BERYL RESOURCES OF NEW HAMPSHIRE

By James J. Page and David M. Larrabee

Trace Elements Investigations Report 551

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

January 30, 1958

AEC - 302/8

Mr. Robert D. Nininger
Assistant Director for Exploration
Division of Raw Materials
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Bob:

Transmitted herewith are three copies of TEI-551, "Beryl resources of New Hampshire," by James J. Page and David M. Larrabee, December 1957.

This report is a summary of a paper that is in preparation for publication as a Geological Survey bulletin. The bulletin will include detailed descriptions of pegmatites, but will not include the tables of reserves of individual properties.

Sincerely yours,

John H. Eric

for W. H. Bradley
Chief Geologist

~~OFFICIAL USE ONLY~~

Geology and Mineralogy

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

BERYL RESOURCES OF NEW HAMPSHIRE*

By

James J. Page and David M. Larrabee

December 1957

Trace Elements Investigations Report 551

This preliminary report is distributed without editorial and technical review for conformity with official standards and nomenclature. It is not for public inspection or quotation.

*This report concerns work done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission, and the New Hampshire State Planning and Development Commission.

~~OFFICIAL USE ONLY~~

USGS - TEI-551

GEOLOGY AND MINERALOGY

Distribution	No. of copies
Division of Raw Materials, Albuquerque	1
Division of Raw Materials, Austin	1
Division of Raw Materials, Casper	1
Division of Raw Materials, Denver	1
Division of Raw Materials, Rapid City	1
Division of Raw Materials, Salt Lake City	1
Division of Raw Materials, Spokane	1
Division of Raw Materials, Washington	3
Grand Junction Operations Office	1
Production Evaluation Division, GJOO	1
U. S. Geological Survey:	
Foreign Geology Branch, Washington	1
Fuels Branch, Washington	1
Geochemistry and Petrology Branch, Washington	1
Geophysics Branch, Washington	1
Mineral Deposits Branch, Washington	2
A. L. Brokaw, Grand Junction	1
N. M. Denson, Denver	1
E. M. MacKevett, Menlo Park	1
L. R. Page, Washington	1
P. K. Sims, Denver	1
Q. D. Singewald, Beltsville	2
A. E. Weissenborn, Spokane	1
D. E. White, Menlo Park	1
TEPCO, Denver	2
TEPCO, RPS, Washington, (including master)	2
	31

CONTENTS

TABLES

BERYL RESOURCES OF NEW HAMPSHIRE

By James J. Page and David M. Larrabee

INTRODUCTION

The beryl resources of New Hampshire were studied by the U. S. Geological Survey as part of its program of investigation of domestic beryllium resources, made partly in behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission. Concurrently, the feldspar and other industrial minerals in the pegmatites were studied in behalf of the New Hampshire State Planning and Development Commission.

The primary purpose of this work was to summarize and bring up to date the information on beryl resources as gained from investigations during 1942-45, to examine in detail certain beryl-bearing pegmatites discovered and developed in recent years, and to study other pegmatites and groups of pegmatites known or suspected to contain beryl. The study began with work by J. C. Olson and J. W. Adams in 1947, and was continued by the senior author and his assistants in 1948-1950.

The pegmatite districts of most economic importance in New Hampshire are the Grafton and Keene districts in the west-central and southwestern parts of the state, respectively. The Raymond district in the southeastern part of the state has received much less study in former years and has not yielded any great quantity of pegmatite minerals.

Although the pegmatites occur in schist, gneiss, quartz monzonite, and granite, most of the economic pegmatites are in schist of the Littleton formation of Devonian age. This formation consists chiefly of mica-quartz or quartz-mica schist, in places containing appreciable amounts of sillimanite, actinolite, or andalusite. Some parts are quartzitic, conglomeratic, or include lime-silicate rocks. Relations of the pegmatites to wall rocks and to major structures have been described by Cameron (Cameron and others, 1954, p. 15-19, 22-24).

The two most important beryl-bearing pegmatites are the Palermo No. 1, in Groton, and Beryl Mountain, in Acworth, both of which were mined extensively after World War II. The small area southwest of Raymond village, referred to as the Raymond district, contains 87 pegmatites that were studied in detail. Still other pegmatites that have been mined or prospected, and that also were studied in some detail, are the Corson mine, Nottingham; the Chickering mine, Walpole; the Millard Chandler mine, Chatham; the Parker Mountain mine, Strafford; and the Vatcher prospect, Raymond. Reconnaissance studies were made elsewhere in the state, notably in the vicinity of Raymond, outside of the Raymond district, in Strafford, in the general vicinity of Gorham and the Presidential Range of the White Mountains, and east of the productive Grafton district.

