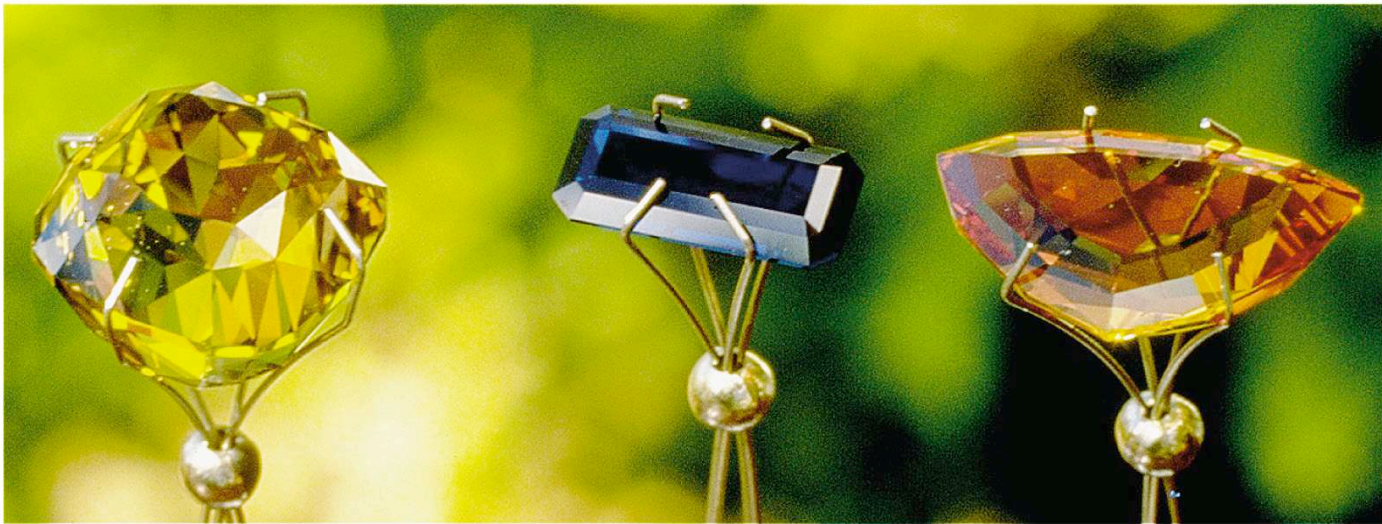


Chapter 3

Matter and Minerals



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Minerals: What are they?

- **4 part definition a mineral**



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Composition of minerals

■ Elements-Periodic Table

Tendency to lose outermost electrons to uncover full outer shell

Atomic number
Symbol of element
Atomic weight
Name of element

Metals
Transition metals
Nonmetals
Noble gases
Lanthanide series
Actinide series

Tendency to fill outer shell by sharing electrons

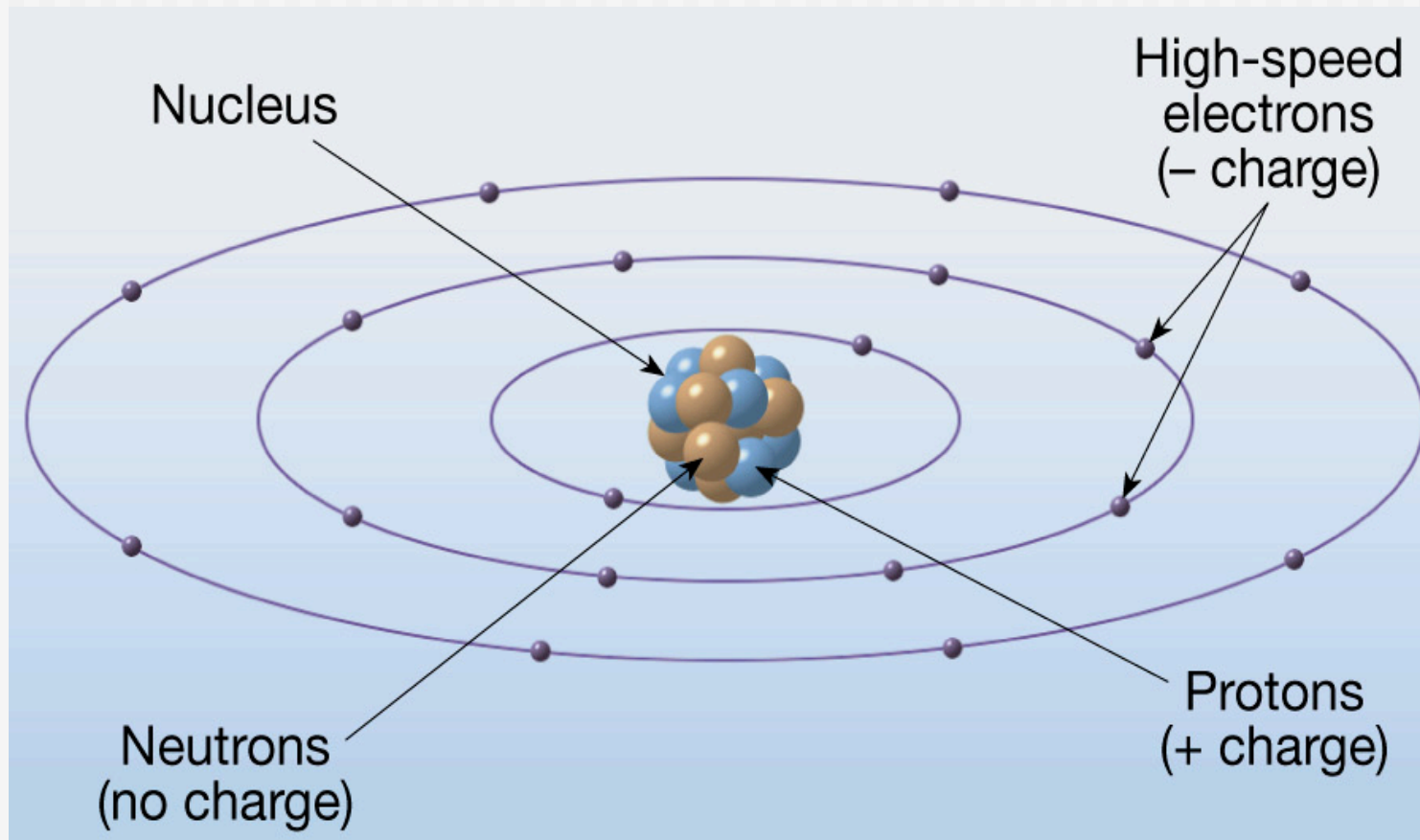
Tendency to gain electrons to make full outer shell

