



Earth and Space Science

Unit 3— Matter and Minerals (Ch. 2)

Defining a Mineral

- Mineral
 1. Naturally occurring
 2. Generally inorganic solid
 - Exception: calcite from animal shells
 3. Solid Substance
 - Ice vs. Water; Mercury
 4. Orderly chemical structure
 5. Definite chemical composition that allows for some variation

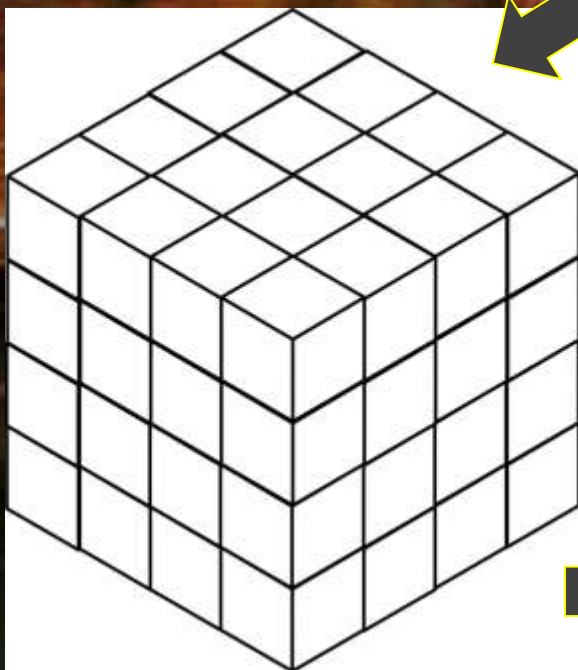
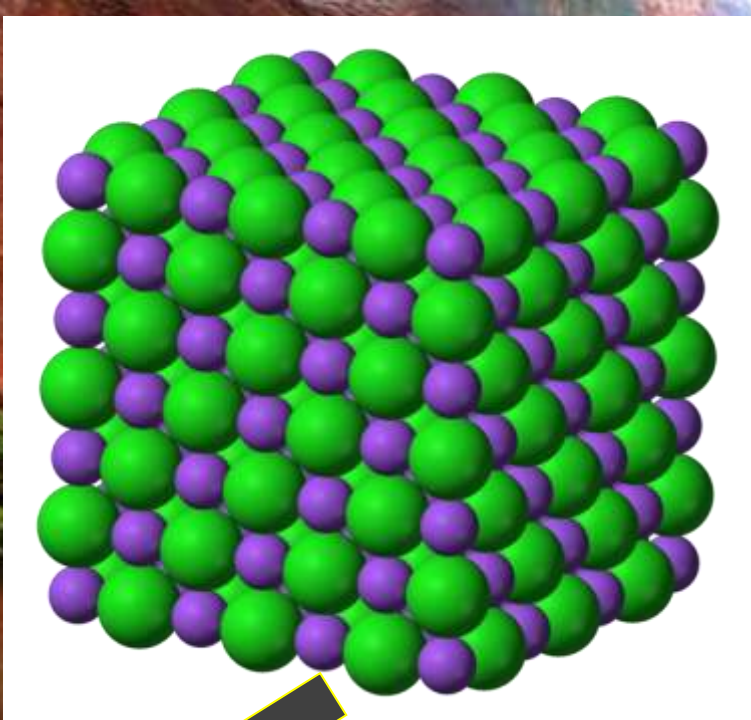


Photo by Dennis Tasa

Defining a Rock

- Rocks are aggregates (mixtures) of minerals
- Most rocks are aggregates of several different minerals
 - Granite
- Some rocks are composed of almost entirely of one type of mineral
 - Limestone

