Mineral Properties and Classification

Physical Geology – GEOL 100

Ray Rector - Instructor

http://www.rockhounds.com/rockshop/mineral_id/index.html

MINERAL INQUIRY

I. What are Minerals?

- ✓ How do minerals form?
- ✓ Where are minerals found?
- ✓ What types of minerals are there?
- ✓ The common rock-forming minerals?

II. Classification of Minerals – Mineral Groups

III. The Physical Properties of Minerals

- ✓ The most important properties?
- ✓ How do you determine these properties?

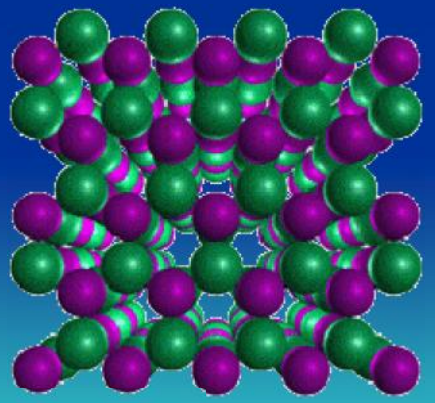
IV. Determining the Identify of a Mineral

What are Minerals?

Definition: any ***naturally-occurring***, homogeneous solid that has a distinctive internal ***crystalline*** structure, a ***definite chemical composition*** and a set of ***unique physical properties***. Minerals are usually ***formed by inorganic processes***.

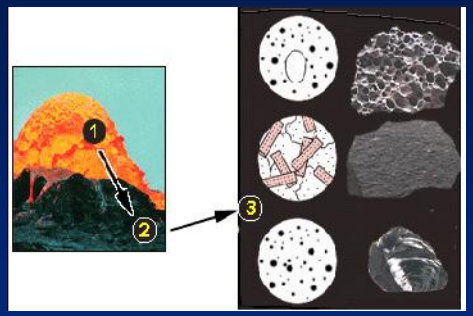
What Makes Each Mineral Unique?

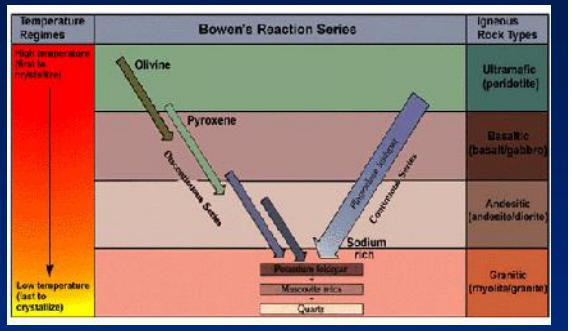
A mineral's crystal structure and chemical composition together determine the mineral's unique physical properties



How do Minerals Form?

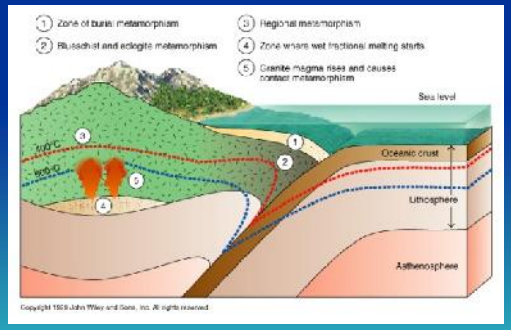
1) Crystallization from a cooling magma or lava

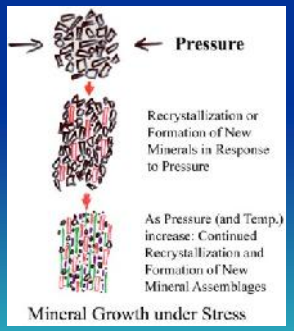


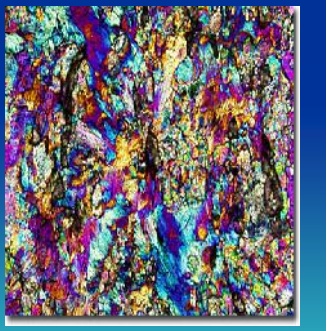


2) Crystallization from aqueous solutions

3) Crystallization from preexisting minerals







Where are Minerals Found?

