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Sterlinghillite, a new hydrated manganese arsenate mineral from Ogdensburg, New Jersey

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Abstract

Sterlinghillite is a new manganese arsenate hydrate mineral from the Sterling Hill mine, Ogdensburg, Sussex County, New Jersey. Microprobe analysis yields MnO 39.5, FeO 0.2, MgO 0.1, ZnO 2.9, As_2O_5 44.7 weight percent, together with water by difference 12.6 percent. The tentative formula is $Mn_3(AsO_4)_2 \cdot 4H_2O$. Sterlinghillite is white to light pink, occurs in 0.1 mm clusters of micron-sized crystals on loellingite–franklinite–willemite–calcite ore, and may have formed by the decomposition of loellingite. There are no crystals suitable for single-crystal studies. The strongest lines in the X-ray diffraction pattern are: 11.12 (100), 3.209 (100), 2.751 (60), 2.848 (40), 2.880 (40), 3.692 (30), and 6.39 (30). Sterlinghillite is named for the locality. The mineral is very rare and only one specimen with a few milligrams of material has been found.

Introduction

This new mineral was called to my attention by Mr. Fred Parker of South River, New Jersey. It was found by a miner in the Sterling Hill mine and was reported to come from the 340 foot level of the mine. The new species and the name were approved by the Commission on New Minerals and Mineral Names, IMA, prior to publication. Type material is preserved at the Smithsonian Institution under catalog # NMNH 147269. The name is for the locality, one of the most remarkable mineral deposits on earth.

Occurrence

Sterlinghillite is from the Sterling Hill mine, Ogdensburg, Sussex County, New Jersey. Apart from its reported occurrence at the 340′ level, no additional information is available on the geologic setting. The only paragenetical information available is that observed on the one known specimen. Sterlinghillite occurs on seams in a franklinite–sphalerite ore which is in contact with a probable seam of loellingite and calcite. Sterlinghillite occurs in two habits on the type specimen; both habits are on seam surfaces. Sterlinghillite appears to be the last mineral to form. In one of these habits, sterlinghillite occurs as bundles of very soft pearly crystals which at first glance resemble some clusters of laumontite. These clusters are rather sparse on the specimen with a total weight of only several milligrams. No constancy of the divergent angle of the crystals in the clusters was observed. The second habit of sterlinghillite is that of tiny hemispherical clusters of platy crystals (Fig. 1). The crystals have a distinctly platy morphology and appear to be randomly intergrown. The extremely small cluster size (0.1 mm) precluded the determination of some of the physical and optical properties. The paucity of paragenetical data precludes any definitive statement on the formation of sterlinghillite, but the oxidation of loellingite in the presence of manganese-bearing solutions provides a ready mechanism.

Chemistry

Sterlinghillite was chemically analyzed with an ARL-SEMQ electron microprobe utilizing an operating voltage of 15 kV and a beam current of 0.15 μA. The standards used were olivenite for As, manganite for Mn, zincite for Zn, and hornblende for Fe and Mg. The data were corrected using a modified version of the *MAGIC-4* program. A microprobe scan indicated the absence of any additional elements with atomic number greater than ten. Sterlinghillite is easily soluble in dilute nitric or hydrochloric acids. It is chemically homogeneous over 10μ beam spots. No detectable differences were noted between the two habits of sterlinghillite; they have identical compositions. The resultant analysis is presented in Table 1.

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Fig. 1. Tabular randomly oriented crystals of sterlinghillite (1200×).

The analysis yields a ratio of M^{2+} cations:As of 3:2 and suggests that the formula of sterlinghillite is $Mn_3(AsO_4)_2 \cdot 4H_2O$. There is too little sterlinghillite for the direct or indirect determination of water and the water content must be inferred by difference. The absence of single-crystal data precludes the calculation of unit-cell contents and thus the given formula must be considered quite tentative. The general formula $M_3^{2+}[(As,P)\ O_4]_2 \cdot 4H_2O$ is common to many species; among these are switzerite, $Mn_3(PO_4)_2 \cdot 4H_2O$; hopeite and parahopeite, $Zn_3(PO_4)_2 \cdot 4H_2O$; and ludlamite, $Fe_3(PO_4)_2 \cdot 4H_2O$. However, the X-ray powder diffraction data (Table 2) are markedly different for sterlinghillite in both *d* values and the general configuration of the pattern, and strongly suggest that sterlinghillite has no structural relationship to these minerals with similar atomic ratios and water content.

Table 1. Microprobe analysis of sterlinghillite

	$Mn_3(AsO_4)_2 \cdot 4H_2O$ (theoretical wt. %)	Sterlinghillite (wt. %)
MnO	41.35	39.5
FeO		0.2
MgO		0.1
ZnO		2.9
As_2O_5	44.66	44.7
H_2O	13.99	12.6*
	100.00	100.00

* water determined by difference due to paucity of material.

Accuracy of data : plus or minus three percent of the amount present.

There are no single crystals of sterlinghillite large enough for single-crystal study. Repeated attempts to find suitable crystals were unsuccessful.

Table 2. X-ray powder diffraction data for sterlinghillite

d Å	I/Io	d Å	I/Io
11.12	100	2.217	2
6.39	30	2.171	2
6.11	2	2.049	2
5.50	2	1.975	5
5.01	10	1.939	5
4.73	10	1.855	5
3.960	2	1.843	10
3.692	30	1.757	2
3.209	100	1.714	5
2.880	40	1.704	10
2.848	40	1.672	5
2.814	5	1.662	5
2.751	60	1.604	2
2.629	10	1.583	2
2.603	10	1.553	2
2.553	2	1.487	2
2.465	10	1.447	2
2.341	2	1.412	10
2.298	2		

Data obtained with a polycrystalline sample in a Gandolfi 114.6 mm camera utilizing nickel-filtered CuKα X-radiation, and NBS silicon as an internal standard.

Physical and optical properties

Sterlinghillite occurs as white to light pink aggregates which have a white streak. The hardness is estimated as 3 (Mohs). There is one perfect cleavage, parallel to the direction of elongation of the lath-like crystals. The luster is silky on fracture and cleavage surfaces and dull to silky on external crystal faces. The density, measured with heavy-liquid techniques, is 2.95 g/cm^3, but this measured value may be low due to the highly porous nature of the aggregate (Fig. 1). Sterlinghillite does not fluoresce in ultraviolet radiation and there is no phosphorescence. Optically, sterlinghillite is anisotropic with wavy but inclined extinction. The very poor quality of the crystals precluded some optical measurements. The refractive indices are $\alpha = 1.656$ and $\gamma = 1.671$ (both ± 0.003). All crystals showed wavy extinction.

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