Composition and Structure of Minerals

- Elements
 - Basic building blocks of minerals
 - Over 100 are known

PERIODIC TABLE OF THE ELEMENTS
<http://www.kf-split.hr/periodni/en/>

PERIOD	GROUP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		IA	IIA	IIIB	IVB	VB	VIB	VII B	VIII	VIII	X	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1		1 H 1.0079 HYDROGEN																	2 He 4.0026 HELIUM
2		3 Li 6.941 LITHIUM	4 Be 9.0122 BERYLLIUM											5 B 10.811 BORON	6 C 12.011 CARBON	7 N 14.007 NITROGEN	8 O 15.999 OXYGEN	9 F 18.998 FLUORINE	10 Ne 20.180 NEON
3		11 Na 22.990 SODIUM	12 Mg 24.305 MAGNESIUM											13 Al 26.982 ALUMINIUM	14 Si 28.086 SILICON	15 P 30.974 PHOSPHORUS	16 S 32.065 SULPHUR	17 Cl 35.453 CHLORINE	18 Ar 39.948 ARGON
4		19 K 39.098 POTASSIUM	20 Ca 40.078 CALCIUM	21 Sc 44.956 SCANDIUM	22 Ti 47.867 TITANIUM	23 V 50.942 VANADIUM	24 Cr 51.996 CHROMIUM	25 Mn 54.938 MANGANESE	26 Fe 55.845 IRON	27 Co 58.933 COBALT	28 Ni 58.693 NICKEL	29 Cu 63.546 COPPER	30 Zn 65.39 ZINC	31 Ga 69.723 GALLIUM	32 Ge 72.64 GERMANIUM	33 As 74.922 ARSENIC	34 Se 78.96 SELENIUM	35 Br 79.904 BROMINE	36 Kr 83.80 KRYPTON
5		37 Rb 85.468 RUBIDIUM	38 Sr 87.62 STRONTIUM	39 Y 88.906 YTTRIUM	40 Zr 91.224 ZIRCONIUM	41 Nb 92.906 NIObIUM	42 Mo 95.94 MOLYBDENUM	43 Tc (98) TECHNETIUM	44 Ru 101.07 RUTHENIUM	45 Rh 102.91 RHODIUM	46 Pd 106.42 PALLADIUM	47 Ag 107.87 SILVER	48 Cd 112.41 CADMIUM	49 In 114.82 INDIUM	50 Sn 118.71 TIN	51 Sb 121.76 ANTIMONY	52 Te 127.60 TELLURIUM	53 I 126.90 IODINE	54 Xe 131.29 XENON
6		55 Cs 132.91 CAESIUM	56 Ba 137.33 BARIUM	57-71 La-Lu Lanthanide	72 Hf 178.49 HAFNIUM	73 Ta 180.95 TANTALUM	74 W 183.84 TUNGSTEN	75 Re 186.21 RHENIUM	76 Os 190.23 OSMIUM	77 Ir 192.22 IRIDIUM	78 Pt 195.08 PLATINUM	79 Au 196.97 GOLD	80 Hg 200.59 MERCURY	81 Tl 204.38 THALLIUM	82 Pb 207.2 LEAD	83 Bi 208.98 BISMUTH	84 (209) Po POLONIUM	85 (210) At ASTATINE	86 (222) Rn RADON
7		87 Fr (223) FRANCIUM	88 (226) Ra RADIUM	89-103 Ac-Lr Actinide	104 (261) Rf RUTHERFORDIUM	105 (262) Db DUBNIUM	106 (266) Sg SEABORGIUM	107 (268) Bh BOHRRIUM	108 (277) Hs HASSIUM	109 (288) Mt MEITNERIUM	110 (281) Uun UNUNNIUM	111 (272) Uuu UNUNNIUM	112 (285) Uub UNUNBIUM	114 (289) Uuq UNUNQUADIUM					

LANTHANIDE

57 138.91 La LANTHANUM	58 140.12 Ce CERIUM	59 140.91 Pr PRASEODYMIUM	60 144.24 Nd NEODYMIUM	61 (145) Pm PROMETHIUM	62 150.36 Sm SAMARIUM	63 151.96 Eu EUROPIUM	64 157.25 Gd GADOLINIUM	65 158.93 Tb TERBIUM	66 162.50 Dy DYSPROSIUM	67 164.93 Ho HOLIUM	68 167.26 Er ERBIUM	69 168.93 Tm THULIUM	70 173.04 Yb YTTERIUM	71 174.97 Lu LUTETIUM
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ACTINIDE

89 (227) Ac ACTINIUM	90 232.04 Th THORIUM	91 231.04 Pa PROTACTINIUM	92 238.03 U URANIUM	93 (237) Np NEPTUNIUM	94 (244) Pu PLUTONIUM	95 (243) Am AMERICIUM	96 (247) Cm CURIUM	97 (248) Bk BERKELIUM	98 (251) Cf CALIFORNIUM	99 (252) Es EINSTEINIUM	100 (257) Fm FERMIUM	101 (258) Md MENDELEVIUM	102 (259) No NOBELIUM	103 (262) Lr LAWRENCIUM
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(1) Pure Appl. Chem., 73, No. 4, 667-683 (2001)
Relative atomic mass is shown with five significant figures. For elements having no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.
However three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.

