NOTES AND NEWS

PRECESSION ORIENTATION PHOTOS

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Precession orientation photos were discussed in a recent number of this journal in the first part of an article by the writer.[1] In what follows it is assumed that the reader is familiar with the material on pages 1037 to 1044 of this paper.

Once a correctly-oriented double exposure picture with dial values 180° apart (see page 1043) has been obtained with a given instrument, the relation of O' (the center of precession for the film; see page 1044) to the direct beam spot s' (see page 1039) is readily established. Thereafter on any new picture, O' can be pricked through the film after it has been in the fixer a minute or so, if it is placed above the polar net light box in such fashion that the Laue streaks lie along radii of the net, when s' will then be at the center of the net. Of course if there is no streak parallel the dial axis, the azimuth of the film under these conditions can be controlled by the cassette dots.

Actually the center c of the circle of precession should first be pricked on the wet film before establishing O' as outlined in the preceding paragraph. Then when O' is located, one can read from the polar net the angle A between the vector $O'c$ and the dial axis (cf. Fig. 40 *b*).[2] If the length (in mm.) of $O'c$ is measured, the orientation error ϵ can be obtained from Fig. 39, since $O'c$ is the same as (δ-r) of this graph.[3] If M' marks the point where the trace of the dial axis on the film is cut by a normal to it from c, then cM' ($=\epsilon\cdot$ sin A; assuming ϵ is represented by $O'c$) is a measure of the dial error and $O'M'$($=\epsilon\cdot$ cos A) of the horizontal arc error.

Figure 40 shows two diffraction patterns of an orthorhombic crystal which permit ready visualization of precession orientation problems. Examination of these yields the following results:[4]

[1] Fisher, D. J. (1952), *X*-ray precession techniques: *Am. Mineral.*, **37**, 1036–1054. On p. 1050, line 1.; D$=c$ should read D$=c^*$. In line 2 of fn. 7 on p. 1044, V_{vl} should read V_{xl}. On p. 1010 of the preceding paper, line 15 from base, *and* should read *end*.

[2] The numbers here assigned to the figures and tables are in continuation of those used in the paper of footnote no. 1.

[3] Fig. 39 is based on the data of Table 13. These were taken from Table 12 (page 1045) as $\delta-r$ values. It is clear from Fig. 34*b* (page 1046) that $s'c=s'v-cv=\delta-r$; on an instrument for which O' and s' do not coincide, one should use $O'c$ rather than $s'c$.

[4] The H-arc and dial values given are readily obtained using an ordinary slide rule. Set 90° on the sin scale against the ϵ value on the A (or D) scale. Then opposite the value for angle A on the sin scale read the dial correction, and opposite the value for (90°-A) read the H-arc correction.

