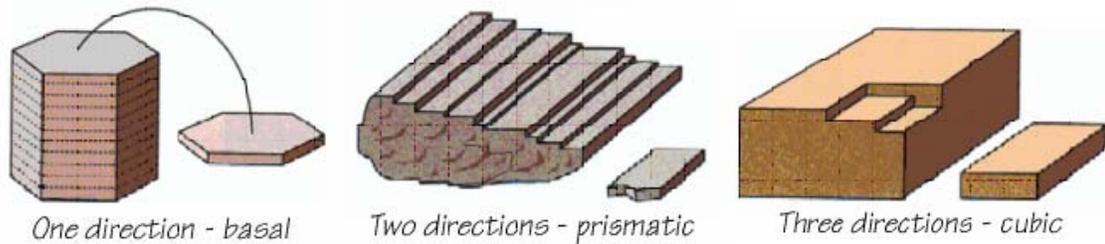


Mineral Identification

Cleavage - Cleavage is the tendency of a mineral to break along a specific direction or plane; that is to break along weaker planes in a mineral's internal crystal structure.

Cleavage can be distinguished from crystal faces because they repeat, often in a step-like manner. A single cleavage *direction* may cause many parallel cleavage *surfaces*.

When describing cleavage always list (1) number of planes and (2) the angle between them (90° or oblique).



Examples of cleavage

Luster - Luster is the way a mineral reflects light. There are two main classifications of luster, metallic and nonmetallic.

1. **Metallic** - A luster is metallic only if it resembles a metal (such as iron, bronze, lead, silver or gold) so much that it might be confused with it. Metallic minerals are opaque – that is, no light penetrates the mineral.
2. **Nonmetallic** - These minerals are those which do not look like metal. Their luster is described by the following terms:
 - **Adamantine** - reflects light brilliantly, like a diamond.
 - **Vitreous** (or glassy) - reflects like glass, although the mineral may be opaque.
 - **Pearly** - like mother-of-pearl.
 - **Resinous** - the luster of peanut brittle, dried pitch, or fiberglass resin.
 - **Waxy** - luster of a broken candle.
 - **Oily** - luster of oil.
 - **Silky** - luster of silk or satin cloth.
 - **Dull** or **earthy** – just like it sounds, dull.

Crystal Form or Specimen Structure - Every mineral specimen encountered will belong to one of the following three classes and one of their subheadings:

1. **Whole crystal** (crystal form): If you have a whole crystal or enough of it to recognize its characteristic shape, that is a very significant property to note. Several characteristic forms are: cubes, octahedrons, dodecahedrons, hexagonal prisms, hexagonal pyramids, etc.

2. **Less than one crystal**: If the specimen does not show enough crystal faces to identify its crystal form, but gives an indication (such as a single crystal face going all the way across it, or a cleavage face showing a light flash) which shows it all belongs to a single crystal, then call it either:

- **Cleavage fragment** - if the specimen is bounded mostly by cleavage planes that give flashes of light (this is a very common form of many mineral specimens).
- **Fracture fragment** - if it is bounded mostly by irregular or curving fractures.

3. **Many crystals grown together (aggregate)**: If you can see many individual grains or a mass that show no recognizable arrangement, identify it as one of the following aggregate specimen structures:

- **Granular** – made of grains large enough to recognize some of their properties.
- **Massive** - a mass of tiny grains (crystals), so small that the individual properties of the grains cannot be recognized.
- **Microcrystalline** - crystals too small to be seen with a hand lens. Can often be recognized by *conchoidal fracture* and *waxy luster*.
- **Fibrous (or acicular)** – mass of long thin crystals which may be parallel, radiating, or crisscrossing. Like threads or hairs.
- **Elongated** – mass of crystals which are longer in one direction than the others and larger than fibrous. If shaped like the blade of a sword, they are called *bladed*.
- **Tabular, platy or in laminae** – intergrown flat, plate-like crystals that may be parallel or at different angles. If they are all more or less parallel, like a heap of coins, they are called *foliated*.
- **Aggregates of microcrystalline** mineral may have rounded or curved surfaces. There are several varieties:
 - **Oolitic** - tiny rounded masses the size of BB's or smaller. (<2mm)
 - **Pisolitic** - rounded masses about the size of peas. (>2mm)
 - **Nodular** - irregular shaped masses about the same size as pisolitic.
 - **Botryoidal** – like a mass of bubbles or bunch of grapes, small to large in size
 - **Reniform or mammillary** – larger irregularly rounded surfaces; like a kidney or composed of rounded protuberances.

