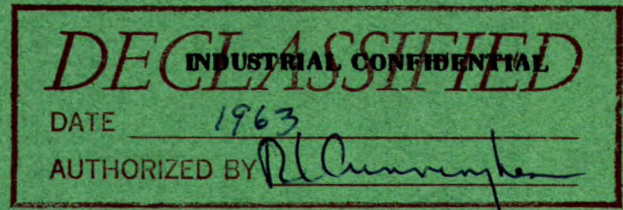


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CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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MINES BRANCH INVESTIGATION REPORT IR 62-41

EUDIDYMITÉ FROM SEAL LAKE, LABRADOR, NEWFOUNDLAND

by

E. H. NICKEL

WITH ANALYSES BY D. J. CHARETTE J. C. HOLE,
MISS E. M. PENNER & H. P. DIBBS

MINERAL SCIENCES DIVISION

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SUMMARY OF RESULTS

Eudidymite has been identified in the beryllium ore from Seal Lake, Labrador, Newfoundland. A chemical analysis of eudidymite isolated from the ore gave the following results: BeO 8.72%, Na₂O 11.90%, SiO₂ 71.52%, H₂O 3.04%, remainder 4.14%. Eudidymite was found in 13 of 19 ore samples investigated. Quantitative determinations of this mineral in four composite samples by a "separatory-analytical" method show that the amounts of eudidymite vary between 0.7 and 1.4%.

* Senior Scientific Officer, Mineralogy Section, ** Senior Scientific Officer, Analytical Chemistry Subdivision, *** Scientific Officer, Analytical Chemistry Subdivision, **** Senior Scientific Officer, Physics and Radiotracer Subdivision, Mineral Sciences Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

INTRODUCTION

The mineralogy of the complex beryllium-niobium deposit at Seal Lake, Labrador, has been under investigation by the writer since August, 1960, when the first shipment of samples was received from officials of Rio Tinto Canadian Exploration Limited, Toronto, Ontario. Samples from this shipment will be referred to as "Series A" in the remainder of this report. The shipment consisted of about 150 pounds of ore in fragments weighing from 2 to 10 pounds each and represented material from two separate zones--the "Main Zone" and "Dyke Zone". In a preliminary report on the mineralogy of the "Main Zone" samples issued early in 1961 (1), it was stated that the only beryllium mineral found up to that time was berylite. A report on the berylite was issued early in 1962 (2).

On September 7, 1961, E.L. Evans, chief geologist of Rio Tinto Canadian Exploration Limited, gave the writer a small chip from a diamond drill core from the deposit, stating that this chip had a particularly high beryllium content, and that he thought it might contain a substantial amount of berylite. Investigation showed, however, that the chip contained a high proportion of eudidymite ($\text{NaBeSi}_3\text{O}_7\text{OH}$), and this was reported in a letter to Dr. Evans on September 15, 1961. This appears to have been the first reference to eudidymite from the Seal Lake deposit.

On March 7, 1962, R.A. Dujardin, geologist with the aforementioned company, submitted three pulverized samples, requesting a determination of the amount of eudidymite in each of them, as well as in a sample that had previously been sent to the Mineral Processing Division of the Mines Branch for experimental processing. These samples, hereafter termed "Series B", were reported to be from different parts of the deposit. It was hoped to ascertain the distribution of the eudidymite, since the presence of this mineral has an adverse effect on the extraction of beryllium from the ore. The samples were labelled as follows:-

- Sample 1: Weighted composite D.D.H. # 1 for ore section
157.0-210.0 feet. Berylometer assay 0.37% BeO.
- Sample 2: Weighted composite D.D.H. # 2 for ore section
216.0-280.0 feet. Berylometer assay 0.41% BeO.
- Sample 3: Weighted composite D.D.H. # 3 for ore section
82.7-217.0 feet. Berylometer assay 0.34% BeO.
- Sample 4: Surface sample sent to Mines Branch for experimental
processing.

DESCRIPTION OF EUIDYMITITE

Physical and Optical Properties

The eudidymite is white and has a very well-developed cleavage. In a hand sample it is virtually indistinguishable from albite, which comprises the majority of the ore, and which is also white and exhibits good cleavage. The only massive eudidymite observed was in the small chip received from Dr. Evans. Here the cleavage faces of the eudidymite grains tend toward parallelism, giving the sample a characteristic appearance. No eudidymite was recognized in place in the other samples, being detectable only in pulverized form, as described below. The eudidymite in these other samples is therefore assumed to occur as disseminated grains.

