Chapter 4 - Minerals

Question of the Day

What are some minerals you know of or use?

Activity: Match the mineral with its product

PRODUCTS THAT ARE MADE FROM MINERALS;

COPPER WIRE, PENNIES, NAILS, MAGNETS, MAKE-UP, POP CANS, COMPUTER CHIPS, CARS, CELL PHONES, ETC.

Objectives

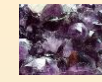
1. Define a mineral, including the 5 characteristics that all minerals have. In addition, I can tell whether the following 3 substances are minerals or not, and why: salt, sugar, coal.
2. Describe how minerals form. This means I can:
   A. List the two types of liquids that minerals form from and describe why solidification occurs.
   B. Describe the conditions necessary for formation of large crystals with well-defined shapes.
3. Identify the most common elements and mineral types in Earth's crust. This means I can:
   A. List the two most common elements in Earth's crust.
   B. Know the composition of the following categories of minerals: silicates, carbonates.
      i. In addition, I know which of those categories is most common and which is least common.
      ii. I can explain why some silicates are light in color and others are dark. (Non-ferromagnesian vs. Ferromagnesian)
   C. Classify the following minerals into the mineral categories listed above in (b): quartz, feldspar, olivine, pyroxene, biotite, calcite.

Objectives

4. Determine the identification of a mineral by performing the following tests: color, luster, texture, streak, hardness, cleavage & fracture.
   A. Define or explain each of the tests listed above.
   B. State which of the tests are least reliable and explain why.
   C. Using the appearance of a given mineral, determine its luster as metallic or nonmetallic.
   D. Using the appearance of a give mineral, determine whether it shows cleavage or fracture.
   E. Use Moh's Scale to determine the hardness of a mineral and to predict whether a mineral will be scratched or not.
5. When given a mineral and testing materials, identify magnetite, graphite, chalcopyrite, galena, feldspar, quartz, calcite, biotite, hematite, olivine.

What is a Mineral?

Sec 4.1

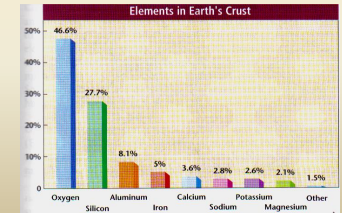


Earth's crust is composed of 99% minerals

1. These are all made from different combinations of the same 8 elements.

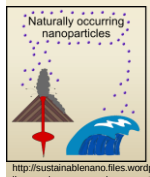
Mineral = A naturally occurring, inorganic solid, with a specific chemical composition and a definite crystalline structure

Examples of minerals: graphite, quartz, copper, diamonds, rubies, sapphires

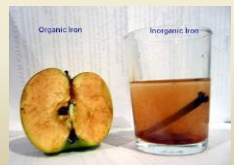


The 5 Common Mineral Characteristics
Explained further

1. **Naturally** occurring
   - Minerals are formed by natural processes, NOT needing to be made in a lab
2. **Inorganic** means minerals are NOT a living organism and do NOT require a living organism to make them
3. **Solid**



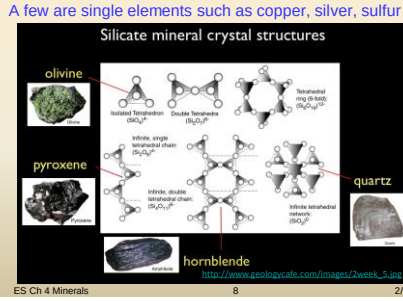
http://sustainablenano.files.wordpress.com/2013/03/naturallyoccurringvsmanmadenanoparticles.png



http://thebestwaterfilter.blogspot.com/2010/02/minerals-organic-and-inorganic.html

Specific Composition

4. **Specific composition**
   - Most minerals are made of compounds with elements in a specific ratio
   - Example: Formula for table salt is _____ which is a 1:1 ratio
   - Example: While water is NOT a solid and NOT a mineral, its formula is _____which is a 2:1 ratio vs. what is H_2O_2?
   - A few are single elements such as copper, silver, sulfur

