Mines Branch Information Circular IC 126

THE BARIUM MINERALS INDUSTRY IN CANADA

by

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SUMMARY

Barite was first mined in Canada near Five Islands, Nova Scotia, about 1866. Since then and until 1960, 2,765,562 short tons have been mined, mainly from a deposit near Walton, Nova Scotia, currently operated by Magnet Cove Barium Corporation, Ltd. To the end of 1959, Nova Scotia had produced 94 per cent and British Columbia 5 per cent of the total, with a small amount of barite having been recovered in Ontario, Newfoundland and Quebec. During 1959, barite was produced in Canada by four companies - from one deposit in Nova Scotia and five in southeastern British Columbia. It is estimated that Canada was the third largest barite producer, shipping 8 per cent of the world output of 3 million short tons in 1959.

The known ore reserves in place in three Canadian deposits are some 2.1 million short tons containing 1.8 million short tons of barite. In addition, an estimated 4 million short tons of barite are present in tailings dumps of lead-zinc mines. Barite is being added to tailings ponds in Canada at a rate of 225,000 short tons per year - at a rate approximating that contained in the 238,967 tons of concentrates shipped by Canadian producers during 1959. At the present annual domestic consumption of some 25,200 short tons of concentrates, the barite reserves are ample for domestic consumption for the distant future. The problem is to maintain these relatively small and currently economical reserves if required to continue supplying considerable quantities to the export market. Canada's position as a potential world source of barite after the next decade will depend mainly upon the economics of recovering pulverized barite from the substantial resources in the tailings dumps at lead-zinc and barite mines. Precautions should be taken to preserve these tailings deposits from removal by erosion.

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The Canadian barium metal and chemical industries are negligible, with small quantities of black ash being processed at the Delson, Quebec, plant of Cooksville-Laprairie Brick Limited, and barium metal produced at the Haley, Ontario, operations of Dominion Magnesium Limited.

The domestic barite industry is dependent for its markets mainly upon the oil-and gas-well drilling industry, principally in foreign countries. Approximately 90 per cent of the output is exported, and more than 95 per cent is consumed as a weighting agent in well-drilling muds. Because most of the Canadian production is by one company and for a single use, the degree of processing and the method and degree of marketing of domestic barite are dependent on the business activity and the economics of the various operations of that company as well as on foreign competition. Because Canada depends on United States markets for three-quarters of its crude barite sales, the major factor governing the type of barite to be exported, and thus the value of domestic production, is the large difference between the United States import duties of $2.55 a long ton for crude and $6.50 a long ton for ground barite.

It appears that there will be no major change in the Canadian barite industry during the next decade. An apparent threat to the main market for barite is the possible universal and economical recovery and re-use of weighting media from used drilling muds. Another threat is the increasing and relatively new use of air and gas as drilling fluids.

Direction des mines
Circulaire d'information IC 126

L'INDUSTRIE DES MINÉRAUX DE BARYUM AU CANADA

par

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RÉSUMÉ

On a commencé à extraire de la barytine au Canada à proximité de Five Islands, en Nouvelle-Écosse, vers 1866. Depuis lors jusqu'à 1960, le volume total de la production a été de 2,765,562 tonnes courtes. Ce minéral provenait principalement d'un gîte situé près de Walton, en Nouvelle-Écosse, et présentement exploité par la Magnet Cove Barium Corporation, Ltd. A la fin de 1959, la Nouvelle-Écosse avait fourni 94 p. 100 de la production canadienne, et la Colombie-Britannique 5 p. 100, de petites quantités de barytine ayant également été récupérées en Ontario, à Terre-Neuve et dans le Québec. Au cours de l'année 1959, quatre sociétés exploitaient des gîtes au Canada; l'un de ces gîtes est en Nouvelle-Écosse et les quatre autres dans le Sud-Est de la Colombie-Britannique. On estime que le Canada occupait le troisième rang parmi les producteurs de barytine dans le monde; ses expéditions atteignaient 8 p. 100 des 3 millions de tonnes courtes produites en 1959.

Les réserves connues de minerai en place dans trois gîtes canadiens se chiffrent par quelque 2.1 millions de tonnes courtes, d'une teneur de 1.8 million de tonnes courtes en barytine. De plus, on évalue à 4 millions de tonnes courtes le volume de barytine présent au sein des rebuts mis en terril par les mines de plomb-zinc. La barytine s'accumule dans les parcs canadiens de rebuts miniers au rythme de 225,000 tonnes courtes par an, soit presque autant que les 238,967 tonnes de concentrés expédiées par les producteurs canadiens au cours de 1959. Puisque, dans notre pays, la consommation annuelle s'élève à quelque 25,200 tonnes courtes de concentrés, les réserves de barytine sont bien suffisantes pour alimenter le marché domestique durant plusieurs

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années. Le problème consiste à conserver ces réserves relativement faibles et présentement rentables pour le jour où il faudra continuer à en fournir des quantités considérables au marché d'exportation. Dans une dizaine d'année, le rôle du Canada comme producteur de baryum à l'échelon mondial va dépendre surtout du coût de récupération de la barytine pulvérisée dont il existe d'énormes quantités dans les rebuts des mines de plomb-zinc et de barytine. Il faudrait prendre les précautions voulues afin de préserver de l'érosion ces stocks mis en terril.

Au Canada, les industries chimiques qui traitent le baryum et les industries du baryum métallique représentent une quantité négligeable. A Delson (P.Q.), l'usine de la Cooksville-Laprairie Brick Limited traite de la cendre noire, tandis qu'à Haley (Ont.) la Dominion Magnesium Limited produit du baryum métallique.

Pour ce qui est des marchés, l'industrie canadienne de la barytine dépend surtout de l'industrie du forage des puits de pétrole et de gaz, principalement à l'étranger. Notre pays exporte environ 90 p. 100 de sa production, dont plus de 95 p. 100 s'emploie comme agent de flottage dans les boues de forage de puits. Comme le gros de la production canadienne est fourni par une seule société et sert à une fin unique, le degré du traitement de même que le procédé de vente et le volume de barytine canadienne vendu dépendent de l'activité des affaires ainsi que de la rentabilité des diverses opérations de cette société aussi bien que de la concurrence à l'étranger. Le Canada dépend des marchés des États-Unis, où il vend les trois quarts de sa production de barytine brute, et, de ce fait, le principal facteur qui détermine le choix du type de barytine à exporter et, par conséquent, la valeur de la production canadienne, c'est l'énorme écart entre les droits d'importation aux États-Unis, soit $2.55 la tonne longue de barytine brute, et $6.50, dans le cas de la barytine broyée.

On ne prévoit pas de grands changements dans l'industrie canadienne de la barytine au cours des dix prochaines années. Une menace apparente plane sur le principal marché de la barytine dans le monde entier: la récupération à peu de frais des agents de flottage contenus dans les boues déjà utilisées afin de les faire servir à nouveau. Il existe une autre menace, et c'est l'emploi de plus en plus répandu, quoique relativement récent, d'air et de gaz utilisés comme agents fluides de forage.

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INTRODUCTION

The element barium occurs in numerous non-metallic minerals but most commonly in barite (barium sulphate) or in witherite (barium carbonate). As a result, these two minerals are the natural raw materials for the barium and barium compounds used in industry. Barite, by far the most abundant of the barium minerals, is the chief one exploited.

Because of the lack of known economic deposits containing other barium minerals, barite is the only one being mined in North America at present. No witherite has been recovered in Canada. The only witherite of any appreciable quantity produced in North America was mined at El Portal, California; the tonnage produced was relatively small and the mine ceased operating in 1948.

Barite is sometimes known as barytes, heavy spar, tiff, or cawk. The term "barite" is derived from the Greek word "barys", which means "heavy", and has been, in turn, commonly known as "barote", "baryta" and "barytes". A relatively high specific gravity and a chemical inertness at normal temperatures and pressures have made barite the preferred mineral for use as a weighting material in oil-and gas-well drilling muds. Because of the normal chemical stability of barite, a more involved processing procedure is required for its preparation for chemical use than for witherite.

Witherite was first identified in England in 1783 by Dr. W. Withering and was subsequently named in his honour. Because it can be dissolved readily by most acids and because it has a higher barium content than barite, witherite is technically preferred as a raw material by the chemical industry.

BARITE

History of The Barite Industry

Because of its specific gravity and whiteness, barite was utilized prior to 1892 as a filler in foods, and later in paints as well. Its use as an adulterant in foods has been terminated in most countries by food laws. In 1892, a lithopone industry was started in the United States, which soon became a major consumer of barite. The production of other barium chemicals began in the United States in 1908 and the first mechanical concentration of barite in that country took place in 1914.

During 1921, B.K. Stroud announced the discovery of the use of barite as a weighting agent in well drilling. A United States patent for this use was obtained by Stroud in 1926 and a Canadian patent was granted on May 17, 1927. National Pigments and Chemical Company (now National Lead Company) was assigned the rights to the patents and began marketing ground barite for use in the oil-well drilling industry, thus creating a third and eventually the most important market for this commodity. The United States patent expired in 1943 and the Canadian one in 1944.

Barite was first used as a flux in the production of glass in 1928. It was first concentrated economically by flotation by Magnet Cove Barium Corporation, Ltd. in 1941. Barium titanate is being used in certain phases of the communications industry, and in 1952 the role of barite in concrete for gamma-ray shielding was reported by the National

Research Council, Ottawa. Other than the development of a number of miscellaneous additional uses, there has been no appreciable change in the technology of this industry.

The first recorded mining of barite in Canada took place at Bass River near Five Islands, Colchester county, Nova Scotia, about 1866. In 1868 barite was mined near Brookfield, Nova Scotia. Minor, occasional mining of the mineral continued in Nova Scotia until 1901, and small but continuous production took place until 1931. Most of this ore was recovered from the Lake Ainslie district, Cape Breton Island, and a small amount from the North Cheticamp district, Cape Breton Island. Production from Nova Scotia, mainly from the Walton deposit, has been continuous since 1941. Up to December 31, 1959, 94 per cent of the barite produced in Canada has been mined in Nova Scotia.