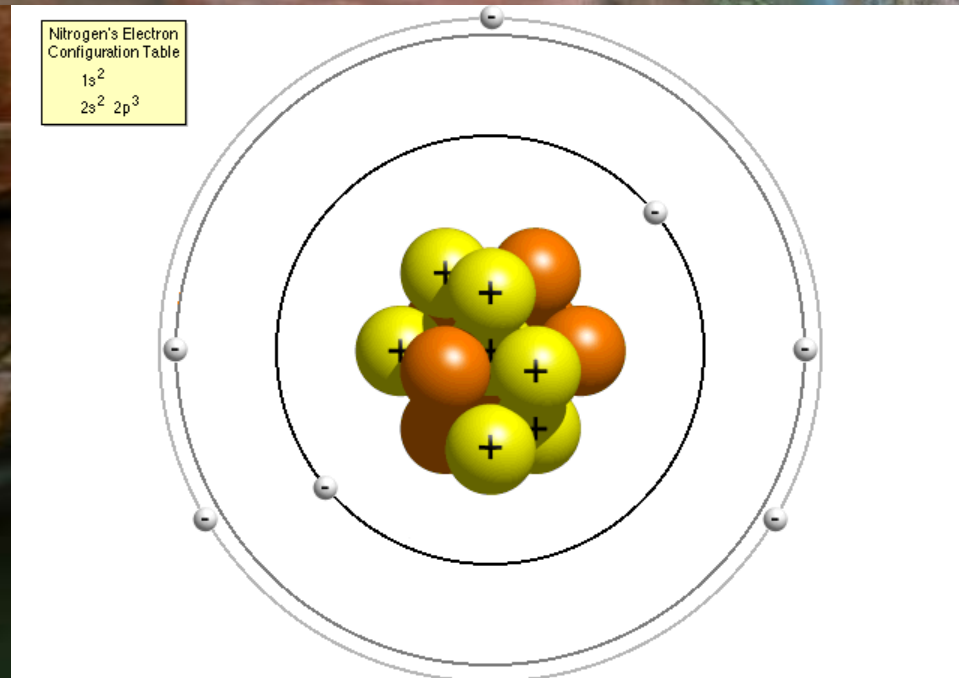
Editor: Aditya Vasthan (advasth@ncitliv.com)

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Composition and Structure of Minerals (cont.)

B. Atoms

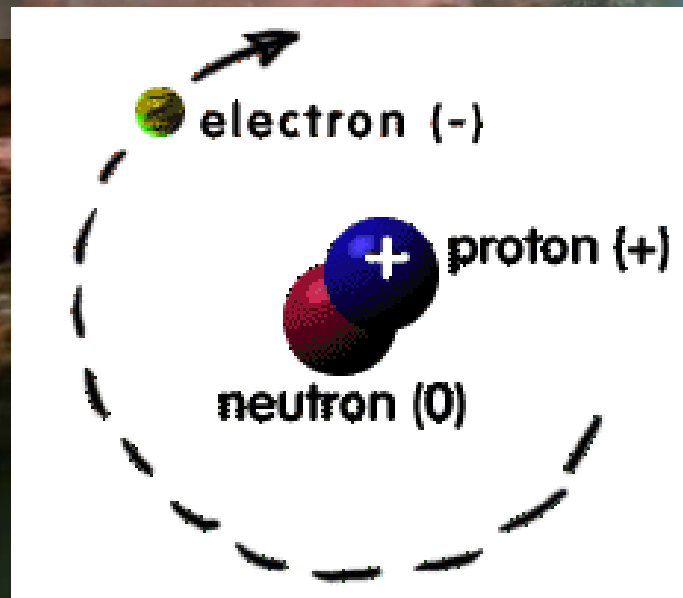
1. Smallest particles of Matter
2. Have all the Characteristics of an element



