MINERALS
PHYSICAL PROPERTIES OF MINERALS

The Study of rocks allows geologist to understand the history of the Earth. Most Rocks are aggregates of minerals. One must therefore, be able to identify minerals, which are components of common rocks.

MINERAL. Naturally occurring inorganic crystalline solid with definite (although not fixed) chemical composition.

MINERAL CHEMISTRY.

Earth scientists have identified over 2000 minerals. Minerals are classified based on their chemical composition in groups		
Group	Examples	Comments
Native Elements	Gold [Au], silver [Ag], copper [Cu], sulfur [S], diamond[C], and graphite[C]	
Sulfides	Cinnabar [HgS], pyrite [FeS_2], galena [PbS]	
Oxides	Corundum [Al_2O_3], cuprite [Cu_2O], hematite [Fe_2O_3]	
Halides	Halite [NaCl], sylvite [KCl]).	
Carbonates	Calcite [$CaCO_3$], dolomite [$CaMg(CO_3)_2$], malachite [$Cu_2CO_3(OH)_2$)]	Most geologists considered **nitrates** and **borates** as subcategories of the carbonates.
Sulfates	Anhydrite [$CaSO_4$] gypsum [$CaSO_4 . 2H_2O$]	Less common sulfates exist containing substitutions for the sulfate compound for example, in **chromates**.
Phosphates	Apatite [$Ca_5(PO_4)_3$ (F,Cl,OH)]	Phosphates are often classified together with **arsenates, vanadates, tungstates**, and **molybdates**.
Silicates	albite [$NaAlSi_3O_8$], augite [$Ca,Na)(Mg,Fe,Al)(Si,Al)_2O_6$], beryl [$Be_3Al_2(Si_6O_{18}$], biotite [$K(Mg,Fe)_3(AlSi_3O_{10}(OH)_2$], hornblende [$(Ca,Na)_{2-3}(Mg,Fe,Al)Si_6(Si,Al)_2O_{22}(OH)_2$], microcline [$KAlSi_3O_8$], muscovite [$KAl_2(AlSi_3O_{10}(OH)_2$], olivine [$Mg, Fe)_2SiO_4$], orthoclase [$KAlSi_3O_8$], and quartz [$SiO_2$]	Largest group of minerals

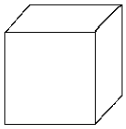
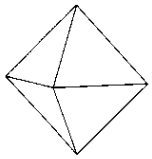
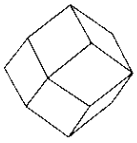
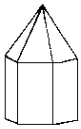
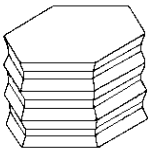
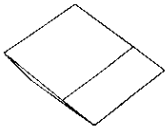
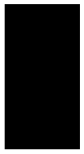
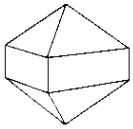
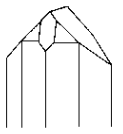
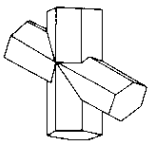
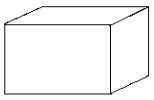
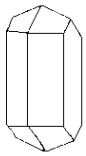
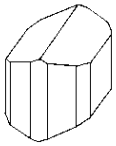
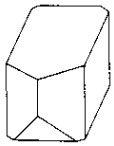
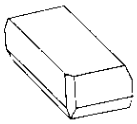
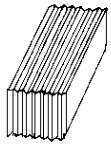
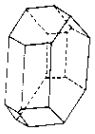
The IDENTIFICATION OF MINERALS can be based upon their physical properties. Physical properties diagnostic of minerals include:

- ✓**CRYSTAL FORM OR STRUCTURE**
- ✓**FRACTURE AND CLEAVAGE**
- ✓**TENACITY**
- ✓**SPECIFIC GRAVITY**
- ✓**HARDNESS**
- ✓**PROPERTIES RELATED TO LIGHT**
  - ☺ **COLOR**
  - ☺ **LUSTER**
  - ☺ **STREAK**
  - ☺ **DIAPHANEITY**
- ✓**SPECIAL PROPERTIES**
  - ☺ **MAGNETISM**
- ✓ **ACID OR CHEMICAL REACTION**
- ✓ **TASTE**
- ✓ **ODOR**
- ✓ **FEEL**
- ✓ **FLUORESCENCE**
- ❑ **etc.**

