Cannonite $Bi_2O(SO_4)(OH)_2$

Crystal Data: Monoclinic. *Point Group*: 2/*m*. As equant to prismatic crystals, elongated along [001], to 200 μm (Utah); as lozenge-shaped to acicular crystals in radiating aggregates (Italy); granular massive.

Physical Properties: *Cleavage*: Presumed on {010}. *Fracture*: Uneven to conchoidal. *Tenacity*: Brittle. Hardness = 4 VHN = 183-280, 229 average (100 g load). D(meas.) = 6.5(1) (synthetic). D(calc.) = 6.494

Optical Properties: Transparent. Color: Colorless. Streak: White. Luster: Adamantine. *Optical Class*: Biaxial. α = [1.91] β = n.d. γ = [1.99] 2V(meas.) = n.d. 2V(calc.) = n.d.

Cell Data: Space Group: $P2_1/c$. a = 7.7196(5) b = 13.8856(9) c = 5.6980(4) β = 109.174(1)° Z = 4

X-ray Powder Pattern: Tunnel Extension mine, Utah, USA.
3.206 (100), 1.984 (90), 2.924 (70), 3.644 (60), 3.466 (60), 2.782 (50), 3.513 (40)

Chemistry:

	(1)	(2)	(3)
SO_3	14.18	14.33	14.20
Bi_2O_3	82.53	77.87	82.61
F		0.28	
H_2O	[3.29]	n.d.	3.19
$-O = F_2$		0.12	
Total	[100.00]	92.35	100.00

(1) Tunnel Extension mine, Utah, USA; by electron microprobe, average of ten analyses, recalculated from an elemental analysis; H_2O by difference, presence of $(OH)^{1-}$ by analogy to the synthetic compound; then corresponds to $Bi_{1.99}O(S_{0.99}O_4)(OH)_{2.08}$. (2) Near Alfenza, Crodo, Italy; electron microprobe, average of ten analyses supplemented by Raman and FTIR spectroscopy that confirm presence of OH^- and not H_2O, low total due to beam damage, corresponds to $Bi_{1.95}S_{1.04}O_6(OH)_{1.91}F_{0.09}$. (3) $Bi_2O(SO_4)(OH)_2$.

Occurrence: An alteration product in Cu-Bi-Au-sulfide deposits.

Association: Covellite, cuprobismutite, bismuthinite, quartz (Marysvale, Utah); bismuthinite, pyrite, arsenopyrite, cosalite, bornite, anglesite, micas (Italy).

Distribution: From the Tunnel Extension mine, Marysvale, Ohio district, Piute Co., Utah, USA. Near Alfenza, Crodo, Italy.

Name: Honors Benjamin Bartlett Cannon, V (b. 1950), amateur mineralogist of Seattle, Washington, USA, who recognized the first specimens.

Type Material: The Natural History Museum, London, England (1992,239, 1992,240, and E.1456); Canadian Geological Survey, Ottawa, Ontario, Canada (67428).

References: (1) Stanley, C.J., A.C. Roberts, D.C. Harris, A.J. Criddle, and J.T. Szymański (1992) Cannonite, $Bi_2O(OH)_2SO_4$, a new mineral from Marysvale, Utah, USA. Mineral. Mag., 56, 605-609. (2) (1993) Amer. Mineral., 78, 845 (abs. ref. 1). (3) Golič, L., M. Graunar, and F. Lazarni (1982) *catena*-Di-μ-hydroxo-μ_3-oxo-dibismuth(III) sulphate. Acta Cryst., 38, 2881-2883. (4) Capitani, G.C., T. Catelani, P. Gentile, A. Lucotti, and M. Zema (2013) Cannonite [$Bi_2O(SO_4)(OH)_2$] from Alfenza (Crodo, Italy): crystal structure and morphology. Mineral. Mag., 77(8), 3067-3079. (5) (2014) Amer. Mineral., 99(11-12), 2443 (abs. ref. 4).