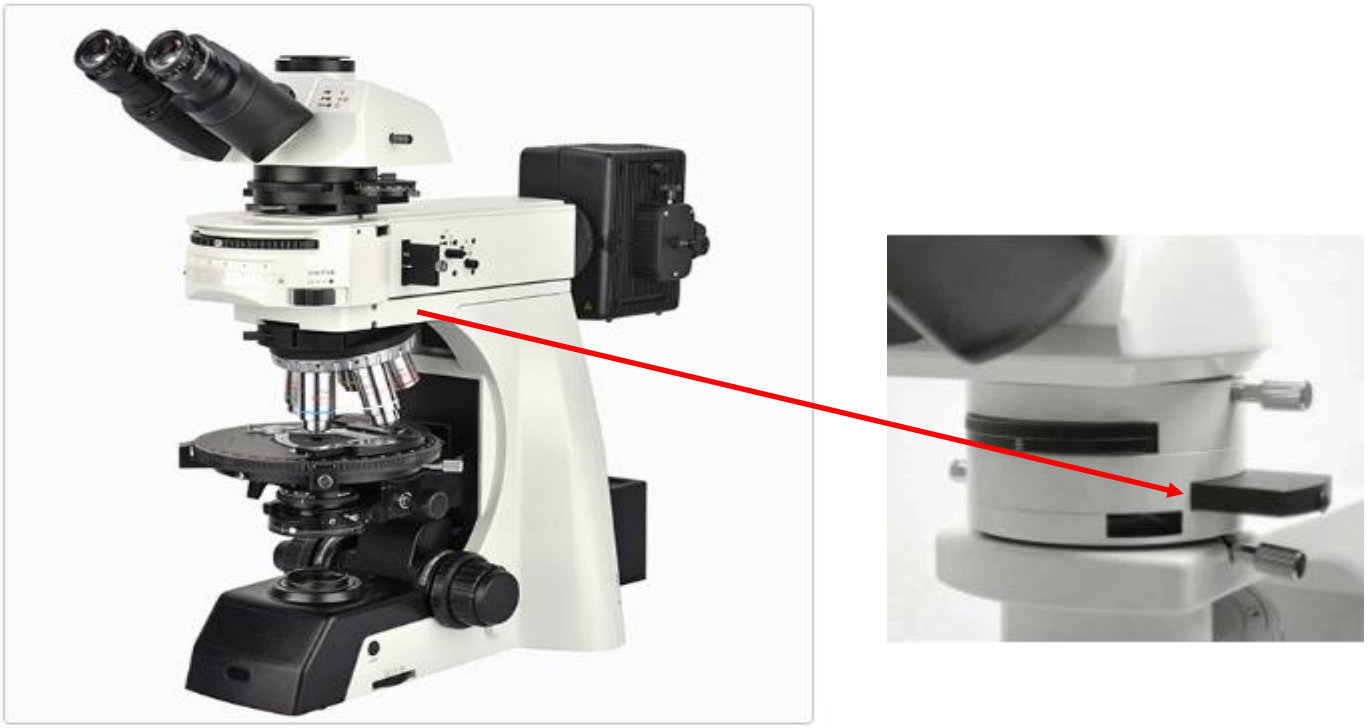
1. DEFINITION OF THE POLARIZING MICROSCOPE:

The polarizing microscope is a tool for observing thin sections of rocks used to determine their nature and mode of formation, in addition to observation at other scales. It allows the identification of minerals and the determination of the texture of rocks. The polarizing microscope does not present any major differences with an optical microscope. It consists of an eyepiece, a stage, a light source and different objectives and is differentiated by the presence of two polarizing devices which are the polarizer and the analyzer.

Polarizing microscope

is a type of microscope that uses polarized light to study the optical properties of materials. It is mainly used in geological studies to study geological specimens. For this reason, it is also known as a petrographic microscope. Recently it has become more widely used in medical and biological research fields, too.