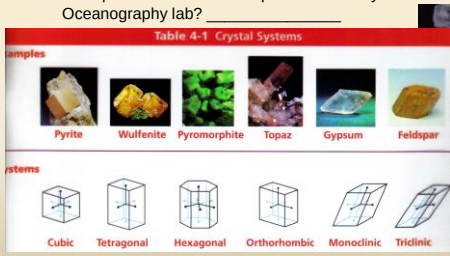


http://www.geologycafe.com/images/2week_5.jpg

Crystalline Structure

5. Definite **crystalline structure**
   - The atoms in minerals are arranged in regular geometric patterns. **(BUT,** well-defined shapes are not seen unless they grow **slowly** in **open space**)
   - Example: What was the shape of the salt crystals in the Oceanography lab? _____

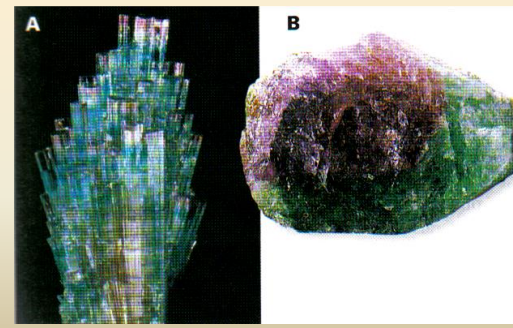
w.bigfoto.com/miscellanetos-16/salt-crystals-



TT #9 & Table 4-1 p. 78 Crystal Systems

Fig 4-2 p. 79 Crystal Definition Depends on Space

Based on observations of the 2 pictures below, both of the same type of mineral, what can you infer about the crystal formation in Picture A vs. B?



Inorganic or Organic?

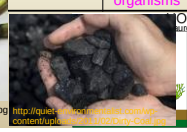
Are the following inorganic or organic? Mineral or non-mineral?

http://blog.smartbear.com/devops/a-taste-of-salt-like-puppet-chefspot-it-doesnt-suck/

http://blog.qualityd.com/wp-content/uploads/luxury_holidays_vietnam1.jpg

http://www.agricorner.com/wp-content/uploads/2014/04/Sugarcane.jpg

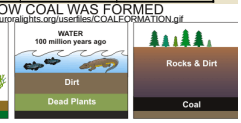
	Where found or made?	Inorganic Or Organic	Mineral Or Non-mineral
Salt	Ocean water	Inorganic	Mineral
Sugar	Plants	Organic	NON-mineral
Coal	Remains of living organisms	Organic	NON-mineral



http://quiet-ocean.blogspot.com/wp-content/uploads/2010/04/Dirty-Coal.jpg

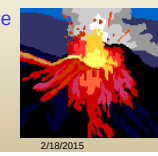
HOW COAL WAS FORMED

euroalights.org/userfiles/COALFORMATION.gif



Mineral Formation Occurs from Two Types of Liquids - Magma

1. **Minerals can form from the cooling of magma**
   - A. **Magma** is the molten material found beneath Earth's surface
   - B. If the magma has more time to cool the atoms have time to arrange themselves, which results in a larger crystal
     - Magma cools slowly deep within the earth
   - C. If the magma cools off rapidly the crystals will be smaller.
     - Magma cools rapidly near earth's surface or when volcano erupts –rapid cooling if contacts air or water
   - D. Show granite vs. rhyolite for grain size



Minerals From Solution

2. **Minerals can also form from a supersaturated solution**
   a. A certain amount of water can only dissolve so much of a solid before the water becomes saturated
   b. In nature, if a solution becomes **supersaturated**, or overfilled, mineral crystals begin to form. (AKA Precipitation = Solid "falls" out of solution)
   c. **Evaporation** can lead to supersaturated solutions, leaving mineral crystals behind.
      i. This can occur along ocean coastlines and along salt lakes as water level decreases.
      ii. It is similar to the lab in Oceanography: "Can Ocean Salts Come from Land Masses". As the water evaporated, the salt water became concentrated or "supersaturated" and salt crystals formed – growing bigger and bigger as more water evaporated.


http://lib.store.yahoo.net/lib/yhst/4283397017122qoiadova/skin-care-dead-sea-salts.jpg

Mineral Identification – HOW???

Question of the Day:
What characteristics can be used to differentiate minerals?

Mini-Lab

Goal:

Find ways to sort these minerals out so that you can tell each mineral apart from each other.

Section 4.2 Mineral Identification Tests Geologists Use

Question of the Day: Now that you've developed a means to differentiate minerals, how is it really done?