Noble gases (inert)

1 H 1.0080 Hydrogen																	2 He 4.003 Helium
I A	II A											III A	IV A	V A	VI A	VII A	VIII A
3 Li 6.939 Lithium	4 Be 9.012 Beryllium	Tendency to lose electrons										5 B 10.81 Boron	6 C 12.011 Carbon	7 N 14.007 Nitrogen	8 O 15.9994 Oxygen	9 F 18.998 Fluorine	10 Ne 20.183 Neon
11 Na 22.990 Sodium	12 Mg 24.31 Magnesium	III B	IV B	V B	VI B	VII B	VIII B			I B	II B	13 Al 26.98 Aluminum	14 Si 28.09 Silicon	15 P 30.974 Phosphorus	16 S 32.064 Sulfur	17 Cl 35.453 Chlorine	18 Ar 39.948 Argon
19 K 39.102 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.90 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.71 Nickel	29 Cu 63.54 Copper	30 Zn 65.37 Zinc	31 Ga 69.72 Gallium	32 Ge 72.59 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.909 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc (99) Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.90 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.87 Silver	48 Cd 112.40 Cadmium	49 In 114.82 Indium	50 Sn 118.69 Tin	51 Sb 121.75 Antimony	52 Te 127.60 Tellurium	53 I 126.90 Iodine	54 Xe 131.30 Xenon
55 Cs 132.91 Cesium	56 Ba 137.34 Barium	57 TO 71	72 Hf 178.49 Hafnium	73 Ta 180.95 Tantalum	74 W 183.85 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.09 Platinum	79 Au 197.0 Gold	80 Hg 200.59 Mercury	81 Tl 204.37 Thallium	82 Pb 207.19 Lead	83 Bi 208.98 Bismuth	84 Po (210) Polonium	85 At (210) Astatine	86 Rn (222) Radon
87 Fr (223) Francium	88 Ra 226.05 Radium	89 TO 103	57 La 138.91 Lanthanum	58 Ce 140.12 Cerium	59 Pr 140.91 Praseodymium	60 Nd 144.24 Neodymium	61 Pm (147) Promethium	62 Sm 150.35 Samarium	63 Eu 151.96 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.92 Terbium	66 Dy 162.50 Dysprosium	67 Ho 164.93 Holmium	68 Er 167.26 Erbium	69 Tm 168.93 Thulium	70 Yb 173.04 Ytterbium	71 Lu 174.97 Lutetium
89 Ac (227) Actinium	90 Th 232.04 Thorium	91 Pa (231) Protactinium	92 U 238.03 Uranium	93 Np (237) Neptunium	94 Pu (242) Plutonium	95 Am (243) Americium	96 Cm (247) Curium	97 Bk (249) Berkelium	98 Cf (251) Californium	99 Es (254) Einsteinium	100 Fm (253) Fermium	101 Md (256) Mendelevium	102 No (254) Nobelium	103 Lw (257) Lawrencium			

Composition of minerals

■ Atoms



Composition of minerals

- **Chemical bonding & electrons**
- **Ionic bonding**
- **Covalent**
- **Metallic**

