

*Minerals: Building
Blocks of Rocks
Chapter 1*

WHAT IS A MINERAL?

- Do we need Minerals? What for?
- Name something made from Minerals
- How to go from Elements to Minerals to Rocks?
- Can we live without Minerals?

Minerals are building blocks of rocks

A. Mineral Definition

- 1. Natural** not man made
- 2. Inorganic** not a living thing
- 3. Solid** like a rock
- 4. Crystalline structure** (internal order of atoms)
- 5. Definite chemical composition**

B. Mineraloid is a mineral that lacks a crystalline structure

C. Rocks are aggregates of minerals

Minerals are Made of Chemical Elements (Atoms)

A. Elements

1. Basic building blocks of minerals
2. Over 100 are known

B. Atoms

1. Smallest particles of matter
2. Have all the characteristics of an element

Periodic table of the Elements

1																	VIII A		
1	H 1.0080 Hydrogen																2		
	IA	IIA											III A	IV A	VA	VI A	VII A	VIII A	
2	3	4											5	6	7	8	9	10	
	Li	Be											B	C	N	O	F	Ne	
	6.939 Lithium	9.012 Beryllium											10.81 Boron	12.011 Carbon	14.007 Nitrogen	15.9994 Oxygen	18.998 Fluorine	20.183 Neon	
3	11	12	III B	IV B	V B	VI B	VII B	VIII B			B	II B	13	14	15	16	17	18	
	Na	Mg										Al	Si	P	S	Cl	Ar		
	22.990 Sodium	24.31 Magnesium										26.98 Aluminum	28.09 Silicon	30.974 Phosphorus	32.064 Sulfur	35.453 Chlorine	39.948 Argon		
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
	39.102 Potassium	40.08 Calcium	44.96 Scandium	47.90 Titanium	50.94 Vanadium	52.00 Chromium	53.94 Manganese	55.85 Iron	58.93 Cobalt	58.71 Nickel	63.54 Copper	65.37 Zinc	69.72 Gallium	72.59 Germanium	74.92 Arsenic	78.96 Selenium	79.909 Bromine	83.80 Krypton	
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
	85.47 Rubidium	87.62 Strontium	88.91 Yttrium	91.22 Zirconium	92.91 Niobium	95.94 Molybdenum	(99) Technetium	101.1 Ruthenium	102.90 Rhodium	106.4 Palladium	107.87 Silver	112.40 Cadmium	114.82 Indium	118.69 Tin	121.75 Antimony	127.60 Tellurium	126.90 Iodine	131.30 Xenon	
6	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
	Cs	Ba	TO 71	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
	132.91 Cesium	137.34 Barium		178.49 Hafnium	180.95 Tantalum	183.85 Tungsten	186.2 Rhenium	190.2 Osmium	192.2 Iridium	195.09 Platinum	197.0 Gold	200.59 Mercury	204.37 Thallium	207.19 Lead	208.98 Bismuth	(210) Polonium	(210) Astatine	(222) Radon	
7	87	88	89																
	Fr	Ra	TO 103	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	
	(223) Francium	226.05 Radium		LA	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
				138.91 Lanthanum	140.12 Cerium	140.91 Praseodymium	144.24 Neodymium	(147) Promethium	150.35 Samarium	151.96 Europium	157.25 Gadolinium	158.92 Terbium	162.50 Dysprosium	164.93 Holmium	167.26 Erbium	168.93 Thulium	173.04 Ytterbium	174.97 Lutetium	
				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) Actinium	232.04 Thorium	(231) Protactinium	238.03 Uranium	(237) Neptunium	(242) Plutonium	(243) Americium	(247) Curium	(249) Berkelium	(251) Californium	(254) Einsteinium	(253) Fermium	(256) Mendelevium	(254) Nobelium	(257) Lawrencium	

