

${}^3T_1(F)$ ,  ${}^3A_2 \rightarrow {}^3T_1(P)$  transitions, are clearly resolved, in order of increasing energy.

The height of the absorption envelope associated with the  ${}^3A_2 \rightarrow {}^3T_1(F)$  transition is the one used to calculate the absorption coefficients of the nickel-serpentine mulls. The manner in which the absorbance, above background, was arbitrarily measured is indicated in spectrum B of Figure 3.

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### A TELLURIUM-BEARING CANFIELDITE, FROM REVELSTOKE, B.C.

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Canfieldite  $[Ag_8(Sn,Ge)S_6]$ , with  $Sn > Ge$  is a rare sulphosalt mineral which is often formulated as the pure end-member of the canfieldite-argyrodite series. Until Perichaud *et al.* (1966) reported the first occurrence of the pure Sn end-member from the Massiac region, France, there was no evidence that this occurs naturally.

The purpose of this paper is to report the first occurrence of a tellurium-bearing canfieldite. The mineral was identified during a mineralogical investigation of a lead-zinc-silver ore submitted to the Mineral Processing Division of the Mines Branch for beneficiation tests by Stannex

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Minerals Limited. The samples originated from a prospect located 19 miles northeast of Revelstoke, British Columbia.

The ore consists chiefly of sphalerite, pyrite and galena with lesser, but appreciable amounts of stannite with the remainder of the minerals — cassiterite, pyrrhotite, rutile, scheelite, argentiferous tetrahedrite, chalcopyrite, covellite, cerussite and three silver-tin bearing minerals — occurring in very small to trace, amounts.

The tellurium-bearing canfieldite occurs as small inclusions (10-50 $\mu$ m) in galena and often at the contact between the galena and pyrite. In reflected light, the mineral is isotropic and in contrast to the galena, it appears medium grey in colour.

Electron microprobe analyses and x-ray powder diffraction studies show that the mineral is a variety of the argyrodite-canfieldite series. Several grains were analyzed using, as standards, stephanite ( $\text{Ag}_3\text{SbS}_4$ ), pure Te and Sn, and the data were processed by a computer program (Rucklidge 1967) which applies corrections for drift, dead time, background, absorption, fluorescence and atomic number. The average results of four separate analyses are given in Table 1. The x-ray powder diffraction data derived from a 114.6mm-diameter camera with Ni-filtered Cu radiation are listed in Table 2. For comparison, microprobe analyses and x-ray diffraction data obtained in this study are given for argyrodite, the Ge member from Colquechaca, Bolivia, kindly supplied by H.R. Steacy, Curator of the Systematic Mineral Collection, Geological Survey of Canada, Ottawa.

Electron microprobe analysis shows that the argyrodite consists of two finely intergrown phases which are optically indistinguishable, but can be recognized by the reaction to the electron beam. The phase containing more Sn, appears to be less conductive, causing the electron beam

TABLE 1. ELECTRON MICROPROBE ANALYSIS OF TELLURIUM-BEARING CANFIELDITE AND ARGYRODITE

	Te-Canfieldite		Argyrodite Colquechaca, Bolivia			
	At. %	At. Prop.	(Low Melting)		(Unaffected)	
			Wt. %	At. Prop.	Wt. %	At. Prop.
Ag	65.12 $\pm$ 1.0	8.00	74.53	8.00	73.01	8.00
Sn	10.57 $\pm$ 0.5	1.18	2.87	1.16	0.16	1.32
Ge	—	—	5.52		8.06	
Te	8.69 $\pm$ 0.5	6.67	—	—	—	—
S	13.95 $\pm$ 1.0		16.80	6.06	20.15	7.40
Total	98.33		99.71		101.37	

