

GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, M.D., D.Sc. (CANTAB.), LL.D., F.R.S., I.S.O.

MINERAL RESOURCES OF CANADA

BULLETIN

ON

ASBESTUS

BY

R. W. ELLS, LL.D., F.R.S.C.



OTTAWA

PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY

1903.

No. 854

This document was produced
by scanning the original publication.

Ce document est le produit d'une
numérisation par balayage
de la publication originale.

THE ASBESTUS DEPOSITS OF CANADA.

By R. W. ELLS.

The asbestos deposits of Canada are found in the peculiar rock group known as the serpentines. These rocks occurs in many parts of the Dominion and at widely separated geological horizons, ranging from the oldest crystallines of Ontario and Quebec, which are usually described under the name Archaean, to the Cænozoic of British Columbia.

Occurrence of
asbestos.

In the far east, serpentine has been observed in connection with the limestones of the oldest division in the island of Cape Breton, Nova Scotia, and in the vicinity of St. John, New Brunswick. In Quebec, north of the Ottawa river, similar serpentines are also found in connection with limestone of a like character, as also in eastern Ontario. These limestones belong to what are styled the Grenville and Hastings series. Occasionally masses of dioritic rocks in all these areas are serpentinized to some extent and small veinings of asbestos are found in portions of the rock-mass.

Localities
where found.

Among the eruptive rocks west of Lake Superior, notably at the Lake of the Woods, the occurrence of serpentine has been recorded by Dr. Dawson and by other geologists who have traversed the area, but these occurrences in so far as examined, appear to be practically destitute of asbestos. Further west in British Columbia, Dr. Dawson records the presence of serpentine in the rocks of the Cache Creek series which were regarded by him as of Carboniferous age; while in the Yukon district the same observer mentions the presence of similar serpentines and says that small veins of asbestos, which may have been derived from some of these-rock masses, have been found; but the exact locality of the deposits of this mineral are not definitely known. The serpentines of the maritime provinces have not as yet yielded asbestos in economic quantities and the rocks are, so far as known, practically destitute of this mineral.

Serpentine of
the west.

In the province of Quebec the serpentines are of two kinds and belong to two distinct horizons. The oldest are associated with the crystalline limestones of the Grenville series and the mineral is found at a number of widely separated points throughout the area north of the Ottawa

Serpentine of
Quebec.

river. Asbestos frequently occurs in the rock in zones of the serpentine which form the outer part of pyroxenite masses and is usually white in colour. These masses are scattered through the limestone formation, generally in the form of bodies of various sizes, but sometimes as longitudinal bands of the pyroxenite which occur nearly along the lines of the banding of the containing limestone. In the Eastern Townships, where the large workable deposits are located, the serpentine occurs as an alteration product from great masses of olivine diabase which run in an extensively developed, but irregular band, from the Vermont boundary nearly to the extremity of Gaspé peninsula. The alteration of these diabase rocks can readily be observed in the field as well as under the microscope. Portions of the eruptive mass are entirely altered to serpentine, while very often intermediate stages can be observed and the rock is then merely a serpentinized diorite or gabbro. The asbestos veins here occur distributed throughout portions of the serpentine mass, intersecting the rock in all directions, with thicknesses ranging from mere threads up to four and occasionally six inches.

Alteration
from gabbro.

The associated rocks are usually hard, schistose slates and quartzite of the Cambrian series, occasionally intersected by quartz veins, and passing at times into a true mica schist. These are cut by granites and diorites, and the serpentine masses themselves have been invaded by dykes, and sometimes contain large areas, of a whitish granite.

Age of
associated
rocks.

While the development of these serpentines of the Eastern Townships is quite extensive, a close study of their field relations and characteristics soon serves to show that the rock varies greatly in aspect in different areas. Sometimes it assumes a slaty or schistose structure and when this is developed the lines of schistosity conform with those of the surrounding rocks, showing that the same causes of metamorphism have affected both series.

The difference in the character of the serpentines of this eastern belt is apparently to some extent due to the amount of alteration the original diabase rock has undergone. Serpentine is a hydrous silicate of magnesia, but the percentage of water varies greatly in different portions of the rock-mass and when it falls below a certain normal amount the rock itself becomes too hard and dry to produce asbestos veins of proper texture and size for economic working. This hard condition is found in much of the rock composing the serpentine belt; and even in the rich districts of Thetford and Black Lake, where the greatest amount of asbestos is obtained, large masses of the rock are unproductive, apparently from this cause. To one familiar with the peculiarities of asbestos rock, the dry and barren variety can usually be

Character
of the
serpentine.

readily recognized in the field by its colour and its peculiar weathering. It may be here remarked that all the asbestos produced in this field belongs to the variety known as chrysotile.

THE ACTINOLITE DEPOSITS IN ONTARIO.

In some parts of Ontario, notably in the northern portions of the counties of Hastings and Addington, in connection with the granites, gneiss and crystalline limestone of this area, quite extensive bands of a blackish-green hornblende or amphibolite rock are seen. These are often schistose in structure and form part of what is known as the Hastings series. In Hastings county these hornblende rocks occur in ridges running in a direction about north-east and are bounded on both sides by granites. Associated with the schists are bands of slate-conglomerate, holding quartz pebbles, which are drawn out along the planes of schistosity. The width of the hornblende belt is from 250 to 500 feet and in places the rock is soft, green and highly chloritic. The area is affected by faults, and the asbestiform mineral is developed in a number of zones, pockets and irregular vein-like bands of fibrous hornblende or actinolite which sometimes assumes the form of stellar crystals and sometimes occurs as broad platy crystals of tremolite, the mineral differing from chrysotile in being anhydrous.

Actinolite of
Hastings
county.

Mining has been carried on in these deposits for about twenty years, and a large amount of material has been extracted and hauled to the village of Bridgewater, a distance of about eight miles, where it is milled for the extraction of the fibre which is produced in three grades, Nos. 1 and 2 being employed for boiler coverings and No. 3, which is finely ground for wall plaster under the name of asbestal.

Mining in
Elzevir.

Fibrous hornblende or actinolite is found at a number of other places, sometimes with a fibre of from 10 to 12 inches in length in connection with hornblende or tremolitic rocks, but not in sufficient quantities to make these deposits of economic value.

At the mines in the township of Elzevir, where the mining is principally done, the central portion of the hornblende ridges is often serpentized, though not altered to a true serpentine rock. The asbestiform minerals are not found in this portion apparently, and in this respect the rock differs from the serpentine of the Eastern Townships of Quebec. The principal mines are situated near a road from Bridgewater to Flinton in the eastern part of the township of Elzevir and of the adjacent township of Kaladar on the east. The actinolite deposits vary in thickness from a few inches up to zones several feet

Serpentine.

in width, the stellar variety being usually in bands distinct from the longer or tremolitic fibred mineral, though occasionally both forms are found in the same band. At one point near the eastern extremity of the area in Elzevir a shaft has been sunk to a depth of about 30 feet along a line of fault, the underlying rock being a soft chloritic mineral and the upper portion consisting of a thick body of the actinolite. Slickensided surfaces along the line of contact are visible, and occasional crystals of the stellar variety are seen to extend for several inches into the chloritic foot wall, the dip of which is south-east from 65 to 85 degrees. There is evidently a considerable body of the actinolite at this place, but the mining has so far been confined to the outer surfaces of the hornblende ridges.

