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Bideauxite, a new Arizona mineral

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SYNOPSIS. Bideauxite is a new mineral found in specimens from the Mammoth–St. Anthony mine, Pinal County, Arizona. The composition is $\text{Pb}_2\text{AgCl}_3(\text{F},\text{OH})_2$ with Pb, Ag, Cl, F by duplicate wet analyses. $Z = 16$, G. calc. 6.256, meas. 6.274 (at 24.2 °C). Crystals are isometric hexoctahedral with $a = 14.132 \text{ \AA}$. Space group $Fd\bar{3}m$. Crystals show a, o, d, m {113}, μ {114}, n {112}, ϕ {116}, and {029} in decreasing order of importance. Colourless, transparent with white streak. Isotropic with $n_D^{20} 2.192$. Cleavage, almost sectile, with conchoidal fracture. $H = 3$. Turns pale lavender in strong light. Low M.P. **R.P.** Decomposes in acids and warm NH_4OH . Bideauxite is an oxide zone mineral found with leadhillite, matlockite, and anglesite. May alter to cerussite.

BIDEAUXITE is a new mineral found at the Mammoth–St. Anthony mine, Tiger, Pinal County, Arizona. The specimen providing material for this study belongs to the U.S. National Museum (No. 114583) and carries a Scott Williams label stating ‘Buddy Miller Collection—1956’. It is labelled ‘cerargyrite’.

The identity of this ‘cerargyrite’ was first questioned by Richard A. Bideaux, a connoisseur of minerals and mineralogist of Tucson, Arizona. He noted a tiny pink fragment on a boléite specimen in the Harvard collection, and subsequently found another fine piece at the U.S. National Museum, so that two specimens are now known. Mr. Bideaux loaned these pieces to me for study at my request, and the new mineral is named in his honour.

Occurrence. The exact site of occurrence in the mine can only be guessed. The specimens strongly suggest an occurrence in the Collins vein near the base of the oxide zone. Bideauxite crystals envelop and replace boléite, the most abundant mineral on the specimens. There is no particular mutual orientation of the two species. Some areas of the pieces are covered with crystalline leadhillite and small corroded matlockite tablets, and interstices among these minerals may be filled with sugary anglesite. The specimen obviously was derived from massive galena and a dense mixture of cerussite, anglesite, and covellite showing relic cleavage pattern comprises the matrix on which other species are crystallized.

Most of the bideauxite crystals are filmed with later cerussite but a few are in pristine condition. The matrix of these oxide minerals is spongy quartz.

Physical and optical properties. Bideauxite is perfectly colourless and exhibits an adamantine lustre. With continued exposure to strong light it gradually assumes a pale lavender tint and becomes dull. The streak is white. Hardness on Mohs's scale is 3. The mineral is brittle but verges on sectile when pressed or pushed with a needle. There is no cleavage and the fracture is conchoidal. This specific gravity is 6.274 ± 0.008 , measured at 24.2°C on a Berman balance in toluene. Four trials were averaged using fragments of about 15 mg each. The mineral is absolutely isotropic and its index of refraction is $n_D 2.178$ measured in S-Se melts. A polished crystal measured by Brewster's method gave $n_D 2.192$. A Gaertner divided circle spectrometer was used for this measurement. Repeated measurements gave a precision (calculated as r.i.) of ± 0.015 . Dispersion is low.

Bideauxite readily melts in a Bunsen burner flame yielding a brilliant yellow liquid (like molten sulphur) and evolving dense white vapour. With further heating it boils to a viscous carmine red liquid. Crystal fragments showed no sign of fusion in the S-Se melts used for index determination but nevertheless the Brewster method results are probably more reliable.

TABLE I. *Chemical analysis of bideauxite*

	Bideauxite	Pb ₂ AgCl ₃ FOH	Cell contents
Pb*	62.66 %	62.35	32.26
Ag*	15.74	16.23	15.55
Cl†	14.74	16.00	44.34
F‡	3.26	2.86	18.30
OH§	(2.78)	2.56	(17.43)
	99.18	100.00	

* Duplicate analyses on 11.45 and 11.15 mg respectively gave Pb = 62.78 %, 62.55 %; Ag = 15.86 %, 15.61 %. Analyses by Jack A. Allen using atomic absorption.

† Duplicate analyses on samples of exactly 3.922 mg each gave Cl = 14.75 %, 14.72 %. Schwarzkopf Microanalytical Laboratory, Inc. Analyses on the same two samples gave no Br or I.

‡ Duplicate analyses on 6.201 and 8.970 mg gave F = 3.40 %, 3.11 % respectively. Schwarzkopf Microanalytical Laboratory, Inc.

§ Calculated from charge balance requirements.

Chemical analysis. Bideauxite is readily dissolved by hot or cold, dilute or concentrated HNO₃. In dilute, cold HCl it throws down flocky AgCl. It is unaffected by cold NH₄OH but decomposes when warmed. Microchemical tests for sulphate, nitrate, and carbonate were negative. A halide test was strongly positive.

