

Freedite**Pb₈Cu¹⁺(As³⁺O₃)₂O₃Cl₅**

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Crystal Data: Monoclinic, pseudotetragonal. *Point Group:* 2/m. As composite crystals in slightly radial aggregates.

Physical Properties: *Cleavage:* Perfect on {100}. *Fracture:* Irregular. *Tenacity:* Brittle. Hardness = ~3 D(meas.) = 7.0(5) D(calc.) = 7.43

Optical Properties: Transparent to translucent. *Color:* Bright greenish yellow. *Streak:* Yellow. *Luster:* Greasy to vitreous. *Optical Class:* Biaxial. *Pleochroism:* Weak to none. $\alpha = > 1.90$ $\beta = > 1.90$ $\gamma = > 1.90$ 2V(meas.) = n.d.

Cell Data: *Space Group:* C2/m. $a = 13.578(2)$ $b = 20.099(3)$ $c = 7.465(1)$
 $\beta = 105.73(1)^\circ$ Z = 4

X-ray Powder Pattern: Långban, Sweden.
2.949 (10), 2.830 (8), 2.734 (8), 3.832 (5), 2.096 (5), 6.51 (4), 3.581 (4)

Chemistry:	(1)	(2)
As ₂ O ₃	9.2	9.02
FeO	0.4	
PbO	80.2	81.45
CuO	4.9	3.26
Cl	8.0	8.09
-O = Cl ₂	1.8	1.82
Total	100.9	100.00

(1) Långban, Sweden; by electron microprobe, total Cu as CuO, total Fe as FeO, total As as As₂O₃; neglecting H₂O + CO₂ 0.2% by TGA-EGA-mass spectrometer, corresponds to Pb_{29.4}Cu_{5.1}Fe_{0.5}As_{7.6}Cl_{18.4}O_{37.1}. (2) Pb₈Cu(AsO₃)₂O₃Cl₅.

Occurrence: An uncommon mineral in andradite-magnetite ore from a metamorphosed Fe-Mn orebody.

Association: Ecdemite, lead, copper, finnemanite, calcite, andradite, magnetite.

Distribution: At Långban, Värmland, Sweden.

Name: Honors Dr. Robert L. Freed, American mineralogist, of Trinity University, San Antonio, Texas, USA.

Type Material: National Museum of Natural History, Washington, D.C., USA, 160353 and 160354.

References: (1) Dunn, P.J. and R.C. Rouse (1985) Freedite and thorikosite from Långban, Sweden, and Laurion, Greece: two new species related to the synthetic bismuth oxyhalides. *Amer. Mineral.*, 70, 845-848. (2) Pertlik, F. (1987) The structure of freedite, Pb₈Cu(AsO₃)₂O₃Cl₅. *Mineral. Petrol.*, 36, 85-92.