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Cuzticite and eztlite, two new tellurium minerals from Moctezuma, Mexico

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ABSTRACT. The new minerals were found together in oxidized ores at the Bambolla mine, Moctezuma, Sonora. Both occur with various iron oxides, emmonsite, schmitterite, and kuranakhite. Cuzticite, $Fe_2TeO_6 \cdot 3H_2O$, is yellowish, H = 3, G = 3.9, occurring as crusts with a scaly structure. No single crystals were found, but X-ray powder data indicate a hexagonal cell $a = 5.045$, $c = 14.63$ Å. Strongest lines are 3.256 (10), 2.518 (7), 4.871 (4), 2.239 (3), and 1.564 (3).

Eztlite, $Fe_6Pb_2(TeO_3)_3TeO_6(OH)_{10} \cdot nH_2O$, is blood red, as paper-thin sparkling crusts, H = 3, G = 4.5. A possible cell found by the Ito method is monoclinic $a = 6.58$, $b = 9.68$, $c = 20.52$ Å, $\beta = 90° 15'$; strongest lines are 3.426 (10), 3.289 (10), 4.037 (9), 3.239 (9), and 2.445 (7B).

Both minerals and their names have been approved by the Commission on New Minerals and Mineral Names, IMA.

DURING examination of the Bambolla mine dumps, three pieces were found containing cuzticite, one of which also contained eztlite. The matrix of these pieces is intensely silicified rhyolite vitrophyre that has been intimately brecciated and cemented by drusy quartz carrying pyrite and tellurides (probably gold tellurides or native gold and tellurium). This material has been thoroughly oxidized. It seems that iron oxides (mainly goethite) first replaced pyrite and encrusted nearby fracture surfaces. Tellurium was evidently retained in emmonsite. Continuing oxidation caused dissolution of most emmonsite, and the tellurium released may have reacted with earlier goethite and other iron oxides to produce cuzticite, eztlite, and kuranakhite.

Cuzticite that is almost gel-like in character replaces goethite pseudomorphs after pyrite. Better crystallized cuzticite forms crusts on fracture surfaces around the pyrite. These crusts are warty, even stalactitic, and can be seen to be built up of minute scales of the mineral. Eztlite occurs as thin but sparkling crusts on cuzticite. Sometimes these are again encrusted by cuzticite.

Kuranakhite occurs as rosettes of coarse (2-5 mm) tabular crystals of deep red-black colour. They seem earlier than cuzticite or eztlite although kuranakhite was not noted in direct contact with the new minerals.

Physical properties. Cuzticite is yellow, inclining to brown, the colour varying subtly from one protuberance to another or through the thickness of the crusts which in fact suggest rhythmic deposition. In hand specimen it could easily be considered goethite. The Mohs hardness of compact material is 3. The specific gravity of tiny, compact particles was estimated as 3.9 in Clerici solution.

Eztlite is a rich, brilliant red colour (RHS 187A) with an orange streak. The appearance could suggest carminite or cuprite. The Mohs hardness of 3; the crusts are very brittle. The specific gravity estimated by the sink-float method in Clerici solution is 4.5.

Chemistry. The analyst looked for Pb, Fe, Te, Mn, and Al by Atomic Absorption, and Te^{+4} was sought by colorimetry. The analytical results are presented in Table I. The value of TeO_2 is determined directly (colorimetry) and ΣTe determined by AAS so that TeO_3 is found by difference. The low summation for eztlite (97.5%) is probably due to losses in recovering insoluble residue following acid digestion.

Cuzticite is easily soluble in cold 10% HCl and slowly soluble in HF-HNO_3; it appears to be insoluble in NaOH (cold) or 50% HNO_3. Heated in the closed tube, it readily loses water, fusing to a black scoriaceous slag. Eztlite is readily soluble in cold 15% HCl, dissolving with difficulty in warm 50% HNO_3. Heated in the closed tube it turns black with a cindery appearance, readily losing its water.

The formulae thus found are given as follows: cuzticite, $Fe_2TeO_6 \cdot 3H_2O$; eztlite, $Fe_6Pb_2(TeO_3)_3TeO_6(OH)_{10} \cdot nH_2O$ with n about 8. Owing to the relative complexity of the formula and the tiny amount analysed, it is best to use 'n' to indicate the lack of certainty.

X-ray study. Neither species occurs in single crystals of sufficient size for X-ray study, so all

TABLE I. *Chemical analyses of cuzticite and eztlite*

	1 %	2 %	3 %	4 %
Fe_2O_3	41.1	41.02	24.3	26.41
Mn_2O_3*	~0.4	—	n.d.	—
Al_2O_3	n.d.	—	n.d.	—
PbO	—	—	25.5	24.61
TeO_2	tr.	—	26.8	26.39
TeO_3	45.1	45.10	8.6	9.68
H_2O	13.6	13.88	12.3	12.91
Total	100.2	100.00	97.5	100.00

* No valence determination.

