MINERALS

INTRODUCTION

In this lab you will learn how to identify about 40 different minerals. Correct identification requires knowing the *properties* of each mineral and determining them accurately. It is not enough to know how each mineral "looks", for the same mineral can look differently in different specimens. Likewise, two different minerals can look the same. Properties are more reliable. Each mineral has a unique set of properties that do not vary from specimen to specimen.

The methods we will use to identify our minerals are restricted to those that can be performed in the field. This limits the kind tools we can use and it also limits our ability to determine properties. Most specimens will only permit accurate determination of a few properties, but that's usually enough to make a reasonably certain identification. The trick lies in knowing what particular properties to determine and how to do that correctly.

PHYSICAL PROPERTIES

Below are listed the mineral properties that can generally be determined in the field. They are listed in roughly the order in which they are determined. Not all these properties apply to, or are important for, each mineral.

Luster, Color and Streak

When light is applied to a mineral it is either absorbed or reflected. We only see what is reflected. Reflection occurs on the surface of the mineral, and if the mineral is translucent, it may also occur on internal surfaces (i.e. fractures or cleavages) as well as from internal atoms.

LUSTER refers to the directional and spatial qualities of the reflected light. Smooth surfaces reflect light in orderly directions – like a mirror, and produce a *vitreous* (glassy) luster. Irregular surfaces scatter the light in random directions and produce a *dull* or *earthy* luster. The interaction of light reflected from internal surfaces can produce more exotic lusters like *pearly*, *resinous*, or *adamantine* (brilliant) lusters.

COLOR is determined by the wavelength and intensity of the reflected light. "White" light contains all the wavelengths detectable by the human eye. The more white light reflects off the surface of the mineral the lighter the mineral will be. Aggregates of small crystals will therefore be generally lighter than those of larger crystals because there are more surfaces to reflect from. Larger crystals will tend to absorb more light and thus appear darker. Trace impurities in the mineral can greatly influence both the quantity and quality of light absorption and reflection. Use great discretion when evaluating color.

STREAK is the color of the powdered mineral. Since color depends on crystal size and aggregation, powdering standardizes these properties and produces a more reliable indication of a minerals true color. An easy way to powder a mineral is to drag it across the rough surface of an unglazed tile (streak plate).

Hardness

HARDNESS refers to a mineral's ability to resist scratching relative to the ten minerals on Moh's scale of hardness (Figure 1.1). To determine a mineral's hardness, rub it against a substance of known hardness and see which is scratched. Although straightforward, the scratch test can be misleading. If care is not taken with aggregates (masses of intergrown crystals), weathered and/or easily cleaved specimens, the test may indicate properties that have nothing to do with hardness. One such property is *toughness* – a mineral's resistance to breaking. Diamond is the hardest mineral, but jade is the toughest.

Kits containing the ten minerals of Moh's scale are available but generally not used because geologists like to keep field gear to a minimum. Instead most geologists sacrifice precision for simplicity, and prefer to judge hardness relative to substances that are almost always at hand – like a fingernail (H~2.5) and a knife blade or glass (H~5.5). Determining a combination of diagnostic properties for the mineral usually compensates for lack of precision in hardness testing.

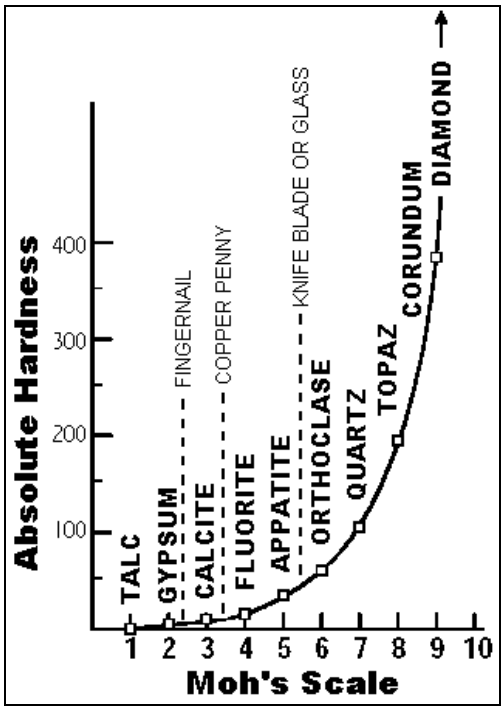


Figure1.1 – Moh's hardness SCALE.

