LYNDOCHITE—A NEW MINERAL OF THE EUXENITE-POLYCRASE GROUP FROM LYNDOCH TOWNSHIP, RENFREW COUNTY, ONTARIO.

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Introduction

This mineral occurs in a pegmatite dike on lot 23, con. XV, Lyndoch township, Renfrew County, Ontario. The occurrence has been known for many years, having been first described by the late Willet G. Miller in the 7th Report of the *Ont. Bureau of Mines*, **1897**, Part III, page 234. Dr. Miller notes microcline, microperthite, quartz, amazon-stone, black mica, smoky quartz, beryl, columbite, thin platy feldspar, black tourmaline and fluorite as occurring in the dike. He states further that: "There is also embedded sparingly in the feldspar another mineral which has not as yet been subjected to careful examination, but it appears to be a columbate. It has a vitreous lustre, is shining black in color, has a conchoidal fracture and resembles rather closely in general appearance certain specimens of the natural glass obsidian. There is also a brown mineral which appears to belong to the same chemical class as the two already described." (i. e., columbite and the unknown columbate). Walker and Parsons[1] also have described beryl and other minerals recently obtained from this dike.

Excellent crystals of the black columbate (lyndochite) collected at different times by A. T. McKinnon of this Department and the writer, have been in the Survey collection for several years. Owing to the roughness and distortion of the faces it has not been possible to make sufficiently exact measurements to be sure to what extent the interfacial angles differ from those of euxenite, but several fairly accurate contact measurements suggest a close similarity of forms and angles. The forms present have been identified as (100), (010), (110), (310) or (410) or both, (201), (111). These may be readily recognized in the photographs. (Fig 1) Measurements on one of the best crystals seemed to indicate that the axial ratio may be about the same as for euxenite. All the crystals are composite, due to parallel growths and twinning.

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[1] Paper read at the meeting of the *Min. Soc. of Am.*, Dec. **1926**. The writer has not seen this paper. (See abstract in *Am. Mineral.*, **12**, 79, 1927.)

There seems to be a possibility that they may be only pseudo-rhombic and in reality characterized by a lower grade of symmetry.

The mineral is brilliant black en masse, reddish brown and translucent by strong illumination of the thin edges or splinters

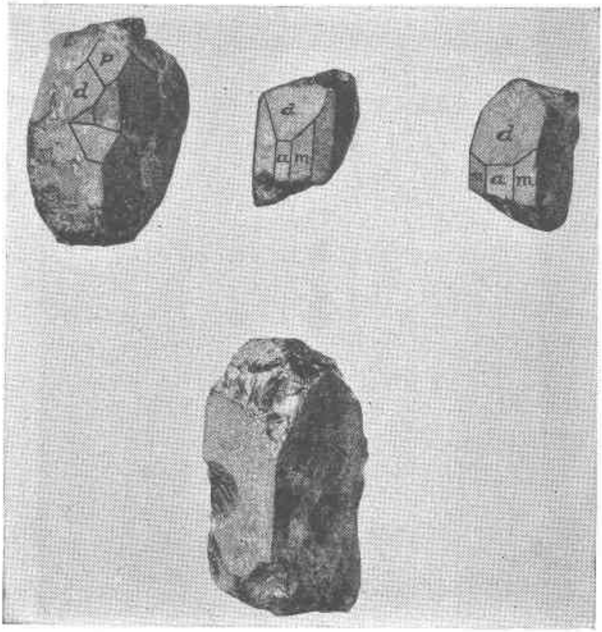

FIG. 1.
Lyndoch crystals oriented with *a* to the front, showing typical development of faces, parallel growths and twinning parallel to *b* bisecting the upper right hand crystal.

or in a powder under the microscope. Powder pale yellow. Isotropic. Lustre vitreous. Perfect conchoidal fracture. Cleavage none. Not as brittle as many minerals of this class. Hardness 6.5. Sp. Gr. 4.909 at 17.88°. Infusible.

Preparation of Samples

Although a number of well developed crystals and crystal fragments were available, the selection of a suitable sample for analysis was complicated by the discovery that all the material, including even the most perfectly formed crystals contained scattered inclusions of an opaque black metallic looking mineral which proved to be columbite, easily distinguishable under the binocular microscope from the vitreous, semitransparent lyndochite. These inclusions fortunately are, for the most part, distributed in such a manner that it was possible, by breaking up the material into small pieces a few millimeters in size, to select fragments showing under the binocular no visible inclusions. This selection was very carefully carried out, any piece showing even the slightest amount of foreign material was rejected, so that the

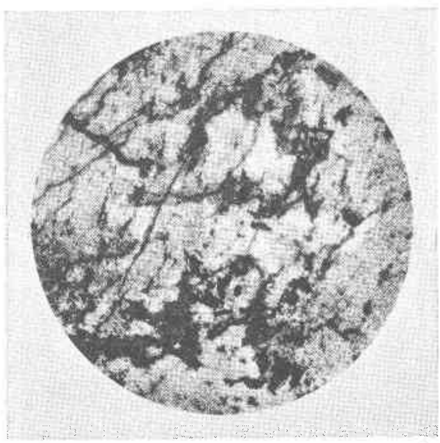

FIG. 2.

