Canadian Mineralogist
Vol. 19, pp. 337-340 (1981)

SPERTINIITE, $Cu(OH)_2$, A NEW MINERAL FROM THE JEFFREY MINE, QUEBEC

J.D. GRICE
National Museum of Natural Sciences, Mineral Sciences Division, Ottawa, Ontario K1A 0M8

E. GASPARRINI
Minmet Scientific Limited, P.O. Box 921, Toronto, Ontario M4P 2H2

ABSTRACT

Spertiniite, a new species from the Jeffrey mine, Quebec, occurs as small botryoidal aggregates associated with chalcocite, native copper and atacamite on a rodingite dyke. It forms blue to blue-green, lath-like crystals < 10 µm in size. It is optically anisotropic, with parallel extinction and positive elongation; pleochroism is strong, with X colorless and Z dark blue; indices of refraction α 1.720(2), γ $>$1.800(2). An electron-microprobe analysis gave 66.9% Cu and 0.1% Cl. By analogy with synthetic $Cu(OH)_2$ (PDF 13-420), spertiniite is orthorhombic, space group *Cmcm*, and $Z = 4$; refined cell parameters are: a 2.951(1), b 10.592(3), c 5.257(3) Å. The strongest nine lines of the X-ray powder-diffraction pattern are 5.28(80)(020), 3.73(90)(021), 2.632(100)(002), 2.494(60)(111), 2.362(50)(041,022), 2.264(70)(130), 1.929(30)(112), 1.716(70)(150,132) and 1.438(30)(152) Å. The measured density is 3.93(2) g/cm^3 and the calculated density, 3.94 g/cm^3.

Keywords: spertiniite, new mineral, cupric hydroxide, Jeffrey mine, Québec, rodingite.

SOMMAIRE

La spertiniite, espèce nouvelle trouvée à la mine Jeffrey (Québec), se présente en petits agrégats botryoïdaux avec chalcocite, cuivre natif et atacamite associés, dans un dyke de rodingite. Les cristaux en lattes, de taille inférieure à 10 µm, passent du bleu au bleu-vert. Optiquement ils sont anisotropes, à extinction parallèle, allongement positif et fort pléochroïsme (X incolore, Z bleu foncé); leurs indices de réfraction sont α 1.720(2), γ $>$ 1.800(2). Une analyse à la microsonde électronique donne 66.9% Cu et 0.1% Cl. Par analogie avec le $Cu(OH)_2$ synthétique (PDF 13-420), la spertiniite est orthorhombique, groupe spatial *Cmcm*, a 2.951(1), b 10.592(3), c 5.257(3) Å, $Z = 4$. Les neuf raies les plus intenses du cliché de poudre [d_{hkl} en Å, (I)(hkl)] sont: 5.28(80)(020), 3.73(90)(021), 2.632(100)(002), 2.494(60)(111), 2.362(50)(041,022), 2.264(70)(130), 1.929(30)(112), 1.716(70)(150,132) et 1.438(30)(152). La densité mesurée est de 3.93(2), calculée 3.94.

(Traduit par la Rédaction)

Mots-clés: spertiniite, espèce minérale nouvelle, hydroxyde cuprique, mine Jeffrey, Québec, rodingite.

INTRODUCTION

During a study of the minerals from the Jeffrey mine, Asbestos, Shipton Township, Richmond County, Quebec (Grice & Williams 1979), a natural occurrence of $Cu(OH)_2$ was discovered. This specimen was submitted for identification to one of the authors (J.D.G.) by Mr. F. Spertini, Chief Geologist at the Jeffrey mine, Johns-Manville Canada Incorporated; it is with great pleasure that we name this new mineral species *spertiniite*.

The name and the mineral have been approved by the Commission on New Minerals and Mineral Names, I.M.A. The holotype specimen of spertiniite consists of a few mg of material on matrix measuring 3x3x2 cm. This specimen is preserved at the National Museum of Natural Sciences, Ottawa (*NMNS* 44696) along with cotype material (*NMNS* 44697, 44698 and 44699).