Optically, the eudidymite is very similar to the albite, both with respect to refractive indices and birefringence. Consequently, the disseminated eudidymite grains cannot be positively distinguished from the albite even in thin sections under the petrographic microscope. Crushed grains of eudidymite and albite can, however, be distinguished by means of the petrographic microscope if they are immersed in a liquid with a suitable refractive index, particularly if phase contrast is used to enhance the slight refractive index differences between the two minerals. It has been found that the optimum refractive index of the immersion medium is 1.540, which is between the refractive indices of albite (1.525 to 1.536) and those of eudidymite (1.545 to 1.551). When the phase contrast plate is correctly adjusted, the feldspar grains have a light blue border in contrast to the eudidymite grains, which have a reddish-violet border. This effect enables eudidymite and albite to be distinguished readily in pulverized samples.

Chemical Analysis

Eudidymite was concentrated from Series A Sample No. 627, this sample being selected because microscopic examination revealed its relatively high content of eudidymite. The eudidymite was concentrated by heavy liquid separations, thereby taking advantage of its low specific gravity (2.55). The eudidymite concentrate was then chemically analyzed. The results, as well as the theoretical composition of the mineral, are shown in Table 1.

TABLE 1

Chemical Analysis of Eudidymite

	Concentrate from Sample 627, Series A	Theoretical Composition (NaBeSi ₃ O ₇ OH)
Na ₂ O	11.90 %	12.64 %
K ₂ O	0.47	--
BeO	8.72	10.20
MgO	0.10	--
CaO	0.23	--
Al ₂ O ₃	2.66	--
Fe ₂ O ₃	0.52	--
SiO ₂	71.52	73.49
H ₂ O ⁻	0.16	--
H ₂ O ⁺	3.04	3.67
	99.32	100.00

Chemical Analyses by D.J. Charette and Miss E.M. Penner (3).

The analytical results given in Table 1 total only 99.32%, leaving a deficiency of 0.68%. The analysts account for some of this deficiency by the fact that the combined percentage of the individually analyzed components of the ammonium hydroxide group (BeO + Al₂O₃ + Fe₂O₃) is 0.34% less than the weight percentage of the unseparated precipitate. Some of the deficiency may also be accounted for by the volatile components, since the total loss on ignition was found to be 3.84%, in contrast to the 3.20% total water determined. Some of this loss on ignition, however, may be attributable to partial volatilization of the alkalis.

Comparison of the analysis with the theoretical composition of eudidymite shows that the percentages of the essential eudidymite components are all somewhat lower than the theoretical values, which indicates that the concentrate was not pure. The rather high Al₂O₃ content is probably due to the presence of some albite in the concentrate. The Fe₂O₃ is possibly due to the presence of amphibole or pyroxene. The other elements reported may or may not be chemically combined with the eudidymite.

X-ray Diffraction Analysis

The X-ray powder data for the eudidymite from Seal Lake are given in Table 2. A comparison of these with the powder data for eudidymite from the type locality at Langesundfjord, Norway shows that the two patterns are practically identical.

TABLE 2

X-ray Powder Diffraction Data for Eudidymite

Line No.	Eudidymite from Seal Lake, Labrador		Eudidymite from Langesundfjord, Norway*	
	I (est.)	d (A)	I (est.)	d (A)
1	2	6.8	2	6.8
2	6	6.35	6	6.35
3	2	6.09	2	6.10
4	1	5.47	1	5.48
5	2	4.94	2	4.95
6	2	4.37	2	4.35
7	2	4.14	2	4.14
8	3	3.91	3	3.93
9	5	3.67	5	3.69
10	4	3.48	4	3.49
11	8	3.39	8	3.40
12	1	3.32	1	3.32
13	2	3.24	2	3.23
14	10	3.17	10	3.16
15	8	3.07	8	3.07
16	6	3.00	6	3.00
17	1	2.915	1	2.928
18	6	2.849	6	2.848
19	2	2.747	2	2.754
20	1	2.712	1	2.715
21	3	2.598	3	2.603
22	2	2.562	2	2.560
23	3	2.495	3	2.501
24	2	2.452	2	2.456
25	2	2.413	2	2.416
26	2	2.391	2	2.396
27	2	2.361	1	2.365
28	1	2.307		--
29	2	2.262		
30	1	2.235	2	2.263
31	1	2.216	1	2.221

(Concluded) -

TABLE 2 (Concluded)

