do not persist into the solid form of the compounds. Orthoclase and carnegieite can not be isomorphous with anorthite because the potassium atom of the one, and still more the two sodium atoms of the other, demand more space than displacement of the calcium can furnish. The simplest formulas adapted to bring out all the relations are: Albite, $NaAl(Si_3O_8)$; anorthite $CaAl(AlSi_2O_8)$.

AUGITE AND HORNBLENDE FROM KILIMANJARO

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In the present paper are described some crystals of augite and hornblende which were collected in 1920 by Mr. Scott, of the Universal Film Company, on "the southeast slope of Kilimanjaro." Dr. W. F. Foshag, of the U. S. National Museum, kindly gave them to us for study and we acknowledge with pleasure our indebtedness to him for the opportunity to add a little to our scanty knowledge of the mineralogy of East Africa.

Little is known in detail of the rocks of Kilimanjaro. According to Hyland,[1] who studied a collection of rocks made by Mayer in 1887, there occur basalt obsidian, limburgite, nephelite basalt, feldspar basalt, tephrite, nephelite basanite with "rhomb" feldspars, and leucite basanite (the first leucite rock to be described from Africa). According to Meyer, in 1900, as cited by Reed,[2] the lavas are chiefly leucitic; while Jaeger[2] reports rhomb prophyry as most abundant, with trachyandesite, trachydolerite, and recent phonolite. There can be no doubt that the lavas of Kilimanjaro in general are dominantly sodic and not very high in silica; and that they resemble those of Kenya and the other volcanoes of the Ethiopian Rift Valley, as described by Prior[3] and others.

Augite

The crystals of augite were evidently found loose in ash, but there is no information as to the kind of lava from which they come. They differ in some respects from those described by Becker,[4] which were also loose crystals. The form and size of our augite crystals are the usual form and size for such augites. They

[1] Hyland, J. S., *Tsch. Min. Pet. Mitth.*, **10**, 203, 1888.

[2] Reed, F. R. C., Geology of the British Empire, 1921, p. 75.

[3] Prior, G. T., *Min. Mag.*, **13**, 228, 1903.

[4] G. Becker, ref. in *Zeits. Kryst.*, **38**, 317, 1904.

are about 1 cm. long, and of the usual habit; bounded by the planes $a(100)$, $b(010)$, $m(110)$, and $s(\overline{1}11)$, with slight tabular development parallel to (100). They are jet black, with bright faces, and are wholly free from attached scoria. The density was not determined.

There is a distinct zonal structure, with differences of $2°$ in extinction angle and of 0.025 in the refractive index β. The lowest value of α found was 1.684, and the highest value of γ was 1.737; from which are estimated the average values: $\alpha = 1.69+$, $\beta = 1.70+$, and $\gamma = 1.72+$; $2V = $ about $60°$; $\gamma_r \wedge c = 43° - 45°$, and $\gamma_v \wedge c = 45° - 47°$. No axial dispersion was visible about the axis, A, therefore $2V_r$ must be about $4°$ greater than $2V_v$. For comparison with these figures the analyzed samples of several other augites were examined to determine the character of the dispersion, the variations of the refractive index β, and other optical properties not already recorded. These data and some others taken from previous descriptions are given in Table 1.

TABLE 1

	$\gamma^r \wedge c$		DISPERSION Axes	Bisectrices
Scano[a]	44°–46°	1.69–1.71		
Stromboli (1914)[b]	43°–45°	1.70–1.71		
Vesuvius (1914)[c]	46°–47°	1.70–1.71		
Etna (1669)[c]	48°–49°	1.71–1.71+	$2V_r > 2V_v$	$\gamma_r \wedge c < \gamma_v \wedge c$
Haleakala[d]	47°–48°	1.70+–1.71		
Kilimanjaro	43°–45°	1.70–1.72		

[a] Washington, H. S., *Jour. Geol.*, 22, 747, 1914.

[b] Kozu and Washington, *Amer. Jour. Sci.*, 45, 463, 1918.

[c] Washington and Merwin, *Amer. Jour. Sci.*, 1, 20, 1921.

[d] Washington and Merwin, *Amer. Jour. Sci.*, 3, 117, 1922.

A chemical analysis was made of the powder freed from the small amount of inclusions by repeated treatment with a powerful magnet. The results are given in Table 2, with an analysis of an augite from Kilimanjaro by Becker. Analyses of similar augites will be found in the papers cited above in connection with the optical characters.

The material of No. 1 was dried at $110°$; the manganese was determined colorimetrically. The analysis by Becker was carried out by a peculiar method in which silica was recovered from a precipitate by ammonia, ignited and fused with potassium bisulphate. As silica is notably soluble in this melted salt, his silica is

TABLE 2

ANALYSES OF KILIMANJARO AUGITE

	1	2
SiO_2	48.16	44.89
TiO_2	0.59	2.39
Al_2O_3	8.45	3.93
Fe_2O_3	2.86	2.72
FeO	3.55	10.54
MnO	0.10	n.d.
MgO	14.23	12.79
CaO	21.69	22.13
Na_2O	0.91	n.d.
K_2O	0.10	n.d.
H_2O+	0.15	0.11
	100.79	99.50

1. Augite from Southeast slope of Kilimanjaro. Washington analyst.

2. Augite from Kilimanjaro. G. Becker analyst. Ref. in *Zeit. Kryst.*, **38**, 317, 1904.

certainly low. Titanium was determined by the old and unreliable method of prolonged boiling with SO_2, which leads to serious plus or minus errors; the TiO_2 in No. 2 is, therefore, untrustworthy and presumably too high. The alkalies were not determined in Becker's analysis, which has little value, and which certainly does not justify the elaborate calculations of the molecular composition which he deduces from it.