The characteristic of polarizing microscope is to change ordinary light into polarized light for microscopic examination to identify whether a material is monorefringent or birefringent. Birefringence is an essential characteristic of crystals. Therefore, polarizing microscopes are widely used in minerals, polymers, fibers, glass, semiconductors, chemistry and other fields



2. DESCRIPTION OF THE POLARIZING MICROSCOPE:

he polarizing microscope is made up from bottom to top of (**Figure. 01**):

- **The illuminator:** is a lighting device generally provided by a low-voltage bulb.
- **The polarizer:** placed above the light source before the stage that supports the thin section. The polarizer is a fixed optical system that only lets light waves vibrating in its N-S polarization plane pass through.
- **The object stage:** is circular and can rotate on itself around a fixed-centering axis.
- **The objectives**: are part of the microscope's magnifying system.
- **The analyzer:** the analyzer is a second polarizer placed under the eyepiece, it is removable, it straightens the two vibrations from the thin section in its own polarization plane.
- **The eyepiece:** together with the objective, constitutes the microscope's magnifying system. it consists of a glass plate on which are engraved the two orthogonal reticles which materialize the polarization planes of the polarizer (N-S wire) and the analyzer (E-W wire).

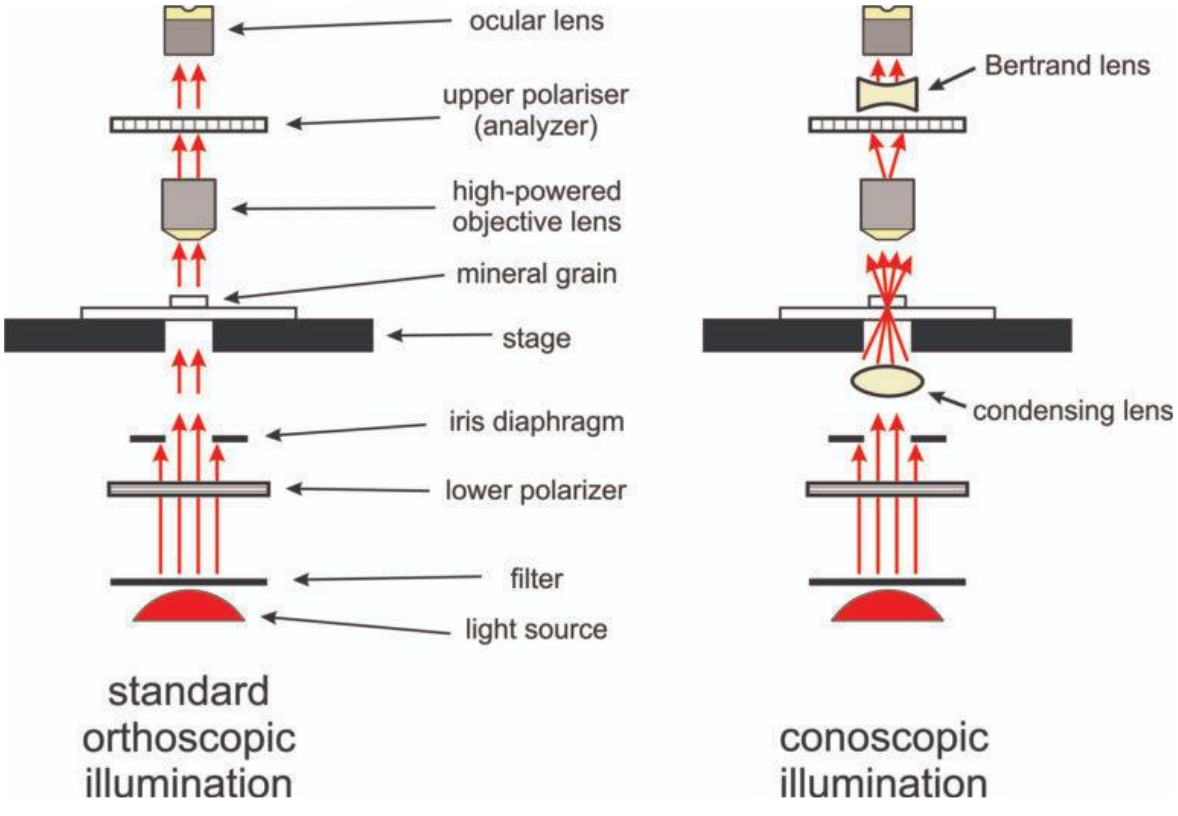


Figure.01: Components of a petrographic microscope

3. PRINCIPE DE FONCTIONNEMENT:

Ordinary light (natural or artificial) is an electromagnetic wave that vibrates in all directions of space (unpolarized light) perpendicular to the direction of propagation of the light ray. When this light passes through the polarizer, it vibrates in only one direction (waves vibrating in its plane (N-S) (unanalyzed polarized light).

