has, therefore, been very gratifying to the author to see how few errors the careful observer makes in using these tables.

A few additions and corrections have been made in this edition; the tables now contain about two hundred minerals, including all the common ones and others that are rarer, some of them of local prominence.

The natural method of identifying minerals is by using those characters which are prominent or which can be determined in the field or laboratory in the simplest manner. Practice in the determination of minerals by their physical properties tends to develop the habit of close and careful observation, and at the same time enables the student to acquire more knowledge of minerals in a given time than could be obtained by any other method. Experience has demonstrated that work in blowpipe analysis is less apt

to become merely mechanical if it has been preceded by such practice.

The author has been greatly assisted by valuable suggestions from many users of the tables, and takes this occasion to express his indebtedness to them.

BERKELEY, February 20, 1923.

MINERAL TABLES.

PHYSICAL PROPERTIES.

THE only apparatus needed for the tables is a pocket-knife, a horse-shoe magnet, a pocket-lens, a piece of unglazed porcelain or streak-plate, and a scale of hardness consisting of nine minerals. This scale can be procured of any mineral dealer or can be made up of specimens from an ordinary collection of minerals.

Color.—The color of a mineral is perhaps the most important property used in its identification, yet it is the most difficult to accurately describe. A mineral may have but one characteristic color, or it may occur in various colors and shades; consequently a mineral may be repeated several times in the tables. The color must always be judged by the fresh surface or fracture, and it should be homogeneous throughout the mineral. Vitreous minerals may often be discolored or stained by impurities, when they manifestly belong to the colorless or white class.

Luster.—The luster of a mineral refers to the kind of reflected surface. The common kinds are: *metallic; submetallic*=imperfect metallic; *vitreous*=glassy; *adamantine*=brilliant oily luster; *resinous; greasy; pearly; silky; waxy.*

Streak.—The streak of a mineral is the color of its fine powder. It is best obtained by rubbing the specimen upon the streak-plate until a definite color is produced.

Hardness.—By hardness is meant the resistance that a mineral offers to abrasion or scratching. The relative hardness of a mineral is usually determined by scratching it successively by minerals or substances of known hardness, two minerals of the same hardness mutually scratching each other. The scale of hardness in common use, called the Moh's scale, in ascending degree of hardness, is as follows: 1, Talc; 2, Gypsum; 3, Calcite; 4, Fluorite; 5, Apatite; 6, Feldspar; 7, Quartz; 8, Topaz; 9, Corundum; 10, Diamond.

The thumb-nail will scratch minerals up to $2\frac{1}{2}$, and the ordinary knife-blade up to $5\frac{1}{2}$ in the scale; with a little practice the relative hardness of a mineral under 6 can be approximately determined with a knife-blade. Above 6 the scale of hardness is necessary. The relative hardness of many of the metallic or submetallic minerals can often be judged by the ease or difficulty in obtaining a streak on the streak-plate. Fine fibrous and fine granular minerals usually appear to be much softer than the individual fiber or grain would be, if it were coarser. Also the surface of some minerals is often much softer than the fresh interior, owing to alteration.

Specific Gravity.—The gravity of a mineral is its weight compared with the weight of an equal volume of water. It is determined by first weighing the mineral in air and then weighing it suspended in water. If w = weight in air, and w' = weight in water, then $G = \frac{w}{w - w'}$. The gravity of minerals can be determined with a chemical balance or

with the convenient Jolly spring-balance. Whether the mineral is light, medium, heavy, or very heavy can often be judged simply by hefting it.

Crystallization.—A few mineral substances on assuming a solid condition do not crystallize and are said to be amorphous, but most mineral substances when solidifying have the property of crystallizing into certain definite crystal forms, and any such crystalline substance must belong to one of six different crystal systems. These systems are: 1, *Isometric;* 2, *Tetragonal;* 3, *Hexagonal;* 4, *Orthorhombic;* 5, *Monoclinic;* 6, *Triclinic.*

Assuming that each system has axes which are intersected by the crystal planes, then:

1. *Isometric* has three equal axes all at right angles. The common forms in this system are: *Cube,* having six square faces; *Octahedron,* having eight equilateral triangular faces; *Rhombic dodecahedron,* having twelve rhombic faces; *Icosatetrahedron* or *Trapezohedron,* having twenty-four trapezohedral faces; *Tetrahedron,* having four equilateral triangular faces; *Pentagonal dodecahedron* or *Pyritohedron,* having twelve pentagonal faces.
2. *Tetragonal* has two horizontal axes equal, and one vertical longer or shorter than these, all at right angles. The common forms are: *Prisms,* faces intersecting one or both horizontal axes, and parallel to the vertical; *Pyramids,* faces intersecting the vertical and one or both horizontal axes; *Basal pinacoids,* faces intersecting the vertical and parallel to the horizontal axes.

3. *Hexagonal* has three horizontal axes equal and making angles of 60° with each other, and one vertical, longer or shorter than these, and at right angles to them. The common forms are: *Prisms,* faces intersecting two or three of the horizontal axes and parallel to the vertical; *Pyramids,* faces intersecting the vertical and two or three of the horizontal; *Basal pinacoids,* faces intersecting the vertical and parallel to the horizontal; *Rhombohedrons,* solids of six oblique rhombic faces; *Scalenohedrons,* solids of twelve scalene-triangular faces.

4. *Orthorhombic* has three unequal axes all at right angles: a short forward-and-back horizontal axis, the brachyaxis; a long right-and-left horizontal axis, the macroaxis; and a vertical axis. The common forms are: *Prisms,* faces intersecting the horizontal axes and parallel to the vertical; *Pyramids,* faces intersecting the three axes; *Macropinacoids,* faces intersecting the brachyaxis and parallel to the other two; *Brachypinacoids,* faces intersecting the macroaxis and parallel to the other two; *Macrodomes,* faces intersecting the brachyaxis and the vertical and parallel to the macroaxis; *Brachydomes,* faces intersecting the macroaxis and the vertical and parallel to the brachyaxis; *Basal pinacoids,* faces intersecting the vertical and parallel to the horizontal axes.

5. *Monoclinic* has three unequal axes: a forward-and-back inclined axis, the clinoaxis; a right-and-left horizontal axis, the orthoaxis; and a vertical axis. The common forms are: *Prisms,* faces intersecting the two lateral axes and parallel to the vertical; *Pyramids,* faces intersecting all three axes; *Ortho-*

pinacoids, faces intersecting the clinoaxis and parallel to the other two; *Clinopinacoids,* faces intersecting the orthoaxis and parallel to the other two; *Orthodomes,* faces intersecting the clinoaxis and the vertical and parallel to the orthoaxis; *Clinodomes,* faces intersecting the orthoaxis and the vertical and parallel to the clinoaxis; *Basal pinacoids,* faces intersecting the vertical and parallel to the other two.

6. *Triclinic* has three unequal axes, all oblique to each other. The common forms are the same as in the orthorhombic system, namely, *Prisms; Pyramids; Macropinacoids; Brachypinacoids; Macrodomes; Brachydomes; Basal pinacoids.*

Twinning.—Some crystals instead of being simple individuals are made up of two crystals, not in parallel position, but united along a plane common to both, and such crystals are said to be twinned. Twinning is usually indicated by reentrant angles between the faces.

Cleavage.—The property which a mineral has of splitting or breaking along certain definite directions is called cleavage. The cleavage is always parallel to a possible crystal plane, and the kind of cleavage is designated by the name of the plane to which it corresponds in direction. The common kinds of cleavage for each system are:

Isometric, cubic, octahedral, and dodecahedral.

Tetragonal, basal and prismatic.

Hexagonal, basal, prismatic, and rhombohedral.

Orthorhombic, basal; prismatic; macro- or brachypinacoidal.

Monoclinic, basal; prismatic; ortho- or clinopinacoidal.

Triclinic, basal and macro- or brachypinacoidal.

The direction of cleavage can usually be determined only on the

actual crystal and not on the average massive mineral specimen. Bright, smooth cleavage faces are, however, usually present on specimens of minerals which possess good cleavage, and often they are very prominent.

Fracture.—When the direction of breakage is not definite, but occurs in any way irrespective of crystal planes, the mineral fractures. The fracture may be *even; uneven; rough; conchoidal*=rounded, shell-like; *splintery;* these terms referring to the kind of surface.

Tenacity.—The terms used to denote the tenacity are:

Malleable, when the mineral can be flattened by hammering.

Sectile, when it can be cut with a knife but will break in pieces by hammering.

Brittle, when it will break in pieces by hammering.

Tough, when it is difficult to break by hammering.

Structure.—Most minerals do not occur as simple individual crystals in nature, but rather as aggregates of imperfectly formed crystals, or simply as crystalline masses. Some of the terms used to describe the structure of specimens are:

Massive, when the specimen has an irregular, indefinite shape. It may be fine or coarse granular.

Crypto-crystalline, extremely fine crystalline; *impalpable*=extremely dense, compact.

Fibrous, composed of fibers. The fibers may be parallel, radiate, or divergent in any direction.

Columnar, stout fibrous, forming columns.

Capillary, hair-like fibers.

Acicular, needle-like.

Reticulated, when the fibers cross each other, forming a net-like structure.

Mammillary, large rounded surfaces.

Reniform, kidney-shaped masses.

Botryoidal, grape-like structure or small rounded surfaces.

Geodal, cavities lined with crystals.

Drusy, rough surfaces due to innumerable small imperfect crystals.

Micaceous, thin sheets or scales, like mica.

Lamellar, thin plates.

Foliated, thin leaves.

Other terms are used to describe the structures of mineral specimens, but their meaning in general is self-evident.

ANALYTICAL KEY.

COLOR DARK GRAY OR BLACK.

Name.	Composition.	Color.	Streak.	Luster.	H.
GRAPHITE	C	Dark steel-gray Iron-black	Black Dark silver-gray	Metallic Dull	**1** **2**
MOLYBDENITE	MoS_2	Bluish lead-gray	Lead-gray Sometime greenish	Metallic	**1** **1.5**
MELACONITE	CuO	Black	Black	Dull Earthy	**1** **2**
PYROLUSITE	MnO_2	Black Blackish Gray	Dull black	Metallic Dull	**1** **2**
STIBNITE	Sb_2S_3	Dark lead-gray	Dark lead-gray Black	Metallic	**2**
ARGENTITE	Ag_2S	Dark lead-gray Black	Dark lead-gray	Metallic	**2** **2.5**
STEPHANITE	Ag_5SbS_4	Iron-black	Iron-black	Metallic	**2** **2.5**
POLYBASITE	Ag_9SbS_6	Black	Black	Metallic	**2** **2.5**
GALENITE	PbS	Dark lead-gray	Grayish black Dark lead-gray	Metallic	**2.5** **3**
CHALCOCITE	Cu_2S	Dark lead- or steel-gray Black	Dark gray Black	Metallic	**2.5** **3**
ENARGITE	Cu_3AsS_4	Grayish black	Grayish black	Metallic	**3**

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Hex.	C, basal, perfect in crystallized masses; sectile; flexible	2.2	Foliated; scaly; massive; granular; earthy	Feels greasy; plates highly flexible; inelastic; occurs with calcite; darker than molybdenite
Hex.	C, basal, very prominent; sectile; flexible	4.7	Foliated; massive; scaly; flaky	Soft and greasy like graphite but lighter colored; usually as flakes in white massive quartz or feldspar
Mono.	C, none F, earthy	5.8	Crusts Sooty coatings	Occurs as black coatings on chalcopyrite, chrysocolla and other copper minerals
Orth.	C, none Brittle	4.8	Fibrous; acicular; columnar; earthy; powder	Blackens fingers; often with psilomelane; darker than stibnite
Orth.	C, brachypinacoidal, perfect and prominent Brittle; slightly sectile	4.5	Fibrous; columnar; bladed; prismatic	Prisms often bent and with long shining cleavage faces; sometimes iridescent. Surface tarnishes black
Isom.	C, not important F, hackly Slightly malleable	7.3	Octahedrons; hackly masses; arborescent; reticulated	Resembles tarnished silver; often with silver, copper, barite; cuts like lead
Orth.	C, imperfect F, uneven Very brittle	6.3	Compact; massive; crystals, short prisms	Often with other silver ores; also barite, quartz, galena
Mono.	C, indistinct F, uneven Brittle	6.2	Platy crystals; short prisms	Resembles stephanite. Often with ruby silver. Thin splinters may be red translucent
Isom.	C, cubic, perfect and prominent Sectile to brittle	7.5	Cubes; cubo-octahedrons; granular; foliated	Often with sphalerite, pyrite, tetrahedrite, cerussite, anglesite, dolomite, calcite, fluorite; heavier than stibnite and never long prismatic cleavage
Orth.	C, indistinct F, conchoidal or granular Sectile	5.7	Compact; massive; crystals with deeply striated faces	Often coated with malachite; occurs with bornite, chalcopyrite, quartz, malachite, enargite
Orth.	C, prismatic and prominent Brittle	4.4	Massive	Often with chalcocite, bornite, famatinite Note cleavage

	Name.	Composition.	Color.	Streak.	Luster.	H.
COLOR DARK GRAY OR BLACK.	ARSENIC	As	Black	Dark gray	Metallic	3.5
	TETRAHEDRITE TENNANTITE	$Cu_8Sb_2S_7$ $Cu_8As_2S_7$	Dark lead- or steel-gray	Dark gray	Metallic	3 4.5
	PSILOMELANE	MnO, MnO_2, H_2O, etc.	Grayish black Dull black	Brownish black	Submetallic	5 6
	WOLFRAMITE HÜBNERITE	$(Fe,Mn)WO_4$ $MnWO_4$	Black	Brownish black	Metallic Submetallic	5 5.5
	ILMENITE (Menaccanite)	$(FeTi)_2O_3$	Iron-black	Brownish black	Metallic	5.5 6
	MAGNETITE	Fe_3O_4	Iron-black	Iron-black	Metallic	5.5 6.5
	FRANKLINITE	$(Fe,Mn,Zn)_3O_4$	Iron-black	Brownish black	Metallic	5.5 6.5
	COLUMBITE	$(Fe,Mn)(Nb,Ta)_2O_6$	Pitch-black	Grayish black	Submetallic Vitreous	6
COLOR METALLIC WHITE TO LIGHT GRAY.	**MOLYBDENITE**	MoS_2	Bluish lead-gray	Lead-gray with often greenish tinge	Metallic	1 1.5
	STIBNITE	Sb_2S_3	Light lead-gray	Dark lead-gray Black	Metallic	2
	GALENITE	PbS	Lead-gray	Dark lead-gray Black	Metallic	2.5 3
	ANTIMONY	Sb	Light steel-gray Tin-white	Lead-gray	Metallic	3 3

