A SUBSTITUTE FOR THE QUARTZ WEDGE USED WITH THE POLARIZING MICROSCOPE

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The ungraduated quartz wedge has long been used with the polarizing microscope for two types of purposes: (1) to determine the directions of fast and slow rays and to measure roughly by compensation the retardation of a flat birefringent section in parallel white light; (2) to find the character of birefringence, or differentiate the fast and slow rays in a birefringent section by other methods than simple compensation in parallel white light. Under the second heading come several different methods, such as finding the sign of birefringence in convergent white or colored light from the motion of the isochromatic bands; finding the fast and slow rays in a wedge-shaped section in parallel light (white or colored) from a similar motion of the isochromatic bands; and finding the fast and slow rays in a thick section in parallel white light by the motion of dark interference bands across the spectrum, according to the method recently described by Lietz (1937). The methods of this second class are often used when the section under examination has a high retardation or when it is strongly colored. The quartz wedge is used often enough in these several ways to make it a standard accessory in petrographic work, in spite of its high cost ($25 from American dealers) as compared with other compensator plates.

One substitute for the quartz wedge is found in the step plate known as Fedorov's comparator or mica echelon (Johannsen (1918)), or the earlier step plate described in the English literature as the Fox Wedge. Such plates, if they can be obtained, cost about as much as the quartz wedge.

A combination of quarter-wave plate and rotating analyzer has long been used by physicists for the analysis of elliptically polarized light by Mach's method (Rinne-Berek (1934)). This combination was adapted by Senarmont and by Friedel for the purpose of measuring retardations with the polarizing microscope, and is occasionally mentioned in the literature (Ambronn-Frey (1926); Wright (1911)). Wright's statement that the method has not been generally adopted by petrologists is as true today as it was when it was written.

Strangely enough, the use of the same combination of quarter-wave plate and rotating analyzer for the second class of purposes mentioned above seems to be nowhere referred to in the literature of the polarizing microscope. For such purposes it is shown in the following that the combination is a practical substitute for the quartz wedge, and at a cost of less than half that of the latter.

For such purposes the specimen is oriented as usual in the diagonal position with respect to the polarizer, and a quarter-wave plate is inserted above the specimen with one of its vibration directions parallel to the vibration direction of the polarizer. On now rotating the analyzer, the isochromatic bands (or dark interference bands in Lietz' method) move in or out in exactly the same manner as when a quartz wedge is used, and from the sense of their motion exactly the same inferences may be drawn concerning the shape or orientation of the index-ellipsoid of the specimen.

Concerning the sense of the motion it is immaterial whether the vibration direction of the polarizer is horizontal or vertical. If the slow ray of the quarter-wave plate is horizontal (left-to-right) and the analyzer is rotated in a clockwise direction, then the motion of the isochromats or interference bands is the same as that given by a conventional quartz wedge (Fig. 1). (The same statement is true if the analyzer is fixed, the quarter-wave plate is inserted with its slow ray horizontal below the specimen, and the polarizer is rotated in a clockwise direction). The question can of course be decided by trial with a piece of mica or other suitable known crystal. A 180° rotation of the analyzer in the one case is equivalent to a translation of the wedge from a point of retardation x to a point of retardation $x+\lambda$ in the other case.

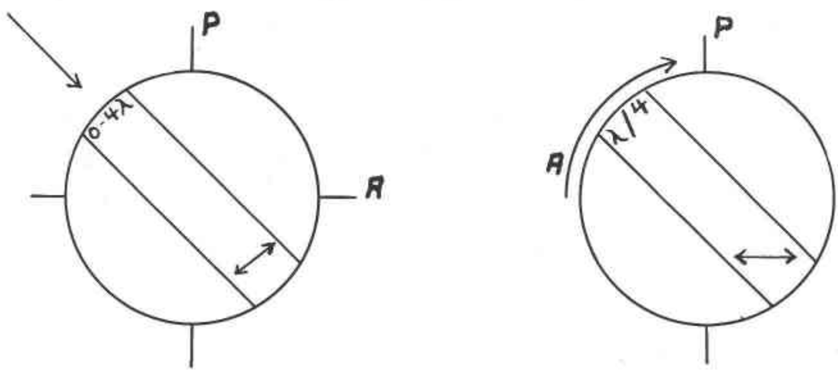

FIG. 1

Quartz wedge inserted in direction of arrow. Slow ray and thin edge marked by ⟷.

Analyzer rotated in direction of arrow. Slow ray of $\lambda/4$ plate marked by ⟷.

It is often of advantage to make the isochromatic bands more distinct by using light filters or monochromatic light. For the present purposes if the quarter-wave plate used is for the middle of the visible spectrum (retardation 137 to 147 millimicrons) it will give satisfactory results for any wavelength or band of the visible spectrum.

If the combination described is used with a standard polarizing microscope (diagonal compensator slot) a special quarter-wave plate must be obtained with the orientation shown in the figure, since in ordinary compensation plates the vibration directions are parallel to the edges of the fitting.[1]

References

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Rinne F. and Berek, M. Untersuchungen mit dem Polarisationsmikroskop. *Leipzig,* **1934,** p. 223.

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[1] A cap analyzer ($7.50) and cap quarter-wave plate ($4.50) are listed under their "Polaroid Micro Accessories" by the Bausch & Lomb Optical Company; these fit over any ocular up to 27 mm. in diameter and are suitable for the present purposes if a pin in the quarter-wave plate mounting is removed so that the analyzer can be rotated freely.