

THE AMERICAN MINERALOGIST, VOL. 52, SEPTEMBER-OCTOBER, 1967

## LITHIOPHORITE FROM CHARLOTTESVILLE, VIRGINIA

RICHARD S. MITCHELL AND ROBERT E. MEINTZER,  
*University of Virginia, Charlottesville, Virginia.*

## INTRODUCTION

Recently lithium-poor lithiophorite,  $(\text{Al,Li})\text{MnO}_2(\text{OH})_2$ , has been found in Charlottesville, Virginia. Coatings of the mineral are very abundant on fracture surfaces in a milky quartz vein. In addition to reporting this new occurrence, a major purpose of this paper is to present indexed X-ray powder data for lithiophorite. Indexed data for the mineral are in the literature (Wadsley, 1950; Berry and Thompson, 1962; ASTM powder data card 12-717), but these are based on erroneous pseudohexagonal cells which do not conform to the monoclinic structure determined by Wadsley (1952).

For many years lithiophorite was grouped with the poorly defined materials called "wad" or "psilomelane." Ramsdell (1932) showed the mineral is a definite species with its own X-ray powder pattern. Fleischer and Richmond (1943), and subsequently numerous others, have verified Ramsdell's conclusion. Wadsley (1952), from single-crystal studies of material from Africa, determined its structure and formula. Recently, Fleischer and Faust (1963) summarized the data known for lithiophorite, and presented differential thermal analyses for the mineral.

## PHYSICAL AND CHEMICAL DATA

The Charlottesville lithiophorite is pulverulent to massive. It is dull to metallic black, with a black streak, and has a hardness of about 3. It occurs as sheetlike coatings, botryoidal crusts, and rarely as dendrites, on joints and fractures in a milky quartz vein. Quartz surfaces are commonly covered by crusts which are over a square foot in area. The crusts are generally about 0.25 mm thick, although crusts over 3 mm in thickness occur. The crusts generally consist of two layers, an outer layer which is dull black and weathered, and an inner layer which is black with a more metallic luster. On some specimens the lithiophorite crust shows a polygonal surface resembling mud cracks, with individual patches about 1.75 mm across.

Semiquantitative spectrographic analyses were made (Table 1) of specially selected specimens from two separate portions of the quartz vein. The analyses verify the mineral by showing the principal cations are aluminum and manganese. The relatively high percentages of silicon, iron, cobalt, and copper also compare well with chemical analyses of

specimens from various localities, summarized by Fleischer and Faust (1963). The amount of lithium (oxide, 0.2 to 0.3%) is less than most analyses for other localities. This provides additional evidence that lithium-free lithiophorite may exist, as suggested by Fleischer and Faust (1963). A preliminary semiquantitative spectrographic analysis, on an

TABLE 1. SEMIQUANTITATIVE SPECTROGRAPHIC DATA ON LITHIOPHORITE FROM CHARLOTTESVILLE, VA. ELEMENTS REPORTED AS OXIDES

Element	No. V4102 (%)	No. V4103 (%)
Li	0.2	0.3
Mg	0.04	.06
Al	15.	15.
Si	7.	2.5
Ca	0.03	0.03
Ti	0.15	0.1
V	0.05	0.025
Cr	0.003	0.002
Mn	Principal constituent in each	
Fe	2.	2.25
Co	2.	1.5
Ni	0.25	0.5
Cu	1.	0.8
Zn	0.6	1.
Ga	0.003	0.003
Sr	—	0.002
Mo	0.01	0.04
Ba	0.015	0.7
Pb	0.1	0.07

Analyst: F. W. Barley, American Spectrographic Laboratories, San Francisco.

impure sample, also showed an appreciable amount of phosphorus. The source of this element was not determined.

