

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON THE

MINERAL RESOURCES

OF THE

PROVINCE OF QUEBEC.

BY

R. W. ELLS, LL.D., F.G.S.A.



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TO ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S.,

Director of the Geological and Natural History Survey of Canada.

SIR,—I have the honour to forward my report on the “Mineral Resources of the Province of Quebec.” In this report I have endeavoured to present, as clearly and concisely as possible, a history of the several Mining industries from their inception to the present time, and have availed myself of all the information, not only to be found in the reports of the Geological Survey, but from leading articles and reports by experts in the different branches of mining, and published in the scientific journals, both in this country and in England. For much information, also, I am indebted to gentlemen, at some time connected with the mining industries of the province, the names of some of whom have been mentioned in the Report, and to all of whom I beg to tender my sincere thanks for the assistance afforded in such cases. Where mines have been closed for a number of years, it has been found impossible to obtain all or the latest information relating to the subject. The report must, therefore, of necessity be imperfect on these points.

I have the honour to be, Sir,

Your obedient servant,

R. W. ELLS.

GEOLOGICAL SURVEY OFFICE,

May 10th, 1890.

THE
MINERAL RESOURCES
OF THE
PROVINCE OF QUEBEC.

By R. W. ELLS, LL.D., F.G.S.A.

In preparing a history of the mineral resources of the province of Quebec it may be premised that a very large part of the material is necessarily derived from the publications of the Geological Survey, which has, for nearly fifty years, been working in this field. I am further indebted for information to the many valuable papers which have been published in one or other of the scientific journals of Canada and the United States, during the same period, by gentlemen connected with the mining industry, among whom may be mentioned Dr. James Douglas, Mr. H. S. Williams, M.E., Mr. James Douglas and Mr. W. Chapman. As, however, many of these publications—notably “The Geology of Canada, 1863,” which contained a summary of nearly all the previous reports of the Survey—are long since out of print, and the valuable information they contain is not now easily accessible to the general public or to those especially interested in the development of the mineral wealth of the province, it has been thought desirable to reproduce certain portions of these publications in order to render the present report as complete as possible; the object being thus to present in an accurate and concise form a sketch of the rise and development, as well as of the present status of the leading mining industries; while the mode of occurrence and probable importance of the various sources of mineral wealth will be indicated as clearly as the available information will permit.

Among those who have furnished valuable information bearing on these subjects, and to whom thanks are due, I may mention Messrs. W. S. Hunter, of Belleville; C. H. Miller, Drummondville; Dr. James Reed, Inverness; Capt. Wm. Warne, Eastman; J. S. Ross, of Beauce; and Thos. Macfarlane, M.E., of Ottawa.

In order to render more intelligible the statements, about to be made, regarding the distribution of the several mineral deposits, a brief

**Geology of the
province.**

sketch of the geological systems and formations is requisite; especially as the labours of the Geological Survey since 1869 have resulted in producing very considerable changes in the geological lines as laid down on the geological map of Canada, published in 1866; and as regards some districts have resulted in an almost entire change of opinion as to the age and relations of the formations over very large areas. These changes of the last fifteen or twenty years affect more especially that part of the province east of the St. Lawrence River, occupied by the crystalline schists and associated rocks, which are of special importance from their constituting the great mineral-bearing belts of the region from Vermont to Gaspé.*

**North side of
the St. Law-
rence River.**

Of the several geological formations now known to exist in Quebec, the oldest and the most important are those known as Metamorphic, Archæan, or Pre-Cambrian, consisting of the Laurentian* and Huronian systems. The first of these, the Laurentian, extends the entire length of the province from the Ottawa River to Labrador, and is confined to the north side of the St. Lawrence. From the vicinity of Montreal to Cape Tourmente, twenty miles below Quebec, it is separated from the river by a belt of irregular width, consisting of overlying, mostly undisturbed, formations which pertain to the Cambrian and Cambro-Silurian systems, and include the Potsdam, Calciferous, Chazy, Trenton, Utica and Hudson River. Below Cape Tourmente some of these formations re-appear, but only at the following widely separated points, viz.: Murray Bay, Bay St. Paul, Mingan Islands, and the Strait of Belle Isle. Except as sources of lime and building stone, mineral waters and small quantities of natural gas, they are not of economic importance, but in the wider parts of the belt they form considerable tracts of level and fertile country.

**Minerals of the
Laurentian
system.**

Except a few basin-shaped areas occupied by outliers of lower palæozoic rocks, as at Lake St. John and Lake Temiscamingue, the whole of the northern part of the province is, so far as at present known, occupied by the crystalline rocks of the Laurentian system, which as productive of economic minerals, are of great importance, furnishing, as they have done where explored, large deposits of iron ore, graphite, apatite, mica and zinc blende; also, veins containing gold and argentiferous galena. There are also extensive strata of quartz rock and orthoclase felspar, suitable for the manufacture of glass and porcelain, while serpentine and marble occur in considerable variety.

Huronian.

The rocks of the second or Huronian division of the Archæan are almost equally important as regards the economic minerals associated with them. They differ in many respects from those of the

* The term Laurentian was first officially used in the Geol. Survey Report for 1852-53.

Laurentian above described, and are confined to that portion of the province which lies to the south and east of the St. Lawrence River and Gulf and the great St. Lawrence and Champlain fault.

For the purposes of the present report they may be considered together with the immediately succeeding lower Cambrian and Cambro-Silurian systems, from which they are not everywhere easily separable, and together with which they have been greatly disturbed and altered, giving rise to conditions that do not occur in the rocks of nearly the same age to the north and west of the great fault.

They consist of schists of various kinds, chloritic, talcose, micaceous and hornblendic, with crystalline limestone, dolomites, great masses of dioritic rock, agglomerates, serpentines, and, in some places, imperfect gneisses and granitoid rocks.

The copper ore which has for so many years been mined in the province is found in this area. There are also extensive beds of iron ore, magnetite, hematite and chromite. In the copper lodes gold and silver occur, the latter often in sufficient quantity to be of economic importance. Antimony ore, argentiferous galena, asbestos and roofing slates also occur; the two latter already constituting important industries.

In connection with the great exhibitions held from time to time at London, Paris and Philadelphia, between the years 1851 and 1886, the Geological Survey took a prominent part in collecting, arranging and forwarding as good a representation as possible of the mineral wealth of Canada. In the catalogues which accompanied these several exhibits the various minerals have been described according to a certain well arranged scheme which places those adapted to certain purposes under their proper heading, and in now describing the mineral resources of the province of Quebec we can probably adopt no better course than to follow the scheme laid down in these publications. According to it the classification of the various sources of mineral wealth is arranged as under:—

- I. Metals and their ores.
- II. Materials used in the production of heat and light.
- III. Materials applicable to certain chemical manufactures, and their products.
- IV. Mineral manures.
- V. Mineral pigments.
- VI. Salt, brine and mineral waters.
- VII. Materials applicable to common and decorative purposes.
- VIII. Refractory materials.
- IX. Materials for grinding and polishing.
- X. Minerals applicable to the fine arts and jewelry.
- XI. Miscellaneous.

Cambrian and
Cambro-
Silurian.

Minerals east
of the St.
Lawrence.

Arrangement
of the subject.

I.—METALS AND THEIR ORES.

Iron Ore.

Of the various ores which come under division I. we may perhaps first consider those of iron, both on account of their great economic importance and their widespread distribution; and, of these, the most prominent are the magnetites, hematites and limonites or bog iron ore.

Early history
of iron mining.

The history of iron mining in the province extends back for many years, but presumably the earliest operations of any importance were those in connection with the limonite or bog iron ore deposits in the district of Three Rivers. These were described as far back as the latter part of the seventeenth century, and in 1737 a blast furnace was erected, and smelting operations undertaken, which have been carried on more or less continuously to the present time. In the Ottawa district the iron deposits were first opened in 1854, near Hull, while those of R. Haycock's location were not mined till nearly twenty years later. The lack of deposits of coal has interfered very largely with the successful smelting of the iron ores, more especially of the magnetites and hematites, and other causes have seriously influenced the practicability of shipping these ores to the American market in the raw state.

Magnetic ores.

The magnetic ores of iron are found at many points, not only among the rocks of the Laurentian system in the vicinity of the Ottawa River and along the north side of the St. Lawrence, but in beds and veins, often of large size, in connection with the metamorphic series of the eastern townships of Quebec. There is, however, at times a marked difference in the character of the ores from the two series of rocks, though this difference is not constant. Thus the ores of the Laurentian, near Ottawa, are remarkably pure and rich, containing a large percentage of metallic iron, while those found along the lower St. Lawrence, below Quebec, often contain a very considerable percentage of titanitic acid, and the ore passes into a true ilmenite.

Magnetites of
Hull.

In the publications of the Geological Survey of Canada, the first reference to the presence of magnetic iron ore is found in the report for 1845-46, where the great ore bed near Hull is described. A brief notice of this deposit, however, appeared in a paper read by Lieut. Baddeley, R.E., before the Literary and Historical Society of Quebec, in 1830, in which it is said "to form a vein or bed from ten to twelve inches thick, and appears to traverse the mountain in a south-west course, having a vertical position as regards the walls of the vein. On the opposite side of the mountain, at the distance of upward of a mile, and in the direction of the vein, ore was again in great abundance." The presence of plumbago in the ore was also pointed out; the associated rocks being stated to be friable white marble.

In the Geological Survey Report for 1845, the ore bed at this place is stated to have a thickness of twenty feet, and to be traceable for about a mile, with a course of N.N.W. and S.S.E., and to occur on the southern half of lot eleven, concession seven of Hull, on the property of Mr. Wright, as well as on the twelfth lot of the same concession, the containing rock at this place being syenitic gneiss and crystalline limestone. The ore is described as coarse granular, and as carrying in places disseminated scales of graphite, while other portions are comparatively free from this mineral. An analysis by Dr. Hunt of an average specimen gave

Magnetic oxide of iron	96.09
Silica and graphite.....	3.18
Metallic iron.....	69.65

In the report for 1847 the width of this deposit is stated as 40 feet, while the scales of graphite are said to sometimes form a vein of an inch or two in thickness.

This bed of iron ore was opened and mined in 1854 by Messrs. Forsyth & Co., of Pittsburg, with the intention of supplying the ore to their own works. In 1855, about 5,000 tons were raised, which were forwarded by the Rideau Canal to Kingston, and thence by lake vessel to Cleveland; but the discovery of the great Newboro' ore bed, in South Crosby on the canal, from which the ore could be mined and shipped at a cheaper rate than from the Hull deposit, acted disadvantageously to the latter, and its mining was for a time abandoned.