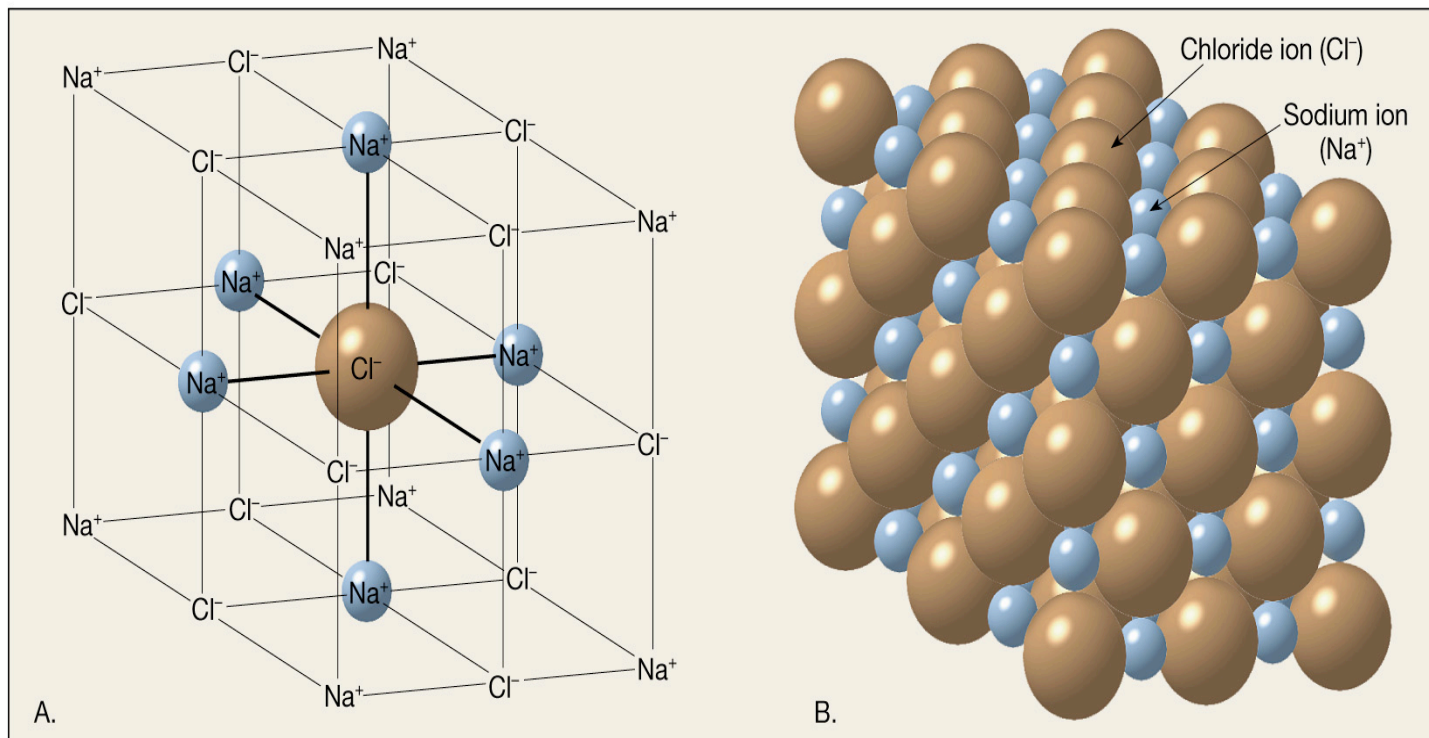


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Halite (NaCl) – An example of ionic bonding

Na = 2,8,1

Cl = 2, 8, 7



Covalent bonding

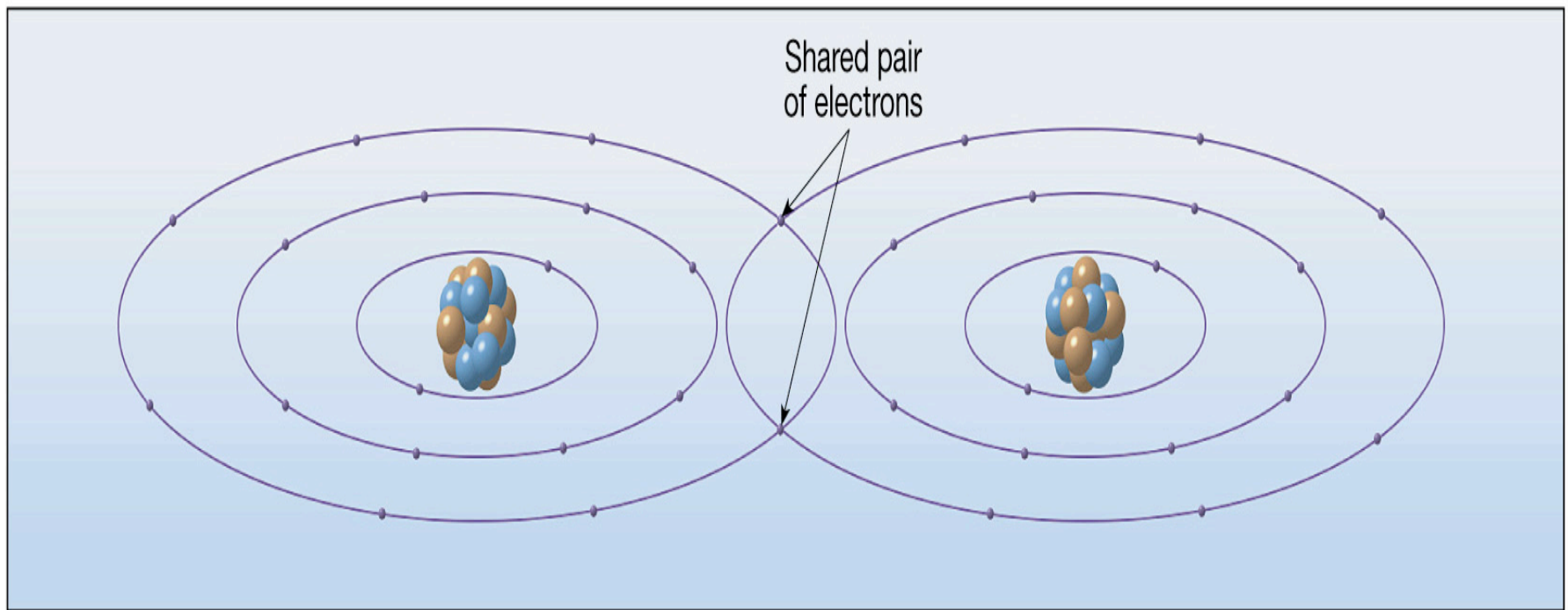


Figure 3.7

Composition of minerals

■ **Metallic bonding**



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Composition of minerals

■ Atomic and Mass Numbers

Tendency to lose outermost electrons to uncover full outer shell

2
He
4.003
Helium

Atomic number
Symbol of element
Atomic weight
Name of element

Metals
Transition metals
Nonmetals
Noble gases
Lanthanide series
Actinide series

Tendency to fill outer shell by sharing electrons

Tendency to gain electrons to make full outer shell

Noble gases (inert)

