Al- Karkh University of Science

College of Geophysics and Remote Sensing

Department of Remote Sensing

Lec. 3 : Properties of Minerals

Assist. Prof. Aqeel A. Al- Zubaidi

Physical Properties of Minerals:

Seven Common Properties: 1. Color and Clarity, 2. Crystal Habits and Forms, 3. Luster, 4. Streak, 5. Hardness, 6. Cleavage, 7. Fractures.

Other Properties: a. Tenacity, b. Reaction with Acid, c. Magnetism, d. Striations, e. Lamellae, f. Specific Gravity, g. Double refraction, h. Piezoelectricity.

1-Color and Clarity: Color is easy to notice, but is often not reliable as a property. Some minerals present varieties, different forms or colors, so other properties must be observed to identify it. Most minerals also present a color on a freshly broken surface, and a different color on a weathered surface.

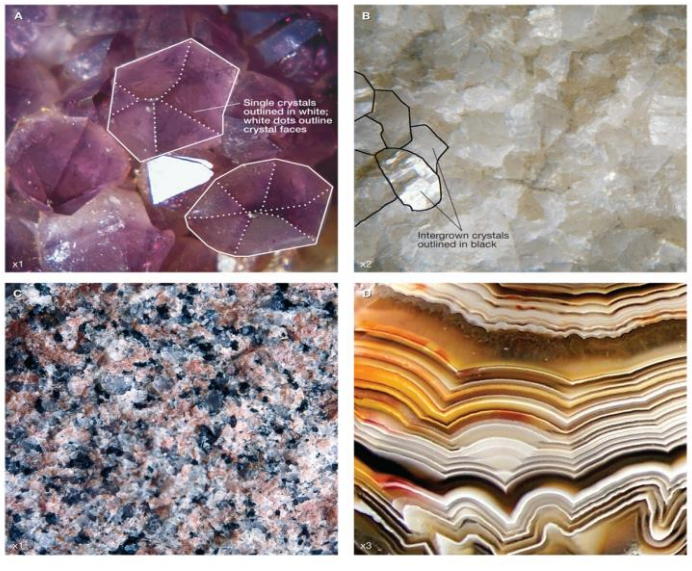
These are crystals of the same mineral, Quartz, SiO_2. Some crystals are: **smoky** **milky,** **white** **purple** A Quartz with purple color (Amethyst) which would have the same composition of "regular" Quartz, SiO_2	

Different minerals has the same color. How would you tell one from the other?

You must determine other physical properties in addition to color.