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Hex.	C, basal, not prominent F, granular Brittle	6	Round and reniform masses; granular	Usually black from tarnish. Tin-white on fresh fracture
Isom.	C, none F, granular Brittle	4.4 5.1	Compact; massive; tetrahedral crystals	Often in quartz with galena, chalcopyrite, sphalerite; sometimes with very brilliant luster
None	C, none F, conchoidal and prominent Tough to brittle	3.7 4.7	Impalpable; massive; stalactitic; botryoidal; rounded masses	Often with limonite, pyrolusite, manganite
Mono.	C, clinopinacoidal prominent Brittle	7.5	Thick tabular crystals; massive	Heavy black masses or cleavage pieces
Hex.	C, none F, conchoidal Brittle	4.5 5	Grains and pebbles; black sand; platy; massive granular	Slightly magnetic to nonmagnetic. In black sands with magnetite
Isom.	C, not prominent F, uneven Brittle	5.2	Octahedrons; massive granular to compact; black sands	Strongly magnetic; often with quartz, feldspar, hornblende, chlorite; crystals usually very perfect
Isom.	C, none F, uneven Very brittle	5.2	Octahedrons, usually rounded; granular; massive	Usually with zincite, willemite, rhodonite, and calcite; magnetic, but not strongly like magnetite. Note associations
Orth.	C, not important F, uneven Brittle	5.3 7.3	Crystals, usually in parallel groups	Occurs in granite or pegmatite, often with albite, tourmaline, beryl
Hex.	C, basal, perfect and prominent Sectile	4.7	Foliated masses; scales; flakes	Soft and greasy, like graphite; highly flexible; often with quartz
Orth.	C, brachypinacoidal very prominent Brittle; slightly sectile	4.5	Prismatic; fibrous; columnar; bladed	Often in quartz with galenite, sphalerite, tetrahedrite
Isom.	C, cubic, perfect and prominent Sectile to brittle	7.5	Cubes; cubo-octahedrons; granular; foliated; massive	Much heavier than stibnite and never long prismatic
Hex.	C, basal, prominent Brittle	6.7	Massive; lamellar	Often with stibnite; usually coated with earthy white oxide of antimony

	Name.	Composition.	Color.	Streak.	Luster.	H.
COLOR METALLIC WHITE TO LIGHT GRAY.	ARSENIC	As	Light steel-gray on fresh fracture	Dark gray	Metallic	3.5
	ARSENOPYRITE	FeAsS	Light steel-gray Tin-white, often with brassy or reddish tinge	Grayish black	Metallic	5.5 6
	SMALTITE CHLOANTHITE	$CoAs_2$ $NiAs_2$	Tin-white Light steel-gray Bluish gray	Grayish black	Metallic	5.5 6
	COBALTITE	CoAsS	Silver-white with usually copper-red tinge	Grayish black	Metallic	5.5
	MARCASITE	FeS_2	Brassy steel-gray Pale brass-yellow	Greenish black Brownish black	Metallic	6 6.5
COLOR BRASS, BRONZE, COPPER-RED, BLUE, OR BROWN.	COVELLITE	CuS	Dark blue Indigo blue	Black	Metallic	1.5 2
	BORNITE	Cu_5FeS_4	Copper-brown Horseflesh-brown Blue	Grayish black	Metallic	3
	MILLERITE	NiS	Brass-yellow	Greenish black	Metallic	3 3.5
	CHALCOPYRITE	$CuFeS_2$	Deep brass yellow	Greenish black	Metallic	3.5 4

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Hex.	C, basal, not usually prominent F, granular Brittle	6	Rounded, reniform masses; granular	Usually tarnished dull black on surface
Orth.	C, not prominent F, uneven Very brittle	6	Compact massive; pointed pyramids with horizontally striated faces	Often with sphalerite, galena, quartz; sometimes with gold; whiter than pyrite or marcasite; more common than smaltite. Arsenic odor when broken
Isom.	C, not important F, granular Brittle	6.5	Compact; massive; reticulated	Often with copper-red niccolite, pink erythrite or green annabergite
Isom.	C, cubic, not prominent Brittle	6.3	Crystals commonly; cubes; pyritohedrons; massive	Often with smaltite, niccolite; crystals usually tarnished to pale copper-red color
Orth.	C, not prominent F, uneven Brittle	4.9	Stalactitic with rough surfaces; cockscomb; radiate; columnar; low pyramids; massive	Never in cubes or pyritohedrons, and different in form from pyrite. Massive or granular marcasite is generally indistinguishable from pyrite
Hex.	C, basal and prominent F, uneven Brittle	4.6	Compact platy masses; granular; crusts	May occur with chalcocite, enargite, chalcopyrite
Isom.	C, not important F, uneven Brittle	4.9 5.4	Compact; massive	Usually tarnished to peacock colors; occurs with quartz, chalcocite, chalcopyrite
Hex.	C, perfect and prominent in crystals Brittle	5.3 5.6	Acicular; capillary; hair tufts; compact fibrous layers	Always needle-like or fibrous; often in cavities in chert or red hematite, or coating pyrrhotite
Tetrag.	C, not important F, uneven to conchoidal Brittle	4.2	Massive; tetrahedral crystals	Often with pyrite, galena, sphalerite, tetrahedrite, chalcocite, dolomite, etc.; often tarnished peacock colors

	Name.	Composition.	Color.	Streak.	Luster.	H.
BRASS, BRONZE, COPPER-RED, OR BROWN.	**PYRRHOTITE**	Fe_7S_8 to $Fe_{11}S_{12}$ or Fe_nS_{n+1}	Bronze-yellow Bronze-brown	Grayish black	Metallic	**3.5 4.5**
	PENTLANDITE	(Fe,Ni)S	Bronze-yellow	Black	Metallic	**3.5 4**
	NICCOLITE	NiAs	Pale copper-red	Brownish black	Metallic	**5 5.5**
	PYRITE	FeS_2	Pale brass-yellow	Greenish black Brownish black	Metallic	**6 6.5**
	MARCASITE	FeS_2	Pale brass-yellow	Greenish black Brownish black	Metallic	**6 6.5**
			STREAK METALLIC WHITE			
COLOR METALLIC WHITE OR LIGHT METALLIC GRAY.	MERCURY	Hg	Tin-white		Metallic	
	SYLVANITE CALAVERITE	$(AuAg)Te_2$	Silver- or tin-white; often with brassy tinge	Silver-white	Metallic	**1.5 2**
	BISMUTH	Bi	Reddish white to light copper-red	Silver-white Lead-gray	Metallic	**2 2.5**
	SILVER	Ag	Silver-white	Silver-white	Metallic	**2.5**
	ANTIMONY	Sb	Tin-white Silver-white	Silver-white	Metallic	**3 3.5**
	ARSENIC	As	Tin-white Light lead- or steel-gray	Tin-white	Metallic	
	PLATINUM PLATINIRIDIUM	Pt PtIr	Tin-white Light steel-gray	Light steel-gray	Metallic	**4 4.5**

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Hex.	C, not important F, uneven Brittle	4.6	Massive; granular; occasional crystals	Usually slightly magnetic; surface often tarnished dark bronze-brown. Only magnetic sulphide
Isom.	C, octahedral, not usually prominent Brittle	4.6 5.1	Massive and granular	Resembles and is usually with pyrrhotite. Nonmagnetic
Hex.	C, none F, uneven Brittle	7.5	Compact; impalpable massive	Usually with smaltite Very heavy
Isom.	C, indistinct F, uneven Brittle	5	Cubes; pyritohedrons; octahedrons; massive; granular	Very common; associated with all sulphides and in all rocks. Often in crystals
Orth.	C, not important F, uneven Brittle	4.9	Coxcomb and curved dome shapes; stalactitic with rough faces	Distinguished from pyrite by form generally. Usually indistinguishable from pyrite when massive or granular
TO LIGHT LEAD- OR STEEL-GRAY.				
		13.6	Liquid globules	Occurs as small globules on cinnabar
Mono.	C, clinopinacoidal, perfect, prominent F, coarse granular Brittle	9.9 8.3	Massive; crystals with deeply striated faces	Often in gray phonolite rock with purple fluorite; also in schist
Hex.	C, basal, perfect and prominent Brittle	9.7	Reticulated; embedded lenticular crystals; massive	Often as lenticular crystals or grains in quartz. Heavy
Isom.	C, none F, hackly Malleable	10.1 11.1	Wires; arborescent; massive; filiform	Usually tarnished on surface to brown or black; often with barite, calcite, other silver ores
Hex.	C, basal, prominent Brittle	6.7	Massive; lamellar	Sometimes with stibnite; usually coated with whitish oxide of antimony
Hex.	C, basal, not usually prominent F, granular Brittle	5.6	Rounded reniform masses; granular	Usually tarnished dull black on surface
Isom.	C, none F, hackly Malleable	14 19	Nuggets; grains	In gold-bearing sands

COLOR RED OR BROWN.

Name.	Composition.	Color.	Streak.	Luster.	H.
BAUXITE	$Al_2O_3 \cdot 2H_2O$	Brown	Reddish brown	Earthy Dull	1 2
HEMATITE	Fe_2O_3	Brownish red Cherry-red Black	Dark red Cherry-red	Earthy Dull Metallic	1 4
ERYTHRITE	$Co_3As_2O_8 \cdot 8H_2O$	Peach-red Crimson	Pale-red	Earthy Vitreous	1 2.5
WAD	MnO_2, H_2O	Dark brown Black	Dark reddish brown	Earthy Dull	1 3
CINNABAR	HgS	Scarlet red Vermilion Dark red	Scarlet Vermilion	Adamantine	2 2.5
PROUSTITE	Ag_3AsS_3	Scarlet Vermilion	Scarlet	Adamantine	2 2.5
PYRARGYRITE	Ag_3SbS_3	Dark red	Cherry-red Dark red	Adamantine	2.5 3
COPPER	Cu	Copper-red	Copper-red	Metallic	2.5 3
SPHALERITE	ZnS	Dark brown	Reddish brown	Resinous Vitreous	3.5 4
CUPRITE	Cu_2O	Dark red Ruby red	Cochineal-red Brick-red Crimson-red	Adamantine Earthy	3.5 4
HEMATITE	Fe_2O_3	Dark brownish red	Brownish red Cherry red	Submetallic	4.5

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
	C, none F, earthy	2.5	Claylike masses with small rounded concretions; pisolitic	Clay odor; distinguished from clay by pisolitic structure. Color due to iron oxide
	C, none F, earthy Scaly	5	Earthy masses; oölitic; powder micaceous	Red ochre; often red clay. Brilliant black micaceous variety is called specular hematite
Mono.	C, not important F, usually earthy	2.9	Earthy; crusts; rarely in crystals	Occurs with cobalt and nickel ores as coatings and crusts
Amorph.	C, none F, earthy Brittle	4	Earthy masses; powder concretions	Often with psilomelane, limonite, malachite, azurite
Hex.	C, prismatic, not important F, uneven Sectile	8 8.2	Granular; crystals; powder; massive; compact	Occurs with marcasite, chalcedony, quartz, sulphur; very heavy; often mixed with siliceous rock and apparently hard
Hex.	C, rhombohedral, not prominent Brittle	5.6	Crystals; red bands or streaks in rock	Light ruby silver ore; often with gray pyrargyrite
Hex.	C, indistinct F, small conchoidal Sectile	5.5	Massive; granular; small crystals	Generally as dark gray and dark red bands in silver ores. Grades into proustite
Isom.	C, none F, hackly Malleable	8.8	Hackly masses; sheets; wires, arborescent forms	Usually tarnished black on surface; often with calcite, cuprite, malachite
Isom.	C, dodecahedral, perfect and prominent Brittle	4	Massive; crystals	Often with galena, pyrite, arsenopyrite, etc. In limestone and chert
Isom.	C, poor F, uneven Brittle	5.9	Massive; compact; crystals; octahedrons; cubes	Usually with malachite, copper
Hex.	C, none F, uneven; splintery Brittle	5	Massive; reniform, mamillary; botryoidal; splintery; oölitic	Massive red hematite

	Name.	Composition.	Color.	Streak.	Luster.	H.
COLOR RED OR BROWN.	TURGITE	$2Fe_2O_3 \cdot H_2O$	Brown	Reddish brown	Submetallic	5 6
	JASPER	SiO_2	Dark red Brownish-red	Dark red	Vitreous	7
COLOR DARK GRAY OR BLACK.	**PYRARGYRITE**	Ag_3SbS_3	Dark steel-gray	Purple-red Cherry-red	Metallic	2.5
	TETRAHEDRITE	$Cu_8Sb_2S_7$	Dard lead or steel gray	Cherry-red Dark red brown	Metallic	3 4.5
	HEMATITE	Fe_2O_3	Dark steel-gray Iron-black	Brownish red	Metallic Brilliant	2.5 4
	SPHALERITE	ZnS	Brownish black	Dark brown	Resinous Submetallic	3.5 4
	MANGANITE	$Mn_2O_3 \cdot H_2O$	Iron-black Dark steel-gray	Dark red-dish brown	Metallic	4
	WOLFRAMITE HÜBNERITE	$(Fe,Mn)WO_4$ $MnWO_4$	Dark gray-ish or brownish black	Dark red-dish brown	Submetallic Metallic	5 5.5
	PSILOMELANE	MnO,MnO_2,H_2O	Dull black	Very dark brown	Submetallic Dull	5 6
	HEMATITE MARTITE	Fe_2O_3	Iron-black Dark steel-gray	Cherry-red Brownish red Red-brown	Metallic	5.5 6.5
	ILMENITE	$(Fe,Ti)_2O_3$	Iron-black	Very dark brown	Metallic	5.5 6
	FRANKLINITE	$(Fe,Mn,Zn)_3O_4$	Iron-black	Dark red-dish brown Blackish brown	Metallic	5.5 6.5

