

A NEW MINERAL:

PERLOFFITE,

THE Fe³⁺ ANALOGUE OF BJAREBYITE

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Introduction

The similarity in the roles played by Al³⁺ and Fe³⁺ in crystals formed at moderate and low temperature is well established. This realization moved Moore *et al.* (1973), when describing the new mineral bjarebyite, Ba(Mn, Fe)(Al₂(OH)₃(PO₄)₃), to suggest the possible existence of the (Fe³⁺ > Al³⁺) analogue of this species. In 1974, Vandall King of Bristol, Maine, collected a specimen of vuggy ludlamite at the Big Chief pegmatite, Glendale, South Dakota. In one vug, he observed lustrous, black, spear-shaped crystals which he was unable to identify. Subsequently, he provided this specimen for identification. Detailed study has shown these crystals to represent a new mineral species, which is, in fact, the Fe³⁺ analogue of bjarebyite.

Occurrence and Paragenesis

The new species, here named perloffite, is as yet known only from the Big Chief pegmatite. Careful examination of the type specimen, provided by King, and of several specimens provided by W.L. Roberts of the South Dakota School of Mines and Technology, revealed the complex mineralogy of the perloffite assemblage. Single crystals and sprays of perloffite crystals occur perched on earlier-formed crystals of ludlamite, hureaulite and siderite in vugs in ludlamite derived from the hydration of parent triphylite. Later-formed phosphate species include vivianite, messelite, beraunite, rockbridgeite, whitmoreite, jahnsite, mitridatite and carbonate apatite. Conspicuously absent are the aluminum-bearing phosphates which typify the bjarebyite association at the Palermo No. 1 pegmatite, North Groton, New Hampshire.

Physical Properties

Perloffite is dark brown to greenish-brown in small crystals (0.1 mm); however, larger crystals have a black appearance. The streak and powder are greenish-yellow. The luster is vitreous to subadamantine. It has a hardness of approximately 5 on Mohs' scale and a perfect {100} cleavage. Crystals are slowly soluble in cold 1:1 HCl. The amount of material available was insufficient for a reliable measurement of the specific gravity using the Berman microbalance or similar methods. Crystals sink rapidly in pure methylene iodide (s.g. 3.32), thus precluding the use of this sink-float method for density determination.

Morphology

Although small crystals of perloffite often possess rounded and indistinct faces, larger crystals, which range up to 1 mm in greatest dimension, generally possess sharp, easily discernible faces (Fig. 1). The crystal class is monoclinic holosymmetric (2/m) and crystals commonly exhibit a simple development consisting of only 4 forms: *c*{001}, *g*{101}, *t*{021} and *x*{131}. This contrasts with the complex development of bjarebyite crystals on the type specimen. Only the forms *c*{001} and *t*{021} are common to both species. No twinning was observed in perloffite, but semi-parallel growth appears common. A plan and clinographic projection of a typical perloffite crystal are shown in figure 2.

X-ray Crystallography

Single-crystal precession photographs provided the unit cell geometry and extinction criteria. The cell constants were refined by a least-squares fit of 22 indexed powder reflections. The similarity in the cell parameters of perloffite and bjarebyite (Table 1) suggests that these minerals are isostructural. The larger cell constants of perloffite are consistent with the replacement of Al³⁺ in the bjarebyite structure by the larger Fe³⁺ cation.

Calculated and observed powder data for perloffite appear in Table 2. The calculated intensities were obtained from a structure factor computation utilizing the atomic coordinates determined by Moore and Araki (1974) for bjarebyite and substituting Fe³⁺ for Al³⁺. The close agreement between the observed and calculated powder intensities is further evidence that perloffite possesses the bjarebyite structure.

Chemical Composition

Electron microprobe analyses were performed by Anthony J. Irving, utilizing barite and arrojadite standards. Averaging eleven sample points over three crystals yielded **Ba** 17.6, **Ca** 1.1, **Mg** 0.39, **Mn** 11.1, **Fe** 18.7, **Al** 0.15 and **P** 13.3. Owing to the small amount of material available, water content could not be determined. The (OH)⁻ anion and the valence states and structural sites of the cations were assigned by analogy to bjarebyite.

The proposed formula based upon P = 3 is (Ba_{0.89}Ca_{0.09})(Mn_{0.41}Fe_{0.37}Mg_{0.11}Ca_{0.11})²⁺(Fe_{1.96}Al_{0.04})³⁺(OH)₃(PO₄)₃. The density of perloffite calculated using this formula and the aforemen-

TABLE 1. PERLOFFITE AND BJAREBYITE. CELL PARAMETERS

	Perloffite	Bjarebyite*
<i>a</i> (Å)	9.223(5)	8.930(14)
<i>b</i> (Å)	12.422(8)	12.073(24)
<i>c</i> (Å)	4.995(2)	4.917(9)
β	100.39(4)°	100.15(13)°
<i>V</i> (Å ³)	562.9(5)	521.8(1.5)
space group	P2 ₁ /m	P2 ₁ /m
formula	Ba(Mn,Fe) ₂ ²⁺ Fe ₂ ³⁺ (OH) ₃ (PO ₄) ₃	Ba(Mn,Fe) ₂ ²⁺ Al ₂ (OH) ₃ (PO ₄) ₃
Z	2	2

*Moore *et al.* (1973).

