

the opinion that this method cannot be used even though the chance of an accidental duplication in the terms of an analysis may be small.

ACKNOWLEDGEMENTS

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REFERENCE

MERTIE, J. B. (1961) Analytic classification and quadriplanar charting of analyses with nine or more components. *Am. Mineral.* **46**, 613-628.

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COMMENT ON "ERRORS IN THE MEASUREMENT OF 2V WITH THE UNIVERSAL STAGE," BY M. MUNRO

ALEX C. TOBI, *Department of Petrography, Geological Institute, Utrecht University, Netherlands.*

In Munro's interesting paper (*Am. Mineral.* **48**, 308-323, 1963) it is concluded that a difference in refractive index of the segments on the one hand and the central assembly (central plate and thin section) on the other, may cause an error of measurement. This error reaches a maximum when a closed substage diaphragm is used in the orthoscopic procedure (his Table 2). A few additional remarks may here be made.

The paper refers exclusively to the Leitz Universal stage. It is, however, of interest to note that the universal stage made by Zeiss (Oberkochen) is not provided with a central plate: the thin section is placed directly between the two segments. As the Leitz central plate (*ca.* 2.5 mm) is about twice as thick as the glass slide of the thin section, the error mentioned above should be considerably less when working with the Zeiss stage.

This advantage, however, is counteracted by the fact that Zeiss recently changed the shape of the lower segments with $n=1.555$ and $n=1.649$. Contrary to the description still provided with the instrument, these segments are now true hemispheres without any slice ground off to account for the thickness of the glass slide of the thin section. Apparently (pers. comm. of the manufacturer) the change was brought about to improve the illumination for conoscopic work. When working orthoscopically, a thin illuminating beam is now deflected on tilting the stage because the horizontal axes of the stage (1) do not pass through the center of curvature of the lower segment (2) (Fig. 1). At first sight, I was inclined to think that the Zeiss stage was better adapted for conoscopic than for orthoscopic work. Judging from Munro's Table 2, however, we

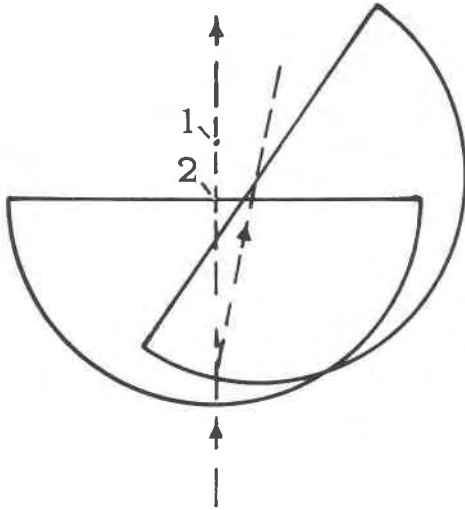


FIG. 1

may conclude that in this case too the effect of the deviation can probably be avoided by using a broad illuminating beam offering a greater choice of incident directions and a greater light spot on the object.

Finally, it is perhaps justified to conclude from his results that the exact optical properties of the lower segment are not very important at all, as long as a broad incident beam is used. It might even be harmless and convenient to use one lower segment for all measurements and to change only the upper segment according to the refractive index of the mineral under consideration! This goes for both stages. An amplification in this direction of the painstaking measurements so aptly performed by Munro should be most cordially welcomed.

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REPLY TO COMMENT ON "ERRORS IN THE MEASUREMENT
OF $2V$ WITH THE UNIVERSAL STAGE"

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Dr. Tobi raises two main issues in his comments on my paper (*Am. Mineral.* **48**, 308–323, 1963), namely, the accuracy of measurements made with the Zeiss universal stage, and the possibility that accurate measurements can be made with a universal stage when the upper and lower segments differ in refractive index. Not having access to a Zeiss