Subsequent exploration on the Hull bed showed it to have an entire thickness of about ninety feet, presenting a dome-shaped structure with gneiss on both sides and a mass of crystalline limestone protruding from below through the summit. The amount of iron ore taken from it up to 1858 is reported to be about 8,000 tons, containing 60.70 per cent. of metallic iron.

The Newboro' ore bed in South Crosby, was reported to have a thickness of 200 feet. It was mined by the Chaffey Bros., by whom some thousands of tons were extracted and forwarded to Kingston for shipment. The Hull deposit, in consequence, remained unworked for some years, but in 1867, a blast furnace was erected for the purpose of reducing the ores on the spot, which was kept in blast for a portion of 1867 and 1868. In the report by Dr. Hunt, on "The Iron Ores of Canada," in the Geological Survey Report for 1866-69, a very full account of the operations of this furnace is given.

Two kinds of ore were obtained from the Hull bed, a black magnetite and a red hematite. The analysis of these, given by Dr. Hunt,* is as follows:—

* Geo. Survey Report, 1866-69, p. 255.

In the hematite

Peroxide of iron.....	66.20	} Metallic iron....	58.78
Protoxide of iron.....	17.78		
Silica.....	10.44		

In the magnetite

Analyses of
Hull ore.

Magnetic oxide of iron.....	73.99
Metallic iron.....	53.20
Silica.....	20.27

Both contained very small quantities of phosphorus and sulphur.

Smelting opera-
tions at Hull.

The results obtained while the furnace was in blast from the 27th of April to the 5th of October, 1868, as quoted by Dr. Hunt, were as follows:—

Ore from Hull and Arnprior.....	1,896	tons
Scrap iron.....	7 $\frac{1}{2}$	"
Limestone.....	211	"
Charcoal, both soft and hard.....	242,782	bushels
Wood.....	25 $\frac{1}{2}$	cords
Peat and coke.....	21 $\frac{3}{8}$	bushels
Resulting pig iron.....	1,040 $\frac{3}{8}$	tons
Cost per ton.....	\$26.50	

The yield per ton of ore from these experiments is 54 $\frac{1}{2}$ per cent. The amount of charcoal used per ton was 235 bushels, and of peat and coke 47 lbs. Leaving out the amount of peat and coke, the quantity of charcoal per ton of ore was 37 $\frac{3}{4}$ cwt.

This amount of fuel is excessive as shown by Dr. Hunt, from a comparison with furnaces smelting similar ores in Sweden, where the average weight of the charcoal required, per ton, is for white or mottled pig iron but sixteen to seventeen cwt., while for gray metal for foundry purposes or for Bessemer steel from twenty-one to twenty-two cwt. On the assumed weight of charcoal at 18 lbs. per bushel, this saving, at 8 cents per bushel, would effect a reduction on the cost per ton of pig iron of seven to eight dollars. At Port Henry, on Lake Champlain, according to the same authority, where magnetic ores, similar to those of Hull are smelted with anthracite coal, the average consumption is from 1.10 to 1.14 tons, equal to 22 or 23 cwt. of anthracite to the ton of pig iron. He further remarks that the lack of profit in smelting the Hull ore is due to excess or wastefulness in use of fuel and to the useless or unnecessary addition of sand and clay in the charge.

So much for the experience of twenty years ago. Probably the most important paper that has been published since then on the subject of iron manufacture in Canada is that by Mr. John Birkenbine on

“The Possibilities of Iron Manufacture at Ottawa.” The remarks in reference to Ottawa are equally applicable to many other portions of Canada. This paper was read before the Institute of Mining Engineers at the Ottawa meeting, in October, 1889. From it we learn that anthracite is laid down at the furnaces on Lake Champlain, at \$4.25 per ton and probably could be supplied at the furnaces in Ottawa at something under \$5 per ton, so that the cost of the fuel necessary to produce a ton of pig iron from the Hull ores should not now exceed \$6. Under the old process with charcoal, the cost of the fuel was from \$12 to \$14 per ton, so that a saving of \$6 to \$8 per ton in this item alone could now be effected. From the figures given by Mr. Birkenbine, who is a leading authority on the manufacture of iron, we may quote the estimated cost of producing pig iron in Ottawa as follows:—

Mr. John Birkenbine quoted.

Fuel, Anthracite.....	\$6.50		
“ Charcoal, estimate.....	7.00 to \$8.00		Cost of pig iron at Ottawa.
Ore.....	4.25		
Flux.....	.50	\$11.25	
Labor and other expenses connected with production.....		2.75	
		<hr/>	
		\$14.00	

The above figures, compared with those of the cost of production while the Hull forges were in operation, show a saving of \$12.50 per ton. In smelting the ores at Hull, a great advantage is derived from having the ores and the flux in close proximity, and the only thing lacking is the fuel supply. At the Londonderry Mines in Nova Scotia, the disadvantage arising from a lack of fuel and flux on the spot is very great; the former having to be brought either from Spring Hill in the raw state and coked at the mines or as coke from Pictou, about eighty miles distant; while the latter is brought from Brookfield, a distance of forty-four miles. In addition to this, the ordinary Londonderry ores are not nearly so rich in metallic iron as those of Hull, and for some years a considerable portion of the supply of ore has been obtained from Pictou or Brookfield; while during the past year a further supply has been contracted for from the county of Annapolis, which will entail a railway haul of not far from two hundred miles.

Londonderry Mines compared.

Mr. Birkenbine also makes a strong point in regard to iron smelting in Canada, by showing that pig iron is protected to the amount of \$5.60 per gross ton by bounties and duties, so that, at the figures quoted for manufacture, the real cost of pig iron to the manufacturer in Canada is only \$8.40 per ton, or, making due allowance for profit and other items, foreign foundry pig would need to be laid down in Ottawa at a cost of \$11.00 per ton to compete successfully with the home manu-

facture. He also thinks it very possible that much of the enormous waste of sawdust and mill refuse could be utilized in connection with some of the processes of manufacture, as is the case in Sweden.

Haycock's
location.

About six miles from the Hull deposit, on the other side of the Gatineau River, may be mentioned that on the Haycock location. The ore is a mixture of hematite and magnetite, and occurs in a series of beds associated with red and grey felspathic gneiss. The deposit has been only partially opened up, and further developments may prove it to be of some importance.

Dr. Harrington
on the Bristol
deposit.

At the Bristol Mines, thirty-five miles up the Ottawa River from Hull, a very extensive deposit of magnetite also occurs. The first reference to this is in the Report of the Geological Survey for 1845-46, pp. 77-78; as well as to the extension of the same ore into McNab on the west bank of the river. In the report for 1873-74 Dr. Harrington gives some important details regarding this ore. He says: (p. 196) "During the winter of 1872-73 several openings were made in deposits of magnetic ore on lots twenty-one and twenty-two, range two, Bristol, Pontiac county, Quebec. The ore here forms a series of beds, interstratified with reddish syenitic gneiss and glistening, micaceous and hornblendic schists. The thickness of what appeared to be the uppermost and most important bed could not be ascertained..... Judging, however, from the quantity of ore taken out, the thickness must be considerable. Besides this bed, three others had been exposed. One of them was two feet thick, another only a few inches, while the fourth appeared to be about nine or ten feet thick, so far as the small amount of work done enabled one to judge."

In the same report, page 208, the analysis of this ore is given as under:—

Specific gravity.....	4.32
Peroxide of iron.....	65.44
Protoxide ".....	14.50
Bisulphide ".....	2.74
Protoxide of Manganese.....	0.11
Alumina.....	0.60
Lime.....	3.90
Magnesia.....	0.45
Silica.....	11.45
Carbonic acid.....	1.64
Phosphoric acid.....	traces
Titanic acid.....	none
Water.....	0.14
	<hr/>
	100.97
Iron as peroxide.....	45.81
" protoxide.....	11.28
" bisulphide.....	1.28
	<hr/>
Total metallic iron.....	58.37
Sulphur.....	1.46

“Combining a sufficient quantity of the peroxide of iron with the protoxide to form magnetic oxide, we find the ore to be a mixture of magnetite and hematite in the proportion of 46.72 of the former to 32.22 of the latter” (1.40:1.)”

Mr. Birkenbine describes the Bristol ore as a rich dense magnetite, with a very small percentage of phosphorus, but with so much sulphur as to render roasting necessary. He says that the mine has been opened to a depth of 150 feet, and with drifts along the strike for 150 feet and across the bed for 50 feet in one place, and from 50 to 60 feet in another, so that the deposit promises to be extensive. The ore is now being extensively shipped to the States. The quantity of sulphur which necessitated roasting the ore from the upper benches has become so much diminished in that from the lower workings as to render roasting no longer necessary. In the vicinity also, on the other side of the Ottawa, in Renfrew and Lanark, beds of both limonite and magnetite occur, which carry a large percentage of iron, and are in such close proximity to those of Hull that if any central location in the vicinity of Ottawa should be selected for smelting operations the supply of ore from many available points could be secured at very cheap rates, either by rail, from the localities up the Ottawa just described, or by canal, from the great ore bed of South Crosby on the Rideau, as well as from the great deposits of bog iron ore, presently to be described.

Mr. Birkenbine
on the Bristol
deposits.

The occurrence of magnetic ores in Grenville, on the south half of lot three, range five, was pointed out by Sir William Logan in the Geological Survey Report for 1853, p. 38. The breadth of the vein was estimated at from six to eight yards. This was traced for 150 yards in a westerly and south-westerly direction, the country rock being a micaceous gneiss, interstratified with many beds of quartzite. The assay of a specimen by Dr. Hunt gave metallic iron 52.23 per cent.

Ores of Gren-
ville.

Indications of similar ore are found on the adjacent lot, in the fourth range, the beds, however, being generally thinner. No attempt has yet been made to work the ores in this area. In addition to the localities just mentioned north of the Ottawa, there are doubtless others in which ores may be found in the area drained by the Gatineau and the Lièvre Rivers. Reference is made by Mr. Vennor, in the Geological Survey Report, for 1876-77, p. 298, to the occurrence of iron ore in Cameron township, near Post Creek, about fifty-four miles in a direct north line from the Ottawa River. It was traced, by frequent exposures, southward to the mouth of the Kasabasua, between the townships of Aylwin and Hincks; and was considered to be an extension of the horizon of the Hull ore bed. More recently, deposits of iron ore have been discovered in Templeton and in the adjacent townships.

Ores of Ottawa
county.

Bay St. Paul.

