CE 2141
ENGINEERING GEOLOGY AND GEOMORPHOLOGY

Lecture 02 – Minerals and Their Properties

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A part of this lecture is from Afifa mam, DWRE, BUET

Where do we see Minerals?


Himalayan Pink Salt


Marble Table

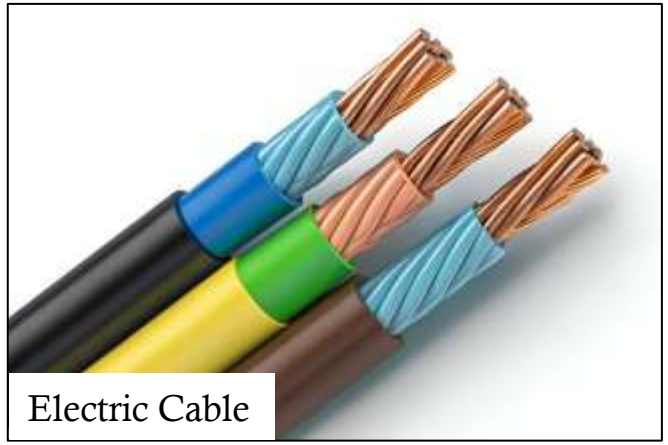

Pencil


Halite

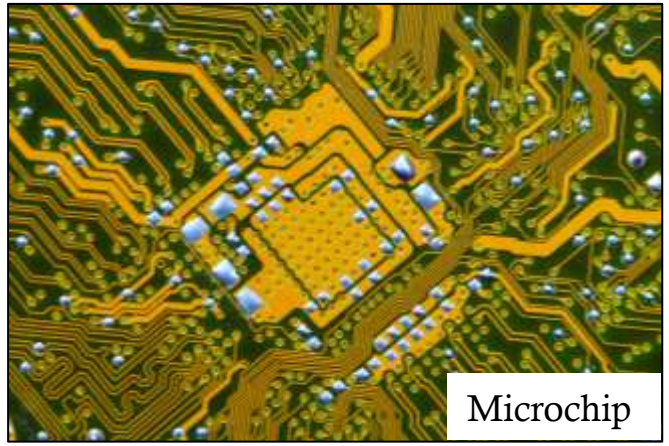

Calcite


Graphite

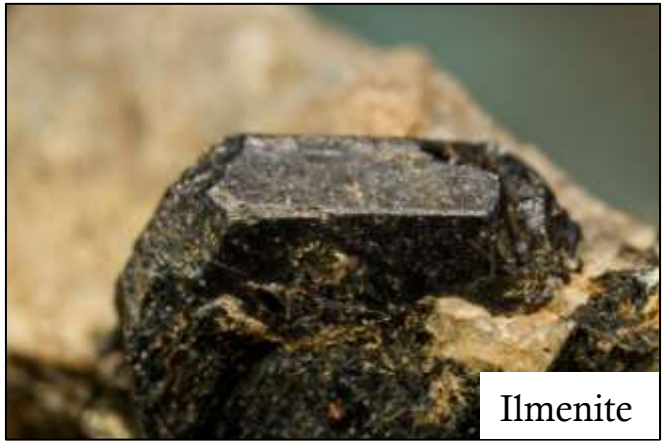
Where do we see Minerals?


Electric Cable


Paint


Microchip


Chalcopyrite


Ilmenite


Silicon Sand

What are Minerals?

To meet the definition of "mineral" used by most geologists a substance must meet five requirements:

1. naturally occurring
2. inorganic
3. solid
4. definite chemical composition
5. ordered internal structure

Properties of Minerals?

1. <u>IT MUST BE naturally occurring</u> – This means that the mineral is not human-made. There are examples of minerals that occur naturally but can now be manufactured artificially. However, a substance that is manufactured artificially and does not occur in nature would not qualify as a mineral.

For instance, Steel is not a mineral because it is an alloy produced by people.

2. <u>IT MUST BE of inorganic compounds</u> – Inorganic means that minerals are not alive and never were alive. Therefore, anything made of plant material would not qualify as a mineral. For example, coal, which is made from dead plants, is not a mineral.

