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BRITISH COLUMBIA DEPARTMENT OF MINES
HON. W. A. McKENZIE, Minister

Non-Metallic Mineral Investigations

REPORT No. 2.

ASBESTOS IN BRITISH COLUMBIA

By
A. M. RICHMOND

Submitted by

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Victoria

BUREAU OF MINES

Victoria, B. C.

April, 1932.

To the Honourable W.A. McKenzie,

Minister of Mines.

Sir:-

I beg to submit herewith Report No. 2 of a series on Non-Metallic Investigations by A. M. Richmond.

In accordance with your instructions, Mr. Richmond commenced this investigation in June, 1931, and has been continuously engaged since that time. The objective is to investigate primarily many non-metallic mineral deposits to see if they can be utilized in British Columbia manufactures and industries. It involves field examination, a study of imports of non-metallics, specifications of purchase and many intricate factors in non-metallic trade.

It is hoped that the facts obtained and inferences drawn therefrom will stimulate the use of Provincial deposits of certain non-metallic minerals.

Further reports in the series will be issued from time to time as completed.

I have the honour to be,
Sir,
Your obedient servant,

JOHN D. GALLOWAY,

Provincial Mineralogist.

THE BRITISH COLUMBIA DEPARTMENT OF MINES

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INTRODUCTION

The purpose of this report, the second of a series to be issued by the Department of Mines on the non-metallic minerals of the Province and the possibilities existing for their economic development, is to give briefly, information about the Asbestos Minerals, such as the varieties found, their chemical and physical characteristics, occurrence, uses, markets and prices, etc.; to describe the known occurrences of asbestiform minerals in British Columbia; and, from the assembled data, come to some definite conclusions as to the economic value of the local deposits so far discovered.

The selected bibliography listed at the end of this report has supplied much of the information for the first part of this paper and is herewith gratefully acknowledged. The bibliography is not a complete one and for further references the reader is referred to pages 133-139 of Bulletin No. 707, "Chrysotile Asbestos in Canada" by J. G. Ross, recently issued by the Mines Branch, Department of Mines, Ottawa.

ASBESTOS

The word asbestos means indestructible or inconsumable and technically speaking it is the name of the hornblende or Italian asbestos of the amphibole group of minerals. General commercial usage has extended the meaning of the word until it is now given to all minerals which separate easily into flexible, threadlike fibres.

Asbestos Minerals.

Asbestos minerals are found in two mineral groups, the AMPHIBOLES, which include anthophylite, tremolite, actinolite, Italian or hornblende asbestos (the mineralogist's asbestos), crocidolite and amosite, and the SERPENTINES, which include picrolite and chrysotile (the asbestos of commerce).

These minerals are all found in fibrous form of varying commercial value. Where a fine, flexible, silky, strong, acid, water and fire-resisting, spinning fibre is required Chrysotile is much superior to the other varieties and is consequently the most valuable of the asbestos minerals.

The looseness in definition of the term "asbestos" has resulted in some confusion and disappointment because the discovery of any fibrous mineral by the uninformed is a discovery to them of great potential wealth, whereas there is actually only a limited, low-priced market for any other than chrysotile, the ore of asbestos fibre.

Composition.

The amphibole minerals (iron or calcium silicates with either magnesium, aluminium, and or, sodium) are generally found in slips and fault planes as slip-fibre. The fibres are harsh, coarse, brittle, weak, and poor non-conductors of heat. Generally speaking, the amphiboles are not suitable for spinning and weaving into yarns and textiles but their superior heat and acid-resisting qualities give them a limited market in the chemical industry for filter purposes.

Anthophylite, grey to brown in color, occurs as mass or slip-fibre and is unsuited for textiles but of some value for chemical uses because of its superior heat and acid-resisting qualities. Tremolite and actinolite, respectively greyish white and green in color, occur as blade-like crystal aggregates in columnar or radiating structures, the fine fibrous silky varieties resembling flax being called Italian or hornblende asbestos. Crocidolite and amosite are found as cross-fibre, the first being a lavender blue color with fibre as much as two inches in length, the second being a grey-green color and with cross-fibres four to seven inches long. They are used to a limited extent for textile purposes, the fibres being quite harsh and coarse though very tough and strong.

The serpentine minerals are hydrous silicates of magnesium the picrolite variety having the same chemical composition as chrysotile but different physical qualities. Picrolite is found as slip-fibre, six to ten inches or more in length and it is tough, not easily separated into fibres, often brittle and harsh to the touch and exhibits a splintery fracture. It is not used commercially.