OCCURRENCE

Spertiniite is a very rare mineral, found in a rodingite dyke exposed in the east side of the Jeffrey mine open pit. At the time of discovery, January 1978, the exposure of the dyke measured 1 m in thickness by 8 m in length (F. Spertini, pers. comm. 1980). Spertiniite occurs in the lower portion of the dyke near the contact with the host serpentinized dunite. This portion of the rodingite consists primarily of fine grained, dense, white diopside and grossular, partly coated with pale green vesuvianite. Wares & Martin (1980) gave further details of the petrology of this assemblage.

Chalcocite commonly constitutes the core of the botryoidal masses of spertiniite, which also contain atacamite. Minor amounts of copper are associated with spertiniite in the rodingite.

A second occurrence of spertiniite from Ely, Nevada, has been reported by Miss E.E. Fejer (pers. comm., 1980), British Museum (Natural History), London (*BM*1972,193).

PHYSICAL AND OPTICAL PROPERTIES

Spertiniite forms discrete botryoidal aggregates approximately 100 μm in diameter (Fig. 1). SEM observation shows them to be composed of lath-like crystals, often having a radial habit (Fig. 2), with their longest dimension approximately 10 μm. Spertiniite is blue to blue-green and transparent with a vitreous lustre. It is soft and crushes easily without any marked cleavage. It does not fluoresce in ultraviolet radiation. There was insufficient material for

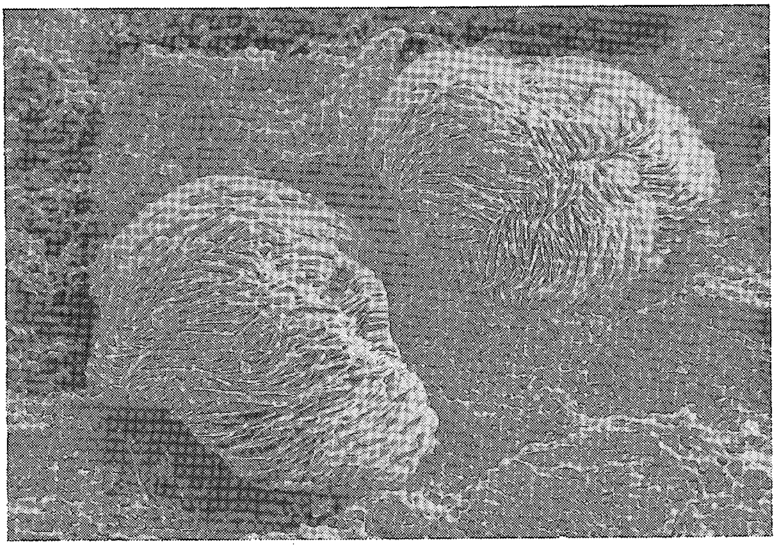

FIG. 1. Botryoidal aggregates of spertiniite on rodingite matrix. SEM image; width of field of view is 380 μm.

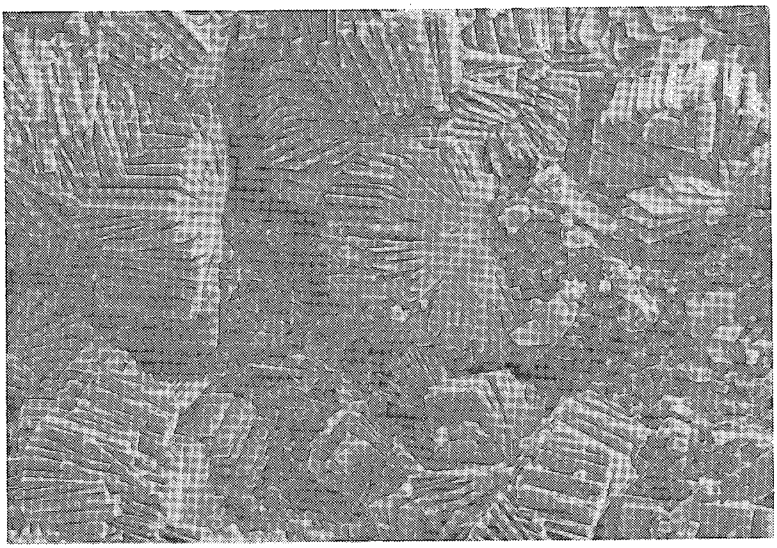

FIG. 2. Radial aggregates of lath-like crystals of spertiniite. SEM image; width of field of view is 230 μm.

solubility measurements on spertiniite, but Weast (1977) reported that synthetic $Cu(OH)_2$ is insoluble in cold water, decomposes in hot water and is soluble in acids.