The analysis of our augite is much like those of other augite crystals found loose at different volcanoes, some of which have been referred to above in discussing the optical characters. It is noteworthy that this chemical and optical resemblance holds despite very marked differences in the chemical characters of the magma or rocks from which the pyroxene is derived. Thus, the augite from Kilimanjaro is associated with decidedly sodic magma, as is that of Scano; those from Etna, Stromboli, and Haleakala with rather ordinary basaltic magmas; and that of Vesuvius with potassic leucite tephrite. It appears, also, that these augites differ, especially in their high content of diopside and low content of hedenbergite, from the common augite of the plateau basalts, such as those of the Deccan in India and the flows of the Columbia and Snake Rivers. These general relations will be discussed elsewhere.

HORNBLENDE

Only four crystals were available. They were about one centimeter long, stoutly prismatic, and of a usual habit; bounded by

the planes $b(010)$, $m(110)$, $p(\bar{1}01)$, and $r(011)$.[5]   They were velvet
black, with smooth, lustrous faces.   The specific gravity was found
to be 3.213 at 30°, but this is probably too low because of the
inclusions of glass.

Optically they are very homogeneous, with variations of about
± 0.002 from the following refractive indices: $a = 1.675$, $\beta = 1.691$,
$\gamma = 1.701$.   The extinction angle $\gamma \wedge c = 11°$ for violet and 12.5° for
red.   There is a scarcely noticeable pleochroism.   For comparison
with chemically similar hornblendes, there are given Ford's[6]
determinations on amphiboles analyzed by Stanley from Monte
Somma and from Bilin, Bohemia.   For the Monte Somma horn-
blende, the mean index $= 1.68$, extinction angle not given; for the
Bilin hornblende, the mean index $= 1.692$, extinction angle $\gamma \wedge c =$
$1°12'$ in the acute angle β.

The chemical analysis of the Kilimanjaro hornblende, after re-
moval of the glassy inclusions by treatment with the magnet, gave
the results of Table 3, two of Stanley's analyses being given for
comparison.

TABLE 3

	1	2	3
SiO_2	41.97	39.48	39.95
Al_2O_3	12.59	12.99	17.58
Fe_2O_3	4.69	7.25	7.25
FeO	5.80	10.73	2.18
MgO	14.20	11.47	14.15
CaO	11.99	12.01	11.96
Na_2O	3.17	1.70	3.16
K_2O	1.63	2.39	1.98
H_2O+	0.26	0.76	0.41
H_2O-	....	0.12	0.13
TiO_2	4.20	0.30	1.68
F	n.d.	0.05	0.03
MnO	n.d.	1.00	trace
	100.50	100.25	100.46
Sp. Gr.		3.283	3.226

1. Hornblende.   Southeast slope of Kilimanjaro.   Washington analyst.

2. Hornblende.   Monte Somma, Italy.   Stanley, analyst.   Penfield and Stanley,
Amer. Jour. Sci., **23**, 41, 1907.

3. Hornblende.   Bilin, Bohemia.   Stanley analyst.   Penfield and Stanley, *op.
cit.*, p. 47.

[5] Cf. Goldschmidt, Atlas der Krystallformen, **1**, Tafel 11, Figs. 6 and 7.

[6] W. E. Ford, *Am. J. Sci.*, **37**, 181 and 188, 1914.

In the analysis of the Kilimanjaro hornblende the small amount of material available precluded the determination of manganese and fluorine; but it is reasonable to suppose that the percentages of both are very low. The analysis is remarkable for the rather high percentages of soda and (especially) potash, and also for the rather high titanium, which was determined colorimetrically. The material was dried at 110°.

Stanley's analysis of the Monte Somma hornblende resembles that of Kilimanjaro in most respects, but ferrous oxide is higher, as is ferric oxide, and magnesia is lower, while soda is lower and potash higher. The extraordinarily high percentage of manganese oxide in Stanley's analysis is almost certainly too high; and the rocks and minerals of Vesuvius are not notably high in manganese, rather the contrary. The Bilin hornblende is similar in many of its chemical features, but the alumina is suspiciously high, the iron oxides are in inverse relation to those in the Kilimanjaro and other similar, well-analyzed hornblendes, while magnesia and lime, soda and potash are much as in the African hornblende. In both of the hornblendes analyzed by Stanley titanium is much lower than in that from Kilimanjaro, and the amount of fluorine is insignificant.

Penfield and Stanley discuss the structural composition of the hornblendes whose analyses are given in Table 3, along with those of others, but it is not necessary to do this here with that from Kilimanjaro. The three hornblendes come from volcanoes whose lavas are decidedly alkalic (in the case of Monte Somma potassic), and the high soda is thus interesting and significant of some relation between the magma and the composition of the hornblende of lavas, as contrasted with that of the augite, from the same volcano, as is illustrated by the analyses of augite and hornblende from Kilimanjaro and Vesuvius (Somma) given here. The point seems to be worthy of further study, when more appropriate analyses of suitable occurrences are available.

BOOK REVIEW

LEHRBUCH DER MINERALOGIE. PAUL NIGGLI. *Berlin W 35:* Gebrüder Borntraeger. Large 8vo., 694 pages. 1920.

This constitutes another book which has a somewhat misleading title. We usually think of a text-book of mineralogy as a book containing more or less introductory or explanatory matter and then descriptions of minerals; here the "introduction" makes up most of the book, and minerals as such are not described