

Physical Geology 101 Laboratory

MINERALS II – Silicate and Carbonate Rock-Forming Minerals

I. INTRODUCTION: The purpose of this lab is you will improve your mineral identification skills and experience. The focus of today's mineral lab is identifying silicate and carbonate rock-forming minerals, which is fundamental in the classification and identification of rocks, particularly for igneous rocks.

The SILICATE MINERAL GROUP: Silicates make up the vast majority of rock-forming minerals (by volume) in the Earth's crust and mantle. Silicates are among our most important rock forming minerals – they are very common in all three major rock types: igneous, sedimentary and metamorphic. They all contain silica and oxygen, but can also contain various metal ions. Quartz and other forms of pure silica consist only of silica tetrahedron covalently bonded together in a three dimensional framework. However, in most silicates some of the silica covalent bonds are replaced by ionic bonds to metals, such as aluminum, iron, magnesium, sodium, potassium, and calcium. These bonds may create planes of weakness and a noticeable cleavage. You need to become familiar with each of these mineral's **color**, **hardness**, and **cleavage** to be good at identifying hand samples of these minerals.

Quartz, the feldspars (the two potassium feldspars and sodic plagioclase), and muscovite are the light-colored minerals rich in silica, sodium and potassium. The rest of the common igneous minerals are dark-colored, and are rich in iron, magnesium, and calcium (including calcic plagioclase). Note that all the common igneous minerals are hard except for the micas. Most have cleavage except for a few minerals, like quartz. Below is a color image of the 12 most common igneous rock-forming minerals, which includes magnetite, an iron oxide mineral common in mafic to intermediate igneous rocks.



The CARBONATE MINERAL GROUP: The carbonate minerals, which include calcite and dolomite – the two most common varieties - are found in sedimentary rocks such as limestone, and in metamorphic rocks, such as marble. The carbonate minerals and carbonate-rich rocks are generally light-colored, except for rocks that have abundant carbon in them. The carbonate minerals and their associated rocks are fairly easy to identify due to their softness and reaction to acid – two tests easily performed in either the field or in lab. These minerals and their associated rocks are soft ($H = 3$ to $3\frac{1}{2}$) and will react to mild hydrochloric acid. All carbonate minerals have very well-developed rhombic cleavage (three sets of cleavage not at 90°) - easy to spot if the crystals are large enough to see.

Calcite is the most common carbonate mineral, with a chemical formula of CaCO_3 . Dolomite is less common in nature, with a very chemistry except that it also has magnesium MgCaCO_3 . Most limestones and marbles consist of typically 80% or higher of these minerals, most typically calcite.

Gypsum is actually a sulfate-group mineral and is exclusively found in sedimentary rocks. Like the carbonate minerals, gypsum is light-colored, soft ($H = 2 \frac{1}{2}$), with 3 sets of cleavage, but it is nonreactive to acid. Halite is another exclusively-sedimentary mineral, and it is also light-colored, soft ($H=3$) with 3 sets of cleavage, but it's nonreactive to acid and tastes salty. Both gypsum and halite are associated with sedimentary evaporate deposits.

II. COMMON ROCK-FORMING MINERAL PROPERTIES AND THEIR ASSOCIATED ROCK TYPES

Directions: Determine the color, hardness, cleavage, and associated rock types of the following mineral samples found in your reference set box. Carefully read the steps listed below:

- 1) Note color as either "Light" or "Dark"; AND note actual hue, like "white", "gray", "black", "brown", "green", or "violet".
- 2) Note hardness as either "Hard" (5 1/2 and harder); or "Soft" (5 or softer).
- 3) Note number of sets of cleavage (0, 1, 2 or 3). Also note the angle between two or more sets (at/near 90° or not at 90°).
- 4) Other includes Acid, Magnetic or Taste tests: Acid fizz = "Fizz"; Magnetic="Mag"; Salty = Salt. If Other test(s) not needed/not done, then mark as "ND"
- 5) Finally, using your mineral glossary charts, list the names of rock that the mineral is most commonly associated with.