Along the north side of the St. Lawrence beds of magnetite have been reported at many points. Here, the ore is found in two forms, viz., as massive beds interstratified with the gneiss and limestone of the Laurentian, or as beds of iron sand along the beaches, often of considerable thickness and of great extent. These ores, while carrying a large percentage of magnetic oxide of iron, also frequently contain a considerable amount of titanitic acid, so much so, as in many cases to entitle them to be classed as ilmenite. Of these iron deposits probably the most important, as well as the largest known, occurs at Bay St. Paul, about fifty-four miles below the city of Quebec. Here an immense bed, having a thickness of ninety feet, has been traced for some hundreds of yards. This great bed has a historic interest, having been discovered in 1666 by Sieur de la Tesserie, and some explorations were carried on in the following year by Colbert's orders under the sanction of the King of France. In spite, however, of the great quantity of ore at this point, it has never been found possible to carry on smelting operations with any measure of success, owing to the large percentage of titanitic acid contained in the ore, as seen by the analysis of Dr. Hunt,* thus:—

Peroxide of iron.....	10.42
Protoxide of iron.....	37.06
Titanic acid.....	48.60
Magnesia.....	3.60

Two furnaces were, however, built at this place in 18 by the Canadian Titanic Iron Company. The undertaking, proving unprofitable, was discontinued in 1880.

Bay of Seven Islands.

Similar magnetic iron ore is found at different points along the north shore. Near the mouth of the Rapid River, which flows into the Bay of Seven Islands, a great mass of magnetite is found in the labradorite rocks of that place. The ore is reported by Dr. Hunt to have a breadth on the stream of about 500 yards from east to west, and to extend some distance north and south. Assays of it have given:—

Protoxide of iron.....	49.77
Metallic iron.....	38.70
Titanic acid.....	34.30

Moisie River.

On the beach at the mouth of the Moisie River there are also great deposits of iron sand interstratified with beds of nearly pure silica. Smelting works were erected there in 1867, which continued in operation for several years, being finally dismantled in 1876 or 1877. Similar deposits in greater or less quantity occur on the shore at Mingan,

* Geological Survey Progress Report, 1869.

Bersimis, Tadousac and at other points along the north side of the St. Lawrence. While these vary somewhat in composition, by far the greater part are titanitic ores. In the preparation of these sands for the blast furnace, a large percentage of the magnetic portion can be separated by an arrangement of magnets, and the titaniferous portion, which interferes with the easy reduction of the ores, eliminated.

North of Montreal, deposits of ilmenite, very similar in character to those just described, also occur, notably at St. Jerome and near St. Lin. These have been examined by Dr. Harrington, and that from St. Jerome was found to contain :—

Metallic iron.....	24.65
Titanic acid.....	32.36

while that from St. Lin had :—

Metallic iron.....	38.27
Titanic acid.....	33.67

Large deposits of similar ores are also reported as occurring along the Saguenay River ; at Lake Kenogami and on islands at the outlet of Lake St. John.

In the country east and south of the St. Lawrence considerable beds of magnetite occur in places. Some of these are titaniferous, but others are remarkably pure and contain no titanitic acid.

The presence of magnetite and hematite ores in Templeton, Buckingham and Hull is referred to in the Geological Survey Report of Progress for 1866, pp. 20-21. In Buckingham, on lot seventeen, range nine ; and on lot twenty-six, range twelve ; a vein of felspar cuts the gneiss and contains large cleavable masses of the magnetite, some of which are four inches thick. The felspar vein is about thirty paces wide, but the ore does not appear to be economically valuable, according to the observations then made.

On lot twenty-eight of the sixth range of Templeton deposits of hematite of considerable extent occur along with the orthoclase gneiss, but these masses, scattered through the rock, do not appear to be of any special value, though subsequent explorations may result in finding deposits of greater extent. A similar ore occurs on the adjoining lot in Hull, but has not yet been developed to any extent.

Among other localities on the north side of the St. Lawrence River yielding iron ores, of which assays have been made, may be mentioned a magnetic ore from the Leduc Mine, lot twenty-three, sixth range of Wakefield, Ottawa county ; the size of the deposit is not, however, stated. The assay by Mr. Kenrick of this Department gave :—

Metallic iron.....	69.185
Phosphorus.....	0.012
Titanium dioxide.....	Trace
Sulphur.....	.....
Insoluble matter.....	1.551

St. Jerome.

An ore from the county of Terrebonne, two miles and a half south of the village of St. Jerome, on the west side of the North River, assayed by Mr. F. D. Adams, of this Department, gave :—

Metallic iron.....	62.191
Phosphorus.....	0.007
Sulphur.....	0.001
Titanium dioxide.....	Trace
Insoluble matter.....	9.897

Brome, Sutton
and St.
Armand.

In the Geological Survey Report for 1847, page 59 *et seq.*, attention was directed to the presence of beds of iron ore at various places in the townships; more especially in those of Brome, Sutton and St. Armand. These were for the most part stated to be situated chiefly in the vicinity of two dolomitic belts, occupying the two sides of a ridge which traverses the two first mentioned townships, and in all, the ores are more or less titaniferous, sometimes strongly so. "The specific gravities of the ores in consequence frequently appear disproportioned to their produce in metallic iron, the specific gravity of the different varieties of titaniferous iron or ilmenite being as great or greater than that of the pure peroxide of iron; and from the presence of different varieties of ilmenite or their unequal mixture in the ore, it sometimes happens that a light ore will have a greater percentage of metallic iron than a heavy one. The produce of many of the beds will be found too low to render them available for economic purposes, but the ore being unequally mixed with chlorite and epidote, different samples from the same bed occasionally give different results, and, in any trial of the beds, with a view to turning them to practical account, great care should be bestowed on an effective test of them for considerable distances on the strike."

East St.
Armand.

Among the localities mentioned in the Geological Survey Report for 1847, and which may be here referred to as of prospective value, are the following:—The forty-fifth lot, East St. Armand, in the south-east corner of the township, where five feet of ore, mostly red hematite or specular schist, are exposed on the west half of the lot, the limits not determined; the rocks of the vicinity are chloritic and epidotic slates. The ore is mixed with chlorite to some extent, and on assay gives 34.73 per cent. of metallic iron. A later assay gave a mean of thirty-seven per cent. of metallic iron. On the seventh lot of the ninth range of Sutton, similar ore was observed, in apparently much greater quantity, the quality varying, however, in different parts of the bed, the percentage of metallic iron by assay ranging from 15.91 to 27.53. The beds are here kept near the surface by a series of folds, so that a considerable thickness of ore is exposed. The ore bed, however, is said to be from five to eight feet thick. A continuation of possibly the

same bed is seen in the south-eastern corner of lot six of the same range. Here a similar folded structure is apparent, and the bed is about seven feet thick. Another ore bed in the south-west corner of the same lot is six feet thick, and the percentage of metallic iron ranges from 22.98 to 23.86. On the fifth lot, range nine, a few yards from that just mentioned, a smooth vertical bluff of ore having a length of twenty feet and fifteen feet high is said to occur. The assay of this ore gives 48.60 of pure iron, and on lot four of the same range, a bed of one to two feet occurs, yielding 22.68 per cent. of metallic iron.

On the north half of lot nine, range nine, Sutton, magnetite grains occur in bands of limestone, in quantity sufficient to constitute more than half of the mass, and making an ore which would yield 38.76 per cent. of metallic iron; and in the tenth range, two beds of specular ore are found, one of a foot in thickness on the seventh lot, the percentage of iron varying from 19.07 to 39.06, the other seven feet thick and yielding from 19.42 to 32.13 per cent. of metallic iron.

On the ninth lot, eleventh range, a seven feet bed of peroxide of iron was found; the assays of two samples gave 21.78 and 39.90; and on the seventh lot another bed of unknown thickness gave 28.63 per cent. of metallic iron.

In Brome, lot one, range three, a very considerable deposit of iron ore is found in several parallel bands, varying from three to ten feet in thickness. A quantity from one of these bands was shipped at one time to the smelting works at Troy, Vermont; a distance of nearly forty miles. The assays of these ores are not given, but in the second lot of the same range a five feet bed occurs, which yielded 28.63 per cent. metallic iron. It is probably an extension of one of those just mentioned. On the Yamaska River also, on the fifth lot, range four, a little below the bridge, an eight feet bed occurs, which gave upon assay 24.08 metallic iron.

On the sixth lot, between ranges three and four, a bed of specular ore was mined and shipped to Troy. It is supposed to be three to four feet thick, though possibly more. Several other thin beds, interstratified with chloritic rocks, also occur in the vicinity; while on the fourth and fifth lots of the same range, beds of similar ore occur, having a thickness of five feet and with a percentage of metallic iron ranging from 30.97 to 37.91.

In Bolton magnetic iron is found on lot two, range fourteen, two miles east of Orford Pond. The size of the bed could not be ascertained. It was visited last season, and the pit was found filled with water. The assay of the ore by Dr. Hunt, given in the Geological Survey Report for 1847, was 37.79 metallic iron. This bed is apparently continued in the twenty-second and twenty-first lots of range fifteen, Orford.

The associated rocks in Bolton are the diorites of Orford Mountain; the mine being a short distance north of the C. P. R. near Miletta Station.

Probable future value.

From the foregoing list of localities it will be seen that the deposits of iron ore in this district are not only numerous, but, from the assays and the extent of the beds, should be of considerable economic value. But little development has, however, been carried out in these areas, and the dimensions of the beds, as given above, cannot be taken as fully determining their extent, since much of the surface was at that time (1847) covered with forest and soil. It is very possible, as in the case of the Hull and Bristol mines, more especially of the latter, which, when discovered, were supposed to be of small extent and but little value, but which have since been found to be of great importance, some of these will also, upon closer examination, be found to be of much greater importance than at first regarded.

Titanic ores of Sutton and Brome.

The presence of titanic acid in considerable quantity in some of these ores tends to exert a prejudicial influence on their value as easy smelting ores. The percentage in some cases has been determined, and is given by Dr. Harrington in the Report of the Geological Survey for 1873-74. Thus the ore from lot nine, range eleven, gives:—

Metallic iron.....	40.87
Titanic acid.....	27.20

From lot eight, range eleven, Sutton:—

Metallic iron.....	39.14
Titanic acid.....	29.86

And from lot one, range three, Brome:—

Metallic iron.....	41.46
Titanic acid.....	24.16

Titanic ores of the Chaudière River, Beauce.

A great bed of magnetic iron ore, or more properly ilmenite, forty-five feet thick, occurring on the Colway River, about four miles north of the Chaudière, in connection with serpentines, is described by Dr. Hunt as being separable with the magnet, after crushing, into two portions; about two-thirds of the whole being a magnetic oxide of iron; the remaining third being an ilmenite which contains 48.60 per cent. of titanic acid and 40.70 per cent. of peroxide of iron. The smelting of such ore is difficult from the great amount of fuel necessary to overcome the resistance offered by the titanic acid. These ores give, generally, a brown streak, and are but slightly affected by the magnet as a whole. Other deposits in the townships are not so highly titaniferous. Thus Dr. Hunt* mentioned that some of these from Brome and Sutton contain only two hundredths of titanic acid. Assays of

* Geology of Canada, 1863, p. 501.

these ores have not, however, been made for some years, nor have tests for the quantity of titanitic acid been made except in the few cases quoted.