Cleavage

The orderly arrangement of atoms within a crystal can create parallel planes of weakness along which a mineral tends to break. The most common cleavage types are shown below:

Figure 1.2 - BASAL CLEAVAGE - One direction parallels to the top and base.

Figure 1.3 – PRISMATIC CLEAVAGE – Two directions @ ~90°.

Figure 1.4 PRISMATIC CLEAVAGE – Two directions @ ~ 57^{o} and 123^{o}.

Figure 1.5 CUBIC CLEAVAGE - Three directions @ 90^{o}.

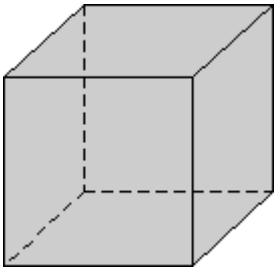
Figure 1.6 RHOMBOHEDRAL CLEAVAGE - Three directions parallel to the sides of a rhombohedron.

Figure 1.7 OCTAHEDRAL CLEAVAGE - Four directions parallel to the sides of an octahedron.

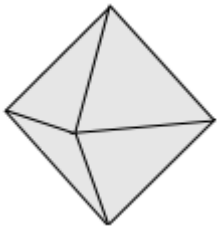
Figure 1.8 DODECAHEDRAL CLEAVAGE – Six directions parallel to the sides of a dodecahedron.