<u>Reference Box #</u>	<u>Color</u>	<u>Hardness</u>	<u>Cleavage</u>	<u>Other</u>	<u>Associated Rock Types</u>
_____ Olivine	_____ / _____	_____	_____	_____	_____
_____ Augite(pyrx)	_____ / _____	_____	_____	_____	_____
_____ Hornblende(amph)	_____ / _____	_____	_____	_____	_____
_____ Biotite (mica)	_____ / _____	_____	_____	_____	_____
_____ Chlorite (mica)	_____ / _____	_____	_____	_____	_____
_____ Garnet	_____ / _____	_____	_____	_____	_____
_____ Tourmaline	_____ / _____	_____	_____	_____	_____
_____ Quartz	_____ / _____	_____	_____	_____	_____
_____ Potassium Feldspar (K-spar Includes Orthoclase and Microcline)	_____ / _____	_____	_____	_____	_____
_____ Plagioclase Feldspar	_____ / _____	_____	_____	_____	_____
_____ Muscovite (mica)	_____ / _____	_____	_____	_____	_____
_____ Kaolin (clay)	_____ / _____	_____	_____	_____	_____
_____ Magnetite	_____ / _____	_____	_____	_____	_____
_____ Calcite	_____ / _____	_____	_____	_____	_____
_____ Gypsum	_____ / _____	_____	_____	_____	_____
_____ Halite	_____ / _____	_____	_____	_____	_____

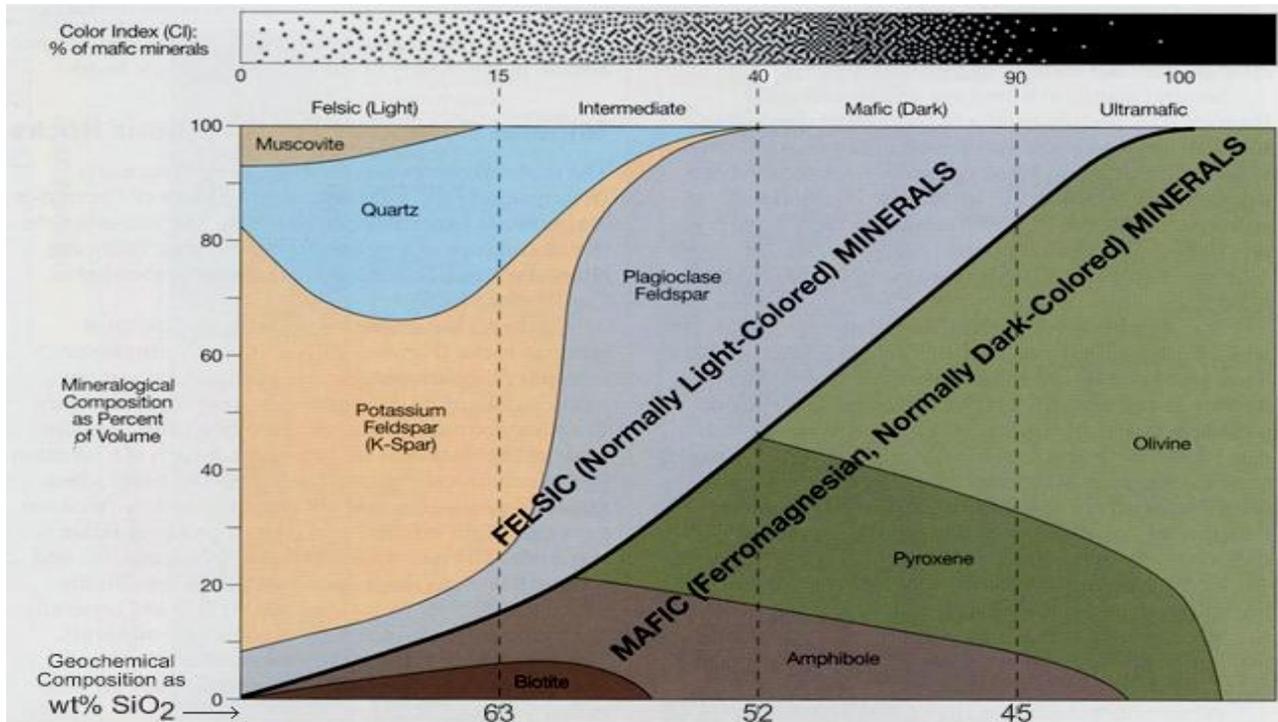
VIII. UNKNOWN COMMON ROCK-FORMING MINERAL SAMPLE IDENTIFICATION:

Directions: Determine the color, hardness, cleavage, and other characterizing physical properties of the following unknown mineral samples. Finally name the unknown mineral based on the determined properties. Follow the steps listed below:

- 1) Note luster as either *metallic* "M" or *nonmetallic* "NM".
- 2) Note color as either "Light" or "Dark"; AND note actual hue, like "white", "gray", "black", "brown", "green", or "violet".
- 3) Note hardness as either "Hard" (5 1/2 and harder); or "Soft" (5 or softer).
- 4) Note number of sets of cleavage (0, 1, 2 or 3). Also note the angle between two or more sets (at/near 90° or not at 90°).
- 5) Mark as "Pos" or "Neg" reaction if you did test. If test not needed/not done, then mark as "ND"
- 6) Mark either "M" (magnetic) or "NM" (nonmagnetic) if you did magnet test. If test not needed/done, then mark "ND".
- 7) Finally, using your mineral ID chart, List the name of the mineral that best fits your listed physical properties.