6 Main Tests to Identify Minerals

1. Color
2. Luster
3. Texture
4. Streak
5. Hardness
6. Cleavage/Fracture

Color

1. **Color**

- Sometimes varies due to trace elements within an element
  Example. Quartz comes in many colors –
  Amethyst purple – Iron,
  Rose color – Titanium & Manganese
- Color is one of the least reliable methods to mineral identity
- Both sapphires & rubies are made of corundum:
  Sapphire blue - Iron & Titanium, Ruby - Chromium

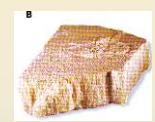

http://www.gemcuttingservice.com/Center-fusedQuartzColorChartA.JPG


http://www.fieldgemology.org/images/FE15/Sapphire_ruby_zircon.jpg


http://media-cache-ec0.pinimg.com/236x/96/16/55/96165595e5d09542d755406c17dac2b5.jpg

Luster

2. **Luster** = the way a mineral reflects light from its surface
   - Luster is described as metallic or non-metallic.
   - Metallic example: galena, magnetite, chalcopyrite
   - Nonmetallic examples: feldspar, quartz, biotite
   - Differences in luster are caused by differences in chemical composition



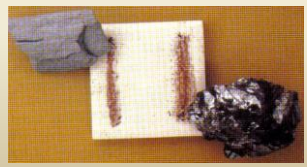

http://www.groupes.polymtl.ca/glq1100/mineraux/chalcopyrite/chalcopyrite.jpg


http://rusoar.es365.pbworks.com/f/1236545389/BIOTITE.jpg

Texture & Streak

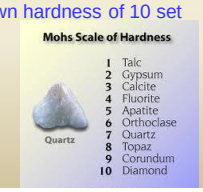
3. **Texture** = Describes how a mineral feels
   - The texture might be described as smooth, rough, ragged, greasy, soapy, soft
4. **Streak** = The color of a mineral when it is broken up & powdered
   - A mineral rubbed across an unglazed porcelain plate will sometimes leave a powder streak on the surface
   - There are times when the streak of a mineral does not match its external color
   - Streak color is constant, but external color varies due to trace elements

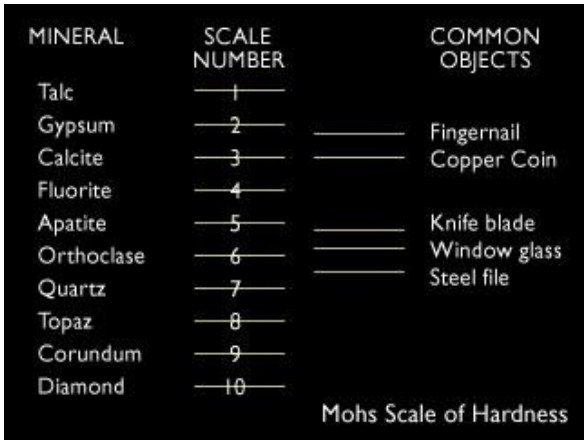




Hardness

5. **Hardness** =Measure of how hard a mineral is & how easily it can scratch or be scratched
   - There is a Moh's Hardness Scale that is used with this test
   - Hardness is one the most reliable tests if mineral ID
   - It is determined by the arrangement of mineral's atoms
   - Harder minerals will scratch softer minerals
   - Softer minerals cannot scratch harder minerals
   - Minerals are compared to the known hardness of 10 set minerals
     - #1 is softest (talc)
     - #10 is hardest (diamond)





TT #10 or Table 4-3 p 86 Mohs Hardness Scale

Table 4-3 Mohs Hardness Scale

	Hardness	Hardness of Common Objects
Talc	1 (softest)	
Gypsum	2	fingernail (2.5)
Calcite	3	piece of copper (3.5)
Fluorite	4	iron nail (4.5)
Apatite	5	glass (5.5)
Feldspar	6	steel file (6.5)
Quartz	7	streak plate (7)
Topaz	8	scratches quartz
Corundum	9	scratches topaz
Diamond	10 (hardest)	scratches all common materials

Examples using the table. Which will scratch the other?

