## Parawulffite $K_5Na_3Cu_8O_4(SO_4)_8$

**Crystal Data**: Monoclinic. *Point Group*: 2/*m*. As skeletal, curved, blocky prismatic crystals, elongated along [010] or irregularly shaped grains, to 1 mm. As divergent sprays to 0.5 cm.

**Physical Properties**: *Cleavage*: Perfect, 1 direction || to elongation and a second || (010). *Fracture*: Laminated. *Tenacity*: Brittle. Hardness = 2.5 D(meas.) = 3.35(2) D(calc.) = 3.32 Soluble in $H_2O$.

**Optical Properties**: Transparent. *Color*: Dark green, deep emerald green. *Streak*: Light green. *Luster*: Vitreous.
*Optical Class*: Biaxial (+). $\alpha$ = 1.585(3) $\beta$ = n.d. $\gamma$ = 1.717(4) 2V(calc.) = n.d.
*Orientation*: $Z = b$. *Pleochroism*: Strong; $X$ = very pale green, $Y$ = n.d., $Z$ = emerald green.
*Absorption*: $X < Z$.

**Cell Data**: *Space Group*: *P*2/*c*. $a$ =13.9043(10) $b$ = 4.9765(3) $c$ = 23.5855(17) $\beta$ = 90.209(6)° Z = 2

**X-ray Powder Pattern**: Yadovitaya fumarole, Tolbachik volcano, Kamchatka, Russia.
9.06 (100), 2.736 (33), 3.096 (31), 2.321 (26), 2.492 (24), 7.00 (23), 5.903 (12)

| **Chemistry**: | (1) | (2) |
|---|---|---|
| $Na_2O$ | 5.61 | 5.79 |
| $K_2O$ | 13.74 | 14.67 |
| $Rb_2O$ | 1.42 | |
| $Cs_2O$ | 1.21 | |
| CuO | 38.79 | 39.64 |
| ZnO | 0.18 | |
| $SO_3$ | 39.26 | 39.90 |
| Total | 100.21 | 100.00 |

(1) Yadovitaya fumarole, Tolbachik volcano, Kamchatka, Russia; average of 6 electron microprobe analyses supplemented by IR spectroscopy; corresponding to $(K_{4.75}Rb_{0.25}Cs_{0.14})_{\Sigma=5.14}Na_{2.95}(Cu_{7.95}Zn_{0.04})_{\Sigma=7.99}S_{7.99}O_{36}$. (2) $K_5Na_3Cu_8O_4(SO_4)_8$.

**Occurrence**: As sublimates at a fumarole as incrustations on the surface of basalt scoria or on tenorite or aphthitalite crusts.

**Association:** Euchlorine, fedotovite, tenorite, alumoklyuchevskite, langbeinite, calciolangbeinite, chalcocyanite, steklite, orthoclase (As-bearing variety), rutile (Fe- and Sb-bearing variety), pseudobrookite, lyonsite, lammerite.

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

**Name**: Recognizes with the prefix *para*, from the Greek παρά for *near*, the similarity to *wulffite*.

**Type Material**: A.E. Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia (94131).

**References**: (1) Pekov, I.V., N.V. Zubkova, V.O. Yapaskurt, D.I. Belakovskiy, N.V. Chukanov, I.S. Lykova, D.P. Savelyev, E.G. Sidorov and D.Yu. Pushcharovsky (2014) Wulffite, $K_3NaCu_4O_2(SO_4)_4$, and parawulffite, $K_5Na_3Cu_8O_4(SO_4)_8$, two new minerals from fumarole sublimates of the Tolbachik Volcano, Kamchatka, Russia. Can. Mineral., 52(4), 699-716.
(2) (2016) Amer. Mineral., 101, 1017-1018 (abs. ref. 1).