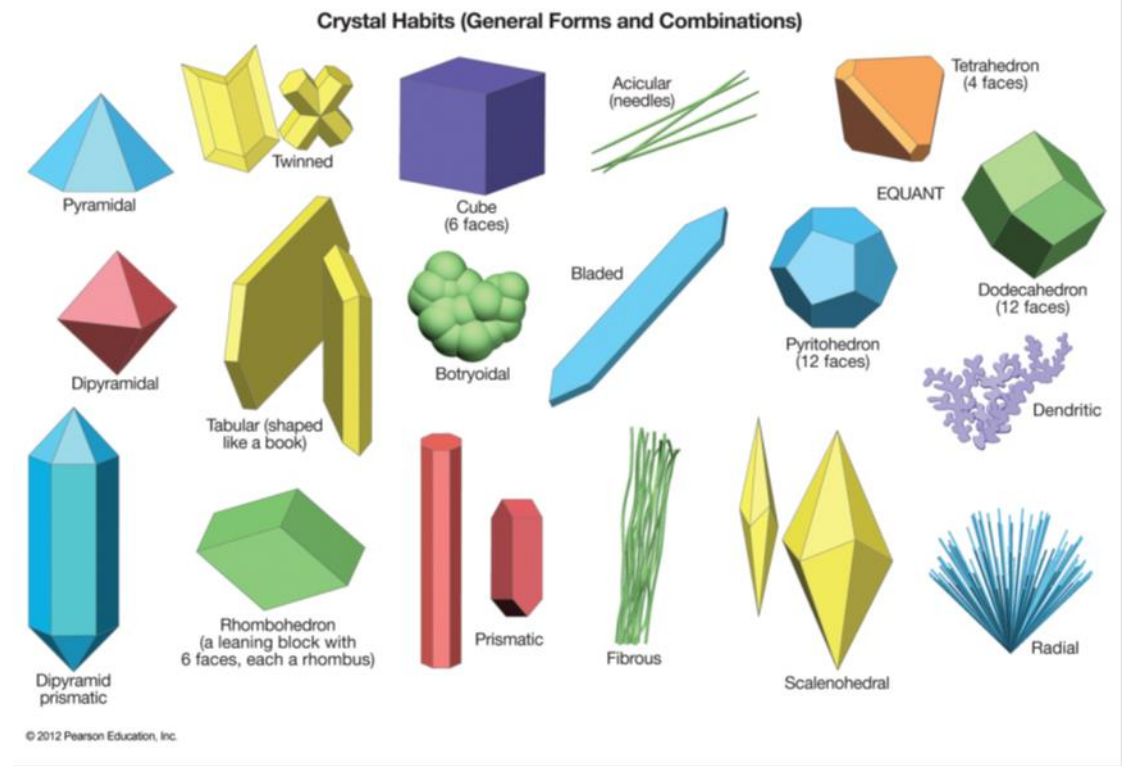
		
A Crystals of Gypsum CaSO4*2H2O Looks like B, but has different properties	B Crystals of Halite (Table Salt) NaCl Looks like A, and is the same as C	C Crystals of Halite (Table Salt) NaCl Same as B, but has a different color

2.Crystal Habits and Forms: The Crystal Form is the geometric shape of a Crystal. The Crystal Habit refers to the general crystal form(s) and combination(s) in which a mineral habitually forms.



A. Amethyst (variety of purple Quartz SiO2). B. Calcite CaCO3: crystals are so tightly **intergrown** that crystal form is not visible. C. Rock made of **black, white, gray and pink crystals**, also tightly intergrown so that crystal form is not visible. D. Agate (variety of multicolored Quartz SiO2) that are cryptocrystalline (so tiny that they are not visible in hand samples.

Crystal habit refers to general forms and combination of crystals Each specific crystal form can be classified into one of six crystal systems, according to the number, length, and angular relationships of imaginary geometric axes along which its crystal faces grew



Common crystal habits, general geometric forms and combination of crystals

General properties of mineral crystals:

• Crystal habit refers to general forms and combination of crystals.

• Each specific crystal form can be classified into one of six crystal systems, according to the number, length, and angular relationships of axes along which its crystal faces grew.

• Crystal form is an external feature of mineral crystals.

• Perfect crystals can only develop if a mineral crystal is unrestricted as it grows,this is rare.

• When crystals grow together (they are intergrown), they do no exhibit their crystal form.

• Most crystalline rocks show intergrown patterns which are used as evidence for classification.

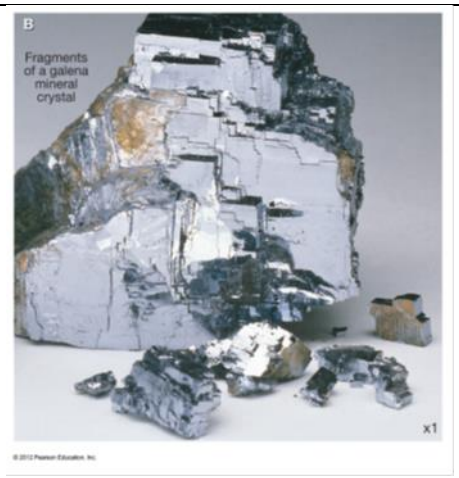
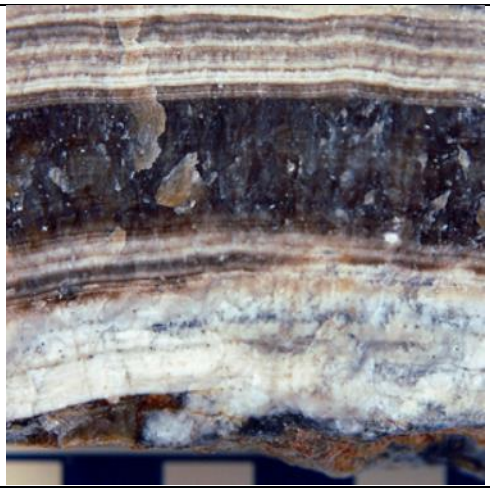
3 – Luster:

• The quality and intensity of light reflected from the surface of a mineral is called its luster.