The most comprehensive account of the geology of New Hampshire pegmatites has been reported by Cameron and others (1954). Their report also contains a summary of studies prior to World War II. On the basis of field studies in 1947, Olson (1950) prepared a report entitled "Feldspar and associated pegmatite minerals in New Hampshire" for the New Hampshire State Planning and Development Commission.

The writers are indebted to mine owners and operators for cooperation that facilitated the work, and to various members of the U. S. Geological Survey who furnished active field assistance and valued advice. This

assistance is acknowledged elsewhere in the description of various pegmatite districts, but it is appropriate to state here that the Raymond district was selected for special attention upon the recommendation of J. C. Olson and J. W. Adams of the U. S. Geological Survey. Field assistance in 1948 and 1949 was provided by L. F. Dellwig, and in 1949 by P. K. Brown, Jr. and for one week by Frederick Stugard, Jr. L. R. Page, together with Larrabee, briefly restudied the Beryl Mountain mine in 1955.

BERYL MINING

Only rarely in New Hampshire has it been economically feasible to mine a pegmatite over an extended period of time solely for one mineral, and the same probably will be so in the future. The economics of pegmatite mining have been described by Bannerman (1943), and Bannerman and Cameron (1947). During World War II, under subsidy prices for strategic mica and beryl, some deposits were operated profitably for mica but not for long periods. Mines were operated for mica and for beryl during the Korean emergency, again under Government-sponsored subsidy programs, which are continuing in 1957.

According to data in the Minerals Yearbooks of the U. S. Bureau of Mines, beryl production in New Hampshire since 1944 was as follows:

Year	Tons	
1945	1	
1946	5	
1947	*	
1948	*	
1949	*	
1950	106	
1951	50	
1952	*	
1953	57	
1954	12	
1955	*	(increased over 1954)

*Not listed separately. However, production generally was very small. Beryl production from New Hampshire represents a small part of the total domestic production during the above period.

Beryl has been the chief product of a few small mines and also has been obtained as a byproduct of feldspar and mica mining. Mining has been by small-scale methods, mostly in open pits, and the beryl concentrated by hand-cobbing. Some of it has been sold to the U. S. Government and some to private firms.

The Government pays a flat rate of $0.20 per pound or $400 per ton for beryl accepted on visual inspection. The price of analyzed beryl is based on the content of BeO. Beryl containing 8.0 to 8.9 percent BeO is bought at $40 per unit, 9.0 to 9.9 percent BeO at $45 per unit, 10.0 to 11.9 percent BeO at $50 per unit, and 12 percent or more at $55 per unit. As an example, beryl having 12 percent BeO is worth $660 per ton. For comparison, in the late 1920's and early 1930's, beryl sold for $35 per ton.

Beryl has an ideal composition of $Be_3 Al_2 Si_6 O_{18}$. This formula indicates a content of 14.0 percent BeO or 5 percent Be (Fleischer and Cameron, 1946). Commercial beryl concentrates have a lower BeO content partly because other elements substitute for Be in the mineral structure and also because the concentrates contain other minerals. These minerals may be small inclusions or alteration products in the beryl. More commonly, however, the contaminants are minerals from the matrix surrounding beryl, chiefly quartz, feldspar, and mica. Many beryl crystals are euhedral, especially where surrounded by quartz, and a clean product can be produced by hand-cobbing. Others are intergrown with the minerals of the matrix, especially feldspar, and the cobbed concentrate is correspondingly impure.

Beryl is the only known economic source of beryllium, which has been used primarily in beryllium-copper alloys for special types of springs and bushings, to mention only two of many uses. New applications of beryllium of great importance are in the atomic energy field as a moderator and reflector of neutrons. The uses and technology of beryllium have been discussed in Mineral Facts and Problems, published in 1956 by the U. S. Bureau of Mines. A more complete compendium on beryllium is contained in Materials Survey, Beryllium, compiled in 1953 by the U. S. Bureau of Mines with the cooperation of the U. S. Geological Survey in behalf of the National Security Resources Board.

INTERNAL STRUCTURE AND MINERALOGY OF PEGMATITES

The internal structure and mineralogy of granitic pegmatites have been described many times in recent years (Bannerman, 1943, Cameron and others, 1949, 1954, Jahns, 1955, Page and others, 1953), and the details will be outlined only briefly here.

Pegmatites that can be mined ordinarily show some degree of systematic arrangement of the constituent minerals into two or more lithologic units, and the mineral to be extracted is more abundant in some units than in others. Boundaries between units are marked by changes in mineralogy, proportions of minerals, or texture. In many pegmatites these boundaries are gradational, in others they are sharp and readily discernable. The names of the units are formed by hyphenating the names of the chief mineral constituents, the names of the minerals appearing in the order of abundance.

