

Identification of Minerals

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CHAPTER

1

Identification of Minerals

Lesson Objectives

- Explain how minerals are identified.
- Describe how color, luster, and streak are used to identify minerals.
- Summarize specific gravity.
- Explain how the hardness of a mineral is measured.
- Describe the properties of cleavage and fracture.
- Identify additional properties that can be used to identify some minerals.

Vocabulary

- cleavage
- density
- fracture
- hardness
- luster
- streak

Introduction

How could you describe your shirt when you are talking to your best friend on the phone? You might describe the color, the way the fabric feels, and the length of the sleeves. These are all physical properties of your shirt. If you did a good job describing your shirt, your friend would recognize the shirt when you wear it. Minerals also have physical properties that are used to identify them.

How are Minerals Identified?

Imagine you were given a mineral sample similar to the one shown in **Figure 1.1**. How would you try to identify your mineral? You can observe some properties by looking at the mineral. For example, you can see that its color is beige. The mineral has a rose-like structure. But you can't see all mineral properties. You need to do simple tests to determine some properties. One common one is how hard the mineral is. You can use a mineral's properties to identify it. The mineral's physical properties are determined by its chemical composition and crystal structure.

Color, Streak, and Luster

Diamonds have many valuable properties. Diamonds are extremely hard and are used for industrial purposes. The most valuable diamonds are large, well-shaped and sparkly. Turquoise is another mineral that is used in jewelry



FIGURE 1.1

You can use properties of a mineral to identify it. The color and rose-like structure of this mineral mean that it is gypsum.

because of its striking greenish-blue color. Many minerals have interesting appearances. Specific terms are used to describe the appearance of minerals.

Color

Color is probably the easiest property to observe. Unfortunately, you can rarely identify a mineral only by its color. Sometimes, different minerals are the same color. For example, you might find a mineral that is a gold color, and so think it is gold. But it might actually be pyrite, or “fool’s gold,” which is made of iron and sulfide. It contains no gold atoms.

A certain mineral may form in different colors. **Figure 1.2** shows four samples of quartz, including one that is colorless and one that is purple. The purple color comes from a tiny amount of iron. The iron in quartz is a chemical impurity. Iron is not normally found in quartz. Many minerals are colored by chemical impurities. Other factors can also affect a mineral’s color. Weathering changes the surface of a mineral. Because color alone is unreliable, geologists rarely identify a mineral just on its color. To identify most minerals, they use several properties.

Streak

Streak is the color of the powder of a mineral. To do a streak test, you scrape the mineral across an unglazed porcelain plate. The plate is harder than many minerals, causing the minerals to leave a streak of powder on the plate. The color of the streak often differs from the color of the larger mineral sample, as **Figure 1.3** shows.

Streak is more reliable than color to identify minerals. The color of a mineral may vary. Streak does not vary. Also, different minerals may be the same color, but they may have a different color streak. For example, samples of hematite and galena can both be dark gray. They can be told apart because hematite has a red streak and galena has a gray streak.

Luster

Luster describes the way light reflects off of the surface of the mineral. You might describe diamonds as sparkly or pyrite as shiny. But mineralogists have special terms to describe luster. They first divide minerals into metallic and

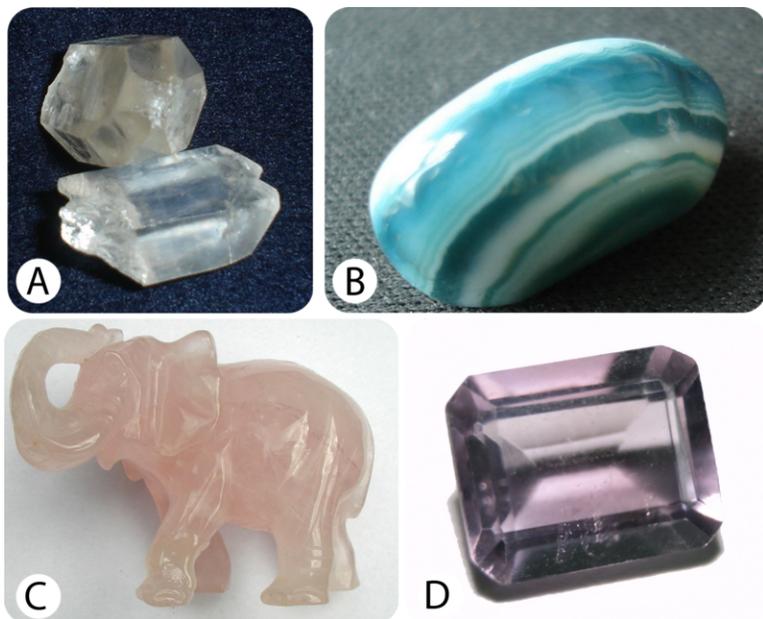


FIGURE 1.2

Quartz comes in many different colors including: (A) transparent quartz, (B) blue agate, (C) rose quartz, and (D) purple amethyst.