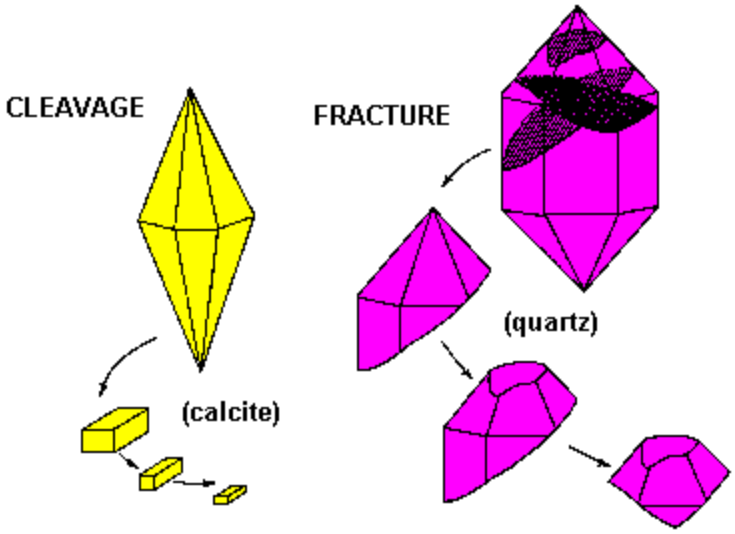
CRYSTAL FORM OR STRUCTURE

Reflection of the internal atomic structure of the minerals. Crystal faces are planar surfaces that develop if a crystal grows in an unimpeded manner in an uncrowned environment (Minerals rarely show perfect development of crystal faces.

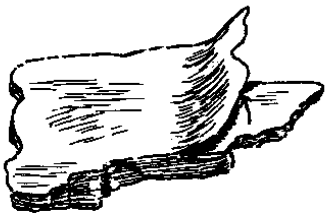
(You can't tell crystalline from an aggregate)

CRYSTAL SYSTEM	COMMON FORMS AND EXAMPLES		
Cubic 	 Cube (Halite)	 Octahedron (Fluorite)	 Dodecahedron (Garnet)
Hexagonal 	 Hexagonal prism / pyramid (Quartz)	 Hexagonal plates (Molybdenite)	 Rhombohedron (Calcite)
Tetragonal 	 Tetragonal disphenoid (Chalcopyrite)		 Tetragonal prism (Scheelite)
Orthorhombic 	 Combined form (Topaz)	 Combined form (Staurolite twin)	 Orthorombic prism (Sulfur)
Monoclinic 	 Combined form (Gypsum)	 Combined form (Hornblende)	 Combined form (Orthoclase [Potassium Feldspar])
Triclinic 	 Combined form (Rhodonite)	 Twinned plagioclase (Albite)	 Combined form (Plagioclase feldspar)

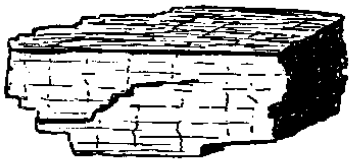
FRACTURE AND CLEAVAGE	
Description of the way in which a mineral breaks	
Irregular breaks are called **FRACTURES**	Breaks **along planes** are called **CLEAVAGE PLANES.**
FRACTURE	**CLEAVAGE DIRECTION**
IRREGULAR	**1** (micas: biotite, muscovite)
FIBROUS	**2 @ 90** (plagioclase, orthoclase)
CONCHOIDAL (quartz; glass)	**2 not @ 90** (hornblende)
SPLINTERY (asbestos	**3 @ 90** (halite)
	3 not @ 90 (calcite)
	4 not @ 90 (fluorite)
	6 not @ 90 (sphalerite)