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
	C, none F, splintery Brittle	4.2 4.4	Compact; fibrous: massive; botryoidal; earthy	Resembles limonite; distinguished by streak; fibers often with satin-like luster
Hex.	C, none F, conchoidal	2.6	Very dense cryptocrystalline masses	Color and streak due to hematite
Hex.	C, not important F, uneven Brittle	5.8	Massive; granular; bands and streaks in rock	Usually as gray bands mixed with red, in quartz rock; dark ruby silver ore
Isom.	C, none F, uneven Brittle	4.4 5.1	Massive; tetrahedral crystals	Often has brilliant luster with brassy tinge; in quartz with sulphides
Hex.	C, micaceous Brittle	4.9 5.3	Foliated; platy; micaceous	Specular hematite; very bright sparkling plates or scales
Isom.	C, dodecahedral, prominent Brittle	4	Massive	Often with galenite, pyrite, chalcopyrite, tetrahedrite
Orth.	C, brachypinacoidal, prominent Brittle	4.4	Prisms; columnar; acicular	Prisms often in bunches with prism faces deeply striated vertically; occurs with pyrolusite
Mono.	C, clinopinacoidal, perfect and prominent Brittle	7.5	Thick tabular crystals; massive; compact	Often with cassiterite, quartz, fluorite Hübnerite is red in thin splinters
	C, none F, conchoidal Tough to brittle	3.7 4.7	Impalpable; massive; stalactitic; botryoidal, round masses	Often with powdery or brilliant needles of pyrolusite
Hex.	C, none F, uneven Brittle	4.9 5.3	Massive; granular; foliated; crystals; scales; micaceous	Crystals often have an iridescent tarnish; fine scaly specular variety seems soft. Martite, a pseudomorph after magnetite is partly magnetite and partly hematite
Hex.	C, none F, conchoidal Brittle	4.5 5	Rounded pebbles; sand; plates; massive	Sometimes slightly magnetic
Isom.	C, none F, uneven Very brittle	5 5.2	Rounded crystals; Octahedrons; granular masses	Usually with zincite, willemite, calcite; magnetic but not so strongly as magnetite Note associations

	Name.	Composition.	Color.	Streak.	Luster.	H.
BLACK.	COLUMBITE	$(Fe,Mn)(Nb,Ta)_2O_6$	Pitch-black	Dark brown	Submetallic Vitreous	6
	CASSITERITE	SnO_2	Black Brownish black	Dark brown	Submetallic to Metallic	6 7
				STREAK YELLOW		
COLOR RED.	**REALGAR**	AsS	Bright red Orange-red	Orange yellow	Adamantine Resinous Vitreous	1.5 2
	ZINCITE	ZnO	Dark red Blood-red	Orange-yellow	Vitreous	4 4.5
COLOR YELLOW.	ORPIMENT	As_2S_3	Lemon-yellow	Lemon-yellow	Adamantine Resinous Pearly	1.5 2
	REALGAR	AsS	Orange-yellow	Orange-yellow	Resinous Vitreous	1.5 2
	SULPHUR	S	Sulphur-yellow Honey-yellow Straw-yellow	Pale yellow	Resinous Greasy Vitreous	1.5 2.5
	COPIAPITE	$2Fe_2O_3 5SO_3 \cdot 18H_2O$	Sulphur-yellow	Pale yellow	Vitreous	1.5 2.5
	LIMONITE	$2Fe_2O_3 \cdot 3H_2O$	Yellow	Yellow Brown	Earthy Dull	1 4
	GOLD	Au	Golden yellow	Golden yellow	Metallic	2.5 3
	SPHALERITE	ZnS	Brownish yellow	Pale yellow	Resinous	3.5 4

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Orth.	C, not important F, uneven Brittle	5.3 7.3	Crystals, usually in parallel groups	Occurs in granite or pegmatite, often with albite, tourmaline, beryl
Tetrag.	C, imperfect F, uneven Brittle	6.8 7.1	Massive	Often in quartz-mica rock with wolframite, fluorite
OR YELLOW-BROWN.				
Mono.	C, clinopinacoidal, not prominent F, conchoidal Sectile	3.5	Massive; granular; crystals	Often with orpiment disseminated in siliceous rock and often apparently hard. Occasionally with stibnite
Hex.	C, basal, perfect and prominent F, uneven Brittle	5.4 5.7	Massive; lamellar; granular	Occurs with franklinite willemite, calcite Note associations
Orth.	C, brachypinacoidal, perfect and prominent Sectile; flexible	3.5	Foliated; plates massive	Usually with realgar
Mono.	C, clinopinacoidal, not prominent F, conchoidal Brittle; sectile	3.5	Crystals; massive; granular	Often with orpiment or finely mixed quartz
Orth.	C, indistinct F, conchoidal Brittle	2	Crystals; pyramids; crusts	May occur with celestite, aragonite, limestone, cinnabar, gypsum
Mono.	C, indistinct F, earthy, scaly	2.1	Scaly; granular; short fibers	Metallic taste like ink. Often with pyrite and pyrrhotite as an oxidation product
	C, none F, earthy	3.6	Earthy masses; ochre powder	Yellow ochre; often yellow clay
Isom.	C, none F, hackly Highly malleable	15.6 19.3	Scales; flakes; leaves; grains; wires; nuggets	Usually in quartz, conglomerates, or schists; sometimes with pyrite or arsenopyrite
Isom.	C, dodecahedral; prominent F, uneven Brittle	4	Massive; cleavage masses; crystals	Usually with galena, pyrite, chalcopyrite, tetrahedrite, quartz, calcite, dolomite

	Name.	Composition.	Color.	Streak.	Luster.	H.
YELLOW	PYROMORPHITE	$(PbCl)Pb_4(PO_4)_3$	Greenish yellow Wax-yellow Brown	Greenish yellow	Adamantine	3.5 4
COLOR BROWN OR BLACK.	**BAUXITE**	$Al_2O_3 \cdot 2H_2O$	Brown	Brownish yellow	Earthy Dull	1 3
	LIMONITE	$2Fe_2O_3 \cdot 3H_2O$	Brown	Brownish yellow Yellowish brown	Earthy Dull	1 4
	SPHALERITE	ZnS	Brown Brownish black	Brownish yellow	Resinous	3.5 4
	SIDERITE	$FeCO_3$	Pale brown Grayish brown Dark brown	Pale yellow Yellowish brown	Vitreous	3.5 4
	GOETHITE	$Fe_2O_3 \cdot H_2O$	Yellowish brown	Yellowish brown Brownish yellow	Submetallic	5 5.5
	LIMONITE	$2Fe_2O_3 \cdot 3H_2O$	Yellowish brown Dark brown	Brownish yellow Yellow-brown	Submetallic Dull	5 5.5
	CHROMITE	$FeCr_2O_4$	Black	Grayish brown Yellowish-brown	Submetallic Pitchlike	5.5
	BROOKITE	TiO_2	Dark brownish black	Pale yellow Grayish brown	Submetallic Metallic	5.5 6
	RUTILE	TiO_2	Reddish brown Black	Pale yellowish brown	Adamantine Metallic	6 6.5

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Hex.	C, not prominent F, uneven Brittle	6.5 7.1	Small hexagonal prisms; massive	Often with galena, cerussite, anglesite, mimetite
	C, none F, earthy	2.5	Clay-like masses; pisolitic	Clay odor; distinguished from kaolinite (clay) by pisolitic structure. Color due to iron oxide
	C, none F, earthy	3.6	Massive; earthy	Brown ochre or brown clay (kaolinite)
Isom.	C, dodecahedral, prominent F, uneven Brittle	4	Massive; cleavage masses; crystals	Common color; occurs with galena in chert; also with many sulphides Note luster
Hex.	C, rhombohedral, perfect and prominent Brittle	3.8	Rhombohedrons; cleavage masses; crystals with curved faces	Often with cryolite, quartz, hematite, fluorite Dark color due to oxidation
Orth.	C, brachypinacoidal, prominent F, uneven Brittle	4 4.4	Acicular; stalactitic; radiate; fibrous	Often in cavities in limonite or hematite; distinguished from limonite by crystals and cleavage
	C, none F, uneven Brittle	3.6 4	Compact; massive: stalactitic; botryoidal; columnar	Often in cubes as an alteration from pyrite; very common iron oxide; botryoidal and mammillary masses often have black varnish-like surfaces
Isom.	C, none F, uneven Brittle	4.3 4.5	Massive	Often coated with green garnets or green chlorite; often with serpentine
Orth.	C, not important F, uneven Brittle	3.8 4	Square pyramids; hexagonal shaped pyramids	Always in crystals; faces deeply striated; not twinned like rutile
Tetrag.	C, not important F, uneven Brittle	4.2	Twinned crystals; long acicular crystals	Faces deeply striated; knee-shaped twins; often in quartz

	Name.	Composition.	Color.	Streak.	Luster.	H.
BR. OR BL.	**CASSITERITE**	SnO_2	Black Reddish brown Yellowish brown Pale yellow	Pale yellow Pale grayish brown	Submetallic	6 7
COLOR GREEN.	**PYROMORPHITE**	$(Pb,Cl)Pb_4(PO_4)_3$	Yellowish green Grass-green	Pale greenish yellow	Adamantine Vitreous	3.5 4
	EPIDOTE	$HCa_2(Al,Fe)_2Si_3O_{13}$	Yellowish green Deep green Oil-green	Pale yellow	Vitreous	6 7

STREAK BLUE

COLOR BLUE, GREEN, OR BLACK.	ANNABERGITE	$Ni_3As_2O_8 \cdot 8H_2O$	Apple-green	Pale green	Vitreous Earthy	1
	VIVIANITE	$Fe_3P_2O_8 \cdot 8H_2O$	Dark blue-green Indigo-blue	Indigo-blue	Vitreous Earthy	1.5 2
	CHLORITE PROCHLORITE CLINOCHLORE	$(Mg,Fe)_5Al_2Si_3O_{14} \cdot 4H_2O$	Dark green	Grayish green	Vitreous Pearly	1.5 2.5
	GLAUCONITE	$FeKSi_2O_6 \cdot H_2O$	Dark green Grass-green	Pale green	Vitreous Dull	1 2
	LINARITE	$(Cu,Pb)SO_4 \cdot (Cu,Pb)(OH)_2$	Deep azure-blue	Smalt-blue Pale blue	Adamantine Vitreous	2.5
	CHRYSOCOLLA	$CuSiO_3 \cdot 2H_2O$	Bluish green Greenish blue	Pale green Pale blue	Vitreous Greasy Earthy	2 4
	BROCHANTITE	$CuSO_4 \cdot 3Cu(OH)_2$	Dark green Emerald green	Pale green	Vitreous	3.5
	AZURITE	$2CuCO_3 \cdot Cu(OH)_2$	Azure-blue	Smalt-blue	Vitreous Velvety	3.5 4

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Tetrag.	C, not important F, uneven Brittle	6.8 7.1	Pebbles with concentric structure; crystals; massive	Stream tin; wood tin Heavy masses
Hex.	C, not important F, uneven Brittle	6.5 7.1	Small hexagonal prisms; drusy crusts; massive	Very heavy; usually with galena
Mono.	C, basal, perfect and usually prominent	3.2 3.5	Prismatic; columnar; reticulated masses	Often in quartz and schists; also with calcite
OR GREEN.				
Mono.	C, none F, earthy		Fine capillary coatings	Occurs with erythrite as coatings and crusts on cobalt and nickel ores
Mono.	C, clinopinacoidal, perfect in crystals Brittle	2.6	Slender prismatic; acicular; earthy	Often as crystals in pyrrhotite; as earthy round masses in clay or sandstone
Mono.	C, basal, perfect and prominent Tough to brittle	2.8	Micaceous scaly flakes; compact scaly masses	Highly flexible but not elastic, like mica; often altered from biotite
Mono.	C, none F, earthy	2.2	Green sand	Dark green scaly and earthy grains in sandstone and marl. Resembles chlorite somewhat
Mono.	C, orthopinacoidal, usually prominent Brittle	5.4	Columnar; fibrous; long prisms sometimes radiate	Usually with galenite; heavier than azurite, and shows cleavage faces
Amorph.	C, none F, uneven Brittle	2 2.3	Massive; stains; earthy	Usually with copper ore: darker and glassier bluish green than malachite, and never fibrous
Ortho.	C, brachypinacoidal prominent Brittle	3.8	Small prisms and drusy crusts	Very dark green. More crystalline and not banded like malachite
Mono.	C, not prominent Brittle	3.8	Crystals; fibrous; acicular	Usually with malachite and often with limonite and wad

COLOR BLUE, GREEN, OR BLACK.

Name.	Composition.	Color.	Streak.	Luster.	H.
MALACHITE	$CuCO_3 \cdot Cu(OH)_2$	Bright green Emerald-green Dark green	Emerald-green	Vitreous Silky Velvety Dull	3.5 4
ALABANDITE	MnS	Black	Dark grayish green Olive green	Submetallic	3.5 4
LAZURITE LAPIS LAZULI	$Na_6Al_3S_3(SiO_4)_3$	Azure-blue Ultramarine blue	Pale blue	Vitreous Greasy	5 5.5
AUGITE	$MgCa_2Fe(SiO_3)_4$ with Al and Fe	Greenish black Blackish green	Pale grayish green	Vitreous	5 6
HORNBLENDE	$Mg_3Ca_2Fe(SiO_3)_6$ with Al and Fe	Greenish black Blackish green Black	Pale grayish green	Vitreous Silky	5 6
GLAUCOPHANE	Silicate of Na, Al, Mg, Fe	Lavender-blue Blackish blue	Grayish blue	Vitreous Pearly	6 6.5

STREAK UNCOLORED, WHITE,

COLOR YELLOW OR BROWN.

Name.	Composition.	Color.	Luster.	H.
CERARGYRITE	AgCl	Dark gray Dark brown	Waxy Adamantine	1 1.5
BAUXITE	$Al_2O_3 \cdot 3H_2O$	Yellow to brown	Earthy Dull	1.5 3
KAOLINITE (Clay)	$H_4Al_2Si_2O_9$	Yellow to brown	Earthy Dull	1.5 2.5
GYPSUM	$CaSO_4 \cdot 2H_2O$	Yellow to brown	Vitreous Silky Dull	1.5 2
SULPHUR	S	Sulphur-yellow Honey-yellow Brown	Vitreous Greasy	1.5 2

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Mono.	C, not prominent F, uneven; Brittle	4	Fibrous; banded; stalactitic; botryoidal; powder	Often with cuprite, copper, chalcocite, chalcopyrite; often as green stains in ore rocks
Isom.	C, not prominent F, uneven Brittle	4	Massive	Sometimes with rhodochrosite, pyrite, argentite, galena; surface usually tarnished brown
Isom.	C, not important Brittle	2.4	Massive; disseminated in rock	Often with calcite and pyrite
Mono.	C, prismatic, not usually prominent Cleavage angle 87° Brittle	3.2 3.6	Almost square prisms; massive	Distinguished from hornblende by cleavage angle; also more often in crystals
Mono.	C, prismatic and very prominent Cleavage angle 124° Brittle	2.9 3.4	Massive; crystals rare	Usually with bright cleavage faces having a fibrous appearance
Mono.	C, prismatic, perfect Brittle	3.1	Fibrous; columnar; reticulated	Usually forms schists; a blue hornblende

OR LIGHT GRAY.

