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Three-layer monoclinic lepidolite from Tørdal, Norway

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Abstract

A 3-layer monoclinic lepidolite from a pegmatite at Tørdal, Norway, previously described as 2-layer orthorhombic, has been identified as the $3M_2$ polytype. The space group is $C2$ with a = 5.239(2), b = 9.070(3), c = 29.886(5) A, and β = 92.58(2)°. The X-ray powder pattern differs in detail from those of the conventional mica polytypes. Electron microprobe analysis gives SiO_2 48.78, Al_2O_3 23.87, FeO 1.39, MgO 0.02, MnO 4.61, TiO_2 0.07, K_2O 9.88, Na_2O 0.20, BaO 0.03, F 6.21 weight percent for the $3M_2$ flakes and SiO_2 53.41, Al_2O_3 21.43, FeO 0.06, MgO 0.02, MnO 1.82, TiO_2 0.06, K_2O 9.85, Na_2O 0.19, BaO 0.03, F 7.63 weight percent for associated $2M_1$ lepidolite flakes.

Heinrich *et al.* (1953) described a 3-layer monoclinic lepidolite from a pegmatite at Skuleboda, Sweden. Neumann *et al.* (1957) and Christie (1961) have described other lepidolite specimens from pegmatites at Varuträsk, Sweden, and Tørdal, Norway, that give X-ray powder patterns similar to that of the Skuleboda specimen. This note reports a more detailed study of the Tørdal material.

Single-crystal X-ray precession photographs of over 50 individual flakes of lepidolite from Tørdal showed three polytypic structures to be present—$1M$, $2M_1$, and $3M$. The $3M$ flakes represent the same material that was originally described as 2-layer orthorhombic by Christie (1961).

The $3M$ lepidolite has diffraction symmetry that could be described as $C2/m$, $C2$, or Cm. Single-crystal intensities were collected on an automated Syntex diffractometer and used for comparison with intensities calculated from the six possible 3-layer stacking sequences. Good agreement was found for only one model, which has ideal symmetry $C2$. Relative to a fixed initial set of axes, the intralayer shifts of $a/3$ in this model are directed in the sequence $-X_1$, $+X_2$, and $-X_3$ within the three successive layers. The resultant shift then is $a/3$ along $-X_2$ of the initial axes to give an ideal β angle of 93.4°.

The structure deduced above is identical to the ideal structure described as $3M_2$ by Ross *et al.* (1966) in their systematic study of possible mica polytypes. Comparison of Weissenberg photographs of the Tørdal specimen with those illustrated by Heinrich *et al.* (1953, Figs. 10–12) indicates that the latter specimens also have the $3M_2$ structure.

Table 1 lists the powder pattern of a pure sample of lepidolite-$3M_2$ from Tørdal. Indexing was achieved by direct comparison of the powder data with observed single-crystal intensities. The pattern differs in detail from those of the conventional mica structures and is characterized by the occurrence of several nonoverlapping triplets of indices $\bar{1}1l$, $02l$, and $11l$. Least-squares refinement of the powder data gave cell dimensions a = 5.239(2), b = 9.070(3), c = 29.886(5) A, and β = 92.58(2)°.

Table 2 lists electron microprobe analyses of flakes of $3M_2$ and $2M_1$ lepidolite from Tørdal. Although this method does not give Li or OH, the high F-contents and the individual oxide totals are characteristic of lepidolite. The $3M_2$ flake has less SiO_2 than the $2M_1$ flake but higher Al_2O_3, MnO, and Fe (expressed as FeO) contents. The Li_2O contents must be approximately 4 to 5 weight percent for each flake,

