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WICKENBURGITE, A NEW MINERAL FROM ARIZONA

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ABSTRACT

Wickenburgite, $Pb_3Al_2CaSi_{10}O_{24}(OH)_6$, is a new mineral found in abundance at several prospects near Wickenburg, Arizona. It is an oxide zone mineral derived from lead ores and occurs with phoenicochroite, mimetite, cerussite, and willemite.

The mineral is well crystallized to granular; white, colorless, or rarely pink, and has a vitreous luster. The hardness is 5, $G=3.85$ (meas); 3.88 (calc.). Fluoresces dull orange in short wave *u.v.*

Crystals show dihexagonal dipyramidal symmetry, are tabular, and dominated by {0001} and $\{10\bar{1}1\}$. The axial ratio is $a{:}c=1{:}2.354$ (morph.) and $a{:}c=1{:}2.363$ with $a=8.53$ Å and $c=20.16$ Å derived from the refined powder data. $Z=2$. Morphological and Weissenberg data establish the space group as $P6_3/mmc$. The strongest lines are 10.085 Å (10), 5.962 (3); 5.043 (3), 3.392 (6), 3.355 (4), 3.257 (8), 2.791 (3), and 2.639 (4).

Crystals are uniaxial (−) with $\epsilon_D=1.6480$, $\omega_D=1.6918$. Dispersion of the indices ($v>p$) is moderate.

No previously established species are likely to be confused with wickenburgite with the exception of belmontite (?).

INTRODUCTION

The new mineral has been found in abundance at several localities south of Wickenburg, Maricopa County, Arizona. The species is named for the locality. The type locality is the Potter-Cramer property which is near the section corner common to sections 13, 14, 23, and 24, T4N, R7W Belmont Mountains 15′ quadrangle. Wickenburgite is abundant here as veins in outcrop near the collar of a steeply inclined shaft. It is also very abundant at another prospect 18 miles to the north along a power line road, at the nearby Moon Anchor mine, and at several other nearby prospects.

OCCURRENCE

At the type locality wickenburgite occurs as an oxide zone mineral in a vein which originally carried galena and sphalerite in a gangue consisting largely of quartz and fluorite. The vein cuts steeply across a nearly horizontal fault contact between granodiorite and overlying rhyolite breccia. An intensely altered purple andesite occurs as irregular lenses along the fault zone.

Only relics of galena remain in a remarkable oxide suite which consists largely of wickenburgite, phoenicochroite, and mimetite with lesser amounts of cerussite, willemite, crocoite, β duftite, hemihedrite, ajoite, vauquelinite, descloizite, laumontite, and shattuckite. Wickenburgite is by far the most abundant of these minerals and was among the last to crystallize.

Physical Properties

Wickenburgite is perfectly transparent and colorless, or rarely salmon pink, when well-crystallized. Massive or granular material is dull white. Crystals vary from 0.2 mm to 1.5 mm in diameter and average about 0.5 mm. Cleavage on the base (0001) is indistinct.

Crystals often occur as spongy aggregates of small, highly perfect individuals. Larger crystals tend to build subparallel aggregates or rosettes on (0001).

The crystals are tough and brittle with a Mohs' hardness of 5. The specific gravity is 3.85 (Berman balance) and 3.88 (calc.).

In short-wave ultraviolet light wickenburgite fluoresces dull orange. Specimens with willemite are particularly handsome for the willemite fluoresces and phosphoresces yellow-green.

Chemistry

The chemical analysis was planned on the basis of results of qualitative tests by spectrographic, X-ray fluorescence, and microchemical means. These tests showed major Pb and Si, and minor Al and Ca. Traces of Mg and P were also noted. X-ray analysis eliminated all elements other than Pb with $Z > 20$; for the lighter elements special efforts were made to prove the absence of B, N, S, CO_3, and the halogens.

The chemical analysis shown in Table 1 is based on three separate samples. All of these samples were obtained from one hand specimen and

Table 1. Chemical Analysis of Wickenburgite

	wt.%	Ratio	% ideal
PbO	44.0[a]	0.197	45.16
SiO_2	42.1[b]	.701	40.53
Al_2O_3	7.6[b]	.0745	6.88
CaO	3.80[a]	.0678	3.78
H_2O+	3.77[c]	.209	3.65
	101.27		100.00

Analysts: (a) Rocky Mountain Geochemical Corp., Salt Lake City, Utah. Pb and Ca by colorimetry on 80 mg sample. (b) E. C. Thompson, Jr., Phelps Dodge Corp., Si and Al gravimetrically on 72 mg sample. (c) by author, gravimetrically on 34 mg sample.

were free of any visible impurities. The analysis gives, in terms of unit cell contents, 6PbO, $2Al_2O_3$, 2CaO, $20SiO_2$, $6H_2O$. This may be written $Pb_3Al_2CaSi_{10}O_{24}\cdot(OH)_6$.