Common Crystal Forms

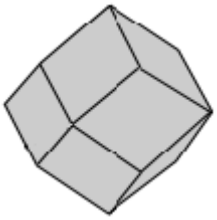
ISOMETRIC FORMS



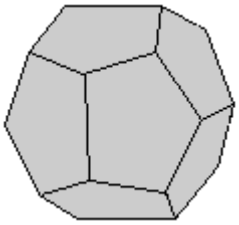
Cube



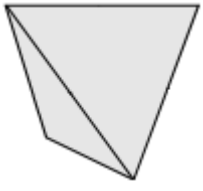
Octahedron



Dodecahedron

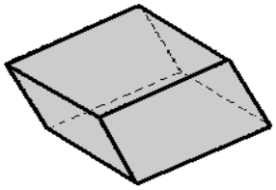


Pyritohedron

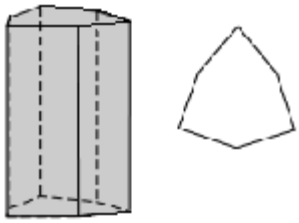


Tetrahedron

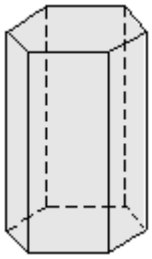
TRIGONAL/HEXAGONAL



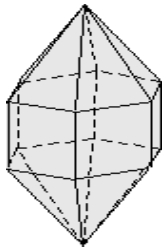
Rhombohedron



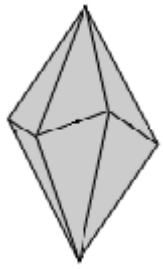
Ditrigonal Prism



Hexagonal Prism

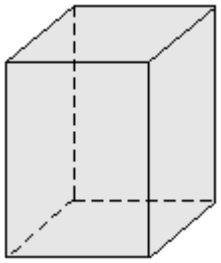


Hexagonal Dipyramid

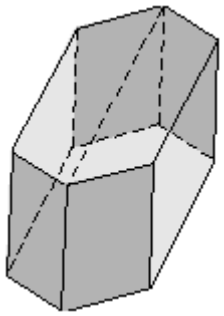


Hexagonal Scalenohedron

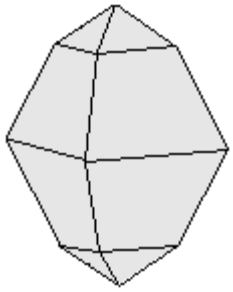
OTHER FORMS



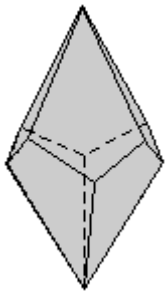
Tetragonal Prism



Rhombic Prism



Rhombic Dipyramid



Trapezohedron

Other Properties

HABIT - In nature perfect crystals are rare. The faces that develop on a crystal depend on the space available for the crystals to grow. If crystals grow into one another or in a restricted environment, it is possible that no well-formed crystal faces will be developed. However, crystals sometimes develop certain forms more commonly than others, although the symmetry may not be readily apparent from these common forms. The term used to describe general shape of a crystal is ***habit.***

- *Tabular* - thick or thin flat plates.
- *Equant* – having roughly the same length in every direction (equidimensional).
- *Acicular* - long, slender crystals.
- *Prismatic* - elongated in one direction.
- *Bladed* - like a wedge or knife blade
- *Striated* – having very shallow parallel grooves or depressions on one or more crystal or cleavage faces

STRUCTURE - The arrangement of crystals relative to each other.

- *Radiating* – growth of many elongated crystals outward from a central point, like the spokes of a wheel.
- *Fibrous* - elongated clusters of fibers
- *Botryoidal* - smooth bulbous shapes like a bunch of grapes
- *Foliated* – parallel alignment of platy or prismatic crystals
- *Reniform* – shaped like a kidney
- *Granular* – mass of non-oriented, equant crystals visible to the naked eye
- *Massive* – interlocking mineral grains, no structure apparent

FRACTURE – The way a mineral breaks other than along cleavage planes.

- *Conchoidal* – concentric “clam shell” –like rings with a smooth curved surface (like a BB hole in glass)
- *Uneven* - rough or irregular surface
- *Hackly* – Sharp jagged surfaces like broken metal
- *Earthy* – Breaking like clay or chalk

TENACITY – Resistance to stress.

- *Brittle* – Easily broken by cutting or hammering
- *Sectile* – Can be cut by a knife into thin shavings
- *Flexible* – Can be bent, but will not return to original form when stress is released
- *Elastic* – Can be bent, and will return to original form when stress is released
- *Friable* – Easily crumbled or crushed into a powder

SECIFIC GRAVITY – Weight relative to volume (relative heaviness). Water has a specific gravity of 1.

FLOWCHART FOR MINERAL IDENTIFICATION

METALLIC LUSTER				
Hardness	**Streak**	**Color**	**Other Properties**	**Mineral Name Handbook Page**
Scratches glass	Black, greenish black, or dark gray	Pale gold	Commonly forms cubes, pyritohedrons, or octahedrons, but may also be massive. Faces often striated. Tarnishes brown. Brittle. H = 6 to 6 1/2	**Pyrite** (p. 60)
	Black to dark gray	Dark gray to black	Attracts a magnet. Commonly forms octahedral crystals but is also massive or granular. Tarnishes gray.	**Magnetite** (p. 79)
Does not scratch glass	Dark red to red-brown	Silvery gray to black	Aggregates of flaky crystals sparkle. Tarnishes red. True hardness of 6 obscured by tendency to flake.	**Hematite** (p. 80) specular variety
	Dark gray	Rich yellow-gold	Tetrahedrons common. Tarnishes dark brown or purple.	**Chalcopyrite** (p. 56)
		Silver gray	Good to excellent cubic cleavage. High specific gravity. Tarnishes dull gray.	**Galena** (p. 52)
		Dark gray to black	When pure it can be scratched by a fingernail, marks paper and feels slippery. Impurities make it harder.	**Graphite** (p. 51)