Three grains were used in the density determination of spertiniite. Grains were suspended in Clerici solution (thallous malonate/formate–water mixtures) at 22°C, and densities of the matching solution were measured in a 2-cm^3 pycnometer. The measured density, 3.93(2) g/cm^3, compares well with the calculated density of $Cu(OH)_2$, 3.94 g/cm^3, with $Z=4$ and $V=164.3$ Å^3.

Optical measurements on spertiniite were difficult owing to the small crystal size. It is optically anisotropic, with parallel extinction and positive elongation. Pleochroism is strong, with X colorless and Z dark blue. The indices of refraction are α 1.720(2) and $\gamma > 1.800(2)$; this phase reacts with immersion liquids having $n > 1.800$.

CRYSTALLOGRAPHY

Spertiniite crystals are tabular (Fig. 2), but neither morphological nor single-crystal X-ray studies could be made owing to the microcrystalline nature of the aggregates. Using powder patterns generated with a 114.6 mm Gandolfi camera, 38 diffraction lines were measured; of these, 19 could be indexed and were suitable for least-squares refinement. The indexing is based on the orthorhombic cell and space group *Cmcm* determined by Jaggi & Oswald (1961) for synthetic $Cu(OH)_2$. The refined unit-cell parameters and volume are a 2.951(1), b 10.592(3), c 5.257(3) Å and V 164.3(2) Å^3. The X-ray powder-diffraction data for spertiniite and synthetic $Cu(OH)_2$ (PDF 13–420) are given in Table 1.

CHEMICAL COMPOSITION

All the chemical analyses were performed on an ARL–EMX electron microprobe with a solid-state detector for analysis by energy dispersion. Although the microprobe is not normally the best instrument for the study of hydrous minerals (neither O nor H is detected), it was in our case the only one capable of analyzing grains as fine as those of spertiniite.

The qualitative study was done by energy-dispersion spectrometry and involved the collection of X-ray spectra showing peaks at the energy positions of the various elements above atomic number 10 constituting the analyzed grains. The quantitative analyses were done by wavelength-dispersion spectrometry with 20 kV accelerating voltage and 0.5 μA sample current measured on spertiniite–atacamite. Standards used were copper metal for copper and halite for chlorine. The intensity counts emitted at the copper and chlorine $K\alpha$ wavelengths by the standards and minerals were reduced by the computer program EMPADR VII (Rucklidge & Gasparrini 1969).

TABLE 1. X-RAY POWDER-DIFFRACTION DATA FOR SPERTINIITE AND SYNTHETIC CUPRIC HYDROXIDE

SPERTINIITE				CUPRIC HYDROXIDE*	
Iest	*dmeas*	*dcalc*	*hkl*	*Imeas*	*dmeas*
80	5.29	5.29	020	90	5.30
90	3.73	3.73	021	100	3.73
<10	2.84	2.84	110	2	2.84
		2.65	040	<1	2.65
100	2.63	2.63	002	70	2.63
60	2.50	2.50	111	16	2.50
50	2.361	2.365 2.354	041 022	12 16	2.364 2.354
70	2.266	2.264	130	35	2.263
20	2.077	2.079	131	4	2.078
30	1.931	1.930	112	2	1.929
		1.866	042	<1	1.865
<10	1.764	1.765	060	6	1.797
70	1.718	1.721 1.716	150 132	35	1.72
10	1.670	1.673	061	6	1.673
		1.664	023	8	1.663
20	1.631	1.635	151	8	1.635
10	1.493	1.492	113	6	1.492
b10	1.474	1.475	200	8	1.476
		1.466	062	6	1.466
b10	1.461	1.461	043		
30	1.440	1.440	152	12	1.439
		1.421	220	2	1.420
		1.386	133	2	1.385
10	1.373	1.372	221	4	1.372
		1.346	170	<1	1.346
		1.324	080	6	1.324
		1.314	004	4	1.314
<10	1.301	1.304	171	4	1.304
<10	1.287	1.289 1.287 1.284	240 202 081	6	1.285
		1.276	024	2	1.275
10	1.253	1.252 1.250	241 222	6	1.249
<10	1.226	1.228	153	2	1.228
		1.198	172	<1	1.195
		1.193	114		
<10	1.181	1.182 1.177	082 044	4	1.180
		1.157	242	<<1	1.156
10	1.136	1.137	134	6	1.131
		1.132	260		

** additional weak lines below, intensities <10

114.6 mm Gandolfi camera, CuKα radiation.