The recovery of barite in British Columbia first took place near Fort Steel in 1940. During 1941, Summit Lime Works Limited mined the Parson deposit. This occurrence, 6 miles by road southwest of Parson, Golden mining division, was initially quarried, mainly for barite for use as permanent ballast in cargo ships. For this use, shipments totalling 45,000 long tons were sent by rail to Vancouver during 1944, 1945 and 1946. In addition, Parson barite, along with that from a deposit near Brisco, Golden mining division, was shipped by Mountain Minerals Limited to the company's grinding plant at Lethbridge, Alberta, for processing, mainly for use as a weighting agent in oil-well drilling muds. This latter trade pattern has continued, with additional production by

other companies coming from the barite deposits of Giant Mascot Mines Limited near Spillimacheen, Sheep Creek Mines Limited near Invermere, and Baroid of Canada, Limited near Invermere.

Minor, sporadic barite production was undertaken in Ontario from 1886 to 1948. The McKellar Island deposit, Thunder Bay district, was mined from 1886 to 1894. Since then and until 1948, small tonnages have been shipped intermittently from Frontenac county, Langmuir township in Porcupine mining division, and Penhorwood township in the Sudbury mining division.

Dominion Magnesium Limited started producing small quantities of barium metal from imported material at its plant at Haley in 1946 and has continued to produce a few hundred pounds most years since.

In Newfoundland, barite is reported to have been recovered from one deposit near Collier bay from 1902 to 1904.

A deposit near Ironside, Hull county, Quebec, was mined for barite for use as a filler by the paint industry from 1898 to 1900. A plant near Delson, Quebec, currently being operated by Cooksville-Laprairie Brick Limited, has been producing black ash for the brick industry since 1942.

A minor and an unknown amount of barite were shipped from an occurrence near Memramcook, New Brunswick, in about 1897.

Production

Lump, crushed and ground barite is produced in Canada. Although during 1959 Canada was the third largest barite producer in the world, the value of Canadian barite production compared with that of the country's other mineral commodities is small. During 1959, 238,967 short tons valued at $2,254,582 were shipped, as compared with 195,719 short tons valued at $2,196,384 during 1958. The respective increases in volume and value were 22 and 2 per cent. The apparent discrepancy in the increase in value is due to a change in statistical interpretation, with the designation of all 1959 production as being crude. Essentially all the output from that province is eventually ground at plants in Alberta. Because the Canadian barite industry is dependent upon the export trade, the increased production was due primarily to the rise in shipments of the crushed and lump varieties to meet the requirements of the United States and other countries. Shipments of the ground variety amounted to 10 per cent of the total. As for many years in the past, the bulk of production came from Nova Scotia.

During 1959, barite was produced in Canada by four companies from six deposits.

The largest Canadian barite mine, operated by Magnet Cove Barium Corporation, Ltd., is near Walton, Hants county, Nova Scotia. The orebody is one of the largest known non-residual barite deposits and, in 1958, was estimated to contain ore reserves of 1,800,000 tons. During 1959, this mine

produced more than 90 per cent of the barite shipped by Canadian operators. The ore was mined by underground blast-hole and block-caving methods between the 350- and 520-foot levels, with some being recovered from the 690-foot level stopes during the latter part of the year. Essentially all the crushed and ground barite concentrates are shipped by water from the port of Walton.

The other three companies producing this commodity operated mines in the Golden-Invermere area of southeastern British Columbia. Mountain Minerals Limited recovered barite from vein deposits near Brisco and Parson. Ore was obtained by open pit methods and from an adit at the Brisco occurrence and from an adit at Parson. Virtually all the ore mined is hand-cobbed and shipped by rail to the company's plant at Lethbridge, Alberta, for crushing and grinding.

Sheep Creek Mines Limited recovers lump barite gangue from sections of its Mineral King lead-zinc deposit near Invermere. The crude by-product is shipped to the grinding plant of Magcobar Mining Company, Limited at Rosalind, Alberta, where it is ground for use in oil- and gas-well drilling muds.

During 1959, Baroid of Canada, Limited recovered, by open pit methods, barite from a vein in the Larrabee claim, approximately 10 miles west of Invermere. The company also mined a small tonnage from the open pit of the Giant mine, near Spillimacheen and owned by Giant Mascot Mines Limited. The lump ore from both properties was shipped to the grinding

plant of Baroid of Canada at Onoway, Alberta.

The Canadian production of barite since 1939 is tabulated in Table 1 and depicted in Figure 1. The shipments by province since 1886 are given in Table 2.

TABLE 1

Canadian Barite Production, 1939 to 1959

Year	Short Tons	Value ($)
1939	323	3,639
1940	338	4,819
1941	6,890	74,416
1942	19,667	188,144
1943	24,474	279,253
1944	118,719	1,023,696
1945	139,589	1,211,403
1946	120,419	1,006,473
1947	128,675	1,380,753
1948	95,747	1,073,380
1949	47,138	557,662
1950	77,177	750,378
1951	98,113	1,131,917
1952	136,002	1,521,162
1953	247,227	2,220,292
1954	221,472	2,003,796
1955	253,736	2,277,166
1956	320,835	3,031,034
1957	228,048	2,992,913
1958	195,719	2,196,384
1959	238,967	2,254,582

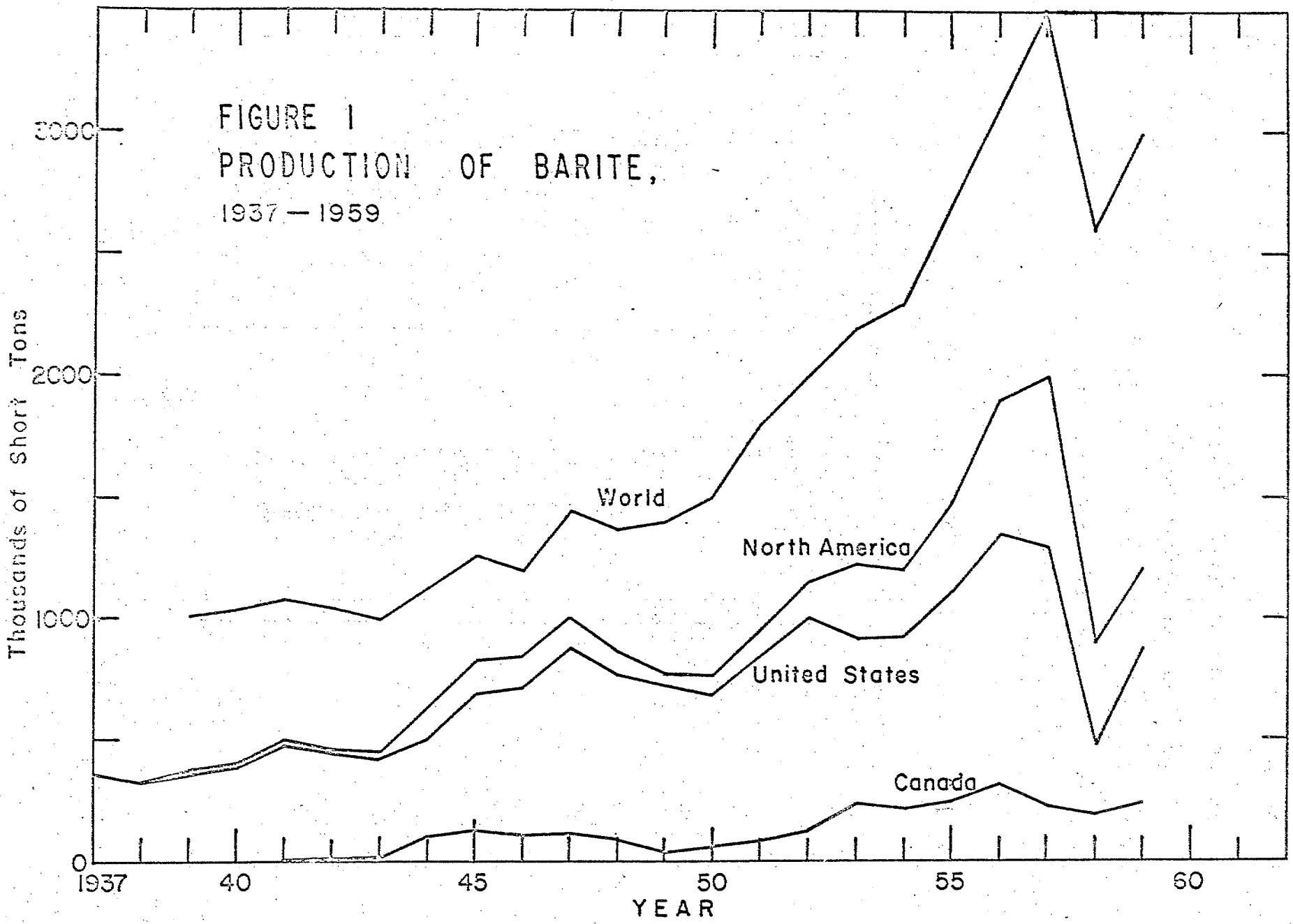
FIGURE 1
PRODUCTION OF BARITE,
1937 — 1959
Thousands of Short Tons
3000
2000
1000
0
World
North America
United States
Canada
1937
40
45
50
55
60
YEAR

TABLE 2

Barite Production by Province, 1886 to 1959

Province	Period	Short Tons	Per Cent
Nova Scotia	1896-1959	2,599,880	94
British Columbia	1940-1959	147,727	5
Ontario	1886-1948	9,597	
Newfoundland	1902-1904	5,075	
Quebec	1898-900	3,182	
New Brunswick	About 1897	Minor and not available	
Prince Edward Island		Nil	
Manitoba		Nil	
Saskatchewan		Nil	
Alberta		Nil	
Unaccounted for		101	
TOTAL		2,765,562	

Canada became an important world supplier of barite in 1944 when the mine formerly operated by Canadian Industrial Minerals Limited near Walton, Nova Scotia, began producing on a relatively large scale. Production has varied in proportion to exports, which are primarily dependent upon the requirements of the North and South American oil- and gas-well drilling industry. In general, since 1944, with the exception of the years 1949, 1950 and 1951, Canada has retained its relative proportion of world production.