Other deposits of magnetic ores, however, exist in the eastern townships, which are apparently entirely free from titanitic acid, and which form rich and valuable ores of iron. Among these may be mentioned that on lot seven, range five, Leeds. This locality was examined by Mr. Charles Robb, who reported the presence of three tolerably regular beds of ore of six, four and three feet in width respectively, separated by bands of chloritic slates. The ore is a fine grained magnetite, more or less mixed with micaceous iron ore. Similar ore occurs in the adjoining township of Inverness. The assay of the Leeds ore gave:—

Metallic iron.....	67.099
Phosphorus.....	.206
Sulphur.....	.038

Several assays of this ore showed the percentage of phosphorus to be variable, ranging from .025 to .335; the average for the three specimens being .188.

An assay of the Inverness ore gave:—

Inverness.

Metallic iron.....	65.433
Phosphorus.....	.193

Neither of these ores contained titanitic acid. The deposit was examined by the writer in 1887, and the principal bed was found to be from five to six feet thick, between green chloritic and micaceous schists on the upper side, having a north-west dip, and crystalline dolomite beneath. This ore has lately been mined to some extent and shipped to the Harvey Hill copper mines, where it is used as a flux in smelting the copper ores. The site of the mine is from ten to twelve miles from Robertson station on the Quebec Central railway.

A large and apparently excellent vein of magnetic ore is found on lots nineteen and twenty of the Gore, west side of Nicolet Lake, township of South Ham. The vein occurs in serpentine with a width of six feet at the surface, increasing to eleven feet in a shaft twelve feet deep. It was opened by Mr. Colombe in 1881, by whom about one hundred tons were extracted. From a partial assay made by Mr. Nagant of Quebec, and kindly furnished me by Mr. Obalski, G.M.E., this ore contained a small quantity of chromic acid. The locality is from eight to ten miles distant from the Quebec Central railway at Garthby station.

In the vicinity of Sherbrooke several deposits of magnetite occur,

Sherbrooke,
Clarke's mine.

which, from their excellent quality and their convenience to lines of railway, should be of economic importance. Of these, the largest is on lot eight, range nine, Ascot, near the summit of the ridge lying south of the city of Sherbrooke and to the east of the Belvidere road, at an elevation of 1000 feet above the St. Francis River at that city. The magnetite here is in irregular veins in chloritic schist, distributed over several acres and ranging in thickness up to ten or twelve feet. Some portion is a hematite. Assays by Bartlett of Portland gave 49.48 of metallic iron, but the quality differs at various points; since an assay in the laboratory of the Geological Survey gave only 28.39 metallic iron, insoluble matter 45.794. It showed no trace of titanitic acid. No determinations for phosphorus or sulphur were made.

Smith's mine.

Adjoining and opposite the city of Sherbrooke, on lot twenty-one, range six, Ascot, about three quarters of a mile from the Grand Trunk railway station, on the property of Mr. Stephen Smith, is another apparently large deposit of magnetic ore. The containing rocks here are also for the most part chloritic schists of the Sherbrooke anticlinal, along with jasper, which was referred to in the earlier reports of the Geological Survey. Precisely similar rocks are found in the city of Sherbrooke itself, and on the road south towards Capelton, near the fork of the road to Belvidere. The thickness of the ore and its extent on Mr. Smith's lot are unknown; but it is evidently quite extensive, and a considerable quantity of ore has been extracted. An analysis by Mr. Hoffmann gave:—

Metallic iron.....	54.074
Phosphorus.....	.660
Sulphur.....	.024

with no trace of titanium.

An ore from one of the beds near Kinnear's Mills, Leeds, gave:—

McVeity's
mine, Leeds.

Metallic iron.....	37.23
Titanic dioxide.....	trace
Insoluble.....	44.31

Ore from the specular schist bands on lot nine, range nine, Sutton, gave:—

Sutton.

Insoluble matter 40 per cent., with a strong reaction for titanitic acid. The percentage of iron is not stated.

The iron ores of the eastern townships present the same difficulty as regards fuel as do those near Ottawa. The erection therefore of smelting works at some central point, as at Sherbrooke or Magog, to which the ores from the various mines could be readily brought, would be desirable, since the railway facilities are at present so great,

that nearly all the most important deposits can be readily reached. Fuel suitable for smelting can be laid down in Sherbrooke at a cost for anthracite of probably not more than \$5.50 to \$6.00 per ton, and for coke from \$4.00 to \$4.50 per ton; and with the facilities presented as regards labour and shipment, the cost of smelting should not greatly exceed that given for the district of Ottawa.

The bog iron ores or limonites found in Quebec occur in beds which are both numerous and extensive, and have, as already stated, been worked for many years, more particularly in the district of Three Rivers. A good description of the smelting works was given by Lieut. Baddeley,* but a specially valuable paper on the history of the enterprise, by Mr. F. C. Wurtele, librarian of the society just mentioned, is contained in the *Trans. Royal Society of Canada*, 1886, from which we have obtained a brief abstract of the inception and history of the smelting operations at this place. The discovery of the bog ore deposits in the district of Three Rivers dates as far back as 1667. The place was visited by the *Sieur de la Potardiere*, who reported the deposit as of no value either in quality or quantity, and it was not until 1733 that any attempt to work it was made. From a letter of *Frontenac*, 1672, however, the importance of these deposits as a source of supply for iron was clearly pointed out, and plans were suggested for the erection of forges at some central point between *Cap de la Madeleine* and *Champlain*, where the deposits of ore are very extensive. They were also favorably reported on to the French Government by *Denonville* in 1681 and 1686, but no action was taken in the matter. In 1733, a company was formed consisting of *Francheville*, *Peter Poulin*, *Gamelin* and *Cugnet*, by whom forges were erected, but the first operations were unsuccessful; and *Francheville* having died, his widow and the company surrendered the forges and rights to the Crown in 1735. In 1737, however, a new company, formed the preceding year, and composed of *Francois Etienne Cugnet*, *Pierre Francois Taschereau* and several others, obtained from the king the privilege of working these ores, and this company acquired, in addition to the property on which the ore beds were more specially known to be situated, the adjoining fief of *St. Etienne* for the purposes of a fuel supply. Work was at once commenced, and a skilled artizan was obtained from France to conduct the operations in 1739. In 1740, the company having expended all their capital in the erection of the forges and various buildings, were compelled to return their charter to the Government of Three Rivers, and in 1743 the king ordered the furnaces to be repaired and work to be

* *Trans. Quebec Lit. and Hist. Soc.*, vol. ii, 183).

resumed and conducted in his own name. This was done by the importation of skilled laborers from France, and the furnaces erected in 1737 have been in use from that date down to the present time, or to the cessation of operations on the original site a few years since.

Changes of
ownership.

During the period between 1743 and 1863 the Three Rivers and St. Maurice forges changed hands several times, but were in almost constant operation or with occasional intervals of but short duration, necessary for repairs or during changes of ownership or management. In 1847, the property was leased to the late Hon. James Ferrier, of Montreal, for a term of four years, by whom the works were carried on very successfully, but the lease was not renewed. A lack of success apparently attended the operations of the company who succeeded him, and in 1862, the entire property was sold by the Crown Lands Department to Mr. Heroux for \$7,000, by whom in turn, in 1863, the forges, water power, etc., were sold to Messrs. John McDougall & Sons, of Three Rivers, for £1,700 currency. This firm carried on smelting operations on this spot till 1876, when the property passed into the hands of Mr. George McDougall, by whom the forges were worked till 1883, when they were shut down owing presumably to the exhaustion of the supply of ore and fuel within convenient distance to be profitably handled. Charcoal alone was used throughout the whole time in which the forges were in operation, and the iron produced, for the most part, enjoyed an excellent reputation, especially for certain lines of manufacture, such as car wheels, etc.

In the report by Dr. Harrington on the iron ores of Canada,* particulars of the blast furnace so long in active operation at this place are given, p. 247, as follows:—

“The internal dimensions of this furnace are:—

Height.....	30 feet
Diameter at hearth.....	2½ “
“ “ boshes.....	7 “
“ “ throat.....	3½ “

“There are two twyers, and the blast, produced by water, is cold and has a pressure of one pound to the square inch. The usual charge was:—

Bog ore.....	600 lbs.
Limestone.....	45 “
Charcoal.....	16 bushels (French†)

* Geol. Survey Report, 1873-74,

† The French bushel weighs two pounds more than the English.

Smelting
works, Three
Rivers.

“Forty-five charges are made in the twenty-four hours, and the furnace tapped at intervals of from twelve to eighteen hours. The daily production is four tons, of which ten per cent. is white and ten per cent. mottled iron. The charcoal required per ton was about 180 bushels, weighing from eleven to twelve pounds, and costing about six cents, per bushel.” The yield of the bog ore in the furnace was from thirty-three to thirty-five per cent. of iron; and the cost of the ore at the furnace was about \$2.50 per ton, and sometimes rather more. The resulting pig of late years was largely used for the manufacture of car wheels. In addition to the cast iron from the blast furnace, a Cost of production. small quantity of iron was also produced direct from the ore by the old fashioned hearth-finery. This was employed in the manufacture of axes, and was found to be of excellent quality, not at all cold short, and showing only traces of phosphorus. From the figures given of the cost of the raw material, the cost of pig ranged from \$19.50 to \$20.00 per ton; the fuel itself costing nearly \$11.00. Attempts made to smelt the magnetic ores of Leeds in these furnaces were not Furnaces not suited for smelting magnetites. attended with success, doubtless owing to the unsuitable size and shape of the furnace for these harder varieties of ore, and similar poor results have attended the attempt to smelt the Sherbrooke magnetites in the bog ore furnaces now located at Drummondville. From the report of Dr. Harrington, above cited, as well as from an excellent and comprehensive paper by Mr. J. H. Bartlett, Montreal, Mr. J. H. Bartlett quoted. “On the Manufacture of Iron in Canada,” read before the American Institute of Mining Engineers at the Halifax meeting, 1885, we are able to present some details of the several blast furnaces and forges which have been worked from time to time, some of which are still in operation and using the bog iron ores of Quebec.

The Batiscan iron works were erected about 1798, comprising a Batiscan forges. blast furnace, casting house, two forges, mills and other buildings on the east side of the Batiscan River, about six miles from its mouth, in the seigniory of Batiscan, Champlain Co. They were similar to those of St. Maurice, and were in operation for several years till the death of the proprietor, when the works were closed. Ore and wood are both reported as plentiful at this place.