Mill product. The percentage of fiberized rock in the mine output is stated to average from 30 to 40, and of this amount, after passing through the mill, about 10 per cent is extracted in the form of fibre for shipment, so that from 100 tons of the mine rock, about $3\frac{1}{2}$ tons of fibre should be obtained. The price of the fibre is stated to be \$20.00 per ton.

Companies working in the area.

Two companies have been operating at this place, viz.; the International Asbestos Co., with head quarters in New York, and a local office at Tweed, and the Joseph James Co. of Actinolite, formerly called Bridgewater. The latter company now uses a mixture of soapstone and talc, ground together and subsequently mixed with a certain proportion of tar to form roofing cement. The mining of the actinolite was first taken up by Mr. James about 1882, the fibre from the ground actinolite being used for the cement.

THE ASBESTUS DEPOSITS OF THE GRENVILLE SERIES, QUEBEC.

The Grenville series.

The rocks of the Grenville series consist of various coloured gneisses, with masses of white quartzite and limestone in the upper portion, which however are often of only local development. Where the quartzite is absent the upper or grey-mica gneiss passes upward into bands of crystalline limestone which, in the lower part, are interstratified with bands of greyish and often rusty gneiss, but become a well-banded pure limestone in the upper portion of the series. These rocks are invaded by masses of granite, diabase, pyroxene, gabbro and anorthosite, which often assume the character of dykes. The distribution of the limestone is frequently irregular, owing in part to the action of the intrusive rocks. With the pyroxene masses are the deposits of mica and apatite, while graphite of the columnar variety, occurs sometimes in veins but generally as disseminated ore, which occurs both in the upper gneiss and in the crystalline limestone.

The serpentine portion of these rocks is found associated with the limestone and is apparently related to pyroxenite, generally near the contact with gabbro or diorite and occasionally with granite. Sometimes the pyroxenite replaces the lower portion of the limestone bands, but it also occurs in places as concretionary masses scattered throughout the limestone itself, forming concentric zones of serpentine surrounding a central portion of hard white pyroxenite, which resembles a white crystalline limestone, but is generally harder and somewhat finer grained. The width of the serpentine zones is sometimes 8 to 10 inches, though in small concretions it is much less, and in these zones the asbestos (which is a chrysotile) is found in small layers, usually following the contour of the outer coat, and ranging in thickness from mere partings to half an inch or sometimes even more. The fibre is usually fine and silky, quite free from the usual impurity of iron grains, which so frequently break the fibre in the veins of the Eastern Townships deposits. Occasionally a number of these small veins unite and form, for short distances, veins of fair size, reaching in places a thickness of from one to two inches, which speedily split up again into the usual small stringers. A similar thickening of veins is also noticed in connection with some of the asbestos in the mines of the Black Lake belt, in eastern Quebec.

Occurrence
of the
serpentine.

Asbestos
veins.

This mode of occurrence of serpentine with asbestos is found at many places in connection with the limestones in the area north of the Ottawa. The deposits occasionally assume a size sufficient to warrant mining, were it not that the irregularity of the deposits, and the necessity of removing such large quantities of barren rock to obtain the fibred mineral have made these attempts, up to the present, unprofitable, and all the asbestos mining locations in this district have been abandoned. Attempts to separate the fibre from the rock by milling have been made and the separation has been successfully accomplished but not at a profit. More recently the serpentinous portions of these deposits with the contained small fibres have been ground fine and used for boiler coverings and asbestos cements, for which purpose the mineral appears to be well adapted, since it is a non-conductor of heat. In much of the material so used, the presence of asbestos veins cannot be recognized with the naked eye, but a large proportion of the output has a slightly fibrous texture which is maintained after the rock is ground to a fine condition.

Character of
output.

Among the many localities where these deposits are seen north of the Ottawa river the following may be mentioned :

Localities for
asbestos.

Near Paugun falls, Gatineau river, township of Denholm, worked at intervals for some years. Two miles from the railway.

Perkins Mills, township of Templeton, eight miles from the Canadian Pacific Railway. Worked quite extensively for several years, now closed.

Lot II, range VIII, Templeton, and lot 16 range V, the last owned by W. A. Allan, on land of Nicholas Orange. Four miles from the Lievre river.

Newton lake, township of Portland. Mined to some extent in 1892.

Côte St. Pierre, La Petite Nation, about 12 miles north of the Canadian Pacific railway at Papineauville. Mined for asbestos some years ago, but better known of late years as yielding the peculiar form known as *Eozoon Canadense*, for some years regarded as a fossil of Laurentian age.

Shores of Gull and Blanche lakes, township of Mulgrave; worked to a small extent some years ago.

Silver Lake township of Wentworth.

Augmentation of Grenville, several miles north of Pointe au Chene on the Canadian Pacific railway.

Township of Wright, about 4 miles west of Wright post office.

Old Chelsea, about one mile and a half west of Chelsea station on the Gatineau Valley railway. Not worked.

The characteristics of the several deposits are stated in the Annual Report of the Geological Survey for 1899, Vol. XII pp. 105-106. Of the Portland West deposit on lot 16, R.V., it is stated that:—

Character of
deposit in
Templeton.

‘The chrysotile occurs in two principal bands, one of which is near the brow of a ridge of limestone with a band of serpentine near the contact with the gneiss, and with a dyke of white granite or pegmatite along the contact. The elevation of this ridge is about sixty feet above the road at its base, and in the serpentine band there are from twenty five to thirty small veins in a space of two to three feet. Most of these are mere threads, but some reach a thickness of half an inch or even a little more, whereas in Templeton, several coalesce to form for a short distance a thicker vein.

The band of limestone is here exposed for a breadth of about 150 yards. A second narrow band of asbestos bearing-rock occurs near the eastern edge of the area which terminates against a mass of red granite-gneiss. In this area, the concretionary-looking masses of pyroxenite are not observed.”

In contrast with the mode of occurrence of the asbestos at this place the deposits found at Perkins mills may be described in an extract taken from the same report.

