

Chalconatronite

Na₂Cu(CO₃)₂•3H₂O

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Crystal Data: Monoclinic (synthetic). *Point Group:* 2/*m*. As fine-grained crusts of pseudohexagonal plates or as laths; massive, in blebs and films.

Physical Properties: Hardness = “Soft”. D(meas.) = 2.27(3) D(calc.) = 2.31 (synthetic). Partially soluble in H₂O.

Optical Properties: Transparent. *Color:* Pale blue to greenish blue.

Optical Class: Biaxial (+). *Pleochroism:* X = nearly colorless; Y = pale blue; Z = blue.

Orientation: Z ⊥ flattening; Y ∥ elongation; Z ∧ c very small. α = 1.483 β = 1.530 γ = 1.576 2V(meas.) = Large.

Cell Data: *Space Group:* P2₁/*n* (synthetic). a = 6.696(2) b = 6.101(2) c = 13.779(3) β = 91.83(2)° Z = 4

X-ray Powder Pattern: Patina on Egyptian bronze figure. 6.92 (10), 4.17 (8), 3.69 (7), 7.76 (4), 2.85 (4), 2.99 (3), 2.88 (3)

Chemistry:

	(1)	(2)
CO ₂	30.5	31.04
SiO ₂	0.4	
R ₂ O ₃	0.6	
CuO	29.2	28.05
Na ₂ O	19.7	21.85
H ₂ O	19.0	19.06
Total	99.4	100.00

(1) Patina on ancient Egyptian bronze figure; CO₂ determined volumetrically, H₂O by the Penfield method; corresponds to Na_{1.74}Cu_{1.00}(CO₃)_{1.89}•2.88H₂O. (2) Na₂Cu(CO₃)₂•3H₂O.

Occurrence: A component of patina on bronze artifacts, apparently characteristic of arid weathering environments (Egypt); an uncommon secondary mineral in the oxidation zone of polymetallic deposits.

Association: Cuprite, atacamite (patina on bronze artifact); paratacamite, gypsum, brochantite, malachite, azurite, epsomite, nickeloan magnesite, glaukosphaerite, takovite, georgeite, carrboydite (Carr Boyd Rocks mine, Australia).

Distribution: Initially characterized on several ancient Egyptian artifacts. From the Carr Boyd Rocks nickel mine, Yerilla district, 80 km north-northeast of Kalgoorlie, Western Australia. At the Glückrad mine, near Oberschulenberg, Harz Mountains, Germany. In the USA, from the Deremo-Snyder mine, San Miguel Co., Colorado, and at the White Pine mine, Ontonagon Co., Michigan.

Name: From the Greek *chalcos*, for *copper*, and *natron*, the modern name for naturally occurring sodium carbonate.

Type Material: Canadian Geological Survey, Ottawa, Canada, 17254; Fogg Museum 1943.1121.6; Harvard University, Cambridge, 105297; National Museum of Natural History, Washington, D.C., USA, 112695.

References: (1) Frondel, C. and R.J. Gettens (1955) Chalconatronite, a new mineral from Egypt. *Science*, 122, 75–76. (2) (1955) *Amer. Mineral.*, 40, 943 (abs. ref. 1). (3) Gettens, R.J. and C. Frondel (1955) Chalconatronite: an alteration product on some ancient Egyptian bronzes. *Studies in Conservation*, 2(2), 64–75. (4) Mosset, A., J.-J. Bonnet, and J. Galy (1978) Structure cristalline de la chalconatronite synthétique: Na₂Cu(CO₃)₂•3H₂O. *Zeits. Krist.*, 148, 165–177 (in French with English abs.).

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