there was an exothermic effect at a temperature near 760° C. which seemed to indicate a transformation of high-carnegieite structure into low-nepheline. At the same time, thermal gravitational analysis curve showed that this transformation was accompanied with a loss of a little amount of water, about 1%.

There may be three possible interpretations for this phenomenon; the one that the structure of decomposed kaolinite is inherited readily by high-carnegieite rather than nepheline, another that the water present in kaolinite has some effects on the phase relation and the other that impurities in kaolinite such as Fe_2O_3 and CaO, the total of which reaches about 2%, play some roles on the reaction process. With respect to impurities the following points were revealed by careful x-ray diffraction. In the original kaolinite some mica was detected which remained undestroyed up to 700° C. in the mixture with Na_2CO_3. In the specimen quenched from 700° C. additional peaks of low-carnegieite and other unidentified phases were recognized which, however, were quite slight as compared with the main peaks of the phase with the high-carnegieite structure. Details will be reported in a separate paper.

ACKNOWLEDGEMENT

REFERENCES

TUTTLE, O. F. AND J. V. SMITH (1957) *Am. Jour. Sci.* **255**, 282–305.
———— (1958) *Am. Jour. Sci.* **256**, 571–589.

SCANDIUM BORATE, ScBO₃

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Single-crystals of scandium borate have been grown from a barium borate flux. The sample was cooled slowly—30° C. per day—from 1160° to 850° C. Another run was cooled from 1170° to 740° C. at a rate of 20° C. per day.

The crystals are equant, up to one half millimeter in size. A study on the optical goniometer revealed trigonal symmetry; the most prominent

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forms are {10.4} and {01.2}; less developed are {11.0} and {00.1}. The crystals are optically uniaxial, negative. The indices of refraction are $\epsilon = 1.817$ and $\omega = 1.867$ ($\pm .002$). The density—3.38 g/cm^3—was determined with the Berman microbalance on a polycrystalline sample.

Precession photographs show reflections with $-h+k+l = 3n$ only. Reflections ($\bar{h}h.l$) with $l = 2n+1$ are absent. The space group is, therefore, $R3c$ or $R\bar{3}c$. The morphological study confirms $R\bar{3}c$. For the measurement of the lattice constants, the precession camera has been calibrated with a silicon crystal ($a = 5.43054$ Å). The following lattice constants have been obtained:

$$a_H = 4.759 \pm .005 c_H = 15.321 \pm .015 \text{ Å}; \frac{c}{a} = 3.219.$$

From these have been calculated $a_R = 5.799$ Å $\alpha_R = 48°25'$. The calculated density is 3.440 g/cm^3.

Scandium borate has been studied previously by Goldschmidt and Hauptmann (1932). They found from powder photographs $a_H = 4.757 \pm .010$, $c_H = 15.305 \pm .040$ (data converted to metric Ångstrom units). As their samples were always contaminated with Sc_2O_3 or B_2O_3, the density was found to vary between 3.34 and 3.50 g/cm^3.

Goldschmidt and Hauptmann have pointed out that the crystal structure of $ScBO_3$ is an analogue of the calcite structure. The new compounds $TiBO_3$, VBO_3, $CrBO_3$, recently described by Schmid (1964), have similar lattice geometry and probably analogous structure (Table 1). A further study of $ScBO_3$ is not intended.

TABLE 1.

Compound	a_H	c_H	a_R	α_R	Reference
$ScBO_3$	4.759	15.321	5.799	48°25′	Biedl
$TiBO_3$	4.670	14.90	5.65	48°48′	Schmid
VBO_3	4.573	14.32	5.453	49°24′	Schmid
$CrBO_3$	4.573	14.23	5.434	49°46′	Schmid
$CaCO_3$	4.9898	17.060	6.3748	46°05′	Strunz (1957)

REFERENCES

GOLDSCHMIDT, V. M. AND H. HAUPTMANN (1932) Nachr. Ges. Wiss. Göttingen, 1932, 53; Strukturbericht 2, 403.
SCHMID, H. (1964) Acta Cryst. 17, 1080.
STRUNZ, H. (1957) Mineralogische Tabellen. Akad. Verlagsgesellschaft, Leipzig.

