

Introduction to Mineral Processing

Introduction to Mineral Processing

Also called ore beneficiation, mineral dressing, or simply “processing”

1. What Is Mineral Processing?

- **Definition:** The series of physical and chemical operations that convert raw mined ore into a market-ready product (concentrate, metal, or refined mineral).
 - **Goal:** Separate valuable minerals from waste (gangue) while maximizing recovery, grade, and profitability, and minimizing environmental impact.
-

2. Why It Matters

Aspect	Reason
Economic	Increases the amount of metal that can be sold from a given ore body.
Resource Efficiency	Allows lower-grade deposits to become viable.
Environmental	Reduces waste volume, energy use, and tailings toxicity when optimized.
Regulatory	Meets legal limits on tailings, water discharge, and emissions.

3. Main Stages of a Mineral Processing Plant

1. **Comminution** – size reduction (crushing & grinding).
2. **Classification** – sorting particles by size (screens, cyclones, classifiers).
3. **Concentration** – increasing the proportion of valuable mineral (gravity, magnetic, flotation, leaching, etc.).
4. **Dewatering & Thickening** – removing water from concentrates and tailings (filters, thickeners, centrifuges).
5. **Tailings Management** – handling the waste stream safely (tailings ponds, dry stacking, backfilling).

Typical flow diagram

Introduction to Mineral Processing

Mine ? Crushing ? Grinding ? Classification ? Concentration ?
Dewatering ? Product

?
Tailings ? Management

4. Key Unit Operations

Operation	Principle	Typical Use
Crushing	Apply compressive force to break rocks.	Reduces run-of-mine (ROM) ore to < 200mm.
Grinding	Impact, attrition, or abrasion to produce fine particles.	Ball mills, SAG mills, HPGR – target 10–150µm for most ores.
Screening	Mechanical sieving to separate by size.	Primary/secondary screens for coarse fractions.
Hydrocyclones	Centrifugal forces separate particles by density & size.	Fine grinding classification (10–150µm).
Gravity Separation	Exploits density differences (e.g., jig, shaking table, spirals).	Precious metals, heavy minerals, coarse sulfides.
Magnetic Separation	Uses magnetic susceptibility.	Magnetite, ilmenite, iron-bearing gangue.
Flotation	Surface chemistry: reagents make target mineral hydrophobic, bubbles carry it to the surface.	Base-metal sulfides, many non-ferrous ores.
Leaching	Dissolves target mineral in a solvent (e.g., cyanide, acid).	Gold, copper, uranium, rare earths.
Thickening	Settles solids to a higher concentration.	Tailings and concentrate handling.
Filtration	Removes water from solids via pressure or vacuum.	Final concentrate drying.

5. Mineral Processing Terminology

Term	Meaning
Feed	Material entering a unit operation.

Introduction to Mineral Processing

Term

Meaning

Product (Concentrate) Material enriched in valuable mineral.

Tailings Residual waste after extraction.

Recovery % of the valuable mineral in the feed that ends up in the product.

Grade Concentration