• Luster cannot always be seen in a photograph: you need to have the mineral in your hands.

• Luster of a mineral is described by comparing it to familiar substances.

• Luster is either Metallic or Nonmetallic.

	
Metallic luster (M) occurs when minerals reflect light “like a metal” Galena PbS	Nonmetallic luster (NM) occurs in all other minerals, Travertine (a form of Limestone) made of Calcite CaCO3

Metallic Luster: Metallic objects,

– Bright could be very reflective, shiny, polished.

– Dull is not very reflective, not very shiny, not very polished.

Nonmetallic Luster: is more common and can also be described with more specific terms: Vitreous, Waxy , Pearly , Satiny , Earthy , Greasy , Porcelaneous.

Note:

• Sometimes, metallic minerals will weather to a nonmetallic luster: you should always observe a freshly broken surface of a mineral to determine luster.

• Sometimes a mineral looks submetallic. For identification purposes, it should be treated as metallic.

4 – Streak:

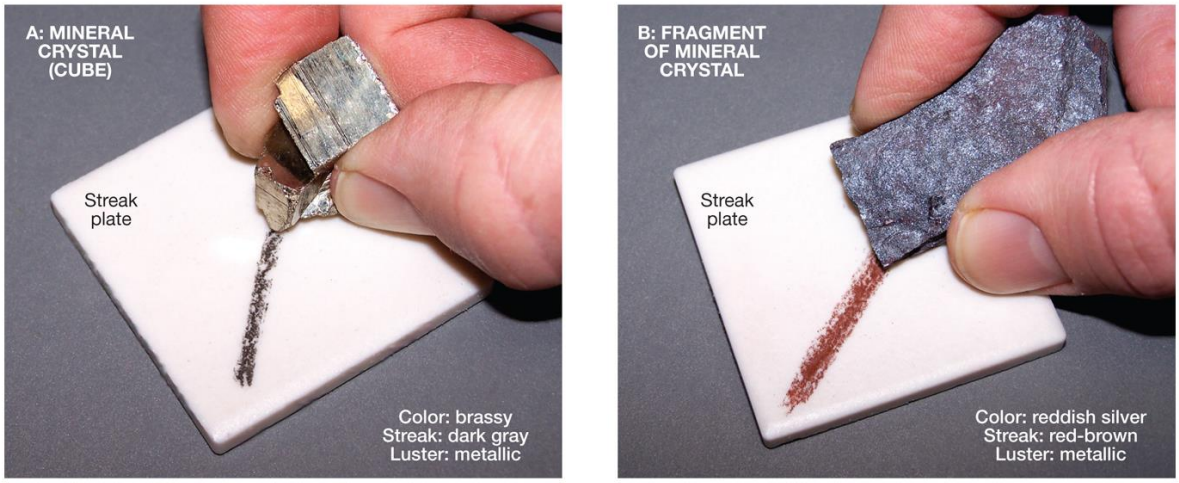
• Streak is the color of a substance after it has been ground to a fine powder.

• To obtain a powder, the easiest way is to scratch a mineral on a porcelain streak plate

• The color of the powder is its streak.

