Plagioclases from Sultan Hamud, Kenya.

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[Read March 31, 1949.]

THE plagioclase which forms the subject of this investigation was presented by Dr. C. Stansfield Hitchen, director of the Kenya Geological Survey, who has kindly sent the following note of its occurrence:

'The pale-green transparent felspar described in this note was found on the western slopes of a hill named Kioo, about 14 miles due north of Sultan Hamud station, Machakos district, Kenya Colony. From a description given by Messrs. D. Lyall and P. Cull, who found the mineral, it appears to have occurred in a small vein-like pegmatite sandwiched between parallel plates of decomposing mica. Towards the periphery of the enclosing mica plates the transparent felspar graded into opaque cream-coloured felspar of more normal appearance. The clear material was somewhat shattered and broke with many fragments on removal. The occurrence suggests a deuteric or possibly hydrothermal origin. Kyanite-gneisses occur in the vicinity.'

Two lots of specimens were presented, an earlier set in 1940 (registered number, B.M. 1940,27) and a later set in 1944 (B.M. 1944,140). It is necessary to separate the two groups, since both chemical and optical analyses indicate a perceptible difference in anorthite content. In hand-specimens the glassy appearance (sub-conchoidal fracture), perfect transparency, and pale-green colour of this plagioclase combine to give it an unusual appearance. The (001) cleavage is prominent, that parallel to (010) less so. Very few specimens show both cleavages. No macroscopic twinning could be seen.

The results of chemical analyses of a representative specimen from each group is given in table I. The empirical unit-cell contents have been derived from the analysis, the determined values of the specific gravity, and the cell constants by the method outlined by M. H. Hey.[1] Since the calculated number of oxygen atoms in each analysis closely

[1] M. H. Hey, On the presentation of chemical analyses of minerals. Min. Mag., 1939, vol. 25, pp. 402–412.

TABLE I. Chemical analyses.

(*a*) Albite-oligoclase (B.M. 1940,27) (Analyst: H. Tanssky.)

Analysis.		Atomic ratios.		Empirical unit-cell contents.[1]	
SiO_2	64·92	Si	1·0809	11·46	16·05
Al_2O_3	21·34	Al	0·4187	4·44	
Fe_2O_3(+FeO)	1·16	Fe	0·0145	0·15	
MgO	0·07	Mg	0·0017	0·02	4·00
BaO	0·008	Ba	0·0001	—	
CaO	2·18	Ca	0·0389	0·41	
Na_2O	10·15	Na	0·3274	3·47	
K_2O	0·44	K	0·0093	0·10	
H_2O+	0·09	Mn	0·0001		—
H_2O-	0·02	O	3·0208		32·03
MnO	0·006				
TiO_2	trace				
	100·38				

Sp. gr. (d_4^{20}) ... $2·631 \pm 0·010$
Molecular composition: Or 2·50, Ab 86·75, An 10·75 %.

(*b*) Oligoclase (B.M. 1944,140). (Analyst: M. H. Hey.)

Analysis.		Atomic ratios.		Empirical unit-cell contents.[1]	
SiO_2	64·10	Si	1·0670	11·35	16·10
Al_2O_3	22·66	Al	0·4446	4·73	
Fe_2O_3	0·14	Fe	0·0018	0·02	
FeO	0·17	Fe	0·0024	0·02	4·10
MgO	0·25	Mg	0·0062	0·06	
CaO	3·26	Ca	0·0582	0·62	
Na_2O	9·89	Na	·0·3190	3·39	
K_2O	0·05	K	0·0011	0·01	
H_2O+	0·17	O	3·0301		32·23
H_2O-	0·06				
TiO_2	*nil*				
MnO	nil				
	100·75				

Sp. gr. (d_4^{20}) ... $2·646 \pm 0·010$
(001) : (010) = 86° 15′
Molecular composition: Or 0·3, Ab 82·7, An 17·0 %

[1] Calculated from the determined values of sp. gr. together with the following cell constants: *a* 8·11, *b* 12·85, *c* 7·16 Å. (S. H. Chao and W. H. Taylor; Proc. Roy. Soc. London; Ser. A, 1938, vol. 176, p. 77. [M.A. 8–13.] α 93° 45′ (measured value), β 116° 23′, γ 90° 5′ (E. S. Dana, 6th edit. 1892, p. 314).

approaches the accepted total of 32 it has not been considered necessary to recalculate the analyses to this basis. The analyses show that the composition of the first specimen is that of an albite-oligoclase, while the later acquired plagioclase approaches a medium oligoclase. The potash content is small in both specimens. The analyses also demonstrate the absence of the carnegieite molecule.

