Lindgrenite $Cu_3(MoO_4)_2(OH)_2$

Crystal Data: Monoclinic. *Point Group:* $2/m$. Crystals are tabular or platy on {010}, to 2 cm, showing {010}, may be striated ‖ [001], showing forms {100}, {021}, and a number of others; rarely acicular along [101] with square outline; as crusts, massive.

Physical Properties: *Cleavage:* {010}, perfect; {101} and {100}, very poor. Hardness = 4.5 D(meas.) = 4.20 D(calc.) = 4.29

Optical Properties: Transparent. *Color:* Green, yellowish green; pale green to yellow-green in transmitted light.
Optical Class: Biaxial (–). *Orientation:* $Z = b$; $X \wedge c = 9°$. *Dispersion:* $r > v$. $\alpha = 1.930(3)$ $\beta = 2.002(3)$ $\gamma = 2.020(3)$ 2V(meas.) = 71°

Cell Data: *Space Group:* $P2_1/n$. $a = 5.608(1)$ $b = 14.023(3)$ $c = 5.394(1)$ $\beta = 98.50(1)°$ Z = 2

X-ray Powder Pattern: Chuquicamata, Chile. (ICDD 36-405).
3.521 (100), 3.479 (65), 4.164 (50), 2.684 (40), 3.583 (30), 2.724 (25), 2.777 (20)

Chemistry:

	(1)	(2)	(3)
MoO_3	53.71	52.88	52.87
SiO_2		0.10	
FeO		0.08	
CuO	42.81	43.01	43.82
PbO		0.46	
H_2O	3.48	[3.30]	3.31
Total	[100.00]	[99.82]	100.00

(1) Chuquicamata, Chile; recalculated from an original total of 99.66% after deduction of Fe_2O_3 1.43% and SiO_2 3.34%; corresponds to $Cu_{2.88}(MoO_4)_{2.00}(OH)_{2.08}$. (2) Do.; by electron microprobe, average of ten analyses; total Fe as FeO, H_2O calculated from stoichiometry; corresponds to $Cu_{2.95}Si_{0.01}Fe_{0.01}Pb_{0.01}(MoO_4)_{2.01}(OH)_2$. (2) $Cu_3(MoO_4)_2(OH)_2$.

Occurrence: An uncommon secondary mineral in the oxidized zone of molybdenum-bearing copper deposits.

Association: Antlerite, molybdenite, powellite, brochantite, chrysocolla, iron oxides, quartz.

Distribution: In Chile, from Chuquicamata, Antofagasta; at the San Samuel mine, Carrara Pinto, and in the Jardinera No. 1 mine, five km east of Inca de Oro, Atacama. From the Brandy Gill mine, Caldbeck Fells, Cumbria, England. In the USA, at the Lodi No. 4 mine, Spring Creek district, Plumas Co., California; from Arizona, in the Live Oak pit, Inspiration mine, Globe-Miami district, Gila Co.; in the Cave Creek district, Maricopa Co.; at the Esperanza mine, Pima Co.; in the Childs-Aldwinkle mine, Copper Creek district, and on the Hull claims, south of Ray, Pinal Co.; from the Helena mine, Seven Devils district, Adams Co., Idaho.

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Type Material: The Natural History Museum, London, England, 1936,102; Harvard University, Cambridge, Massachusetts, USA, 97527, 97528.

References: (1) Palache, C., H. Berman, and C. Frondel (1951) Dana's system of mineralogy, (7th edition), v. II, 1094–1095. (2) Hawthorne, F.C. and R.K. Eby (1985) Refinement of the crystal structure of lindgrenite. Neues Jahrb. Mineral., Monatsh., 234–240. (3) Francis, C.A., L.C. Pitman, and D.E. Lange (1997) Szenicsite, a new copper molybdate from Inca de Oro, Atacama, Chile. Mineral. Record, 28, 387–394. (4) Palache, C. (1935) Lindgrenite, a new mineral. Amer. Mineral., 20, 484–491.