

Introduction to Mineralogy

Introduction to Mineralogy

Fundamentals, classification, properties, and significance

1. What Is Mineralogy?

- **Definition** – The scientific study of minerals: naturally occurring, inorganic solids with a defined chemical composition and ordered atomic structure.
 - **Scope** – Includes identification, classification, physical & chemical properties, formation processes, and economic uses.
 - **Relation to other fields** – Overlaps with crystallography, petrology, geochemistry, materials science, and environmental science.
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2. Basic Concepts

Concept	Description
Mineral Species	A distinct chemical composition and crystal structure (e.g., quartz = SiO_2).
Mineral Group	A set of species sharing a similar structural framework (e.g., feldspar group).
Crystal Lattice	The three-dimensional arrangement of atoms repeated periodically.
Unit Cell	The smallest repeat unit of a crystal lattice; defined by lattice parameters (a, b, c, α , β , γ).
Polymorphism	Different crystal structures for the same chemical composition (e.g., calcite vs. aragonite, both CaCO_3).
Solid Solution	Continuous chemical variation between end-member minerals (e.g., olivine: $(\text{Mg,Fe})_2\text{SiO}_4$).

3. Classification of Minerals

3.1 By Chemical Composition (Dana & Strunz systems)

Class	Main Anions / Elements	Typical Examples
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Native Elements	Pure elements (metals, semimetals)	Gold (Au), Diamond (C)
Silicates	SiO ₂ tetrahedra	Quartz, Feldspar, Mica
Oxides	O ²⁻	Hematite (Fe ₂ O ₃), Rutile (TiO ₂)
Sulfides	S ²⁻	Pyrite (FeS ₂), Galena (PbS)
Carbonates	CO ₃ ²⁻	Calcite (CaCO ₃), Dolomite (CaMg(CO ₃) ₂)
Halides	Cl ⁻ , F ⁻ , Br ⁻	Halite (NaCl), Fluorite (CaF ₂)
Phosphates	PO ₄ ³⁻	Apatite (Ca ₅ (PO ₄) ₃ (F,Cl,OH))
Sulfates	SO ₄ ²⁻	Gypsum (CaSO ₄ ·2H ₂ O)
Phyllosilicates (sheet silicates)	SiO ₄ layers	Mica, Talc
Tectosilicates (framework silicates)	SiO ₄ framework	Quartz, Feldspar

3.2 By Crystal System

System	Axes & Angles	Representative Minerals
Cubic (Isometric)	$a = b = c; \alpha = \beta = \gamma = 90^\circ$	Halite, Pyrite
Tetragonal	$a = b \neq c; \alpha = \beta = \gamma = 90^\circ$	Zircon
Hexagonal	$a = b \neq c; \alpha = \beta = 90^\circ, \gamma = 120^\circ$	Beryl
Trigonal	$a = b \neq c; \alpha = \beta = 90^\circ, \gamma = 120^\circ$ (often treated as a subset of hexagonal)	Calcite

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