CHAPTER 1: MINERALS: BUILDING BLOCKS OF ROCKS

I. MINERALS ARE USEFUL AND ESSENTIAL TO PEOPLE

A. PRACTICALLY EVERY MANUFACTURED PRODUCT CONTAINS MATERIALS OBTAINED FROM MINERALS

1. AL, CU, AU, SI, GRAPHITE, BABY POWDER, QUARTZ

II. MINERALS: THE BUILDING BLOCKS OF ROCKS

A. MINERAL DEFINITION

1. SOLID
2. INORGANIC
3. NATURALLY OCCURRING
4. CRYSTAL STRUCTURE - POSSESS AN ORDERLY INTERNAL STRUCTURE OF ATOMS
5. CHEMICAL COMPOSITION

B. *MINERALOID* - LACKS AN ORDERLY INTERNAL STRUCTURE

C. *ROCKS* ARE AGGREGATES (MIXTURES) OF MINERALS

1. *AGGREGATE* IMPLIES THAT THE MINERALS ARE JOINED IN A WAY THAT THE PROPERTIES OF EACH MINERAL ARE RETAINED
2. SOME ARE COMPOSED OF NONMINERAL MATTER
   A. OBSIDIAN, PUMICE AND COAL

III. COMPOSITION AND STRUCTURE OF MINERALS

A. NEARLY 4,000 MINERALS

B. ELEMENTS

1. BASIC BUILDING BLOCKS OF MINERALS
2. 112 ARE KNOWN, 92 ARE NATURALLY OCCURRING
3. SOME MINERALS ARE MADE ENTIRELY OF ONE ATOM
4. MOST ELEMENTS ARE NOT STABLE, AND THUS MOST MINERALS ARE A COMBINATION OF TWO OR MORE ELEMENTS JOINED TO FORM A CHEMICALLY STABLE COMPOUND

B. ATOMS

1. SMALLEST PARTICLES OF MATTER
   A. *A* = NOT, *TOMOS* = CUT
2. HAVE ALL THE CHARACTERISTICS OF AN ELEMENT

IV. HOW ATOMS ARE CONSTRUCTED

A. NUCLEUS, WHICH CONTAINS

1. PROTONS^{+} = POSITIVE ELECTRICAL CHARGES
2. NEUTRONS^{0} = NEUTRAL ELECTRICAL CHARGES

B. ENERGY LEVELS, OR SHELLS

1. SURROUND NUCLEUS
2. CONTAIN SPECIFIC NUMBER OF ELECTRONS^{-}

B. ATOMIC NUMBER IS THE NUMBER OF PROTONS IN AN ATOM'S NUCLEUS

1. ALL ATOMS WITH 6 P^{+} ARE CARBON

D. BONDING OF ATOMS

1. FORMS A COMPOUND WITH TWO OR MORE ELEMENTS BONDED TOGETHER IN DEFINITE PROPORTIONS
2. BONDING RESULTS IN A CHANGE IN THE ARRANGEMENT OF E^{-} IN THE SHELLS OF THE BONDED ATOMS
3. WHEN AN ATOMS COMBINES CHEMICALLY, IT EITHER GAINS, LOSES, OR SHARES E^{-}
    A. IONS ARE ATOMS THAT GAIN OR LOSE ELECTRONS
4. THE PROPERTIES OF A CHEMICAL COMPOUND ARE DRAMATICALLY DIFFERENT FROM THE PROPERTIES OF THE ELEMENTS COMPOSING IT.
    A. CL → GREEN, POISONOUS GAS
    B. NA → SOFT, SILVERY METAL THAT SEVERELY REACTS WITH WATER
        I. PRODUCES NACL

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

V. MINERALS

A. PROPERTIES OF MINERALS

1. CRYSTAL FORM
    A. THE EXTERNAL EXPRESSION OF A MINERAL'S INTERNAL ORDERLY ARRANGEMENT OF ATOMS
2. LUSTER
    A. APPEARANCE OR QUALITY OF LIGHT REFLECTED FROM THE SURFACE OF A MINERAL
        I. *METALLIC* → APPEARANCE OF A METAL