The Radnor forges, situated at Fermont, seigniory of Cap de la Radnor forges. Madeleine, Champlain Co., on the River Lard, were erected in 1860, by Messrs. Larue & Co. The works comprised a blast furnace, forge and rolling mill, with a car wheel foundry at Three Rivers, about ten to twelve miles distant. The product was manufactured into car wheels principally, which had an excellent reputation. The rolling mills and forges were destroyed by fire some years ago, but the blast

furnace is still in operation, the probable output for 1887, according to Mr. Obalski, being 1,000 tons, employing forty workmen. Work at the Radnor furnace was suspended in the fall of last year. Mr. Bartlett says: "The ore is taken up from Lake Tortue. The iron manufactured is used for car wheels in the foundry of Mr. George McDougall at Three Rivers. A large sum of money has been spent on this Radnor industry."

L'Islet forges.

The L'Islet blast furnace was built by Messrs. McDougall, the proprietors of the St. Maurice forges, about four miles further up the river, north-west of the St. Maurice works, where the same conditions prevailed. These have not been in operation for some years. The Yamaska works were erected by the St. Francis River Mining Co. in 1869, on the River Aux Vaches, Yamaska county, on the east side of the St. Lawrence, and near the St. Francis River. This furnace was completed in 1869, and worked by the company till 1873, making in that time 5,520 tons of charcoal pig iron. It was then sold to Messrs. John McDougall & Co., of Montreal, who worked it till 1880, when it was closed, owing to the exhaustion of the ores in the vicinity.

Yamaska.

Drummondville.

The works at Drummondville were erected in the township of Grant-ham, county of Drummond, on the River St. Francis, in 1880-81, by Messrs. John McDougall & Co., of Montreal. They consist of two blast furnaces, each thirty-four feet high, with a diameter at the boshes of eight and ten feet respectively. They are worked by hot and cold blast, the motive power for the air-pump being the St. Francis River. The fuel used is charcoal. The supply of ore is obtained in part from beds of bog ore in the vicinity, and in part from Vaudreuil, near the St. Lawrence, above Montreal. The ore contains from forty to forty-four per cent. of iron; and the annual capacity of the furnace is about 4,000 tons of pig iron. It is principally used for car wheels, which are made at the foundry in Montreal.

Localities for bog iron ore.

Bog iron ores are distributed at many points throughout the province of Quebec. The deposit at Vaudreuil, now being worked for the Drummondville furnace, was referred to in the Report of the Geological Survey for 1845, as occurring on a number of lots, and having, in Côte St. Charles as well as in the Petite Côte in the same seignior, a thickness of four feet. Near Ottawa, deposits of bog iron ore are mentioned as occurring in several places, among which are the Blanche River in Templeton, above McArthur's Mills; the fourteenth lot, concession seventeen, Hull; Eardley; at Upper Rocky Point in March; in Constance Lake and in the vicinity of the Chats. Analyses of some of these will be found further on.

Ireland.

Among other deposits referred to in the Geological Survey Report for 1849-50, are the twelfth lot, fourth range, Ireland, where an area of

two yards by fifteen, in a bed about fifteen inches thick, was noted; also a bed at St. Lambert, on the west side of the Chaudiere, in the seigniorship of Lauzon, about twenty inches thick, but the area not ascertained, though apparently of considerable extent. In the seigniorship of St. Vallier, one mile above the forks of the River Sud, two considerable areas were noted; one of which had a breadth of twenty-eight yards and a length of three hundred and eighty yards north-west from the mill, with a thickness of twenty inches; the other twelve hundred yards by twenty-four yards, and twelve to twenty inches thick; with others in the vicinity, sufficiently extensive to be of economic importance. Other deposits occur on the road between Ste. Anne des Plaines and St. Lin; and on the road between Rivière Ste. Marie and Achigan, the thickness being about six inches, but the area unknown. Considerable deposits of bog ore also occur in the township of Kildare, and the augmentation of the seigniorship of La Noraye and Dautraye, near the River l'Assumption; but these areas have never been worked. They are situated on the north bank of the St. Lawrence, about midway between Montreal and Three Rivers.

St. Lambert, Chaudière district.

St. Vallier.

North side of the St. Lawrence above Quebec.

The areas from which the St. Maurice furnaces drew their supplies are for the most part entirely exhausted. They were very extensive, having furnished ore for nearly 150 years. Further to the north-east, in the seigniorship of Champlain and Batiscan, large beds of this ore still exist, which, in the early part of the century, supplied forges which were operated on the Batiscan River. On the eastern side of this river, also, several areas of considerable extent occur in the vicinity of the road between the Batiscan River and the village of St. Prosper. The old forges on the Batiscan were apparently situated on the south side of the river about six to eight miles from the mouth.

Three Rivers and vicinity.

Further down the St. Lawrence, between Port Neuf and St. Basil, as well as on the Jacques Cartier, in Bois Brulé and Cap Sante, other deposits occur, the particulars of which are not to hand. The low grounds which flank the ranges of Laurentian hills along the north side of the St. Lawrence River seem to carry areas of this bog ore in great abundance, and would appear to point out the presence, at many points, of masses of pyrite or other forms of ore in the hills, not far from where these deposits are located, and from which these latter have been derived. Below Quebec similar ore is reported in small quantities in the east side of Ha Ha River, a branch of the Saguenay, and, though the quantity is not said to be very extensive, it was thought it might indicate more valuable ores in the vicinity; but on the south side of the lower St. Lawrence River, deposits have been noted and described by Mr. Richardson in several localities, which appear to possess economic values. Among these, are concession two

St. Lawrence below Quebec.

Ha Ha River.

Green Island. of Green Island, where beds from ten to twenty inches thick and of considerable extent are found on ten lots, having a surface breadth of one hundred yards. In the seigniory of Cacouna, at the village of La Plaine, several small patches, with a thickness of four inches or so, were observed; and in the seigniory of Villeray, about three miles west of Green Island Seigniory, patches of ore of considerable extent, from six to twelve inches thick, occur on several of the farms in that vicinity. The ore-bearing belt here is stated to be comprised in an area of about twenty-four miles from east to west by four to six miles from north to south.

Kamouraska. Small deposits are also reported from the seigniory of Kamouraska, near the road between that village and St. Paschal, one of which, with a thickness of six to eight inches, has an extent of three hundred by thirty paces.

St. Francis River. On the River St. Francis several areas of bog iron ore are found, one of which, near the River aux Vaches, which joins the St. Francis about ten miles from its mouth, was worked for some years and supplied the ore for the St. Francis furnace, the yield of iron obtained being about 36 per cent. At Drummondville, about twenty miles further up the stream, extensive deposits are now being worked for the furnaces at that place already referred to.

Memphremagog Lake, Hog's Back Mountain. A considerable deposit, lately opened up, occurs near the west shore of Memphremagog Lake, on the west side of the Hog's Back mountain, at Knowlton Landing, on lot twenty-eight, range nine, Potton. This ore overlies a heavy bed or vein of pyrites, carrying both copper and iron, and has a considerable surface area, with a thickness of from one to three feet. Its remoteness from smelting works and the consequent high rate of freight are at present a bar to its being profitably worked; but should furnaces be erected at some central point, as already suggested, this deposit could then be utilized, since it is within a short distance of shipment on Lake Memphremagog.

An analysis of bog ores from several localities is here appended. It will be seen that the percentage of iron varies very considerably in the ore from the different areas.

ANALYSES OF BOG IRON ORE

By DR. B. J. HARRINGTON.*

	I.	II.	
Peroxide of iron.....	40.96	69.64	No. I. is from Ste. Ange- lique, Vaudreuil (Mc- Gillis property). No. II. is from L'Islet forges, Three Rivers.
Protoxide of iron.....	....	17.25
Oxide of manganese.....	26.34	Analyses of bog ores.
Protoxide of manganese.....	....	0.05
Lime.....	1.48	0.53	
Alumina.....	....	.90
Magnesia.....	Traces	Traces	
Phosphoric acid.....	0.60	Traces	
Sulphuric acid.....	Traces	0.05	
Silica.....	....	1.93
Insoluble matter and silica.....	12.08	....
Water and organic matter.....	17.97	22.04	
	99.43	102.39	
Metallic iron.....	28.67	54.34	

ANALYSES OF BOG IRON ORES

By DR. T. S. HUNT.†

	I.	II.	III.	IV.	V.	VI.
Peroxide of iron.....	74.50	76.95	....	77.60	74.30	64.80
Sesquioxide of manganese	....	....	....	0.30	Traces	5.50
Alumina.....	0.30	0.80	....	....	....	....
Silica.....	7.10	1.50	5.43	5.40	3.60	4.80
Phosphoric acid.....	....	....	1.52	1.81	1.80	Undet.
Volatile matters.....	18.95	19.80	19.70	17.25	22.20	23.65
	100.85	99.05	....	102.36	101.90	98.75
Metallic iron.....	52.15	53.86	....	54.32	52.01	45.36

I. From Petite Côte, Vaudreuil.

II, III. Côte St. Charles, Vaudreuil.

IV., V., VI. From the St. Maurice forges.

Dr. Harrington remarks on the bog iron ores of the province, (Geological Survey Report for 1873-74):—"That they are mainly of recent age, occurring at or near the surface, and generally in sandy regions, ferruginous sands often being the source of the iron. The variety employed for smelting, concretionary lumps or massive, often

Dr. Harrington
quoted.

* Geol. Sur. Rep., 1873-74, pp. 236-37.

† Geol. Sur. Rep., 1873-74, pp. 236-37.

Value of
bog ores.

shows a curious cavernous structure, and is either dull and earthy or at times highly lustrous when fractured. The color is usually yellowish or reddish brown, and dark brown or black when much manganese is present. The proportion of iron obtained on analysis is variable, averaging about fifty per cent. In the blast furnace, however, the yield has usually been only from 30 to 40 per cent., as the ores contain a considerable quantity of silica in the form of sand, which is not easily removed even by washing. When sulphur is present it is usually only in very small quantity. The amount of phosphoric acid ranges from mere traces to nearly two per cent. The volatile matter (water and organic matter) averages about twenty per cent." The ore is easily reduced; and, judging from the iron made by Messrs. McDougall, produces, when rightly manipulated, a metal of uniform value.

Dr. Hunt on
peat for smelt-
ing iron ores.

