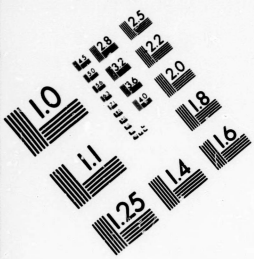

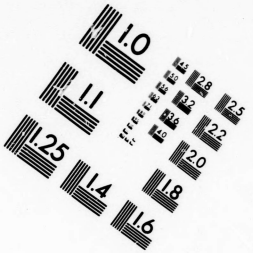

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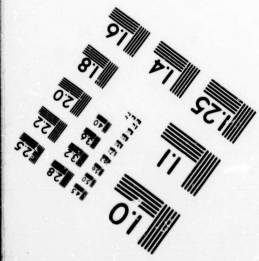

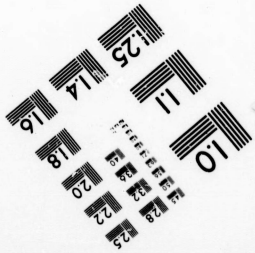

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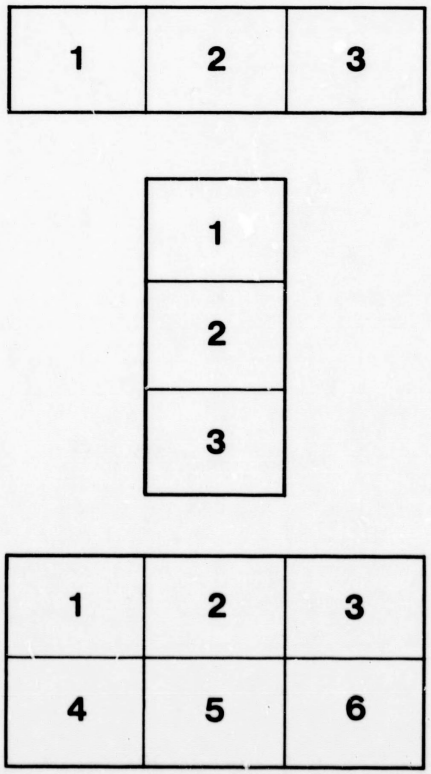


INTERIOR VIEW OF GYPSUM QUARRY, HILLSBOROUGH, ALBERT COUNTY, N.B.

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

THE

MINERAL RESOURCES

OF THE

PROVINCE OF NEW BRUNSWICK

BY

L. W. BAILEY, PH.D., LL.D., F.R.S.C.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY
1898

No. 661.

INTERIOR VIEW OF GYPSUM QUARRY, HILLSBOROUGH, ALBERT COUNTY, N.B.

To

DR. GEO. M. DAWSON, C.M.G., F.R.S.,

Director Geological Survey of Canada.

SIR,—I have the honour to submit the following Report upon the Mineral Resources of New Brunswick, made in compliance with your instructions received May 26th. 1897.

ERRATA—PART M.

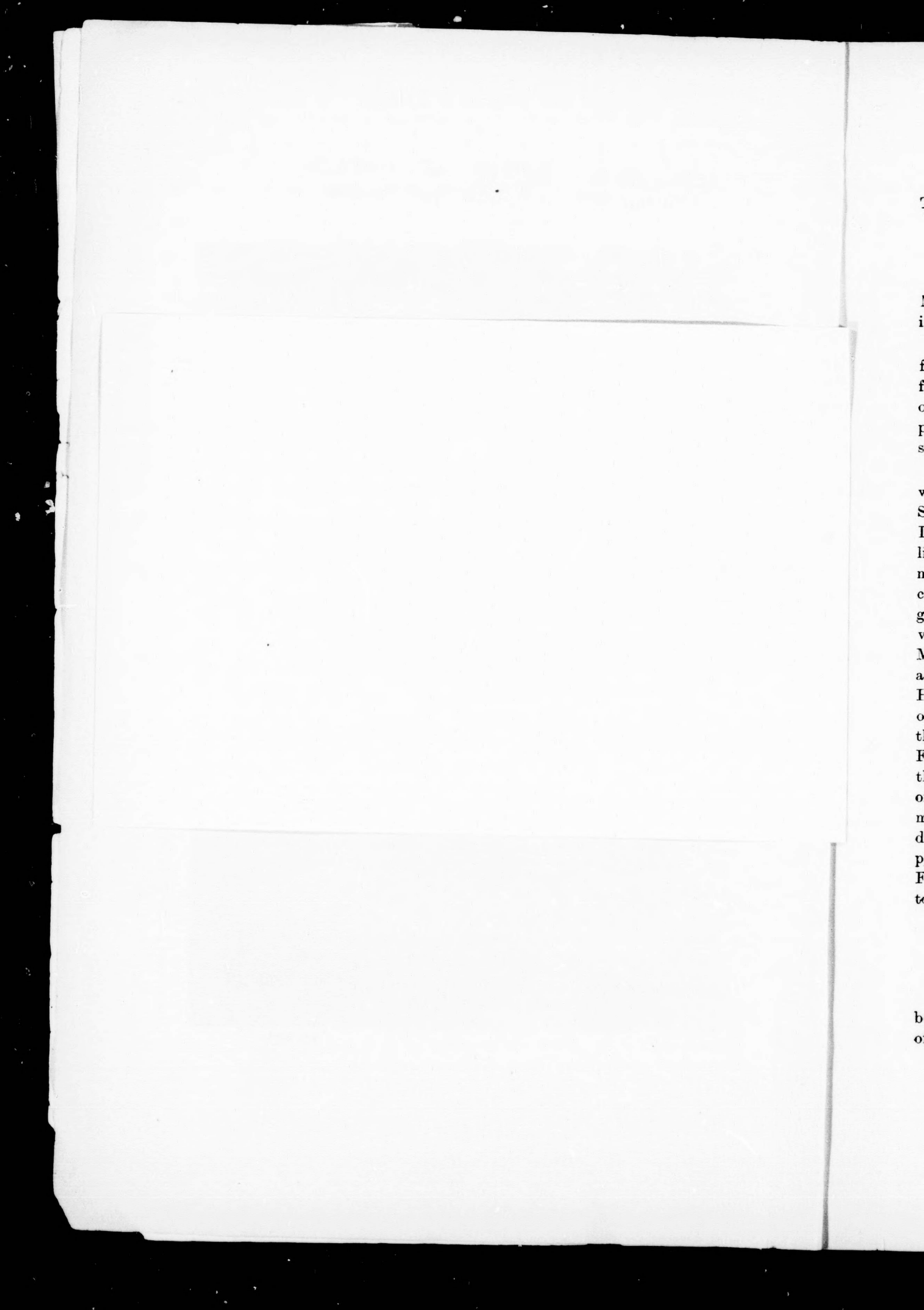
Page 13, line 23—"north-east" read "north-west."
" 14, " 17—"were" read "the furnace was."
" 17, " 29—"south" read "east."
" 19, " 14—"Borestown" read "Boiestown."
" 27, " 27—"showing" read "showed."
" 28, " 32—"east" read "north."
" 55, " 5—"north-east" read "west."
" 115, " 12—"Tattagouche" read "Tête à Gauche."

pyrrhotite deposits of St. Stephen, Charlotte county; and to Prof. W. F. Ganong, of Smith College, Northampton, Mass., for facts relating to peat-bogs and siliceous deposits in different parts of the province.

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

March, 1898. L. W. BAILEY.

NOTE.—Some further data, obtained during the summer of 1898, have been added by Professor Bailey to his Report as presented in March of that year.



To

DR. GEO. M. DAWSON, C.M.G., F.R.S.,

Director Geological Survey of Canada.

SIR,—I have the honour to submit the following Report upon the Mineral Resources of New Brunswick, made in compliance with your instructions received May 26th, 1897.

The data upon which the report is based have been derived in part from the published reports of members of the Survey staff and others, from information furnished by persons engaged or interested in mining operations, and finally from observations made by myself during the past season with a view to obtain the latest facts bearing upon the subjects discussed.

I would desire here to return my thanks to the many persons by whom aid has been rendered, more particularly to Hon. A. T. Dunn, Surveyor General of New Brunswick, and the officials of the Crown Lands and Mining Departments at Fredericton, for lists of mining licenses issued, and other information; to C. J. Osman, Esq., M.P.P., manager of the Albert Manufacturing Co., for an historical and descriptive sketch of the extensive operations in the manufacture of gypsum at Hillsborough, Albert county; to Major Alfred Markham, for valuable information relative to the mining of manganese; to Messrs. Milne, Coutts & Co., St. George, for information relative to the growth and conditions of the red granite industry; to Mr. R. P. Hoyt, of Hillsborough, for particulars of the deposits of bog-manganese recently opened at Dawson Settlement, Albert county, and the conversion of this material into briquettes for use in steel manufacture; to Mr. C. E. Fish, of Newcastle, Northumberland county, for data regarding the manufacture of building-stone, grindstones, etc.; to Robt. McMahon, of Grand Lake, for information respecting the working of the coal mines of Queens county; to Mr. Charles Boardman, of Calais, Maine, for data and other assistance in connection with the nickeliferous pyrrhotite deposits of St. Stephen, Charlotte county; and to Prof. W. F. Ganong, of Smith College, Northampton, Mass., for facts relating to peat-bogs and siliceous deposits in different parts of the province.

I have the honour to be, Sir,

Your obedient servant,

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NOTE.—Some further data, obtained during the summer of 1898, have been added by Professor Bailey to his Report as presented in March of that year.

NOTE.—*Unless otherwise stated, the bearings in this report are all referred to the true meridian.*

THE

MINERAL RESOURCES OF THE PROVINCE OF NEW BRUNSWICK.

Introduction.

New Brunswick as a mineral producer.

If the past history of mineral production in New Brunswick be alone considered, this province certainly can not be claimed with truth to be a country of great mineral wealth. Indeed, if we except building stones and other materials applicable to construction, such as gypsum, limestone, brick-clays, etc., there are but four substances that, in the whole history of the province, have been the basis of anything like extended or successful mining operations, viz., coal, iron, manganese and albertite, and of these one only, namely, coal, is at the present time actually being worked.

Is the conclusion, then, to be drawn that New Brunswick is without useful minerals, or that, its limited supply being already exhausted, there is no reason to hope for anything further in this direction in the future?

The importance of the subject.

The question would under any circumstances be an important one, but is specially so in view of the fact that, while the products of the forest, upon which the province in its earlier history depended so largely for support, are rapidly becoming reduced in quantity and value, the tracts which are being deforested are to a large extent unsuited for agriculture, and hence, unless something can be found beneath the surface to replace the deficiency, the revenues of the province must suffer considerably.

Favourable facts.

In endeavouring to answer the question proposed, everything which either directly or indirectly bears upon it, is deserving of consideration; and viewed thus comprehensively, a number of facts are brought to light which go far to give a much more favourable view of the situation than would at first seem possible. Among these the following are the most important:—

Variety of minerals found.

1. The variety of useful products actually observed in New Brunswick.—These include:—among metallic ores; iron, in the forms of

hæmatite, limonite and magnetite, besides pyrite and pyrrhotite; manganese, as pyrolusite, mangantite and wad; copper, as native copper, and various sulphides; lead, as galena, usually with a small percentage of silver; zinc, as blende; antimony, as native antimony and stibnite; nickel sulphide, in pyrrhotite and serpentine; bismuth as a sulphide; and gold. To these must be added, among substances affording combustible products, bituminous coal, anthracite, bituminous shale, cannelite, albertite, petroleum and peat; among materials for construction, granite (gray, black and red) freestone, slate, limestone and marble, gypsum, clays and sands; besides graphite, salt, infusorial earth, silica, fire-clay, mineral water, etc. It is true that many of these substances, especially in the case of metallic ores, are not known to occur in other than small amounts; but the fact of their occurrence at all is important, in rendering it at least possible that any one of the substances enumerated may hereafter be found in profitable quantities.

Variety of geological formations.

2. The number and character of the geological formations represented in the province.—These include all the subdivisions of the geological scale, from the earliest Archæan to the Trias; while those formations, such as the Laurentian, Huronian and Cambrian, which elsewhere are usually most productive of metallic ores, and the Carboniferous formation yielding coal and related products, are among those which occupy the largest areas. As regards the former, it is also important to notice that the beds representing them have very generally been subjected to profound disturbance with its accompanying metamorphism; or, in other words, to the conditions most favourable to the occurrence in them of useful minerals and ore-bodies. The general resemblance and probable equivalency of some of the most important of these groups of strata to those of the bordering provinces of Quebec and Nova Scotia, as well as the state of Maine, all of which have proved more or less productive, is not without significance in the same direction.

Disturbances.

Distribution.

3. The distribution of useful products.—The occurrence of many of the mineral products above enumerated, not at one or two points only, but over large areas, is worthy of notice. Thus the iron ores of Woodstock extend through the greater part of Carleton county; copper ores characterize the Archæan rocks of the southern coast along the whole length of the Bay of Fundy; bituminous shales, with more or less of albertite, extend from Apohaqui, Kings county, almost to Dorchester, Westmorland county; the coal of the Newcastle basin, Queens county, though thin, covers an area of about 100 square miles, and outcrops, which may represent the same seam, are found over almost all parts of

the Carboniferous area, or a tract equal to one-third the entire superficies of the province; manganese is found at not less than six widely separated points, and antimony in at least two localities quite remote from each other.

Concealment by forests.

4. The possible concealment of economic minerals by soil and forests, together with the absence of systematic prospecting.—While the facts above enumerated are, as stated, distinctly favourable to the existence within the province of useful minerals, the circumstances here alluded to go far to explain why such possible existence has not, except in a few cases, been definitely confirmed or disproved. It is only necessary to examine a good map of the province to see that large portions of its extent, including just those districts whose geological age and character would point them out as most likely to be productive of useful minerals, are still covered with unbroken forest, and hence are rarely visited except by those whose training and occupations would be little likely to make them close observers in this direction. These tracts have, indeed, been traversed by the members of the Geological Survey staff in various directions, and attention has been continually given by these gentlemen to the possible occurrence of useful products along such lines of traverse; but the main work of the explorers has been the determination of the age and character of the formations represented and the delimitation of their boundaries, rather than that of systematic prospecting, for which they have only paved the way. It is still true that very little of such prospecting has been done, and in its absence it would be wrong to assume too hastily that nothing worthy of discovery exists because so little has yet been found. The probabilities point strongly to an opposite conclusion, and one of the main objects of this report will be to suggest methods and directions through which, it is hoped, the present uncertainty may be removed, and the province may attain, to a much greater extent than at present, the position of a mineral producing country.

Absence of systematic prospecting.

Subdivision of report.

The considerations above given afford a basis for the method of treatment adopted in the Report. A short account will first be given of the general geological structure of the province, and of the areas likely to be productive respectively of metallic ores, of carbonaceous materials, of granites, of freestones, of limestone, salt and gypsum. In a second division of the Report, full details will be given of the extent and mode of occurrence of all useful products so far observed, with particulars as to the history, development and output of all such as have been or are now being profitably worked; and in a third division some suggestions will be made, which, it is hoped, may help to

awaken new interest in the subject on the part both of the government and the people of the province, and possibly lead to results of which the outcome cannot now be anticipated.

Economic Geology of New Brunswick.

The following is a summary of the geological formations represented in New Brunswick, with a brief statement of their distinctive features, their distribution and the minerals which they afford :*—

Laurentian system.

1. Laurentian.—The rocks referred to in this system are, so far as known, confined to the area of the southern counties, where they form a belt of land intersected by the St. John River between Fairville and the Kings county line, stretching thence westward to Musquash Harbour and Lepreaux, and eastwardly along the southern side of the Kennebecasis River, and near the line of the Intercolonial Railway, to and a little beyond the mouth of the Hammond River.

Rocks.

The rocks included under this system are all highly crystalline, the lower portion, of unknown thickness, consisting chiefly of coarse gneiss and granite, while the upper, estimated as having a thickness of over 1000 feet, exhibits a succession of quartzites, slates, limestones and dolomites. These beds are greatly folded and faulted.

Economic products.

The economic products afforded by the Laurentian rocks include granite, limestone (extensively quarried and calcined), graphite and magnetite. Serpentine occurs, and in places carries small veins of asbestus. There are also veins of argentiferous galena, apparently small, but which have not yet been fully proven.

Huronian.

2. Huronian.—The rocks distinctly referable to this system are also confined to southern New Brunswick, where they occupy extensive areas in the counties of St. John, Kings, Queens, Albert and Charlotte. With the exception, indeed, of the small Laurentian tract already noticed, and belts of intrusive granite such as constitute the axis of the Nerepis Hills, all the prominent ridges of the counties named are

Distribution.

composed of Huronian rocks. In the northern part of the province, about the head-waters of the Tobique, Miramichi and Nipisiguit rivers, are other considerable areas which are almost certainly Archæan, and probably Huronian, but of which the age has not yet been indisputably fixed.

*New Brunswick has been geologically mapped on a scale of four miles to one inch. The areas covered by the respective sheets is shown on the index map accompanying this Report. The surface geology and extent of forest are shown on a second series of sheets, of which ten have already been issued. These are also indicated on the index map. The price of the above map-sheets is ten cents each.

Character.

The Huronian rocks of the southern counties consist very largely of volcanic materials, in the form of amygdaloid, felsite, ash-rocks and breccias, variously mingled with aqueous sediments such as conglomerates, sandstones, slates and some limestones, all metamorphic, and all showing evidence of profound disturbance. The thickness of the formation is very variable, but at its maximum cannot fall far short of 10,000 feet. In the northern counties, the lithological aspects are somewhat similar, but the strata embrace a larger proportion of schists and felsites, with less of the more obviously volcanic materials.

Minerals.

The rocks of the Huronian system, are here, as elsewhere, very generally characterized by the presence of useful minerals. Veins of magnetic iron are a common feature in certain members of the system, while in others are found considerable deposits of specular ore, hæmatite and siderite. The nickel-bearing pyrrhotites of St. Stephen are in rocks which are probably of this age. To the same system also belong the numerous veins of copper ore found at various points along the north shore of the Bay of Fundy as well as in the interior, the Huronian being in fact the copper-bearing series of New Brunswick, recalling in this, as in many other respects, the copper-bearing rocks of the "Eastern Townships" of Quebec.

3. Cambrian and Cambro-Silurian.—For the purposes of this Report the rocks of these two systems may well be considered together, for although in southern New Brunswick the existence of both has been clearly shown upon the evidence of fossils, the areas known to be occupied by the Cambro-Silurian rocks are quite insignificant; while in the northern part of the province, though the districts referred to this latter system in the reports and maps of the Survey are large, distinctive fossils have been found at a few points only, and it is now thought probable, that the larger part of the region so referred is in reality Cambrian. In subsequent references therefore the latter term alone will be used.

Distribution in southern New Brunswick.

The Cambrian rocks of southern New Brunswick, occupy relatively but a small area, being confined essentially to three parallel troughs, of which the first crosses St. John harbour, and thence extends eastward by Coldbrook and Loch Lomond to the Hammond River in Upham, the second is represented in isolated patches in the valley of the Kennebecasis, and the third is confined to the valley of the Long Reach, chiefly along its northern side. The strata are mainly dark-coloured slates and sandstones, with some coarse red sediments beneath, but as far as known, contain no minerals or rocks of economic importance.

Distribution in northern New Brunswick.

The supposed Cambrian (possibly Cambro-Silurian) rocks of the northern counties, have a much wider distribution, being found in two principal belts which, upon either side of an extensive granitic axis, stretch completely across the province from the Maine frontier to the Gulf of St. Lawrence. The width of these belts, as fully indicated in the published maps of the Survey, is subject to considerable variation (ranging from three to twelve miles) but the nature of the strata is much more uniform, the rocks of the system consisting, as in the southern counties, mainly of slates and hard sandstones or quartzites which are very much alike wherever found, except that in approaching the granite they become more highly metamorphic, taking the character of fine gneisses and mica-schists, in this as in other respects bearing a very close resemblance to the rocks of the gold-bearing system of Nova Scotia, which are in like manner doubtfully referred to a Cambrian horizon.

From an economic point of view, the strata in question are among the most important to be found in the province. Long since compared by Sir Wm. Logan with the rocks of his Quebec group (now known to contain both Cambrian and Cambro-Silurian strata), they are, like that group, largely metalliferous, and constitute areas that, already to some extent productive, are those in which future developments of importance are chiefly to be looked for. In these rocks are included ores of iron, copper, manganese and lead, in Gloucester county; of copper in Carleton county, and of antimony in York county; while it is also in the area which they occupy that many of the reported discoveries of gold have been made. The rocks are throughout highly disturbed and in places abound in quartz veins, many of which contain mispickel or other metallic sulphides.

Economic minerals.

Silurian.—The rocks of this system have a wide distribution in New Brunswick, but are relatively unimportant from an economic standpoint.

Distribution in southern New Brunswick.

In the southern part of the province they are found skirting the borders of Passamaquoddy Bay and portions of the valley of the St. Croix River, whence they extend eastward in two main belts, one on either side of the Nerepis granite range, to the St. John River. The strata are chiefly slates and sandstones, largely associated with volcanic products, but with the exception of some rocks available for construction or for decorative purposes (slates and porphyries) afford few if any materials of a useful character.

Distribution in northern New Brunswick.

In northern New Brunswick the Silurian rocks are widely spread, covering most of the area included in the counties of Victoria, Mada-

waska and Restigouche, with portions of York and Gloucester, and determining a district of remarkable fertility and valuable forest growth. They are interesting economically chiefly as containing the iron ores of Carleton county. Small veins of galena are occasionally met with, as well as beds of limestone, and drift gold has been reported from localities within the district.

Devonian

Devonian.—The Devonian rocks are confined to small areas in St. John county, such as the Mispeck valley and Lepreau basin, and (probably) to a somewhat larger tract lying just south of the central coal-fields in Queens and Charlotte counties. The impure anthracites of Lepreau, together with slates and flags in the county last named, are the only mineral substances of interest.

Lower Carboniferous.—Though geologically but a subdivision of the Carboniferous system, the formation designated as Lower Carboniferous is in New Brunswick, as in Nova Scotia, strongly differentiated from the proper Carboniferous or Coal Measure rocks, by dissimilarity of character and origin, by difference of fossils, and by at least a partial unconformity. The contrast as regards economic minerals is equally marked and important.

Distribution.

In the southern counties, the Lower Carboniferous rocks, usually readily recognized as consisting of coarse red sediments, which are more or less calcareous and contain marine fossils, occupy large areas in Kings, Albert and Westmorland counties, with smaller areas in Charlotte. In central New Brunswick they are mostly concealed from view by overlying Coal Measures, but appear as a rim or margin to the latter around almost the entire extent of the large triangular tract which these Coal Measures cover, beside occasionally protruding through them. In northern New Brunswick they cover a considerable tract in the valley of the Tobique River, with smaller areas on the Beccaguimec River in Carleton county, and on the shores of Bay of Chaleurs.

Useful minerals.

The useful minerals of this formation are numerous and important, including bituminous shale, cannelite and albertite, with some petroleum, in Albert county; the extensive gypsum (plaster) deposits of the same county and of Kings, with associated bituminous limestone; the manganese deposits of Markhamville and Jordan mountain, (Kings county); Shepody Mountain, (Albert county), and Quaco, (St. John county); the salt and other mineral springs of Kings county; the gypsum deposits of the Tobique River in Victoria county.

Distribution.

Carboniferous.—The rocks of the Coal Measures cover nearly one-third of the entire area of the province, but owing to their generally

horizontal attitude have, with large surface extent, apparently but little thickness and but little coal. The principal tract is in the centre of the province, in the form of a triangle, of which the apex is at Oromocto Lake, and the base along the so-called "North Shore," between Bathurst and Cape Tormentine, there becoming continuous with the coal formation of Nova Scotia. Smaller areas occur in Kings, Albert and Westmorland counties, as well as along the shore of the Bay of Fundy in St. John county. In the last-named instances the beds are, as a rule, more highly disturbed, but still usually without evidence of much thickness or of workable coal-beds.

The subject of the occurrence of coal will be more fully considered later in this report.

Economic products.

Besides bituminous coal, the Carboniferous rocks afford valuable building materials, such as freestones of gray, purple and olive colours, also grindstones, stones for pulp-mills, fire-clays, etc.

Triassic.—The rocks of this age, in the form of soft, red, friable sandstones, as occurring on the mainland of New Brunswick, are confined to small tracts along the Bay of Fundy shore, chiefly in the vicinity of Quaco. They are without economic interest.

On the island of Grand Manan, the volcanic beds of the same system are largely displayed, and may in the future become useful for road-making; but, with the exception of nodules of native copper, too small and infrequent to admit of profitable removal, they contain no minerals of value.

Granite.

Granite.—Very large areas in New Brunswick are occupied by this rock. Two main belts may be distinguished, of which the more northerly and larger crosses the central part of the province from the St. Croix River, north of Vanceboro, to the Nipisiguit River, but with much irregularity in detail, while the second, or southern belt, also somewhat irregular in outline, forms the axis of the Nerepis Hills, and extends from the St. Croix River, below St. Stephen, to the St. John River, at Spoon Island. Smaller areas are met with in the Quaco Hills in eastern St. John and Albert counties.

These granites present much variety of colour and texture, the red granite of St. George being especially noteworthy. They do not carry ores of any kind.

Surface deposits.

Pleistocene.—Under this name are comprised the superficial deposits of sand, gravel and clay distributed over the preceding formations as the result of glacial, marine or sub-aerial action in post-Tertiary and recent times. In the same connection occur deposits of so-called infusorial

earth or "tripolite", deposits of silica, not of organic origin, and beds of peat. The clays are available for the manufacture of bricks and pottery, the silica and tripolite as abrasive material and in the manufacture of dynamite, the peat for use as fuel and the manufacture of moss-litter. The materials employed in the macadamizing of streets and highways are also largely drawn from this source.

IRON.

Iron. The ores of iron found in New Brunswick include the hæmatites and limonites of Carleton county; hæmatites and specular ores of Black River and West Beach, St. John county; magnetites found in western St. John and Charlotte counties; with deposits of bog-iron from various localities.

Ores of Carleton county.—As these have been very fully described, in previous reports of the Survey, only a brief summary of the facts, with references, will be given here.

Woodstock ores. What are commonly known as the Woodstock hæmatite beds, were first brought to public notice in the year 1836, by Dr. C. T. Jackson, of Boston, in connection with a geological survey of portions of the State of Maine, then being made by him. Subsequent explorations, made by the officers of the Canadian Geological Survey and others, showed that these beds, probably in more than one belt, extend across the principal part of the county of Carleton,* but have their greatest thickness and are most readily accessible in Jacksontown, about three miles north-east of the town of Woodstock. They are here, as elsewhere, associated with a series of slates, usually bluish or grayish in colour and highly calcareous, but, when in connection with the iron ores, commonly becoming more or less reddish or greenish. At various points, though not at Jacksontown, the slates are associated with beds of limestone, and in both are contained fossils showing them to be members of the Silurian system. Their exact horizon has not yet been certainly fixed, but it is probable that they are of about the same age as that of many of the iron-bearing beds of Nova Scotia, *i. e.* near the summit of the Silurian.

Distribution.

Age.

Nature of ore-beds. As seen at Jacksontown and vicinity, the ore-beds are quite numerous, having a thickness ranging from one foot to sixteen feet, and are conformable to the inclosing slates which usually dip north-westerly at an angle of 85°, although in places much contorted. Individual beds, however, when followed, are found to exhibit notable variation in width. In places they contain considerable quantities of manganese,

*Annual Report, Geol. Surv. Can., vol. I. (N.S.), 1885, p. 20 G.

which also often gives a black colour to the slates, while occasionally green stainings indicate the presence of copper. Slickensided surfaces, indicative of shearing and vertical displacements, are not uncommon. The ores also vary in composition, usually yielding water when heated, and consisting of admixtures of limonite and hæmatite. The average of six analyses* of ore from Iron Ore Hill, made by Mr. John Mitchell, of London, and quoted by Dr. Ells gave†:—

Analysis.

Metallic iron	35·593 %
Sulphuric acid	·723
Phosphoric acid	1·298

Production.

The first attempts to utilize the Jacksontown ores were made in 1848, when a blast-furnace was erected by the Woodstock Charcoal Iron Company upon the bank of the St. John River, a short distance above Upper Woodstock, and about two miles and a half from the ore-beds. Ore was obtained by the ordinary process of quarrying, and, according to information supplied to the writer by the manager, Mr. Norris Best, were charged as follows:—

Ore	1,350 lbs.
Limestone	70 "
Charcoal	20 bush.

According to statements quoted by Dr. Harrington,‡ 3·33 tons of ore and 126 bushels of charcoal were required to make a ton of pig-iron, the charcoal (in 1865) costing 7 cents a bushel. "There were 10 charcoal kilns, having an average capacity of 75 cords of wood and a production of 2800 to 3200 bushels of coal. The quantity of ore used was, on an average, three tons to the ton of pig, and the cost at the furnace, $1.20 per ton." The cost of pig produced was $20 to $22 per ton.

Furnaces.

The first furnace, erected in 1848, was 39 feet high, 33 feet square at the base and 9¾ feet at the boshes, with three tuyere arches and a capacity of about seven tons a day; while a later and smaller one built in 1863, was inclosed in boiler-plate, had a circumference of 40 feet, and a capacity of 5½ tons per day.§ Both were lined with Stourbridge bricks, a sandstone from the Gulquac, one of the tributaries of the Tobique, being used as a hearth. The "hot blast" was used, the steam necessary for the purpose being obtained from suitable boilers,

*The numerous assays, analyses, etc., of ores and minerals quoted throughout this Report, are given on the authority of the authors only, except in the case of examinations made in the laboratory of the Survey.

†Report of Progress, Geol. Surv. Can., 1874-75, p. 104.

‡Report of Progress, Geol. Surv. Can., 1873-74, p. 252.

§R. W. Ells.

which were in turn heated by combustion of waste gas from the furnace head. The average duration of each crucible and hearth was about 24 weeks, during which time an average production of 50 tons per week was attained. The limestone employed as a flux, was obtained from the Beccaguimec River, seven miles distant from the furnaces. The operations were subject to numerous interruptions, made necessary for repairs, and it is stated that the whole time during which the principal furnace was in blast was only about eight years.*

Iron smelting at Woodstock is now, however, a thing of the past. Is it possible to look forward to a resumption of operations? Possible future.

In attempting to answer this question many considerations arise, the main one being, of course, the cost of manufacture and transportation to market. The figures as to the former, already given, are based upon the conditions at the time of working, or about thirty years ago. Since then a much larger proportion of Carleton county has been denuded of forest, especially in the vicinity of Jacksontown, and the cost of fuel has been considerably increased. It is not, however, probable that this alone would prevent the ores being worked, more especially as their position, on the bank of the St. John River, is in every way favourable to the easy and cheap removal of the product. A more serious difficulty is to be found in the nature of the product itself, which owing to the high percentage of phosphorus, was often found to be brittle or cold-short to a degree which detracted very materially from its value. On the other hand, it is difficult to reconcile this deficiency with the statements given as to experiments made in England with armour-plates constructed of Woodstock iron, which, according to a paper by Mr. Wm. Fairbairn, F.R.S., published in the *Artizan*, had a resistance in excess of that of any other plates then tested, or a tensile strength in tons per square inch of 24·80. It is also to be observed that the presence of phosphorus is not now the serious objection to the use of iron ores that it formerly was, the introduction of the basic process of Thomas and Gilchrist, making it possible to reduce such ores effectively. It is also not impossible that processes may be introduced whereby the extensive deposits of nickeliferous pyrrhotite occurring near St. Stephen, may be used in connection with the Woodstock ores, the combination, after the removal of sulphur, affording an iron suited for the manufacture of armour-plate.

Cost of fuel.

Presence of phosphorus.

Tensile strength.

While, then, it is doubtful whether, in the present condition of the iron industry and in the face of adverse tariffs, the Woodstock ores

* Dr. B. J. Harrington.

could be worked with profit, they must still be looked upon as valuable assets, which changed methods of treatment and changed commercial conditions may at any time bring again into prominence.

The following lists of publications referring in various ways to the Woodstock ores, may be of service to those seeking further information upon the subject :—

Bibliography.

Abraham Gesner. Geological Report, 1842. This author asserts that the ore had been sent abroad and examined as early as 1820.

Chas. T. Jackson. Reports on the Geology of Maine, 1836.

Geo. L. Goodale. Seventh Annual Report Maine Board of Agriculture.

Wm. Fairbairn. London *Artizan*. This paper gives accounts of experiments illustrating the tensile strength of armour-plates in the making of which Woodstock ore was used. This tensile strength is quoted in tons per square inch as 24·80.

L. W. Bailey. Report on Mines and Minerals of New Brunswick, Fredericton, 1864, pp. 55–59.

H. Y. Hind. Preliminary Report on Geology of New Brunswick, 1864.

B. J. Harrington. Report of Progress, Geological Survey of Canada, 1873-74. p. 251.

R. W. Ells. Report of Progress, Geological Survey of Canada. 1874-75.

West Beach hæmatite.

West Beach.—This locality is twelve miles east of the city of St. John, and not far from the shore of the Bay of Fundy. The ore is mainly a dark reddish-brown hæmatite, contained in the upper part of a large bed of coarse reddish gray conglomerate, but associated with quartz veins containing more or less micaceous or specular iron. The deposit is probably of pre-Cambrian (Huronian) age. Only a small quantity of this ore has been removed, and that many years ago.

Black River ores

Black River.—The ore-beds at this point, which is two or three miles eastward of those of West Beach, are somewhat similarly situated, and probably mark the same geological horizon, but yet differ both in their character and associations. The ore is chiefly the specular variety, and is contained in beds of trap-ash and hydromica schists, attaining in one instance a thickness of twenty feet. Though known for many years, and frequently made the subject of examination, no serious attempts have been made to carry on mining operations.

Magnetite.—Magnetic oxide of iron, in the form of scattered crystals, is a very common mineral in connection with the probably intrusive rocks of the pre-Cambrian systems, and in one of these, the Huronian, is also often found in the form of beds or veins, though none of great thickness have yet been observed.

Lepreau magnetites.

Among localities at which such veins have been found, one of the most notable is in the vicinity of the village of Lepreau, near the boundary between the counties of St. John and Charlotte. About two miles west of the village, and a quarter of a mile north of the post-road to St. George, on the farm of John A. Wright, a series of dark hornblendic schists, representing that portion of the Huronian system which has locally been designated as the "Kingston group," contains a number of these veins, varying from a quarter of an inch to eight inches in thickness. Though termed veins, the deposits are strictly conformable to the inclosing schists, and may be traced with little variation for considerable distances, the dip being at a very high angle and the strike quite regular. Ore from these deposits was analysed by Dr. Hoffmann (Dec. 5th, 1895) with the following results:

Metallic iron	66·71 per cent.
Insoluble matter	4·36 " "
Nickel and cobalt	Traces
Titanic acid	None.

The beds are massive, granular and generally very free from admixtures of any kind, but owing to the large proportion of very hard rock to be removed to get the ore, cannot, unless thicker beds are found, be mined with profit. As yet nothing has been done beyond a small amount of exploratory work.

Deer Island.

Veins similar to the above have been observed at New River, on the south shore of Deer Island, (from 2 to 3 feet thick) and at other points. They may indeed be looked for in almost any part of the Kingston group; and, as much of the country occupied by the rocks of this group is still uncleared and has been only imperfectly explored, it is quite possible that beds large enough to be mined may exist.

Cranberry Head specular hæmatite.

In addition to such occurrences in the rocks of the Kingston group, that portion of the Huronian which in the reports of the Survey has been designated the "Coastal group" also contains ores of iron to some extent. One locality of this kind was visited in 1897 near Cranberry Head, on the coast of Charlotte county, on the farm of one Murray, now owned by Hon. A. T. Dunn, Surveyor General of New Brunswick. The ore is a specular hæmatite, and occurs in veins

in silico-felspathic rocks, often exhibiting a purple tint, but usually white-weathering, and varying in texture from slates to conglomerates. The veins are somewhat numerous, but rarely exceed two inches in width, besides being very irregularly distributed. Several pits have been opened, but at the time of examination these were all filled with water. No well-defined bed or vein was seen.

Bog-iron.

Bog-iron Ores.—These have been noticed in many parts of the province and by various observers, but in the presence of better and more available ores are of little present importance. In the reports of Dr. A. Gesner, reference is made to their occurrence in Sussex Vale and Bull Moose Hill, Kings county; at Liverpool, Kent county, and in the Tobique valley, Victoria county; but few details are given. Similar deposits have been observed in connection with the work of the Geological Survey on the Tracadie River, North-west Miramichi; Queensbury, York county; Beaver-dam settlement, York county; at Maugerville and Burton, Sunbury county; but the two latter are the only ones which have as yet been used for practical purposes.

