Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Third Year)

Subject: Geology

Paper Code: GEC- 105

Paper Title: Mineralogy

Unit: IV

Module Name: Properties under conoscopic light and its applications in the study of uniaxial and biaxial minerals – I

Module No: 30

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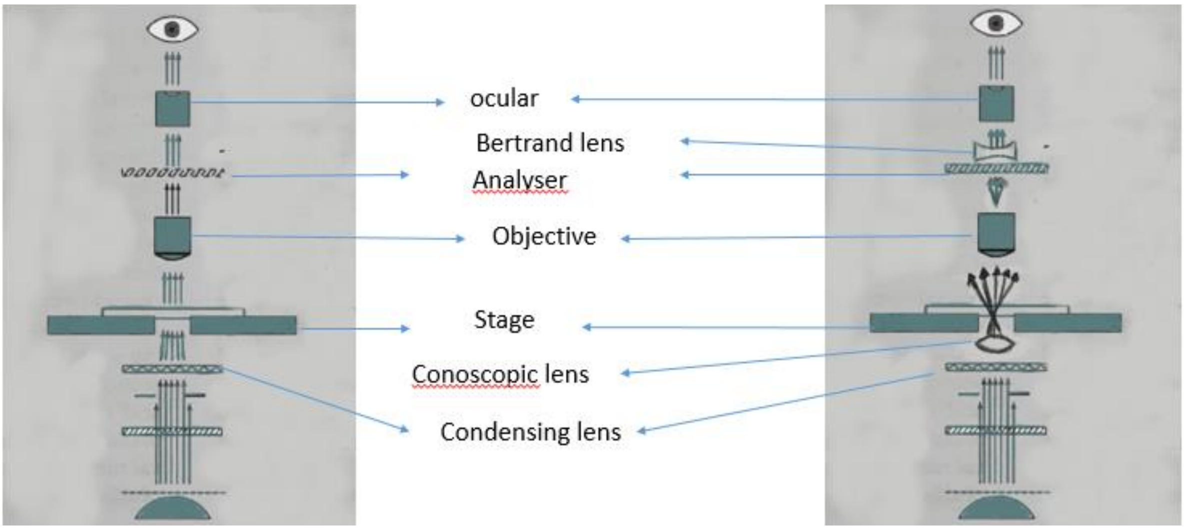
Notes:

Orthoscopic illumination is when an unfocused beam travels from the substage through the sample and straight up the microscope tube. The light rays travel orthogonal to the stage and to a sample or thin section on the stage. However, we can insert a a conoscopic lens between the lower polarizer and stage to produce conoscopic illumination when needed. The conoscopic lens, causes the light beam to converge (focus) on a small spot on the sample and illuminates the sample with a cone of nonparallel rays.



The view that is obtained between crossed polars in this arrangement is called the interference figure. The Bertrand lens brings the image of the interference figure into focus in the ocular. Good figures but of small size, can be obtained by removing the ocular and not using the Bertrand lens.

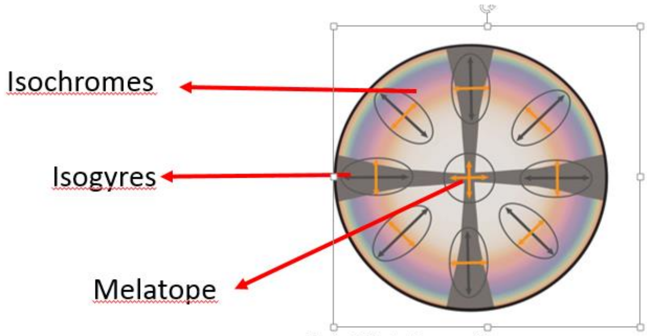
Interference figures show a variation depending on whether the mineral is uniaxial or biaxial and also on the orientation of the section being observed.

THE UNIAXIAL INTERFERENCE FIGURE:

When the basal section of a uniaxial mineral with high birefringence is viewed conoscopically in white light, it produces a pattern consisting of a dark cross with it's arms parallel to the cross-hairs and a series of coloured rings each of which is a sequence of the colours of the Newton's scale.

Optic axis Figure

If the axis of the microscope coincides with the optic axis of the mineral, the uniaxial figure will be centered with the two arms crossing at the intersection of the cross hairs; the figure remains unchanged as the stage is rotated.