As shown in Table 3, with few exceptions Canada has been the third largest producer, although temporarily and decisively placed in fourth position in 1957 because of increased Mexican production. Nevertheless, Canada continued to supply its approximate normal proportion of world production and in 1958 was in fifth place and during 1959 occupied the third position, shipping 8 per cent of the world output.

North American production (see Figure 1) retained its relative position in world output until 1957, after which it decreased notably owing to relative decreases in Mexican and United States production.

TABLE 3

Proportion of World Barite Production

Year	Per Cent of World Production		Position in World Production	
	North America	Canada	Canada	U.S.A.
1944	52	11	3	1
1945	60	11	3	1
1946	64	10	3	1
1947	63	9	2	1
1948	58	7	3	1
1949	51	3	6	1
1950	44	5	5	1
1951	47	5	4	1
1952	58	7	3	1
1953	56	11	3	1
1954	52	10	3	1
1955	55	10	3	1
1956	62	10	3	1
1957	67	7	4	1
1958	35	8	5	1
1959	44	8	3	1

World output of barite (see Figure 1) has been increasing with the increasing demands of the population and industry for oil and gas. The average increase up to the year 1944 was relatively minor and due to demands by the chemical and related industries. The output of barite rose appreciably after 1943, following the expiration of the United States patent relating to the use of barite in well drilling. The rate of increase has been particularly constant and rapid from 1950 to 1957 inclusive. The greatest decrease in output occurred in 1958, due mainly to a proportional reduction in the quantity required by the United States. These major trends were essentially the direct result of the requirements of the oil-well drilling industry and do not reflect the decreasing demand for barite in the production of lithopone.

The world production of barite by countries for the years 1957, 1958 and 1959 is given in Table 4.

TABLE 4

World Production of Barite by Countries, 1957 to 1959, in Short Tons [1]

Country [2]	1957	1958	1959
North America:			
Canada	228,048	195,719	255,023 [4]
Cuba (exports)	22,796	9,407	---
Mexico (exports)	429,537	217,350	198,579
United States	1,304,542	486,287	867,201
Total	1,984,923	908,763	1,320,803
South America:			
Argentina	25,264	18,596	18,700 [4]
Brazil	55,349	68,630 [4]	68,000 [4]
Chile	860	1,100	1,100
Colombia	6,963	14,330	11,023
Peru	95,388	117,802	105,557
Total	183,824	220,458	204,400 [4]
Europe:			
Austria	3,902	4,709	4,008 [4]
France	71,650	85,980	132,000
Germany:			
East [4]	27,600	27,600	27,600
West (marketable)	448,144	409,105	428,304 [4]
Greece	143,549	227,091	165,000 [4]
Ireland	11,231	11,283	11,000
Italy	134,945 [4]	122,976 [4]	107,122 [4]
Poland	12,400	12,400	12,400 [4]
Portugal	853	1,351	1,300
Spain	20,287	31,408	27,600 [4]
Sweden	---	---	---
U.S.S.R. [4]	110,000	130,000	130,000
United Kingdom [6]	87,280	78,078	77,000 [4]
Yugoslavia	133,137	103,801	118,267
Total [3,4]	1,200,000	1,250,000	1,250,000
Asia:			
India	14,462	15,481	14,718
Japan	27,514	16,510	21,594
Korea, Republic of	8	---	---
Philippines	6,088	64	186
Turkey	2,111	6,035	3,000 [4]
Total [3,4]	83,000	93,000	95,000

Continued -

TABLE 4 (Cont'd)

World Production of Barite by Countries, 1957 to 1959, in Short Tons [1]

Country [2]	1957	1958	1959
Africa:			
Algeria	37,724	47,415	48,771
Egypt	294	2,282	3,300 [4]
Morocco: Southern Zone	16,276	47,060	40,574
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	---	34	241
Swaziland	351	480	461
Union of South Africa	3,369	2,721	2,355
Total	58,014	99,992	95,702
Oceania: Australia	10,951	7,618	4,400 [4]
World Total (estimate) [2,3]	3,500,000	2,600,000	3,000,000

1. From U.S.B.M. Mineral Market Report MMS No.3084.

2. Barite is produced in China, Czechoslovakia and North Korea, but statistics on production are not available. Estimates by the U.S. Bureau of Mines are included in the total.

3. This table incorporates some revisions. Totals, including estimated production, are approximate.

4. Estimated.

5. Includes witherite.

The Canadian barium metal and chemical industries are extremely small. At its plant at Haley, Ontario, Dominion Magnesium Limited produces up to a few hundred pounds of barium metal each year from imported barium oxide. At Delson, Quebec, Cooksville -Laprairie Brick Limited calcines domestic barite, for the production of barium sulphide for use as an additive in the production of brick.

Trade

Despite the fact that lump barite is a relatively low-priced commodity, it experiences extensive world trade. The transportation cost of exported barite is commonly as great as the cost of the lump material. Widespread world trade is essential to satisfy the demands of all consuming countries and is a result of either uneconomic or insufficient barite reserves in certain consuming countries.

Exports play an important role in the Canadian barite industry. Complete export statistics are not available, but approximately 90 per cent of domestic production is exported to the United States, Trinidad, Venezuela, Barbados, Colombia and Iran. Exports of crude to the United States, shown in Table 5, are normally more than seventy per cent of Canadian production. Ground barite is rarely shipped to the United States. Crude and ground barite are exported to other countries.

Imports are minor and constant and consist of ground, high-quality barite mainly from United States and West Germany.

TABLE 5

Canadian Exports and Imports of Barite, 1940 to 1959

Year	IMPORTS		EXPORTS		
	Short Tons	$	Short Tons	$	Per Cent of Volume of Production
1940	2,622	64,922	Nil		
1941	3,431	81,620	Nil		
1942	2,536	68,196	Not available	N.A.	
1943	1,686	43,239	"	"	
1944	1,824	47,913	"	"	
1945	1,150	32,531	"	"	
1946	1,547	42,904	"	"	
1947	1,737	51,060	"	"	
1948	1,263	39,613	95,787	"	100
1949	934	32,269	49,456	"	100
1950	2,089	70,095	70,541	"	91
1951	1,068	37,471	94,990	"	97
1952	1,445	44,488	134,126	"	99
1953	1,207	40,143	242,530	"	98
1954	1,236	39,264	165,612*	1,177,616	75
1955	1,449	46,017	187,355*	1,364,285	74
1956	1,475	50,828	240,650*	1,707,597	75
1957	1,831	58,009	109,180*	745,394	48
1958	1,382	56,644	114,299*	870,862	58
1959	1,662	64,468	171,462*	1,457,502	72

* From United States import statistics and pertains to the crude to that country only. Barite is shipped to other countries, but the quantities are not available.

The barium chemicals lithopone, blanc fixe, barium chloride, barium carbonate and barium nitrate are also imported in relatively small amounts (Table 6). Imports of one of the more important of these chemicals, lithopone, have been decreasing appreciably each year. On the other hand, imports of barium carbonate have increased from a value of $137,257 during 1957 to $265,684 in 1959.

TABLE 6

Imports of Lithopone and Blanc Fixe, 1950 to 1958

Year	LITHOPONE		BLANC FIXE	
	Short Tons	$	Short Tons	$
1950	8,154	1,069,672	722	49,691
1951	6,911	1,189,717	371	38,530
1952	3,155	481,466	212	19,281
1953	3,348	474,638	262	18,962
1954	2,541	350,149	312	34,027
1955	1,894	265,224	599	54,887
1956	2,295	348,267	448	42,762
1957	1,365	197,418	371	41,557
1958	1,242	179,954	448	49,236

During 1958, 45 per cent of the barite shipped by world producers was purchased by companies in the United States. Normally, 10 to 15 per cent of the European production and much of the South American output are exported to North America. The bulk of the remainder of the world barite

production is shipped to oil-producing countries in Asia and Europe.

Uses and Specifications

The use of barite in its mineral form is based mainly on the fact that it is heavy, chemically inert, sometimes white, and comparatively cheap. Because it is chemically inert, its use in chemical processes involves more costly processing. However, because barite is by far the most common source of barium for chemical purposes, it is not in immediate danger of substitution.

Barite is marketed in lump, crushed and ground form, for sale as bulk and in bags.

In North America, in the order of importance, barite is consumed mainly as follows: as a weighting agent in drilling muds; in the manufacture of barium chemicals; as a filler; in the production of lithopone; and in the glass industry.

1. Drilling Muds

Most of the barite produced in the world is consumed by the oil- and gas-well drilling industry as a heavy medium in drilling muds. In this type of drilling, the fluid known as 'drilling mud' is forced down through the drill rods, out the bit, and up the drill hole to the surface. This mud, composed mainly of bentonite and water, removes the rock cuttings from the bottom of the hole to the surface, prevents caving of rock into the hole, fills fractures and partings,

deposits an impermeable coating on well walls, lubricates the rods and bit, cools the bit, and assists in restraining oil, gas and other pressures. When pressures are encountered that cannot be controlled by the column of mud in the hole, blow-outs occur possibly resulting in damaged equipment, in injury, and in loss of time in completing a well. Ground barite, when added to the drilling mud, increases the specific gravity of the mud and assists in restraining these abnormal pressures. The mineral is, at present, the most commonly used commodity for this purpose.

Certain muds can be weighted by barite so that they weigh up to 22 pounds per gallon. In one area in offshore Louisiana, where pressures are extremely high, an average of approximately 1 ton of weighting material per 10 feet of hole was used for all holes drilled in 1957.

