

Lesson E2

Minerals: Building Blocks of Rocks

Guiding Question:

What is the difference between a mineral and a rock?

Key Concepts

- A mineral is a solid with specific characteristics that define a unique composition and structure.
- Rock is composed of a combination of different minerals.

Objective:

To explore the properties and characteristics of minerals and to understand that rock is composed of different minerals

Introducing the Lesson:

Mineral resources have many applications. The mineral tantalite contains the rare earth element tantalum, which is used in consumer electronics such as cell phones, DVD players, computers, and video game systems. It is also used in aircraft engines, surgical equipment, and in chemical processing plants. The explosion in the global demand for, and use of, cell phones has led to extensive prospecting and mining for this mineral. Tantalum is mined in Australia, Brazil, Canada, China, and Nigeria. It is also mined in the Democratic Republic of the Congo.

At the present rate of consumption, Earth is set to run out tantalum in about twenty years.

But tantalite is just one mineral. A few thousand different minerals have been identified in the rock of Earth's crust. Most of that rock is composed of only a small number of the many identified minerals. Humans have used minerals for a variety of purposes for thousands of years. A number of minerals exist in relative abundance and have common, well-known uses. Aluminum, iron, and quartz are examples. Less common, but still well-known minerals are copper, gold, silver, platinum, and diamonds.

Time Required

Main Lesson:
45 minutes

Digging Deeper (optional)

Math Link:
10 minutes

History Link:
5 minutes

Vocabulary

Mineral
Inorganic
Crystalline
Streak
Luster
Cleavage

Fracture
Density
Hardness
Rock
Rock-forming minerals

Assessment

Pretest:
List-Group-Label,
on page 344

Posttest:
Three-Level Study Guide, on page 351

Ask your students to define a mineral. What is a mineral? What differentiates minerals from rocks? Use graphic organizer **Contents Brainstorming** on page 340 to help students activate their existing knowledge about minerals, and to help identify the main ideas and concepts of the lesson.

In this lesson, students will learn about the properties and identification of minerals, they will explore the mineral composition of rocks, and learn that the rock-forming minerals are those that make up most of the rock of Earth's crust.

Science Background

What Is a Mineral?

The Earth provides many substances that benefit humans. Items such as electrical wiring, computer chips, ceramics, and cosmetics all contain substances mined from the Earth called minerals. A **mineral** is a naturally occurring inorganic, crystalline solid with a definite chemical composition.

Characteristics of Minerals

A substance must have five characteristics for it to be considered a mineral. It must be:

Naturally occurring: Natural geological processes create minerals. A diamond formed naturally in the Earth is a mineral. A synthetic diamond made in a laboratory is not a mineral.

Inorganic: These substances are not made from living things, nor from the remains of living things. Coal is not a mineral because it is composed of the remains of ancient plants.

Solid: Minerals are solids at room temperature. Materials in the liquid or gas state at room temperature are not minerals. Not all solids, however (e.g., coal), are minerals.

Crystalline: The atoms that make up the mineral are arranged in a regularly repeated, orderly, geometric pattern.

Definite composition: Minerals have a clearly defined chemical composition. The mineral salt (NaCl) is made up of one atom of sodium plus one atom of chlorine. Quartz (SiO_2) has one silicon atom plus two oxygen atoms. The ratio of atoms that defines a specific mineral remains constant.

Properties of Minerals

Geologists use several physical properties to help identify minerals, including:

Color: This is an easily observed physical property, but must be used carefully. Many different minerals can have the same color. Gold and pyrite can look like one another based solely on surface color. Weathering can also hide the true color of a mineral.

Streak: This is the color of a mineral in powdered form. The mineral is rubbed across an unglazed piece of porcelain called a streak plate. Streak is a better diagnostic test for minerals than just surface color. For example, streak allows us to distinguish between gold and pyrite, which have similar surface colors. Gold will leave a yellow streak, while pyrite will leave a blackish streak. Not all minerals show streak on a streak plate. Minerals harder than streak plates will not show streaks. Hardness will be covered later.

Luster: This refers to the way light is reflected from a mineral's surface. Those that shine like metals have a metallic luster. Those reflecting dull, flat, or glassy light have a non-metallic luster.

Cleavage or fracture: This refers to the way a mineral breaks. **Cleavage** is the ability of a mineral to break along smooth, flat surfaces. **Fracture** is the ability of a mineral to break along irregular, uneven surfaces.

Density: This is determined by dividing an object's mass by its volume (i.e., $D = M/V$). It is widely used to distinguish minerals. For example, gold and pyrite have a strong physical resemblance, but very different densities. Gold has a density of 19.3 g/cm^3 , while pyrite has density of 5.2 g/cm^3 .

Hardness: This measures how easily a mineral's surface can be scratched. An unknown mineral's hardness is compared to that of ten reference minerals in a scale devised by German scientist Friedrich Mohs in 1812. Talc is at the bottom of the scale with a hardness of 1. Diamond, the hardest mineral, is at the top of the scale with a hardness of 10.

For example, an unknown mineral that can't be scratched by an iron nail (hardness = 4.5) and that can be scratched by a piece of glass (hardness = 5.5) has a hardness greater than 4.5, but less than 5.5.

What Is a Rock?

Rock is a naturally occurring mixture of minerals. Minerals are the building blocks of rocks. For example, granite is a mixture of the minerals feldspar, quartz, mica, and hornblende. The eight most common elements in Earth's crust combine to form approximately 98%, by mass, of all of Earth's minerals. The two most common elements are silicon and oxygen. They form the foundation of about 96% of all the minerals in Earth's crust.

