

GEOL 333 - Lab 6 (Mafic Igneous Rocks in Hand Sample and Thin Section)

Introduction

Igneous rocks form from *cooling of molten rock* at or below Earth's surface. In general, rocks are classified and identified based on their **composition (chemical or mineral content)** and **texture**, which refers to the size, shape and arrangement of the mineral grains. Igneous rocks are classified based on their **composition** and **grain size**. The cooling rate of the molten rock controls grain size; fast cooling forms small grains (called a fine-grained texture), and slow cooling forms large grains (called a coarse-grained texture). The most common chemical compositions of igneous rocks include felsic/silicic (high in silica, SiO₂ and low in Fe and Mg), intermediate, and mafic (low in silica and high in Fe and Mg). This week, you will examine hand samples and associated thin sections of mafic igneous rocks.

Mafic igneous rocks are a dark color because they contain abundant (>50% by definition) mafic silicate minerals, which are dark minerals. Major mafic silicate minerals are **olivine** and **pyroxene**; minor ones are biotite and hornblende. **Ca-rich plagioclase feldspar** (anorthite) is the only major felsic mineral (high silica, low Mg and Fe) in mafic igneous rocks. The two end-members of mafic igneous rocks are **basalt** (fine-grained) and **gabbro** (coarse-grained). Other less common mafic igneous rocks are **scoria** (basalt with abundant holes termed vesicles) and **obsidian** (volcanic glass that can be mafic or other compositions).

To summarize, the most important minerals in mafic igneous rocks are plagioclase feldspar, olivine and pyroxene. The optical characteristics of these minerals as well as volcanic glass and vesicles are listed later in this document just before the Unknown Rock Identification Sheets.

Lab Exercise

1. Define the following terms (do with TA). You will need to use them later in your rock descriptions.
 - a. Vesicular:
 - b. Intrusive
 - c. Extrusive
 - d. Felsic
 - e. Mafic
 - f. Phaneritic
 - g. Aphanitic
 - h. Interlocking Texture
 - i. Euhedral
 - j. Subhedral
 - k. Anhedral
 - l. Porphyritic
 - m. Phenocrysts
 - n. Groundmass

2. Complete an Unknown Rock Identification Sheet (found at the very end of this document) for each of the following four mafic igneous rock samples.
 - a. 8809
 - b. 82-12-31A
 - c. 8988
 - d. DC-1

Unknown Rock Identification Sheets - Explanation of Terms

For the four mafic igneous rocks assigned today, fill out an identification sheet that includes your observations on both hand sample and associated thin section. These observations are key to naming the sample, however the most important part is an accurate description of the mineral content and texture. Normally, the more information you collect and record about the sample, the better.

- **Hand Sample Description**

Complete the hand sample description first by observing the sample with and without a binocular microscope. Describe the color (e.g., "overall medium gray", or "overall grayish-green rock with white veins"), mineral content (names and approximate abundance of each mineral, especially feldspar vs. mafic silicate minerals) and texture, which includes grain size (e.g., fine, medium, or coarse-grained), grain shape, and grain arrangement (see below for specific textural terms). Finally, name the rock based on your hand sample description (e.g., "olivine basalt"). There is no need to change your hand sample description to fit what you may later find in thin section.

- **Thin Section Description**

- **Rock Texture**

Rock texture refers to the size, shape and arrangement of the mineral grains. In your rock descriptions use the appropriate mineralogical terms for texture given in several lists below. Examples of questions to address include: What is the average grain shape? Are the grains similar in shape or is there a wide range? What is the average grain size? Are most of the minerals the same size or two groups of sizes or a wide range of sizes? Is the shape similar for all mineral grains?

Field of View Size for our Petrographic Microscopes (used for grain size determination)

<u>Power</u>	<u>Width of field</u>	<u>Radius</u>
2.5x (low)	4.5 mm	2.25mm
10x (med.)	1.8mm	0.9mm
40x (high)	0.45mm	0.225mm

- ❖ **Grain Size Terms** (Note: Use these for both hand samples and thin sections)