Sometimes, the color of the mineral and the color of the streak are different

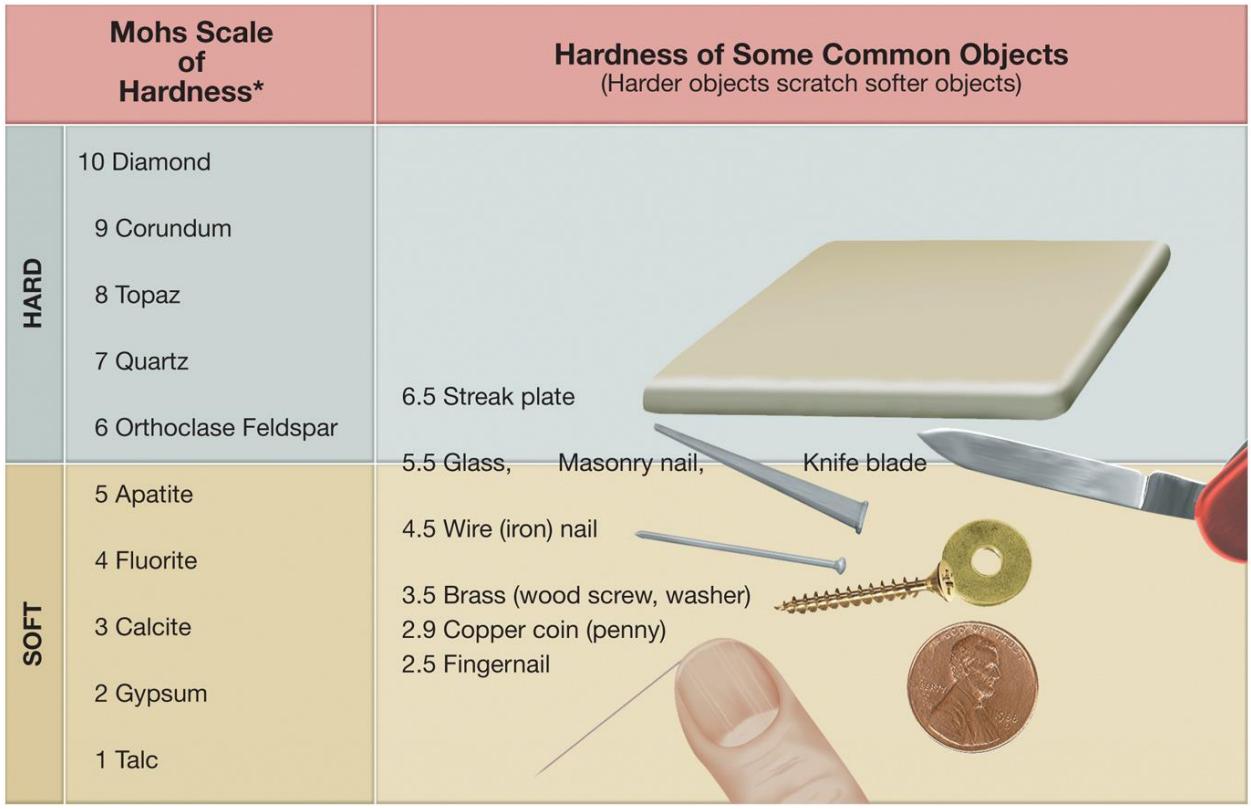
• If the mineral is harder than the streak plate, it will scratch the plate and not leave a streak, in this case, you can crush a tiny piece with a hammer, or record the streak as unknown.



5 - Hardness

• Hardness is a measure of resistance to scratching.

• A harder substance will scratch a softer one, but a softer one cannot scratch a harder one.
• Mohs developed a quantitative scale of relative mineral hardness.
• In the Mohs scale, the softest mineral (Talc) has a hardness of 1, and the hardest mineral (Diamond) has a hardness of 10.



* A scale for measuring relative mineral hardness (resistance to scratching).

A piece of glass has a hardness of 5.5
• Glass is used as a reference to distinguish between hard and soft minerals.
• If the mineral scratches the glass, it is hard.
• If the mineral cannot scratch the glass, it is soft.
• You can use your hardness kit to determine a mineral's hardness number.

A hardness kit includes:
A set of minerals with known hardness.
A magnifying lens
A porcelain streak plate (H = 6.5)
A glass square (H = 5.5)
A wire (iron) nail (H = 4.5)
A penny (H = 2.9)
A magnet
You should also remember that your
fingernail has a H = 2.5

How to determine hardness of minerals?

