9.2 Identifying Minerals

Section Objectives

- **Describe some characteristics that help distinguish one mineral from another.**
- **List four special properties that may help identify certain minerals.**

If you have ever found an unfamiliar mineral, you may have wondered how to go about identifying it. Earth scientists called **mineralogists** conduct tests with special equipment to properly identify minerals. Mineralogists work in laboratories and in the field to identify minerals—from the most common to the most rare and precious.

Characteristics of Minerals

Each mineral has specific properties that are a result of its chemical composition and crystal structure. These properties provide useful clues for identifying minerals. You can identify some of these properties by simply looking at a sample of the mineral. You can determine other properties through simple tests.

Color

A property you can easily observe is the color of a mineral. Some minerals have very distinct colors. For example, sulfur is bright yellow, and azurite is a deep blue. The mineral cinnabar is red, while serpentine is green. Color alone, however, is generally not a reliable clue in identifying a mineral sample. Many minerals are similar in color, and very small amounts of certain elements may greatly affect the color. For example, corundum is a colorless mineral composed of aluminum and oxygen atoms. However, corundum that contains traces of chromium (Cr) forms ruby, a rare red gem. Sapphire, a rare blue gem, consists of corundum with traces of cobalt (Co) and titanium (Ti). Quartz exists in many colors. Amethyst, for example, is purple because it contains tiny amounts of the elements manganese (Mn) and iron (Fe).

Color is also an unreliable identification clue because weathered surfaces may hide the color of minerals. For example, iron pyrite is the color of gold, but it appears dark yellow when it is weathered. When you examine a mineral for color, be sure to inspect a freshly exposed surface.

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Figure 9–4. Pure quartz (left) is colorless. Amethyst (above) is a variety of quartz that is purple because of the presence of manganese and iron.

Figure 9–5. All minerals have either a metallic luster like platinum (top) or a nonmetallic luster like muscovite mica (bottom).

Luster

Light reflected from the surface of a mineral is called **luster.** Minerals that reflect light like polished metal are said to have a *metallic luster.* All other minerals have a *nonmetallic luster.* Mineralogists distinguish several types of nonmetallic luster. Transparent quartz and other minerals that look like glass have a glassy luster. Minerals with an appearance like the surface of candle wax have a waxy luster. Some minerals, such as the micas, have a pearly luster. Diamond is an example of a mineral with a brilliant luster. A mineral that lacks any kind of shine has a dull (earthy) luster.

Streak

A more reliable clue to the identity of a mineral is the color of that mineral in powdered form, which is called its **streak.** The easiest way to observe the streak of a mineral is to rub some of the mineral against a piece of unglazed ceramic tile called a streak plate. Because the streak is the powdered form of the mineral, it may not be the same color as the larger piece of the mineral. Metallic minerals generally have a dark streak. For example, the streak of gold-colored pyrite is black. For most nonmetallic minerals, however, the streak is either colorless or a very light shade of the normal color of the mineral.

Cleavage and Fracture

Some minerals tend to split easily along certain flat surfaces. This property, called **cleavage,** is related to the types of bonds in the internal structure of the mineral. The surface along which cleavage occurs runs parallel to a plane in the crystal where bonding is relatively weak. For example, the micas, which are made of tetrahedral sheets, tend to split into parallel sheets. Mineralogists use cleavage to identify and describe some minerals. The mineral galena breaks into small cubes because the three cleavage directions are at right angles to each other.

Many minerals, however, do not break along cleavage planes. Instead, they *fracture,* or break, unevenly into curved or irregular pieces. Mineralogists describe a fracture according to the appearance of the broken surfaces. For example, a rough surface is called *uneven* or *irregular.* A broken surface that looks like a piece of broken wood is called *splintery* or *fibrous.* Curved surfaces on a fractured mineral are called *conchoidal.*

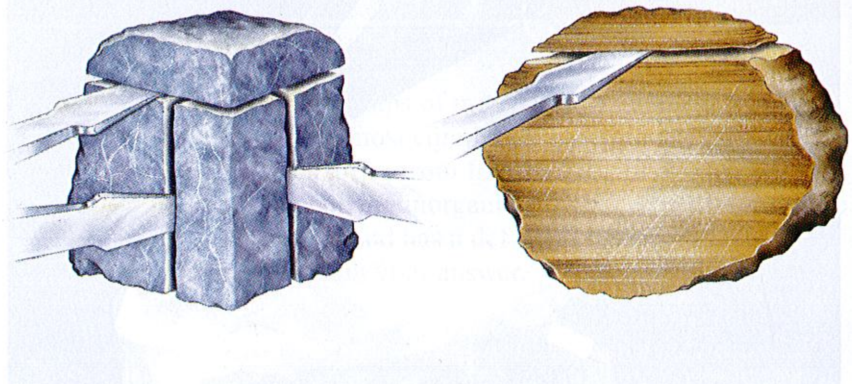

Figure 9–6. The diagram on the left demonstrates cleavage in three directions. Galena is a mineral that cleaves in three directions. The diagram on the right demonstrates cleavage in one direction. The micas are minerals that have cleavage in only one direction.

Hardness

The measure of the ability of a mineral to resist scratching is called **hardness.** Hardness does not mean resistance to cleavage or fracture. A diamond, for example, is extremely hard, but it can be split along cleavage planes more easily than can calcite, a softer mineral.

