GEOLOGY 335 LAB -- MINERAL IDENTIFICATION REVIEW

This lab is a review exercise on the techniques of mineral identification in hand specimen. By the study of well-formed examples of individual minerals, the investigation of rocks that typically consist of fine-grained intergrowths of several minerals will be made easier in the succeeding labs.

A. OBJECTIVES

A key objective is to develop a systematic procedure to define the physical properties of a mineral and to utilize this information for identification. At the end of this lab you should be able to ...

1. Define mineral.

2. Recognize that minerals differ from each other because they have specific physical properties.

3. List, define, and describe the following physical properties of a given mineral:
   a. luster (metallic vs. non-metallic)
   b. hardness
   c. cleavage
   d. crystal form
   e. specific gravity
   f. streak

4. Know that color is not always reliable property to use in identifying a mineral. For example, see the fluorite display in the case next to Room 111.

5. List in correct order the minerals of Mohs' hardness scale, and know how it is used to identify an unknown mineral.

B. MINERAL IDENTIFICATION

A **mineral** is a naturally occurring, inorganic substance that has an orderly internal arrangement of atoms and a definite chemical composition that may vary within certain limits. Each mineral possesses specific **physical properties**, many of which are nearly constant for a particular mineral species. Therefore, the first step in identifying an unknown mineral specimen is to recognize the relevant physical properties. Minerals also possess **chemical properties**, most of which require sophisticated investigations to define, but may aid in their identification. Some simple tests of chemical properties, such as effervescence of calcite in dilute HCl, can be diagnostic.

Hardness: Hardness is the resistance that a smooth surface of a mineral offers to abrasion. Like many other physical properties of minerals, hardness is dependent upon crystal structure. The hardness is expressed in terms of a relative scale from 1 to 10, each number being represented by a special mineral. This scale, known as **Mohs' scale of hardness**, is as follows:

Mineral Scale		Common Substance	
1	Talc		
2	Gypsum	2.5	thumbnail
3	Calcite	3	penny
4	Fluorite		
5	Apatite	5	nail

6	Orthoclase	5.5	glass
7	Quartz	7	streak plate
8	Topaz		
9	Corundum		
10	Diamond		

In determining the hardness of a mineral it is necessary to see which common substances (above) the mineral will scratch and which ones it will not. Some of the common substances above will be provided for you, and the gaps can be filled in by minerals in the study set after they are identified. The following should be observed when testing the hardness of a mineral:

1) When testing the hardness of one mineral against another, the softer mineral may leave a mark on the harder one which can be mistaken for a scratch. However, this mark is not permanent and can be easily rubbed off, while a true scratch will be permanent. For example, when chalk is rubbed across a blackboard, a mark is left on the board. This mark, however, is chalk that has rubbed off on the board, rather than a scratch on the board, and can be easily rubbed away.

2) Some minerals are commonly weathered on the surface to a substance (commonly a different mineral) that generally is somewhat softer than the original mineral. Therefore, care should be taken to test the hardness of a mineral. Be sure that you are not testing a weathering rind.

3) When testing the hardness of a mineral against that of glass, lay the piece of glass <u>flat on the table</u>, and try to scratch it with a corner or sharp edge of the mineral. A mineral having a hardness of 7 will cut the glass readily; hardness 6 minerals will leave only a slight scratch.

4) When testing the hardness of a mineral against that of a nail, try scratching the mineral with the pointed end of the nail. If no scratch is made, find a sharp edge on the specimen and rotate the nail against it. A mineral having a hardness of 7 will cut the nail easily. One with hardness 6 will cut slightly if sufficient pressure is applied, although the mineral edge may be somewhat crushed. (One should be aware that the hardness of nails may vary over a range of types).

Color: Color is one of the most obvious physical properties, but because it can be highly variable, it is one of the least valuable diagnostic properties. Trace quantities of certain elements (e.g., iron, manganese, etc.) in the crystal can cause wide variations in color among examples of the same mineral species. Quartz, for example, has no inherent color of its own, but varies according to the occurrence of these impurities within its crystal lattice. Color is relatively constant for most metallic minerals. A good example is pyrite, a mineral that is always brassy yellow.

Luster: Luster refers to the way in which a <u>fresh</u> surface of a mineral reflects light. Many nonmetallic minerals have a <u>glassy</u> luster. **Metallic** luster is characteristic of metals and sulfide minerals such as pyrite (iron sulfide) and galena (lead sulfide). Weathering of the surface may obscure the true luster. Some minerals truly have a <u>dull</u> "luster", even on fresh surfaces.

