Lab 02 - Identification of Nonsilicate Minerals And Their Uses

Introduction

One of the five parts of the definition of a mineral is that all minerals have a definite chemical composition. Since minerals are the basic building blocks of rocks and rocks are what make up the earth's crust, the chemical composition of minerals reflects that of the earth's crust itself. Below is a table listing the 8 most abundant elements in the earth's crust.

Elemental Composition of the Earth's Crust (by weight).

Oxygen	46.6%
Silicon	27.7%
Aluminum	8.1%
Iron	5.0%
Calcium	3.6%
Sodium	2.8%
Potassium	2.6%
Magnesium	2.1%
All Others	1.4%

From this table it can seen that almost 75% of the earth's crust consists of just two elements; silicon and oxygen. This provides a convenient means of separating the almost 4000 known minerals into two large groups for the purpose of study and identification; the silicate minerals and the nonsilicates minerals. Silicate minerals are those that contain both silicon and oxygen (and can contain other elements as well). Silicate minerals are also known as rock-forming minerals because they make up the vast bulk of the rocks in the crust. Minerals that may contain either silicon or oxygen, but not both, as well as containing other elements are classified as nonsilicate minerals. Although nonsilicate minerals are not as abundant as silicate minerals, they are nonetheless an extremely important group of minerals. Many of these minerals are extracted from rock by miners and processed as ore minerals or minerals that contain high amounts of metals. It is from these minerals that we acquire the world's stockpile of iron, copper, zinc, lead, gold and other metals. Other nonsilicates are mined as industrial minerals and when processed become critical ingredients in the manufacture of such items as concrete, wall board, paper and can even be found in some of our foods, medicines and clothing.

In this lab we will focus on using the fundamental physical properties from Lab 1 to identify a collection of the more common and more important nonsilicate minerals. In addition, we will see how the nonsilicate minerals are classified and groups both by chemical composition and usage.

Chemical Classification and uses of Minerals

Minerals are grouped chemically based on their major cation (a positively charged ion), anion (a negatively charged ion) or complex (generally negatively charged groupings of ions).

Chemical Classification and Common Uses for Selected Nonsilicate Minerals.

Chemical Class	Chemical Makeup	Mineral Name	Common Uses
Native Elements	elements found in nature in their nearly pure form	Graphite	lubricant; high temperature crucibles; mixed with clay, the lead in pencils
		Sulfur	battery acid; certain medicines; nylon and rayon cloth; matches; explosives; many others
		Native Copper	important ore mineral of copper
Sulfides	metal + sulfur	Galena	major ore mineral of lead
		Sphalerite	major ore mineral of zinc
		Chalcopyrite	major ore mineral of copper
		Pyrite	a source of sulfur for sulfuric (battery) acid
Oxides	metal + oxygen	Hematite	important ore mineral of iron
		Magnetite	major ore mineral of iron
		Corundum	abrasives, sandpaper; when pure and red calley ruby, other gem varieties called sapphire
Hydroxides	metal + oxygen + hydrogen	Limonite	minor ore mineral of iron
Halides	metal + halogen (chlorine or fluorine)	Halite	salt for food and many industrial uses
		Fluorite	a flux for manufacturing steel and aluminum
Sulfates	metal + sulfur + oxygen	Gypsum	used in wallboard, plaster and concrete manufacturing
Carbonates	metal + carbon + oxygen	Calcite	major ingredient in cement; many other uses
Phosphates	metal + phosphorus + oxygen	Apatite	fertilizers; detergents; explosives
Silicates	silicon + oxygen or metal + silicon + oxygen	see Lab 3 for list	Major Rock Forming Minerals

Identification of Nonsilicate Minerals

Mineral identification involves the systematic use of physical properties to separate a single pile of minerals into smaller and smaller piles until you zero in on the correct name. This generally involves the use of a mineral key (see the following page). The following steps should enable you to identify all of the minerals in this lab.

1. *Determine the Luster.* Minerals with a dark-colored streak have a metallic luster and the streak color is a very important physical property for identification of a particular metallic mineral. Minerals with a light or white streak have a nonmetallic luster and streak color is NOT a good property for identifying these minerals.

2. *Determine the approximate Hardness*. The key is using the terms soft, medium and hard by the following criteria:

Can scratch with a fingernail	$H \leq 2.5$	Hardness is **Soft**
between a fingernail and a steel nail	$H > 2.5 \leq 5$	Hardness is **Medium**
can scratch a steel nail	$H > 5$	Hardness is **Hard**

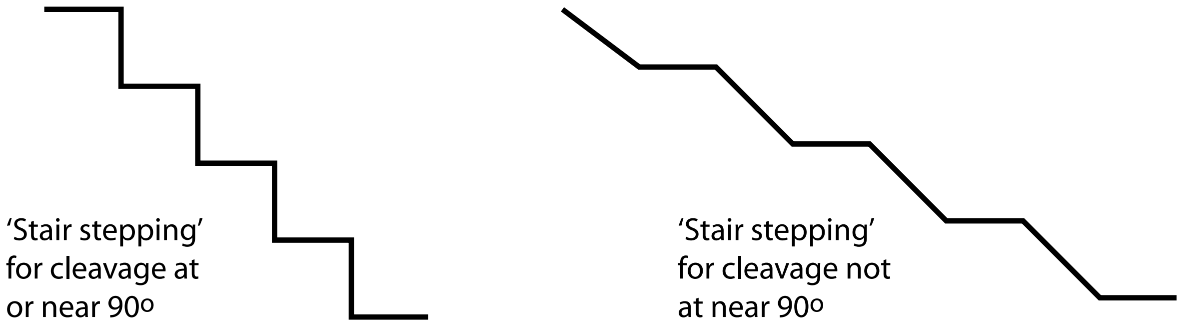
Other common tools may be used (see the table in Lab 1) and the Mohs Hardness Set is available if you wish is get a more exact hardness. Five important things to keep in mind when testing the hardness of an unknown mineral:

- minerals with the same hardness will scratch each other
- the hardness of any ‘Mohs Mineral’ in you set of unknowns is its major physical property;
- scratch each sample with the other and wipe off any powder so that you can see the scratch;
- the harder the mineral is, the harder it is to scratch that mineral;
- NEVER use your jewlery for hardness testing !! There is a vast difference between hardness and brittleness in a mineral. Harder minerals (your jewelry) will tend to be brittle and scatter easily.