Chrysotile when pure contains 43.0% magnesia, 44.1% silica, and 12.9% water. As mined, it usually contains some alumina and iron oxide. It should be noted that the moisture content of chrysotile is four times or more than found in the amphibole asbestos minerals and is the chief chemical difference between the two groups. Commercial chrysotile ore always contains more than 13% moisture whereas the harsh asbestos fibres such as tremolite and actinolite seldom contain more than one to two percent moisture.

Chrysotile has a greasy, silky lustre and feel, is found as both slip and cross-fibre and is usually white or light green to dark green or brown in color. It has a hardness of 3 to 3.5 and can be easily scratched with a knife. The specific gravity of 2.2 is less than that of either the amphiboles or quartz.

The smooth, greasy feel, the white color of the finely divided fibres together with their spinnability and superior tensile strength distinguishes chrysotile readily from the other asbestos minerals. If a small quantity of chrysotile be heated in a closed tube moisture will collect on the inside of the tube.

Occurrence.

The amphibole asbestos minerals are generally found as slip-fibre aggregates in metamorphosed crystalline schists of high magnesia content and never as alteration products of serpentine.

Both picrolite and chrysotile are found in altered peridotitic rocks (rocks of igneous origin low in silica and high in iron and magnesia content) and in metamorphosed crystalline limestone near contacts with intrusive sills of basic igneous rock. Chrysotile occurs mostly as cross-fibre (the fibres are arranged perpendicular to the plane of the vein) forming a network of narrow veins through the serpentinized peridotite. The veins vary in thickness from one-sixteenth of an inch and less to as much as three inches or more, though seldom over three-fourths of an inch. The Canadian occurrence of chrysotile in Quebec, the most productive field of high-grade asbestos fibre in the world, is found in serpentine, an altered olivine rock of the peridotite group of igneous rocks.

Valuable Qualities of Asbestos.

Asbestos is commercially valuable chiefly because it can be woven into strong, non-combustible fabrics. Canadian chrysotile from Quebec is considered the best spinning fibre in the world due to its extreme flexibility, its white silkiness of color and texture, its fineness of fibre thread and its superior tensile strength. For some uses asbestos is required to be a good non-conductor of heat and electricity as well as non-combustible and unaffected by acids, alkalies or moisture. Some amphibole varieties meet these last mentioned requirements in part and can be used where brittleness and harshness of fibre is not detrimental, such as in filters in industrial chemical plants.

As stated in the section on Asbestos, pp. 62-63, of R. B. Ladoo's "Non-Metallic Minerals, Their Occurrence, Preparation and Utilization" a few simple tests which can be made by anyone interested will show the quality and suitability of asbestos for most uses. Ladoo states "Length, color, silkiness, flexibility and, to some extent, fineness of fibre and tensile strength may be determined by inspection. A sample of asbestos should be fiberized by rubbing or crushing between the fingers. Some fibres may then be tested for flexibility and tensile strength by bending and breaking. Several fibres may be twisted into a strand or yarn and again tested for flexibility and strength. Asbestos of good quality should be soft, easily fiberized, silky, strong, flexible and easily twisted into a strong yarn. Fibres one-quarter of an inch in length or longer and otherwise of good grade are of commercial interest."

Tests for heat conductivity and final tests for tensile strength and resistance to corrosive acids and alkalies, etc., must be conducted in the laboratory but generally it may be said that any asbestos fibre which successfully meets and passes the simple tests enumerated above has some economic value as a source of commercial asbestos, if reasonably situated with regard to transportation, and provided other factors such as grade and quantity of fibre can be established for steady production.

A significant fact which should not be overlooked is that the average fibre content (or grade) of the asbestos ore mined in Eastern Canada during the past few years has been 5.25% of the total asbestos-bearing rock mined.

Uses.

The uses for asbestos are so many and varied that only the better known applications will be listed here. The best fibre is made into yarn, cordage and textiles, from which are made brake linings, clutch facings, steam packings, fireproof theatre curtains, fireproof clothing such as caps, helmets, leggings, gloves, etc., mailbags, webbing, electrical insulation and conveyor belts, etc. The shorter fibres are made into paper, compressed sheets and blocks, from which many secondary articles such as roof and wall coverings, heat and electrical insulating materials, brake blocks, automobile muffler linings, table mats, pads, etc., are manufactured. In combination with Portland cement the fibre is made into shingles, lumber, wall tile, switchboards, blackboards and similar products. When mixed with magnesite and properly prepared, asbestos finds a market as heat and electrical insulating cements, as pipe and boiler coverings. The shorter fibres are used for paint fillers, the pulverized asbestos being called asbestine. Some of the amphibole varieties of fibre are better heat and acid resisters than chrysotile and are used for chemical filters where length, flexibility and strength of fibre are not required.