“The country rock is also a crystalline limestone, but the serpentinized pyroxenite here frequently assumes the shape of concretionary masses, sometimes like rounded boulders, but also in irregularly shaped areas extending downward to a considerable distance. The exposed surface of the masses has often an irregularly oval outline. The masses themselves consist of a core of white pyroxenite, resembling at first sight certain of the limestones but generally harder and finer grained, surrounded by a zone of serpentine, and near the contact with the limestone the small veins of chrysotile occur. In one pit a section is made across one of the pyroxenite masses, which here has the aspect of a dyke, showing it to descend through the limestone for at least twenty feet, with a thickness of a little more than two feet, and along the margin of which the small chrysotile veins are arranged parallel to the walls. Some of the rounded masses of the pyroxenite are detachable from the limestone and this mode of occurrence presents several interesting features. That the pyroxenite is clearly a distinct rock from the limestone is plainly seen at a number of points, and that the chrysotile is confined to the serpentine can also be readily observed. When the limestone is serpentinized the mineral appears in the form of small irregularly distributed spots forming an opihalecite, but this is distinct from the serpentinized pyroxenite.”

Area near
Perkin's
Mills.

Mode of
occurrence.

THE ASBESTUS DEPOSITS OF THE EASTERN TOWNSHIPS, QUEBEC.

The early history of the asbestos industry as developed in eastern Quebec has been given in the reports of the Geological Survey for the years 1886-1887, and in the “Mineral Resources of Quebec, 1888-89. Since the last date, practically nothing has been written by the officers of the department on this subject beyond the annual statements as to output given in the reports of the Mining Section. As the development of the mines in the districts of Thetford, Black Lake and Danville has been carried on continuously since the latter date, and the conditions of working have been greatly changed, the principal object of the present report is to indicate briefly the more important features connected with the recent development of the industry, and to incorporate any new facts which have been observed in an examination of the several mining areas during the past season.

Asbestos of
Eastern
Townships.

The principal economic feature introduced in connection with the serpentine areas of this district since the report for 1888-89, is the development of the deposits of chromic iron, which, as well as the asbestos, is found in connection with the serpentines of the Eastern

Occurrence of
chromic iron.

Townships. Reference to the occurrence of this mineral was made in the reports already quoted, but at that date the known deposits were of small size and of comparatively little importance. Within the last ten years, however, this branch of mining has come largely to the front, and numerous and often extensive occurrences of chromic iron have been discovered, chiefly in the area of barren serpentine to the south of Black lake in the vicinity of Lakes Caribou and Little St. Francis, from which large quantities of the mineral are now being extracted.

Age of associated rocks.

In the earlier reports on this subject the relations of the serpentine to the associated slates and other rocks were indicated. As a rule, the rock forms masses in the great series of slates which have been referred to the Silly portion of the Quebec group, which are now regarded as a part of the Cambrian system. Most of the serpentine masses are so situated, and the rock, as already observed, is undoubtedly an alteration product from an olivine diabase or gabbro which forms important hill-features in this part of the province. The occurrence of pyroxene in the mass is clearly observed, as also in sections under the microscope.

Intrusive rocks in serpentine.

The serpentine itself is frequently cut by white granite, sometimes in the form of narrow dykes which are frequently disclosed in the several pits from which the asbestos is mined. These dykes have shattered and otherwise altered the rock in contact. Other masses of granite, both red and grey, form prominent hills in the area between Black lake and Thetford, but these differ in character from the white dykes alluded to. In places a greenish dioritic rock or gabbro also occurs, which forms ridges. A good example of this is seen on the line of the Quebec Central railway about a mile north of Black Lake station, where the western end of a ridge crosses the track. This gabbro is serpentinous, and in places almost passes over into a true serpentine. The alteration, however, as a whole is not complete.

Character of barren serpentine.

The character of the serpentine varies considerably in different areas. Some portions are hard and siliceous, weathering reddish-brown, features seen in much of the rock of the townships of Wolfestown, Ireland and Garthby, as well as in a large part of the high ridge south of Black lake. In this hard serpentine, which often weathers to a peculiar tawny orange yellow, asbestos is rarely found and when present occurs as an imperfectly developed fibre, often stiff and harsh and in short and gashy veins. Seamy partings are frequently seen traversing the serpentine, and these, at first sight, would appear to indicate the presence of large veins of asbestos, but on examination the mineral is usually found to be present as mere thread-like partings in the centre of the seams. These

barren seams are sometimes known as "dead veins." The seamy bands "Dead veins. are seen in connection with the workable asbestos veins at all the mines, and in these places the asbestos has evidently segregated from the sides of the surrounding rock. There is no apparent reason for the lack of asbestos in some of these, while it is present in others, unless it is due to the less percentage of water in the barren portion of the serpentine.

The asbestos-bearing serpentine, on the other hand, presents quite distinct features. The rock is usually greyish-weathering, and generally a soft greyish-green on fresh fracture. It frequently contains small grains of magnetic or chromic iron disseminated, which in the formation of the asbestos veins also segregate out and become an integral part of the fibre. A serpentine with a hard, brittle and harsh aspect, and a black colour does not promise well for asbestos. In the mining areas there are masses of this rock, as also of the brown-weathering variety, which are comparatively barren, either because the rock originally contained too little water in composition, or because it has been altered in this respect by the presence of granite or diorite masses.

Character of productive serpentine.

All the rocks in the district from the Vermont boundary north-ward, have been involved in the great series of folding and disturbance which has affected the greater part of the strata from the Maine boundary to the St. Lawrence river. The direction of this crushing force was distinctly from south-east to north-west, and it included the masses of serpentine as well as the associated schists and slates, by which they are surrounded. The results of this pressure can be well seen in all the serpentine masses throughout the belt. In small areas the rock has assumed a decidedly slaty or schistose structure throughout, with the development of much talcose matter, but in the larger masses of the Thetford and Black Lake belt, while slips and dislocations are quite numerous and a slaty structure has developed in some portions, the great mass of the rock has withstood the shearing strain to a certain extent, so that the rock, as a whole, is much more massive. This shearing and consequent faulting has often affected the value of large veins of asbestos by cutting off an entire face of working and presenting a barren wall for a time. Great slickensided surfaces are seen and the sides of these fissures are often coated with the soft green serpentine resulting from the action of the thrust movement. Along these thrust-planes the serpentine often occurs in broad sheets forming the variety of asbestos known as picrolite, of but small commercial value, since it lacks the soft flexible fibre; but portions of it are utilized in the fibreizing mill with the

Alteration of the serpentine.

Slaty structure.

Faults.

other material. Occasionally these slides have involved veins of asbestos which have been crushed along the line of dislocation and drawn them out to a width of some inches. Where the rock is comparatively undisturbed the fibres of the asbestos veins are usually at right angles to the enclosing walls.

Character of
rocks at East
Broughton.

The slaty or schistose structure of the serpentine is well seen in the outcrops which occur near East Broughton, as also on the Bras du Sud-Ouest and the Des Plantes rivers which are branches of the Chaudière. In these areas, the rock is completely shattered in places and highly cleaved, the cleavage of the slaty portions corresponding with that of the adjacent slates. In these outcrops there are numerous veins of asbestos of good quality which have also been distorted, and flattened along the shearing planes. Similar cleaved masses of the serpentine are found to the south-west in the areas of Bolton township, and about the north side of Orford mountain, while around the shores of Brompton lake the rock is associated with heavy masses of gabbro and diabase.