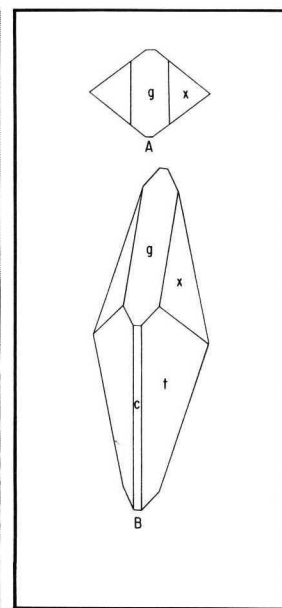
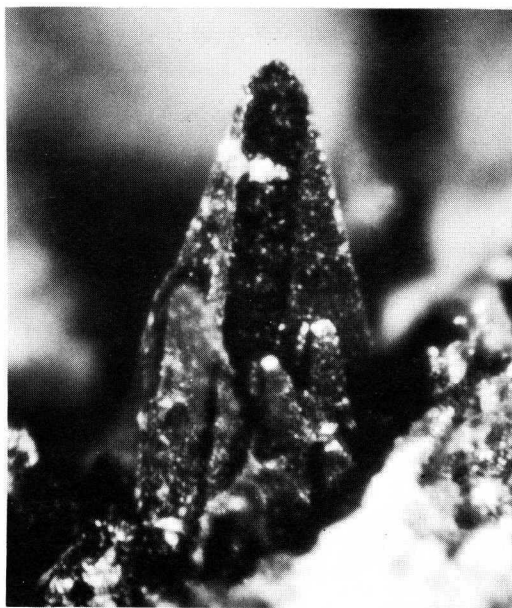
TABLE 2. PERLOFFITE. CALCULATED AND OBSERVED POWDER DATA

Calculated			Observed*		Calculated			Observed*	
I/Io	d	hk \bar{l}	I/Io	d	I/Io	d	hk \bar{l}	I/Io	d
13	9.072	100	2	9.06	7	2.167	340		
32	5.125	120	3	5.12	11	2.132	122	<1	2.130
9	4.193	001			9	2.088	$\bar{4}21$		
38	4.689	$\bar{1}01$	3	4.69	25	2.070	060	4	2.070
39	4.569	011	3	4.56	9	2.040	$\bar{2}32$		
20	3.663	220	1	3.651	11	1.991	132	1	1.990
10	3.528	$2\bar{1}1$			7	1.954	$\bar{4}31$		
7	3.379	121			6	1.915	222		
64	3.166	$031\bar{1}$.10	3.166	6	1.894	$\bar{1}61$		
36	3.166	$\bar{2}21$			6	1.871	$\bar{2}42$		
53	3.104	$\bar{1}31$	4	3.105	6	1.833	142	<1	1.837
35	3.058	230			8	1.820	$\bar{4}12$	1	1.815
60	2.979	211	5	2.982	7	1.814	500		
31	2.938	310	4	2.939	6	1.804	$\bar{4}41$		
19	2.938	140	4	2.939	6	1.722	351	<1	1.637
40	2.887	131	3	2.887	10	1.640	441	<1	1.610
24	2.751	221			9	1.610	501		
43	2.742	$\bar{3}11$	8	2.73 (broad)	7	1.591	$\bar{1}62$	<1	1.565
31	2.719	320			6	1.565	541		
10	2.589	$\bar{1}41$			10	1.536	271		
25	2.487	$\bar{1}02$	2	2.490	11	1.530	370		1.53
19	2.457	002	2	2.457	11	1.523	033		(broad)
7	2.373	$\bar{2}41$			8	1.501	$\bar{3}71$	2	1.498
9	2.231	410	<1	2.229	10	1.496	$\bar{5}32$		
22	2.195	$\bar{1}51$	2	2.195					

*114.6 mm camera diameter, Mn filtered Fe radiation.

Figure 1 (right). Perloffite crystals on the type specimen. The large crystal is about 1 mm long (photomicrograph by Julius Weber).

Figure 2 (far right). Crystal drawing of perloffite showing the forms $c\{001\}$, $g\{101\}$, $t\{021\}$ and $x\{131\}$. A. Plan. B. Clinographic projection.



tioned cell parameters is 3.996 gm/cm³. The formula may be idealized as $Ba(Mn,Fe)_2^{2+}Fe_2^{3+}(OH)_3(PO_4)_3$.

Optical Properties

The optical properties of perloffite are summarized in table 3. Perloffite exhibits much more pronounced absorption and pleochroism effects than does bjarebyite. The strong absorption in the X optical direction is attributable to electron transfer along the Fe³⁺ octahedral chains which parallel the b-axis; the strong absorption in the Z direction is attributed to Fe²⁺-Fe³⁺ charge transfer between the M(1) and M(2) cation sites (see Moore and Araki, 1974).

Name

It is a pleasure to name this new mineral after Louis Perloff of Tryon, North Carolina. His keen eye, unceasing curiosity, and years of experience with minerals rank him as one of the most outstanding amateur mineralogists in our country. His remarkable ability as a mineral photographer and his penchant for delightfully dry witticisms have captivated many an audience.

The species and name were approved by the International Commission on New Minerals and New Mineral Names (IMA). The type specimen is preserved in the collection of the U.S. National Museum of Natural History (Smithsonian Institution).

TABLE 3. PERLOFFITE. OPTICAL DATA

α	1.793(5)
β	1.803(5)
γ	1.808(5)
2V	70° - 80°
sign	(-)
absorption	X,Z > Y
pleochroism	X,Z dark greenish-brown Y light greenish-brown
dispersion	$r \ll v$
orientation	$x \parallel b, Y \perp c \sim 42^\circ$

Acknowledgements

Vandall King brought the original specimen to my attention and sacrificed it for study. Willard L. Roberts provided additional specimens. The photomicrograph of perloffite was prepared by Julius Weber. Paul B. Moore offered many helpful comments.

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