VIII A

2
He
4.003
Helium

I A II A

3 4
Li Be
6.939 9.012
Lithium Beryllium

11 12
Na Mg
22.990 24.31
Sodium Magnesium

19 20
K Ca
39.102 40.08
Potassium Calcium

37 38
Rb Sr
85.47 87.62
Rubidium Strontium

55 56
Cs Ba
132.91 137.34
Cesium Barium

87 88
Fr Ra
(223) 226.05
Francium Radium

21 22 23 24 25 26 27 28 29 30
Sc Ti V Cr Mn Fe Co Ni Cu Zn
44.96 47.90 50.94 52.00 54.94 55.85 58.93 58.71 63.54 65.37
Scandium Titanium Vanadium Chromium Manganese Iron Cobalt Nickel Copper Zinc

39 40 41 42 43 44 45 46 47 48
Y Zr Nb Mo Tc Ru Rh Pd Ag Cd
88.91 91.22 92.91 95.94 99 101.1 102.90 106.4 107.87 112.40
Yttrium Zirconium Niobium Molybdenum Technetium Ruthenium Rhodium Palladium Silver Cadmium

57 58 59 60 61 62 63 64 65 66 67 68 69 70 71
La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
138.91 140.12 140.91 144.24 (147) 150.35 151.96 157.25 158.92 162.50 164.93 167.26 168.93 173.04 174.97
Lanthanum Cerium Praseodymium Neodymium Promethium Samarium Europium Gadolinium Terbium Dysprosium Holmium Erbium Thulium Ytterbium Lutetium

72 73 74 75 76 77 78 79 80
Hf Ta W Re Os Ir Pt Au Hg
178.49 180.95 183.85 186.2 190.2 192.2 195.09 197.0 200.59
Hafnium Tantalum Tungsten Rhenium Osmium Iridium Platinum Gold Mercury

81 82 83 84 85 86
Tl Pb Bi Po At Rn
204.37 207.19 208.98 (210) (210) 222
Thallium Lead Bismuth Polonium Astatine Radon

31 32 33 34 35 36
Ga Ge As Se Br Kr
69.72 72.59 74.92 78.96 79.909 83.80
Gallium Germanium Arsenic Selenium Bromine Krypton

49 50 51 52 53 54
In Sn Sb Te I Xe
114.82 118.69 121.75 127.60 126.90 131.30
Indium Tin Antimony Tellurium Iodine Xenon

89 TO 103

89 90 91 92 93 94 95 96 97 98 99 100 101 102 103
Ac Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lw
(227) 232.04 (231) 238.03 (237) (242) (243) (247) (249) (251) (254) (253) (256) (254) (257)
Actinium Thorium Protactinium Uranium Neptunium Plutonium Americium Curium Berkelium Californium Einsteinium Fermium Mendelevium Nobelium Lawrencium

