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Karlite, $Mg_7(BO_3)_3(OH,Cl)_5$ a new borate mineral and associated ludwigite from the Eastern Alps

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Abstract

Karlite, a new borate mineral with the idealized formula $Mg_7(BO_3)_3(OH,Cl)_5$ occurs in a clinohumite-chlorite marble associated with ludwigite at Schlegeistal, Zillertaler Alpen, Austria. The mineral is white to light green and has a silky luster. It occurs as aggregates of minute needles and prisms elongated parallel to *c*, as much as 10 mm long, which sometimes have rosette-like forms. Karlite is biaxial negative with a mean $2V$ of 24°, $\alpha = 1.589$, $\beta = 1.632$, $\gamma = 1.634$, $\gamma - \alpha = 0.045$, X = *c*, Y = *b*, Z = *a*; and is colorless in thin section. The (001) cleavage is perfect. The two most common forms are {110} and {100}. Hardness is 5.5. Streak is colorless.

Karlite is orthorhombic, $P2_12_12_1$, with $a = 17.929(5)$, $b = 17.600(5)$, $c = 3.102(1)$Å, $Z = 4$, $G_{calc} = 3.02$, $G_{meas} = 2.80$ to 2.85. The six strongest lines of the X-ray pattern (*d*, in Å, intensity, *hkl*) are 2.21,100,810,740,441; 2.83,92,620;2.25,87,251; 2.78,82,260,221,540; 12.53,76,110; and 2.89, 68, 160,221,121. IR spectra indicate that water is present as (OH) only. DTA shows only one strong nonreversible endotherm at 830°C. Melting occurs at 1345°C.

Combined microprobe, thermogravimetric and wet chemical analysis yielded SiO_2 0.02, $TiO_2 < 0.01$, B_2O_3 22.92, Al_2O_3 2.96, $Cr_2O_3 < 0.01$, FeO 2.27, MnO 0.17, MgO 58.90, CaO 0.14, K_2O 0.01, Na_2O 0.01, F 0.16, Cl 3.26, H_2O^+ 10.40, H_2O^- 0.63 (not included in total), total 101.22, O ≡ F 0.82, corr. total 100.40.

The mineral is named in honor of Prof. Dr. Franz Karl, late professor of mineralogy and petrography at the Christian Albrechts University, Kiel, West Germany; in recognition of his geologic studies of the Eastern Alps.

Introduction

Karlite was found in the Furtschaglkar near the Furtschaglhaus in the Schlegeistal, Zillertaler Alpen, Austria. It occurs in calcsilicate–carbonate lenses which are embedded in amphibolites.

The mineral was named in honor of Prof. Dr. Franz Karl (1918–1972), late professor of mineralogy and petrography at the Christian Albrechts Universität, Kiel, West Germany. Prof. Karl mainly investigated the "Zentralgneis" complex of the Tauern window and gave great stimulation to geological studies of the Eastern Alps.

Type material will be preserved at the Mineralogisches Institut und Museum der Universität Kiel, Olshausenstr. 40–60, D 2300 Kiel, West Germany,

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Table 2. X-ray powder data

$2\theta_{obs}$	d_{obs}	$2\theta_{calc}$	d_{calc}	h	k	l		I/I_o
+ 7.05	12.53	7.03	12.56	1	1	0		76
+ 7.87	8.95	9.86	8.96	2	0	0		47
+ 10.09	8.76	10.04	8.80	0	2	0		18
+ 11.10	7.97	11.07	7.99	2	1	0		8
+ 11.21	7.89	11.19	7.90	1	2	0		5
+ 14.11	6.27	14.09	6.28	2	2	0		58
+ 15.67	5.65	15.65	5.66	3	1	0		15
+ 15.89	5.57	15.88	5.58	1	3	0		3
17.95		17.93	4.94	3	2	0	s	
+ 18.07	4.91	18.06	4.91	2	3	0		16
ni 18.75	4.73	-	-		---			3
+ 19.81	4.48	19.79	4.48	4	0	0		8
+ 20.17	4.40	20.17	4.40	0	4	0		8
21.25		21.20	4.19	3	3	0		1
+ 22.26	3.990	22.24	3.994	4	2	0		36
+ 22.51	3.947	22.49	3.950	2	4	0		63
+ 25.09	3.546	25.11	3.543	3	4	0		6
+ 25.34	3.512	25.33	3.514	5	1	0		6
+ 25.79	3.452	25.77	3.452	1	5	0		17
ni 26.65	3.342	-	-		---			5
+ 26.81	3.223	26.82	3.321	5	2	0		14
+ 27.22	3.273	27.20	3.276	2	5	0		3
28.42		28.40	3.140	4	4	0		39
29.20		29.16	3.060	5	3	0		4
		29.21		0	1	1		
+ 29.45	3.031	29.43	3.033	3	5	0		10
+ 29.66	3.010	29.64	3.011	1	1	1		12
+ 29.88	2.9878	29.88	2.9883	6	0	0		8
30.33		30.31	2.9462	6	1	0	s	
30.55		30.54	2.9251	0	2	1	b	12
30.91		30.86	2.8948	1	6	0		68
		30.90	2.8912	2	1	1		
		30.95	2.8870	1	2	1		
+ 31.60	2.8290	31.59	2.8295	6	2	0		92
32.15		32.08	2.7878	2	6	0		82
		32.16	2.7808	2	2	1		
		32.18		5	4	0		
32.30		32.31	2.7683	4	5	0	s	
+ 32.66	2.7396	32.63	2.7419	0	3	1		14
32.96		32.90	2.7198	3	1	1		4
33.04		33.02	2.7104	1	3	1		3
+ 33.65	2.6612	33.63	2.6627	6	3	0		13
+ 34.18	2.6211	34.17	2.6222	2	3	1		65
+ 35.17	2.5496	35.16	2.5505	4	0	1		35
35.43		35.38	2.5350	0	4	1		58
				7	1	0		