Hardness	Luster	Color	Streak	Specimen Structure	Cleavage or Fracture	Heft	Misc. Properties	Name / Formula
<i>Metallic Minerals</i>								
1 - 1.5	<i>Metallic</i>	<i>Silver-gray</i>	<i>Dark gray</i>	<i>Foliated</i>	<i>One perfect cleavage</i>	<i>H</i>	<i>Slippery; gives off blue light between flakes</i>	<i>MOLYBDENITE MoS₂</i>
1 - 2	<i>Metallic</i>	<i>Dark gray or black</i>	<i>Dark gray or black</i>	<i>Foliated</i>	<i>One perfect cleavage</i>	<i>L</i>	<i>Slippery feeling; writes on paper</i>	<i>GRAPHITE C</i>
1 - 2	<i>Metallic</i>	<i>Dark gray or black</i>	<i>Dark gray or black</i>	<i>Massive</i>		<i>H</i>	<i>Often with psilomelane</i>	<i>PYROLUSITE MnO₂</i>
2 - 2.5	<i>Metallic</i>	<i>Silver-gray</i>	<i>Dark gray or black</i>	<i>Bladed</i>	<i>One good cleavage on one side of blade</i>	<i>H</i>	<i>May tarnish black or gun-metal blue</i>	<i>STIBNITE Sb₂S₃</i>
2.5 - 3	<i>Metallic</i>	<i>Copper-red</i>	<i>Copper-red</i>	<i>Wires, etc.</i>		<i>VH</i>	<i>Tarnishes black or green; malleable</i>	<i>NATIVE COPPER Cu</i>
2.5 - 3	<i>Metallic</i>	<i>Golden yellow</i>	<i>Golden yellow</i>	<i>Tiny grains, etc.</i>		<i>VH</i>	<i>Malleable</i>	<i>NATIVE GOLD Au</i>
2.5 - 3	<i>Metallic</i>	<i>Silver-gray or dark gray</i>	<i>Dark gray or black</i>	<i>Cleavage fragments or cubes or octahedrons with dull faces</i>	<i>Perfect cubic cleavage</i>	<i>VH</i>	<i>Looks like lead; heavy silver cubes</i>	<i>GALENA PbS</i>
2.5 - 3	<i>Metallic</i>	<i>Dark gray or black</i>	<i>Dark gray or black</i>	<i>Massive or granular</i>	<i>Conchoidal fracture</i>	<i>H</i>	<i>Often with blue tarnish, greenish stains</i>	<i>CHALCOCITE Cu₂S</i>
3	<i>Metallic</i>	<i>Red-brown if fresh; purple-blue if tarnished</i>	<i>Dark gray or black</i>	<i>Massive or granular</i>	<i>Conchoidal fracture</i>	<i>H</i>	<i>Blue tarnish starts to form in a few hours after break</i>	<i>BORNITE Cu₅FeS₄</i>
3.5 - 4	<i>Metallic</i>	<i>Rich brass</i>	<i>Greenish-black</i>	<i>Massive or granular</i>	<i>Conchoidal fracture</i>	<i>H</i>	<i>Slight tarnish; softer than pyrite</i>	<i>CHALCOPYRITE CuFeS₂</i>
3.5 - 4.5	<i>Metallic</i>	<i>Brownish-bronze</i>	<i>Gray-black</i>	<i>Massive or granular</i>	<i>Conchoidal fracture</i>	<i>H</i>	<i>Very slightly magnetic</i>	<i>PYRRHOTITE FeS₂</i>

