Atacamite $Cu_2Cl(OH)_3$

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Crystal Data: Orthorhombic. *Point Group:* $2/m\ 2/m\ 2/m$. As slender crystals, to 10 cm, prismatic along [001]; striated ‖ [001], on {010} ‖ $[1\bar{1}0]$; commonly tabular ⊥ {010} or pseudo-octahedral with {110} and {011}. Fibrous, sandy granular to compact, massive. *Twinning:* Twin plane {110}, composition plane {110}, rare; about [544], more common. Doublets, triplets, both contact and penetration, and complex groups result from twinning.

Physical Properties: *Cleavage:* {010}, perfect; {101}, fair. *Fracture:* Conchoidal. *Tenacity:* Brittle. Hardness = 3–3.5 D(meas.) = 3.745–3.776 D(calc.) = 3.756

Optical Properties: Transparent to translucent. *Color:* Bright green, dark emerald-green to blackish green; shades of green in transmitted light. *Streak:* Apple-green. *Luster:* Adamantine to vitreous.
Optical Class: Biaxial (–). *Pleochroism:* X = pale green; Y = yellow-green; Z = grass-green. *Orientation:* $X = b$; $Y = a$; $Z = c$. *Dispersion:* $r < v$, strong. $\alpha = 1.831$ $\beta = 1.861$ $\gamma = 1.880$ 2V(meas.) = n.d. 2V(calc.) = 74°56′

Cell Data: *Space Group: Pnam.* $a = 6.030(2)$ $b = 9.120(2)$ $c = 6.865(2)$ Z = 4

X-ray Powder Pattern: Inca de Oro mine, Copiapó, Chile.
5.48 (100), 5.03 (70), 2.278 (69), 1.6060 (57), 2.759 (55), 2.836 (51), 2.779 (51)

Chemistry:	(1)	(2)	(3)		(1)	(2)	(3)
Cu	14.82	14.53	14.88	CaO		0.23	
CuO	56.01	55.33	55.87	Cl	16.55	16.22	16.60
CoO		0.21		H_2O	12.69	13.15	12.65
				Total	100.07	99.67	100.00

(1) Collahurasi, Chile. (2) Boleo, Mexico. (3) $Cu_2Cl(OH)_3$.

Polymorphism & Series: Polymorphous with botallackite, clinoatacamite, and paratacamite.

Occurrence: An oxidation product of other copper minerals, especially under arid, saline conditions; in fumarolic deposits; a weathering product of sulfides in subsea black smoker deposits; an alteration of bronze and copper objects of antiquity.

Association: Cuprite, brochantite, linarite, caledonite, malachite, chrysocolla, paratacamite, botallackite.

Distribution: In small amounts from many copper deposits worldwide. In Chile, originally from an undefined locality in the Atacama Desert; now known from many places, as at Copiapó, Carrizal, Tierra Amarilla, and Remolinos, Atacama; Collahurasi, Tarapacá; an ore mineral at Chuquicamata, Antofagasta. From Boleo, Baja California, Mexico. In the USA, in Arizona, at Bisbee, Cochise Co., in large amounts in the Santa Cruz porphyry deposit, in the Mammoth-St. Anthony mine, Tiger, and in the San Manuel mine, Pinal Co.; from the Tintic district, Juab Co., Utah. In South Australia, large crystals from Moonta, in the Burra district, and from Mt. Howden. At Vesuvius, Campania, and Etna, Sicily, Italy. From Laurium, Greece, in slag. At the Turinsk copper mine, Bogoslovsk, Ural Mountains, Russia. From Kara-Kamys, Kazakhstan. In England, at Roughtongill, Caldbeck Fells, Cumbria; and in the Penberthy Croft mine, St. Hilary, and at Botallack, St. Just, Cornwall. From Tsumeb, Namibia. Along the Mid-Atlantic Ridge, in the TAG Hydrothermal Field.

Name: For the undefined occurrence in the Atacama Desert, Chile.

Type Material: Harvard University, Cambridge, Massachusetts, USA, 110816.

References: (1) Palache, C., H. Berman, and C. Frondel (1951) Dana's system of mineralogy, (7th edition), v. II, 69–73. (2) Larsen, A.L. and R.B. Tripp (1972) New X-ray data on natural atacamite. U.S. Geol. Surv. Prof. Paper 800B, 119–120. (3) Parise, J.B. and B.G. Hyde (1986) The structure of atacamite and its relationship to spinel. Acta Cryst., C42, 1277–1280.

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