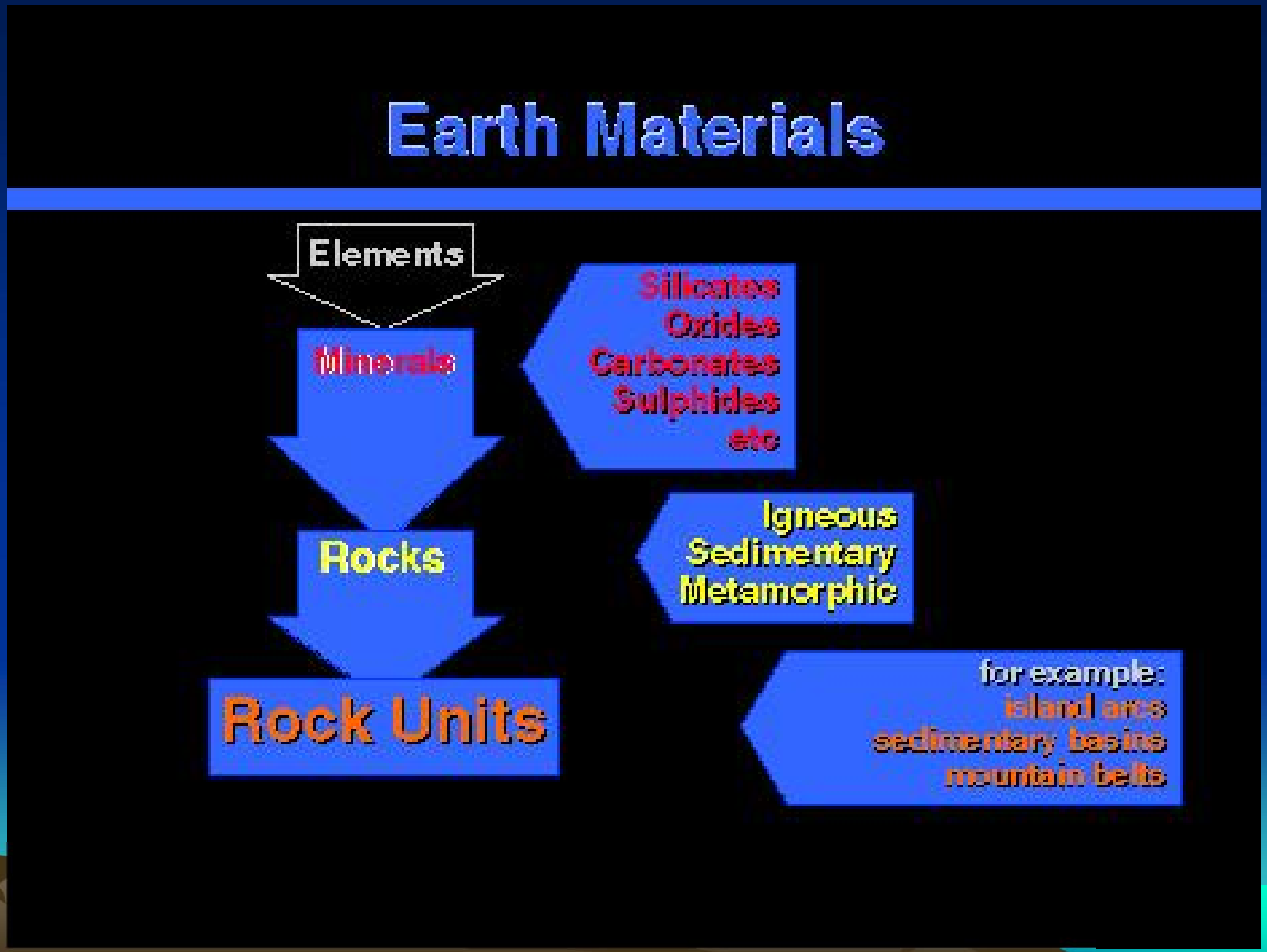
Short Answer = Everywhere!

