Minerals

Important role in forming rocks and shaping Earth’s surface

What is a mineral?

It is a naturally occurring inorganic substance which has a definite chemical composition and a definite crystalline structure with a repeated pattern.

Opposite of naturally occurring = man-made

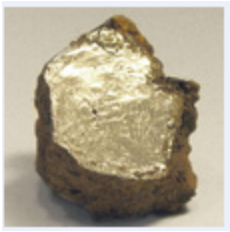
Opposite of inorganic = organic

Opposite of definite chemical composition = random composition

What causes minerals to have different physical properties?

Their internal arrangement of atoms… arranged in regular geometric patterns

Two minerals which have the same chemical composition but different properties:



Graphite:
Composition = Carbon
Color = Silver-gray to black
Streak = black
Hardness = 1-2
Crystal System = Hexagonal
Transparency = Opaque
Specific Gravity ~2
Luster = Metallic
Cleavage 1,1-basal
Fracture = Conchoidal

Diamond:
Composition = Carbon
Color = Colorless, white, yellow, and brown, gray, and black
Streak = white
Hardness = 10
Crystal System = Isometric
Transparency = Transparent to opaque
Specific Gravity ~3 - 3.5
Luster = Greasy luster
Cleavage 1, octahedral
Fracture = Conchoidal

Rock forming Minerals with Variations in Mineral Composition

Page 88 Textbook: "Chemical composition can vary slightly depending on the temperature at which the mineral crystallizes."
ex. Quartz with iron is yellow/brown color
Amethyst = Silicon dioxide. Its purple coloring is usually caused by impurities of iron or manganese compounds.

S.No	Name of Mineral	Chemical Composition
1	Quartz	SiO_2
2	Feldspar	$NaAlSi_3O_8 - CaAl_2Si_2O_8$
3	Pyroxene	$(Mg,Fe)_2Si_2O_6$ & $Ca(Mg,Fe)Si_2O_6$
4	Amphiboles	Na, Ca, Mg, Fe, Al silicates
5	Olivines	$(Fe,Mg)_2Si\ O_4$
6	Mica	$K(Fe,Mg)AlSi_3O_{10}$
7	Calcite & Dolomites	$CaCO_3$
8	Clays	$CaMg(CO_3)_2$
9	Magnetite	Fe_3O_4
10	Pyrites	$FeSO_4$

Variations in Mineral Composition

Minerals can have different appearances:

- ➢Due to slight changes in chemical compositions
  - Due to different growth patterns
    - Due to temperature differences during the mineral crystallization process.

“Rock-Forming Minerals” page 89

How do minerals form from:

Magma?

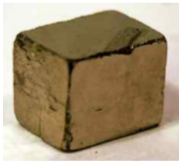
Supersaturated Solutions?

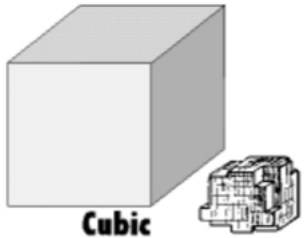
Evaporation of solutions in which they are dissolved?

The Main Physical Properties Used to Identify Minerals:

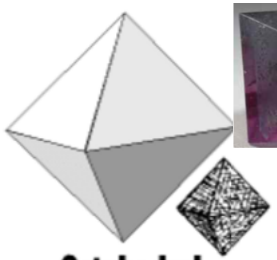
• Crystal form	• Streak
• Luster	• Texture
• Hardness	• Density
• Cleavage	• Specific Gravity
• Fracture	• Color

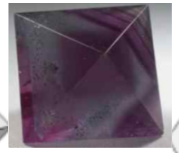
Physical Property of Identification: Crystal Form



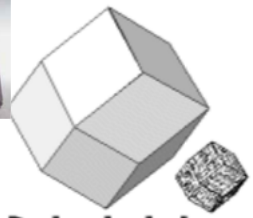


Cubic
(3 cleavages, 6 faces at right angles; e.g. halite)

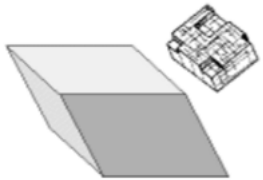




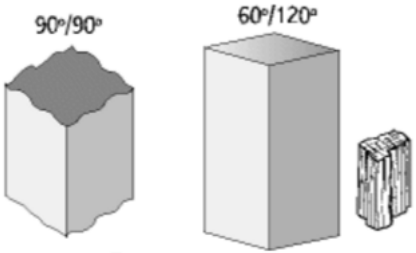
Octahedral
(4 cleavages, 8 faces; e.g. fluorite)



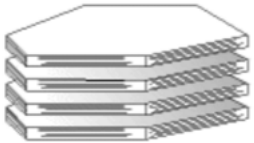
Dodecahedral
(6 cleavages, 12 faces; e.g. sphalerite)