Fracture fillings are commonly tabular bodies that fill fractures in previously consolidated pegmatite. Replacement bodies are formed along boundaries between pegmatite units, along fractures, at the contact of pegmatite and wall rock, or along other structural features within the pegmatite. Many replacement bodies are controlled by fractures.

Zones are continuous or discontinuous shells or units that in many pegmatites have the same shape as the entire body. Zones are classified as follows, in order from the outside: border zone, wall zone, intermediate zones, and core.

Border zones are usually less than 6 inches thick and are made up chiefly of quartz, muscovite, and plagioclase. Wall zones are much thicker, and also consist of quartz, muscovite, and plagioclase, but some contain perthite. Intermediate zones have more perthite and less plagioclase than outer units. The cores are commonly quartz and perthite, or quartz alone.

In a general way, grain sizes may be described as follows:

Fine	- Less than 1 inch
Medium	- 1 to 4 inches
Coarse	- 4 to 12 inches
Very coarse	- Greater than 12 inches

METHODS USED IN ESTIMATING RESOURCES

To eliminate the confusion arising from the all-too-common interchangeable use of the terms reserves and resources in past work, the definitions of Blondel and Lasky (1956) are used in this report. Reserves refer to minerals exploitable under present economic and technologic conditions; potential ores are those awaiting more favorable conditions; resources are the sum of the reserves and potential ores.

The percentage of beryl in a pegmatite may be determined by several methods: by measuring the area of all beryl crystals on representative exposures of each unit; by measuring the length of crystals along equally spaced traverses, as in the Rosiwal petrographic method; by measurement of crystals intersected in core drilling; or by analyses of representative samples of the beryl-bearing pegmatite. Visual estimates, although used at times, are much less accurate and usually misleading.

The volume of the beryl-bearing unit is determined by projection along strike, dip, and plunge. Where more than one structural interpretation of the beryl unit can be made on the basis of available data, it is necessary to acquire more information by physical exploration. The determination of grade and reserves of pegmatite minerals is the subject of a paper by Norton and Page (1956).

The BeO content of the beryl is determined by measuring the omega index of refraction of the crystal, as this index varies with the BeO content.

BERYL RESOURCES

The resources of beryl in known pegmatites of New Hampshire shown in table 2 are 1,634 tons in the indicated and inferred category, and in the Raymond district, an additional 146 tons may be present (tables 1, 3, and 4). Thus the total is 1,780 tons. Of this quantity, about 1,200 tons are in crystals that are at least 1 inch in diameter and can be recovered by hand-cobbing. Most of the beryl in New Hampshire is so scattered throughout any given zone or zones in a pegmatite that it can be recovered only as a byproduct from mining for other minerals, such as feldspar or mica. Only a very minute part of the beryl in table 2 is suitable for gem aquamarine or gem golden beryl.

Some of these pegmatites may contain additional beryl that has not been recognized in the field, either because it is fine-grained and white, or anhedral. Such beryl can be recovered only by milling, and suitable methods have not yet been developed.

Details of the individual pegmatites and maps are given in a more complete report now in preparation for a U. S. Geological Survey bulletin entitled "Beryl resources of New Hampshire."

Table 1. MINERAL ASSEMBLAGES IN PEGMATITES[1/] OF THE RAYMOND DISTRICT, ROCKINGHAM COUNTY, NEW HAMPSHIRE.

20529

Pegmatite No.