OPTICAL PROPERTIES OF METAMORPHIC ALBITE

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Universal stage measurements on pure metamorphic albite suggest that Slemmons' (1962a,b) values for the position of the optical directions relative to the main crystallographic axes for An_0 should be modified

TABLE 1. CHEMICAL COMPOSITION AND OPTICAL PROPERTIES OF METAMORPHIC An_0.

	Measured	Stoichiometric	
SiO_2	68.6	68.73	$\alpha-1.5290$
Al_2O_3	19.4	19.44	$\beta-1.5335$
CaO	0.00	0.00	$\gamma-1.5395$
Na_2O	not meas.	11.83	$2V-77°\pm1°$
K_2O	0.02	0.00	

Ba, Cs, Rb, Sr—Not detected

Position of the optical directions (in degrees) X, Y, Z relative to $\perp$(010) and $\perp$(001)

	$\perp$(010)			$\perp$(001)		
	X	Y	Z	X	Y	Z
Measured	−88.5	72.0	18.0	−69.0	25.0	−76.5
Slemmons (Table 3)	−89.0	73.3	16.5	−68.4	25.5	−77.5

slightly, as the measured values consistently lie off Slemmons' published curves (Plate 2, 1962a; Fig. 4, 1962b). Table 1 lists the chemical composition and optical properties of fully ordered albite $[2\theta(131)-2\theta(1\bar{3}1) = 1.07°$; Slemmons, 1962b] collected from a vein in glaucophane schist on Tiburon Peninsula, Marin County, California. A comparison of this albite with those used by Slemmons shows that it is unusually pure and, in contrast to many pegmatite albites, the K_2O content is negligible. The chemical analysis was made with an ARL EMX electron probe microanalyzer by measuring Si, Al, Ca, K and Ba; and scanning for Cs, Rb and Sr. By comparing the measured values with those of stoichiometric pure albite it was assumed that the difference represents Na and O. The refractive indices were determined by the double variation method (Emmons, 1943). The values reported for the universal stage measurements were determined on grains showing albite twins in sections cut parallel to {001} and {010} and represent the average of eight measurements. They clearly indicate a slight but definite departure from the

values listed by Slemmons (Table 3, 1962a). It seems most probable that the difference between the values listed here and those reported by Slemmons reflect the greater purity and high degree of ordering of albite formed in a relatively low temperature metamorphic environment and that these values are characteristic of metamorphic An_o.

REFERENCES

EMMONS, R. C. (1943) The Universal Stage. *Geol. Soc. Am. Mem.* **8.**
SLEMMONS, D. B. (1962a) Determination of volcanic and plutonic plagioclases using a three- or four-axis universal stage. *Geol. Soc. Am. Spec. Paper* **69.**
———— (1962b) Observations on order-disorder relations of natural plagioclase: 1. A method of evaluating order-disorder. *Norsk Geol. Tidsskr.* **42**(2), 533–554.

DIMENSIONAL AND COMPOSITIONAL CONTROL OF GARNET GROWTH BY MINERALOGICAL ENVIRONMENT

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OCCURRENCE AND CRYSTAL MORPHOLOGY OF GARNET

During the course of a geochemical study of the Kiawa pegmatite group, Las Tablas Quadrangle, Rio Arriba County, New Mexico (Gresens, 1964), attention was called to the dual nature of the occurrence of spessartite garnet in the pegmatites. Large irregular anhedral spessartite masses (10 cm or more in diameter) are present in albite concentrations. These masses are weak and commonly crumble when handled. Smaller (1 cm or less) clear euhedral tablets are found within large muscovite books. These crystals are "flattened" in the *c*-axis direction of the muscovite crystals and are hard with no tendency to crumble. Jahns (1946) noted these relationships in an earlier study. The "flattened" garnets show dodecahedral faces. These faces are commonly distorted, that is, the polygonal outline of the face does not have the perfect bilateral symmetry of the polygonal face of a perfect dodecahedron. The large "flattened" face is not necessarily a dodecahedral face. (The angle between the "flattened" face and an adjacent face is usually not the dodecahedral angle.) It seems instead to be merely the termination of the garnet against the muscovite layer structure, truncating the dodecahedral faces.

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