Rhombohedral
(3 cleavages, 6 faces not at right angles; e.g. calcite, dolomite)



Prismatic
(2 cleavages, 4 faces of many possible angles; third side fractures irregularly; e.g. pyroxene, amphibole, feldspar)



Basal
(1 cleavage, 2 faces; e.g. biotite, muscovite, chlorite)

Physical Property of Identification: Luster

Luster: how light reflects off a mineral

Metallic = looks like a metal

Metallic Luster - Pyrite

Non-metallic = looks dull, pearly, silky, earthy, waxy, glassy, greasy or brilliant

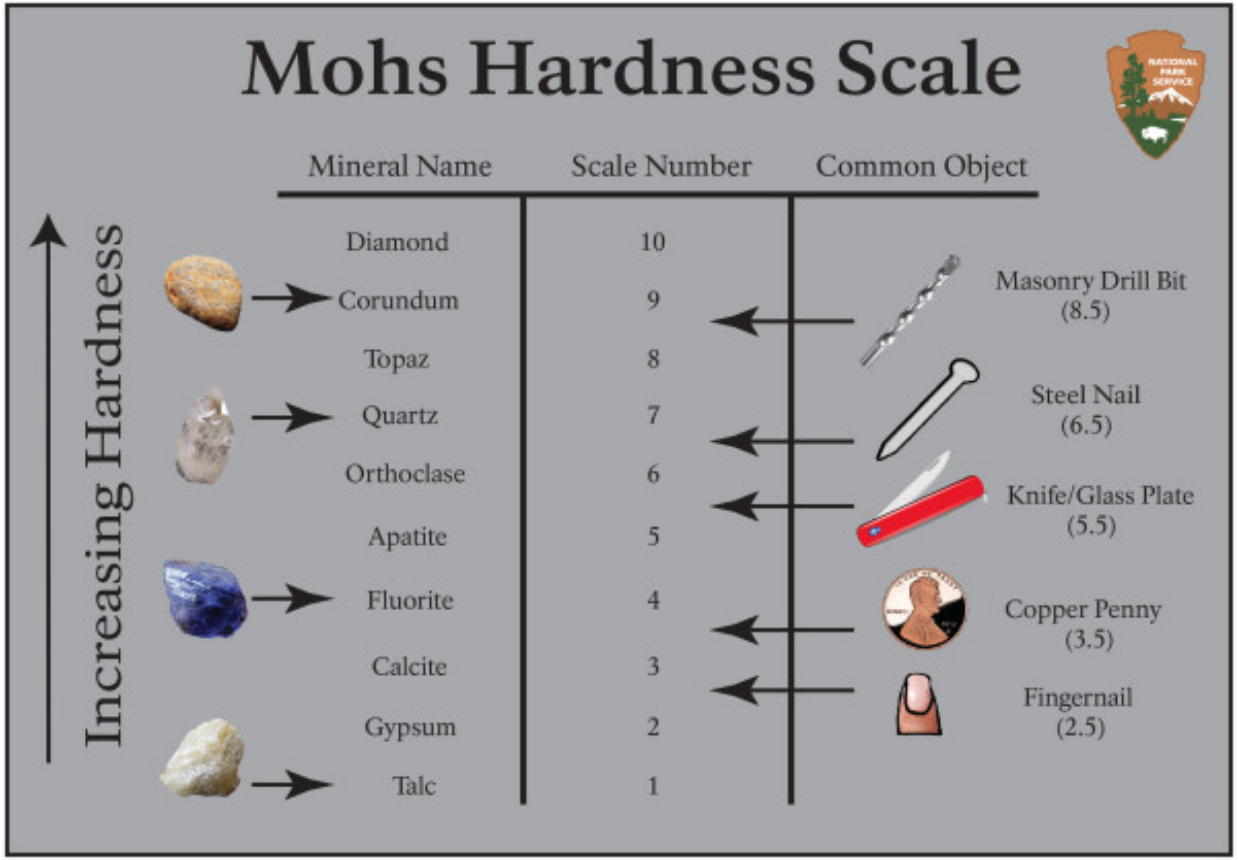
Calcite

Kaolinite

Differences in luster caused by differences in the chemical compositions of minerals

Physical Property of Identification: Hardness

MOHS HARDNESS	MINERAL	IMAGE
01	TALC	
02	GYPSUM	
03	CALCITE	
04	FLUORITE	
05	APATITE	
06	FELDSPAR	
07	QUARTZ	
08	TOPAZ	
09	CORUNDUM	
10	DIAMOND	



Physical Property of Identification:
Cleavage and Fracture

The mineral breaks in a predictable pattern because of its arrangement of atoms.