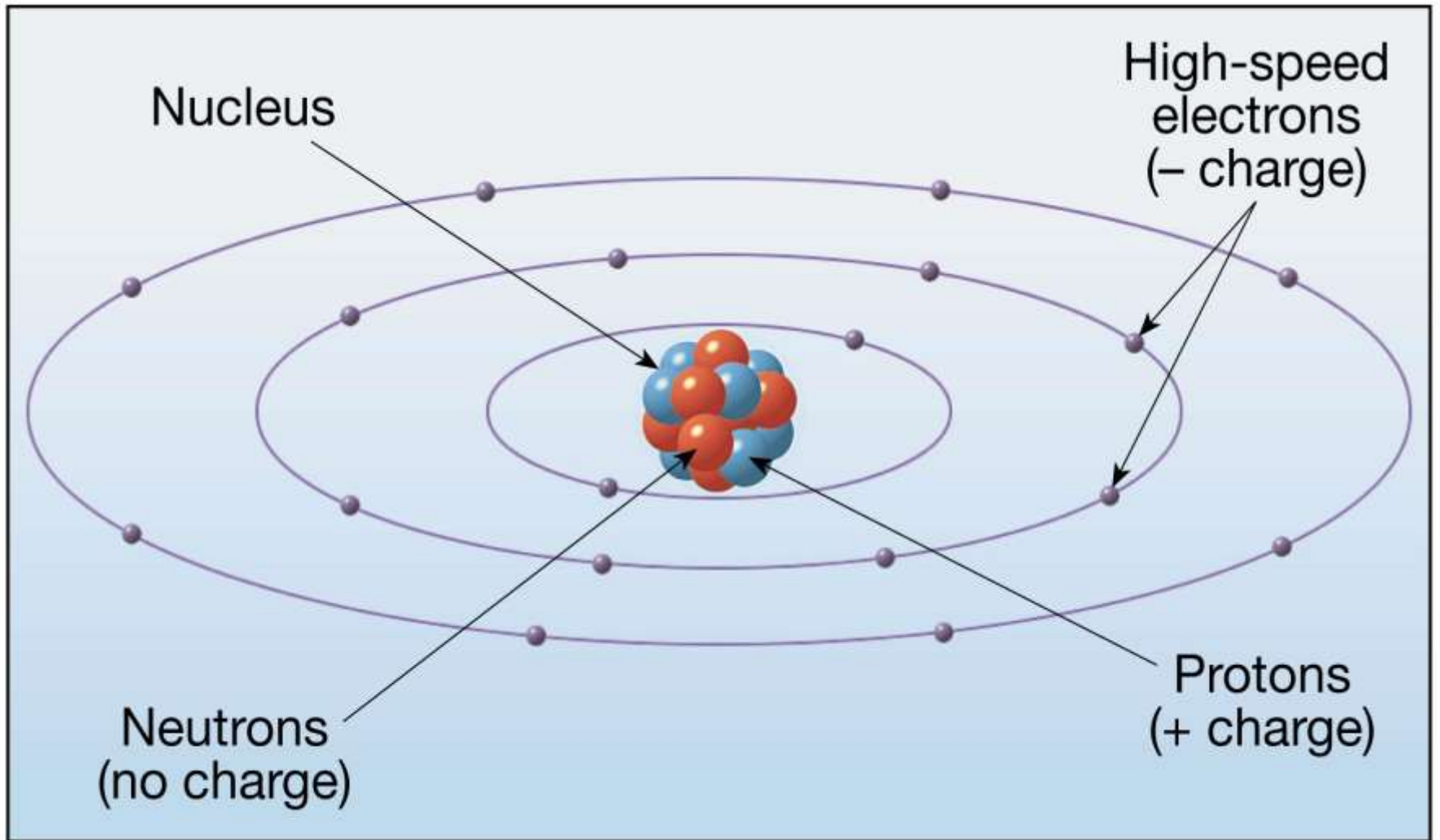
 Metals
 Transition metals
 Nonmetals
 Noble gases
 Lanthanide series
 Actinide series

2 ← Atomic number
He ← Symbol of element
4.003 ← Atomic weight
Helium ← Name of element

Atomic Structure

- A. **Nucleus** – central part of an atom that contains
 1. **Protons** – positive electrical charges
 2. **Neutrons** – neutral electrical charges
- B. Energy levels, or **shells**
 1. Surround nucleus
 2. Contain **electrons** – negative electrical charges

Simplified view of the atom



A.

