Amherst College
Department of Geology

THE IDENTIFICATION OF MINERALS

INTRODUCTION

This exercise is designed to be completed at home, using the mineral tray of approximately 30 mineral specimens that has been assigned to you for the semester. You are asked to identify the mineral name of these specimens by determining (and learning) their physical properties so that you can use mineral identification to aid your study of rocks in future labs.

The effective way to identify these specimens is to work with all the specimens at once. Each sample is consecutively numbered (running from left to right and then top to bottom so that row 1 has #1-7, row 2 has #8-14, etc.), so go ahead and gently dump them on a table (protected with a newspaper or other cover). Divide the minerals into luster groups, then subdivide the luster groups by streak, hardness, and so on - using the physical properties you learned to recognize in lab (luster, streak and color, hardness, and cleavage), plus a few others that are mentioned in the descriptions of the minerals below. By this process of elimination you can best identify your specimens.

After working with the whole collection and subdividing it into smaller and smaller groups, begin entering the information you have gathered on the mineral identification form. First list the physical properties of each specimen, and then its mineral name. This procedure follows the scientific method, in which one first gathers data, and then arrives at a conclusion.

Refer to the lab exercise on physical properties in order to recall the method of determining those properties in which you are interested. Typically scientists would both scratch and break specimens to test key physical properties. These specimens are not sacred, but please do NOT break them. You should assume that most of the samples were broken when they were collected and so already show cleavage. Do go ahead and scratch the samples. Certain materials, usually available in the home, will be quite useful for testing minerals. A nail or pocket knife, a copper cent, and a piece of window glass are useful for hardness tests and are included in your mineral tray. Streak may be determined with a piece of unglazed porcelain, or by finely powdering a small piece of a specimen between two hard objects. A small lens will be useful, especially to determine cleavage. A magnet will identify your magnetite specimen.

You should be cautious of two problems that will arise with some of your mineral tray specimens. The first is that some are impure, containing other minerals in addition to the main one. For example, sillimanite occurs as part of a rock sample in your tray. The other important problem is that mineral specimens can occur in aggregate form, in other words, some of your specimens will consist of many individual grains. Your sample of olivine is one such case. The physical properties to be determined must be determined on individual grains, not on an aggregate of grains. The separation of grain characteristics from aggregate characteristics requires careful examination of each specimen.

PROCEDURE

First, divide all your specimens into the luster groups under Category "I" below, and then try to subdivide those groups further by employing Categories II to V. Note that some of the minerals are listed in more than one category. Write these important physical characteristics of each mineral, as you determine them, in the table at the end of the lab. Using these properties, and the mineral descriptions provided here, identify each mineral and write its name in the appropriate box on the diagram of a mineral tray at the end of the lab. Bring your mineral tray to lab next week. You should have made considerable progress in determining the physical properties of the minerals and in identifying them.

I. Luster in combination with color and streak.

A. Minerals with metallic luster. These will be opaque, but may be of various colors.

1. Magnetite - color black; streak black; magnetic.

2. Hematite - color blue-black, but also may be earthy red; streak dull red always.

3. Galena - color lead grey; metallic luster very bright; streak shiny grey-black; perfect cleavage in three directions.

4. Pyrite - color brass yellow; streak black; very hard for a metallic mineral.

5. Sphalerite - color yellow to brown to black; luster bright (note quite metallic); streak pale yellow; soft; several directions of cleavage.

6. Graphite - color grey; streak black; soft, perfect cleavage in one direction.

B. Non-metallic minerals, dark color, glassy (vitreous) luster.

1. Sphalerite - color resinous yellow to dark brown; cleavage perfect in six directions; soft.

2. Amphibole - color dark green to black; cleavage in two directions.

3. Biotite - color brown to black; cleavage perfect in one direction (cleaves into flexible, elastic sheets).

4. Feldspar - color variable, occasionally dark grey; cleavage excellent in two directions; hard.

5. Apatite, corundum, olivine, tourmaline, chlorite, serpentine, epidote, staurolite, and kyanite.

6. Calcite, pyroxene, dolomite, and fluorite can fall into this category also.

C. Non-metallic minerals with a dull or earthy luster.

1. Limonite - color yellow to dark brown; in a fine-grained aggregate.

2. Talc - color bright green to grey in fresh pieces, handling may change to dull, greasy color; cleavage perfect in one direction; very soft, feels greasy.

