

# GY 302: Mineralogy and Crystallography

## Lab Assignment 8: Optical Mineralogy Exercise

**Introduction:** If all went according to plan, you have already been thoroughly entertained with a lecture(s) outlining the basics of optical properties of minerals and the petrographic microscopes. You should have been introduced to terms like **birefringence, polarization, isotropic, anisotropic, pleochroism** and **relief**, but without hands-on exposure with petrographic microscopes, they would simply remain abstract terms. You need to know these basics in order to understand the rocks that you will see in other classes like GY 303 (Igneous and Metamorphic Petrology) and GY 402 (Sedimentary Petrology). This lab is designed to familiarize you with the workings of a petrographic microscope and how to use optical properties to identify common rock-forming minerals in thin-section. It is meant to be straight-forward (e.g., the questions are simple, though the answers may not be!), but there are a lot of them. Take your time looking them over and refer back to your notes for help.

**Note about the exercises:** We do not have enough microscopes for you to work independently on them during the lab period. **Work with a partner.** This is also a lab that you cannot do without hands on help. **Use the lab period wisely** and when all else fails, **ask questions!**

**Note about format.** Although there are specific questions to answer, and your mark will be based upon those questions, I *strongly* advise you to learn as much about each of the minerals that you are going to see as possible in this lab. Draw quality sketches of the minerals and their characterizing attributes such as cleavage, or relief etc and include scales on all of your sketches. In short, record everything that you can about these minerals, not just when you have to. These diagrams may be the only help you have when it comes to identifying minerals in rocks next semester. **Use your lab not books to answer these questions.**

This lab is due: See the calendar or website for due dates.

List of thin-sections (*n*) where *n* = the number of thin-sections available in the lab

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*Q*(5), *Q2*(1) - quartz

*F*(4)-fluorite

*M*(2)-muscovite

*P2* (2)- Plagioclase

*Rel 1*: covellite

*K* (6) – microcline

*O* (2)-olivine

*H*(4)-hornblende (amphibole)

*Ig1*(2), Basalt 1-zoned plagioclase

*Rel 2*: chalcopyrite

*CC* (4)-calcite

*B* (3), *B1* (1)-biotite

*Px* (5)-Pyroxene (augite)

*Rel 3*: Magnetite

Unlabeled (multimineral slides): use to see pleochroism

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### Warning!

Not all thin-sections are of equal quality. Some of my home made sections suck bad, but then again so do the store-bought ones. If you can't find what you are looking for in one section, try another.

**All Answers are to go in your Notebooks. Do a quality job**  
(no quick and dirty crappy drawings)

1) Determine the field of view scales for the 4x, 10x and 40x objectives on your scope. (You will be shown how to do this during the lab.

2) Examine one of the quartz thin-sections (Q) and answer the following questions concerning birefringence and extinction.

a) Describe the birefringence of the quartz in thin-section Q.

b) Describe the nature of the extinction of the quartz in the 2 thin-sections you examined (e.g., straight, inclined, strained etc.). This may vary depending upon which Q section you examined.

**Bonus (2 extra points):** In thin-section Q2, the largest quartz grain varies in thickness from one end to the next. How can you tell? And,

What is the approximate thickness variation of the quartz grain? Report your results in your note book in the following manner:

from \_\_\_\_\_  $\mu\text{m}$  to \_\_\_\_\_  $\mu\text{m}$

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3) Examine the microcline feldspar thin-sections (K) and thin-section Ig1 which contains plagioclase and answer the following question concerning zonation, and twinning. You can also use P2 sections for plagioclase, but they are not as good as Ig1.

a) Basalts are lovely rocks to look at under the petrographic microscope (even if they are bloody igneous rocks!) This basalt contains excellent zoned crystals of plagioclase. How can you tell they are zoned? (Sketch required).

b) Describe and sketch the twinning pattern that characterizes microcline and plagioclase.

c) What is the birefringence of the K section? (report as a number).

d) Assuming that this is a normal basalt, how does the composition of the core of the plagioclase crystals probably compare with the outer layers?

**Bonus (1 extra point):-** The K samples show clear evidence of mineral exsolution. What is exsolution and how does it appear in these sections (sketches are necessary).

**This is an observation, not a question.** Potassium feldspar has the same birefringence as quartz and that some times it does not display twinning. This can make it difficult to distinguish the two minerals from one another in rocks. Feldspar is the more unstable of the two and frequently displays alteration fabrics. See if you can spot this

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4) Examine the fluorite, calcite, muscovite and olivine thin-sections (F, CC, M, O; You can also use Basalt 1 for O).

a) Describe each of these minerals in terms of their optical character (anisotropic vs. isotropic vs. opaque), crystallinity (euhedral vs. anhedral) and relief (high, medium, low, variable).

b) How does the relief of calcite differ from the other minerals? (careful observation is needed here)

c) How would you describe the birefringence of muscovite, olivine and calcite? (ditto here for calcite)

d) Fluorite commonly contains numerous **fluid inclusions**. Do you see any in the F thin-section that you examined? If so, what do they look like? (sketches needed).

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5) Examine the hornblende, biotite and pyroxene thin-sections (H, B, Px) and answer the following questions concerning color, pleochroism, cleavage and extinction.

a) How would you describe the color (in plane polarized light) of each of the 3 minerals.

b) Are any of the minerals pleochroic? If so, what colors do you observe during stage rotation? Can you foresee any potential complications in identifying the composition of pleochroic minerals in thin-sections of rocks?

c) All 3 minerals also have cleavages that are more or less "perfect". Unfortunately you don't always see them for the reasons explained in the lab lecture. Hunt around the thin-sections that you are examining and see if you can identify the cleavage patterns of the 3 minerals. (**Beware of cracks!**) When you find representative cleavage patterns, draw the patterns as well as you can. Here is a hint: Biotite has only 1 cleavage (Note: B1 does not show good cleavage). Hornblende and pyroxene each have 2 (one good, one weak).

d): Compare the birefringence of any one of the B thin-sections with B1, another biotite section. The B sections are cut *parallel* to the (001) crystallographic direction whereas the B1 section is cut perpendicular to (001). This means that B is cut *parallel* to the c and optic axes of biotite and B1 is cut *perpendicular* to those axes. How and why does the birefringence between the 2 orientations compare? Can you foresee any potential complications in identifying the composition of variably orientated minerals in thin-sections of rocks?

e) Describe the nature of the extinction of the three minerals (e.g., straight, inclined, strained etc.).

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6) Transmission microscopy is not the only technique available for studying minerals. You can also use reflected light to study **opaque** minerals. Using the research grade reflected light microscope, examine the three REL specimens provided (they will be adjacent to the microscope in room 340, not with the other thin sections). For each of the samples, describe the colour and intensity of reflection that you observe under the microscope. Please do not take a long time to do this. We only have 1 microscope and 30+ students need to use it within the week duration of the lab.