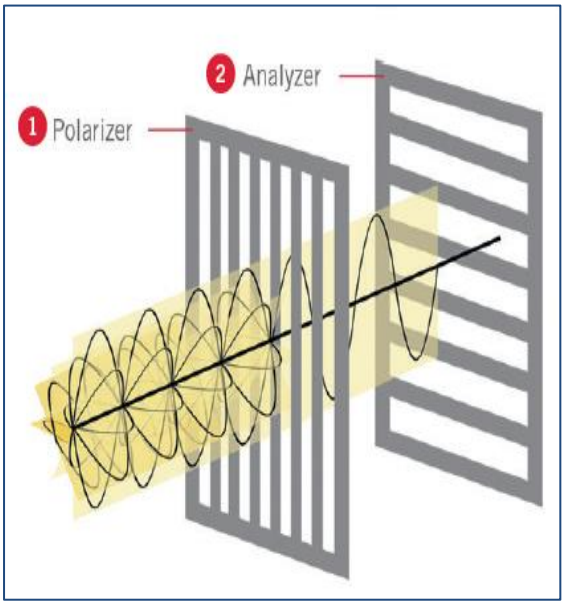
If we insert a thin blade (section of mineral) between the polarizer and the analyzer, the light ray is divided into two refracted rays (the ordinary ray and the extraordinary ray) that propagate at different speeds, which defines the maximum index ng and the minimum index np of the section. The analyzer is a second polarizer that straightens the two vibrations from the thin blade in its own plane of polarization (analyzed polarized light), where they are in interference. This interference produces a vibration that depends on the ng-np value (numpy.argmax - NumPy)

Note:

The planes of the polarizer and the analyzer are perpendicular in the absence of a sample, the light passes through the polarizer, retaining only one plane of vibration. Once polarized in this way, the light cannot pass through the analyzer. Without a slide, no light reaches the observer's eye.

-A polaroid is a transparent system (prism, sheet...) polarizing the light that passes through it.

- **A polarizer** is a sheet of a substance that transmits light rays only in one direction from a multi directional source.