Photomicrograph of a thin section of lyndochite by transmitted light, showing black columbite inclusions, in an area in which the latter was particularly abundant. Minute detail visible to the eye is not reproduced in the photograph.

final sample was comprised of only the purest crystal fragments. Nevertheless thin sections of crystals showed that it would be impossible to obtain an absolutely pure sample as occasional microscopic inclusions exist in small amount even in the best material. These microscopic inclusions (Fig. 2) are plainly remnants of columbite in process of assimilation by the lyndochite, or perhaps more correctly, in process of transformation to lyndochite when the reaction was interrupted by a change in conditions; such as a decrease in temperature, a change in the character of the mother solution, or perhaps by the depletion of the reacting constituents.

A small sample of the included material was also prepared but it was impossible to get any appreciable quantity entirely free from lyndochite and it was estimated that the pure included material made up approximately 2/3 or 3/4 of the total sample of 0.0190 grams, the remainder, of course, being adhering lyndochite.

An analysis yielded the following results:

Analysis of Lyndochite, Lyndoch Township, Renfrew Co., Ontario.

	Per cent.	Mol. Wt.	Bases	Acids
PbO_2	0.37	222	0.0017	
($Pb=0.34$)				
UO_2[1]	0.67	270.2	0.0025	
UO_3	0.04	286.2	0.0001	
($U=0.63=0.74$ U_3O_8[2])				
ThO_2	4.95	264	0.0187	
($Th=4.35 \times 0.38=1.65$ U equivalent)				
$(Ce, La, Di)_2O_3$	4.34	330	0.0131	
$(Yt, Er)_2O_3$ (Av. At. Wt. = 105.4)	18.22	258.8	0.0704	
FeO	0.77	72	0.0107	
Fe_2O_3	1.32	159.7	0.0076	
MnO	0.59	70.9	0.0083	
Al_2O_3 }	0.13	102.2	0.0013	
BeO }		25.1		
CaO	4.86	56	0.0868	
MgO	0.13	40.3	0.0032	
ZrO_2	0.04	122.6		0.0003
SnO_2	0.12	150.7		0.0008
TiO_2	16.39	80.1		0.2046
Ta_2O_5	3.84	443		0.0087
Cb_2O_5	41.43	266.2		0.1556
SiO_2	0.07	60.3		0.0001
F	Not detected		0.2244	0.3701
$H_2O-110°$	0.06			
$H_2O+110°$	1.90	18	(0.1090)	
He, etc	Not determined			
Loss on ign.	(1.76)			
	100.24			

[1] Determination on 2 g.
[2] Determination on 5 g.
Sp. Gr. = 4.909 at 17.88°

Pb/U+0.38 Th=0.15=1100 million years.

Partial analysis of inclusions (columbite) in Lyndochite:—

	Per cent	
T_2O_5 / Cb_2O_5	62.6	(probably low)
TiO_2	5.8	

The partial analysis of the included mineral serves to show plainly from the high percentage of Cb and Ta oxides and the small amount of Ti, that it must be, or must have been originally, columbite, now probably somewhat altered by the enclosing lyndochite.

Compared with typical euxenites, to which lyndochite seems to be most nearly related, especially in crystal form, considerable differences appear. Whereas euxenites seldom have less than 5%, usually between 5 and 15 and may have as much as 20%, of uranium oxides, this mineral has less than one, while it has two or three times the usual amounts of ThO_2 and CaO. Further, it is higher in Cb_2O_5 and total Ti, Ta, Cb oxides than any euxenites hitherto known to the writer. Some of this excess of acid earth oxides is to be credited to microscopic inclusions of columbite but the larger part must be present in chemical combination, for if all the MnO of the lyndochite be considered as due to columbite inclusions alone, there would be at most only 3% of columbite present and this would account for only about 3/4 of one per cent of the excess of Ta, Cb oxides. The high columbium content apparently results from the partial digestion of columbite which acted as nuclei around which the lyndochite crystallized. Advocates of the replacement theory in pegmatites would doubtless consider this a typical example of such action.

Thus it appears that lyndochite is one of the numerous theoretically possible isomorphous minerals of the euxenite-polycrase group—essentially a thorium-calcium euxenite with uranium only a minor constituent. Opinions may differ as to the advisability of classifying it as a new mineral but it appears to be at least as much entitled to a distinctive name as is polycrase. It is noteworthy that in spite of its exceptional composition, the lyndochite displays a strong tendency to crystallize, the crystals as they occur in the rock are often almost perfect, though it is seldom possible to remove them without more or less injury. The mineral, therefore, is apparently, or was originally, a definite chemical compound.

