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Wickmanite, $Mn^{+2}[Sn^{+4}(OH)_6]$, a new mineral from Långban

By PAUL B. MOORE and JOSEPH V. SMITH

Introduction

The late Dr. Gustav Flink, in the course of his classic studies on Långban minerals, had assembled over 480 different materials representing unknown or incompletely studied minerals, many perhaps new.

Three specimens, described by Flink (1923, 1924, 1926), bear the Flink labels No. 161, No. 234, and No. 374. The mineral of interest occurs as yellow perfect unmodified octahedra and appears to be among the youngest of the minerals represented in the specimens. X-ray powder photographs of the octahedra gathered from the three specimens were almost identical and subsequent studies demonstrated that a new species had been discovered from Långban.

Wickmanite is named in honour of Prof. Frans-Erik Wickman who has made many contributions regarding the mineralogy of Långban. The mineral was approved as a new species by the IMA Commission on New Minerals and New Mineral Names.

Occurrence

The Flink No. 161 specimen was collected in the "Hindenburg" stope, No. 234 from the "Irland" stope, and No. 374 from the "Skottland" stope. These three stopes, situated in the western portion of the Långban workings are relatively close to each other, at a level between 150 and 170 meters and contained both iron and manganese ores.

The wickmanites in Nos. 161 and 234 occur as perfect unmodified octahedra implanted upon a botryoidal pale brown bementite, associated with calcite and barite in pockets in magnetite ore. The No. 374 specimen is associated with calcite, allactite, and numerous sparse unidentified minerals in brecciated jacobsite-richterite-manganophyllite skarn.

Wickmanite appears to be a late-stage low temperature mineral and quite likely occurs associated with a vein system common to all three stopes mentioned above. Though about twenty specimens are in the museum collections, nothing can be said concerning its relative abundance *in situ*, and wickmanite seems to be another late stage mineral peculiar to Långban, occurring in very small amounts and of no genetic connection to the principal ore minerals.

Table 1. Wickmanite. Structure Cell Data.

	Wickmanite, Fl. No. 374	Synthetic $Mn[Sn(OH)_6]$	Stottite
a	7.873 ± .004 Å	7.88 Å	7.55 Å
c	—	—	7.47
S.G.	Pn3m	Pn3m	$P4_2/n$
ϱ obs.	3.89 ± .05 gm/cc		3.596
ϱ calc.	3.82		
Z	4	4	4
formula	$(Mn_{.95}, Mg_{.03}, Ca_{.02})[Sn(OH)_6]$	$Mn[Sn(OH)_6]$	$Fe[Ge(OH)_6]$
ref:	this paper	Strunz and Contag (1960)	Strunz, Söhnge, Geier (1958)

Crystallographic data

An excellent single octahedron averaging 0.2 mm on an edge was subjected to rotation and Weissenberg studies using filtered copper radiation. The derived structure cell data appear in Table 1. The structure cell data for synthetic $Mn[Sn(OH)_6]$ as determined by Strunz and Contag (1960) are also included. Powder

Table 2. Wickmanite. Powder Data.

Fe/Mn radiation; 114.6 mm camera diameter; standardized film; visual estimates.

Fl. 374				Fl. 161		Fl. 234		Synthetic $Mn[Sn(OH)_6]$[1]	
I/I_0	d_{hkl} obs.	d_{hkl} calc.	hkl	I/I_0	d_{hkl}	I/I_0	d_{hkl}	I/I_0	d_{hkl}
4	4.552	4.546	111	5	4.522	6	4.528	7	4.500
10	3.931	3.936	200	10	3.920	10	3.921	10	3.890
6	2.778	2.784	220	7	2.777	7½	2.784	6	2.748
2	2.487	2.490	310	3	2.484	3	2.479	3	2.467
3	2.372	2.374	311	4	2.373	4	2.366	4	2.3484
3	2.273	2.273	222	4	2.274	4	2.265	3	2.2492
1	2.104	2.104	321	2	2.102			2	2.0845
3½	1.9710	1.9682	400	4	1.9658	4	1.9630	4	1.9483
2	1.8060	1.8062	331	2½	1.8051	3	1.8033	2	1.7900
7	1.7618	1.7605	420	8	1.7600	8	1.7600	7	1.7430
5	1.6080	1.6071	422	6½	1.6074	6½	1.6059	6	1.5955
2	1.5138	1.5152	511, 333	3	1.5149	3	1.5122	3	1.5032
2	1.4038	1.3918	440	3	1.3921	2	1.3902	4	1.3847
		1.3502	530, 433	1	1.3510				
2	1.3315	1.3308	531	3½	1.3308	2	1.3276	3	1.3238
3	1.3130	1.3122	600	4	1.3128	3	1.3113	4	1.3051
3	1.2452	1.2448	620	3½	1.2460	3	1.2447	5	1.2394
1	1.2000	1.2006	533	2	1.2020			1	1.1968
3	1.1882	1.1869	622	4	1.1881	2	1.1849	5	1.1821
		1.1364	444	2	1.1379			2	1.1323
		1.1024	711, 551	3	1.1041	2	1.1018	3	1.1007
2	1.0929	1.0918	640	4	1.0938			4	1.0893
4	1.0536	1.0521	642	6	1.0538	4	1.0511	7	1.0513
3	1.0268	1.0250	731	5	1.0269	2½	1.0248	5	1.0253
		0.9841	800	3	0.9860				

[1] Data of Strunz and Contag (1960).