Bog ores of Burton, Sunbury county.

The deposit at Maugerville is thus described by Mr. Robert Chalmers:* "The ore-bed consists of a mixture of loamy and boggy or peaty materials of the depth of from one to three feet below the surface, underneath which is a clayey hard-pan. The ore is found in the form of cakes, or loose flattened aggregations, few of them more than six to twelve inches in diameter, although sometimes two to three feet. An intervale or alluvial terrace of considerable extent occurs here at a height of about ten to twelve feet above the level of the St. John River, and the ore-bed occupies a longitudinal belt in it, parallel to the river, about 50 yards in width and three to four miles in length."

During the latter years of the operations at Woodstock, bog-ores from Sunbury county were carried to that place to be used in connection with the hæmatites and limonites of Jacksontown.

Some of these bog-iron ores might, no doubt, be employed as pigments, either as raw ochres or after grinding and calcination.

Vivianite.

A blue phosphate of iron (vivianite) has been observed upon the bank of the St. John River, four miles above Grand River, in the parish of Madawaska, associated with or contained in heavy beds of clay. The quantity, however, is not large.

To the above observations on the occurrence of iron, the following notes may be added as bearing some degree of interest, though in no case, probably, of economic importance:—

*Report of Progress, Geol. Surv. Can., 1882-84, p. 46 GG.

Occurrences of iron ores.

Veins in the granite about St. George and Lake Utopia in Charlotte county are in some instances filled with scales of micaceous specular iron.

On Coal Creek, in Queens county, where a series of slates protrude through the Carboniferous strata, nodules of hæmatite, several inches in diameter, are frequently met with.

At Spraggs Cove, on the island of Grand Manan, veins of siderite, (iron carbonate) have been observed in connection with rocks of presumably Huronian age. Rocks of similar age on the Nerepis River, in Kings county, also hold veins of like composition.

Beds of bog-iron, as indicated by specimens in the museum of the University of New Brunswick, occur on the South-west Miramichi River, one mile below the Clearwater Stream, and nineteen miles above Borestown.

On the Clarendon road, in Queens county, and at a point about six miles west of Gaspereau station, small veins of magnetite have been observed in connection with massive dark-gray quartzites, and dark argillites, associated with dioritic and hornblendic beds, of uncertain age. As exposed in a pit, about twenty feet deep, dug here, the vein has a width of about eighteen inches, but is much mixed with quartz and rock. It does not invite further expenditure.

On the western side of Oak Mountain, about a mile distant from the line of the New Brunswick railway, and three miles distant from Benton, beds of hæmatite have been observed in rocks, probably of Cambro-Silurian age, but have not been sufficiently laid bare to make evident their extent or value.

On the Peabody farm, two miles south of Woodstock, and in a position corresponding geologically to that of Oak Mountain, loose blocks of hæmatite are scattered over the land, but whether derived from beds *in situ* near by, or driftage from the Jacksontown beds to the north, has not yet been ascertained.

Copper.

Copper.

This metal has been found in the province in the forms of native copper, oxide of copper (cuprite), sulphides of copper (copper-pyrites, erubescite or bornite), and the carbonates of copper (malachite and azurite.)

Native copper

Native Copper.—In the Triassic traps of the Island of Grand Manan, scattered nodules or irregular strings or bunches of pure

copper have been frequently met with, especially in the vicinity of the South-west Head. They are, however, of small size, have none of the characteristics of true veins, and even fail to show any tendency to concentration at particular points. From an economic point of view, therefore, they are wholly without interest. The red sandstones of the same formation which may be seen, but only at very low tides, to underlie the traps at various points between South-west Head and Dark Harbour, are also said to hold the same mineral.

Cuprite.

Oxide of Copper or Cuprite is said to have been found in connection with the sulphides of the metal during the course of mining operations on the Albert county coast, to be presently noticed, but not in quantities requiring special mention.

Sulphides.

Sulphides of Copper.—These have been reported from many different localities, and from rocks of various ages.

Copper ores of southern coast

The rocks of the Coastal group, (Huronian ?) are specially characterized by the occurrence of copper sulphides. These rocks, though not confined to the southern seaboard, are there very prominently developed, including a large part of the coast of Charlotte county, much of that of St. John, and portions of that of Albert. They embrace granitoid gneisses, talcose or hydromica schists, chloritic schists, gray and purple slates and conglomerates, felsites, etc., with numerous masses of diorite, all highly tilted and folded. To the west of the St. John River they have an average width of four miles, forming a country which, though rugged, is of moderate elevation; but, eastward of the same stream, they rise into much greater prominence, having in eastern St. John county a breadth of at least ten miles, and an elevation of six hundred feet or more.

Comparison with copper-bearing rocks of Quebec.

This series has been compared lithologically to the rocks of the "Eastern Townships" of Quebec (formerly known as the Quebec group), and like the latter, is generally cupriferous. The ores, which are usually the sulphides, especially erubescite or bornite (gray and peacock ores), have been observed at a great many points, but (as is also the case in Quebec), are rarely sufficiently concentrated to offer any attractions to the miner. Still, attempts have in several instances been made to develop them, of which the most important are the following:—

Adams and Simpson Islands.—These are small islands lying to the east of Deer Island, on the Charlotte county coast, and not far from the entrance of La Tête Passage. Attention was first drawn to them through the occurrence upon the shore of Simpson Island of a quantity

of pale-green powdery malachite, in which, upon examination, were found numerous nodules or irregular lumps of black or dark-gray copper sulphide, the malachite being evidently a secondary product resulting from the action of the sea on the original and solid ore. Some sixty or seventy barrels of this green carbonate were removed by a local company (Messrs. Lord and Dakin) about the year 1863, but, owing to the influx of water, the underlying vein could not be worked. An attempt was then made to strike the latter farther from the shore and upon higher ground, but owing probably to some displacement, the effort was without success. Other veins, however, (Nos. 2 and 3) were thus discovered, leading to more or less prospecting, but for a time to no further underground work. Work of all kinds was then dropped for a period of about twenty years, when (about the year 1890) Messrs. Crow and Welter, associated with James Lord, of Lords Cove, Deer Island, sunk a shaft on vein No. 2 to a depth of 52 feet, finding a vein of about two inches of copper glance, inclosed in a veinstone, chiefly of quartz, with a thickness of eight inches. Another vein (No. 4) was also prospected, while on No. 3 a shaft was sunk to a depth of 110 feet, showing strings and veins, of which the largest was about five inches. A cross cut having been made from this for a short distance, a further descent of 26 feet was made, but without result. Since then no further operations have been undertaken. The vein on the beach (No. 1) showed four feet wide of the green carbonate, with a core of about eight inches of copper glance. It is said to have yielded, upon analysis, 27 per cent of copper, and nearly four ounces of silver to the ton.

Discovery of copper.

Development.

Adams Island is separated from Simpson Island by a narrow channel only, and their position is such as to show that the rock formations and veins of the one are a direct continuation of those of the other. Upon Adams Island two companies have worked at different times, and several shafts have been sunk, the results being, however, unsatisfactory. An examination made during the summer of 1897, of a pile of ore, lying near one of these openings, showed this to consist almost entirely of a dark-gray felspathic ash-rock, through which were scattered irregularly large numbers of blebs, consisting chiefly of erubescite (peacock copper), but sometimes of quartz or of mixtures of both minerals. No appearance of a well-defined lode was observed. This shaft was sunk to a depth of 80 feet.

Adams Island

At about the same time that mining operations were first in progress on Adams and Simpson islands, work of a similar character was being undertaken upon the mainland on the eastern side of La Tête

La Tête Passage.

Passage and Passamaquoddy Bay (Mascarene Peninsula). The rocks here, however, belong to a somewhat different geological horizon from that of the localities first named, while the character of the ores is also not the same.

Wheal Louisiana mine.

One of the points upon the peninsula referred to at which a considerable amount of work was done was that known as the Wheal Louisiana mine, opened by the Messrs. Johnson, of Liverpool, under direction of Mr. J. B. Key. This is about ten miles from the town of St. George, and not far north of the promontory known as La Tête, the rock being chloritic and talcose slates of Huronian age. The ore was mostly copper-pyrites, but with this were large quantities of pyrite and pyrrhotite, the latter forming a large proportion of the material raised. This pyrrhotite is now known to be, like that of St. Stephen, nickeliferous. A shaft was sunk to a depth of nearly one hundred feet, but the returns were not commensurate with the cost, and the mine was soon abandoned.

La Tête mine.

One mile north or north-west of the Wheal Louisiana mine was the La Tête copper mine, consisting of a shaft sunk about 100 feet on a lode of mixed quartz and calcspar included between clay-slates and trap. Several other shafts were also sunk, but, as in the case of the Wheal Louisiana mine, the ore obtained bore but an inconsiderable proportion to the associated rock, and operations were soon suspended.

Coast of eastern St. John and Albert counties. This is another region in which attempts at copper mining have been repeatedly undertaken, but so far with but little success.

The rocks of this district, consisting of gray and purple micaceous slates and conglomerates, with granitoid or gneissic beds and much intrusive diorite, are essentially the same as those of the Charlotte county coast, and the ores are also similar.

Vernon mine.

The principal works undertaken were those of the so-called Vernon mine, situated directly upon the coast about two miles east of the mouth of Goose Creek, in St. John county, where for a time (about 1865) not less than forty men were employed, and a considerable quantity of ore was extracted. The latter consisted essentially of copper glance or bornite, but copper-pyrites was also met with, and as a secondary product more or less malachite—the veins being of quartz, with some calcspar and chlorite. Several veins were traced, two of them being described as five feet and one as twelve feet in width, but the relative proportion of ore and of veinstone is not now known.

Assays.

Assays of samples sent to Boston and to Swansea gave returns vary-

ing from 18 to 25 per cent of copper, but how far these were representative of the general average is only matter of conjecture.

Unfavourable position of mine.

Apart from the quality of the ore, the situation of this mine was also such as to make its development a doubtful venture; for this part of the coast is not only high (500 to 600 ft.) but rises from the waters of the bay with great abruptness, making it impossible to secure safe wharfage, while communication by any other means than water is both long and difficult. At the time of the visit by the writer to these mines (in 1863) the boarding-house of the workmen was actually supported against the side of the cliff by being let into the nearly vertical face of the rock, while much of the ore previously mined and piled at the foot of the cliff for shipment had been washed away by a storm. It is now many years since the works were abandoned.

Williams mine.

At about the same time that work was being undertaken at the Vernon mine, several other openings, known as the Alma, Gordon and Williams mines, were made a few miles farther east, in the neighbourhood of Upper Salmon River in Albert county. From one of these, the Williams mine, about 100 tons is said to have been taken, yielding according to the prospectus of the company from 28 to 30 per cent of copper, but in a recent visit to the locality no indications of anything like a distinct vein could be found, while such specimens of ore as were still to be got in the vicinity certainly did not seem to hold out much inducement for the expenditure of capital.

Other places.

For further particulars regarding the copper mines of Charlotte, St. John and Albert counties, reference may be made to a report on the Mines and Minerals of New Brunswick by the writer, published by the legislature of the province in 1863.

Dorchester mine.

Westmorland County.—About three miles and a half north-east of the town of Dorchester, in this county, are some beds of copper-bearing rock which, a few years since, attracted attention, and upon which a considerable expenditure was made, but of which the real interest is rather scientific than economic.

The rocks in question are gray sandstones and conglomerates, belonging to the base of the Millstone Grit division of the Carboniferous system, and resting unconformably upon red marly shales of Lower Carboniferous age. In the sandstones are contained numerous stems of plants, and about these were found deposits of copper glance mingled with more or less of the green carbonate. The remainder of the rock, though showing no visible ore, was stated by the manager of

the property to carry from four to five per cent of copper glance. Indications of ore were found at intervals for a distance of a mile and a half. For the purpose of developing the property, commodious buildings were erected and mining and hoisting machinery was introduced. A shaft was also sunk to a depth of 100 feet, reaching the underlying red beds, but no considerable body of ore was discovered; and little return being found for the heavy expenditure made, the works were after some months' trial, finally abandoned.

List of localities in southern New Brunswick.

The following list of localities in the southern counties, at which veins of copper ore, of greater or less size, have been observed, is reproduced from the Report of Progress of the Geological Survey for 1870-71 (p. 225), as indicating the wide distribution of such ores, and as possibly affording aid towards further exploration :—

CHARLOTTE COUNTY.

Seely Cove.—Quartz veins holding small quantities of copper-pyrites in a chlorito-felspathic rock.

Seely Head (on the shore west of).—Copper-pyrites in small quantities in red syenite.

Seely Creek.—Copper-pyrites in a quartz vein intersecting felspathic rocks.

Shore west of Crow Harbour Island.—Copper-pyrites and copper glance in a quartz-vein about 2 feet wide, running through greenish gray chlorito-felspathic rocks.

Cove of Red Head.—Copper-pyrites and iron-pyrites disseminated through schistose talco-micaceous rocks. No distinct lode was seen.

McLean's Mills on Lockes Brook near New River.—Copper-pyrites in quartz veins. Quantity small.

Negro Harbour.—Copper-pyrites.

Beaver Harbour.—Copper-pyrites in quartz veins and disseminated in schistose diorite of Kingston group: also with galena, in a quartz lode (3 feet and a half wide) in chlorito-felspathic rocks of Coastal group.

Clark Point, Mascarene shore.—Native copper and gray copper ore in strings and pockets, in trap associated with red argillites of Silurian age.

Wheal Louisiana Mine. La Tête.—Described above.

Woodward's Mine.	*Mascarene shore.*	do	do
Hardwood Island.	*Bay of Fundy.*	do	do
Adams Island.	do	do	do

Simpson Island. *Bay of Fundy.*—Described above.
Campobello Island. do do do do
Grand Manan. do do do do

ST. JOHN COUNTY.

Black River Settlement.—Copper-pyrites and malachite in hard clay-slate, containing remains of plants; also copper glance in limestone.

Little Salmon River (near mouth).—Copper-pyrites, in small quantity, with much iron-pyrites, in slates.

Martin Head.—Erubescite, in rocks of Coastal group.

Goose Creek (Vernon Mine).—Described above.

ALBERT COUNTY.

Point Wolf. do do
Upper Salmon River. do do
Blackwood Block, (N. E. angle, Alma parish).—Malachite.

WESTMORLAND COUNTY.

Beech Hill.—Copper glance in veins of quartz, with fluorite.

KINGS COUNTY.

Quispamsis.—Copper-pyrites with galena and blende in gray chloritic Laurentian gneiss.

Norton.—On north side of Dickie Mountain, copper glance encrusting gray quartzite of Kingston group, and overlain by Lower Carboniferous limestone with galena.

Springfield.—In Scotch Settlement, north of Bull Moose Hill, copper-pyrites and copper glance in gray argillites; also on southern slope of Kierstead Mountain.

London Settlement, parish of Kars.—Copper-pyrites in rusty-weathering felspathic sandstones.

Nerepis station, parish of Westfield.—Copper-pyrites, with galena and iron-pyrites, in purple slates of Coastal group.

Northern New Brunswick.

In northern New Brunswick copper ores have been observed in the vicinity of Woodstock, Carleton county, and Bathurst, Gloucester county.

Bull Creek.

(*a*). *Woodstock.*—About three miles below this town, the St. John River receives, on its right bank, a small tributary known as Bull Creek. At the point of junction and for some distance up the creek, the rocks consist of coarse gray syenite, in which are contained veins of quartz carrying sulphides of iron and copper. The latter is mostly in the form of copper-pyrites, and is in sufficient quantity to have led,

on more than one occasion, to the formation of a company to work it but without remunerative results.

In the town of Woodstock itself, the underlying rocks appear to be metalliferous. In digging a sewer, about the year 1896, a quantity of ore, embracing several metallic sulphides, including copper sulphide and galena, was obtained to the amount, it is said, of 500 or 600 lbs. The exact composition of the ore, however, and its extent, have not been ascertained.

Bathurst copper mine.

(*b*). *Bathurst.*—At the falls of the Tête à Gauche River, eight miles from this town, the metamorphic slates of this region, described as manganiferous, carry also certain quantities of copper. This is in the form of the yellow sulphide, associated with iron-pyrites, and is contained in well defined lodes, of which not less than seven occur within a space of sixty feet, and have in some instances a width of five or six feet. A number of openings were made on these latter about the year 1859 or 1860, the product, in connection with that of the manganese beds near by, being shipped to England, but soon after all further operations were abandoned and have not since been renewed. According to analysis made by the late Dr. James Robb, the copper ore, when dressed, would be worth about £35 per ton.

Nipisiguit.

At the mouth of the Nipisiguit River, about three miles from Bathurst and about ten miles from the locality on the Tête à Gauche last described, the strata which form the basal beds of the Carboniferous formation, consisting of conglomerate, sandstone and shale, hold small irregular seams of bituminous coal, intimately mixed with which occur irregular masses and veins of sulphide of copper and malachite. They thus resemble the copper-bearing strata near Dorchester, in Westmorland county, described above, and like them have been supposed to afford indications of sufficient promise to justify expenditure for their extraction. It is stated that about the year 1859 some 20 or 30 tons of ore was shipped from these deposits. The anticipations, however, as to their productiveness were not realized, and work thereon was soon abandoned. At present, like the beds at Dorchester, they are only interesting as helping to indicate the metalliferous character of the underlying systems from which these conglomerates and ores were derived, and as illustrating one of the methods—that of the reduction by vegetable matter of soluble metallic salts and their consequent conversion into sulphides,—by which this class of ores may have been formed.

NICKEL.

In the Report of Progress of the Geological Survey of Canada for the years 1870-71, an account is given of the geology of Charlotte county, in connection with which reference is made to a group of dioritic rocks, presumably of Huronian age, as occurring a short distance to the eastward of the town of St. Stephen. These same rocks are further described as being traversed by fine veins of dark-green serpentine, which, as shown by an analysis of Dr. T. Sterry Hunt, carried a certain percentage of chromic oxide and of nickel. This was the first intimation of the existence of nickel in New Brunswick. Original discovery.

A few years later, in consequence probably of the discoveries then being made at Sudbury, Ontario, attention began to be directed to the existence, in connection with the St. Stephen rocks, of considerable deposits of pyrrhotite, some of which, upon analysis, also showed a small percentage of nickel. The first deposit of this mineral was observed on the bank of the St. Croix River at the Union mills, about 100 yards below the bridge at that point. A second deposit was struck soon after in sinking a well on the property of Mr. Stephen Hitchings about half way between the Union mills and cotton mills in Milltown. The Union mills deposit was, as exposed on the bank of the river, about 30 feet wide, and was at first pronounced to be an arsenical iron of no value. A later analysis showed it to contain $\frac{1}{4}$ of 1 per cent of nickel. In 1880 a similar deposit was found on the Basswood Ridge road, on the property of Mr. Ed. Hall, and was also considered of no value. Mineral rights were, however, leased from Mr. Hall by Messrs. Gilbert Ganong and James Bixby, and subsequently by Mr. Jerry Carrell, while about the same time the examination of the surrounding country having been made by Mr. C. A. Boardman, showing a wide distribution of the pyrrhotite. The last-named gentleman and Mr. W. F. Todd, both of St. Stephen, secured mineral rights on a number of other lots, and steps were at once taken to determine their value. On a lot known as the Rogers lot, a cut of 175 feet was made through the mineral without any indication of a break in the ore. In 1893, a dozen holes were made, over an extent of country about two miles square, and ore was found in most of them. In the fall of 1896, Mr. Jerry Carroll sunk a shaft about 20 feet deep on the Hall lot, and in 1891 a shaft was sunk to about the same depth on the Rogers lot. The ore on the surface assayed only about eight-tenths of 1 per cent, but further down was found to be better, running from 1·25 to 3·10 per cent of nickel. Most of the analyses ranged from 1·75 to 2 per cent, but some ore from the Carroll shaft had no nickel in it, and Analysis. Exploitation. Carroll property.

some on one lot showed over 4 per cent. The ores contain small portions of copper as well as nickel, and in several of them small percentages of gold and silver are said to have been found.

Conclusions.

From the above data, for the most part kindly furnished by Mr. C. A. Boardman, two conclusions may be drawn, first, that the ore is spread over a large area and in considerable quantity, and, second, that the nickel contents are subject to considerable variation. The first of these conclusions has been fully confirmed by the personal observations of the writer. During the summer of 1897, a visit was made to the district in question, and a somewhat careful examination made of the more important of the localities referred to above. The exposures on the Rogers lot were particularly noticeable, the trench of 175 feet showing for the greater part of this distance a nearly solid bed of pure pyrrhotite. Towards the southern end, however, is a mass of dark diorite, into which the pyrrhotite seems to graduate and which itself contains considerable quantities of the latter; while resting on both, and forming a capping of indefinite extent on either side, is a mass of ferruginous conglomerate, doubtless of comparatively recent origin, and resulting from the oxidation of the pyrrhotite through exposure to air and water. Particles of copper-pyrites could be seen here and there through the mass of rock. A shaft sunk to the depth of 17 feet failed to pass through the pyrrhotite, though irregular masses of diorite were found to be contained in it. In the fields around, low ledges of similar rock outcrop at no great distance from the trench, and are distinctly but not coarsely crystalline, and without evident stratification. At the Carroll mines on the Hall farm, about a furlong east from the last, the beds exposed are, as before, nearly all pyrrhotite, and have been penetrated to a depth of 22 feet.

Later observations.

Observations of H. P. Brumell.

In the year 1890, an examination of the nickel deposits about St. Stephen was made by Mr. H. P. Brumell, with results essentially the same as those above given.* In addition to the localities described above, reference is made to beds at Moore Lake, eight miles east of St. Stephen, where a shaft has been sunk on one of two parallel veins, respectively 12 and 7 inches wide, and only a few inches apart. In this shaft, at the depth of about 15 feet, the two small veins were found to come together and to show a strong and highly mineralized ore-body. An assay of this ore by W. French Smith, of Boston, gave:—

Copper, to the ton	8·00 lbs.
Nickel do	12·46 do

*Annual Report, Geol. Surv. Can., vol. V. (N.S.), 1890-91, p. 112 ss.

Compared with the well known deposits of Sudbury, Ontario, the nickel-bearing rocks of St. Stephen show many features of close resemblance.

Comparison with Sudbury ores.

1. The St. Stephen beds, like those of Sudbury, consist of basic intrusive rocks, such as diorite and diabase, with probably gabbro and norite, associated with heavy beds of quartzite.

2. As at Sudbury, the pyrrhotite would seem to be a normal constituent of the dioritic rock and not an intrusion in the latter. The rock has not yet been subjected to petrographical examination, but it is highly probable that on the one hand the felspars and iron-magnesian silicates of which the rocks consist and the nickel-bearing pyrrhotites on the other, represent successive separations by cooling from the same fluid or semi-fluid magma, thus accounting for the graduations between them and their intimate interblending.

The association of the St. Stephen nickel ores with serpentine, diallage, bronzite, actinolite and picrolite is also interesting, such association having been observed not only at Sudbury but in New Caledonia, Oregon, the Urals, North Carolina and Silesia.

3. The St. Stephen rocks, like those of Sudbury, are referable to the Huronian system, and were probably formed under like conditions.

4. The heavy capping of gossan covering the St. Stephen pyrrhotites has its counterpart at Sudbury, and is in each case indicative of the large bodies of mineral below.

On the other hand.

5. While portions of the St. Stephen ore show little more than a trace of nickel and the maximum so far attained does not exceed 4 per cent, the pyrrhotite of Sudbury rarely carries less than $2\frac{1}{2}$ per cent, and frequently averages 4 per cent.

Possible future.

From the above it would appear that while the general similarity of the St. Stephen and Sudbury deposits in geological age, lithological characteristics, mineral associations and probable origin, favour the belief that the former, like the latter, may be a profitable source of nickel-supply, the relatively low percentage of this metal as found at St. Stephen is adverse to this conclusion. But the variability of the nickel-contents of pyrrhotite deposits, not only at the localities named, but at others from which considerable quantities of this metal are derived, make it at least possible that portions of the deposit may be much richer than any yet recognized. Considering the large extent and thickness of the deposit this is quite possible, and could probably

be determined at no great cost by the selection and analysis of samples from many different parts of the field. As a contribution in this direction a number of such samples have been collected by the writer, but have not yet been submitted to analysis. A series of borings with the diamond drill now under the control of the Provincial Government, would doubtless also give much valuable information in the same direction.

It may be mentioned in this connection that during the working of the so-called Woodward Mine at La Tête, elsewhere described in this Report, large quantities of pyrrhotite were removed in connection with chalcopyrite, and it has been stated that these ores, like those at St. Stephen, are nickeliferous, but to what extent the writer has not been informed.

Antimony.

First discovery.

Prince William, York county.—The existence of ores of this metal in New Brunswick was first made known about the year 1863, through the discovery of a deposit of stibnite, or sulphide of antimony, in the parish of Prince William, York county. The locality is about twenty-five miles from the city of Fredericton and about three miles from the St. John River, being very near the summit of a somewhat elevated tract overlooking Lake George and the valley of the Pokiok River.

Geological horizon.

The rocks exposed in the vicinity consist of alternating beds of slate and quartzite, being part of a wide belt of such rocks traversing the central counties, and supposed to be of either Cambrian or Cambro-Silurian age, though, so far as at present known, without recognizable fossils. The beds are very highly disturbed, and show abundant evidence of metamorphism, connected, no doubt, with the close association of the strata with masses of intrusive granite, which may be seen *in situ* within a mile of the principal deposits of ore. These latter occur in connection with veins of milky quartz, some of which appear to be coincident with the bedding, though more commonly intersecting this at various angles. The total area over which lodes bearing antimony were found was about 350 acres, the quartz veins varying from a few inches to six feet, in which those of stibnite occurred partly in a network of fine veinlets and partly in more considerable masses, sometimes attaining a thickness of twelve or fifteen inches.

Area of antimony deposits.

Native antimony.

In some parts of the workings very fine specimens of native antimony were met with.

Development.

The first company to undertake active operations at Prince William was the Lake George Mining and Smelting Company, their location

being that of the old "Hibbard property," adjoining the road to Lake George, and about three miles from Prince William. At this place a considerable quantity of ore was raised, followed by the erection of a somewhat extensive plant including crushers, rolls, jiggs, etc., and, somewhat later, works for desulphurization and smelting. When in full operation these works yielded fifteen tons of metal every six weeks, the charges (of 500 cwt.) affording from 45 to 55 per cent of regulus. The product was partly exported in cubes or ingots to the United States, and was partly employed on the ground in the manufacture of babbit metal, by admixture with lead, copper and tin. The value of the regulus was quoted on the ground at 12 to 14 cts. per pound; that of the babbit metal, according to quality, from 20 to 50 cts. per pound. Manufacture of babbit metal.

The manufacture of the above products was continued for several years, but a continued decrease in the demand for the metal, with increased protective duties imposed by the government of the United States, soon made it difficult to carry on the work with profit. At the same time, discoveries having been made of antimony lodes upon adjacent properties, the competition of rival companies, with more or less litigation arising out of disputed claims, tended still further to hinder progress. It was then determined to export the ore in the raw state, this being hauled to Magaguadavic station on the Canadian Pacific Railway for shipment. At the same time an entire change in the destination and use of the material was made, almost the whole product being sent to the town of Medford, Mass., and there used in connection with processes for the vulcanization of rubber. To supply this demand, about eighty men were, in the year 1883, employed in the Brunswick mines, and during five months of that year about 29 tons of ore was exported, a shaft being sunk to the depth of about 300 feet. This business also appears to have been short-lived, as about the year 1890 all work was suspended. The property of the Brunswick company, originally known as the Hibbard property is now in the hands of trustees, resident in Haverhill, Mass. The other properties are a portion of the Lawrence estate owned in St. John, N.B. Difficulties. Change of application.

As to the quantity or quality of the antimony ores of Prince William there can be but little question. The distance from the Hibbard shafts to those opened later by the Messrs. Lawrence, is nearly half a mile, and at many points in the interval, as well as about each of these centres, which apparently occupy different sides of an anticlinal fold, quartz veins are numerous and generally metalliferous. There was also no sign of diminution in the quantity of the ore as followed in depth, but on the contrary, a tendency to greater concentration, with Quantity of ore.

a replacement to some extent of stibnite by native antimony. The question of the future working of the deposits is therefore mainly one of demand.

Demand.

From statements contained in *The Mineral Industry*, it appears that the domestic production of antimony ore in the United States in 1897 amounted to 500 short tons, averaging 45 per cent of antimony. The production of the metal, amounting to 750 tons was, therefore chiefly derived from imported ore. A great part of the antimony employed there is, however, imported in the refined state. There should, therefore, be a good market for antimony in the United States, but the prices are lower than those ruling some years ago.

Proposed resumption of work.

It has been recently stated in the public press that the mines at Prince William are to be reopened by a company, and that preparations for that purpose are now in progress, under direction of Messrs. Hammond and Adriance.

Analyses.

The following are analyses of the Prince William ores :—

1. Sample sent to England.

Sulphide of antimony	50·70	per cent.
" iron	1·87	"
Silica	47·43	"
	100·00	"

2. Sample analysed by Dr. A. A. Hayes, Boston, Mass.

Antimony	59·00	per cent.
Sulphur and rock	41·00	"

3. Sample analysed by Dr. Hayes (Silliman's Journ. Jan., 1863).

Sulphide of antimony	36·00	per cent.

This sample contained some silver.

4. Analysis by James R. Chilton & Co., New York.

Antimony	66·00	per cent
Iron	·60	"
Sulphur	23·40	"
Silica	10·00	"

5. Three analyses by W. W. Bailey.

	1.	2.	3.
	per cent.	per cent.	per cent
Antimony	68·98	70·1	69·09
Sulphur	28·86	28·4	27·28
Iron	·85	·0	·85
Gangue	·81	1·5	1·50
	99·50	100·00	98·63

Springfield, Kings county :—"Small quantities of stibnite or sulphide of antimony have been found in connection with dioritic rocks which are either intrusive or of Laurentian age near Sunnyside Lake in the

Scotch Settlement, parish of Springfield, Kings county. A small portion only of the vein has been disclosed by the removal of the soil, and little is known of its extent or value." Antimony veins at Scotch settlement, Kings county.

The above extract is from the Report of Progress for 1870-71. No further developments in the locality, so far as known to the writer, have since been made.

TIN.

A specimen of oxide of tin, labelled "Pokiok," was some years ago noticed as occurring in a collection of New Brunswick minerals made by Dr. Abraham Gesner, in connection with his geological explorations of the province in 1839 and subsequent years. The specimen, which is quite small, is now in possession of the writer. Discovery.

Though the locality given above is very indefinite, the more so as there are several Pokiok rivers and settlements in the province, there would seem to be little doubt that the place from which the specimen came was in the vicinity of the Pokiok River in York county; for this is the best known of the localities bearing that appellation, while the geological age and structure of the region are such as to render the occurrence of this metal there very probable. The river referred to traverses a district partly occupied by metamorphic slates and sandstones and partly by granites, for portions of its length running along the line of contact of the two. It is in just such situations that the tin of Cornwall and other countries is found to occur. It is also to be noticed that it is in this same district that antimony, a mineral often associated with tin, is abundantly met with, as at the Prince William mines. Finally, at the town of Waterville, Maine, in rocks which appear to be the equivalents, if not the direct extension of those of Prince William, in New Brunswick, small quantities of tin have been found. Doubts regarding locality.

There is, therefore, some possibility that this important ore may yet be found in available quantities. Unfortunately the aspect of the ore, when not crystallized, is of such a character as to attract little attention from the ordinary observer, and hence it may readily be overlooked. So far all search for the precise locality from which Dr. Gesner's specimen was derived has proved fruitless.

LEAD AND SILVER.

No pure or native silver is known to occur in New Brunswick, but veins of galena or sulphide of lead, met with at various points, usually Occurrence of veins of argentiferous galena.

carry a certain percentage of silver, making it necessary that the two metals should be considered together.

Geological formations.

The geological formations in which galena has been observed, include the Laurentian, the Huronian, the Cambrian and Cambro-Silurian, the Silurian and the Lower Carboniferous. In most instances the amount is small. In the following descriptions the localities are taken by counties.

Charlotte County.

Frye Island lodes.

Frye Island.—The geology of this island, also known as L'Etang Island, and situated near the mouth of L'Etang Harbour, is complicated, and is fully described in the Geological Survey Report for 1870-71 (p. 86). Of the rocks met with, the most important in the present connection is a series of limestones, in part dolomitic, and associated with quartzites, that form the shore of that portion of the island which overlooks the "Back Bay." They are quite similar to rocks to be presently noticed both on the mainland of Charlotte county and in St. John county, and, with the latter, have been referred to the Laurentian system. Intersecting these limestones, which also carry more or less serpentine, are a number of well-defined lodes consisting mainly of quartz, but containing also considerable quantities of barite and fluor-spar, besides veins of galena. One of these lodes, when stripped, showed a width of from six to eight feet, with a course about east-north-east, while two other lodes, each about six feet, and approximately parallel, approached the first with a course about north-east or nearly that of the inclosing strata. Portions of these lodes contain numerous small veins of galena, sometimes associated with blende or pyrite, but no considerable body of ore was visible. Beyond stripping the lodes and the firing of a few blasts, no attempt has been made to mine the ore.

Character and associations.

Campobello.—At several points on this island, veins of galena, usually in association with sphalerite or zinc blende have been observed, but at one point only have they been found large enough to lead to any expenditure of capital. This point is near the eastern extremity of the harbour of Welchpool, not far from the former residence of Admiral Owen, where, nearly forty years ago, a quantity of the above ores, chiefly galena, was found to occur in connection with a series of chloritic and hornblendic strata, probably of Huronian age. A level being opened in the bank, not far above high-water mark, several tons of very good ore were extracted, but while the vein, as first exposed, was several feet wide, consisting of galena with associated barite

Welchpool.

and pyrite, at the distance of twenty feet or so it dwindled down to a thickness of only a couple of inches. It was then abandoned.

Lead ores of Lubec, etc.

In this connection, it is of some importance to notice that ores of lead have been observed at a number of localities in the neighbouring district of Washington county, Maine, some of which, as near Lubec, have at times been the basis of more or less extended mining operations.

On the Magaguadavic River, half a mile below the village of St. George, is a small island upon which, it is said, a vein of galena occurs, yielding masses of pure ore as large as a barrel.

ST. JOHN COUNTY.

Lancaster.

Frenchman Creek, Parish of Lancaster.—The rocks of this locality bear much resemblance to those of Frye Island, Charlotte county, and are almost certainly of Laurentian age. The principal rock is a whitish or cream-coloured, more or less siliceous limestone, becoming in parts dolomitic; but with this are dark-gray to black rubbly slates, while a little to the north, and covering a space of many acres, are very heavy beds of dark-gray quartzite. In visiting the locality in 1897, a trench was found to be in process of excavation on a bed of dolomite, disclosing a series of small veins, from one to three inches in width, in which, besides quartz, was contained a quantity of galena associated with honey-yellow sphalerite or zinc blende and some tetrahedrite. Stainings of green and blue copper carbonates were also noticeable.

The locality is on the farm of Mr. Jno. Burchell, and was being prospected by Mr. C. J. Weldon, of St. John. The amount of work, however, so far done, has been too small to afford any data for an estimate of its value. Samples having been sent for analysis to the office of the Survey, and there, freed from all gangue, the metallic sulphides were found by Dr. Hoffmann to contain no gold, but to carry silver to the extent of 25·08 ounces to the ton of 2000 lbs.

Musquash Harbour.

Musquash Harbour, West side.—The Laurentian syenites which occur here, carry veins of white quartz holding sulphides of copper and lead. A specimen of the pure galena, assayed by Dr. B. J. Harrington, in the laboratory of the Geological Survey, yielded 14·219 ounces to the ton.* The extreme hardness of the country-rock, as compared with that of Frenchman Creek, is against its profitable working.

*Report of Progress, Geol. Surv. Can., 1877-78, p. 52 G.

KINGS COUNTY.

The following localities are quoted in the reports of the Geological Survey as showing small veins of galena :—

Norton. *Norton.*—The veins are in Lower Carboniferous limestone resting upon the Huronion rocks of Dickie Mountain. They were observed as early as 1863, but have not been considered sufficiently important to warrant exploration.

Hammond River. *Hammond River*, near Wanamake's Inn, parish of Upham. Galena, with copper-pyrites, in quartz veins penetrating dioritic and petro-siliceous rocks of Huronian age. The veins are small but carry a little silver. An assay by Dr. F. D. Adams gave, silver 3·099 ounces to the ton.

Quispamsis.—Galena with pyrites and blende, in Laurentian gneiss.

GLOUCESTER COUNTY.

The localities in this county at which ores of lead have been observed are three in number, viz., the Nigadoo River, the north branch of Elm-tree River and Rocky Brook, a tributary of the Nipisiguit. All are within moderate distance of the town of Bathurst, and not far from the line of the Intercolonial Railway, but in tracts which are still wooded, and somewhat difficult of access.