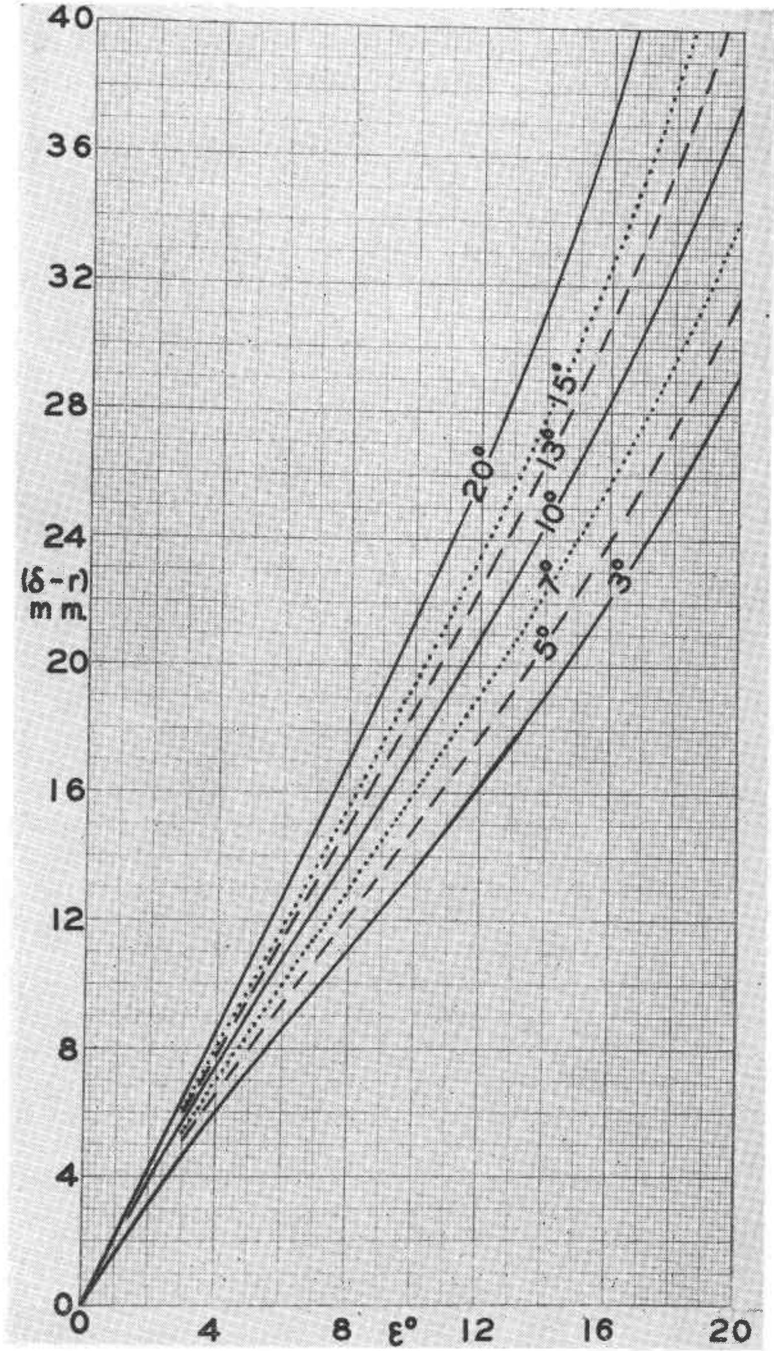

FIG. 39. Graph showing variation in $(\delta - r)$ in mm. with ϵ (in degrees) for various values of $\bar{\mu}$ (the figures on the curves) where $F = 60.00$ mm.

