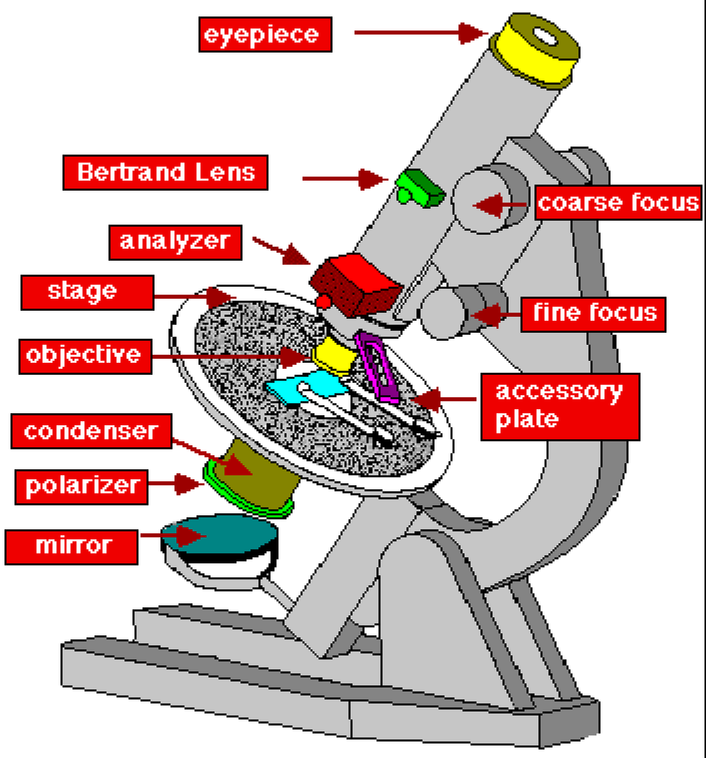
Optical Mineralogy

Optical mineralogy is the study of the interaction of light with minerals, usually involving visible light and non-opaque minerals. The Polarizing Light Microscope (PLM) is a powerful tool for identifying minerals and observing textural details. The physics behind how the microscope works is fascinating, but we will focus primarily on the images that the instrument produces.

In simple terms, the polarizing microscope polarizes the light source (vibration directions of the light are restricted to a plane parallel and coincident with the ray path), this light passes through the sample and is refracted by the crystalline structure of the mineral. This changes the wavelength of the light that exits the mineral. This light can one again be altered by a second polarizing filter (analyzer), this is referred to as crossed polars. The character of the light can be used to identify the specific minerals that it is passing through. It also produces intense images that change as the stage is rotated. Prepared to be dazzled.



Important
The microscopes and thin sections are costly (several grand for the microscope and $20 for the thin section) and can easily be broken if care is not taken. Please be very careful during this lab. Only use the low-power objective (don't rotate the objectives), this will give you plenty of magnification and will reduce the risk of damaging a lens.

Samples
All of the sedimentary and igneous samples that we have looked at in lab are back. There are thin sections (slides) of similar rock types; please consult the key to determine the matches. Look at the hand sample under the dissecting microscope and the thin section under the polarizing microscope. Try to identify the minerals in the thin section and draw at least one field of view (or part of a field of view) for at least 2 samples.

Things to look for in thin sections

Relief: Under plane polarized light (PPL) you will immediately notice when you look at thin sections that some minerals are clearly visible (that is, details of surface texture, cleavage, etc., are obvious) while others appear almost featureless and, if colorless, barely visible. This is the property known as relief. Minerals that have *refractive indices* that differ significantly from that of the mounting medium (epoxy) show up clearly in thin section and are said to have high relief. Minerals with low relief have refractive indices close to that of the mounting medium. Mafic minerals have high relief and the felsic minerals (with the exception of muscovite) show low relief.

Color and Pleochroism: Augite (pyroxene) can appear slightly pink in PPL because of selective absorption of certain of the wavelengths of the white light source. The *anistropy* shown by non-cubic crystals in their physical properties can also be shown by their absorption; this phenomenon is called *pleochroism* and is a useful distinguishing property. Pleochroism is apparent in thin section when minerals undergo a color change as they are rotated in plane PPL.

Opaque mineral: Magnetite and haematite are opaque in transmitted light. They will appear black throughout the rotation of the stage.

Extinction: The rotation of the sample allows the polarized light to vibrate along different directions within the crystal. Crossed polars is when a second polarizing filter is inserted above the sample, placing the sample between two polarizers. If a randomly oriented anisotropic mineral is inserted, the crystal will appear and go extinct (dark) every 90 degrees of stage rotation.

Twinning: One consequence of the symmetry of the internal structure of crystals is the possible growth of twinned crystals. A twinned crystal is a single crystal divided into two (or more) parts in which the crystal lattice of one part is differently oriented with respect to the next. Repeat twinning is a prominent feature of many minerals, particularly in plagioclase feldpar. The crystal is divided up into narrow lamellae with alternate orientations. The black and white stripes are caused by lamellae of one orientation being in an extinction position, while lamellae of the second orientation are not when viewed in crossed polar light.