

- CARRI, L.J. (1969) : Density determinations : Accuracy and application to sphalerite stoichiometry. *Am. Mineral.* **54**, 539-548.
- GREENWOOD, N.N. & WHITEFIELD, H.J. (1968) : Mössbauer effect studies on cubanite (CuFe_2S_3) and related iron sulphides. *J. Chem. Soc. (A)*, 1697-1699.
- MANNING, P.G. (1967) : Absorption spectra of Fe (III) in octahedral sites in sphalerite. *Can. Mineral.* **9**, 57-64.
- SCOTT, S.D. (1968) : Stoichiometry and phase changes in zinc sulphide. *Unpublished Ph.D. thesis, The Pennsylvania State University.*
- SCOTT, S.D. & BARNES, H.L. (1967) : Sphalerite geothermometry. *Econ. Geol.* **62**, 874-875 (abstract).
- (in prep.) : Sphalerite geothermometry and geobarometry. *Econ. Geol.*
- TOULMIN, P., III & BARTON, P.B., Jr. (1964) : A thermodynamic study of pyrite and pyrrhotite. *Geochim. et Cosmochim. Acta* **28**, 641-671.
- WERTHEIM, G.K. (1964) : *Mössbauer Effect: Principles and Applications*. Academic Press, New York.

Manuscript received June 1970.

AN OCCURRENCE OF VALLERIITE FROM NEW IMPERIAL MINE, YUKON

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During the course of mineralogical investigations of ores in connection with beneficiation tests being conducted in the Mineral Processing Division, Mines Branch, an ore sample was received from New Imperial Mines, Yukon. This sample had been submitted to the Mines Branch by Dr. A.C. Skerl, consulting mining geologist, Vancouver, B.C. in April, 1964. Dr. Skerl stated that the late Dr. R.M. Thompson, University of British Columbia had identified valleriite in a specimen of this ore. A thorough study of the ore failed to reveal the presence of valleriite, and therefore Dr. Skerl kindly submitted part of the specimen that had been studied by Dr. Thompson. This specimen, about $\frac{3}{4}$ inches of quartered drill core, contained a valleriite with such a distinct x-ray diffraction powder pattern that it was used as a standard in the Mines Branch x-ray diffraction laboratory. In 1969, D.C. Harris analysed the valleriite in this specimen with an electron microprobe, using synthetic CuFeS_2 , MgO and Al_2O_3 as standards, and processing the data with a computer program that included corrections for absorption, fluorescence and atomic number. X-ray powder diffraction data and unit-cell dimensions were obtained by the film method

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by E.J. Murray using 114.6-mm-diameter, Debye-Scherrer powder cameras, and Fe-filtered Co radiation. Film shrinkage corrections were applied and intensities were estimated visually. Pieces of the specimen are stored in the National Mineral Collection, G.S.C., Ottawa, and the Royal Ontario Museum, Toronto.

The ore from New Imperial Mines is composed of disseminated ore minerals in gangue. The ore minerals are magnetite, bornite, chalcopyrite, chalcocite, native copper, valleriite, covellite and pyrite, and the gangue minerals are pyroxene, serpentine, amphibole, chlorite, calcite and garnet. Magnetite is the most abundant ore mineral and it contains inclusions and veinlets of the copper-bearing minerals. The valleriite is present as veinlets along the cleavage planes in magnetite and along grain boundaries between the magnetite and bornite (Fig. 1). The bornite is intergrown with chalcocite.

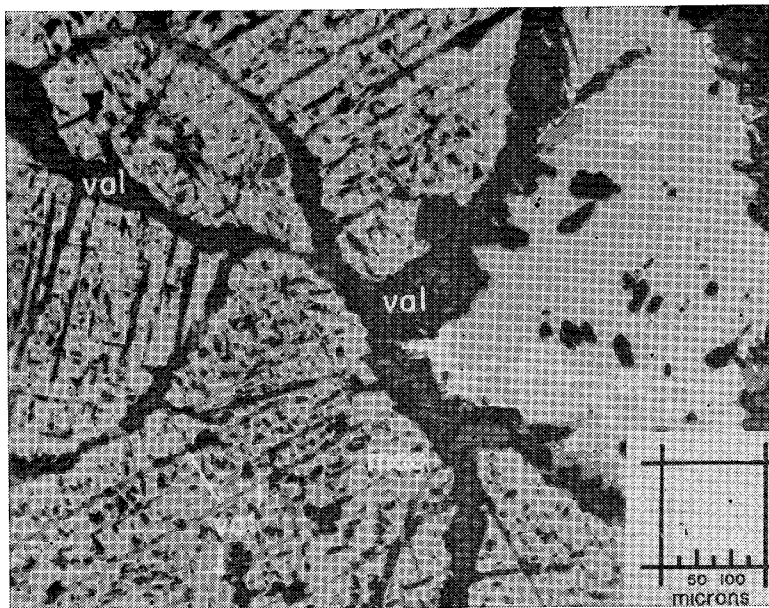


FIG. 1. Photomicrograph of a polished section showing valleriite veinlets (val) along cleavage planes in magnetite (mag) and along grain boundaries. A bornite (bn) grain partly intergrown with chalcocite (cc) is also present.