Earth's crust contains over 3,000 minerals. Only a small number of them are common. These common minerals are referred to as the **rock-forming minerals** because they form most of the rocks in Earth's crust. The six most common rock-forming minerals are quartz, feldspar, mica, pyroxene, amphibole, and olivine.

Mohs Hardness Scale		
Mineral	Hardness	Hardness of Common Objects
Diamond	10	
Corundum	9	
Topaz	8	
Quartz	7	Streak plate (7)
Feldspar	6	Steel file (6.5)
Apatite	5	Glass/knife blade (5.5)
Fluorite	4	Iron nail (4.5)
Calcite	3	Copper penny (3.5)
Gypsum	2	Fingernail (2.5)
Talc	1	



Math Link

Students will explore the mathematical relationship between mass, volume, and density for several common minerals.

Time required: 10 minutes

History Link

Students will learn about Martin Frobisher's 16th century Arctic voyages in search of a northwest passage to Cathay (China). He instead discovered what some thought to be large deposits of gold.

Time required: 5 minutes

Did You Know? 1

Calcite (CaCO_3), or Iceland Spar, has the unusual property of double refraction. It produces two images when this transparent crystal is placed on printed material.

Did You Know? 2

Quartz makes up about 30% of Earth's continental crust.

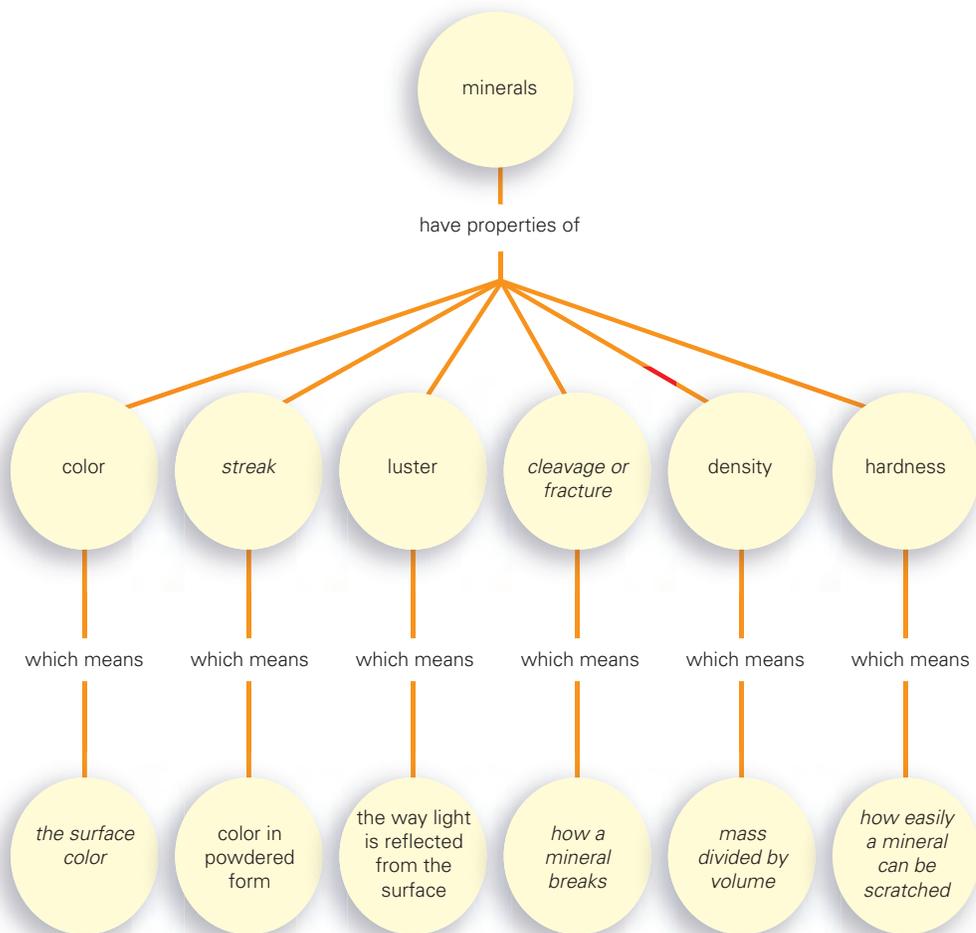
Evidence of Learning

Upon completion of lesson activities, students should have a basic understanding of the properties of minerals and their role in forming rocks. They should understand that the rock-forming minerals are those that make up most of the rock of Earth's crust. Lesson activities, along with the provided graphic organizer activities and learning review questions, will give you evidence that students can:

- Describe the properties and characteristics of minerals
- Relate some of the principles involved in identifying common minerals
- Distinguish between minerals and rocks
- Illustrate the relationship between elements, minerals, and rocks

Review Questions and Answers

1) Complete this concept map describing the properties of minerals.



2) Is a tree a mineral? Explain.

A tree is not a mineral because it is organic. A tree is living material.

3) Why can color sometimes be a misleading property when used to identify minerals?

Color can sometimes be misleading because different minerals can have the same surface color. Gold and pyrite, for example, have similar surface colors.

4) An unknown mineral can't be scratched by a fingernail. This same mineral can't scratch an iron nail. What is the possible range of hardness for this unknown mineral?

Your fingernail has a hardness of 2.5, and an iron nail has a hardness of 4.5. The unknown mineral must thus have a hardness greater than 2.5, but less than 4.5.

5) Can a streak plate be used to determine the color of powdered topaz? Explain.

A streak plate cannot be used to determine the color of powdered topaz. This is because topaz, with a hardness of 8, has a greater hardness than that of a streak plate (7). Moving a sample of topaz across a streak plate will not result in a powdered streak of topaz. The topaz will instead scratch the streak plate.

