

Name(s):

Grade:

Physical Geology Laboratory

IGNEOUS MINERALS AND ROCKS IDENTIFICATION

INTRODUCTION & PURPOSE:

In this lab you will learn to identify igneous rocks in hand samples from their physical properties. You will become familiar with the most common assemblages of igneous-rock forming minerals. The nature and origin of magmas, important aspects of mineral crystallization, the major types of intrusive and extrusive igneous rock structures, and the connection between plate tectonics and the rock cycle will also be explored. The purpose of this laboratory experience is to become familiar with both, identifying common igneous rocks, and understanding their origin.

PRELAB SECTION – To be completed before the lab meeting (due at start of lab #4)

I. GENERAL CLASSIFICATION OF IGNEOUS ROCKS

A. Overview: The classification of igneous is based upon two major criteria:

1. **Texture** (crystal grain size and grain size distribution)
2. **Composition** (mineralogy/geochemistry)

B. Igneous Textures: Igneous rocks are divided into **four major textural categories** based on differences in crystal grain size and distribution:

- 1) **Pegmatitic** = extremely coarse-grained (plutonic)
- 2) **Phaneritic** = coarse- to medium-grained (plutonic)
- 3) **Porphyritic** = mixed-grained = coarse-grained surrounded by fine-grained (volcanic)
- 4) **Aphanitic** = very fine-grained (volcanic)

There are **three additional textural** classifications:

- 1) **Glassy** = the absence of minerals (volcanic)
- 2) **Vesicular** = the presence of vesicles (volcanic)
- 3) **Pyroclastic** = composed of volcanic rock fragments (volcanic)

An igneous rock's texture is controlled primarily by the **1) rate of cooling of the magma** as it crystallizes into a solid rock, and also its **2) dissolved gasses content**:

- ✓ Igneous rocks that are **pegmatitic** or **phaneritic** have an **intrusive** (plutonic) origin and thereby cooled very slowly into a coarse-grained rock
- ✓ Igneous rocks that have a **aphanitic, glassy, vesicular**, or of **fragmental** texture, have an **extrusive** (volcanic) origin and thereby, cooled very quickly into a fine-grained rock.
- ✓ Igneous rocks that are **porphyritic** have a complex cooling history: first cooling slowly underground (partially crystallizing the magma), followed by transport to the surface, where the remaining molten material is cooled very rapidly into a mixed-grain rock.
- ✓ **Glassy** = extremely fast cooling – magma is literally quenched with no crystals forming.
- ✓ **Vesicular** = degassing (effervescing) of lava while it undergoes very rapid cooling.

C. Igneous Compositions: Igneous rocks are divided into **four major groups** based upon their mineralogy, which reflects the rocks' geochemical make-up:

1. **Silicic or Felsic** = silica, sodium and potassium-rich; lots of quartz and feldspar minerals
2. **Intermediate** = plagioclase and amphibole minerals most abundant;
3. **Mafic** = iron, magnesium, and calcium-rich; plagioclase and pyroxene most abundant;
4. **Ultramafic** = silica-poor; very rich in iron and magnesium; mostly pyroxene and olivine

An igneous rock's composition is controlled primarily by the **1) composition of its parent magma, 2)**

crystallization fractionation of magma, 3) magma mixing, or 4) assimilation of wall rock into magma.

The classification and naming of igneous rocks is based in part on their composition:

- 1) Igneous rocks with a **felsic-silica-rich** composition are classified as either **granite** (intrusive) or **rhyolite** (extrusive).
- 2) Igneous rocks with an **intermediate** composition are classified as either **diorite** (intrusive) or **andesite** (extrusive).
- 3) Igneous rocks with a **mafic-rich** composition are classified as either **gabbro** (intrusive) or **basalt** (extrusive).
- 4) Igneous rocks with an **ultramafic-rich** composition are classified as either **peridotite** (intrusive) or **komatiite** (extrusive).

D. Common Igneous Rock-Forming Minerals: There are ten common igneous rock-forming minerals that you should be familiar with by now (studied and identified in mineral lab). Each of the four compositional/texture pairs of igneous rocks (listed above) has a unique assemblage of these minerals. For example, the granite-rhyolite pair is rich in the light-colored feldspars and quartz, poor in the dark-colored biotite and amphibole, and totally lacking pyroxene and olivine. On the other side of the compositional spectrum, the mafic gabbro-basalt pair is rich in dark-colored amphibole, pyroxene, and olivine, including calcium-rich plagioclase, but totally lacks light-colored minerals such as potassium feldspar and quartz. The reason for the unique mineral assemblage for each igneous rock pair is explained by **Bowen's Reaction Series**, which involves the systematic crystallization of specific minerals in a given composition of parent magma as the temperature falls during cooling.

