Extinction-Angles in Cleavage-Flakes.

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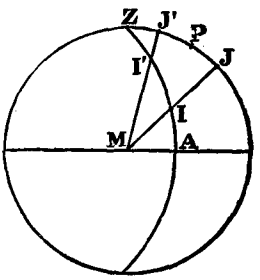
NOW that the measurement of extinction-angles in cleavage-flakes is frequently used to assist in the identification of minerals, the question of the relation of angles so measured to the orientation of the optic axes is one that must frequently arise. I confine myself here to the case of monoclinic minerals, such as hornblende and augite, in which the optic axes are parallel to the clinopinacoid and the cleavage is prismatic.

To obtain the requisite trigonometrical relations, project for convenience on a prism-plane M, and let I and I' be the positions of the optic axes; so that $ZI = \alpha + V$ and $ZI' = \alpha - V$, where α is the extinction-angle ($c\gamma$) in a clinopinacoidal section and $2V$ the angle between the optic axes.



Now for a given wave-front the two possible planes of vibration bisect the angles between the two planes drawn through the normal and the two optic axes severally.[1] Hence, if the great circles MI and MI' meet the circle of projection in J and J', and the arc JJ' be bisected in P, ZP is the extinction-angle for a cleavage-flake. The right-angled triangle IJZ gives the relation

$$\tan ZJ = \cos IZJ . \tan ZI = \sin \phi \tan (\alpha + V),$$

where $\varphi = MA$, or half the cleavage-angle. Similarly

$$\tan ZJ' = \sin \phi \tan (\alpha - V),$$

and since

$$ZP = \tfrac{1}{2}(ZJ + ZJ'),$$

the extinction-angle in a cleavage-flake is thus determined as depending on α and V.

The following tables for hornblende and augite are calculated from the

[1] See (*e.g.*) Fletcher, *Min. Mag.* (1891), Vol. IX., p. 341.

above relations. They give, to the nearest quarter of a degree, the extinction-angle in a cleavage-flake as depending on α, the extinction-angle in a clinopinacoidal section, and $2V$, the true angle between the optic axes. The cleavage-angles are taken from Miller : $2\phi = 55°30'$ for hornblende and 92°54′ for augite. In the case of augite the two directions of extinction are supposed to be discriminated: if this be not done, an ambiguity arises between an angle over 45° and its complementary angle.

HORNBLENDE.

For Values of α.	For Values of $2V$.					
	40°.	50°.	60°.	70°.	80°.	90°.
°	°	°	°	°	°	°
4	2	2	2¼	2½	2¾	3
5	2½	2¾	3	3¼	3½	3¾
6	3	3¼	3½	3¾	4¼	4½
7	3½	3¾	4	4½	4¾	5¼
8	4	4¼	4¾	5	5¾	6¼
9	4¾	5	5¼	5¾	6¼	7
10	5¼	5½	6	6¼	7	7¾
11	5¾	6	6½	7	7¾	8½
12	6¼	6½	7	7¾	8½	9½
13	6¾	7¼	7¾	8¼	9¼	10¼
14	7¼	7¾	8¼	9	9¾	11¼
15	8	8¼	9	9¾	10¾	12
16	8½	9	9½	10½	11½	12¾
17	9	9¼	10¼	11	12¼	13¾
18	9½	10	11	11¾	13	14½
19	10	10¾	11½	12½	13¾	15½
20	10¾	11¼	12¼	13¼	14¾	16¼

AUGITE.

For Values of α.	For Values of $2V$.		
	50°.	60°.	70°.
°	°	°	°
38	32½	33¼	34¾
39	33½	34½	35¾
40	34½	35½	36¾
41	35	36½	37¾
42	36	37½	38¾
43	37	38½	39¾
44	38	39¼	40¾
45	39	40¼	41¾
46	40	41½	42¾
47	41	42½	44
48	42	43½	45
49	43½	44½	46
50	44½	45½	47
51	45½	46½	48
52	46½	47½	49½
53	47½	48½	50½
54	48½	49½	51½

It will be noticed that the figures for different values of $2V$ do not differ very widely. It would be impossible to determine $2V$ with any accuracy by combining observations of extinction-angles in a cleavage-flake and a clinopinacoidal section.