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Isom.	C, none Very sectile	5.5	Thin crusts; coatings; massive	Cuts like wax; often with silver ores
	C, none F, earthy	2.5	Compact earthy; pisolitic	Clay odor; distinguished from kaolinite (clay) by pisolitic structure
Mono.	C, none F, earthy	2.6	Compact earthy; soapy; friable	Clay odor; massive clay; occasionally soapy feel
Mono.	C, pinacoidal Brittle	2.3	Fibrous; columnar; granular; compact massive	Ferruginous gypsum; cleavage very prominent in transparent selenite variety
Orth.	C, not important F, uneven Brittle	2	Crystals; pyramids; crusts.	Often with limestone, celestite, aragonite, cinnabar

COLOR YELLOW OR BROWN.

Name.	Composition.	Color.	Luster.	H.
CHLORITE PROCHLORITE CLINOCHLORE PENNINITE, etc.	$(Mg,Fe)_5Al_2Si_3O_{14}\cdot 4H_2O$	Dark yellowish brown Greenish brown	Vitreous Pearly	1.5 2.5
BIOTITE	$(HK)_2(Mg,Fe)_2(Al,Fe)_2(SiO_4)_3$	Dark brown Greenish brown	Pearly to Vitreous	2.5 3
PHLOGOPITE	$H_2KMg_3Al(SiO_4)_3$	Light brown Cinnamon-brown	Pearly Vitreous	2.5 3
HALITE	$NaCl$	Light yellow or brown	Vitrecus	2.5
CRYOLITE	Na_3AlF_6	Grayish brown	Vitreous Icy	2.5 3
CALCITE	$CaCO_3$	Honey-yellow Light to dark brown	Vitreous	3
BARITE	$BaSO_4$	Lemon-yellow Yellowish brown	Vitreous	2.5 3.5
SERPENTINE	$H_4Mg_3Si_2O_9$	Greenish brown Yellowish brown	Greasy Vitreous	2.5 4
STRONTIANITE	$SrCO_3$	Light brown	Vitreous	3 3.5
WULFENITE	$PbMoO_4$	Lemon-yellow Orange-yellow	Greasy Adamantine	3
MIMETITE	$(PbCl)Pb_4(AsO_4)_3$	Brownish yellow Yellow-brown	Adamantine Greasy	3.5
PYROMORPHITE	$(PbCl)Pb_4(PO_4)_3$	Greenish yellow Yellowish brown	Greasy Adamantine	3.5 4

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Mono.	C, basal, perfect and prominent Tough	2.9	Micaceous; scales; flakes; compact scaly masses	Highly flexible but not elastic, like the micas; often an altered biotite
Mono.	C, basal, perfect and very prominent Tough	2.7 3.1	Mica plates; scales; flakes	Dark color even in thinnest plates; flexible and elastic; black mica
Mono.	C, basal, perfect and prominent Tough	2.8	Micaceous; scales; flakes; sheets	Lighter brown than biotite; almost colorless in thin sections; brown mica
Isom.	C, cubic, perfect and prominent Brittle	2.1 2.6	Cubes; massive; granular	Tastes salt
Mono.	C, basal, prominent, and pinacoidal not so good	3	Massive	Three cleavages almost at right angles, making cubes; usually with siderite
Hex.	C, rhombohedral, very prominent Brittle	2.7	Rhombohedrons; scalenohedrons; granular; massive	Rhombohedral cleavage very characteristic; very common mineral
Orth.	C, basal and prismatic, perfect and prominent	4.3 4.6	Massive; platy crystals	Heavy, vitreous mineral; often with galena
Mono.	C, not important Brittle	2.6	Massive; compact	Very smooth feel, almost greasy
Orth.	C, prismatic, not prominent Brittle	3.7	Columnar masses; coarse granular	Heavier than brown calcite
Orth.	C, not prominent F, conchoidal Very brittle	6.5	Massive; crusts	Usually with galenite or anglesite; very heavy
Tetrag.	C, not prominent Brittle	6.7 7	Square plates; thin plates and tables	Often with vanadinite or galenite
Hex.	C, not prominent Brittle	7 7.2	Rounded aggregates of plates; small crystals	Often with pyromorphite, galena
Hex.	C, none Brittle	6.5 7.1	Short hexagonal prisms; columnar masses	Often with galena, cerussite, anglesite; crystal faces deeply striated vertically

COLOR YELLOW OR BROWN.

Name.	Composition.	Color.	Luster.	H.
ARAGONITE	$CaCO_3$	Honey-yellow Yellow-brown	Vitreous Glassy	3.5 4
STILBITE	$(Na_2Ca)Al_2Si_6O_{10}.6H_2O$	Yellowish brown Light brown	Vitreous Silky	3.5 4
DOLOMITE	$(CaMg)CO_3$	Yellowish brown Grayish brown	Vitreous	3.5 4
SIDERITE	$FeCO_3$	Grayish brown Dark brown	Vitreous Pearly	3.5 4
SPHALERITE	ZnS	Honey-yellow Yellowish brown Reddish brown	Resinous	3.5 4
FLUORITE	CaF_2	Lemon-yellow Pale yellow Yellowish brown	Vitreous Glassy	4
SCHEELITE	$CaWO_4$	Yellowish brown Grayish brown	Greasy Adamantine	4.5 5
CALAMINE	$H_2Zn_2SiO_5$	Pale brown	Vitreous	4.5 5
SMITHSONITE	$ZnCO_3$	Yellowish brown	Vitreous	5
APATITE	$(CaF)Ca_4(PO_4)_3$ or $(CaCl)Ca_4(PO_4)_3$	Brown Greenish brown	Vitreous Greasy	5

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Orth.	C, not prominent Brittle	2.9	Stalactitic; banded; massive	Differs from calcite in not having prominent cleavage
Mono.	C, clinopinacoidal Brittle	2 2.2	Columnar; sheaf-like; fibrous	Often in cavities in lava rocks, with chabazite, heulandite, analcite
Hex.	C, rhombohedral, not prominent	2.9	Massive	Harder than calcite
Hex.	C, rhombohedral, perfect and very prominent	3.8	Rhombohedrons with curved faces; saddle-shaped crystals; massive	Often in cryolite; more glassy than sphalerite Dark color due to oxidation
Isom.	C, dodecahedral, very prominent	3.9 4.1	Massive	Resinous cleavage faces characteristic; often with galena, tetrahedrite, etc.
Isom.	C, octahedral, perfect and prominent Very brittle	3.1	Cubes; granular, massive	Often with pyrite, galena, and sulphides
Tetrag.	C, not prominent Brittle	5.9 6.1	Crystals; pyramids; massive	Often with wolframite, cassiterite; very heavy masses
Orth.	C, prismatic, prominent	3.5	Drusy coatings; small crystals fibrous layers	Often with smithsonite on yellow earthy masses
Hex.	C, rhombohedral, not prominent	4.3 4.5	Small rhombohedral crystals; drusy crystals; bone-like masses	Dry bone; often with the silicate calamine; also with sphalerite
Hex.	C, basal, imperfect, not prominent Brittle	3.2	Hexagonal prisms; granular	Green and brown colors often intermixed; crystals often have fused and oily appearance

COLOR YELLOW OR BROWN.

	Name.	Composition.	Color.	Luster.	H.
	MONAZITE	$(Ce,La,Di,Th)PO_4$	Honey-yellow Brown	Adamantine Vitreous	5 5.5
	TITANITE	$CaTiSiO_5$	Dark brown Brownish yellow	Adamantine Greasy Vitreous	5 5.5
	WILLEMITE TROOSTITE	Zn_2SiO_4	Greenish yellow Reddish brown	Vitreous	5.5
	CANCRINITE	$H_6Na_6Ca(NaCO_3)_2$ $Al_8(SiO_4)_9$	Lemon-yellow	Greasy Vitreous	5 6
	OPAL	$SiO_2 \cdot nH_2O$	Yellow Brown	Waxy Vitreous	5.5 6.5
PYROXENE	ENSTATITE	$MgSiO_3$	Grayish brown Greenish brown	Vitreous Pearly	5.5
PYROXENE	BRONZITE	$(Mg,Fe)SiO_3$	Bronze-brown	Vitreous Bronzy	5 6
PYROXENE	HYPERSTHENE	$(Fe,Mg)SiO_3$	Dark brown Blackish brown	Bronze-metallic Vitreous Pearly	5 6
PYROXENE	AUGITE	Silicate of Ca, Mg, Al, and Fe, chiefly	Dark brown	Vitreous	5 6
AMPHIBOLE	ANTHOPHYLLITE	$(Mg,Fe)SiO_3$	Light grayish brown Brownish gray Greenish gray	Vitreous Pearly	5.5 6
AMPHIBOLE	TREMOLITE	$CaMg_3(SiO_3)_4$	Grayish brown	Vitreous Silky	5 6
AMPHIBOLE	HORNBLENDE	$Ca(MgFe)_3(SiO_3)_4$ with $(MgFe)_2(AlFe)_4Si_2O_{12}$ and $Na_2Al_2(SiO_3)_4$	Dark reddish brown	Vitreous	5 6

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Mono.	C, basal, not prominent Brittle	5 5.5	Yellow sand; brown crystals	Commonly as yellow sand; crystals rare
Mono.	C, indistinct usually Brittle	3.5	Flat wedge-shaped crystals; massive	Often in syenitic rocks; often with hornblende and magnetite; masses show cleavage
Hex.	C, basal, sometimes prominent	3.9 4.1	Crystals; granular; massive	Often in calcite with zincite, franklinite
Hex.	C, prismatic not prominent Brittle	2.4 2.5	Compact and lamellar	Associated with nepheline, sodalite, biotite and feldspar in nepheline rocks
Amorph.	C, none F, conchoidal and prominent	2.2	Massive; wood-like	Softer than brown jasper; wood opal shows wood structure
Orth.	C, prismatic and brachypinacoidal, very prominent Brittle	3.2	Bladed, columnar; massive	Often softer because of alteration to serpentine; pearly cleavage faces usual
Orth.	C, prismatic and brachypinacoidal, very prominent Brittle	3.5	Reticulated masses; columnar	Bronze luster and color characteristic
Orth.	C, clinopinacoidal, very prominent Brittle	3.5	Broad cleavage; masses	More bronze brown than hornblende
Mono.	C, prismatic, not usually prominent Cleavage angle 87°	3.5	Crystals	Distinguished from hornblende by the prism being nearly square
Orth.	C, prismatic and prominent	3.2	Lamellar; fibrous; reticulated; columnar	Often soft because of alteration; structure resembles actinolite
Mono.	C, prismatic and prominent	2.9 3.4	Bladed; columnar; prismatic; fibrous	Cleavage angle 124°; often in marble or calcite with brown tourmaline
Mono.	C, prismatic, very prominent	3.4	Crystals	Prismatic cleavage angle about 124°

COLOR YELLOW OR BROWN.

Name.	Composition.	Color.	Luster.	H.
NEPHELITE (Elæolite)	$NaAlSiO_4$	Reddish brown	Greasy Vitreous	5.5 6
ALLANITE	$(CaFe_2)(Al,Fe,Ce)_2(AlOH)(SiO_4)_3$	Dark brown Blackish brown	Pitchy Submetallic	5.5 6
SILLIMANITE (Fibrolite)	Al_2SiO_5	Light grayish brown Hair-brown	Vitreous	6 7
ZOISITE	$Ca_2Al_2(AlOH)(SiO_4)_3$	Grayish brown Yellowish brown	Vitreous	6 6.5
EPIDOTE	$HCa_2(Al,Fe)_3Si_3O_{13}$	Oil brown Greenish brown Greenish yellow	Vitreous	6 7
RUTILE	TiO_2	Reddish brown	Adamantine	6 6.5
CASSITERITE	SnO_2	Reddish brown Yellowish brown	Adamantine Dull	6 7
CHONDRODITE	$Mg_3[Mg(F,OH)_2(SiO_4)_2]$	Reddish brown Brownish yellow	Vitreous	6 6.5
AXINITE	$HCa_3Al_2B(SiO_4)_4$	Clove-brown Yellow	Vitreous	6.5 7
ORTHOCLASE	$KAlSi_3O_8$	Pale brown Flesh-brown	Vitreous Pearly	6 6.5
QUARTZ var. Citron Smoky Ferruginous	SiO_2	Brownish yellow Hair brown Smoky brown Yellowish brown Reddish brown	Vitreous Glassy Greasy	7
CHALCEDONY var. Agate Jasper Flint	SiO_2	Brown or yellow in all shades	Waxy Vitreous	7

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Hex.	C, prismatic, not prominent Brittle	2.6	Massive	Usually in crystalline rock with feldspar, biotite, leucite
Mono.	C, not important F, uneven Brittle	3.5 4.2	Thin tabular crystals; seldom massive	In granitic rocks as thin brownish, pitch-like crystals and streaks
Orth.	C, brachypinacoidal, prominent Brittle	3.2	Long slender prisms; fibers; columns	Always in schist rocks; fibers often bent and reticulated
Orth.	C, brachypinacoidal, prominent Brittle	3.2	Stout columns; sometimes fibrous masses	Columnar crystals usually much broken by cross-fracture
Mono.	C, basal, perfect, sometimes prominent Brittle	3.2 3.5	Prismatic crystals; columnar; fine granular	Often as prisms in quartz
Tetrag.	C, prismatic, not important Brittle	4.2	Twinned crystals; long prisms; acicular	Crystals usually with deeply striated faces; knee-shaped twins
Tetrag.	C, not important F, uneven Brittle	6.8 7	Crystals; rounded pebbles	Pebbles of reddish, grayish, and yellowish color, with often concentric structure
Mono.	C, not prominent F, uneven, brittle	3.2	Crystals; embedded grains in rock	Often in calcite with octahedrons of spinel
Tric.	C, not prominent F, conchoidal Brittle	3.2	Thin sharp-edged crystals	Often with garnet, tourmaline, albite, quartz
Mono.	C, basal and clinopinacoidal, very prominent	2.6	Crystals; cleavage pieces; massive	Commonly with quartz, mica, hornblende; two cleavages at R. A.
Hex.	C, none F, conchoidal Very prominent Brittle	2.6	Hexagonal prisms and pyramids; prism faces usually horizontally striated; massive.	Smoky quartz common in granites with orthoclase, biotite, or hornblende; conchoidal fracture characteristic
Hex.	C, none F, conchoidal Very prominent Brittle	2.6	Colloidal masses; often banded; botryoidal; mammillary	Conchoidal fracture, very characteristic

