

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). $D(\text{meas.}) = \text{n.d.}$ $D(\text{calc.}) = 4.104$

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. Birefractance 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 $\text{Cu}_{3.96}\text{Fe}^{3+}_{0.85}\text{Al}_{0.19}\text{Ti}_{0.03}(\text{V}_{2.78}\text{As}_{0.15}\text{Mo}_{0.04})_{\Sigma=2.97}\text{O}_{13}$.

(2) $\text{Cu}_4\text{Fe}^{3+}\text{O}_2(\text{V}_2\text{O}_7)(\text{VO}_4)$.

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 $(\text{V}_2\text{O}_7)^{4-}$ and orthovanadate $(\text{VO}_4)^{3-}$.

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

References: (1) Pekov, I.V., N.V. Zubkova, V.O. Yapaskurt, Y.S. Polekhovskiy, S.N. Britivin, A.G. Turchkova, E.G. Sidorov, and D.Y. Pushcharovskiy (2020) Kainotropite, $\text{Cu}_4\text{Fe}^{3+}\text{O}_2(\text{V}_2\text{O}_7)(\text{VO}_4)$, a new mineral with a complex vanadate anion from fumarolic exhalations of the Tolbachik volcano, Kamchatka, Russia. *Can. Mineral.*, 58, 155-165.