Ponomarevite $K_4Cu_4OCl_{10}$

Crystal Data: Monoclinic. *Point Group:* $2/m$. Anhedral pseudohexagonal plates, to about 0.1 mm, in nodules, skeletal forms, droplike clusters; most commonly in fine-grained incrustations, to 3 cm thick.

Physical Properties: *Cleavage:* Imperfect on {001} and {110}. *Tenacity:* Brittle. Hardness = 2.8 VHN = 66–97, 71 average (10 g load). D(meas.) = 2.78(1) D(calc.) = 2.72 Soluble in H_2O; alters to mitscherlichite on exposure.

Optical Properties: Transparent in thin fragments when fresh; becoming opaque on exposure. *Color:* Brick-red with a golden tint, dark red, black, probably due to admixed molysite; on exposure becomes grass-green by alteration to mitscherlichite. *Streak:* Red-orange. *Luster:* Vitreous, resinous to greasy in aggregates.
Optical Class: Biaxial (–). *Orientation:* $Y = b$; $X \wedge c = 30°$. $\alpha = 1.686(5)$ $\beta = 1.718(5)$ $\gamma = 1.720(5)$ 2V(meas.) = 28(5)°

Cell Data: *Space Group:* $C2/c$. $a = 14.740(3)$ $b = 14.900(3)$ $c = 8.948(2)$ $\beta = 104.9(1)°$ Z = 4

X-ray Powder Pattern: Tolbachik volcano, Russia.
2.801 (100), 7.31 (80), 2.787 (80), 6.074 (70), 2.470 (65), 3.654 (60), 3.048 (60)

Chemistry:

	(1)	(2)
CuO	38.02	40.73
ZnO	0.31	
PbO	0.03	
Na_2O	2.76	
K_2O	20.6	24.12
F	0.03	
Cl	42.5	45.39
H_2O^+	0.37	
H_2O^-	0.62	
$-O = (F, Cl)_2$	9.6	10.24
SO_3	1.25	
insol.	3.3	
Total	100.19	100.00

(1) Tolbachik volcano, Russia; Cu, Pb, Zn by AA, K, Na by flame photometry; after deduction of mitscherlichite 3.3%, SO_3 as thenardite 2.2%, insoluble and H_2O^-, corresponds to $(K_{3.53}Na_{0.49})_{\Sigma=4.02}(Cu_{3.97}Zn_{0.03})_{\Sigma=4.00}O_{1.10}Cl_{9.82}$. (2) $K_4Cu_4OCl_{10}$.

Occurrence: As a fracture filling and in fumaroles, deposited from 280–400 °C.

Association: Halite, sylvite, tenorite, tolbachite, dolerophanite, piypite, chalcocyanite, cotunnite, sofiite, klyuchevskite, kamchatkite.

Distribution: From the Tolbachik fissure volcano, Kamchatka Peninsula, Russia.

Name: Honors Vasilii Vasil'evich Ponomarev (1940–1976), Russian vulcanologist, Institute of Volcanology, Petropavlovsk-Kamchatskii, Russia, who early studied the Tolbachik volcano.

Type Material: Mining Institute, St. Petersburg, Russia, 1483/1.

References: (1) Vergasova, L.P., S.K. Filatov, Y.K. Serafimova, and T.F. Semenova (1988) Ponomarevite $K_4Cu_4OCl_{10}$ – a new mineral from volcanic sublimates. Doklady Acad. Nauk SSSR, 300, 1197–1200 (in Russian). (2) Semenova, T.F., I.V. Rozhdestvenskaya, S.K. Filatov, and L.P. Vergasova (1989) Crystal structure of the new mineral ponomarevite, $K_4Cu_4OCl_{10}$. Doklady Acad. Nauk SSSR, 304, 427–430 (in Russian). (3) (1990) Amer. Mineral., 75, 709 (abs. refs. 1 and 2).