It is not always necessary to use a weighting agent when drilling for oil and gas. The amount consumed depends upon the pressures to be confined. In most drilling in the prairie provinces east of a line between Calgary and Edmonton, barite is not commonly employed. A relatively small amount is consumed in the drilling of wells in the foothills and a greater amount in the bore holes in the Fort St.John, British Columbia, area. Thus, in general, the requirements for barite for use as a heavy medium in drilling fluids in Canada are relatively small.

Specifications vary according to the particular needs of the consumer. Chemically, some require a minimum barium

sulphate content of 94 per cent, others a minimum of 95 per cent, but most have no direct restrictions on barium sulphate content. As for soluble salts, which may cause undesirable flocculation, specifications vary. Some consumers require a maximum of 0.01 per cent of soluble constituents, some less than 0.1 per cent calcium carbonate, and others up to a maximum of 250 parts per million of soluble calcium ion. A few companies have maximum limits on the clay content (approximately 1 per cent), iron oxide and silica (approximately 3 per cent), strontium sulphate, lead, and zinc.

Most consumers require a minimum specific gravity of 4.25. Some will accept, at a lower price, limited amounts of material having specific gravities as low as 4.0. As to particle size, most require the barite to be 98 to 100 per cent minus 200 mesh and 86 to 95 per cent minus 325 mesh.

When added to a standard bentonite suspension, the viscosity effect caused by barite is important and the maximum permissible effect varies for most consumers.

Normally, when barite ore is concentrated by a dry process or by a process employing only fresh water as a fluid medium, the only necessary routine tests are for specific gravity and particle size.

2. Barium Chemicals

Barite, used in the chemical industry for the manufacture of barium chemicals, is normally in crushed or lump form. A size range of 4 to 20 mesh is sometimes desired. A minimum of 94 per cent barium sulphate and a maximum of 1 per

cent ferrous oxide are commonly desired for this purpose.

Barium carbonate, produced from barite, is used to prevent scumming in brick and in other ceramic products. It is also used to prevent efflorescence in these products. These effects are caused by clay and shale raw materials that are relatively high in such soluble salts as calcium sulphate. When such raw materials are used, a solution of barium carbonate is added to convert the soluble sulphate to insoluble barium sulphate. When this compound is used for this purpose, the resulting mixture in a stiff-mud process normally contains in the order of 0.1 per cent by weight of barium carbonate. The compound is also employed in the case-hardening of steel, in the production of optical glass, in softening water, and in the reduction of flocculation in drilling mud. Barium oxide may be used in the production of glass or barium metal. Barium hydroxide prevents scumming on bricks and assists in recovering sugar from beet-sugar molasses. Barium chloride has many applications, such as in case-hardening, preventing scumming of bricks, and as a mordant in fabrics. Blanc fixe, precipitated barium sulphate, is used as an extender and pigment in paints, linoleum and paper and as a filler in rubber products. There are numerous other barium compounds having more limited applications. One of these, barium titinate, has become important owing to its high dielectric constant and its piezoelectric and ferroelectric properties. Although used in relatively minor amounts, its use has been widespread,

particularly in the miniature-electronic-components and communications industry.

3. Fillers

Barite, used as a filler in paints, rubber, oilcloth, linoleum and paper, should contain a minimum of 84 per cent barium sulphate and have a mesh size of minus 200. Copper and manganese are objectionable. Barite concentrates containing as low as 90 per cent barium sulphate have been used as a filler in rubber in Canada.

The American Society For Testing Materials (ASTM) 1958 specifications for barite pigments are as follows:

$BaSO_4$, min.	94	per cent
Ferric oxide, max.	0.05	per cent
Free silica, max.	2.0	per cent
Volatile matter, max.	0.5	per cent
Soluble matter in water, max.	0.2	per cent
pH, min.	3.5	
Plus 325 mesh, max.	0.5	per cent

4. Lithopone

Lithopone, a precipitate of barium sulphate and zinc sulphate, formerly was the main source of extender and white pigment for paint. It has now been replaced extensively by titanium dioxide, which has greater hiding power. The steady decrease in the consumption of lithopone in Canada is expected to continue. Specifications of the raw material for this application are similar to those for chemical use.

5. Glass

In the glass industry, barite is consumed as a flux and as a decolorizer. It makes glass more brilliant and workable.

It must contain a minimum of 98 per cent barium sulphate and less than 0.2 per cent ferrous oxide, and be between 16 and 200 mesh.

6. Other Uses

Barite under $\frac{3}{4}$ inch in size is used as heavy aggregate in the manufacture of concrete to assist in shielding against atomic radiation and to produce a heavy concrete for weighting purposes. Because of its high density, barite absorbs X-rays when used for shielding purposes. Experiments recently conducted in Germany indicate that columns made of a blast furnace slag - barium cement can withstand the effects of sea water much better than similar columns of Portland and high-alumina cement. Also, concrete made with barium cement and barium-containing aggregate was observed to give twice as much protection against X-rays as did concrete made with Portland cement and barite aggregate.

An asphalt mixture containing ground barite and rubber has recently been developed for roads, aircraft runways, roofing paints, papers, sidings, and undercoatings.

Barium metal, owing to its high rate of electron emission under the proper conditions, is used in alloys in electronic tubes.

Consumption

Over 95 per cent of the Canadian output of barite during 1959 was consumed in drilling muds, but only about 10 per

cent of this was used in Canada. Detailed Canadian consumption statistics for barite are not available but the total is estimated at 25,200 short tons for 1959. An estimated 23,200 tons, or 92 per cent, were consumed in drilling muds and 2,000 tons were used for other purposes.

The Canadian consumption of barite in drilling muds is very low in relation to the yearly gas- and oil-well drilling footage. As a result, the value of production is low because of the necessity to export, commonly in the crude form, at a low unit value. During 1959, 13,208,460 feet of exploration and development drilling were completed by the oil-and-gas industry for an average consumption of 1.8 tons of barite for every 1000 feet of hole. For the same period, 5.6 tons per 1000 feet of hole were consumed in the United States. If the requirements of the Canadian oil-and-gas industry were in proportion to those of the United States, the Canadian consumption of barite would be tripled.

Figure 2 illustrates the relationship between North American production (which is essentially proportional to consumption) and United States and Canadian well-drilling footage. More than 95 per cent of the North American production of barite is consumed as a weighting agent in drilling mud.

During 1959, 91 per cent of the wells completed in the Free World were completed in the United States and Canada.

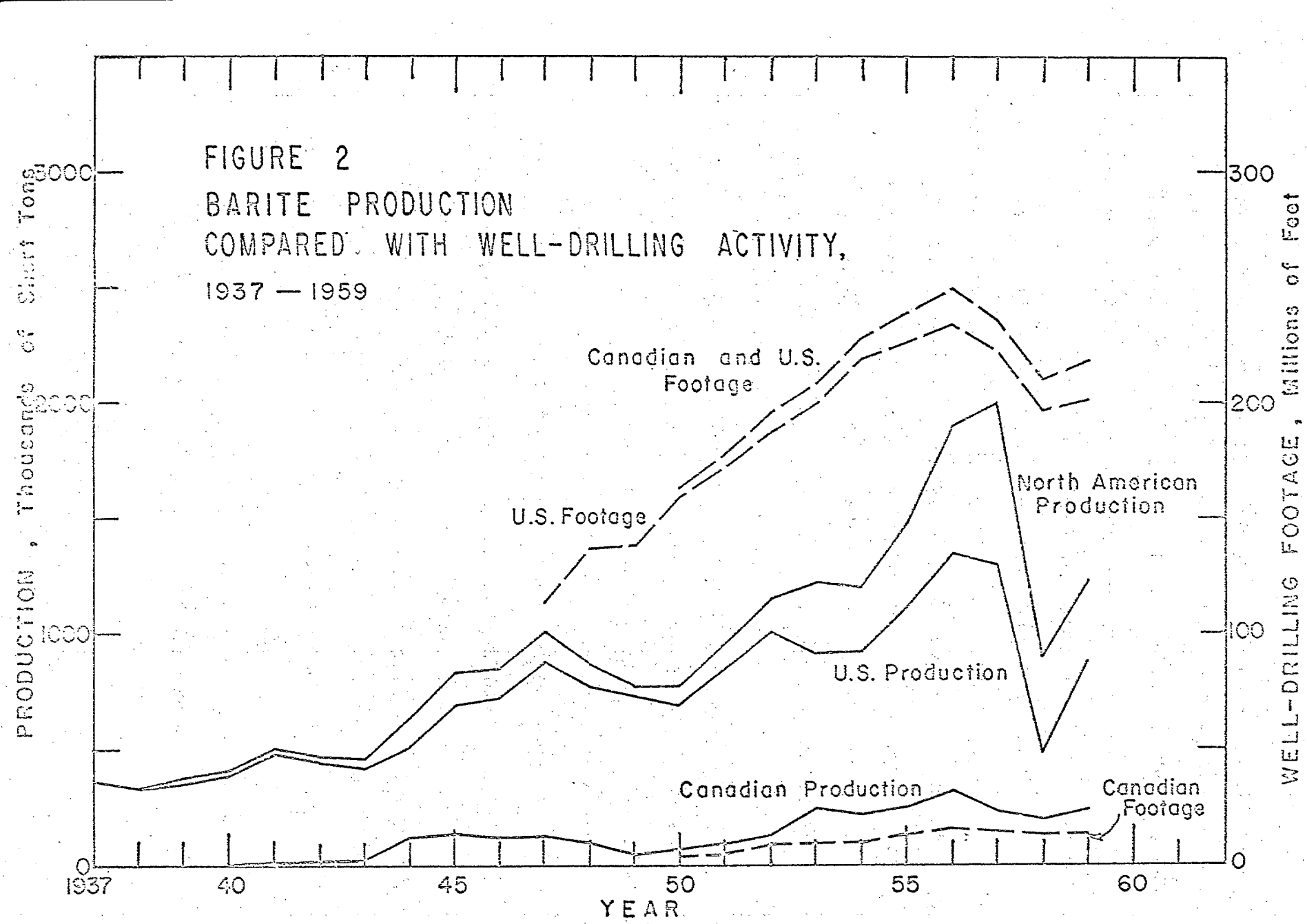
FIGURE 2
BARITE PRODUCTION
COMPARED WITH WELL-DRILLING ACTIVITY,
1937 — 1959
PRODUCTION, Thousands of Short Tons
WELL-DRILLING FOOTAGE, Millions of Feet
3000
2000
1000
0
300
200
100
0
1937
40
45
50
55
60
YEAR
Canadian and U.S. Footage
U.S. Footage
North American Production
U.S. Production
Canadian Production
Canadian Footage

The Canadian consumption of barite for 1959 is given in Table 7.