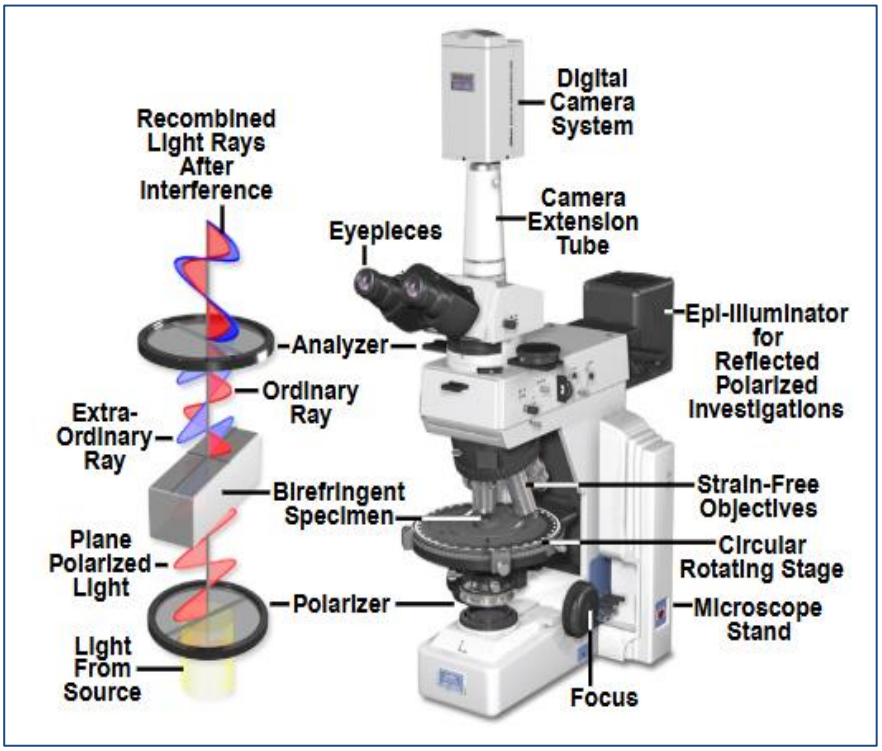


Figure. 02 : Polarized microscope schematic operation

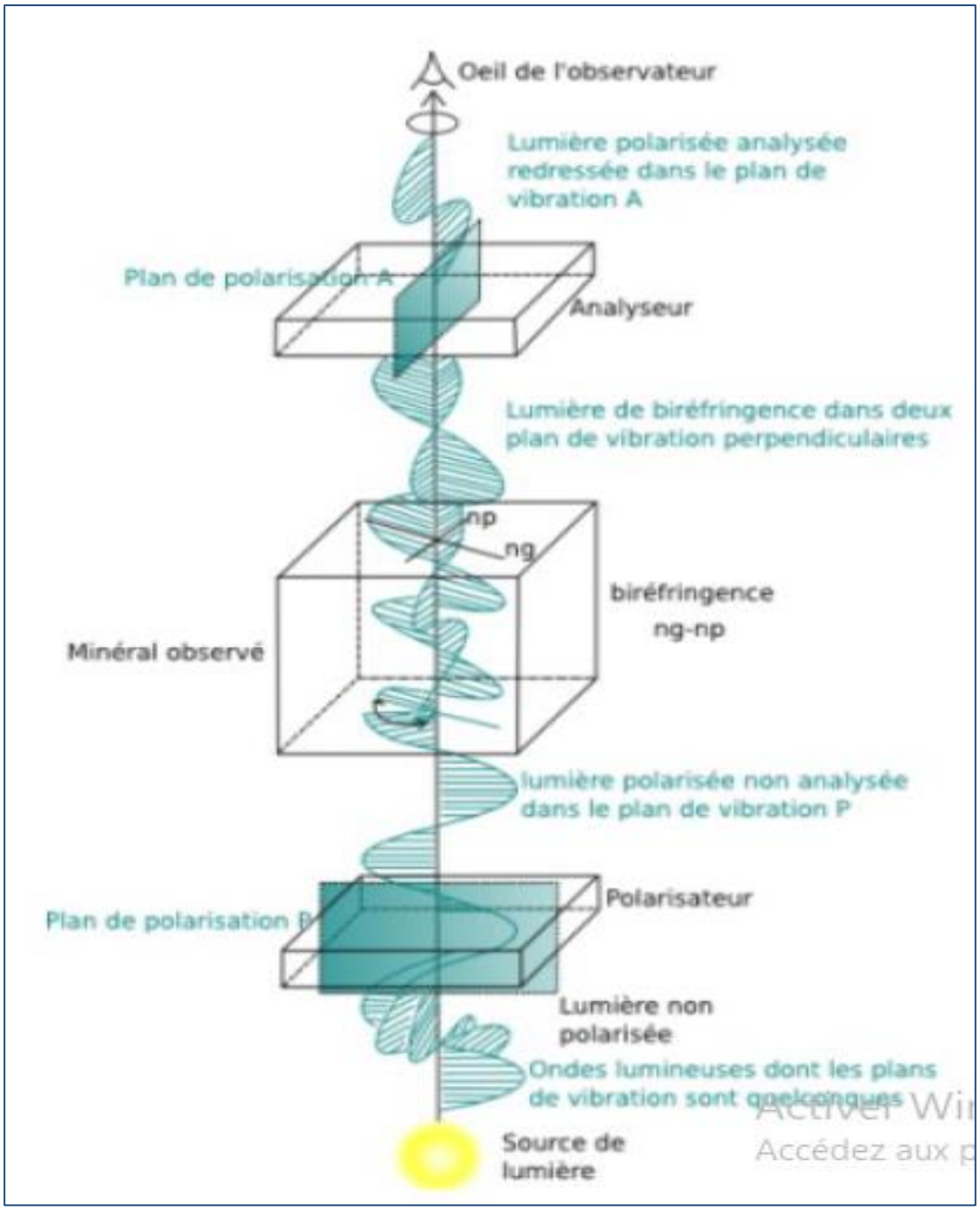


Figure. 02 : Polarized microscope schematic operation

4. GENERAL NOTIONS ON CRYSTAL OPTICS:

- **The refractive index:**

The refractive index is a number without unit that expresses the ratio of the speed of light in air to that measured inside the mineral:

n = Speed of light in air/Speed of light in the mineral.

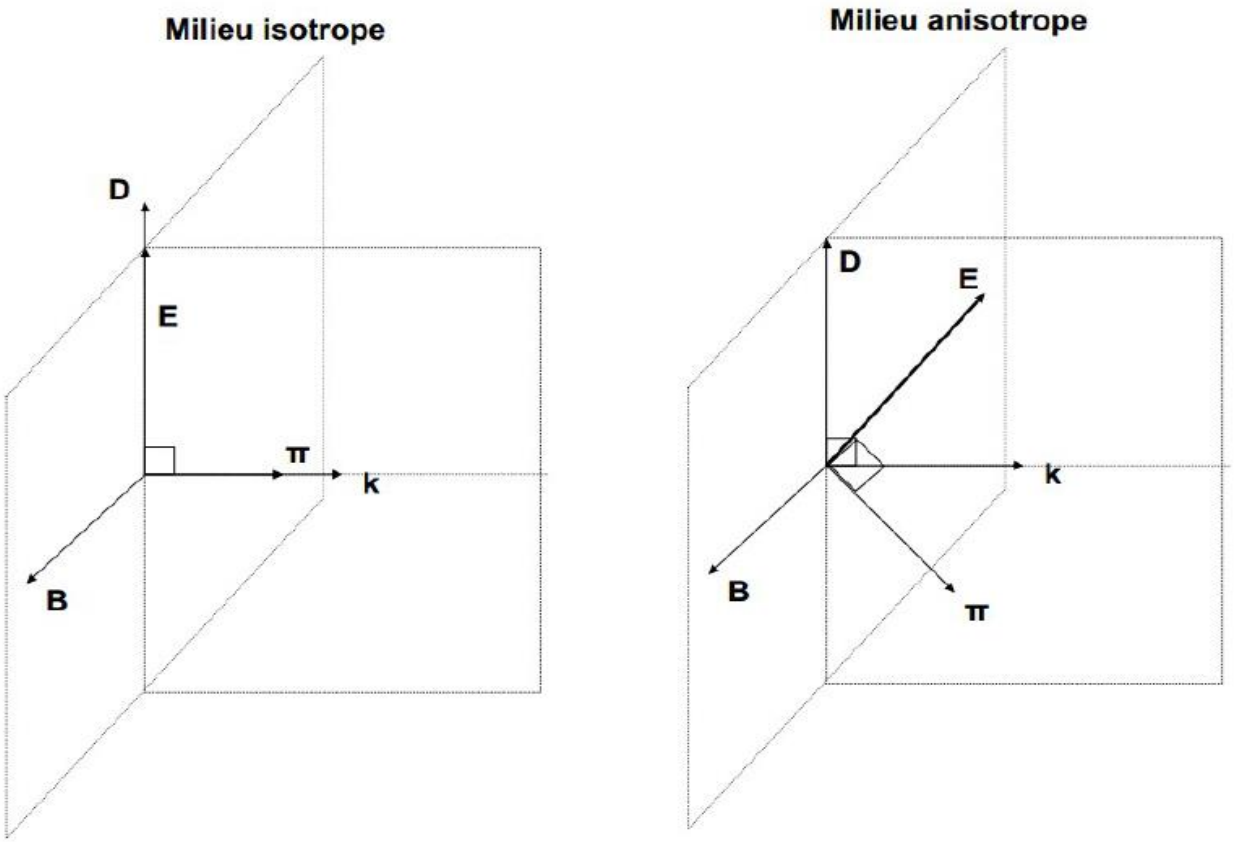
- **Monorefringence and birefringence:**

Light passing through an isotropic medium (gas, glass, minerals crystallizing in the cubic system) propagates with the same speed in all directions and the refractive index is constant. On the other hand, an incident ray gives a single refracted ray, and these media are said to be monorefringent.