For example, Wood and pearls are made by organisms and thus are not minerals.

Properties of Minerals?

3. <u>IT MUST BE a solid element or compound</u> – All minerals are solid and occur as solids at normal temperatures and pressures that exist on the surface of the Earth.

Thus, mercury, which is a liquid at room temperature, is not a mineral. Water is also, not a mineral, but its solid form, ice, is a mineral. So are snowflakes.

4. <u>IT MUST HAVE a regular internal crystal structure</u> – The atoms that make up a mineral are arranged in a regular, repeating, orderly pattern. You cannot see this pattern with the naked eye. There are some solids that look like solids but do not have a regular internal structure.

For example, glass is not a mineral because the atoms that make up glass are not arranged in a regular pattern. Glass is a super-cooled liquid. Given enough time, glass will flow. If you look at the windows of really old buildings, you may notice that the bottom of the window is thicker than the top of the window.

Properties of Minerals?

5. IT MUST HAVE a definite chemical composition – All minerals have a regular chemical composition. Sometimes this composition is made up of just one element, like gold. More commonly, minerals are made of many elements called compounds. Most minerals are made up of various combinations of only 8 elements: Oxygen, silicon, aluminum, sodium, potassium, chlorine, iron, and magnesium.

For example, the mineral halite (known as "rock salt" when it is mined) has a chemical composition of NaCl. It is made up of an equal number of atoms of sodium and chlorine.

Difference between Minerals and Rocks

Minerals and Rocks both are naturally produced solid.

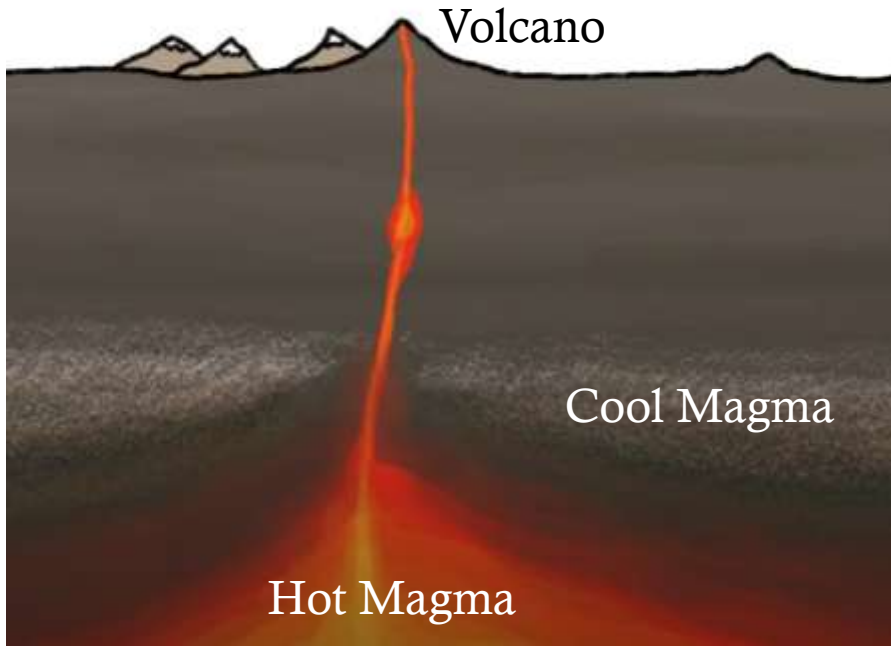
But!!!

- Rocks are made up of one or more minerals!!!
- The reason why some rocks have more than one color, is because they contain more than one mineral.
- Also, some rocks are made of other things, such as sand and pebbles, in addition to minerals.

