The crystallization of Parahopeite.

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THIS species, a hydrous zinc phosphate, $Zn_3P_2O_8.4H_2O$, dimorphous with hopeite, was first described by Spencer in 1907.[1] While the material then available was suitable for the physical and chemical description of the new mineral, it did not permit a full crystallographic investigation. Spencer noted that the crystals resembled in a general way those of hemimorphite, and made sufficient measurements to indicate the triclinic character of the mineral. In his sketch of a crystal he indicates that the mineral is twinned, and that this twinning is best seen on the perfect cleavage which is parallel to the brachy-pinacoid.

Recently some very fine specimens of this mineral from the Broken Hill mines, North-Western Rhodesia, the type locality, were obtained by the Royal Ontario Museum of Mineralogy. The following crystallographic description of parahopeite is based on this material. The crystals are prone to form groups in approximately parallel position, but by careful search a number of simple crystals or of groups in which the individuals are in twinned relationship to each other were obtained. These are very small—usually not more than two millimetres long, one millimetre broad, and one-half millimetre thick. We find that the crystals are triclinic with the macropinacoid (100) as twinning-plane and composition-face. The elements derived from measurements are as follows:

$$a:b:c = 0{\cdot}7729:1:0{\cdot}7124;$$
$$\alpha = 93^\circ\ 22',\ \beta = 91^\circ\ 12',\ \gamma = 91^\circ\ 22'.$$

The faces most prominent on the crystals are the pinacoids (100), (001), and (010); the pyramids $(1\bar{1}1)$, $(\bar{1}\bar{1}1)$, and (322); the prisms (110) and $(1\bar{1}0)$; and the domes $(0\bar{1}1)$, $(0\bar{1}2)$, and (011), fig. 1. The

[1] L. J. Spencer, Mineralogical Magazine, 1908, vol. xv, p. 18.

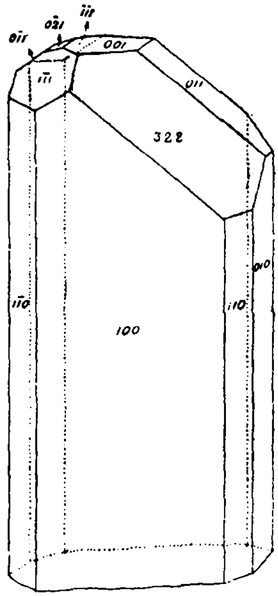

Fig. 1.—Crystal of Parahopeite showing the principal forms.

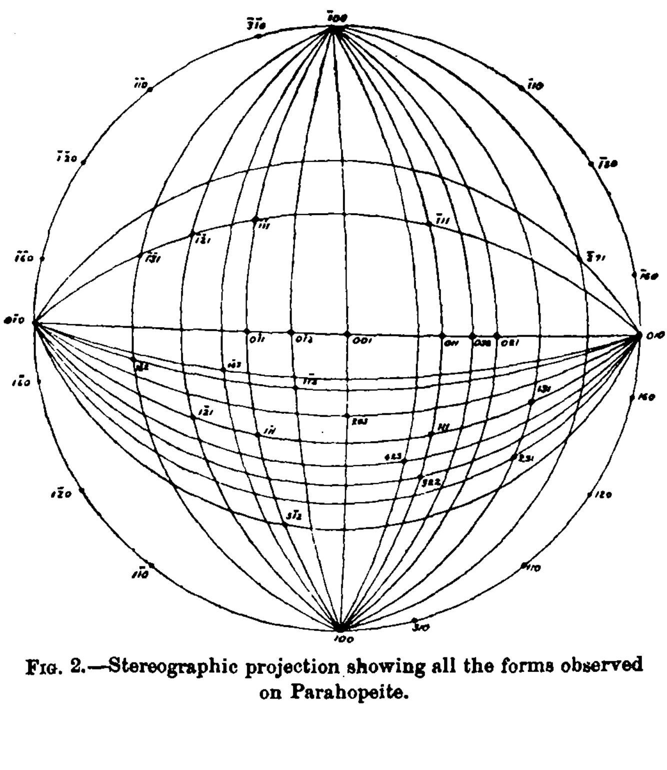

Fig. 2.—Stereographic projection showing all the forms observed on Parahopeite.

three pinacoids, the two unit prisms, and the pyramid (322) are so much more prominent than the other forms that they are responsible for the general habit of the crystals. The following forms, thirty-two in number, have been definitely established from our observations:

Pinacoids—(100), (001), (010);
Prisms—(310), (110), (120), (160), (11̄0), (12̄0), (16̄0);
Brachydomes—(021), (032), (011), (01̄2), (01̄1);
Macrodomes—(203);
Pyramids—(111), (11̄1), (1̄11), (1̄1̄1), (423), (131), (231), (322), (11̄2), (12̄1), (51̄2), (14̄3), (16̄2), (2̄71), (1̄2̄1), (1̄3̄1).