Hardness	Luster	Color	Streak	Specimen Structure	Cleavage or Fracture	Heft	Misc. Properties	Name / Formula
3 - 6	<i>Metallic - Submetallic</i>	<i>Dark gray or black</i>	<i>Brownish black</i>	<i>Massive or nodular</i>		<i>H</i>	<i>Often with pyrolusite</i>	<i>PSILOMELANE</i> <i>H₄MnO₅</i>
5.5 - 6	<i>Metallic</i>	<i>Tin-white or gray</i>	<i>Dark gray</i>	<i>Massive</i>		<i>H</i>	<i>Gives slight garlic odor when rubbed</i>	<i>ARSENOPYRITE</i> <i>FeAsS</i>
5.5 - 6.5	<i>Metallic</i>	<i>Black</i>	<i>Brownish red</i>	<i>Massive or sparkling black scales</i>	<i>Parting</i>	<i>H</i>	<i>Streak is distinctive</i>	<i>HEMATITE</i> <i>Fe₂O₃</i> <i>Varieties: specularite (black massive), micaceous specularite (foliated)</i>
5.5 - 6.5	<i>Metallic</i>	<i>Gray-black</i>	<i>Gray-black or brownish-black</i>	<i>Massive or granular</i>	<i>Poor cleavage; subconchoidal fracture</i>	<i>H</i>	<i>Magnetic</i>	<i>MAGNETITE</i> <i>Fe₃O₄</i>
6 - 6.5	<i>Metallic</i>	<i>Pale brass</i>	<i>Greenish-black</i>	<i>granular, cubes, pyritohedrons</i>	<i>Conchoidal fracture</i>	<i>H</i>	<i>Cubes may be striated; harder than chalcopyrite</i>	<i>PYRITE (fool's gold)</i> <i>FeS₂</i>
6 - 6.5	<i>Metallic</i>	<i>Brownish-black or black</i>	<i>Brownish-black to black</i>	<i>Massive or granular</i>		<i>H</i>	<i>Harder than psilomelane</i>	<i>BRAUNITE</i> <i>Mn₂O</i>

Hardness	Luster	Color	Streak	Specimen Structure	Cleavage or Fracture	Heft	Misc. Properties	Name / Formula
Non-Metallic Minerals								
1-2	Waxy, silky, pearly	White, gray, greenish	White	Foliated or massive	One perfect cleavage	M	Slippery feeling	TALC $Mg_3Si_4O_{10}(OH)_2$
1 -2.5	Earthy	White; slightly colored by impurities	White	Massive		L	Slippery feeling; clay odor when breathed upon	KAOLINITE $Al_2Si_2O_5(OH)_4$
1-2	Earthy	White or colored by impurities	White	Massive or laminated		VL	Microscopic organisms (diatoms) Lighter than chalk	OPAL $SiO_2 \cdot nH_2O$ Var: diatomite
3	Earthy	White	White	Massive or oolitic		L		CALCITE Var: chalk
1 -2.5	Silky, pearly	White	White	Fibrous, rounded mass; "cotton balls"	One perfect cleavage	L	Transmits light along fibers	ULEXITE $NaCaB_5O_6(OH)_6 \cdot 5H_2O$
1-3	Earthy	White, cream, red brown	Same as mass	Pisolitic (pisolites = pea-like structures)		L	Color due to traces of hematite and limonite	BAUXITE $Al(OH)_3$
1 - 4	Earthy	Rusty-red	Same as mass	Massive or oolitic		M-H		HEMATITE +I61 Var: ochre, oolitic, etc.
1-4	Earthy	Yellow to yellow-brown	Same as mass	Massive or nodular		M	Also oolitic when replacing glauconite	LIMONITE $FeO(OH) \cdot nH_2O$ Var: yellow, ochre, bog, ore, etc.
1.5 - 2	Resinous	Red to orange	Orange-yellow	Granular	One poor cleavage; conchoidal fracture	M	Occurs with orpiment	REALGAR As_4S_4
1.5 - 2	Resinous	Lemon yellow	Yellow	Foliated	One good cleavage	M	Occurs with realgar	ORPIMENT As_2S_3