Cleavage: Cleavage is the tendency shown by many minerals to break along certain well-defined planes that represent planes of weakness in the bonds that hold the atoms together in the crystalline structure. A planar surface so produced is characteristically flat and reflects light to differing degrees depending on the degree of perfection of the cleavage; see the figures for examples of cleavage types. The flat surface is called the cleavage plane, and the orientation of the plane is called the cleavage direction. Some minerals have only one such cleavage direction; the micas are excellent examples. Notice that although the micas have only one cleavage direction, this cleavage direction is represented by two parallel planes, one on top of the specimen, the other on the bottom. The feldspars have two directions of cleavage. A mineral may have 2, 3, 4 or more directions of cleavage, and there may not be a dominant direction; that is, the mineral might break with equal ease along all cleavage directions. This can result in the formation of a stair-step surface that may at first appear to be an irregular fracture. Galena, a mineral that has three directions of cleavage in cubic orientation, and because none of these directions of cleavage is dominant, a stair-step pattern results. Each of these "steps" represents a side of a cube. If such a specimen is rotated in the light the small parallel cleavage surfaces will reflect light in the same manner as will the large smooth cleavage surface. An uneven fracture will not concentrate light in any particular direction, and therefore will not appear shiny. In minerals with two or more directions of cleavage, the angles at which the different cleavage directions intersect are important and diagnostic. Exact measurements of these cleavage angles are seldom necessary, as careful estimation is usually sufficient for determination.

Fracture: In some minerals the internal bonding is so uniform in strength that there are no planes of weakness in the crystal structure. Such minerals do not have cleavage, but instead break or fracture in an irregular random manner. There are two important types of fracture:

CONCHOIDAL - smooth, curved fracture (like glass).
UNEVEN - rough and irregular surfaces.

Specific Gravity: A measure of the density of a mineral is provided by the "specific gravity", a comparison between the weight of a given volume of a mineral and the weight of an equal volume of water that expresses the density of the mineral. Some minerals are much heavier than others in proportion to their volume, although the majority of common minerals are neither notably light nor heavy. For elementary study, the density can be estimated with sufficient accuracy by "hefting" the specimen. Most common rock-forming minerals have specific gravities between 2.6 and 2.8. Densities substantially above or below this range can be detected with a little practice, and the minerals can thereby be classed as heavy (specific gravity greater than 3.0), average, or light (specific gravity less than 2.3).

Crystal Habit: The crystal form of a mineral will be indicative of the basic chemical structure that controls mineral growth and may be useful in identification. However, many factors control whether a given formative enviroment will result in the development of well-formed crystals of a particular mineral.

Other diagnostic properties: taste, feel, magnetic character, etc.

C. MINERAL IDENTIFICATION EXERCISE

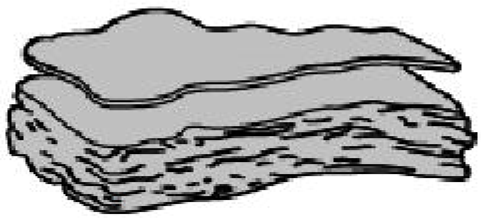
This exercise assumes an understanding of the physical properties of minerals as reviewed in the preceding discussion.

Materials: A set of about 20 minerals is provided for practice in recognition of physical properties. This set principally consists of important "rock-forming" minerals, i.e. those minerals that form the majority of rocks that form in igneous, metamorphic, and sedimentary environments. Some other minerals are included because they are important from the Texas mineral resource perspective.

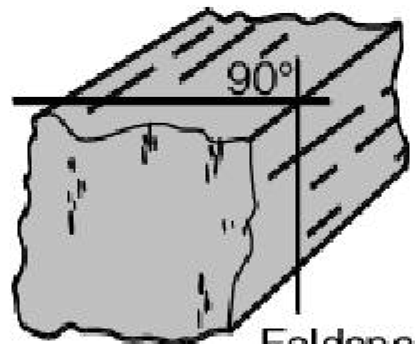
See the summary tables for the additional information on mineral properties.

Equipment: Streak plate, small glass plate, nail, and acid bottle; a low magnification glass or "hand lens" would be useful.