How atoms are constructed

C. Atomic Number is the number of protons in an atom's nucleus = Charge of the Atom

D. Bonding of atoms

1. Forms a compound with two or more elements.

2. Ions are atoms that gain or lose electrons.

❖ Ions Atoms that have gained (Anion) or lost (Cation) one or more electrons

How atoms are constructed

❖ Isotopes

- Have different mass numbers – the sum of the neutrons plus protons (atomic weight)
- Many isotopes are radioactive and emit energy and particles

Minerals

A. Physical properties of minerals

1. Crystal form – the internal structure of a mineral defined by its atomic arrangement.
2. Luster – how a mineral sample reflects light
Metallic or Nonmetallic
3. Color – simply the color of a sample. Many mineral varieties appear as different colors.
4. Streak – the color of a mineral's powder
5. Hardness – the resistance of a mineral to be scratched by another mineral Scale of 1 - 10

TABLE 2.2 Mohs Scale of Hardness

Relative Scale		Mineral	Hardness of Some Common Objects
Hardest	10	Diamond	
	9	Corundum	
	8	Topaz	
	7	Quartz	
	6	Potassium Feldspar	
	5	Apatite	5.5 Glass, Pocketknife
	4	Fluorite	
	3	Calcite	3 Copper Penny
	2	Gypsum	2.5 Fingernail
	Softest	1	Talc

What are the two minerals your fingernail can scratch?