Table 1. Indexed powder pattern of Tørdal lepidolite-$3M_2$

hkl	Int.	d(obs)	d(calc)
003	80	9.97 Å	9.952 Å
006	20	4.988	4.976
021	60	4.488	4.484
111			4.456
$\bar{1}14$	5	3.940	3.943
024	7	3.877	3.876
114	10	3.809	3.809
025	7	3.614	3.611
115	30	3.544	3.545
$\bar{1}16$	2	3.419	3.418
026	70 B	3.350	3.352
009		3.314	3.317
$\bar{1}17$	35	3.171	3.169
027	15	3.112	3.107
117	5	3.044	3.048
$\bar{1}18$	20	2.939	2.938
028	20	2.883	2.882
118	23	2.827	2.828
$\bar{1}19$	2	2.728	2.728
029	5	2.679	2.677
131	100	2.595	2.603
$\bar{2}02$			2.598
201			2.597
$\bar{1}32$			2.589
$\bar{2}03$	10 B	2.550	2.559
202			2.558
$\bar{1}33$			2.546
$\bar{1}1.10$			2.539
00.12	7	2.488	2.488
134	15 B	2.447	2.453
$\bar{2}05$			2.437
204	15 B	2.425	2.435
$\bar{1}35$			2.418
135	5 B	2.364	2.378
$\bar{2}06$			2.360
205	5 B	2.349	2.358
$\bar{1}36$			2.339
136	2	2.293	2.296
$\bar{2}07$	15	2.267	2.277
040			2.268
220			2.267
$\bar{2}23$	5	2.228	2.229
223	4	2.189	2.192
$\bar{2}07$			2.187
$\bar{1}38$	7	2.167	2.166
138	2	2.123	2.121
045			2.120
$\bar{2}09$	13 B	2.096	2.101
208			2.099
$\bar{2}26$			2.094
$\bar{1}39$	9 B	2.078	2.078
046			2.063
139	10	2.033	2.033
00.15	35	1.989	1.990
229	2	1.839	1.838
13.13	12	1.709	1.707
$\bar{2}0.14$	7	1.690	1.691
20.13			1.689
$\bar{1}3.14$	12	1.672	1.672
155	8 B	1.640	1.641
$\bar{2}46$		1.635	1.635
20.14	2	1.615	1.618
246	12	1.601	1.606
$\bar{1}3.15$			1.602
$\bar{1}57$			1.599
247	5	1.568	1.574
13.15			1.567
$\bar{1}58$			1.566
$\bar{2}0.16$	5	1.552	1.553
158			1.549
$\bar{3}31$	60	1.513	1.512
060			1.512
332	9	1.496	1.498
$\bar{1}5.10$			1.496
063			1.495
$\bar{2}4.11$	2	1.467	1.469
04.16	2	1.440	1.441
$\bar{1}3.18$	7	1.416	1.416
$\bar{2}2.17$			1.415
11.20	2	1.402	1.402
04.17	5	1.387	1.388
13.18			1.387
$\bar{2}0.19$	2	1.375	1.375
$\bar{2}2.18$	5	1.362	1.364
$\bar{1}3.19$			1.361
04.18	10	1.336	1.339
13.19			1.334
$\bar{2}0.20$	2	1.322	1.323
22.18	25 B	1.309	1.314
$\bar{1}3.20$			1.310
$\bar{2}61$			1.309
260			1.309
400			1.308
$\bar{2}62$			1.307
261			1.306
$\bar{4}03$			1.305
06.12	8 B	1.287	1.292
$\bar{3}3.13$			1.286
$\bar{2}67$	3	1.259	1.259
$\bar{2}68$	7	1.244	1.244
00.24			1.244
424	3 B	1.228	1.231
$\bar{3}56$			1.229
175			1.228
$\bar{2}2.21$			1.226
$\bar{1}76$			1.222
355			1.222
$\bar{1}77$	3 B	1.207	1.210
06.15			1.204

Pattern taken with CuKα radiation in 114.59 mm diameter camera. Intensities estimated visually. D-values calculated on basis of a = 5.239, b = 9.070, c = 29.886 Å, and β = 92.58°.

but lower for the $3M_2$ flake than for the $2M_1$ flake, as based on the observed F contents and oxide sums.

Table 2. Electron microprobe analyses of Tørdal lepidolites

	$3M_2$	$2M_1$
SiO_2	48.78 wt. %	53.41 wt. %
Al_2O_3	23.87	21.43
FeO	1.39	0.06
MgO	0.02	0.02
MnO	4.61	1.82
TiO_2	0.07	0.06
K_2O	9.88	9.85
Na_2O	0.20	0.19
BaO	0.03	0.03
F	6.21	7.63
Sums	95.06	94.50

Analyses run on ARL microprobe with an accelerating potential of 15 KV. The correction procedure devised by Bence and Albee (1968) has been followed, with incorporation of the alpha factors of Albee and Ray (1970).

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