How Minerals are formed

1. Cooling of Magma and Lava:

- As magma cools, atoms begin to bond and form solid crystals.
- The slower the cooling, the larger the crystals (e.g., granite).
- Common minerals: feldspar, mica, quartz, olivine



How Minerals are formed

2. Precipitation from Solution (Chemical Process):

- When a solution becomes saturated with ions, minerals begin to precipitate (settle out).
- These ions usually come from minerals that dissolved earlier through weathering.
- Occurs in evaporating lakes, oceans, hot springs.
- Example: Halite (rock salt) from evaporating seawater

How Minerals are formed

3. Metamorphosis of Minerals Due to Heat and Pressure:

- Existing minerals recrystallize or form new ones due to intense pressure and temperature, without melting.
- This happens deep inside the Earth during mountain building or tectonic collision.
- Example: Graphite forming from carbon, Garnet forming in schist

How can we identify minerals?

Physical properties:

- ✓ Color
- ✓ Streak
- ✓ Luster
- ✓ Hardness
- ✓ Crystal form
- ✓ Cleavage
- ✓ Fracture
- ✓ Density
- ✓ Distinctive

Physical Properties of Minerals

Color:

– It is the most obvious property of mineral but might be misleading often.

– Different colors may result from the percent presence of impurities

– Bright green color of Malachite, pale yellow color of sulfur, Iron black color of Magnetite, Galena in lead grey, minerals containing aluminum are light colored, purple, deep red or brown

Example: Quartz

Physical Properties of Minerals

Streak:

- Streak is the color of a mineral when it is powdered (used for metallic minerals)
- Color of a mineral may vary but streak is constant
- Obtained by scratching a mineral on a piece of unglazed porcelain.

Example:
-Hematite: Reddish brown to black
-Limonite: Yellowish brown

Example: Hematite

Physical Properties of Minerals

Luster:

A property that defines how a mineral surface reflects light

– Two major types: Metallic luster & Non-metallic luster

Metallic example: **Galena**

Non-metallic example: **Orthoclase**

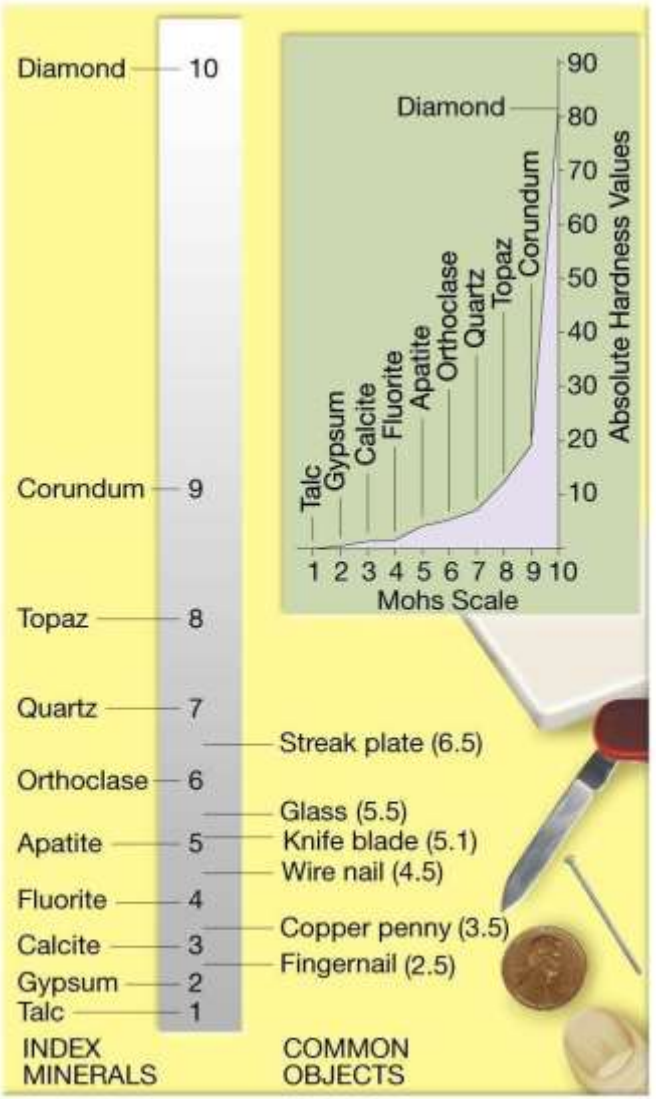
Physical Properties of Minerals

Hardness:

– A property that defines how easy it is to scratch a mineral

– Mohs Scale of Hardness

- relative scale
- consists of 10 minerals, ranked 1 (softest) to 10 (hardest)



Physical Properties of Minerals

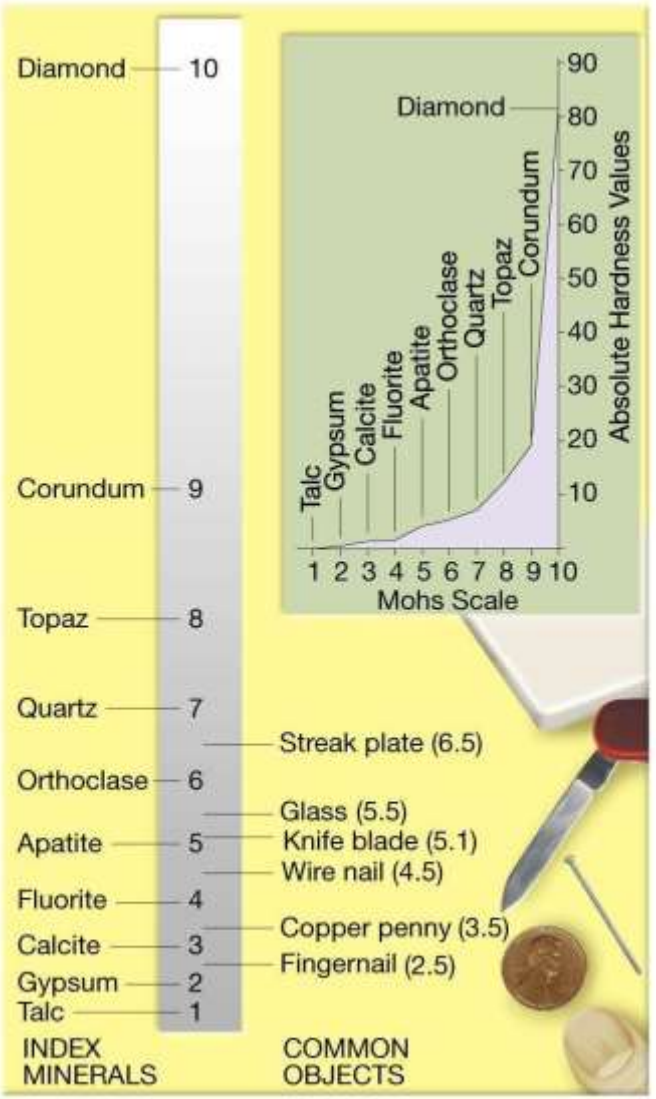
Mohs Scale of Hardness

Hardest (10) – Diamond

Softest (1) – Talc

Common objects:

- Fingernail (2.5)
- Copper penny (3.5)
- Wire nail (4.5)
- Glass (5.5)
- Streak plate (6.5)



Physical Properties of Minerals

Crystal Form (or shape):

– external expression of a mineral's internal atomic structure

– planar surfaces are called crystal faces

– angles between crystal faces are constant for any particular mineral.

Quartz

Physical Properties of Minerals

Cleavage vs. Fracture:

– They both are the way a mineral breaks.

– Cleavage: It is the tendency of a mineral to break along smooth planes parallel to zones of weak bonding.

– Cleavage and Fracture both describe a tendency of a mineral to break.

– In cleavage, a mineral may split apart along various smooth planes. These smooth planes are parallel to zones of weak bonding.

– On the other hand, fracture breaks a mineral along the curved surface with irregular shapes.