As the principal use of asbestos is in the automobile industry, where it is used for brake linings, clutch facings, muffler linings, etc., it follows that the prosperity of the asbestos miner depends on the prosperity of the automobile business to a marked degree.

Grading, Specifications and Prices.

Fibre asbestos grades are different with different producers and countries, the following table giving the American and Canadian practice::

GRADES AND PRICES OF ASBESTOS FIBRE

American usage in METAL AND MINERAL MARKETS.	Canadian Classification. See Note Page 12.	Length of Fibre in inches.	Prices $ per Ton.
Crude No. I	Crude No. I	Plus 3/4	$400
Crude No. II	Crude No. II	5/16 to 3/4	$200
Spinning Fibre	Mill Stock #1	Plus 5/16	$80 - 125
Shingle Stock	Mill Stock #2	1/32 to 3/16	$50 - 65
Paper Stock, etc.	Mill Stock #3	Minus 1/32	$27 - 35
Cement, Plaster St.	Mill Stock #3	Minus 1/32 & fines	$15 - 20
Floats, Fillers.	Asbestic	Powdered fibre	$10 - 15

All prices f.o.b. Quebec mines, Apr. 28, 1932. Metal & Mineral Mkt

Some manufacturers use the screen classification of asbestos fibre. In this method one pound of fibre is placed in the top screen of three and vibrated 600 times in the space of two minutes, after which time the amount of fibre contained on each of the three screens and the bottom pan is weighed in ounces. Should 2 ounces of fibre be retained on screen No. 1 (2-mesh #11 wire), 8 ounces be retained on screen No. 2 (4-mesh #17 wire), 4 ounces be retained on screen No. 3 (10-mesh #18 wire), and only 2 ounces shake through to the bottom pan, the fibre would be classed as long spinning fibre and numerically referred to as 2-8-4-2 fibre. The screens are 24 x 14 x 4 inches in size and vibration is produced by a 1½ inch throw eccentric cam.

Screen classification grades as given by B. Marcuse may be taken as representative and are as follows:-

CLASSIFICATION.	SCREENINGS IN OUNCES			
	Screen #1	#2	#3	Pan
Long spinning fibre	2	8	4	2
Medium spinning fibre	0	8	6	2
Pipe Covering fibre	0	5	8	3
Shingle stock fibre.	0	1½	9½	5
Paper and Millboard stock,	0	0	10	6
Cement stock fibre.	0	0	5	11

Markets.

No asbestos fibre has been produced commercially in British Columbia, the market being supplied by shipments from Quebec and importations from the United States, England and Italy. The imports into Canada for 1929 and 1930 and the imports into British Columbia for the year ending March 31st, 1931, are shown in the following table, kindly prepared by the Department of National Revenue, Ottawa.

Imported Article.	Canadian Totals. 1929	1930	B.C. Total 1930-31
Asbestos brake lining	-	$193,824	$26,126
Asbestos packings	$116,207	$82,111	$7,956
Asbestos n.o.p.	$897,229	$597,915	$47,413
TOTALS:	$1,013,436	$873,850	$81,495

About 85% of the imports into Canada are from the United States, the remainder coming from England and other countries in the British Empire. The reason for this is that until a few years ago only a small amount of the Canadian asbestos production was prepared and manufactured in Canada.

The list of uses given will indicate to the reader where the local markets for asbestos minerals are to be found. Most of the asbestos brought into the Province is in the manufactured form for use a brake linings and clutch facings. The paint companies of Vancouver and Victoria use about 150 tons of asbestine per year for which they pay $32 to $40 per ton delivered. Asbestine is finely pulverized fibre, very white and usually screened through 325 mesh screens for marketing purposes. In the roofing industry of the Province there is a demand for several thousand tons of roofing and paper quality fibre per annum, if it could be obtained for $45 to $55 per ton. Fibre for this purpose can be short but it must have fineness, strength, flexibility and pulpability (that is, it must form a pulp instead of a powder when beaten in the pulp vats).

Tariffs.

Canadian Asbestos in any form other than crude fibre and all manufactures thereof is subject to a 25% general tariff or a 15 % British preference tariff.