<u>Samp#</u>	<u>Luster</u>	<u>Color</u>	<u>Hardness</u>	<u>Cleavage</u>	<u>Acid test</u>	<u>Magnetic</u>	<u>Mineral name</u>
1.	_____	_____ / _____	_____	_____	_____	_____	_____
2.	_____	_____ / _____	_____	_____	_____	_____	_____
3.	_____	_____ / _____	_____	_____	_____	_____	_____
4.	_____	_____ / _____	_____	_____	_____	_____	_____
5.	_____	_____ / _____	_____	_____	_____	_____	_____
6.	_____	_____ / _____	_____	_____	_____	_____	_____
7.	_____	_____ / _____	_____	_____	_____	_____	_____
8.	_____	_____ / _____	_____	_____	_____	_____	_____
9.	_____	_____ / _____	_____	_____	_____	_____	_____
10.	_____	_____ / _____	_____	_____	_____	_____	_____
11.	_____	_____ / _____	_____	_____	_____	_____	_____
12.	_____	_____ / _____	_____	_____	_____	_____	_____
13.	_____	_____ / _____	_____	_____	_____	_____	_____
14.	_____	_____ / _____	_____	_____	_____	_____	_____
15.	_____	_____ / _____	_____	_____	_____	_____	_____

II. IGNEOUS ROCK-FORMING MINERALS ABUNDANCES IN IGNEOUS ROCKS: Each of the common igneous rock-forming minerals varies in occurrence and abundance in the various types of igneous rocks, based on the chemistry of the magma or lava that they crystallized from. You need to become familiar with the igneous mineral abundance chart below, in terms of which specific minerals characterize each igneous rock type and the general proportion that each mineral contributes to the total mineral make-up of the rock. The COLOR INDEX (shown at top of figure below) helps to classify the mineral composition of the unknown igneous rock, but is only useful for coarse-grained rocks.



FELSIC IGNEOUS ROCK (Granite): Rich in potassium feldspars, sodic plagioclase and quartz, granites also have accessory minerals, including (but necessarily all present in same rock) biotite, muscovite, garnet, tourmaline and hornblende. Color index is low: between 0 and 20.



1. The light-colored minerals in the above rock are: _____
2. The dark-colored minerals in the above rock are: _____
3. What is your estimated color index for the granite pictured above? _____

INTERMEDIATE IGNEOUS ROCK (Diorite): Rich in intermediate plagioclase and hornblende, diorites can also have accessory minerals including (but not necessarily all present in same rock) quartz, pyroxene, biotite, and magnetite. Color index is mid range: between 20 and 30



4. The light-colored minerals in the above rock are: _____
5. The dark-colored minerals in the above rock are: _____
6. What is your estimated color index for the diorite pictured above? _____

MAFIC IGNEOUS ROCK (Gabbro): Rich in calcic plagioclase, pyroxenes, olivine, and hornblende, gabbros can also have accessory minerals, like magnetite. Color index is high: between 40 and 90.



7. The light-colored minerals in the above rock are: _____
8. The dark-colored minerals in the above rock are: _____
9. What is your estimated color index for the gabbro pictured above? _____

UNKNOWN IGNEOUS ROCK SET

Directions: Do the following for each of the eight unknown coarse-grained igneous rock samples provided by your instructor: **1)** Determine the color index (0 to 100); **2)** Make your best determination as to what the light and dark minerals are in the hand sample; And **3)** List the igneous rock type, based on the color index (Granite, Diorite, or Gabbro). Note to use your igneous rock chart to help you answer both 1), 2) and 3). Use the microscope to help in the determination of the minerals.

<u>Sample</u>	<u>Color Index</u>	<u>Observable minerals present in Rock Sample</u>	<u>Igneous Rock Name</u>
1.	_____	_____	_____
2.	_____	_____	_____
3.	_____	_____	_____
4.	_____	_____	_____

- 5. _____
- 6. _____
- 7. _____
- 8. _____

III. Written Laboratory Reflection

Directions: Write a reflection of the lab activity, explaining its purpose, the methods used, the results obtained, and a brief personal reflection of what you enjoyed and learned about doing this lab (3 points possible). Answer the following 3-point question reflection set (fill in all the lines for full credit.)

1) *What was the purpose of this lab? What did you actually discover and learn during this lab?*

2) *What did you enjoy most about this lab? Also, what was challenging or thought-provoking?*

3) *What are your constructive comments about the design and execution of this lab? What's good? What's bad? Offer suggestions for making the lab better.*
