

Connellite**Cu₃₆(SO₄)₂Cl₆(OH)₆₂•6–12H₂O**

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Crystal Data: Hexagonal. *Point Group:* 6/m 2/m 2/m. As acicular prismatic crystals, elongated and striated || [0001], to 2.5 cm; commonly in tight radiating groups; fibrous, felted, or crusty aggregates.

Physical Properties: Hardness = 3 D(meas.) = 3.36–3.41 D(calc.) = 3.46

Optical Properties: Translucent. *Color:* Azure-blue; blue in transmitted light. *Streak:* Pale greenish blue. *Luster:* Vitreous.

Optical Class: Uniaxial (+). $\omega = 1.724\text{--}1.738$ $\epsilon = 1.746\text{--}1.758$

Cell Data: *Space Group:* P6₃/mmc. $a = 15.78\text{--}15.82$ $c = 9.10\text{--}9.14$ $Z = 1$

X-ray Powder Pattern: Concordia mine, Cape Province, South Africa; close to buttgenbachite.

13.70 (vvs), 8.00 (vvs), 2.75 (vvs), 2.29 (vvs), 3.27 (vs), 1.613 (vs), 2.51 (s)

Chemistry:	(1)	(2)	(4)		(1)	(2)	(4)
SO ₃	3.84	3.15	4.04	H ₂ O	16.81	17.13	19.55
N ₂ O ₅	0.30	0.72		–O = Cl ₂	1.59	1.53	1.21
CuO	73.41	73.38	72.25	Total	99.82	99.67	100.00
Cl	7.05	6.82	5.37				

(1) Grand Central mine, Tintic, Utah, USA; corresponds to Cu_{36.00}[(SO₄)_{1.87}(NO₃)_{0.22}]_{Σ=2.07} Cl_{7.76}(OH)_{60.28}•6.26H₂O. (2) Czar mine, Bisbee, Arizona, USA; corresponds to Cu_{36.00}[(SO₄)_{1.54}(NO₃)_{0.52}]_{Σ=2.06} Cl_{7.51}(OH)_{60.89}•6.66H₂O. (3) Toughnut mine, Tombstone, Arizona, USA; crystal structure analysis yields Cu_{36.0}[(SO₄)_{1.6}(NO₃)_{0.4}]_{Σ=2.0} Cl_{7.8}(OH)_{60.6}•6.7H₂O. (4) Cu₃₆(SO₄)₂Cl₆(OH)₆₂•12H₂O.

Polymorphism & Series: Forms a series with buttgenbachite.

Occurrence: An uncommon secondary mineral in the oxidized portions of copper deposits.

Association: Cuprite, spangolite, atacamite, botallackite, langite, malachite, azurite.

Distribution: In England, in the Wheals Gorland, Unity, Edward, the Botallack mine, and others in St. Just, and several other mines in Cornwall. At Southwick Cliffs, near Dalbeattie, Kirkcudbrightshire, Scotland. In the Britannia mine, Snowdonia, Wales. At the Cap Garonne mine, near le Pradet, Var, France. In the Sa Duchessa mine, Oridda district, Sardinia, Italy. From Laurium, Greece, in slag. At Fontana Rossa, Corsica, France. From Weibing, Salzburg, Austria. In the Clara mine, Black Forest, Germany. In the USA, in Arizona, from several mines at Bisbee and in the Toughnut mine, Tombstone, Cochise Co.; in Utah, from the Grand Central mine, Tintic district, Juab Co. and the Gold Hill mine, Tooele Co. At Spring Creek and the Ediacara mine, Flinders Ranges, South Australia, and at Broken Hill, New South Wales, Australia. In the Marharahara mine, near Woodville, New Zealand. Increasingly recognized from other minor localities.

Name: Honors Arthur Connell (1794–1863), Scottish chemist who first examined the mineral.

References: (1) Palache, C., H. Berman, and C. Frondel (1951) Dana's system of mineralogy, (7th edition), v. II, 572–573. (2) Bannister, F.A., M.H. Hey, and G.F. Claringbull (1950) Connellite, buttgenbachite, and tallingite. *Mineral. Mag.*, 29, 280–286. (3) McLean, W.J. and J.W. Anthony (1972) The disordered, “zeolite-like” structure of connellite. *Amer. Mineral.*, 57, 426–438. (4) Pollard, A.M., R.G. Thomas, P.A. Williams, R.E. Bevins, and S. Turgoose (1989) Carbonatian connellite, a new variety, from the Britannia mine, North Wales, and from the Botallack mine, Cornwall. *J. Russell Soc.*, 2(2), 23–27. (5) Hibbs, D.E., P. Leverett, and P.A. Williams (2003) A single crystal X-ray study of a sulphate-bearing buttgenbachite, Cu₃₆Cl_{7.8}(NO₃)_{1.3}(SO₄)_{0.35}(OH)_{62.2}•5H₂O, and a re-examination of the crystal chemistry of the buttgenbachite – connellite series. *Mineral. Mag.*, 67, 47–60.

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