1) Igneous Rocks
2) Sedimentary Rocks
3) Metamorphic Rocks
4) Sediment

Various Types of Minerals

- ✓ Over 4000 Species
- ✓ Grouped into Categories
- ✓ Silicate group is by far the largest and most important mineral group
- ✓ Only about 20 minerals make up 95%+ of all rocks
- ✓ Minerals are identified by their Chemical and Physical Properties

Common Rock-Forming Minerals



Common Silicate Mineral Groups

1) **Tetrasilicates**
   - ✓ Olivine and Quartz
2) **Pyroxenes**
   - ✓ Augite most common
3) **Amphiboles**
   - ✓ Hornblende most common
4) **Phylosilicates**
   - ✓ Micas and Clays
5) **Feldspars**
   - ✓ K-feldspar and Plagioclase

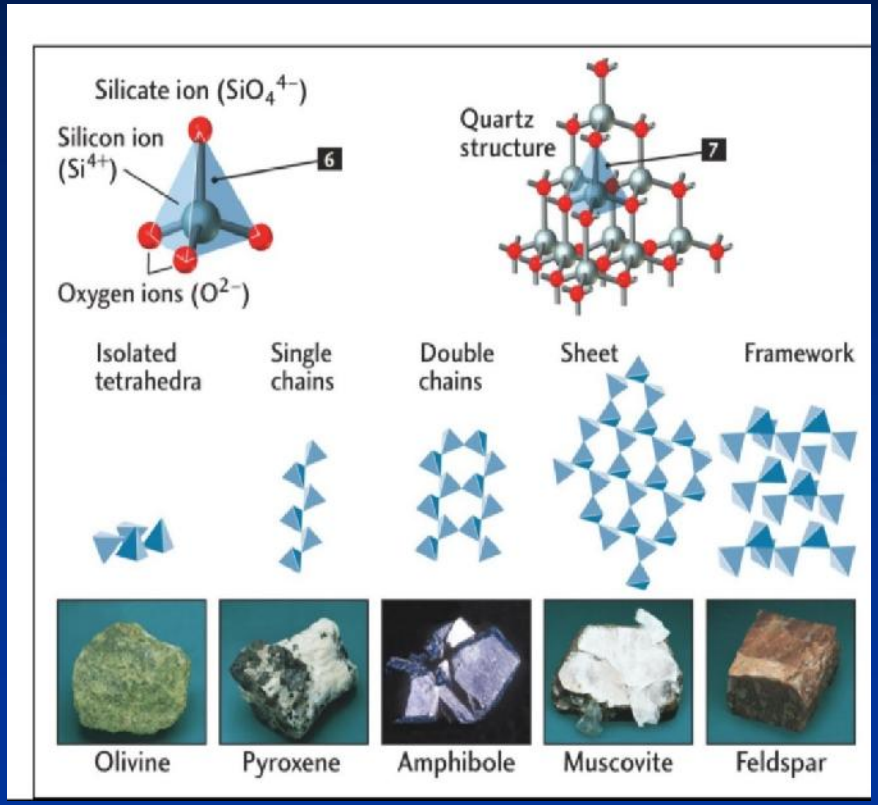
Mineral/Formula	Cleavage	Silicate Structure	Example
Olivine group $(Mg, Fe)_2SiO_4$	None	Independent tetrahedron	Olivine
Pyroxene group (Augite) $(Mg,Fe)SiO_3$	Two planes at right angles	Single chains	Augite
Amphibole group (Hornblende) $Ca_2(Fe,Mg)_5Si_8O_{22}(OH)_2$	Two planes at 60° and 120°	Double chains	Hornblend
Micas: Biotite $K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$	One plane	Sheets	Biotite
Micas: Muscovite $KAl_2(AlSi_3O_{10})(OH)_2$	One plane	Sheets	Muscovite
Feldspars: Potassium feldspar (Orthoclase) $KAlSi_3O_8$	Two planes at 90°	Three-dimensional networks	Potassium feldspar
Feldspars: Plagioclase feldspar $(Ca,Na)AlSi_3O_8$	Two planes at 90°	Three-dimensional networks	
Quartz SiO_2	None	Three-dimensional networks	Quartz

Common Rock-Forming Minerals

Rock-Forming Minerals

- Clay
- Quartz
- Calcite
- Olivine
- Dolomite
- Pyroxene
- Amphibole
- Biotite, Muscovite Micas
- Orthoclase, Plagioclase Feldspars

Although there are very many *rock types*, they are mainly built from one or more of 11 rock-forming minerals. Others are uncommon to rare.