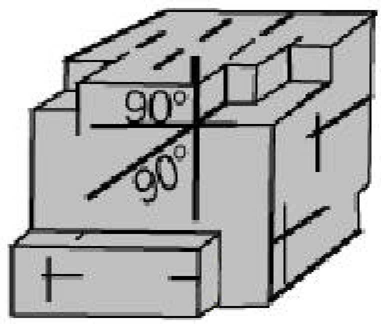
Procedure: The first step is to evaluate the physical properties of the minerals before making any attempt to name the specimen. Try to develop good identification habits, i. e. a systematic documentation of the physical properties, instead of operating from a "recognition" perspective. Enter the number of the specimen in the first column of a work sheet. Then, determine as many physical properties of the specimen as you can and enter them in a second column. You are then ready to compare the physical properties which you have determined with those of the minerals listed in the attached tables. The minerals in the tables are listed in order of increasing hardness. Further subdivision is based on color, streak, cleavage, etc. In this way you can determine the name of the unknown mineral. Notice which of the physical properties of the mineral were most important in determining its identity. What were the chief diagnostic properties used in identifying each mineral?



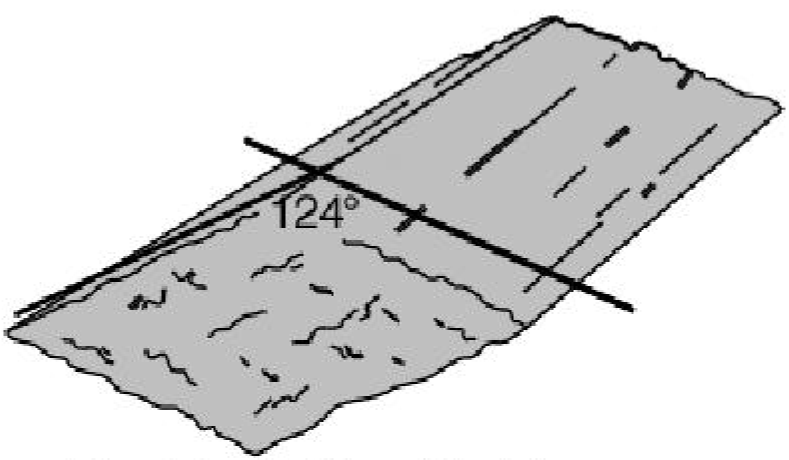
Mica
One excellent direction of cleavage.



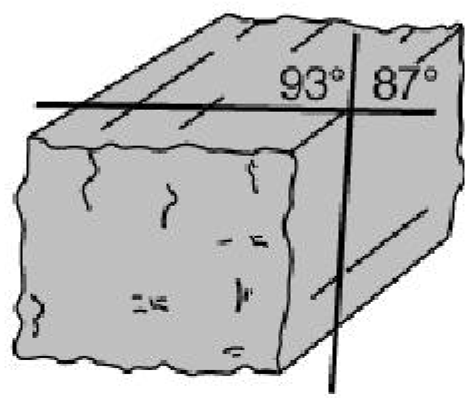
Feldspar
Two good directions of cleavage at 90°.



Galena
Three excellent (cubic) cleavage directions.



Hornblende (Amphibole)
Two good cleavage directions at 124°.



Augite (Pyroxene)
Two good cleavage directions at 93°.

GEOLOGY 335 -- MINERAL IDENTIFICATION CHECK LIST

Rock-forming Minerals

Quartz (a framework silicate)
Potassium feldspar (K-spar) (a framework silicate)
Plagioclase feldspar (Na & Ca) (a framework silicate)
Hornblende (a variety of amphibole)
Augite (a variety of pyroxene)
Olivine (an isolated silicate)
Garnet (an isolated silicate)
Muscovite (a sheet silicate)
Biotite (a sheet silicate)
Talc (a sheet silicate)
Kaolinite (clay mineral) (a sheet silicate)
Calcite (a carbonate)
Dolomite (a carbonate)

Other Minerals (* = concentrations in Texas)

*Halite (a chloride)
*Fluorite (a fluoride)
*Magnetite (an oxide)
Hematite (an oxide)
*Gypsum (a sulfate)
*Celestite (a sulfate)
Pyrite (a sulfide)
*Galena (a sulfide)
*Cinnabar (a sulfide)
*Graphite (one form of a native element)
*Sulfur (one form of a native element)