parallel light at this position. It may often be easier to remove the lower polarizer and to substitute an external polarizer and the quartz plate somewhere in the light train where the light can be nearly parallel.

For photomicrography, an equivalent display on color film can be obtained without the quartz plates by making a triple exposure, with the polarizer and analyzer rotated together through 30° between exposures and with one tricolor filter in place during each exposure. The only difficulty is finding an analyzer that can be rotated without shifting the image out of register. Several models of microscopes with rotatable analyzers have been examined, and varying degrees of image shift were found. A large rotatable sheet of Polaroid immediately in front of the film contributes very little shift in the image positions. Figure 2 is a photomicrograph taken using this technique.

AN *X*-RAY STUDY OF SURSASSITE FROM NEW BRUNSWICK[1]

R. L. FREED, *Department of Geology and Mineralogy, The University of Michigan, Ann Arbor, Michigan.*

INTRODUCTION

The geology and mineralogy of sursassite from New Brunswick have been described by Heinrich (1962). Sursassite from the only other known locality, Oberhalbstein, Graubünden, Switzerland, has been analyzed chemically by Müller (1916), Jakob (1926, 1931, 1933), and de Quervain (Jakob: 1931, 1933). Various chemical formulae have been proposed for sursassite and these are listed in Table 1. Heinrich (1962) presents *x*-ray powder-diffraction data of both the New Brunswick and Swiss materials, and a chemical analysis of the sursassite from New Brunswick. Geiger (1948) gives *x*-ray powder-diffraction data of the Swiss material. He also determined a value of 3.2 Å for the fiber, or *b*-axis, translation.

TABLE 1. PROPOSED SURSASSITE FORMULAE

1. $5SiO_2 \cdot 2Al_2O_3 \cdot 5MnO \cdot 3H_2O$ +ca. 1.80 mol. % excess SiO_2	(Jakob, 1926)
2. $21SiO_2 \cdot 8Al_2O_3 \cdot 20MnO \cdot 12H_2O$	(Jakob, 1931)
3. $(Si, Al)_3(Al, Mg, Fe, Mn)_3(Ca, Mn, Na, K)_2(O, OH)_{13.5}$	(Geiger, 1948)
4. $MgMn_4Al_4Si_5O_{20}(OH)_2 2H_2O$?	(Winchell & Winchell, 1951)
5. $Mn_5Al_4Si_5O_{21} \cdot 3H_2O$	(Hey, 1955)
6. $(Mn \ldots)_3Al_2(SiO_4)_3 \cdot 2H_2O$	(Strunz, 1957)
7. $Mn_9Al_4(Si, Al)_{12}O_{39} \cdot 6H_2O$	(Heinrich, 1962)

[1] Contribution No. 257, from the Mineralogical Laboratory, Dept. of Geology and Mineralogy, The University of Michigan.
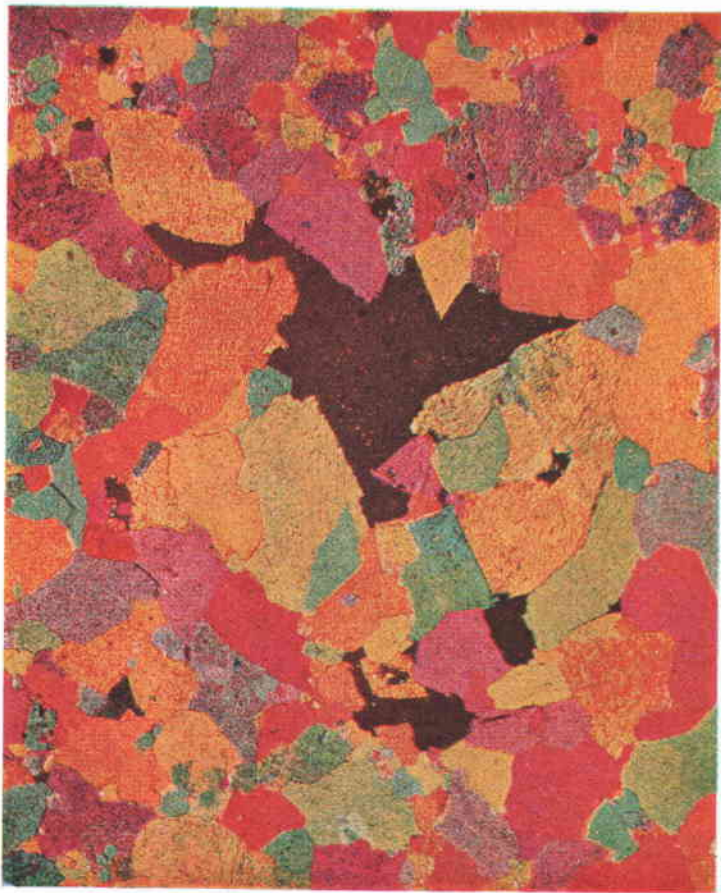
FIG. 2. Triple exposure made through tricolor filters with the polarizers crossed and rotated 30° between exposures. The thin section is from the dolomitized D-3 reef, Rimby field, Alberta (Hudson Bay Rimby 26-A-3, 7782 feet).