It is an important consideration in connection with the smelting of the iron ores of Eastern Quebec to ascertain to what extent the great deposits of peat already worked by several companies for the manufacture of fuel, can be utilized in the smelting of the ores of this section. In Europe, peat charcoal is largely employed in certain sections, but, owing to its friability, is unsuited for transportation to a distance or to withstand the pressure of the blast furnace. It also frequently contains a large quantity of ash. But in the Geological Survey Report for 1869, Dr. Hunt discusses the question of using peat, even in the wet state in peculiarly constructed furnaces, at some length, the feasibility of using such fuel, being demonstrated from experiments in this direction made in Sweden, where it was found practicable to use a fuel holding as much as forty-five per cent. of water in a furnace, specially adapted for this process. In this furnace not only peat but sawdust slabs and mill refuse can be used with success and economy. Dr. Hunt remarks that when such results can be obtained from the use of such materials as sawdust or with ordinary peat, the want of mineral coal need no longer be an obstacle to the development of the metallurgical industry of this country. In view of this statement by so eminent an authority, as well as of the fact that in Quebec, in the great extent of flat country east of the St. Lawrence, there are very extensive peat swamps, excellently suited for the manufacture of this form of fuel, it is certainly not unreasonable to expect that, with improved and economic methods of preparing and compressing, the peat of these great bogs may, at some time not distant, be extensively utilized for these purposes, and with results as satisfactory as have been obtained in other countries.

From the great extent of many of the ore beds, both of the Laurentian rocks and of those east of the St. Lawrence, it appears very strange that they cannot be profitably utilised. The duty imposed

by the United States Government, combined with the long carriage to the smelting works at Cleveland, or other points in the adjoining states, seriously affects their profitable export. From the figures given by Dr. Harrington in the Geological Survey Report for 1873-74, we find that no less than 47,200 tons were shipped for export in 1872-73, and about 12,000 tons additional extracted. Lately, ore from the mines at Bristol is being shipped quite extensively, with every prospect of a profitable result.

Export of iron ore.

COPPER.

While we have seen that the presence of iron ores in workable quantities was known in eastern Canada more than two hundred years ago, and have been utilized for nearly a century and a half in the manufacture of metallic iron, the first reference to deposits of copper in the province of Quebec is apparently contained in the reports of the Geological Survey, 1847-48, where, on pages 26-27, the presence of copper pyrites is noted in connection with the limestones of Acton, Upton and Wickham, and further north in Inverness. Reference was, however, made in 1830 by Gen. Baddeley, R. E., to the copper ores of western Ontario, but at this date it does not appear that anything was known in relation to those of Quebec. As regards the deposits observed in Quebec, and referred to by Sir William Logan in the report just mentioned, the quantity was generally regarded at that time as unimportant; but several localities were recommended for trial. Among these was a quartz vein on lot four, range two, of Inverness, having a thickness of about two feet, with a course a little north by east, which, however, upon testing, although the quality of the ore was excellent, did not appear to contain sufficient to render its further exploration profitable.

First reference to the copper ores of Quebec.

Inverness.

A second area recommended for trial at the same time was the seventeenth lot, seventh range of Ascot, about one mile from Sherbrooke, on the road to Lennoxville. The thickness of the quartz vein carrying copper pyrites was from ten to twelve inches, cutting chloritic and talcose slates, and it carried, in addition to the copper ore, small quantities of gold and silver. The third locality recommended was in the fifty-first lot of the twenty-first range of Upton; the breadth of the lode, which is in a whitish gray massive limestone, being from twelve to eighteen inches, consisting of white quartz and calcspar, carrying pyrites also in small quantity. Assays of the ores from these three localities were made by Dr. Hunt. The percentage of metallic copper in the washed pyrites from Ascot was 30.34, or eighteen per cent. of

Ascot.

Upton.

the vein; from Inverness, 34.93, or seven per cent. of the unwashed ore, and from the Upton lode, from an average sample, 3.84 per cent.

St. Joseph,
Beauce.

In the report of 1849-50, reference was made to traces of copper in the rocks of the Chaudière, in the seigniory of St. Joseph, where, in rear of the church at that place, spots of vitreous copper were found disseminated through quartz veins in red and green slate, and about one mile from the Chaudière River on the road to Frampton. Similar ore, in quartz veins in the red slates, was also at the same time noted as occurring in Ste. Mary's seigniory; but neither of these localities appeared to possess any special value. The deposit at Upton was opened up and found to consist of a series of bunches, following a bend in the stratification; but the opinion was expressed that their irregularity was such as to seriously interfere with their being successfully worked for copper.

Lanoraie and
Dautraye.

The copper deposits of the eastern townships appear to have been entirely neglected for some years after this, but some examinations made about this time on the north side of the St. Lawrence, in the augmentation of Lanoraie and Dautraye, on the left bank of the River L'Assomption, showed the presence of a vein nine inches thick of calc and pearl-spar, cutting gneiss, which carried copper and iron pyrites. On either side of the main vein, other veins were reported of an inch or more in thickness, also carrying copper pyrites, and the whole was comprised in a breadth of about nine feet. In this a shaft was sunk for sixteen feet, the vein, which had the aspect of a regular lode, appearing uniform throughout, though the quantity of copper it contained did not appear to be remarkably promising.

Upton.

A more detailed description of the Upton deposit appeared in the report for 1858. It is there stated to occur in a mass of greyish-white, sometimes reddish-grey limestone, compact sub-crystalline and yellowish weathering, reticulated by small veins of copper pyrites, as well as by others of quartz and various ores of iron, all of which were regarded as of segregation origin. This ore-bearing limestone was overlaid by a bed of breccia, or conglomerate, which also carried pyrites and was supposed to be underlaid by red-grey limestone, which, towards the bottom, became interstratified with red slates. No copper was found in the underlying limestone. The general dip of the measures was to the south-east at angles of 10° to 27° . The bands of limestone, carrying ore, extend through the northern part of Acton into Wickham, where, also, on the twenty-sixth lot of the last range of that township, they also carry similar ores. A second band to the south-east is seen at Acton on lot thirty-two of the third range, which extends approximately parallel to that just mentioned, and also at Wickham, and this was regarded as the equivalent of the Upton bands of rock coming to the surface on the south side of the synclinal.

Wickham.

The description of the rocks of this copper belt is considered of some importance, as illustrating a peculiar series, in which has occurred, more particularly at Acton, and presently to be described, one of the most productive copper mines ever worked in Quebec; a band entirely distinct in character from those which contain the copper deposits now so extensively worked in the townships. In order that the relations of the several ore belts may be better understood, we may here proceed to describe, before taking up the history of the several copper mines, which nearly thirty years ago were so prominently before the mining public, the views of structure of the several areas of cupriferous rocks, as stated in the Geology of Canada, 1863 and 1866, more especially since the new views of the structure and of the age of these rocks, as stated in the more recent reports, have modified the opinions there expressed to a very considerable extent.

The metamorphic rocks of eastern Quebec were, for many years, regarded as the altered equivalents of the fossiliferous and comparatively unaltered sediments of the St. Lawrence basin; and these were divided at first into two and subsequently by sub-division into three portions, viz.: The Levis, Lauzon and Sillery formations. Early views of the geology and structure of the copper-bearing rocks.

These were supposed to be arranged in a series of long and sometimes narrow folds, with many overturn dips, of which it was remarked that "the latter circumstance renders it difficult to determine which of these folds are synclinal and which anticlinal, inasmuch as the outcrop in both cases presents a similar arrangement." These metamorphic rocks, for the portion north of the Vermont boundary, considered to be specially cupriferous, were held to occur in three approximately parallel bands or areas. Thus the first area, or the most westerly, extended from Farnham, near Missisquoi Bay, to the seigniory of Lauzon, on the St. Lawrence. Where it is traversed by the St. Francis it was supposed to be nearly, or quite, separated into two parts by the appearance of what was then regarded as the underlying series of slates. In this supposed synclinal are found the deposits of Upton, Acton, Wickham, Roxton and Durham, while in the north-eastern extension are those of Wendover, Somerset, Nelson and St. Flavien. The second area, which was supposed to be divided into two parts by the ridge of the Sutton Mountain, extended from St. Armand to the seigniory of Ste. Mary, on the Chaudière. In this were the copper deposits of the townships of Sutton, Stukely, Melbourne, Cleveland, Shipton, and further to the north-east those of Halifax, Leeds, Inverness and Ste. Mary. Western area.

The western portion of this supposed synclinal occupied the Sutton valley; the eastern, the Potton and Bolton area along the valley of the Missisquoi River. The third area extends from the Owl's Head on Divided into two parts by the Sutton Mountains.

Eastern area.

Memphremagog Lake to the township of Ham, and included the Stoke Mountains, while further to the north-east it was traced across the Chaudière into Buckland. It was supposed to be separated from the last by what were regarded for the most part as newer rocks, much of which were supposed to be of Upper Silurian age, although now known to belong, in great part, to much older horizons. In this area were included the deposits of Ascot, Ham and Garthby.

Character of the copper-bearing rocks of the three areas.

The rocks of the first or most westerly area, extending from Farnham north-easterly, were regarded as belonging to the Lauzon and Sillery divisions of the Quebec group. They include slates, black, red, green and grey, with sandstones, diorites and dolomitic limestones; which are seen at many points. The outcrops at Upton and Acton appear to be very similar in character, and probably represent portions of the same series, brought to the surface by synclinal structure. Of the second main synclinal, as then considered, viz., that in which the Sutton mountain was supposed to occur, the rocks vary somewhat on either side of the mountain ridge; those on the west being, for the most part, schistose and crystalline, either talcose, micaceous or chloritic, while on the east side there is a large development of serpentines, diorites, slates and hard quartzite. The rocks which were found in the third area, or that of Ascot, were also largely schistose, resembling rather those of the western side of the Sutton mountain than of the eastern. It will be seen, therefore, that there is a manifest difference in character of rocks in the three areas, and, by a careful examination of the copper ores obtained from each of these, a corresponding difference in their character will also be observed; the ore of the Ascot belt being unlike that from the Potton area, while this in turn is of a different character from that of Acton or Inverness and Leeds.

Present view of structure.

The studies made of these several groups of strata during the past ten or fifteen years have led to an entire change of opinion regarding their relative age and structure from that expressed in the *Geology of Canada*, 1863. Instead of now regarding these different copper-bearing belts as synclinals in the Sillery or other divisions of the Quebec group, and all of Lower Silurian age, it is now very clearly established that, while the rocks of the first area are, in large part, of the age and character of what have been described as the Sillery formation, and which is now held to form the lowest member of the fossiliferous Quebec group, as developed along the south side of the St. Lawrence River, those of the second and third areas, or of Sutton and Ascot, belong, for the most part at least, to the pre-Cambrian horizon; while the slates and serpentinous or dioritic portions may probably, with more propriety, be classed in the lower portion of the Cambrian system, the

slate rocks of which flank the pre-Cambrian schists on either side, and that the greater part at least of these crystalline schists really occur as anticlinal axes instead of as synclinals of altered Lower or Middle Silurian rocks.