Origin of
asbestos
veins.

The asbestos veins which traverse the serpentine in all directions in the asbestos-bearing portion probably owe their origin to fissures which have been formed in the rock-mass as a result of some one of the several periods of movement. That some of them were formed prior to the final crushing is probable, since occasional veins are found in the crushed condition; the greater part of these veins however are but little disturbed and are still at right angles to the sides of the fissure. The intrusion of the white granite dykes has probably exercised some influence in this direction, since often in the mining, as the dykes are approached, the veins increase in number as if the rock had been opened up by their action. Sometimes masses of granite invade the serpentine and cut off the rock entirely so that the workings have to be abandoned. When a face of good workings has been cut off by the action of faults, good ground is generally found again by driving for a short distance through the barren wall.

Granite
intrusives.

Segregation
veins.

In whatever way these fissures were formed, it is evident that the subsequent filling of the vein-matter was brought about by a process of segregation from the adjacent sides, in the same way as quartz and certain other mineral veins have been formed. In support of this view, it may be said that the central zone of many of the veins, especially of the larger size, shows a distinct comb of iron particles, while the rock walls are leached out, the colour being markedly changed for some inches on both sides, so that the run of the veins can be readily seen around the sides of the pits. In the dryer and harder rock, some of

these veins are almost filled with the iron grains cemented together with asbestos fibres.

Any one familiar with the character of the serpentines of this district can readily distinguish between that which is likely to prove profitable as a source of asbestos and that which is comparatively barren. Thus, in the area between Thetford and Black lake, certain conditions appear to have prevailed by which the serpentinization of the original gabbro mass has reached a high stage of perfection and much of this ground appears to be exceptionally rich in good fibre. Even in masses of the rock which appear to be wanting in true veins, a certain amount of fibre is disseminated, sufficient in quantity to render a large part of the rock profitable for milling purposes. This feature is entirely absent in the harder and dryer looking serpentine. The character of the rock gradually changes as we advance southward from the comparatively low areas adjacent to the Quebec Central railway, and as we ascend the high range of hills in this direction, at the distance of a mile or so, the rock becomes harder and assumes the peculiar orange-yellow aspect of the more siliceous portion. The veins gradually become smaller, though still abundant in many places, to the top of the high ridge south of the government road between the two villages, and there is a marked decrease in the amount of No. I fibre. Further south the serpentine, in so far as examined, is practically barren as regards asbestos; at least no areas regarded as economically productive have yet been discovered in this direction, but pocket deposits of chromic iron frequently occur.

Different kind
of serpentine.

None of the serpentine areas of the southern belt, which includes those found in the townships of Potton, Sutton, Bolton, Orford, Melbourne and Shipton have as yet proved to be of the class regarded as asbestos-bearing, with the exception of a small area in the last-named township, about four miles east of the village of Danville, where a peculiar dome-shaped outcrop of the soft light green rock occurs, which has been mined for some years. The rocks of this belt are frequently associated with soapstone and dolomite, and have a soft talcose character on the slaty surfaces. The asbestos veins when found are soft, gashy and pasty, or stiff and harsh, owing apparently to the lack of contained water in the mineral.

The southern
belt.

To the north-east of the Chaudière river, areas of serpentine are sometimes met with. They differ in character from that found at Thetford and are generally intimately associated with diabase masses. Small veins of asbestos are sometimes seen, but the conditions, as a whole, are not favourable to the occurrence of the mineral in workable quantities.

The
Chaudière
areas.

The
Shickshock
area.

Still further east, in the Shickshock mountain range of the Gaspé peninsula, a considerable area of these rocks occurs. The character of the serpentine here is also unfavourable to the occurrence of asbestos, much of the area being of the hard, siliceous variety. In places it is banded with red and green colours, and though small veins of asbestos are occasionally seen, nothing of importance, so far as yet known, has been found. Small quantities of chromic iron have been observed at several points on the surface of the mountain. The most easterly outcrop of the rock is seen at Mount Serpentine on Ladysteps brook about ten miles west of Gaspé basin, and here also the serpentine is associated with diorite and hornblende rocks, similar to the rock of the Shickshocks. A few small and irregular veins only were noticed at this place.

THE MINES OF THETFORD AND BLACK LAKE.

Mines of
Thetford.

The discovery of asbestos in this area was made during the construction of the Quebec Central railway, which passes directly across the belt of serpentine between Thetford and the village of Coleraine. In this work the rock was laid bare at what is now the Thetford mines, and a number of veins of asbestos were disclosed at the surface. Attention being directed to these, their value was speedily recognized and mining was begun in 1878 by the Boston Asbestos Co, and by Mr. A. Johnston. The King Bros., of Quebec began operations shortly after. The output by the Boston Co. in 1878 was about 50 tons, taken from the Ward property, which is directly along the line of the railway.

The principal mines in this district are situated on a small ridge of serpentine lying a short distance east of the track, and having an elevation of about 90 feet above the railway. On this ridge the properties of three largest companies, known as Kings, the Bell Co., and the Johnston Co. are all located. The Beaver Asbestos Co. lies to the north of the railway on an adjoining lot to the south-west, being on lot 32 Range C, of Coleraine township. The three first mentioned are in the township of Thetford.

Asbestos
producing
areas.

At present the mining of asbestos is practically confined to the belt of serpentine which extends from the Standard Asbestos Co's property (formerly the Anglo-Canadian) at Black lake to Kings mine at Thetford. In addition, two areas are worked at East Broughton and one at Asbestos village, four miles south-east of Danville, in the township of Shipton. Other mines which have been worked at intervals are situated

about two miles north-west of Coleraine station. All the other mines which were opened years ago at different points in the serpentine belt, are at present closed.

The conditions of mining which prevailed prior to 1889, as regards the separation of the fibre have greatly changed. In the early years of the industry, a great amount of so called waste rock, in the form of dumps was allowed to accumulate and greatly hampered the successful working of the pits. All the mining is now carried on by a system of open quarrying, and the different mines are equipped with a modern outfit of cable derricks, by which the removal of the rock is greatly expedited. It was pointed out in 1888 that a large proportion of the dump material could be profitably handled in properly constructed mills, and a great amount of good fibre which it was found unprofitable to separate by the process of hand-cobbing could in this way be saved. The suggestion was speedily acted upon and now all the mines are equipped with milling plants, so that the product below what is known as crude Nos. 1 and 2, which are still hand-cobbed, passes directly through the mill and the short fibre is there separated, the waste going thence to a dump on what is regarded as barren ground to the west of the railway. In this way most of the large rock dumps have been profitably worked over and greater facilities for operating the pits have been secured, while the present method provides a cheap and economical way of treating the lower grades of rock and saving the short fibre. The manufacture of asbestic is not carried on at any of the Thetford mills to any great extent, and when this is done the asbestic is regarded merely as a by-product.