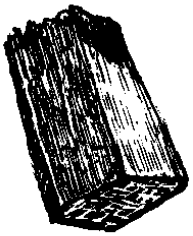
CLEAVAGE



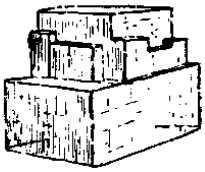
CLEAVAGE IN ONE DIRECTION



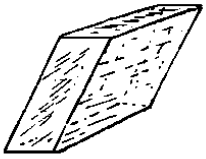
CLEAVAGE IN TWO DIRECTIONS
@ RIGHT ANGLES



CLEAVAGE IN TWO DIRECTIONS
NOT @ RIGHT ANGLES



CLEAVAGE IN THREE DIRECTIONS
@ 90 DEGREES



CLEAVAGE IN THREE DIRECTIONS
@ 60 DEGREES (NOT @ 90 DEGREES)

CLEAVAGE IN FOUR DIRECTIONS

CLEAVAGE IN SIX DIRECTIONS

TENACITY	
Index of a mineral's resistance to be broken or bent	
BRITTLE	(Shatters; **quartz**),
ELASTIC	(Bends, returns to its original shape; **biotite**),
FLEXIBLE	(Bends, does not return to original shape; **gypsum**),
SECTILE	(Resistant to be cut by a knife; **talc**),
MALLEABLE	(Resistant to breakage; pounded into different shapes; **gold, copper)**.

SPECIFIC GRAVITY	
Measure of the relative weight of a substance. Ratio of between the mass of a minerals and the mass of an equal volume of water. (**HEFT**) Useful only if the mineral is "heavy"	
Galena (PbS)	7.5
common Silicates	2.7-2.9

HARDNESS			
Ability of a mineral to resist abrasion. Resistance of a mineral to be scratch. Relative property			
MOHS SCALE *(1812)*:			
1	**TALC**		**T**he
2	**GYPSUM**	Fingernail 2.5	**G**reen
3	**CALCITE**	Copper Penny 3	**C**lawed
4	**FLUORITE**		**F**erocious
5	**APATITE**	Pocket Knife Blade 5	**A**ardvark
6	**ORTHOCLASE**	Glass 5.5	**O**rdered
7	**QUARTZ**		**Q**uick
8	**TOPAZ**		**T**asty
9	**CORUNDUM**		**C**hinese
10	**DIAMOND**		**D**inners
Two minerals with the same hardness will scratch each other			
Greater or less than Glass Plate (LAB KIT)			

PROPERTIES RELATED TO LIGHT

COLOR	
Usually the first an most easily observed property of a mineral.	
Not diagnostic for most minerals	
Quartz, Fluorite	Purple, black, white, green yellow, pink, almost any color).
For a few is diagnostic	
Azurite	Blue
Malachite	Green
Galena	Gray
Olivine	Green
Sulfur	Yellow

LUSTER	
Way in which the surface of minerals reflect light (in a fresh surface).	
METALLIC	Galena, pyrite
NON METALLIC	
VITREOUS OR GLASSY	Quartz
PEARLY	Talc
SILKY	Gypsum
RESINOUS	Sphalerite, sulfur
EARTHY OR DULL	Kaolinite, limonite
GREASY OR OILY, ADAMANTINE, WAXY, etc	

STREAK	
Color of a powdered mineral. Tested by rubbing it against a piece of porcelain **(Streak plate)**.	
Most useful for **METALLIC MINERALS**.	**Hematite** (gray or red color; red-brown streak)
Most **NON METALLIC MINERALS**	Have a white streak

DIAPHANEITY	
Way in which a mineral transmits light.	
TRANSPARENT	Transmit light; images can be seen
TRANSLUCENT	Transmit light not images
OPAQUE	Does not transmit light or images

SPECIAL PROPERTIES

MAGNETISM	Strongly magnetic	**Magnetite**
ACID OR CHEMICAL REACTION	($CaCO_3$) reacts with dilute HCl (hydrochloric acid). [(CaMg) CO_3]	**Calcite Dolomite**
	$CaCO_3$ + HCl ====> CaCl + H2O + CO2	
TASTE	NaCl; common salt KCl	**Halite** **Sylvite**
ODOR	"nasty odor" (stink)	**Sulfur** **Sphalerite** (when scratched)
FEEL	Sensation gained by rubbing a specimen	**Talc** soapy **Halite** greasy (in humid climates)
FLUORESCENCE	Some minerals when they are exposed to UV light emit a characteristic colored light	Willemite (Zn_2SiO_4)