Most-Common Rock-Forming Minerals

1) Quartz
2) Na- Plagioclase
3) Ca- Plagioclase
4) K-Feldspar
5) Hornblende (amphibole)
6) Augite (pyroxene)
7) Olivine
8) Tourmaline
9) Garnet
10) Biotite
11) Muscovite
12) Chlorite
13) Kaolin (type of clay)
14) Calcite
15) Dolomite
16) Gypsum
17) Halite
18) Magnetite
19) Hematite
20) Limonite
21) Pyrite

Important Mineral ID Properties

1) **Crystal Form & Habit**
2) **Luster**
3) **Color**
4) **Hardness**
5) **Cleavage**
6) **Other properties**
   - Streak
   - Reaction to acid
   - Magnetic
   - Taste

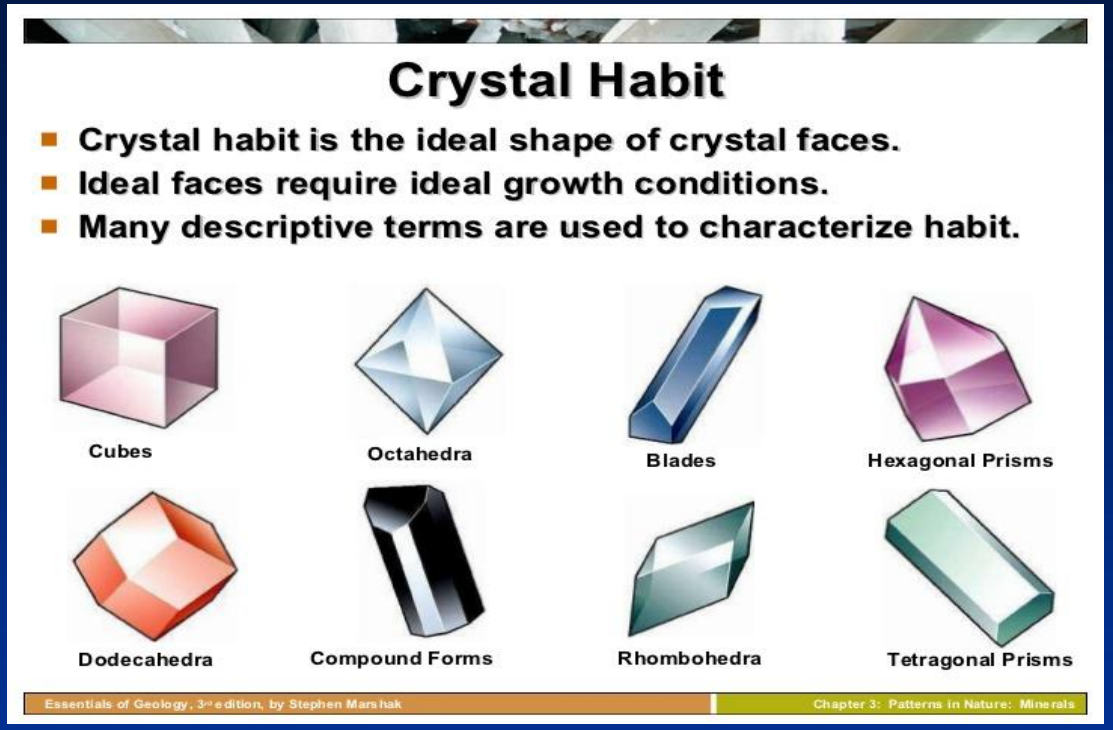
Mineral Habit

Defined: Characteristic external habit or shape of an individual crystal or groups of crystals

Crystal habit is divided into several categories, based on:

- Internal crystal structure
- External crystal shape

Crystal habit is useful for mineral ID, but can be confused with cleavage faces.



Mineral Luster

Defined: The quality of reflected light emitted by a mineral crystal

Luster can divided into two useful categories:

- Metallic and Nonmetallic

Nonmetallic lusters can be further subdivided into:

- Glassy, Pearly, Waxy, and Dull

Luster is useful for mineral ID

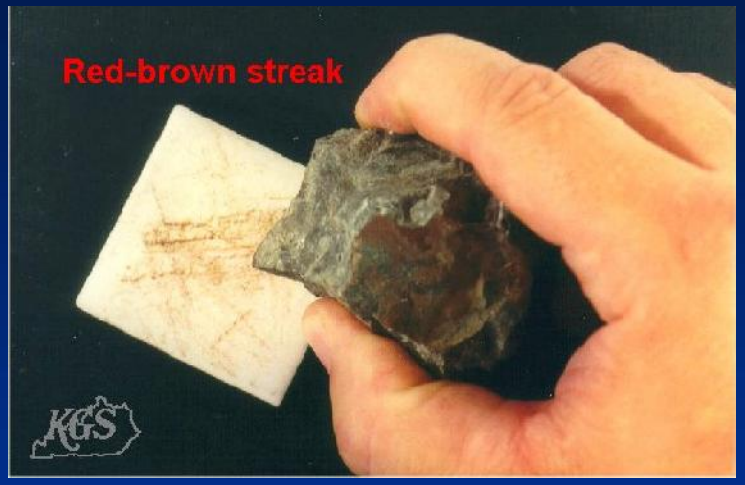
- http://cmsc.minotstateu.edu/Labs/web%

Mineral Streak

Defined: The color of the crushed powder of a mineral left on a porcelain plate

✓ **Only** for determining the **metallic** minerals

✓ Only works is mineral has lower hardness than the streak plate



- http://academic.brooklyn.cuny.edu/geology/grocha/mineral/mineral.html

Mineral Color

Defined: The hue and shade of the reflected light emitted by a mineral crystal

Mineral color can divided into two useful shade categories:

- Dark-colored and Light-colored

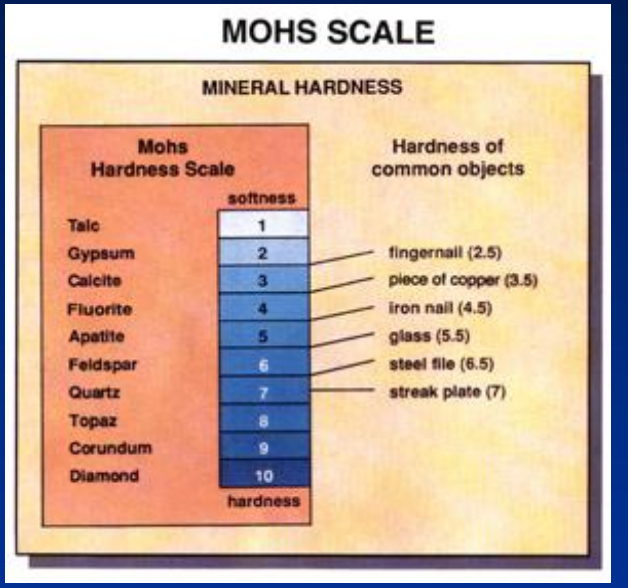
Color can also divided into the hue categories:

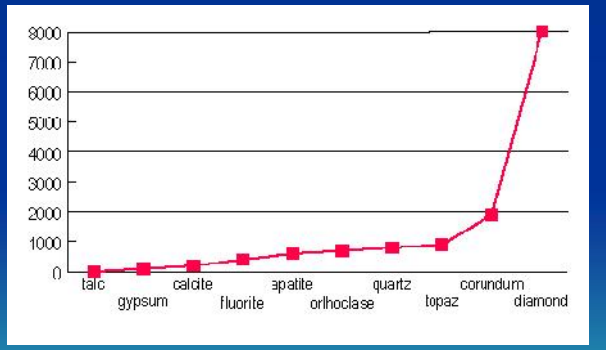
- White, Gray, Black, Red, Orange, Yellow, Green, Blue, Purple, etc.
- Color is useful for mineral ID

- http://cmsc.minotstateu.edu/Labs/web%20minerals/minerals%20lab.html

Mineral Hardness

- ✓ Mohs Hardness Scale
- ✓ Identify Mineral by Testing for Hardness
- ✓ Doing the Scratch Test
- ✓ Other Testing Objects