During a recent examination of the serpentine areas, all the workable deposits were inspected, including those of Thetford, Black Lake, East Broughton, Ireland and Danville, and some new facts of considerable importance were observed. The industry, as a whole, has been almost entirely revolutionized since the date of the last report on the district in 1888-89 and in the following pages these new features are presented, so that the general conditions and status of the industry may be brought down to the present time.

The old method of open quarry work is still maintained at all the mines, as best suited to the economic extraction of the mineral, since practically all the rock is asbestos-bearing, with the exception of occasional hard bands and limited areas of comparatively barren serpentine, due to displacement of rich ground through the agency of faults, and of certain dykes of granite which traverse the serpentine mass and are of more recent age.

Present state
of the quarries
at Thetford.

These open pits now reach a depth of 135 to 150 feet, and an examination of the lower benches shows that the rich ground, holding large veins of first class fibre, continues downward without interruption or perceptible decrease. Possibly the general thickness of some of the large-sized veins noted twenty years ago near the upper portion of these pits has somewhat decreased, but otherwise there appears to be but little difference in the value of the serpentine as a producer. This remark applies to all the three mines mentioned as occurring along the Thetford ridge. In the Beaver property, which is situated on the west side of the railway, the development has not proceeded at the same rate as in the others, and from the fact that mining operations have been suspended on this area for some time owing to change in ownership, the principal openings were filled with water and the lower portions of the pits could not be examined. At the old Ward property, adjacent to the Johnston mine, work has not been carried on for some years, but when formerly examined the area showed excellent fibre. At the Beaver mine, where the pit walls were exposed, the conditions are excellent and the value of the property appears to be equal to what was observed in the early days of the working of this area.

In none of these mines was any well defined zone or belt of asbestos veins recognized. They traverse the serpentine in all directions but are affected by faults, along the course of which, slickensided surfaces are common. But little iron oxide is visible except in the form of disseminated grains and in the partings seen in the large veins. No large pockets of chromic iron have been found in the asbestos-bearing rock, those now worked occurring in the areas to the south where asbestos is rarely seen.

Black Lake
mines.

In the group of mines situated in the Black Lake area the conditions are somewhat different. The rock mass forms a high ridge lying from half a mile to a mile south of the railway with a steep face to the north and north-west. The ownership of several of these mines has changed in the last twelve years so that the names as given on the Geological Survey map of the asbestos area in 1888, require revision. Thus the Anglo-Canadian is now known as the Standard Asbestos Co.; the Danville, afterward the United Asbestos Co. is now the Manhattan; the Scottish-Canadian is now the Glasgow and Montreal; and the American Asbestos Co. is now the Union Asbestos Co. In addition to these areas, a mine has been opened by the Johnston Co. of Thetford on the west end of lot 31, range B; and on lot 32 of the same range formerly owned by Mr. A. Murphy and worked to some extent in 1888, a new company, styled the American Asbestos Co. has

recently commenced mining at another point with a very promising outlook. To the south-west the old workings of George Turcot and of Lomas, and Johnston as also the mines started by King Bros. some ten to twelve years ago have since been abandoned. New areas at
Black lake.

The workings in this group of mines have been carried on for many years in the high lying areas along the front of the ridge at elevations of 400 to 700 feet above the line of railway at Black Lake station. The serpentine of this portion has never been as productive of large veins as that of the lower series at Thetford, although the veins themselves are abundant and the quality of the fibre is in many places excellent. As a rule it may be said that the rock of these upper areas is less hydrous than that from the lower workings and the mass of the rock does not contain the same amount of fine veins or milling fibre as that from the Thetford areas.

Owing probably to the fact that much of the lower ground near the railway is largely drift-covered while that of the upper shows the bare rock, these low-lying areas were left practically unproved for many years. About four years ago, however, a prospector working for Mr. A. Johnston in this vicinity, uncovered a group of veins of large size and excellent quality on lot 31, range B, and on sinking at this place, the rock was found to resemble in character that from the best mines of the Thetford area, containing many large and fine veins of No. 1 fibre, quite equal to any that had been found in the Thetford district. This discovery has added a new value to all these lower areas adjacent to the railway on the south. New
discoveries.
Mr. A.
Johnston.

The new area of Messrs Kerr and Slade, now the American Asbestus Co., on lot 32 adjoining lot 31 of Johnston, was discovered accidentally by removing the drift in an excavation, by which several large veins of No. 1 quality were exposed. This new pit is close to the road, leading from Black Lake station to Thetford and about a fourth of a mile from the former place. The present condition of this new pit promises to give good results when it is further developed. The American
Asbestus Co.
(Kerr and
Slade).

The remaining portion of the area between this last property and that of the Beaver Co. near Thetford, which is on the north-east corner of lot 32, range C, Coleraine, has not yet been prospected, with the exception of a small amount of exploratory work in a couple of shallow pits on lot 32 range A, known as the Hayden property. The rock here is a somewhat slaty serpentine of good character but not, where opened, as massive as that of the Thetford areas. A good showing of veins was found and the fibre is of good quality as far as could be ascertained. Ground
between
Thetford and
Black lake.

Dr. James
Reed's areas.

On lots 27, 28 and 29, range A, owned by Dr. James Reed, considerable development has been done within the last ten years. A number of openings or prospects have been made on the face of the serpentine ridge which extends east to a large mass of white and sometimes red granite that forms a conspicuous feature, especially on lot 27. Mining has been carried on to some extent on this lot near the Poudrier road, and some hundreds of tons of good asbestos-bearing rock have been taken out, which carry a number of veins of good size and quality of fibre. Veins with a length of from half an inch to one inch and a half were quite numerous in the upper part of the pit, but in the bottom of the excavation which had a depth of some 30 feet, a number of larger veins, reaching in places a thickness of two and a half inches, of good No. 1 fibre were observed; much of which equals in character that from the best mines of Thetford and Black lake. A considerable amount of crude Nos. 1 and 2 have been cobbled out. There are a number of dykes and masses of white granite in the vicinity, and the quality of the fibre evidently improves as lower workings are reached.

Mining plant.

To the north of this, approaching the main granite mass, a number of shallower openings show the presence of thinner veins at the surface. A good, but small mining plant has been erected at this place.

On lot 29, mining is now in progress with a limited force in a pit located in the angle formed by the government road to Thetford and the Poudrier road. The fibre near the surface at this place is not of such good quality, but the veins are numerous and some thousands of tons have been extracted, but not cobbled. A large proportion of this output will make good milling stock. In this connection it may be mentioned that the greater part of the output from the old Black Lake mines is now run through the mill without preliminary cobbing. With the exception of the pits referred to, on this property, but little exploratory work has been done beyond mere surface tests on the slope toward the granite of the higher levels. The greater portion of the areas, being lower and drift-covered, has not yet been tested.

Serpentinized
gabbro ridge.