3. Pyroxene - color dark; cleavage in two directions; hard.

4. Kaolinite - luster earthy or greasy; smell earthy when slightly moist; very soft.

5. Barite - very heavy, dark earthy color.

D. Light colored minerals with a glassy (vitreous) luster.

1. Quartz - color variable; hard; streak none; cleavage none obvious; very hard; often transparent.

2. Feldspar - similar to quartz, except it has two directions of perfect cleavage; translucent, but not transparent.

3. Muscovite - color light; cleavage perfect in one direction; cleaves into flexible, elastic sheets.

4. Gypsum - translucent to transparent; cleaves into sheets; very soft.

5. Calcite - cleavage perfect in three directions; hardness of 3; commonly transparent to white, in some cases colored.

6. Fluorite - color white, grey, green or purple; cleavage in four directions; hardness of 4; otherwise very similar to calcite.

7. Dolomite - very similar to calcite, except that it reacts weakly with dilute hydrochloric acid, while calcite reacts strongly.

8. Halite - cleavage perfect in three directions; taste salty.

9. Talc - cleavage perfect in one direction, breaks into flexible sheets; very soft (softest of all minerals).

10. Topaz - perfect cleavage parallel to base, very hard.

II. Cleavage and Fracture

A. <u>One cleavage: Biotite, muscovite, talc, chlorite</u>.

Talc is so soft that it feels slippery.
Biotite, muscovite, and chlorite are micas, biotite dark brown or black, muscovite is pale colored or colorless, and chlorite is green.
Kyanite and epidote both have one cleavage.
Topaz has one cleavage perpendicular to the long dimension of the crystal.
Graphite (similar to micas in cleavage), greasy feel.
Barite one excellent basal cleavage (has others not so well developed).

B. <u>Two cleavages: Amphibole, pyroxene, feldspar</u>.

Feldspar, although rather hard, cleaves very well in two perpendicular directions. It is usually (not always) light colored.
Pyroxene has two almost perpendicular cleavages, not perfect.
Amphibole cleavages form angles of about 60 degrees (and 120 degrees).
Both amphiboles and pyroxenes are usually dark green or black in color.

C. <u>Three cleavages: Galena, halite, gypsum, calcite, dolomite</u>.

Galena, and halite have cubic cleavage, the former being metallic and dense, the latter non-metallic, of low density, and soluble.
Calcite and dolomite have very perfect rhombohedral cleavage.
Gypsum has one perfect cleavage with a glassy luster, one less perfect with a pearly luster, and one with a silky luster.

D. <u>More than three cleavages: Sphalerite, fluorite.</u>

Sphalerite has 6 directions of cleavage, and has a pale yellow streak.
Fluorite has 4 cleavage directions.

E. <u>Fracture</u>:

Olivine and quartz have a smooth curved (concoidal) fracture.
Most of the others have an uneven fracture (e.g., garnet, magnetite, corundum, pyrite, hematite).

III. Hardness

Less than 2.5: Talc (slippery feel), gypsum, limonite (earthy), hematite (earthy), chlorite, muscovite, biotite, kaolinite, chlorite, graphite.

2.5 to 3.5: Calcite, halite, galena, dolomite, barite

3.5 to 5.5: Sphalerite, fluorite, serpentine, apatite

5 to 6: Amphibole, pyroxene, feldspar, hematite (massive), limonite, epidote, kyanite (parallel to long axis of crystal)

Over 6: Pyrite, magnetite, quartz, garnet, kyanite (across crystal)

Variable: Note that limonite and hematite have variable hardnesses according to the type of aggregate.

IV. Density

Below average: (< 2.5 g/cc)	halite, gypsum, kaolinite, serpentine, graphite.
Average: (2.5 to 3.5 g/cc)	calcite, quartz, feldspar, muscovite, biotite, amphibole, pyroxene, fluorite, dolomite, talc, chlorite, epidote, topaz, olivine, tourmaline, staurolite, kyanite, kaolinite
Above average: (>3.5 g/cc)	sphalerite (4.1), limonite (4.3), pyrite (5.0), magnetite (5.2), hematite (5.3), galena (7.6), garnet (3.9), corundum (4.0), barite (4.5).

V. Other properties:

1. Halite is soluble in water, tastes salty.
2. Magnetite is strongly magnetic.
3. Calcite fizzes strongly in dilute HCL, dolomite fizzes weakly where scratched.
4. Kaolinite is insoluble in water, touch lightly to your tongue.

MINERAL LIST

The following is a list of the mineral specimens with which you are working, together with the chemical composition of each one. Additional information is provided to aid in distinguishing between certain of those which are superficially very similar.

1. Quartz – SiO_2 - Can be distinguished from feldspar by its lack of cleavage. Feldspar has two directions of cleavage.

2. Orthoclase or Potassium feldspar – $KalSi_3O_8$ - See quartz and plagioclase.

3. Plagioclase feldspar (Albite and Labradorite) - $NaAlSi_3O_8$ - $CaAl_2Si_2O_8$ – A fimily of minerals that includes Albite and Labradorite. Plagioclase may have striations on its cleavage faces, potassium feldspars do not.