- Scratch your mineral on the glass plate
- If the mineral scratches the glass, it is hard
- If the mineral does not scratch the glass, it is soft
- This mineral scratches the glass (H = 5.5): it is a hard mineral

6 – Cleavage, and 7 - Fracture

- **Cleavage** is the tendency of some minerals to break (cleave) along flat, parallel surfaces
- Cleavage can be excellent, good, poor, or absent. If cleavage is absent, the mineral has a fracture
- **Fracture** refers to any break in a mineral that does not occur along a cleavage plane.

Light reflection on cleavage and fracture:

• Excellent cleavage, light is reflected in one direction from a set of large parallel surfaces.

• Good cleavage, light is reflected in one direction from a set of many small parallel surfaces.

• Poor cleavage, light is reflected from a set of small flat parallel surfaces difficult to detect.

• Fracture, light is reflected randomly.

Fractures

• Fractures can be described as:

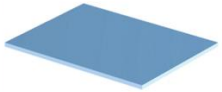
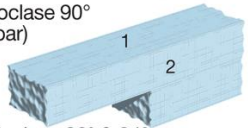
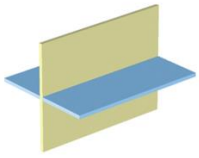
– Conchoidal (like glass, with ribbed, smoothly curved surfaces)

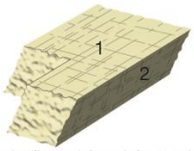
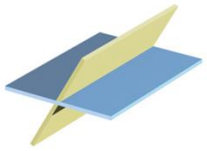
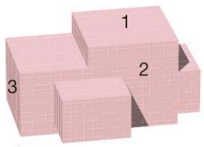
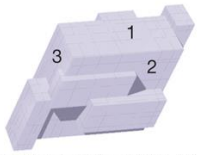
– Uneven (rough)

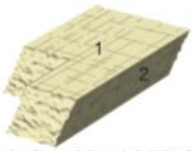
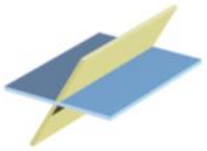
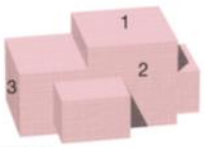
– Hackly (having jagged edges)

– Splintery (like splintered wood)

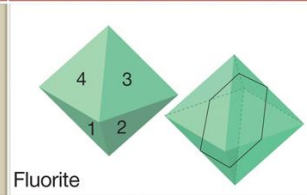
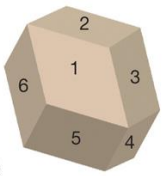
– Fibrous (showing fiber-like structures)

Number of Cleavages and Their Directions	Name and Description of How the Mineral Breaks	Shape of Broken Pieces (cleavage directions are numbered)	Illustration of Cleavage Directions
No cleavage (fractures only)	No parallel broken surfaces; may have conchoidal fracture (like glass)	 Quartz	None (no cleavage)
1 cleavage	**Basal (book) cleavage** "Books" that split apart along flat sheets	 Muscovite, biotite, chlorite (micas)	
2 cleavages intersect at or near 90°	**Prismatic cleavage** Elongated forms that fracture along short *rectangular* cross sections	Orthoclase 90° (K-spar)  Plagioclase 86° & 94°, pyroxene (augite) 87° & 93°	

Number of Cleavages and Their Directions	Name and Description of How the Mineral Breaks	Shape of Broken Pieces (cleavage directions are numbered)	Illustration of Cleavage Directions
2 cleavages do not intersect at 90°	**Prismatic cleavage** Elongated forms that fracture along short *parallelogram* cross sections	 Amphibole (hornblende) 56° & 124°	
3 cleavages intersect at 90°	**Cubic cleavage** Shapes made of cubes and parts of cubes	 Halite, galena	
3 cleavages do not intersect at 90°	**Rhombohedral cleavage** Shapes made of rhombohedrons and parts of rhombohedrons	 Calcite and dolomite 75° & 105°	

