# Assignment #1: Investigating the Physical Properties of Minerals

## Overview

Minerals are the 'building blocks' of rocks, and are also an important part of our day-to-day existence as natural concentrations of metals and industrial materials. A mineral is a "naturally occurring, inorganic, crystalline solid with a narrowly defined chemical composition and characteristic physical properties".

The main goals of this assignment are to give you some practical experience in examining the physical properties of minerals, and using these properties to identify them. If you are in GEOL-111 you will spend quite a bit of time handling and looking at minerals in the labs. If you are in GEOL-111A this may be your first (and possibly only) opportunity in this course to get a hands-on look at some minerals.

The main objective of the assignment is to observe and describe what you see when looking at the minerals in the mineral kit. For minerals, as for rocks, it is important to learn what to look for and how to observe them in a systematic manner so that you can identify them with relative ease.

The physical properties of minerals are determined by their internal atomic structure and chemical composition. You will learn more about this in class. Some of the key physical properties of minerals are:

- **Hardness** – a mineral's resistance to being scratched by other minerals or materials. Some are very soft (e.g., talc), while other are extremely hard like a diamond.
- **Colour** – the colour of a mineral as it appears in natural daylight. Some minerals have very distinctive colours (e.g., the bright green of malachite)
- **Streak** - is a way to evaluate colour using the powdered form of a mineral after rubbing it on a piece of unglazed porcelain.
- **Lustre** – is the appearance of a mineral under reflected light, usually metallic or non-metallic.
- **Cleavage and Fracture -** is how a mineral reacts when it is broken, whereby if it breaks either along a distinct plane this is cleavage, or irregularly this is fracture
- **Specific Gravity or Heft** – is the relative weight of a mineral, being light, average or heavy
- **Other Physical Properties**: crystal habit, feel, taste, magnetic, optical properties and reaction to acid.

### Methodology

You will either have purchased a mineral kit or be using one in the lab that contains ten minerals. Your assignment will be to examine specific physical properties of these minerals, and then use your findings along with some further information to identify and name them.

The minerals you will be looking at include:

| | | |
|---|---|---|
| Orthoclase feldspar (or K-feldspar) | Hornblende (amphibole) | Hematite |
| Plagioclase feldspar | Pyroxene | Chlorite |
| Quartz | Calcite | |
| Biotite mica | Gypsum | |

You will need your mineral testing kit (or you can use the ones in the classroom), a steel nail, a copper coin, your finger nail, plus a piece of unglazed tile (if you can find one).

**Step 1 – Labelling Minerals A to J in Your Kit** Before you start the assignment you need to label each mineral A, B, C, D, E, F, G, H, I, and J as shown in class. There is a specific order in which to mark them – so do not do so randomly!

**Step 2 – Hardness** Hardness is one of the key physical properties for a mineral and is a measure of its resistance to abrasion or scratching by other minerals or materials. It is generally expressed using the Mohs hardness scale, which is based on a standard set of minerals. Each mineral in the scale has a characteristic hardness as follows:

1 – Talc
2 – Gypsum
*2.5 – Finger nail*
3 – Calcite
*3.5 - Copper coin or wire*
4 – Fluorite
5 – Apatite
*5.5 –Steel point*
6 – Feldspar
*6.5 – Unglazed porcelain tile*
7 – Quartz
8 – Topaz
9 – Corundum
10 – Diamond

A good way to first test for hardness is to attempt to scratch the mineral using the sharp point of a steel nail. If it won't scratch at all, its hardness is 6 or more and it is **hard**. If it scratches with difficulty, it may have a hardness of 4 or 5 - **moderate**. If it scratches very easily it is likely to be 2 or 3 - **sof**t. Other tools for testing hardness include your finger nails, a copper coin or porcelain tile.

Do this test systematically on each mineral. Using *Table 1* put the letter (A, B, C, etc) of the mineral in the appropriate box below hard, medium or soft.

**Step 3 – Colour & Streak** The colour of a mineral is easy to determine in most cases. However for many minerals colour is very variable and therefore should not solely be relied upon on for identification. Streak of a mineral is its colour in a powdered form. This can be a better guide to the true mineral colour than just looking at the sample. Typically we check the streak by rubbing the sample on an unglazed porcelain plate, but since you may not have one of those at home you could also check it by taking a tiny fragment and crushing it. Don't bother to check the streak colour of the light minerals like quartz, feldspar, calcite and gypsum; their streaks are white! Using *Table 2* group your samples into light or dark coloured with the A, B, C… labels and add any other comments you have about colour or streak.