#### X-RAY POWDER DATA

Fleischer and Faust (1963) assembled X-ray powder data for lithiophorite from several localities, but they did not index these data. Wadsley (1950) assigned tentative hexagonal indices to his data, which he later showed to be monoclinic (1952). Berry and Thompson (1962) published data indexed by J. McAndrew (Ph. D. thesis, Univ. Toronto, 1951). Unfortunately these data were also based on an erroneous interpretation of the unit cell. A pseudo-hexagonal cell was used, which is closely related dimensionally to the correct monoclinic cell determined by Wadsley (1952). Other incorrectly indexed data, based on a smaller

pseudohexagonal cell, are given on ASTM powder data card 12-717. In order to index the X-ray reflections on the basis of the monoclinic structure, all interplanar spacings allowed down through  $1.44 \text{ \AA}$  were calculated from the following data obtained from the Postmasburg, Union of South Africa, lithiophorite by Wadsley (1952):  $C2/m$ ,  $a = 5.06 \text{ \AA}$ ,  $b = 2.91$ ,  $c = 9.55 \text{ \AA}$ ,  $\beta = 100^\circ 30'$ . In Table 2 these calculated values are compared with earlier published powder data for material from the same locality. A large number of the observed reflections correspond to  $20l$  and  $\bar{2}0l$  planes. The writer has noticed in the calculated intensity data of Wadsley (1952) that these are reflections of high intensity, and therefore are to be expected on powder films. The correlation between the Charlottesville and African data is very good considering variations in unit cell sizes resulting from slight differences in chemistry. Also X-ray data from numerous other localities, summarized by Fleischer and Faust (1963), can now be indexed, and impurity lines can be eliminated with certainty.

#### OCCURRENCE

The Charlottesville lithiophorite-rich quartz vein is about 0.25 miles west of Emmet Street, and is nearly perpendicular to Arlington Boulevard. The best exposure is north of the Georgetown Apartments and west of the Leeland Nursery Home. The vein strikes generally N.  $35^\circ$  E. It is from 2 to 4 feet wide and was traced at the surface for over 425 feet. The full extent of the vein could not be determined. It seems to follow the cleavage of the Lynchburg formation (Nelson, 1962, p. 19), which at this place is a gray fine-grained graphitic sericite schist. West of the vein a short distance is a deeply weathered felsite dike (sill?) with a similar strike. The quartz of the vein varies from milky vitreous to white saccharoidal in appearance. The vein is full of planar fractures upon which lithiophorite has been deposited. Usually this mineral only coats the surfaces, instead of completely filling the fractures. Although the quartz is by far the major primary component of the vein, some specimens show subhedral cavities in the quartz from which an unknown mineral (feldspar?) has been weathered. Some of these contain kaolinite (with tiny white mica flakes). Porcellaneous moderate reddish-brown metahalloysite clay is intimately associated with the lithiophorite crusts, and also fills fractures in the quartz vein and associated rocks.

Apparently lithiophorite is a common mineral in Virginia. X-ray analyses of miscellaneous black crusts have shown occurrences at the Champion pegmatite, Amelia County; Bishop turquoise mine, Lynch Station, Campbell County; quartz mine in Fluvanna County (just east of Scottsville, Albemarle County); old Tellurium gold mine, Fluvanna County; and the Eureka manganese mine, Stanley, Page County. Cos-

TABLE 2. INDEXED X-RAY POWDER DATA FOR LITHIOPHORITE BASED ON MONOCLINIC STRUCTURE OF WADSLY (1952)