The speed of light passing through an anisotropic medium varies according to the direction of propagation. These media are said to be birefringent, because an incident ray gives two refracted rays (double refraction phenomenon) which propagate at different speeds.

Example: all minerals crystallizing in the quadratic,

hexagonal, rhombohedral, orthorhombic, monoclinic and triclinic systems are **anisotropic.**



Example :

With a **Calcite** crystal (**$CaCO_3$**) , on a written sheet, the text appears twice: the crystal is crossed by two refracted rays and therefore gives two images (see fig. 3). Light propagates faster for one ray than for the other: we have two indices of different value for this crystal.

- Calcite is said to be **birefringent** or **anisotropic**.

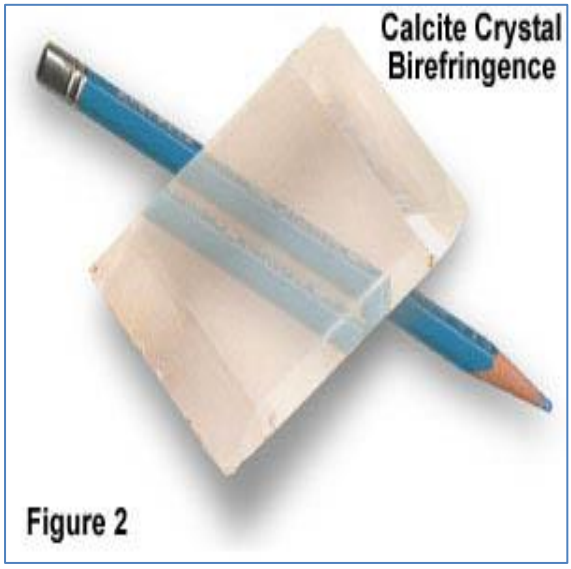


Figure 2

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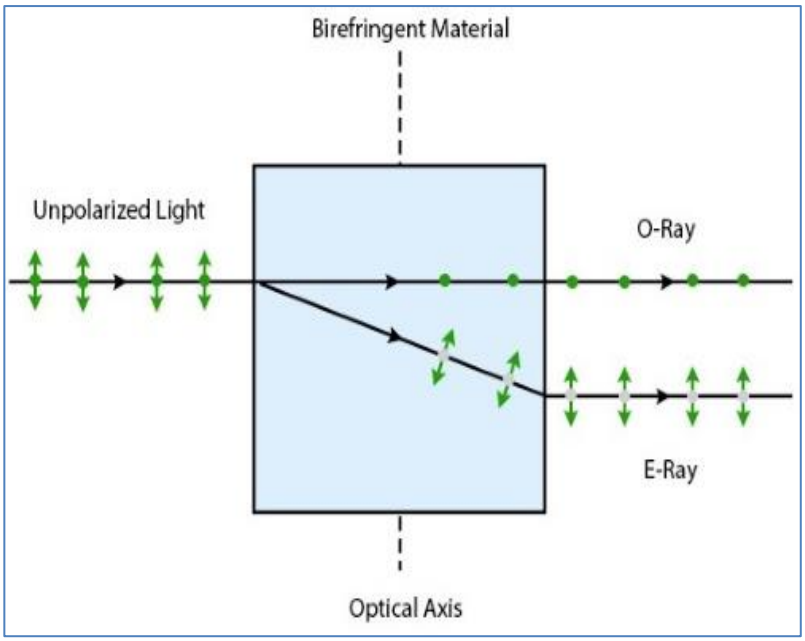

Many minerals are birefringent require the use of a polarized microscope to be demonstrated.