Mineral assemblage	4	5	7	10	12	14	18	19	21	22	23	25	26	31	32	35	37	42	44	45	46	47	48	49	50	52	54	56	57	60	62	64	65	66	69	78	82	85	86
Wall zone																																							
Plagioclase-quartz-muscovite																									x														
Plagioclase-quartz-perthite	x			x		x											x	x						x			x				x				x		x	x	x
Quartz-plagioclase-muscovite		x													x								x																
Perthite-plagioclase-quartz			x																																				
Plagioclase-quartz-perthite-muscovite				x																									x										
Quartz-perthite-plagioclase					x								x						x																				
Plagioclase-perthite-quartz							x	x																															
Plagioclase-quartz									x																														
Quartz-muscovite-perthite										x																													
Quartz-plagioclase											x																												
Perthite-quartz-plagioclase-aplite												x																											
Perthite-quartz-muscovite														x																									
Graphic granite-quartz																x																							
Quartz-plagioclase-perthite-muscovite																				x																			
Quartz-plagioclase-perthite																					x					x								x					
Quartz-muscovite-plagioclase																						x						x				x				x			
Muscovite-quartz-plagioclase																														x									
Quartz-perthite-plagioclase-muscovite																																	x						
Intermediate zone(s)																																							
Perthite-quartz-plagioclase	x	x		x																								x			x								
Muscovite-cleavelandite-quartz			x																																				
Quartz-cleavelandite-muscovite			x																																				
Plagioclase-quartz-muscovite				x																																			
Perthite-quartz							x																										x						
Quartz-perthite-plagioclase																	x																						
Plagioclase-perthite-quartz-muscovite																		x																					
Perthite-quartz-muscovite																													x										
Plagioclase-quartz-perthite																														x									
Aplite-perthite-plagioclase-quartz																															x								
Quartz-plagioclase																															x								
Plagioclase-quartz-perthite-muscovite																																						x	x
Core																																							
Perthite-quartz-plagioclase	x	x							x									x						x															
Quartz-beryl-spodumene			x																																				
Perthite-quartz				x	x	x						x		x							x					x	x											x	
Quartz							x																						x	x			x	x					
Quartz-perthite-plagioclase								x											x																				
Quartz-perthite										x					x										x			x											
Quartz-plagioclase-muscovite											x																												
Quartz-perthite-muscovite													x			x																							
Perthite-quartz-plagioclase-graphic granite																	x																						
Perthite-cleavelandite-muscovite																				x																			
Perthite-plagioclase-quartz																						x														x			
Plagioclase-quartz																							x																
Perthite-quartz-muscovite-cleavelandite																															x								
Quartz-plagioclase-perthite																																x					x		x
Perthite-quartz-plagioclase																																							

1/ Only zoned pegmatites are shown.

Table 4.-BASIC DATA SHEET USED FOR CALCULATION OF PEGMATITE MINERAL RESOURCES IN THE RAYMOND DISTRICT, N. H.