Number of Cleavages and Their Directions	Name and Description of How the Mineral Breaks	Shape of Broken Pieces (cleavage directions are numbered)	Illustration of Cleavage Directions
2 cleavages do not intersect at 90°	**Prismatic cleavage** Elongated forms that fracture along short *parallelogram* cross sections	 Amphibole (hornblende) 56° & 124°	
3 cleavages intersect at 90°	**Cubic cleavage** Shapes made of cubes and parts of cubes	 Halite, galena	
3 cleavages do not intersect at 90°	**Rhombohedral cleavage** Shapes made of rhombohedrons and parts of rhombohedrons	 Calcite and dolomite 75° & 105°	

© 2012 Pearson Education, Inc.

Number of Cleavages and Their Directions	Name and Description of How the Mineral Breaks	Shape of Broken Pieces (cleavage directions are numbered)	Illustration of Cleavage Directions
4 main cleavages intersect at 71° and 109° to form octahedrons, which split along hexagon-shaped surfaces; may have secondary cleavages at 60° and 120°	**Octahedral cleavage** Shapes made of octahedrons and parts of octahedrons	 Fluorite	
6 cleavages intersect at 60° and 120°	**Dodecahedral cleavage** Shapes made of dodecahedrons and parts of dodecahedrons	 Sphalerite	

Other Properties

a. Tenacity the manner in which a substance resists breakage (britle, malleable, elastic, sectile).

b. Reaction to Acid only carbonate minerals, mostly Calcite $CaCO_3$, will “fizz” when a drop of dilute HCl is applied to their surface.

c. Magnetite (Fe_3O_4) will be attracted to a magnet.

d. Striations “hairline” grooves on the cleavage surface of some minerals (typical of K-feldspar).

e. Exsolution Lamellae similar to striations, these are thin discontinuous layers of Plagioclase within K-feldspar.

f. Specific Gravity, the ratio of density of a mineral divided by density of water.

g. Piezoelectricity Quartz can generate electricity when squeezed in a certain direction.

h. Double refraction Calcite crystals can split light into two components.

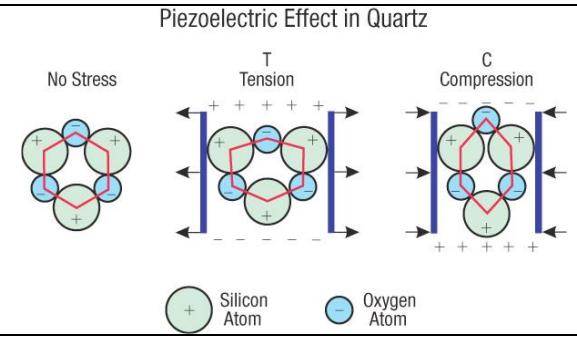
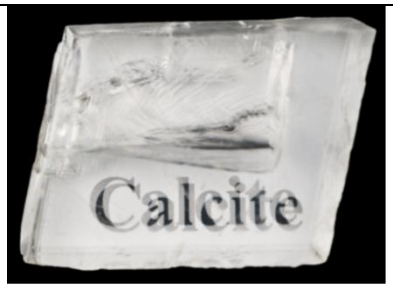
Gold Au is malleable

		
Calcite CaCO3 reacts with HCl	Exsolution lamellae in K-feldspar	Striations in Tourmaline

Specific Gravity: (SG)

- Specific Gravity (SG) is the Density of the mineral (D_{min}) divided by the Density of water (D_{H2O})
- What is Specific Gravity of Copper Cu, when its density is 9g/cm3?
- $SG_{copper} = D_{Cu} / D_{H2O} = 9\ g/cm3 / 1\ g/cm3 = 9$
- Specific Gravity is always a number (without units).
- Density always has units (mass divided by volume).
- Specific Gravity has the same numerical value of density.

Piezoelectricity & Double Refraction

		
Quartz Crystal	Piezoelectric Effect of Quartz	Double Refraction