Hard-ness	Luster	Color	Streak	Specimen Structure	Cleavage or Fracture	Heft	Misc. Properties	Name / Formula
1.5 -2.5	Resinous	Pale yellow	Pale yellow	Massive, granular or single crystals	Uneven or conchoidal fracture	VL	Smells like matches	NATIVE SULFUR S
2	Pearly; vitreous; dull= massive, silky= fibrous	White; colorless; colored by impurities	White	Massive or granular or fibrous; cleavage fragment; twinned or complicated crystals	One good cleavage & 2 poor, the latter oblique to each other	L		GYP SUM CaSO ₄ ·2H ₂ O Varieties: selenite (transparent) alabaster (massive or granular) satin spar (fibrous)
2	Vitreous or pearly	Gray-white or green	Light gray	Foliated	One good cleavage	M-	Flexible but not elastic; may resemble mica	CHLORITE complex hydrous Mg, Fe silicate
2 - 2.5	Adamantine or earthy	Deep red or scarlett	Same as mass	Massive or granular		H		CINNABAR HgS
2 -2.5	Pearly	Black or dark brown	Light gray or brown	Cleavage fragment; pseudo-hexagonal tabular "books"	One perfect cleavage	M	Elastic; thin cleavage fragments show streak color mica family	BIOTITE Fe, Mg, K aluminosilicate
2 -2.5	Pearly	Silver, white or pale green	White	Same as above	One perfect cleavage	M	Transparent; elastic mica family	MUSCOVITE K aluminosilicate
2 - 4	Pearly	Pale pink, lavender, or yellow	White	Granular; cleavage fragment	One perfect cleavage	M	mica family	LEPIDOLITE Li mica
2 - 4	Waxy to dull	Blue-green or green-blue	Same as mass	Massive	Conchoidal fracture	L		CHRYSOCOLLA
2.5	Silky, greasy	Dark green or yellow-green	Greenish-gray or white	Fibrous		M-		SERPENTINE Var: asbestos Mg ₃ Si ₂ O ₅ (OH) ₄

Hardness	Luster	Color	Streak	Specimen Structure	Cleavage or Fracture	Heft	Misc. Properties	Name / Formula
2.5	Vitreous	White; colorless; colored by impurities	White	Massive or granular or cleavage fragment or cubic crystals	3 cleavages at 90° (cubic)	L	Salty taste; transparent, dissolves in water	HALITE NaCl Var: rock salt
2.5 - 3	Vitreous	White; colorless; colored by impurities	White	Granular; cleavage fragments; tabular crystals	3 cleavages; unequally good, one angle oblique	H	Heavy for white mineral	BARITE BaSO ₄
3	Vitreous	White, colorless; colored by impurities	White	Massive or granular or cleavage fragment or "dog-tooth" crystals	3 cleavages at oblique angles (rhombohedral)	M	Effervesces in dilute HCl	CALCITE Var: Iceland spar (transparent); travertine (banded) Ca ₂ (CO ₃) ₂
3 -3.5	Vitreous	White; colorless, colored by impurities	White	Massive or granular	3 cleavages at 90°, unequally good	M		ANHYDRITE CaSO ₄
3 -3.5	Adamantine	White, colorless; colored by impurities	White	Massive or elongated crystals or V-shaped twins	2 cleavages, oblique	VH	Heavier than barite	CERRUSITE PbCO ₃
3.5	Vitreous	White; colorless; colored by impurities	White	Massive; granular; rhombohedrons (curved)	3 cleavages at oblique angles (rhombohedral)	M	Slightly harder than calcite; effervesces in dilute HCl only if powdered	DOLOMITE CaMg(CO ₃) ₂
3.5	Subvitreous	White	White	Compact nodular masses resembling unglazed porcelain	Smooth fracture	L		HOWLITE Ca borosilicate

Hard-ness	Luster	Color	Streak	Specimen Structure	Cleavage or Fracture	Heft	Misc. Properties	Name / Formula
3.5 - 4	Vitreous	White	White	Radial groups of acicular crystals	One perfect cleavage	L		PROBERTITE $\text{NaCaB}_5\text{O}_7(\text{OH})_4 \cdot 3(\text{H}_2\text{O})$
3.5 - 4	Pearly	Light to dark brown	Light tan	Massive or granular or cleavage fragment	3 cleavages at oblique angles (rhombohedral)	M		SIDERTITE $\text{Fe}_2(\text{CO}_3)_2$
3.5 - 4	Resinous to vitreous	Yellow to dark brown	Pale yellow	Massive or granular or cleavage fragment	6 cleavages at oblique angles (dodecahedral)	M+	Streak smells like sulphur	SPHALERITE $(\text{Zn},\text{Fe})\text{S}$
3.5 - 4	Adamantine or earthy	Dark red	Brownish-red	Massive or tiny octahedral crystals	Conchoidal fracture	H		CUPRITE Cu_2O
3.5 - 4	Vitreous or earthy	Bright green	Green	Massive or granular or mammillary or nodular or fibrous		M+	Often with azurite	MALACHITE $\text{Cu}_2(\text{CO}_3)(\text{OH})_2$
3.5 - 4	Vitreous or earthy	Light to dark blue	Blue	Massive or granular or mammillary or nodular or fibrous		M	Often with malachite	AZURITE $\text{Cu}_3(\text{CO}_3)_2(\text{OH})$
3.5 - 4.5	Vitreous or dull	White or gray	White	Cauliflower masses or cleavage fragment	3 cleavages at oblique angles (rhombohedral)	M		MAGNESITE MgCO_3
3.5 - 4.5	Vitreous	Pink, rose red	White	Granular or massive or cleavage fragment	3 cleavages at oblique angles (rhombohedral)	M	May turn brown on exposure	RHODOCROSITE MnCO_3
4	Vitreous	Colorless, green, purple, etc.	White	Cleavage fragment or cubes or octahedrons	4 cleavages at oblique angles (octahedral)	M		FLUORITE CaF_2