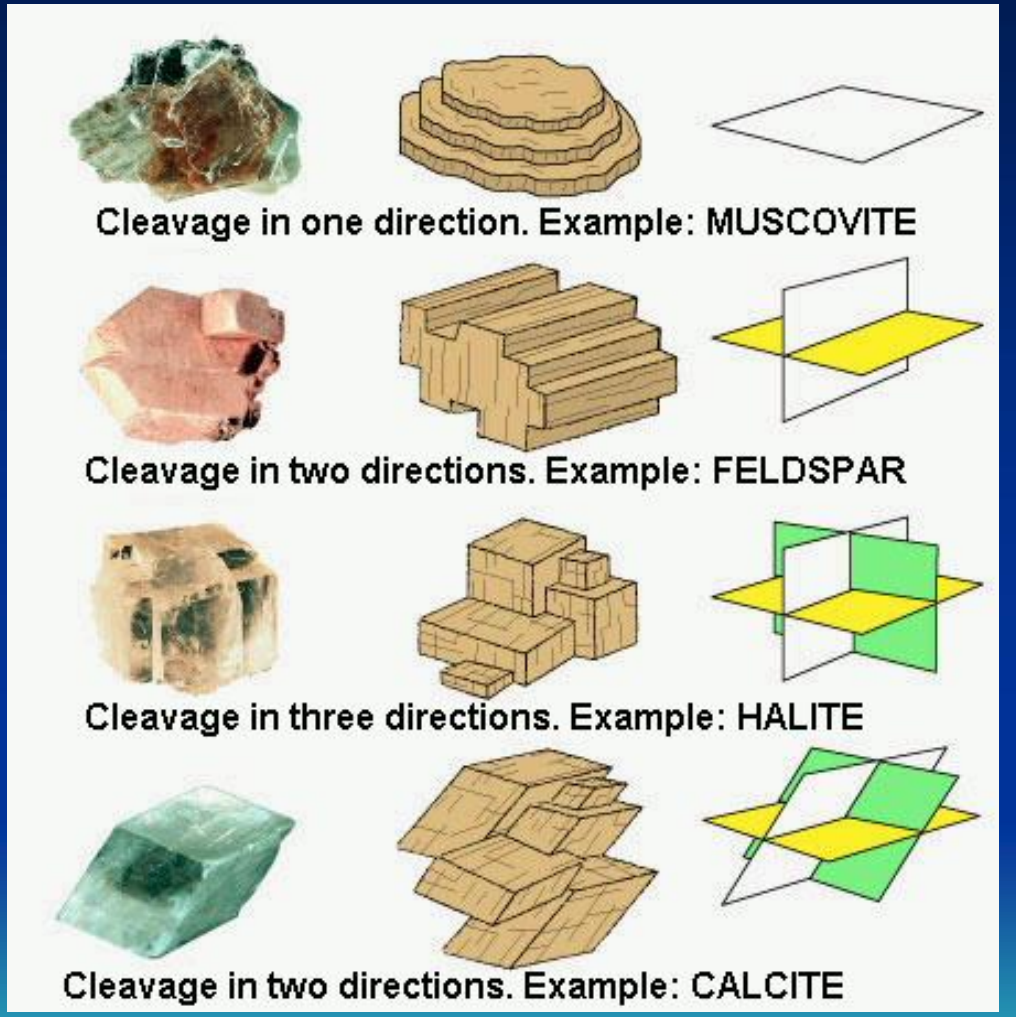
Mineral Cleavage

Defined: Geometric planes of inherent weakness through a mineral crystal

✓ Each mineral has a unique identifying cleavage property

✓ A mineral has either none, one, two, four, or six sets of cleavage

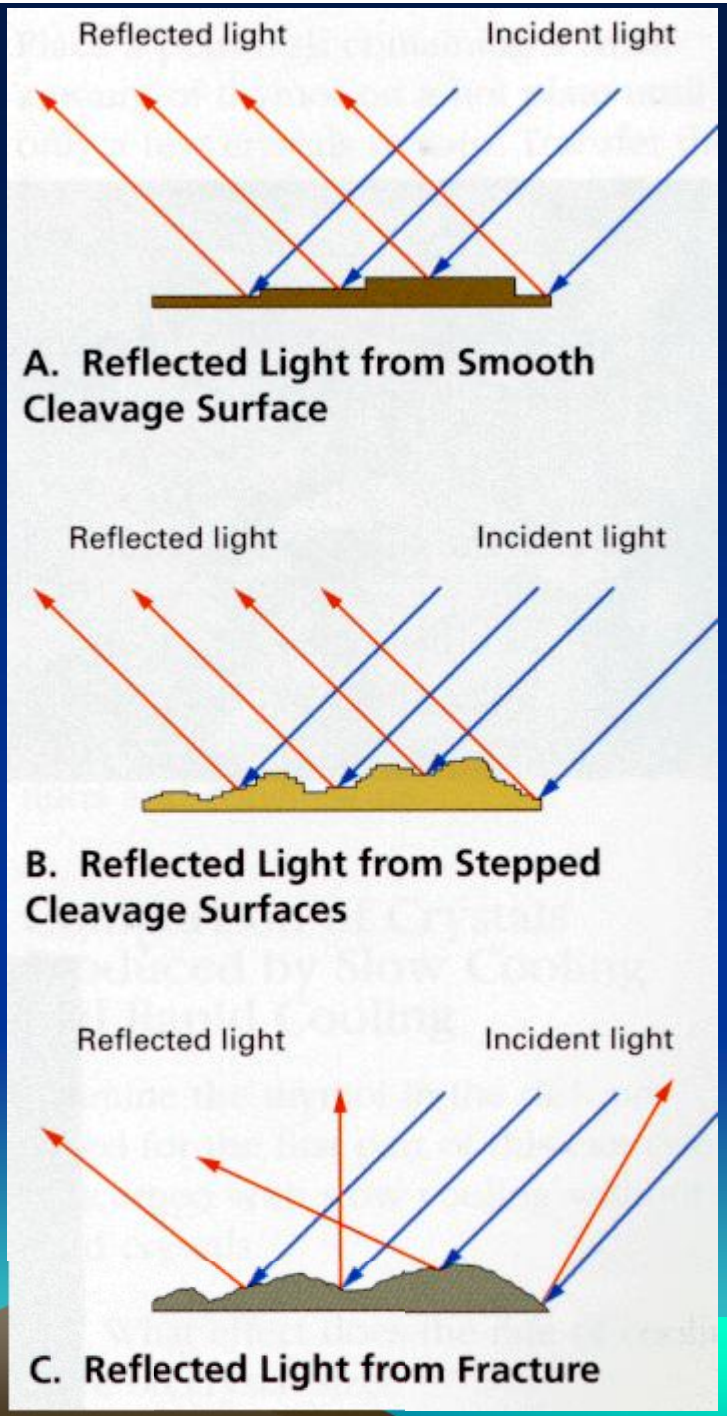
✓ Cleavage is observed as shiny parallel planes on the surfaces of a mineral crystal