How Atoms are Constructed

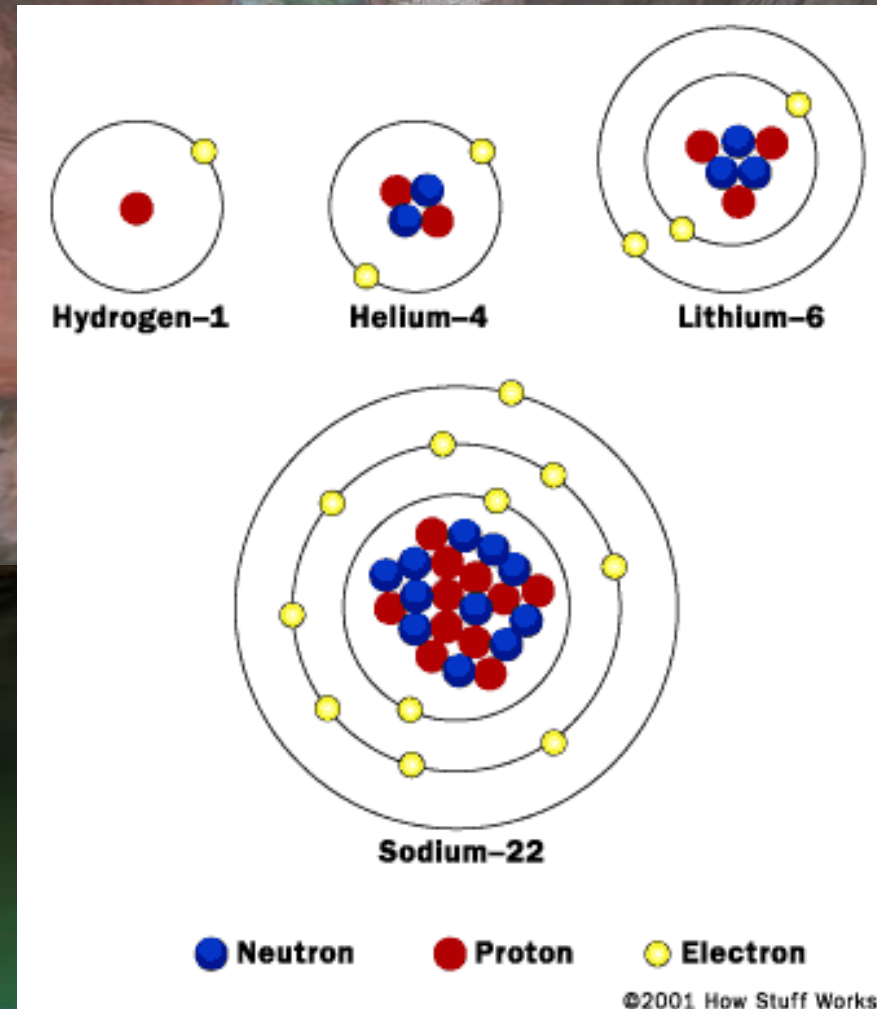
A. Nucleus, which contains

1. Protons – positive electrical charges
2. Neutrons – neutral electrical charges (no charge)
3. Only Protons & Neutrons are considered to have mass



How Atoms are Constructed (cont.)

- Energy levels, or shells
 - Surround nucleus
 - Contain electrons – negative electrical charges
 - Are considered to be massless



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LANTHANIDE

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ACTINIDE

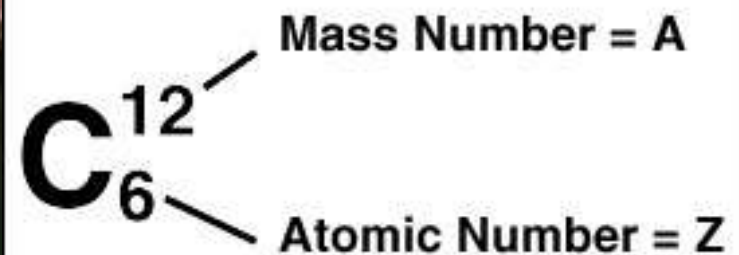
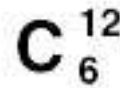
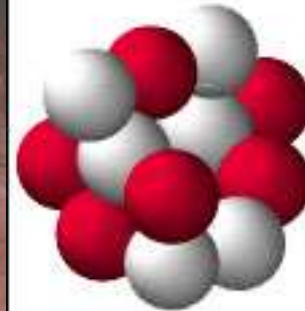
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III. How Atoms are Constructed (cont.)