Directions: Write down the names of the ten minerals in the appropriate column, either as light-colored or dark-colored. Knowing and understanding the relationship between each igneous rock pair (discussed above) and their respective mineral assemblage will make classifying and identifying igneous rocks much easier. You will identify and carefully (re)examine the nine igneous mineral samples in lab. Note that plagioclase can be either light (sodium-rich) or dark colored.(calcium-rich).

<u>Light-colored igneous minerals</u>	<u>Dark-colored igneous minerals</u>
1. _____	1. _____ 5. _____
2. _____	2. _____ 6. _____
3. _____	3. _____ 7. _____
4. _____	4. _____

E. Igneous Rock Names: Review the four igneous rock intrusive/extrusive pairs (subgroups) and the common minerals associated with each igneous rock sub-group. Intensely study Mineral ID Chart in your lab manual. Make sure you understand all the textural and compositional terms before analyzing this lab's rock samples. Carefully examine the color index, mineralogical assemblage, and rock nomenclature charts in Lab Manual. **Note:** These three charts are lined up vertically to illustrate the compositional relationship between color index, mineralogy, and rock nomenclature.

Directions: List the names of the four paired igneous rock groups and their associated minerals as discussed in sections C. and D. above.

<u>Rock Pair</u>	<u>Felsic</u>	<u>Intermediate</u>	<u>Mafic</u>	<u>Ultramafic</u>
Intrusive:	_____	_____	_____	_____
Extrusive:	_____	_____	_____	_____
Most Common	1. _____	_____	_____	_____
Minerals in Rock	2. _____	_____	_____	_____
in Rock	3. _____	_____	_____	_____
	4. _____	_____	_____	_____

IN-LAB SECTION –To be completed during lab

I. REVIEW ID OF IGNEOUS ROCK-FORMING MINERALS:

Directions: Carefully examine each of the following unknown igneous mineral samples that you studied in the previous mineral lab. Write the sample number next to the correct mineral name.

<u>Sample Code</u>	<u>Sample Code</u>
a. Quartz _____	g. Augite (pyroxene) _____
b. Plagioclase Feldspar _____	h. Olivine _____
c. Potassium Feldspar _____	i. Tourmaline _____
d. Muscovite (mica) _____	j. Garnet _____
e. Biotite (mica) _____	k. Magnetite _____
f. Hornblende (amphibole) _____	

II. THE INTRUSIVE/PLUTONIC IGNEOUS ROCKS:

A. Introduction: Intrusive rocks have textures that you **can clearly see nearly ALL the crystal grains by eye** = “megascopic”. In contrast, most crystals in a volcanic rock are invisible to the eye.

B. Plutonic Textures: The **two** basic **plutonic** rock textures are: **Pegmatitic** (very coarse-grained) and **Phaneritic** (coarse-grained). (see Figure 5.3 and page 93). Both types form by very slow cooling of magma at depth.

C. Color Index (CI) is a quantitative feature of **phaneritic** igneous rocks that expresses the rock’s mineral composition in terms of the **volume percentage of dark minerals** found in the rock.

Color index is used exclusively for classifying **only intrusive** igneous rocks (see page 93 in lab book)

D. Intrusive Sample Collection Analysis: Five samples (I1 through I4A) are found in the **Igneous Collection box** for close study and comparison. List the Color index, observable minerals, and texture for each hand sample.

<u>Rock Name</u>	<u>CI</u>	<u>ID’d Minerals</u>	<u>Texture</u>
Sample# I1A Peridotite	_____	_____	_____
Sample# I1B Dunite	_____	_____	_____
Sample# I2 Gabbro	_____	_____	_____
Sample# I3 Diorite	_____	_____	_____
Sample# I4 Plagio-granite	_____	_____	_____
Sample# I5 Granite	_____	_____	_____
Sample# I6 Granite Pegmatite	_____	_____	_____

III. THE EXTRUSIVE/VOLCANIC IGNEOUS ROCKS:

A. Introduction: Extrusive or volcanic igneous rocks are distinguished from their intrusive or plutonic compositional twin by their texture: extrusive rocks have textures where by you **cannot distinguish most, or all, of the crystal grains by eye** (microscopic); the grain size is so small, that you need a microscope to view the minerals. Color index **does not** apply to the naming of volcanic rocks. However, the **groundmass color** of a volcanic rock can be used as a rough first guess for identifying the rock's composition, e.g. dark = basalt; light = rhyolite.

B. Volcanic Textures: The **five** basic volcanic rock textures are **Porphyritic, Aphanitic, Glassy, Vesicular, and Volcanoclastic** (see Figure 5.3 and page 93). Each textural type is based on both grain size and rock "fabric", e.g. vesicles and/or rock fragments. These rocks cooled very fast.

