Paddlewheelite $MgCa_5Cu_2(UO_2)_4(CO_3)_{12}\cdot 33H_2O$

Crystal Data: Monoclinic. *Point Group*: *m*. As thin tabular crystals flattened on {100}, massive.

Physical Properties: *Cleavage*: At least one perfect on {100}. *Fracture*: n.d. *Tenacity*: Brittle. Hardness = ~2 D(meas.) = n.d. D(calc.) = 2.497 Soluble with effervescence in dilute HCl.

Optical Properties: Transparent. *Color*: Blue-green. S*treak*: Very pale blue-green.
Luster: Sub-adamantine.
Optical Class: Biaxial (+). $\alpha = 1.520(2)$ $\beta = 1.527(2)$ $\gamma = 1.540(2)$ 2V(meas.) = 72(1)°
Pleochroism: $X \approx Y$ = blue green, Z = pale yellow. *Absorption*: $X \approx Y >> Z$.
Orientation: $Z \parallel b$, $X = a$, $Y = c$. *Dispersion*: Weak, $r < v$.

Cell Data: Space Group: *Pc*. $a = 22.052(4)$ $b = 17.118(3)$ $c = 19.354(3)$ $\beta = 90.474(2)°$ Z = 4

X-ray Powder Pattern: Prokop vein, Svornost mine, Jáchymov District, Bohemia, Czech Republic. 11.12 (100), 7.33 (46), 4.642 (38), 5.54 (37), 4.215 (34), 4.823 (33), 3.717 (33)

Chemistry:

	(1)	(2)	(3)
CaO	12.47	10.74	10.21
CuO	2.65	2.28	5.80
FeO	0.01	0.01	
MgO	1.7	1.47	1.47
SiO_2	0.42	0.36	
UO_3	49.38	42.97	41.65
CO_2	[22.8]	19.84	19.23
H_2O	[25.66]	22.33	21.64
Total	115.09	100.00	100.00

(1) Prokop vein, Svornost mine, Jáchymov District, Bohemia, Czech Republic; average of 6 electron microprobe analyses supplemented by Raman spectroscopy and laser-ablation inductively-coupled-plasma mass spectrometry, CO_2 and H_2O calculated from structure. (2) Do. Normalized; corresponds to $Mg_{0.98}Ca_{5.16}Cu_{0.77}Si_{0.16}(UO_2)_4(CO_3)_{12}(H_2O)_{33}$. (3) $MgCa_5Cu_2(UO_2)_4(CO_3)_{12}\cdot 33H_2O$.

Occurrence: A secondary oxidation product of uraninite, formed by concomitant dissolution of uraninite, calcite, dolomite, chalcopyrite, and andersonite, in a weathered hydrothermal Ag-Co-Ni-Bi-As±U (five-element vein type) ore deposit.

Association: Calcite, dolomite, chalcopyrite, andersonite, uraninite, quartz, hematite, goethite (var. "sammetblende").

Distribution: From the Prokop vein on the 5th level, Svornost (Concord) mine, Jáchymov District, Bohemia, Czech Republic.

Name: Alludes to the geometry of uranyl tricarbonate units in the atomic structure, which resemble steamboat "paddle-wheels".

Type Material: Natural History Museum of Los Angeles County, Los Angeles, California, USA (66696).

References: (1) Olds, T.A., J. Plášil, A.R. Kampf, F. Dal Bo, and P.C. Burns (2018) Paddlewheelite, a new uranyl carbonate from the Jáchymov District, Bohemia, Czech Republic. Minerals, 8(11), 511. (2) (2020) Amer. Mineral., 105(8), 1280-1281 (abs. ref. 1).