TABLE 7

Canadian Consumption of Barite, 1959

Uses	Short Tons
Well drilling	23,200 *
Paints, varnish	698
Glass	356
Rubber and linoleum products	173
Miscellaneous chemicals	65
Miscellaneous non-metallic products	708 *
Estimated total	25,200

* Estimated.

Table 8 illustrates the consumption of the main barium compounds. The demand for lithopone has decreased steadily since 1949, when the price of titanium dioxide became more competitive.

TABLE 8

Canadian Consumption of the Main Manufactured Barium Compounds, in Short Tons, 1956 and 1957

Barium Compound *	1956	1957
Lithopone	1,845	1,379
Barium chloride	328	361
Blanc fixe	472	301
Barium nitrate	83	86

* During 1957 the apparent consumption of barium carbonate was valued at $137,257.

Deposits

Mineralogy

Barium can substitute for elements of similar ionic radii such as potassium and strontium, and, although it is not abundant, it occurs in many minerals. Barium commonly is deposited as the sulphate (barite) or as the carbonate (witherite).

Barite, by far the most common ore mineral, can be transparent to opaque and white, light yellow, grey, light brown, pink or blue in colour. It has a hardness of 2.5 to 3.5 and a specific gravity varying from 4.3 to 4.6. The mineral is commonly coarse-grained, with tabular grains which are usually curved and in globular or platy forms. Occasionally a crested variety occurs, consisting of aggregates of tabular crystals in crest-like forms. Because of its softness and textural characteristics, barite is a relatively friable mineral. Some deposits are comprised of barite that can be crumbled to a certain extent with the hand. In other cases barite can be relatively compact. Crystals are not uncommon and are usually tabular but may be prismatic.

In vein or bedding replacement deposits, barite is commonly associated with calcite, quartz, galena, fluorite, dolomite, celestite, siderite, calcite, sphalerite and chalcopyrite. Ferruginous clays are commonly associated with the residual deposits.

Types of Deposits

a) Vein:

Most of the known Canadian barite occurrences are of the vein type and vary up to 60 feet wide and up to 750 feet long.

Barite occurs as vein deposits in structural weaknesses in country rocks of almost every type and age. The youngest consolidated rocks known to contain barite are of Carboniferous age and are found in the Maritime Provinces. The walls of these deposits are normally sharp. A parting or plane of juncture commonly occurs along the middle of veins. These partings may be tight or open and when open often contain assemblages of crystals. Elongated horses of country rock may occur as remnants along the partings or in central zones of veins. The inclusions may be partly replaced by disseminated barite and other vein minerals, may be transected by ladder veins, or may have been subjected to various stages of brecciation. Fragments of country rock occasionally are present in other parts of the veins. Some deposits contain a large number of breccia fragments of country rock, which in some cases are almost completely replaced by barite so that only ghost remnants are present.

The texture and grain size of the barite may vary from one deposit to another, although there is a tendency for deposits in some areas to be similar in texture and grain size. Most of the occurrences in the Maritime Provinces contain barite that is coarse-grained and has a

platy texture, whereas that in southern Ontario is more compact and more massive. Barite of the Walton, Nova Scotia, deposit, however, is fine- to medium-grained and compact. Northern Ontario barite is compact, coarsely granular, and massive. The characteristics of barite in deposits in the Kootenay district of British Columbia are varied, from friable and finely granular, to compact and platy, to fine-grained and compact.

The colour of the ore material is commonly affected by the country rock.

Other than usually minor vein impurities such as quartz, fluorspar and calcite, the barium content of a vein varies with the amount of country-rock contaminants. Such contaminants are common in veins as horses of rock and as breccia fragments, and occur along the central zones. Although the barium sulphate content of these veins varies, it invariably is greater than 50 to 60 per cent and commonly is above 80 per cent. Many veins predominantly of fluorite contain barite in amounts less than 10 per cent, although a greater barite content in these veins is not rare. The fluorite occurrences in Newfoundland, a few of which rank among the largest in the world, contain less than 10 per cent barite.

The ages of these occurrences are difficult to determine. In most instances there appears to be no intrusive of similar age with which these veins could be associated in time. Because of the probable epigenetic origin of this type

of deposit, the age cannot be closely determined from the immediate country rock. However, in Canada, no barite is recorded to have been found in place in rocks younger in age than Carboniferous. Occurrences in each region appear to be of similar ages. Those in southern Ontario have similar structural and environmental characteristics, as do those in northern Ontario, Cape Breton Island, and the Kootenay district, British Columbia.

It is not within the scope of this circular to discuss fully the possible origin of such veins. Some occur in joints and fissures and others in breccia and shear zones. As a result, most have crosscutting relationships with the country rocks. The usual number of theories have been ascribed to this type of barite deposit, among which are the following: hydrothermal, lateral secretion, and leaching. Most vein deposits in Canada appear to have the characteristics of either the epithermal or telethermal type of hydrothermal deposit.

b) Bedding Replacement:

The greatest volume of Canadian barite production has come from bedding replacement deposits which are similar in many respects to vein deposits but which replace in whole or in part certain beds of sedimentary formations.

These deposits are usually more extensive than the vein type, although the barium content may not be as uniform nor as high. The Walton replacement deposit is up to 250

feet wide and has a minimum strike length of 1500 feet and a minimum depth of 700 feet.

Limestone is commonly the host rock for this type of barite occurrence. It is often the rock that completely contains the barite, although in some cases barite replaces limestone along a contact or may replace such rocks as shale and tuff. Other non-massive rock types may also be host rocks. In Canada, essentially all are Paleozoic in age. These barite bodies are more irregular in shape than other vein deposits. However, there is a tendency for them to be confined to one horizon.

A barite zone may contain such relic structural features of the rocks it replaces as remnant bedding, banding and zoning of silicate minerals. As in vein deposits, the colour of the ore mineral commonly is affected by the country rocks. The grain size, texture and friability vary from one deposit to another and in detail within each deposit.

Overall, the four main barite replacement orebodies in Canada fall into two categories. The Walton orebody originally contained a minimum of 4 million tons grading approximately 90 per cent barite, whereas the Giant Mascot, Mineral King and Buchans orebodies, which have been primarily mined for lead and zinc, contain, on the average, between 30 and 50 per cent barite.

The ages of this type of deposit are difficult to determine. Those known to be of any appreciable size occur,

in Canada, in either Precambrian, Cambrian, Ordovician or Mississipian rocks.

Conflicting evidence for the origin of this type of barite occurrence indicates that the barite may have been deposited in these preferred zones by fluids which obtained the barium sulphate either from a distant deep-seated source or from rocks in the immediate vicinity. Most geologists who have examined this type of occurrence in Canada believe the former theory.

c) Residual:

No commercial residual barite deposits are known in Canada and the only barite in residual form is that found in minor amounts at the surface of vein and replacement deposits.

Residual barite deposits resulting from the weathering of other barite occurrences are common in the eastern and mid-western United States. According to reports they are comprised of rounded barite fragments up to the size of huge boulders in clay with or without sand and gravel. These occurrences vary up to several hundred acres in area and are up to 150 feet deep. When formed in place, the outlines tend to conform with those of the primary source. The barite content varies and averages approximately 15 per cent.

Distribution and Exploration

More than 150 barite occurrences have been recorded. Although found in all provinces with the exception of Alberta, Saskatchewan and Prince Edward Island, they are mainly confined very markedly to certain metallogenetic provinces. These are listed, in decreasing order of the number of recorded occurrences, in Table 9.

TABLE 9

Canadian Metallogenetic Provinces Containing Barite Deposits

Area	Age of Most Common Host Rock	Age of Youngest Host Rock
Bay of Fundy to northeastern Cape Breton Island.	Lower Carboniferous	Upper Carboniferous
Lake Simcoe, Ontario, to Buckingham, Quebec.	Lower Ordovician and Grenville	Lower Ordovician
Placentia Bay - Trinity Bay area, Newfoundland.	Precambrian	Ordovician (?)
Golden-Invermere area, British Columbia.	Proterozoic or Cambrian	Ordovician (?)
Lake Nipigon-Pigeon River area, Ontario.	Proterozoic	Proterozoic
Foleyet to Elk Lake, Ont.	Precambrian	Precambrian
Port au Port to Cornerbrook, Newfoundland.	Mississippian	Mississippian
Mileage 400 to 500, Alaska Highway, British Columbia.	Devonian and Devonian-Mississippian	Devonian-Mississippian

Other areas in which a small number of occurrences have been located are the Portland Canal area, British Columbia; near Lake Cowichan, Vancouver Island; in south-eastern Yukon Territory; and the Northwest Territories. The remainder occur sparsely scattered in southern British Columbia, Ontario, southern Quebec, New Brunswick, and Newfoundland.

No barite occurrences have been recorded in rocks younger than those of Upper Carboniferous age. As can be seen in Table 9, in almost every metallogenetic province the youngest host rocks are the most common host rocks and these rocks, in general, are the youngest non-dyke formations in the immediate area.

The barite deposits in any one metallogenetic province are not necessarily of the same type nor necessarily similar mineralogically. They may be similar in age.