NON-METALLIC LUSTER

Hardness		Cleavage		Color		Luster	Other Properties	Mineral Name Handbook Page	
SCRATCHES GLASS	6 to 6.5	EXCELLENT OR GOOD	1 perfect 1 good @ 90°	LIGHT	White, gray, rarely pink	Vitreous	Striations, lath-shaped crystals	PLAGIOCLASE FELDSPAR	Anorthite 169
									Bytownite 171
									Labradorite 169
									Andesine 170
									Oligoclase 170
									Albite 168
	6 to 6.5		1 perfect 1 good @ 90°		Tan, pink, salmon, white, gray, green, orange, brown	Vitreous to pearly	Exsolution lamellae	POTASSIUM FELDSPAR (alkali feldspar)	Sanidine 168
									Orthoclase 171
									Microcline 167
	8		1 perfect		Colorless, white, gray, pink, golden yellow, brown, light blue, orange, greenish, purple	Vitreous	Rainbows on internal cleavages; transparent prismatic crystals with diamond-shaped cross section and striated faces	Topaz 135	
	5 to 6		1 perfect 1 good @ 60° and 120°	DARK	Black, dark green	Vitreous	Opaque, shinier, darker and longer prismatic crystals than augite	Hornblende 153 (an amphibole)	
	5.5		2 good @ 60° and 120°		Light green to blackish green	Vitreous to dull	Opaque; long prisms or needles	Actinolite 154 (an amphibole)	
	5.5 to 6		2 good @ 90°		Dark green, black	Vitreous to dull	Vitreous luster when fresh, but quickly weathers to a dull luster; opaque; short prismatic crystals	Augite 151 (a pyroxene)	
	7	POOR OR ABSENT		Various		Vitreous to greasy	Transparent to translucent, conchoidal fracture; six sided columnar crystals with pyramidal terminations; crystal faces often striated perpendicular to length of crystal	Quartz	Clear = "Rock Crystal" 87
									White ="Milky" 87
									Black/brown = "Smokey" 86
									Pink = "Rose" 86
	7			Various		Waxy	Often translucent, conchoidal fracture; often banded	Chalcedony (cryptocrystalline quartz) 88-89	
	7			Light to dark olive green		Vitreous	Transparent to translucent; conchoidal fracture; thick tabular crystals are nearly equidimensional like glassy beads; weathers rapidly to iron oxide	Olivine 132	
	6 to 7			Yellowish green to pistachio green, brownish green to greenish black, or black		Vitreous	Transparent to nearly opaque; commonly massive or granular, but also in striated prismatic crystals	Epidote 142	
	7 to 7.5			Dark brown, reddish brown, yellowish brown or brownish black		Vitreous to resinous	Translucent to nearly opaque; short prismatic crystals with diamond-shaped cross sections; crystals often form cross-shaped twins	Staurolite 136	
	6.5 to 7.5			Commonly reds and browns; also yellow, green, orange, black, purple, pink		Vitreous to resinous	Ball-shaped, dodecahedral crystals with diamond-shaped faces; transparent to opaque; brittle; partings can mimic cleavage	Garnet 133	
	9			Commonly red-gray or gray but varies; red = ruby; blue = sapphire		Vitreous to greasy to ada-mantine	Hexagonal bipyramids or short hexagonal prisms; also tabular or rhombohedral	Corundum 82	
	7.5 to 8			Light greens and blues common; also colorless, white, pink, yellow		Vitreous	Commonly pale green; hexagonal prisms with flat ends	Beryl 146	
	7 to 7.5			Black, pink, green, blue, brown, yellow		Vitreous	Vertically grooved, prismatic crystals, rounded triangular cross sections	Tourmaline 147	