Table 2, continued

$2\theta_{obs}$	d_{obs}	$2\theta_{calc}$	d_{calc}	h	k	l		I/I_o
+ 35.52	2.5253	35.53	2.5241	4	1	1		52
35.75		35.71	2.5119	5	5	5		39
		35.74	2.5100	1	4	1		
36.00		36.01	2.4921	3	3	1		82
		36.04	2.4898	1	7	0		
36.70		36.65	2.4497	4	2	1		20
		36.81	2.4393	2	4	1		
37.10		37.11	2.4208	2	7	0		3
+ 38.32	2.3469	38.31	2.3474	7	3	0		25
38.72		38.45	2.3390	4	3	1		21
+ 38.72	2.3236	38.69	2.3252	5	1	1		55
+ 38.83	2.3173	38.83	2.3175	3	7	0		56
+ 39.00	2.3076	39.00	2.3077	1	5	1		30
+ 39.75	2.2657	39.73	2.2666	5	2	1		17
+ 40.00	2.2522	39.99	2.2524	2	5	1		87
40.20		40.20	2.2412	8	0	0	s	
40.75		40.54	2.2232	8	1	0		100
		40.73	2.2136	7	4	0		
		40.86	2.2065	4	4	1	s	
+ 40.98	2.2005	40.99	2.1999	0	8	0		23
41.10		41.13	2.1928	4	7	0	s	11
+ 41.30	2.1842	41.31	2.1836	1	8	0		9
+ 41.61	2.1687	41.61	2.1684	3	5	1		10
+ 41.95	2.1519	41.95	2.1519	6	0	1		8
42.30		42.27	2.1365	2	8	0		17
		42.27		6	1	1	b	
		42.38	2.1311	0	6	1		
43.15		43.17	2.0936	8	3	0		20
		43.18		6	6	0		
43.67		43.62	2.0733	2	6	1		13
		43.67	2.0710	7	5	0		
		43.69	2.0700	5	4	1		
43.80		43.80	2.0653	4	5	1	s	
		43.81		3	8	0		
43.95		43.95	2.0586	5	7	0		5
ni 44.60	2.0990	–	–		---			12
44.70		44.82	2.0203	6	3	1	b	34
+ 45.12	2.0078	45.13	2.0073	3	6	1		5
+ 45.36	1.9977	45.38	1.9970	8	4	0		5
+ 46.20	1.9633	46.22	1.9626	7	1	1		6
+ 46.68	1.9442	46.69	1.9440	1	9	0		5
47.15		47.12	1.9270	7	2	1	b	33
		47.18	1.9247	4	6	1		

Table 2, continued

$2\,\theta_{obs}$	d_{obs}	$2\,\theta_{calc}$	d_{calc}	h	k	l		I/I_c
+ 47.55	1.1907	47.55	1.9106	2	9	0		60
+ 48.18	1.8872	48.20	1.8864	9	3	0		17
+ 48.49	1.8758	48.51	1.8752	5	8	0		5
+ 48.60	1.8718	48.60	1.8718	7	3	1		3
		48.97	1.8585	3	9	0		
49.00							b	1
		49.03	1.8565	3	7	1		
+ 49.72	1.8322	49.73	1.8320	5	6	1		30
+ 50.15	1.8175	50.18	1.8165	8	0	1		6
50.60		50.62	1.8017	7	4	1		2
+ 50.98	1.7899	50.96	1.7905	4	7	1		21
		51.11	1.7854	1	8	1		
51.13								22
		51.17	1.7837	10	1	0		
+ 51.25	1.7811	51.26	1.7808	8	6	0		20
51.52		51.54	1.7716	6	8	0	s	5
		51.91	1.7599	0	10	0		
51.95		51.92		2	8	1	b	16
		52.01	1.7568	10	2	0		
52.14		52.18	1.7515	1	10	0	s	6
		52.70	1.7353	8	3	1		
52.73		52.71		6	6	1		14
		52.75	1.7337	9	5	0		
+ 53.24	1.7191	53.26	1.7186	3	8	1		44
+ 53.38	1.7149	53.39	1.7152	10	3	0		32
54.80		54.83	1.6730	8	7	0		7
54.97		54.96	1.6689	7	8	0		8
55.00		54.98		9	1	1		8
55.10		55.08	1.6659	4	8	1	b	
55.24		55.28	1.6604	10	4	0		
+ 55.75	1.6475	55.76	1.6472	1	9	1		34
56.10							s	
56.24								5
56.50								6
56.65								4
57.00							b	6
57.34								3
57.75								12
58.74								8
59.42								35
+ 59.56	1.5509	59.57	1.5507	0	0	2		65
60.05								13
+ 60.57	1.5274	60.58	1.5272	2	2	0		34
61.60								14
62.20								5
62.50								8
63.15								7

Table 2, continued

$2\theta_{obs}$	d_{obs}	$2\theta_{calc}$	d_{calc}	h	k	l	I/I_o
63.65							2
64.25							40
65.10							s
65.40							24
65.90							16
66.15							b 14
66.33							8
66.65							6
67.00							10
68.04							4

plus numerous weak lines (not measureable) up to 75° 2 θ
s = shoulder; b = broad line; + = used in the indexing and refinement program; ni = not indexed