II. *NONMETALLIC*→ VITREOUS (GLASSY), PEARLY, SILKY, RESINOUS, EARTHY (DULL)

3. COLOR
   A. AN OBVIOUS, YET, UNRELIABLE PROPERTY
      I. SLIGHT IMPURITIES CAN CAUSE A VARIETY OF COLORS
4. STREAK
   A. COLOR OF A MINERAL IN ITS POWDERED FORM
      I. A MORE RELIABLE INDICATOR OF COLOR
   B. DETERMINED BY USING A STREAK PLATE
   C. METALLIC MINERALS GENERALLY HAVE A DENSE, DARK STREAK
5. HARDNESS
   A. A MEASURE OF THE RESISTANCE OF A MINERAL TO ABRASION OR SCRATCHING
   B. MOHS SCALE
      I. RANKS MINERALS FROM 1 – 10
      II. FINGERNAIL = 2.5
      III. CU PENNY = 3.5
      IV. GLASS, STEEL = 5.5
6. CLEAVAGE
   A. THE TENDENCY OF A MINERAL TO CLEAVE, OR BREAK, ALONG PLANES OF WEAK BONDING
      I. *KLEIBEN* = CARVE
      II. NOT ALL MINERALS HAVE DEFINITE PLANES OF WEAK BONDING
      III. THOSE WITH CLEAVAGE CAN BE IDENTIFIED BY THE DISTINCTIVE SMOOTH SURFACES THAT ARE PRODUCED WHEN THE MINERAL IS BROKEN
   B. WHEN MINERALS BREAK EVENLY IN MORE THAN ONE DIRECTION, CLEAVAGE IS DESCRIBED BY THE *NUMBER OF PLANES* EXHIBITED AND THE *ANGLES AT WHICH THEY MEET*
7. FRACTURE
   A. OCCURS WHEN MINERALS THAT DO NOT EXHIBIT CLEAVGE BREAK
      I. CONCHOIDAL FRACTURE – SMOOTH CURVED SURFACES
      II. MOST FRACTURE IRREGULARLY
8. SPECIFIC GRAVITY
   A. COMPARES THE WEIGHT OF A MINERAL TO THE WEIGHT OF AN EQUAL VOLUME OF WATER
   B. "HEFT"

C. USUALLY BETWEEN 2.5 & 3

D. SOME METALLIC MINERALS ARE HIGHER

I. GALENA ➔ 7.5

II. PURE 24K GOLD ➔ 20

9. OTHER PROPERTIES

A. MALLEABILITY

B. TASTE

C. ELASTICITY

D. SMELL

E. FLUORESCENCE

F. FEEL

G. MAGNETIC

H. DOUBLE REFRACTION

I. EFFERVESCENCE W/ HCL

J. RADIOACTIVITY

B. A FEW DOZEN MINERALS ARE CALLED THE ROCK-FORMING MINERALS

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 1.2 Relative abundance of the most common elements in Earth's 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	1.7
Total	100

Source: Data from Brian Mason.