The structure of valleriite, recently determined by Evans & Allmann (1968) for material from Loolekop, South Africa, consists of alternating layers of copper-iron sulphide and magnesium-aluminum-iron hydroxide. Spot analyses by means of the electron microprobe show that the valleriite from New Imperial Mines contains constant amounts of Cu, Mg and S and variable amounts of Al and Fe (Table 1). Calculated formulae suggest that the sulphide layer has a constant composition and that the aluminum and iron variations occur in the hydroxide layer. Data for spots containing maximum and minimum amounts of aluminum are given in Table 1, and formulae for valleriites reported to date are given in the footnote. The x-ray powder diffraction pattern for the New Imperial Mines' valleriite (Table 2), has more reflections than the powder pattern for the Loolekop valleriite, but corresponds to that of a valleriite-type mineral from Noril'sk, Western Siberia (Harris *et al.* 1970).

TABLE 1. CHEMICAL COMPOSITION OF VALLERIITE FROM NEW IMPERIAL MINE

<i>Element</i>	Spot 1, Wt.%	Spot 2, Wt.%
Cu	26.65	26.68
Fe	17.85	22.69
Al	3.59	0.95
Mg	9.94	10.31
S	22.59	22.49
OH (calculated)	19.59	19.85
Total	100.21	102.97

OH (calculated)	= Amount of OH required to combine with analysed quantities of Mg, Al and the Fe in excess of that to give $(\text{Cu,Fe})_2\text{S}_2$.
Spot 1	= $(\text{Cu}_{1.19}\text{Fe}_{0.81}\text{S}_{2.00}) \cdot 1.64(\text{Mg}_{0.71}\text{Al}_{0.28}\text{Fe}_{0.06}(\text{OH})_2)$.
Spot 2	= $(\text{Cu}_{1.20}\text{Fe}_{0.80}\text{S}_{2.00}) \cdot 1.67(\text{Mg}_{0.73}\text{Al}_{0.06}\text{Fe}_{0.21}(\text{OH})_2)$.
Kaveltorp, Sweden (type locality)	= $(\text{Cu}_{0.81}\text{Fe}_{1.19}\text{S}_{2.00}) \cdot 1.56(\text{Mg}_{0.83}\text{Fe}_{0.17}(\text{OH})_2)$. (Springer 1968).
Loolekop, South Africa	= $(\text{Cu}_{0.98}\text{Fe}_{1.07}\text{S}_{2.00}) \cdot 1.53(\text{Mg}_{0.68}\text{Al}_{0.32}(\text{OH})_2)$. (Evans & Allmann 1968).
Loolekop (Palabora), South Africa	= $(\text{Cu}_{1.04}\text{Fe}_{0.96}\text{S}_{2.00}) \cdot 1.67(\text{Mg}_{0.75}\text{Al}_{0.09}\text{Fe}_{0.17}(\text{OH})_2)$. (Springer 1968).
Noril'sk, Western Siberia	= $(\text{Cu}_{1.00}\text{Fe}_{1.00}\text{S}_{2.00}) \cdot 1.47(\text{Fe}(\text{OH})_2)$. (Harris <i>et al.</i> 1970).

REFERENCES

- EVANS, H.T., JR., & ALLMANN, R. (1968) : The crystal structure and crystal chemistry of valleriite. *Zeit. Krist.*, **127**, 73-93.
- HARRIS, D.C., CABRI, L.J. & STEWART, J.M. (1970) : A new "valleriite-type" mineral from Noril'sk, Western Siberia. *Am. Mineral.*, **55**, 2110-2114.
- SPRINGER, G. (1968) : Electronprobe analysis of mackinawite and valleriite. *N. Jb. Miner. Mh.*, **8**, 252-258.

Manuscript received January 1970.

TABLE 2. X-RAY POWDER DIFFRACTION PATTERN OF VALLERIITE FROM NEW IMPERIAL MINE

$a = 3.780 \pm 0.003\text{\AA}$ $c = 34.14 \pm 0.02\text{\AA}$			
hkl	$d_{(\text{calc})}$	$d_{(\text{obs})}$	I
00 3	11.380 \AA	11.371 \AA	10
		7.22 *	3
00 6	5.690	5.701	10
00 9	3.793	3.800	5
10 1	3.259	3.258	8
01 2	3.214		
		3.143*	6
10 4	3.057	3.051	1
01 5	2.952	2.950	1
00 12	2.845	2.848	5
		2.796*	1
10 7	2.718	2.720	2
		2.675*	1
01 8	2.597	2.599	1
		2.484*	3
10 10	2.363	2.364	1
00 15	2.276	2.277	4
		2.110*	5
10 13	2.049	2.047	5
01 14	1.956	1.955	2
00 18	1.897	1.892	7
11 3	1.864	1.868	7
11 6	1.794	1.792	3
11 9	1.692	1.690	2
02 1	1.635	1.634	3
00 21	1.626	1.621	2
11 12	1.574	1.574	2
02 7	1.552	1.550	2
02 10	1.476	1.472	1

* X-ray diffraction lines that cannot be indexed as valleriite, using the structure of Evans & Allmann (1968) but correspond to those reported for valleriite from Noril'sk, Western Siberia (Harris *et al.* 1970).