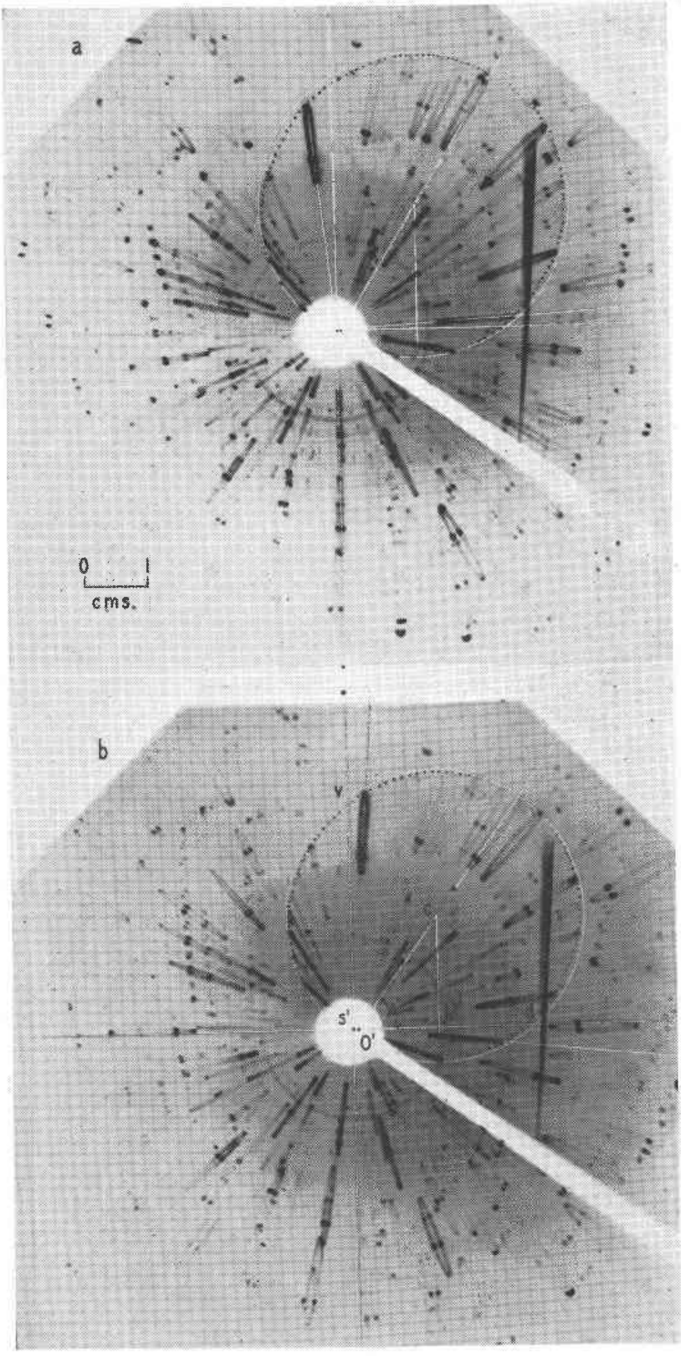

FIG. 40. Precession orientation photos of hopeite with $\bar{\mu}=3°$ and Mo radiation at $F=60.00$ mm. If correctly oriented, precession would be on [*a*] ,with [*c*] parallel to the dial axis. Here the dial reading is off 15° (up), the H-arc off 10° (to the right), and the V-arc off 5°; this last error is up in (*a*) and down in (*b*).

Fig.	Measurements		ε	H-arc	Dial
	$O'c$	A	(Fig. 39)	$\epsilon \cdot \cos A$	$\epsilon \cdot \sin A$
40*a*	26.1 mm.	58°	18°.4	9°.8	15°.6
40*b*	24.8 mm.	54°	17°.6	10°.3	14°.2

It will be noted that the average values for the dial and H-arc errors are within 0°.1 of the true figures. But if one were working from a single picture, the common case, results following this scheme might be as much as 1° off. This is largely because of the error in the orientation of the vertical arc, which prevents this simplified method from being exact. To correct the V-arc setting, one may use the technique given on page 1040. However this is highly empirical, and will not work out as satisfactorily in many cases as one might gather from the example given.

Thus in the orthogonal case of Fig. 40, the proper V-arc setting may be obtained from the bearings of the streak which would be vertical (given correct orientation) and the one that should be horizontal (parallel the dial axis). The bearings of these are as follows:

Fig. 40*a*—N. 6° W. & N. 87° E. (off 6° and 3° resp.)
Fig. 40*b*—N. 4° E. & S. 84° E. (off 4° and 6° resp.)

If one takes the mean errors, these are $4\frac{1}{2}$° and 5° respectively. These mean results are quite close to the true value of 5°. However in the case of an unknown material having a non-orthogonal relationship, this mean error method cannot be applied. It should also be noted that the technique of correcting the V-arc error where c does not coincide with O' (given as s' on page 1040) would be only moderately satisfactory in the case of Fig. 40*a* and would be downright erroneous in the case of Fig. 40*b* (where the so-called correction factor should be negative; the first sentence of the paragraph starting near the top of page 1040 is thus seen to be incorrect).

In conclusion, with a badly misoriented photo[5] such as those in Fig. 40, approximate corrections are computed by the method given above, or by the technique described on page 1039 neglecting the correction factors (of course allowance should be made for the case where an arc is not horizontal). From the next (second) picture, which should be taken with one arc horizontal, it is easy to get the correct setting for this arc from the δ_d-value (measured from O'; not from s'

[5] It is interesting to note that on such photos the circle of precession becomes slightly elliptical, with the major axis along $O'c$. This contrasts with the case of less severe misorientation, where certain Laue streaks are shortened on the direct beam side of c; see page 1039.

as given on page 1039) and Fig. 31 on page 1041. Then rotate the dial 90° and take a third picture to obtain the correct setting for the other arc. Using these two pictures the desired dial settings can be had from the δ_v-values and Fig. 31.

TABLE 13. LENGTHS OF $O'c$ (in mm.) FOR VARIOUS VALUES OF $\bar{\mu}$ AND ϵ (where F=60.00 mm.)