Wickenburgite is not visibly affected by hot or cold acids or alkalis (HCl, HNO_3, KOH, NH_4OH). Solution must be affected by prior fusion as with borax or sodium bicarbonate. Fusion of the pure mineral occurs at red heat and the resulting glass has an index of refraction of 1.64_D.

Morphology

Because of an unfortunate tendency for wickenburgite to build subparallel aggregates on {0001}, only the smallest (0.2 to 0.4 mm) crystals were suited for the determination of angular constants. Larger crystals tend to be more complex, however, so these were used to discover the rarer forms. A varied batch of 20 crystals was examined. No evidence contrary to dihexagonal dipyramidal symmetry was discovered.

Other than the forms given in Table 2 are the uncommon forms $\{10\bar{1}2\}$, $\{31\bar{4}4\}$, and $\{41\bar{5}0\}$. Most crystals exhibit only *c* {0001}, and *x* $\{10\bar{1}1\}$ with traces of *m* $\{10\bar{1}0\}$. A typical crystal and an unusually complex one are shown in Fig. 1. No twinning was observed.

Table 2. Crystallographic Data for Wickenburgite

Dihexagonal dipyramidal, $6/mmm$; $a:c=1:2.354$, $\rho_0:r_0=2.718:1$

	Form	ϕ	ρ	M	A_2
c	0001	....	0°00′	90°00′	90°00′
m	$10\bar{1}0$	30°00′	90 00	60 00	90 00
	$10\bar{1}4$	30 00	34 12	73 41	90 00
x	$10\bar{1}1$	30 00	69 48	62 1	90 00
z	$30\bar{3}2$	30 00	76 13	60 57	90 00
p	$11\bar{2}4$	0 00	49 39	90 00	67 36
d	$6.1.\bar{7}.12$	22 24	56 3	71 34	83 42

The larger crystals and the most complex ones were found only with willemite. These crystals fluoresce more strongly than small or simple crystals.

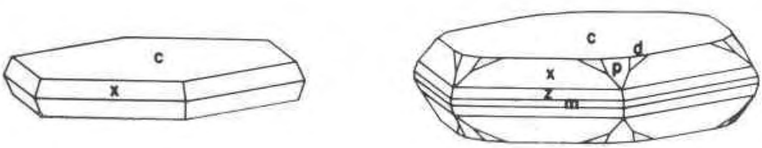

Fig. 1. A typical crystal on the left and an unusually complex crystal on the right.

Crystal Data

If the symmetry is taken as $6/mmm$ on the basis of morphological study, Weissenberg level photographs of single crystals establish the space group as $P6_3/mmc$. Cell data found by various methods are presented in Table 3.

Table 3. Unit Cell Constants for Wickenburgite

	Morph.	Powder	Rotation	Weissenberg
$a{:}c$	1:2.354	1:2.363	1:2.365	1:2.358
a		8.53 Å ± .007	8.53 Å ± .01	8.53 Å ± .01
c		20.16 Å ± .02	10.16 Å ± .04	20.12 Å ± .02

The powder data given in Table 4 were obtained with both CrK_α and CuK_α radiation; CuK_α radiation was used only for lines with very small d spacings. The pattern was indexed and then used to refine the cell constants with programs created by F. B. Millett on an Epic 3000 calculator. The cell volume determined from the refined constants is 1271 Å^3 which gives a calculated specific gravity of 3.88 if $Z=2$.

