GEOL 333 - Lab 5 (Optical Microscopy, Minerals in Thin Section)

Name: _____

Objectives (students will be able to:)

- Explain special purpose of petrographic (polarizing) microscope and how it accomplishes that purpose
- Identify following components on a petrographic microscope: ocular, objective lenses, upper (cross) polarizer, rotating stage, coarse and fine focus adjusters, and light source
- Determine pleochroism, relief, cleavage, and birefringence of minerals in thin section.
- Define the following terms: petrographic microscope, plane polarized light (PPL), cross polarized light (XPL), pleochroism, relief, isotropic, anisotropic, birefringence (or interference colors) and twinning.
- Identify the following minerals by characterizing their thin sections with a petrographic microscope: quartz, plagioclase feldspar, olivine, pyroxene (you do not have to distinguish between different pyroxenes), amphibole (hornblende), biotite, muscovite, and calcite.

Discussion

Up until now, we have used only hand samples to identify minerals. This week we will add a useful new tool to our mineral identification toolbox: thin sections. Mineral hand samples sometimes can be difficult to identify because of the presence of mineral impurities, and poorly developed crystal form and cleavage. This week we will learn how to identify some of the minerals we have already seen using a petrographic or optical microscope. The thin sections we will be studying are thin (about 30 microns or 0.03 mm) slices of minerals. First, we will learn about optical characteristics that can be seen with the petrographic microscope and then we will use these optical characteristics to identify some common minerals.

Petrographic microscopes are very different than microscopes used in biology. Light interacts with different materials in different ways. Petrographic microscopes take advantage of this by observing polarized light interacting with thin slices of rocks and minerals. We can use a mineral's behavior when exposed to polarized light to identify it. In later labs we will also make detailed observations of a rock's constituent mineral grains (size, shape, and arrangement) that allow the identification of the rock.

Note: The MacKenzie and Adams book is very helpful for identifying minerals using the petrographic microscope (2 copies are available during Lab). Use table of contents on p. 3 - 4 to find summaries of key properties in optical microscopy as well as optical microscopic features of common minerals and rocks.

Materials

- petrographic microscope for each group of two to three students
- thin sections of quartz, plagioclase feldspar, olivine, pyroxene, amphibole (hornblende), biotite, muscovite, and calcite
- colored pencils

DO NOT TOUCH OBJECTIVE LENSES!

GEOL 333 Lab Exercise #5

1. Properties of Light

a. Describe Plane Polarized Light (PPL) in terms of light traveling in waves. Draw a picture of PPL.

b. Describe Cross Polarized Light (XPL) in terms of light traveling in waves. Draw a picture of XPL.

2. **Relief**
   a. Look at the relief of quartz (thin section label = Quartz) under PPL. Then, look at the relief of calcite (thin section label = Calcite) under PPL. Compare the relief of quartz and calcite.

   b. In your own words, what is relief and how does it show up in thin section?

3. **Pleochroism**
   a. Look at the amphibole thin section (thin section label = B20 Hornblende) under PPL. Rotate the stage while looking at the sample. What happens when you rotate the stage?

   b. Do the same thing with the quartz thin section (thin section label = Quartz). Does quartz exhibit the same behavior that amphibole did? What are the pleochroic properties of amphibole and quartz in thin section?

   c. What causes pleochroism and how does it appear in thin section?

4. **Cleavage**
   a. Look at a thin section with muscovite (thin section label = Muscovite) in PPL. Can you find muscovite's cleavage? What does muscovite's cleavage look like in thin section?

   b. Look at a pyroxene thin section (thin section label = B38 Diopside). How many directions of cleavage are there in pyroxene in thin section? Do you see the same number of cleavage planes in all pyroxene grains in thin section? Why or why not? What is the angle between pyroxene's cleavage?

   c. What is the property of cleavage in minerals? How does it appear in thin section?

5. **Birefringence (Interference Colors)**
   a. Look at a quartz thin section (thin section label = Quartz) under XPL. Rotate the stage. Describe the colors.

   b. Look at an olivine thin section (thin section label = A1 or A4) under XPL. Rotate the stage. Describe the colors.

   c. What is birefringence of a mineral? How do we observe it with the petrographic microscope?

6. Describe the following thin sections using the forms provided. Make sure you fill out each form completely.

- **Thin Sections (TS) to Describe**

o Quartz (large round grains only)	TS Label = Quartz (2 thin sections available)
o Plagioclase feldspar (large crystals only)	TS Label = 54-2-18A (2 thin sections available)
o Olivine (~80% of sample)	TS Label = A1 (1 thin section available; please treat this section gently, it's very fragile)
o Pyroxene	TS Label = B38 Diopside (1 thin section available)
o Amphibole	TS Label = B20 Hornblende (1 thin section available; thin section contains only one large amphibole grain)
o Biotite (~35% of sample)	TS Label = Biotite (2 thin sections available) or 8995 Biotite (1 thin section available)
o Muscovite (~15% of sample)	TS Label = Muscovite (2 thin sections available)
o Calcite	TS Label = Calcite (2 thin sections available)

Strategy for Thin Section Descriptions

- **Begin by examining thin section using low power magnification, followed by intermediate power magnification.**
- **Use plane-polarized light to characterize relief, cleavage and pleochroism as well as opaque minerals.**
- **Use cross-polarized light to characterize birefringence and twinning as well as isotropic minerals.**

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

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

Mineral Description

Student Name:_____

Mineral Name:_____

TS Label:_____

Plane-Polarized (PPL)

PPL XPL
Circle one

Opaque: Yes No

Relief: High Med Low

Pleochroic: Yes No

If pleochroic, give colors:

Cleavage (in thin sect.): 0 1 2

excellent good poor

Cross-Polarized (XPL)

Isotropic: Isotropic Anisotropic
(Isotropic minerals are always black in XPL)

Interference Colors: 1st order 2nd order 3rd+ order

Color(s): _____

Polysynthetic Twinning: Yes No

Notes:

In above circle, sketch a few typical grains under cross-polarized illumination (unless it is isotropic).