_____ VS. _____

_____ VS. _____

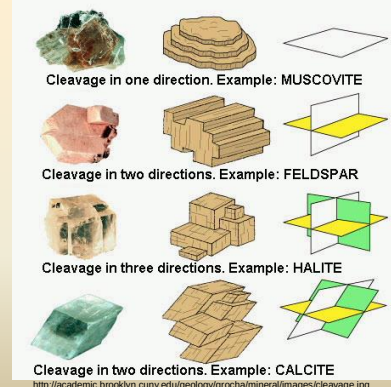
_____ VS. _____

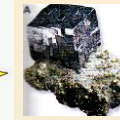
Cleavage and Fracture

7. **Cleavage/Fracture** = Describes how a mineral breaks
   - Atomic arrangements also determine how a mineral will break
   - Minerals break where atomic bonding is weak
   - A mineral that splits relatively easily and evenly along one or more flat planes to have cleavage
   - Minerals that break in rough or jagged edges are said to have fracture

Figure 4-11 Mica has perfect cleavage in one direction (A).

Diagram – Cleavage in Multiple Directions





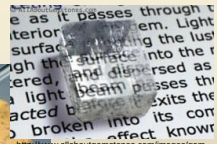
http://academic.brooklyn.cuny.edu/geology/grocha/mineral/images/cleavage.jpg

Special Properties

7. **Special Properties** unique to a specific mineral can sometimes be helpful in identification.
   A. Calcite:
      i. Double refraction: Mineral bends light, causing a double image.
      ii. Fizzes and is dissolved by acid. (Acid rain can dissolves calcite & form caves.) Reaction releases CO_2
   B. Magnetite is <u>magnetic</u>


http://www.minerals.net/images/lodestone-magnetite-magnetic.jpg


http://www.dinojim.com/Geology/GeoBasics/Images/ReactstoAcid.jpg


http://www.allaboutgemstones.com/images/gem-birefringence_double_refraction_calcite.jpg

Mineral Groups/Classification

Based on observations of the table below, make an inference about what determines which group a mineral belongs in. Explain.

Mineral Group	Major Minerals	Chemical Formula
Carbonates	Calcite Dolomite	$CaCO_3$ $Ca\ Mg\ (CO_3)_2$
Silicates	Quartz Potassium Feldspar Biotite Pyroxene Amphibole Olivine	SiO_2 $KalSi_3O_8$ $K(MgFe)_3AlSi_3O_{10}\ (OH_2)$ $(Mg, Fe)_2Si_2O_6$ Variable $(Mg, Fe)_2\ SiO_4$
Sulfides	Galena Pyrite Sphalerite	PbS FeS_2 ZnS
Oxides	Hematite Magnetite Corundum	Fe_2O_3 Fe_3O_4 Al_2O_3
Sulfates	Gypsum Anhydrite	$CaSO_4 \cdot H_2O$ $CaSO_4$
Halides	Halite Fluorite	NaCl CaF_2
Native Elements	Silver Gold Graphite/Diamond	Ag Au C

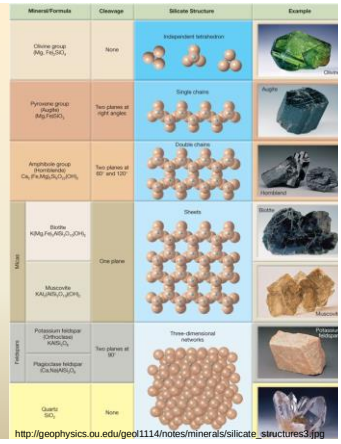
http://www.oncoursesystems.com/images/user/8552/388319/Minerals/commin.jpg

Silicates

The chart contains minerals of the Silicate Mineral Group.
Examine the chart:

1. **<u>Elements in all silicates</u>**: What symbols (elements) are present in ALL of the formulas?