Pegmatite No.	Tons pegmatite	Number of beryl crystals	Average size of beryl crystals (Sq. in.)	Beryl content (Percent)	Beryl resources Tons		Total beryl 1/ resources	Scrap muscovite resources	Sheet muscovite 2/ resources	Perthite resources Tons			Total perthite 1/ resources		Columbite-tantalite resources (Pounds)
	Indicated and Inferred				Indicated	Inferred	Tons	Tons inferred	Tons inferred	Rec. 3/	Indicated	Inferred	Rec. 3/	Tons	
1	67,000	-	-	-	-	-	-	1,300	-	M	8,000	12,000	-	25,000	-
2	128,000	-	-	-	-	-	-	2,500	13.00	M	10,000	25,000	-	50,000	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	5,900	81	0.3	0.0600	0.5300	2.0700	5.00	85	-	MH	600	800	M	2,000	-
5	800	2	.2	.0020	.0080	.0080	.25	-	-	-	-	-	-	-	-
6	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	9.0	-	77.0000	78.0000	155.00	2,250	10.00	-	10,000	15,000	-	35,000	17,400
8	-	3	.1	.0600	-	-	-	-	-	-	-	-	-	-	-
9	10,400	57	.4	.0100	.5200	.5200	2.00	200	1.00	MH	2,000	3,000	MH	8,000	500
10	23,500	5	1.3	.0020	.4700	2.0000	5.00	300	3.00	MH	7,000	3,000	MH	15,000	2,000
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,450
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	1,300	-	-	-	-	-	-	-	-	H	500	500	H	1,000	-
15	24,000	-	-	-	-	-	-	120	-	M	3,500	3,700	-	15,000	-
16	96,000	-	-	-	-	-	-	950	-	M	5,000	14,000	-	25,000	-
17	480,000	-	-	-	-	-	-	4,800	24.00	M	50,000	70,000	-	200,000	9,600
18	385	1	3.0	.1400	.2700	.2700	1.00	-	-	M	65	65	-	200	-
19	9,100	2	1.7	.0150	.6800	.6800	2.00	50	-	M	1,225	1,225	M	3,000	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	2,620	5	1.4	.0600	.2000	.1600	.50	40	.30	-	-	-	-	-	60
	-	-	-	-	-	-	-	30	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	13,400	29	.7	.0080	.5400	.5400	5.00	50	-	M	500	2,500	M	5,000	400
26	11,250	55	.9	.0500	1.8200	3.8000	10.00	200	.20	M	1,000	2,400	M	5,000	-
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	6,400	-	-	-	-	-	-	50	-	M	480	480	M	1,000	-
31	80	2	.1	.0015	.0012	-	-	-	-	M	40	-	M	50	-
32	1,200	13	.2	.0100	.0800	.0400	.50	-	-	M	175	350	M	750	-
33	6,000	2	.8	-	-	-	-	60	-	M	600	1,200	M	2,500	-
34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	1,200	1	.01	-	-	-	.25	-	-	M	400	200	M	1,000	60
36	3,200	-	-	-	-	-	-	50	-	M	300	650	M	1,000	-
37	-	74	.7	-	2.0000	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	26,250	70	.2	.0035	.2200	.6800	5.00	250	-	M	3,000	6,500	M	12,000	-
40	136,000	6	.2	.0006	-	.8200	2.00	2,500	-	M	10,000	15,000	M	40,000	-
41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	12,800	10	3.3	.0600	.4300	1.4400	10.00	140	.60	MH	1,500	6,000	M	50,000	-
	136,000	-	-	-	-	-	-	1,350	-	M	10,000	25,000	-	-	-
43	-	3	.2	.1000	-	-	-	-	-	-	-	-	-	-	-
44	12,500	16	.1	.0010	.0200	.0800	2.00	500	-	M	600	2,500	M	5,000	-
45	200,000	4	.1	-	-	-	-	5,000	-	H	1,000	2,000	M	15,000	-
	-	-	-	-	-	-	-	-	-	M	3,500	7,000	-	-	-
46	4,200	27	.4	.0380	.6600	.6600	3.00	35	-	M	500	600	-	1,500	-
47	320	3	.2	.0040	.0060	.0060	.25	-	-	-	-	-	-	-	-
48	250	5	.03	.0010	.0012	.0013	-	-	-	-	-	-	-	-	-
49	1,600	2	.5	.0060	.0480	.0480	.50	-	-	-	-	-	-	-	-
	18,600	102	.2	.0036	.3300	.3400	5.00	375	-	H	1,500	1,600	H	5,000	-
	-	-	-	-	-	-	-	-	-	M	500	1,000	M	3,000	-
50	130	23	.1	.0170	.1200	.0600	1.50	-	-	-	-	-	-	-	-
51	1,000	8	.1	.0200	.1000	.1000	1.00	-	-	-	-	-	-	-	-
52	480,000	-	-	-	-	-	-	4,500	-	M	-	150,000	-	200,000	?
53	96,000?	-	-	-	-	-	-	950	-	M	-	14,000	-	20,000	-
54	4,700	89	.1	.0200	.2800	.5000	2.00	100	-	M	300	550	-	1,500	-
55	1,280	26	.6	.1350	1.7200	1.7200	5.00	25	-	M	100	100	-	300	-
56	21,250	16	1.5	.0340	14.7600	10.7500	60.00	230	1.60	MH	6,750	4,950	HM	15,000	7,000
	-	186	.2	.1480	19.6100	-	-	-	-	-	-	-	-	-	-
	-	-	-	.3700	-	-	-	-	-	-	-	-	-	-	-
57	24,000	8	7.3	.0300	2.3700	4.8300	10.00	1,100	-	H	950	2,000	-	4,000	-
	80,000	27	.9	.0140	5.6000	5.6000	20.00	1,500	-	M	5,000	7,000	-	20,000	-
58	8,300	26	.2	.0100	.4100	.4100	2.00	150	-	M	500	750	-	2,000	-
59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60	64	7	.4	.0900	-	.0600	.50	-	-	-	-	-	-	-	-
61	16	1	.2	.0130	-	.0020	.25	-	-	-	-	-	-	-	-
62	77,000	112	3.3	.0390	11.7000	7.6800	25.00	1,500	4.00	H	4,000	6,000	H	15,000	3,000
	-	41	.3	.0300	1.6800	-	-	-	-	M	6,000	8,500	M	20,000	-
63	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
64	32,000	4	.6	.0030	.4800	.4800	5.00	650	-	M	2,500	4,000	M	10,000	-
65	27,000	93	1.1	.0450	2.8800	2.8800	15.00	600	-	H	1,000	2,250	H	4,000	800
	-	-	-	-	-	-	-	-	-	M	1,500	2,000	M	4,000	-
66	12,000	-	-	-	-	-	-	240	-	M	500	1,300	M	2,000	-
67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
69	105,000	304	.5	.0820	11.8000	60.7800	100.00	1,000	-	M	7,500	30,000	M	50,000	5,250
73	144,000	80	.3	.0160	5.6000	9.7600	25.00	1,400	-	M	20,000	30,000	M	75,000	-
74	46,300	111	.2	.0125	.7400	5.0500	10.00	450	-	M	5,000	8,000	M	20,000	-
75	100	6	.2	.0310	-	.0300	.25	-	-	-	-	-	-	-	-
76	240	4	.3	.0340	-	.0800	.25	-	-	-	-	-	-	-	-
77	5,850	70	.1	.0190	.2700	.8400	5.00	-	-	M	500	700	M	2,000	-
78	750	5	.4	.0150	-	.1100	.50	-	-	-	-	-	-	-	-
79	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
81	65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
82	11,100	207	.3	.1270	3.4000	10.7200	25.00	325	-	M	500	600	-	1,500	555
83	2,500	4	34.3	.0880	1.5800	.6300	5.00	125	1.25	MH	500	700	-	2,000	125
86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
87	2,550	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total					170.9344	215.2353	532.50	38,030	58.95		196,585	496,670		1,008,800	50,200

1/ Total resources include fine-grained mineral classed as potential ore, as well as the indicated and inferred resources of easily visible mineral, much of which is also potential ore.

