THE OPTIC PROPERTIES OF SEIGNETTE AND RELATED SALTS

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For more than a century the optic properties of Seignette salts have attracted attention; but, nevertheless, they are still imperfectly known. Herschell[1] described the strong dispersion of sodium-potassium tartrate tetrahydrate (Seignette or Rochelle salt) as early as 1829. Senarmont[2] studied the properties of the ammonium-potassium series of tartrates in 1851. Des Cloizeaux[3] measured the optic angle and refractive indices of Seignette salt in red and yellow light in 1858. Muttrich[4] made similar measures in red light at 16° and 45°C in 1864. Wyrouboff[5] measured ammonium Seignette salt in 1884. Lavenir[6] repeated these measures on potassium Seignette salt in sodium light in 1894. Bacuvier[7] repeated such measures on both potassium and ammonium Seignette salts and also on seven different proportions of mix-crystals in 1922. Buckley[8] studied the dispersion of Seignette and related salts in many kinds of pure and mix-crystals. Recently, Kozik[9] has studied the optic properties of sodium-rubidium tartrate and also of mix crystals of sodium-ammonium and sodium-rubidium tartrates.

In view of all these studies it is fair to ask why the subject should be investigated farther. The answer is that previous investigators have made no attempts to correlate their results, particularly in the form of graphs. Such correlations bring out certain imperfections in the data and lead to conclusions of interest.

The series from sodium-potassium tartrate (Seignette salt proper or potash Seignette salt) to sodium-ammonium tartrate (ammonium Seignette salt) has been studied most fully in the past. Published data showing the relations between optic properties and composition are assembled in Fig. 1. The indices of refraction as measured by Bacuvier require optic angles as follows, as compared with the measured optic angles:

[1] *Edinburgh Jour. Sci.*, vol. **10,** p. 296, 1829.
[2] *Ann. Chem. Phys.*, vol. **33,** pp. 416, 429, 1851.
[3] *Ann. Mines,* vol. **11,** p. 321, 1857; vol. **14,** p. 367, 1858. Also Seve, *Jour. Phys.*, Series VI, vol. **I,** p. 176, 1920.
[4] *Ann. Phys.*, vol. **121,** p. 193, 1864.
[5] *Bull. Soc. Fr. Min.*, vol. **7,** p. 8, 1884.
[6] *Bull. Soc. Fr. Min.*, vol. **17,** p. 153, 1894.
[7] *Bull. Soc. Fr. Min.*, vol. **45,** p. 73, 1922.
[8] *Mineral. Mag.*, vol. **20,** p. 159, 1924; and vol. **21,** p. 55, 1926.
[9] *Bull. Int. Acad. Polon. Sci. Varsovie,* A., p. 229, **1927,** and p. 247, **1931.**

%NH_4	17	27	30	36	52	72	76
%K	83	73	70	64	48	28	24
$2V$ over X (calc.)	86°	84°	93°	87°	84°	72°	76°
$2V$ over X (meas.)	64°	50° 40′	44° 25′	5°	40°	48°	50° 40′

The diagram indicates that the measurements of the optic angle are much more accurate than the measurements of the indices.

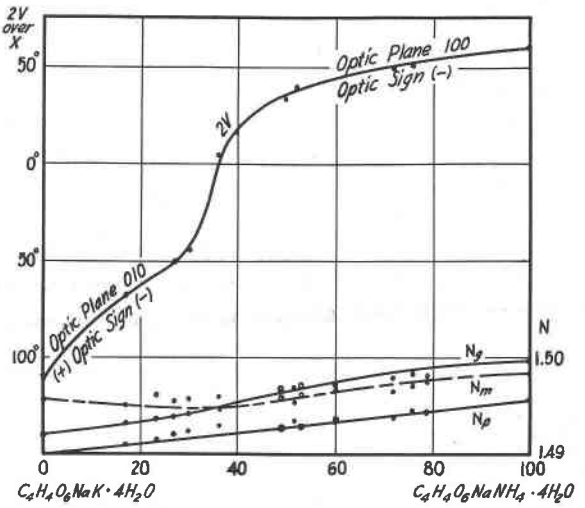

FIG. 1. Variations of optic properties for $\lambda = 589$ in Seignette salts. Data of L. Bacuvier: (•) *Bull. Soc. Fr. Min.*, vol. **45,** p. 73, 1922; and H. E. Buckley: *Mineral. Mag.*, vol. **20,** p. 159, 1924, and vol. **21,** p. 55, 1926; and A. Lavenir: (°) *Bull. Soc. Fr. Min.*, vol. **17,** p. 153, 1894.

The indices of refraction as measured by Lavenir require optic angles as follows as compared with the optic angles derived from the diagram (Fig. 1):

%NH_4	23	47	53	60	79
%K	77	53	47	40	21
$2V$ over X (calc.)	86°	67°	38°	46°	27°
$2V$ over X (diagram)	57°	33°	40°	45°	53°

Two of these check very well, but the others do not, although the measures of N_p seem to be exceptionally accurate.