Elemental abundances in continental crust

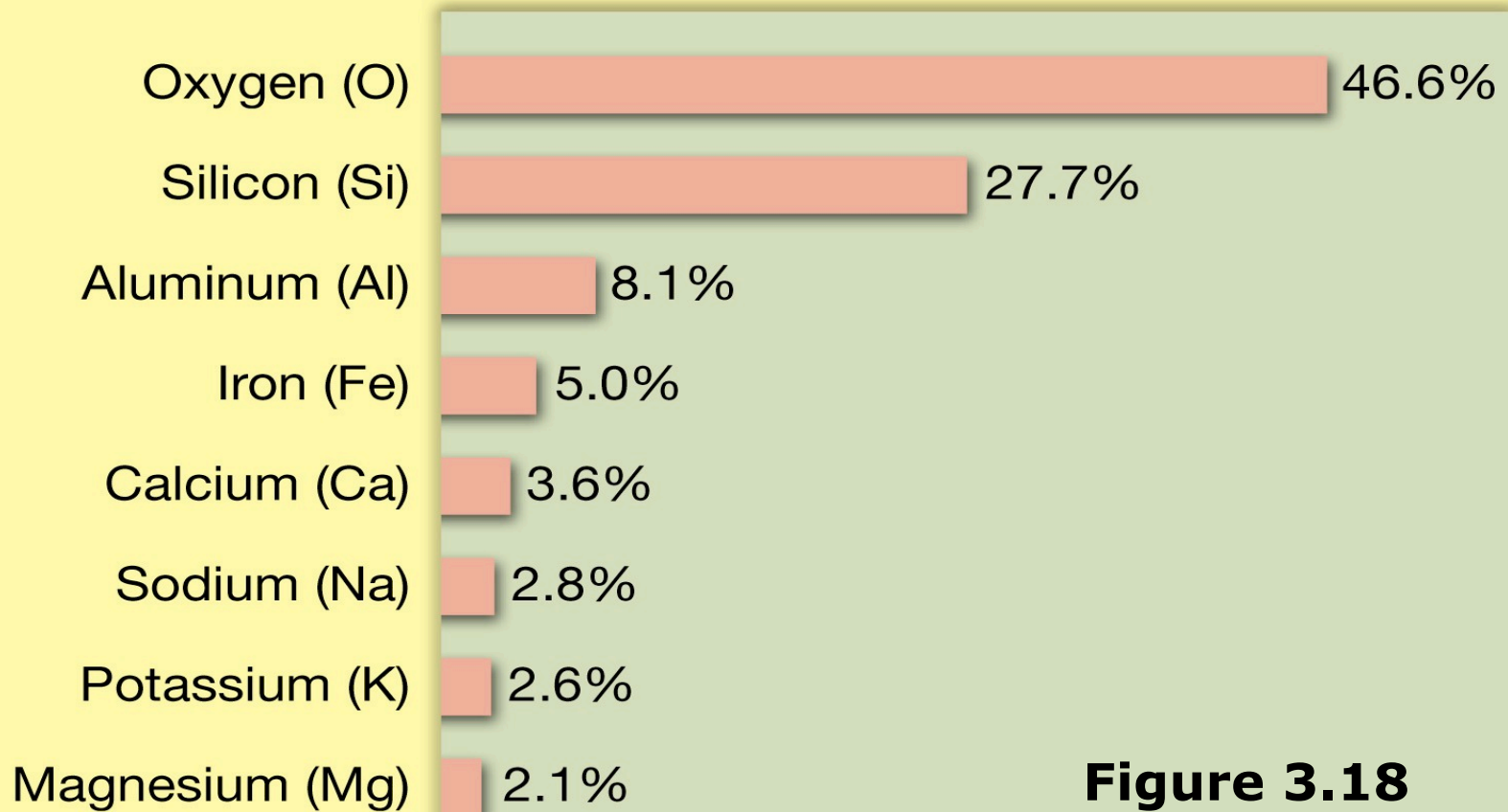
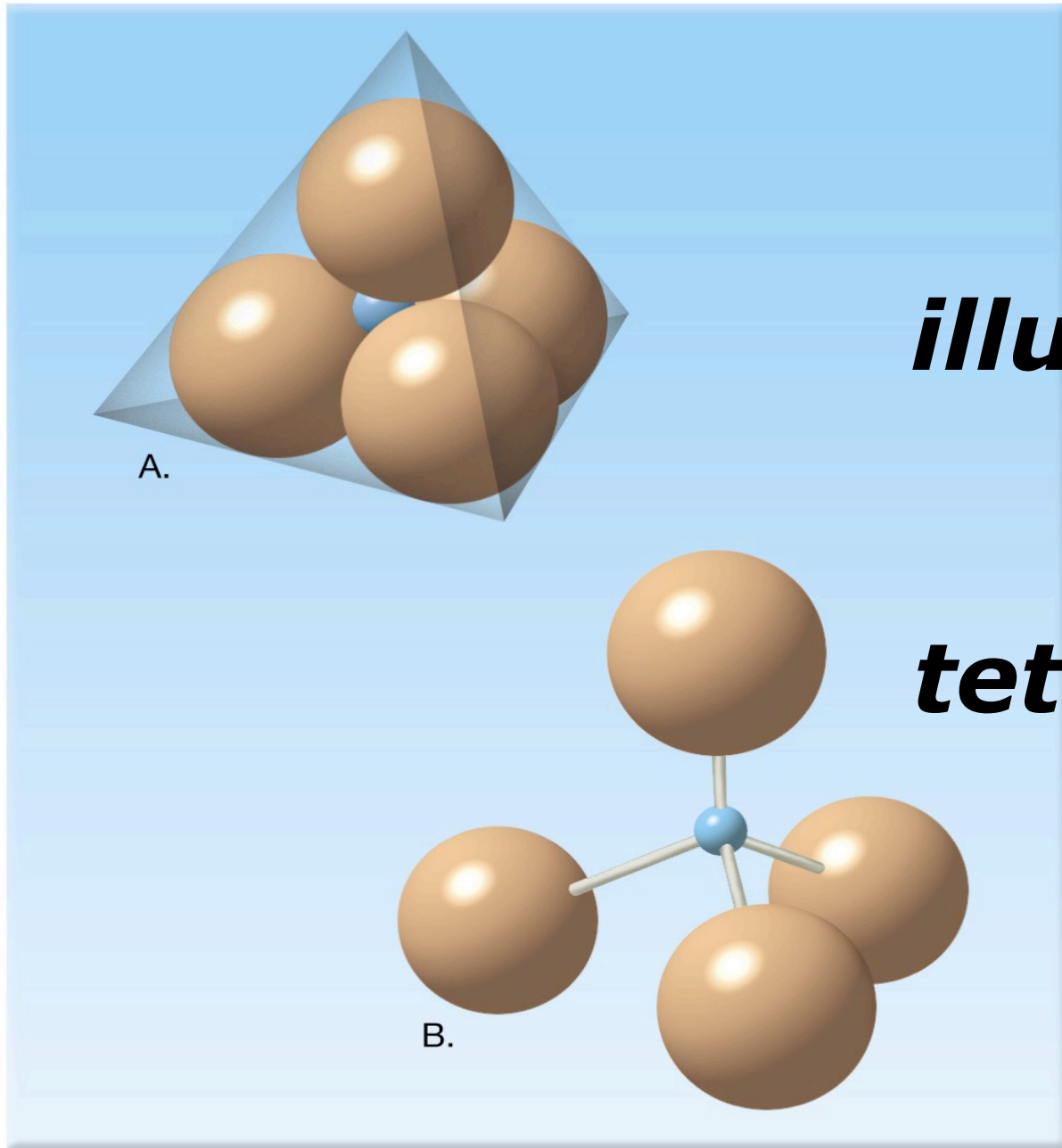