2/ Book mica from which block mica can be recovered.

3/ Recoverable by milling (M), hand-cobbing (H), or a combination of both (MH).

REFERENCES

Bannerman, H. M., 1943, Structural and economic features of some New Hampshire pegmatites: New Hampshire State Plan. Devel. Comm., Mineral Res. Survey, pt. 7, p. 1-22.

Bannerman, H. M., and Cameron, E. N., 1947, The New England mica industry: Am. Inst. Min. Metall. Eng. Trans., v. 173, p. 524-531.

Blondel, F., and Lasky, S. G., 1956, Mineral reserves and mineral resources: Econ. Geology, v. 51, no. 7, p. 686-697.

Cameron, E. N., Jahns, R. H., McNair, A. H., and Page, L. R., 1949, Internal structure of granitic pegmatites: Econ. Geology, Mon. 2, p. 61, 65.

Cameron, E. N., Larrabee, D. M., McNair, A. H., and others, 1954, Pegmatite investigations 1942-45, in New England: U. S. Geol. Survey Prof. Paper 255, 352 p.

Fleischer, Michael, and Cameron, E. N., 1946, Geochemistry of beryllium: U. S. Geol. Survey MDDC-643, issued by U. S. Atomic Energy Comm., Tech. Inf. Service Extension, Oak Ridge, Tenn.

Jahns, R. H., 1955, The study of pegmatites: Econ. Geology, 50th Anniversary volume, 1905-1955, pt. 2, p. 1025-1130.

Norton, J. J., and Page, L. R., 1956, Methods used to determine grade and reserves of pegmatites: Mining Engineering, v. 8, no. 4, p. 401-414; Am Inst. Mining and Metall. Eng. Trans., v. 205, p. 401-414.

Olson, J. C., 1950, Feldspar and associated pegmatite minerals in New Hampshire: New Hampshire State Plan. Devel. Comm., Mineral Res. Survey, pt. 14, 48 p.

Page, L. R., and others, 1953, Pegmatite investigations 1942-45, Black Hills, South Dakota: U. S. Geol. Survey Prof. Paper 247, 229 p.

Reno, Horace T., 1956, Beryllium, in Mineral facts and problems: U. S. Bur. Mines Bull. 556, p. 95-101.

United States Bureau of Mines, 1945-54, Beryllium, in Minerals Yearbook.

__________, with the cooperation of the U. S. Geological Survey, 1953, Materials survey, beryllium.

Table 3.-SIZE AND DISTRIBUTION OF PEGMATITES, AND DISTRIBUTION OF MINERALS THEREIN

RAYMOND DISTRICT, N. H.

Status of operation: No = no operation, P = prospect only, St = overburden stripped, only, Oc = open cut
Relation to foliation: P = parallel, X = crosscutting
Essential minerals: Apl = aplite, B = beryl, Cl = cleavelandite, Gg = graphic granite, M = muscovite, P = perthite, Pl = plagioclase, Q = quartz, S = spodumene
Distribution of major useful minerals: A = throughout pegmatite, C = core, FC = fracture-controlled body, FW = footwall, I = intermediate zone, W = wall zone