	Name.	Composition.	Color.	Luster.	H.
COLOR YELLOW OR BROWN.	VESUVIANITE	$Ca_6(AlOH)Al_2(SiO_4)_5$	Dark brown Greenish brown Brownish yellow Greenish yellow	Vitreous Greasy	6.5 7
	GARNET var. Grossularite Andradite Almandite Spessartite Pyrope	 $Ca_3Al_2(SiO_4)_3$ $Ca_3Fe_2(SiO_4)_3$ $Fe_3Al_2(SiO_4)_3$ $Mn_3Al_2(SiO_4)_3$ $Mg_3Al_2(SiO_4)_3$	 Reddish brown Yellowish brown Reddish yellow Brownish yellow	 Vitreous	 6.5 7.5
	TOURMALINE	$7H_2O.2Na_2O.12MgO.6B_2O_3$- $13Al_2O_3.24SiO_2$	Cinnamon-brown Dark brown	Vitreous Glassy	7 7.5
	STAUROLITE	$(AlO)_4(AlOH)Fe(SiO_4)_2$	Dark reddish brown	Vitreous	7 7.5
	BERYL	$Be_3Al_2(SiO_3)_6$	Golden yellow Greenish yellow	Vitreous Glassy	7.5 8
	ZIRCON	$ZrSiO_4$	Slate-brown Light brown Dark brown	Vitreous Pearly Resinous	7.5 8
	TOPAZ	$Al_2(F,OH)_2SiO_4$	Honey-yellow Wine-yellow Yellowish brown	Vitreous	8
	CORUNDUM	Al_2O_3	Light brown Grayish brown	Vitreous	9
PINK, RED, OR RED-VIOLET.	GYPSUM	$CaSO_4 \cdot 2H_2O$	Brick-red	Vitreous Silky	1.5 2
	LEPIDOLITE	$(Li,K)_2Al_2(F,OH)_2(SiO_3)_3$	Pale pink to Deep rose-red	Pearly	2.5 4
	VANADINITE	$(PbCl)Pb_4(VO_4)_3$	Bright red Orange-red Ruby-red	Adamantine Greasy	2.5 3
	WULFENITE	$PbMoO_4$	Orange-red	Adamantine Greasy	3
	CALCITE	$CaCO_3$	Pink Brick-red	Vitreous	3

System.	Cleavage or Fracture.	G	Common Structure.	Observations.
Tetrag.	C, not prominent Brittle	3.4	Square prisms with low pyramids; massive; granular	Often in white or blue calcite; prism faces generally vertically striated
Isom.	C, none F, uneven, coarse Brittle	3.1 4.3	Crystals; dodecahedrons with icosatetrahedrons; granular; massive	Often in schists and gneisses; also with calcite; usually in crystals
Hex.	C, none F, uneven Very brittle	3 3.2	Trigonal; prisms with vertically striated faces	Prisms usually much cross-fractured; often in calcite with tremolite
Orth.	C, not important F, uneven Brittle	3.7	Crystals; often twinned in crosses, or ×-shaped	Usually in schists; often with cyanite; sillimanite
Hex.	C, not important F, uneven Brittle	2.6 2.8	Hexagonal prisms with base	Harder than quartz, and crystals have basal planes
Tetrag.	C, none F, conchoidal Brittle	4.7	Square prisms with pyramids; rounded grains	Often in granitic rocks; crystals always, and usually small
Orth.	C, basal, very prominent Brittle	3.4 3.6	Crystals; prisms; pyramids	Always in crystals; sometimes in cavities in rhyolite
Hex.	C, rhombohedral, often prominent Brittle or Tough	3.9 4.1	Massive; crystals	Hard brownish masses often in red orthoclase feldspar
Mono.	C, clinopinatoidal, perfect and prominent Brittle	2.3	Columnar; fibrous; massive; granular	Gypsum stained by ferric oxide
Mono.	C, basal, perfect and prominent Tough	2.9	Micaceous; flakes; scales; compact scaly masses	Usually with rose-red tourmaline, feldspar, or quartz
Hex.	C, not important Brittle	6.6 7.2	Small hexagonal prisms	Often with wulfenite or galenite
Tetrag.	C, not important Brittle	6.7 7	Square tabular crystals	Often with vanadinite
Hex.	C, rhombohedral, prominent Brittle	2.7	Rhombohedrons; stalactites; massive	Color due to stain of ferric oxide or manganese oxide

COLOR PINK, RED, OR RED-VIOLET.

Name.	Composition.	Color.	Luster.	H.
CELESTITE	$SrSO_4$	Brick-red	Vitreous	3 3.5
HEULANDITE	$H_4CaAl_2(SiO_3)_6 \cdot 3H_2O$	Deep brick-red Flesh red	Pearly	3 5.4
SPHALERITE	ZnS	Brownish red Yellowish red	Resinous	3.5 4
DOLOMITE	$(Ca,Mg)CO_3$	Pale pink	Vitreous	3.5 4
RHODOCHROSITE	$MnCO_3$	Rose-red	Vitreous	3.5 4.5
MARGARITE	$H_2CaAl_4Si_2O_{12}$	Pink Rose-red	Pearly Vitreous	3.5 4.5
FLUORITE	CaF_2	Violet-red Purple Pink Amethystine	Vitreous Glassy	4
CHABAZITE	$CaAl_2(SiO_3)_4 \cdot 6H_2O$	Pale brick-red Flesh-red	Vitreous	4 5
APOPHYLLITE	$(H,K)_2Ca(SiO_3)_2 \cdot H_2O$	Pale violet-red	Vitreous Pearly	4.5 5
APATITE	$(CaF)Ca_4(PO_4)_3$ $(CaCl)Ca_4(PO_4)_3$	Pink Brownish red	Vitreous Greasy	5
SCAPOLITE WERNERITE	$Ca_4Al_6Si_6O_{25}$ with $Na_4Al_3ClSi_9O_{24}$	Lilac-red Violet-red Pink	Vitreous Greasy	5.5
RHODONITE	$MnSiO_3$	Rose-red Brownish red	Vitreous	5.5 6.5

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Orth.	C, basal very prominent; prismatic less prominent	3.9	Platy masses	Uncommon color; in cavities in dark gray limestone
Mono.	C, clinopinacoidal, prominent Brittle	2.2	Tabular plates; crystals	Often in cavities of lava rock with stilbite, chabazite, analcite
Isom.	C, dodecahedral, very prominent Brittle	3.9 4.1	Crystals; massive	Cleavage masses common; occurs with various sulphides
Hex.	C, rhombohedral, not usually prominent Brittle	2.9	Rhombohedrons; with curved faces; saddle-shaped crystals	Often with galenite, calcite quartz, chalcopyrite
Hex.	C, rhombohedral, very prominent Brittle	3.4 3.6	Rhombohedrons; massive	Often with silver ores, also quartz, galenite, pyrite
Mono.	C, basal, perfect and prominent Brittle	3	Micaceous; foliated	Often as veins in green chlorite with diaspore, corundum; not elastic like muscovite; called brittle mica
Isom.	C, octahedral, perfect and prominent Brittle	3 3.2	Cubes; massive	Often with cassiterite, wolframite, galenite, pyrite
Hex.	C, not prominent F, uneven Brittle	2	Crystals; rhombohedrons	Crystals almost cubes in shape; often with stilbite and heulandite in cavities in lava
Tetrag.	C, basal, perfect and prominent Brittle	2.4	Square prisms with base; resemble cubes	Prism faces vertically striated; basal planes have very pearly luster
Hex.	C, basal but not prominent Brittle	3.2	Hexagonal prisms; granular	Uncommon color; usually green and brown; often with calcite
Tetrag.	C, not prominent Brittle	2.6 2.8	Massive; coarse granular	Harder than fluorite
Tric.	C, prismatic, prominent Tough	3.4 3.6	Massive granular; crystals	Often in calcite with franklinite; also with silver ores

COLOR PINK, RED, OR RED-VIOLET.

Name.	Composition.	Color.	Luster.	H.
OPAL	$SiO_2 \cdot nH_2O$	Brownish red	Waxy	5.5 6.5
ORTHOCLASE	$KAlSi_3O_8$	Brick-red Flesh-red	Vitreous Pearly	6 6.5
CHONDRODITE	$Mg_3[Mg(F,OH)_2](SiO_4)_2$	Dark red Brownish red	Vitreous	6 6.5
RUTILE	TiO_2	Dark red	Adamantine	6 6.5
QUARTZ var. Amethyst Rose Ferruginous	SiO_2	Amethystine Rose-red Brick-red Violet-red	Vitreous Glassy Greasy	7
CHALCEDONY var. Agate Carnelian Jasper	SiO_2	Bright red Carnelian-red Dark red Brownish red	Waxy Vitreous	7
GARNET var. Grossularite Essonite Andradite Pyrope Almandite Spessartite	$Ca_3Al_2(SiO_4)_3$ $Ca_3Fe_2(SiO_4)_3$ $Mg_3(Fe,Al)_2(SiO_4)_3$ $(Mg,Fe)_3(Fe,Al)_2(SiO_4)_3$ $Mn_3(Fe,Al)_2(SiO_4)_3$	Light to dark red Brownish red Cinnamon-red Rose-red	Vitreous	6.5 7.5
TOURMALINE	$H_8(Na,Li)_4Al_{10}B_6Si_{12}O_{63}$	Pink Rose-red	Vitreous Glassy	7 7.5
ANDALUSITE	Al_2SiO_5	Pink Pale rose	Vitreous	7 7.5
STAUROLITE	$(AlO)_4(AlOH)Fe(SiO_4)_2$	Dark brownish red	Vitreous	7 7.5
SPINEL	$MgAl_2O_4$	Ruby-red	Vitreous	8

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Amorph.	C, none F, conchoidal, prominent	1.9 1.9	Colloidal masses	Conchoidal fracture characteristic; softer than jasper
Mono.	C, basal and clinopinacoidal, prominent	2.6	Crystals; massive	Occurs with quartz, mica, hornblende in red granite; see feldspar.
Mono.	C, not prominent F, uneven Brittle	3.2	Crystals; embedded grains	Occurs with spinel in crystalline limestone; often with chlorite
Tetrag.	C, not prominent F, uneven Brittle	4.2	Crystals; long slender prisms; acicular	Often as acicular crystals in quartz
Hex.	C, none F, conchoidal, prominent Brittle	2.6	Hexagonal prisms and pyramids; massive	Ferruginous quartz usually with specular hematite; rose quartz usually massive; amethyst usually in crystals
Hex.	C, none F, conchoidal, prominent Brittle to tough	2.6	Massive; cryptocrystalline; banded	Very common as jasper; agate usually finely banded
Isom.	C, not prominent F, uneven Brittle	3.1 4.3	Crystals; granular; rounded grains; massive	Common in schists, gneisses, and crystalline limestone Some massive dark red shows good cleavage
Hex.	C, none F, uneven Very brittle	3 3.2	Prismatic, often radiate or divergent; long trigonal prisms	Usually in lepidolite; crystals often parti-colored red and green
Orth.	C, not prominent Brittle	3.2	Crystals; nearly square prisms; massive	Often in schists with albite, staurolite
Orth.	C, imperfect Brittle	3.7	Crystals; often twinned into crosses and × shapes	Occurs in schists with cyanite, sillimanite, andalusite, chlorite
Isom	C, imperfect Brittle	3.5 4.1	Rounded grains; small octahedrons	Resembles red garnet and ruby corundum

COLOR BLUE OR BLUE-VIOLET.

Name.	Composition.	Color.	Luster.	H.
TOPAZ	$Al_2(F,OH)_2SiO_4$	Pink	Vitreous	8
CORUNDUM	Al_2O_3	Ruby-red	Vitreous	9
VIVIANITE	$Fe_3P_2O_8 \cdot 8H_2O$	Greenish blue Indigo-blue	Vitreous Pearly Dull	1.5 2
CHALCANTHITE	$CuSO_4 \cdot 5H_2O$	Sky-blue Greenish blue	Vitreous	2.5
CHRYSOCOLLA	$CuSiO_3 \cdot 2H_2O$	Greenish blue	Greasy Vitreous Dull	2 4
LEPIDOLITE (Mica)	$(LiK)_2Al_2(F,OH)_2(SiO_3)_3$	Lavender-blue	Pearly Vitreous	2.5 4
CALCITE	$CaCO_3$	Sky-blue	Vitreous	3
CELESTITE	$SrSO_4$	Light sky-blue	Vitreous	3 3.5
BARITE	$BaSO_4$	Pale greenish blue	Vitreous	2.5 3.5
FLUORITE	CaF_2	Violet-blue Greenish blue	Vitreous Very glassy	4
CALAMINE	$H_2Zn_2SiO_5$	Pale blue	Vitreous Silky	4.5 5
SODALITE	$Na_4(Al,Cl)Al_2Si_3O_{12}$	Lavender-blue Azure-blue	Vitreous Greasy	5.5 6
LAZURITE (Lapis Lazuli)	$Na_4(AlS_2Na)Al_2(SiO_4)_3$	Deep azure-blue Berlin blue Ultramarine blue	Vitreous	5 5.5

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Orth.	C, basal, very perfect and prominent Brittle	3.4 3.6	Crystals	Usually artificially colored; uncommon color in nature
Hex.	C, rhombohedral, not prominent Brittle to tough	3.9 4.3	Crystals; grains; massive	Often intermixed with blue when massive; very hard
Mono.	C, pinacoidal, prominent in crystals	2.6	Long prisms; fibrous; earthy	Earthy globular masses in clay or rock, common; prisms in pyrrhotite cavities
Tric.	C, not prominent F, conchoidal Brittle	2.1 2.3	Crystals; massive; stalactitic; fibrous	Taste metallic, nauseous; artificial crystals common; as blue vitriol
Amorph.	C, none F, conchoidal Sectile	4 2.2	Granular; stains; incrustations; seams	Often with clay, chalcopyrite, limonite, malachite
Mono.	C, basal, perfect and prominent Tough	2.9	Compact masses of micaceous plates and scales	Associated with pink and green tourmaline, albite and quartz
Hex.	C, rhombohedral, very prominent Brittle	2.7	Coarsely granular; coarse cleavage masses	Often with vesuvianite, pyroxene
Orth.	C, basal and prismatic, prominent	3.9	Massive; fibrous	Massive varieties show good cleavage and are almost colorless; heavy
Orth.	C, not prominent F, fibrous	4.3 4.6	Fibrous	Heavy fibrous mineral
Isom.	C, octahedral very prominent Brittle	3 3.2	Cubes; compact or granular; massive	Usually violet-blue or greenish blue; often with galena, cassiterite
Orth.	C, prismatic, sometimes prominent	3.5	Drusy crystals; coatings; massive	Geodal-shaped masses with drusy surface; also layers of radiating fibers
Isom.	C, dodecahedral, not prominent Brittle	2.1 2.5	Massive; grains	Usually with nephelite, leucite and albite in syenite rock
Isom.	C, not prominent Brittle	2.4	Massive	Usually intermixed with calcite and pyrite

