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Choloalite, $CuPb(TeO_3)_2 \cdot H_2O$, a new mineral

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ABSTRACT. Probably first found in Arabia, then Moctezuma, Sonora (the type locality), finally at Tombstone, Arizona. Crystals are cubic, invariably octahedral in habit, up to 2 mm in size. Colour forest green (RHS 136A), H = 3, $D = 6.4$.

Wet chemical analysis gave CuO 11.0%, PbO 33.0, TeO_2 50.7, H_2O 3.4; soluble in cold dilute acids. The strongest lines are 7.223(5), 4.170(2), 3.614(3), 3.472(4), 3.343(6), 3.036(10), 2.952(3), 2.454(5) Å. The cell indexes as cubic, $a = 12.519$ Å; for Z = 12, $\rho_{calc} = 6.41 \cdot g/cm^3$. May be anisotropic in thin section with birefringence up to 0.011; $n = 2.04$.

ACCORDING to information provided by F. P. Cesbron (pers. comm.) this mineral was first found in Arabia with a host of other unknown tellurium minerals. An X-ray powder pattern was taken (see Table II) and the material then discarded. Some years later (July 1977) one specimen containing choloalite was found in waste rock littering the floor of the tunnel at the Mina La Oriental (formerly Mina Bambollita), Moctezuma, Mexico. Despite careful study of this mine, the mineral had escaped detection for eight years. Careful search of the remaining debris in the tunnel turned up one more piece which fitted together with the original one. No more has been found there, nor has the mineral ever been observed *in situ* in the vein.

These two pieces represent the type specimen on which most of the work to define the species has been done. Choloalite crystals and crystalline crusts vein the matrix of the type piece extensively (the matrix is intensely sericitized rhyolite vitrophyre) and no other tellurium minerals, or any metallic minerals of any kind, are present.

A month after the discovery at Mina La Oriental, a specimen containing tiny choloalite crystals was found at Tombstone, Arizona. This small piece, rich in cerussite, rodalquilarite, and emmonsite was found lying on the surface between the dumps of the Joe and Grand Central shafts. There is uncertainty as to which mine produced the specimen because at this time the dumps had been removed for leaching and the surface extensively scraped. A few other similar pieces were subsequently found in the same area.

Only the Tombstone material is able to provide paragenetic information. A thin section of a rich piece shows large (1 mm) subhedra of choloalite corroded by fibrous crusts of emmonsite. Cerussite is younger, and rodalquilarite, which occurs elsewhere in the specimen, is also older than emmonsite and cerussite. These minerals all occur within fragments of severely brecciated shale that has been replaced by opal and granular jarosite. The breccia matrix is vuggy quartz.

TABLE I. *Chemical analysis of choloalite*

	1	2	3
CuO	11.0%	0.90	12.4%
PbO	33.0	0.96	34.9
TeO_2	50.7	2.07	49.9
H_2O	3.4	1.23	2.8
	98.1		100.0

1. CuO, avg. of 11.02, 11.02, 11.0, 11.0 on 109 μg, 330 μg, 285 μg, and 464 μg; PbO avg. of 33.2%, 32.8, 32.9 on 330 μg, 285 μg, and 464 μg; TeO_2 51.2%, 50.5, 50.5 on 109 μg, 330 μg, and 464 μg; H_2O by Penfield method on 156 μg.
2. Atoms per 6 oxygen (excluding H_2O).
3. Theory for $CuPb(TeO_3)_2 \cdot H_2O$.

Chemistry. Preliminary spectrographic analysis showed major Cu, Pb, and Te with minor Ca and Sb, the latter two shown to be trace constituents. Wet chemical analysis for Cu, Pb, and Te was planned to also determine the valence of Te, all of which was found to be Te^{4+}. The results of the analysis are shown in Table I. They lead to the empirical formula $Cu_{0.87}Pb_{0.93}(TeO_{2.90})_{2.00} \cdot 1.19H_2O$ or $CuPb(TeO_3)_2 \cdot H_2O$.

The absence of other anions was shown by microchemical tests. During testing it was found that choloalite is readily soluble in cold, dilute nitric or hydrochloric acid. It fuses with ease (F = 2) to a runny brown glass.

Crystallography. Powder pattern lines from the type specimen were found to match those provided by Dr Cesbron for Arabian material well. Arabian and Tombstone patterns match still more closely. These results are presented in Table II.