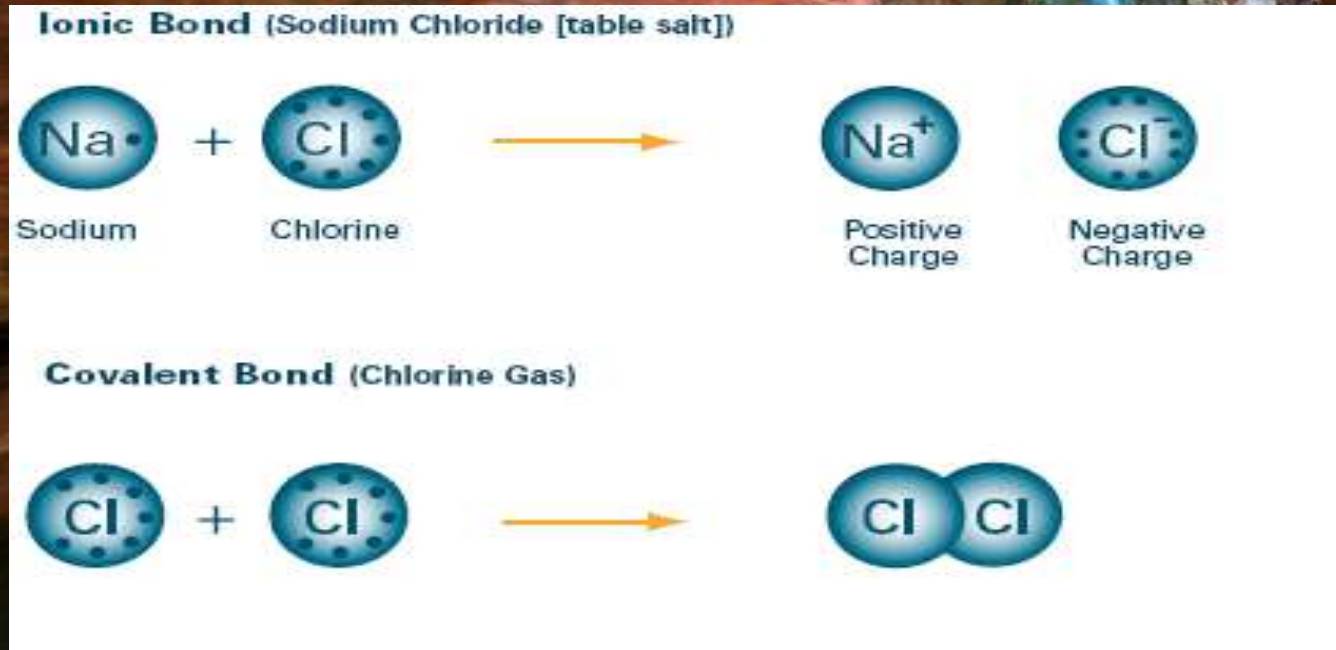
C. Atomic number is the number of protons in an atom's nucleus



III. How Atoms are Constructed (cont.)

D. Bonding of Atoms

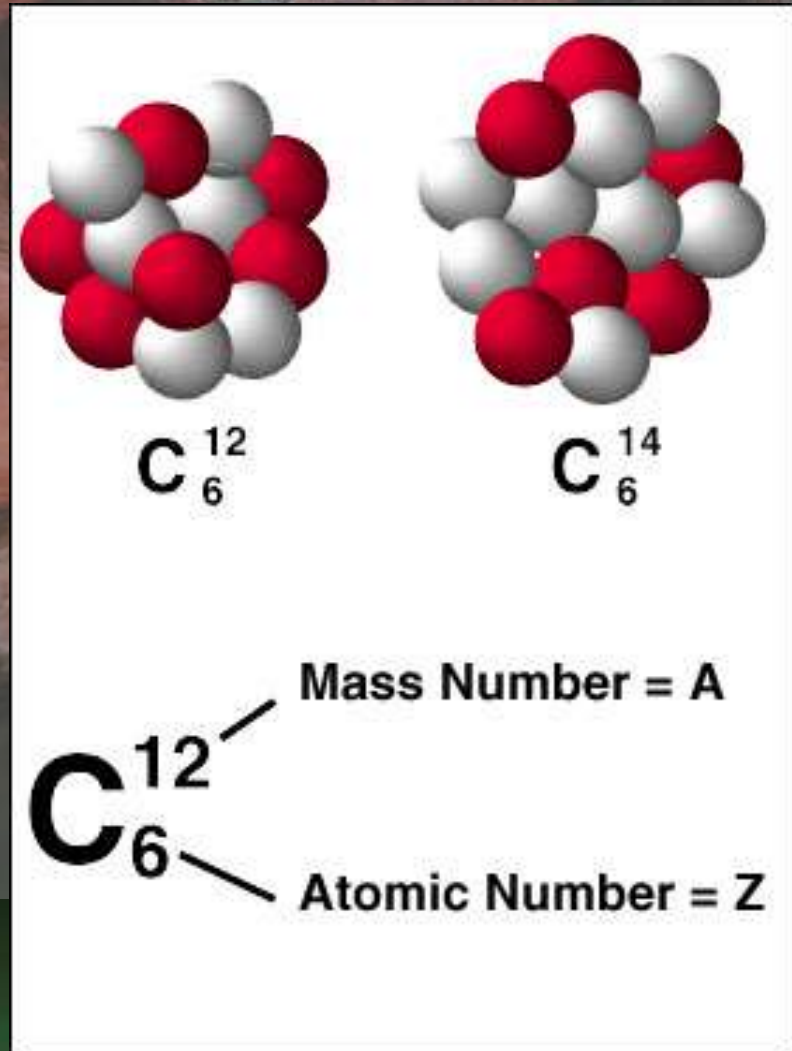
1. Forms a compound with two or more elements
2. Ions are atoms that gain or lose electrons