Mineral Cleavage Quality

Cleavage is observed as shiny parallel planes on the surfaces of a mineral crystal

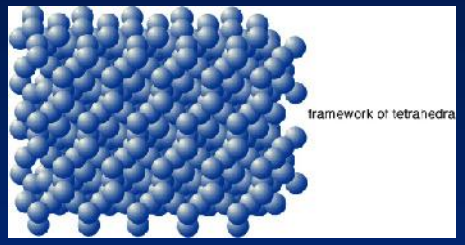
- ✓ **Quality:** Variation in degree of smoothness of cleavage surface.
- ✓ Each mineral has a unique cleavage quality
- ✓ A mineral has either excellent/ perfect, good, poor, or none

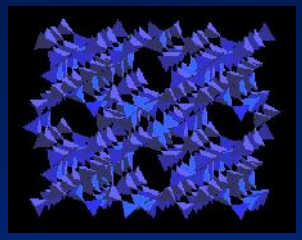


Determining Mineral Cleavage

No Cleavage

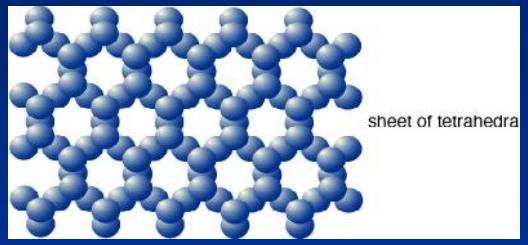
Example = Quartz

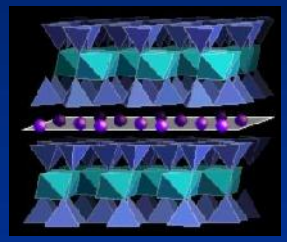




One Set of Cleavage

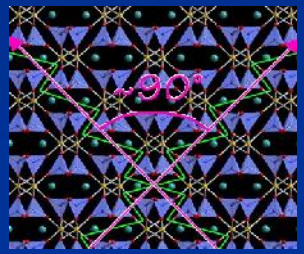
Example = Muscovite





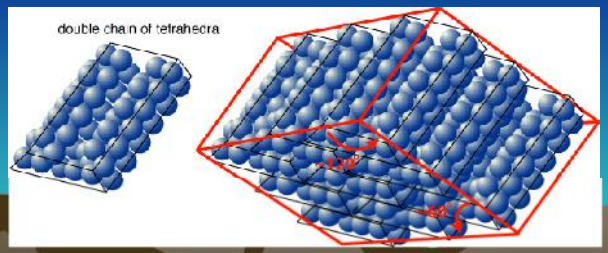
Two Sets of Cleavage

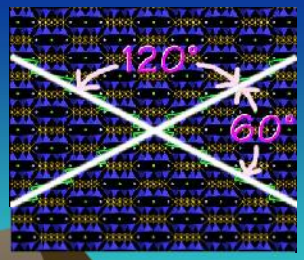
- ✓ 90 degrees
- ✓ Example = Augite



Two Sets of Cleavage

- ✓ 120 & 60 degrees
- ✓ Example = Hornblende

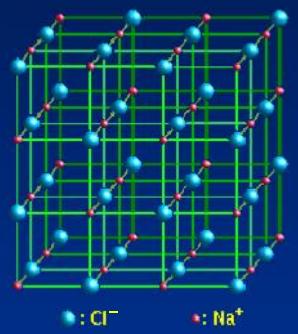




Determining Mineral Cleavage

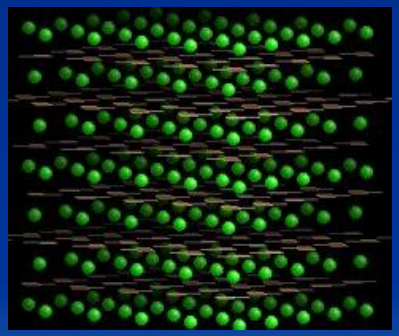
Three Sets of Cleavage

- ✓ 90 degrees
- ✓ Example = Halite



Three Sets of Cleavage

- ✓ 120 & 60 degrees
- ✓ Example = Calcite



Reaction to Acid – The "Acid" Test

Defined: Some minerals react to acid solution (HCl) - they start to bubble and dissolve

✓Good for determining the ***carbonate*** minerals

✓ Use the acid test only if you think that your unknown mineral has low hardness – close to 3.

✓ Typically either calcite or dolomite

- http://academic.brooklyn.cuny.edu/geology/grocha/mineral/mineral.html

Magnetism – The "Magnet" Test

Defined: Some minerals are magnetic – some weakly, some strongly. A magnet will stick to a magnetic mineral.

✓Good for determining the certain ***magnetite and hematite***

✓ Need a hand-held magnet.

- http://academic.brooklyn.cuny.edu/geology/grocha/mineral/mineral.html

Fluorescence– The “Black-light” Test

