Kainotropite $Cu_4Fe^{3+}O_2(V_2O_7)(VO_4)$

Crystal Data: Orthorhombic. *Point Group*: 2/*m* 2/*m* 2/*m*. As prismatic crystals to 0.5 mm isolated or combined in clusters to 0.7 mm.

Physical Properties: *Cleavage*: None. *Tenacity*: Brittle. *Fracture*: Uneven.
Hardness = ~5 VHN = 432-531, 481 average (20 g load). D(meas.) = n.d. D(calc.) = 4.104

Optical Properties: Opaque. *Color*: Iron-black to reddish black, gray in reflected light with strong brown-red internal reflections. *Streak*: Dark brown-red. *Luster*: Semimetallic.
Optical Class: Weakly anisotropic. Bireflectance weak.
R_1-R_2: (470) 18.3-17.3, (546) 17.3-16.3, (589) 16.9-15.7, (650) 16.3-15.1

Cell Data: *Space Group*: *Pnma*. *a* = 14.139(2) *b* = 6.7102(7) *c* = 11.4177(15) Z = 4

X-Ray Diffraction Pattern: Arsenatnaya fumarole, Tolbachik Volcano, Kamchatka, Russia.
8.89 (100), 3.034 (77), 2.968 (60), 3.357 (52), 3.698 (35), 5.728 (33), 2.655(27)

Chemistry:

	(1)	(2)
CuO	46.69	47.43
Al_2O_3	1.40	
Fe_2O_3	10.04	11.90
TiO_2	0.32	
V_2O_5	37.58	40.67
As_2O_5	2.55	
MoO_3	0.76	.
Total	99.34	100.00

(1) Yadovitaya fumarole, Tolbachik Volcano, Kamchatka, Russia; average electron microprobe analysis; corresponding to $Cu_{3.96}Fe^{3+}_{0.85}Al_{0.19}Ti_{0.03}(V_{2.78}As_{0.15}Mo_{0.04})_{\Sigma=2.97}O_{13}$.
(2) $Cu_4Fe^{3+}O_2(V_2O_7)(VO_4)$.

Occurrence: A sublimate at an active volcanic fumarole.

Association: Hematite, langbeinite, calciolangbeinite, tenorite, piypite, lyonsite, rutile, pseudobrookite, sanidine, lammerite.

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

Name: From the Greek for 'unusual', in allusion to its uncommon (for natural vanadates) anionic composition as the first mineral containing both pyrovanadate $(V_2O_7)^{4-}$ and orthovanadate $(VO_4)^{3-}$.

Type Material: A.E. Fersman Mineralogical Museum, RAS, Moscow, Russia (95603).

References: (1) Pekov, I.V., N.V. Zubkova, V.O. Yapaskurt, Y.S. Polekhovsky, S.N. Britivin, A.G. Turchkova, E.G. Sidorov, and D.Y. Pushcharovsky (2020) Kainotropite, $Cu_4Fe^{3+}O_2(V_2O_7)(VO_4)$, a new mineral with a complex vanadate anion from fumarolic exhalations of the Tolbachik volcano, Kamchatka, Russia. Can. Mineral., 58, 155-165.