Uniaxial interference figures
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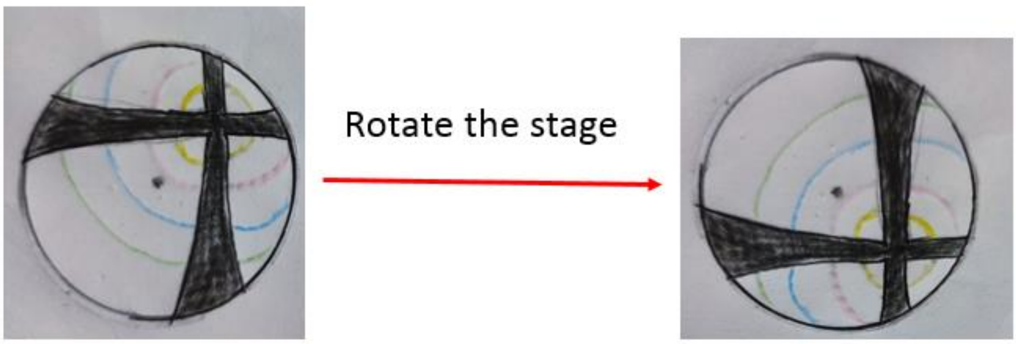
Uniaxial Optic axis Figure

The light rays converging on the mineral from below diverge upwards through the mineral forming a series of cones of wider and wider angle as we go outwards from the central ray, which is incident normally upon the mineral. The central ray, being parallel to the optic axis, is not doubly refracted. But the diverging rays do not travel along the optic axis and hence suffer double refraction. Hence, as we proceed from the centre of the microscope field to the edge, the relative retardation increases. Moreover, as the inclination of the rays increases, the birefringence increases as we move outwards leading to increasing relative retardation. This is the cause of the concentric colour rings.

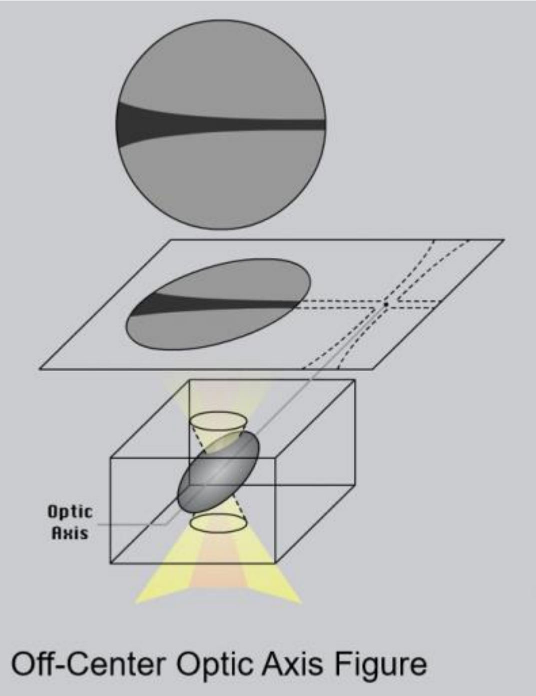
Each ray of the convergent beam, as it passes through the mineral, is refracted into two rays since it strikes the mineral oblique to the optic axis. Of these two rays, the extraordinary ray vibrates in the plane containing the ray direction and the optic axis. Since the optic axis is vertical, all the extraordinary rays will vibrate radially to the field of the microscope. Consequently, the ordinary rays vibrate tangentially. Thus for a ray which emerges on the E-W diameter, the extraordinary will vibrate EW and the ordinary ray NS. Similarly, for a ray emerging on the N-S diameter, the extraordinary ray vibrates N-S and the ordinary ray E-W. Thus we see that the preferred vibration directions on the E-W and N-S diameter are parallel to the vibration directions of the polars. Hence, these parts will be in extinction and so produce the dark cross. This status does not change on the rotation of the stage; hence the cross remains stationary. The arms of the cross intersect at the emergence of the optic axis.

<u>Off Centre Optic axis figure</u>

If the optic axis is inclined to the axis of the microscope, the point of intersection of the cross arms lies away from the cross-hairs center. The intersection of the cross arms mark the point of emergence of the optic axis. As the stage is rotated the intersection of the cross arms describes a circle around the cross-hairs intersection; the arms of the cross maintain their parallelism with the cross hairs throughout the rotation of the stage.