The hardness of an unknown mineral can be determined by scratching it against the minerals on **Mohs hardness scale,** shown in Table 9–2. This scale lists 10 minerals in order of increasing hardness. The softest mineral is talc, with a hardness of 1. The hardest mineral is diamond, with a hardness of 10. The difference in hardness between two consecutive minerals is about the same throughout the scale except for the difference between the two hardest minerals. Diamond (10) is much harder than corundum (9), the mineral just before it on the scale. Care must be taken in testing hardness. For example, the mark usually left by talc on an unknown mineral may appear to be a scratch. Actually, it is the streak made by talc, and it is easily rubbed off. A true scratch will remain when a harder mineral rubs a softer mineral.

To test an unknown mineral for hardness, you must determine which is the hardest mineral on the scale that it can scratch. For example, galena can scratch gypsum but not calcite. Between which two numbers on Mohs scale does galena fall? If neither of two minerals scratches the other, they have the same hardness.

The hardness of a mineral is largely determined by the strength of the bonds between the atoms or ions that make up its internal structure. Both diamond and graphite consist exclusively of carbon atoms. Diamond has a hardness of 10, however, while the hardness of graphite is only between 1 and 2. A diamond's hardness results from a strong crystal structure in which each carbon atom is firmly bonded to four other carbon atoms. In contrast, the carbon atoms in graphite are arranged in layers that are held together by weak forces.

Figure 9–7. Conchoidal fracture is a type of fracture that looks like broken glass and that helps to identify some minerals.

Table 9–2 Mohs Hardness Scale

Minerals	Hardness	Common Test
Talc	1	Easily scratched by fingernail
Gypsum	2	Can be scratched by fingernail
Calcite	3	Barely can be scratched by copper penny
Fluorite	4	Easily scratched with steel file or glass
Apatite	5	Can be scratched by steel file or glass
Feldspar	6	Scratches glass with difficulty
Quartz	7	Easily scratches both glass and steel
Topaz	8	Scratches quartz
Corundum	9	No simple tests
Diamond	10	Scratches everything

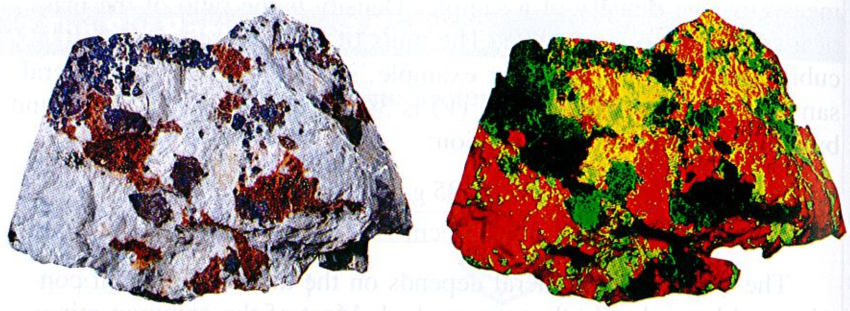

Figure 9–8. Notice the change in color of the fluorescent minerals calcite and willemite as they go from ordinary light (left) to ultraviolet light (right).

INVESTIGATE!

To learn more about identifying minerals, try the In-Depth Investigation on pages 172–173.

Special Properties of Minerals

All minerals exhibit the properties described earlier in this section. In addition to those properties, however, a few minerals have some special properties that can aid in their identification.

Magnetism

A magnet passed through some sand or loose soil may attract small particles of iron-containing minerals. Magnetite is the most common among this group of magnetic minerals. Lodestone is a form of magnetite that acts as a magnet. When lodestone happens to be in an elongated shape, it is polarized, with a north pole at one end and a south pole at the other, just like a bar magnet. The needles of the first magnetic compasses used in navigation were made of tiny slivers of lodestone.

Fluorescence and Phosphorescence

The mineral calcite is usually white in ordinary light, but under ultraviolet light it often appears red. This ability to glow under ultraviolet light is referred to as **fluorescence.** Fluorescent minerals absorb ultraviolet light and then produce visible light of various colors. For example, willemite is light brown in ordinary light, but under ultraviolet light it appears green. You can see the effect of fluorescence on minerals in Figure 9–8.

Some minerals subjected to ultraviolet light will continue to glow after the ultraviolet light is cut off. Minerals that continue to glow have the property called **phosphorescence.**

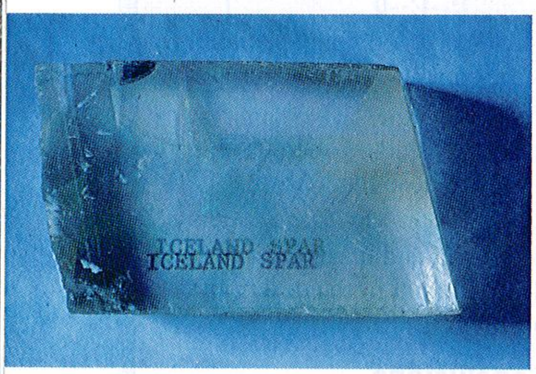

Figure 9–9. The mineral calcite exhibits double refraction.

Double Refraction

Light rays bend as they pass through transparent minerals. This bending of light rays as they pass from one substance, such as air, to another, such as a mineral, is called **refraction.** Crystals of calcite and some other transparent minerals bend light in such a way that they produce a double image of any object viewed through them. This property is called **double refraction.** Double refraction occurs because the light ray is split into two parts as it enters the crystal.

Radioactivity

Some minerals have a property known as *radioactivity.* You learned in Chapter 8 that certain atoms have unstable electron arrangements. Some atoms also have unstable arrangements of protons and neutrons in their nuclei. Radioactivity results as unstable nuclei decay