1. Calcite and Gypsum

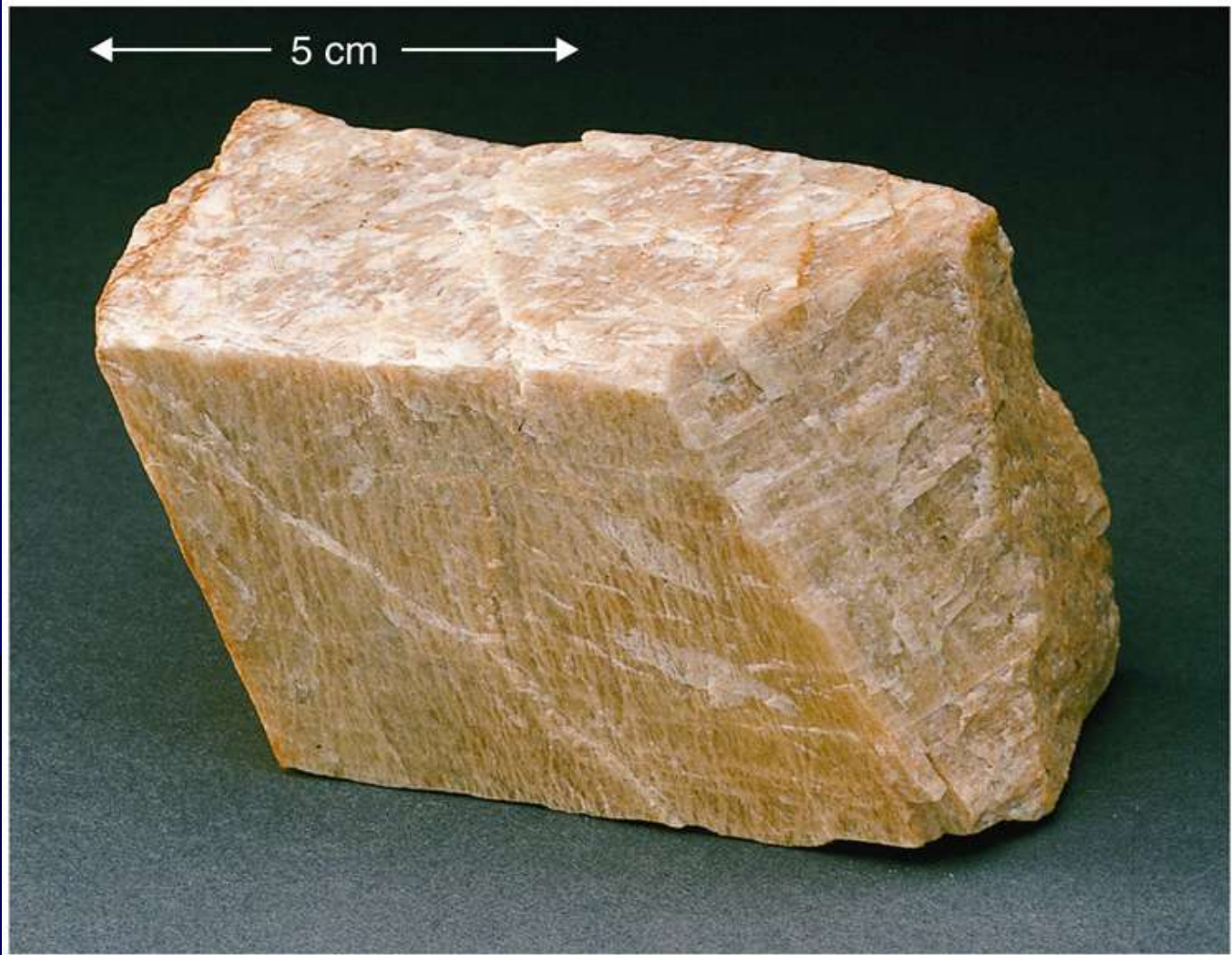
2. Gypsum and Talc

3. Talc and Calcite

What is the luster displayed by this mineral ?



Potassium feldspar



Minerals

❖ Physical properties of minerals

6. Cleavage – tendency of a mineral to break along smooth faces or surfaces
7. Fracture – tendency of a mineral to break along rough, uneven faces or surfaces
8. Specific gravity – unit-less measure comparing density of 1 cc of mineral to 1 cc of water

Does this quartz crystal exhibit crystal form or cleavage faces, why?