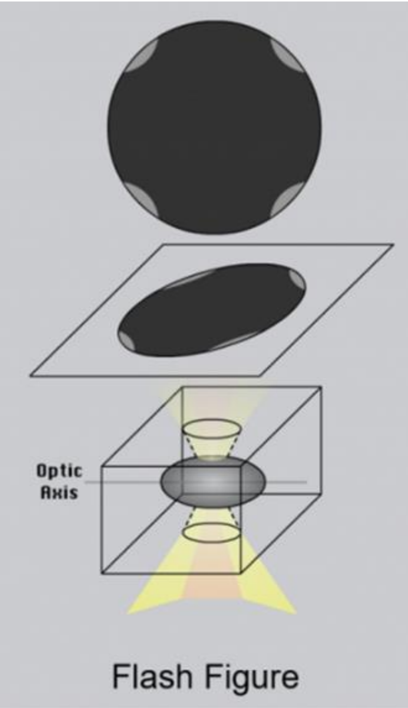


When the optic axis is so oblique that its emergence falls outside the periphery of the field of view, only one arm of the cross is visible at a time.



Flash Figure

When the cut is parallel to the optic axis (the optic axis falls in the plane of the preparation) a figure called flash is formed. It is characterized by an isogyric cross with extraordinarily wide branches that occupy practically the entire field of vision. It is enough to turn a small angle (<5 degrees) so that they disappear completely from the visible field.

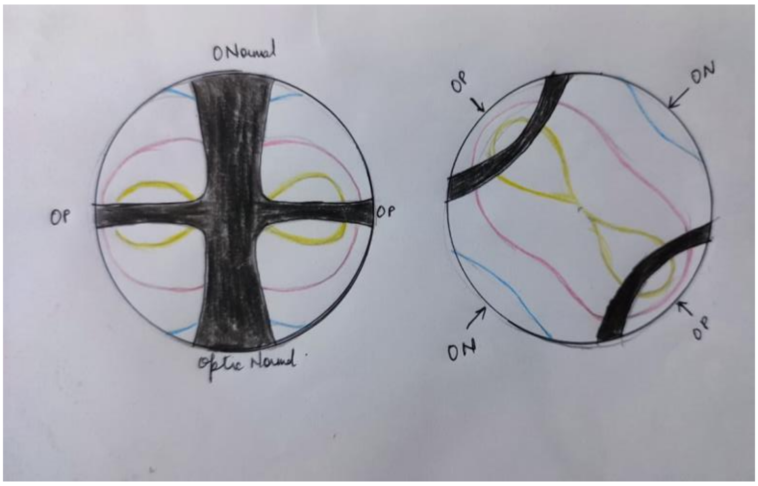


BIAXIAL INTERFERENCE FIGURES

Biaxial minerals when observed conoscopically on a polarizing microscope, produce interference figures which vary according to the shape and orientation of the section. The interference figure consists essentially of black bars or brushes, which change position as the stage of the microscope is rotated. The black brushes are called Isogyres because they mark positions of equal vibration direction.

They are determined by the loci of points of emergence of rays whose planes of vibration are parallel or nearly parallel to the vibration planes of the polars. These isogyres appear in the form of crosses or hyperbolas. If the birefringence is high, the isogyres are found superimposed on isochromatic curves. These are colour bands representing positions of equal retardation and are distribute symmetrically around the points of emergence of the optic axis.

The acute bisectrix figure



Acute Bisectrix Figure

This is given by a slice of a biaxial mineral cut normal to the acute bisecttrix. When the optic plane coincides with the vibration plane of one of the polars, the interference figure takes the form of a cross whose arms are parallel to the cross hairs. This is the interference figure in the "parallel position". As the stage is rotated, the cross breaks up into two hyperbolas. When the optic plane makes an angle of 45° with vibration planes of the polars (the 45° position). The hyperbolas (isogyres) attain their maximum separation, which is dependent on the 2V of the mineral. When 2V is very small, the figure becomes practically the same as that of a uniaxial mineral. The vertices of the isogyres mark the position of the optic axes. Therefore as the 2V increases the separation of these vertices also increases. When 2V becomes more than 50° the points of emergence commonly lie outside the field of the microscope. In this case the hyperbola arms join to form a cross in the parallel position and then as the stage is rotated, they curve out of the field. The larger the 2V, the more rapidly will the brushes disappear from the field.

