LAB 2: MINERAL PROPERTIES AND IDENTIFICATION

OBJECTIVES:

1) to become familiar with the properties important in identifying minerals;
2) to learn how to identify the common rock-forming minerals.

Preparatory reading in Marshak: p 117-136; Appendix B-2 and B-3

INTRODUCTION:

Minerals – naturally occurring inorganic crystalline substances – are the basic building blocks of rocks. A mineral has a definite chemical composition (or a restricted range of compositions) and a specific, regular organization of the atoms that make it up. It is this regular internal structure that makes the mineral **crystalline** and which gives it the unique properties which allow us to identify it.

Although there are around 4000 known minerals, only 16 minerals or so are important constituents of most rocks. We will concentrate on learning the appearance and properties of these common rock-forming minerals.

Most common minerals are **silicates** – combinations of light metals (sodium, calcium, magnesium, aluminum) or iron with silicon and oxygen (this is reasonable since these elements make up more than 99% of the earth's crust). The important silicate minerals are:

quartz
orthoclase feldspar
plagioclase feldspar
amphibole (hornblende)
pyroxene (augite)
biotite mica
muscovite mica
clay
olivine

Common non-silicate minerals which are important constituents of rocks:

calcite (calcium carbonate)
dolomite (calcium magnesium carbonate)
hematite (iron oxide)
magnetite (iron oxide)
limonite (hydrous iron oxide)
pyrite (iron sulfide)
gypsum (calcium sulfate)

WHAT TO DO IN THIS LAB

In **Part 1**, you will learn the fundamental physical properties used in identification of minerals: luster, hardness, cleavage, streak, and density.

In **Part 2**, you will examine the most common rock forming minerals and describe the properties which allow you to recognize them.

In **Part 3** you will use your observations and the mineral identification tables in Pellant and this lab to identify several unknown minerals.

WHAT YOU ARE EXPECTED TO KNOW

A. Be able to recognize *cleavage surfaces* on a mineral, and to be able to determine the *number of cleavages* and the *approximate angles between cleavages* of an unknown mineral.

B. Be able to recognize/identify the following 16 important rock-forming minerals:

quartz
orthoclase feldspar
plagioclase feldspar
amphibole (hornblende)
pyroxene (augite)
biotite mica
muscovite mica
clay
olivine
calcite
dolomite
hematite
magnetite
limonite
pyrite
gypsum

I will not hold you responsible for knowing any other minerals in this lab.

GEOLOGY 109 MINERALS LIST

What minerals you'll see in lab, which you are required to know (**bold**), and where to find information about them

MINERAL GROUP, MINERAL	**Included in Marshak mineral identification key?**	**Pellant, page #**	**Required mineral? introduced in lab #**
			—
Native elements			
graphite	X	51	not required
Sulfides			
galena	X	52	not required
pyrite	X	60	Lab 2
Halides			
halite	X	70	not required
fluorite	X	74	not required
Oxides			
magnetite	X	79	Lab 2
hematite	X	80	Lab 2
quartz	X	86-89	Lab 2
limonite	X	95	Lab 2
Carbonates			
calcite	X	99	Lab 2
dolomite	X	100	Lab 2
Sulfates			
gypsum	X	110	Lab 2
Silicates			
quartz	X	86-89	Lab 2
olivine	X	132	Lab 2
garnet (almandine)	X	133	not required
pyroxene (augite)	X	151	Lab 2
amphibole (hornblende)	X	153	Lab 2
serpentine (antigorite)	X	158	Lab 5
talc	X	158	not required
muscovite mica	X	160	Lab 2
biotite mica	X	161	Lab 2
clay (kaolinite)	X	163	Lab 2
chlorite mica			Lab 5
plagioclase feldspar	X	168-171	Lab 2
orthoclase feldspar	X	171	Lab 2

PART I IMPORTANT PHYSICAL PROPERTIES OF MINERALS (Pellant, p. 22-28; Marshak p. 117-122)

1. HARDNESS (specimens 1- 6) (Pellant, p.25; Marshak, p.131)

The **hardness** of a mineral is measured by its resistance to scratching and its ability to scratch other materials. Examine specimens 1 through 6 and determine their approximate hardness by trying to scratch them with your fingernail, seeing whether they will scratch glass, and seeing if they can be scratched with a nail or a knife blade.

CAUTIONS: the hardness of most minerals can be properly determined only on a single crystal. If you scratch across an *aggregate* of mineral grains, you will commonly determine a hardness that is too low, since you will only be measuring how strongly the crystals are glued to one another, and not the true hardness of the mineral. So it is important to single out an individual crystal grain and do your tests on it. (The only exception to this rule is in the case of very very fine-grained aggregates where individual crystals cannot be seen without a microscope.)

When you scratch a mineral, or use it to scratch glass, be sure that it really has made a scratch by running your fingernail across it. If you drag a soft material across a harder one, you can sometimes powder the soft material and leave a streak of it on the harder one. This is NOT a scratch — it will rub off easily with your finger.