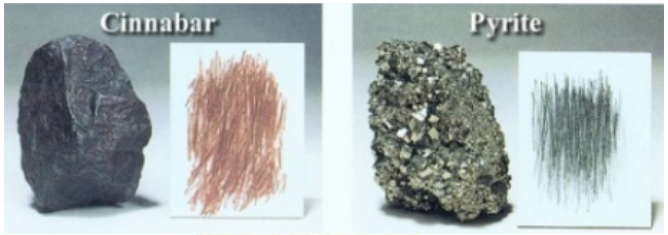
Cleavage: if a mineral breaks or splits apart easily and evenly with smooth surfaces in certain directions (creates flat planes)

Fracture: if a mineral breaks with a rough or jagged surface

Physical Property of Identification: Streak

Streak: more reliable than color

Mineral rubbed against an unglazed ceramic tile (streak plate)



3) Streak

Color can fool you (ex- pyrite)

Streak test will help identify even if
It looks like a different mineral

Scratching mineral sample across
unglazed white tile (streak plate)
produces streak of color
(not always same as mineral itself in color)

Pyrite- greenish-black or brownish-black streak
Gold- yellow streak

Physical Properties of Identification: Color

Presence of trace elements or compounds within a mineral

Quartz with different amounts of iron

Red Jasper

Purple amethyst

Orange Citrine

Milky quartz = trapped bubbles of gas and liquid

Rose quartz with manganese or titanium

Special properties of Minerals

Density and Specific Gravity

D = Mass/Vol

Specific Gravity = ratio of the mass of a substance to the mass of an equal volume of water at $4^{o}C$