Name of deposit	Pegmatite number	Status of operation	Exposed size of pegmatite (feet)		Relation to foliation	Pegmatite zoned	Essential minerals (in order of abundance)				Distribution of major useful minerals					
			Length	Thickness			Wall zone	Intermediate zone	Core	Other units or unzoned pegmatite	Beryl	Sheet muscovite	Scrap muscovite	Perthite	Columbite-tantalite	Other
	1	No	400	75	± P	No	-	-	-	Pl-q-p	A	-	A	A	-	-
	2	P	400?	125?	X	Yes?	Pl-q-m	-	P-q-pl	P-q-pl	A	?	A	A	-	-
		-	-	-	-	-	-	-	-	Cl-m-q	-	-	-	-	-	-
	3	No	200	?	X?	No	-	-	-	Pl-q-p	-	-	A	A	-	-
	4	Do	80	20- 60	± X	Yes	Pl-q-p	P-q-pl	P-q-pl	-	W	-	W	I	-	-
	5	Do	115	5	X	±Yes	Q-pl-m	P-q-pl	P-q-pl.	-	W	-	-	-	-	-
	6	St	35	2	± X	±No	-	-	-	P-m-q	-	-	-	-	-	-
Chandler	7	Oc	180	70-170	X	Yes	P-pl-q	M-cl-q	Q-b-s	-	A	-	I	W	C	Spodumene, lepidolite
		-	-	-	-	-	-	Q-cl-m	-	-	-	-	-	-	-	
	8	No	5	1	X	No	-	-	-	Q-m-b	A	-	-	-	-	-
Smith	9	P	110	10- 50	± X	No	-	-	-	P-q-pl	A	A?	A	A	A?	-
Smith	10	Oc	270	10- 50	P	Yes	Pl-q-p	P-q-pl	-	Q-p-b-m	W	-	W,I	-	I	Lithium minerals
		-	-	-	-	-	Pl-q-p-m	Pl-q-m	P-q	-	C,W	W,I	A	C,I	I,C	Lepidolite
	11	St	25	6	P	No	-	-	-	Q	-	-	-	-	-	-
	12	Do	100	8	± X	Yes	Q-p-pl	-	P-q	Pl-p-q	-	-	-	-	-	-
	13	No	60	15	X	No	-	-	-	P-pl	-	-	-	A	-	-
	14	P	40	± 20	X	±Yes	Pl-q-p	-	P-q	-	-	-	-	C	-	-
	15	No	125	± 25	X	No	-	-	-	Q-p-pl	-	-	A	A	-	-
	16	Do	350	50	X	No	-	-	-	Pl-q-p	-	-	A	A	-	-
	17	P	1100	200	X	No	-	-	-	P-q-pl	-	-	A	A	A	-
	18	No	15?	8	P	Yes	Pl-p-q	P-q	Q	Pl-p-q	A	-	-	A	-	-
	19	Do	190	± 15	X	±Yes	Pl-p-q	-	Q-p-pl	Q-p	FC?,C	-	-	C	-	-
	20	Do	-	-	X	No	-	-	-	Pl-q-p	-	-	-	-	-	-
	21	Do	15	3	P	Yes	Pl-q	-	P-q-pl	-	-	-	-	-	-	-
	22	Do	20	1.5	P	Yes	Q-m-p	-	Q-p	-	W?	-	-	-	-	-
	23	Do	65	20	X	Yes	Q-pl	-	Q-pl-m	-	C	?	W	C,W	-	-
	24	Do	10	3	X	No	-	-	-	Pl-q-apl	-	-	-	-	-	-
	25	P	125	10- 50	X?	Yes?	P-q-pl-apl	-	P-q	-	A	-	A	C	C	-
	26	No	130	25	X	Yes?	Q-p-pl	-	Q-p-m	-	C	?	A	A	-	-
	27	Do	± 50	± 3	P?	No	-	-	-	Q-p	-	-	-	-	-	-
	28	P	± 50	4- 20	F	No	-	-	-	Pl-p-q	A?	-	-	-	-	-
	29	No	25	10	P?	No	-	-	-	Pl-p-q	-	-	-	-	-	-
	30	Do	200	± 10	X	No	-	-	-	Pl-q-p	-	-	A	A	-	-
		-	-	-	-	-	-	-	-	Q-p-m	-	-	-	-	-	-
	31	St	20	± 5	± P	Yes?	P-q-m	-	P-q	-	W	-	-	C	-	-
	32	Do	45	8	X	Yes?	Q-pl-m	-	Q-p	-	A	-	-	C	-	-
	33	No	125	25	X	No	-	-	-	Q-p-pl	-	-	A	A	-	-
	34	Do	2	0.5	± P	No	-	-	-	P	-	-	-	-	-	-
	35	St	+ 20	25	X	Yes?	Gg-q	-	Q-p-m	-	-	-	-	-	-	-
	36	No	100	± 10	± X	No	-	-	-	Q-p-pl	-	-	A	A	-	-
	37	St	350	170	± P	Yes	Pl-q-p	Q-p-pl	P-q-pl-Gg	-	I	-	A	A	-	-