In general, barite prospecting entails no different approach than any other type. One should, at least initially, prospect in metallogenetic provinces containing occurrences of the mineral and pay particular attention to those rocks that are most commonly the host rocks in any one particular area. Lead, zinc and fluorite mineralizations and barite in overburden are also important guides. Economic concentrations of lead, zinc and silver have been associated, or are associated, with three of the six mines from which barite is being produced. In addition, an appreciable amount of barite occurs as gangue in the zinc-lead-copper mine at Buchans, Newfoundland.

Deposits of well-drilling grade only, should normally not be too distant from markets or from water transportation. Distances from markets can be greater for barite of chemical grade, or for barite that can be beneficiated relatively easily to chemical grade.

Geophysical exploration has been carried out in some exploration programmes and has consisted usually of either a gravity or an induced potential survey. No barite veins of present economic importance have been discovered in Canada by geophysical means.

The minimum grade required for an economic operation varies greatly, depending on the nature of the ore, mining costs, beneficiation costs, transportation charges, and tariffs. Until 1958, when Magnet Cove Barium Corporation, Ltd. constructed a beneficiation mill, essentially all the barite produced in Canada had not been subjected to beneficiation other than hand-cobbing, washing, crushing, grinding and sizing. That is, most of the barite ore mined was of a grade suitable for the well-drilling or the chemical industries and contained a minimum of approximately 90 per cent barite. In the United States, depending on the economics and on the mining and milling problems, ore from bedded barite deposits containing as low as 30 per cent barium sulphate has been mined. Residual deposits containing as low as 150 pounds of barite per cubic yard have been worked in the United States.

Productive Deposits and Operations

Barite was recovered from six deposits during 1959: one in Nova Scotia, and five in British Columbia.

Magnet Cove Barium Corporation, Ltd.

This company, a wholly-owned subsidiary of Dresser Industries Incorporated of Houston, Texas, produces barite from its mine near Walton, Nova Scotia. During 1955, Magnet Cove Barium Corporation, Ltd. purchased the operation, with the exception of the mineral rights, from Canadian Industrial Minerals Limited, a wholly-owned subsidiary of Barymin Company Limited. The mineral rights were leased to Magnet Cove Barium Corporation on a royalty basis of $1.15, U.S. funds, per ton of ore mined and shipped.

The Walton deposit was explored by Canadian Industrial Minerals Limited in 1940 and prepared for mining in 1941. Since then it has been mined continuously, first by open pit and glory-hole methods and then by underground means. The pit reached an ultimate depth of over 300 feet and has surface dimensions of 1600 feet by 1100 feet. Work commenced on the present underground operation during 1956. A 5-compartment vertical shaft reached its ultimate depth of 977 feet in February, 1958, and levels have been established at depths of 350, 520, 690, 850 and 920 feet. Preparations for blast-hole stoping and block caving have continued since then, and the first underground production from this program came in 1957 from development headings.

During 1941, a mill having a capacity of 100 tons per day was put into operation at the nearby port of Walton. It was subsequently expanded to a capacity of 400 tons per day. Milling consisted of washing, crushing, pulverizing, sizing and bagging. Early in 1958 this mill was partly replaced by a new beneficiation plant, at the mine site, having a rated capacity of 100 tons an hour.

Although essentially all the company's production is consumed in the well-drilling industry, small quantities are consumed by the chemical and paint industries. Shipments are mainly made by water from the nearby port of Walton, either as bulk in lump or crushed form, or as crushed or ground in bags. Most of the lump barite, for eventual use by the drilling industry, is shipped to the parent company's grinding plants at Lake Charles and New Orleans, Louisiana, and Brownsville, Texas. The barite is pulverized and sized at these ports on the Gulf of Mexico. Ground products are also shipped from the Walton plant to such countries as Trinidad, Venezuela and Colombia, and to the Middle East.

The barite deposit is on the south limb of a regional synclinal flexure at and near the contact of the Mississippian rocks of the Windsor and Horton series. It is lens-shaped in plan, strikes northwest-southeast, dips 15 to 40 degrees northeast, and is bounded along the northeasterly contact by a fault zone and, at the surface, on the southwesterly contact by a major fault. In general, the ore zone occurs mainly in the lower limestone and limestone conglomerate

formation of the Windsor series. Barite also replaces the footwall siderite-carbonate and siliceous limestone members of that series and in some places may replace the underlying quartzite and sandstone of the Horton series. The intermediate hangingwall member is commonly an argillaceous horizon.

Mineralization is known to extend to a depth of over 900 feet. The deposit originally contained an estimated 4 million tons of material grading approximately 90 per cent barium sulphate. In 1958, estimated reserves were 1,800,000 short tons.

A zone containing proven and possible reserves of some 450,000 tons of lead-silver-zinc-copper mineralization has been outlined recently near the footwall of the barite orebody, from depths of 500 to 850 feet.

Although there are exceptions, the barite is normally iron-stained, massive, fine- to coarse-grained and compact, and contains iron-oxide and limy inclusions. Angular inclusions of the hangingwall rocks are not uncommon in the immediate hangingwall of the orebody. Both walls are relatively well-defined, although replacement of the footwall rocks has occurred for distances of up to 10 feet. Some geologists believe that the deposit may have originated by the replacement, by fluids, of the fractured limestone and limestone conglomerate horizon of the basal part of the Windsor series, and of the partial replacement of some of the underlying rocks.

Mountain Minerals Limited

Mountain Minerals Limited recovers barite from the Parson and Brisco veins in the Kootenay mining division of British Columbia.

The Parson deposit is in two mineral claims in section 7, township 24, range 19, west of the fifth meridian or 6 miles by road southwest of Parson, B.C. Barite has been mined from this claim group continually and on a seasonal basis since 1941.

Until 1957, mining was accomplished by open pit methods and the ore was hand-cobbed and shipped in the lump form. Since 1957 ore has been recovered from adits as well. An adit has been advanced some 450 feet along the east vein and approximately 50 feet below the quarry floor. A second adit 50 feet below the first has been started. Most hand-cobbed ore is trucked to rail transportation at Parson siding and shipped to the grinding plant near Lethbridge, Alta., for further processing. The product has been used in the glass, paper and paint industry, and for ship ballast. However, most is consumed as a weighting agent in oil- and gas-well drilling muds.

The deposit consists of two parallel veins 300 feet apart, striking north-south and dipping 45 to 65 degrees west. Country rocks consist of interbedded quartzite, dolomite and shale and are of Lower Cambrian age. The veins are commonly confined between two well-defined fault planes. The west vein is exposed in one quarry for a length of over

200 feet and is from 11 to 30 feet wide. The east vein is exposed in two quarries and the adits, for a total length of 600 feet, and is up to 35 feet wide. A few relatively large horses of country rock are present in both veins.

The barite is white to creamy white, coarse-grained and compact, and contains minor impurities consisting of hematite, quartz, pyrite, chalcopyrite, siderite, and calcite. Vugs are common. With the exception of the zones of barren rock, the ore normally has a specific gravity of over 4.3, and with hand-cobbing, much of the ore from both veins has been suitable for use in the production of paint and glass.

The Brisco occurrence is 4 miles by road west of Brisco siding and has been worked continuously on a seasonal basis since 1945. Other barite veins are nearby and have received minor attention to date. The main vein strikes north, dips from 75 degrees west to vertical, is in brecciated dolomite containing siliceous horizons, and is believed to be of Ordovician age. The barite zone is up to 40 feet wide, is over 800 feet long, and occupies a fault zone. The hangingwall contains slickensides and is well-defined, whereas the footwall is irregular. Vein material consists of light grey to white, fine-grained, compact barite containing black carbonaceous gouge as disseminations and streaks. Barite, particularly along the footwall, commonly has a brecciated appearance. Minor amounts of quartz, carbonate, pyrite, hematite and chalcopyrite are also present, as well as horses of country rock.

Nearly all the production has come from open pit mining. However, during 1957 and 1958 an adit was driven along the projection of the vein approximately 50 feet below the floor of the open pit and some barite was recovered from this operation. Ore is hand-cobbed, trucked to Brisco siding where it is reduced to minus 3 inches, and shipped by rail to the company's grinding plant at Lethbridge, Alberta. After hand-cobbing, the ore is of sufficient quality for use in oil-and gas-well drilling. The grey colour created by carbonaceous matter has prohibited the use of this barite for most other purposes.

Mineral King Mine

Sheep Creek Mines Limited operates the Mineral King lead-zinc mine, 28 miles southwest of Invermere, B.C. The lead-zinc mineralization above the No.3 level occupies zones in a dolomitic horizon of the Precambrian Mount Nelson formation. Here, the orebodies are undulating, have low dips, and plunge up to 30 degrees northwest. C and D ore zones, above No.3 level, consist essentially of galena and sphalerite in a predominantly barite gangue. Barite and the metallic minerals have replaced certain zones of the carbonate member to form the resulting banded orebody.

In December, 1958, the company began recovering lump barite from zones in the C and D lead-zinc ore zones above the third level, and has been shipping continuously since early 1959. When these relatively large and barren zones of barite are encountered in the faces or walls of the open

stopes, they are now normally removed after the stopes have been cleaned of broken lead-zinc ore and the barite is removed to a storage bin on surface.

The barite is trucked to Invermere where it is shipped by rail to the grinding plant of Magcobar Mining Company, Limited at Rosalind, Alberta, for grinding and bagging. It is exceptionally white, of high quality, has a very friable, sugary texture, and is used as a weighting agent in the well-drilling industry in western Canada.

The mill feed from the A, B, C and D zones above No.3 level has contained approximately 50 per cent barite. As a result, the existing tailings pond, which was established during 1954 and which is now receiving approximately 450 tons of material a day from these and other ore zones, contains a large amount of barite and should be considered as a major reserve of that commodity.

