

Minerals - Not Rocks

Mineral Lab Introduction

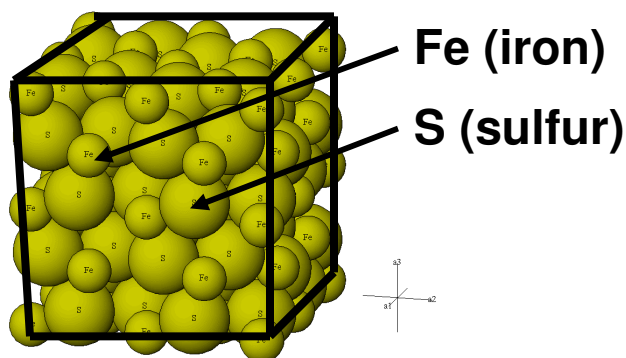
This exercise presents systematic procedures for identifying minerals by their physical properties. Your ability to determine these properties by careful observation and testing is more important than merely being able to recognize and name the mineral. Later exercises will show how minerals combine to form rocks, and from various rock types, geological environments can be interpreted. Thus, it is essential for you to learn the common minerals and their physical properties so that you will be able to complete the rock identification exercises.

Minerals

A mineral is a substance that adheres to the following "5-part" definition:

- a. a mineral **naturally occurs**
- b. a mineral is an **inorganic substance**
- c. a mineral is considered **solid**
- d. a mineral possesses a **chemical composition**
- e. a mineral possesses a **crystalline structure**

The crystalline structure of a mineral refers to an orderly, predictable arrangement or pattern of atoms that bond together, producing various geometrical configurations that can be observed on several minerals in your box. A mineral's geometric "shape" is directly due to the internal arrangement of atoms. For example, the mineral pyrite forms cubical structures that reflect the atomic bonding of iron (Fe) and sulfur (S). Below is an illustration that shows the cubical relationship between iron and sulfur atoms that bond together, forming the mineral pyrite (FeS_2).



All minerals are able to form visible geometric structures that reflect the mineral's chemistry if three conditions exist: enough **space**, **time**, and **solution (material)**. If any one of the three conditions are absent, the likelihood of definite crystalline faces is low. It is common for most minerals to form as aggregates, lacking crystalline faces (smooth surfaces). Substances possessing crystalline structure

are called crystals. For example, the pyrite cube illustrated above is a pyrite crystal. The chemical composition and crystalline structure determine the physical properties of a mineral: its color, hardness, shape, feel, and how it reflects light. Different minerals, therefore, have different physical properties, and these properties are used to distinguish one mineral from another.

A mineraloid is a naturally occurring, inorganic substance with a characteristic chemical composition and physical properties. However, mineraloids lack crystalline structure. A substance that lacks a crystalline structure is referred to as amorphous. Glass would be considered a mineraloid. In fact, any chemical compound that does not possess a distinct melting point is a mineraloid. For example, the mineral pyrite will melt (from solid phase to liquid phase) at temperatures ranging from 1,177 - 1,188 °C. Glass does not possess a melting point and will only become more viscous at temperatures ranging from 1000 - 2000 °C.

Mineral Physical Properties

Minerals are properly identified using a combination of physical properties that reflect the crystalline structure and chemical composition. In this lab, you will test each mineral specimen for its combination of physical property types and determine the chemical composition, mineral class, and the mineral's proper name. Below are descriptions of various physical properties that the student will use as a tool to properly identify each mineral in the box. Next to each physical property heading is a number that represents the "usefulness" or importance for identification of your hand specimen. One is the least important with ten being the most important.

Crystal form (2)

Crystal form is the external geometrical appearance of a perfectly formed crystal. The flat external surfaces of the crystal are called crystal faces. The quartz crystal in the figure below represents well-formed, smooth external crystal faces. This particular quartz crystal formed under specific type conditions: enough space, time, and material available to create smooth crystal faces. In most cases, perfect crystal faces are rare due to the lack of conditions outlined above. Therefore, crystal form is rarely used to identify minerals in field studies.



Color (2)

The color of a mineral, usually its most noticeable property, may be one of the least accurate diagnostics in mineral identification. For example, quartz can be colorless, violet, white, rose, gray, blue, green, red, yellow, brown and more! However, most minerals do have a typical color that can be used as a clue in identification, but don't be fooled. One must **not** always trust color.

Streak (8)

Streak is the color residue or powder left on an unglazed porcelain streak plate after a mineral has been scratched across its surface. The color of the powder remaining on the plate is the streak. It is common for a hand specimen mineral color to be different than the actual powdered residue left on the streak plate. In other words, the same mineral can occur in different varieties but still exhibit the same streak.

Luster (10)

Luster is the manner in which the surface of the mineral reflects light. Terms used to describe luster include earthy (concrete), glossy (polished auto paint), metallic (silvery, gold, and copper appearance), pearly, greasy, waxy, and vitreous (glassy--like the broken end of a coke bottle). When identifying minerals, the student will classify them as having either metallic or non-metallic type lusters. When classifying a non-metallic luster, the student can use descriptive terms such as earthy, glossy, pearly, greasy, waxy, and vitreous. Below is a table showing various terms associated with metallic and non-metallic lusters. It will be very important for the student to properly classify the mineral according to its proper luster.

