Copiapite $Fe^{2+}Fe^{3+}_4(SO_4)_6(OH)_2 \cdot 20H_2O$

Crystal Data: Triclinic. *Point Group:* $\overline{1}$. As pseudo-orthorhombic platy crystals, tabular on {010}, may be highly modified, with more than 300 forms measured, to 1 mm; typically in incrustations of scaly or granular pulverulent aggregates. *Twinning:* Contact twins with twin axis [$\overline{1}$01] and composition plane {010}.

Physical Properties: *Cleavage:* On {010}, perfect; on {$\overline{1}$01}, imperfect. Hardness = 2.5–3 D(meas.) = 2.04–2.17 D(calc.) = [2.12] Soluble in H_2O.

Optical Properties: Transparent to translucent. *Color:* Sulfur-yellow, golden yellow, pale yellow, yellow-orange; may be greenish yellow to olive-green in aggregates. *Luster:* Pearly on {010}.
Optical Class: Biaxial (+). *Pleochroism:* $X = Y$ = pale yellow to colorless; Z = sulfur-yellow. *Orientation:* $X \perp$ {010}; Y = [$\overline{1}$01]; Z = [101]; $Y \wedge c = 38°$. *Dispersion:* $r > v$, strong. *Absorption:* $X = Z > Y$. α = 1.496–1.53 β = 1.531–1.55 γ = 1.579–1.60 2V(meas.) = 52°–73°

Cell Data: *Space Group:* $P\overline{1}$. $a = 7.337(6)$ $b = 18.76(1)$ $c = 7.379(6)$ $\alpha = 91.46(7)°$ $\beta = 102.18(6)°$ $\gamma = 98.95(6)°$ Z = 1

X-ray Powder Pattern: Cache Creek, British Columbia, Canada.
18.4 (10), 9.23 (10), 5.57 (7), 6.15 (6), 3.58 (6), 3.49 (6), 4.20 (4)

Chemistry:

	(1)	(2)		(1)	(2)
SO_3	38.37	38.43	FeO	4.06	5.75
Al_2O_3	trace		H_2O	30.68	30.27
Fe_2O_3	26.10	25.55	insol.	0.71	
			Total	99.92	100.00

(1) Capo d'Arco, Elba, Italy. (2) $Fe^{2+}Fe^{3+}_4(SO_4)_6(OH)_2 \cdot 20H_2O$.

Mineral Group: Copiapite group.

Occurrence: A secondary mineral formed typically by the weathering and oxidation of pyrite in a wide range of rock types, preserved in arid climates; rarely associated with fumarolic action.

Association: Melanterite, alunogen, fibroferrite, halotrichite, botryogen, butlerite, amarantite.

Distribution: One of the most common ferric sulfates. In small amounts from many localities, with well studied material from: in Chile, at Tierra Amarilla, southeast of Copiapó, Atacama; from Alcaparrosa, near Cerritos Bayos, southwest of Calama, and at Chuquicamata, Antofagasta. In the USA, in California, from Coso Hot Springs, Inyo Co., Sulphur Bank, Lake Co., the Alma mine, Leona Heights, Alameda Co., and elsewhere; from the Comstock Lode, Virginia City, Storey Co., Nevada; in the Dexter No. 7 mine, Calf Mesa, San Rafael district, Emery Co., Utah; in Arizona, at Bisbee, Cochise Co., and from the United Verde mine, Jerome, Yavapai Co. At the Rammelsberg mine, near Goslar, Harz Mountains, Germany. In Italy, at Capo Calamita and Capo d'Arco, Elba; in Alum Cave, Vulcano, Lipari Islands. From volcanoes on the Kamchatka Peninsula, Russia.

Name: For the city of Copiapó, Chile, near which specimens were first collected.

Type Material: Harvard University, Cambridge, Massachusetts, USA, 99059.

References: (1) Palache, C., H. Berman, and C. Frondel (1951) Dana's system of mineralogy, (7th edition), v. II, 623–627. (2) Süsse, P. (1972) Crystal structure and hydrogen bonding of copiapite. Zeits. Krist., 135, 34–55. (3) Fanfani, L., A. Nunzi, P.F. Zanazzi, and A.R. Zanzari (1973) The copiapite problem: the crystal structure of a ferrian copiapite. Amer. Mineral., 58, 314–322. (4) Schmetzer, K. and O. Medenbach (1983) Challantit [= copiapite] aus Cache Creek, British Columbia, Kanada - ein zweiter Fundpunkt. Neues Jahrb. Mineral., Monatsh., 158–162 (in German with English abs.). (5) Bayliss, P. and D. Atencio (1985) X-ray powder-diffraction data and cell parameters for copiapite-group minerals. Can. Mineral., 23, 53–56.