1. Cuzticite, average of three analyses on 629, 602, and 509 μg. Water by Penfield method on 224 μg. Analyses based on 629 and 602 μg were used for elemental ratios only; the analysis on 509 μg was corrected for 108 μg insol. (quartz).
2. Theory for $Fe_2TeO_6 \cdot 3H_2O$.
3. Eztlite, one analysis based on 271 μg corrected for 48 μg insol. (quartz); Water by Penfield method on 945 μg.
4. Theory for $Fe_6Pb_2(TeO_3)_3TeO_6(OH)_{10} \cdot 8H_2O$.

work was confined to use of the powder method. Cuzticite that replaces pyrite *in situ* gives very diffuse patterns, but they are clearly identical to the much better patterns provided by scaly crusts. In some places crusts show extra faint lines; elsewhere all lines visible are indexible on the Ito cell chosen. The pattern of the purest material available (also used for the analysis) is presented in Table II.

These data were readily indexed as hexagonal, the proposed cell having $a = 5.045$, $c = 14.63$ Å. This cell would provide a density of 4.01 g/cm^3 if Z = 2, in fair agreement with the measured specific gravity of 3.9.

The powder pattern for eztlite is considerably more complex, with numerous strong lines from 10 to 2.5 Å, rapidly deteriorating below that value to more diffuse lines. An orthorhombic cell was found by the Ito method and could be substantially improved by assuming lower symmetry. The proposed cell is then monoclinic with $a = 6.58$, $b = 9.68$, $c = 20.52$ Å, $\beta = 90° 15'$. This indexes the lines adequately and gives a calculated density of 4.60 g/cm^3 (Z = 2) as contrasted with a measured specific gravity of 4.5.

Optics. Neither species is well suited for thin-section study owing to minute grain size. Cuzticite is dark yellow in thin section and could perhaps

TABLE II. *X-ray powder data for cuzticite and eztlite*

Cuzticite				Eztlite			
$I/I_{0\,\mathrm{est}}$	d_{meas}	d_{calc}	*hkl*	$I/I_{0\,\mathrm{est}}$	d_{meas}	d_{calc}	*hkl*
4	4.871	4.875	003	5	10.27	10.26	002
10	3.256	3.256	103	5	5.587	5.587	013
7	2.518	2.525	110	6	5.130	5.131	004
3	2.239	2.242	113	5	4.752	4.752	$10\bar{3}$
2	1.994	1.996	203	3	4.534	4.534	014
2	1.751	1.752	205	3	4.257	4.251	113
		1.754	116	9	4.037	4.037	104
3	1.564	1.566	213	2	3.721	3.726	114
3	1.457	1.458	300	10	3.426	3.421	006
				10	3.289	3.289	200
						3.283	$11\bar{5}$
				9	3.239	3.245	201
				3	3.129	3.128	202
						3.131	025
						3.114	210
				5	3.019	3.029	106
				5	2.941		
				4B	2.792		
				5	2.669		
				6	2.613		
				5	2.566		
				7	2.445		

be confused with goethite. The scales are sensibly isotropic viewed normal to the plane (which is also a fair cleavage). Thus 2V(−) must be very small or nil. The indices were determined in oils as $\omega = 2.06$, $\varepsilon = 2.05$ in white light. Despite the strong colour, no dichroism is observable.

Eztlite grains are deep cloudy orange in thin section and are not pleochroic. A good cleavage, probably (001) is always a length slow direction with extinction (to γ) of 3°. This provides some support for monoclinic (or lower) symmetry. The indices were estimated in S–Se melts as np = 2.14, ng = 2.15 (white light).

Additional comments. Eztlite is clearly distinct as a new species, the only compound even remotely similar is kuranakhite. This recently described mineral (Yablokova *et al.*, 1975) has been assigned the formula $PbMnTeO_6$ on the basis of microchemical evidence and microprobe analysis. Our analyses by AAS and XES, based on what sounds like considerably superior material, fail to confirm the assigned formula, yet there is still no similarity with eztlite. A study of kuranakhite is forthcoming but awaits solution of the nettlesome problem of mixed valences.

Proof that cuzticite is a new species is easily obtained; it differs considerably from chemically similar minerals such as 'blakeite', sonoraite, poughite, emmonsite, rodalquilarite, or mackayite. There are numerous artificial compounds of Fe–Mn and TeO_x reported in the literature, however. Some are of dubious purity, perhaps, but all were considered as candidates for identity with cuzticite. One is remarkably similar. Described by Bayer (1962) as Fe_2TeO_6 it is evidently tetragonal, but with X-ray lines similar to those of cuzticite. In fact, there are other compounds, including 'blakeite', that seem similar, or exhibit one or two of the same strongest X-ray lines. Clearly there are numerous possible tellurites and tellurates of iron, and considerable work will have to be done to properly characterize them. The names are derived from the Nahua language. Cuzticite (CŪ·ZTĬKAIT) is from *cuztic*, something yellow, in allusion to the colour. Eztlite (Ĕ·STLAIT) is from *eztli* meaning blood, again in reference to the colour.

Thus far, only one specimen of eztlite, three of cuzticite, have been found, and the total quantity of minerals involved is in the tens of mg range. Type material will be provided to the British Museum (N.H.) and the Geological Museum of the University of Arizona.

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