FIGURE 1.3

Rub a mineral across an unglazed porcelain plate to see its streak. The hematite shown here has a red streak.

non-metallic luster. Minerals that are opaque and shiny, like pyrite, are said to have a “metallic” luster. Minerals with a “non-metallic” luster do not look like metals. There are many types of non-metallic luster. Six are described in **Table 1.1**.

TABLE 1.1: Minerals with Non-Metallic Luster

Non-Metallic Luster	Appearance
Adamantine	Sparkly

TABLE 1.1: (continued)

Non-Metallic Luster	Appearance
Earthy	Dull, clay-like
Pearly	Pearl-like
Resinous	Like resins, such as tree sap
Silky	Soft-looking with long fibers
Vitreous	Glassy

Can you match the minerals in **Figure 1.4** with the correct luster from **Table 1.1** without looking at the caption?

Density

You are going to visit a friend. You fill one backpack with books so you can study later. You stuff your pillow into another backpack that is the same size. Which backpack will be easier to carry? Even though the backpacks are the same size, the bag that contains your books is going to be much heavier. It has a greater density than the backpack with your pillow.

Density describes how much matter is in a certain amount of space. Substances that have more matter packed into a given space have higher densities. The water in a drinking glass has the same density as the water in a bathtub or swimming pool. All substances have characteristic densities, which does not depend on how much of a substance you have.

Mass is a measure of the amount of matter in an object. The amount of space an object takes up is described by its volume. The density of an object depends on its mass and its volume. Density can be calculated using the following equation:

$$\text{Density} = \text{Mass}/\text{Volume}$$

Samples that are the same size, but have different densities, will have different masses. Gold has a density of about 19 g/cm³. Pyrite has a density of only about 5 g/cm³. Quartz is even less dense than pyrite, and has a density of 2.7 g/cm³. If you picked up a piece of pyrite and a piece of quartz that were the same size, the pyrite would seem almost twice as heavy as the quartz.

Hardness

Hardness is a mineral's ability to resist being scratched. Minerals that are not easily scratched are hard. You test the hardness of a mineral by scratching its surface with a mineral of a known hardness. Mineralogists use the Mohs Hardness Scale, shown in **Table 1.2**, as a reference for mineral hardness. The scale lists common minerals in order of their relative hardness. You can use the minerals in the scale to test the hardness of an unknown mineral.

Mohs Hardness Scale

As you can see, diamond is a 10 on the Mohs Hardness Scale. Diamond is the hardest mineral; no other mineral can scratch a diamond. Quartz is a 7. It can be scratched by topaz, corundum, and diamond. Quartz will scratch minerals that have a lower number on the scale. Fluorite is one. Suppose you had a piece of pure gold. You find that calcite

**FIGURE 1.4**

(A) Diamonds have an adamantine luster. These minerals are transparent and highly reflective. (B) Kaolinite is a clay with a dull or earthy luster. (C) Opal's luster is greasy. (D) Chalcopyrite, like its cousin pyrite, has metallic luster. (E) Stilbite (orange) has a resinous luster. (F) The white ulexite has silky luster. (G) Sphalerite has a submetallic luster. (H) This Mayan artifact is carved from jade. Jade is a mineral with a waxy luster.

scratches the gold. Gypsum does not. Gypsum has a hardness of 2 and calcite is a 3. That means the hardness of gold is between gypsum and calcite. So the hardness of gold is about 2.5 on the scale. A hardness of 2.5 means that gold is a relatively soft mineral. It is only about as hard as your fingernail.

TABLE 1.2: Mohs Scale

Hardness	Mineral
1	Talc
2	Gypsum

TABLE 1.2: (continued)

Hardness	Mineral
3	Calcite
4	Fluorite
5	Apatite
6	Orthoclase feldspar
7	Quartz
8	Topaz
9	Corundum
10	Diamond

Cleavage and Fracture

Different types of minerals break apart in their own way. Remember that all minerals are crystals. This means that the atoms in a mineral are arranged in a repeating pattern. This pattern determines how a mineral will break. When you break a mineral, you break chemical bonds. Because of the way the atoms are arranged, some bonds are weaker than other bonds. A mineral is more likely to break where the bonds between the atoms are weaker.