The ridge of serpentinized gabbro, already alluded to as occurring on the line of railway north of Black Lake station, crosses the railway on lot 26, range VII of Ireland, and extends across the eastern half of lot 32, range B, Coleraine. This rock, while largely serpentinized, cannot be classed as a true serpentine and in portions of the ridge the several phases of the alteration are well displayed. It will be readily seen that in the light of the new discoveries of asbestos, in the areas lying in close proximity to the railway, careful prospecting in this direc-

tion is desirable. Local conditions may, however, favour the occurrence of rich veins at certain points rather than throughout the entire field, but this is a matter for future determination. It has, however, been conclusively proven that the rich ground is not entirely confined to the areas included in the workings of twenty years ago.

East of King Bros. mine in Thetford, the limit of the serpentine ridge has not yet been traced, owing largely to drift deposits and forest growth. By means of test-pits, it has been shown that the serpentine extends in this direction for some distance and that it contains asbestos similar to that found in the pits now worked, and there is apparently no reason why the area of rich ground should not be largely increased in this direction. To the south of the present line of pits, little in the way of prospecting has been attempted and the actual conditions, owing to the drift covering, are not as yet fully known.

On range A, lot 26, Coleraine, some work has also been done and several large pits have been opened. Work has been suspended for some time and the largest of these are now partly filled with water. Indications of veins are quite numerous, but the rock, as a whole, appears to belong to the harder and dryer variety of serpentine, indicating an approach to the comparatively barren belt further to the south-east. A number of short-fibre veins occur in this area, but as a whole, the output must be regarded as milling stock. On the adjacent area, lot 25, but little work of an exploratory kind has been done and the rock here also appears to be largely of the harder variety.

THE EAST BROUGHTON MINES.

The areas at East Broughton are about 20 miles north-east of those at Thetford. They are small in extent, consisting of two local outcrops of the serpentine situated to the west of the Quebec Central railway, and owing to their limited size are somewhat more highly affected by the alterations which are visible in all the associated rocks of the district, the serpentine being distinctly slaty or schistose.

Three mines are located at this place, known as the old Broughton mine, on lot 14, range VII; the Quebec Asbestos Co. mine on lot 13, same range, and the Broughton Asbestos Co. mine on lot 14, range VIII, near the line of range VII. Work on the first named has been stopped for some time; the others are new areas.

In the old Broughton property (Fraser mine) which was described in the Report for 1888-89, a large amount of work was done some years ago. The serpentine has the slaty structure already mentioned.

The asbestos occurs in small veins on the west portion of the outcrop, but the mining has been, for the most part, confined to a peculiar vein which was developed on the south-east margin of the serpentine close to the contact with the overlying schistose slates. These have a south-east dip at an angle of 65 degrees.

The hanging wall of the vein at this place consists of a soft talcose rock or fine soapstone from 12 to 14 inches thick, and the asbestos vein followed down conformably with the bedding of the overlying rock, reaches a thickness, in places, of 10 to 12 inches. The quality of the fibre was excellent, but the vein was irregular, sometimes splitting up into fine strings disseminated through the serpentine, and at other places uniting to form a good continuous fibre for a considerable distance. It has been worked downward by shafts with drifts for about 100 feet. Portions of the shorter fibred veins appear to be somewhat stiff and harsh in texture. Where the vein attained a large size the fibre was beautifully soft and silky.

The Quebec
Asbestos Co.

At the mine of the Quebec Asbestos Co., on lot 13, range VII, the breadth of the serpentine mass is not more than 150 feet. It is enclosed between greyish schistose altered slates of supposed Cambrian age, in which numerous small gashy veins of white quartz lie along the schist planes. The veins of asbestos are often crushed out along the lines of schistose structure in the serpentine, many of them being short and occurring in the form of sheety partings. Some of the larger veins have a width of two inches or sometimes more, and though somewhat crushed still maintain their fibrous character, so that a certain amount of good No. 1 fibre can be hand-cobbed. The rock, as a whole, is much softer than that of the larger masses at Thetford and the yield of large-sized veins proportionately less. Of the whole output of rock and fibre, it is estimated by Mr. J. Penhale, the manager, that as much as 7 to 7½ per cent can be obtained as fibre from the milling. This is made into three grades, with possibly a fourth saved as a by-product and containing very short fibre, not comparable with the other grades. Great sheets of a ligniform serpentine or asbestos, resembling picrolite, traverse the serpentine, probably along lines of fault. The dip of the cleavage in the serpentine is to the south-east, conforming with that of the cleaved slates.

Broughton
Asbestos Co.

At the Broughton Asbestos mine, which is situated to the south-west of the old Broughton mine and on the extension of the same serpentine area, somewhat similar conditions are seen. The area is larger and the shearing of the rock has not become quite so marked. The enclosing rocks are the usual altered slates and schists of the district with quartz veins.

In the pit, veins of asbestos of large size, sometimes reaching a thickness of from two to three inches, are seen with many of smaller size, so that a good percentage of it can be taken out as Nos. 1 and 2 crude, but a very large proportion of the mine-output goes through the mill, as elsewhere. The mine is well equipped in this direction. The serpentine here also shows many crushed veins along the planes of schistosity. Some of the veins are a clear green; others an amber colour, while near the centre of the pit is a mass of inky-black serpentine, through which are numerous veins of chrysotile of good size and quality, which are also black when freshly mined. A peculiarity of this black mineral, both of the rock and the veins, is that by exposure to the light for a few days the black colour entirely disappears and the rock assumes its usual green tint.

Black
serpentine
and asbestos.

Great bands of the coarse woody-fibred picrolite occur around the sides of the pit, and in one place there is a strong vein of a dark, soft clayey material, probably a decomposed serpentine, with a thickness of from four to six inches, which, after removal, becomes quite hard. Many of the larger veins have the usual partings of chromic iron, and in some of them the mass of the vein is largely composed of this mineral with fibres of the asbestos disseminated.

Picrolite.

The outcrops on the Chaudière river at the Bras du Sud-Ouest, present somewhat different features from those already described. The rock is in places largely a serpentine-breccia, being only partially serpentinized as an alteration apparently from a pyroxenic mass. Occasionally, where the serpentine is better displayed, small veins of impure asbestos are seen, but these are of no economic importance, in so far as developed. The associated rocks are black rusty slates with bands of hard grits and slate conglomerate; and diorite and granite are found in the immediate vicinity.

Outcrops on
the Chaudière
river.

On the DesPlantes river, which is on the north side of the Chaudière, the black and grey altered slates and quartzites are in contact with a dark green slaty serpentine, which is cut by dykes of whitish granite. Some small veins of impure asbestos are seen in this rock, but in so far as could be determined, the deposits are of little value. Both these areas are small in extent and the rock is affected by strong slaty cleavage like that of the Broughton areas.