Baroid of Canada, Limited

During 1959, Baroid of Canada, Limited commenced mining barite by open pit methods, from a vein on the Larrabee claim located approximately 10 miles west of Invermere, B.C. During that same year, Baroid of Canada mined barite from the open pit of the Giant mine, owned by Giant Mascot Mines Limited. The ore was trucked to Invermere and shipped by rail to the company's grinding plant that began operations in 1960 at Onoway, Alta.

Some Other Domestic Deposits

There are numerous other barite occurrences, some of which have been worked in the past. Although it is not the scope of this report to describe the deposits in detail, those among the more noteworthy are discussed below.

British Columbia

The tailings pond at the Giant mine of Giant Mascot Mines Limited, located 7 miles by road west of Spillimacheen, contains an estimated 800,000 tons of material containing 35 to 45 per cent barite. The nearby abandoned mine contains an unknown quantity of barite with and without low-grade lead and zinc mineralization. During 1958 Giant Mascot converted its flotation mill and produced from it a few thousand tons of barite from the tailings. The concentrate was dried and bagged at a plant at Spillimacheen and shipped for use by the drilling industry. This latter plant burned down in 1958 and all operations ceased.

During 1959, Baroid of Canada, Limited optioned the property, buildings and equipment of the Giant mine with the intention of recovering barite from both the tailings dump and the mine. In that year a small tonnage was mined from the existing open pit.

Prospectors Airways Company, Limited controls a barite property near mileage 397 on the Alaska highway and has carried out exploration work, along with sampling and milling tests.

At least one other deposit of interest has been reported near the same location.

A large witherite-fluorite-barite deposit, owned by Conwest Exploration Company Limited, occurs near mileage 498 on the Alaska highway. Mainly because of the distance from markets, there has been no production from this deposit.

Ontario

The deposit of the Premier Langmuir mine, located in Langmuir township, 15 miles southeast of South Porcupine, was mined in 1918, 1939, 1940 and 1946. Barite occurs in two main veins, one of which is up to 6 feet wide and can be traced at intervals for a distance of about one thousand feet. The mineral is relatively white and comprises, on the average, 85 to 90 per cent of the vein.

Descriptions of a vein on McKellar island near Fort William indicate that the vein is up to 60 feet wide. One bulk sample contained 88 per cent barium sulphate. The deposit has not been worked for barite since 1894.

Nova Scotia

The Upper Brookfield barite deposit is 3 miles northeast of Brookfield. It was worked by Maritime Barytes Limited during 1951. The vein has been indicated by trenching and diamond drilling for a strike length of 320 feet and to a depth of 250 feet. Representative samples assayed from 77 to over 80 per cent barium sulphate.

The Middle Stewiacke showing is 7 miles east of Brookfield and was worked in the late 1890's. Except for a pit measuring 80 by 50 feet and 30 feet deep, there is no definite indication of the size of the orebody.

Barite veins occur in the Lake Ainslie district, Cape Breton Island. The more important of these are known as the Campbell-MacMillan, Trout Brook, Johnson, McDougal, and McKinnon deposits. In general, samples from these have contained up to 80 per cent barite. Some veins have been worked for both fluorite and barite. Dr. B.J. Keating* has estimated from diamond drilling and some underground development work that the Campbell-MacMillan deposit contains 1 million tons containing 44.5 per cent barite and 16.6 per cent fluorite.

Newfoundland

The zinc-lead-copper ore mined by American Smelting Refining Co. at the Buchans mine contains approximately 30 per cent barite. It has been mined since 1927 and is now being exploited at an approximate rate of 375,000 tons a year, resulting in the disposal in the tailings pond of some 170,000 tons of barite in tailings each year.

Reserves and Resources

Data concerning the barite resources of Canada are incomplete and in many cases unknown. In some instances, tonnage calculations, especially from exploratory programs, are not made public, whereas in other cases individuals and

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* Consulting geologist, personal correspondence.

small companies often do not determine reserves owing to insufficient exploration. For economic reasons companies of this latter group may not deem exploration feasible.

Assuming that probable ore reserves include mineralization that can be exploited economically under present conditions and that has been exposed on two sides or has been outlined by a sufficient amount of diamond drilling, the only figures available for publication are those of Magnet Cove Barium Corporation, whose reserves, in October 1958, were estimated to be 1,800,000 tons. Since then, approximately 500,000 tons have been mined from this property. The grade is probably in the order of 90 per cent barite.

Reserve estimates of the other deposits are either unknown or not available for publication. For the Mountain Minerals deposits, assuming that the deposits extend to depths equal to half their lengths and that the average widths of the Parson veins are 15 feet and that of the Brisco vein is 10 feet, it can be calculated that the probable reserves total some 800,000 tons grading some 80 per cent barite.

Although classified as a barite resource rather than a reserve, an estimated 1 million tons of material grading 44.5 per cent barite (and 16.6 per cent fluorite) have been outlined by diamond drilling by Fluor-Bar Mines Limited at the Campbell-MacMillan deposit near East Lake Ainslie, N.S.

An estimated 800,000 tons of tailings containing 40 per cent barite comprise the tailings dump of the

Giant mine near Spillimacheen. Sheep Creek Mines Limited is producing approximately 450 tons of tailings a day containing 35 per cent barite, depending on the orebodies being mined. Approximately 375,000 tons of tailings containing 45 per cent barite are disposed of annually at the Buchans mine. It is estimated that 4 million tons of barite are present in tailings ponds in Canada.

Thus, the known reserves of barite ore in place in three Canadian deposits total some 2.1 million short tons, containing 1.8 million short tons of barite. Excluding the known noteworthy deposits in northern British Columbia and the Northwest Territories, other large deposits containing over 32 per cent barite contain an estimated 2 million tons of the mineral. In addition, 4 million short tons of barite are present in tailings ponds. Based on current output, the amount of barite being added annually to these tailings ponds is in the order of 225,000 short tons--approximately equal to that contained in the 238,967 tons of concentrates shipped by Canadian producers during 1959. In short, as much barite is being dumped in tailings ponds in Canada as is normally shipped by Canadian producers.

In summary, 1.8 million short tons of barite exist in producing barite mines; at least 2 million tons are present in a few large deposits; 4 million tons occur as tailings; and 225,000 tons are being added to the tailings ponds each year. At Canada's present annual consumption of some 25,200 short tons of barite concentrates containing from 90 to 95 per cent

barite, the reserves of that commodity are ample for this country's requirements for the distant future. Disregarding any new major uses, substitutions or methods of reclamation for that mineral, the Canadian consumption of barite should, in general, increase slowly.

The problem, however, is to maintain economic reserves while continuing to supply considerable quantities (estimated at 213,500 short tons during 1959) to the export market. When taking into consideration these exports with domestic consumption, the currently economic Canadian barite reserves are not overly large.

Most of the larger Canadian deposits, if they contain more than 10 per cent barite, usually contain in the order of 70 to 80 per cent of the mineral and, if transportation and the market warrant, can be concentrated economically under present conditions. Except for the Buchans mine, there is an apparent lack of large barite deposits that are sub-marginal in grade. As a result, Canada must continue for some time to depend on the relatively smaller high-grade deposits, on certain tailings ponds, or on by-product production, for its barite.

On the other hand, as the higher-grade deposits throughout the world become depleted, and barring the discovery of additional major deposits, the United States, because of its large lower-grade residual deposits, will even more so be the dominant world barite producer. This is indicated by an estimate by Brobst of the United States Geological Survey who, in 1958,

determined that the apparent barite reserves in the United States are sufficient to supply that commodity, at the current production rate of approximately 1 million tons per year, for at least 40 years under existing markets and technology. He estimated further that the inferred reserves - those that may probably be reclassified as demonstrated reserves as economics warrant - in the United States are sufficient for about an additional 67 years at the rate mentioned above.

The resources data for the remainder of the world as a whole are not available.

Mining

In Canada, barite is mined in a number of ways, all of which are common to hard-rock mining. Most is now being recovered by blast-hole stoping and block caving at the Walton, Nova Scotia mine of Magnet Cove Barium Corporation. Here, levels have been established at 170-foot intervals, and ore has been removed by blast-hole stoping above the 690 level. Previously, ore from this mine was recovered by open-pit and glory-hole methods. By-product barite is recovered along with the open-stope mining of lead-zinc ore at the Mineral King mine of Sheep Creek Mines Limited. Mountain Minerals Limited has employed the open-pit method and drifting to remove barite ore from its Parson and Brisco deposits.

Beneficiation

Until 1958, when the beneficiation mill of Magnet Cove near Walton and that of Giant Mascot Mines near Spillimacheen

went into operation, essentially all barite produced in Canada had either received no concentration or had been hand-cobbed. Since that time, the trend has been towards more mechanical concentration.

The degree to which a barite ore is crushed, ground, and sized depends largely upon the market and type of concentration employed. Concentrates from mills using flotation are mainly minus 200 mesh in size. Those from jigs are usually minus 20 mesh, and those from heavy media are normally plus 10 mesh. Those concentrates used by the domestic drilling industry are crushed and then ground to approximately 95 per cent minus 325 mesh. Mainly because of United States tariffs, most exports to the United States are in the unground form.

The Magnet Cove mill near Walton concentrates ore by means of a heavy media circuit in conjunction with a Remer jig. Raymond mills reduce the size of the concentrate when required.

The hand-cobbed ore from the Mountain Minerals mines is normally ground in Raymond mills at the company's Lethbridge plant. Other plants, all of which occasionally grind domestic barite from the western Canadian producers with the use of a Raymond mill, are those of Magcobar Mining Company, Limited at Rosalind, Alta.; Baroid of Canada, Limited at Onoway, Alta.; and Industrial Fillers Limited at Montreal, P.Q.

The recovery of the commodity by flotation was undertaken during the latter part of 1958 by Giant Mascot Mines

near Spillimacheen. It is probable that additional flotation concentrates will be produced from the same source.

No bleached or calcined barite is produced in Canada.