1. Phaneritic - Coarse Grained: most grains are distinguishable as individual entities by naked eye or with a magnifying glass.
2. Aphanitic - Fine Grained: may be glassy or crystalline. Individual grains below resolution of naked eye or hand lens.
3. Porphyritic - contains both large and small grains
4. Fine-grained - between 0.1 - 1 mm
5. Medium-grained - between 1 - 5 mm
6. Coarse-grained - between 5 - 10 mm
7. Very coarse-grained - between 10 - 20 mm
8. Pegmatitic - >20 mm
9. Microcrystalline - microscopically crystalline (between 0.01 - 0.1 mm)
10. Cryptocrystalline - sub-microscopically crystalline (between 0.002 - 0.01 mm)
11. Glassy - volcanic glass (amorphous)

❖ **Grain Shape Terms**

1. Euhedral - has good crystal outline (flat crystal surfaces on all sides)
2. Subhedral - has incomplete or poor crystal outline
3. Anhedral - no crystal outline

❖ **Grain Arrangement Terms**

Describe how the mineral grains are situated in relation to each other, as well as any disruptions of the normal pattern. Some relevant terms are **interlocking texture** (no space between mineral grains, i.e., jigsaw puzzle-like fit), **random grain arrangements** (a typical igneous texture), **aligned grains** (most grains oriented in a specific direction), and **vesicular** (empty spaces between crystals).

○ **Rock Composition - Major Minerals**

Identify each major mineral (those with >5% abundance) and for each mineral, give the % abundance, grain shape and grain size. **Be as detailed and as descriptive as you can.** Refer to your thin section sketch to show the grain shape and size, but do not substitute the sketch for a verbal description.

○ **Minor Minerals**

Do not worry about identifying minor (<5% abundance) minerals, unless they are relatively easy to identify (e.g., biotite, olivine, hornblende, or some other mineral you have seen before in class), but try to describe them.

○ **Interpretations and Environment of Formation**

Based on the size of the mineral grains, select the cooling rate (coarse-grained texture = slow cooling, fine-grained texture = fast cooling). Based on the cooling rate, select the environment of formation (slow cooling = intrusive environment, cools deep within Earth, fast cooling = extrusive environment, cools at Earth's surface from a volcanic eruption). Also, explain any unusual features in the rocks, such as vesicles. If you see banding, try to explain it, even if you make only an educated guess.

○ **Rock Name**

Classify the rock based on your observations in hand sample and thin section. You can include the most abundant or especially distinctive lesser abundant minerals before the rock name, such as "biotite granite" for granite containing abundant biotite, or "olivine basalt" for olivine-rich basalt.

Optical Characteristics of Minerals and Other Components of Mafic Igneous Rocks

Mineral Name	Plane Polarized Light	Cross Polarized Light
Plagioclase feldspar	Low relief	Polysynthetic twinning (black and white stripes), low birefringence (white or gray)
Olivine	High relief, irregular fractures prominent, no cleavage	2 nd order birefringence (vivid and variable colors)
Pyroxene	Medium-high relief, 2 directions of cleavage (parallel lines) at 90°	2 nd order birefringence (vivid and variable colors)
Glass	Low relief, variable color (clear - dark)	Completely black (isotropic) unless altered to minerals
Vesicles	Clear holes (may see epoxy glue)	Completely black (isotropic)

Unknown Rock Identification Sheet - Mafic Igneous Rocks

Sample #: _____

TEXTURE

Grain Size (circle one): **Phaneritic (coarse)** **Aphanitic (fine)** **Porphyritic (both)**

If the sample is porphyritic, then identify the phenocrysts and groundmass:

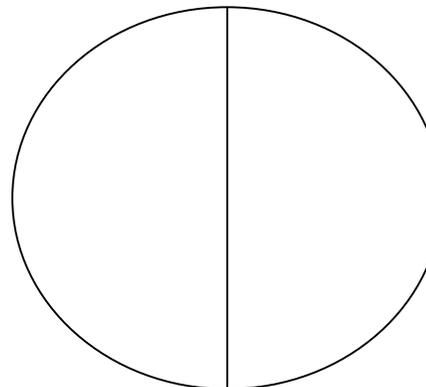
Phenocrysts: _____

Groundmass: _____

Grain Arrangement (circle one): **Interlocking** **Vesicular**

Additional features and observations? (e.g., color, weight, flow banding)

Thin Section Sketch
PPL/XPL
Color and Label Grains



COMPOSITION

Complete the following table. You should look at the rocks using both the Petrographic Microscope and Binocular Microscope to identify the mineral composition. Identify Major and Minor minerals, and classify groundmass (unidentifiable fine grains), glass, vesicles, or alteration products (i.e., clay) in the **'Other'** column. The Abundance of mineral/other row should add up to 100% for all listed species.