TABLE 2. X-RAY POWDER-DIFFRACTION DATA, SURSASSITE, PLYMOUTH ORE BODY, WOODSTOCK, NEW BRUNSWICK

$P2_1$ or $P2_1/m$, $a = 8.82$ Å, $b = 5.84$ Å, $c = 9.71$ Å, $\beta = 108°24'$ CuKα (Ni filter), $\lambda = 1.5418$; Camera diameter 114.59 mm

hkl	d(calc.)	d(obs.)	I	hkl	d(calc.)	d(obs.)	I
002	4.606	4.6	3	$\bar{4}$02	2.182	2.18	6
$\bar{2}$02	3.740	3.7	6	$\bar{4}$11	2.055	2.05	2
210	3.401	3.4	3	$\bar{4}$14	1.781	1.78	2
020	2.919	2.9	10	412	1.643	1.64	2
202	2.702	2.7	7	$\bar{4}$24	1.575	1.575	2
121	2.568	2.6	7	006	1.536	1.537	2
220	2.394	2.39	3	040	1.460	1.459	2
$\bar{2}$22	2.301	2.29	2	plus 6 additional weak lines			

X-RAY ANALYSIS

The New Brunswick sursassite was investigated by both powder-diffraction and single crystal methods. The single crystal work was carried out on small cleavage fragments with one well developed direction of cleavage.

The diffraction symbol, as determined from precession and Weissenberg photographs, is $2/mP2_1/-$. Thus the space group is $P2_1/m$ or $P2_1$. Unit cell parameters are presented in Table 3, and data for an indexed powder-diffraction pattern in Table 2. Precession photographs indicate that the cleavage plane is parallel to (101).

The similarity of sursassite and piedmontite was mentioned by Heinrich (1962). A routine check of piedmontite from Piedmont, Italy, shows some similarities of the crystallographic parameters of sursassite and piedmontite. Weissenberg b-axis photographs of each were not similar however. The calculated parameters of the piedmontite unit cell compare favorably to those for epidote (Ito *et al.*, 1954), while the values of a and c are considerably different than the values obtained by Ödman

TABLE 3. COMPARISON OF UNIT CELL PARAMETERS OF PIEDMONTITE, EPIDOTE AND SURSASSITE

	Piedmontite Ödman (1950)	Piedmontite this paper	Epidote, Ito *et al.* (1954)	Sursassite this paper
a	8.05 Å	8.83 ± .03 Å	8.98 Å	8.82 ± .03 Å
b	5.70 Å	5.71 ± .02 Å	5.64 Å	5.84 ± .02 Å
c	9.41 Å	10.35 ± .04 Å	10.22 Å	9.71 ± .04 Å
β	115.7°	115.1 ± .5°	115.4°	108.4 ± .5°

TABLE 4. COMPARISON OF CELL CONTENT OF SURSASSITE FROM NEW BRUNSWICK
AND SWITZERLAND

Sp. Gr.[1]=3.256; Vol.=474.58 Å³; Cell mass=930.86 at. wt. units

	New Brunswick[2]		Switzerland[3]	
	Metal atoms/cell	Oxygen atoms/cell	Metal atoms/cell	Oxygen atoms/cell
SiO₂	6.11	12.22	5.38	10.76
TiO₂	—	—	0.02	0.04
Al₂O₃	3.42	5.13	4.18	6.27
FeO[4]	0.45	0.45	0.27	0.27
MnO	3.50	3.50	3.86	3.86
MgO	0.61	0.61	0.64	0.64
CaO	0.33	0.33	0.38	0.38
Na₂O	0.06	0.03	0.04	0.02
K₂O	—	—	0.04	0.02
(H₂O⁺)	(6.92)	(3.46)	(6.00)	(3.00)
H₂O⁻	—	—	—	—
sum[5]	14.48	22.27	14.81	22.26

[1] Heinrich (1962).
[2] Analysis by Wiik (Heinrich, 1962).
[3] Analysis by de Quervain (Jakob, 1931).
[4] All iron considered divalent.
[5] Omitting H₂O.

(1950). This and the similarity of chemical formulae (Ödman, 1950) confirms that piedmontite is a manganese-rich member of the epidote group. The unit cell parameters for piedmontite (Ödman, 1950; this paper) are compared to those for epidote (Ito *et al.*, 1954) and sursassite (this paper) in Table 3.

CHEMISTRY

The numbers of metal and oxygen atoms per unit cell for both Swiss and New Brunswick materials are listed in Table 4. These values were calculated from the chemical analyses cited in Heinrich (1962) and Jakob (1931).

Space groups $P2_1/m$ and $P2_1$ have equipoints of rank 2 and 4 and 2, respectively. The total number of cations per cell (Table 4) do not conform to these ranks. For this reason, and because the available cations are well known to enter into solid solution series, a precise formula must await a structure analysis. However, it appears likely that there is at least partial solid solution between Si and Al. The water content is

assumed to be present as hydroxyl ion inasmuch as DTA and TGA results indicate only a single loss of a constituent at approximately 785° C.

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COEXISTING ALBITE AND OLIGOCLASE IN SOME SCHISTS FROM NEW ZEALAND

B. W. Evans, *Department of Geology and Geophysis, University of California, Berkeley.*

Introduction

A question of considerable concern to many petrographers using the universal stage for the determination of plagioclase compositions is the extent to which the scatter of stereo-measurements may be attributed to real variations of composition within the rock slice. Since the newly