	Name.	Composition.	Color.	Luster.	H.
COLOR BLUE OR BLUE-VIOLET.	LAZULITE	$MgAl_2P_2O_9 \cdot H_2O$	Smalt-blue Sky-blue Azure-blue	Vitreous	5.5 6
	OPAL	$SiO_2 \cdot nH_2O$	Pale grayish blue Greenish blue	Waxy Vitreous	5.5 6.5
	CYANITE	Al_2SiO_5	Sky-blue Pale greenish blue	Vitreous Pearly	5 7
	TURQUOIS	$AlPO_4Al(OH)_3 \cdot H_2O$	Greenish blue	Dull Waxy	6
	QUARTZ	SiO_2	Grayish blue Greenish blue	Vitreous Glassy	7
	CHALCEDONY	SiO_2	Grayish blue Greenish blue	Waxy Greasy	7
	CORDIERITE (Iolite)	$Al_6Mg_4(AlOH)_2(Si_2O_7)_5$	Grayish blue Greenish blue Smoky blue	Vitreous Glassy	7 7.5
	BERYL	$Be_3Al_2(SiO_4)_5$	Aquamarine blue Pale blue Sky-blue	Vitreous Glassy	7.5 8
	TOPAZ	$Al_2(F,OH)_2SiO_4$	Greenish blue Sky-blue	Vitreous	8
	CORUNDUM	Al_2O_3	Grayish blue Sapphire-blue	Vitreous	9
COLOR GREEN.	**TALC**	$H_2Mg_3(SiO_3)_4$	Pale green Deep green	Greasy	1 1.5
	VIVIANITE	$Fe_3P_2O_8 \cdot 8H_2O$	Bluish green	Vitreous Pearly Dull	1.5 2
	MELANTERITE	$FeSO_4 \cdot 7H_2O$	Pale green to white	Vitreous Earthy	2

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Mono.	C, not prominent F, uneven Brittle	3	Crystals; acute pointed pyramids	Usually as crystals in white quartzite rock
Amorph.	C, none F, conchoidal, prominent	1.9 2.3	Massive	Color not usually homogeneous
Tric.	C, pinacoidal, prominent Tough	3.6	Bladed; reticulated	Cleavage faces usually wavy or bent and with much cross parting; often in schists with staurolite
None	C, none F, uneven	2.6	Irregular-shaped masses; grains; seams; impalpable	Occurs intermixed with rock in veins, seams, etc.
Hex.	C, none F, conchoidal and prominent	2.6	Crystals; massive	Much more glassy and crystalline than chalcedony
Hex.	C, none F, conchoidal, prominent	2.6	Geodes; botryoidal; banded; stalactitic	Geodes often have glassy quartz centers
Orth.	C, not important F, uneven Brittle	2.6	Massive; granular	Occurs in gneisses and schists with sillimanite, andalusite; resembles blue quartz
Hex.	C, rough basal F, uneven Brittle	2.6 2.8	Hexagonal prisms; broken crystals	Occurs in granite with quartz, feldspar, and mica
Orth.	C, basal, perfect and prominent Brittle	3.4 3.6	Crystals	Resembles aquamarine beryl except in crystal form; not common color
Hex.	C, rhombohedral, prominent Tough	3.9 4.1	Massive; grains; barrel-shaped crystals	Masses often show fine parallel striations due to twinning and cleavage
Orth.	C, basal, perfect and prominent F, splintery, uneven	2.8	Foliated massive	Soft and greasy feel; very flexible, but not elastic
Mono.	C, clinopinacoidal, prominent in crystals Brittle	2.6	Long prisms with striated faces; earthy; powder	Earthy masses in clay, bones, fossils; crystals often in pyrrhotite
Mono.	C, basal but not prominent F, small conchoidal or earthy	1.8 1.9	Stalactitic; fine fibrous powder	Green when fresh but soon becomes white and powdery; alteration of iron sulphides; tastes like ink

COLOR GREEN.

Name.	Composition.	Color.	Luster.	H.
GARNIERITE	$H_3(Ni,Mg)SiO_4 \cdot nH_2O$	Apple-green	Dull	1 2
CHLORITE PROCHLORITE CLINOCHLORE	$H_8(Mg,Fe)_5Al_2Si_3O_{18}$	Grass-green Brownish green Dark green	Pearly Vitreous	1.5 2.5
MUSCOVITE (Chrome mica) MARIPOSITE	$H_2KAl_3(SiO_4)_3$ with Cr	Emerald-green Apple-green	Pearly Vitreous	2 2.5
BIOTITE	$(HK)_2(Mg,Fe)_2(AlFe)_2(SiO_4)_3$	Brownish green Deep green	Pearly Vitreous	2.5 3
CHALCANTHITE	$CuSO_4 \cdot 5H_2O$	Bluish green	Vitreous Greasy	2.5
CHRYSOCOLLA	$CuSiO_3 \cdot 2H_2O$	Bluish green	Greasy Vitreous Dull	2 4
SERPENTINE CHRYSOTILE ASBESTOS	$H_4Mg_3Si_2O_9$	Oil-green Light green Dark green Blackish green	Greasy Silky	2.5 4
ACTINOLITE	$Ca(Mg,Fe)_3(SiO_3)_4$	Grass-green Deep green	Vitreous Silky	2.5 4
BARITE	$BaSO_4$	Pale green	Vitreous Glassy	2.5 3.5
WAVELLITE	$Al_3(OH)_3(PO_4)_2 \cdot 5HO_2$	Pale green Bright green	Vitreous Pearly	3 4
PYROMORPHITE	$(PbCl)Pb_4(PO_4)_3$	Yellowish green Dark green	Adamantine Pearly	3.5 4
FLUORITE	CaF_2	Pale green Bright green Bluish green	Vitreous Glassy	4

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Amorph.	C, none F, earthy	2.3 2.8	Friable masses; clay-like masses	Rounded and pod-shaped masses in clay
Mono.	C, basal, perfect and prominent Tough	2.8	Foliated; micaceous; scaly; flaky	Flexible but not elastic; dark-colored in thin plates; very common in schists
Mono.	C, basal, perfect and prominent Tough	2.7 3	Micaceous; scales; flakes; sheets	Light color to colorless in thin sheets; highly elastic. Forms schists
Mono.	C, basal, perfect and prominent Tough	2.7 3.1	Micaceous; scales; flakes	Dark-colored mica in thinnest sheets; elastic and flexible
Tric.	C, not prominent F, conchoidal Brittle	2.1 2.3	Crystals; massive; cross-fibered veins	Taste nauseous metallic; blue vitriol
Amorph.	C, none F, conchoidal Sectile to brittle	2 2.2	Incrustations; seams; stains	Never fibrous like malachite; often with malachite, chalcopyrite
Mono.	C, not important F, conchoidal or splintery	2.6	Massive; fibrous	Feels smooth and looks greasy; dark masses often intersected by veinlets of chrysotile asbestos
Mono.	C, fibrous Brittle	3	Fibrous reticulated masses	Occurs as actinolite schists; individual prisms are harder
Orth.	C, basal and prismatic, very prominent Brittle	4.3 4.6	Platy; massive; crystals	Usually nearly colorless with greenish cast; heavy vitreous mineral
Orth.	C, not prominent Brittle	2.3	Fine radiating fibrous globules; rosette-like	Usually on rock surface as small fibrous rosettes
Hex.	C, not prominent Brittle	6.5 7.1	Hexagonal prisms with striated faces; granular; fibrous	Often with galena, anglesite, mimetite
Isom.	C, octahedral, very prominent Brittle	3 3.2	Cubes; octahedral cleavage pieces; massive; granular	Often with calcite, galena, pyrite, dolomite

COLOR GREEN.

	Name.	Composition.	Color.	Luster.	H.
	CALAMINE	$H_2Zn_2SiO_5$	Bluish green Pale green	Vitreous	4.5 5
	SMITHSONITE	$ZnCO_3$	Grayish green Bluish green	Vitreous	5
	APATITE	$(CaF)Ca_4(PO_4)_3$ or $(CaCl)Ca_4(PO_4)_3$	Pale green Grass-green Dark green Brownish green	Greasy Vitreous	5
	OPAL	$SiO_2 \cdot nH_2O$	Grayish green	Waxy Vitreous	5.5 6.5
	WILLEMITE	Zn_2SiO_4	Yellowish green Bright green	Vitreous	5.5
	CYANITE	Al_2SiO_5	Pale bluish green	Vitreous	4 7
PYROXENE	ENSTATITE	$MgSiO_3$	Grayish green Brownish green	Vitreous Pearly Silky	5.5
PYROXENE	DIOPSIDE	$CaMg(SiO_3)_2$	Pale green Bright green	Vitreous Glassy	5 6.6
PYROXENE	AUGITE	Silicate of Ca, Mg, Fe and Al, chiefly	Blackish green	Vitreous	5 6
AMPHIBOLE	ACTINOLITE	$Ca(Mg,Fe)_3(SiO_3)_4$	Grass-green Dark green	Vitreous Silky	5 6
AMPHIBOLE	HORNBLENDE	Silicate of Ca, Mg, Fe, and Al, chiefly	Blackish green	Vitreous Pearly	5 6
	TURQUOIS (Variscite)	$AlPO_4Al(OH)_3 \cdot H_2O$	Bluish green Apple-green	Waxy Dull	5 6

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Orth.	C, prismatic, sometimes prominent	3.5	Fibrous mammillary masses	Often with smithsonite
Hex.	C, rhombodehral, not usually prominent Brittle	4.4	Drusy masses; botroyidal or mammillary shapes	Usually very compact, like chalcedony
Hex.	C, basal, not prominent Brittle	3.2	Hexagonal prisms; granular; massive	Commonly intermixed with brown colors; often with calcite; crystals often have fused appearance
Amorph.	C, none F, conchoidal and prominent	1.9 2.3	Colloidal masses	Waxy luster characteristic
Hex.	C, prismatic, not prominent	3.9 4.1	Massive; granular	Usually with franklinite, zincite, and calcite
Tric.	C, macropinacoidal, prominent Tough	3.6	Bladed; columnar	Divergent columnar; long blades usually bent and cross-fractured; easily scratched lengthwise but very hard crosswise
Orth.	C, prismatic, prominent Brittle	3.1 3.3	Prismatic masses; divergent columns	Often much softer, owing to alteration to serpentine
Mono.	C, prismatic, not prominent Brittle	3.3	Crystals; square prisms with oblique base	Usually prisms have a prominent basal parting. Green grains in crystalline limestone
Mono.	C, prismatic, not prominent Cleavage angle=87°	3.3	Crystals; massive	Cleavage not so prominent as in hornblende; more common as crystals
Mono.	C, prismatic, prominent Cleavage angle = 124°	3 3.2	Divergent columnar or fibrous; reticulated masses	Often with talc or chlorite; fine to coarse fibrous and reticulated; often in schists
Mono.	C, prismatic and very prominent Cleavage angle = 124°	3 3.2	Massive; prismatic; columnar	Cleavage faces usually have fibrous appearance; common in granitic rocks and schists
None	C, none Brittle	2.6	Globular masses; veins; seams	Usually intermixed with rock in irregular masses or veinlets

COLOR GREEN.

Name.	Composition.	Color.	Luster.	H.
NEPHELITE (Elæolite)	$(Na,K)AlSiO_4$	Grayish green Brownish green	Greasy Vitreous	5.5 6
MICROCLINE (Feldspar)	$KAl \cdot SI_3O_8$	Bright green	Vitreous Pearly	6 6.5
PREHNITE	$H_2Ca_2Al_2(SiO_4)_3$	Pale green Bright green	Vitreous	6 6.5
CHLORITOID	$H_2(Fe,Mg)Al_2SiO_7$	Dark green Greenish black	Pearly Vitreous	6.5
EPIDOTE	$HCa_2(Al,Fe)_3Si_3O_{13}$	Pistachio-green Yellowish green Oil-green Brownish green	Vitreous	6 7
VESUVIANITE	$Ca_6(AlOH)Al_2(SiO_4)_5$	Brownish green Bright green	Vitreous Greasy	6.5
OLIVINE (Chrysolite)	$(Mg,Fe)_2SiO_4$	Bottle-green Oil-green Grass-green	Vitreous Glassy	6.5 7
NEPHRITE JADE	$NaAl(SiO_3)_2$	Grayish green Deep green	Vitreous Silky	6.5 7
QUARTZ	SiO_2	Light to dark green	Vitreous Glassy	7
CHALCEDONY var. Jasper Chrysoprase Plasma	SiO_2	Apple-green Leek-green Light to dark green	Vitreous Waxy	7
GARNET (Uvarovite)	$Ca_3Cr_2(SiO_4)_3$	Emerald-green	Vitreous	7 7.5
TOURMALINE	$4H_2O \cdot 2(Na,Li)_2O \cdot 3B_2O_3 \cdot 8Al_2O_3 \cdot 12SiO_2$	Dark green	Vitreous Glassy	7 7.5

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Hex.	C, not prominent Brittle	2.6	Massive; short hexagonal prisms (rare)	Usually with augite sodalite, leucite, cancrinite nepheline rocks usually have greasy appearance
Tric.	C, basal and brachypinacoidal Brittle	2.5	Crystals; cleavage pieces	Pearly luster on basal cleavage, also vein-like markings; green Amazon stone
Orth.	C, not prominent F, uneven Brittle	2.9	Reniform masses with drusy surfaces; small stalactitic	Occurs usually in cavities and fissures in basalts and diabases
Mono.	C, basal, prominent Brittle	3.5	Foliated massive; micaceous; platy	Deep green in thin plates; resembles hornblende
Mono.	C, basal, perfect and usually prominent Brittle	3.2 3.5	Crystals; prismatic; long columnar; granular; massive	Often in quartz; also with pyroxene, hornblende, magnetite, garnet
Tetrag.	C, not prominent F, uneven Brittle	3.4	Square prisms; faces often vertically striated; massive; granular	Often with calcite; crystals usually not perfect
Orth.	C, not important Brittle	3.3	Rounded masses of green grains; massive granular	Occurs in basalt as bomb-shaped masses of light and dark green, very glassy grains
Mono.	C, not prominent Tough	3.3	Very compact fibrous	Tough masses of interlocking fibers. Jade is compact without fibrous structure
Hex.	C, none F, conchoidal and prominent	2.6	Hexagonal prisms and pyramids	Quartz stained with chlorite or actinolite
Hex.	C, none F, conchoidal and prominent Brittle	2.6	Massive, compact; cryptocrystalline	Not so glassy as quartz; chrysoprase is light apple-green
Isom.	C, none Brittle	3.5	Small crystals; granular	Sometimes on chromite as green glassy crystals
Hex.	C, none F, uneven Very brittle	3 3.2	Trigonal or hexagonal prisms	Often with pink tourmaline in lepidolite or with quartz, biotite, feldspar