Line No.	Eudidymite from Seal Lake, Labrador		Eudidymite from Langesundfjord, Norway*	
	I (est.)	d (Å)	I (est.)	d (Å)
32	2	2.186	2	2.183
33	2	2.123	2	2.125
34	1	2.084	--	--
35	2	2.053	2	2.056
36	5	2.011	5	2.014
37	1	1.945	--	--
38	1	1.924	--	--
39	1	1.874	1	1.879
40	2	1.844	1	1.845
41	5	1.823	5	1.823
42	3	1.768	3	1.769
43	3	1.741	3	1.742
44	4	1.694	4	1.697
45	1	1.660	--	--
46	1	1.644	1	1.644
47	1	1.613	1	1.613
48	3	1.591	3	1.592
49	3	1.576	3	1.575
50	3	1.543	3	1.545
51	1	1.527	--	--
52	2	1.507	2	1.509
53	2	1.456	2	1.460
54	2	1.439	2	1.440
55	3	1.422	3	1.424
56	2	1.409	2	1.410
57	1	1.383	--	--
58	3	1.357	2	1.359

Copper radiation, nickel filter; camera diameter 114.6 mm

* From an X-ray powder mount supplied by the Geological Survey of Canada.

QUALITATIVE DETERMINATION OF EUIDYMITES
IN THE "SERIES A" SAMPLES

Thirteen of the individual samples from the Main Zone and a composite sample of Dyke Zone material were separated in tetrabromoethane with a specific gravity of 2.96. The float fractions, which consisted largely of albite, were examined for the presence of eudidymite by means of phase contrast. The results, given in Table 3, show that eudidymite was found in eight of the fourteen samples. This indicates that this mineral is not uniformly distributed throughout the ore.

TABLE 3

Distribution of Eudidymite in Series A Samples

Eudidymite Detected	Eudidymite not Detected
Sample No. 583	Sample No. 579
" 618	" 691
" 622	" 697
" 626	" 702
" 627	" 718
" 701	Dyke Zone composite
" 724	
" 863	

QUANTITATIVE DETERMINATION OF EU DIDY MITE
IN THE "SERIES B" SAMPLES

Procedure

The most accurate way of determining the abundance of a mineral quantitatively is to make a quantitative separation. This is not practicable in the case of eudidymite, however, because its physical properties are so similar to those of albite with which it is associated. Consequently, an alternative method had to be employed. The method used, hereafter called the "separatory-analytical method", is as follows:-

The samples which, when received, had been ground to minus 100 mesh, were screened on a 325 mesh screen. The oversize and under-size fractions were then individually separated into float (lighter) and sink (heavier) portions using tetrabromoethane with a specific gravity of 2.96. The +325 mesh fractions were separated in separatory funnels under the normal force of gravity, whereas the -325 mesh fractions were centrifuged to aid separation. The separated products were then weighed and analyzed for beryllium oxide. The assumptions entailed in using this method are that eudidymite is the only beryllium mineral in the ore having a specific gravity below 2.96 and that it is liberated from the other minerals. If these assumptions are valid, then all the BeO in the float fractions is due to eudidymite. It therefore follows that, given the composition of eudidymite, the percentage of eudidymite in the float can be calculated and, from that, the percentage of eudidymite in the sample may be derived.

In order to ascertain whether or not the separatory-analytical method provides a reasonably accurate estimate of the eudidymite content, the results obtained on the +325 mesh float fractions were compared to the results of eudidymite grain counts made on the same samples using phase contrast. In making the grain counts, small amounts of each of the samples were mounted on glass slides and immersed in refractive index oil with a refractive index of 1.540. The results obtained, compared with the results of the separatory-analytical method, are shown in the two lower sets of figures in Table 4.

TABLE 4

Comparison of Results of Eudidymite Determination on
+ 325 Mesh Float Fractions by Grain Counting and by
Separatory-Analytical Method

Sample No.	1	2	3	4
Eudidymite grains counted	44	22	39	21
Other grains counted	<u>3186</u>	<u>3256</u>	<u>3099</u>	<u>2256</u>
Total	3230	3278	3138	2277
Eudidymite (from grain count)	1.36%	0.67%	1.24%	0.92%
Eudidymite (by separatory-analytical method)	1.37	1.28	1.08	1.28

The two sets of values are of the same order of magnitude. The greatest discrepancy is in Sample No. 2, where the grain count indicates almost 50% less eudidymite than the separatory-analytical method. Although this may seem like a large discrepancy, this is approximately the statistical accuracy that can be expected from a sampling of this size. Hence, the microscopic determinations confirm the results obtained by the separatory-analytical method, which suggests that the latter method provides an accurate method of determining the amount of eudidymite in these samples.