Figure 3.18

Mineral groups

Importance of Si and O

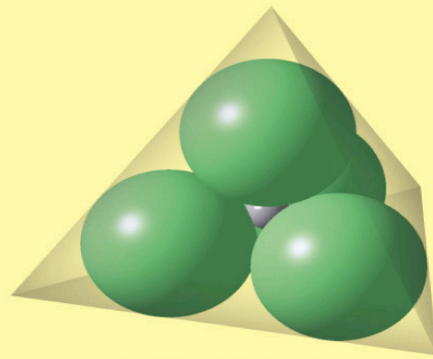
- **The Silicate Minerals**
- **The Non Silicate Minerals**



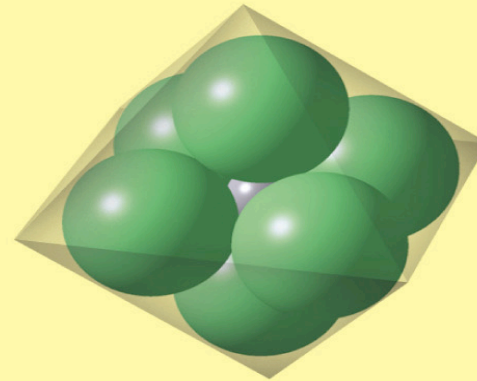
***Two
illustrations
of the
Si-O
tetrahedron***