At each of the localities named, some little work, chiefly of a prospecting character, has been done, but at the time of the visit of the writer to the vicinity this had been suspended, the trenches and shafts were filled with water, and nothing could be learned by personal

Nigadoo River. inspection. The locality upon the Nigadoo River, however, was visited by Dr. Ells in 1879, and again in 1881, after mining operations had been commenced, and the ore was described by him as being of good quality.* That of Rocky Brook was similarly examined by the late Edward Jack, C.E., of Fredericton, on behalf of the Provincial Government, and was described as showing a vein of quartz carrying more or less galena and pyrite, with a total width of twenty feet. An assay of the ore by Prof. H. O. Hoffman, of the Massachusetts Institute of Technology, is also quoted, as yielding 11 ounces of silver and $\frac{1}{2}$ 0·24 ounces of gold to the ton. Another analysis (by Prof. Ricketts, of New York) yielded 14·20 ounces of silver per 2000 pounds of the ore, as submitted.

Elm-tree mine. In the printed prospectus of the Elm-tree Silver Mining Company, it is stated that about 800 pounds of ore were taken out from a

* Report of Progress, Geol. Surv. Can., 1879-80, p. 45 D.

six-foot lode upon their property, an assay of which (by J. D. Marsh, New York), gave silver to the value of $182 to the ton, lead $72 and a trace of gold. Another assay (by Frank L. Bartlett, State Assayer of Maine) gave silver 9 ounces, gold 2 penny-weights, lead 73 per cent.

The prospectus of the Nigadoo Silver Mining Company quotes the following analyses of ore from their property :— Asseys of Nigadoo ores.

SACKVILLE, June 22nd, 1881.

Assay of Galena.

(1). Lead 613 lbs. to ton of 2,000 lbs.
Silver 31 oz. to ton of lead.
Gold, slight traces.

(Signed), J. BURWASH,

August 8th, 1881.

(2). Lead 71 per cent or 1,420 lbs. to ton.
Silver 36·3 oz. troy to ton of ore.
Nearly 50 oz. to ton of lead.
Value about $119 per ton.

(Signed), JOHN BURWASH.

(3). Metallic contents per ton of 2,000 lbs.

Gold, at present value U. S. cy.	$ 0·51
Silver in troy oz 72·67	81·39
Lead per cent 60·75	60·75
Total assay value.	$142·65

(Signed and sealed), F. L. BARTLETT
State Assayer.

Portland, Maine, Aug. 15th, 1881.

GOLD.

The consideration of the occurrence of this metal in New Brunswick must, with our present information, be rather a discussion of probabilities than a statement of facts. It is true that numerous reports of its discovery have from time to time appeared in the public prints, but in the very few instances in which it has been possible to trace them back to authentic sources, they have proved to be the product of alluvial washings, and of very small amount. Assays of ores from different parts of the province have also shown traces of gold, but these again go but a little way towards establishing the auriferous character of the rock formations represented. On the other hand, it is easy to adduce many considerations which favour the belief—fully entertained by the writer—that New Brunswick will yet be found to yield gold in economic quantities. Reported discoveries.

Among these reasons are the following :—

Reasons favouring a belief in occurrence of gold.

I. The occurrence in the province, over extensive tracts, of rocks in all probability of the same geological age as those of regions elsewhere generally auriferous. These rocks are mainly the slates and quartzites, with their metamorphic equivalents, which traverse New Brunswick a little north of its centre, on either side of the great band of intrusive granite extending from the Chiputneticook lakes, on the western frontier, to the neighbourhood of Bathurst. Though holding at one point (Rocky Brook upon the Nashwaak River,) fossils referable to the base of the Devonian, the larger portion is non-fossiliferous, and in the case of the northern belt this is unquestionably overlapped, unconformably by rocks of Silurian age. Both belts have accordingly been coloured in the Survey maps as Cambro-Silurian (the Rocky Brook beds being regarded as an infolded outlier of more recent strata), but it is quite as probable that they include Cambrian strata also, being thus brought into parallelism with the gold bearing belt of the south coast of Nova Scotia, about the geological age of which a similar doubt exists.

Probable equivalence with gold-bearing strata of Nova Scotia

It may also be added that a third belt of similar strata, like that of Nova Scotia auriferous, exists in the Chaudière region of Quebec, coming up on the northern side from beneath the same basin of Silurian slates as that which directly overlaps the supposed Cambrian rocks of central New Brunswick. Sir William Logan long since expressed the belief that the rocks of the Quebec group as understood by him, (and now known to include in that province both Cambrian and Cambro-Silurian strata), were repeated in New Brunswick on either side of the granite axis referred to above, and finally, by another anticlinal undulation on the Atlantic coast of Nova Scotia*. It seems, therefore but reasonable, in view of the auriferous character of the rocks of the Chaudière district and of Nova Scotia, that the probably equivalent rocks of New Brunswick should be alike productive of the precious metal.

Comparison of lithological character.

II. The lithological characters of the supposed Cambrian or Cambro-Silurian rocks of New Brunswick, though not identical with, bear much resemblance to those of the Nova Scotia gold series, the likeness being seen not only in the system as a whole and in individual members, but also in the order of succession, and the results of metamorphism. In both, the lower and greater portion of the series consists of fine-grained sandstones or quartzites (in New Brunswick usually felspathic) alter-

*See letter to Prof. H. Y. Hind in Preliminary Report on Geology of New Brunswick.—H. Y. Hind. Fredericton, 1865. p. 15.

nating with gray argillites, while above there are simple argillites, mostly dark-coloured, but sometimes green or red. In both, these rocks are more or less invaded by granite, in approaching which they assume, to some extent, the character of fine gneisses and mica-schists, more or less charged with such minerals as garnet, staurolite, tourmaline, etc. In both places the higher rocks or argillites are markedly pyritiferous and with the pyrite other metallic sulphides, as those of antimony, arsenic, lead and zinc occur. In the New Brunswick rocks hornblendic strata, closely similar to those of Yarmouth, N. S., are met with.

Record of finds.

III. A considerable proportion of all the reported "finds" of alluvial gold have been from districts in or closely adjacent to the belts, which, on other grounds, would seem to afford the most favourable indications of the presence of this metal. Among them may be especially mentioned the tributaries of the Tobique and Little Southwest Miramichi rivers. Prof. H. Y. Hind, in connection with a survey for the Provincial Government in 1865, reported alluvial gold from both of these streams, and exhibited specimens at the Provincial Exhibition of the same year, which are now in the cabinet of the University of New Brunswick. Other observers report like results, and upon the strength of these, or possibly independent observations, certain parties have gone so far as to erect on the Serpentine River, a branch of the Tobique, at a point at least fifteen miles from the nearest settlement, a small stamp-mill whereby to test more thoroughly the nature of the ground. Under instructions of the Director of the Survey, this point was visited by the writer during the summer of 1897, with results which, though negative as regards the actual finding of gold, nevertheless go far, in his opinion, to confirm the views already expressed as to its probable future discovery.

Supposed occurrence on Serpentine River.

The Serpentine River joins the Campbell River, or Right Hand branch of the Tobique, about eight miles above the Forks of the Tobique, and, according to the published map of the Survey, very nearly in the middle of a band of supposed Cambro-Silurian rocks, extending thence south-westerly to the head-waters of the Gulquac, and north-easterly nearly to Sagamook Mountain at the head of the Nictor or Little Tobique. About four miles above the mouth of Serpentine River, the Cambro-Silurian rocks, according to the map referred to, give place to an extensive tract regarded as pre-Cambrian, within which the remainder of this stream lies, together with the lakes at its head. The ground for such a separation upon the Serpentine, whatever may be the case elsewhere, does not seem to be very obvious, and the writer would rather be disposed to regard all

Rocks of Serpentine River.

the strata between the lower and the upper fall as being of similar age, and that age probably Cambrian. Excepting a band of crystalline felsite, which, like the granite of the main fall, is probably intrusive, all the other rocks are quartzites and slates; and except that those nearer the granite are more glossy and unctuous, it is difficult to see wherein they differ from those below. It is, however, in these more glossy slates or schists that quartz veins especially abound, and it is here that the stamp-mill to which reference has been made, has been placed. Immediately beneath the latter is a vein of milky quartz, from six to twelve inches in width, much stained with iron and holding irregular masses of dark-green chlorite, while numerous similar veins are exposed in the banks of the stream for several miles above and below. A considerable quantity of broken quartz was lying about, and from this samples were selected for analysis. The slate was in aspect very similar to the auriferous schists of North Carolina, and the appearance alike of the veins and the country-rock, appeared favourable to the occurrence of gold. The occasional occurrence of mispickel or arsenopyrite was another favourable indication. Several veins examined were found to be, like many of those in Nova Scotia, conformable to the bedding, and in some instances to be lenticular. Boulders of white or of ferruginous quartz are common in the bed of the stream for a mile or more below the mill.

Stamp-mill.

Frequency of quartz veins.

No work was in progress at the time of our visit, nor were we subsequently able to obtain any definite information as to the reason for the erection of the mill or the returns therefrom. We were ourselves unable to find any gold, and heard that the parties operating the mill had also failed to obtain any, except by washing in a neighbouring brook; but of this we are unable to speak with certainty. We can only add that the assays referred to above, made in the laboratory of the Geological Survey, also failed to give satisfactory results. Samples from various veins found at and near the mill, and aggregating twelve pounds and a half in weight, were submitted to trial, but were found to contain neither gold nor silver.

Result of analysis.

If the information as to the Tobique is indefinite, that relating to the Miramichi and its tributaries is even more so. Positive statements as to the occurrence of gold have indeed been made, and by apparently reliable persons, but until the discoveries are followed up by applications for mining licenses, they can hardly be regarded as worthy of serious attention.

IV. The regions most likely to be gold producing have been very imperfectly explored. It is true that all have been examined, more or

Absence of exploration.

less, by the members of the Survey staff and by others, but the purpose of these explorations was mainly the determination of the age, character and limits of the formations represented, not that of systematic prospecting. This has yet to be done. It is to be remembered also, that the larger part of the districts in question is still unsettled and for the most part densely covered with forest, and such observations as have been made have been chiefly confined to the larger streams or such as are navigable by canoes. Even in countries which, like Nova Scotia, are known to be auriferous, and where the conditions of the occurrence of gold are now well understood, the discovery of new veins is to a great degree a matter of chance, and a similar chance may at any time alter the view now generally entertained as to the non-productive character of the New Brunswick rocks.

Possible gold area in Charlotte county.

In addition to the two great belts to which the above remarks mainly apply, some other districts also deserve notice as possible gold producers. One of these is the tract lying to the north and northeast of the town of St. Stephen, in Charlotte county. Here again the rocks may, both in character and succession, be closely paralleled with those of the Nova Scotia gold series, and their age also is in all probability the same. A series of massive gray quartzites is overlain by black pyritous argillites, and both are invaded by masses of granite, becoming thereby altered, the one into imperfect gneisses and the other into micaceous, garnetiferous and hornblendic schists. Quartz veins also abound, in some instances of very large size, and some of these, upon the authority of Prof. C. H. Hitchcock,* formerly State Geologist of Maine, yielded, at more than one locality, small quantities of gold. On the other hand, assays made by Dr. T. Sterry Hunt, of samples obtained from one of these localities (that of the Bolton property) failed to show any gold, while a similar negative result has been obtained in the case of specimens since collected from other points by the writer and submitted to assay in the laboratory of the Survey. These were partly from Bailey Settlement and partly from the Grimmer farm, between Basswood Ridge road and Getchell Settlement road.

In view of this conflicting testimony the question in this instance, must be regarded as being still an open one, to be decided by further exploration.

Albert county

The last region to which reference may be made, is that of the hilly country comprising the eastern part of St. John county with the adjoining portions of Kings and Albert. Small quantities of drift gold were found by the writer, as early as 1864, in the hills south of the

* Report on Mines and Minerals of New Brunswick. Bailey. 1864.

Coverdale River: and Prof. H. Y. Hind speaks of the country between Hopewell and Golden Mountain, examined by him, as being also slightly auriferous. The existence of small percentages of gold in the copper ores of the southern coast of Albert county has also been noticed by Prof. Hind.

The following are other localities in which alluvial gold has been reported:—

1. Upsalquitch Lake. Reported by Prof. Hind as slightly auriferous.
2. Nipisiguit River, near the Grand Falls. Hind.
3. Right-hand Branch Tobique River and Long Lake. Hind.
4. Blue Mountain Brook. Hind.
5. Springfield, seven miles north-west of Norton station. Hind.
6. Dutch Valley road. Traces of gold in pyrite. Hind.
7. Muniac River, Carleton county.
8. Nashwaak River, York county.
9. Frye Island, Charlotte county. Reported by Dr. A. A. Hayes, of Boston, as occurring in quartzites to the extent of $10 to the ton.

Manganese.

Deposits of manganese.

The deposits of manganese found in New Brunswick occur in three different formations, of widely differing character.

Tête à Gauche River.

The deposits which are the oldest geologically, as they were also the first to attract notice, are found in the county of Gloucester, in the vicinity of the falls of the Tête à Gauche River, about eight miles from Bathurst. Veins of copper-pyrites having been found in the same neighbourhood, a company was formed about the year 1860 for their development, and a small stamp-mill was erected, but the results proving unsatisfactory, operations were soon suspended and have not since been renewed.

Recent observations.

During the summer of 1897, a visit to this vicinity was made by the author of this report, with the result of showing that the manganese veins of the region are, in all probability, much more numerous than had previously been supposed, and that the metal may possibly occur in quantities which will admit of profitable working. Thus, at points nearly a quarter of a mile from the place of their first discovery at the Falls, the red slates of the district, (probably of Cambrian age), were found to carry numerous small veins

Preliminary Report on Geology of New Brunswick, Fredericton, 1865.

of pyrolusite; while I was assured by resident farmers that, in road making, they had exposed similar veins, attaining in some instances a width of eight inches. Masses of pure ore, usually highly crystalline, are also found scattered over the neighbouring fields. Unfortunately, the whole district, which is nearly flat, is covered deeply with a clayey soil, that completely conceals the underlying rocks, and with them any ores they may contain; but in consideration of what has been stated above, and the further fact that indications of manganese are found in the same belt of rocks in their extension to the Nepisiquit River, it would certainly seem that the district is worthy of closer investigation than it has as yet received. As the veins observed are of the nature of "stringers" rather than well characterized lodes, a tracing of them to their points of origin might reveal deposits of considerable extent and value.

The second class of manganese ores in New Brunswick, is that found in connection with the rocks of the Lower Carboniferous formation; and includes the deposits of Markhamville, Jordan Mountain and other points in Kings county; those of Shepody Mountain, in Albert county and those of Quaco, in St. John county.

Markhamville deposits.

Markhamville.—The deposits at this place are by far the most interesting which have been yet found in New Brunswick, whether they be regarded from a scientific or from an economic standpoint. Thus not only did they for years form the basis of an extensive and profitable industry, but in the course of their development they afforded admirable illustrations of the conditions under which most of the manganese deposits of the Maritime Provinces are found. A review of the operations undertaken at this point and of the facts then revealed, will therefore be of value with reference to any future undertakings of a like character.

Situation.

The Markhamville mines are situated near the head of the Hammond River, at a point about forty miles north-east of the city of St. John, and about eight miles south of Sussex station on the line of the Intercolonial Railway. The district in which they occur is an elevated one, and though the ore-beds are found on the sides and towards the bottom of a considerable valley, drained by the river, the necessity of surmounting the high ridges which border the latter, in order to reach, within reasonable distance, a suitable place of shipment, was, during the operation of the mines, at all times a serious difficulty. The more recent construction of the St. Martins and Upham (now Central of New Brunswick) Railway, would, were the mines at any time reopened, afford a much more easy and less expensive outlet.

Associated rocks.

As described in the report of the Geological Survey for 1870-71, the rocks which on either side border the valley of Hammond River, at Markhamville, are of Huronian age, consisting of dark-gray to black diorites and felsitic beds, that in places are more or less brecciated, and are probably of volcanic origin. They are themselves to some extent manganiferous, and are probably the source from which the more considerable deposits have been derived, but these are wholly confined to beds of more recent age, viz., to Lower Carboniferous limestones and associated strata resting upon the Huronian beds, and to deposits of clay and gravel connected therewith. A deep covering of drift makes it impossible to determine with accuracy the order of succession of the Lower Carboniferous sediments, but from what data are available, it is probable that the limestones represent the base of the Carboniferous system at this point, the higher beds being represented by red conglomerates and sandstones.

First discoveries.

The earliest discoveries of manganese in this vicinity are said to have been made by Mr. G. F. Matthew, the property being subsequently leased by Mr. Wm. Davidson, of St. John. The first systematic operations, for the extraction of the ore, were, however, undertaken by Colonel Alfred Markham, on behalf of the Victoria Manganese Company, about the year 1874, and to his energy and perseverance is to be credited the large development which they subsequently underwent.

Development.

The deposits first removed were superficial ones, consisting of ore inclosed, in the manner of pockets, in beds of clay, mingled more or less with gravel, and holding boulders of limestone. These deposits had a depth of twelve feet or more. Somewhat later, operations were extended to the underlying limestones, but in these also the distribu-

Irregularity of occurrence.

tion of the ore was found to be most irregular, thus leading to great fluctuations in the output of successive years, as well as in the profits derived therefrom. In more than one instance an entire season would be occupied in profitless search, and operations would be upon the point of abandonment, when new and possibly richer deposits would be struck, thus prolonging, for a greater or less time, the life of the

Stoppage.

mine. Such finds, however, eventually became too rare to admit of continued expensive search, and about the year 1893 the mines were finally closed, though the extensive plant used in connection there-

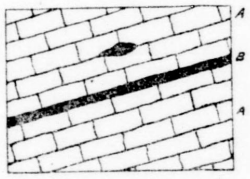
Output.

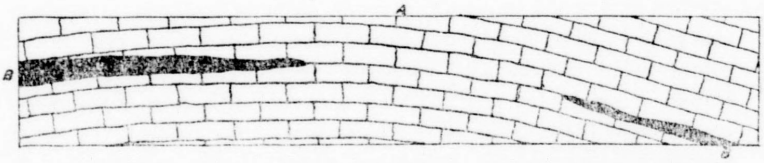
with has never been removed. The output, during the first twenty-three years of operation, varied from 500 to 1500 tons per year, and the value, as delivered at Sussex, from $15 to $50 per ton. The total output appears to have exceeded about 23,000 tons.

During the period of their greatest activity, the deposits at Markhamville were visited and very carefully examined by Dr. R. A. F. Penrose, in connection with a similar examination then being made by him of all known deposits of this metal in North America, and the results of his observations were published in a volume wholly devoted to this subject, forming a part of the Annual Report of the Geological Survey of Arkansas for 1890. As, owing to the closing of the mines, such observations are not now possible, and those referred to, the work of a recognized authority, are not only a remarkably full and clear account of these mines, but of their probable origin and their relations to manganese mines elsewhere, it has been thought well to reproduce here, from the volume referred to, some of the more important statements.— Observations of Dr. Penrose

"The ore occurs either as crystalline pyrolusite and manganite, or in a compact, massive, nodular or bedded form, sometimes containing psilomelane. Nature of ore.

"The ore-bearing limestone is generally of a gray colour, but at times is pink or buff, and is associated with shaly strata. It contains veins of crystalline calcite, in which masses of pyrolusite are frequently found, but the principal ore-deposits are lenticular bodies interstratified with the limestone. These occur either as irregular pockets, or as flat layers, more or less continuous for considerable distances, and Mode of occurrence.





Scale 8 feet to 1 inch.

Fig. 1. Sections in Openings at the Markhamville Mine, New Brunswick, Showing the mode of Occurrence of the Manganese Ore.

A. Limestone.
B. Manganese ore.

becoming thin and thick at intervals. In some places such deposits widen out into pockets from which several hundred tons of ore have been taken, and in one opening 3000 tons are said to have been mined. Though in places the pockets do not always adhere strictly to the bedding of the rock, yet in a general way they follow it. Sometimes veins and pockets cut directly across the bedding, but these are generally smaller than the others and are probably due to a secondary chemical action by which they have been derived from the bedded ores.

Explanation of sections.

"The two sections [Fig. 1] represent exposures of ore in openings on the property, and illustrate on a small scale the characteristic modes of occurrence, though very much larger bodies of ore than those here shown have been worked. The smaller section shows an interstratified lenticular layer of ore through the centre and an irregular, isolated pocket lying in another plane of stratification above. The larger section shows two lenticular pockets following the same line of stratification in the limestone, but separated by a barren area.

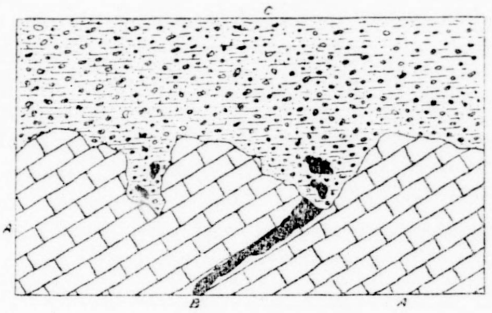
Decomposition of limestone.

"The surface of the limestone has often been decomposed and a red residual clay, frequently mixed with surface gravel, has collected in considerable quantities. The ore that was originally in the part of the limestone which has decayed, is now found buried in the clay; and therefore deposits of ore-bearing clay or gravel, overlying the partly decomposed surface of the limestone, are of frequent occurrence. Such deposits are rarely more than from eight to twenty feet in thickness, but the ore in them is cheaply worked, and they have supplied a large part of the output of the Markhamville mine. Frequently the decomposition of the limestone has spread downward more rapidly along the outcrop of a body of ore than elsewhere, causing somewhat abrupt hollows filled with residual clay and manganese ore, and containing in the bottom, the outcrop of the ore *in situ* in the rock.

"Not only has decomposition taken place on the surface, but it has also gone on to a considerable extent underground, frequently causing subterranean cavities and passages. When these have intersected bodies of manganese the floors are covered with loose fragments of ore, brought there in the same way as that in the residual clay on the surface. Kidney-shaped masses of glossy, black limonite are frequently found with the cave deposits, and these also have doubtless come from the limestone.

"The figure [Fig. 2] represents a section exposed in a surface pit. It shows the decayed surface of the limestone and the overlying residual

material, with fragments of ore that have weathered out of the rock. Surface pit.
It will be observed that the body of ore in the limestone has been partly freed from the rock by decay, and that the fragments have become enveloped in the overlying clay. It will also be noticed that the decay of the rock has reached deeper where there is ore than where there is none.



Scale 10 feet to 1 inch.

Fig. 2. Section at the Markhamville mine, New Brunswick, showing the decay of the ore-bearing limestone and the formation of residual ore-bearing clay.

A. Limestone.
B. Manganese ore.
C. Manganese-bearing clay.

"Though a large amount of manganese has been taken from the sur- Workings.
face clay beds and the caves, yet the deposits of ore in the limestone have also been extensively worked, and in many places the rock is honeycombed with a network of shafts and drifts, following the erratic courses of the ore-bodies in all their intricacies.

"The thickness of the limestone varies considerably; in one of the The limestone.
pits a depth of twelve feet was found, and a diamond drill boring in another part of the property showed a thickness of fifty-five feet. Probably a greater thickness will be found elsewhere. The bed is much disturbed and is folded into small anticlines and synclines, but at Markhamville it has a general dip to the north-west and a strike of north-east and south-west. In many places it contains fossils, and sometimes the carbonate of lime of these has been partly replaced by manganese, which has subsequently been oxydized, and now exists as a black, more or less calcareous, mass."

Annual output.

The following table affords more exact information of the annual output of manganese in New Brunswick between the years 1868 and 1894, almost the whole of which was furnished by the Markhamville mines.

Exports of Manganese ores from New Brunswick, 1868-1894:—

	Tons.	Value.
1868	861	$ 19,019
1869	332	6,174
1870	146	3,580
1871	954	8,180
1872	1,075	24,495
1873	1,031	20,192
1874	776	16,961
1875	194	5,314
1876	391	7,316
1877	785	12,210
1878	520	5,971
1879	1,732	20,016
1880	2,100	31,707
1881	1,504	22,532
1882	771	14,227
1883	1,013	16,708
1884	469	9,635
1885	1,607	29,595
1886	1,377	27,484
1887	839	20,572
1888	1,094	16,073
1889	1,377	26,326
1890	1,729	34,248
1891	233	6,1 :1
1892	59	2,025
1893	10	112
1894	45	2,400
Total	23,024	409,203

In the year 1894, the export practically ceased. The mines at Markhamville yielded over one half of the whole Canadian product up to the time at which work was suspended.

High grade of ore.

As indicated by the preceding table, the manganese ores of Markhamville are largely high-grade ores, and derive their value not so much from their manganese contents as from their being in a condition to readily part with their oxygen, and hence to be of service in such chemical processes as demand the free use of the latter. Among these are the manufacture of chlorine, the decolorization of glass and the making of varnishes and cements, and for these purposes the Markhamville product was chiefly used. Other uses to which they are adapted are the construction of Leclanche batteries, the manufacture of disinfectants, such as manganate and permanganate of potash, as

colouring materials in the printing of calicoes, the staining of glass, pottery, brick, etc., and the making of paints. For the manufacture of spiegeleisen and ferro-manganese, alloys of the metal used in the manufacture of steel, the "available oxygen" has no importance, and much cheaper ores may be employed. But little of the Markhamville ore was, accordingly, used for this purpose. Applications.

In preparation for market, the better class of ores, known locally as high-class ores, were first crushed, then washed and finally sized in screens, to be afterwards loaded in old petroleum barrels, containing something over 1000 pounds each. These were usually estimated by their appearance, but sometimes by analysis, the very best ranging as high as ninety-six per cent of pure manganese ore, worth about five cents per pound. The lower grades, under the name of "furnace ore" or "metallic ore" were shipped without special treatment, the price being based upon analysis, fifty per cent of manganese being employed as the standard. In the year 1888, the price in England of this latter ore was $15 per ton. Estimation of values.

The Markhamville mine is said to have produced some of the highest grade manganese found in the world.

The following are three analyses of high-class ore from Markhamville, taken from The Mineral Resources of the United States, 1888:— Analyses.

—	No. 1.	No. 2.	No. 3.
Manganese binoxide	98·70		
Manganese peroxide		97·25	96·62
Silica	·55		
Iron	·75		
Iron peroxide		·85	·78
Barium	Trace.		
Baryta and Silica		·95	·85
Water		Trace.	Trace.
Loss		·95	1·75
Total	100·00	100·00	100·00

An analysis of furnace ore (No. 3) as quoted in The Mineral Resources of the United States, 1885, gave:—

	Per cent.
Peroxide of iron	3·75
Peroxide of manganese	52·74
Carbonate of lime	13·40
Silica	9·50
Sulphur	·02

Glebe mine.

Glebe Mine.—This mine was situated three miles north-east of Markhamville, and about seven miles from the I. C. R. at Sussex.

According to Dr. Penrose, the ore was found in a limestone resembling that at Markhamville, though much less disturbed than at that place, and dipping gently to the west. The ore occurs in the limestone in nodules and thin layers, frequently associated with calcite, and following the general direction of the stratification. Several shafts and tunnels were opened, the deepest being eighty-five feet.

Operations at this point were carried on for a short time only, and no particulars are now available.

Jordan Mountain mines.

Jordan Mountain.—This mine, discovered in 1882, is situated on the south-eastern side of Jordan Mountain, and near the head of a brook forming one of the tributaries of Smith Creek, itself a branch of the Kennebecasis River. It is distant about seven miles from Sussex station on the Intercolonial Railway, and about seventeen miles from Markhamville, being connected with the former (with the exception of about a mile near the mine) by a well built and easily travelled thoroughfare.

Geological condition.

The general geological relations at Jordan Mountain are similar to those of Markhamville, *i. e.* the ores are similarly found in Lower Carboniferous strata near the contact of the latter with older metamorphic rocks (gneisses, felsites, etc.) presumably of pre-Cambrian age. But instead of occurring, as at the locality last named, chiefly in limestones, or in clayey deposits which have been formed by the decomposition of the limestone, they are here found in connection with shales and shaly conglomerates, made up largely of fragments of the older rocks on which they rest, which are distant from the mine only about 200 yards. The mine, so called, is merely a trench, which at the time of examination, several years ago, was found to be about seventy feet in length, with a depth of from ten to twelve feet. The sides of this trench show the shaly conglomerates dipping in each case to the south-east at an angle of 70°, while the base of the trench was chiefly occupied by the deposit of manganese, extending for a distance of about sixty-five feet, with an average thickness of about six feet.

Ores.

In approaching the ends of the cutting, the ore-deposit was found to thin out rapidly and to alternate with the conglomerates; but the trench had not been opened sufficiently far to enable one to form a very accurate idea, either as to its extent or character. Its appearance was that of a lenticular mass conformable to the bedding rather than that of a vein, but such mode of occurrence has already been

referred to as common in manganese deposits, and has little bearing upon the total quantity of ore which the beds may contain. About 250 tons are said to have been removed. Removal of ore.

In addition to the main vein, small veins and stringers of manganese oxide were observed penetrating the surrounding rocks for a distance of twenty or thirty feet, while in some instances angular fragments of conglomerate were apparently cemented by the ore into a sort of breccia.

This brecciated character of the Jordan Mountain deposits, in contrast with those of Markhamville, is interesting, as being, according to Dr. Penrose, a common feature in connection with manganese ore-beds both in Canada and the United States. Thus at Tenny Cape, in Nova Scotia, this feature is very conspicuously seen, as it is also in the great deposits of the Batesville region in Arkansas. In discussing its probable origin, the author referred to, points out that the brecciation is confined to the manganese-bearing strata, and therefore can hardly be the result of folding, especially as the associated beds are of a character which would make them equally susceptible to the effects of shearing; and is inclined to ascribe the result to chemical action, this action being possibly connected, in some instances at least, with the association of gypsum beds. None of the latter, however, have as yet been observed in immediate proximity to the Jordan Mountain deposits. Brecciation of manganese beds.

The ore of the main vein at Jordan Mountain is mostly a fine-grained pyrolusite, of a massive character and iron-black or steel-gray colour and dull lustre, but exhibiting also crystalline veins and masses. Probably with the pyrolusite is more or less manganite and other oxides. The rocks in the vicinity are everywhere stained brown from the presence of the same ores, and trial-pits opened upon other portions of the same property at considerable distances from, but on the same general line as that of the vein already opened, have been found to contain manganese in greater or less abundance. Of specimens collected at random, some were found to be quite pure, while others contained a considerable admixture of quartz. Limonite, hæmatite, barite and calcite, all of which occur at Markhamville, were not observed at Jordan Mountain. The absence of clay deposits here is probably connected with the absence of limestones. Character of ores

The following are several analyses of the Jordan Mountain ore :—

Analyses.

1. Analysis by Prof. P. B. Wilson, Baltimore, Md., Nov. 7, 1887 :

	Per cent.
Manganese binoxide	86·08
(Equal to metallic manganese 54·57).	
Iron oxide	0·87
Silica	2·86

2. Analysis by Dr. Olto Wirth, Pittsburgh, Pa., Nov. 22, 1887 :

	Per cent.
Metallic manganese	52·88
Iron	1·18
Silica	9·70
Phosphorus	·014

3. Analysis by Pennsylvania Steel Company, Dec. 12, 1887 :

	Per cent.
Manganese	57·37
Silica	0·23
Phosphorus	0·015
Sulphur	0·61

Quaco mines.

Quaco Head Mine.—This mine was also examined by Dr. Penrose, whose description of its features could not well be improved. It is as follows: "The Quaco Head mine is situated on Quaco Head, on the north shore of the Bay of Fundy, one mile south of the town of St. Martins, about thirty miles east of St. John, and twenty-four miles south of Markhamville. It forms a bold headland protruding into the bay for almost a mile and forming the southern barrier of Quaco Harbour. A branch railway connects St. Martins with Hampton, on the Intercolonial Railway, which runs thence to St. John, making the total distance from Quaco Head to St. John, by rail, fifty-one miles. The mine has been worked at several different times, and up to April, 1889, several hundred tons of ore are said to have been taken out. The property was acquired in 1889 by the Brunswick Manganese Company.

Situation.

Nature of ore.

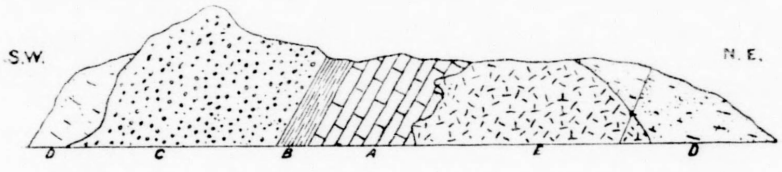
"The manganese is sometimes crystalline, representing pyrolusite and possibly also manganite, while at other times it is hard and massive, possibly representing psilomelane, and still again it is in porous, honeycombed form. These ores are found in Lower Carboniferous shales and limestones, associated with a large conglomerate bed.

Associated rocks.

"The rocks are greatly disturbed and have been much shattered and broken by igneous intrusions. They now stand at steep angles, sometimes almost vertically, exposing, in different parts of the headland, areas of limestone, shale and coarse conglomerate. Masses of igneous material protrude into these beds at different points, and

on either side of the headland are beds of Triassic sandstone and fine conglomerate lying unconformably on the upturned edges of the older rocks.

"The general section [here reproduced] shows the relation of the different rocks. It will be seen that the conglomerate forms the highest part of the headland, that to the north-east of it are successively the shale, limestone and an igneous intrusion, and that the Triassic sandstone occupies both sides of the headland. Geological section.



Horizontal scale 660 feet to 1 inch. Vertical scale 100 feet to 1 inch.

FIG. 3. SECTION ON QUACO HEAD, NEW BRUNSWICK.

A. Limestone.
B. Shale.
C. Conglomerate.
D. Triassic sandstone.

"The manganese occurs as nodules and irregular, discontinuous veins, in both the shale and the limestone, though the larger quantities are in the former. The nodules vary from the fraction of an inch to several inches in diameter, and the thickness of the veins is equally variable. The disturbed character of the rocks renders it somewhat difficult to determine the thickness of the main ore-bearing bed, but it is probably not over thirty feet, though smaller quantities of manganese are found in the rocks on either side. The ore is scattered through this thickness in very variable quantities. The amount of commercially available ore at Quaco Head is small. Mode of occurrence.

"The igneous rock is a hard, light-gray, close-grained material of a texture somewhat like trap. The limestone is like that of Markhamville, though it is much reddened at the contact with the igneous rock. The conglomerate bed is composed of coarse pebbles of metamorphic rocks. It dips steeply to the south, and forms a bold bluff, on which the lighthouse of Quaco Head is situated. The sandstones and conglomerates at each end of the section are of a brick-red colour, and vary from coarse sandstone to a fine conglomerate, with pebbles from a quarter of an inch to one inch in diameter, both sand and pebbles being composed of white quartz stained by a ferruginous cement.

Sometimes these beds contain small irregular seams or nodules of manganese ore, which, however, are in very limited quantity, and have doubtless been derived, during the deposition of the beds, from the erosion of the Lower Carboniferous rocks."

The accompanying analyses by Dr. A. M. Comey, show the composition of the better grades of ore from Quaco Head,

Analyses.

Analyses of Manganese ore from Quaco Head, New Brunswick.

Constituents.	Compact variety.	Porous variety.
Manganese peroxide	71·54	65·00
Ferric oxide	2·19	1·75
Calcium	trace.	trace.
Phosphorus	0·02	0·04
Sulphur	0·00	0·00
Insoluble silicates	8·37	6·66
Manganese	58·20	57·15
Iron	1·53	1·23

"The ore-bearing rocks can be traced back on the promontory at intervals for almost a mile, to a place where an opening has been made on the farm of Mr. Molaskey. On the north side of the Head, small scattered nodules of manganese ore are found in the gravel drift that lines that part of Quaco Harbour and extends inland over the Lower Carboniferous rocks. They have doubtless been derived from the latter rocks during deposition of the gravel, in the same way that the red sandstone just mentioned obtained its manganese contents at an earlier date."

lisbury Bay

On the east side of Salisbury Bay, in Albert county, a small deposit of manganese ore occurs near a contact of Lower Carboniferous and Triassic sandstones, but is not of economic importance.

In the vicinity of Elgin, in the same county, large pieces of good ore are scattered over the surface, but when seen (1878) their source had not been ascertained.*

Shepody Mountain mines.