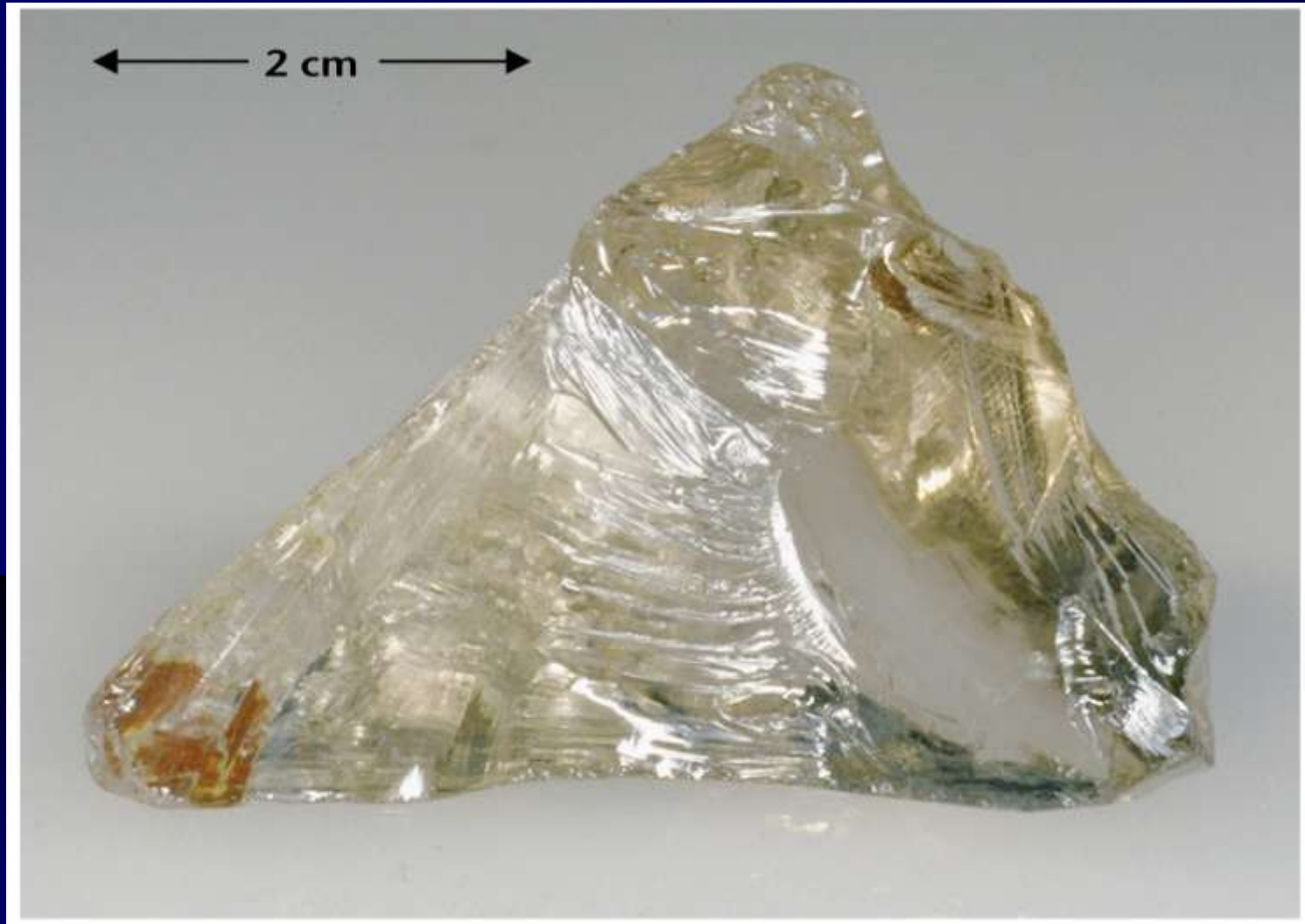


A.

*Fluorite (left), Halite (center), and
Calcite (right): do they show
a perfect cleavage?*



Quartz with a conchoidal fracture
Does this mineral have cleavage?



Mineral Identification

❖ 9. Other properties

a. Taste

b. Smell

c. Elasticity

d. Malleability

e. Feel

f. Magnetism

g. Double refraction

h. Reaction to hydrochloric acid

i. Radioactivity

B. A few dozen minerals are called the Rock Forming Minerals:

Are common minerals found in all igneous rocks

1. The eight elements that compose most rock-forming minerals are
 - a. oxygen (O),
 - b. silicon (Si),
 - c, aluminum (Al),
 - d. iron (Fe),
 - e. calcium (Ca),
 - f. sodium (Na),
 - g. potassium (K),
 - h. magnesium (Mg)

Table 2.3 Relative abundance of the most common elements in the continental crust

Element	Approximate Percentage by Weight
Oxygen (O)	46.6
Silicon (Si)	27.7
Aluminum (Al)	8.1
Iron (Fe)	5.0
Calcium (Ca)	3.6
Sodium (Na)	2.8
Potassium (K)	2.6
Magnesium (Mg)	2.1
All others	1.5
Total	100

Source: Data from Brian Mason.