In the area west of the Quebec Central railway and north east of Thetford mines, several outcrops of serpentine were examined. Among these may be mentioned lots 16, 17 and 18, range IV, Thetford township, where several knolls are found which carry both chromic iron and asbestos, the latter apparently in small quantities. On lot 13,

Areas north
of the Quebec
Central rail-
way.

range V, Broughton, near Robertson station, occurrences of serpentine have been noted, and on the road out to Harvey hill from Broughton station both serpentine and soapstone are seen at several points. Near Kinnears Mills also, in the township of Leeds, several outcrops are found, but these have not yet shown much indications of asbestos, although chromic iron occurs; and in the concession of Ste. Catherine on the road east from St. Sylvester, a mass of the rock was mined some years ago, but nothing of importance was found.

Areas south
of railway.

East of the railway in Thetford township, serpentine is seen on lots 10 and 11, range VII; on lots 14, 15 and 16, range VIII; on lots 14 and 15, range IX; and on lots 5, 7, 9 and 10, range X. The rock at all these places appears to belong rather to the unproductive variety. In Adstock, serpentine is found in several places in that portion adjoining Thetford, but the rock at these points also appears to lack asbestos veins in profitable quantity. The same remark applies to the serpentine in the vicinity of Little Lake St. Francis, though workable deposits of chromic iron are found in this area at a number of points.

THE MINES IN IRELAND AND WOLFESTOWN TOWNSHIPS.

Mines in
Coleraine.

To the west of the railway between Coleraine station and Black lake there is a conspicuous ridge of serpentine, which forms a rugged and well-marked feature in the landscape. The rock is, for the most part, a hard dry siliceous variety, but at several points it has disclosed the presence of asbestos veins, and attempts to mine these have been made by several companies. In the township of Coleraine, on the south-east flank of this great ridge several openings were made in 1886 by the Megantic Mining Company and operations have been carried on at intervals for some years. At this place several large veins were disclosed, but these were not persistent, the greater portion of the mineral being confined to zones of small veins which interlaced the rock and which could only be extracted by crushing the matrix in mills, as they were too small for hand-cobbing. On the extreme north-west side of the ridge on lots 24 and 25, range III, of Ireland, another series of these veins was opened up by King Bros. of Thetford. The rock here presents a roughly bedded appearance with a dip to the north-west of 35 to 40 degrees, in which the fibre was also found in zones, the veins ranging from a quarter of an inch to one inch in thickness, and occurring throughout a working face of six to eight feet. Occasionally even larger veins are found, but the rock between the zones is of the hard unproductive variety, and the output is chiefly of value as milling stock. During the working,

Ireland
township.

King Bros.
mines.

small amounts of crude Nos. 1 and 2 were taken out, and an output amounting to some 500 tons was extracted and hauled a distance of five miles to Coleraine station. The great bulk of the ridge between this area and the shores of Black lake is apparently of the unproductive variety, but on lot 26, range III, there is a knoll of serpentine, on the surface of which there is a showing of veins intersecting the rock, but generally of short character, in which the fibres range up to a length of one inch. Around the sides of Silver mountain, which is the prominent peak west of the lake, small veins are also disclosed, but the district, as a whole, does not appear to be very promising and no mining has yet been attempted. Chromic iron of high grade, is found at several points in this area, but the deposits have not yet been proved as to their actual extent.

Country north
of Black lake.

In the township of Wolfestown, on lots 23 and 24, range II, are located the old Belmina mines. These were worked to some extent in 1886, and a number of veins were disclosed, some of which promised fair returns. The rock is generally of the hard variety, and chromic iron in the shape of pockets occurs, but the grade is rather low, in so far as examined. These mines have been described in the Report for 1886. Furthur to the south-west, around the shores of Breeches lake in Garthby and on Lake Nicolet in Ham township, serpentine is also found. At the former locality, asbestos seems to be practically absent, but at the latter place veins are met with, and a considerable amount of the variety of asbestos known as picrolite occurs. No mining of any consequence has been attempted at these localities.

Belmina
mines.

Ham and
Garthby.

In the south-west portion of the serpentine belt, practically the only mines worked are situated at the north end of Brompton lake. The serpentine of this district is associated with masses of diabase and granite, and differs in character from the purer serpentines of the Thetford and Black Lake area. As a rule, it is harder and darker-coloured, but in places it becomes talcose in aspect. Some of the contained veins are soft and without a true fibrous character; others are harsh, stiff and lack elasticity. The rock often weathers a tawny yellow, like that which elsewhere carries chromic iron. A considerable amount of development has been done at the Brompton mine, but at present the work has been discontinued. The area has never been a producer to any large extent.

Areas near
Broughton
lake.

The small openings in the serpentine outcrops west of Memphremagog lake have never yielded merchantable asbestos. The rock is sometimes soft and talcose, often slaty, and the fibre occurs in small and gashy veins of but little value. This area contains much eruptive rock, in

Areas west of
Memphrema-
gog lake.

the form of diabase with some granite, and large areas of siliceous magnesite and dolomite. The general indications are unfavourable to the presence of asbestos in workable quantities in this southern district.

The Danville
area.

The mine near Danville occurs in a detached mass of good serpentine of small size. It was opened in 1885-86 and at first showed a number of good-sized veins of fine quality, from which a large percentage of Nos. 1 and 2 crude was obtained. The area is much affected by faults and the large veins were apparently cut off to some extent. At present the output is confined principally to milling stock, but the general character of the rock is excellent, small veins, up to half an inch and over being abundant, while much of the rock-mass contains a great deal of disseminated short fibre asbestos which is easily separated in the milling process. A small amount of good No. 1 crude is still taken out and about 10 per cent of No. 2 by hand-cobbing. The manager, Mr. Pearson, says about 75 to 80 per cent of the rock quarried now goes through the mill, producing an excellent quality of fibre which is separated into three grades as elsewhere. In the last two years 10,000 tons of this fibre have been produced. As a milling proposition, this mine is one of the best in the serpentine areas. The asbestic, of which a certain amount is produced, as a fourth grade, is merely a by-product for which a good market is readily obtained at remunerative prices. The mill is well equipped with a complete milling plant, and the mine is connected by a branch railway four miles in length with the Grand Trunk line at Danville station. The main pit has now reached a depth of about 150 feet and is furnished with a cable-derrick. Dykes of the white granite traverse the sides of the pit and the veins are numerous in all directions, though generally of small size.

GENERAL CONDITIONS OF THE INDUSTRY.

Present
condition of
mining plant.

Within the last twelve years the general aspect of the mining towns of Black Lake and Thetford has greatly changed. At all the mines which are still carried on by the system of open quarry work, cable-derricks, steam trams and an elaborate system of milling plant for the separation of fibre have been installed, so that the lower grades of rock which formerly were partly treated by hand-cobbing and produced in this way a certain amount of No. 3 grade fibre, are readily and economically handled. The grades Nos. 1 and 2 are still extracted by hand-cobbing, as crude. The villages are supplied with good water, brought in by gravity from lakes several miles distant; streets are well laid out and electric lighting has been installed.