Table II gives the results of the optical determinations for both felspars. Refractive indices were determined on polished surfaces with a previously calibrated Abbe-Pulfrich refractometer in sodium-light. Optic axial angle measurements and the relationship between the morphological and optical direction were determined on the universal microscope stage.

TABLE II. Optical data.

	Albite-oligoclase (B.M. 1940,27).	Oligoclase (B.M. 1944,140).
α	1·5314 (Na)	1·5351 (Na)
β	1·5355	1·5393
γ	1·5408	1·5437
2V	$82\frac{1}{2}(+)$	89(+)
α' : (001) on (010) cleavage flakes	—	$11\frac{1}{2}°$
α' : (010) on (001) cleavage flakes	—	$2\frac{1}{2}°$

Comparison of optical data with previously published results.—In fig. 1 the refractive indices of the two sodic plagioclases described in this note are compared with values obtained by earlier investigators.[1] The figure shows that the three values of both the oligoclase and the albite-oligoclase are lower than the mean of previous determinations by 0·0010 to 0·0016. The birefringences, however, are very close to those determined by Duparc and Reinhard. The values of the optic axial angles (obtained by direct measurement) are in almost exact agreement with those given by Duparc and Reinhard, Winchell, and by Köhler.[2]

Projection of morphological reference planes on migration curves.—Although several thin sections of each plagioclase were made, none of these sections showed both the (010) and (001) cleavage. The albite-oligoclase sections showed (010) cleavage traces, while the oligoclase

[1] A. Offret, Bull. Soc. Franç. Min., 1890, vol. 13, p. 654. C. Viola, Zeits. Kryst. Min., 1899, vol. 30, p. 438; 1900, vol. 32, p. 320. F. Becke, Tsch. Min. Petr. Mitt., 1901, vol. 20, p. 71. L. Duparc and M. Reinhard, Mém. Soc. Phys. Hist. Nat. Genève, 1924, vol. 40, p. 134 [M.A. 3–34]. A. N. Winchell, Elements of optical mineralogy, New York, 1933, pt. 2, p. 333. V. B. Meen, Univ. Toronto Studies, Geol. Ser., 1933, no. 35, p. 37 [M.A. 5–439.]

[2] A. Köhler, Tsch. Min. Petr. Mitt., 1941, vol. 53, p. 41. [M.A. 8–313.]

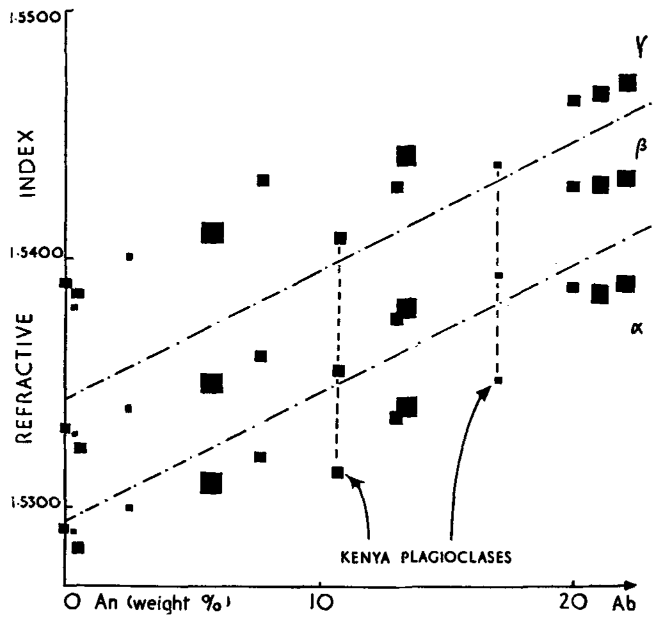

FIG. 1. Refractive index values for analysed albites and oligoclases. Sides of squares are proportional to percentages of orthoclase (0·3–4·0 %). [0·66 mm. = 1 % orthoclase.]