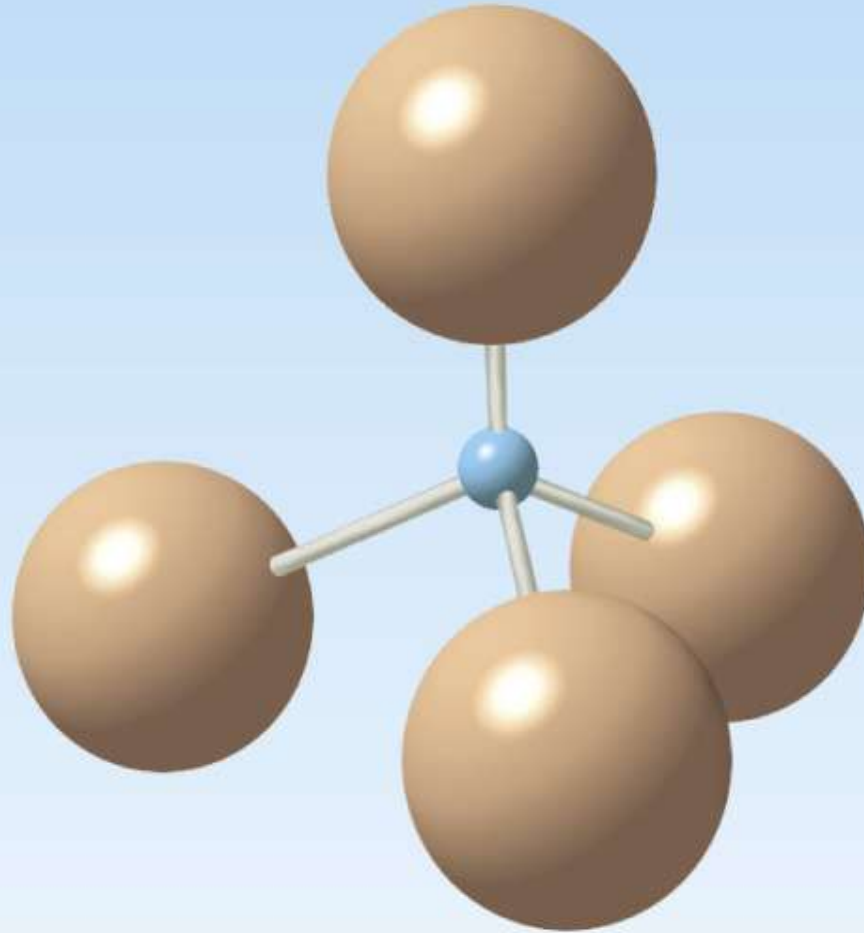
C. *Mineral Groups*

1. Rock-forming silicates

- a. Are the most common mineral group
- b. Contain the silicon-oxygen tetrahedron
 1. Four oxygen atoms surrounding a much smaller silicon atom
 2. Combines with other atoms to form the various silicate structures

Form from a magma or lava (molten rock)

The silicate $(\text{SiO}_4)^{-4}$ molecule



❖ Non Silicate Mineral Group

- Major groups
 - Oxides – minerals composed of oxygen and some other elements except sulfur, silicon, or carbon. (Hematite, Limonite)
 - Sulfides – minerals composed of sulfur and some other elements except oxygen, silicon or carbon. (Galena, Pyrite)
 - Sulfates – minerals composed of sulfur and 4 oxygen atoms and some other elements except silicon or carbon. (Gypsum)



Hematite – Oxide Mineral

Galena – Sulfide Mineral





Sulfur – Native Mineral

Fluorite – Halide Mineral



❖ Non Silicate mineral groups

- Major groups
 - Halides – minerals composed of combinations of chlorine, bromine, or fluorine with some other elements except oxygen, carbon, sulfur, or silicon. (Halite, Fluorite)
 - Carbonates – minerals composed of carbon and oxygen and some other elements except sulfur or silicon. (Calcite, Dolomite)
 - “Native” elements – minerals composed of a single element (Sulfur, Graphite)

Native Copper



b. Carbonates

1. A major rock-forming group
2. Found in the rocks **limestone** and **marble**

c. **Halite** and **gypsum** are found in sedimentary rocks

d. Many have economic value

Some common non-silicate minerals

Calcite



Halite



Gypsum



Diamonds

- Are made of pure carbon like graphite minerals
- Form at High pressure, high temperature deep underground unlike graphite
- Only 20% of diamonds traded are used in jewelry, the rest goes to industry

Mining Minerals

1. What are minerals used for?
2. How can we found them?
3. What Earth Scientists look for minerals?
4. What are the steps for mineral exploration?
5. Are we going to run out of mineral resources?

Minerals

D. Mineral resources

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

Steps for Mineral Exploration

❖ **Exploration Stage:**

1. Identify target on a Geological map
2. Collect rock samples for analysis
3. Use core drilling to confirm the presence of deposit underground

❖ **Feasibility Study:**

1. Evaluate the reserves of economic mineral found
2. Plan for the exploitation of the resource found

An underground halite (salt) mine



The Bingham copper mine in Utah