**Step 4 - Lustre** is the way a fresh mineral surface appears in reflected light. The two main categories are metallic and non-metallic. Metallic minerals reflect most of the light that hits them, and none of the light penetrates into the interior of the mineral. Light will not penetrate even through a thin film of a metallic object. (Think of a sheet of aluminum foil.) Light can penetrate into a non-metallic mineral (although it may seem that it can't in some cases). Non-metallic lustre terms include terms like: glassy, resinous or earthy. Fill in *Table 3* using lustre terms like metallic, glassy, resinous or earthy.

**Step 5 - Fracture and Cleavage** is the way in which mineral breaks. An irregular break is a fracture, while a break along a flat plane is cleavage. Fracture is where the mineral breaks unevenly and not along a defined plane. It can be described as irregular, hackly or conchiodal. Cleavage planes must not be confused with crystal faces, which reflect how a crystal grows. If a mineral has cleavage it may break along a series of parallel planar surfaces with small steps in between. Cleavage can be described by its character (very good, good, fair or poor), the number of different cleavage planes, and their orientation with respect to each other. Cleavage is one of the most important diagnostic characteristics of many minerals, but it is also one of the most difficult to see, especially when you are just beginning. As you do not want to 'smash your samples to smithereens', this is best demonstrated in class on sample 'seconds'. For your purpose examine each sample and speculate how it may break. Will it display fracture or cleavage and if so what might this look like? In recording the cleavage please note the number of cleavage planes and their orientation with respect to one another (e.g., 2 @ 60º). Report you findings in *Table 4*.

**Step 6 – Using Key (Or Diagnostic) Physical Properties to Identify Minerals**
You have now tested your samples thoroughly and should have a good idea of their physical properties. The last step of this assignment is to use you observations along with some information from a mineral identification book to identify (name) your minerals. One of the most important aspects of this exercise is to determine the diagnostic physical properties of a mineral – these are the key physical properties that help you rapidly identify a mineral. For each mineral in the list, write down one or two key features that allow you to distinguish it from some others that may look similar. In most cases, colour will not be one of these key features.

**References:**

Make sure you have read Chapter 3 in the textbook. You might also find that a mineral and rock identification book is useful. The following is a good web site for finding information on minerals:
http://www.cln.org/themes/rocks_minerals.html

## GEOL-111 and 111A

Name _____

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**Table 1 - Hardness** Being very careful not to scratch yourself, use a sharp knife or a needle (hardness ~5.5) to scratch each mineral. Put the mineral letters in the appropriate boxes below "hard", "medium" or "soft". Also add any other observations you make as you scratch the mineral. For example: Can you mark it all? Does it form a powder? Is a streak of steel left on the mineral?

| Hard (6 or more) | Moderate (4 or 5) | Soft (3 or less) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

**Table 2 - Colour & Streak** Complete the table below by putting the mineral letters into the correct column, and add any other comments you have about colour or streak.

| Light Coloured | Dark Coloured |
|---|---|
| | |
| | |
| | |
| | |
| | |

**Table 3 - Lustre** Use one of these terms metallic glassy, resinous or earthy to describe the lustre of each sample, or use a term that means something to you.

| Lustre | |
|---|---|
| A | F |
| B | G |
| C | H |
| D | I |
| E | J |

**Table 4 - Fracture and Cleavage** Note the number of cleavage planes and their orientation with respect to one another. (e.g., 2 @ 60°). If there is no cleavage write "fracture".

| **Fracture or cleavage** | |
|---|---|
| A | F |
| B | G |
| C | H |
| D | I |
| E | J |

**Table 5 - Name and Diagnostic Properties** In the table below write the names for each of the ten minerals, and list some of the key physical properties that allow you to distinguish each mineral from the other similar-looking ones.

| **Mineral name** | **Key and/or diagnostic physical properties that <u>you</u> observed** |
|---|---|
| A | |
| B | |
| C | |
| D | |
| E | |
| F | |
| G | |
| H | |
| I | |
| J | |