The optic angle has been measured by Buckley in three intermediate types of the series from sodium-ammonium tartrate to potassium-ammonium tartrate; the simple variation in the series is shown in Fig. 2.

In the series from potassium-ammonium tartrate to sodium-potassium tartrate (also measured by Buckley) the variations in the optic angle are much greater; the optic angle varies through 0° (with change in the

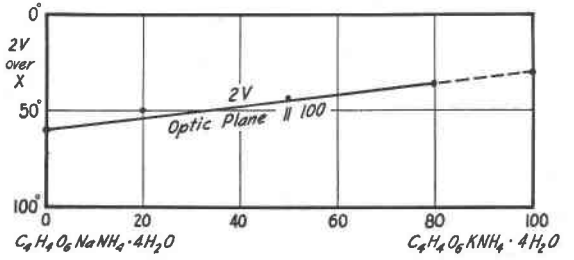

FIG. 2. Variations of optic angle for $\lambda = 578$ in sodium-ammonium to potassium-ammonium tartrates. Data of H. E. Buckley: *Mineral. Mag.*, vol. **21,** p. 55, 1926.

position of the optic plane) and also through 90° (with change in the optic sign), as shown in Fig. 3.

Variations in the optic sign, optic angle, and position of the optic plane in the entire ternary system, NaK-$NaNH_4$-KNH_4 tartrates, are shown

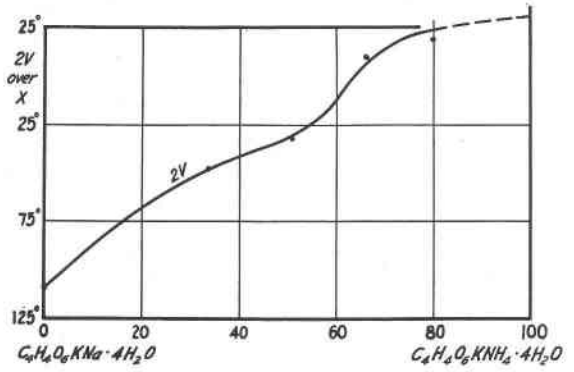

FIG. 3. Variations of optic angle for $\lambda = 578$ in potassium-sodium to potassium-ammonium tartrates. Data of H. E. Buckley: *Mineral. Mag.*, vol. **21,** p. 55, 1926.

in Fig. 4. This diagram is based entirely on the three binary series; no data are available for points inside of the triangle.

Buckley also shows that $NaNH_4$ and Na_2 tartrates form a series, the variation of the optic angle in which is shown in Fig. 5.

In a similar series from $NaNH_4$ to $(NH_4)_2$ the optic angle varies as shown in Fig. 6.

Kozik has studied the series of tartrates from sodium-ammonium to sodium-rubidium; he measured the optic angle and also the refractive indices of the pure salt and also of four intermediate types. His results

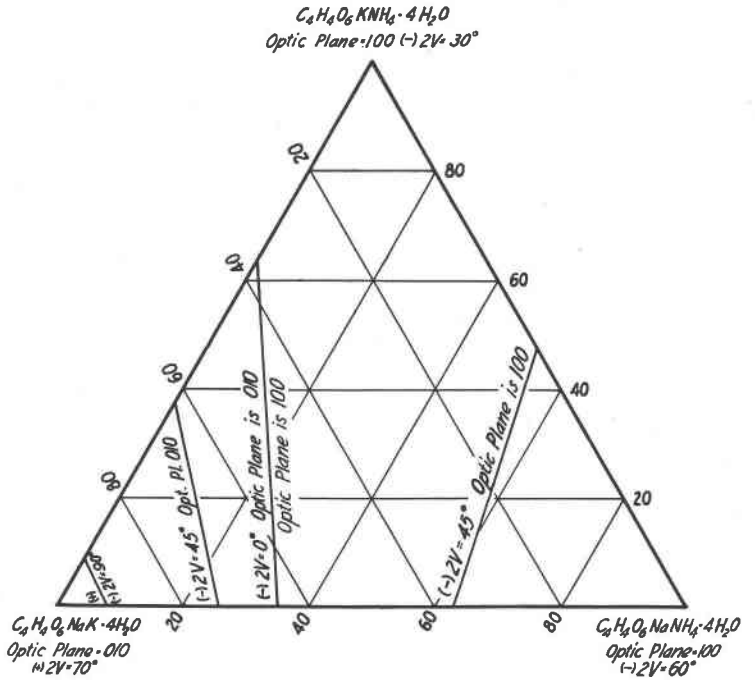

FIG. 4. Variations of optic angle, sign, and optic plane for $\lambda = 578$ in the KNH_4—NaK —$NaNH_4$ system of tartrates. Data of H. E. Buckley: *Mineral. Mag.* vol. 21, p. 55, 1926.

are shown graphically in Fig. 7, which is consistent with the work of others except for the measures for N_p, which cause an unexplained break in that curve.