The milling process is largely automatic throughout. After the rock suitable for hand cobbing is extracted, the bulk of the output is run to the mill by steam trams, and the rough material passes at once to a Blake crusher, generally of two dimensions, where it is sized for the rolls. In the King Bros' mills these are corrugated, and the rock from the crusher goes directly through the rolls, from which it passes to a series of cyclones that reduce the rock to powder and separate the contained fibre. Exhausts are provided by which the greater part of this is removed and the material from the cyclone passes on to a set of shaking screens of different sized mesh by which the fiberized material is separated ready for bagging. Boys are stationed at points to regulate the supply of the material along the conveying belts. The bottom of the mine holds a considerable amount of broken fibre, generally wet and dirty and this before going through the mill is put through a drying cylinder set at an angle of about 5 degrees and revolving slowly, by which the moisture is readily extracted. At present the motive power in all the mills is steam.

The milling process.

While the general principle in all these mills is practically the same, scarcely two are built on precisely the same plan. In some, the rolls are discarded, and other points of difference are seen depending upon the conditions at different mines. The extraction of the fibre is successfully accomplished at all the mines, and a large amount of the rock output which formerly would have gone to the dump as waste material is now profitably utilized. At the present time, at Black Lake, with the exception of Mr. Johnston's new mine, and that of the American Asbestos Co., which is still in the development stage, the greater portion of the output in this district is sent to the mill and the production of crude asbestos which at one time formed an important part of the output at this place has in consequence largely fallen off.

PRODUCTION.

The production of asbestos has steadily increased since the commencement of the industry in the province of Quebec. Thus, from an output in 1880 of 380 tons, valued at \$24,700 it reached in 1901, a total, including asbestic, of 40,217 tons, worth \$1,259,759.

Production of asbestos.

In 1896 the manufacture of asbestic was commenced. This is largely a finely ground serpentine in which there is a small amount of very fine fibre disseminated, and the resulting product is specially adapted for fine plaster for walls and interior decoration. It is usually made as a by-product from the residue after separating the fibre in the

Asbestic.

milling process. Its value per ton is low, but as its preparation involves but little extra expense it is claimed that a profit results from its manufacture. In several of the large mines this branch of the industry is practically neglected.

At a number of the mines, notably in the Black Lake areas and at Danville, as already remarked, the greater portion of the mine output is sent direct to the mills and at present is converted into mill fibre. This is separated into three grades, known usually as Nos. 1, 2 and 3. At the Union Asbestos Cos' mine a special higher grade is also made as the result of running a quantity of extra length crude through the mill. This commands a much higher price than the ordinary No. 1 grade of mill fibre, almost equalling in value the lower grade of No. 2 crude. Of the higher grades of the mill fibre a certain amount can be extracted and used for spinning after mixing with the longer fibre of the crude.

Prices of output.

As to prices, it may be stated generally that the market value of crude No. 1 ranges from \$150.00 to \$200.00 per ton; of No. 2 crude from \$75.00 to \$125.00; and of the milling fibre from \$40.00 for No. 1 to \$20.00 for No. 3. The price of asbestic varies somewhat but may be stated to range from \$1.00 to \$1.50 per ton.

The full returns of output and values will be found in the official report of the Section of Mines, 1901.

Production of asbestos.

PRODUCTION OF ASBESTUS IN CANADA, 1880-1895.

Calendar Year.	Tons (2,000 lbs.)	Value.	Average value per ton.
		\$	\$ cts.
1880.....	380	24,700	65 00
1881.....	540	35,100	65 00
1882.....	610	52,650	65 00
1883.....	955	68,750	71 98
1884.....	1,141	75,097	65 80
1885.....	2,440	142,441	58 37
1886.....	3,458	206,251	59 64
1887.....	4,619	226,376	49 14
1888.....	4,404	255,997	57 90
1889.....	6,113	426,554	69 77
1890.....	9,090	1,260,240	127 81
1891.....	9,279	999,878	107 75
1892.....	6,062	390,462	64 19
1893.....	6,331	310,156	49 02
1894.....	7,630	420,825	55 15
1895.....	8,756	368,175	42 05

PRODUCTION OF ASBESTUS AND ASBESTIC IN CANADA, 1896-1902.

Production of asbestos and asbestic.

Calendar Year.	Tons (2,000 lbs.)	Value.	Average value per ton.
1896. Asbestos ..	10,892	\$ 423,066	\$ 38.84
Asbestic...	1,358	6,790	5.00
	12,250	429,856	35.09
1897. Asbestos ..	13,202	399,528	30.26
Asbestic. ..	17,240	45,840	2.66
	30,442	445,368	14.63
1898. Asbestos ..	16,124	475,131	29.46
Asbestic. ...	7,661	16,066	2.10
	23,785	491,197	20.65
1899. Asbestos ..	17,790	468,635	26.34
Asbestic. ...	7,746	17,214	2.22
	25,536	485,849	19.03
1900. Asbestos ..	21,621	729,886	33.76
Asbestic. ...	7,520	18,545	2.46
	29,141	748,431	25.68
1901. Asbestos ..	32,892	1,248,645	37.96
Asbestic. ...	7,325	11,114	1.52
	40,217	1,259,759	31.32
1902. Asbestos ..	30,219	1,126,688	37.28
Asbestic. ...	10,197	21,631	2.12
	40,416	1,148,319	28.41

COMPANIES ENGAGED IN MINING ASBESTUS.

(In the Province of Quebec.)

Locality and Name.	Manager.	Post office.
<i>Thetford</i> —		
King Bros.,.....	B. Bennett,	Thetford Mines.
Bell Asbestos Co.,.....	G. R. Smith,	"
Johnston Co.,.....	A. Johnston,	"
Beaver Co.,.....	C. H. VanNostrand, ..	"
<i>East Broughton</i> —		
Quebec Asbestos Co.,	J. J. Penhale,	East Brompton.
Broughton Asbestos Co.,.....	H. H. Williams,	"

Black Lake—

Standard Asbestos Co.,	R. A. Hopper,	Black Lake.
Union Asbestos Co.,	T. H. Crabtree,	"
Johnston Co.,	A. Johnston,	"
American Asbestos Co.,	W. R. Kerr,	"
Reed Asbestos Co.,	Dr. James Reed,	"
Manhattan Asbestos Co.,	B. C. Green,	"

Coleraine—

Megantic Mining Co.,	D. Anderson,	Coleraine Station.
Lambley & Co.,		"

Danville—

Asbestos and Asbestic Co.,	James R. Pearson,	Danville.
----------------------------	-------------------	-----------

Brompton Lake—

Brompton Lake mine,	E. B. Greenshields,	Montreal.
---------------------	---------------------	-----------

Denholm Township—

Ottawa Asbestos Co.,		514 Sussex street Ottawa.
----------------------	--	------------------------------

(In the Province of Ontario.)

International Asbestos Co.,	A. C. Seward,	Tweed.
Joseph James Co.,	Joseph James,	Actinolite.