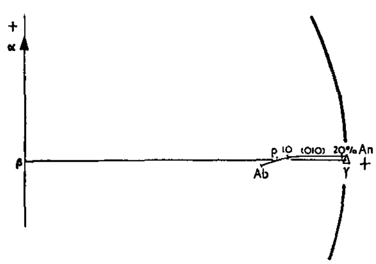

FIG. 2

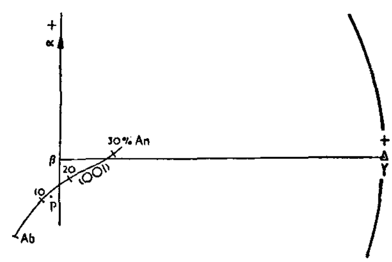

FIG. 3

FIG. 2. Albite-oligoclase (An 10·7 %). Position of pole of (010) cleavage in relation to migration curve of M. Reinhard.

FIG. 3. Oligoclase (An 17 %). Position of pole of (001) cleavage in relation to migration curve of M. Reinhard.

showed (001) traces. The relationship of the poles of these morphological directions to the indicatrix was determined on the stage. The indicatrix axes were then transposed to bring β to the centre in each instance. The resulting plots were then superimposed on a Reinhard[1] stereogram (20 cm. diameter) in order to compare the positions of the poles (P) of (010) and (001) relative to the appropriate migration curves. Figs. 2 and 3 show these positions. It will be seen that in the case of the albite-oligoclase, the pole of (010) lies practically on the (010) migration curve, and that its position on the curve corresponds to an anorthite content of about 7%. The (001) pole of the oligoclase falls 1 mm. (on the 20 cm. scale) from the corresponding migration curve, and the indicated anorthite content is about 13 %.

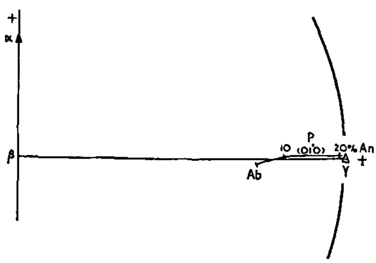

Fig. 4

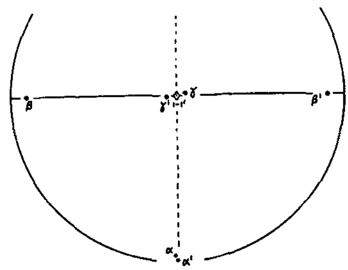

Fig. 5

Fig. 4. Oligoclase (17 %). Position of pole of composition-plane (010) in relation to migration curve of M. Reinhard.

Fig. 5. Oligoclase. Stereogram of twinned individuals with the pole of the composition-plane at centre. The dotted line indicates a possible symmetry-plane.

Very few sections of either plagioclase showed any twinning. In the exceptional instances one set of twin-lamellae was invariably extremely fine (the widest was only 0·027 mm.). The difficulties of obtaining the optical reference directions in these fine lamellae were further increased by the fact that these directions closely approached the corresponding ones in the remainder of the plagioclase (the wide lamellae) and tended, therefore, to be obscured by them when trying to orient the principal optic planes.

For these reasons it was not possible to determine the twin system with certainty. But, by transposal of the plotted poles of the wide lamellae, bringing β to the centre, the transposed pole of the composition-plane was found on the 20 cm. net to lie 3 mm. above the (010) migration curve at a point indicating an anorthite content of An 15 %. Fig. 4 shows the position of this pole in relation to the curve. The composition-plane is, therefore (010).

[1] M. Reinhard, Universal Drehtischmethoden. Basel, 1931, pl. 2. [M.A. 4-435.]

Fig. 5 shows the stereogram of the twinned individuals; in this stereogram the poles have been transposed to bring the pole of the composition-plane to the centre of the projection. The composition-plane itself is thus the plane of projection. The disposition of the poles of individuals 1 (wide lamellae) and 1′ (fine lamellae) suggests the presence of a symmetry plane through α and α'. This indicates a parallel or complex twin. Confirmation of the existence of this type of twinning was obtained by measuring the extinctions of both twin-lamellae in the zone perpendicular to the composition-plane. The extinction angles measured with respect to this plane were unequal (i.e. asymmetrical); the twin-plane is, therefore, not coincident with the composition-plane, and the twinning is not normal.

Owing to the absence of morphological reference directions in the twinned sections it was not possible to determine the twin-law. All that can be said, therefore, is that the twinning is of the parallel or complex type and the composition plane is (010).