Hence it appears that minerals of the euxenite-polycrase-lyndochite group may vary in content of Ti, Ta, Cb oxides from about 48 to 62 per cent, and in uranium content from 0.74 to 20% of U_3O_8, while the total rare earths plus thorium remains fairly constant.

Further points of interest are; first, that the age of the lyndochite as here determined agrees exactly with the best results from the Ontario uraninites; secondly, that silica is present in only minute amount. An apparent connection between silica content and age results in the case of the titano-tantalo-columbates-*ie*-that those containing appreciable silica give low results while those with no silica agree with the uraninites—was noted in an earlier paper.[2]

Mineral Associations

Lyndochite occurs chiefly in a pink microcline feldspar which with white and smoky quartz and some green amazonstone makes up the mass of the dike. Much of the microcline contains some plagioclase, as noted by Miller. This is true even of the platy variety. Well formed beryl crystals usually from 1 to 3 inches sometimes 6 or 8 inches in diameter and 3 feet or more in length occur rather abundantly in places, and are often associated with the peculiar platy feldspar which seems to be characteristic of many beryl occurrences. A few crystals with well developed terminations have been found, but they are exceptional. Occasional crystals may be in part clear and transparent but the color is not attractive, having a very pale bluish or greenish tint, or almost colorless. Thin, flat disc-shaped masses of columbite[3] with concentric markings reach a diameter of a foot or more but are rarely more than 1/2 inch thick. Also crystal aggregates of zircon or cyrtolite occur the size of a fist. A few red garnets in good crystals up to 2 inches in diameter have likewise been found and a small amount of fluorite. Magnetite is abundant in places. There is reason to believe that bismuthinite was also found, as this mineral is recorded[4] as occurring in a dike with beryl in the same township, and Mr. John Sullivan, the discoverer of the dike,

[2] Ellsworth, H. V. *Am. Mineral.*, **11**, 329, (1926).

[3] Analyzed by Dr. W. L. Goodwin (Miller, W. G., *Rept. Ont. Bureau of Mines*, **1907**, *loc. cit.*), and more recently by E. W. Todd (Walker, T. L., and Parsons, A. L., *Contributions to Canadian Mineralogy*, **1923**, p. 34.)

[4] *Geol. Surv. Canada. N. S.* **VIII**, 14R.

some years ago informed the writer that he had found in earlier years a mineral answering to the description of bismuthinite.

The dike was almost entirely covered by soil, brush, etc., only a few square yards being exposed, until a year or so ago when it was opened up in an attempt to produce beryl in commercial quantities. Mr. Eardley-Wilmot of the Mines Branch, Department of Mines, informs me that the dike can now be seen to be of considerable size, the beryl occurring over a width of 15 feet, the total width not being exactly ascertainable, and that it can be traced for 200 feet or more in a north-easterly direction.

NOTES AND NEWS

NAMES FOR THE SYMMETRY-CLASSES BASED ON AXES

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While the crystal systems have been assigned different names by various authors, there is on the whole a general agreement as to which are preferable, and uncertainty rarely arises as to what system is intended, even when the less familiar terms are employed. With the thirty-two symmetry-classes, however, it is a different story. Few of them have had less than 10 distinct designations (including names, letter-symbols, and numbers) assigned, and as noted by Spencer[1] one of the hexagonal classes has received at least as many as 31. It would indeed be highly desirable if some general agreement could be reached as to the names to be used for the classes, as urged by Spencer, but those he recommends seem capable of considerable improvement. A new, relatively simple, series of names is here put forward, as possibly suitable for general adoption.

The most systematic set of names in wide use is that of Groth, each class being characterized by its general form. There are two principal objections to this plan, the first that the names of symmetry-classes ought to be based on symmetry rather than on forms, and the second that the general form names are unnecessarily cumbersome. Dana endeavored to avoid the second objection by using names of other than the general form for some classes, and descriptions of peculiar features for others, and Spencer follows the same plan, but this does not answer the first objection, and introduces the further disadvantage of lack of uniformity.

Sets of names based on symmetry are used by some authors, notably Miers and other English crystallographers, and one of these sets has been adopted in this country by Phillips.[2] The chief objection to it lies in its cumbersomeness, which is scarcely less than that of the Groth series.

The class-names noted in the preceding paragraph are based on both planes and axes of symmetry. The writer's proposal involves the use of names based as far as practicable on symmetry axes only. They are brought out in the accompanying tabulation, which is self-explanatory.

[1] L. J. Spencer, *Mineralog. Mag.*, **20**, 361 (1925).

[2] Mineralogy, 1912.