3. *Check for Cleavage or Fracture*. Minerals with ‘good ‘cleavage should show that cleavage readily. In fact, if a mineral has good cleavage and is transparent to translucent, you can usually hold the mineral up to a light and see fine parallel traces of that cleavage within the mineral. If a mineral has fair to poor cleavage first look at the overall shape of the mineral:

- in basal cleavage the minerals tend to be flat if broken
- in prismatic cleavage the minerals then to look like bricks with rough ends
- in cubic or rhombic cleavage you should see either square or bent box shapes
- in octahedral cleavage you can see triangle shapes on freshly cleaved surfaces.

A hand lens is also a handy tool for checking cleavage. Any cleavage at 90^{o} will show regular stair steps on broken edges. Any cleavage not at 90^{o} will show irregular stair steps on broken edges (see diagram on the next page).



The edges of minerals can show these shapes as clues to mineral cleavage.

Samples with an irregular fracture often appear grainy-looking or have sharp, ragged edges like broken metal. Shaples with a conchoidal fracture have very sharp, rounded breaks like pieces of broken bottle glass.

4. *Check the ‘Other Properties’*. There may be special properties for a given unknown mineral or the color or Specific Gravity (abbreviated SG in the mineral key) may give clues to its identification.

L.	Streak	H.	Cleavage / Fracture	Other Properties	Name
Metallic Luster	black to lead gray	Soft	basal (fair)	H = 1; SG = 2.1; greasy to the touch, marks on paper	**Graphite**
	lead gray		cubic (good)	H = 2.5; SG = 7.5; feels very heavy; bright metallic silver colored	**Galena**
	reddish-brown	Soft to Med	irregular fracture	H = 1 - 5; SG = 5 - 6; reddish-brown color common	**Hematite**
	yellow - brown		irregular fracture	H = 1 - 5; SG = 4; yellow-brown color common	**Limonite**
	bright copper red	Med	irregular fracture	H = 3; SG = 4.2; metallic copper color with common light green tarnish	**Native Copper**
	light brown		6 directions of cleavage appears to have an irregular fracture	H = 3.5 - 4; SG = 4; resinous brown to nearly black in color; strong sulfur odor when rubbed	**Sphalerite**
	black with green tint		irregular fracture	H = 3.5 - 4; SG = 4; brass-yellow, often tarnished to bronze, purple or black	**Chalcopyrite**
	black	Hard	irregular fracture	H = 6; SG = 5.2; black color, granular appearance; will stick to a magnet	**Magnetite**
	black		irregular fracture	H = 6; SG = 5; shiny brass-yellow color; often in cubic crystals with striations on the crystal faces	**Pyrite**
Nonmetallic Luster	NOT USEFUL FOR THESE MINERALS	Soft	irregular fracture	H = 2; SG = 2.1; yellow to yellow-brown color; strong sulfur smell when rubbed	**Sulfur**
			basal (good), plus 2 other fair cleavages	H = 2; SG = 2.3; clear when pure; thin edges slightly flexible	**Gypsum**
			cubic (good)	H = 2.5; SG = 2.2; clear when pure; soluble in water; salty taste	**Halite**
		Med	rhomb (good)	H = 3; SG = 2.7; clear when pure, may be white or any color depending on impurities	**Calcite**
			octahedral (good)	H = 4; SG = 3.3; clear when pure, common colors include light green, yellow and purple	**Fluorite**
			irregular fracture	H = 5; SG = 3.2; commonly green or brownish in color; 6-sided crystals common, but brittle and breaks easily	**Apatite**
		Hard	irregular fracture	H = 9; SG = 4; commonly brown or gray in color, but may be red or blue; 6-sided crystals very common	**Corundum**

NONSILICATE MINERAL FORM

Mineral Name	Two Characteristic Physical Properties

Lab 2 - Nonsilicate Minerals

1. What is the difference between an element and a mineral?

2. What two elements are present in all silicate minerals?

3. Which of the major elements that make up the earth's crust can be considered cations?

4. Which major element that is present in the earth's crust can be considered an anion?

5. What is the difference between a sulfide and a sulfate?

6. Of the major chemical classes of minerals which classes lack the element oxygen?

7. If an unknown mineral specimen has metallic luster, is soft, and has good cleavage what possible minerals can you identify?

8. Select the minerals from question #7 that can be used as “lead” in the pencil you are writing with? What mineral class is this mineral?

9. For what type of luster is streak not a useful property?

10. If an unknown mineral specimen has metallic luster and is medium in hardness what possible minerals can you identify?

11. Do all the hard minerals in today’s lab lack cleavage?

12. Comment on the validity of the following statement “Minerals that lack cleavage are strongly chemically bonded without planes of weakness at the atomic scale.”

13. Describe the difference in the cleavage present for the minerals calcite and halite?

14. The minerals magnetite and pyrite both have metallic luster, black streak, are hard, and have irregular fracture. How would you tell the difference between these minerals?