

**Bornemanite****BaNa<sub>4</sub>Ti<sub>2</sub>NbSi<sub>4</sub>O<sub>17</sub>(F, OH)·Na<sub>3</sub>PO<sub>4</sub>**

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**Crystal Data:** Orthorhombic. *Point Group:* 2/m 2/m 2/m or mm2. As platy aggregates, to 1 cm, of fine leaflets along cleavages and on the surface of lomonosovite and in natrolite.

**Physical Properties:** *Cleavage:* Perfect on {001}. *Tenacity:* Brittle; fibers are flexible. Hardness = 3.5–4 VHN = 257–283 D(meas.) = 3.47–3.50 D(calc.) = 3.49

**Optical Properties:** Translucent to transparent. *Color:* Pale yellow. *Luster:* Pearly. *Optical Class:* Biaxial (+). *Pleochroism:* Weak; X = Y = colorless; Z = brownish. *Orientation:* X = c; Y = b; Z = a.  $\alpha = 1.682\text{--}1.683$   $\beta = 1.687\text{--}1.695$   $\gamma = 1.718\text{--}1.720$  2V(meas.) = 40° 2V(calc.) = 66°

**Cell Data:** *Space Group:* Ibm̄m or Ibm2. a = 5.48(5) b = 7.10(5) c = 48.2(1) Z = 4

**X-ray Powder Pattern:** Lovozero massif, Russia.

24.1 (100), 8.04 (100), 3.44 (100), 3.02 (100), 2.682 (80), 1.610 (80), 1.781 (70)

<b>Chemistry:</b>	(1)	(2)		(1)	(2)
SiO <sub>2</sub>	23.96	25.00	BaO	12.05	13.00
TiO <sub>2</sub>	18.72	18.00	Li <sub>2</sub> O	0.10	
ZrO <sub>2</sub>	0.20	0.25	Na <sub>2</sub> O	19.62	20.00
Al <sub>2</sub> O <sub>3</sub>	0.55	0.00	K <sub>2</sub> O	0.65	0.67
Fe <sub>2</sub> O <sub>3</sub>		0.30	Rb <sub>2</sub> O	0.002	
Nb <sub>2</sub> O <sub>5</sub>	9.22	8.86	Cs <sub>2</sub> O	0.00	
Ta <sub>2</sub> O <sub>5</sub>		0.66	F	1.52	1.64
FeO	0.17		H <sub>2</sub> O <sup>+</sup>	2.44	
MnO	2.97	2.48	H <sub>2</sub> O <sup>-</sup>	0.30	
MgO	0.04	0.06	H <sub>2</sub> O		0.70
CaO	0.33	0.77	P <sub>2</sub> O <sub>5</sub>	6.57	6.80
SrO	0.70	0.68	–O = F <sub>2</sub>	0.64	0.69
			<b>Total</b>	<b>99.47</b>	<b>99.18</b>

(1–2) Lovozero massif, Russia.

**Occurrence:** In the natrolite zone of alkalic pegmatites in a differentiated alkalic massif.

**Association:** Natrolite, lomonosovite.

**Distribution:** In the Jubilee pegmatite, on Mt. Karnasurt, and on Mt. Alluaiv, Lovozero massif, Kola Peninsula, Russia.

**Name:** To honor Irina Dmitrievna Borneman-Starynkevich (1891–1988), Russian mineralogist specializing in Khibiny and Lovozero minerals, Institute of Geology of Ore Deposits, Petrology, Mineralogy, and Geochemistry, Moscow, Russia.

**Type Material:** Mining Institute, St. Petersburg, 1057/3; Geology Museum, Kola Branch, Academy of Sciences, Apatity, 3274, 3308; A.E. Fersman Mineralogical Museum, Academy of Sciences, Moscow, Russia, 75318; National School of Mines, Paris, France; The Natural History Museum, London, England, 1994,4; National Museum of Natural History, Washington, D.C., USA, 143813.

**References:** (1) Men'shikov, Y.P., I.V. Bussen, E.A. Goiko, N.I. Zabavnikova, A.N. Mer'kov, and A.P. Khomyakov (1975) Bornemanite, a new silicophosphate of sodium, titanium, niobium and barium. Zap. Vses. Mineral. Obsch., 104, 322–326 (in Russian). (2) (1976) Amer. Mineral., 61, 338 (abs. ref. 1).

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