	38	No	750	60	P	No	-	-	-	Q-p-pl	-	-	A	A	-	-
	39	Do	150	50	± P	No	-	-	-	Q-p-pl	A	-	A	A	-	-
	40	P	800	± 50	± X	No	-	-	-	Q-pl-p	A	-	A	A	-	-
	41	No	35	4	X	No	-	-	-	Pl-q-m	-	-	-	-	-	-
	42	P	700	10-100	X	Yes	Pl-q-p	Pl-p-q-m	P-q-pl	-	I	I?	I,A	A	-	-
	43	No	8	.5	P	No	-	-	-	Q-pl-m	A	-	-	-	-	-
Smith No. 2	44	P	375	25	P	Yes?	Q-p-pl	-	Q-p-pl	-	W	-	A	A	-	-
	45	Do	1200	± 50	X	±Yes	Q-pl-p-m	-	P-cl-m	-	W	-	A	A	-	-
	46	No	130	5- 25	X	±Yes	Q-pl-p	-	P-q	-	W	-	W	C	-	-
	47	Do	125	4	P	Yes	Q-m-pl	-	P-pl-q	-	W	-	W	-	-	-
	48	Do	25	3	P	Yes	Q-pl-m	-	Pl-q	-	W	-	-	-	-	-
Smith No. 3	49	P	200	20- 50	X	Yes	Pl-q-p	-	P-q-pl	-	A	-	A	A	-	-
	50	St	20	4	X	Yes	Pl-q-m	-	Q-p	-	A	-	A	-	-	-
	51	No	± 80	± 4	X	No?	-	-	-	Q-pl-m	A	-	A	-	-	-
	52	Do	1000	200	P	Yes?	Q-pl-p	-	P-q	-	-	-	A	A	C	-
	53	Do	400?	100?	P	No	-	-	-	Q-pl-p	-	-	A	A	-	-
	54	St	60	20	X	Yes	Pl-q-p	-	P-q	Q-m-b	W,FC	-	A	A	-	-
	55	No	100	8	X	No	-	-	-	Q-pl-p	A	-	A	A	-	-
Blake	56	Oc	130	70	P	Yes	Q-m-pl	P-q-pl	Q-p	-	W,I	W	I,W	I,C	I,C	-
	57	P	750	50	X	Yes	Pl-q-p-m	P-q-m	Q	-	A	-	W,I	I	-	-
	58	No	140	20	X	No	-	-	-	Q-pl-p	A	-	A	A	-	-
	59	Do	10	1	± P	No	-	-	-	Q-pl	-	-	-	-	-	-
	60	Do	40	2	P	Yes	M-q-pl	Pl-q-p	Q	-	W,I	-	-	-	-	-
	61	Do	10	2	± X	No	-	-	-	Q-pl-p	A	-	-	-	-	-
Welch	62	Oc	320	85	X	Yes	Pl-q-p	Apl-p-pl-q	P-q-m-cl	-	A	-	A	A	I?	-
		-	-	-	-	-	-	Q-pl	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	P-q-pl	-	-	-	-	-	-	-	-
	63	No	8	3.5	± P	No	-	-	-	Q-pl-m	-	-	A	-	-	-
	64	Do	500	10- 50	X	±Yes	Q-m-pl	-	Q-pl-p	-	A	-	A	C	-	-
	65	P	250	20- 60	X	Yes	Q-p-pl-m	P-q	Q	-	W,C	-	W	W,I	W	-
	66	No	200	15- 20	P	±Yes	Q-pl-p	-	Q	-	-	?	W	W	-	-
	67	Do	20?	3	X	No	-	-	-	Q-pl	-	-	-	-	-	-
	68	Do	10	?	X	No	-	-	-	Pl-q	-	-	-	-	-	-
	69	Do	850	250	P?	Yes	Pl-q-p	-	P-q-pl	-	A	-	A	A	A	Lepidolite
	73	Do	250	15	P	No	-	-	-	Pl-q-p	A	-	A	A	-	-
	74	Do	360	25	P	No	-	-	-	-	FC	-	-	-	-	-
	75	Do	10	3	X	No	-	-	-	Q-pl-p	A	-	-	-	-	-
	76	Do	50	3	P	No	-	-	-	P-pl-q	A	-	-	-	-	-
	77	Do	170	3- 15	P	No	-	-	-	P-pl-q	A	-	A	A	-	-
	78	Do	105	4	P	±Yes	Q-m-pl	-	P-pl-q	-	C	-	-	-	-	-
	79	Do	2.5	1	P	No	-	-	-	Q-m-pl	-	-	-	-	-	-
	80	Do	20	1	P	No	-	-	-	Q-pl	-	-	-	-	-	-
	81	Do	60	1	P	No	-	-	-	Q-pl	-	-	-	-	-	-
	82	Do	280	12	P	±Yes	Pl-q-p	-	Q-pl-p	-	A	-	A	A	W?	-
	83	P	60	15	X	No	-	-	-	P-q-pl-m	A	A	A	A	A	-
	84	Do	120	45	X	No	-	-	-	Pl-q-p	-	-	-	-	-	-
	85	Do	120	45	X	Yes	Pl-q-p	Pl-q-p-m	P-q	-	-	-	I	A	-	-
	86	Do	250	80	X	Yes	Pl-q-p	Pl-q-p-m	P-q	-	-	-	I	A	-	-
	87	No	40	20	X	No	-	-	-	P-pl-q	-	-	A	A	-	-