Shepody Mountain.—This eminence, one of the highest in southern New Brunswick, having an elevation of about 1000 feet, has a composite structure, its lower half being composed of chloritic hydromica-

*Report of Progress, Geol. Surv. Can., 1878-79, p. 18 D.

schists and related rocks, forming a portion of a long ridge of such sediments extending along the St. John and Albert county coasts; while the upper half consists of Lower Carboniferous strata, including the usual association of gray, more or less bituminous limestones, red conglomerates, red and gray sandstones and shales. On the north-east side of the mountain, near the road leading from Hopewell Corner to the Albert mines, the contact of the two sets of rocks may be seen, and in the limestones occurring here are the old excavations of the Hopewell Manganese Mines.

History. These mines were opened about the year 1860, by Mr. Steadman, of Hopewell, an adit being driven horizontally into the limestones for a distance of about five hundred feet. From the latter a considerable quantity, at least 500 tons, was removed and shipped partly to England and partly to the United States, bringing, it is said, about $50 per ton, though exact returns of the product are not now available.

Nature of ore. The ore was a compact black oxide, less crystallized than the ores of Markhamville, but said to be of very high grade. It was found to occur both in veins and beds, of which the latter attained in places a thickness of five feet. Owing to various causes, however, of which little is now known, work was abandoned many years ago, and the works have long been in ruins. It is thought by many that the deposits of manganese are by no means exhausted.

The third class of manganese ores to which reference has been made are the superficial, impure and more or less earthy ores, commonly known as wad or bog manganese. These are found in beds of greater or less extent, and with varying proportions of manganese oxide, in many parts of the province, but with one exception have been considered as being without value. This exception will now be more particularly noticed.

Dawson settlement deposits. *Bog Manganese or Wad of Dawson Settlement, Albert county.*— This very remarkable deposit is located about five miles and a half from the town of Hillsborough, on the slope of a hill inclining northeasterly at a low angle towards a small brook, flowing thence to the Petitcodiac River, and whose opposite slope is occupied by the settlement above named. The upper part of the first ridge is wooded, but between the edge of the latter and the brook the ground is cleared, and upon removal of a thin coating of vegetable matter, usually not more than two inches in depth, is found to be everywhere covered with a very fine black powdery deposit, consisting essentially of manganese oxide.

Extent

The property, as leased, embraces an area of about 150 acres, and upon about eighteen or twenty acres, or as far as searched for, the ore has been found, the deposit varying in depth from a few inches to thirty feet. In a survey recently made by a Crown Land surveyor, seventy-three borings were made, in squares of one hundred feet, over a space of seventeen acres, showing an average depth of six feet seven and three-quarter inches, equal to 1900 pounds to the cubic yard. There is, accordingly, already in sight and available for use :—

	Tons.
In situ on hillside, 17 acres	173,176
In drying-house and sheds	400
Total	173,576

Depth.

According to the statements of the manager of the property, Mr. R. P. Hoyt, to whom I am indebted for assistance and valuable information, the iron rods used in the above borings, in many of the deepest places, failed to go down over twenty-five or thirty feet, and then struck what was apparently hard manganese ore, so that the above results indicate the minimum quantity. The general aspect of the ground is shown in an accompanying photograph, representing one of the numerous trenches dug in the course of development.

Analyses.

Twelve analyses of the ore have been made by competent chemists, including Prof. E. P. Dunnington, University of Virginia, William White, jr., Pittsburgh, Pa., the chemists of the Cambria Iron Works, Johnstown, Pa., the Carnegie Steel Co., Pittsburgh, Pa., and the Illinois Steel Co., Chicago, Ill., the average of these giving :—

	Per cent.
Metallic manganese	45·81
Metallic iron	9·95
Sulphur	·03
Phosphorus	·05
Silica	5·36

Uses.

These ores are thus, in comparison with those of Markhamville, low-grade ores, and would be of little or no value for the uses to which the latter are chiefly put. Nor in their natural condition would they have commercial value of any kind. It is, however, proposed to subject them to a bricquetting process whereby the pulverulent and absorbent mass shall be rendered solid, non-absorbent and capable of easy handling, in which condition it may be advantageously used in the manufacture of spiegeleisen and ferro-manganese. For this purpose an extensive plant, embracing drying furnaces, compressors, bricquetting machines, etc., has been erected close by the manganese deposits,

Proposed application to manufacture of spiegeleisen

TRENCH IN BOG MANGANESE DEPOSIT, DAWSON SETTLEMENT, ALBERT COUNTY, N.B.

and also near to the track of a branch railway, one mile and a half in length, built by the company, and connecting with the Harvey and Salisbury Railway at a point eleven miles from Salisbury, whence, over the Intercolonial Railway the product may be readily shipped to all Canadian and United States points, the freight rate being on a basis of about $5.20 per ton to Chicago. The shipping point by sea is five miles and a half by rail from the mine to Hillsborough, with direct landing at wharf for vessels of 800 to 1000 tons capacity. The rail rate to Hillsborough is about twenty-five cents per ton, the vessel rate to Atlantic ports of the United States, and others at a greater distance, is about $1.00 per ton. Shipping.

On Sawmill Creek, which traverses a valley along the western base of Shepody Mountain, manganese ore has been observed, and is now being exploited by Mr. R. P. Hoyt, of Hillsborough. Other localities.

The following additional localities of bog manganese are indicated by specimens in the Museum of the University of New Brunswick, but of which particulars are not now available:—Richibucto, (Kent county); Bull Moose Hill, (Kings county); Queensbury, (York county); Elgin, (Albert county); Moores Mills, (Charlotte county); and the vicinity of Woodstock, (Carleton county). One of the Fredericton cemeteries, just above the old Government House in Fredericton, is underlain by a bed of impure wad.

According to the scale of valuation in use among consumers of manganese ores (multiplying the percentage of manganese by the price per unit, and forty-five per cent ores being worth twenty-eight cents a unit), the Dawson Settlement ore would have, allowing sixty cents for iron value, a total average value of $13 to $14, though portions of it would range much higher than this. At present it is the intention of the company to use the material solely in the manufacture of steel, and with that object in view it has bought the plant of the Pictou Charcoal Iron Company, at Bridgeville, N. S., to which the ore is to be sent. In the latter place the company is in possession of 4000 acres of woodland and twenty-two charcoal kilns, while the plant at Dawson Settlement, with railway, has an estimated value of about $30,000. The company is known as the Mineral Products Company, the head-quarters being in New York, with Mr. Russel P. Hoyt, of Hillsborough, as general manager. Valuation.

The process of manufacture now in operation at Dawson Settlement may be briefly summarized as follows:— Process o manufacture.

The ore is brought in tram-cars from the deposits near by, and on reaching the works is dumped on a platform on a level with the feed-

hopper of a large revolving "drier," the latter being a cylinder of half-inch iron, five feet in diameter, and twenty-eight feet long, inclosed in a brick chamber 10 x 44 feet, and thirty feet high. By the revolution of the drier, which is heated by wood or coal fires beneath, the material now deprived of a large part of its water, is carried to the end of the brick chamber, and there dropped into a special conveyor, by which it is carried to the foot of a bucket elevator, and by this to the top of the building. Here it is made to pass through a revolving screen with the effect that the finer part passes into and is retained by the "dry ore bin," while the coarser part is carried off to be subjected to the action of a grinder, after which it also comes back to be again passed through the revolving screen as before. Above the drier is a dust chamber with a V-shaped bottom, and provided with a spiral conveyor. By this any fine ore which may be passing along with the steam or gases from the drier is made to settle, and thence passes to the foot of the elevator to be carried to the revolving screen and dry ore bin.

Bricquetting.

From the "dry ore bin" the material is removed to a mixer, there to be mixed with a suitable "binder," the nature of which is not made public. The mixed material is then ready for the bricquetting machine, into which it enters at the top, issuing from below in the form of very compact cylinders, each about three inches in diameter, and about two and a half inches long. These are at once transferred, on the same level, to cars for removal.

Probable origin of bog-manganese deposits.

An interesting question, in connection with these deposits, is that of their probable origin. Upon this point the locality throws very little light, there being absolutely no exposures of rocks anywhere in the vicinity, or any visible source from which the manganese may have come. The nearest rocks are indeed those of the Millstone Grit, though these are doubtless underlain, as at Hillsborough and about the Albert mines, by Lower Carboniferous rocks including limestones. None of these, however, are markedly manganiferous. It is also a little singular that the deposit should have such a decided slope, instead of being, as usual with bog-ores, nearly horizontal. Finally, the abruptness with which the deposit ends along the line of the brook referred to above, towards which it inclines, while no such material is to be found on the opposite slope, is also remarkable and seems to suggest that the ores are the result of deposition from springs originating on the one slope but wanting on the other, while the brook has carried off the excess of the solvent water. In support of this view it may be observed that the hillside on which the ore-beds rest is

remarkable for the number of springs which issue from its surface, in the waters of which both iron and manganese may be readily detected.

In connection with the subject of the origin of the bog-ores of Dawson Settlement, a few words relative to the formation of the older and purer manganese deposits, such as those of Markhamville, Jordan Mountain, Quaco, etc., may not be out of place.

Other views as to origin.

It has been suggested by Sir J. Wm. Dawson that the manganese deposits in the marine Lower Carboniferous limestones of Nova Scotia may have been derived from the decomposition of trappean débris, not unfrequently associated with these limestones and of contemporaneous origin; and a like view is taken by Mr. E. Gilpin, Deputy Commissioner of Mines for Nova Scotia, except that he regards the older strata bordering the Carboniferous tracts as being also a possible source from which the metal may have been originally derived. Both explanations would be equally applicable to the deposits of New Brunswick, for igneous ejections, in the form of dolerite, diabase, etc., are, as at Quaco, a common accompaniment of the Lower Carboniferous limestones; while in the rocks of the Huronian system, such as underlie the manganese-bearing strata at Markhamville and Jordan Mountain, are also contained much material of volcanic or semi-volcanic origin, these in the latter instances having been found to be actual carriers of this metal. On the other hand, the observations made by various exploring expeditions, and especially that of H. M. S. *Challenger*, have made it certain that manganese deposits, much like those under discussion, may be in process of formation over many portions of the sea-floor.

Bituminous Coal.

First discoveries.

There can be but little doubt that among the minerals of New Brunswick, bituminous coal was one of the first to attract attention, its mode of occurrence, ready recognition and obvious utility alike contributing to that result. It is probable that the first discoveries were made at Grand Lake, and from the beds in that vicinity, coal would appear to have been obtained in small quantities as early as 1782;* but it was not until nearly sixty years later, through the explorations of Dr. Abraham Gesner, that the full extent of the areas occupied by coal-bearing rocks was made known. Between the years 1839 and 1841, Dr. Gesner, in addition to the recognition of limited areas of such rocks near the coast, styled by him the "Chignecto Bay

Explorations of Dr. Gesner.

*Rev. W. O. Raymond, in a paper read before the Historical Society of St. John, Dec. 1897.

Coal formation" and the "Westmorland Coal-field" ascertained that a large part of the central counties, including the whole of Sunbury and Kent, with large portions of Queens, York, Northumberland and Gloucester were underlain by rocks of the same age. These general conclusions were subsequently fully verified, especially by the work of the Geological Survey,* with the recognition, however, of the fact that, with a large superficies, owing to the approximate horizontality of the beds, the formation had in all probability but little thickness, and, in direct contrast to the extravagant views of Dr. Gesner, coal-seams of inconsiderable amount. As the facts bearing upon this question have been largely derived from explorations in the Grand Lake region, a brief history of the operations there will be of interest.

Exaggerated views.

Grand Lake deposits.

The coal mines of Grand Lake are situated on its northern side and about its eastern extremity, mainly in the vicinity of the Newcastle River, on the Salmon River, in Chipman, and about the lower part of Coal Creek, the entire extent of the Newcastle basin being estimated at about 100 square miles. The country has an average elevation of not more than fifty feet above the lake, while the surface of the latter is not far from sea-level. The country, except where cut by water-courses, is also nearly flat, with a drift covering varying from a few inches to thirty or forty feet. The lake is navigated by steamboats and small sailing vessels, the distance from Newcastle to St. John by water being forty-five miles, and from Chipman to the same port about fifty-two miles. Chipman is now connected by the Central Railway with the Intercolonial Railway at Norton, a distance of forty-four miles, and it has been proposed that this line be extended, a distance of thirty-five miles, to Fredericton. The means for removal of the product of the mines to market are therefore ample.

Means of access.

Development.

The development of the mines has been very slow. Indeed, through their entire history there has been almost a total lack of combined and persistent effort. For many years the removal of coal was effected in a most desultory way, each farmer upon whose land the seam was exposed devoting a portion of his winter's leisure to getting out what was needed for his own use, or occasionally hauling a load on sleds to Fredericton. A considerable quantity was also sent to the same place or to St. John, mostly the former, by wood-boats, obtaining a ready sale. Little or no care was, however, taken in the handling of the coal. Screening, if undertaken at all, was very imperfectly done, and no attempt whatever was made in the direction of system or economy. To a considerable extent the same state of things still prevails,

Careless working.

*Report of Progress, Geol. Surv. Can., 1872-73.

all tending to give the coal a reputation considerably below its real value. There being only one seam of coal, but twenty-two inches in thickness, and this occurring often so near the surface as to be obtained by the simple process of stripping and quarrying, the coal was liable to considerable deterioration from exposure, dirt, etc., detracting still further from its value. Even at the present time, so slight is the attention paid to preserving the quality of the coal, that it is often loaded and unloaded several times in surmounting the low swells of the surface which intervene between the pits and the wharf, while at the latter it is not even dumped upon a platform, but thrown upon the ground, to be further mixed with earth or crushed by the wheels of passing vehicles.

Thickness of seam.

It has been said that practically only one seam of coal, twenty-two inches in thickness, exists at Grand Lake. The idea that other and thicker seams might be found at greater depths was long entertained, and was favoured by what was known of coal-development in Nova Scotia. Accordingly, in 1837, a company was formed to test this point by boring. As a result, at a point about two miles above the mouth of Salmon River, a bore-hole was sunk to a depth of a little over 400 feet, the return of the borings embracing, at a depth of about 250 feet, "eight feet of shale and coal." The relative amount of each was not stated, and prominence is given to the shale; still the result was regarded as affording some encouragement towards more systematic and extensive mining. Nothing, however, beyond the continual removal of the "surface seam" was actually done, and it was not until 1866 that further borings were undertaken, in this case at Coal Creek. A depth of ninety-six feet was attained, but showed no coal. In 1870 still another boring, but equally without result, was made on Salmon River to a depth of 217 feet.

Result of borings in 1837

Borings 1866.

Results.

Of the above borings the first was certainly unreliable and inconclusive, while the two last were decidedly unfavourable. Still the impression continued to prevail that the question had not been finally settled, and with a view to its determination, the assistance of the Geological Survey was invoked for the purpose of making a more thorough and systematic investigation of the whole subject, the sum of $4,000 being at the same time appropriated by the local legislature for the purpose of assisting the investigation through the use of a diamond drill. In pursuance of these undertakings, the whole field was very thoroughly examined, the position and nature of all outcrops determined, and the geological structure carefully studied; the general conclusion being that the area of the Grand Lake coal-field proper,

embracing about 112 square miles, was evidently that of a shallow basin, with a maximun depth not exceeding 600 feet, and of this fully 200 feet belonging to the lower or barren measures. This conclusion was in a measure confirmed by the results of the borings, which at a depth of 217 feet were found to have passed entirely through the coal formation, bringing up characteristic cores from underlying and older rocks, and showing no trace of any beds other than those near the surface. Notwithstanding, however, the removal, which would thus seem to be conclusive, of any reason for belief in deeply seated beds, the same observations sufficed to show that the surface seam, if, as is probable, the latter underlies the entire area, must contain a large quantity of coal, and that this, from the ease with which it is worked must possess a considerable aggregate value. Taking only the Newcastle area proper into account, the estimated amount of coal contained therein is 22,135,449 tons, or, if the associated areas of Salmon River and Coal Creek be included, (about which the information is less conclusive,) the total will be nearly 155 million tons. Of this it is probable that from 100,000 to 125,000 tons have already been removed.

Borings 1873.

Estimated capacity of Newcastle coal-fields.

Annual output.

The output of the Grand Lake coal mines in 1863 was about 3000 chaldrons, and since that time has averaged about 4000 chaldrons annually, the chaldron being about one and a half tons or 3200 lbs. Of this about 1000 chaldrons go to Fredericton, where the coal is used in the electric light works and water-works, as well as in factories, mostly for steam-making purposes. Its selling price in Fredericton is now about $3.50 per chaldron, though in some cases as high as $4. It is sent by water, at a cost of eighty cents per chaldron. From Newcastle all the coal now goes by water, either to Fredericton or St. John, the price being about the same. From Chipman none has been shipped by water either to Fredericton or St. John, but what is here raised (the amount being small,) is used on the Central Railway.

Markets.

Manufacture of, coke.

In 1891 an attempt was made to manufacture coke; and again, two years later, by Messrs. Geo. King and Silas McMahon, but the work was not pushed beyond a test. The coke was pronounced good, but for some reason not ascertained the work was abandoned.

Methods of mining.

The average work of one man at the mines is about one chaldron per day, of good coal, at a cost of $1.50. With a thicker seam coal could be readily extracted at a cost of fifty cents.

The soil covering varies from three feet to thirty feet. If not more than seven or eight feet in depth the soil is "stripped." Beyond that depth it is usual to go under. The seam lies nearly at the level of

the lake, and much difficulty is experienced in connection with drainage. No pumps have been used, except in one instance, by Mr. MacFarlane, of Fredericton, the small size of the seam not making the inducement sufficient for the introduction of steam pumps.

Recent examinations.

In the Geological Survey Report for 1873, full descriptions are given of all the openings made up to that time. During the visit of the writer in 1897, an interesting opening had just been made on the farm of Robt. Cox, now leased to the Central Railway on the Emigrant Settlement road, about four miles from Newcastle Landing. It is fairly representative of all. A stripping has been here made showing a surface of coal for about fifty feet in length by ten feet in width, and having a gentle slope west-northwest of about one foot in twenty. The soil covering, which at one end is about five feet deep, increases to about ten feet at the other, and is largely clayey, with many imbedded blocks of sandstone and shale. The following is a section of the exposure:—

Soil	5 to 10 feet
Good coal	22 inches.
Shale and clay	6 "
Coal	11 "
Fire-clay, at least 4 feet deep, but of which the bottom has not been reached.	

The coal is firmer and can be mined in larger lumps here than at many of the openings in the vicinity. The seam is doubtless the same as at other localities in the Newcastle field, differing only in the fact that the clay and shale parting found here between the upper and lower part of the seam, is elsewhere usually shale only, locally known as "bone". The lower coals are usually not removed, as affording a good solid foundation on which to work, in preference to the soft clay beneath.

Transport.

It may here be noted that a tramway down the valley of Newcastle River would pass near most of the important openings, and by doing away with the loading, dumping and reloading already alluded to, (which tends to reduce the coal to very small fragments, if not to dust), would serve to bring the coal to market in a much more satisfactory condition.

Other areas.

As to other parts of the New Brunswick coal-field, it would be out of place to describe here in detail all the localities at which outcrops of coal have been observed. In most instances the seams are small and of no economic value; but as bearing upon the general question

*Report of Progress, Geol. Surv. Can., 1878-79, p. 20 D.

of the character of the field and its possible supply, it may be well to enumerate them briefly.* They are as follows :—

QUEENS COUNTY.

Coal occurrences.

Clones Settlement.—According to explorations made here by Dr. G. F. Matthew, there are two seams, with thicknesses respectively of one and two feet. The quality of the coal is good, and some attempts to work it were made in 1872, but the situation of the mine being unfavourable, these were soon abandoned.*

Otnaboq and Mersereau Brooks. Report of Progress, 1872-73, p. 219.

SUNBURY COUNTY.

Near Tracey.

North-west Oromocto, below mouth of Hardwood Creek.—Seam of five inches.

Three-tree Creek. Borings made here reached a depth of 600 feet, but failed to show seams of coal.

North-west Branch of Oromocto River, one and a half miles above the mouth of the Yoho stream. Coal seams four and five inches.

YORK COUNTY.

Nashwaaksis River.
Taxis River.
Cork Settlement.
Prince William.

KENT COUNTY.

Coal Creek.

GLOUCESTER COUNTY.

Bay Chaleurs.

New Bandon or Stonehaven.—The stone quarries opened at this locality, as well as at Clifton, near by, upon the southern shore of the Bay Chaleurs, besides affording a fine exposure of Carboniferous strata, lying probably near the base of the system, show also a seam of coal about eight inches in thickness, while other seams are said to show at low water, one of them with a thickness of eighteen inches. The strata

*Report of Progress, Geol. Surv. Can., 1872-73, p. 219.

exposed in the nearly vertical bluffs which form the shore for several miles, consist below of massive sandstones, often of pale-greenish colour, with thin intercalated beds of shale (the latter often replete with fossil ferns admirably preserved), and above of gray, green and red crumbling shale, the whole series showing a very gradual south-east dip. As representative of the probable structure of a large part of the coal-field in this county, this coast-section is very instructive. The total thickness of exposed beds is about seventy-five feet.

KINGS COUNTY.

Dunsinane, Kings county.

Dunsinane.—At this locality, which is a few miles east of Sussex and close to the track of the Intercolonial Railway, a seam of bituminous coal occurs, with a thickness of about twenty inches, the associated rocks being gray sandstones with blue, gray and reddish shales. In the latter are typical Carboniferous plants. A number of excavations have been made, in one instance to a depth of sixty feet, but without further result than that stated.

During the year 1897, boring operations were undertaken with the drill belonging to the provincial government, and a depth of nearly 1300 feet has since been reached. All the rocks passed through are such as belong to the coal formation, most of them being fine bluish-gray sandstones, associated with grit and fine conglomerates, but without red rocks. The unexpected thickness of the Coal Measures at this point is very remarkable, and must have an important bearing upon the possible thickness elsewhere.

Longs Creek, Queens county.

Longs Creek, (near mouth.)—Seam ten to twelve inches, but very impure.

Discussion on coal supply.

In regard to the question of the probable productive capacity of the New Brunswick coal-field, the facts afforded by the Newcastle or Grand Lake basin are of the utmost importance. Considering the results of the careful surveys of this district (fully detailed in the Geological Survey Report for 1873), together with the results of borings and mining operations, no reasonable doubt can be entertained that, in this particular basin, the coal formation is very shallow (probably not exceeding 500 feet), and that the twenty-four inch seam which has there been so long worked is practically the only one present. The structure of the district at the same time shows that this seam, occupying a low position in the Carboniferous formation, rests upon a floor of older rocks, including red sediments and trappean overflows of the Lower Carboniferous formation, in such a way as to clearly indicate not only unconformity but also extensive erosion between the two. It

Thicker seams possible.

is, therefore, possible that while the Coal Measure rocks over certain tracts, as over prominent ridges of the underlying beds, may be very thin, (or, as at Newcastle Forks and Coal Creek, may allow these to protrude through then.), at other points, where underlying pre-existing valleys or depressions exist, they may have a thickness corresponding to these depressions. In these latter cases it is also possible that, with greater bulk of strata, they may include more seams of coal.

This condition of things is really typical of the entire central coal-field of the province. The strata are everywhere in an attitude varying but little from horizontality; the seams of coal approximate in thickness to that of Grand Lake; the associated fossil plants indicate about the same horizon; and the thickness of beds exposed in river-sections are too inconsiderable to admit of any conclusion being drawn as to what the total thickness is, or the extent to which it may vary. The only possible way, therefore, by which to test its productive capacity, is that of instituting systematic borings, along several parallel lines, at such intervals as may clearly indicate the varying thickness of the formation, and reveal the presence of additional seams of coal, if any such exist. Even should the results be negative, the information obtained would be of value as substituting certainty for conjecture, and thereby tending to save the useless expenditure of money.

Three-tree Creek, York county, 1897.

In addition to the borings at Newcastle, Salmon River and Coal Creek, previously referred to, borings have already been made at several other points with negative results. One of these was at Three-tree Creek, near Fredericton Junction, where, in the year 1873, a diamond drill penetrated to a depth of 600 feet, but found no coal.

Borings at Moncton, 1897.

Another locality is the vicinity of Moncton, where during the summer of 1897, with a diamond drill leased from the local government, a number of bore-holes were made, in some instances to considerable depths. A visit to one of these was made by the author of this report, the locality being the farm of Peter Wilson, about nine miles north-west of Moncton and near the base of the southern slope of Lutes Mountain. This latter is a ridge of coarse red conglomerate, of Lower Carboniferous age, associated with reddish felsites, boulders of which strew its sides. The bore-hole is close to Wilson's house, and less than a furlong from the conglomerate ridge. At the time a depth of 120 feet had been reached, about two-thirds of this being in a very fine rather dark-gray sandstone, while the beds below were generally reddish, though less markedly so than is usually the case with Lower Carboniferous strata. No beds of coal were passed through and this

notwithstanding the fact that an eighteen inch seam was said to have been exposed, some fourteen years ago, within a few feet of where the present boring has been made. No rock is visible at the surface, the beds being covered with about eighteen feet of clay, in which some small fragments of coal were seen. Two miles west of the above, another boring obtained a depth of 737 feet. It is proposed that the cores obtained from these several borings, together with those derived from the operations at Dunsinane, shall be sent to Fredericton for critical examination. The results there obtained, with additional data derived during the past summer (1898) from examinations over various parts of the coal-field, will be embodied in another report now in course of preparation.

Anthracite.

First discovery.

The occurrence of anthracite coal, in limited quantities, in the Devonian rocks of St. John county, was first brought to notice by the observations of Dr. A. Gesner,* in the year 1839, small seams of such coal having been noticed by him in the neighbourhood of the Lepreau River, and subsequently, in the form of trunks of trees converted into anthracitic matter, in the vicinity of Little River, east of the city of St. John. Later observations showed that such coal was not of uncommon occurrence in the rocks referred to, but at two points only, both in the Lepreau basin, and not far apart, did the quantity of coal appear to be such as to warrant any attempt to work it.

Location at Lepreau Basin.

The locality in which mining operations was first undertaken, in 1877, was that of Lepreau Basin, a short distance west of the line between St. John and Charlotte counties, on the land of Mr. G. K. Hanson.† Several shafts were here sunk, one of them reaching a depth of 140 feet, the strata penetrated consisting largely of gray sandstone, but with alternating beds of shale, both of which carry, somewhat abundantly, characteristic Devonian plants. At a depth of 125 feet a seam of mixed coal and shale was found, having a total thickness of fifteen feet; but the shale was irregularly distributed through the coal, of which not over four feet could be found at any one point, and this much mixed with earthy matter. An analysis of samples from the outcrop, made by Dr. B. J. Harrington, gave 36·88 per cent of ash; though two other analyses, of selected samples from lower levels, reduced the proportion of impurities to twenty-one and fourteen per cent respectively. When tested on a large scale for steam

Result of boring operations.

* First Report on Geology of New Brunswick, pp. 51-53.

† Report of Progress, Geol. Surv. Can., 1876-77, p. 345.

producing purposes, the coal is said to have ignited readily, and to have had good heating capacity, but, as might be expected, burned imperfectly, leaving a considerable quantity of clinker. Work was carried on at this locality, more or less continuously, for four or five years and then abandoned. Considering the nature and age of the associated rocks, the impurity of the larger part of the product and the difficulties attendant upon its removal, it does not seem probable that mining operations of a profitable character are ever likely to be prosecuted here.

Development.

Albertite.

No mineral found in New Brunswick has awakened more interest than this. None is so peculiar in its nature and associations, none has been the subject of greater controversy, both scientific and legal; upon none has more capital been expended, and from none has a larger return been obtained.

Geological horizon.

The mineral is essentially confined to the Lower Carboniferous formation, though in very limited quantities it has also been observed in underlying metamorphic slates and in overlying Coal Measures. By far the larger part is confined to heavy beds of very fine-grained dark-gray to black bituminous shales which occur near, if not at, the base of the Lower Carboniferous, penetrating these shales in the form of veins.

Physical character.

Albertite is soft and brittle, jet black, brilliantly lustrous and breaks with a marked conchoidal fracture. In its physical characters it bears much resemblance to asphaltum, but is less friable, is differently affected by solvents and has a different chemical constitution. Though for a long time regarded as unique, it is now thought to be identical or nearly so with the mineral gilsonite, found in small quantities in Utah as well as with the grahamite of Western Virginia. Its hardness is 3, nearly, of Moh's scale, its specific gravity being from 1·08 to 11·1. It may be readily ignited in the flame of a spirit lamp, and may be melted, though less readily than asphalt. It is of uniform quality, and under the microscope reveals no trace of structure. The conditions of its occurrence and its characteristics, both physical and chemical, favour the idea that it is an oxidized hydrocarbon, related to petroleum, and originally in a condition of partial or complete fluidity.*

Probable origin.

*Albertite has been recently found in small quantities forming veins and irregular masses in the pure white and stratified gypsum of the Hillsborough quarries. No stronger evidence of its character as injected hydrocarbon could be desired.

A full description of the history of the Albert mines, involving a protracted dispute as to the nature of the deposit and its consequent ownership, would be too lengthy for the present Report, and reference may therefore be made to the Report of Progress of the Geological Survey for 1876-77 (pp. 351-401) in which the subject is very fully treated, and which is accompanied by a map showing the geographical distribution of the albertite-bearing shales. A brief summary of the more important facts is all that can be given here.

Reference to Reports of the Geological Survey.

The vein was originally discovered in the year 1849, on Frederick Brook, about four miles south-west from the town of Hillsborough, and showed at the surface a thickness of sixteen feet. The title to the property having been determined, on the supposition that the albertite was a variety of coal, and therefore reserved to the Crown, a company was at once formed for its development, and operations actively entered upon. These were continued for a period of fourteen years, the greatest output being in the years 1865 and 1866, in each of which the shipments were 20,500 tons, while the total from 1863 to 1874 was 154,800 tons. The royalty paid to the Government up to January, 1866, was $8,089.29. The exportation was principally to the United States, where the mineral was partly employed as an enricher in the manufacture of coal gas and partly in the making of oil. The yield of the latter was said to be about 100 gallons to the ton, while the gas-product was 14,500 cubic feet per ton, of a superior illuminating power. The price at which it sold varied at different periods from $15 to $20 per ton on the wharf at Hillsborough, but its present value, owing to the competition of petroleum, would be greatly reduced. In the course of the operations, it was found to occupy an irregular and nearly vertical fissure, to have a thickness varying from one inch to seventeen feet, to have numerous branch veins, in places cementing innumerable fragments of the shattered strata and even crystals of selenite into a sort of breccia, and finally to show, through much of its extent, complete discordance with the associated strata. The depth attained was over 1100 feet. The width of the vein in the lower workings was greatly diminished, and as a consequence gave a greatly lessened output. Between 1869 and 1870 there was a falling off from 17,000 tons to 6000 tons, and from this time little was done beyond exploratory work and the removal of reserves. These having finally become exhausted and all efforts to find new veins or enlargements of old ones having been ineffectual, the works were closed down.

Discovery.

Development.

Value.

Mode of occurrence.

Both before and since the stoppage of the Albert mines, many attempts have been made to discover deposits of a similar nature at

Later attempts to discover similar deposits.

different points in Albert and Westmorland counties, where the occurrence of the characteristic bituminous shale seemed to render its presence possible. In several instances these attempts led to the discovery of veins of albertite, but in no case of such a size as to warrant the expenditure of capital in working them.

The facts relating to the possible occurrence of workable deposits of albertite are fully detailed in the report to which reference has already been made. The circumstance that the mineral has been found at points so distant as Norton station in Kings county and Beliveau in Westmorland county, the one fifty miles west and the other ten miles east of the Albert mines, is interesting as indicating the extent of the area over which the conditions resulting in the formation of albertite must have prevailed; but apart from the mine referred to, no facts at present known warrant a belief in its occurrence in other than small veins. At Beliveau, a shaft was sunk to a depth of 500 feet, and large sums of money were spent in exploratory work, but without favourable results.

Geological range.

Bituminous Shales.

The only development of these shales which is of economic importance, is that already referred to as being, in Kings, Albert and Westmorland counties, holding veins of albertite. Apart, however, from this fact, these shales are capable of yielding products which, even if not immediately available, are likely in the future to become of considerable value.

Geological position.

The position of the shales, geographically and geologically, has already been referred to. Lying for the most part along the northern side of the ridge of pre-Cambrian metamorphic rocks that occupy the larger part of St. John and Kings counties, they occur at intervals all the way from Norton station on the west to the vicinity of Dorchester on the east; while their stratigraphical relations and contained fossils indicate that they occupy a position near or at the base of the Lower Carboniferous formation. Full particulars as to both of these points are given in a special report contained, with accompanying map, in the Report of Progress of the Geological Survey for 1876-77.

Exposures at Baltimore, Albert county.

The best exhibition of these rocks, viewed from an economic standpoint, is to be seen in the settlement of Baltimore, Albert county, at which point operations for their working and treatment were undertaken about the year 1862. As seen at this point they consist, for the most part, of heavy beds of a very dense, tough and fine-grained charac-

ter, from dark-gray to black in colour, effervescing readily upon the addition of an acid, and when rubbed emitting a strongly bituminous odour. Subjected to heat in furnaces erected for the purpose, the shales readily yielded oil to the amount, in the case of the best bed, known as the "black band," of sixty-three gallons to the ton; while the gas-yielding capacity per ton was 7500 cubic feet. In fact, the rock of this band may fairly be regarded as a true cannelite, closely resembling some varieties of the latter in specific gravity, colour and lustre, and like this mineral readily igniting and burning. Blocks, cut from the mass, are jet-black in colour and on polished surfaces much resemble jet.

Amount removed.

During the course of operations at this locality, openings were made upon six different strata, the available beds varying from a few inches to four feet. In all about 1000 tons were extracted, and the operations would, no doubt, have been a source of profit, had it not been that the discovery, about this time, of the flowing petroleum wells of Pennsylvania brought the latter into active competition, making the further manufacture of the oil at Baltimore impossible. A few years later (in 1865) about 2000 tons of similar material, but less rich than at Baltimore, were removed from Taylorville, on the Memramcook River, in Westmorland county, and exported to the United States, selling there at the rate of $6 per ton.

Petroleum.

Occurrence of oil at Albert mines, etc.

It has already been stated that the Albert shales, as seen at Baltimore and Memramcook, have been made the basis of the manufacture of oil, as also that the mineral albertite is in all probability an oxidized mineral oil derived from these same shales. It is now to be added that these are in places so saturated with petroleum as to result in a direct, though small, natural flow of the latter. This fact was well shown during the course of the operations in the Albert mines, when buckets placed in certain positions were found, after periods more or less prolonged, to be filled with oil. The gray sandstones associated with the shales, and for the most part above them, were found to be even more prolific than the shales themselves, and from these sandstones petroleum has been obtained, not only at the Albert mines, but in Upper Hillsborough, Beliveau and Memramcook. In the rear of St. Joseph College, in the last-named village, is a well from which small quantities of petroleum have been obtained, while at Dover, in the same county, a similar flow of oil has, by oxidation at the surface, given rise to deposits of maltha. Jets of inflammable gas are occa-

Inflammable gas.

sionally met with in connection with springs and streams in the same district.

Results borings.

Several attempts have been made by boring, in one instance to a depth of 2000 feet, to discover such oils in available quantities, but so far the flow has, in every case, been found to be too small to admit of profitable collection. It is possible that, with a more careful selection of locations, and with greater regard to the principles of geological structure, future efforts in this direction may be more successful. The facts relating to the albertite deposits seem to point to the former existence, in this region, of enormous quantities of oil, and unless this has been wholly oxidized into the condition of that mineral, (a view at least partly negatived by the occurrence of petroleum) it is difficult to assign a reason why it should not be still available.

GRAPHITE.

Strata containing more or less disseminated graphite or plumbago, occur in connection with rocks of varied age and character in the province, but are especially distinctive of the upper portion of the Laurentian system as found in St. John county. They here consist largely of limestones, and in places carry sufficient bodies of graphite to admit of being worked.

Beds at Suspension Bridge, St. John.

The only point at which operations have been undertaken, is in close proximity to the Suspension Bridge, near the mouth of the St. John River, on the eastern side.* The first opening was made here some twenty-five years ago, close to the water's edge, and a quantity was shipped to the United States. Somewhat later, work was resumed by Mr. S. S. Mayer, of Carleton, from a point on the land of Messrs. Hazen and Botsford, some 600 yards from the river; a few hundred tons being removed, which was also sold in the United States. These works having also been abandoned, Mr. W. F. Best and others united in an effort to revive the industry by sinking a shaft in what was regarded as a position more favourably situated for working. This was 200 feet north-east from Mayer's workings, and four feet from the face of the limestone cliff. At fifteen feet below the surface the deposit was reached. The top was found to be in the form of the sharp edge of a wedge, which widened out rapidly, until, at a depth of thirty feet, it was eight or ten feet wide. Great difficulty being experienced on account of water (from the old workings) which penetrated the loose limestone, making it necessary that a pump should be constantly

Difficulties.