	Name.	Composition.	Color.	Luster.	H.
COLOR GREEN.	**BERYL** var. Aquamarine Emerald Common	$Be_3Al_2(SiO_3)_6$	Pale green Bluish green Sea-green Emerald-green	Vitreous Very glassy	7.5 8
	TOPAZ	$Al_2(F,OH)_2SiO_4$	Bluish green	Vitreous	8
	CHRYSOBERYL	$BeAl_2O_4$	Brownish green	Greasy Vitreous	8 8.5
	CORUNDUM	Al_2O_3	Bluish green Grayish green	Vitreous	9
	BIOTITE (Mica)	$(HK)_2(Mg,Fe)_2(Al,Fe)_2(SiO_4)_3$	Brownish black Greenish black	Vitreous Pearly	2.5 3
	CALCITE DOLOMITE (Limestone)	$CaCO_3$ $(Ca,Mg)CO_3$	Grayish black	Vitreous	3 3.5 4
	FLUORITE	CaF_2	Dark purple-black	Vitreous	4
COLOR BLACK.	**HORNBLENDE**	Silicate of Ca, Mg, Fe, and Al, chiefly	Greenish black Brownish black	Vitreous Silky Pearly	5 6
	AUGITE	Silicate of Ca, Mg, Fe, and Al, chiefly	Greenish black Brownish black	Vitreous	5 6
	ALLANITE	$(Ca,Fe)_2(Al,Ce,Fe)_2(AlOH)(SiO_4)_3$	Brownish black Pitch-black	Pitchlike Submetallic	5.5 6
	BROOKITE	TiO_2	Brownish black	Submetallic Adamantine	5.5 6

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Hex.	C, rough basal, not prominent Brittle	2.6 2.8	Hexagonal prisms with basal planes; broken crystals	Often in granite with mica and feldspar Transparent
Orth.	C, basal, perfect and prominent Brittle	3.4 3.6	Crystals	Often nearly square prisms with base; resembles aquamarine beryl, except in form. Transparent
Orth.	C, not prominent Brittle	3.5 3.8	Twinned crystals; tabular	Plates with twinning striations radiating from center; occurs with feldspar, garnet
Hex.	C, rhombohedral prominent Tough	3.9 4.1	Massive	Often with cleavage striations on faces; uncommon color
Mono.	C, basal, perfect and prominent Tough	2.7 3.1	Micaceous; plates; scales	Dark-colored mica in thinnest plates; common in granitic rocks
Hex.	C, none F, fine or coarse granular Brittle	2.7 2.9	Compact granular	Black limestone or marble
Isom.	C, octahedral, prominent Brittle	3 3.2	Massive; banded	Black color not common
Mono.	C, prismatic, prominent Cleavage angle 124°	2.9 3.4	Massive; fibrous; long prismatic	Cleavage faces very bright with often fibrous appearance; common with feldspar, quartz. Very common rock-forming mineral
Mono.	C, prismatic, not very prominent Cleavage angle 87°	3.3	Almost square prisms with oblique bases; massive	Usually with dark basaltic rocks; cleavage not so good as in hornblende
Mono.	C, not prominent F, uneven Brittle	3.5 4.2	Tabular crystals; thin seams in rock; massive	Occurs in granitic rocks as black, pitch-like veins or as crystals; massive in pegmatite veins
Orth.	C, not prominent Brittle	3.8 4.8	Crystals only square or hexagonal-shaped pyramids	Crystal faces often striated; not twinned like rutile

	Name.	Composition.	Color.	Luster.	H.
COLOR BLACK.	**RUTILE**	TiO_2	Brownish black	Metallic Adamantine	6 6.5
	CASSITERITE	SnO_2	Black	Submetallic Adamantine	6 7
	QUARTZ	SiO_2	Grayish black Brownish black	Vitreous	7
	GARNET var. Melanite	Silicate of Ca, Fe, Al, and Ti	Velvet-black Brownish black	Vitreous Velvety	7 7.5
	TOURMALINE	Borosilicate of Al, Fe, and Mg	Coal-black	Vitreous Very glassy	7 7.5
	SPINEL	$(Mg,Fe)Al_2O_4$	Grayish black	Vitreous Dull	8
COLOR WHITE, GRAY, OR COLORLESS.	ULEXITE	$NaCaB_5O_9 \cdot 8H_2O$	Snow-white	Pearly Silky	1 1.5
	TALC Soapstone	$H_2Mg_2(SiO_3)_4$	White Greenish white Gray	Pearly Greasy Dull	1 1.5
	PYROPHYLLITE	$HAl(SiO_3)_2$	White Grayish Brownish gray	Pearly Greasy Dull	1 2
	CERARGYRITE (Hornsilver)	AgCl	Gray Brownish gray	Resinous Waxy	1 1.5
	TRONA	$Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$	White	Vitreous	1
	CALCITE var. Chalk	$CaCO_3$	White	Earthy Dull	1 2
	TRIPOLITE Diatomaceous earth	$SiO_2 \cdot nH_2O$	White	Vitreous Dull	1 2

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Tetrag.	C, not prominent Brittle	4.2	Crystals, usually twinned and faces deeply striated	Crystals generally imperfect; knee-shaped twins common
Tetrag.	C, not prominent F, uneven, coarse Brittle	6.8 7.1	Massive; granular; rolled pebbles; twinned crystals	Often with quartz, mica, wolframite, fluorite; heavy black masses
Hex.	C, none F, conchoidal Brittle	2.6	Crystals; hexagonal prisms and pyramids	Very dark smoky quartz
Isom.	C, none F, uneven Brittle	3.8	Crystals; rhombic dodecahedrons	Uncommon color
Hex.	C, none F, uneven Very brittle	3 3.2	Crystals; long trigonal-shaped prisms; sometimes divergent columnar	Crystal faces usually striated vertically, and much fractured horizontally; often as coal-black crystals in quartz and feldspar
Isom.	C, imperfect F, conchoidal Brittle	3.5 4.1	Crystals; octahedrons	In granular limestone often with chondrodite
	C, not important F, fibrous	1.6	Soft fibrous masses divergent columnar	Usually in ball-like masses of fibers, soft as flour, called cotton balls
Mono.	C, basal, perfect and prominent in the foliated masses	2.8	Foliated; compact massive; fibrous	Soft and greasy feel; fibers usually not radiate like pyrophyllite
Mono.	C, basal and prominent Flexible	2.9	Fibrous, radiate; foliated; massive	Often in small hemispheres of radiating fibers; soft and greasy like talc
Isom.	C, none Sectile	5.5	Wax-like crusts; born-like masses	Cuts like wax; often with ores of silver
Mono.	C, not prominent F, granular	2.1 2.2	White friable masses; efflorescences	Tastes alkaline like soda
	C, none Brittle	2.7	Soft white earthy masses	Resembles white kaolinite, but has no clay odor
Amorph.	C, none F, powdery	2.1 2.3	Soft chalk-like masses	Very light weight; fine gritty powder when rubbed between thumb and finger; may be colored yellow to brown by iron oxides

COLOR WHITE, GRAY, OR COLORLESS.

Name.	Composition.	Color.	Luster.	H.
GYPSUM var. Selenite Alabaster Satin-spar Common	$CaSO_4 \cdot 2H_2O$	Colorless White Gray	Pearly Vitreous Silky Dull	**1** **2**
KAOLINITE (Clay)	$H_4Al_2Si_2O_9$	White Gray Colorless	Dull Earthy Greasy	**1** **2.5**
BAUXITE	$Al_2O_3 \cdot 3H_2O$	White Gray	Earthy Dull	**1** **2.5**
SEPIOLITE (Meerschaum)	$H_4Mg_2Si_3O_{10}$	White	Earthy Dull	**1** **2.5**
TREMOLITE var. Asbestos Mountain leather Mountain cork	$CaMg_3(SiO_3)_4$	White Gray	Silky Pearly	**1** **2.5**
SERPENTINE var. Crysotile or Asbestos	$H_4Mg_3Si_2O_{10}$	Greenish white	Silky	**1** **2.5**
PECTOLITE	$HNaCa_2(SiO_3)_3$	White	Silky Vitreous	**1** **3**
BORAX	$Na_2B_4O_7 \cdot H_2O$	Snow-white Colorless	Earthy Dull Vitreous	**1** **2.5**
EPSOMITE	$MgSO_4 \cdot 7H_2O$	White	Vitreous	**1** **2.5**
HALITE	NaCl	Colorless White Bluish white	Vitreous	**2.5**
SYLVITE	KCl	White Gray Colorless	Vitreous	**2** **2.5**
BRUCITE	$Mg(OH)_2$	White Greenish white	Pearly	**2.5**

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Mono.	C, clinopinacoidal, prominent in selenite Sectile	2.3	Colorless crystals and cleavage plates; massive white; fibrous; columnar; granular	Soft and brittle; not so pearly luster as brucite, and softer; compact translucent masses common; soft white masses called gypsite
Mono.	C, basal in crystals, none in massive F, earthy Brittle or sectile	2.6	Compact massive; rarely in colorless flakes	Rough feeling; soapy var. has greasy feel; strong odor of clay when breathed on
	C, none F, earthy Brittle	2.5	Compact massive; pisolitic	Distinguished from clay only by pisolitic structure
Mono.	C, none F, earthy	2	Massive; mammillary; reniform; very compact	Very smooth feel; has not the clay odor of kaolinite
Mono.	C, fibrous F, fibrous Brittle	<1 3	Fibrous; asbestiform; sheets, cork-like masses	Occurs with tremolite, feldspar quartz; not green like chrysotile when compact; fibers brittle
Mono.	C, fibrous Brittle	2.6	Fibrous; asbestiform	Narrow fibrous veins in serpentine; fibers are green in compact mass; fibers like silky threads
Mono.	C, not prominent F, fibrous	2.7 2.8	Divergent fibrous, radiating from sharp points	Flexible fibers very soft and gritless
Mono.	C, orthopinacoidal, not prominent Brittle	1.7	Crystals; powder	Taste alkaline; white crystals often have fresh, unaltered glassy centers
Orth.	C, brachypinacoidal, prominent Brittle	1.7	Long acicular crystals; capillary tufts; efflorescences	Taste bitter and salt; often in sulphide mines as efflorescences on walls
Isom.	C, cubic, perfect and prominent Brittle	2.1 2.6	Cubes; massive, granular	Salt taste; sometimes with anhydrite
Isom.	C, not prominent F, conchoidal Brittle	1.9 2.0	Granular; compact	Tastes salt and slightly bitter; resembles halite
Hex.	C, basal, perfect and prominent Flexible	2.5	Foliated; massive	Resembles gypsum but has more pearly luster; often with serpentine

COLOR WHITE, GRAY, OR COLORLESS.

Name.	Composition.	Color.	Luster.	H.
ANDALUSITE var. Chiastolite	Al_2SiO_5	Dark gray Blackish gray	Vitreous	2 4
MUSCOVITE (Mica)	$H_2KAl_3(SiO_4)_3$	Colorless Gray	Pearly Vitreous	2 2.5
LEPIDOLITE (Mica)	$(LiK)_2Al_2(F,OH)_2Si_3O_9$	Pale pinkish white Lavender Gray	Pearly	2.5 4
THENARDITE	Na_2SO_4	White Gray	Vitreous	2 3
CRYOLITE	Na_3AlF_6	Pure white	Icy Vitreous	2.5
CALCITE var. Iceland spar Stalactites Marble Common	$CaCO_3$	White Gray Colorless	Vitreous Glassy	3
ANGLESITE	$PbSO_4$	Gray White Colorless	Adamantine Greasy Dull	3
CERUSSITE	$PbCO_3$	Cream-white Gray	Adamantine	3 3.5
BARITE	$BaSO_4$	White Colorless Gray Yellowish white	Vitreous Pearly	2.5 3.5
ANHYDRITE	$CaSO_4$	White Bluish white Reddish white Gray	Vitreous Pearly	3 3.5

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Orth.	C, not prominent Brittle	3.2	Rounded prisms; square prisms	Occurs in schists often as knotty projections; end sections show black squares or crosses of carbonaceous material
Mon.	C, basal, perfect and very prominent Tough	2.73	Micaceous; large sheets; foliated; flakes; scales	Highly flexible and elastic; colorless in thin sheets; cleavable in the thinnest sheets
Mono.	C, basal, perfect and prominent Tough	2.9	Fine or coarse scaly masses; platy; micaceous; foliated	Compact scaly masses containing pink tourmaline
Orth.	C, basal but not prominent Brittle	2.7	Crystals often large in cruciform twins Crusts	Slight soda taste
Mono.	C, basal and pinacoidal; basal is prominent	3	Massive	Snow-ice appearance; often with siderite; cleavage in three directions almost at right angles; translucent
Hex.	C, rhombohedral, very perfect and prominent Brittle	2.7	Crystals; rhombohedrons; scalenohedrons; granular; stalactitic; banded, etc.	Commonly associated with the metallic minerals; colorless variety is Iceland spar; calcite is apt to be stained any color
Orth.	C, not prominent F, conchoidal Brittle	6.1 6.3	Massive, often banded; crystals	Occurs with galena as an alteration product; crystals are colorless; gray masses often have core of galena and are heavy
Orth.	C, not prominent Very brittle	6.5	Prismatic crystals; massive	Occurs similar to anglesite; gray masses somewhat porous or reticulated and are heavy
Orth.	C, basal and prismatic, prominent	4.3 4.6	Crystals; crested masses; granular; lamellar; concretions massive	Often with galena; heavy white mineral, called heavy spar; told from marble or anhydrite by weight
Orth.	C, pinacoidal, not prominent Brittle	3	Massive; granular; scaly	Cleavage in three directions at right angles, making cube forms, occurs with gypsum, limestone

COLOR WHITE, GRAY, OR COLORLESS.

