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USE OF THE NAKAMURA PLATE IN UNIVERSAL STAGE ORIENTATIONS

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The Nakamura plate is a refined biquartz wedge and can be used to determine accurately the optical orientation with the universal stage. It consists of two halves of equal thickness, one a right-handed quartz, the other a left-handed quartz which rotate the plane of polarization in opposite directions. The Nakamura plate divides the field into two halves and if the polarizer and analyzer are exactly crossed and the crystal is at extinction, the two halves of the plate will be exactly equally illuminated. Its use is similar to that of the biquartz wedge and has been described by Wright (1908).

The Nakamura plate is designed to be used at the focal plane of the ocular, between the polarizer and the analyzer, and the ocular must be adapted so as to permit its insertion. The Wright slotted ocular enables one to focus on the accessory plate and on the normal orthoscopic image at the same time. The slotted ocular used by this author is an improved Wright slotted ocular designed by Hallimond and Taylor (1948) which contains a rotatable internal sliding analyzer above the accessory slot. With wide tube microscopes it is necessary to construct a special joint in order to place the slot at the normal focal plane of the instrument.

Extinction positions with the Nakamura plate are more easily determined than with the normal orthoscopic image. When the mineral is at extinction both halves of the Nakamura plate are exactly equally illuminated, and if the crystal is rotated from extinction, the intensity of illumination in the two halves of the plate is rendered unequal. Extinction positions can be determined to 0.10 degree (Hallimond, 1953).

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In orienting a mineral optically with the universal stage two optical symmetry planes are made vertical and parallel to the nicols. When an optical symmetry plane is vertical, and for example east-west, it will remain at extinction throughout a rotation on a horizontal north-south axis. In using the Nakamura plate, slight departures from true orientation can be observed, for if an optical symmetry plane is not vertical, the intensity of illumination of the two halves of the plate will be unequal in a rotation on this plane. Slight departures from verticality are easily recognized. The optical orientation with the Nakamura plate can be determined to ± 0.5 degree with low birefringent minerals, and this accuracy increases with an increase in birefringence. The plate also allows one to use many grains that would not normally be used because of ill-defined extinction.

The general procedure for use of the Nakamura plate is that the mineral is initially oriented according to standard techniques (see Emmons, 1943, p. 23–27), and then this orientation is checked with the Nakamura plate by wide rotations on a north-south and east-west axis. Small departures from true orientation are usually observed in this check. Best results in orientation are obtained when the objective diaphragm and the upper substage diaphragm are partially closed.

With the Nakamura plate it is possible to consider and minimize errors in the optical system. The objectives are set at a position of minimum strain as follows: With the analyzer and polarizer exactly crossed and the objective placed in a rotatable collar (or one which has been loosened so that it can be rotated 360 degrees), the objective is rotated until a position of minimum strain is found. At this position the halves of the Nakamura plate will be as closely matched in intensity of illumination as is possible and the position should be marked so that it can be found again. With paper shims the objective is adjusted in its original collar to the position marked. The objective is now in a position of minimum strain, and the analyzer must be rotated so that both halves of the Nakamura plate match. All of the objectives tested contained some strain, the greatest strain observed produced a departure from extinction of more than 2.0 degrees; however most objectives were only slightly strained and produced departures from extinction of less than 0.20 degree.

Strain in the universal stage hemispheres can be readily detected with the Nakamura plate. In the hemispheres tested the departures from extinction were less than 0.15 degree when the inclination of the stage was less than 40 degrees. Greater than 40 degrees inclination produced departures from extinction of a much greater magnitude, and as the edge

of the hemisphere was approached, departures from extinction were nearly 1.0 degree. All hemispheres tested contained some strain.

A comparison of the accuracy with the standard orthoscopic method and with the Nakamura plate was made by determining the extinction positions on an optically perfect plagioclase grain. The standard deviation for extinction positions with the Nakamura plate was 0.16 degree; with the standard method 0.39 degree.

For precise optical measurements with the universal stage it is recommended that the Nakamura plate be used in conjunction with standard orthoscopic orientation procedures. Uncertainties with respect to the optical orientation are eliminated with this accessory.

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IRIGINITE FROM SOUTH DAKOTA[1]

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X-RAY DATA

The *x*-ray powder data given by Getseva and Savel'eva (1956) for iriginite agree well with those obtained from the South Dakota mineral. Additional powder data obtained by Kazitsyn and Komkov (Fleischer, 1960) also agree with the data of the current investigation. All lines and intensities calculated from the South Dakota mineral are listed in Table 1. The data of Getseva and Savel'eva (G&S) are also listed for

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