2. MOST ABUNDANT ATOMS IN EA

A. OXYGEN (46.6% BY WEIGHT

B. SILICON (27.7% BY WEIGHT)

C. MINERAL GROUPS

1. ROCK-FORMING SILICATES

A. MOST COMMON MINERAL GROUP

B. CONTAIN THE SILICON-OXYGEN TETRAHEDRON (*TETRA* = FOUR, *HEDRA* = A BASE)

I. FOUR OXYGEN ATOMS SURROUNDING A MUCH SMALLER SILICON ATOM

II. MILLIONS JOIN TOGETHER IN A VARIETY OF WAYS: SHEETS, CHAINS OR 3-D NETWORKS

C. GROUPS BASED UPON TETRAHEDRON ARRANGEMENT

I. OLIVINE ➔ INDEPENDENT TETRAHEDRON

II. PYROXENE GROUP → TETRAHEDRON ARE ARRANGED IN CHAINS

III. AMPHIBOLE GROUP → TETRAHEDRON ARE ARRANGED IN DOUBLE CHAINS

IV. MICAS

A. TETRAHEDRON ARE ARRANGED IN SHEETS

B. TWO TYPES OF MICA

1. BIOTITE (DARK) AND

2. MUSCOVITE (LIGHT)

V. FELDSPARS

FERROMAGNESIAN	*NONFERROMAGNESIAN*
▪ FE & MG ▪ DARK IN COLOR ▪ GREATER SPECIFIC GRAVITY *3.2 – 3.6 ▪ OLIVINE, BIOTITE, GARNET	▪ VARYING AMOUNTS OF AL, K, CA, NA ▪ LIGHT IN COLOR ▪ SPECIFIC GRAVITY ≈ 2.7 ▪ FELDSPAR – MOST COMMON *ORTHOCLASE – K, CREAM TO SALMON *PLAGIOCLASE – NA & CA WHITE TO MED GRAY WITH STRIATIONS

A. THREE-DIMENSIONAL NETWORK OF TETRAHEDRON

B. TWO TYPES OF FELDSPARS

1. ORTHOCLASE AND

2. PLAGIOCLASE

VI. QUARTZ → THREE-DIMENSIONAL NETWORK OF TETRAHEDRON

A. BONDS ARE EQUALLY STRONG IN ALL DIRECTIONS = FRACTURE

D. FELDSPARS ARE THE MOST PLENTIFUL MINERAL GROUP → 50% OF CRUST

E. CRYSTALLIZE FROM MOLTEN MATERIAL

2. NONSILICATE MINERALS – ¼™ OF CONTINENTAL CRUST

A. MAJOR GROUPS

I. OXIDES: HEMATITE, MAGNETITE, CORUNDUM, ICE

II. SULFIDES: GALENA, PYRITE, CHALCOPYRITE

III. SULFATES: GYPSUM, BARITE

IV. HALIDES: HALITE, FLUORITE

V. CARBONATES: CALCITE, DOLOMITE

VI. "NATIVE" ELEMENTS: AU, CU, C, S, AG, PT

B. CARBONATES

I. A MAJOR ROCK-FORMING GROUP

II. FOUND IN THE ROCKS LIMESTONE AND MARBLE

C. HALITE AND GYPSUM ARE FOUND IN THICK LAYERS, WHICH ARE THE LAST VESTIGES OF ANCIENT SEAS THAT EVAPORATED

D. MANY HAVE ECONOMIC VALUE

D. MINERAL RESOURCES

1. RESERVES ARE ALREADY IDENTIFIED DEPOSITS
   A. MINERALS CAN BE EXTRACTED PROFITABLY
2. ORES ARE USEFUL METALLIC MINERALS THAT CAN BE MINED AT A PROFIT
   A. TO BE CONSIDERED OF VALUE, AN ELEMENT MUST BE CONCENTRATED ABOVE THE LEVEL OF ITS AVERAGE CRUSTAL ABUNDANCE
      I. CU MAKES UP 0.0135% OF CRUST, CU ORE MUST CONTAIN A CONCENTRATION THAT IS ABOUT 100X THIS AMOUNT
3. ECONOMIC FACTORS MAY CHANGE AND INFLUENCE A RESOURCE

Table 1.B Important gemstones.

Gem	Mineral Name	Prized Hues
Precious		
Diamond	Diamond	Colorless, yellows
Emerald	Beryl	Greens
Opal	Opal	Brilliant hues
Ruby	Corundum	Reds
Sapphire	Corundum	Blues
Semiprecious		
Alexandrite	Chrysoberyl	Variable
Amethyst	Quartz	Purples
Cat's-eye	Chrysoberyl	Yellows
Chalcedony	Quartz (agate)	Banded
Citrine	Quartz	Yellows
Garnet	Garnet	Reds, greens
Jade	Jadeite or nephrite	Greens
Moonstone	Feldspar	Transparent blues
Peridot	Olivine	Olive greens
Smoky quartz	Quartz	Browns
Spinel	Spinel	Reds
Topaz	Topaz	Purples, reds
Tourmaline	Tourmaline	Reds, blue-greens
Turquoise	Turquoise	Blues
Zircon	Zircon	Reds