

Classification of Minerals

How are minerals classified?

Since the mid-nineteenth century, minerals have been systematically grouped into different chemical classes on the basis of their chemical composition.

Such groupings are based on the composition of the **dominant anion or anion complex**.

For example, minerals with sulfur, S^{2-} , as an anion are grouped under sulfides; those with $(SiO_4)^{4-}$, as an anionic group, are silicates.

The broadest classification subdivisions used in all mineralogical literature are based on the anionic unit in the chemical formula as indicated in the following:

Classes of minerals

- Native elements Au, Cu, Pt
- Sulfides ZnS, FeS₂, CuFeS₂
- Sulfosalts Cu₃AsS₄, Cu₁₂Sb₄S₁₃
- Oxides Al₂O₃, Fe₃O₄, TiO₂
- Hydroxides Mg(OH)₂, FeO(OH)
- Halides NaCl, KCl, CaF₂
- Carbonates CaCO₃, CaMg(CO₃)₂
- Phosphates Ca₅(PO₄)₃(F, Cl, OH)
- Sulfates CaSO₄·2H₂O
- Tungstates CaWO₄
- Silicates Mg₂SiO₄, Al₂SiO₅

Approximately 4150 minerals are known, of which 1140 are silicates; 624, sulfides and sulfosalts; 458, phosphates; 411, oxides and hydroxides; 234, carbonates; and 90, native elements.

In this text, we systematically review only about 85 minerals, of which the majority are silicates.

The remaining minerals are members of the carbonate, oxide, hydroxide, phosphate, sulfide, and native element classes.

The reason for this small number is that these 85 represent the most common minerals that enter into the composition of the most abundant rock types.

This small number of minerals is, therefore, referred to as the rock-forming minerals. Combinations of these minerals reflect the composition of the most common rock types, and they are the basis for rock classifications.

These data were provided by J. A. Mandarino, Toronto, Ontario, Canada in March 2006. A complete listing of all chemical classes is given in Klein and Dutrow, 2008, p. 333

Rock-forming minerals.

Over 4,000 minerals have been named, and several new ones are identified each year. Collectively, these few make up most of the rocks of Earth's crust and, as such, are often referred to as the **rock-forming minerals.**

Although less abundant, many other minerals are used extensively in the manufacture of products and are called *economic minerals.*

However, rock-forming minerals and economic minerals are not mutually exclusive groups.

When found in large deposits, some rock-forming minerals are economically significant. One example is the mineral calcite, which is the primary component of the sedimentary rock limestone and has many uses including being used in the production of cement.

It is worth noting that only eight elements make up the vast majority of the rock-forming minerals and represent more than 98 percent (by weight) of the continental crust (Figure 2.21). These elements, in order of abundance from most to least, are:

**oxygen (O),
aluminum (Al),
calcium (Ca),
potassium (K),**

**silicon (Si),
iron (Fe),
sodium (Na),
magnesium (Mg).**

As shown in **Figure 2.21**, silicon and oxygen are by far the most common elements in Earth's crust.

Furthermore, these two elements readily combine to form the basic "building block" for the most common mineral group, the silicates.

More than 800 silicate minerals are known, and they account for more than 90 percent of Earth's crust.