As just stated, the character of the ores in the different copper-bearing belts,—for it is scarcely necessary to maintain the use of the term synclinal in view of the change of opinion expressed—varies greatly when contrasted. Thus, from the more westerly belt the ores are largely yellow sulphurets, though occasionally variegated sulphurets are found mostly in a dolomitic limestone. In the township of Roxton the principal deposit was on lot twenty-three, range three, where the ore, according to the late Mr. Charles Robb, M.E., who had great experience in the mines of this section of Quebec, appeared to be disseminated through a band of this rock for a breadth of fifty feet, but was more particularly concentrated into a breadth of about one foot near a band of diorite. From the west half of this lot, belonging to Lord Aylmer, there had been obtained in January, 1864, fifty-six tons of three and a half per cent. ore, sixteen tons of five per cent. and two tons of twelve per cent. ; and from the eastern half, eight tons of eight per cent. and fourteen of three and a half per cent. were taken. In the adjoining township of Ely, though indications of ore are found at a number of points, the principal deposit was on lots nine and ten of the second range, owned by the Ely Copper Mining Co., where the ores were the yellow and variegated sulphurets in a crystalline limestone. In Upton mining was carried on at four places, viz. 1st, on lot forty-nine of range twenty, called the Bissonette mine, where there was a yellow sulphuret in a thickness of three feet and a half of dolomite, yielding from 10 to 15 cwts. of 10 per cent. ore per fathom. 2nd, at the Prince of Wales Mine, on lot fifty-one of the same range, (the ore being scattered through about twenty feet of the same band as the last,) from which about forty tons of twelve and a half per cent. were obtained from open cuttings. 3rd, on lot forty-nine, range twenty-one ; the ore and rock being similar to the last, and owned by Col. McDougall, by whom, from open cuttings also, about twelve tons of twenty per cent. ore and eight tons of twelve per cent. were obtained ; and 4th, the Upton Mine, on lots fifty and fifty-one of the same range, where two shafts were sunk to a depth of forty-two and twenty-five feet respectively, which yielded a considerable quantity of ore, the amount, however, not being stated.

In the township of Acton several mines were located and worked to some extent about this time, but of all these, that known as the Acton Mine, situated on the thirty-second lot of range three, and about half a mile south of Acton station on the Grand Trunk railway, was the most important.

Different character of ores in the several areas.

Roxton.

Lord Aylmer's mine.

Ely Copper Mining Co.

Upton. Bissonette mine.

Prince of Wales mine.

McDougall's mine.

Upton mine.

The Acton mine.

Early history.

The discovery of this mine is said to have been made by Mr. H. P. Merrill, but the date of this discovery is not mentioned. In a paper by Mr. Robert Williams, for many years connected with copper mining in eastern Quebec, read before the Lit. and Hist. Soc. of Quebec, 1865, we learn that in the autumn of 1858, operations were commenced by Mr. Sleeper; and "that although the discovery of copper ore of very rich quality was known some years previously, so incredulous appeared the human mind on the subject that the property was purchased by Mr. Davis, of Montreal, from the owner, Mr. Cushing, of Actonvale, for a very insignificant sum and a royalty, but that gentleman had so little faith in his purchase, that he at once leased it to Mr. Sleeper on tribute, at two-thirds of all the ore that he could obtain from it for a period of three years."

It was largely in consequence, apparently, of the great results obtained by Mr. Sleeper at this mine, that the great boom in copper and copper explorations took place in the townships, which resulted in the finding of the ore in greater or less quantity at hundreds of places throughout the areas already outlined, and of which a full list of localities will be found in the report of the Geological Survey for 1866, by Mr. James Richardson.

Description of the Acton mine.

The peculiar character of the deposit at this place, and the great importance which for some years attached to this mine renders it worthy of a somewhat detailed description. When first found "the surface presented an accumulation of blocks of copper ore, evidently in place, and covering an area of about sixteen paces in length by ten in width. These masses consisted of variegated sulphuret of copper, intermingled with limestone and a siliceous matter, without anything like veinstone, and evidently constituted a bed, subordinate to the limestone, whose strike was about north-east, and with a dip to north-west at an angle of about forty degrees. In continuation of this bed for about seventy paces in either direction the limestone was observed to hold little patches and seams of variegated ore and yellow pyrites, with stains of the blue and green carbonates of copper. The limestones in the immediate vicinity presented several veins of quartz crossing the strike, but containing only traces of copper."*

Change of owner.

The mine was worked by Mr. Sleeper to September, 1861, when it reverted to the proprietors, Messrs. Davis and Duncan, of Montreal, by whom it was sold, in October, 1862, to the Southeastern Mining Company of Canada. The enormous masses of rich ore-bearing rock gradually became exhausted, though no attempt at any very deep exploratory works appears to have been undertaken. According to Mr. Richard-

* Report Geol. Survey, 1858, pp. 57, 58.

son's notes, the mine produced, during the period in which it was worked, 16,300 tons of 12 per cent. ore, sent to market, besides a great amount of lower grade left at the surface.*

The ore at this mine, from a number of sections furnished by Mr. Thos. Macfarlane, who was in charge of operations there for some time, and who published an exhaustive paper on the subject in the Can. Nat., 1863, is apparently for the most part confined to a bed of dolomitic limestone interstratified with dark grey shales, a considerable thickness of which lies between the copper limestone and a great mass of another limestone band, which forms a prominent ridge to the south of the workings. Between the copper limestone and the shale beneath, intrusions occur, often of considerable size, of a greenish, fine-grained diorite which are also at times found above the limestone band. The strata, both above and below the limestone band, also contains small strings of copper pyrites, but the workable deposits are for the most part confined to the calcareous portion. The cupriferous rocks appear to be bent in an anticlinal fold, and are, to some extent, affected by faults; these being probably due to the diorite intrusions.

Mr. Macfarlane's notes.

The bed of limestones, which appears to have carried the bulk of the ore, in places appeared as a solid mass, at others as a brecciated rock or conglomerate; those which consisted of the pyritous, the variegated and the vitreous, being disseminated through the brecciated bed, constituting, to some extent, with silica, the paste of the mass. The ore deposit at Upton presents a somewhat similar set of conditions, with this important difference that, while at Acton the prevailing ores were vitreous and variegated, at Upton the ore was mostly a pyritous sulphuret.

If the two localities of Upton and Acton should be the outcrop of the same beds on the two sides of a synclinal it is very possible that other large deposits of similar ores may occur other than already worked. To test this point at Acton would, however, require considerable expense of shafting. Several bore-holes have been put down, but the results obtained have not been made available. From the fact that red slates of the Sillery formation cross the Grand Trunk railway a short distance east of this mine, and appear, also, near the village of Acton, as well as in the lower beds of Upton, it is probable, that this unusual development of copper is in rocks of this age, and that its presence is due to the intrusion of dioritic matter at this point, since at other localities in this formation, as at Nelson, St. Apollinaire, &c., though the amount of copper is not so large as at Acton, the presence of diorite masses at these places, in somewhat similar rocks, has apparently produced similar effects, though on a much more limited scale.

Probable age of the rocks and origin of copper at this place.

* See Geol. Can. Supplement, 1866.

- The Vale mine.** Among other localities in this township, where exploratory work was carried on about this time, were lot thirty-one, range four, called the Vale mine, the results from which were of little value; and the White Horse mine on lot twenty-nine of range six, and on lot thirty-one, range three, the ores being very similar to those of the Acton mine, and, as at that place, occurring in dolomite. It is probable, that the diorites were absent from these localities, no mention being made of them at either place. In Wendover, in the diorites which cross the St. Francis from the town of Drummondville, several shafts from 30-40 feet in depth were sunk between 1860 and 1863 by the Drummondville Mining Co. of Canada, but without finding copper in any quantity, though just before the suspension of the company a large vein was reported to have been struck. Since the failure of this company no further attempt has been made to ascertain its value.
- The White Horse mine.**
- Wendover. The Drummondville Mining Co.**
- Wickham.** In Wickham but two mines were located. The first, and most important, was styled the Wickham mine, on lot fourteen, range ten; the ores being yellow and variegated sulphurets in dolomite. Here a shaft was sunk to a depth of thirty feet and a few tons of ore removed. The Toomey mine, on the third lot of the eleventh range, was similar in rock and character of ore, but the work done was merely exploratory and confined entirely to the surface.
- The Toomey mine.**
- Durham.** In the township of Durham, adjoining Acton, the same character of ores is found. Two mines were here started, of which that on the twenty-first lot of the seventh range, styled the Durham mine, was apparently the more important. Shafts were here sunk on three veins, varying from three to twelve inches in thickness, the deepest of which was eighty-four feet, ending in black slate. The ore obtained amounted to ten tons of five per cent., 110 tons of three per cent., and 300 tons of one per cent., consisting of yellow sulphuret in a calcspar vein cutting dolomite. On lot nine, range six, a shaft was also sunk to a depth of sixty-four feet in similar ore, but no returns are given; and on the south-west half of lot nine, range four, a shaft was sunk to a depth of forty feet, showing good specimens of the variegated and yellow sulphurets, while a second shaft of sixty feet was sunk on the north-east quarter of the same lot, in green and black slates, for which no returns are available.
- Durham. The Durham mine.**
- Somerset.** In Somerset, near the northern portion of this area, small quantities of the yellow sulphurets have been observed in beds of limestone conglomerates near diorites; and in Nelson, on lot eight of range eleven, the yellow and variegated ores are disseminated through limestone, also near diorites, from which about ten tons were extracted by a company formed in Boston, the width of the ore-bearing bed being about thirteen feet. At various points along this line, also, indications
- Nelson.**

of ores, for the most part similar to those already described, but presumably in even smaller quantity, were observed. In the county of Lotbiniere, near St. Apollinaire, indications of the yellow sulphuret are found in amygdaloidal diorite; and in this vicinity the St. Flavien mines were worked about thirty years ago. Since that time no attempt at exploration in all this area appears to have been made.

St. Apollinaire.
St. Flavien mine.

Throughout the rocks of the western division the workable deposits of copper also appear in all cases to have been associated with masses of intrusive diorite, which have penetrated the red and green slates and limestones of the Sillery formation, now regarded as forming the upper portion of the Cambrian system. The want of success which has attended many of these workings is due largely to decline in the price of the copper, and also to a lack of concentration of the ore in the cupriferous beds, since the quality of much of that obtained is excellent, and, in some cases, peculiarly rich as seen in the Actonvale deposits.

Diorite intrusions in the Sillery formation.