TABLE 2. CANFIELDITE-ARGYRODITE X-RAY POWDER DATA

<i>hkl</i>	<i>a</i> = 21.70		Te-Canfieldite		Argyrodite Bolivia	
	<i>d</i> (calc)	<i>I</i> (est)	<i>d</i> (meas)	<i>I</i> (est)	<i>d</i> (meas)	<i>d</i> (calc)
222	6.264	6	6.243	2	5.949	6.111
440	3.836	2	3.827			
600	3.617	4	3.612			
442	3.617					
620	3.431	2	3.434			
622	3.271	5	3.279	4	3.198	3.191
444	3.132	10	3.143	10	3.034	3.056
640	3.009	3	3.003			
642	2.900	3	2.912	2	2.791	2.829
800	2.712	4	2.742	6	2.687	2.646
820	2.631	2	2.633	1	2.585	2.567
644	2.631					2.567
822	2.557	4	2.535	½	2.491	2.495
660	2.557					2.495
662	2.489	3	2.488	3	2.452	2.428
840	2.426	3	2.398	2	2.319	—
664	2.313	3	2.309			
844	2.215	5	2.214	2	2.162	2.161
10.0.0	2.170	1	2.173			
860	2.170					
10.2.0	2.128	1	2.134			
862	2.128					
10.2.2	2.088	3	2.103	8	2.037	2.037
666	2.088					2.037
10.4.0	2.015	1	2.022			
864	2.015					
10.4.2	1.981	1	1.997	2	1.941	1.932
880	1.918	4	1.942	9	1.875	1.871
10.4.4	1.889	5	1.912			
882	1.889					
10.6.2	1.834	5	1.841	3	1.792	1.789
12.4.0	1.716	½	1.733	1	1.693	1.674
12.4.2	1.694	1	1.703			
10.8.0	1.694					
10.6.6	1.655	1	1.651			
12.6.2	1.600	2	1.594	2	1.584	1.561
14.2.2	1.519	1	1.526	3	1.475	1.482
10.10.2	1.519					1.482
12.8.2	1.490	1	1.486	1	1.445	1.454
14.6.0	1.425	2	1.429	1	1.407	1.390
14.6.2	1.412	1	1.402	2	1.383	1.378
10.10.6	1.412					1.378

to "melt" the mineral, whereas the phase of composition closer to the Ge end-member is not affected. To obtain an analysis on the less conductive areas, an electron beam of  $10\mu\text{m}$  in diameter with a low specimen current ( $0.03\mu\text{a}$ ) had to be used. Even under these conditions, the accuracy of the analysis is questionable. The tellurium-bearing canfieldite also showed a small tendency to "melt" under a finely focused electron beam. Therefore, a  $10\mu\text{m}$  beam was used to obtain the analysis given in Table 1.

Comparison of the  $x$ -ray powder diffraction data (Table 2) of the tellurium-bearing canfieldite with that of argyrodite shows that the minerals are similar. The slight differences which could possibly distinguish the minerals are the more intense line at  $6.243(6)$  and the additional reflections, not observed for argyrodite, particularly the  $3.827$ ,  $3.612$  and  $3.434$  lines.

Indexing the  $x$ -ray powder pattern on the cubic cell proposed by C. Frondel for argyrodite with a little Sn (in Dana's System of Mineralogy, ed. 7, 1, 356, 1944) yields an  $a$  dimension of  $21.70\text{\AA}$  for the Te-canfieldite and  $21.17\text{\AA}$  for the argyrodite.

The formula derived from the electron microprobe analysis, and the similarity of the powder pattern to argyrodite, suggests that the Te replaces sulphur, yielding an ideal formula of  $\text{Ag}_8\text{Sn}(\text{S},\text{Te})_6$ .

Two additional silver-tin phases were observed, but were too small for complete identification. One of the phases is a pure silver-tin sulphide, probably canfieldite, which also occurs as inclusions in the galena and the second phase, a silver-copper-tin sulphide which gave Ag 50.3, Cu 17.4, Sn 11.5, S 20.9 from a  $10\mu\text{m}$  grain. The mineral forms the core of a composite grain which consists of successive layers of an unidentified copper sulfide, covellite and stannite and which occurs in sphalerite. This mineral appears to be a copper-bearing canfieldite.

No further work is contemplated at the present time to characterize these two phases.

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