Certain of the preceding forms appear as very small faces, so that there is a considerable difference between the measured and calculated angles, but as the most of them have been observed on more than one crystal, it is our opinion that their position should be regarded as established. This applies particularly to (111), (131), (310), (160), (11̄2), (51̄2), (2̄71), (16̄0).

Measured and Calculated Angles for Parahopeite.

	Measured.	Calculated.	Difference.		Measured.	Calculated.	Difference.
	° ′	° ′	′		° ′	° ′	′
(100) (010)*	88 33	88 33	0	(423) (001)	51 20	51 29	− 9
(110) (010)	51 3	51 22	−19	(322) (001)	55 11	55 36	−25
(120) (010)	31 49	32 27	−38	(110) (001)	86 57	86 56	+ 1
(1̄20) (010)	33 29	33 17	+12	(1̄1̄1) (001)	51 15	51 26	−11
(1̄10) (010)	53 18	53 9	+ 9	(231) (001)	67 40	67 44	− 4
(100) (001)*	88 43	88 43	0	(1̄21) (001)	61 52	62 33	−41
(010) (001)*	86 36	86 36	0	(1̄20) (001)	93 52	93 31	+21
(021) (001)	52 17	52 21	− 4	(1̄31) (001)	69 41	69 0	+41
(032) (001)	44 30	45 6	−36	(11̄1) (010)*	114 40	114 40	0
(011) (001)	33 53	34 18	−25	(021) (100)	87 35	88 9	−34
(01̄2) (001)	20 5	19 57	+ 8	(322) (100)	41 58	41 36	+22
(01̄1) (001)	36 18	36 35	−17	(011) (100)	87 44	88 10	−26
(16̄2) (001)	67 20	66 48	+32	(1̄11) (1̄00)	55 3	55 6	− 3
(14̄3) (001)	45 30	46 13	−43	(11̄1) (100)*	52 13	52 13	0
(12̄1) (001)	60 53	60 48	+ 5	(1̄1̄1) (1̄00)	52 11	52 28	−17
(12̄0) (001)	91 38	92 11	−33	(14̄3) (01̄0)	50 24	49 53	+31
(1̄10) (001)	88 55	88 55	0	(12̄1) (1̄00)	62 1	61 48	+13
(1̄11) (001)	47 59	48 22	−23	(1̄21) (1̄00)	61 29	61 5	+24
(11̄1) (001)	49 22	49 35	−13	(16̄2) (01̄0)	28 40	29 24	−44
(203) (001)	31 21	31 11	+10				

	Measured.	Calculated.	Difference.		Measured.	Calculated.	Difference.
	° ′	° ′	° ′		° ′	° ′	° ′
(111) (001)	47 9	47 54	− 45	(1$\bar{1}$2) (100)	67 9	65 34	+1 35
(111) (100)	55 3	52 42	+2 21	(5$\bar{1}$2) (001)	68 10	68 21	− 11
(1$\bar{3}$1) (001)	62 53	63 55	−1 2	(5$\bar{1}$2) (100)	22 47	21 45	+1 2
($\bar{3}$10) (010)	73 8	74 10	−1 2	($\bar{2}$71) (001)	75 1	76 32	−1 31
(160) (010)	13 5	12 5	+1	($\bar{2}$71) ($\bar{1}$00)	73 53	72 6	+1 47
(1$\bar{1}$2) (001)	28 46	30 8	−1 22	($\bar{1}$60) (010)	11 4	12 12	−1 8

