Bettertonite $Al_6(AsO_4)_3(OH)_9(H_2O)_5 \cdot 11H_2O$

Crystal Data: Monoclinic. *Point Group*: 2/*m*. As curved rectangular laths, flattened on {010}, to 0.20 μm; as divergent sprays and hemispherical clusters.

Physical Properties: *Cleavage*: Perfect on (010). *Fracture*: Irregular. *Tenacity*: Flexible. Hardness = n.d. D(meas.) = n.d. D(calc.) = 2.02 Dehydrates to penberthycroftite between 67 and 97° C.

Optical Properties: Translucent. *Color*: White, rarely pale orange. *Streak*: White. *Luster*: Vitreous to pearly, somewhat silky.
Optical Class: Biaxial (+). α = 1.511(1) β = 1.517(1) γ = 1.523(1) 2V(meas.) = n.d. 2V(calc.) = 60.2° *Orientation*: $X = c$, $Y = b$, $Z = a$.

Cell Data: *Space Group*: $P2_1/c$. a = 7.773(2) b = 26.991(5) c = 15.867(3) β = 94.22(3)° Z = 4

X-ray Powder Pattern: Penberthy Croft mine, St. Hilary, Cornwall, England.
13.65 (100), 13.51 (50), 7.805 (50), 7.461 (30), 5.880 (20), 3.589 (20), 2.857 (14)

Chemistry:	(1)	(2)
Al_2O_3	29.5	30.1
Fe_2O_3	2.0	
As_2O_5	30.1	33.7
SO_3	1.8	
Cl	0.5	
H_2O	[36.2]	36.2
Total	100.0	100.0

(1) Penberthy Croft mine, St. Hilary, Cornwall, England; average of 4 electron microprobe analyses, H_2O calculated from structure; corresponds to $Al_{5.86}Fe_{0.26}(AsO_4)_{2.65}(SO_4)_{0.23}(OH)_{9.82}Cl_{0.13}(H_2O)_{15.5}$.
(2) $Al_6(AsO_4)_3(OH)_9(H_2O)_5 \cdot 11H_2O$.

Occurrence: Extremely rare, in quartz veins in a multi-stage, polymetallic hydrothermal deposit; probably formed from leaching and the replacement of Al to Fe in pharmacosiderite. Dehydrates to penberthycroftite at temperatures likely on oxidizing mine dumps.

Association: Arsenopyrite, chamosite, liskeardite, penberthycroftite, pharmacoalumite, pharmacosiderite, brochantite, chalcopyrite, cassiterite.

Distribution: From the Penberthy Croft mine, ~1.5 km from the village of Goldsithney, St. Hilary, Cornwall, England.

Name: Honors Mr. John Betterton (b. 1959) a museum geologist/mineralogist at Haslemere Educational Museum, Haslemere, Surrey, England, for his extensive contributions to the characterization of minerals from the Penberthy Croft mine for more than 30 years.

Type Material: Museum Victoria, Melbourne, Victoria, Australia (M53274) and the Natural History Museum, London, England (BM.2014,100).

References: (1) Grey, I.E., A.R. Kampf, J.R. Price and C.M. Macrae (2015) Bettertonite, $[Al_6(AsO_4)_3(OH)_9(H_2O)_5] \cdot 11H_2O$, a new mineral from the Penberthy Croft mine, St. Hilary, Cornwall, UK, with a structure based on polyoxometalate clusters. Mineral. Mag., 79(7), 1849-1858. (2) (2016) Amer. Mineral., 101, 2124 (abs. ref. 1). (3) Grey, I.E., H.E.A. Brand, and J. Betterton, (2016) Dehydration phase transitions in new aluminium arsenate minerals from the Penberthy Croft mine, Cornwall, UK. Mineral. Mag, 80(7), 1205-1217.