2. **<u>Dark Colors:</u>** What symbols are present in the DARK colored silicates but not usually in the light colored silicates?


http://geophysics.ou.edu/geol1114/notes/minerals/silicate_structures3.jpg

Silicates & Dark Colored Silicates

1. **Silicates -** Made of <u>silicon, oxygen</u> and usually 1 or more other elements
   A. Silicates are the most <u>common</u> mineral , <u>96%</u> of the minerals in the crust
   B. **DARK-COLORED Silicates**
      - Lower amount of oxygen & silicon
      - High amount of <u>iron</u> & <u>magnesium</u> which cause dark color.
      - Called **<u>Ferromagnesian</u>** silicates. Why? Fe = <u>Iron</u> Mg = <u>Magnesium</u>
      - Examples of dark silicates HIGH in Fe and/or Mg:
        - Olivene
        - Pyroxene
        - Amphibole
        - Biotite

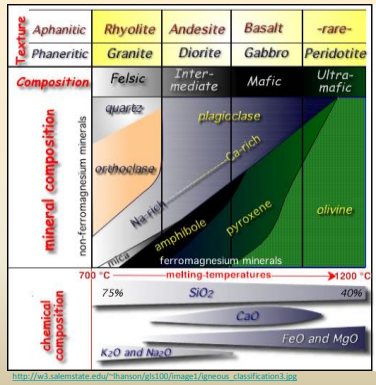

http://www.geologic.org/images/Minerologyminerals-windows2univers-Biotite.jpg

http://gsi.ir/Images/Training/BIOTITE.jpg


http://itc.gsw.edu/faculty/bcarter/physgeol/min/femag.jpg

Diagram – Chemical Composition of Silicates

- NOTE: Mineral colors & names
- Chemical % composition that correlates with those colors
- Preview names of rocks at top of table: minerals combine to make rocks.
- Rocks will be light or dark based on the percent of light & dark minerals in them



http://w3.salemstate.edu/~lhanson/gls100/image1/igneous_classification3.jpg

Light Colored Silicates

C. **LIGHT-COLORED Silicates**
   A. Highest amount of <u>Silicon (Si) & Oxygen (O)</u>
   B. High amount of <u>Potassium (K) & Sodium (Na)</u>
   C. Called **<u>NON - Ferromagnesian</u>** silicates. Why?
   _____
   D. Examples of LIGHT-colored Silicates: <u>Quartz & Feldspar</u>


http://www.pitt.edu/~cejones/GeoImages/1Minerals/1Igneous Minerals/Feldspars/FeldsparCleavages.jpg

Carbonates

2. **Carbonates**: made of Carbon (C) and oxygen and a metal
   a. **Example**: Calcite
   b. Carbonate = CO_3
   c. In rocks such as limestone & marble

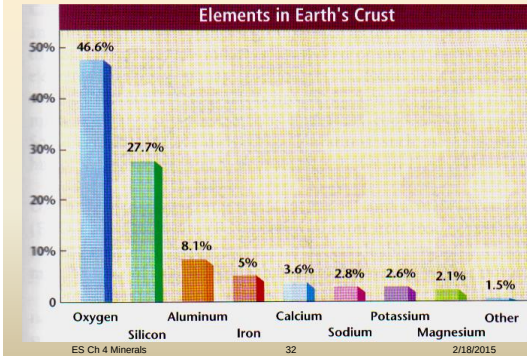
There are some carbonates that have distinctive colorations.
Fig 4-7 p. 83

Calcite | Azurite | Malachite



Fig 4-4 p. 81 Elements in Earth's Crust

NOTE: 8 elements combined make up 98.5% of Earth's crust, and they are the main elements in the minerals we've discussed.



Review & Test Prep

1. Streak vs. color – which is most reliable?
2. Types of luster?
   A. Show examples
3. 5 characteristics common to all minerals?
4. 5 tests to identify minerals?
5. Moh's scale
   A. Scale of what?
   B. Example questions on next slide
6. Test overview
7. Review & discuss objectives. Suggest writing outline or flash cards based on the objectives as a means to study.

Review: Table 4-3 p 86 Mohs Hardness Scale

Table 4-3 Mohs Hardness Scale

	Hardness of	Common Objects
Talc	1 (softest)	
Gypsum	2	fingernail (2.5)
Calcite	3	piece of copper (3.5)
Fluorite	4	iron nail (4.5)
Apatite	5	glass (5.5)
Feldspar	6	steel file (6.5)
Quartz	7	streak plate (7)
Topaz	8	scratches quartz
Corundum	9	scratches topaz
Diamond	10 (hardest)	scratches all common materials

1. What does it tell you if a mineral scratches glass?
2. Fluorite vs. topaz
3. What happens if mineral with hardness of 3.5 is rubbed against: Feldspar? Calcite?
4. A mineral scratches gypsum, but not apatite:
   A. What is its hardness range?
   B. How could you further determine its hardness?