*JCPDS card #13-420

**1.039, .9822, .9617, .9471, .9308, .9222, .9149, .9059, .8907, .8641, .8442, .8147, .7880, .7743.

A preliminary qualitative study of the spertiniite, in a predominantly diopside matrix, showed that the mineral is very fine grained, 10–20 μm in size, and intimately associated with atacamite, from which it is not distinguished optically in polished section. The qualitative study also showed that the mineral consists of copper with very minor chlorine and no other minor elements. Quantitative analyses of the spertiniite and atacamite for copper and chlorine gave amounts of the two elements very close to the stoichiometric values. Subsequent to this

TABLE 2. ELECTRON MICROPROBE ANALYSES OF SPERTINIITE AND ATACAMITE AND THEIR THEORETICAL COMPOSITIONS

	1	2	3	4
Cu	66.9	65.1	63.1	59.5
Cl	0.1	-	14.6	16.6
OH	nd	34.9	nd	23.9

1. Spertiniite
2. Theoretical composition of $Cu(OH)_2$
3. Atacamite
4. Theoretical composition of atacamite

nd: not determined

study, one grain, about 50 μm in size and with an X-ray pattern very similar to that of synthetic $Cu(OH)_2$, was mounted, polished and analyzed quantitatively. The average analysis, *i.e.*, the values obtained for this grain and for the grains in the diopside matrix, is shown in Table 2, together with the analysis of the associated atacamite and the theoretical compositions of the two minerals.

GENESIS

In the Jeffrey specimens, it appears that spertiniite is a product of the supergene alteration of chalcocite. Three groundwater samples were collected in the area where the spertiniite was found. This percolating water was found to be oxidizing, Eh = + 0.83, which is to be expected for groundwater, but it was quite alkaline, pH=9.2. These rather unique conditions preclude the formation of copper sulfates, which are the normal alteration products of chalcocite. In this range of Eh and pH, the solubility is due almost entirely to the cupric ion, and the stable solid phase is cupric hydroxide (Garrels 1954).

From the chemical analysis it is apparent that the spertiniite structure does not accept much chlorine. Any chloride ions available in the groundwater have been essential to the formation of atacamite.

ACKNOWLEDGEMENTS

The authors are grateful to several staff members of the National Museums of Canada: Mr. J. Van Velthuizen for preparing the X-ray powder-diffraction patterns, Messrs. I. Wainwright and G. Young for the SEM photographs and initial EDA, and Mr. R. Waller for the pH measurements. We thank Dr. J.E. Dutrizac, CANMET, for providing Eh measurements. Mr. J.M. Kukielka was particularly skillful at mounting and polishing single grains of spertinite for electron-microprobe analysis.

REFERENCES

GARRELS, R.M. (1954): Mineral species as functions of pH and oxidation-reduction potentials, with special reference to the zone of oxidation and secondary enrichment of sulphide ore deposits. *Geochim. Cosmochim. Acta* **5**, 153-168.

GRICE, J.D. & WILLIAMS, R. (1979): The Jeffrey mine, Asbestos, Québec. *Mineral. Record* **10**, 69-80.

JAGGI, H. & OSWALD, H.R. (1961): Die Kristallstruktur des Kuferhydroxids, $Cu(OH)_2$. *Acta Cryst.* **14**, 1041-1045.

RUCKLIDGE, J.C. & GASPARRINI, E. (1969): EMPADR VII. Specifications of a computer program for processing electron microprobe analytical data. *Dep. Geol. Univ. Toronto.*

WARES, R.P. & MARTIN, R.F. (1980): Rodingitization of granite and serpentinite in the Jeffrey mine, Asbestos, Quebec. *Can. Mineral.* **18**, 231-240.

WEAST, R.C. (1977): *Handbook of Chemistry and Physics* (57th ed.). Chemical Rubber Publ. Co., Cleveland, Ohio.

Received October 1980, revised manuscript accepted December 1980.