

CHAPTER 2

Minerals

Resource Integration Guide

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Chapter Outline

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Chapter Summary

Minerals are the substances that make up rocks. Therefore, minerals are the basic building blocks of Earth. Most rocks contain two to five common minerals and several less common minerals in smaller amounts. A mineral is a naturally occurring, inorganic solid with a definite chemical composition and a crystalline structure.

Each mineral consists of chemical elements represented by atoms, the fundamental components of matter that cannot be broken into smaller particles by ordinary chemical processes. Only eight elements, out of the 88 naturally occurring elements, make up more than 98 percent of Earth's crust. Most elements in nature are electrically charged, hence appearing as ions instead of atoms. Positively charged ions are called cations; negatively charged ions are called anions. Ions with opposite charges are attracted to each other, forming strong bonds. Elements occur in definite proportions in each mineral, so that its chemical composition can be given as a chemical formula, written by combining the letter symbols of the individual elements.

The crystalline structure of a mineral is the orderly, periodically repeated arrangement of its atoms. If a crystal grows freely, it forms perfectly flat surfaces that reflect light called crystal faces. In nature, however, mineral grains often impede the growth of adjacent crystals.

Geologists commonly recognize minerals visually and by performing simple tests. Properties that are used to identify minerals include crystal habit, cleavage, fracture, hardness, specific gravity, color, streak, and luster. Crystal habit refers to the characteristic shape of an individual crystal, and the manner in which aggregates of crystals grow. Cleavage is the tendency of some minerals to break along flat surfaces, which are planes of weak bonds in the crystal. Fracture is the manner in which a mineral breaks other than along planes of cleavage. The hardness of a mineral is determined by its resistance to scratching, which is controlled by the bond strength between the atoms in the mineral. Mineral hardness is measured by geologists, using the Mohs hardness scale and relying on some easily available objects for comparison.

Specific gravity is the weight of a substance relative to that of an equal volume of water. Most common minerals have specific gravities of about 2.7, whereas metals have much greater specific gravities. Color is the most obvious mineral property, but it can vary dramatically for the same type of mineral. Streak refers to the color of the fine powder of a mineral, observed by rubbing it across a piece of unglazed porcelain. Luster is the manner in which light is reflected from the surface of a mineral.

Geologists classify minerals according to their chemical elements into nine groups. Although more than 3,500 minerals are known in Earth's crust, only the nine rock-forming minerals are abundant in most rocks. They are feldspar, quartz, pyroxene, amphibole, mica, clay, olivine, calcite, and dolomite. The first seven on this list are silicates; their structures and compositions are based on the silicate tetrahedron in which a silicon atom is surrounded by four oxygen atoms to form a pyramid-shaped structure. Most silicate tetrahedra combine with additional elements to form minerals. Quartz is the only common silicate containing only silicon and oxygen. Silicate tetrahedra link together by sharing oxygen atoms to form the basic structures of the silicate minerals, such as chains, sheets, or three-dimensional networks. The silicates are the most abundant minerals because silicon and oxygen are the two most abundant elements in Earth's crust and bond together readily. Carbonate minerals include carbon and oxygen as a major part of their chemical composition; the rock-forming minerals calcite and dolomite belong to this mineral class. Native elements occur in nature uncombined with other elements.

Many minerals are commercially important. Metals or other elements can be profitably recovered from ore minerals. Industrial minerals have an economic value (other than metal ores, fuels, and gems). Gems are valuable because of their rarity and beauty.

Most minerals and rocks are environmentally safe in their natural states, but some can release environmentally hazardous materials, especially when they are mined.

Lecture Suggestions

- Bring several mineral samples to class, and let the students circulate while lecturing about them.
- Bring a mineral identification kit to class and demonstrate how to use it.
- Make a list of relatively common white minerals that look similar. Show how to distinguish them by using simple tests and tools.
- Have students compile a list of all of the gems they know.
- Discuss which minerals have been used for objects present in the classroom (such as walls, windows, doorknobs, pencils, and so on). Use Table 2.3 from the text as well as Internet resources to find this information.

Key Terms

mineral
element
ion
cation
anion
rock-forming minerals
crystal
crystalline structure
crystal face

crystal habit
cleavage
fracture
hardness
Mohs hardness scale
specific gravity
streak
luster
silicates

carbonates
sulfides
native elements
silicate tetrahedron
ore minerals
industrial minerals
gem

Web Links

<http://minerals.usgs.gov/minerals/>

Information on mineral supplies and uses from the United States Geological Survey.

<http://webmineral.com/>

Descriptions and images for more than 4,000 minerals.

<http://www.nma.org/index.php/minerals-publications/40-common-minerals-and-their-uses>

Explanations of forty common minerals and their uses from the the National Mining Association.

<http://www.minerals.net/GemStoneMain.aspx>

A searchable gemstone library with images, properties, and descriptions.