* For information relative to these deposits I am indebted to W. F. Best, analytical chemist, St. John.

employed, it was decided to start a level at the depth above mentioned. A drift from the shaft to the north-east resulted in showing a continuous mass of the material between layers of limestone and trap, which here come together and present an unbroken face as far as work was continued.

The quality of the graphite at thirty feet, was found to be far better than that of the first samples from the apex of the wedge, and could the deposit be tested with a diamond drill it is not improbable that at a lower level a still further improvement might be met with. Quality.

When this shaft was first opened, the results were fairly satisfactory, about $1,200 worth of the mineral being sold in two or three months. The workings were, however, expensive, chiefly on account of water, and a "combine" among the manufacturers of foundry facings having caused sales to fall off, it finally became necessary to again suspend operations.

The first shipments were made to Chicago, Cleveland, and other western points, the average price obtained being $7 per ton delivered on the railway at Fairville, St. John county. After the closing of the works, inquiries were made for several lots of ten car-loads each, but these orders could not then be filled. Somewhat later, the mine was opened by the Canada Paint Company, which uses graphite in connection with the manufacture of certain kinds of paint, but we are without information as to the results of their experience. Markets.

In the case of a specimen of "disseminated graphite" from the old Split-rock plumbago mine, near the St. John River falls, collected by Mr. Wallace Broad and examined by Dr. Hoffmann in the laboratory of the Geological Survey, the associated earthy matter, amounting to about six per cent, having been excluded, the residue gave* :— Analysis.

Graphitic carbon	48·775
Rock matter	50·058
Hygroscopic water	1·167
	100

A quantity of the graphite having been extracted, and its comparative freedom from foreign matter having been assured, samples were sent to England for the purpose of having them practically tested. The result is thus stated by Dr. Hoffmann :— Practical tests.

"In the one case—that examination has shown the graphite to be of fair quality and adapted to the manufacture of the commoner kinds of

* Report of Progress, Geol. Surv. Can., 1878-79, p. 3 H.

lead pencils; although its 'quality and nature' does not equal, as far as suitability for pencil making is concerned, the graphite obtainable in Bohemia and some other places.

Results.

"In the other—and as regards its employment in electrotyping—the trial did not give a very good result; it was not considered so good as that which they were in the habit of using for this purpose."

This failure to meet the higher requirements of the application of graphite, notwithstanding its purity, was thought by Dr. Hoffmann to result from its state of physical aggregation, as implied in the terms "quality and nature" quoted above.

Peat.

Occurrence.

Peat-bogs are of common occurrence in New Brunswick and in several places cover large areas. The regions in which they are especially noticeable are the southern part of Charlotte county, the adjoining portions of St. John county, and the district bordering the Gulf of St. Lawrence. They have been made a subject of survey and study by Mr. R. Chalmers* and Prof. W. F. Ganong, and from an article by the last-named gentleman relating thereto, published in the transactions of the Royal Society of Canada, 1898, the following extracts bearing on their economic applications are taken :—

"Finally, the economics of the raised bogs merit some attention. In Europe the moss from them has long been used, and in great quantities, as a bedding for horses and for various sanitary purposes, for which its antiseptic qualities and great absorptive power make it especially adapted. It can absorb some twenty times its own dry weight of water, and in stables, by absorbing all liquid matters and allowing the water to evaporate, it retains the nitrogenous matter and becomes a valuable fertilizer. Considerable quantities are imported into New York from Germany for stable use, but no attempt to utilize our own bogs for this purpose appears to have been made until a few years ago, when a company, attracted by the great purity of the Spruce Lake bog (western St. John county), attempted to work it. It was soon found that natural methods of drying the moss as practised in Europe are not here practicable, partly on account of the cost of labour, partly on account of the foggy weather. Five years ago the bog came into the hands of Mr. W. F. Todd, of St. Stephen, N.B., who attempted to make steam and machinery supplant hand labour

Operations of Mr. W. F. Todd.

*Annual Report Geol. Surv. Can., vol. III,(N.S.),1887-88, pp. 22-25, N. *Ibid.*, vol. IV. (N.S.), 1888-89. p. 70 N., p. 89 N., and p. 27 S. *Ibid.*, vol. VII. (N.S.), 1894, pp. 121-146 M.

and artificially replace natural heat. After long experimenting, an ingenious system of machinery was constructed by which moss was dug from the bog, passed through presses and hot air chambers and over hot air cylinders, and pressed into bales ready for shipment, all within three hours from the time it was in the bog, and without being touched by a workman from start to finish. The German process requires weeks of time and many handlings. The product of the new process is a spongy, finely divided substance, which is considered by good judges to be greatly superior to the imported material. In the autumn of 1895 the buildings were burned and have not been rebuilt. The supply is exhaustless, and if the many new uses occasionally reported for the fibre prove to be extensive, or if its preparation for stable purposes can be made profitable, it will be the basis here of a large industry."

Results.

To the information given above, Prof. Ganong now adds:—"Another very fine bog owned by Mr. Todd is at Seely Cove, and another owned by Mr. Oscar Hansen at Little Lepreau. These three are the best, but there are some twenty-four of fair size scattered from Beaver Harbour to Spruce Lake.

Hansen's peat-bog.

"The chief difficulty to be overcome in working these bogs, next to the foggy weather, is the freight rates, which are high to New York by rail; but if the material can be worked in large enough quantities, it could be easily sent from any of these bogs by schooner.

Difficulties of working.

"The moss is coming to be much used in hospitals in Europe, and the moss powder is said on good authority to be germicidal. It has also been found that the fibrous part can be woven, and is said to have been made into a pulp from which boxes and ornaments of a rich dark-brown colour have been made."

Uses.

A considerable quantity of the moss from the Spruce Lake bog was sold in the province and is reported to have given satisfaction.

It has also been suggested as a material adapted for packing perishable goods, and a consequent substitute for cold storage. It was recommended for this purpose by the late Edward Jack, C.E., and it is stated that the result of an experiment in the shipping of fruit to England, packed in this way, was entirely successful.

The area of the Spruce Lake bog is from 350 to 400 acres, while the depth is sometimes more than twenty-four feet. In sounding with a rod, Prof. Ganong was unable, at several places, to find the bottom

Area of Spruce Lake bog.

*Report of the Department of Agriculture, 1893.

at a depth of sixteen feet, and Mr. Todd met with the same result at a depth of twenty-four feet.

Spruce Lake bog.

At Spruce Lake, according to Prof. Ganong, practically the entire deposit, except for two feet on the bottom, is adapted to the same uses. It is a pure sphagnous moss, with stems of sedges and some small roots of the dwarfed woody perennials, the latter not being in any way troublesome. Some parts are drier than others, but do not differ materially in composition. The proportion of sphagnum to sedge stems, etc., is far greater in these bogs than in specimens seen from Welland, Ont. The true peat forms a layer on the bottom, two to three feet thick, and no thicker, wherever trenches have been dug. Above that layer all of the moss is utilizable for bedding, etc., thus giving twelve feet or more in the places where the trenches have been dug. A micro[illegible]pic examination made by Prof. Ganong of samples from different depths, shows that the conversion into peat does not even begin until a depth of seven or eight feet is reached, and it proceeds very slowly at lower levels. Mr. Todd's work shows that the moss makes good litter down to within two feet of the bottom or to depths of about fourteen feet. How it is in greater depth is unknown. There is also a fringe of peat around the margin over which the moss at a later period grows.

True peat.

Lepreau and Seely Cove bogs.

The area of the Lepreau bog is from 300 to 350 acres, and the known depth, as sounded by Mr. Hansen, from sixteen to twenty-three feet, in each case without bottom being reached.

The area of the Seely Cove bog is about 250 acres, and the depth unknown.

The true peat, as far as ascertained, has not been practically employed as a fuel.

Bogs in N.E. New Brunswick.

The following notes on peat-bogs in north-eastern New Brunswick, are quoted from the reports of Mr. R. Chalmers :—

Gloucester county :—

Miscou Island

1. A large peat-bog occurs on Miscou Island, covering fully half the entire island. "It occupies a shallow basin in the Middle Carboniferous rocks, portions of the rim of which are being eroded by the sea. The surface of the bog is ten to twenty-five feet above high-tide level in the centre, while the bottom, which is full of the roots of shrubs and small trees *in situ*, seems to lie below that of the lowest tides, and wherever visible appears to rest on gravel and sand. The bog as already mentioned, is dotted all over with ponds, which form

favourite resting places for the wild geese and brant in their passage over the region every spring and fall. Cranberries abound on it.

2. "A peat-bog about three miles long and a mile and a half wide, was seen on the east side of Shippegan Island, which also rests on a hard-pan of gravel and clay. The surface is ten to fifteen feet above the sea and is likewise destitute of trees. Numerous ponds were observed on it. In the bank the peat is ten feet thick, the bottom lying below high-tide level. Shippegan Island.

3. "The neck of land between St. Simon Inlet and Pokemouche Harbour, is formed of peat. Similarly to the two bogs just described, it is considerably higher in the central part than at the margin, but is nowhere more than ten to fifteen feet above high-tide level. Immense quantities of cranberries grow upon it." St. Simon Inlet.

Northumberland county :—

4. "South of Tracadie River, near Point Barreau, a peat-bog borders a lake, both being surrounded by a tamarac swamp. Point Barreau.

5. "An extensive bog occurs on the west side of the mouth of Tabusintac River, length about three miles, width two miles. Its general features are the same as those described. It is also a favourite resort for wild geese, brant, etc., every spring and autumn. Tabusintac River.

6. "On the east side of Point Cheval a bog was also seen which thins out on the northern margin over an old sand beach." A section of this bog is given on page 24 N. of the report cited. Point Cheval.

7. "A large and interesting peat-bog was observed at Point Escuminac . . . . . covering an area of six or seven square miles. It is highest in the middle and also dotted over with numerous small ponds. . . . . Mr. Phillips, lighthouse keeper at Point Escuminac, informed me that he found it twenty-four feet deep in one place. Like those already described it is almost treeless, but is partly covered with heath plants." A section of this bog is also given on the page above referred to.* Point Escuminac.

Kent county :—

8. "An extensive peat-bog lies on the north side of Kouchibouguac Harbour. Kouchibouguac.

9. "Another occurs on the coast about a mile south of the mouth of Kouchibouguacis River facing the sea.

*The above quotations are from Annual Report, Geol. Surv. Can., vol. III. (N. S.), pp. 22-25 N.

Aldouane.

10. "A third occupies part of the peninsula between the estuary of Aldouane and the coast of Northumberland Strait. This bog is large and raised in the centre and merges into the salt-marsh on the shoreward side.

Near Kingston.

11. "Two large bogs occur along the Kent Northern Railway, situated from one to five miles above the village of Kingston." *

A number of other peat-bogs are enumerated in the reports cited, and although no use has yet been made of peat in north-eastern New Brunswick, Mr. Chalmers states that should it ever be required for fuel, or for any other purpose, there is here an almost inexhaustible supply.

Limestones.

Geological horizons.

Limestones are met with in the province of New Brunswick in not less than six distinct geological formations, and therefore with much diversity of association and character. As will appear below, their value as a source of lime appears to be nearly in direct proportion to their age.

A. Laurentian Limestones.—These include all the heavy beds of this rock exposed on either side of St. John River from Grand Bay to the Suspension Bridge, together with their extensions westward to Musquash and Lepreau, and eastward along either side of the Intercolonial Railway to Hampton. They are distributed in several parallel belts, disposed with reference to a general anticlinal structure, but severally exhibiting great diversity of attitude, as also of colour and texture. Certain beds sometimes attain a thickness of 350 feet, but usually alternate in thinner beds with fine-grained siliceous and dioritic rocks or with quartzites. Diorite dykes of all dimensions also cut the beds, the latter frequently exhibiting, for some distance on either side of the intrusive mass, a marked alteration as the result of the high temperature accompanying the intrusion of the diorite. The best limestones are dark-gray in colour from disseminated graphite, which, however, is wholly lost in calcination.

Distribution in St. John county.

It would appear that the limestones of the St. John River narrows, which still form a striking feature in the scenery, were seen and described by Champlain and his associates not less than three hundred years ago. It is also asserted that from them came the lime used by Brouillon in rebuilding the fort at Port Royal in the year 1701.

Used by Brouillon in 1701.

*The above bogs in Kent county, are described in Annual Report, Geol. Surv. Can., vol. VII. (N.S.), pp. 117-122 M.

Somewhat later, but before the landing of the Loyalists, St. John lime was exported, in small sloops, to Newburyport and other New England ports, having even then a high reputation. It has at all times been preferred to other limes for use in the Maritime provinces, but as an article of export has only acquired importance in recent years.

Later exports.

The following figures of exports, (all to the United States), taken from the Trade and Navigation Returns of Canada, will serve to give some idea of the extent of the industry, as well as the variations in the amount of the product exported, between the years 1881 (when the trade practically began) and 1897 :*

1881,..	3,644	brls,.. Value, $	1,822
1882,..	6,804	" .. "	3,402
1883,..	10,488	" . "	5,244
1884,..	6,840	" .. "	3,420
1885,..	9,850	" ..	4,925
1886,..		" .. "	
1887,..	76,858	" .. "	38,429
1888,..	183,680	" . "	91,840
1889, .	232,710	" .. "	116,355
1890,..	286,584	" .. "	143,292
1891,..	203,668	" .. "	101,834
1892,..	120,350	" .. "	60,175
1893,..		" .. "	61,017
1894,..		" .. "	25,598
1895,..		" .. "	35,709
1896,..		" ... "	22,035
1897,..		" .. "	15,634

There are about twenty-four draw-kilns in the vicinity of St. John, the most important quarries being the following :—

Armstrong's quarry.

I. and F. Armstrong's quarry.—Green Head.—This quarry was opened about the year 1825 or 1828, but for several years with an output not exceeding 800 casks per year. About 1837, this amount, under a different ownership, was increased to 1100 casks, and in 1839 to about 1500 casks. In 1866 the output had increased to about 10,000 barrels, and since that time has not varied greatly from this amount.

The width of the bed at this quarry is about 300 yards, with an exposed face of nearly 100 feet. The facilities for shipment are excellent, and the lime has always held a high reputation.

*Fiscal year ending June 30th.

Miller and Woodman's quarry.—Narrows of St. John River.—The rock here, as at Green Head, is a dark, somewhat graphitic limestone, the worked face being about forty feet.

Randolph and Baker's quarry.

Randolph and Baker's quarry.—Narrows of St. John River—There are here two kilns, each with a capacity of 120 to 140 barrels of lime per day, and therefore, for the nine months during which they are kept running (March to December), yielding from 25,000 to 30,000 barrels of lime.* "They are built of brick, faced with stone, about thirty feet in height; hopper-shaped inside for the upper third of the height, then with a straight funnel for the next third to the level of the fire, and again widening out to the lower floor, from which the lime is drawn.

Construction of kilns.

The limestone is put in at the rear of the kiln above, and the burnt lime drawn out from the front of the kiln below, while the fuel is fed in at the side, at the height of a few feet above the floor from which the burnt lime is drawn. The two kilns are inclosed in a large gravel-roofed shed, which extends to the edge of the wharf, so that the lime is protected from the weather even when being shipped."

An analysis of limestone from the quarry made by Mr. A. E. MacIntyre, showed it to consist of 97·38 per cent of carbonate of lime with a little less than 2 per cent of magnesia.

Removal from quarry.

The quarries are distant from the kilns about one-eighth of a mile, and have an exposed face of forty or fifty feet in height, with a width of limestone of some sixty or seventy feet. The rock is removed by the use of a steam drill and dynamite, and has been already penetrated to a distance of 300 or 400 feet. The rock is fed to the kiln as fast as it can be brought by team during a working day of nine hours, and the burnt lime withdrawn from below every six hours.

Importance.

"Every article used in the manufacture of a barrel of lime is made on the premises, excepting hoops, which cost $4.50 to $5.00 per thousand, or about three cents for each barrel. Everything else represents labour employed at the mill and lime-kilns. Hence the great importance and value of the lime industry; for $100,000 worth of lime exported means $91,000 expended in labour." Of the 30,000 barrels of lime manufactured at this point during the year 1898, only 2000 were exported to the United States. This shows that the present tariff is almost prohibitory.

Stetson's quarry.—Indiantown, St. John City.

* For these and some other particulars relating to the lime industry at St. John, I am indebted to a very interesting article upon the subject published in the St. John *News*, May 13, 1893.

W. D. Morrow's quarry.—Narrows of St. John River.—One kiln Product about 3000 casks per year (in 1886).

Steven's quarry.—South Bay.

Wm. Lawlor & Sons.—Brookville.—Operations have been carried on here for many years, the market being restricted to the city of St. John. The product in 1876 was from 8000 to 10,000 barrels.

The character of the St. John limestones is further indicated by the subjoined analyses, made in the laboratory of the Survey. Previous to analysis the specimens were dried at 100° C. the hygroscopic water thus abstracted being as follows, respectively :—No. 1, 0·09 per cent, No. 2, 0·04 per cent, No. 3, 0·05 per cent :—

	No. 1.		No. 2.		No. 3.	
Carbonate of lime	95·60		99·05		98·39	
" magnesia	0·44		0·88		0·71	
" iron	0·13		0·05		0·05	
Alumina	0·11		0·01		0·02	
Silica, soluble	0·16	4·27	0·09	0·26	0·64	1·19
Insoluble mineral matter	3·54		0·14		0·82	
Organic matter	0·46		0·02		0·31	
	100·44		100·24		100·34	

The specimens were supplied by Mr. E. T. P. Shewen, of the Department of Public Works. No. 1 is from Messrs. Armstrong's quarry, Green Head ; No. 2, from Stetson's quarry, Indiantown ; and No. 3, from W. Lawlor & Sons quarry at Brookville.*

Effects of adverse tariff.

As in the case of so many other mineral products, the lime industry has suffered greatly from the effects of the adverse tariff imposed by the United States. This is well seen in connection with the table of exports already given. Thus, prior to the passage of the "McKinley bill," the total production of lime, from about twenty-four kilns, was not less than 350,000 barrels† per annum, employing about 300 men ; but this was subsequently reduced to about 175,000 or 200,000 bbls., with a proportionate decrease of kilns and men employed. By the McKinley tariff a duty of six cents per 100 lbs., including the weight of the barrel, was imposed, which was equal to 13½ cents a barrel, or about twenty per cent on the value as delivered in United States markets. Hence, in 1892, a decline in the export of lime to about forty-two per cent of what it had been in 1890.

*Annual Report, Geol. Surv. Can., vol. VIII. (N.S.), 1895, pp. 15-16 R. In the report cited No. 3 is, according to Prof. Bailey, assigned in error to "Lawlors Lake."

†A barrel holding about 218 pounds of lime.

Competition with Rockland, Me.

In addition to the deterrent effect of high duties, the St. John lime-burners are directly affected by the competition of the great lime-quarries at Rockland, Maine, in the interests of which, chiefly, those duties have been imposed. According to the authority above referred to, there were at Rockland, in 1893, 100 kilns in operation, with a very large output, showing that but for the adverse tariff the industry at St. John might assume great importance. In several respects St. John has great natural advantages, making the competition more equal, one of these being the situation of the quarries and the facilities for shipment (the quarries at Rockland being distant two miles and a-half from the kilns); and another, the cheapness of fuel, the latter consisting largely of the refuse from lumber mills. In several instances, indeed, as at Randolph and Baker's, the saw-mills and the lime-kilns are run by the same owners, and side by side. The cost of Rockland limestone, placed in the kilns, is twenty cents a barrel, as against ten cents a barrel at St. John. The cost of kiln-wood at Rockland is $3 for the small cord, as against $2 at St. John. Cord-wood burned in a kiln at St. John costs ten cents for each barrel of lime, while at Rockland it is fifteen cents. The Rockland people estimate that their lime costs, ready for shipment seventy-two cents per barrel, while the freight to Boston is thirteen cents and the price eighty-five cents, leaving no profit. The following figures show the corresponding cost at St. John.

Cost of St. John lime.

	Cents.
Stone at kiln	10
Boring (labour)	5
Cordwood	10
Barrel	16¼
Trimming barrel	1½
Foreman	½
Repairs	½
Interest on investment	¾
Duty	14
Freight	18
Consular certificate	½
	77

Freight by rail.

The freight by rail to Boston would be twenty cents, and the cost, laid down there, about eighty cents.

In addition to the localities in the vicinity of St. John, two other districts deserve notice as containing limestones of similar age and character, so situated as to be capable of easy working and shipment.

The first of these is in the vicinity of Musquash Harbour, upon both sides of which are large exposures of limestone. Some of these are

dolomitic and others contain more or less serpentine, but beds free from magnesian compounds and suitable for burning, also occur. On the eastern side these limestones form a well defined band extending from near Frenchmans Creek to Pisarinco Cove; and on the western side, though less exposed to view, probably extend continuously to Lepreau Basin. Some quarries were at one time opened upon the Musquash River, but they have been long since abandoned.

L'Etang deposits, Charlotte county.

A second district exposing large deposits of Laurentian limestone is the harbour of L'Etang in Charlotte county. The rock here is a bluish-gray, well stratified limestone, with a marked rhomboidal cleavage, covering an area of at least 100 acres and admirably situated for calcination and shipment. As at St. John, the limestones are intersected by dykes of intrusive rock. Quarries have been opened here, but have now been idle for many years. Similar beds occur upon Frye Island, near by.

Huronian limestones.

B. HURONIAN LIMESTONES.—The rocks referred to the Huronian system include limestones at a number of points in the southern counties, but the beds are of much smaller dimensions than those of the Laurentian system, and no attempt, except perhaps locally and in a very small way, has been made to work them. Among localities of this character may be mentioned the mouth of the Nerepis River, in Kings county; the village of Lancaster, in western St. John county; Lepreau Basin, in eastern Charlotte county, the head of Dipper Harbour, in the same county, and in Albert county. The latter may possibly become of service in connection with the treatment of the bog-manganese ores of Dawson Settlement. Impure limestones also occur on Kent Island, off the south coast of Grand Manan.

Cambro-Silurian limestones.

C. CAMBRO-SILURIAN LIMESTONES.—These are of rare occurrence, but nevertheless are found at one or two points, chiefly in the northern part of York county, in the district lying north of the central granite range between Eel River settlement on the St. John River and Canterbury station. They have been utilized to a limited extent, but are quite impure, and have been used only for local consumption.

Silurian limestones.

D. SILURIAN LIMESTONES.—A large part of the counties of Carleton, Victoria, Madawaska and Gloucester are underlain by slates which are highly calcareous, and in places these become pure enough to be entitled to the designation of limestones. They are, however, greatly inferior to the Laurentian limestones of St. John as a source of lime, and such operations as have been undertaken in connection with them have been mostly with reference to use in the neighbourhood of the

localities where the beds occur. Of these, perhaps the most important is the Beccaguimic valley and its vicinity, where, in the aggregate, a considerable quantity of rock has been burned. The writer has not visited this region since 1885, but at that time the product at Turner's, in the Beccaguimic valley, was stated to be about 500 casks or 2000 bushels per annum.

About the year 1874, quarries were opened at Henderson Corner, in the parish of Brighton, and work carried on by the Hendersons until 1886, two kilns being kept in operation, yielding 450 casks for the two, each cask weighing about 350 pounds, and selling at Woodstock for $1.50, or at the price of St. John lime. About 1885 other quarries were opened in the Beccaguimic valley, at Turner's, with an annual product of about 500 casks, or 2000 bushels. In the same vicinity the Belyea Bros. are now burning lime at about the rate last stated, the product being used locally and in Hartland, and being well spoken of, but owing to want of capital and facilities for making casks, necessitating sales by the bushel, the business is less extensive than it might otherwise be.

Carboniferous limestones.

E. Lower Carboniferous Limestones.—These rocks, though abundant and widely distributed, are comparatively unimportant as a source of lime, the material which they yield being unable to compete with the highly esteemed product of the St. John quarries. They have, however, at times been the basis of somewhat extended operations, more especially in the vicinity of Demoiselle Creek, Albert county, where at one time lime burning was largely carried on for several years.

Other localities of Lower Carboniferous limestones, some of which have been worked locally, are Rush Hill and Merritt Landing (Long Island), in Queens county; Butternut Ridge, in Kings county; the vicinity of Hillsborough, in Albert county.

Gypsum.

Geological position of gypsum.

The occurrence of extensive deposits of gypsum is a notable feature in the rocks of the Lower Carboniferous formation in New Brunswick as it is also in Nova Scotia. These deposits, as fully described in the reports of the Geological Survey, usually occupy a position at or near the summit of the group, and are generally in close connection with beds of limestone, from which, in part at least, they may have been derived by alteration. Among them the beds found in the vicinity of Hillsborough, Albert county, are at once the most extensive, the purest, and the basis of the largest operations. They will, therefore,

be described in some detail, other deposits being subsequently noticed chiefly as affording points of contrast.

For the following summary of facts relating to the development and present condition of the Hillsborough deposits, I am indebted to Mr. C. J. Osman, M.P.P., at present manager of the Albert Manufacturing Company. Hillsborough deposits.

Gypsum deposits in Hillsborough, Albert county, New Brunswick.

The picturesque little village of Hillsborough is situated at the head of the Bay of Fundy, on the west side of the Petitcodiac River, about five miles from its mouth. Owing to the great rise and fall of the tides of this bay, vessels of any draught can sail up to this point, and take in cargo, if of sufficiently strong build to permit of grounding and carrying loads when not water-borne.

There are no authentic records of the first discovery and opening of the large deposits of gypsum, which are now being somewhat extensively worked at Hillsborough, but there are some evidences of very early work, in the shape of small deposits of waste, and signs of excavations at different points in this formation. For accurate information regarding the early shipments, and extent of the same, it would be necessary to refer to the Custom-house records. It is, however, quite certain that the shipment of gypsum from Hillsborough was a very limited business previous to the year 1854, though for many years earlier than this, the farmers living in the vicinity, who owned lands that included portions of the gypsum deposit, quarried and hauled to the river on sleds during the winter small cargoes of "plaster rock," taken from points in the deposit which were exposed, and where this work could be done with the least amount of labour in stripping. These cargoes were purchased from the farmers during the season of navigation, by masters of small coasting vessels, and carried to ports on the United States seaboard, where "plaster" mills were in operation, the principal market being Lubec, in the state of Maine, at which place mills were operated by Messrs. Fowler Brothers; but some few cargoes were shipped as far south as New York; the principal source of supply of crude material for the New York manufacturers being, however, Windsor and other points in Hants county, Nova Scotia. First discovery. Early developmen

Previous to the year 1854, Messrs. Fowler Brothers, of Lubec, Maine, acquired rights to a portion of the gypsum deposits of Hillsborough, and constructed a plank-road from the quarry, afterwards known as the Fowler quarry, to the Petitcodiac River, distant about

three and one-half miles. The gypsum was hauled out in wagons during the summer months, and on sleds during the winter. During the period of their ownership, shipments did not exceed from two to three thousand tons per annum.

Change of ownership.

The superior quality of plaster of Paris made from Hillsborough gypsum, had by this time become well known to other manufacturers of plaster and building materials in the United States, and, about 1854, Mr. Calvin Tomkins, a manufacturer of cement and lime, who carried on an extensive business on the Hudson River, came to Hillsborough and acquired the properties then owned by the Fowler Brothers, and other gypsum properties adjoining, which included nearly all the available and valuable portions of this deposit. At this time the duty upon manufactured plaster entering the United States, was very low, and a large market was open for the product of a mill on the

Favourable conditions.

Canadian side of the line. These favourable conditions led to the formation, by Mr. Tomkins, of a company under provincial Act of incorporation, under the name of the Albert Manufacturing Company, for the purpose of carrying on the business of quarrying and mining gypsum, and erecting mills for the purpose of manufacturing it, carrying on the business of grinding grain, sawing lumber, constructing railways and operating the same, and all other work in connection with the operation of the quarries and shipment of the product. Subsequently a large milling establishment was erected, railways were built to two or three points in the gypsum belt and extended to the river, where wharf and timber beds for the accommodation of vessels were also constructed. A plaster mill was also built by Mr. Tomkins, at Newark, New Jersey, and the business of making plaster of Paris in Hillsborough, as well as that of shipping

Drawbacks.

the crude rock to Newark, prosecuted with energy. Later the withdrawal of the reciprocal trade relations between the provinces and the United States occurred, and the favourable conditions under which a large trade in the manufactured article promised, was seriously interfered with, and only a very limited business was obtainable, and had it not been for the very superior quality of the plaster made from Hillsborough rock, profitable business with the United States would not have been possible.

Exclusion of Canadian market.

The Canadian market was not at that time available for the Hillsborough mills, as plaster was extensively manufactured in Montreal, carried from Antigonish in Nova Scotia by vessels at a very much lower rate of freight than rock or manufactured plaster could be freighted from Hillsborough to the same point. The western Cana-

dian market was also largely supplied with plaster manufactured at Grand Rapids, in the State of Michigan, which place is conveniently situated almost on the shore of Lake Michigan, and therefore has the advantage of cheap water communication with all the important cities of Canada. At that time a very low rate of duty was collected upon manufactured plaster imported into Canada, and the most important portion of the Canadian market was thus open to the manufacturers in the United States. For the finer grades of calcined plaster, required for casting and dental purposes, New York plaster was used, which, as already stated, was manufactured from rock plaster supplied to New York, either from Hillsborough or Windsor, neither the Michigan plaster or plaster made in Montreal being equal in quality for fine work, to what was then known as New York plaster.

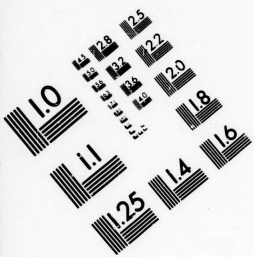
Effect of opening I. C. R.

By the construction of the Intercolonial Railway, this market was made more available for the Hillsborough mills, and in 1876 active efforts were made to secure a share of the Canadian business, and with considerable success, for as soon as this plaster was placed on the market at competitive prices, dealers and consumers recognized that they were being offered plaster equal in all respects to the best New York plaster. Still the competition from Montreal and Michigan in a lower grade, made it difficult for Hillsborough to supply the demand for which an inferior grade was good enough, and not until the era of the Canadian protective tariff was it possible for the general demand in Canada to be supplied from Hillsborough. The increase in duty soon excluded Michigan plaster and the chief competition then came from Montreal, which, of course, enjoyed equal advantages with Hillsborough under protection, and freight at about half the rate paid by Intercolonial Railway; but in spite of this disadvantage, in a few years, the great superiority of Hillsborough plaster was so firmly established that the Montreal manufacturers retired from business. This left the Canadian market entirely open for Hillsborough plaster, with exception of the output of a small mill on the Grand River, near Hamilton, Ontario, and a more limited output from a factory at Paris, Ontario.

Influence of protective tariff.

Enlarged market.

The following figures will illustrate the development of this market between the years 1877 and 1897. In 1877, the total sales in Canada were about 8000 barrels. In 1897, the total sales in Canada were about 38,000 barrels from Hillsborough. In the interim a plaster mill had been established at Windsor, Nova Scotia, and limited shipments made from that point. Paradoxical as it may seem, the increase in the rate of duty and the surrender of the Canadian market to Canadian manufacturing establishments, have not perceptibly increased the cost



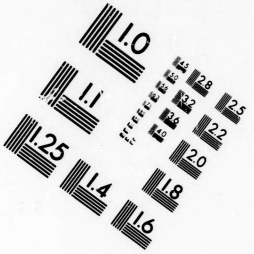


IMAGE EVALUATION
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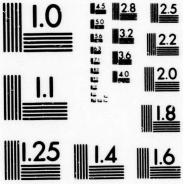
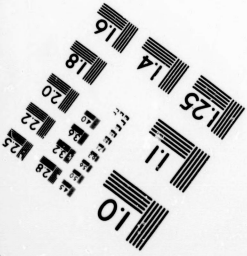
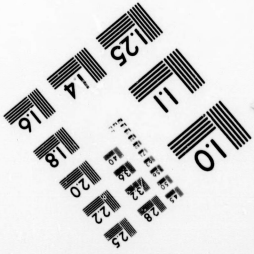






2.8
2.5
3.2
2.2
3.6
2.0
1.8
1.1
1.0

to the consumer, for while the duty in 1897 was about twenty cents per barrel in excess of the duty in 1877, the average price to dealers throughout Canada is between twenty cents and twenty-five cents per barrel less in 1897 than it was in 1877, the price at mill in 1877 being $1.05 per barrel and in 1897 not averaging over eighty cents per barrel.

Exports from Hillsborough.

The development in the business of shipping crude rock to the United States shows also a large increase:—

Shipments of crude gypsum from Hillsborough to the United States.

1877, ...	5,000 tons.	1888, ...	26,784 tons.
1878, ...	5,380 "	1889, ...	25,672 "
1879, ...	5,641 "	1890, ...	24,126 "
1880, ...	8,575 "	1891, ...	21,125 "
1881, ...	7,540 "	1892, ...	24,588 "
1882, ...	14,095 "	1893, ...	23,764 "
1883, ...	15,792 "	1894, ...	37,170 "
1884, ...	21,132 "	1895, ...	50,128 "
1885, ...	14,334 "	1896, ...	59,266 "
1886, ...	22,600 "	1897, ...	59,334 "
1887, ...	18,797 "		

Effects of recent U. S. legislation.

Shipments of manufactured plaster to the United States have averaged for the last ten or fifteen years about 20,000 barrels per year. Under the "Wilson bill," a low tariff measure passed during President Cleveland's administration, it was hoped a larger business could be secured in the United States, and some gain was made: but owing to the large increase in rate of duty under the more recent "Dingley bill," new business then obtained has since been lost, and it is with difficulty and only at extremely low prices for the manufacturer, that any foot-hold can be retained in that market. Indeed, under the present rate of duty of $2.25 per ton, it is quite impossible for a Canadian manufacturer to compete with manufacturers in the United States, although under the "Dingley bill" a duty of fifty cents per ton upon the crude material is imposed. The difference in duty of $1.75 per ton between the crude and manufactured article very much more than covers the increased cost of manufacture in the United States as compared with cost of manufacture in Canada. Only the superiority of the Hillsborough plaster and its well established reputation, make sales possible in the United States at figures which would even cover the cost of manufacture. There is very keen competition between the manufacturers in the United States, consequently prices are exceedingly low.

The duty upon the raw material levied under the "Dingley bill" was inserted in the tariff to meet the wishes of the manufacturers of plaster in the Western States, who at first asked for a duty of $2 per ton. This would have enabled the western manufacturers to supply the whole of the eastern market with plaster suitable for all ordinary purposes, although it would have been necessary to meet a demand for a limited quantity of plaster suitable for fine casting and dental work, which would have to be made from Nova Scotia or New Brunswick rock, the western rock not being suitable for these purposes. This condition of things brought about strong opposition from the eastern manufacturers, who had a great deal of capital invested in their manufacturing plants. There was also a very strong opposition movement on the part of owners of U. S. coasting vessels, who were largely interested in this matter, from the fact that of the total shipments at that time, amounting to about 220,000 tons per annum, a large proportion was carried in these vessels, which were engaged in carrying coal from New York and points south as far as Newport News to New England ports. When these cargoes were discharged, they would run up the Bay of Fundy light, take in cargoes of gypsum, and return with them to New York, Philadelphia, Baltimore and other coaling points south; therefore, the business of carrying gypsum was essential to these vessels as a means of making a run back to the coal ports profitable, there being no other return freight upon which they could depend. In response to these protests, an agreement was arrived at under which a duty of fifty cents per ton on crude rock was imposed, and, to satisfy the demands of eastern manufacturers, the duty on manufactured plaster was increased from $1.25 per ton to $2.25 per ton. A very considerable quantity of the 220,000 tons of crude material, shipped to the United States, as before stated, is used in the manufacture of fertilizers, a great deal entering into the manufacture of high-grade fertilizers, and more being simply crushed and finely ground and put upon the market under the name of ground gypsum or "land plaster." This business is done in regular mills established for the purpose, as well as in small mills that are used for grinding corn, etc.

Duty.

Present conditions.

Character and Mode of Occurrence of the Gypsum Deposits of Hillsborough.

The gypsum deposits of Hillsborough are exceedingly varied in character, and in their mode of occurrence present many features of geological interest. These will be more readily understood by refer-

ence to the accompanying diagram, and by the descriptions which follow.