The data of Kozik on the NaRb to $NaNH_4$ series permit the preparation of sketch of the entire NaRb-$NaNH_4$-NaK ternary system, shown in Fig. 8. Data for the NaRb-NaK series and also for all points inside the triangle are not available, but the differences between this ternary system and the one shown in Fig. 4 are very distinct.

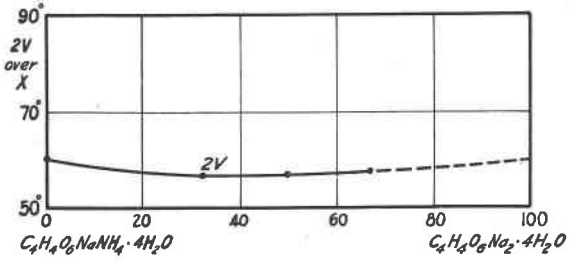

FIG. 5. Optic angle for $\lambda = 578$ in sodium to sodium-ammonium series of tartrates. Data of H. E. Buckley: *Mineral. Mag.*, vol. **21,** p. 55, 1926.

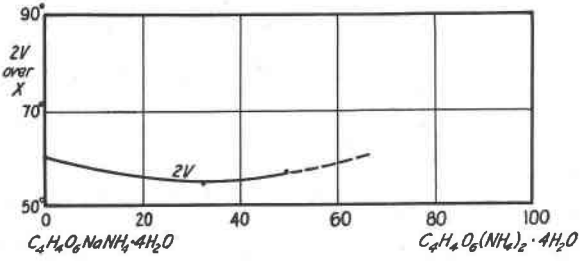

FIG. 6. Optic angle for $\lambda = 578$ in ammonium to sodium-ammonium series of tartrates. Data of H. E. Buckley: *Mineral. Mag.*, vol. **21,** p. 55, 1926.

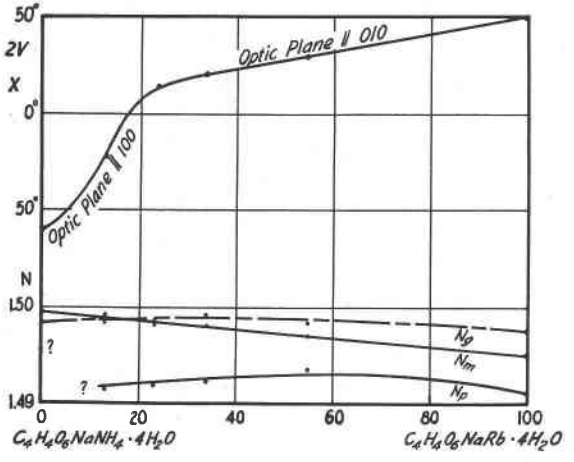

FIG. 7. Variations in the optic properties in sodium light in sodium-ammonium to sodium-rubidium tartrate. Data S. Kozik: *Bull. Int. Acad. Polon. Sci. Lit., A,* p. 229, **1927,** and p. 247, **1931.**

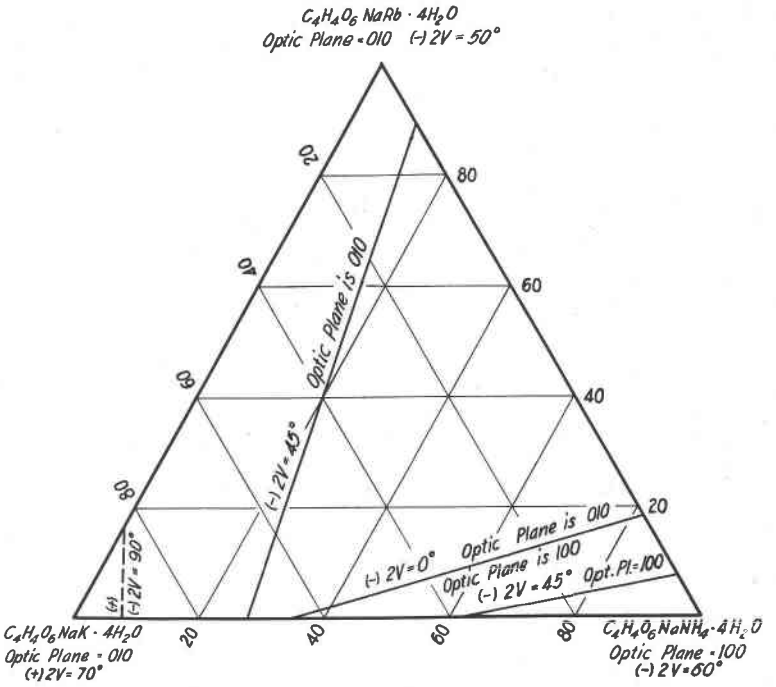

FIG. 8. Variations of optic angle, sign, and optic plane in the NaK—$NaNH_4$—NaRb system of tartrates. Data of H. C. Buckley: *Mineral. Mag.*, vol. **21,** p. 55, **1926,** and S. Kozik: *Bull. Int. Acad. Polon. Sci. Lit. I, A*, p. 247, **1931.**