At both La Oriental and Tombstone crystals show a strong tendency to euhedral development and are invariably simple octahedra. All crystals large enough to measure goniometrically, however, were flawed by corrosion of their faces, a simple 'frosting' that prevented reflection of signals. Perfect crystals were found but were far too small for measurement. Thus the term 'octahedra' is reduced to a visual assessment of habit.

Crystals viewed in thin section show sectoring into polygonal domains. Some are sensibly isotropic, others show birefringence up to 0.011 but variable optical character.

The reader will note, however, that the powder data index convincingly on an isometric cell, and this is assumed to be the true symmetry. Using the data to refine a cell, for the type specimen a = 12.519 Å, for Tombstone 12.576, for Arabia 12.586. For Z = 12, ρ_{calc} = 6.41 g/cm^3 (type specimen). The estimated intensities of lines in Table II are based on the Tombstone pattern but apply well to the other two.

Physical and optical properties. Choloalite is forest green (RHS 136A) with a paler streak (RHS 136C), both at La Oriental and Tombstone. The lustre is adamantine. No cleavage was observed; crystals are brittle with irregular fracture and Mohs hardness is 3. The specific gravity was determined by the Thoulet method on 253 μg in alcohol (Cahn balance) and found to be 6.4 $\pm$ 0.1 (three trials).

The colour in thin section is deep green and no pleochroism can be observed in crystals that show anomalous birefringence. I know of no species that closely resembles choloalite in thin section. The refractive index of type material is 2.04 (white light).

Discussion. Although choloalite closely resembles khinite and parakhinite in chemistry and appearance in hand specimen, it is clearly distinct since it is a tellurite, not a tellurate.

The larger cell edge of the Tombstone choloalite corresponds with the presence of minor Sb in that

TABLE II. *X-ray powder data for choloalite*

	La Oriental		Tombstone		Arabia		
I/I_{est}	d_{meas}	d_{calc}	d_{meas}	d_{calc}	d_{meas}	d_{calc}	$\Sigma(h^2+k^2+l^2)$
5	7.223	7.228	7.260	7.261	7.300	7.267	3
2	4.170	4.173	4.187	4.192	4.189	4.196	9
½	—	—	3.975	3.977	3.993	3.980	10
3	3.614	3.614	3.632	3.630	3.647	3.633	12
4	3.472	3.472	3.490	3.488	3.490	3.491	13
6	3.343	3.346	3.360	3.361	3.358	3.364	14
10	3.036	3.036	3.052	3.050	3.053	3.053	17
3	2.952	2.951	2.964	2.964	2.953	2.967	18
1	2.875	2.872	2.885	2.885	2.874	2.888	19
½	2.809	2.799	2.812	2.812	—	—	20
1	2.734	2.732	2.746	2.744	2.738	2.747	21
½	—	—	2.680	2.681	2.675	2.683	22
5	2.454	2.455	2.467	2.467	2.464	2.468	26
½	—	—	2.339	2.335	2.330	2.337	29
½	2.184	2.179	2.189	2.189	2.195	2.191	33
½	—	—	2.162	2.157	—	—	34
½	—	—	2.127	2.126	2.121	2.127	35
½	—	—	2.097	2.096	2.096	2.098	36
½	—	—	2.059	2.040	2.046	2.042	38
2	1.954	1.955	1.966	1.964	1.963	1.966	41
2	1.931	1.932	1.942	1.941	1.937	1.942	42
2	1.906	1.909	1.921	1.918	1.916	1.919	43
2	1.888	1.887	1.897	1.896	1.893	1.897	44
1	—	—	1.877	1.875	—	—	45
2	1.844	1.846	1.856	1.854	1.851	1.856	46
1	—	—	1.819	1.815	—	—	48
1	—	—	1.799	1.797	1.797	1.798	49
2	1.772	1.770	1.780	1.779	1.776	1.780	50

material. It was not possible, unfortunately, to pick enough material for analysis.

The name choloalite derives from the Nahua word choloa, meaning evasive, in allusion to the fact that the mineral escaped detection for many years. The mineral and name have been approved by the Commission on New Minerals and New Mineral Names, IMA (80-19).

Although several pieces have been found (including the type), only a scant few milligrammes of mineral are represented. Type material has been deposited at the British Museum (NH).

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