British There are no duties.

United States Asbestos unmanufactured, fibres, stucco and sand containing not more than 15% foreign matter is admitted free, but manufactures of yarn and woven fabrics composed wholly or chiefly of asbestos are subject to a 40% ad valorem duty, and all other manufactures of asbestos are subject to a 25% ad valorem duty.

BRITISH COLUMBIA DEPOSITS OF ASBESTOS MINERALS

Many samples of asbestiform minerals from widely scattered parts of the Province have been received in the past by the Bureau of Mines for identification, but in most instances the samples have been of the amphibole varieties of fibre with negligible value. One occurrence of chrysotile is found at Sidmouth in the Revelstoke Mining Division, and fair samples of cross-fibre were received late in 1931 from the Kamloops area and to the south of that city. Other areas from which fibrous samples have been received include, Vanderhoof, Tulameen, Lytton, Hope and Harrison Lake. These occurrences are mentioned briefly in the following notes:

ASBESTOS GROUP The Asbestos group of eight claims, held on location by J. T. Lauthers and associates of Revelstoke, is situated 3 miles northeast of Sidmouth, a small station on the Revelstoke-Arrowhead branch of the Canadian Pacific Railway in the Revelstoke Mining Division of the Eastern Mineral Survey District. The main showings are located on the steep bluffs overlooking the Columbia river from an elevation of 4,200 feet above sea-level. The nearest point of the railway is two miles due west and 2,800 feet below the property showings. A steep, rough, narrow trail connects the camp and Sidmouth.

The chrysotile in association with talcose material, occurs in serpentine, an altered portion of a large intruded dyke of basic igneous rock which cuts through the quartzites and crystalline limestone country rocks of the area. The serpentine belt is from 800 to 1,000 feet wide, the belt striking north and south and paralleling the Columbia river. Both cross-fibre and slip-fibre are found in the serpentine, the slip-fibre being from 3 to 10 inches in length and the cross-fibre usually from 1/8 to 3/8 inches long. Cross-fibre up to 1/2 inch in length is occasionally found.

An examination of the three large opencuts which constitute the major portion of the development work to-date, indicates possibilities for a large tonnage of fibre containing serpentine. No measurements to show the fibre content could be made with any degree of accuracy, but a visual examination of the fibre rock would suggest from 1% to 2% fibre content, with selected sections containing as much as 4% and more fibre. The fibre is somewhat harsh to the touch, short in length, of medium silkiness and low tensile strength. When examined microscopically the individual threads of fibre are very much coarser and apparently more brittle than the Quebec chrysotile used for comparative purposes. The Sidmouth fibres are needle-like rather than thread-like in form and individually much larger in diameter than the Eastern fibre.

In 1928 the Lardeau Mines Exploration Syndicate, Ltd. of Vancouver, under the direction of J. M. Humphreys, took an option on the property and shipped 300 pounds of fibre rock to the Ore Dressing and Metallurgical Laboratories of the Department of Mines at Ottawa for testing purposes. Salient points from the report by the Mines Branch show that when a piece of soft white fibre from the shipment was heated to 1000°C. it lost 35.8% of its weight, turned pink in color and became very brittle. The longest fibres (plus 2 to 4 mesh) were found to be woody in texture, of low tensile strength and unsuited for spinning, shingle or paper-making stock. The only possible marketable stock which could be made from the sample would be cement stock grading 0-0-5-11, and asbestic sand for plaster work.

The low quality fibre products such as just mentioned are never mined alone, being always obtained as a by-product from rock containing the better length fibres. Further prospecting at the property with a view to finding better quality fibre areas should be done, but until such areas are found little in the way of commercial exploitation could be attempted in view of the small local markets for low-grade fibre materials.

<u>INDUSTRIAL GROUP</u> This group of three claims, held on location by G. Bower and K. Kaminishi of Vancouver, is situated on the west side of Jones creek, a northerly flowing stream which enters the Fraser river about 15 miles below Hope. The deposit of fibrous mineral is easily reached by half a mile of trail from the Vancouver-Hope highway and is in the New Westminster Mining Division of the Western Mineral Survey District. It is about one mile from the main line of the Canadian National Railway.