Cleavage

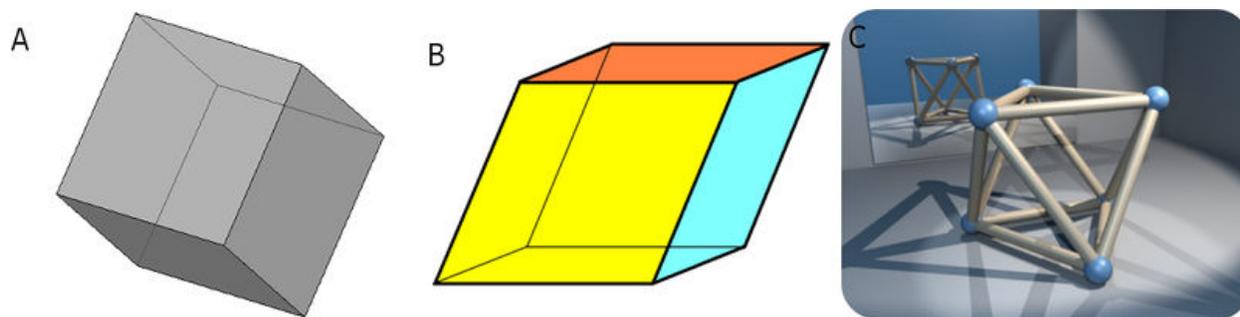
Cleavage is the tendency of a mineral to break along certain planes. When a mineral breaks along a plane it makes a smooth surface. Minerals with different crystal structures will break or cleave in different ways, as in **Figure 1.5**. Halite tends to form cubes with smooth surfaces. Mica tends to form sheets. Fluorite can form octahedrons.



FIGURE 1.5

Minerals with different crystal structures have a tendency to break along certain planes.

Minerals can form various shapes. Polygons are shown in **Figure 1.6**. The shapes form as the minerals are broken along their cleavage planes. Cleavage planes determine how the crystals can be cut to make smooth surfaces. People who cut gemstones follow cleavage planes. Diamonds and emeralds can be cut to make beautiful gemstones.

**FIGURE 1.6**

Cubes have six sides that are all the same size square. All of the angles in a cube are equal to 90° . Rhombohedra also have six sides, but the sides are diamond-shaped. Octahedra have eight sides that are all shaped like triangles.

Fracture

Fracture describes how a mineral breaks without any pattern. A fracture is uneven. The surface is not smooth and flat. You can learn about a mineral from the way it fractures. If a mineral splinters like wood, it may be fibrous. Some minerals, such as quartz, fracture to form smooth, curved surfaces. A mineral that broke forming a smooth, curved surface is shown in **Figure 1.7**.

Other Identifying Characteristics

Minerals have other properties that can be used for identification. For example, a mineral's shape may indicate its crystal structure. Sometimes crystals are too small to see. Then a mineralogist may use a special instrument to find the crystal structure.

Some minerals have unique properties. These can be used to the minerals. Some of these properties are listed in **Table 1.3**. An example of a mineral that has each property is also listed.

TABLE 1.3: Special Mineral Properties

Property	Description	Example of Mineral
Fluorescence	Mineral glows under ultraviolet light	Fluorite
Magnetism	Mineral is attracted to a magnet	Magnetite
Radioactivity	Mineral gives off radiation that can be measured with Geiger counter	Uraninite
Reactivity	Bubbles form when mineral is exposed to a weak acid	Calcite
Smell	Some minerals have a distinctive smell	Sulfur (smells like rotten eggs)



FIGURE 1.7

This mineral formed a smooth, curved surface when it fractured.

Lesson Summary

- You can identify a mineral by its appearance and other properties.
- The color and luster describe the appearance of a mineral, and streak describes the color of the powdered mineral.
- Each mineral has a characteristic density.
- Mohs Hardness Scale is used to compare the hardness of minerals.
- The way a mineral cleaves or fractures depends on the crystal structure of the mineral.
- Some minerals have special properties that can be used to help identify the mineral.

Lesson Review Questions

Recall

1. What is cleavage? What is fracture? If you are looking at a mineral face, how can you tell them apart?

2. What is color? When would you use color to identify a mineral?
3. What is streak? Why would you use streak instead of color to identify a mineral?

Apply Concepts

4. What type of luster do gemstones mostly have? Why do you think this type of luster is popular for jewelry?
5. If a mineral has a unique property that only that type of mineral has is it good for identifying that mineral? Is there any time that it might not be?

Think Critically

6. You are trying to identify a mineral sample. Apatite scratches the surface of the mineral. Which mineral would you use next to test the mineral's hardness—fluorite or feldspar? Explain your reasoning.
7. You have two mineral samples that are about the size of a golf ball. Mineral A has a density of 5 g/cm^3 . Mineral B is twice as dense as Mineral A. What is the density of Mineral B?

Points to Consider

- Some minerals are colored because they contain chemical impurities. How did the impurities get into the mineral?
- What two properties of a mineral sample would you have to measure to calculate its density?

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