- Use colored pencils
- Draw crystal form, cleavage, and twinning, if present

Mineral Description

Student Name:_____

Mineral Name:_____

TS Label:_____

Plane-Polarized (PPL)

PPL XPL
Circle one

Opaque: Yes No

Relief: High Med Low

Pleochroic: Yes No

If pleochroic, give colors:

Cleavage (in thin sect.): 0 1 2

excellent good poor

Cross-Polarized (XPL)

Isotropic: Isotropic Anisotropic
(Isotropic minerals are always black in XPL)

Interference Colors: 1st order 2nd order 3rd+ order

Color(s): _____

Polysynthetic Twinning: Yes No

Notes:

In above circle, sketch a few typical grains under cross-polarized illumination (unless it is isotropic).

- Use colored pencils
- Draw crystal form, cleavage, and twinning, if present

Mineral Description

Student Name:_____

Mineral Name:_____

TS Label:_____

Plane-Polarized (PPL)

PPL XPL
Circle one

Opaque: Yes No

Relief: High Med Low

Pleochroic: Yes No

If pleochroic, give colors:

Cleavage (in thin sect.): 0 1 2

excellent good poor

Cross-Polarized (XPL)

Isotropic: Isotropic Anisotropic
(Isotropic minerals are always black in XPL)

Interference Colors: 1st order 2nd order 3rd+ order

Color(s): _____

Polysynthetic Twinning: Yes No

Notes:

In above circle, sketch a few typical grains under cross-polarized illumination (unless it is isotropic).

- Use colored pencils
- Draw crystal form, cleavage, and twinning, if present

Mineral Description

Student Name:_____

Mineral Name:_____

TS Label:_____

Plane-Polarized (PPL)

PPL XPL
Circle one

Opaque: Yes No

Relief: High Med Low

Pleochroic: Yes No

If pleochroic, give colors:

Cleavage (in thin sect.): 0 1 2

excellent good poor

Cross-Polarized (XPL)

Isotropic: Isotropic Anisotropic
(Isotropic minerals are always black in XPL)

Interference Colors: 1st order 2nd order 3rd+ order

Color(s): _____

Polysynthetic Twinning: Yes No

Notes:

In above circle, sketch a few typical grains under cross-polarized illumination (unless it is isotropic).

- Use colored pencils
- Draw crystal form, cleavage, and twinning, if present

Mineral Description

Student Name:_____

Mineral Name:_____

TS Label:_____

Plane-Polarized (PPL)

PPL XPL
Circle one

Opaque: Yes No

Relief: High Med Low

Pleochroic: Yes No

If pleochroic, give colors:

Cleavage (in thin sect.): 0 1 2

excellent good poor

Cross-Polarized (XPL)

Isotropic: Isotropic Anisotropic
(Isotropic minerals are always black in XPL)

Interference Colors: 1st order 2nd order 3rd+ order

Color(s): _____

Polysynthetic Twinning: Yes No

Notes:

In above circle, sketch a few typical grains under cross-polarized illumination (unless it is isotropic).

- Use colored pencils
- Draw crystal form, cleavage, and twinning, if present

Mineral Description

Student Name:_____

Mineral Name:_____

TS Label:_____

Plane-Polarized (PPL)

PPL XPL
Circle one

Opaque: Yes No

Relief: High Med Low

Pleochroic: Yes No

If pleochroic, give colors:

Cleavage (in thin sect.): 0 1 2

excellent good poor

Cross-Polarized (XPL)

Isotropic: Isotropic Anisotropic
(Isotropic minerals are always black in XPL)

Interference Colors: 1st order 2nd order 3rd+ order

Color(s): _____

Polysynthetic Twinning: Yes No

Notes:

In above circle, sketch a few typical grains under cross-polarized illumination (unless it is isotropic).

- Use colored pencils
- Draw crystal form, cleavage, and twinning, if present

Mineral Description

Student Name:_____

Mineral Name:_____

Plane-Polarized (PPL)

d twinning, if present

TS Label:_____

PPL XPL
Circle one

Opaque: Yes No

Relief: High Med Low

Pleochroic: Yes No

If pleochroic, give colors:

Cleavage (in thin sect.): 0 1 2

excellent good poor

Cross-Polarized (XPL)

Isotropic: Isotropic Anisotropic
(Isotropic minerals are always black in XPL)

Interference Colors: 1st order 2nd order 3rd+ order

Color(s): _____

Polysynthetic Twinning: Yes No

Notes:

In above circle, sketch a few typical grains under cross-polarized illumination (unless it is isotropic).

- Use colored pencils
- Draw crystal form, cleavage, and twinning, if present

Mineral Description

Student Name:_____

Mineral Name:_____

TS Label:_____

Plane-Polarized (PPL)

PPL XPL
Circle one

Opaque: Yes No

Relief: High Med Low

Pleochroic: Yes No

If pleochroic, give colors:

Cleavage (in thin sect.): 0 1 2

excellent good poor

Cross-Polarized (XPL)

Isotropic: Isotropic Anisotropic
(Isotropic minerals are always black in XPL)

Interference Colors: 1st order 2nd order 3rd+ order

Color(s): _____

Polysynthetic Twinning: Yes No

Notes:

In above circle, sketch a few typical grains under cross-polarized illumination (unless it is isotropic).

- Use colored pencils
- Draw crystal form, cleavage, and twinning, if present