The fibre, more accurately an actinolite, is found in a series of northerly and westerly striking fractures in an area of altered basic dioritic rocks. Prospecting and small development stripping operations have uncovered several wide slips of fibre along the bank of the creek. The exposed area is 150 to 200 feet long. Several samples were taken for testing and analysis, the average grade of selected fibre containing:

Silica,	55.2%	Lime,	13.2%
Iron Oxide,	5.6%	Magnesia,	18.9%
Alumina	3.2%	Water,	2.9%
Alkalies by difference	2.9%		

This analysis closely approximates that of actinolite, though containing less iron and some alumina. Examined microscopically, the fibres when powdered tend to maintain their lenticular shape but are coarse and brittle, and without the silky appearance so desirable. Practical tests showed the fibre to be without tensile strength, brittle and unsuited for any use except for mineral filler in rubber goods, moulded and pressed articles where synthetic resins can be used for binding the mineral particles together. On account of its brittleness it could not be used for paper or roofing stock.

MISCELLANEOUS OCCURRENCES. Samples of tremolite (amphibole) from a deposit 18 miles south of Vanderhoof in the Omineca Mining Division of the North-Eastern Mineral Survey District were examined but were of no economic value, the fibres being easily powdered, very brittle and dirty. The tremolite was found by an Indian on the upper slope of Sinkut mountain and submitted by G. Ogston of Vanderhoof.

In the Central Mineral Survey District two deposits of fibre have been found, one being situated south of Kamloops and the other at the head of Quoieck creek, several miles west of Kanaka, a small station of the Canadian Pacific Railway near Lytton. The deposit south of Kamloops was not examined as the discovery was made late in the fall of 1931, but fair quality slip-fibre specimens have been taken from the property. It is owned by J.C. Couture and associates of Kamloops. The property west of Kanaka is in the Ashcroft Mining Division and can be reached by trail from that point. The cross and slip-fibre occurs in a serpentine belt of rocks traversing the area, but unfortunately, selected samples from the property crush readily to a powder and lack tensile strength and spinnability. As the area is at a high elevation (6,000 feet and higher) and difficult of access, the known factors are unfavorable for the property.

Samples of asbestos fibre have been found by prospectors at several localities in the Tulameen country in the olivine rocks. This area is in the Similkameen Division of the Southern Mineral Survey District. The asbestos so far discovered has been short, usually in veins less than ¼ inch wide, and while not of value in themselves, the discoveries and the rocks of the district indicate an excellent area for prospecting.

An occurrence of asbestos of scientific interest only, is recorded in L. Reinecke's "Ore Deposits of the Beaverdell Map Area" on pages 79 and 143. This publication is Memoir No. 7 of the Geological Survey of Canada, Ottawa.

Asbestos fibre discoveries were made in 1931 in the Harrison Lake section of the New Westminster Mining Division. The deposit owned by E. J. Leveson of Vancouver, is situated o the north side of the southern tributary of 15-Mile creek and 1½ miles east of the lake shore. Two exposures were examined the first at the creek camp consisting of a one-foot width of tremolite developed along fracturing in the altered ferro-magnesium rocks; the second, at a considerably higher elevati and to the north consisting of four to six inches of tremolite of poor quality. The tremolite is light to dark green in color, portions of it being highly fibrous, the individual fibres being coarse, brittle and without much tensile strength.

The poor quality of the fibre, the limited quantity indicated, and the unfavorable prospecting conditions are not encouraging factors.

Samples of asbestos minerals were submitted by R. Fadden of McLeod Lake, B. C., but no information as to the source of the samples is available.

CONCLUSIONS

The available data on the asbestos deposits of the Province are not encouraging for the development of this branch of non-metallic minerals, the fibre in general being unsuited to any but the lowest grade products. There is a convenient and ample reserve of cement and plaster stock fibre at Sidmouth but almost a negligible demand for this material within and adjacent to the Province. There is a demand for several thousand tons per year of the better quality fibres which would be suitable for roofing and paper manufactures. The relatively small demand for asbestine as used in the paint industry would not permit the economic working of the Hope deposits of greyish white actinolite. It is possible that some of the un-investigated sources of asbestiform mineral fibre may have sufficient merit to overcome difficult transportation problems.

The simple tests given in the first part of this short paper will indicate to those interested the economic possibilities of any new discoveries. It should always be remembered that to be of interest the fibre should be flexible, fine, silky and strong.

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NOTE:

Since this report was written a new Classification of Canadian Asbestos has been adopted by the Quebec producers of asbestos fibre and for a complete discussion of this now accepted standard classification the reader is referred to an article by A. O. Dufresne and E. Larochelle in the April 1932 issue of "The Canadian Mining and Metallurgical Bulletin," pages 224 to 232.