Physical Properties of Minerals

Cleavage is described by:

– Number of planes

– Angles between adjacent planes

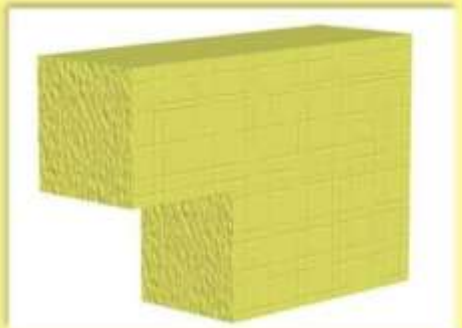
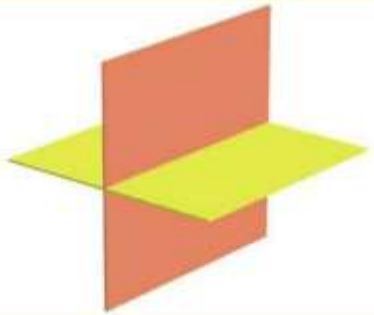
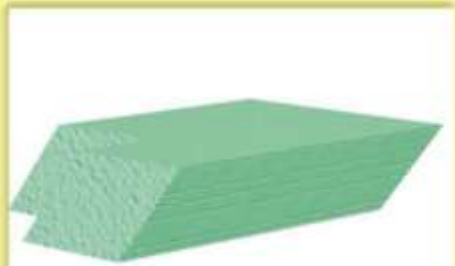
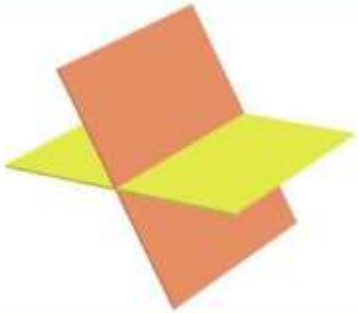
– These are constant for a particular mineral

Cleavage 1 Direction

Number of Cleavage Directions	Sketch	Illustration of cleavage directions	Example
1			mica 

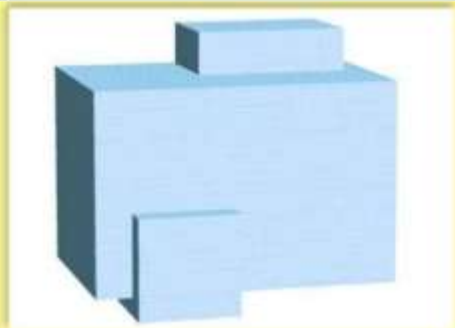
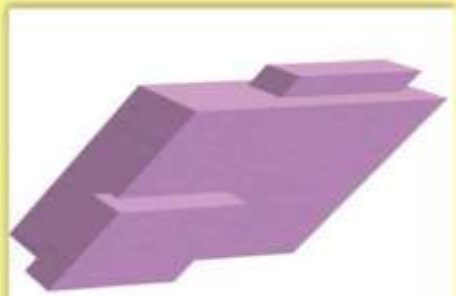
Physical Properties of Minerals

Cleavage 2 Directions

Number of Cleavage Directions	Sketch	Illustration of cleavage directions	Example	
2 at 90°				orthoclase
2 not at 90°				amphibole

Physical Properties of Minerals

Cleavage 3 Directions

Number of Cleavage Directions	Sketch	Illustration of cleavage directions	Example	
3 at 90°				halite
3 not at 90°				calcite

Physical Properties of Minerals

Cleavage 4 Directions

Number of Cleavage Directions	Sketch	Illustration of cleavage directions	Example
4			

fluorite

Physical Properties of Minerals

Fractures:

– Fracture in minerals refers to how a mineral breaks when it doesn't follow a cleavage plane, resulting in an uneven, irregular surface.

– Unlike cleavage, which produces smooth, flat surfaces along planes of weakness, fracture results in a variety of textures and shapes depending on the mineral's internal structure and the applied force.

Physical Properties of Minerals

Density:

– mass of a mineral divided by volume of the mineral
– metallic minerals tend to have higher densities than non-metallic minerals

Physical Properties of Minerals

Distinctive properties:

– taste (halite tastes salty)

– feel (talc feels soapy, graphite feels greasy)

– magnetism (magnetite attracts a magnet)

– double refraction (calcite when placed over printed material, letters appear doubled)

– smell (sulfur smells like rotten eggs)