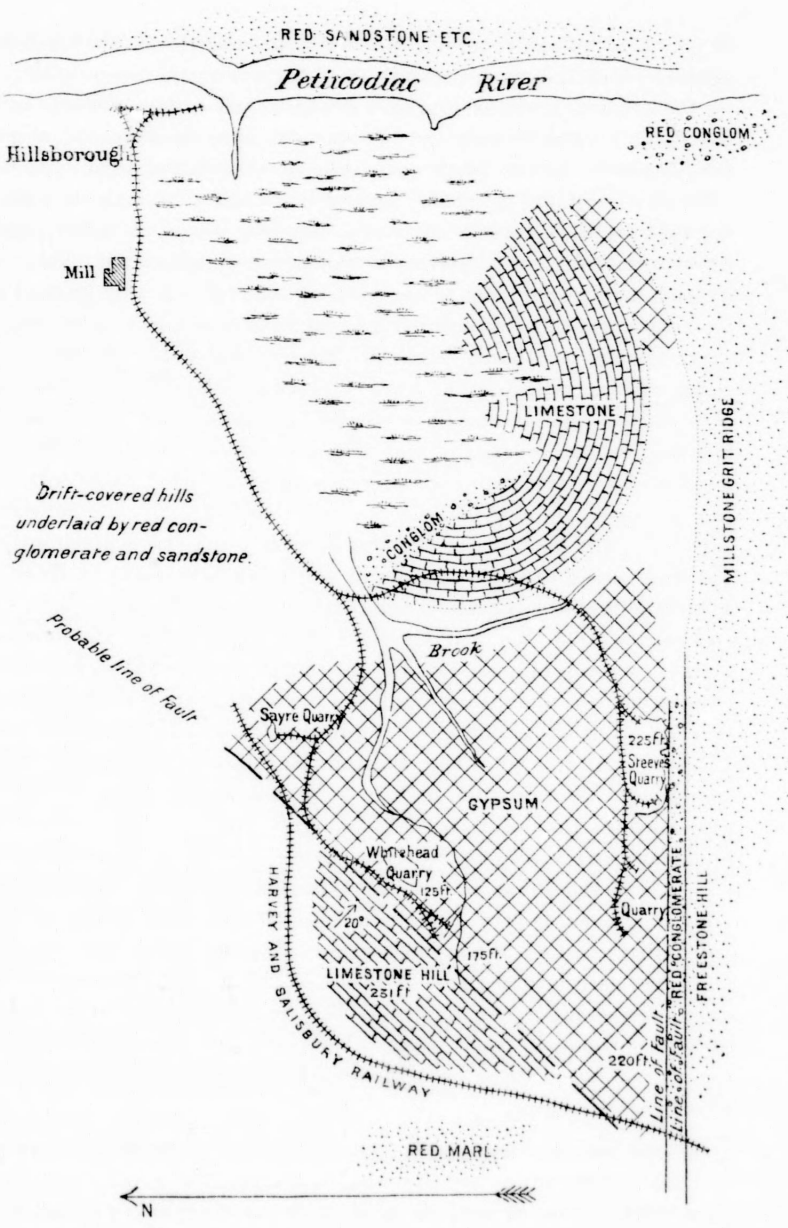
Varieties.

At several points on the northern edge of the outcrop, considerable quantities of gypsum are found, being snow-white in colour and varying in molecular structure, some of it being of exceedingly fine grain and some quite coarse and sufficiently soft to be crushed between the fingers, with intermediate grades of fineness, but all grades equal in purity and colour. This part of the deposit is in masses and not any in regular seams. With the pure, white stone are intermixed irregular veins of discoloured gypsum, of all shades of red, gray, and blue-gray, Most of these discoloured masses contain more or less "grit," which when subjected to hydrochloric acid effervesces and show evidence of the presence of carbonate of lime. Occasionally seams of red marl-like stone fill the spaces between the seams and fissures in the gypsum. These are rarely in horizontal positions, but as a rule cut the face at varying angles, and occasionally are nearly perpendicular. This marl-like substance also contains carbonate of lime. Underlying the beds of pure white and mixed stone, as above described, masses of anhydrite are found; sometimes in thin layers only and at other times in beds of such thickness that attempts to penetrate them have been given up as unprofitable and work has been pursued elsewhere. Immediately under the white stone, and running into it without any perceptible break, are generally found beds of pure anhydrite, which at this time has no commercial value, although some of it has been ground and exported to the United States as terra alba for paper filling and other purposes; but for use as a paper filler, it is not as acceptable to manufacturers as the product of the pure white hydrated gypsum. The demand for white soft stone is limited, and it is used entirely as a paper filler; the process of manufacturing it for this purpose being to grind and bolt it through very fine silk bolts, after which it is calcined, mixed with water, and the setting properties destroyed by continuous stirring; when it is found to be more suitable as a filler for the higher grades of paper than china-clay, and is coming into more general use for this purpose every year.

Occurrence of anhydrite.

Indications of pure, white stone, of this character, are visible at many points along the northern edge of the gypsum deposit, for a distance of about three quarters of a mile. The surface indications of this gypsum belt extend in width for about half a mile, the belt running in a north-easterly and south-westerly course, the southern edge rising somewhat abrubtly against a very steep hillside, which is supposed to consist

Geological relation.



SKETCH-MAP SHOWING GEOLOGICAL RELATIONS OF THE GYPSUM DEPOSITS OF HILLSBOROUGH, ALBERT CO., N. B.

SCALE :—50 chains to 1 inch.

largely of a reddish conglomerate that apparently forms the south wall against which the gypsum rests. Still higher up on the hillside, and on the summit, freestone boulders are seen, and a short distance below the summit a clean break and opening exposing the freestone, is quite conspicuous. At this point several natural trenches, parallel to each other, with walls of freestone, and about twenty or thirty feet apart, are exposed for a distance of several hundred yards, strongly suggesting the existence of a series of faults or downthrows. Thus the gypsum area would seem to be bounded on two sides by marked dislocations converging westward at an angle of about 45°. Between the northerly and southerly edges of the gypsum formation are several small valleys, evidently the work of brooks which have cut their way through the gypsum, and have created at some points small bays or openings that have caught and retained alluvial deposits, producing meadows or intervales, which are exceedingly fertile. At many points the gypsum has entirely disappeared, leaving only the anhydrite exposed. The main brook on the northerly side, rises apparently at the west end of the gypsum deposit and flows in an easterly direction, until it falls over a limestone bed, with a descent of about eight feet, and at this point the conglomerate rock upon which the limestone rests is exposed, dipping towards the north-west at an angle of about twenty degrees, and rising rapidly to the south until it reaches the top of a hill about three-quarters of a mile distant, at an elevation of about 150 feet. At this point the limestone is exposed and plainly seen on the surface. It then dips slightly to the south and again underlies a gypsum formation of from fifty to sixty feet in height. The conglomerate rock is also to be seen a little further to the eastward on the slope of the hill as it descends towards the river. This exposed body of gypsum is very much broken and discoloured and of so little value that, though much nearer a convenient point for shipment than the main quarries now in operation, it is not at present worked and is not considered a profitable field from which to draw supply. Following the main brook, already referred to, in a westerly direction, the wall of anhydrite extends the whole length of the gypsum deposit, though not unbroken.

Boundaries.

Several quarries have been opened at points where the soft gypsum had been left untouched by the action of the brook and much pure, white stone, as well as good gray merchantable gypsum, have been taken therefrom, and there are still large quantities which have not yet been opened or worked; but in all operations extending in a southerly direction along the course of this brook, the anhydrite has made its presence evident, and consists of dark-gray and white

Relations of gypsum and anhydrite.

stone, or of white stone containing blood-red streaks or veins ; the white anhydrite generally underlying the formation, and the wall being formed by the darker stone. This wall, however, is not uniform in hardness, there being many points where small brooks and springs have cut their way through, probably at places where seams of soft gypsum have broken the uniformity of the harder rock. In some instances the action of the water has created subterranean passages into which the brooks disappear, reappearing lower down the valley and joining the main brook.

Main quarries

The most extensive plaster quarry now in operation is at the base of the high hill forming the southern wall of the deposit, and was first opened with the intent of making a permanent working about forty years ago. After going to a great deal of expense, work was abandoned at this point on account of the very large quantity of anhydrite encountered. This anhydrous gypsum is dark-gray in colour and very hard. After lying idle for a number of years, work was again undertaken at this place and the band of hard stone was broken through, when a very fine quality of gypsum, slightly gray in colour, was exposed, and since that time this quarry has been in constant operation, and still yields a large output of very fine close-grained stone, from which the best quality of calcined plaster is made. There is, however, considerable variation in the character of the rock, though nearly all of it will make plaster of Paris of good quality. Some of it, however, immediately underlying the clay, is coarse in grain and more or less intermixed with selenite crystals or consisting entirely of gray selenite. This character of stone will not make good plaster of Paris, and after calcination, if mixed with water and allowed to set, will yield and become more or less soft and non-coherent. The presence of a very small quantity of this stone will seriously impair the quality of a large quantity of plaster in process of manufacture. In extending this quarry the underlying beds of anhydrite have been followed, and represent to-day the floor of the quarry. Operations at a lower level have, however, established the fact that soft gypsum underlies the hard formation at a depth of thirty feet, but these operations have not been of sufficient extent to prove whether this is present in large bodies or not. White stone, both hydrous and anhydrous, has also been found at a lower level in this working.

Working face.

The working face of the quarry varies in height from thirty feet to one hundred feet, and at this time has from twenty to thirty feet of exceedingly tough clay overlying it. At several points there are veins, bands, or masses of anhydrite running through and across the face,

not always connected with the main body of anhydrite, but sometimes in thin veins running out to a point and gradually assimilating with the softer stone; at other times, in small kernels, and often in large masses having no connection with the main underlying body. These masses of hard stone are removed by drilling and blasting, if not in too great quantities; if too large to be profitably removed, they are left and gradually worked around, the soft stone generally making its appearance at the back of the hard, sooner or later. The soft stone can all be bored with a common pod auger, although it is found more economical to use hand-power augers especially constructed for this purpose. The hard stone when struck with a pick will emit sparks.

Modes of removal.

Stratification. The formation is irregular, being at the west end very much stratified, and lying in horizontal beds which show a great variety in character, being in layers of varying thickness, purity and colour, from white to light-gray and dark-gray.

Irregularities. At this point there is no overlying earth and the surface is very irregular and full of depressions and holes that extend many feet down towards the base. Invariably, where there is no protecting earth-surface, the gypsum is very much broken up and can be removed with pick and bar with very little blasting, but is too much shattered to be of commercial value. The face of the main quarry at the eastern end, contains many seams and evidences of slips, continuous "face marks" being broken and signs of unequal settlement quite apparent, which may indicate the presence of a soft base of insufficient strength to sustain the whole overlying mass intact. The general character of the beds indicates an original horizontal formation, (see plan), but owing to settlement, subsidence, or upheaval, they have become very irregular and represent a wave-like formation. During the operations some few years ago, a dome-like formation was disclosed, very perfect and sloping towards the floor of the quarry, and from the summit an equal dip towards the back, which at this time was represented by a deep depression in the surface, towards which the face of the quarry was leading. This was worked through and the gypsum was found on the other side, but under a greater depth of clay than had before been noted. There has been very little variation in the excellent quality of this stone from the opening of the quarry until the present time.

Cover. It promises to yield indefinitely, but there is every evidence that the depth of clay is increasing as the face of the quarry is pushed into the hillside. When it becomes unprofitable to move the clay, it will be necessary to tunnel. From this point to the western end of the gypsum outcrop, where the white rock is found, is about three-quarters

of a mile, and the outcrop of gypsum between these two points is continuous.

Other quarries.

Two other quarries have been opened at intermediate points near this main working, and gypsum of excellent quality has been disclosed. The character of the stone is laminated, lying in almost horizontal beds with occasional waves and a slight general trend of dip to the south-west, but with surface indications of a counteracting rise in the formation as the hill is ascended. Very little selenite is found here, but occasional particles occur through all the stone and occasionally very narrow seams of fibrous gypsum are also found, generally slightly pink in colour. Beyond this point to the west end of the belt, no work has been done, and the surface indications show gypsum both hard and soft of different grades, but no pure, white stone. The high ridge that forms the backing of the main working of the Hillsborough quarry, apparently cuts off the gypsum, but after crossing this ridge and descending into the next valley, known as the valley of Demoiselle Creek, the gypsum outcrop is again apparent, and some soft rock of good quality is now obtained, and limited shipments made, from a quarry recently opened. The water of Demoiselle Creek is highly impregnated with lime and gypsum, and is known to run immediately over the gypsum formation at several points. No gypsum shows itself on the surface from this point until the lower end of the valley is reached, when there is a small outcrop at a little lake, and it is known to exist towards the main river in an easterly direction, on the other side of the ridge forming the east wall of this valley, and crops out on the opposite side of Shepody Bay, in the county of Westmorland: here it is very dark in colour and is not suitable for making plaster of Paris.

Occurrence in valley of Demoiselle Creek.

Hopewell Hill.

Following the shore-line of Albert county, the next outcrop is at Hopewell Hill, about sixteen miles from Hillsborough, and back from the shore about two miles, and a half at an intermediate point between this deposit and the shore and then next at a point on the marsh near by, where it is some eight or ten feet below the surface, but no surface outcrop occurs. No more surface indications are visible until New Horton is reached, about twenty-eight miles from Hillsborough, and no further outcrop nearer than Martin Head, situated at the head of the Bay of Fundy, distant about fifty-three miles from Hillsborough. Here the gypsum is of poor quality and the deposit not worked. Inland from Hillsborough, the nearest outcrop of gypsum is at Petitcodiac in Westmorland county, about forty miles distant, where it is very much broken, selenitic in character, and not valuable for commercial purposes.

Methods of quarrying.

The method of quarrying gypsum is by boring holes of varying depth and blasting out with ordinary blasting powder. The hard rock is removed by drilling by hand and steam drills, and, when necessary to dislodge in large quantities, dynamite is found to be more economical than powder. The gypsum for shipment is carried to the river over a horse-railway in cars containing about three and one-third gross tons, each horse hauling three cars, making three trips per day, or an average output per day of thirty tons to a horse and driver, the distance from quarry to river being about three miles and a half. Average rate of wages paid to quarryman, $1 per day. Until within two or three years, common pod-augers were used for boring, but a special hand-power drill has been put upon the market by the Howells Mining Drill Co. of Plymouth, Pa., U.S.A., which is found to be especially suited for this work and character of stone, a short hole being first bored into the face, into which an arm is placed and upon which the drill is clamped, being then adjustable, so that holes can be bored in any direction or at any angle, either up or down.

Wages.

Process of Manufacturing Plaster of Paris.

Manufacture of plaster of Paris.

The old process of manufacturing plaster of Paris from gypsum was to burn the stone in kilns, in the same manner as limestone is burned, and this method is still followed to some considerable extent in England and the Continent of Europe, but in the United States and Canada it is found that more uniform results are obtained by first grinding and afterwards subjecting the ground material to a process of calcination, which can be regulated in duration and temperature. The method followed at Hillsborough is to pile the newly quarried stone in sheds until it is sufficiently dry to grind easily without clogging the mill-stones, after which it is passed through crushers in which the stone is broken into fragments about the size of a hazel nut and then delivered to ordinary granite mill-stones, when it is ground to whatever fineness of grade may be required. Thence it is conveyed to bins, under which are placed large iron kettles furnished with stirring-arms, so that the material may be kept in constant motion. These kettles are set in brick and have grates and large fire-boxes below them. The fuel used is soft wood in four-foot lengths. In the United States, the fuel used for calcining plaster is anthracite coal, which produces a much hotter fire, and the work of calcination is very much more rapid. Each kettle has a capacity of about sixty barrels of 300 pounds, of calcined plaster. By this process, the water contained in the gypsum in a state of combination is driven off as steam through openings in the top

of the kettles constructed for that purpose. These openings discharge into a dust-loft that collects large quantities of the finer particles of the ground gypsum, carried off in steam from the kettles; a considerable portion of which can be returned to the kettles when next filled, but not all, as too large a proportion would seriously interfere with the setting properties of the product. Thermometers are used, and when a temperature of 285 degrees Fahrenheit is reached, the kettles are at once emptied into bins, and the plaster is then elevated to revolving bolts and thence delivered to bins from which it is packed into paper-lined barrels, for market. A branch line of railway connects the mill with the Salisbury and Harvey Railway, and car-load shipments are made to all important points in Canada, to some points in the western United States, and to the Pacific seaboard without transhipment.

Recent uses of gypsum.

Crude gypsum will not stand exposure to the weather, but is speedily affected by moisture. A method has, however, been recently discovered under which, by chemical treatment, it can be both hardened and toughened, and when so treated will take a very perfect polish. In this state gypsum may be employed instead of the more expensive marbles.

Price.

The price obtainable for crude gypsum delivered to vessels in the Petitcodiac River, ranges from 60 cents to $2.50 per ton of 2240 lbs., the lower grades of rock and discoloured stone, suitable only for the manufacture of land-plaster, being sold at 60 cents per ton; that of a quality suitable for the manufacture of calcined plaster, at from $1.00 to $1.20 per ton, and the selected pure, white stone at $2.50 per ton.

Labour employed.

The total number of hands employed in quarrying, conveying to point of shipment, milling and otherwise in this work, in the year 1897, was about 225, including boys.

Analysis.

The following is an analysis of a sample of gypsum from Hillsborough, by A. A. Breneman, of New York :—

	Per cent.
Lime	32·45
Sulphuric acid, (SO_3)	46·38
Water	21·05
Silica	0·25
Iron	Trace
Magnesia	"

The analysis indicates an almost absolutely pure gypsum, 99·88 per cent of the whole consisting of that mineral.

Origin of gypsum.

An examination of the Hillsborough deposits, as indicated in the foregoing description, suggests many interesting questions as to their origin. A lengthy discussion of these would be out of place here ; but a few general conclusions may be referred to as highly probable.

(1.) A large part of the deposit, by its markedly stratified character, points clearly to a sedimentary origin, whatever may have been the original nature of the sediment.

(2.) As it is well known that anhydrite, on exposure to percolating waters, can absorb moisture and thus become converted into gypsum, and as the first-named mineral forms the general floor upon which the workable gypsums rest, as well as occurring irregularly intermixed with the latter, it is highly probable that the present condition is the result of such alteration. In this case the conversion may have begun at any time since the formation of the original anhydrite beds and may still be in progress.

(3.) The conversion of anhydrite into gypsum, the latter containing 20·9 of water, of which the former is wholly destitute, involves a great expansion in bulk of the original rock, amounting, according to Geikie, to about thirty-three per cent ; and the anhydrite, if confined on either side by unyielding rock, must as the result of this expansion be thrown into undulations, with accompanying breaks and dislocations. The removal of the rock by the solvent action of water, clearly indicated by the numerous and large sink-holes surrounding the gypsum beds, may further tend, by undermining, to determine such displacements.

Geological conditions.

(4.) The conditions under which aqueous deposits of anhydrite may have been originally laid down are not understood. Sir J. Wm. Dawson has suggested that they may have been formed from beds of calcium carbonate *in situ*, acted upon by vapour or heated solutions of sulphuric acid, the latter resulting from springs or streams issuing from volcanic rocks. In the present instance the plaster beds have been described as resting on limestone ; but no deposits of a volcanic nature are found in near proximity.

We may now proceed to notice briefly some of the other localities in which gypsum occurs.

Albert county.

ALBERT COUNTY.

Demoiselle Creek.—This locality has been referred to above. The beds here are, apparently, quite limited in extent, forming a narrow ridge between the valley of the creek and a small tributary of the latter, the western side of which shows a different rock. The ridge is

about 150 feet high, and shows some good white plaster, but also a large proportion of anhydrite. Similar rock also forms cliffs east of Demoiselle Creek, but these are mostly on the land of the Albert Manufacturing Company.

The Demoiselle Creek deposits are being worked by the Hillsborough Plaster Company, under the direction of Messrs. C. H. Dimock & Co., of Windsor, Nova Scotia. About 600 tons were shipped from this this locality in the year 1892 to the New York market. At present the product is said to be largely used in the manufacture of "cold water paint." Only about five or six men are employed. In connection with these gypsum deposits there is a remarkable subterranean lake.

Hopewell Hill.—Two miles and a half from the shore, and at intermediate points. No surface outcrop.

New Horton.—Surface indications.

ST. JOHN COUNTY. St. John county.

Martins Head.—Deposit small and of poor quality.

WESTMORLAND COUNTY. Westmorland county.

Petitcodiac.—At Fawcetts Brook, about two miles and a half northwest of Petitcodiac station, is a deposit of gypsum, about forty rods in breadth and about a mile in length, mostly of the fibrous variety. It is traversed for the whole distance by a vein of coarse selenite, about eight feet wide. The material is unsuited for the manufacture of plaster of Paris, but being easily crushed is well adapted for a fertilizer and at one time was somewhat extensively employed for that purpose.

KINGS COUNTY. Kings county.

Considerable beds of gypsum occur in the vicinity of Sussex and in the parish of Upham, near the road connecting Sussex and Quaco; but they are less pure than those of Hillsborough, and have never been turned to useful account, unless, it may be, locally and to a very limited amount.

VICTORIA COUNTY. Victoria county.

The succession of the Lower Carboniferous strata of the Tobique valley is as follows, in ascending order:—

Red conglomerates and sandstones, the former with pebbles of Silurian slates.

White, red and variegated calcareous sandstones and grits.

Red, gray and green shaly and marly beds, with thin beds of fine-grained gray, red or mottled limestone. Thickness, 140 feet.

Heavy beds of impure gypsum, of pale-green and reddish colours, mostly fibrous but sometimes compact, alternating with thin beds of red shale. Thickness, about 350 feet. Trappean beds, consisting of gray amygdaloidal dolerite.

Extent of deposits.

It is therefore a succession corresponding in the main features to that of Hillsborough, in Albert county. The total breadth of the Carboniferous area is about twelve and the total length, from Red Rapids to Blue Mountain, about twenty-seven miles. What proportion of this area is underlain by gypsum beds has not yet been definitely ascertained, but from observations made on different outcrops it is certain that the extent of the deposits is large.

Comparison with Hillsborough gypsum.

Where the area described is intersected by the Tobique River, the presence of gypsum beds is conspicuously marked by the occurrence of high bluffs (130 feet) known as the "Plaster cliffs," which are largely composed of this mineral. In contrast with the beds of Hillsborough which are so largely compact, amorphous and of snowy whiteness, these are coarsely granular, often looking like a rough sandstone, for the most part deeply stained a reddish colour, or mottled with red and green. Thinner layers, however, of pure, white gypsum, as well as fibrous selenite, also occur.

Use as a fertilizer.

The impurity of the Tobique gypsum, as indicated both by its colour and texture, render it unfit for the uses for which the Hillsborough gypsum is employed. It is, however, admirably adapted for use as a mineral fertilizer, and for many years considerable quantities of it were annually removed on sleds during the winter season, to find a market in the valley of the St. John River or in Aroostook county, Maine, under the name of "land plaster." So highly valued was it, indeed, for this use that, for the purpose of facilitating its removal, a railway, now known as the Tobique Valley Railway, was constructed from Perth, opposite Andover on the St. John River, to the Plaster Rock, a distance of twenty-eight miles. This has recently become a branch of the northern division of the Canadian Pacific Railway in New Brunswick.

The Tobique Valley Gypsum Mining and Manufacturing Company, (Limited), incorporated in 1893, erected machinery for crushing and grinding gypsum at this place, the plant being very conveniently situated on the railway. A quantity of the material was ground and shipped for "land plaster," meeting with a very favourable reception,

but difficulties arose in connection with railway facilities and rates, In 1897 the property passed into new hands and it is supposed that operations will shortly be resumed.

GRANITES, DIORITES, ETC.

Distribution

The areas covered by granites and similar crystalline rocks in New Brunswick are very large, and the supply, including many varieties, is practically inexhaustible. It will be necessary to consider here only those which, either from their advantageous position or from peculiar features of texture or colour, acquire special economic importance.

Hampstead, Queens County.—These granites, from their position on the right bank of the St. John River, near the foot of Spoon Island, (and hence often known as Spoon Island granites), attracted early notice, and, though never the seat of a very extensive industry, have, in the aggregate, yielded a large supply of rock, well suited to the purposes to which it has been applied.

Hampstead granite.

Though geologically related, in age and position, to the granites of the Nerepis range, the Hampstead rocks are not actually continuous with the latter, besides lacking some of the features usually characterizing the rocks of those hills. Thus the rock at Spoon Island is uniformly gray, without any admixture of red, and though somewhat porphyritic, usually less markedly so, and at the same time of a finer grain, than much of the Nerepis granite. A conspicuous feature in the quarries is the existence of divisional planes, sometimes horizontal and sometimes inclined 6° or 8°, by which the mass of the rock is separated into bed-like layers from four to ten feet in thickness, which greatly facilitate quarrying. Vertical joints are also common, but unlike those in the rock at St. George, to be presently noticed, are said to have no detrimental effect upon the quality of the stone. A more objectionable feature is the occurrence in the gray rock of nodules or irregular masses of a darker colour, looking like imbedded pebbles; but these are important only where the stone is to be used for monumental purposes, and are neither common nor large.

Suited for building foundations.

The Hampstead granites are especially suited for foundations, and have been thus used in the construction of the Parliament Building at Fredericton, the piers of the Fredericton bridge, and the cotton mill at Marysville, besides many buildings, both public and private, in the city of St. John. At present much of the rock is sent to the works at St. George to be polished. Columns of any desired size may be readily obtained, but the larger part of the output is employed in

the construction of monuments. Shipment is easy, the quarries being upon the face of a hill and connected with a wharf at a distance of about a furlong, by tramways. At the date of our visit (1897) work was slack, only ten men being engaged, but at times as many as one hundred and fifty men have been employed.

Nerepis Valley.—This transverse depression across the Nerepis range of hills, through which passes the main line of the Canadian Pacific Railway, has, in its high and precipitous sides, been at several points the basis of quarrying operations. At the time of the construction of the railway, most of the rock required in the making of culverts was obtained from a series of bluffs known as Eagle Rock, about two miles below Welsford station, and subsequently other quarries were opened for general purposes, a little above the same station. In these localities the rock is rather a syenite than a granite, the mica being more or less replaced by hornblende, and the colour either a tawny yellow or pale red. The rock is easily quarried, splits readily into blocks of convenient size, and owing to the proximity of the railway, may easily be carried away. It is an excellent and durable building material. Full particulars as to these and other granites of the Nerepis range will be found in the Report of the Geological Survey for 1870-71, (pp. 184-185).

Welsford quarries.

St. George quarries.

St. George.—The granite range of the Nerepis Hills, in its extension westward, crosses the Magaguadavic River a few miles above the town of St. George, and is there very noticeable for the bright-red colour which distinguishes it, and its consequent adaptability to monumental and ornamental purposes.

First discovery.

The existence of these red granites and their suitability for the uses mentioned, were noticed by the writer and his associates as early as the year 1869, during the course of a geological examination of southern New Brunswick then in progress, and in the report relating thereto they compared the rock with the well-known red granites of Aberdeen in Scotland. Several years, however, elapsed before this evident similarity attracted the investment of capital with the consequent undertaking of systematic operations for the quarrying and finishing of the stone. For information as to the subsequent development and present status of the granite industry, I am indebted to Mr. Milne, of the firm of Milne, Coutts & Co., of the Bay of Fundy Red Granite Works at St. George. Mr. Milne writes:—

First development.

"Regarding the granite business at St. George, we might say that it was started in 1872 by a company of New York capitalists and practical granite men, who purchased some 2000 acres of granite

mountains and built and equipped the best manufacturing plant in America, their buildings and machinery costing over $75,000. They employed about 150 men, and did a large business for a few years, but the dull times during the years 1875 and 1876 drove them to the wall. Several different firms tried to handle the business after they closed down, but failed to make a success. In the year 1881, Milne, Coutts & Co. rented the property, and in 1883 bought the land and plant, and have since succeeded in building up a good trade in the Dominion. Three other firms have since sprung up, and are doing a fair business. The output is valued at between $80,000 and $90,000 per year, and about 300 men are employed.

Competition

"Our chief competition is with Aberdeen, where they not only manufacture their own granites, but import stone from Norway and Sweden. The low rate of wages in those countries enables them to lay down these granites in Aberdeen at about the cost of quarrying their own. The wages for stone cutters in Aberdeen are between four and five shillings per day. The wages in St. George are from $2 to $2.50 per day. Our close proximity to the United States granite centres keeps the wages at their rates, as our men, who are well-known and famed as good workmen, and a much steadier class of men than the general run of journeymen, are always welcome in the neighbouring republic; consequently we have to pay the wages to keep them.

"The freight rates from Aberdeen to Ontario are about the same or a little less than from St. George. The duty on foreign granite has been 30 per cent for some years. On a fine class of work that required a good deal of labour this did not make up the difference in the wages. Consequently a great deal of the better work has come from Scotland.

Competition of American granites.

"There is quite a demand in Canada for Quincy, Westerley, Barrel and other American gray granites. St. George firms import the rough stone and compete favourably with American firms for this work. In large jobs the American firms send the rough granite to Scotland, have it manufactured there and shipped to Canada. ..... The St. George granite is well and favourably known throughout Canada and the United States, and is extensively used both in monumental and building work. The Museum of Natural History in New York is in part built of it, and a great many public and private buildings are trimmed with it in the form of polished columns, pilastres, etc. Its crushing test is 13,000 lbs. to the cubic inch."

Companies engaged.

The following are the names of the companies now working granite in the vicinity of St. George, with their output for the year 1893:—

	Tons.	Value.
Milne, Coutts & Co., Bay of Fundy Red Granite Co.	400	$32,000
Tayte, Meeting & Co.	300	24,000
Epps, Dodds & Co.	300	24,000
Victoria Red Grantite Co.	...	.....

Returns received by the Geological Survey for 1897, show a production of granite in New Brunswick valued at $87,300, the industry giving employment to 170 men during eight or nine months. Of the total output, about seventy-five per cent is to be credited to the vicinity of St. George.

Works at Carleton.

For several years Messrs. Taylor Bros. did a considerable business, their output for each of the years 1892 and 1893 being 300 tons, worth, at $80 per ton, $24,000. The Messrs. Burpee were also at one time largely engaged in the business, the rough stone being shipped to Carleton (St. John), where an extensive manufacturing plant was for several years in active operation; but difficulties having arisen in connection with the export of the product to the United States, their works were abandoned, and the raw stone was shipped from St. George by the Grand Southern Railway to Calais, Maine, where the industry is now carried on.

Duties.

The duty on manufactured granite sent to the United States was, under the "Wilson" tariff, thirty per cent; but the subsequent increase to forty per cent is well nigh prohibitive. The St. George product is now almost wholly marketed in Canada, being sent west even to Manitoba and British Columbia.

Situation of St. George quarries.

The St. George quarries are situated on the southern slope of a range of granite hills about two miles and a half distant from the town of St. George, and not far from the so-called "canal" or "thoroughfare" connecting Lake Eutopia with the Magaguadavic River. Openings have been made at many different points upon the sides and summits of the hills, the rock exhibiting considerable variety of colour and texture in passing from one to another. The rock is also intersected by numerous large and smooth-faced joint-planes, while in places it is irregularly seamed or even shattered. No difficulty is experienced in getting out good blocks of any desired dimensions, but columns from eight to ten feet are about the largest ever made. A curious feature is the covering of the surfaces of some of the joint-planes by a pale-green soft mineral resembling serpentine, mixed with scattered grains of graphite. At some points the rock is highly charged with scales of specular iron.

At the base of the main ridge of red granite, may be seen some ledges of so-called "black granite" somewhat similar to those described below. It takes a good polish and is not without beauty, but is apt to be streaky and is not regarded by the proprietors as a good or durable stone.

The possibility of successful operations at St. George is due not only to the fine quality of the stone, but also to the facilities afforded by the great water-power of the Magaguadavic River. Between the hills and the town, the stream traverses meadow land and is sufficiently deep and broad to allow of the easy carriage of blocks in scows, if desired; but then, changing its character, it descends for about a quarter of a mile in a deep narrow gorge and is broken into a series of tumultuous falls, the whole descent from the upper to the lower basin being probably forty or fifty feet. The granite works are situated on the edge of the ravine, and from the stream all needed power is directly drawn. To avoid the re-handling involved in shipping by scows, the rock is hauled directly from the quarries to the works.

The following description of the works at St. George is taken from a report of Dr. G. F. Matthew: *

Description works.

"The [Bay of Fundy Red Granite] company have their works in this village [St. George] on the branch or the Magaguadavic, just below the falls. The river here connects with tide-water in a narrow gorge in which the water-power machinery is placed, by which the works are driven. The power is taken from a five feet Leffel wheel (of 160 horse-power), with twenty-four feet of water, to a line of shafting passing into the buildings. The buildings of the company occupy three sides of an oblong space, about 300 feet long and 175 wide, extending to the nearest street. In the enclosed yard is a travelling crane, for lifting and carrying the stone to all parts of the buildings; it has a hoist of twenty feet, and is capable of lifting eight tons. On the south side is the grinding and polishing shop, and on the west and north the cutting shed. The offices of the company are also on the north side, at the entrance to the yard. The buildings are so constructed that the work can be carried on without hindrance from storm and winter cold. The grinding and polishing shed is 300 feet long, and contains four large rotary carriage machines or vertical rubbers, capable of polishing seventy or eighty superficial feet at once; also four hand rotary, vertical polishers, six pendulum machines, two of which are double, and thirteen lathes. This machinery is driven by a long line of four-inch shafting connected with the water-wheel under the falls.

*Report of Progress, Geol. Surv. Can., 1876-77, p. 347.

There is an additional line of shafting at the west end of the polishing shop, for driving the lathes. These lathes are of various sizes, the largest being capable of turning columns twenty-eight feet long and three feet in diameter. The large carriage machines have carriage-beds four feet by ten feet, and the motion is taken to the vertical rotary polishers which work upon them by cog-wheel movements; on the tables of these machines the stones are bedded to a uniform level with plaster of Paris. The four small rotary polishers are moved in a similar way, and have universal joints, to enable the workmen to move them at will to any part of their work.

Process of cutting and polishing.

"The rough stone is first taken into the cutting shed, which is about 250 feet long, where it is dressed with chisels to the required form. It is next transferred to the grinding and polishing shop, where the rough grinding is done with sand and water. When the stone is sufficiently smooth the sand is cleaned off, and emery applied to the amount of one pound to two superficial feet of surface; this is kept upon the stone till it (the emery) is ground to an impalpable powder, or "sludge," free from grit. The emery is then thoroughly cleaned off, and moist putty powder (oxide of tin) applied, to polish the stone and give it a brilliant surface.

"An ordinary spire, six feet high, can be cut and shaped in four days by one workman, and when transferred to the polishing shop, about four days more are consumed in grinding and polishing the several sides of it. The expense connected with the preparation of the stone for market is, therefore, considerable; but its colour and quality is such as to make it well worthy of the expenditure of time, labour and capital, and it is highly prized wherever it is known."

Existing appliances.

At the present time (1898) the grinding and polishing machinery consists of one granite lathe or column cutter, six Jenny Lind polishing machines, six vertical polishing machines, two sets pendulum polishing machines, seven polishing lathes, and other necessary appliances. About $3500 worth of finished work is turned out monthly, and about sixty men are employed for eleven months of the year, but the facilities are much in excess of this output.

The granites of the northern, or York county belt, are too remote from shipping ports to make them a profitable source of supply on an extended scale; they have, however, been employed to a limited extent. Then on the St. John River, just opposite the mouth of the Sheugomoc are the works of the Southampton Marble and Granite Company (Oldham Bros.) which extracts in the vicinity and uses each year from 400 to 500 tons, chiefly for the manufacture of monumental

bases, but sometimes for entire monuments. A considerable quantity of rock was also removed from that neighbourhood to be used as foundations in the construction of public buildings in Fredericton.

"*Black Granites*," *or Mica-diorites.*

Black granite.

At various points in connection with the great mass of granitoid rocks constituting the Nerepis Hills, rocks containing more or less hornblende, and often of a highly basic character, as well as of a dark colour, are met with, some of which have been quarried to a limited extent and brought to market under the above designation.

Bocabec.

One such locality is that of Bocabec, bordering the north side of Passamaquoddy Bay, in Charlotte county, where a quarry has been opened by Sheriff Stuart and others, in a rock consisting of a granular admixture of Labrador felspar and hornblende, with grains of magnetic iron. It is a handsome stone and susceptible of a good polish, but tougher and harder to work than ordinary granites, and said to require, as compared with that of St. George, about 20 per cent more labour for its finishing.

Frye road.

A rock of somewhat similar aspect, but carrying a certain percentage of quartz, and at the same time somewhat lighter in colour, occurs on the Frye road, a little west of Bocabec, and not far from the line of the Canadian Pacific Railway at Limeburner Lake. It is the property of Angus Kennedy, of St. Andrews, by whom a quarry has been opened and a considerable quantity of rock taken out, but not removed. The stone is of even texture, firm and durable, besides being susceptible of a good polish. Its position is favourable to shipment.

Dolins Lake, St. John county.