Metallic Luster

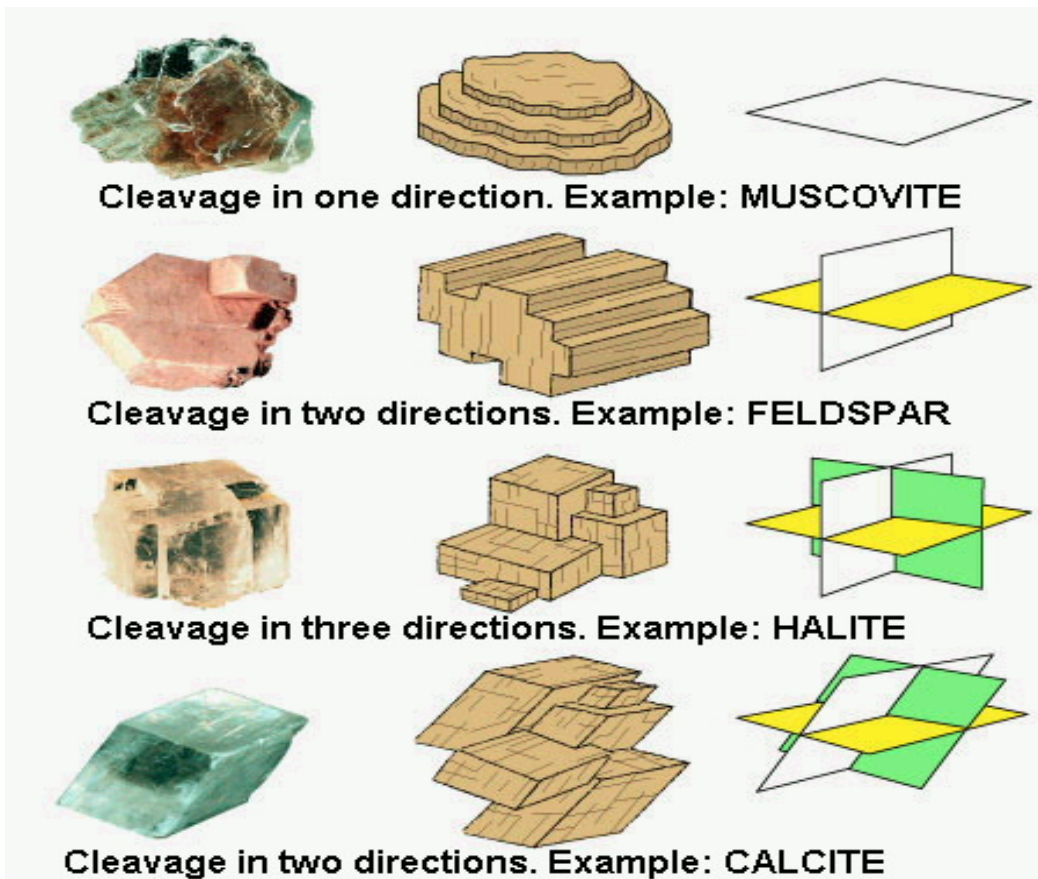
silvery-shiny
"gold" looking
"shiny piece of metal"

Non-Metallic Luster

earthy
pearly
greasy, waxy
vitreous

Cleavage planes (8)

Cleavage planes are flat surfaces along which some crystalline substances break along planes of atomic weakness. In other words, when the mineral is broken into smaller pieces, each mineral piece will show or repeat the same flat surfaces that the original specimen possessed. For example, halite (table salt) will always remain as cubes even when struck by a hammer. Just look at the salt crystals on a pretzel. Below (the following page) illustrates cleavage patterns of various minerals, which cause minerals to break into preferred shapes.



Fracture surfaces (8)

Fracture surfaces are nonplanar, nonparallel surfaces along which minerals and other substances may break in addition to cleavage or in the absence of cleavage planes. Quartz and volcanic glass are examples of materials that fracture and lack cleavage. They break along smoothly curved surfaces called *conchoidal fractures*. When minerals contain fracture surfaces, they will randomly break into smaller pieces and NOT REPEAT their original shape. For example, once the crystal faces on quartz are destroyed, the faces will never again be observed. Most gem quality minerals do not exhibit cleavage but rather fracture. In other words, once the smooth gemstone surface is destroyed, the gem is ruined.

IMPORTANT - How do you know when a mineral displays cleavage or fracture?