Sample number	Hardness
1	
2	
3	
4	
5	
6	

2. CLEAVAGE (specimens 5 -11) (Pellant, p.24; Marshak, p. 133-134)

Cleavage reflects the tendency of the mineral to break along *sets of parallel planes* due to its internal atomic structure having regular directions of weaker bonding. We are interested in determining three things:

a) does the mineral show any cleavages? (Are there any sets of parallel planes along which it preferentially breaks?) Not all minerals display cleavage.

b) if the mineral shows cleavage, how many different cleavage directions (different sets of parallel planes) does it have? Most minerals with cleavage have 1, 2, or 3 directions.

c) what are the approximate angles between the different cleavage directions? 30°? 45°? 60°? 90°? 120°? etc.

Examine the specimens numbered 5 through 11 and determine the number of cleavage directions (if any) and the angles between them. Cleavages are commonly recognized by rotating the mineral under a bright light and noting that even though the mineral surface is irregular, in some positions the entire surface will act as a mirror to brightly reflect light (you get a flash.) This flash is due to all those parallel planes reflecting at once.

CAUTION: Don't confuse *crystal faces* (planes formed by the growth of the crystal) with *cleavages*. Crystal faces will not be *sets* of parallel planes; they will be single surfaces. (See Marshak, Fig. 5.22, p. 134 for a good example.)

Please do not break the minerals to determine cleavage. Determine it by looking at them.

Sample number	Number of cleavage directions	Angle between cleavage planes
5		
6		
7		
8		
9		
10		
11		

3. LUSTER (specimens 12 -19) (Pellant, p. 27)

Luster is a qualitative judgement about the way in which the mineral reflects light. We are really concered with one thing: does the mineral appear *metallic* (it looks like a piece of metal), or is it *non-metallic* (it looks glassy, or like pitch, or clay, or pearly, etc. It just doesn't look like metal.)

Examine the specimens numbered 12 through 19 and determine their luster.

Sample number	Luster
12	
13	
14	
15	
16	
17	
18	
19	

4. STREAK (specimens 16 -21) (Pellant, p. 26)

Streak is the color of the mineral when powdered. It is useful chiefly in identification of metallic minerals. Non-metallic minerals usually have a streak that is identical to their color. Streak is determined by rubbing the mineral on a porcelain plate and then rubbing the resulting streak lightly with your fingertip to better bring out the color.

Examine the specimens numbered 16 through 21 and determine their streak.

Sample number	Streak
16	
17	
18	
19	
20	
21	

5. DENSITY (OR SPECIFIC GRAVITY)) (Pellant, p. 25)

Density measures how much matter is packed into a given volume. Some materials (like lead and gold) are very dense: they quite heavy for their size. Others (like aluminum and carbon) are light for their size. In some cases, density can be very useful in identifying minerals. We commonly express the density of minerals as a ratio to the density of water . This is known as **specific gravity**. Specific gravity can be determined numerically with a balance by weighing the specimen in air and then underwater:

$$\text{sp. gr.} = \frac{\text{weight in air}}{\text{weight in air} - \text{weight in water}} \quad ,$$

but for most purposes you can get an idea of the specific gravity by hefting the mineral in your hand. Does it seem particularly heavy or light for its size?

6. OTHER PROPERTIES

Other physical properties that are sometimes useful in identifying minerals are:

magnetism - magnetite is attracted to a magnet

reaction to acid - calcite (and, to a lesser extent, dolomite) fizzes when dilute hydrochloric acid is dropped on it

striations are fine parallel lines that are visible on some plagioclase feldspar cleavage surfaces. Orthoclase feldspar does not have striations (although it may have fuzzy, discontinuous, subparallel color bands called "exsolution lamellae").

PART II. MINERAL IDENTIFICATION

Examine the 16 labeled minerals. Determine their luster, hardness, color, and cleavage, and note any other important identifying characteristics (such as streak, magnetism, fizzing in acid, especially high or low density, etc.) The idea here is to fill in the table on the next page *with the characteristics that will help YOU to recognize these minerals in the future*. Check your observations with the mineral descriptions in Pellant's book to see if you are on the right track.

PART II MINERAL IDENTIFICATION

Mineral	Luster	Hardness	Cleavages (no. and angles)	Color	Streak	Other
Orthoclase feldspar						
Plagioclase feldspar						
Quartz						
Pyroxene (augite)						
Amphibole (hornblende)						
Muscovite mica						
Biotite mica						
Olivine						
Clay						
Calcite						
Dolomite						
Gypsum						
Magnetite						
Hematite						
Limonite						
Pyrite						

PART III. UNKNOWN MINERALS (specimens 1- 6, 8 - 20)

Go back to the specimens you used in part 1. Use the mineral identification tables handed out with this lab and in Marshak (p. B2-B3) and photos in Pellant to determine the names of minerals 1 through 6, and 8 through 20.

The secret to efficient identification is to *USE THE TABLES SYSTEMATICALLY*. First determine luster. If non-metallic, decide whether light or dark color. Then determine hardness; then cleavage, then look at the individual descriptions.

Note: there may be more than one example of some minerals

Sample number	Mineral name
1	
2	
3	
4	
5	
6	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Questions: 1) How can you tell amphibole from pyroxene? _____

2) How can you tell plagioclase feldspar from orthoclase feldspar? _____