Results of Separatory-Analytical Procedure

The results of the heavy liquid separations and the chemical analyses are shown in Table 5. The beryllometer analyses of the unseparated fractions are in satisfactory agreement with the calculated analyses of the head samples, thereby confirming the reliability of the chemical determinations.

TABLE 5

Results of Heavy Liquid Separations and Analyses

Sample No.	Product	Wt %	Per cent BeO	
			Chemical*	Berylometer**
1	Float, +325 m	27.5	0.14	0.33
	" -325 m	41.8	0.25	
	Sink +325 m	12.1	0.63	
	" -325 m	18.6	0.55	
	Calc. head	100.0	0.32	
2	Float, +325 m	23.9	0.13	0.34
	" -325 m	40.2	0.21	
	Sink, +325 m	10.0	0.66	
	" -325 m	25.9	0.43	
	Calc. head	100.0	0.29	
3	Float, +325 m	21.6	0.11	0.30
	" -325 m	31.3	0.25	
	Sink, +325 m	13.9	0.60	
	" -325 m	33.2	0.21	
	Calc. head	100.0	0.25	
4	Float, +325 m	40.7	0.13	0.48
	" -325 m	17.5	0.26	
	Sink, +325 m	24.5	0.90	
	" -325 m	17.3	0.65	
	Calc. head	100.0	0.43	

* Chemical analyses by J. Hole (4).

** Berylometer analyses by H.P. Dibbs (5).

A noteworthy feature of the data in Table 5 is the difference in BeO content in the +325 and -325 mesh fractions of the same samples. In all the float portions the BeO content of the +325 mesh fraction is considerably less than that of the -325 fraction, whereas in the sink portions, the +325 mesh fractions contain more BeO than the -325 mesh fractions. This can be explained in either of two ways: 1) The eudidymite pulverizes more readily than the other minerals and is therefore preferentially concentrated in the -325 mesh fraction, whereas the heavy beryllium minerals (chiefly berylite) pulverize less readily and are preferentially concentrated in the +325 mesh fraction; or 2) the heavy liquid separation of the -325 mesh material is less complete than that of the coarser material,

with the result that a certain proportion of the heavy beryllium minerals was retained in each of the float portions, thereby contributing to the relatively high BeO content of the -325 mesh float.

Attempts were made to minimize the second possibility by the use of a centrifuge, and by re-centrifuging the float portions; nevertheless, the possibility of an incomplete separation of the -325 mesh material cannot be entirely ruled out. Indeed, a microscopic examination of the -325 mesh float fraction showed that it did contain some heavy minerals, although berylite itself could not be positively identified. However, the proportion of heavy minerals did not appear to be sufficiently high to account for the entire difference in BeO content between the coarse and fine sizes. It may be concluded, therefore, that the amount of eudidymite actually present probably lies somewhere between the results based on the +325 mesh fractions alone, and those on the combined +325 and -325 mesh fractions. The percentages of eudidymite calculated from the analytical data of Table 5 are shown in Table 6. Both sets of values were calculated on the assumption that the theoretical BeO content of the eudidymite is 10.2%. The first set, however, is based entirely on the BeO content of the +325 mesh float fractions, whereas the second set is based on the BeO content of the combined +325 and -325 mesh float fractions.

TABLE 6

Eudidymite Content of Samples

Sample No.	1	2	3	4
Eudidymite percentage, based on +325 m fraction	0.95	0.90	0.66	0.80
Eudidymite percentage, based on combined +325 and -325 m fractions	1.40	1.13	1.00	0.97

Calculated from data of Table 5.

Although the precise amount of eudidymite present is in some doubt, probably lying between the two extremes, both sets of calculations indicate that the eudidymite percentage is greatest in Sample No. 1, and second in abundance in Sample No. 2. The relative positions of Samples 3 and 4 remain in doubt.

CONCLUSIONS

The following conclusions may be drawn from this investigation:-

1. The presence of eudidymite in the ore has been established.
2. Eudidymite is a widespread component in the ore.
3. Quantitative determinations of the eudidymite in the composite samples indicate that this mineral comprises between 0.7 and 1.4% of the ore, which represents BeO values of from 0.07% to 0.14%.

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