C. Volcanic Sample Collection Analysis: Eight samples are found in **Collection B** for study and comparison. Texture, mineralogy and color index of each sample will be discussed in class.

	<u>Rock Name</u>	<u>Rock Color</u>	<u>Visible Minerals</u>	<u>Texture</u>
Sample# I7	Basalt	_____	_____	_____
Sample# I8	Porphyritic Basalt	_____	_____	_____
Sample# I9	Vesicular Basalt	_____	_____	_____
Sample# I10	Andesite	_____	_____	_____
Sample# I11	Porphyritic Andesite	_____	_____	_____
Sample# I12	Rhyolite	_____	_____	_____
Sample# I13	Porphyritic Rhyolite	_____	_____	_____
Sample# I14	Obsidian	_____	_____	_____
Sample# I15	Pumice	_____	_____	_____
Sample# I16	Scoria	_____	_____	_____
Sample# I17	Tuff	_____	_____	_____

IV. IDENTIFYING IGNEOUS ROCKS – DETAILED DESCRIPTION AND IDENTIFICATION

A. Identifying the Various Igneous Rock Types: Identification of unknown igneous rock samples are done utilizing a simple step-by-step procedure that is outlined in **Figure 5.2** in your Lab manual.
Igneous Rock Identification Procedure:

Step 1: Estimate the rock's **DARK MINERAL Percentage** (if coarse-grained) or **Rock Color** (if fine-grained) **Note** that **dark mineral %** is applicable for **phaneritic rocks ONLY!** IF **APHANITIC** or **PORPHYRITIC** where there is little to no observable minerals, then estimate the composition by the **Overall Rock Color** ("light-colored" = felsic/silicic, "medium-colored" = intermediate, or "dark-colored" = mafic).

Step 2: Identify all visibly discernable minerals. Estimate relative abundances of each mineral type.

Step 3: Observe and record the rock's **TEXTURE** (Use seven texture terms in part III.B. above)

Step 4: Use the igneous rock flowchart in your lab manual to **NAME the ROCK**

B. Identifying Unknown Igneous Rock Samples

Directions: Identify the ten(10) unknown igneous rock samples found in sample **Collection IU**.

Circle all the appropriate attributes for each unknown sample and then list the rock's name.

- a) **DARK MINERAL %** (plutonic) **OR Overall Rock Color** (volcanic);
- b) **Identifiable minerals**; if none observable than write "None Observed"
- c) **Texture** (pegmatitic, phaneritic; porphyritic, aphanitic, aphanitic vesicular, glassy, volcano-clastic)
- d) **Cooling Origin:** 1) Solidified deep underground = (**Slow**); 2) Partially crystallized deep underground followed by eruption (**Slow-then-Fast**); 3) Crystallized almost entirely at or near surface (**Fast**); or 4) crystallized in the air after eruption (**Super Rapid / Air-Cooled**)
- e) Write down the **Name** of the rock.

UNKNOWN IGNEOUS ROCK WORKSHEET

Sample# UN1

- a) **Dark Mineral Index** ____% (pegmatitic or phaneritic); OR **Rock Color Index** (aphanitic or porphyritic) _____
- b) **Observed Minerals** Quartz; K-spar; Plag; Muscovite; Biotite; Tourmaline; Hornblende; Pyroxene; Olivine
- c) **Texture:** Pegmatitic; Phaneritic; Porphyritic; Aphanitic; Aphanitic vesicular; Glassy; Volcano-clastic
- d) **Rock Cooling History:** Slow; Slow-then-Fast; Fast; Super-Rapid / Air-cooled
- e) **Rock Name** _____

Sample# UN2

- a) **Dark Mineral Index** ____% (pegmatitic or phaneritic); OR **Rock Color Index** (aphanitic or porphyritic) _____
- b) **Observed Minerals** Quartz; K-spar; Plag; Muscovite; Biotite; Tourmaline; Hornblende; Pyroxene; Olivine
- c) **Texture:** Pegmatitic; Phaneritic; Porphyritic; Aphanitic; Aphanitic vesicular; Glassy; Volcano-clastic
- d) **Rock Cooling History:** Slow; Slow-then-Fast; Fast; Super-Rapid / Air-cooled
- e) **Rock Name** _____

Sample# UN3

- a) **Dark Mineral Index** ____% (pegmatitic or phaneritic); OR **Rock Color Index** (aphanitic or porphyritic) _____
- b) **Observed Minerals** Quartz; K-spar; Plag; Muscovite; Biotite; Tourmaline; Hornblende; Pyroxene; Olivine
- c) **Texture:** Pegmatitic; Phaneritic; Porphyritic; Aphanitic; Aphanitic vesicular; Glassy; Volcano-clastic
- d) **Rock Cooling History:** Slow; Slow-then-Fast; Fast; Super-Rapid / Air-cooled
- e) **Rock Name** _____