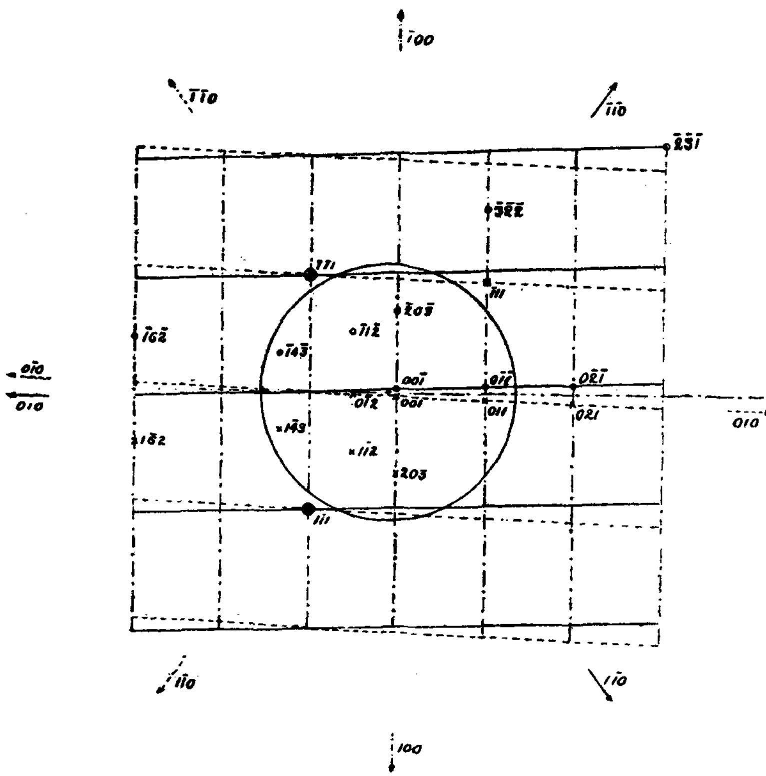

Fig. 3.—Gnomonic projection showing the faces observed on a twin-crystal of Parahopeite.

The angles marked thus * have been used for the calculation of the elements. Faces with poor reflections, giving differences of more than one degree between the measured and calculated values, are set apart at the end of the table.

All the forms observed on the ten crystals measured are indicated on the accompanying stereographic projection, fig. 2. The gnomonic projection, fig. 3, shows the faces observed on a twin-crystal, the twin-plane being (100). The faces belonging to one individual are shown by small rings, while those of the other are marked by small crosses.

On many of the twinned crystals measured most of the terminal faces belong to a single individual. This is explained by the fact that in cleavage plates parallel to the brachypinacoid the end of the crystal is frequently composed of a single individual, fig. 4 (and also shown in Spencer's fig. 4). In the prism-zone on such crystals, faces representing both individuals are frequent.

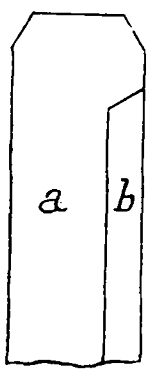

FIG. 4.—Sketch of cleavage plate of Parahopeite parallel to the pinacoid (010). On the upper end of the twin-crystal only one individual is present.

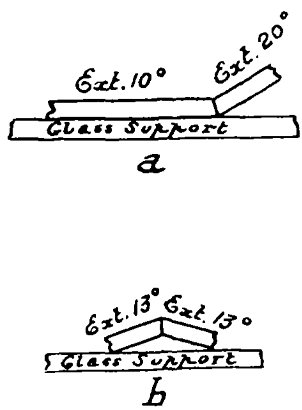

FIG. 5.—Sketches showing the relationship between extinction values measured on cleavage plates and the position of the cleavage with regard to the glass support.

Cleavage plates parallel to the brachypinacoid show lamellar twinning resembling that of plagioclase according to the albite law. Alternate individuals extinguish simultaneously just as in albite. Very varied extinction-angles have been recorded.[1] This is due to the absence of parallelism between the cleavage flake of the crystal individual and the glass support. When the plate measured lies so that the cleavage is parallel to the glass the extinction-angle is about 10° from the edge (100) (010). In this case the individual twinned with the first being

[1] Spencer, loc. cit., p. 20.

inclined to the glass support at an angle of about three degrees shows an extinction of about 20° to the same edge. If, on the other hand, both cleavages make equal angles with the glass support, the extinction of the two individuals is symmetrical at 13° with regard to the edge referred to. The true extinction-angle on a cleavage plate parallel to (010) is therefore 10°, and the other values are due to lack of parallelism between the glass support and the cleavage of the individual concerned (fig. 5).

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