$\bar{\mu}$ \ ϵ	1°	2°	3°	5°	7°	10°	13°	15°	20°
3°	1.84	3.37	4.75	7.32	9.81	13.59	17.62	20.55	29.18
5°	1.93	3.63	5.19	8.05	10.79	14.90	19.24	22.38	31.66
7°	1.98	3.78	5.45	8.57	11.54	16.05	20.67	24.05	34.09
10°	2.04	3.94	5.75	9.17	12.45	17.39	22.61	26.38	37.74
13°	2.09	4.07	6.01	9.65	13.23	18.65	24.43	28.65	41.54
15°	2.12	4.16	6.12	9.94	13.71	19.46	25.64	30.17	44.24
20°	2.23	4.35	6.47	10.66	14.89	21.50	28.78	34.25	51.95

Addendum

In this series of papers (*Am. Mineral.*, **37**, 1952, page numbers as indicated) the writer has spoken of "enlarged reciprocal lattice translation values" (p. 100) which are measured on the precession films. It was stated (fn. 8, p. 100) that in non-orthogonal cases these were really enlarged "spacing" values between reciprocal lattice *lines;* but nevertheless the symbol t^* was used to designate these (pp. 101, 104, 109), except on pages 1049–1051, where G, H, J, K, M, & N were employed. Reading Terpstra,[6] it has seemed that the term *interval* is more appropriate to describe the distance between the equal-spaced lines in any plane of the non-orthogonal lattice. The matter is summarized in Table 14

TABLE 14. DESIGNATION OF INTERVALS IN THE ENLARGED TRICLINIC RECIPROCAL LATTICE

Orientation (Table 1, p. 83)	Standard	First Permutation	Second Permutation
Precession axis (pp. 104, 1049–1050)	c	a	b
Intervals	$M^* = i^*_{\perp b^*c}$ $N^* = i^*_{\perp a^*c}$	$G^* = i^*_{\perp ac^*}$ $H^* = i^*_{\perp ab^*}$	$J^* = i^*_{\perp bc^*}$ $K^* = i^*_{\perp a^*b}$

[6] Terpstra, P. (1952), A Thousand and One Questions on Crystallographic Problems, Groningen. See p. 100.

for the case of the reciprocal lattice; corresponding letters without the asterisk may be used for the direct lattice should occasion arise.

It will be noted that these are much the same symbols as used on pp. 1049–1051, except that the capitals are marked with an asterisk, and the t^* is replaced by i^*. The use of the "meaningless" capitals is much simpler for the printer.

Professor M. J. Buerger informs me[7] that nearly all of his precession orientation work is done using a "layer-line" screen with a *circular* (not annular) opening of 12 mm. diameter (ideal $r=5$ mm. with an extra mm. for tolerance) with $s=28.4$ mm. and $\bar{\mu}=10°$. If my 7 mm. radius screen (fn. 6*a*, p. 1041) is used with a circular opening (actual diameter 17 mm.) at $\bar{\mu}=10°$, then it will not cut off the ends of the longer radiating Laue streaks if the orientation error is not greater than 1° with s at 39.7 mm. With a larger error in orientation, the screen should be moved closer to the crystal; thus with the screen at $s=31.7$ mm., the orientation error may be as much as 3° without decapitating the longer Laue streaks. This method of taking orientation pictures is very rapid and yields "clean" negatives that lack the sometimes-confusing n-level Laue streaks.

Erratum

Assuming the negative ends of the a and b axes are where indicated in Fig. 36 (p. 1049), then $+c^*$ must extend *up* normal to the paper (fn. 8 on p. 1048 should be corrected). This means that $+c^*$ must extend to the *left* in Fig. 37*b*, hence the signs for all the digits of the node indices in this figure must be reversed. Also $+c^*$ should be changed to read $-c^*$ on p. 1051 (line 8 from base) and p. 1054 (line. 2).

[7] Personal communication, Dec. 24, 1952 and Jan. 13, 1953.

TWO DEFINITIONS OF POSITIVE AND NEGATIVE EXTINCTION ANGLES IN THE PLAGIOCLASE FELDSPARS: ONE LEADING TO CONSISTENCY AND CLARITY, THE OTHER TO INCONSISTENCY AND CONFUSION

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An extinction angle has been defined as positive by Duparc and Reinhard,[1] by Rosenbusch and Mügge,[2] and by Chudoba,[3] if the rotation of

[1] Duparc, L., and Reinhard, M., La détermination des plagioclases dans les coupes minces: *Mémoires de la Société de Physique et d'Histoire Naturelle de Genève*, **40,** 14, 22 (1924). (It is to be noted that the statement of the definition of a positive extinction angle by Duparc and Reinhard was not accompanied by any qualification limiting the application of the definition to the upper half of the crystal.)