Hardness	Luster	Color	Streak	Specimen Structure	Cleavage or Fracture	Heft	Misc. Properties	Name / Formula
4	Greasy	Dark green to yellow green	Greenish-gray or grayish-white	Massive		M-	Slippery feeling	SERPENTINE $Mg_3Si_2O_5(OH)_4$
4.5	Vitreous or silky	White or colorless	White	Fibrous or columnar crystals	2 cleavages at nearly 90°	M	Pyroxene family	WOLLASTONITE $Ca_2Si_2O_6$
4 - 4.5	Vitreous or silky	Green	Greenish-gray to white	Fibrous or bladed crystals	2 cleavages at oblique angles (56° - 124°)	M	Amphibole family	ACTINOLITE complex Ca Mg Fe silicate
4 - 4.5	Vitreous	White	White	Massive or prismatic crystals	One good cleavage	L	Harder than gypsum or calcite	COLEMANITE $Ca_2B_6O_{11} \cdot 5H_2O$
4.5 - 5.5	Earthy or submetallic	Brown, yellow or black	Brown or yellow	Massive or nodular		M+		LIMONITE $FeO(OH) \cdot nH_2O$
4.5 - 6.5	Dull or metallic	Dark red or shiny black	Red or brownish red	Massive or sparkling black scales	parting along xl faces	H	Streak is most diagnostic property	HEMATITE Fe_2O_3 Var: pencil or kidney ore (both mammillary); specularite (silvery black); micaceous specularite (black scales)
5	Vitreous	Yellow, green, brown, etc.	White	Massive or hexagonal prisms	One poor cleavage	M		APATITE $Ca_5(PO_4)_3(F,Cl,OH)$
5	Vitreous	Many colors	White	Curved surface forms, or crusts	3 perfect cleavages, oblique	H		SMITHSONITE $ZnCO_3$
5 - 5.5	Vitreous	White	White	Small nearly spherical crystals		L	Crystals as amygdales in basalt, etc.	ANALCITE $NaAlSi_2O_6 \cdot H_2O$
5 - 5.5	Vitreous	White	White	Fibrous or granular	One perfect cleavage	L	Needle-like crystals as amygdales in basalt, etc.	NATROLITE $Na_2Al_2Si_3O_{10} \cdot 2H_2O$

Hard-ness	Luster	Color	Streak	Specimen Structure	Cleavage or Fracture	Heft	Misc. Properties	Name / Formula
5 -5.5	Vitreous	Brown, reddish, yellow	White, gray	Massive or granular; tabular or prismatic crystals		M	Occurs as disseminated accessory in many igneous rocks	SPHENE CaTiO(SiO ₄)
5 - 6	Vitreous to pearly	Pink, rose red	White	Massive; granular	Conchoidal to uneven fracture	M	Pyroxene family	RHODONITE (Mn,Fe,Mg,Ca)SiO ₃
5.5	Vitreous to dull	Black or dark green	Grayish-green to white	Cleavage fragment or stubby crystals	2 cleavages at nearly 90°	M	Pyroxene family	AUGITE Ca, Mg, Fe, Al silicate
5.5	Vitreous	Black or dark green	Grayish-green to white	Cleavage fragment or elongated crystals with diamond-shaped cross section	2 cleavages at oblique angles (56° - 124°)	M	Amphibole family	HORNBLLENDE complex CaMgFeAl silicate
5.5	Vitreous or pearly	White	White	Fibrous or bladed crystals	2 cleavages at oblique angles (56° - 124°)	M	Amphibole family	TREMOLITE complex CaMg silicate
5.5 - 6	Vitreous or pearly	Blue, lavender-blue, gray	Gray-blue	Massive, granular or fibrous	2 cleavages at oblique angles (56° - 124°)	M	Amphibole family	GLAUCOPHANE complex NaMg silicate
5 & 7	Vitreous	Gray-blue, green-blue	White	Bladed crystals	One good cleavage on side of blade	M	H = 5 parallel to blade; H = 7 across blade	KYANITE Al ₂ SiO ₅
5.5 - 6.5	Waxy	White, gray, multicolor	White	Massive	Conchoidal fracture	L	Softer than chalcedony; may be banded	OPAL SiO ₂ ·nH ₂ O
6	Waxy to earthy	Green-blue, Blue-green	White or like mass	Massive or nodular	Conchoidal fracture	M	Harder than chrysocolla	TURQUOISE CuAl ₆ (PO ₄) ₄ (OH) ₈ ·4H ₂ O
6	Pearly	Colorless, white, pink, gray, etc.	White	Cleavage fragment or square prisms	2 cleavages at 90°	M	Often with exsolution lamellae	ORTHOCLASE KAISi ₃ O ₈