Defined: Some minerals fluoresce under ultraviolet light.

✓Good for determining the certain ***ore and gem*** minerals

✓ Need a hand-held black-light instrument.

- http://academic.brooklyn.cuny.edu/geology/grocha/mineral/mineral.html

Distinguishing Between K-Feldspar and Plagioclase

Potassium Feldspar

- ✓ Orthoclase and Microcline
- ✓ Salmon pink- to white cream-colored
- ✓ Wavy “flame-like” streaks

Plagioclase Feldspar

- ✓ Albite, Oligoclase, Andesine, Labradorite, Bytownite, Anorthite
- ✓ White- to Dark grey-colored
- ✓ Sets of thin, straight, groove-like striations on some cleavage faces

Mineral Identification Procedure

Step #1 Mineral Luster? – Metallic or Nonmetallic?

Metallic	Nonmetallic
Step #2 Mineral Hardness?	**Step #2** Mineral Color? – Light or Dark
Step #3 Mineral Streak?	**Step #3** Mineral Hardness?
Step #4 Other Properties?	**Step #4** Mineral Cleavage?
Step #5 Mineral Name?	**Step #5** Other Defining Properties?
	Step #6 Mineral Name?

Next Lecture Topic

Igneous Rocks

- Define
- Origin and Importance to Formation of Igneous Rocks
- Classification – Igneous Rock Groups
- Physical Properties
- Identification of Hand Specimens

Preparation

- Read Mineral and Igneous Chapter in Textbook
- Study Lecture Notes and PowerPoint

Mineral Web References

Common Minerals in Igneous Rocks
Mineral Hardness Testing
Mineral Identification – Physical Properties
MINERAL PROPERTIES, USES, & IDENTIFICATION
Index of minerals in thin-section
WHAT IS CRYSTAL CLEAVAGE?
PHYSICAL CHARACTERISTICS OF MINERALS

http://www.cobweb.net/~bug2/mineral.htm

http://www.rockhounds.com/rockshop/mineral_id/index.html

http://www.union.edu/PUBLIC/GEODEPT/COURSES/geo-10/mineral.htm

http://academic.brooklyn.cuny.edu/geology/grocha/mineral/mineral.html

http://cmsc.minotstateu.edu/Labs/web%20minerals/minerals%20lab.html