Of the mines found in the second belt, beginning at St. Armand, it may be remarked that the ores here observed differ somewhat both in character and mode of occurrence, and, as already pointed out, in the nature of the containing rock. In this area, at the time of the great copper excitement, several localities were indicated in which traces of copper, both the sulphurets and the carbonates, the latter in green chloritic and epidotic rock, were found, but none were at that time shewn to be of much importance. In 1882, however, a vein of yellow and variegated ore was opened on the south side of the Pinnacle Mountain, St. Armand, in greenish micaceous and chloritic schist, which was worked for some time, and at first promised well. Crushing and concentrating works were erected, and a considerable quantity of the ore extracted and prepared for market, but the works were shortly after abandoned, and no returns from this location are to hand.

St. Armand.

The Pinnacle Mountain mine

In the township of Sutton, adjoining, copper mining was carried on at a number of points; indications of the presence of the ore being frequent. These ores were mostly the yellow sulphuret, but green carbonate of copper, with deposits of the variegated and vitreous ores, are frequently observed. Among the most important of these in this township, and which have been opened up to some extent, may be mentioned the following:—

Sutton.

Sweet's mine, on the west half of lot eight, range ten, where variegated and vitreous sulphurets occur in a bed of nacreous schists from one to four feet and a half wide, which, for the whole breadth, yielded four and a half per cent. of copper. A band of dolomite occurs in the vicinity, but the ore is confined principally to the schists; differing in this respect from those of the first belt, of which the Acton mine may be taken as the type. This mine was one of the

Sweet's mine.

first opened in this portion of Quebec; samples being displayed at the International Exhibition in London, 1862. The schists in which it and the mine on the Pinnacle are located belong to a distinctly lower geological horizon than that of the belt just described from Farnham, north. A considerable quantity of ore was raised from the Sweet mine, but probably the limited size of the lode interfered with its successful development.

North Sutton
Mining Co.

The works of the North Sutton Mining Co. were located on the north half of the eleventh lot in the tenth range, on a bed from eight inches to two feet thick, in talcose slate, near black plumbaginous slate. Three shafts were sunk, one of which was twelve feet deep and about two tons of five per cent. ore obtained. Explorations were also carried on by this company on a seven foot vein in nacreous slates, on the west half of lot twelve, range eleven, carrying yellow sulphuret with iron pyrites, but no returns are at hand from this exploration. Two shafts of a depth of fourteen and nineteen feet respectively, were sunk.

Brome Mining
Co.

On the east half of lot nine, range eleven, the Brome Mining Co. also sank a shaft sixty feet deep on a bed of variegated and vitreous ore in similar nacreous slates, of which it was supposed three feet of the rock would carry three per cent. ore. From this also no returns are available, and in the south-east half of lot seven, same range, explorations on a four feet band in chloritic slates yielded, according to Mr. Chas. Robb, a considerable quantity of ore.

Brome.

In the adjoining township of Brome, mining was carried on at several points. On the east half of lot five of the fifth range, the yellow and variegated sulphurets were found in three bands, varying from two to thirteen feet thick, supposed to be repetitions of one and the same bed through undulations of the strata. Three shafts were here sunk by the Canada Copper Mining Co. to a considerable depth, and a large quantity of ore, estimated at three per cent., extracted. Machinery for crushing and concentrating was erected, but the company soon ceased operations. On lot six, range six, considerable exploratory work was carried on by the Bedford Mining Co., but with no satisfactory result. On the west half of lot twelve, range seven, the Tibbets mine, owned by Messrs. Ball and Morell, consisting of a shaft to the depth of eighteen feet, was sunk on a band of yellow sulphuret in nacreous and chloritic schist. On lot six, range seven, the variegated ore was found in two bands, one of which, two to three feet thick, was estimated to carry one per cent. copper, the other band of five feet was supposed to carry one and a half per cent. ore.

Canada Copper
Mining Co.

Bedford Min-
ing Co.

The Tibbets
mine.

On lot eighteen of range eight variegated and vitreous ores were observed to occur in four bands in nacreous, chloritic and epidotic

slates, and dolomite, in a breadth of several yards, and a small excavation, not sufficient for a test, was made. These ores were continued on lot nineteen, same range, and on lot twenty-one, range nine, but no returns as to value or output from any of these are to hand.

In the township of Shefford, mining was carried on at two places only, viz.: by the Glencoe Mining Co., on lot seventeen, range two, where the different ores occur with quartz and calcspar in four separate bands in micaceous and chloritic slate, and on lot twenty-eight, range three, by the Waterloo Mining Co., in similar ores, and with similar country rock, where a shaft was sunk to a depth of sixty feet, but no returns are available.

Further north in Stukely, the Grand Trunk mine was situated in the south-east quarter of lot six, range one. A shaft was here put down to a depth of sixty feet on a band of yellow and variegated sulphurets, in micaceous and chloritic slates, with dolomite of the usual character. The same bed with a thickness of three feet was found on the lot adjoining; some good ore was obtained, but the quantity is unknown. A trial shaft, twenty-one feet deep, was also sunk by Messrs. Lambe and Shepherd in the south half of lot seven, range two, on a band of fifteen to twenty feet of dolomite, carrying disseminated yellow ore with pyrites. On the south-east quarter of lot nine and the south-west quarter of lot ten, range six, vitreous sulphuret occurs in chloritic sandstone associated with quartz, felspar and chlorite; masses of pure ore being obtained of from three to twelve pounds weight. On the latter area the Logan mine was located, in which

from four to five tons of twenty per cent. ore were obtained. On lot seven, range eight, two parallel bands of dolomite carrying vitreous sulphuret occur, with a breadth of twenty-three and thirty-six feet respectively, separated by about a hundred and seventy-five yards of micaceous and chloritic slates. The ores are intimately associated with veins and strings of quartz, calcspar, chlorite and epidote. A shaft was sunk for sixty feet and a cross-cut driven twelve feet across toward the vein to the west, but did not reach the ore. On the north-east half of lot six, range nine, a shaft was sunk for one hundred and forty-two feet in a slate band, carrying similar ore to the last, without satisfactory results, and on the south half of lot four, tenth range, a shaft twenty-two feet deep was sunk in order to cut a band of eighty to ninety paces, in which four cupriferous bands occur. No returns from any of these are available.

Tracing this belt to the north, we have, in Melbourne, several deposits of copper ore, for the most part in green chloritic rocks and micaceous schists. On these deposits three mines have been in operation, viz., the Ryan Hill, the Cold Spring and the Balrath. The first is situated

- on lot two, range two; the ore is the variegated and vitreous sulphuret in chloritic slates; the size of the band not being stated.
- The Cold Spring mine.** At the Cold Spring mine, lot six, range two, some shafting was done; the ore occurring in narrow bands over a considerable breadth, but presumably not in sufficient quantity to be economically valuable.
- The Balrath mine.** At the Balrath mine, on lot two, range four, the ore, which is of the kind just described, is said to occur in a series of bands, eight in number, ranging from one and a half to five feet in width, in one of which a shaft was sunk, which disclosed some rich bunches of ore. Considerable exploratory work was also done on lot eight, range one, in the shape of pits and trial shafts, on a deposit of yellow sulphuret; the copper being mixed with magnetic and specular iron ore, in a gangue of quartz and calcspar, cutting quartzite and talcose slates. None of these areas appear to have yielded very much copper.
- Cleveland.** In Cleveland, across the St. Francis River, variegated and vitreous ores also occur, with similar chloritic rocks, at a number of places. The only locations worked to any extent, however, were on lot twenty-five, range twelve, at the St. Francis mine, and at the Jackson mine, on the south-west quarter of lot twenty-six of range thirteen. At the former place, in addition to the usual ores already mentioned, green and blue carbonates are said to occur with a little native copper; the whole contained in a lode three feet thick. A shaft was here sunk for 195 feet, and levels and other works driven for 513 feet along the lode, from which a large quantity of ore was taken, which, according to Mr. Bennett, the manager, ranged from six to twenty-six per cent.
- The St. Francis mine.** At the Jackson mine a shaft was sunk to a depth of twenty feet, the ore being found in a lode of a foot in width, with other larger veins carrying ore in smaller quantity at no great distance. The amount of ore extracted from either of these places is not known.
- The Jackson mine.**
- Shipton.** In Shipton, copper ores are comparatively rare, at least in so far as known, and not in quantity apparently sufficient to warrant mining operations; but in Halifax the variegated and vitreous ores are again quite extensively distributed, the rocks being of the same character of schists as in Melbourne. Mining was carried on at two places, viz., by the Halifax Mining Co., on lot ten of range three, where a considerable admixture of different ores was found in a vein from eight inches to three feet in width, on what is known as the Halifax mine, and visible gold was reported in a quartz vein which was cut. Considerable work was done here by shafts and adits, but no returns as to the amount of ore obtained are to hand, though no large bodies of ore were found.
- The Halifax mine.** At the Black Lake mine, on lot nine, range nine, some exploratory work was also done by Dr. James Reed and others, but nothing of importance was encountered.
- The Black Lake mine.**

In Chester, although exploratory work was carried on at a number of points, the most important location probably was that in the S. E. half of lot eight, range six, known as the Viger mine. Here the ore was principally the yellow sulphuret in quartz veins, and vitreous ore in the slates. The veins were scattered through a width of 170 feet and were opened at a number of points, from which a considerable quantity of ore was extracted, but involving a large outlay and much work. No deposits of large size were met with, and the explorations, after a very thorough trial, were found to be unprofitable. The metalliferous veins on this property extend across into the adjoining lot, but their size was insufficient to pay for the labor involved in their opening. On lot nineteen, range ten, the Austin Mining Co. made a couple of openings, one on a two-foot vein, the other on one of six feet, but the ores were found to be not sufficiently concentrated in the gangue to pay for extraction. Explorations were also made on lots eleven and fourteen of Craig's Road range, in variegated and vitreous ores in limestone, but without success, as well as on lot five, range six, where a quartz vein from two to four feet thick was observed, which presented some good specimens of ore, but the quantity was too small for successful mining.

Ores similar to the last are found at several points in Inverness, occurring in micaceous, chloritic and nacreous slates or schists, but, in so far as known, no attempt at mining these was made, though one of these localities was among the first recommended for trial in 1847. In Leeds, however, in addition to the great Harvey Hill mine, very fully described in the Geol. Can., 1863, several other deposits were worked, notably that on the fifteenth lot of the fourteenth range, in close proximity to the Harvey Hill deposit, the ore veins and beds from which were supposed to be continuous in this direction. The ores are all vitreous, variegated and yellow sulphurets occurring in beds or veins, in what have been styled nacreous slates, and, on the lot just mentioned, were owned by the English and Canadian Mining Co. Native gold was found in one of the ore veins. