Puninite $Na_2Cu_3O(SO_4)_3$

Crystal Data: Monoclinic. *Point Group*: 2/*m*. As crusts of irregularly-shaped grains to 50 μm.

Physical Properties: *Cleavage*: {100}, perfect. *Tenacity*: Brittle. *Fracture*: Uneven. Hardness = 2-3 D(meas.) = n.d. D(calc.) = 3.298 Water soluble.

Optical Properties: Transparent. *Color*: Emerald-green, pale green in transmitted light. *Streak*: Greenish. *Luster*: Vitreous.
Optical Class: Biaxial (+). $\alpha = 1.562(2)$ $\beta = 1.591(2)$ $\gamma = 1.634(2)$ 2V(meas.) = Moderately large. 2V(calc.) = 80.7° *Pleochroism*: Very weak.

Cell Data: *Space Group*: *C*2/*c*. $a = 17.3885(13)$ $b = 9.4009(8)$ $c = 14.4045(11)$ $\beta = 112.039(2)°$ $Z = 8$

X-ray Powder Pattern: Glavnaya Tenoritovaya fumarole, Tolbachik volcano, Kamchatka, Russia. 8.058 (100), 3.839 (33.89), 2.854 (29.15), 6.466 (28.47), 6.675 (18.88), 4.247 (17.37), 2.724 (14.95)

Chemistry:	(1)	(2)
Na_2O	9.98	11.46
K_2O	0.63	
CuO	43.21	44.13
ZnO	0.66	
SO_3	44.33	44.41
Total	98.81	100.00

(1) Glavnaya Tenoritovaya fumarole, Tolbachik volcano, Kamchatka, Russia; average of 10 electron microprobe analyses; corresponds to $(Na_{1.76}K_{0.08})_{\Sigma=1.84}(Cu_{2.97}Zn_{0.04})_{\Sigma=3.01}(SO_4)_{3.02}O_{0.92}$.
(2) $Na_2Cu_3O(SO_4)_3$.

Occurrence: As a sublimate around an active fumarole.

Association: Lammerite-β, tenorite, hematite, anhydrite.

Distribution: From Glavnaya Tenoritovaya fumarole, Second scoria cone, Northern Breakthrough of the Great Fissure Eruption, Tolbachik volcano, Kamchatka, Russia.

Name: Honors crystallographer, Professor Yurii Olegovich Punin (1941-2014), St. Petersburg State University, Russia.

Type Material: Mineralogical Museum, Department of Mineralogy, St. Petersburg State University, St. Petersburg, Russia (19638).

References: (1) Siidra, O.I., E.V. Nazarchuk, A.N. Zaitsev, E.A. Lukina, E.Y. Avdontseva, L.P. Vergasova, N.S. Vlasenko, S.K. Filatov, R. Turner, and G.A. Karpov (2017) Copper oxosulphates from fumaroles of Tolbachik volcano: puninite, $Na_2Cu_3O(SO_4)_3$ - a new mineral species and structure refinements of kamchatkite and alumoklyuchevskite. Eur. J. Mineral., 29(3), 499-510. (2) (2018) Amer. Mineral., 103, 661-662 (abs. ref. 1).