Hard-ness	Luster	Color	Streak	Specimen Structure	Cleavage or Fracture	Heft	Misc. Properties	Name / Formula
6	Pearly	Colorless, white, gray, purplish, etc.	White	Cleavage fragment or square prisms	2 cleavages at 90°	M	Striations on one cleavage parallel to the second cleavage	PLAGIOCLASE (Na-Ca) Al ₂ Si ₂ O ₈
6 - 7	Vitreous to dull	Yellow-green or dark green	Grayish	Massive or granular or long light or dark xls	One cleavage	M	Often in thin veins or coating a joint surface	EPIDOTE Ca ₂ (Fe,Al) ₃ (SiO ₄) ₃ (OH)
6 - 7	Vitreous to silky	Gray, brown, yellowish, greenish	White	Radiating fibrous masses	One cleavage	M		SILLIMANITE Al ₂ SiO ₅
6.5	Vitreous, resinous	Green to brown	White	Massive or granular or square prisms	Poor cleavage	M		IDOCRASE complex CaAl silicate
6.5 - 7	Vitreous	Grass-green	White	Granular	Conchoidal fracture	M		OLIVINE (Mg, Fe) ₂ SiO ₄
7	Vitreous	Colorless, white, gray, etc.	White	Massive or granular or hexagonal prisms and pyramids	No cleavage; conchoidal fracture	M		QUARTZ SiO ₂ Var: rock crystal (clear); smoky; rose; milky; amethyst (purple); etc.
7	Waxy	White, gray, red, yellow, multi-colored, etc.	White or light-colored	Massive or nodular or mammillary	No cleavage; conchoidal fracture	M	Microcrystalline SiO ₂	CHALCEDONY Var: typical (colorless); jasper (red, yellow, brown); flint (dark gray, black); chert(light); agate (mottled or banded)
7 - 7.5	Vitreous	Reddish-brown	Light tan or white	Prismatic crystals	Poor cleavage	M+	Often twinned with crossed crystals	STAUROLITE Fe,Mg,Zn, Al silicate

Hardness	Luster	Color	Streak	Specimen Structure	Cleavage or Fracture	Heft	Misc. Properties	Name / Formula
7.5	Vitreous	Wine-red, brown, green, etc.	White	Massive or crystal fragments or dodecahedrons and other forms with many faces	Subconchoidal fracture	M		GARNET complex silicate Many varieties with general formula: e.g. almandite
7.5	Vitreous	Black, pink, green, etc.	White or light gray	Trigonal prisms, many faces, or striated	Subconchoidal fracture	M		TOURMALINE Complex boro-silicate Var: schorl (black); rubellite (pink); elbaite (green); etc.
8	Vitreous	Pale green, white	White	Massive or crystal fragment or hexagonal prisms	Conchoidal fracture	M		BERYL $\text{Al}_2\text{Be}_3\text{Si}_6\text{O}_{18}$ Var: emerald (green); aquamarine (blue); common
8	Vitreous	Pale yellow, white, etc.	White	Complex prisms with steep ends; or cleavage fragment	One perfect cleavage	M+	May look like glass	TOPAZ $\text{Al}_2\text{SiO}_4(\text{F},\text{OH})_2$
9	Vitreous to waxy	Gray, brown, etc.	White	Crystal fragment or hexagonal prisms	Basal parting, breaks at base of xtl	M		CORUNDUM Al_2O_3 Var: ruby (red); sapphire (blue); common