NAME______________________

89.215 - FORENSIC GEOLOGY
THE POLARIZING LIGHT MICROSCOPE AND FORENSIC SCIENCE

I. Introduction

An important principle in forensic science is transference, i.e., when someone comes into contact with another person or object material is transferred between the two persons or objects. Much of this evidence is microscopic and hence the polarizing light microscope (PLM) can provide important information during a forensic investigation. In this exercise we will look at various properties that can be determined with the PLM which can be used to make comparisons between trace constituents.

II. Micrometry

One useful property is the thickness or diameter of particles. These can be measured using a microscope that has a calibrated ocular micrometer scale. This calibration has been done for the microscopes that you are using in the course and the calibration is shown in Figure 1. As expected, the diameter of the field of view decreases (and hence the distance represented by the micrometer scale decreases) as we increase the power of the objective that we are using to view the material (Table 1).

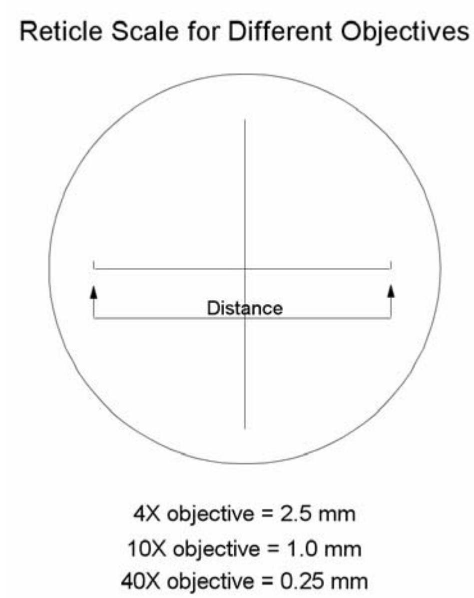

Figure 1. Calibration of reticle scale for student polarizing light microscope.

Objective	4X	10X	40X
Scale bar (mm)	2.5	1.0	0.25
Large divisions (mm)	0.25	0.1	0.025
Small divisions (mm)	0.05	0.02	0.005

1. Using the slide set provided by the instructor, measure the thickness of the following fibers.

   a. Dynel (#47)

   b. Dog hair (#34)

   c. Human hair - mongoloid (#33)

2. Measure the diameters of at least 10 particles of each of the following materials. Include an average and the range for each slide.

    a. Potato starch (#16)

    b. Corn starch (#17)

    c. Rice starch (#18)

III. Crystal morphology

Draw a sketch of the following minerals and describe the crystal habit (equant/massive, needle/acicular, tablet, plate/flake) of each one.

a. Calcite (#64)

b. Crocidolite (#54)

c. Mica - biotite (#59)

IV. Relief and index of refraction

Relief is a qualitative measurement of the degree to which mineral grains (or other particles) stand out from the mounting medium. If the refractive index of the mounting medium and the particle is not the same, the light is refracted on passing from the mounting material to the grain. Relief may be described as high, moderate, or low (Fig. 2). The approximate differences of the index of refraction between the mounting media and the particle is **high relief** > 0.12, **moderate relief** between 0.12 and 0.04, and **low relief** < 0.4. Note that the relief of anisotropic particles (particles that have more than one index of refraction depending on the direction light travel through the particle) may change as the stage is rotated in plane light. If the index of refraction of the particle is greater than the mounting media the particle has a **positive relief** and if it is lower the particle has a **negative relief**. However, in both cases the particle will appear to stand out.

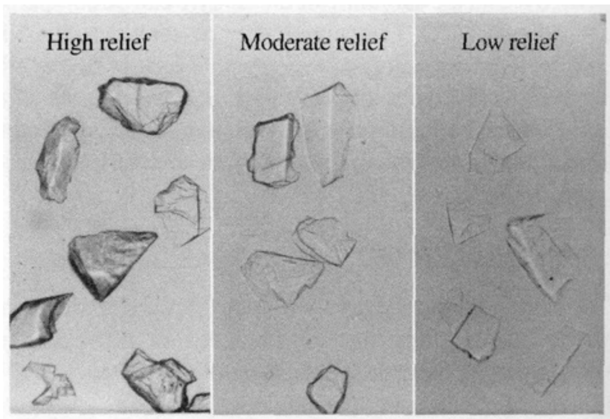

Figure 2. Relief. From Nesse (2000) Introduction to Mineralogy.

1. Determine the relative relief (high, moderate, low) of the following particles. Unless otherwise indicated on the slide, the particles are mounted in a Meltmount media that has a refractive index of 1.662.

   a. Radiolaria (#2)

   b. Quartz (#71)

   c. Corundum (#65)

d. Halite/table salt (#93)

The **Becke line method** is used to distinguish between positive and negative relief. The Becke line (Fig. 3) consists of a band or rim of light along the edge of a particle. The Becke line is most easily seen using the medium-power objective with the image slightly out of focus and the aperture diaphragm somewhat closed. If the stage of the microscope is lowered so that the distance between the sample and the objective lens is increased, the Becke line moves into the material with the higher index of refraction. The simple rule is **as the stage is lowered the Becke line moves into the material with the higher index of refraction**.

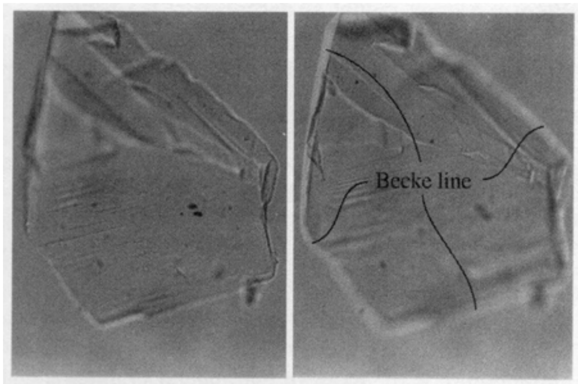

Figure 3. The Becke line. (*Left*) Microscope focused on grains of fluorite that show moderate relief. (*Right*) Microscope stage lowered. The Becke line is a thin band of light that moves into the medium with the higher index of refraction, which in this case is the immersion oil. From Nesse (2000) Introduction to Mineralogy.

2. Use the Becke line test to determine if the following particles have an index of refraction (a) greater than, (b) less than, or (c) nearly equla to 1.662. Remember that anisotropic particles have more than one index of refraction. An isotropic mineral has only one index of refraction. A uniaxial mineral has two indices of refraction. A biaxial mineral has three indices of refraction.

   a. Ground glass (#72, isotropic)

   b. Quartz (#70, uniaxial)

   c. Olivine (#68, biaxial)

   d. Human hair (#31, uniaxial)

   e. Triacetate (#42, uniaxial)

V. Pleochroism

Pleochroic minerals change color as the stage is rotated when the sample is observed in plane light. Isotropic materials (which have only one index of refraction) are never pleochroic. Uniaxial (two indices of refraction) and biaxial (three indices of refraction) material **may be** pleochroic. The color changes because the slow and fast rays (corresponding to two different indices of refraction) are absorbed differently as they pass through the material and therefore have different colors. When the fast ray vibration direction is parallel to the lower polarizer, all light passes as fast ray, so the material displays that color. When the slow ray vibration direction is parallel to the lower polarizer, the material displays the color of the slow ray. If the stage is rotated to allow both slow and fast rays to come through, the perceived color is typically intermediate.

Determine if the following particles are pleochroic (yes or no). If they are plochroic, describe the colors when the state is rotated.

a. Feldspar (#66)

b. Crocidolite (#54)

c. Cigarette ash (#96)

d. Amphibole/hornblende (#62)