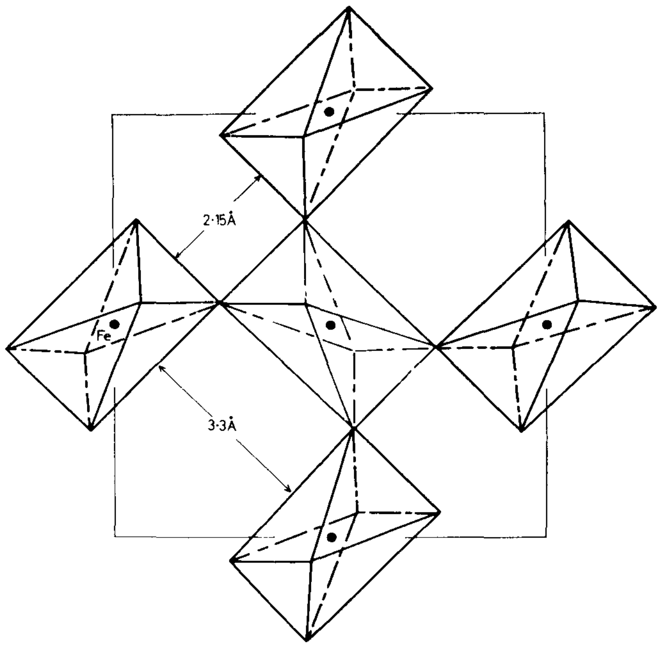

Fig. 1. Projection down [001] of the crystal structure of $Fe[Sn(OH)_6]$. Four of the six Fe-centered oxygen octahedra surrounding a Sn-centered octahedron are shown. The coordinates are from Strunz and Contag (1960).

data for the three wickmanites appear in Table 2, including the data of Strunz and Contag for synthetic material. The agreement between the structure cell and powder data of Strunz and Contag is not good and it is not known whether these data reflect errors in cell edge or powder determinations or both.

Only $7.80 \pm .03$ milligrams of wickmanite (Flink No. 374) could be sacrificed for a density determination, employing a Mettler balance cup suspension system with air and CCl_4 as weighing media. The agreement between observed and calculated densities is satisfactory considering the small quantity of material used in the determination.

The crystal structure for the synthetic isostructural $Fe^{+2}[Sn(OH)_6]$ is approximately known (Strunz and Contag, 1960) and consists of the simple linkage of distorted Fe^{+2} and Sn^{+4} centered oxygen octahedra through their vertices forming a three dimensional constricted cage array of octahedra referred to as the ReO_3 type structure. The ordering of Fe and Sn and distortion of the octahedra require a doubling of the ReO_3 type cell edge. A portion of the structure is depicted in Figure 1, showing the Sn-centered ligand group and four of the six surrounding Fe-centered oxygen octahedra. The only other known mineral bearing close structural relationship to wickmanite is stottite, $Fe^{+2}[Ge^{+4}(OH)_6]$, though further distortions require stottite to be tetragonal (pseudocubic). The stottite structure cell data also appear in Table 1.

Optical properties

Wickmanite is isotropic. The refractive index was determined by the immersion method, yielding $n = 1.705 \pm .003$ (white light). The calculated index for pure

$Mn^{+2}[Sn(OH)_6]$ from the relationship of Gladstone and Dale using the specific refractive energies of Larsen (1921) for H_2O, SnO_2, and MnO and the average of calculated and observed densities is 1.750. The greatest error most likely arises from the uncertainty of specific refractive energy for SnO_2.

Physical properties

Wickmanite occurs as excellent unmodified octahedra up to 2 mm on an edge. The mineral is transparent to translucent and the color ranges from a waxy brownish-yellow to greenish-yellow and honey-yellow. The No. 234 specimen is pink. The hardness is about $3\frac{1}{2}$ and the streak is white. The cleavage is good {100}. The mineral is difficultly soluble in cold 1:1 hydrochloric acid solution, coloring the solution pale green.

Chemical composition

A preliminary emission spectrogram revealed Sn and Mn as major; Ca minor; Pb and Fe trace.

Since not enough material was available for chemical analysis, a fragment was subjected to ARL electron microprobe analysis. The data corrected for absorption and efficiency of generation yielded Mn 16.6 %, Sn 47.2, Mg 0.3_5, Ca 0.2_5, Fe 0.1 and traces of Si and Sb. All elements from Na to U were scanned. For the oxides, this calculates to $(Mn_{.95}, Mg_{.03}, Ca_{.02})$ O 22.1 % and SnO_2 59.9. For pure Mn $[Sn(OH)_6]$ the values are MnO 25.7 % and SnO_2 54.7. The total oxide percent (including the hypothetical amount of water) is 101.8 %, the high Sn value probably resulting from uncertainties in the probe corrections.

Because of the very small quantity available, a water determination was impossible. However, from charge balance considerations and the obvious identity of wickmanite with the artificial compound, the postulated hydroxyl content is believed to be correct. Granted, these considerations do not rule out fluorine, but a density calculation for the hexafluoride yields a value of 4.00 gm/cc which is too high.

Thus, wickmanite appears to be $(Mn_{.95}, Mg_{.03}, Ca_{.02})[Sn(OH)_6]$ and is of interest since it is the first tin mineral reported from Långban.

The type specimen used in this study is Flink No. 374, bearing the catalogue number NRMS 532405.

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The Swedish Natural History Museum, Mineralogical Section Stockholm 50, Sweden (P. B. M.)
Department of Geophyscial Sciences, University of Chicago, Chicago 37, Illinois, U.S.A. (J. V. S.)

SUMMARY

Wickmanite, $Mn^{+2}[Sn^{+4}(OH)_6]$, is a rare late stage low temperature mineral occurring in yellow octahedra. Structure cell data are $a = 7.873 \pm .004$ Å, Z = 4, space group Pn3m. It is the first tin mineral reported from Långban.

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