



### Mineral Deposits

- 1) Non-Metallic or Industrial Minerals
- 2) Metallic or Ore deposits

### Industrial Minerals

- 1) Abrasives: diamonds, corundum, garnet, quartz
- 2) Ceramic raw materials: shale, clay minerals, feldspar, quartz, zircon, graphite
- 3) Fertilizers: phosphate, k-minerals, gypsum, nitrates, sulfur
- 4) Fluxes: fluorite, silica, limestone
- 5) Construction: aggregate, cement, dimension stone, insulation
- 6) Electronic and Optical: quartz, calcite, magnetite
- 7) Fillers, Filters, absorbent: pumice, perlite, kaolinite, diatomite, zeolites
- 8) Gemstones: diamond, ruby, sapphire, emerald, quartz, jade, opal
- 9) Mineral Pigments: limonite, hematite, magnetite, rutile
- 10) Drilling Fluid: barite, bentonite, perlite, gypsum

### Metallic Mineral Deposits

- Metal ions bonded with sulfide ( $S_2$ ), oxide ( $O_2$ ), or silicate ( $SiO_4$ ) or in their native state, such as gold.

- Copper  $CuS$ ,
- Iron  $Fe_2O_3$
- Nickel  $Ni_3Si_2O_5(OH)_4$

### Ore Deposits

- Ore: aggregate of metallic minerals that can be mined economically for a profit.
- Gangue: waste minerals left after the ore minerals are removed

### Ore Deposits Status Depends on:

- Economy, technology, and politics

**Example:** Copper price fell drastically in the late 1970's due to:

- 1) Economic factors: Chile and Zimbabwe major new source of cheap copper
- 2) Technologic advance: plastic tubing (PVC) produced widely and cheaply

**Result:** Many US copper mines in the Southwest closed down because their deposits were no longer "ore grade"

### Geologic Processes that "High Grade" Metallic Mineral Deposits

#### Igneous Processes

- 1) Gravity settling or fractionation
- 2) Hydrothermal Fluids
- 3) Contact Metamorphism

#### Sedimentary Processes

- 1) Chemical precipitates
- 2) Diagenetic/stratabound deposits
- 3) Sedimentary deposits (Placer deposits)
- 4) Weathering deposits

### Igneous Processes: Gravity Settling/Fractionation

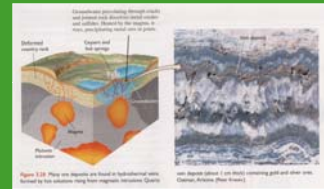
- Heavy metallic minerals settle to bottom of magma chamber and concentrate on the bottom of the pluton.



- Example: Magnetite(Fe), Nickel(Ni), Chromium (Cr), Platinum(Pt)

### Igneous Processes: Hydrothermal Fluids

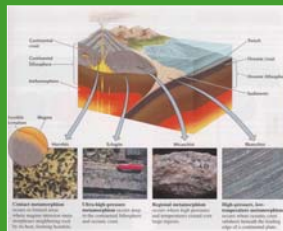
- Hot fluids circulating around cooling pluton



- Example: Gold(Au), Silver(Ag), Copper(Cu), Lead(Pb) associated with quartz or calcite

### Igneous Processes: Contact Metamorphism

- Intrusion heats up or partially melts surrounding country rock concentrating metallic minerals
- Common ores: Copper (Cu), Gold (Au)



### Sedimentary Processes: Chemical Precipitation

- Metallic minerals precipitate directly from surface waters.



**Example:** Banded Iron Formation (Precambrian >2by old) Interlayered chert (SiO<sub>2</sub>) and Hematite (Fe<sub>2</sub>O<sub>3</sub>) that precipitated directly from ocean waters when ocean chemistry was very different than today.

### Sedimentary Processes: Stratabound or Diagenetic

- Form when hydrothermal fluids react with groundwater systems

**Example:** Uranium ore concentrated in sandstones at water table in 4-corners area.



### Sedimentary Processes: Weathering

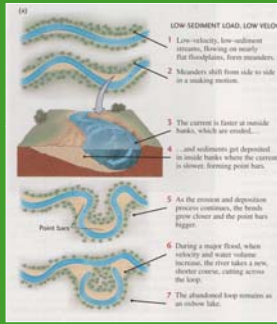


**Example:** Bauxite (Al(OH)<sub>3</sub>) deposits in lateritic soils

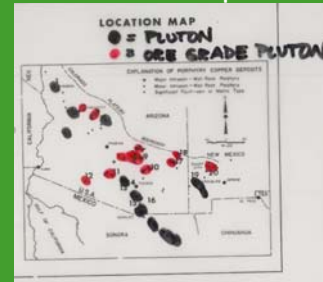
### Sedimentary Processes: Placer Deposits

- Metals concentrated by river depositional processes on point bars.

**Example:** Witwatersrand gold deposits of South Africa



### Plate Tectonics and Ore Deposits



**Example:** Copper Porphyry deposits of Arizona and New Mexico related to plutons associated with an old (70my) subduction zone.

### First gold discovery site on Witwatersrand



### Claim 32



### This gold mine is located in Johannesburg, South Africa

A city that at one time had the world's largest known gold deposits. The golden spoil heaps, the result of decades of gold extraction, are a typical sight in the city. Today Johannesburg has few gold mines, but extensive gold mining continues in the Witwatersrand, a rocky uplift region beyond the city.



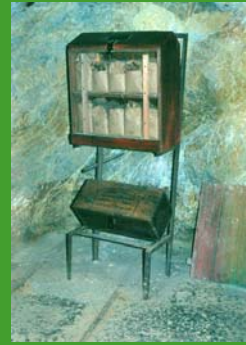
### The cable winding machinery to raise and lower the people and cargo containers into the mine



### Track in mine over a mile deep



### Mine explosive material storage



### The shoring timbers



### Walking through the mine corridor