The two isogyres are convex towards the emergence of the acute bisectrix. The degree of curvature of the isogyres increases as the 2V decreases. Isochromatic curves are seen when the birefringence is high and form a figure "8". The vortices of these curves or "eyes" called melatopes mark the points of emergence of the optic axes. As the stage is rotated, the figure of 8 also rotates unchanged. When light rays converging on the mineral slice from below, diverge upwards through the mineral. Two of these travel along the two optic axis of the mineral and hence do not suffer double refraction. Hence dark spots will appear at the points of emergence of these two rays. All the other rays are incident normal to various elliptical sections of the optical indicatrix. Therefore, they are split into two rays each, vibrating at right angles to one another. The ellipticity of the sections increases as the rays become more and more oblique to the optic axes. This means that the birefringence of the mineral slice increases as one moves away from the optic axes. Thus we get the concentric rings of isochromatic curves. As the rings around both the axes widen outwards, they merge to assume the figure of 8 shapes.

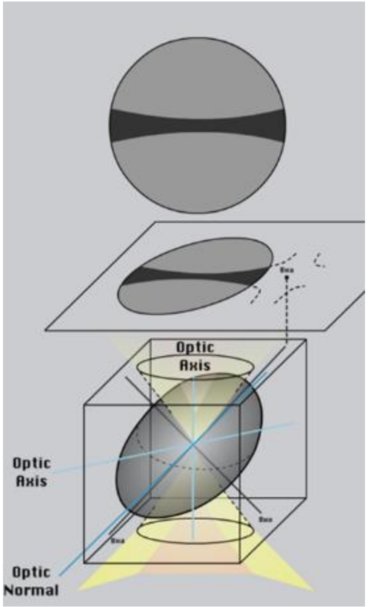
The directions of vibration of light emerging at any particular point P in the field is given by the bisectors of the angle formed by the lines joining the point to the two points A and B where the optic axes emerge using this method. Vibration directions of ray at P, parallel position, 45° position we get the vibration directions as shown in the figures.

Now, when the mineral slice is in the parallel position, we find that along the NS and EW diameters the vibration planes are parallel to those of the polars. Hence these areas show darkness in the shape of a cross, whose arms intersect at the emergence of the acute bisectrix.

When we turn this figure through 45°, i.e. we observe the mineral in the 45° position we find that the points whose vibration planes are NS and EW lie on hyperbolic curves which pass through the emergence of the optic axes. Hence these areas are in extinction, thus producing the two isogyres. The two curves are convex towards the center of the field where the acute bisectrix emerges.

The optic axis figure

This is given by a slice of a biaxial mineral cut normal to an optic axis. Only one isogyre is visible. It bends and straightens during the rotation of the stage. In parallel position, i.e. when the optic plane is parallel to the vibration plane of one of the polars, the isogyre becomes a straight line parallel to one of the cross hairs. This straight marks the position of the optic plane. As the stage is rotated, the isogyre becomes more and more curved and attains the maximum curvature in the 45° positions. The isogyre is convex towards the emergence of the acute bisectrix, and the optic axis emerges at the center of the field.