Name.	Composition.	Color.	Luster.	H.
CELESTITE	$SrSO_4$	Colorless with bluish tinge White	Vitreous Glassy	3 3.5
WITHERITE	$BaCO_3$	White	Vitreous	3 3.5
STRONTIANITE	$SrCO_3$	White Yellowish white	Vitreous Glassy	3 3.5
ARAGONITE	$CaCO_3$	White Gray Colorless	Vitreous Glassy	3.5 4
DOLOMITE	$(CaMg)CO_3$	White Gray	Vitreous	3.5 4
SIDERITE	$FeCO_3$	Brownish gray	Vitreous Pearly	3.5 4
HEULANDITE	$H_4CaAl_2(SiO_3)_6 \cdot 3H_2O$	White Light gray	Vitreous	3 4
STILBITE	$H_4(Na_2,Ca)Al_2(SiO_3)_6 \cdot 4H_2O$	White Gray	Vitreous	3 4
Alunite	$K_2(Al \cdot 2OH)_6(SiO_4)_4$	White Gray	Vitreous	3.5 4
FLUORITE	CaF_2	Greenish white White Colorless	Vitreous Glassy	4
COLEMANITE	$Ca_2B_6O_{11} \cdot 5H_2O$	Colorless White Yellowish white	Vitreous Very glassy	4 4.5
SCHEELITE	$CaWO_4$	White Gray Yellowish	Adamantine Greasy	4.5 5
WOLLASTONITE	$CaSiO_3$	White Gray	Vitreous Pearly	4.5 5

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Orth.	C, basal and prismatic; basal very prominent	3.9	Cleavage masses; crystals	Often as colorless crystals with native sulphur
Orth.	C, not prominent Brittle	4.3	Columnar; hexagonal-shaped crystals with striated faces	Sometimes with galena; heavy snow-white masses common
Orth.	C, prismatic, sometimes prominent Brittle	3.7	Columnar masses	Divergent columnar masses resembling aragonite or calcite, but much heavier
Orth.	C, prismatic but not usually prominent Brittle	2.9	Stalactitic; banded; columnar; hexagonal-shaped crystals	Distinguished from calcite by lack of cleavage and by hardness
Hex.	C, rhombohedral, sometimes prominent Brittle	2.9	Rhombohedrons, with curved faces; massive; granular	Massive variety indistinguishable from calcite except somewhat harder; crystals have curved faces
Hex.	C, rhombohedral, very prominent Brittle	3.8	Rhombohedrons with curved faces; saddle-shaped masses; compact; massive	Darker and heavier than dolomite; often as rhombohedrons in cryolite; surface often oxidized brown
Mono.	C, clinopinacoidal and prominent Brittle	2.1 2.2	Tabular crystals; foliated plates; globular	In cavities of lava rock often with chabazite, stilbite, apophyllite
Mono.	C, clinopinacoidal; not prominent Brittle	2.0 2.2	Divergent and sheaf-like; platy; globular	In cavities of lava rock. often with chabazite, apophyllite, heulandite
Hex.	C, basal; not prominent	2.6 2.8	Compact massive; granular; earthy	Resembles clay and often with quartz and clay
Isom.	C, octahedral, very prominent Brittle	3 3.2	Cubes; octahedrons; massive; granular	Often with magnetite, pyrite, calcite; sometimes very compact granular
Mono.	C, clinopinacoidal, very prominent Brittle	2.4	Crystals; massive; divergent columnar	Cleaves into thin brittle plates
Tetrag.	C, not prominent Brittle	5.9 6.1	Crystals; pyramids; massive	Often with cassiterite, wolframite, purple fluorite; very heavy
Mono.	C, orthopinacoidal, not prominent Brittle	2.9	Fibrous; columnar	Parallel, or reticulated, fibrous masses; often in marble; resembles tremolite but generally longer and whiter

COLOR WHITE, GRAY, OR COLORLESS.

Name.	Composition.	Color.	Luster.	H.
CHABAZITE	$Ca_3Al_6(SiO_4)_3(Si_3O_8)_3 \cdot 18H_2O$	White Colorless Gray	Vitreous	**4** **5**
APOPHYLLITE	$H_7KCa_4(SiO_3)_8 \cdot 4\frac{1}{2}H_2O$	White Colorless Yellowish	Vitreous Glassy Pearly on base	**4.5** **5**
CALAMINE	$H_2Zn_2SiO_5$	Colorless White Gray	Vitreous	**4.5** **5**
MAGNESITE	$MgCO_3$	Snow-white Gray	Vitreous Dull	**3.5** **4.5**
SMITHSONITE	$ZnCO_3$	Bluish gray Yellowish gray	Vitreous	**5**
APATITE	$(CaF)Ca_3(PO_4)_3$ $(CaCl)Ca_3(PO_4)_3$	Colorless Gray	Vitreous Greasy	**5**
PECTOLITE	$HNaCa_2(SiO_3)_3$	White	Silky Vitreous	**5**
NATROLITE	$NaAl(AlO)(SiO_3)_3 \cdot 2H_2O$	White Colorless	Vitreous Silky	**5** **5.5**
DATOLITE	$Ca(BOH)SiO_4$	Colorless White	Vitreous Glassy	**5** **5.5**
ANALCITE	$NaAl(SiO_3)_2 \cdot H_2O$	Colorless White	Vitreous Glassy	**5** **5.5**
OPAL	$SiO_2 \cdot nH_2O$	Gray White	Waxy Vitreous	**5.5** **6.5**
SCAPOLITE WERNERITE	Silicate of Ca, Al, Na, and Cl	Gray Greenish gray White	Vitreous Silky	**5.5** **6**

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Hex.	C, not prominent Brittle	2.1	Crystals, almost cubic in shape	Usually in cavities of lava rock with stilbite, heulandite, natrolite
Tetrag.	C, basal, perfect and prominent Brittle	2.4	Crystals; short prisms with base; also pointed pyramids	Basal cleavage has very pearly luster, prismatic faces glassy and vertically striated
Orth.	C, prismatic and prominent Brittle	3.5	Drusy coatings and crusts; small crystals	Often on yellowish brown earthy masses, in small drusy crystallizations and radiating fibrous bands
Hex.	C, rhombohedral in crystals F, conchoidal and prominent	3.1	Crystals rare; massive, impalpable	Very compact impalpable tough white masses with soiled surfaces; are apparently very hard, but surfaces often soft
Hex.	C, rhombohedral, but not usually prominent Brittle	4.3 4.5	Botryoidal crusts; drusy crusts; bone-shaped masses	Often with sphalerite or calamine
Hex.	C, basal, not prominent Brittle	3.2	Crystals; massive	Common white phosphate rock; crystals are green or brown usually
Mono.	C, not prominent Brittle to tough	2.7	Fibrous; divergent, radiate, reticulated	Long white fibers divergent to sharp points; also compact interlocking fibrous
Orth.	C, prismatic, prominent in coarse varieties Brittle	2.2	Acicular; coarse; columnar; fibrous	Often with stilbite, apophyllite, analcite, chabazite, in cavities of lava rock; usually in more acicular prisms than pectolite and not divergent
Mono.	C, none F, uneven Brittle	3	Crystals; massive; granular to compact	Small glassy crystals with slight greenish tint on lava rock; massive white
Isom.	C, not prominent Brittle	2.2	Crystals; icosatetrahedrons or cubes	Often in cavities of lava with apophyllite, natrolite, chabazite, prehnite, datolite; large white crystals
Amorph.	C, none F, conchoidal and very prominent	1.9 2.3	Massive; colloidal; blebby; globular	Wood opal; common opal
Tetrag.	C, not prominent Brittle	2.5 2.8	Square prisms with low pyramidal ends; massive	Crystals usually have rough, uneven faces; often in crystalline limestone

COLOR WHITE, GRAY, OR COLORLESS.

	Name.	Composition.	Color.	Luster.	H.
	LEUCITE	$KAl(SiO_3)_2$	Gray White	Vitreous	**5.5**
	ENSTATITE	$MgSiO_3$	Greenish gray Brownish gray	Pearly Vitreous	**5.5**
	PYROXENE DIOPSIDE	$CaMg(SiO_3)_2$	Colorless Yellowish white Greenish white	Glassy Vitreous	**6** **6.5**
	TREMOLITE	$CaMg_3(SiO_3)_4$	White Gray	Silky Pearly Vitreous	**5** **6**
	NEPHELITE ELÆOLITE	$(Na,K)AlSiO_4$	Greenish gray Brownish gray	Greasy Vitreous	**5.5** **6**
	AMBLYGONITE	$Li(Al,F)PO_4$	White	Vitreous	**6**
FELDSPARS	**ORTHOCLASE** SANIDINE	$KAlSi_3O_8$	White Gray Colorless	Vitreous Pearly	**6** **6.5**
FELDSPARS	**MICROCLINE**	$KAlSi_3O_8$	White Gray Yellowish	Vitreous Pearly	**6** **6.5**
FELDSPARS	**ALBITE**	$NaAlSi_3O_8$	White Colorless Gray	Glassy Vitreous	**6** **6.5**
FELDSPARS	OLIGOCLASE	$NaAlSi_3O_8 + CaAl_2Si_2O_8$	Colorless White	Vitreous Glassy	**6** **6.5**
FELDSPARS	**LABRADORITE**	$CaAl_2Si_2O_8 + NaAlSi_3O_8$	Dark gray Grayish white	Vitreous Pearly	**5** **6**
FELDSPARS	ANORTHITE	$CaAl_2Si_2O_8$	White Gray	Vitreous	**6** **6.5**

System.	Cleavage or Fracture.	G.	Common Structure.	Observations.
Tetrag.	C, imperfect F, conchoidal Brittle	2.5	Crystals; trapezohedrons	Always in crystals; occurs in volcanic rocks with nephelite, sodalite as small round crystals
Orth.	C, prismatic and pinacoidal, prominent Brittle	3.1 3.3	Columnar, divergent masses; lamellar	Often soft owing to alteration to serpentine; cleavage faces quite pearly or silky in luster
Mono.	C, prismatic, not prominent Brittle	3.3	Crystals, almost square or rounded	Often with blue calcite, brown tourmaline
Mono.	C, prismatic, prominent Cleavage angle 124°	2.9 3.1	Columnar; fibrous; prismatic crystals	Often as crystals in dolomitic limestone or marble; also as compact fibrous masses
Hex.	C, not prominent Brittle	2.6	Massive; sometimes hexagonal prisms	Often with sodalite, albite, leucite; greasy luster characteristic
Tric.	C, basal, perfect and prominent Brittle	3	Compact massive	Often with lepidolite, tourmaline and white feldspar
Mono.	C, basal and clinopinacoidal, prominent Brittle	2.4 2.6	Crystals; massive; cleavage pieces	Two cleavages at right angles; common in granitic rocks with mica, hornblende, and quartz
Tric.	C, basal and brachypinacoidal, prominent	2.5	Crystals; massive	Usually has fine cross-veined structure on the basal plane
Tric.	C, basal and brachypinacoidal, not so prominent	2.6	Small crystals; twinned crystals; platy masses	Fine parallel striations or reentrant angles on the base due to twinning
Tric	C, basal and brachypinacoidal, not so prominent	2.6	Crystals; massive	Fine parallel striations on the basal cleavage due to twinning
Tric.	C, basal and brachypinacoidal, prominent	2.7	Massive; cleavage pieces	Fine striations on basal cleavage due to twinning; usually shows a beautiful play of colors; blue, green, gold, etc.
Tric.	C, basal, prominent F, uneven Brittle	2.7	Crystals; prismatic	Occurs in volcanic lavas; not so common as the other feldspars

COLOR WHITE, GRAY OR COLORLESS.

Name.	Composition.	Color.	Luster.	H.
ZOISITE	$Ca_2Al_2(AlOH)(SiO_4)_3$	Grayish white Greenish gray Lavender gray	Vitreous Pearly	**6** **6.5**
SPODUMENE	$LiAl(SiO_3)_2$	Gray White Ash gray	Vitreous Pearly	**6.5** **7**
DIASPORE	$AlO(OH)$	Lavender-gray Grayish white Cream white	Pearly Vitreous Adamantine	**6.5** **7**
QUARTZ var. Rock crystal Milky Smoky Common	SiO_2	Colorless White Smoky gray	Vitreous Greasy	**7**
CHALCEDONY var. Agate Chert Flint Hornstone Siliceous sinter	SiO_2	Gray White	Waxy Vitreous	**7**
ANDALUSITE (CHIASTOLITE)	Al_2SiO_5	Gray Reddish gray	Vitreous	**7.5**
LAWSONITE	$H_4CaAl_2Si_2O_{10}$	Bluish white Gray	Vitreous	**7.5** **8**
ZIRCON	$ZrSiO_4$	Brownish gray Lavender-gray Colorless	Vitreous Pearly	**7.5** **8**
TOPAZ	$Al_2(F,OH)_2SiO_4$	White Colorless	Vitreous Glassy	**8**
CORUNDUM	Al_2O_3	Gray Bluish gray Greenish gray	Vitreous	**9**
DIAMOND	C	Colorless GRAY Yellowish	Adamantine	**10**

System	Cleavage or Fracture.	G.	Common Structure.	Observations.
Orth.	C, brachypinacoidal prominent Brittle	3.3	Columnar; fibrous; prismatic	Columns deeply striated vertically, and broken transversely
Mono.	C, prismatic often prominent Brittle	3.2	Large crystals and broad cleavage plates; lamellar	Often parts in broad lamellar masses
Orth.	C, brachypinacoidal; prominent Brittle	3.3 3.5	Bladed; foliated	Often as veins in chlorite with margarite, corundum; very pearly to adamantine luster
Hex.	C, none F, conchoidal and prominent Brittle	2.6	Hexagonal prisms and pyramids; massive; granular; sand; pebbles	Commonest mineral; occurs in most crystalline rocks as a constituent; conchoidal fracture is characteristic
Hex.	C, none F, conchoidal and prominent Brittle to tough	2.6	Geodal; botryoidal; mammillary; banded; concretionary; massive	Not glassy like quartz; cryptocrystalline in structure; banded varieties classed as agates; geodes often have quartz centers
Orth.	C, not prominent F, uneven Brittle	3.2	Almost square prisms with broken ends	End sections of chiastolite show black crosses or squares due to carbon inclusions
Orth.	C, brachypinacoidal; prominent Brittle	3.1	Crystals; lenticular plates	Often with margarite, actinolite, chlorite; resembles corundum
Tetrag.	C, none Brittle	4.7	Crystals; prisms and pyramids	Occurs in granites and syenites; loose crystals in gold sands; prominent in concentrates
Orth.	C, basal, perfect and prominent Brittle	3.4 3.6	Crystals; white massive	Massive white distinguished from white quartz by presence of cleavage faces
Hex.	C, rhombohedral, prominent Tough	3.9 4.1	Massive; barrel-shaped crystals	Often with chlorite, margarite, magnetite; massive; has usually fine parallel parting striations
Isom.	C, octahedral, not prominent Brittle	3.5	Small rounded octahedral-shaped crystals	Occurs in dark bluish-green igneous rock

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