Barium and Barium Chemicals

Because of the small amount of barium chemicals consumed annually, the production of these compounds is negligible. During 1957, 2127 tons of barium chemicals other than barite were consumed in Canada. In addition, barium carbonate valued at $137,257 was imported that year.

Other than barite, only one barium chemical, black ash, is produced. This barium sulphide compound has been produced by Cooksville-Laprairie Brick Limited at its Delson, P.Q., plant since 1941. It is used captively as an addition in certain raw mixes for brick and tile products, to prevent scumming and some types of efflorescence.

Black ash is normally produced by roasting lump barite with some form of carbon in a rotary kiln at a temperature of approximately 2400°F. The product is dissolved in water, and filtered. The filtrate is used as the additive to the wet mix.

Small quantities of barium metal have been produced from time to time by Dominion Magnesium at its plant at Haley, Ont. It is produced by a modified Pidgeon process, reducing barium oxide with aluminum powder in a heated and partly evacuated retort. The metal is then moulded and sold to electronics manufacturers.

Technology

At present, there appears to be no use or technological advancement that will create additional major markets for barite. The two more recent and more important developments are the new uses for barium titanate and for barite as a component in asphalt-rubber pavement and coatings. Other than these, there have been no new uses that have become of major interest during the past few years.

Problems

Such materials as iron ores, ilmenite and galena can be used as substitutes for barite in the oil-and gas-well drilling industry. Barite is preferred because of its chemical inertness, its cleanliness in handling, its relatively low cost, and its very low abrasive properties. Witherite, natural barium carbonate, is preferred to barite for almost all other applications. However, barite occurs in much greater quantities and is relatively cheaper than witherite for most of these uses. The trend towards the replacement of lithopone by titanium dioxide for use as a pigment in paints is almost complete, with the result that further adverse effects to the barite industry in this respect will be negligible.

One problem which is common to all industries is the combined effect of periods of recession and high prosperity, resulting in fluctuating production demands. In the case of barite, this is accentuated by the fact that the consumption

of this commodity is greatly dependent upon one market only --a market that has wide seasonal fluctuations.

One apparent major threat to the barite producers is the possibility that the drilling companies may widely adopt the procedure of recovering weighting agents after they are discharged from the wells. Such a procedure would drastically reduce the consumption of barite for this use, probably cause an increase in the initial cost of the commodity, and may make it more economical to use other heavy media. For instance, ilmenite, magnetite or certain artificial compounds have higher specific gravities than barite and can be recovered cheaply by magnetic separation. Another threat is the relatively new and increasing use of air and gas as drilling fluids in oil-and gas-well drilling, especially in arid and northern regions. Thus, while substitutes are used and while the threat of substitutes will always remain, there appears to be no need for serious and immediate concern by the barite industry until world barite reserves become critical, unless an effective method of recovering heavy media from discharged drilling muds is developed, or unless the new method of using air or gas as drilling fluids becomes popular in fields where barite would normally be consumed in relatively large quantities.

Marketing

Barite is marketed in lump, crushed, and ground forms. It may be either wet- or dry-ground. Some is sold after being

bleached or 'calcined'. The ground material is sold normally in 100-pound bags, as is most of the sized, crushed barite for use in the production of glass.

Approximately 95 per cent of the barite consumed in Canada is used by the drilling industry and is sold mainly by the producers to suppliers of drilling mud, or sold by drilling-mud servicing companies. With the recent commencement of fairly integrated mining, milling, marketing and servicing businesses by Magcobar and Baroid in western Canada, much of this barite will be produced and sold by these two companies. The area of marketing of this type of commodity will be mainly in eastern Alberta, British Columbia, and the Yukon and Northwest Territories. The market area for the remainder of this mineral is in eastern Canada.

Most of our exports are produced and consumed captively and are shipped in lump or crushed form to the grinding plants located along the United States Mexican Gulf coast. The area of next importance is the Caribbean area, followed by the Middle East. Because most of the Canadian production is controlled by one company which in turn is one of the major producers and supplies of barite in the world, the degree of processing and manner and degree of marketing of this Canadian barite are dependent upon the business activity and economics encountered by this company.

The producers in western Canada have ample reserves to supply the domestic drilling industry with barite for a number of years. Thus, the major market remaining for barite

of well-drilling grade is the export market. To be economically competitive with such strategically located operations as those at Walton, a potential producer should be located close to water transportation. An operation involving a Canadian barite deposit of chemical grade, if exploited for a chemical-grade product, could withstand higher transportation costs. However, the Canadian market is negligible and as for other uses, the main markets would be in the United States.

Prices and Tariffs

The average values of production per short ton for ground and crude barite from 1948 to 1959 are shown in Table 10. These have remained relatively constant for the crude product, our major barite export, but have risen gradually but considerably for the ground variety.

TABLE 10

Average Values of Canadian Barite Production Per Short Ton, 1948 to 1959*

Year	Ground	Crushed and Lump
1948	13.58	8.52
1949	13.09	6.61
1950	13.29	7.59
1951	14.79	8.62
1952	16.10	8.29
1953	14.35	7.58
1954	14.58	7.08
1955	15.30	6.49
1956	16.91	7.08
1957	21.57	7.84
1958	20.26	8.52
1959	18.20	8.46

* $ f.o.b. plant

Prices quoted in E & M J Metal and Mineral Markets on August 4, 1960, were as follows:

Canada
Crude, in bulk, f.o.b. shipping point, per long ton $11.00

Ground, in bags, per short ton $16.50

Georgia
Crude, jig and lump, per short ton $18.00

Beneficiated, per short ton
in bulk $21.00
in bags ..... $23.50 to $25.00

U.S. Gulf ports
Foreign, crude, oil-well grade, minimum specific gravity 4.25, bulk, c.i.f. ports, per short ton ..... $16.00 to $18.00

At present, the Canadian and United States tariffs on barite are as follows:

Canada

	British Preferential	Most Favoured Nation	General
Barite, crude or ground	free	25%	25%
Barite, for drilling-mud use	free	free	free

United States

Ore, per long ton	
Crude or unmanufactured	$2.55
Ground or otherwise unmanufactured	6.50

Because grinding costs at the grinding plants in the United States do not differ appreciably from those at the Magnet Cove Barium Corporation plant at Walton, N.S., and because of the large difference of $3.95 a long ton between the United States import duties for the crude and ground material, there is an incentive for United States consumers to

import only crude barite. Thus, by far the major factor governing the type of barite product to be exported to the United States, and thus the value of production of most of the Canadian output, is the large differential between the United States import duties on these two commodities.

Outlook

Unless there is political or international interference with currently existing trade laws, the production of Canadian barite during the next decade should increase slightly over that of 1959, with the main part of the export trade being in the crude form. Canada will retain approximately the position it now holds in world production. The existing world trade pattern will remain somewhat the same during the next decade, with a larger proportion of barite being consumed by the drilling industry in the Middle East. The chief hope for Canada to increase its output lies in the ability of the Walton mine to compete mainly with Mexico, West Germany and the United States in supplying ground barite to the Middle East. Increased markets for Canada in the Middle East would allow more of the higher-valued, ground barite to be produced. Barite from Mexico, Peru and Greece, in that order, is a major threat to Canadian barite markets in the Caribbean area.

The drilling industry, by far the major consumer of barite, will in most cases continue to use the commodity in preference to other substitutes, as long as world reserves

remain ample and obtainable at a reasonable cost and at least until suitable recovery from spent drilling muds should become economically feasible. The presently-known North American barite resources alone will assure the world of a sufficient supply for several decades.

For Canada's own needs, there are sufficient resources for many decades. However, the Canadian resources in place that could possibly be economical in a decade will be small, because of the large export trade and the apparent small resources of additional strategically located high-grade or large submarginal grade deposits. Unless major economic reserves are found in Canada in the next decade, Canada's position as a major barite producer will depend mainly on the economics of recovering and marketing pulverized barite from the large reserves in the tailings dumps at lead-zinc and barite beneficiation plants. These tailings dumps are well situated either as to ocean transportation or as to certain oil-and gas-producing areas. Because of the large low-grade barite resources of the United States, Canada will continue to lag far behind the production of the United States. The major threat to barite producers is the possibility of economically recovering and re-using weighting media from used drilling mud.

WITHERITE

Witherite, the natural form of barium carbonate, contains 77.7 per cent barium oxide as compared with 65.7 per cent barium oxide in barite. It can be readily dissolved by most acids to form the corresponding barium salts. For these reasons it is preferred for many of the chemical uses for which barite is consumed. However, it is rarely found in commercial quantities.

The presence of witherite has been reported in three deposits in Canada. That in small veins in Nepean township, Carleton country, Ontario, and in Gillies township, Thunder Bay district, Ontario, is present in minor amounts. The third occurrence, near mileage 498 on the Alaska highway in northern British Columbia, is of major dimensions. It is known as the Liard River deposit, and is controlled by Conwest Exploration Company Limited.

There has been no witherite industry in Canada, and the only production of the mineral in North America has come from the El Portal mine in California, which ceased operations in 1948. The mineral is imported into the United States in small amounts, at the rate of 2,000 to 3,000 tons annually, from the United Kingdom, France, Belgium, and Luxembourg. It is consumed for chemical purposes.

The United Kingdom has produced small quantities of witherite almost continuously for many years, mainly as a by-

product in the mining of lead, zinc and barite ores. Deposits containing witherite are common to the Upper Carboniferous strata in Northumberland county, England. The mineral is recovered mainly by gravity separation and hand-cobbing.

The Liard River occurrences are composed mainly of fluorite and witherite, and are replacement deposits, both in massive Middle Devonian limestones and along the disconformity between Middle Devonian limestone and Upper Devonian and Mississippian argillite and slate. The latter type of occurrence is usually the more important, with the main zone containing in the order of 35 per cent witherite, 30 per cent fluorite and 5 per cent barite. Much of this mineralization is within 50 feet of the surface. The indicated tonnage of witherite is of major proportions. The remoteness of this deposit from major markets has prevented its development to the production stage.

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