http://www.mineralogy4kids.org/mineral-properties/specific-gravity

Special Properties

Double refraction = see two images

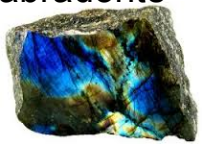
Calcite

Effervescence= reaction to hydrochloric acid

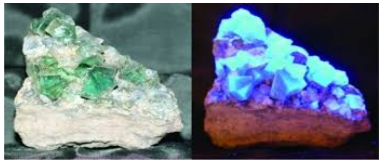
Magnetite

Magnetism

Labradorite



Fluorite



Iridescence= color from bending of light rays

Calcite

Fluorescence= Glow in dark from exposure to UV light

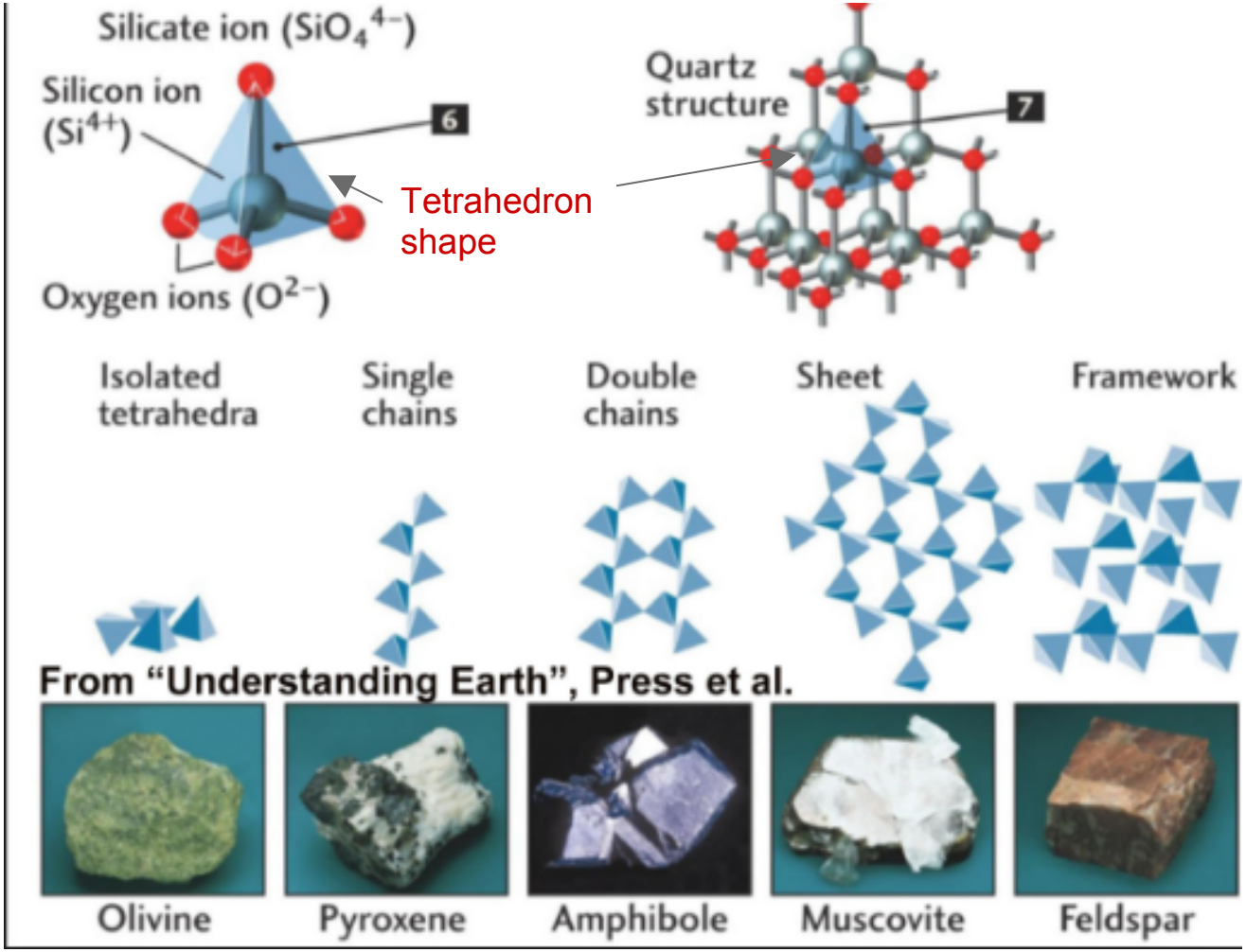
Mineral Group: Silicates

Oxygen and silicon are two elements, by mass, that make up the greatest percentage of the Earth's crust.

Combine to form compounds called: silicates $(SiO_4)^{-4}$

Silicates make up approximately 96 percent of the minerals present in Earth's crust

Ex. feldspar and quartz


Silicate ion (SiO_4^{4-})
Silicon ion (Si^{4+})
6
Oxygen ions (O^{2-})
Tetrahedron shape
Quartz structure
7
Isolated tetrahedra
Single chains
Double chains
Sheet
Framework
From "Understanding Earth", Press et al.
Olivine
Pyroxene
Amphibole
Muscovite
Feldspar

Mineral Group: Carbonates

CO_3^{2-}

➢Carbon bonds with three oxygens to form mineral group carbonate

➢One or more metallic elements connected to carbonate

➢Carbonate class of minerals

➢Transparent

➢lightly -colored with a white streak

➢Average to above average specific gravity

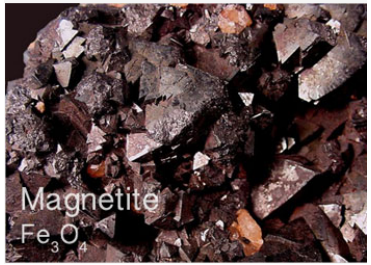
➢Soft with good to perfect cleavage

Mineral Group:

Oxides

The minerals that make up the oxide class include those in which oxygen is combined with one or more metals. The minerals are very diverse in their physical properties: they can be quite hard (H=9) and quite soft (H=5) and the colors can range from black to very colorful. This is all due to the abundance of oxygen in the Earth's crust and the many opportunities that exist for single oxygen ions to combine with various elements in different ways.

Within the oxide class are several minerals of great economic importance. These include the chief ores of iron, chromium, manganese, tin, and aluminum.

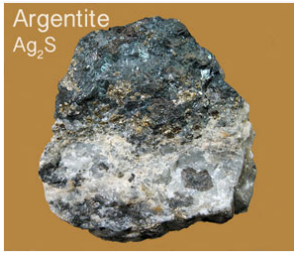


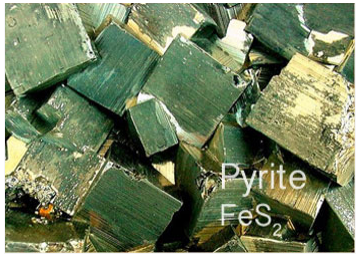
Mineral Group:

Sulfides

The minerals that make up the sulfide class are composed of metal cations (+2 charge) combined with sulfur. The sulfides form an important group of minerals which includes the majority of the ore minerals for iron, copper, nickel, lead, cobalt, zinc, and silver.

Most of the minerals in this class allow light to transmit through them (are opaque) with distinctive colors and colored streaks. The majority of these minerals in this class are also metallic, tend to have high densities, low hardness, exhibit electrical conductivity, and black or dark-colored streaks. They form in igneous environments.

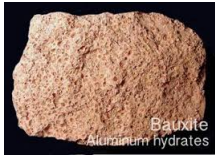




Economic Minerals

Ores: naturally occurring solid material from which a metal or valuable mineral can be profitably extracted.

Iron from Hematite



Aluminum ore bauxite

Titanium ilmenite

Gems: valuable minerals prized from their rarity and beauty