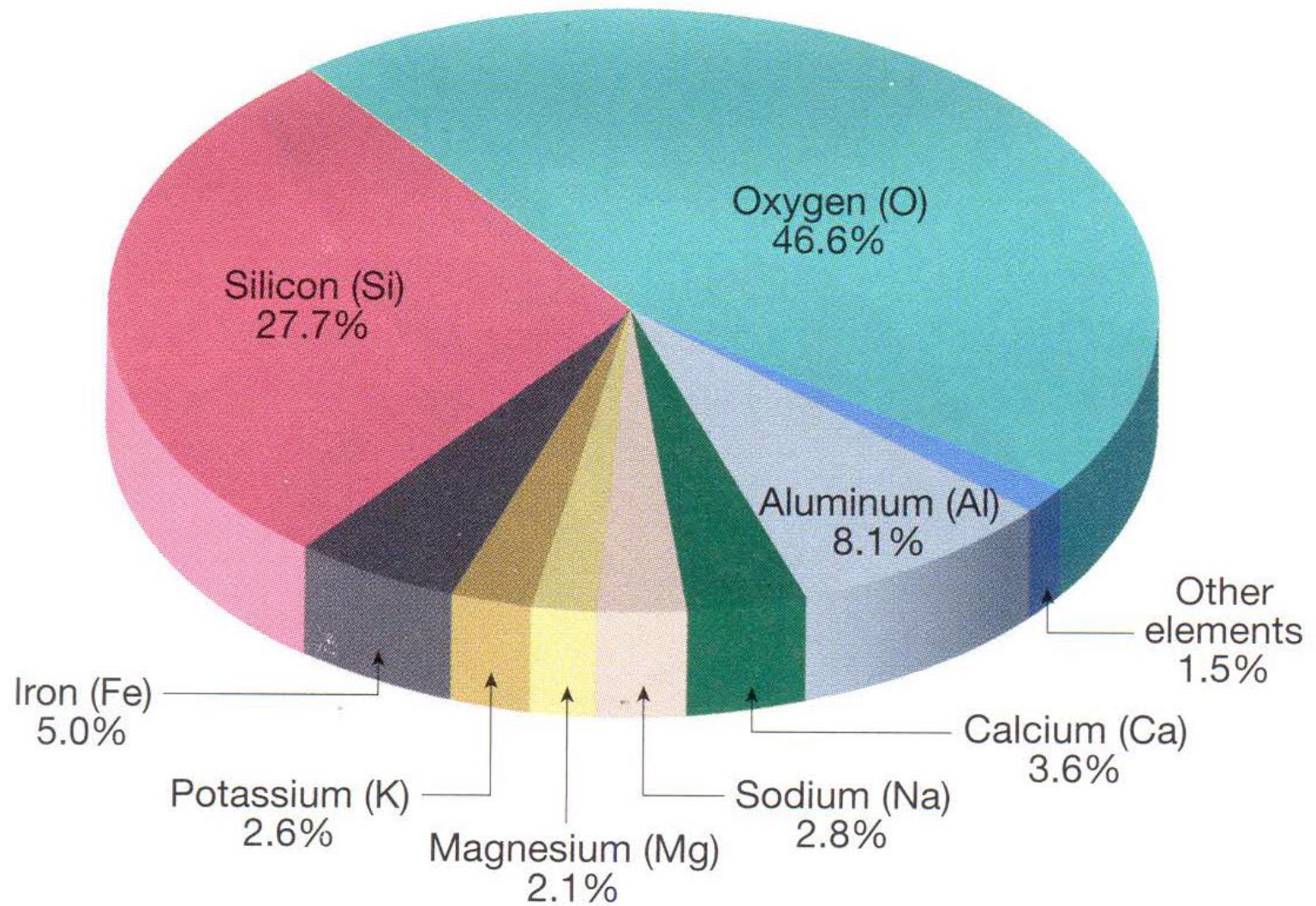


FIGURE 2.21 Relative abundance of the eight most common elements in the continental crust.

Nonsilicates Minerals

Because other mineral groups are far less abundant in Earth's crust than the silicates, they are often grouped together under the heading **nonsilicates.**

Although not as common as silicates, some nonsilicate minerals are very important economically. They provide us with iron and aluminum, gypsum, and copper.

Some common nonsilicate mineral groups include the:

- **Carbonates**
- **Sulphides**
- **Sulfates,**
- **Halides**
- **Oxides**
- **Native elements**

In addition to their economic importance, these mineral groups include members that are major constituents in sediments and sedimentary rocks.

TABLE 2.1 Common Nonsilicate Mineral Groups

Mineral Groups [key ion(s) or element(s)]	Mineral Name	Chemical Formula	Economic Use
Carbonates (CO_3^{2-})	Calcite	CaCO_3	Portland cement, lime
	Dolomite	$\text{CaMg}(\text{CO}_3)_2$	Portland cement, lime
Halides (Cl^- , F^- , Br^-)	Halite	NaCl	Common salt
	Fluorite (Fluorspar)	CaF_2	Hydrofluoric acid production, steelmaking
	Sylvite	KCl	Fertilizer
Oxides (O^{2-})	Hematite	Fe_2O_3	Ore of iron, pigment
	Magnetite	Fe_3O_4	Ore of iron
	Corundum	Al_2O_3	Gemstone, abrasive
	Ice	H_2O	Solid form of water
Sulfides (S^{2-})	Galena	PbS	Ore of lead
	Sphalerite	ZnS	Ore of zinc
	Pyrite	FeS_2	Sulfuric acid production
	Chalcopyrite	CuFeS_2	Ore of copper
	Cinnabar	HgS	Ore of mercury
Sulfates (SO_4^{2-})	Gypsum	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	Plaster
	Anhydrite	CaSO_4	Plaster
	Barite	BaSO_4	Drilling mud
Native elements (single elements)	Gold	Au	Trade, jewelry
	Copper	Cu	Electrical conductor
	Diamond	C	Gemstone, abrasive
	Sulfur	S	Sulfa drugs, chemicals
	Graphite	C	Pencil lead, dry lubricant
	Silver	Ag	Jewelry, photography
	Platinum	Pt	Catalyst

TABLE 2.A Important Gemstones

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