Rocks of a highly basic character and dark colour like that of Bocabec, also occur at Dolins Lake, near St. John, and Bull Moose Hill, Kings county, as well as at many other points, but as yet have not been worked.

During the summer of 1897, a company known as the Dominion Granite Company, of Bridgewater, N.S., have opened quarries and erected works at Welsford (Queens county, N.B.) for the manufacture of so-called "black granite." The rock is in reality a mica-diorite, and is described as forming a mass about one mile long and half a mile wide. It is situated about a mile from the line of the Canadian Pacific Railway, and about twenty-two miles from the city of St. John. It takes a good polish and is being worked for monumental purposes.

Ornamental Stones.

Ornamental stones.

The materials found in New Brunswick which are capable of being employed for ornamental or decorative purposes, besides granite, include certain varieties of marble, serpentine and porphyry, with, possibly, the minerals quartz, garnet, tourmaline and fluorite.

Marbles.

Marbles.—These are almost wholly confined to the rocks of the Laurentian system, in which they occur in considerable beds, and of many different varieties. In tint they vary from pure white to cream-colour, reddish, grayish or greenish, the latter tint due to associated pale-green serpentine, constituting *verde antique*. In texture they similarly graduate from kinds which are almost cryptocrystalline to others which are coarsely saccharoidal. Many of them are not without beauty, and are susceptible of a fine polish, but they are apt to be much shattered by the shearing strains to which they have been subjected, and this has greatly interfered with their being turned to useful account. Small quarries have at times been opened, but no extensive or continuous work has yet been undertaken.

Serpentines.

Serpentines.—As stated above, pale-green serpentine is at various points (St. John, Pisarinco, Musquash, Fry Island) associated with Laurentian limestones, forming a variety of *verde antique* marble. Hand specimens are often quite handsome, but large blocks, free from cracks, are not easily obtained.

Porphyry.

Porphyry.—In the hills around Passamaquoddy Bay, the upper portion of the Silurian system is marked by the occurrence of extensive sheets of fine-grained rock, consisting to a large extent of felspar, with porphyritic crystals of the same mineral, but having associated with the felspars more or less of finely disseminated quartz. It is probable that among these rocks, all of which are ancient volcanic overflows, quartz-porphyries and rhyolites are included. In many instances the beds are of very fine texture, and readily take a high polish, while their colour, varying from a pale salmon-red to a deep brownish-red, diversified by the occurrence of numerous small felspar crystals dis seminated through the mass, is such as to make them very attractive. In some instances, in addition to minute crystals, the rock is further characterized by what would appear to have been lines of flow, producing a delicately banded and wavy structure, suggestive of some varieties of polished wood.

Situation favourable for working.

Some of these beds are very favourably situated for quarrying and shipment, being (as at Chamcook Lake) directly on a branch

line of the Canadian Pacific Railway, or (as at MacMaster Island) close to navigable waters. That they have not, up to this time, been regarded as worthy of attention, seems to be largely due to the fact that, as seen near the surface, they are freely intersected by divisional planes, and blocks of suitable size are not easily obtainable; but the interior of these blocks is often of a very firm texture, and it is not at all improbable that, were excavations made sufficiently deep to get beyond the reach of the frost, the objection referred to might be greatly if not wholly removed. At all events there would seem to be no good reason why small blocks of the rock should not be used, in the form of tablets, etc., in connection with the red granites of St.George, with the colour of which they would completely harmonize.

Freestones, Millstones, Grindstones.

Carboniferous rocks.

With the rocks of the Carboniferous system, including the Millstone Grit formation, occupying so large a portion of its surface, it is not to be wondered at that rocks of the character indicated by the above title should be abundant in New Brunswick. As a matter of fact they can be obtained, more or less readily, over almost all parts of the area thus occupied. Their extraction has been chiefly determined by demand, and by their greater or less accessibility and proximity to means of transport.

Bay of Fundy quarries.

For many years, the chief centre of the freestone industry was to be found at the head of the Bay of Fundy, along portions of the Albert county coast, upon that of Westmorland county and some of the adjacent islands. One of these latter, viz., Grindstone Island, emphasises in its name the nature of the materials of which it is composed, as it was also one of the earliest localities at which grindstones were made. On Mary Point, on the mainland near by, similar beds occur, and about forty years ago considerable quantities of stone were quarried and removed from both places. It is said that, in 1851, as many as 58,949 grindstones were made, mostly from the Bay of Fundy beds. In 1856, more considerable quarries, known as the Budreau quarries, were opened on the left bank of the Petitcodiac River, in Westmorland county, and in 1864 the Caledonia quarries at Rockland in the same county. Still later, a quarry known as the Westmorland Union Freestone quarry, was opened near Cumberland Basin, with others in the valley of Demoiselle Creek, in Albert county.

Budreau quarries.

Geological conditions.

At all the above localities, the rocks lie at or near the base of the Millstone Grit, and may often be seen to rest upon and to graduate

into the red rocks of the underlying Lower Carboniferous formation. The former are usually gray or olive in colour, but shade on the one hand into chocolate-brown, or on the other into a bluish-gray. At Mary Point a portion of the beds were of a pale purplish-gray colour. The olive-gray was generally preferred, and of this very massive beds, from two to six feet in thickness, were readily obtained, yielding in the case of the Budreau quarries, blocks of any desired size up to a length of thirty feet, and a weight of twenty tons. The fine, even texture of these rocks, the facility with which they could be worked, their durability, combined with their pleasing colour, soon led to their being held in high estimation, and the so-called "brown stone fronts" of some cities of the United States, as well as many public buildings both in the United States and in the Maritime Provinces, illustrate the extent to which they were at one time employed. All this, however, is now changed, there being at the present time, so far as known to the writer, not a single quarry in either Albert or Westmorland county, at which work is being prosecuted. The explanation of this is mainly, if not wholly, to be found in the operation of the adverse tariff imposed by the United States.

Cessation of work.

While the working of freestones and grindstones in the south-eastern counties is thus for the time being dormant, somewhat extensive operations have, for a number of years, been in more or less continuous progress along the so-called north shore of the province, more especially near Newcastle, in Northumberland county, and on the shore of the Bay Chaleurs at New Bandon or Stonehaven, in Gloucester county.

French Fort quarry near Newcastle.

The French Fort quarry, near Newcastle, was opened in the year 1885, by Mr. C. E. Fish, as the result of inquiries then made for sandstone in connection with the construction of the large departmental building at Ottawa, now known as the Langevin block. For this building some 30,000 cubic feet of stone were quarried and shipped. Since that time the output has varied considerably, but the work has been continuously carried on, with an average, for the full seven months in each year, of between 3000 and 4000 tons, an amount which might easily have been increased by the employment of a larger plant and by additional effort to secure a market. The average number of men employed is about thirty, with wages at about $9 per week.

Situation.

The quarry is situated almost on the line of the Intercolonial Railway, and three-quarters of a mile from the Miramichi River, with both of which it is connected by tramways for ship

ping. The upper thirty feet of stone is olive-gray in colour, becoming sometimes greenish-olive, beneath which, to the level of the river, the rocks are gray. The greenish-olive or olive stone is most pleasing to the eye, whether with a natural or rock face, or dressed in various ways. It retains its colour well.

Various grades

The best grades of the stone are almost entirely free from defects, and are generally quarried from the same level. The stone is so easily wrought that it can be cut and carved very elaborately and at a small cost. It also makes a most desirable stone for trimming brick buildings. Other grades are admirably suited for the manufacture of stones, for wood-pulp grinding and for all classes of foundation work. The natural outcroppings, structures nearly one hundred years old, the numerous bridge-piers, culverts, abutments etc., for which it has been employed, both in salt and fresh water; its exposure to rough wear from the lashing of the ocean or swift running water, as well as to the grating of ice-floes and the knocking of drift timber, all tend to show the great durability of the stone and its fitness for every class of work, there being no evidence of weakness or decay under any of these circumstances. The stone needs to be quarried long enough before using to become thoroughly dried. The finer grades however, are much affected by the frost, while the coarser grades, do not seem to be affected in any way. Its power of resistance to shearing and crushing forces has not as yet been definitely determined.

Durability.

Thickness of Beds.

The thickness of the beds in the quarry runs from six inches to nine feet, the thickest being always the lowest. They contain seams, called by the quarrymen "sand-beds," "mica-beds," "mud-beds," "iron-beds," and "coal-beds," according to their predominant characteristics, and also hold spots and nodules of slate, as well as of a soft brownish-black material, probably manganese, occurring in "pockets." Iron is more abundant in some localities than in others. In some quarries it is found very largely in the best grades of stone, and in others it occurs chiefly in the less valuable sheets. Joint-planes occur throughout the quarry, some of them very long and deep while others are much shorter, branching off from the former in different directions. The width of the beds between these joint-planes is from 4 to 30 feet, and the actual joints are in some places quite close, while in others a little more open—about three-fourths of an inch—and then usually full of a very tough clay. Concretions are of common occurrence in the larger sheets of stone. They are usually round and consist of a brownish-black soft material on the outside, similar to that of the "pockets" referred to above, while the interior is of a fine, hard,

Concretions.

gray material. Much larger deposits of a like nature and termed "bull" by the quarrymen, are occasionally met with. They are sometimes three feet in diameter and six to ten feet in length. The stone surrounding concretions is always of poor quality.

Waste.

In the quarrying operations there is generally a good deal of waste, consisting of "earth," "shelly rock" and "bad rock," all of which has to be handled and got out of the way in producing the best grades of stone. This of course makes it a little expensive, but not more so than in the case of similar grades elsewhere at the quarries. The consequence is that very little of the rock is used in the Maritime Provinces, architects and their clients being there satisfied with the second grade of stone. Whether this is due to a lack of knowledge of the quality on the part of the builders, or to the aim of the architect to give a stone building at a small cost, is not known. Probably both these reasons come into play. It would, however, certainly be much better, in the case of our public buildings at least, if more definite instructions were given to the architects, properly specifying the quality of stone. Any class of stone can be produced at these quarries and as cheaply as elsewhere. The outcrops extend in distance for over three miles.

Markets.

The cost of transportation to our own markets very seriously injures the expansion of the stone industry at Newcastle. The distance to our larger cities and more prosperous towns entails a freight charge that cripples these works very much in competition with nearer quarries situated in the United States, as these can deliver stone, freight and duty included, at a less rate than the freight alone from Newcastle.

Effects of tariffs.

The change in tariff lately made, allows building stone and grindstones to come into Canada at a much less rate of duty than that imposed by the United States. This practically gives to Ohio and the West, our Ontario and Quebec market, while we are shut out from the New England market. Ontario takes no grindstones from the Maritime Provinces, and what is produced by them has been and is marketed in the New England states at a very great disadvantage, in competition with the quarries in the United States.

Competition from abroad.

Another very serious hindrance in the development of this industry, is the very large quantity of foreign stone that is brought to this country in vessels coming for return cargoes. These boats often carry it as ballast, at very small cost, and while the quarries in Great Britain actually get more for the same grade of stone than the Newcastle quarries, the latter are at a disadvantage.

In 1894 the United States duty was as follows :—

Grindstones finished and unfinished	10 per cent.
Building stone, etc., in rough	7c. per cubic foot.
do dressed	30 per cent.

In 1897 the United States duty is as follows :—

Grindstones finished and unfinished	$1.75 per ton.
Building stone, etc., in rough	12c. per cubic foot.
do dressed	50 per cent.

In addition to the Langevin block in Ottawa, Newcastle stone has been used in the construction of the city hall, Hamilton, Ontario; Erskine and St. James churches, Birks' building and various private residences in Montreal; the post-offices of Rimouski, Fraserville, Richmond, Chatham and Newcastle in Quebec and New Brunswick, and in St. Dunstan cathedral in Charlottetown, P.E.I. It has also been employed extensively as trimmings for brick structures.

The Bay Chaleurs stone quarries are, geologically, probably a little lower than those of Newcastle in the Carboniferous system, but do not differ essentially in their character.

Stonehaven quarries.

They are two in number, the principal one being that of Stonehaven (formerly New Bandon) and the other at Clifton, the two being about two miles apart. Both are situated directly upon the shore, which here presents, for several miles, a series of nearly vertical bluffs of rock, the admirably exposed strata having a very light south-east dip. At Stonehaven, the rocks are all gray in colour, including massive beds from sixteen to twenty feet in thickness, while at Clifton, only the basal beds are gray, the greater part of the fifty feet of rock that here constitutes the bluff being composed of gray, green and red crumbling shales. Layers of the latter are replete with fossil ferns, remarkable alike for their variety and the perfection of their preservation. At one point (Knowles' quarry) may be seen several beds of bituminous coal, the thickest being about eight inches. Other seams are said to show at very low water, one of them with a thickness of eighteen inches.

Manufacture of grindstones.

The freestone of Stonehaven, according to its proprietor, Mr. John W. Love, is not well suited for building, being subject to too rapid decay. The post-office at Bathurst has, however, been built of it. By far the larger part of the rock is used in the manufacture of grindstones, with pulp-stones, scythe-stones etc., as subordinate products. About fifty or sixty men are employed, and the yearly product is from 1000 to 1200 tons. The grindstones vary from four inches to seven feet in diameter, and their value is estimated at ½ a cent per pound or

Market.

$10 to $12 to the ton. At one time as many as 300 men were employed, but the production of stone in the west and the imposition of high duties by the United States have greatly reduced the force engaged. At present the product is wholly used by one firm near Hartford, Ct., U.S., (Collins Co., manufacturers of edged tools).

Freight charges from Stonehaven to New Haven, are about $3 per ton, the duty on large stone under the old tariff being $2 a ton.

History.

Quarrying was first begun at Stonehaven about 1844, the first workers being Messrs. Sprague, of Boston. The present proprietor commenced operations about 1852. The quarries are worked for about five months each year, the wages paid being $1.40 to $1.50 per day. The facilities for shipment by water are all that can be desired, while the line of the Caraquet Branch of the I. C. R. is less than a mile distant.

Some eight or nine years ago, a small quarry was opened in Scotch Settlement, at the head of the Shediac River, under the name of McSweeny's quarry. The stone therefrom was used in the building of the Roman Catholic chapel in Moncton, but since that time nothing further has been done.

At Cocagne Bridge, on the Cocagne River, in Kent county, where this stream is crossed by the Moncton and Buctouche railway, eighteen miles from the city of Moncton, quarries have been opened and are now being worked, but on a small scale only, by Mr. John Dobson. The rock is partly gray and partly purple, and can be readily removed either by rail or water. The building of the Young Men's Christian Association in Moncton is constructed of rock from these quarries and presents an attractive aspect.

No other quarries of importance are at present being worked in the province. Stone for local consumption has, however, at different times been obtained from other localities, especially along the line of the

Quarries near Fredericton.

Fredericton Branch of the C. P. R. From quarries opened there was obtained the stone used in the construction of the Fredericton city hall as well as the large departmental building of the Provincial Government. Besides a gray stone, these quarries yield a rather dark-purple rock. When used together, as in the first of the buildings named, the effect is pleasing to the eye; but when employed alone, as in the second, is so dark as to be somewhat sombre.

Slates, Flags, etc.

No slate quarries have as yet been opened in New Brunswick, but probably rather because of the very limited demand for the material

than from the inability of the province to produce it. Slate is in fact a very common rock in New Brunswick, and though nothing has been done in the way of testing its quality, it can hardly be doubted that localities could be found in which it would satisfy all requirements.

Among the districts which may be especially referred to as likely to furnish good slates, is that of northern Charlotte county, in the parishes of St. James and Dumbarton; the southern part of Queens, in Petersville and Hampstead; the Tobique valley, in Victoria; and portions of Madawaska, Gloucester and Restigouche counties. It is stated that the court house at Bathurst is roofed with slate from the Tattagouche River. Slate districts.

Flags.—Materials suitable for flagging are also not uncommon. In northern Charlotte county, the country is strewed with large tabular blocks of sandy and micaceous argillites, showing the natural tendency of the rocks there met with to break in this form. Portions of the Cambrian system east of St. John would also furnish good flags.

Hearth-stones.—During the operation of the blast-furnaces at Woodstock, sandstones derived from the Lower Carboniferous rocks of the Tobique and Beccaguimic valleys were to some extent used in the making of the hearths of these furnaces and were stated to give good results. Hearth-stones.

Hone-stones.—It is stated by Mr. M. H. Perley, in his Handbook for Emigrants to New Brunswick (London, 1857), that fine oil-stone, equal to Turkish, is found at Cameron Cove, near the northern head of Grand Manan, whence it has been taken in quantity. He also states that excellent blue whetstone has been worked to some extent near the Sevogle, a tributary of the North-west Miramichi, and again from Moose-horn Brook, in Kings county. The present writer has no personal knowledge of either of these localities. Hone-stones.

At Rockport, on the shores of Cumberland Bay, Westmorland county, a small quarry opened by Capt. S. Cole, includes beds which appear to be well fitted for the manufacture of scythe-stones and similar articles.

Clays.

Clays suitable for the manufacture of bricks occur in many parts of New Brunswick, being a common feature among the deposits of Pleistocene age, especially along river-valleys and upon the seaboard. Some are doubtless of estuarine or marine origin; others are probably Origin.

to be ascribed to the deposition, either in lakes or rivers, of the mud of melting glaciers. The former usually contain fossils and are, in consequence, more or less calcareous; the latter are usually destitute of such remains, and are more purely argillaceous, except where derived from calcareous rocks. In connection with the Coal Measures, especially at Grand Lake, are found thick deposits of under-clay, occurring beneath coal-seams, and stated to be adapted for the manufacture of fire bricks.

The manufacture of bricks has been carried on at so many different points and with so much irregularity that, with few exceptions, no very definite statements can be made regarding it. Only the most important works will be here particularly noticed.

1. Works of Messrs. John Lee & Co., Little River, Simonds, St. John County.

These works are by far the most important in New Brunswick. The following information regarding them has been kindly furnished by the proprietors:—

Lee Brothers brickyard.

John Lee, about 1846, bought a tract of land two miles from the city of St. John, containing a bed of brick-clay, and started brick-making by the hand-moulding process. On this site he continued to make brick until his death in 1860. In 1861, James and John Lee, under the name of Lee Brothers, enlarged the works by leasing an adjoining brick-yard from Mr. Thomas Davidson, and increased the output to one million bricks per year. Half of these were for five years sold to the Imperial Government to build the fortifications at Halifax, having been selected by the engineers for strength and durability in preference to any other bricks offered.

Development.

In 1870, the brick-yard of Mr. James Sullivan, situated at Little River, was bought. With increased facilities the three yards were kept running, five million being the output for 1877 and 1878, after the St. John fire. In 1880 the name of the firm was changed to John Lee and Co., and operations have since been continued with increased capital and improved machinery.

Quality of product.

The excellence of the product of these works is so well known to the building trade that "Lee's bricks" have been used in nearly every building of note erected in New Brunswick for the past twenty years.

Pressed-brick making was made a specialty in 1870, with an average annual output of 150,000. Drain-tiles have been made since 1863, varying in size from one and a-half to six inches in the bore. The

annual consumption of them has been about 35,000, the chief markets being in Nova Scotia and New Brunswick.

To Lee Brothers belongs the credit of introducing the manufacture of brick by steam machinery in New Brunswick in 1870. For the past thirty-seven years the average annual output of pressed and common brick has been one and a-half millions, with an annual average consumption for fuel of 700 cords of wood. The output for 1897 was 1,700,000 of common and pressed bricks, and 20,000 drain tiles. The number of men employed, thirty-five; the average wages paid, $1.35. The price of labour amounted to $6,000; the wood consumed, 800 cords, costing $2,400; the cost of hauling, $2,000; the price of the products delivered in St. John, $12,000. The brick-making season lasts from April to November, and the working day is nine hours. Output.

Although St. John is the chief market for these products, one-third of the output each year has been sold in the surrounding villages and cities of New Brunswick and Nova Scotia. Lots of small and large quantities are from time to time sold in Prince Edward Island, Newfoundland, the West Indies and the State of Maine. Market.

The residences, offices and brick-works are located at Little River, two miles from St. John, on the sea-shore of Courtney Bay, the position being favourable for the landing of wood and shipment of brick, besides being within easy hauling distance of railways. The plant consists of two semi-stiff-mud wire cutting machines, of their own invention, one Martin soft-mud machine, with a capacity of 50,000 bricks per day, one drain-tile machine and six brick presses, the whole driven by two twenty horse-power steam engines. The company's property covers 400 acres, thirty of which are of brick clay, very strong, and averaging nine feet in depth. The stock on hand on the first of January, 1898, was 1,700,000 stock bricks, 100,000 pressed bricks and 40,000 drain tiles. Plant.

According to Mr. R. Chalmers*, bricks have been or are being manufactured from marine clays at Campbellton, Restigouche, Bathurst, Newcastle and Moncton; while clays of apparently fluviatile origin have been similarly employed at Fredericton, Marysville, Woodstock, Shiketehawk and elsewhere on the St. John River.

The brick-yard at Newcastle is on the main line of the Intercolonial Railway, about half a mile east of the station, and formerly produced about 200,000 bricks per year. It has not been worked for about three years. The material is said to be of superior quality. Newcastle brick-yard.

* Annual Report, Geol. Surv. Can., vol. I. (N.S.), 1885, p. 58 GG.

The plant is still upon the ground, and an abundant supply of wood is within easy reach.

Fredericton brick-yards.

At Fredericton, the brick-yards of Mr. M. Ryan are situated at the north-west outskirts of the city, and within a few rods of the bank of the St. John River. The thickness of the clay is unknown. The works here were begun in the spring of 1872, and have since that time yielded an annual output of from 1,000,000 to 1,500,000 bricks, and from 50,000 to 60,000 drain tiles, the latter ranging in size from two to six inches. Mr. Ryan employs on an average twenty men, the average wage paid being $1.50 per day. The clay is removed to a depth of twenty-five feet, and has been tested to a depth of fifty feet, without reaching stone. It is blue in colour, quite free from surface stones or loam, and is very easily tempered. Occasionally fragments of land plants are met with, and in one instance a very perfectly preserved fossil fish was found in the clay, but whether of marine or fresh-water origin is not yet known. The bricks from this yard find a market in various parts of York, Carleton, Madawaska and Sunbury counties, but especially in the city of Fredericton. Prior to the opening of these yards others had been in operation, but upon a smaller scale, at different points in this vicinity, which is probably everywhere underlain by similar clay deposits.

At Marysville, on the Nashwaak River, three miles from Fredericton, are beds of brick-clay from which were obtained the bricks used in the building of the large cotton mills of Mr. Alex. Gibson, besides many residences in the same town. The works are not, however, carried on continuously, or for other than local consumption.

Moncton.

The Moncton brick-yard is that of Mr. W. H. Cummings, and is distant from the city about two miles, but only a quarter of a mile from the track of the Intercolonial railway, and less than this from the rails of the Moncton and Buctouche railway. The annual product is from 500,000 to 1,000,000 bricks, sometimes a little more. The market for the output is found chiefly in Moncton, Amherst and Sackville. About thirty men are employed, at about $1.50 per day, the cost of wood being about $1.50 per cord. No tiles are made here. Two qualities of bricks are manufactured, the one for inside and the other for outside work. Pressed bricks are also made if ordered. The works have been in operation here for forty years or more. At first the bricks were made by hand, but now steam is employed in connection with a dry-house and fans. The dry-house is capable of holding 65,000 bricks at a temperature of 150°. The Aberdeen school, recently constructed in Moncton, was made of bricks from these works.

Silica, Infusorial Earth, Etc.

Infusorial Earth.—As far as known to the writer, deposits of this material have been found in quantity at but two places in New Brunswick, though it is highly probable that careful search would reveal its presence at many other points as well.

Pollet River.

The first of the localities referred to is that of Pollet River Lake, Mechanic Settlement, Kings county. As described in the report of Dr. Hoffmann (Report of Progress, 1878-79 4 H) from data afforded by Dr. R. W. Ells. The deposit is of considerable extent, having a depth of about four feet over the floor of the lake, from which it could be removed either by dredging or draining. An analysis showed a little over eighty per cent of silica, a little over three per cent of alumina, and about thirteen per cent of water and organic matter, with very small quantities of ferric oxide, lime, magnesia and carbonic acid.

Economic value of product.

As regards the economic value of the material Dr. Hoffmann says:— "It may be said to constitute an excellent polishing material; and although no experiments have been made to determine its absorbent power, it may reasonably be expected to prove well adapted for the preparation of dynamite. Again, the extreme facility with which it is dissolved by caustic alkalies (potash or soda), would suggest its advantageous employment for the manufacture of what is commonly known as water-glass or soluble-glass, a preparation which meets with many important applications in the arts, as for instance, as a cement for the manufacture of artificial stone; for the hardening and preserving of building-stones; in fixing fresco colours by the process of stereochromy; as an addition to soap in the preparation of the so-called silicated soaps."

Fitzgerald Lake.

A second locality in which infusorial earth has been found, is that of Fitzgerald Lake in St. John county, seven or eight miles from St. John city, brought to notice in draining the lake by the St. John Water Company. The character of the material is essentially the same as that of Pollet Lake.

Silica.

Silica.—Deposits of this material, which are entirely sedimentary and not of organic origin like those above noted, occur in several parts of Charlotte county. The most remarkable is one found near Blacks Harbour, regarding which the following particulars have been kindly furnished by Prof. W. F. Ganong and Mr. C. E. Boardman.

The deposit occupies a flat plain, of which the extent is between one hundred and two hundred acres, but nowhere with a greater depth than ten inches. Though referred to as silica it is by no means purely

silicious, though in some samples the silica has been found to be over ninety per cent. A darker coloured material of the same nature underlies that just referred to and has, in some places a depth of at least twenty feet. Both materials may be described as fine silts.

Analysis.

An analysis by the Ledoux Chemical Laboratory of New York gave—

Silica	72·65
Alumina	17·93
Sesquioxide of iron	0·57

with small quantities of lime and magnesia and some combined water.

Considerable quantities of the material have been taken away to be tested for various uses, among which are: polishing powder, filling of wood preparatory to varnishing, filling for the walls of safes, and the making of scouring soaps; but in none of these has it proved superior or equal to infusorial earth.

Deposit not now being worked.

It has also been proposed to use it for the making of special kinds of bricks, but the negotiations in this direction have not been successful. At present nothing is being done with it. The property is now owned by Mr. G. W. Ganong and others of St. Stephen.

Mineral Paints.

Ochres.

Clays containing sufficient admixtures of ferric oxide or of manganese, to make them available for this use have been observed in various parts of the province, but have never been utilized except locally and on a very small scale. One of the best known to the writer, is represented by a specimen collected by the late James Robb in the vicinity of Edgett Landing, near Hillsborough, Albert county. It is a brownish-red ochre, which, after burning, gives a fine deep-red powder, well adapted for the manufacture of some varieties of paint.

On the North-west Miramichi River, in Northumberland county, and about one mile and a half above Chaplins Island, the slates of the district are found to hold veins and masses of brownish-red ochre which has a local reputation as a mineral paint, but the quantity appears to be small.

At Lyndfield, Charlotte county, in the excavation of a well, a quantity of dark-brown, almost black earth, was found beneath a mass of trap rock, and was penetrated without change to a depth of eighteen feet. An analysis of a sample made by Dr. Hoffmann, showed it to

consist essentially of bog manganese and oxide of iron. It would require some treatment to fit it for use as a mineral paint.

Another occurrence of ochre has been noted by Mr. Chalmers on the North-west Miramichi River, near Chaplin Island.*

It is also probable that some of the bog-iron ores elsewhere mentioned (p. 18) might be advantageously employed as ochres.

Mineral Springs.

Springs more or less charged with mineral matters have been observed in various parts of the province, but only in a few instances have so far been employed.

Salines.—The rocks of the Lower Carboniferous formation are in several places the sources of salt springs, as in the vicinity of Sussex in Kings county, at Salt-spring Brook, parish of Upham, in the same county, and on the Tobique River, in Victoria county. Of these the Sussex springs are the most important.

Salt works at Sussex.

As nearly as can be ascertained, the first operations for the manufacture of salt near Sussex were begun fully one hundred years ago, the quantity manufactured being, however, but small, very variable in amount, and employed wholly for local consumption. A similar description would to a large extent, apply to more recent undertakings in the same direction. The present proprietor (Mr. Geo. N. Hendricks) commenced work in 1887, since which time, on an average, about 150 barrels of salt per year have been made, each barrel holding four bushels. During the year 1897, 140 barrels were made, at a cost of about $2 per barrel. The salt is sold for $3 per barrel, and is especially esteemed for table and dairy use.

Mode of manufacture.

The salt is made by evaporation, two furnaces being employed, side by side, and having over them one pan made of boiler-plate, holding 2000 gallons and one holding 400 gallons. There are also two kettles holding 200 gallons each, and four holding 150 gallons each. These latter kettles, weighing 1000 lbs. and costing $50 each, are found to be very liable to crack, and sometimes last only a single season, thus increasing materially the cost of production, as well as giving uncertainty to the amount of product. Wood, in four-foot lengths, is burnt in one end of each furnace, and the fire is continued from Monday morning until Saturday night. Only two men are employed, one for the day and the other for the night, and great care is taken to secure a

* Annual Report, Geol. Surv. Can., vol. III. (N.S.), p. 33 S.

Output.

product which is pure and clean. Work is carried on in warm weather only. During the time the works were running in 1897, they turned out a little over twenty-one barrels per week; but there is plenty of brine to run a much larger plant, while if, by boring, a brine of greater strength were reached and more economical methods of concentration were employed, the yield could, no doubt, be very largely increased. There would be no difficulty in selling a larger quantity. The strength of the brine at present is twenty per cent. Salt made at this place is held in high repute for the curing of meat.

Results of borings.

About ten or twelve years ago, a boring was made to a depth of 150 feet, solid rock being struck at a depth of twenty-six feet from the surface. The water obtained at the depth of 150 feet showed an increase in strength of about four degrees in the salinometer. There are half a dozen springs within a radius of a quarter of a mile, all about six miles from Sussex station, but less than a mile from the line of the Intercolonial Railway. No attempt has been made to manufacture salt in other localities in the province.

Brine springs also occur at Salina, on Salt-spring Creek, Kings county, about thirty miles south of Sussex. This locality was visited by Mr. R. Chalmers, of the Geological Survey, in 1895, when a boring in the highly inclined Lower Carboniferous rocks had been made to a depth of 330 feet. A specimen of the brine was collected and subjected to analysis in the laboratory of the Survey with the following result, expressed in grains to the imperial gallon, and remarkable because of the large proportion of potassium*:—

Potassium chloride	19·963
Sodium "	1293·648
Magnesium "	22·315
Sulphate of lime	268·212
" magnesia	11·336
	1615·474

Sussex mineral water.

Mineral Waters.—A spring of mineral water found on the property of Mr. S. H. White, 1500 feet south of Sussex station, in connection with rocks of Lower Carboniferous age, has within the last two years become the basis of somewhat extensive operations. The flow, which is the result of an artesian boring, is at present that of a four-inch pipe, without pressure, but if confined, is sufficient to throw a jet to a height of fifty feet. It is, however, subject to considerable variation, apparently unconnected with the variations in rainfall, the flow even in a single day varying from five to twenty-five barrels.

* Annual Report, Geol. Surv. Can., vol. VII. (N.S.), p. 55 R.

An analysis of this water, made by Mr. F. G. Wait, under direction of Dr. G. C. Hoffmann, in the laboratory of the Survey, gives the following results, expressed in grains to the imperial gallon*:— Analysis.

	Grains.
Potassium chloride	6·21
Sodium chloride	2·10
Sodium carbonate	25·35
Carbonate of lime	1·47
Silica	1·05
	30·53

Carbonic acid in excess of that required to form the mono-carbonate, 9·24 grs.

In commenting on this analysis Dr. Hoffmann remarks that "the amount of water at the disposal of the analyst was far from adequate to allow the detection of any of the more rarely occurring constituents met with in waters. The analysis cannot be said to be an exhaustive one. It is, however, sufficiently so to show the general character of the water, which would be regarded as an alkaline water. If used dietetically it would be classed as a table water and might be drunk *ad libitum*."

No trace of hydrogen sulphide was found in the water at the time of analysis, having undoubtedly decomposed in the interval after bottling. The presence of this gas is, however, very obvious at the well, both to taste and smell.

The waters described above, are now the property of the Sussex Mineral Spring Company, and are used by them as the basis of the manufacture of various beverages, the water being carbonated and variously flavoured. The company is now putting up about 3000 bottles a day, and during the year 1897 the total product was some 300,000 bottles. Output.

In the parish of Havelock, also in Kings county, are other mineral waters which are being extensively used in the manufacture of beverages, but the writer has been unable, after repeated inquiries, to get particulars. Havelock water.

Road Material.

The subject of the better construction of highways is one which has of late been attracting a good deal of attention in New Brunswick, as illustrated by the formation of a Good-Roads Association and the making to the latter, by the Provincial Government, a legislative grant. Importance of using better road material.

* Annual Report, Geol. Surv. Can., vol. VII. (N.S.), p. 55 R.

The better construction of roads necessarily involves, as a most important factor, the consideration of the materials most suitable for their construction; and as the question has elsewhere, and especially in Massachusetts, been made the subject of extensive and elaborate investigations, it only remains to see in what position New Brunswick stands with reference to the supply of those kinds of material which the investigations referred to show to be best adapted for the purpose.

Considering the sparsely settled character of a large part of New Brunswick and the great cost involved in the transportation of quantities of stone such as would be required for macadamizing purposes, it is not to be expected that, for many years at least, the materials used for the purpose of ordinary road construction will be other than those to be found in the vicinity of the roads themselves. The conditions, of the principal towns, are, however, such that portions at least of their streets should be so made as to enable them to endure a considerable amount of wear. As examples it may be sufficient to consider here the two cases of St. John and Fredericton.

Road material used in city of St. John.

In the city of St. John, where rock-material has been employed as the basis of road or street construction, the material used has been largely derived from the beds of crystalline limestone, of pre-Cambrian age, which occur abundantly in that vicinity. It can hardly be said that the result has been satisfactory; for the same softness which admits of the rock being readily broken at comparatively slight cost, leads also to its rapid comminution and to the consequent necessity of frequent renewal, while the dust which results from its pulverization is of an especially fine and irritating character.

The slates and quartzites formerly removed in large quantities in the grading of the streets and in excavating for cellars, have been largely employed for a like purpose, but never gave satisfactory results. This supply having also now failed, the city authorities have resorted to the felsites and ash-rocks of the Huronian system, found just behind the city. In each case convenience and present cost have been the main guiding motives in the choice.

Fredericton.

In Fredericton the case has been still worse, the material here used having, until quite recently, been obtained solely from the beds of sandstone, belonging to the Coal Measures, which outcrop at various points in the vicinity of the city. This rock, at the best, has little durability, but when, as was often the case, material from near the surface which had long been exposed to the action of the air was chosen, a single season sufficed to reduce it to powder, forming masses of mud when wet or clouds of dust when dry. It was also wholly de-

ficient in binding power. At last, however, better counsels have prevailed, and by advice of the author of this Report, resort has been had to the deposits of diabase and related rocks which are found not far from the city, and especially about Curries Mountain in connection with the Lower Carboniferous formation. As yet but little of the material has been used, but so far as employed it has given perfect satisfaction.

As this type of rock is that which, after exhaustive comparisons, has been pronounced by Prof. Shaler and the members of the Massachusetts Road Commission to be the best suited for the purpose, it is of interest to know that it may be abundantly and cheaply obtained in almost every part of the province.

Miscellaneous.

The following substances, though either from lack of quantity or deficient quality are of little present economic interest, are deserving of mention, if only as indicative of possible future discoveries.

Barytes.

Barytes.—This mineral is formed in veins traversing Laurentian limestones on Frye Island, Charlotte county, and about the Northern Head of Grand Manan.

In the settlement of Gouldville, one mile and a half east of Memramcook, in Westmorland county, barytes has been found in connection with a series of dark-red rubbly sandstones and shales, capped by gray rocks of the Millstone Grit formation. It is therefore near the summit of the Lower Carboniferous system. It is not now possible to see the vein, but several pits were at one time sunk upon it, and a considerable quantity of the mineral was removed and shipped. It proved, however, to be too impure to be of much value. It carries small quantities of galena.

Fluor-spar.

Fluor.—Found associated with the barytes of Frye Island, Charlotte county; also in connection with semi-volcanic rocks of the Lower Carboniferous system near Harvey station and Listers Mills, York county.

Iceland spar.

Iceland Spar.—Veins of this mineral, sufficiently clear for optical purposes, are now of considerable value. Specimens suitable for such use were formerly found at Belledune, in Gloucester county, but the locality is now exhausted.

Asbestus.

Asbestus.—Veins of this mineral are found associated with serpentine, in the limestones of the Laurentian system of St. John county. They are of the variety chrysolite, but are too thin, so far as observed, to yield workable fibre.

