## Lehmannite $Na_{18}Cu_{12}TiO_8(AsO_4)_8FCl_5$

**Crystal Data**: Monoclinic. *Point Group*: 2/*m*. As equant, thick tabular or short prismatic crystals with pyramid-like terminations to 30 $\mu$m in crusts. Epitaxial on arsmirandite.

**Physical Properties**: *Cleavage*: None. *Tenacity*: Brittle. *Fracture*: Uneven.
Hardness = ~4.5 VHN = 339-537, 416 average (100 g load). D(meas.) = n.d. D(calc.) = 3.676

**Optical Properties**: Translucent to nearly opaque. *Color*: Dark grayish green to olive-greenish black, dark gray in reflected light. *Streak*: Grayish green with olive hue. *Luster*: Strong vitreous. *Optical Class*: *Bireflectance*: Weak with brown internal reflections. *Anisotropism*: Weak. *Pleochroism*: None.
$R_1$-$R_2$: (470) 8.1-8.7, (546) 7.9-8.5, (589) 7.6-8.4, (650) 7.6-8.3

**Cell Data**: *Space Group*: *C*2/*m*. $a$ = 10.8236(15) $b$ = 21.1077(17) $c$ = 11.8561(11)
$\beta$ = 117.195(8)° Z = 2

**X-ray Powder Pattern**: Arsenatnaya fumarole, Tolbachik volcano, Kamchatka, Russia.
8.74 (100), 2.573 (98), 5.273 (74), 10.52 (65), 2.636 (43), 3.772 (37), 1.889 (33)

**Chemistry**:

| | (1) | | (1) |
|---|---|---|---|
| $Na_2O$ | 20.62 | $SiO_2$ | 0.06 |
| $K_2O$ | 0.31 | $P_2O_5$ | 0.23 |
| CaO | 0.51 | $As_2O_5$ | 33.04 |
| CuO | 34.25 | $SO_3$ | 0.43 |
| $Fe_2O_3$ | 0.63 | Cl | 7.13 |
| $TiO_2$ | 2.53 | F | 0.53 |
| $SnO_2$ | 0.62 | -O = Cl + F | 1.85 |
| | | Total | 99.05 |

(1) Arsenatnaya fumarole, Tolbachik volcano, Kamchatka, Russia; average electron microprobe analysis supplemented by IR spectroscopy; corresponds to $(Na_{17.92}K_{0.18}Ca_{0.24})_{\Sigma=18.34}(Cu_{11.59}Fe^{3+}_{0.92})_{\Sigma=11.80}(Ti_{0.85}Sn_{0.11})_{\Sigma=0.96}(As_{7.74}S_{0.14}P_{0.09}Si_{0.03})_{\Sigma=8.00}O_{40.10}F_{0.75}Cl_{5.42}$.

**Occurrence**: A sublimate around an active volcanic fumarole.

**Association**: Arsmirandite, hematite, sanidine, sylvite, halite, tenorite, cassiterite, rutile, and 40 other species.

**Distribution**: From the Arsenatnaya fumarole, Second scoria cone, Tolbachik Fissure Eruption, Tolbachik volcano, Kamchatka, Russia.

**Name**: Honors Johann Gottlob *Lehmann* (1719-1767) Academician of the Royal Prussian Academy of Sciences (1754) and the Imperial Russian Academy of Sciences (1761); author of the first mineral description of a new species discovered in Russia - crocoite.

**Type Material**: A.E. Fersman Mineralogical Museum, RAS, Moscow, Russia (96255).

**References**: (1) Pekov, I.V., S.N. Britvin, V.O. Yapaskurt, N.N. Koshlyakova, Y.S. Polekhovsky, J. Göttlicher, N.V. Chukanov, M.F. Vigasina, S.V. Krivovichev, A.G. Turchkova, and E.G. Siderov (2020) Arsmirandite, $Na_{18}Cu_{12}Fe^{3+}O_8(AsO_4)_8Cl_5$, and lehmannite, $Na_{18}Cu_{12}TiO_8(AsO_4)_8FCl_5$, new minerals from fumerole exhalations of the Tolbachik Volcano, Kamchatka, Russia. Zap. Ross. Mineral. Obshch., 149(3), 1-17.