Emission spectrography of a sample diluted with graphite showed strong Pb and Ag lines and traces of Mg and Ca. Another sample doped with CaCO₃ showed a strong CaF bandhead at 6064.4 Å. The results of chemical analyses planned on the basis of this information are presented in table I. The Cl was determined by titration with AgNO₃ after combustion in V₂O₅ and O₂ and collection in H₂O and H₂O₂. Br was determined iodometrically as BrO₃; I by the starch colorimetric procedure. Fluorine was determined by combustion and titration with La-EDTA. Lead and silver were

run on atomic absorption in 25 % HCl. The OH was found qualitatively by a modification of Penfield's method and its weight % calculated on the basis of charge requirements.

The unit cell contents, derived on the basis of the measured cell-edge and specific gravity, are included in table I. The formula may clearly be written as $Pb_2AgCl_3(F,OH)_2$ with F:OH close to 1:1 and $Z = 16$.

Morphology. Crystals occur only on one specimen and vary from 2 to 7 mm in greatest dimension. They are well-formed and free of distortion. All evidence of symmetry points to the hexoctahedral class. A small crystal showed $a, d, o, \phi, \mu, m, n,$ and $\{029\}$. Larger crystals are dominated by a, o and modified by d and $m \{113\}$.

TABLE II. X-ray powder data for bideauxite; Cr-K α radiation.
Intensities estimated

<i>I</i>	<i>d</i> _{meas}	<i>d</i> _{calc}	<i>hkl</i>	<i>I</i>	<i>d</i> _{meas}	<i>d</i> _{calc}	<i>hkl</i>	<i>I</i>	<i>d</i> _{meas}	<i>d</i> _{calc}	<i>hkl</i>
4	8.162 Å	8.159 Å	111	1	1.577 Å	1.580 Å	840	3	1.146 Å	1.146 Å	{12.2.2 10.6.4
2	4.986	4.996	220	4	1.541	1.542	842	1	1.135	1.135	{11.5.3 975
7	4.259	4.261	311	3	1.506	1.506	664	2	1.104	1.104	{12.4.2 886
7	4.076	4.080	222	1	1.481	1.481	931	3	1.420	1.420	{755 771 933
9	3.530	3.533	400	1	1.441	1.442	844	1	1.385	1.386	{10.2.0 862
7	3.240	3.242	331	5	1.366	1.366	{951 773	1	1.080	1.081	{11.7.1 11.5.5
3	2.882	2.885	422	1	1.312	1.312	864	1	1.056	1.056	{13.3.1 11.7.3 977
10	2.718	2.720	{511 333	1	1.289	1.290	10.4.2	1	1.033	1.033	{13.3.3 995
9	2.497	2.498	440	2	1.274	1.274	{11.1.1 775	2	0.9995	0.9993	{14.2.0 10.10.0 10.8.6
3	2.353	2.355	442	3	1.231	1.230	{10.4.4 882	2	0.9896	0.9894	{10.10.2 14.2.2
4	2.234	2.234	620	2	1.212	1.212	{10.6.0 866	3	0.9707	0.9706	{14.4.0 12.8.2
1	2.128	2.130	622	2	1.198	1.199	{11.3.3 973	3	0.9380	0.9380	{15.1.1 13.7.3 11.9.5
2	2.039	2.040	444	3	1.166	1.166	{11.5.1 777				
5	1.978	1.979	{711 551								
2	1.888	1.888	642								
6	1.839	1.840	{553 731								
1	1.765	1.766	800								
4	1.727	1.726	733								
3	1.665	1.665	{660 822								
3	1.631	1.632	{555 751								

The relative importance of forms, in decreasing order, is approximately: $a\{100\}$ and $o\{111\}$ about equal; $d\{011\}$ and $m\{113\}$ about equal, $\mu\{114\}$, $n\{112\}$, $\phi\{116\}$, and $\{029\}$. The last form is vicinal. The list agrees reasonably well with that required by the space group although one might fail to predict a diagonal glide.

X-ray analysis. A single crystal was examined by rotation and Weissenberg methods using Ni-filtered Cu-K α radiation. The cell edge determined by the rotation method is 14.117 ± 0.008 Å. The space group is $Fd3m$.

Powder data were collected with V-filtered Cr- $K\alpha$ radiation using a 114-mm diameter camera. Low d spacings were found using Cu- $K\alpha$ radiation. A Taylor-Sinclair treatment of these results gives a 14.132 Å. The indexed powder data are given in table II. No unindexed or forbidden lines appeared.

The unit cell has a volume of 2822.34 Å³; with $Z = 16$ the calculated specific gravity for $\text{Pb}_2\text{AgCl}_3\text{FOH}$ is 6.256.

Conclusions. No established mineral is similar to this species. Its presumably small stability field may lie between those of boléite and matlockite. The type specimen will be returned to the U.S. National Museum.

The name should be pronounced BĪDŌ·ĀĪT.

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