Minerals and Rocks

Minerals

Read to Learn

What is a mineral?

Do you ever drink mineral water? Maybe you take vitamins and minerals to stay healthy. The word *mineral* has many common meanings. For geologists, scientists who study Earth and the materials of which it is made, the word *mineral* has a very specific definition.

A **mineral** *is a naturally occurring, inorganic solid that has a crystal structure and a definite chemical composition.* In order for a substance to be classified as a mineral, it must have all five of the characteristics listed in this definition. Both coal and pyrite are shiny, hard substances that form deep inside Earth. But only one is a mineral. Coal formed from ancient plant material. Pyrite crystals are made of the elements iron and sulfur. One substance is a mineral, and one is not.

Characteristics of Minerals

How can you determine which substance is the mineral? Consider each of the five characteristics of minerals.

Naturally Occurring To be classified as a mineral, a substance must form naturally. Materials made by people are not minerals. Diamonds that form deep beneath Earth's surface are minerals. Diamonds that are made in a laboratory are not minerals. However, manufactured diamonds may look similar to naturally occurring diamonds.

Inorganic A material that contains carbon and was once alive is organic. A mineral cannot be organic. This means that a mineral cannot have once been alive. Also, a mineral cannot contain anything that was once alive, such as plants.

Solid A mineral must be solid. Liquids and gases are not considered minerals. Solid ice is a mineral, but water is not.

Crystal Structure A mineral must have a crystal structure. *The atoms in a crystal are arranged in an orderly, repeating pattern called a* **crystal structure.** This organized structure produces smooth faces and sharp edges on a crystal.

Definite Chemical Composition A mineral is made of specific amounts of elements. A chemical formula shows the amount of each element in a mineral. For example, pyrite is made of the elements iron (Fe) and sulfur (S). There always must be one iron atom for every two sulfur atoms. Therefore, the chemical formula for pyrite is FeS_2.

Think again about coal and pyrite. The plants that turned into coal were once alive. Coal cannot be a mineral. Pyrite has all five characteristics of a mineral, so it is a mineral.

Mineral Formation

How do atoms form minerals? Atoms within a liquid join together and form a solid. **Crystallization** *is the process by which atoms form a solid with an orderly, repeating pattern.* Crystallization can happen in two main ways.

Crystallization from Magma Melted rock material is called magma. As magma cools, some of the atoms join together and form solid crystals. As the liquid magma continues to cool, more atoms are added to the surface of the crystals. The longer it takes the magma to cool, the larger the crystals become because atoms continue to be added to the crystals. Crystals grow large when the magma cools slowly. When magma cools quickly, the crystals that form remain small.

Crystallization from Water Many substances, such as salt, dissolve in water—especially if the water is warm. When water cools or evaporates, the particles of the dissolved substances come together again and crystallize. Gold crystals form this way. The orderly arrangement of atoms in the mineral gold is visible using a very powerful microscope.

Mineral Identification

Every mineral has a unique set of physical properties, or characteristics. These properties are used to identify minerals. By testing several properties, scientists can distinguish between similar minerals.

Density

If you pick up two mineral samples that are about the same size, one might feel heavier than the other. The heavier mineral has a higher density. It has more mass in the same volume. The densities of many minerals are similar, but a very high or a very low density can help identify a mineral.

Hardness

Scientists measure the hardness of a mineral by observing how easily it is scratched or how easily it scratches something else. The Mohs hardness scale, shown in the table below, ranks hardness from 1 to 10. On this scale, diamond is the hardest mineral, with a hardness value of 10. The softest mineral is talc, with a hardness of 1.

Mohs Hardness Scale for Minerals

Mineral	Hardness	Hardness of Common Objects
talc	1 (softest)	
gypsum	2	fingernail (2.5)
calcite	3	copper wire or penny (3.5)
fluorite	4	wire nail (4.5)
apatite	5	glass, steel knife blade (5.5)
feldspar	6	streak plate (unglazed porcelain) (6.5)
quartz	7	
topaz	8	
corundum	9	
diamond	10 (hardest)	

Color and Streak

Some minerals can be identified by their unique color. The mineral malachite always has a certain green color. But the colors of most minerals vary. Quartz is a common mineral that has many different colors.

The colors of most minerals vary from sample to sample, but the color of a mineral's powder does not vary. *The color of a mineral's powder is called its* **streak.** You can observe streak by scratching the mineral across a tile of unglazed porcelain. Sometimes, the color of a mineral and the color of its streak are different. For example, the mineral hematite can have a red, brown, or black color, but its streak is always a dark, rusty red.

Luster

Minerals reflect light in different ways. **Luster** *describes the way that a mineral's surface reflects light.* Some terms used to describe mineral luster are *metallic, glassy, earthy,* or *pearly.* Hematite can have either a metallic luster or a dull luster. Muscovite mica has a pearly luster. Quartz has a glassy luster.

Cleavage and Fracture

Sometimes the way a mineral breaks helps identify it. Minerals break in two ways. *If a mineral breaks along smooth, flat surfaces, it displays* **cleavage.** The mineral on the left in the figure below illustrates the property cleavage. It forms a flat surface where it breaks. A mineral can break along a single cleavage direction or along several directions. Muscovite mica has one cleavage direction and peels off in sheets. Halite has three cleavage directions and breaks into cubes.

A mineral that breaks along rough or irregular surfaces displays **fracture.** The mineral on the right in the figure below illustrates the property fracture.

Cleavage and Fracture

Cleavage **Fracture**

Crystal Shape

Minerals exhibit many different crystal shapes. A mineral's atomic structure determines its crystal shape.

Crystal shapes can vary greatly. Crystals of hematite have no definite shape, or are shapeless. They are described as massive. Muscovite mica has diamond-shaped or six-sided crystals, but muscovite commonly occurs in flat, sheetlike layers. Amethyst, a type of quartz, has crystals shaped like pyramids.

Sometimes crystals grow so close to each other that the crystal shape is too small to see. If there is room for large crystals to grow, the crystal shape can be used to help identify the mineral.

Unusual Properties

Some minerals have unusual properties that make them easy to identify. For example, halite tastes salty. Magnetite is magnetic and attracts steel objects. Calcite fizzes when acid touches it. A type of calcite called Iceland spar has a property called double refraction. Images viewed through a crystal of Iceland spar appear doubled.

Quartz crystals can produce an electric current when compressed. This property makes quartz crystals useful in radios, microphones, and watches. Several minerals display the property of fluorescence. Calcite and quartz glow under ultraviolet light.

Minerals in Everyday Life

From the moment you wake in the morning until you fall asleep at night, you use materials made from minerals. For example, table salt contains the mineral halite. Toothpaste contains calcite or silica. Some cosmetics contain mica. Some minerals are valuable because we use them every day. We appreciate others simply for their beauty.

Did you know that beverage cans and car batteries are made from minerals? These items are made of metals. Most metals combine with other elements in the formation of a mineral. For example, aluminum can be removed from the mineral bauxite. The minerals must be processed to remove the metals from them. *Deposits of metallic or non-metallic minerals that can be produced at a profit are called* **ores.**

Some minerals, such as gemstones, are valuable because of their appearance. Gemstones have physical properties that make them valuable. They are usually harder than quartz. Gemstones often have intense colors and brilliant luster. The natural crystals are cut and polished. Emeralds are green gemstones often used in jewelry.