Mineral shows cleavage

Mineral surfaces will repeat

Surface will "flash" when rotated under the light

"Typically," minerals with cleavage are soft

Mineral shows fracture

Mineral surfaces will NOT repeat

Smooth surface will show damage on the crystal surface

"Typically," minerals with fracture are hard

Hardness (10)

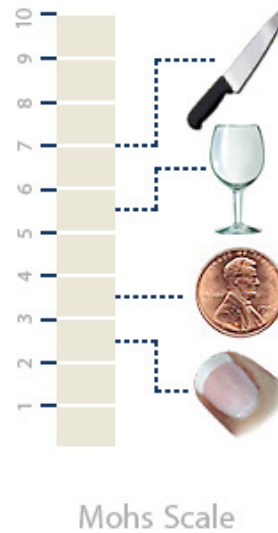
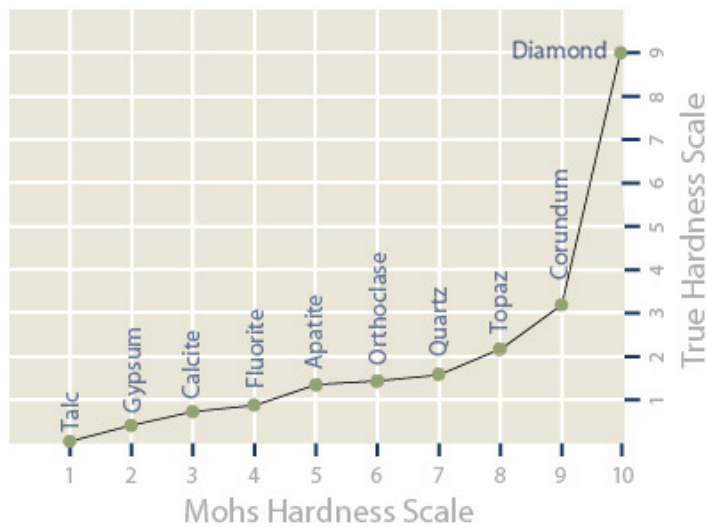
Hardness of a mineral measure its resistance to scratching. A harder substance will scratch a softer substance. The German mineralogist Friedrich Mohs (1773-1839) developed a quantitative scale of mineral hardness in which the softest mineral (talc) has a hardness of 1, and the hardest known mineral (diamond) has a hardness of 10. Higher-numbered minerals will scratch lower-numbered minerals. Below is Moh's scale of hardness. Other tools can be used to test the hardness of minerals. Observe the various tools used to detect the hardness of minerals (fingernail, steel nail, penny, and porcelain plate).

Moh's Scale of Hardness

- 1- Talc
- 2- Gypsum (fingernail-2.5)
- 3- Calcite (copper penny-3.5)
- 4- Fluorite
- 5- Apatite (steel knife - 5.5)
- 6- Orthoclase
- 7- Quartz (glass plate 6.5-7)
- 8- Topaz
- 9- Corundum
- 10- Diamond

Moh's Hardness vs. True Hardness

The table below (next page) shows a comparison of absolute hardness measures using a sclerometer. The Mohs scale is an ordinal or successive scale, and, therefore, does not measure or compare actual hardness. For instance, corundum is twice as hard as topaz, but diamond is almost four times as hard as corundum. Yet, there is only one step between each of these three minerals. In this lab, the student will compare hardness by scratching glass with the mineral. In other words, does the mineral scratch or not scratch glass? Therefore, is the mineral's hardness greater or less than 7 on Moh's scale of hardness?



Special mineral properties

Reaction to Acid

minerals belonging to the CO_3 (carbonate family) will effervesce (fizz) when reacted with hydrochloric acid (HCl)

Tenacity

the ability for the mineral to resist breakage. The mineral may bend (elastic) or "snap" (brittle).

Striations

Minerals may show "hairline" grooves on cleavage faces.

Magnetism

minerals exhibit magnetism. Magnets are attracted to the surface.

Double Refraction

double refraction occurs when light passes through the crystalline structure of some minerals. The observer will notice that the image beneath the mineral is repeated or doubled.

Specific Gravity

measures the density of the mineral. In other words, how heavy is the mineral?

Taste

does the mineral have taste? (example-halite)

Mineral Identification

The ability to identify minerals is one of the most fundamental skills of an earth scientist. It is also fundamental for identifying rocks, for you must first identify the minerals composing the rocks. Only after minerals and rocks have been identified can their origin, classification, and alteration be adequately understood.

To identify a mineral, you must list as many of its properties as you can determine, using available tools and your senses. Then use the compiled list of physical properties and identify the minerals using the mineral identification charts provided with this lab. The object of the mineral charts is to narrow the field of choices to a single mineral specimen.

Use the following procedure for each mineral

1. Identify the mineral's **luster**. Decide if the mineral is non-metallic or displays a metallic-type luster. This determination will narrow the mineral field to different identification charts.
2. Check the **hardness** of the mineral. Determine if the mineral either scratches glass or does not scratch glass. This determination will further narrow the mineral choices on the mineral ID charts.
3. Does the mineral display **cleavage** planes? Use the field techniques discussed in class ("flashing" of the smooth surface). At this point, your mineral should be narrowed down to a few mineral choices.
4. Carefully read the choices of minerals and test the **streak**, observe **color**, and test for **special properties**. At this point, you should read the various minerals' descriptions in each mineral box (mineral charts) and find a match that names the mineral and gives the chemical composition.