I Minerals
- A Chemistry (Review Box 5.1, A 1-3 will not be covered in lecture)
  - 1 Atom are composed of
    - a Nucleus
    - b Protons – positive (+) charged species
    - c Neutrons – neutral charge
    - d Shell of electrons – negative (-) charge
  - 2 Elements are defined by its atomic number (number of protons in nucleus)
    - a Mass number – the total number of protons + neutrons
    - b Isotopes – an element in which different mass numbers are possible
    - c i.e. Helium 3 and Helium 4
  - 3 Ions
    - a Cations – positively charged ions
    - b Anions – negatively charged ions
    - c Compounds
  - 4 Types of Bonds
    - a Ionic
    - b Covalent
    - c Metallic
    - d Van der Waals
- B Mineral Definition
  - 1 Naturally occurring
  - 2 Inorganic
  - 3 Solid
  - 4 Orderly Internal Structure
  - 5 Definite chemical composition
- C Physical Properties (used to differentiate minerals, does not define what a mineral is, will not be covered in lecture)
  - 1 Crystal Form – expression of internal arrangement of atoms
  - 2 Luster – appearance or quality of light reflected from the surface of a mineral
  - 3 Color – not a reliable property
  - 4 Streak – color of the mineral's powder
  - 5 Hardness – resistance to abrasion or scratching
  - 6 Cleavage – predictable breakage along planes of weak bonding
  - 7 Fracture – random/unpredictable breakage
  - 8 Specific Gravity – ratio of the weight of the mineral to that of an equal volume of water
  - 9 Taste
  - 10 Feel – i.e. greasy, soapy, etc.
  - 11 Magnetism
  - 12 Reaction to acid
- D Groups of Minerals
  - 1 Over 4000 minerals
  - 2 Only a few dozen are common – rock forming minerals
    - a Oxides
    - b Carbonates

i Examples: calcite or dolomite
ii Will react with acid
iii Form sedimentary rocks

c Sulfates
d Sulfides
e Phosphates
f Halides
g Native Elements
h Silicates
i Most common rock forming group of minerals – comprise 95% of Earth's Crust
ii Silicon-oxygen tetrahedron $(SiO4)^{-4}$
(i) Fundamental building block of silicates
(ii) An anion (negatively charged ion) with a –4 charge
(iii) Forms compounds by combining tetrahedrons with other tetrahedrons and/or cations (positively charged ions)
iii Structures
(i) Combination of tetrahedrons produces different structures
(ii) Combination occurs as a result of sharing oxygen atoms between tetrahedrons
(iii) Isolated tetrahedron
1. 1 silicon to 4 oxygen
2. low silicon content
3. simplest structure – tetrahedrons are connected by ionic bonds with cations, primarily iron and magnesium
4. example: olivine
(iv) Chain Structure
1. silicon to 3 oxygen
2. simple structure, some tetrahedrons are connected through sharing (covalent bonds between) oxygen atoms, chains are connected by ionic bonds with cations, primarily iron, magnesium, and calcium
3. example: augite
(v) Double Chain Structure
1. 4 silicon to 11 oxygen (1 Si to 2.75 O)
2. Stacking of chains through sharing (covalent bonds between) oxygen atoms, double chains are connected by ionic bonds with cations, primarily iron, magnesium, and calcium
3. Example: hornblende
(vi) Sheets Structure
1. 2 silicon to 5 oxygen (1 Si to 2.5 O)
2. Stacking of multiple chains through sharing (covalent bonds between) oxygen atoms, sheets are connected by ionic bonds with cations, (iron, magnesium, sodium, potassium, or calcium)
3. Example: biotite
(vii) 3-dimensional complex

1. silicon to 2 oxygen
2. high silicon content
3. most complex structure
4. example: quartz

iv Ferromagnesium (Mafic) Silicates
   (i) Composed of iron and magnesium
   (ii) Dark in color

v Nonferromagnesium (Felsic) Silicates
   (i) Do not have iron and magnesium, rather potassium, sodium, calcium, etc.
   (ii) Light in color
   (iii) Lower specific gravity (lighter weight) than ferromagnesium minerals