Figure 3.19

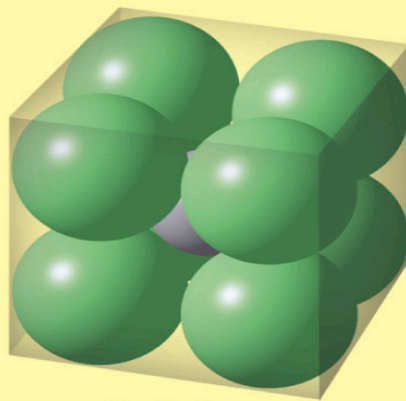
Geometric packing of various ions



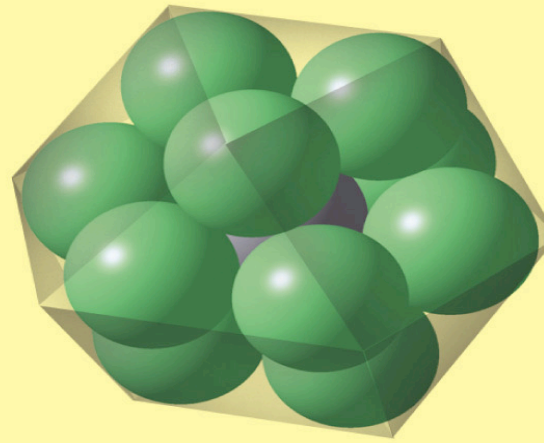
A. Tetrahedron



B. Octahedron



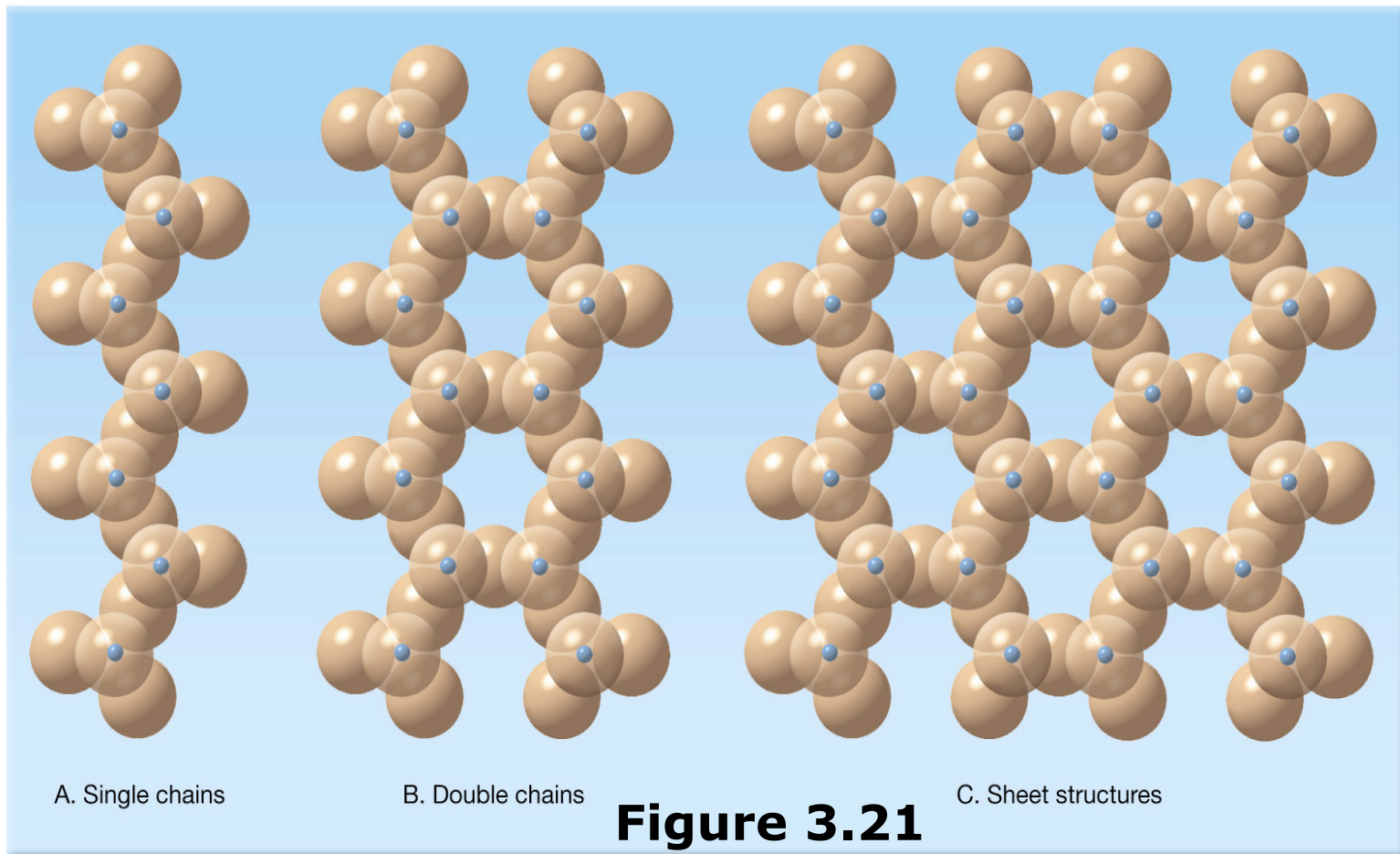
C. Cube



D. Cuboctahedron

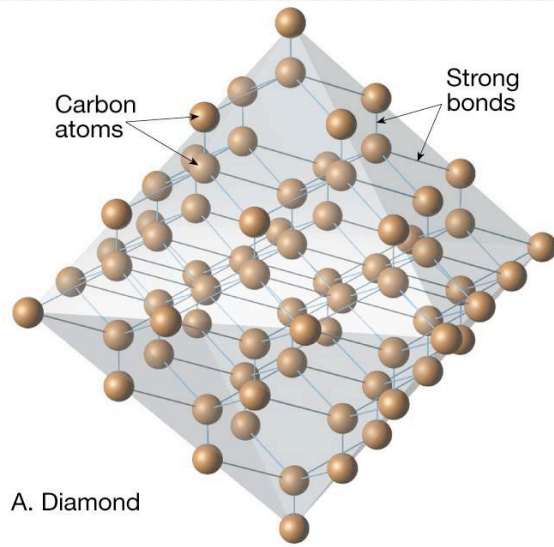
Figure 3.8

Three types of silicate structures



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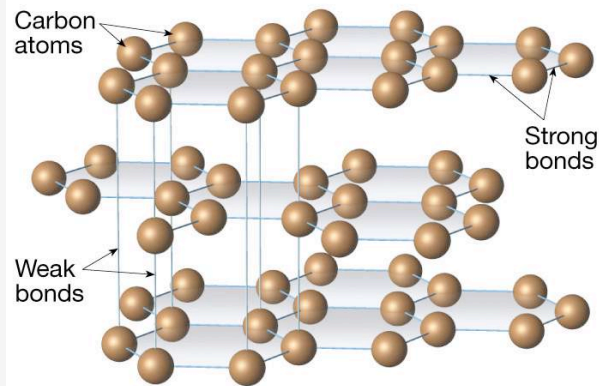
Diamond vs Graphite