Gem-stones.

Gem-stones.—Garnets are somewhat abundantly distributed through the mica-slates of the region about Moores Mills, in Charlotte county, and less commonly in the similar beds of Canterbury, York county, but none large enough to be of value have as yet been observed.

Crystals of black tourmaline, well crystallized and of considerable size, have been found near Moores Mills, but are very rare.

Amethysts of some beauty have been found on Grand Manan, but are not common.

Rare Metals.

Molybdenite.

Molybdenite.—Occurs in granular quartz-rock in Pennfield, Charlotte county, two miles north of the post-road on Trout Brook. It is in scattered grains and scales, some of the latter being as large as the thumb-nail. The quantity is said to be considerable. It has also been observed in granite rocks near St. Stephen, on the Nipisiguit River, near Bathurst, and elsewhere in rocks of like character.

Conclusions.

Having now given, as fully as the data available for the purpose will permit, the facts relating to the distribution and characters of the economic minerals of New Brunswick, it only remains to offer a few suggestions of a practical character, which may help in the extension of our present knowledge, and possibly lead to discoveries of importance.

Materials abundantly represented.

As regards materials used for purposes of construction, such as granite and freestone, already the basis of profitable industries, it is not necessary to say anything further. The same remark will also apply to deposits of gypsum, limestone, clay, sand, and probably to those of bog manganese. There is no dearth of any of these materials, their working depending solely upon their more or less favourable location and the obtaining of profitable markets.

Coal.

The question of the occurrence of coal has already been fully discussed, and will be made the subject of further consideration in a special report now in course of preparation. To set at rest any doubts which may still exist regarding its possible existence along the eastern seaboard, a line of systematic borings should be made parallel to this seaboard, from the vicinity of the Lutz Mountain ridge in Westmorland county to Bathurst in Gloucester county, with, possibly, another parallel line some thirty miles further west. This would fully settle

the questions upon which doubt still exists, and even if yielding only negative results, would be of value as tending to save useless expenditure in abortive exploration.

Albertite.

As regards Albertite, the large sums of money already spent in the fruitless search for further deposits of this mineral, together with its greatly diminished value, make it undesirable that there should be any further considerable expenditure in that direction.

The extent and character of the Bituminous shales of Albert and Westmorland counties are fully known. Nothing more is needed in this direction; but a possibly profitable field for experiment is to be found in the methods of their use. Apart from their character as sources of oil, they possess qualities of texture and composition which seem to suggest their possible employment in the manufacture of cements, pavements, etc. It is now proposed to make practical tests in this direction.

Gold.

Among metallic minerals, it is certain that gold is that around the existence of which the greatest amount of interest at present centres. From what has been already stated, it will be evident that the existence of the metal in profitable quantities in New Brunswick remains to be proven, and that that proof is only to be had by a prolonged and systematic prospecting of the areas in which it is likely, if anywhere, to be found. These areas are large, and at the same time, for the most part, difficult of access. They are not, therefore, likely to obtain anything like thorough exploration through the efforts of private parties; and, if left to the chance discoveries of those who occasionally traverse them in the interests of sport or the lumber industry, may for an indefinite period remain, from a mineral point of view, the *terra incognita* which they are at present. If, however, the local government were to offer reasonable wages to competent prospectors for a limited period, with the provision that, in case of discovery of valuable ores, the finders should have the first claim thereto on returning to the government the previous cost of exploration, it is probable that the offer would be readily taken up and might lead to important results. Should this plan be thought desirable, small maps, such as could be easily prepared, and which should clearly designate the region to be prospected, might be furnished to intending prospectors, and the whole subject made public by advertisement in the daily papers as well as in the mining journals of Canada. It might at the same time be made the duty of such prospectors to collect samples of quartz leads and of such other minerals as they might meet and to send these to the Crown Lands office for examination.

Suggested aid to competent prospectors.

As regards minerals other than gold, a similar plan might be adopted.

Mining laws.

It is an important question, in this connection, whether the mining laws of New Brunswick, imported with but slight alteration from the statute-book of Nova Scotia, sufficiently recognize the very different situation of a province rich in mineral wealth, with an organized mining bureau, and mines of many kinds yielding handsome returns, and that of one with but little known resources of this character, with no distinct mining bureau, and with mines yielding but little if any profit. In the latter case, not only should every inducement be held out to stimulate exploration, but the methods of acquiring proprietory rights should be at once simple and such as would tend to secure to the discoverer the fruits of his discovery. At present many a farmer, stumbling upon what may or may not be of value, hesitates to make any inquiries as to its character, fearing lest some one else more shrewd than he, or better acquainted with the requirements of the law, may step in and reap the profits of his observations; whereas if he were assured that his claim would have priority, he would make no delay in proving its value, and thus perhaps become the means of making known facts which would be of great and general importance.

Information for prospectors.

The appointment of a local officer, whose duty it should be to spend the summer months in visiting regions likely to become the seat of mineral discoveries, to pronounce, without elaborate assays, upon the probable value, or the reverse, of specimens brought in for examination, to direct the operations of the diamond drills and to be prepared to answer reasonable inquiries as to promising districts for exploitation and the mode of occurrence of useful minerals, would probably also be a step which would be justified by its results. The submission by such an officer of an annual report to the provincial legislature, would be the means of keeping the latter, as well as the public at large, accurately informed as to the condition of the mineral industries of the province for each successive year, would supply important information to those seeking an investment for capital in this direction, and would enable the government to make from time to time such legislation or such grants as would tend to originate or to stimulate new enterprises.

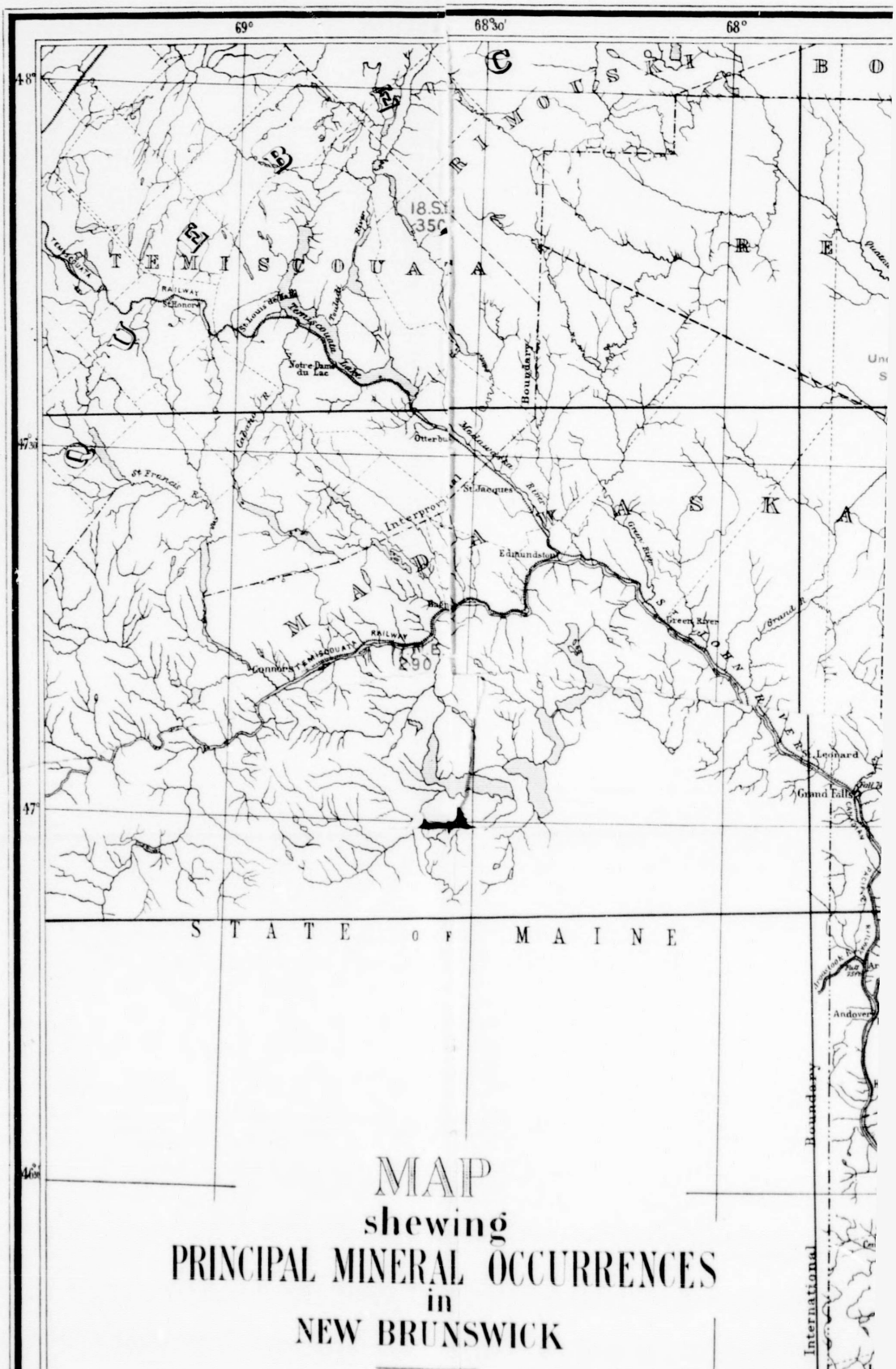
ADDENDUM.

Freestone

On page 110 M, the statement is made that no freestone was being worked in the Albert or Westmoreland quarries. This is still essentially true as regards the county first named, but not as regards the second. Through information since received it would appear that there are two brown-stone quarries at Wood Point, in the parish of Sackville, owned and operated by Mr. H. C. Read. They are fully equipped to handle rock up to the extent of 3000 tons each per year, of the best grade, and more of lower grades. These quarries have been in operation for several years, and have furnished stone for some prominent buildings, among others the city hall in Toronto (in 1896), and the new armoury in Halifax (1897).

In addition to the above Mr. Chas. Pickard is opening a quarry, said to be a very excellent one, in Sackville; while the Hon. A. D. Richard, with others, has been working successfully a quarry near the old Boudreau quarry, opposite Dorchester. G. P. Sherwood & Co., also have a quarry at Boudreau village, and expect soon to ship stone therefrom for the construction of the new government building at Liverpool, N.S.

While the freestones about the head of the Bay of Fundy are abundant in quantity, excellent in quality and usually well situated for shipment, their actual working is of a very irregular and intermittent character, and dependent on the varying demand.

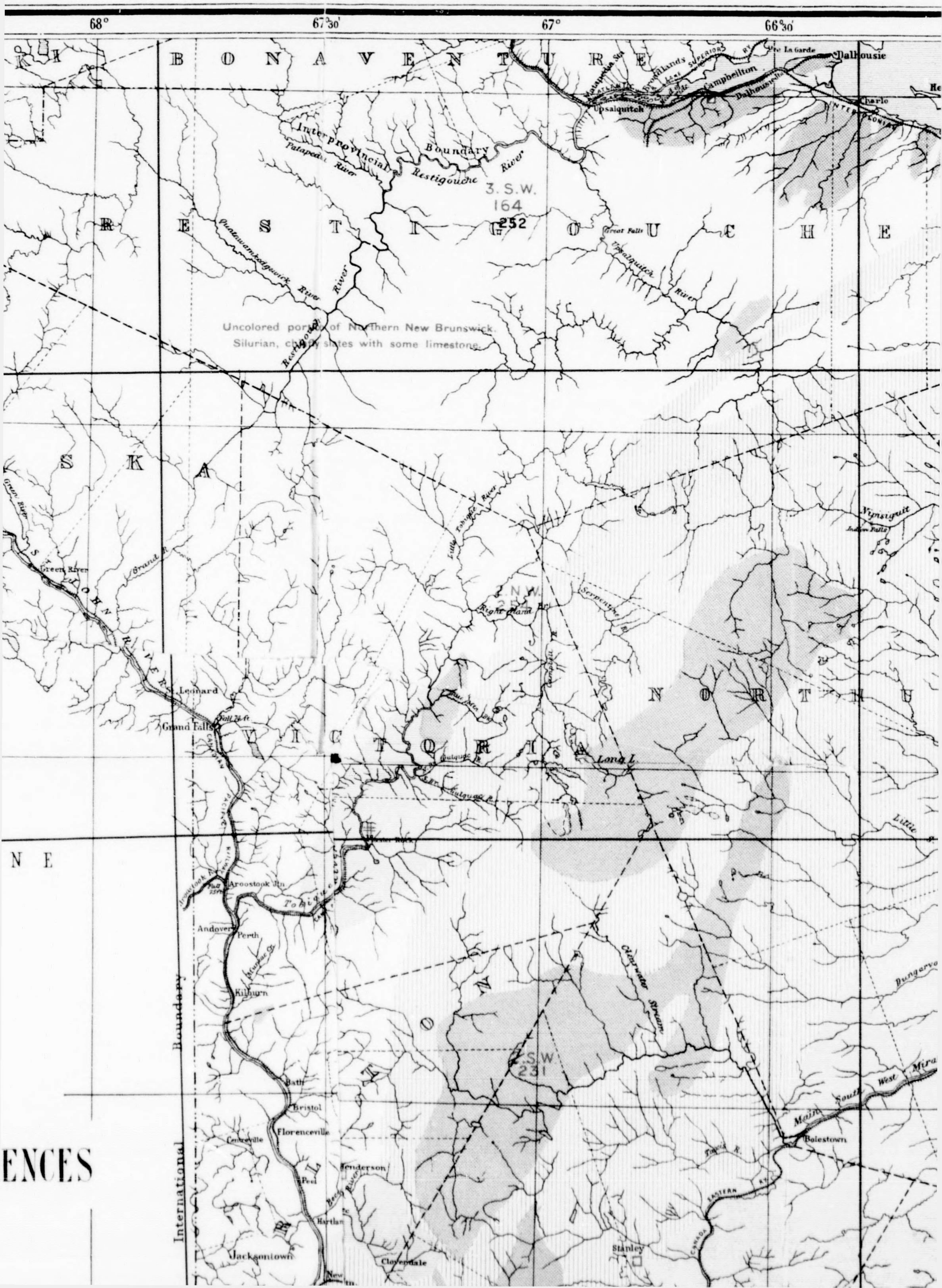


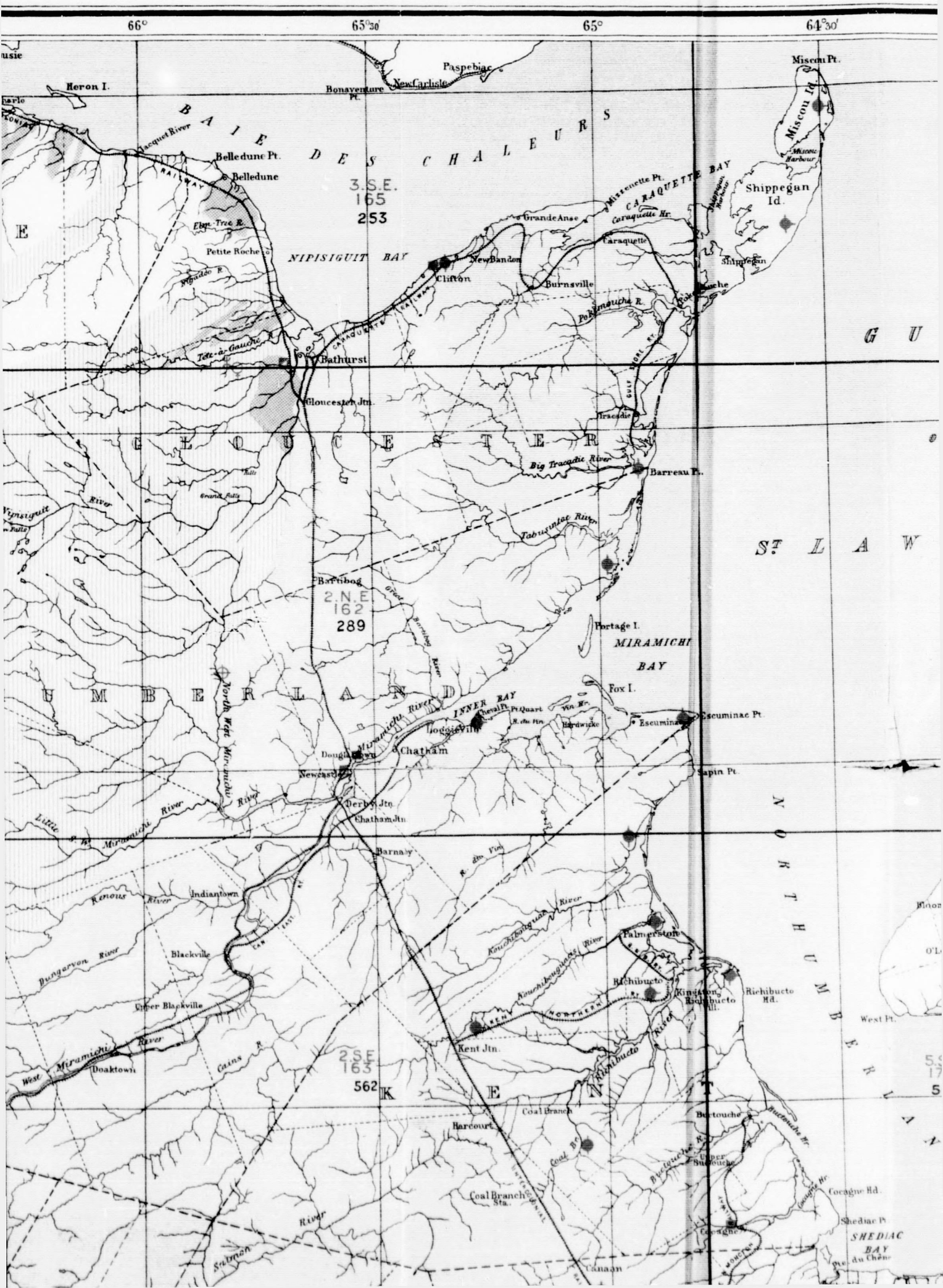
MAP
shewing
PRINCIPAL MINERAL OCCURRENCES
in
NEW BRUNSWICK

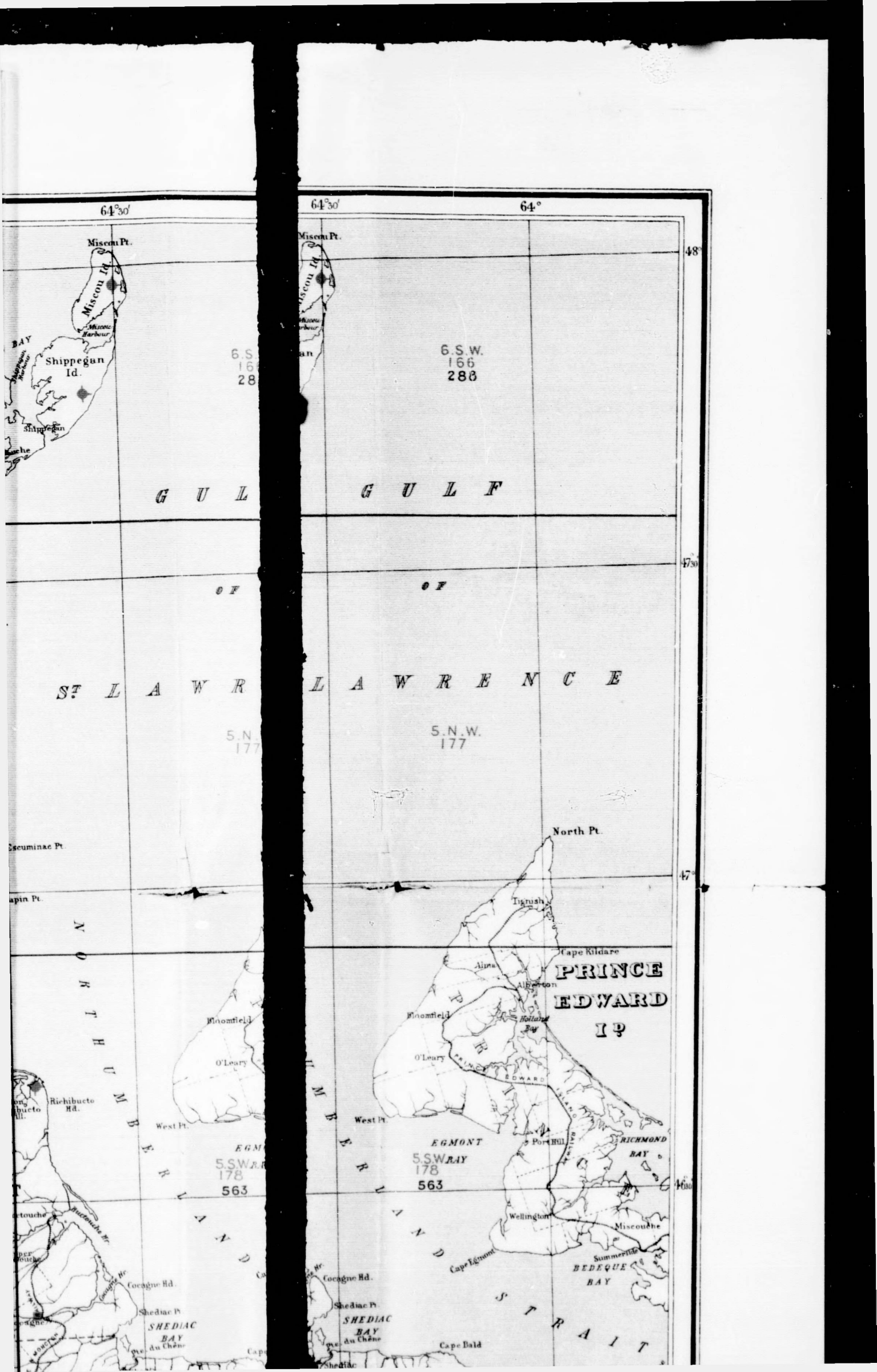
Geological Survey of Canada

GEORGE M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

1899




66°
65°30'
65°
64°30'
Paspebiac
New Carlisle
Bonaventure Pt.
Heron I.
Miscou Pt.
Miscou Id.
Miscou Harbour
BAIE DES CHALEURS
Jacquet River
Belledune Pt.
Belledune
RAILWAY
3.S.E.
165
253
Miscouche Pt.
CARAQUETTE BAY
Shippegan Harbour
Shippegan Id.
Grande Anse
Caraquette Hr.
Caraquette
Shippegan
Eel River
Petite Roche
NIPISIGUIT BAY
Nigadoo R.
New Bandon
Clifton
Burnsville
Pokemouche R.
Pokemouche
Tete-à-Gauche
CANADIAN GOVT. RAILWAY
Bathurst
GULF SHORE ST.
Gloucester Jtn.
Tracadie
GLOUCESTER
Big Tracadie River
Barreau Pt.
Grand Falls
Tabusintac River
ST LAW
Bartibog
2.N.E.
162
289
Portage I.
MIRAMICHI
BAY
Fox I.
INNER BAY
Escuminac Pt.
Loggieville
Chatham
Douglastown
Newcastle
Sapin Pt.
Derby Jtn.
Chatham Jtn.
Barnaby
Indiantown
Renous River
Blackville
Dungarvon River
Upper Blackville
Miramichi River
Doaktown
Gains R.
2.S.E.
163
562
Kouchibouguac River
Palmerston
Richibucto
Kingston
Richibucto Hd.
Kent Jtn.
Richibucto River
KENT
NORTHUMBERLAND
Coal Branch
Harcourt
Buctouche
Buctouche R.
Upper Buctouche
Cocagne Hd.
Shediac Pt.
SHEDIAC
BAY
Cocagne
Coal Branch Sta.
Salmon River
Canaan


64°30'
64°
Miscou Pt.
Miscou Id.
Miscou Harbour
Shippegan Id.
Shippegan
6.S.W.
166
288
GULF
OF
ST LAWRENCE
5.N.W.
177
48°
47°30'
47°
North Pt.
Escuminac Pt.
Tignish
Cape Kildare
PRINCE EDWARD I.
Alma
Alberton
Bloomfield
Holland Bay
O'Leary
PRINCE EDWARD ISLAND
West Pt.
EGMONT BAY
5.S.W.
178
563
Port Hill
RICHMOND BAY
Richibucto Hd.
Wellington
Miscouche
Summerside
Cape Egmont
BEDEQUE BAY
Cocagne Hd.
Shediac Pt.
SHEDIAC BAY
du Chêne
Cape Bald
NORTHUMBERLAND STRAIT

NEW BRUNSWICK

Natural Scale $\frac{1}{633,600}$

Scale 10 statute miles to 1 Inch

10 5 0 10 20 30

Natural Scale $\frac{1}{633,600}$

Scale 10 statute miles to 1 Inch

10 5 0 10 20 30

Legend

- *Carboniferous*
- *Slate Belt*
- *Granite, Diorite, Etc.*

Coal Anthracite	*Baryta*
Coal Bituminous	*Gypsum*
Albertite	*Mineral Paints*
Peat	*Mineral Springs*
Iron	*Infusorial Earth*
Manganese	*Grindstones*
Antimony	*Limestone*
Copper	*Granite*
Nickel	*Building Stone*
Argentiferous Galena	*Clays*
Graphite	*Silica*
Salt Springs	*Petroleum*

I.N.W. *Numbers of quarter-sheet maps of regular series*

174 *Catalogue numbers of Geological sheets*

317 *Catalogue numbers of Surface Geology sheets*

46°

45° 30'

45°

69° 68° 30' 68°

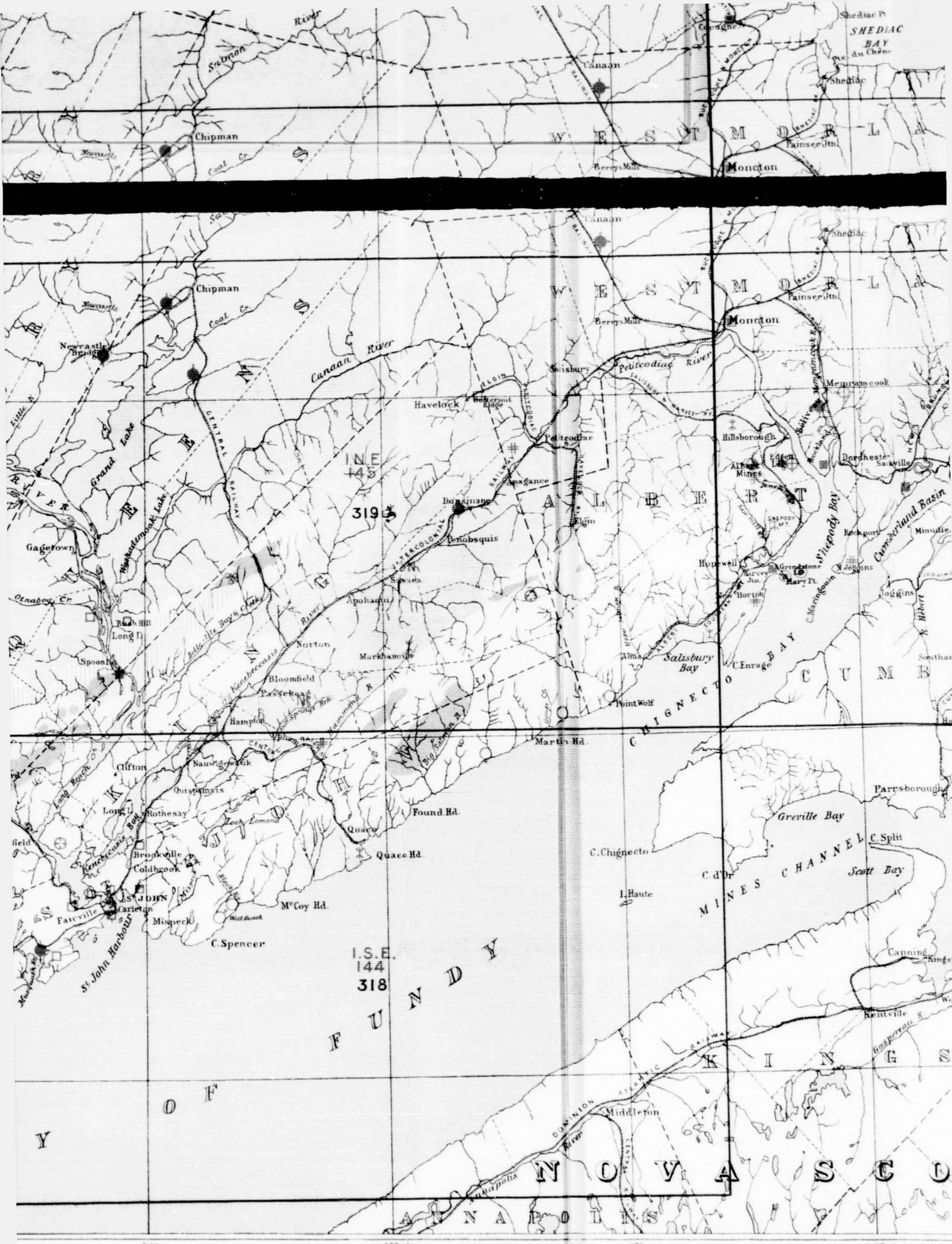
Uncolored portion of Southern N
Chiefly Devonian, Silurian and

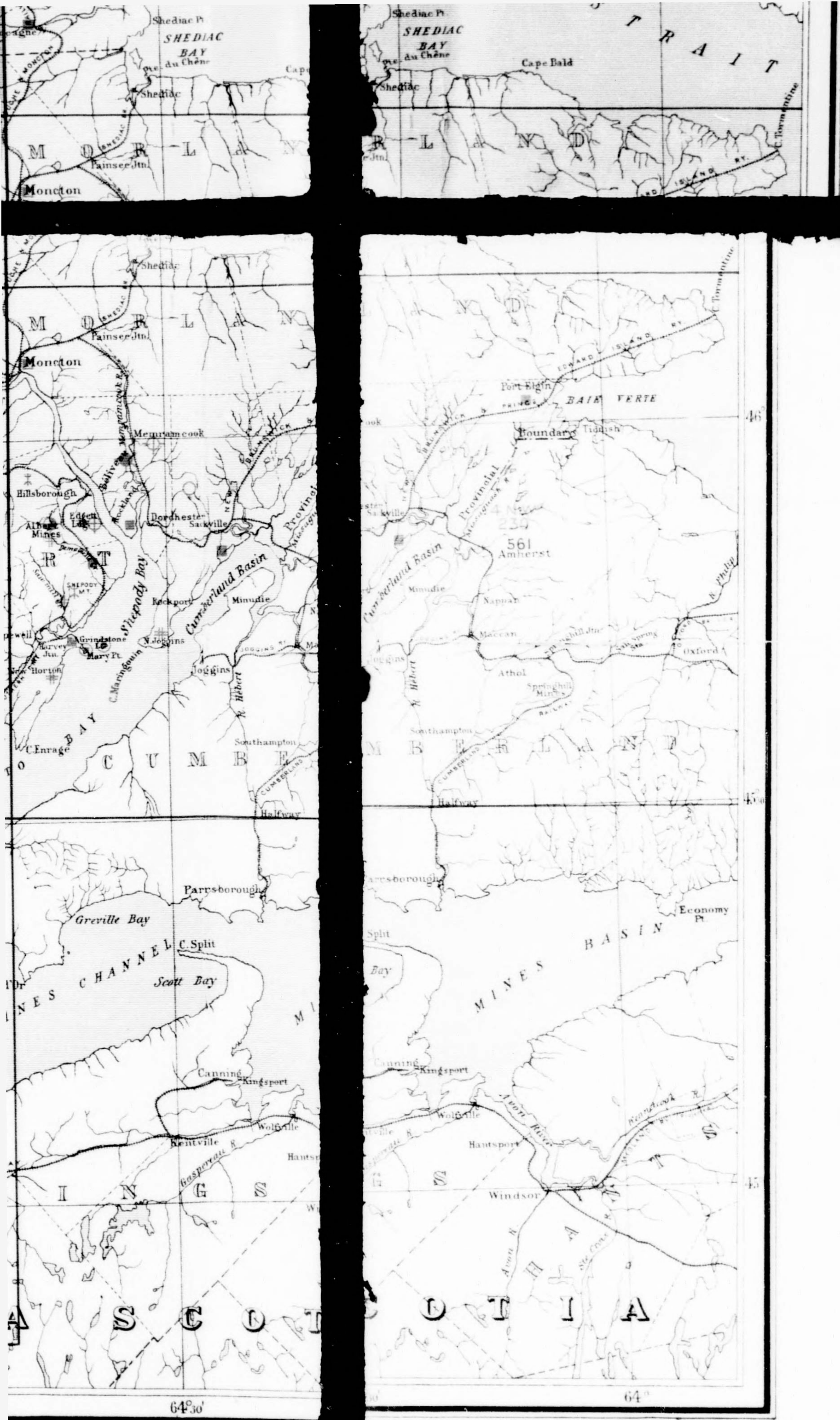
Monument

MAINE CENTRA

Drawn for photo-lithography by C. O. Senecal, B.A.Sc.


Jacksontown
Clovendale
Stanley
Woodstock
Newburg Jtn.
Upper Keswick
Cardigan
Rockland
Fredericton
Marysville
Benton
Canterbury
Prince William
Gagetown
Russagornis
Magaguadavic Lake
Harvey
Cork
Three Tree
Tracy
Fredericton Jct.
Macadam Jct.
Oromocto Lake
Hoyt
Vanceboro
Saint Croix
Chiputneticook Lakes
MAINE CENTRAL RY.
Watt Jtn.
Meduxnekeag River
Moore Mills
St. Stephen
Milltown
Calais
Utopia
St. George
Pennfield
Seely Hd.
Mace Bay
Pt. Lepreau
Bryer
Adams I.
Deer Id.
The Wolves
Campobello Id.
Quoddy Hd.
Long Eddy Hd.
Swallow Tail
Grand Manan Id.
S.W. Hd.
I.S.W.
143
317 St. Andrews
STATE OF MAINE
BAY
YORK
SUNBURY
ST. JOHN RIVER
CARLETON
WESTMORLAND
Uncolored portion of Southern New Brunswick
Chiefly Devonian, Silurian and Pre-Cambrian
68°
67°30'
67°
66°30'


Shediac Pt.
SHEDIAC BAY
Cocagne
Shediac
Canaan
Chipman
Salmon River
Coal Cr.
Berrys Mills
Moncton
Painsec Jtn.
Shediac
Canaan
Chipman
Coal Cr.
Newcastle Bridge
Canaan River
Berrys Mills
Moncton
Petitcodiac River
Salisbury
Petitcodiac
Havelock
Elgin
Hillsborough
Memramcook
Dorchester
Sackville
Albert Mines
Grand Lake
Washademoak Lake
Gagetown
Dunsinane
Penobsquis
Elgin
Sussex
Apohaqui
Norton
Markhamville
Hopewell
Grindstone
N. Joggins
Joggins
Minudie
Shepody Bay
Cumberland Basin
Kouchibouguac Bay
Salisbury Bay
C. Enrage
Point Wolf
Martin Hd.
Found Hd.
Quaco
Quaco Hd.
Clifton
Nauwigewauk
Quispamsis
Rothesay
Long I.
Loch Lomond
Brookville
Coldbrook
St. John
Carleton
Fairville
Mispeck
McCoy Hd.
C. Spencer
St. John Harbour
Parrsborough
Greville Bay
C. Split
C. Chignecto
C. d'Or
Scott Bay
I. Haute
MINES CHANNEL
Canning
Kentville
Middleton
Annapolis R.
Dominion Atlantic Railway
Intercolonial Railway
Central Railway
I.N.E. 145
319
I.S.E. 144
318
NOVA SCOTIA
BAY OF FUNDY
WESTMORLAND
ALBERT
KINGS
CUMB
66°
65°30'
65°
64°30'



SHEDIAC BAY
Shediac Pt.
Pte. du Chêne
Shediac
Cape Bald
STRAIT
C. Tormentine
Painsec Jtn.
Moncton
WESTMORLAND
Port Elgin
BAIE VERTE
Boundary
Tidnish
Memramcook
Hillsborough
Albert Mines
Dorchester
Sackville
Amherst
Shepody Bay
Cumberland Basin
Rockport
Minudie
Nappan
Maccan
Grindstone
Mary Pt.
Harvey Jtn.
N. Joggins
C. Maringouin
Joggins
Athol
Springhill Mines
Oxford
Hopewell
New Horton
C. Enrage
Southampton
CUMBERLAND
Halfway
Parrsborough
Economy Pt.
Greville Bay
C. Split
Scott Bay
MINES CHANNEL
MINES BASIN
Canning
Kingsport
Wolfville
Kentville
Hantsport
Windsor
Avon R.
KINGS
HANTS
NOVA SCOTIA
64°30'
64°
46°
45°30'
45°
Toronto Lith. Co.