4. Amphibole - Complex FeMg silicate. Amphibole tends to have a bright luster and has two directions of cleavage <u>not</u> at right angles, unlike pyroxene, which has a dull luster (usually) and two directions of cleavage at right angles. Amphiboles typically form elongate prisms whereas Pyroxenes are short, boxy prisms.

5. Pyroxene - Complex FeMg silicate. See amphibole.

6. Biotite - Complex FeMg silicate. Has a dark color, which distinguishes it from the light colored muscovite.

7. Muscovite - Complex silicate. See Biotite. Also cleaves into flexible elastic plates, distinguishing it from gypsum.

8. Pyrite - FeS_2 - Hard with a brassy color.

9. Galena - PbS - It is almost impossible to confuse this mineral with any other, unless it is very fine grained.

10. Gypsum - $CaSO_42H_2O$ - Distinguished from calcite by its softness. Also, see muscovite.

11. Calcite - $CaCO_3$ - Very difficult to distinguish from dolomite except that it fizzes strongly in dilute HCL, while dolomite fizzes weakly. See also gypsum and fluorite.

12. Hematite - Fe_2O_3 - Usually easy to identify, although luster is variable from metallic to earthy. Always has a dull red streak.

13. Magnetite - Fe_3O_4 - Strong magnetic property makes it usually easy to identify.

14. Fluorite - CaF_2 - Noted for four directions of cleavage, but frequently forms cubic crystals which may be confused with cleavage. Distinguished from Calcite and Dolomite by cleavage.

15. Epidote – $Ca_2Al_2FeSi_3O_{12}(OH)$ Pistachio green, forms prismatic or tabular crystals, in some cases with striations. Hardness of 6.

16. Talc - $Mg_3Si_4O_{10}(OH)_2$ - The softest mineral. Cleaves into flexible plates, distinguishing it from clay.

17. Dolomite - $CaMg(CO_3)_2$ - See fluorite and calcite.

18. Limonite - FeO OH - Usually easy to identify. Yellow to brown with a yellow streak.

19. Kaolinite - $Al_4Si_4O_{10}OH_8$ - Usually no problems, but see talc.

20. Halite - NaCl - Taste it.

21. Sphalerite - ZnS - Usually no problems. Pale yellow streak distinctive. Streak has "rotten egg" odor.

22. Apatite - Calcium phosphate - variable color, hardness of 5, prismatic habit (6 sided), poor cleavage parallel to base, streak always white. This is what your bones and teeth are made of.

23. Corundum - Al_2O_3 - Very hard (9), heavy, no cleavage, usually grey or brown but in some casses red (ruby), blue, yellow, green, purple, or colorless (sapphire). Does not occur with quartz. Six sided prism like apatite.

24. Olivine - Mg_2SiO_4 - Commonly occurs as granular green to yellow-green crystals. Does not occur with quartz.

25. Tourmaline - complex boron-silicate - often triangular end section coupled with striations parallel to the direction of elongation make tourmaline easy to identify.

26. Chlorite - complex Fe-Mg "mica" - similar to muscovite and biotite except for diagnostic green color. Softer (<2.5) than serpentine (4-5).

27. Serpentine - $Mg_3Si_2O_5(OH)_4$ - greasy feel, harder than chlorite.

28. Graphite - C - usually no problem. Think pencils.

29. Garnet - Fe-Mg-Ca-Al silicate - Characteristic well-formed dodecahedral to round shape coupled with dark color (red, brown, black) make garnet easy to identify.

30. Staurolite - Fe-Mg-Al silicate - Brown to reddish-brown to brownish-black short, stubby crystals that are usually larger than rock matrix. Can be cross shaped. H = 7 to 7.5.

31. Kyanite - Al_2SiO_5 - Long bladed or tabular light blue crystals with differential hardness. H-7 across crystal and H-5 parallel to crystal length.

32. Andalusite - Al_2SiO_5 - Elongate brown to pink mineral with a square end section that may contain a dark colored cross. Hardness (7.5) is greater than quartz.

33. Sillimanite - Al_2SiO_5 - Brown to white slender, elongate to fibrous crystals. This mineral has a hardness of 6-7 and typically occurs in a very fine grained fibrous habit.

34. Barite - $BaSO_4$ - commonly occurs as earthy masses that are anomalously heavy.

35. Topaz - $Al_2SiO_4(F, OH)_2$ - nearly transparent with bright luster, very hard (8), heavy, perfect cleavage parallel to base of crystal.

MINERAL PROPERTIES

Number	Is specimen in aggregate form or is it a single crystal or a fragment of a single crystal? How pure is the specimen?	Luster	Color and Streak	Hardness	Cleavage or Fracture
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2					
3					
4					
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IDENTIFICATION OF MINERALS IN TRAY

	1	2	3	4	5	6	7
A							
B							
C							
D							
E							
F							