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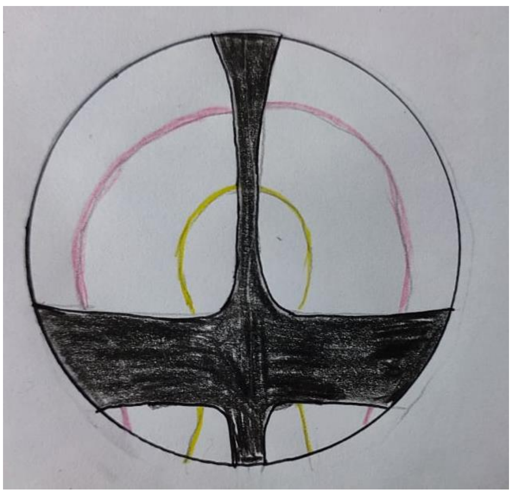
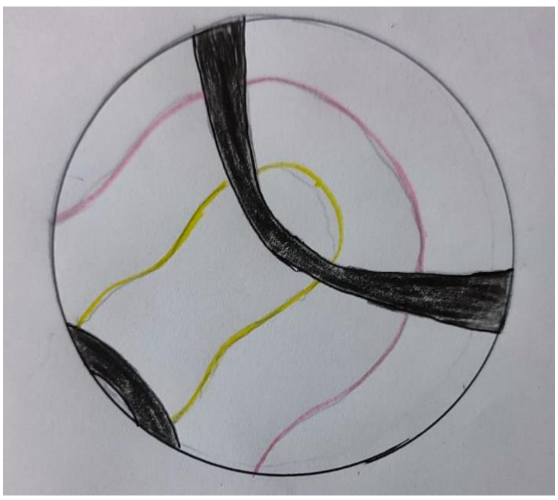
The optic axis figure may be considered as one half of an acute bisectrix figure, the isogyre going through the same changes of shape (Parallel position and 45° position) and position as one of the segments during the rotation of the stage.

In the Bxa figure we find that the isogyre straighten out in the parallel position to form a cross whose arms are parallel to the cross hairs. One of these arms contains the melatopes. Hence in the parallel position the isogyres straighten out parallel to one of the cross hairs.

In the 45° position, the isogyre attains the maximum curvature with the acute bisectrix being situated on the convex side. The same situation exists in the optic axis figure in the 45° position, the only difference being that the emergence of the optic axis is at the center of the field.

The degree of curvature of the isogyre increases with decreasing 2V. The images below depict the optic axis figure wherein 2V is less than 30°





When the 2V is 90° degree the isogyre is a straight line, which rotates about the center as the stage is rotated. Since this movement simulates that of a compass needle, this figure is sometimes referred to as the “compass figure”.

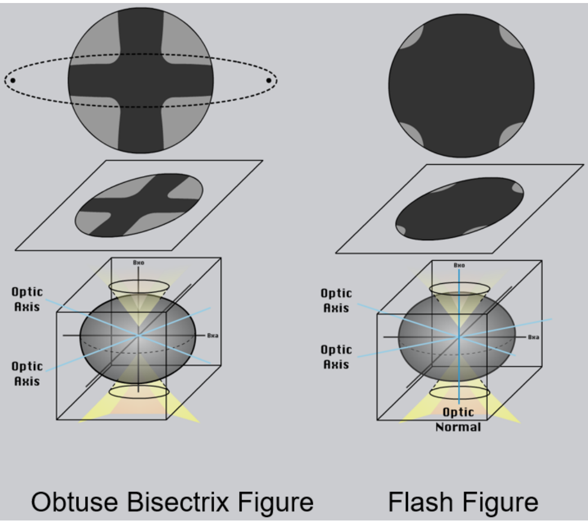
<u>The obtuse bisectrix figure</u>

This figure is obtained by a section cut normal to the obtuse bisectrix. In the parallel position, it consists of a dark cross first as in the case of the acute bisectrix figure, but the isogyre disappear from view within a few degrees of rotation of the stage (<15 degrees). The isogyre leave the field in the quadrants containing the trace of the optic plane. The isochromatic curves have the same general shape as those of the acute bisectrix figure, but only a segment (the central part) is seen. The shape is maintained during the entire rotation of the stage.

In the acute bisectrix figure the isogyres swing outwards as the stage is rotated from the parallel position and attain the maximum separation after a rotation of 45°. If the optic axes emerge at the periphery of the field, the isogyre become tangent to the circumference of the field at the 45° rotation. But if the 2V is still larger, they quit the field even before the 45° positions is reached. Thus, we can see that the isogyres will move out of the field faster and faster as the 2V increases. In the case of the obtuse bisectrix figure, the angle 2V that is bisected by the axes of the microscope is greater than 90°. Hence the isogyres move out very fast.

<u>Flash Figure</u>

When the cut is parallel to the plane of the optical axes (the optical axes fall in the plane of the preparation) a figure called flash is formed. It is characterized by an isogyric cross with extraordinarily wide branches that occupy practically the entire field of vision. It is enough to turn a small angle (<5 degrees) so that they disappear completely from the visible field.



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