

**Braithwaiteite****NaCu<sub>5</sub>(TiSb)O<sub>2</sub>(AsO<sub>4</sub>)<sub>4</sub>[AsO<sub>3</sub>(OH)]<sub>2</sub>(H<sub>2</sub>O)<sub>8</sub>**

**Crystal Data:** Triclinic. *Point Group:*  $\bar{1}$ . Crystals tabular, to 1 mm; form {001} dominant, {010} less prominent, {100}, {10 $\bar{3}$ }, and {203} subordinate.

**Physical Properties:** *Cleavage:* Perfect on {001}. *Fracture:* Uneven. *Tenacity:* Brittle. Hardness = ~ 2 D(meas.) = 3.44(2) D(calc.) = 3.753

**Optical Properties:** Transparent. *Color:* Sky-blue. *Streak:* Pale blue. *Luster:* Vitreous. *Optical Class:* Biaxial (-).  $\alpha = 1.698(2)$   $\beta = 1.757(5)$   $\gamma = 1.783(5)$  2V (meas.) = 59(2)<sup>o</sup> 2V (calc.) = 65<sup>o</sup> *Pleochroism:* Weak; X = Y = pale blue; Z = greenish blue. *Absorption:* X = Y < Z. *Orientation:* X ^ a = 20.5<sup>o</sup>; Y ^ c = 79.9<sup>o</sup>; Z ^ b = 12.9<sup>o</sup>.

**Cell Data:** *Space Group:*  $P\bar{1}$ .  $a = 7.0308(4)$   $b = 9.8823(5)$   $c = 10.6754(6)$   $\alpha = 106.973(1)^{\circ}$   $\beta = 104.274(1)^{\circ}$   $\gamma = 93.839(1)^{\circ}$  Z = 1

**X-ray Powder Pattern:** Laurani, Bolivia.

9.825(100), 2.947(60), 5.887(50), 4.635(30), 3.354(30), 3.232(30), 2.736(30)

<b>Chemistry:</b>	(1)	(2)
Sb <sub>2</sub> O <sub>5</sub>	11.7	10.63
As <sub>2</sub> O <sub>5</sub>	42.3	45.30
TiO <sub>2</sub>	4.5	5.25
FeO	0.2	-
CuO	25.8	26.13
ZnO	trace	-
Na <sub>2</sub> O	1.7	2.04
<u>H<sub>2</sub>O</u>	<u>10.17</u>	<u>10.65</u>
Total	96.37	100.00

(1) Laurani, Bolivia; average of 4 electron microprobe analyses, low analytical total due to beam damage of sample, H<sub>2</sub>O and valances assigned from structure analysis, corresponding to Na<sub>0.87</sub>Cu<sup>2+</sup><sub>5.17</sub>Fe<sub>0.04</sub>(Ti<sup>4+</sup><sub>0.90</sub>Sb<sup>5+</sup><sub>1.15</sub>) $\Sigma=2.05$ O<sub>2</sub>(As<sup>5+</sup><sub>0.98</sub>O<sub>4</sub>)<sub>4</sub>[As<sup>5+</sup><sub>0.98</sub>O<sub>3</sub>(OH)]<sub>2</sub>·8H<sub>2</sub>O.

(2) NaCu<sub>5</sub>(TiSb)O<sub>2</sub>(AsO<sub>4</sub>)<sub>4</sub>[AsO<sub>3</sub>(OH)]<sub>2</sub>(H<sub>2</sub>O)<sub>8</sub>.

**Occurrence:** An uncommon secondary mineral in the weathering zone of a hydrothermal enargite deposit.

**Association:** Lammerite, lavendulan-lemmereite.

**Distribution:** Laurani, near Sica Sica, Bolivia.

**Name:** Honors Richard S.W. Braithwaite (b. 1930), chemist and mineralogist at the University of Manchester, England, for his contributions to the chemistry of secondary Cu-Pb minerals.

**Type Material:** Canadian Museum of Nature, Ottawa, Ontario (CMNMC 86085).

**References:** (1) Parr, W.H., M.A. Cooper, F.C. Hawthorne, E. Moffat, M.E. Gunter, A.C. Roberts, and P.J. Dunn (2009) Braithwaiteite, NaCu<sub>5</sub>(TiSb)O<sub>2</sub>(AsO<sub>4</sub>)<sub>4</sub>[AsO<sub>3</sub>(OH)]<sub>2</sub>(H<sub>2</sub>O)<sub>8</sub>, a new mineral species from Laurani, Bolivia, Can. Mineral., 47, 947–953. (2) Hawthorne, F.C., M.A. Cooper, and W.H. Parr (2008) The crystal structure of braithwaiteite. J. Coord. Chem., 61, 15–29. (3) (2010) Amer. Mineral., 95, 204 (abs. refs. 1 and 2).