Sample# UN4

- a) **Dark Mineral Index** ____% (pegmatitic or phaneritic); OR **Rock Color Index** (aphanitic or porphyritic) _____
- b) **Observed Minerals** Quartz; K-spar; Plag; Muscovite; Biotite; Tourmaline; Hornblende; Pyroxene; Olivine
- c) **Texture:** Pegmatitic; Phaneritic; Porphyritic; Aphanitic; Aphanitic vesicular; Glassy; Volcano-clastic
- d) **Rock Cooling History:** Slow; Slow-then-Fast; Fast; Super-Rapid / Air-cooled
- e) **Rock Name** _____

Sample# IU5

- a) **Dark Mineral Index** ____% (pegmatitic or phaneritic); OR **Rock Color Index** (aphanitic or porphyritic) _____
- b) **Observed Minerals** Quartz; K-spar; Plag; Muscovite; Biotite; Tourmaline; Hornblende; Pyroxene; Olivine
- c) **Texture:** Pegmatitic; Phaneritic; Porphyritic; Aphanitic; Aphanitic vesicular; Glassy; Volcano-clastic
- d) **Rock Cooling History:** Slow; Slow-then-Fast; Fast; Super-Rapid / Air-cooled
- e) **Rock Name** _____

Sample# UN6

- a) **Dark Mineral Index** ____% (pegmatitic or phaneritic); OR **Rock Color Index** (aphanitic or porphyritic) _____
- b) **Observed Minerals** Quartz; K-spar; Plag; Muscovite; Biotite; Tourmaline; Hornblende; Pyroxene; Olivine
- c) **Texture:** Pegmatitic; Phaneritic; Porphyritic; Aphanitic; Aphanitic vesicular; Glassy; Volcano-clastic
- d) **Rock Cooling History:** Slow; Slow-then-Fast; Fast; Super-Rapid / Air-cooled
- e) **Rock Name** _____

Sample# UN7

- a) **Dark Mineral Index** ____% (pegmatitic or phaneritic); OR **Rock Color Index** (aphanitic or porphyritic) _____
- b) **Observed Minerals** Quartz; K-spar; Plag; Muscovite; Biotite; Tourmaline; Hornblende; Pyroxene; Olivine
- c) **Texture:** Pegmatitic; Phaneritic; Porphyritic; Aphanitic; Aphanitic vesicular; Glassy; Volcano-clastic
- d) **Rock Cooling History:** Slow; Slow-then-Fast; Fast; Super-Rapid / Air-cooled
- e) **Rock Name** _____

Sample# UN8

- a) **Dark Mineral Index** ____% (pegmatitic or phaneritic); OR **Rock Color Index** (aphanitic or porphyritic) _____
- b) **Observed Minerals** Quartz; K-spar; Plag; Muscovite; Biotite; Tourmaline; Hornblende; Pyroxene; Olivine
- c) **Texture:** Pegmatitic; Phaneritic; Porphyritic; Aphanitic; Aphanitic vesicular; Glassy; Volcano-clastic
- d) **Rock Cooling History:** Slow; Slow-then-Fast; Fast; Super-Rapid / Air-cooled
- e) **Rock Name** _____

Sample# UN9

- a) **Dark Mineral Index** ____% (pegmatitic or phaneritic); OR **Rock Color Index** (aphanitic or porphyritic) _____
- b) **Observed Minerals** Quartz; K-spar; Plag; Muscovite; Biotite; Tourmaline; Hornblende; Pyroxene; Olivine
- c) **Texture:** Pegmatitic; Phaneritic; Porphyritic; Aphanitic; Aphanitic vesicular; Glassy; Volcano-clastic
- d) **Rock Cooling History:** Slow; Slow-then-Fast; Fast; Super-Rapid / Air-cooled
- e) **Rock Name** _____

Sample# UN10

- a) **Dark Mineral Index** ____% (pegmatitic or phaneritic); OR **Rock Color Index** (aphanitic or porphyritic) _____
- b) **Observed Minerals** Quartz; K-spar; Plag; Muscovite; Biotite; Tourmaline; Hornblende; Pyroxene; Olivine
- c) **Texture:** Pegmatitic; Phaneritic; Porphyritic; Aphanitic; Aphanitic vesicular; Glassy; Volcano-clastic
- d) **Rock Cooling History:** Slow; Slow-then-Fast; Fast; Super-Rapid / Air-cooled
- e) **Rock Name** _____

V. IGNEOUS ROCK LABORATORY REFLECTION

Directions: Write a reflection (minimum 100 words) about your experience in doing the igneous rock exercises lab today. Include the following:

1) What did you learned from this laboratory? _____

2) What did you find interesting? Challenging? _____

3) Your opinion on lab design and execution? _____