A. Diamond



Diamond

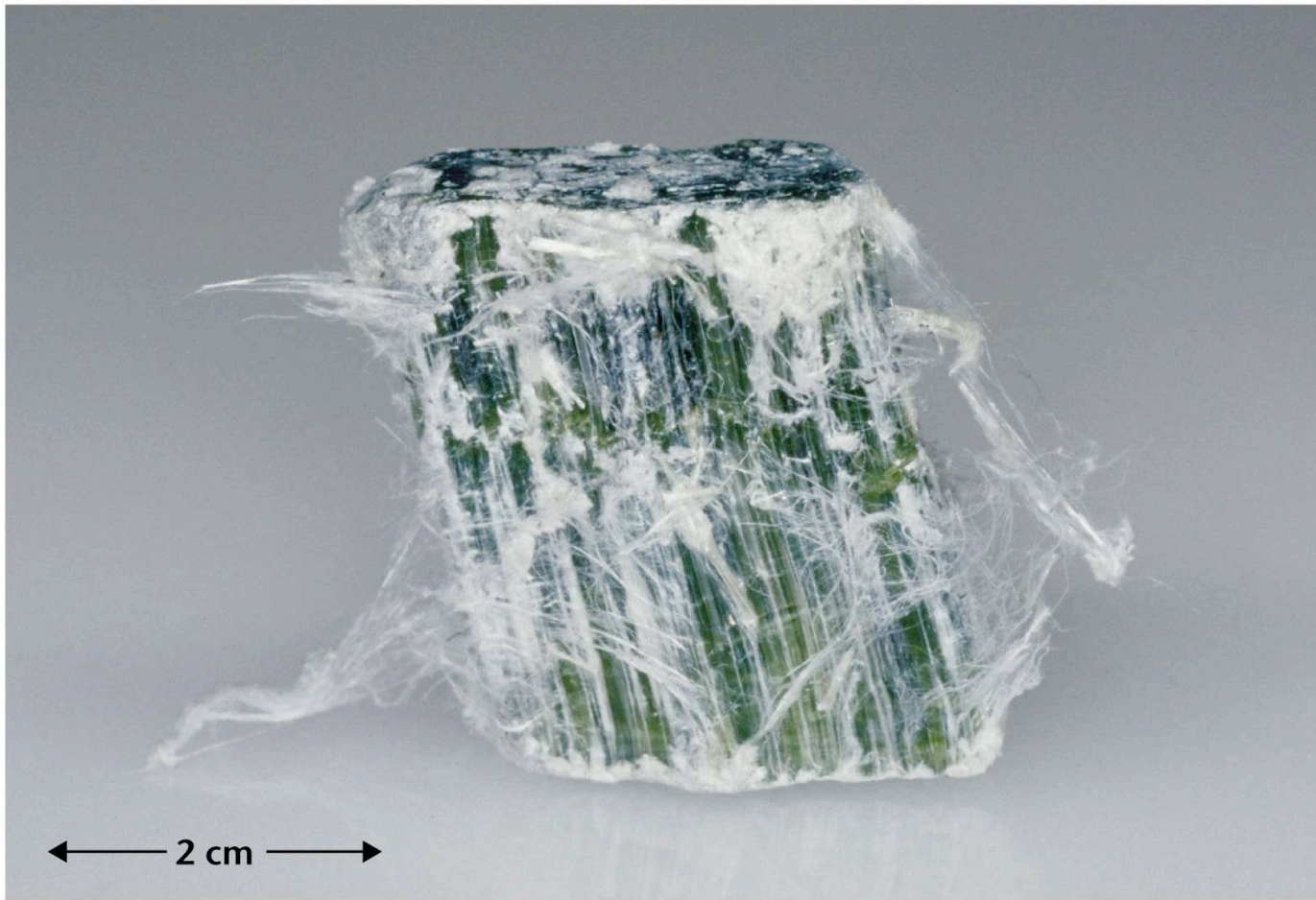


B. Graphite



Graphite

Asbestos



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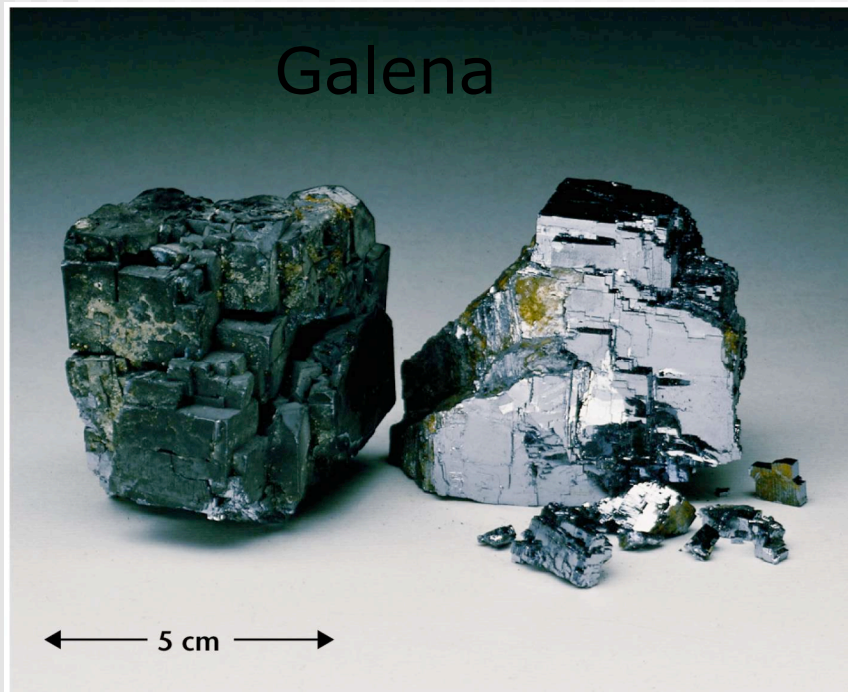
TABLE 3. Common Nonsilicate Mineral Groups

Mineral Groups key (anion(s) or element(s))	Mineral Name	Chemical Formula	Economic Use
Carbonates (CO_3^{2-})	Calcite	CaCO_3	Portland cement, lime
	Dolomite	$\text{CaMg}(\text{CO}_3)_2$	Portland cement, lime
Halides (Cl^- , F^- , Br^-)	Halite	NaCl	Common salt
	Fluorite	CaF_2	Used in steel making
	Sylvite	KCl	Fertilizer
Oxides (O^{2-})	Hematite	Fe_2O_3	Ore of iron, pigment
	Magnetite	Fe_3O_4	Ore of iron
	Corundum	Al_2O_3	Gemstone, abrasive
	Ice	H_2O	Solid form of water
Sulfides (S^{2-})	Galena	PbS	Ore of lead
	Sphalerite	ZnS	Ore of zinc
	Pyrite	FeS_2	Sulfuric acid production
	Chalcopyrite	CuFeS_2	Ore of copper
	Cinnabar	HgS	Ore of mercury
Sulfates (SO_4^{2-})	Gypsum	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	Plaster
	Anhydrite	CaSO_4	Plaster
	Barite	BaSO_4	Drilling mud
Native elements (single elements)	Gold	Au	Trade, jewelry
	Copper	Cu	Electrical conductor
	Diamond	C	Gemstone, abrasive
	Sulfur	S	Sulfa drugs, chemicals
	Graphite	C	Pencil lead, dry lubricant
	Silver	Ag	Jewelry, photography
	Platinum	Pt	Catalyst

Table 3.2

Mineral groups

- **Important nonsilicate minerals**
 - **Metals and Non Metals**



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Physical properties of minerals

- **Primary diagnostic properties**
 - **Determined by observation or performing a simple test**
 - **Several physical properties are used to identify hand samples of minerals**

Physical properties of minerals

- **Color**
- **Streak**
- **Hardness**
- **Magnetism**
- **Taste**
- **Acid Reaction**
- **Radioactivity, etc**



End of Chapter 3
