

**Philoxenite**

**Crystal Data:** Triclinic. *Point Group:*  $\bar{1}$ . As isolated euhedral tabular crystals to 0.6 mm. Crystals are oblique-angled, pseudotrigonal or polygonal.

**Physical Properties:** *Cleavage:* None. *Tenacity:* Brittle. *Fracture:* Uneven. Hardness = ~3  
D(meas.) = n.d. D(calc.) = 2.732

**Optical Properties:** Transparent. *Color:* Colorless to very pale yellowish. *Streak:* White.  
*Luster:* Vitreous.

*Optical Class:* Biaxial (-).  $\alpha = 1.562(2)$   $\beta = 1.572(2)$   $\gamma = 1.580(2)$   $2V(\text{meas.}) = 85(5)^\circ$   
 $2V(\text{calc.}) = 83^\circ$  *Dispersion:* Very strong,  $r > v$ . Nonpleochroic.

**Cell Data:** *Space Group:*  $P\bar{1}$ .  $a = 8.8410(3)$   $b = 8.9971(3)$   $c = 16.1861(5)$   $\alpha = 91.927(3)^\circ$   
 $\beta = 94.516(3)^\circ$   $\gamma = 90.118(3)^\circ$   $Z = 2$

**X-Ray Diffraction Pattern:** Yadovitaya fumarole, Tolbachik Volcano, Russia.  
3.146 (100), 3.136 (72), 2.784 (42), 2.965 (36), 2.834 (36), 2.912 (35), 4.030 (24)

Chemistry:	(1)		(1)
Na <sub>2</sub> O	4.67	CuO	5.40
K <sub>2</sub> O	13.34	ZnO	1.48
Rb <sub>2</sub> O	0.13	Al <sub>2</sub> O <sub>3</sub>	3.40
CaO	2.84	Fe <sub>2</sub> O <sub>3</sub>	3.29
PbO	4.54	<u>SO<sub>3</sub></u>	<u>54.62</u>
MgO	6.37	Total	100.28
MnO	0.20		

(1) Yadovitaya fumarole, Tolbachik Volcano, Kamchatka, Russia; average electron microprobe analysis supplemented by IR and Raman spectroscopy; corresponding to  $(\text{K}_{3.30}\text{Na}_{1.76}\text{Ca}_{0.59}\text{Pb}_{0.24}\text{Rb}_{0.02})_{\Sigma=5.91}(\text{Mg}_{1.84}\text{Cu}_{0.79}\text{Al}_{0.78}\text{Zn}_{0.21}\text{Mn}_{0.03})_{\Sigma=4.13}\text{S}_{7.96}\text{O}_{32}$  or structural formula  $A^{(2,6)}(\text{K}_{0.90}\text{Na}_{0.07}\text{Pb}_{0.03})_4 A^{(5)}(\text{K}_{0.69}\text{Na}_{0.28}\text{Pb}_{0.03})_2 A^{(7)}(\text{K}_{0.85}\text{Pb}_{0.15})_2 A^{(1)}(\text{Na}_{0.61}\text{Ca}_{0.39})_2 A^{(3)}(\text{Na}_{0.72}\text{Ca}_{0.28}) A^{(4)}(\text{Na}_{0.81}\text{Ca}_{0.19}) M^{(2)}(\text{Mg}_{0.60}\text{Cu}^{2+}_{0.40})_2 M^{(1)}(\text{Mg}_{0.56}\text{Cu}^{2+}_{0.44})_2 M^{(4)}(\text{Mg}_{0.43}\text{Al}_{0.35}\text{Zn}_{0.22})_2 M^{(3)}(\text{Fe}^{3+}_{0.42}\text{Al}_{0.40}\text{Mg}_{0.18})_2(\text{SO}_4)_{16}$ .

**Occurrence:** A sublimate at an active volcanic fumarole.

**Association:** Euchlorine, langbeinite, hematite, tenorite, piypite, alumoklyuchevskite, dolerophanite, vergasovaite, cupromolybdate, ziesite, yaroshevskite.

**Distribution:** From the Yadovitaya fumarole, Second scoria cone, Northern Breakthrough of the Great Tolbachik Fissure Eruption, Tolbachik Volcano, Kamchatka, Russia.

**Name:** From the ancient Greek for ‘friend’, and ‘guest’, in allusion to the complex cationic composition and the presence of significant amounts of admixtures at nine of eleven independent cationic positions in the crystal structure.

**Type Material:** A.E. Fersman Mineralogical Museum, RAS, Moscow, Russia (95283).

**References:** (1) Pekov, I.V., A.A. Agakhanov, N.V. Zubkova, D.I. Belakovskiy, M.F. Viganina, S.N. Britvin, A.G. Turchkova, and E.G. Sidorov (2020) Philoxenite,  $(\text{K,Na,Pb})_4(\text{Na,Ca})_2(\text{Mg,Cu})_3(\text{Fe}^{3+}_{0.5}\text{Al}_{0.5})(\text{SO}_4)_8$ , a new mineral from fumarole exhalations of the Tolbachik volcano, Kamchatka, Russia (in English). *Zap. Ross. Mineral. Obshch.*, 149, 67-77. (2) Zubkova, N.V., I.V. Pekov, A.A. Agakhanov, D.A. Ksenofontov, and D.Yu. Pushcharovsky (2021) A Novel-Type Microporous Heteropolyhedral Framework in Crystal Structure of the Natural Sulfate Philoxenite. *Crystallography Reports*, 66(1), 60-65.