Table 4. Powder Data for Wickenburgite

I_{est}	$d_{meas.}$	$d_{calc.}$	$hkil$	$d_{meas.}$[a]	$d_{calc.}$	$hkil$	$d_{meas.}$[a]	$d_{calc.}$	$hkil$
10	10.08	10.08	0002	2.446	2.443	$21\bar{3}4$	1.764	1.761	$30\bar{3}8$
2	7.394	7.388	$10\bar{1}0$		2.445	$30\bar{3}1$	1.750	1.747	$21\bar{3}9$
1	6.961	6.937	$10\bar{1}1$	2.391	2.392	$30\bar{3}2$		1.750	$31\bar{4}6$
3	5.962	5.959	$10\bar{1}2$	2.314	2.312	$30\bar{3}3$	1.735	1.734	$40\bar{4}4$
3	5.043	5.040	0004	2.277	2.271	$20\bar{2}7$	1.696	1.695	$32\bar{5}0$
2	4.267	4.266	$11\bar{2}0$	2.215	2.213	$30\bar{3}4$	1.673	1.670	$31\bar{4}7$
1	4.158	4.164	$10\bar{1}4$	2.171	2.170	$11\bar{2}8$		1.672	$32\bar{5}2$
6	3.932	3.928	$11\bar{2}2$	2.144	2.144	$10\bar{1}9$	1.646	1.642	$2.0.\bar{2}.11$
1	3.700	2.694	$20\bar{2}0$		2.147	$21\bar{3}6$		1.644	$32\bar{5}3$
1	3.541	3.539	$10\bar{1}5$	2.088	2.087	$22\bar{4}2$	1.636	1.638	$1.0.\bar{1}.12$
2	3.475	3.468	$20\bar{2}2$	2.044	2.049	$31\bar{4}0$		1.635	$2.1.\bar{3}.10$
4	3.355	3.360	0006		2.039	$31\bar{4}1$	1.620	1.619	$40\bar{4}6$
8	3.257	3.256	$11\bar{2}4$	2.012	2.016	0.0.0.10	1.610	1.607	$32\bar{5}4$
1	3.058	3.059	$10\bar{1}6$		2.008	$31\bar{4}2$		1.612	$41\bar{5}0$
2	2.980	2.980	$20\bar{2}4$	1.987	1.986	$30\bar{3}6$		1.607	$41\bar{5}1$
3	2.791	2.792	$21\bar{3}0$	1.963	1.964	$22\bar{4}4$	1.590	1.590	$31\bar{4}8$
1	2.767	2.766	$21\bar{3}1$		1.960	$31\bar{4}3$	1.563	1.563	$1.1.\bar{2}.12$
2	2.726	2.724	$20\bar{2}5$	1.900	1.898	$31\bar{4}4$		1.560	$3.0.\bar{3}.10$
2	2.691	2.691	$21\bar{3}2$	1.872	1.871	$21\bar{3}8$		1.563	$32\bar{5}5$
4	2.639	2.639	$11\bar{2}6$		1.872	$30\bar{3}7$	1.539	1.536	$41\bar{5}4$
2	2.520	2.520	0008	1.848	1.847	$40\bar{4}0$	1.514	1.512	$31\bar{4}9$
2	2.466	2.463	$30\bar{3}0$	1.822	1.823	$1.1.\bar{2}.10$		1.513	$32\bar{5}6$

[a] $I<3$. 60 additional lines to 0.78 Å.

Spacings in Å from Crk_α Radiation. Camera diameter = 114.59 mm.

Optics

In thin section wickenburgite exhibits a poor basal cleavage which is enhanced by grinding. Extinction is parallel to this cleavage which is the length slow direction. When fine grained, wickenburgite could easily be confused with sericite.

Most of the crystals are perfectly uniaxial (−) but some of the aggregate crystals show a small separation of isogyres. Dispersion of the indices is moderate and normal ($v > r$). The refractive indices are given in Table 5.

Table 5. Refractive Indices of Wickenburgite

Line	F	E	D	C
ω	1.7043	1.7006	1.6918	1.6835
ϵ	1.6603	1.6556	1.6480	1.6418
biref. (calc)	0.0440	0.0450	0.0438	0.0417
biref. (meas)	.0439	.0447	.0441	.0425

The indices were measured on a heating stage using interference filters for monochromatic light. Liquids and filter bandpass characteristics were checked on a divided circle spectrometer. The measured birefringence was determined in monochromatic light using a Berek compensator specially calibrated for the interference filters used. Values of refringence and birefringence are probably within 0.0005 although no correction for dn/dt of the mineral was applied.

Similar Species

Wickenburgite is unlikely to be confused with any well defined species. It is most similar to an unnamed artificial lead silicate described by Dana and Penfield (1885) and Wheeler (1886) The artificial material has a much higher Pb:Si ratio and is morphologically distinct.

The mineral belmontite (?) was not available for comparison. It is said to be a yellow lead silicate occurring with stetefeldite at the Highbridge mine, Belmont, Nevada. Several days' examination of these dumps produced considerable amounts of stetefeldite and many other species. Some of the stetefeldite occurs with bright yellow mimetite crystals on quartz, and I suspect that this is belmontite (?). No wickenburgite was found at this locality.

Type specimens of wickenburgite will be deposited at the U. S National Museum.

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