<i>hkl</i>	<i>d</i> , Å (calc.)	Africa				Virginia	
		1.		2.		3.	
		<i>d</i> , Å	<i>I</i>	<i>d</i> , Å	<i>I</i>	<i>d</i> , Å	<i>I</i>
001	9.39	9.45	m	9.27	4	9.52	s
002	4.70	4.70	s	4.70	10	4.76	vs
003	3.13	3.12	mw	3.13	2	3.17	w
201	2.52			2.52	2	2.47	vw
110	2.51						
200	2.49						
111	2.48						
202	2.39	2.39	mw	2.38	8	2.36	m
111	2.37						
004	2.35						
112, 201	2.30			2.31	1	2.28	vvw
203	2.15			2.15	.25	2.13	vw
112	2.13						
113, 202	2.05			2.06	.25		
204	1.89	1.88	m	1.89	7	1.88	mw
005, 113	1.88						
114	1.80						
203	1.79						
205	1.65						
114	1.64						
115	1.58	1.51 <sup>1</sup>	w	1.58	5	1.58	vw
204, 006	1.57						
311, 020	1.46	1.46	vw	1.46	5	1.44	vvw
206	1.45	1.45	vw	1.45	1		
312, 115	1.44						
310, 021							
		1.40	vw	1.40	4	1.38	vw
				1.25	2		
		1.23	w	1.23	3		
		1.17	vw				
		1.15	vw	1.16	3		
				1.07	1		

<sup>1</sup> The writer believes this value was reported incorrectly in the original work since it neither corresponds with the value reported by McAndrew nor is close to a calculated value.

1. Wadsley (1950), Postmasburg, Union of South Africa.

2. McAndrew quoted by Berry and Thompson (1962), Postmasburg, Union of South Africa. Omitted are lines at 4.41 Å and 2.40 Å which are probably from an impurity.

3. Charlottesville, Virginia. Average of values obtained from seven films, 11.46 cm diameter cameras, CuK $\alpha$  radiation.

minsky (1948) has reported the mineral from Falls Church, Virginia. Fleischer and Faust (1963) report the mineral in Virginia but give no specific localities.

## REFERENCES

- BERRY, L. G. AND R. M. THOMPSON (1962) X-ray powder data for ore minerals: the Peacock atlas. *Geol. Soc. Amer. Mem.* **85**, 281 p.
- COSMINSKY, P. R. (1948) An occurrence of psilomelane, variety lithiophorite, in Falls Church, Va. *Rocks Minerals*, **23**, 204.
- FLEISCHER, M. AND G. T. FAUST (1963) Studies on manganese oxide minerals. VII. Lithiophorite. *Schweiz. Mineral. Petrog. Mitt.*, **43**, 197-216.
- AND W. E. RICHMOND (1943) The manganese oxide minerals: a preliminary report. *Econ. Geol.*, **38**, 269-286.
- NELSON, W. A. (1962) Geology and mineral resources of Albemarle County. *Va. Div. Miner. Res., Bull.* **77**, 92 p.
- RAMSDELL, L. S. (1932) An x-ray study of psilomelane and wad. *Amer. Mineral.*, **17**, 143-149.
- WADSLEY, A. D. (1950) Synthesis of some hydrated manganese minerals. *Amer. Mineral.*, **35**, 485-499.
- (1952) The structure of lithiophorite,  $(Al, Li)MnO_2(OH)_2$ . *Acta Crystallogr.*, **5**, 676-680.

THE AMERICAN MINERALOGIST, VOL. 52, SEPTEMBER-OCTOBER, 1967

## OLIVINE IN ENSTATITE CHONDRITES

R. A. BINNS, *Department of Geology, University of New England, Armidale, New South Wales, Australia.*

Although abundant in chondritic meteorites belonging to the more common classes, olivine has hitherto been considered absent from enstatite chondrites. In a recent review of the mineralogy, chemistry, and structure of this latter group Mason (1966) noted that many stones, having orthorhombic enstatite and sodic plagioclase as their main silicate constituents, possess granular recrystallized textures. He also drew attention to the slight excess of silica over magnesia and other basic oxides revealed by chemical analyses. A new investigation of thoroughly recrystallized enstatite chondrites represented in the British Museum (Natural History) collection, London, has shown that all but one contain accessory tridymite. The exception, *Blithfield*, has small amounts of cristobalite. Under these circumstances, olivine would not be expected to occur had equilibrium been attained during recrystallization.

Three enstatite chondrites in the British Museum collection may be classified texturally as Primitive Group (Binns, 1967) or Type 4 (Van