	Mineral	Mineral	Mineral	Other (glass, vesicles,
Name				
Size (coarse, medium, or fine)				
Grain Shape (euhedral, subhedral, or anhedral)				
Color of grains in Hand Sample				
Abundance of mineral/other (0 - 100%)				

INTERPRETATION

Cooling rate (circle one): **Slow** **Fast** **Both**

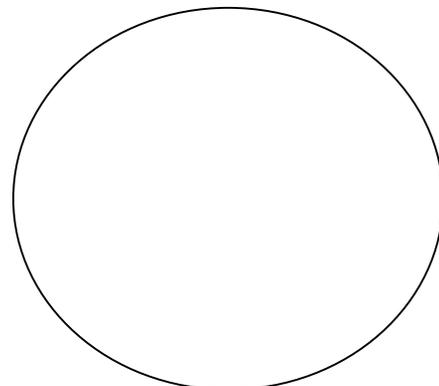
Environment of formation (circle one): **Intrusive** **Extrusive** **Both**

Location of Cooling (circle one): **Deep in Earth** **Earth's Surface** **Both**

Any other processes (e.g., presence of gas, lava flow):

Rock Name: _____

Hand Sample Sketch
Color and Label Grains



Unknown Rock Identification Sheet - Mafic Igneous Rocks

Sample #: _____

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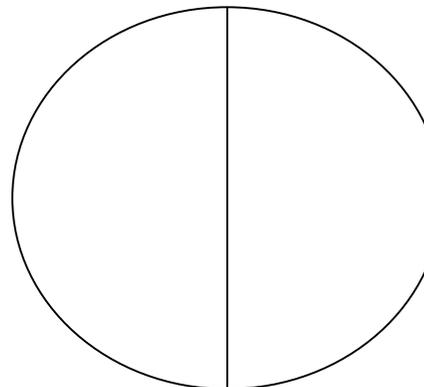
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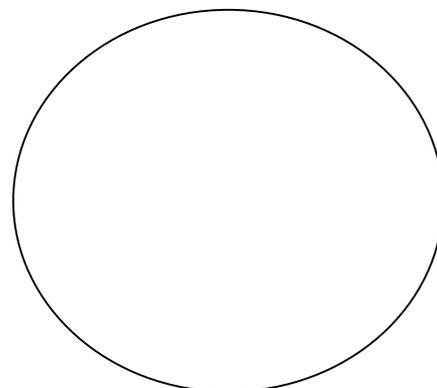
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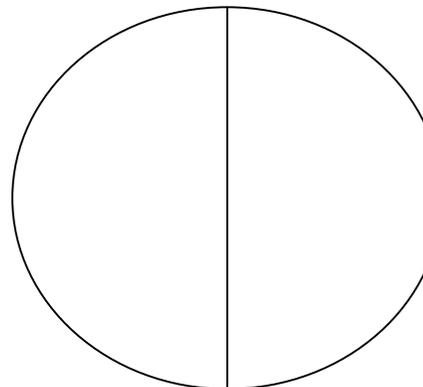
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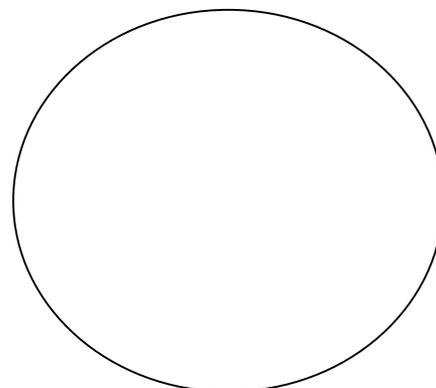
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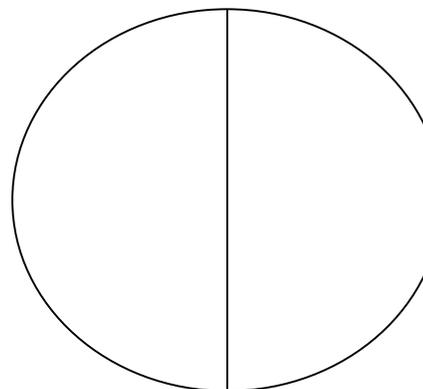
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