III. How Atoms are Constructed (cont.)

E. Isotopes

1. Have varying number of neutrons
2. Have different mass numbers – the sum of the neutrons plus protons
3. Many isotopes are radioactive and emit energy and particles



Phases of Matter

Solids - definite shape and volume

- Atoms are held close together by strong bonds
- Movement is slow

Liquids - definite volume, but NO definite shape

- Bonds are weaker and atoms are spaced farther apart
- They take the shape of container they are in

Gases - NO definite volume OR shape

- Bonds are weakest and atoms far apart
- Expand to fill the container they are in
 - Examples - air, oxygen, smoke

Plasma

- Gas like mixture of + and – charged particles
- Movement very rapid
- 99% of mass of our solar system
 - Examples: Sun, Stars and Lightning

IV. Properties of Minerals

A. Optical Properties

1. Luster
2. Color



B. Crystal Shape, or Habit



◀ Bladed



Banded ▶

C. Mineral Strength

- 1. Hardness
- 2. Cleavage
- 3. Fracture
- 4. Tenacity

1	Talc	
2	Gypsum	scratched by fingernail
3	Calcite	scratched by coin
4	Fluorite	
5	Apatite	scratched by knife blade
6	Orthoclase	
7	Quartz	
8	Topaz	
9	Corundum	
10	Diamond	harder than steel



D. Density & Specific Gravity



Specific Gravity Measurement

V. Mineral Groups

1. Silicate minerals

a. Most common mineral group

a. Contain silicon-oxygen tetrahedron

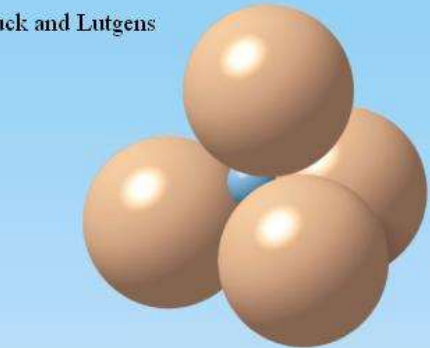
b. Crystallize from molten material

c. Groups based upon tetrahedron arrangement

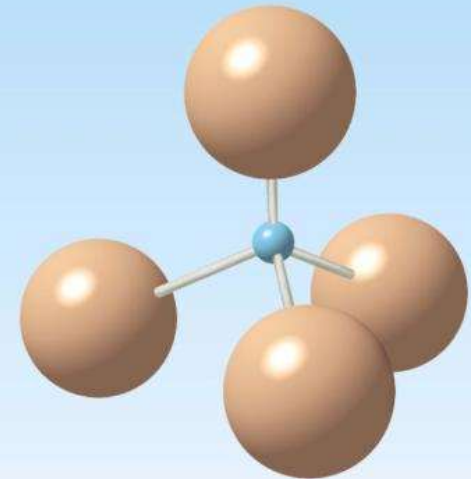
SiO tetrahedron

Photo: Tarbuck and Lutgens

A.



B.



V. Minerals Groups (cont.)

2. Nonsilicate minerals

- Usually based on the negatively charged ion or complex ion that the members have in common.

a. Major groups

- i. Oxides
- ii. Sulfides
- iii. Sulfates
- iv. Halides
- v. “Native” elements

VI. Natural Resources

A. Mineral resources

- Renewable vs. Nonrenewable
 1. Reserves are already identified deposits
 2. Ores are useful metallic minerals that can be mined at a profit
 3. Economic factors may change and influence a resource