NON-METALLIC LUSTER								
Hardness		**Cleavage**			**Color**	**Luster**	**Other Properties**	**Mineral Name Handbook Page**
WON'T SCRATCH GLASS	3	EXCELLENT OR GOOD	3 perfect rhombo-hedral	LIGHT	Colorless, white, yellow, green, pink, brown, orange, blue	Vitreous to dull	Breaks into rhombohedrons (leaning cubes); crystals transparent to translucent usually in 6-sided forms; effervesces in dilute HCl	Calcite 99
	3.5 to 4		3 perfect rhombo-hedral		White, colorless, gray, crème, or pink	Vitreous to pearly	Breaks into rhombohedrons; crystals commonly rhombohedrons with curved faces; slowly effervesces in dilute HCl only if powdered	Dolomite 100
	3 to 3.5		1 perfect 1 good and 1 distinct		White, gray, colorless or white with shades of brown, yellow, blue, black	Vitreous to pearly	Short tabular crystals, bladed aggregates or roses; opaque, transparent or translucent; high specific gravity (4.3 to 4.6)	Barite 112
	2 to 2.5		3 perfect @ 90° (cubic)		Colorless, white, yellow, salmon, orange, blue, brown, or red	Greasy to vitreous	Cubic crystals break into cubes and can be hopper-shaped; tastes salty; feels damp or slippery; low specific gravity	Halite 70
	4		4 perfect octa-hedral		Colorless or in pastel shades of violet, green, yellow, gray, blue	Vitreous	Cubic crystals often as penetration twins; transparent to translucent; fluorescent	Fluorite 74
	1.5 to 2		1 perfect 2distinct		White colorless, gray, yellow, red, brown	Vitreous to pearly	Scratches with fingernail, splintery to conchoidal fracture; transparent to translucent; brittle; thin flakes flexible but not elastic	Gypsum 110
	2.5 to 3		1 perfect		Lavender, pink, yellowish, grayish white	Pearly	Usually in scaly aggregates; rarely as stubby hexagonal prisms; thin flakes are tough and elastic	MICA: Lepidolite 160
	2 to 2.5		1 perfect		White or colorless, yellow, brown, golden tan, red-brown	Vitreous to pearly	Stubby hexagonal prisms like "books" split into thin, tough, very elastic, transparent sheets	MICA: Muscovite 160
	2.5 to 3		1 perfect	DARK	Black, golden black, brownish black, greenish black, dark green	Vitreous, pearly, submetal-lic	Stubby, opaque hexagonal prisms like "books" split into thin, tough, very elastic, non-transparent sheets; becomes brittle when weathered	MICA: Biotite 161
	2 to 3		1 perfect		Light to dark green, black	Pearly, vitreous, dull	Usually in scaly, foliated, granular or compact masses; crystals are short opaque prisms; slightly soapy feel; thin flakes are flexible but not elastic	MICA: Chlorite (see 136 chloritoid)
	3.5 to 4		6 perfect dodeca-hedral		Commonly yellow to brown; also red, green, black; rarely white or pale gray	Resinous, submetal-lic, ada-mantine	Streak light brown; translucent to opaque; specific gravity 3.9 to 4.1; crystals commonly tetrahedral or dodecahedral; also granular, compact	Sphalerite 55
	1.5 to 2.5	POOR OR ABSCENT		LIGHT	Yellow, greenish or reddish yellow, brown, gray	Greasy, resinous, adaman-tine	Crystals transparent, usually steep bipyramids, or tabular; also granular, fibrous, compact, earthy; very brittle	Sulfur 49
	5				Usually pale green or yellow; also brown, red, violet, pink, white, colorless	Greasy to vitreous	Crystals hexagonal prisms, frequently tabular, also massive; fracture uneven, conchoidal; transparent to translucent; brittle; partings may mimic cleavage	Apatite 125
	1				White, light green, often gray impurities	Pearly, greasy	Soapy feel; sectile; crystals rare, usually foliated, granular, fibrous, compact, waxy: never porous	Talc 158
	2 to 2.5				White, cream, gray, yellowish	Dull	Plastic when wet; absorbs water; friable; smells of wet clay when damp	Koalinite 163
	4 to 5.5			DARK	Yellow, brown, ocher	Dull, silky	Streak yellowish brown; amorphous; fracture conchoidal, splintery, uneven, earthy; often porous	Limonite 95
	3.5 to 4				Azure-blue, dark blue	Dull to vitreous	Usually in radiating, botryoidal, incrusting, or earthy masses; well formed crystals have 2 good cleavages; usually associated with malachite	Azurite 105
	3.5 to 4				Emerald-green, grass-green, dark green	Dull, ada-mantine, silky	Usually in radial, fibrous, botryoidal, incrusting, or earthy masses often with concentric color banding; well formed crystals rare but have 1 prefect cleavage	Malachite 105
	5 (ish)				Red, reddish brown	Dull	Streak deep red to brownish red; specific gravity 4.9 to 5.3; crystals powdery, compact, granular, radiated, reniform, botryoidal, earthy	Hematite 80 (earthy variety)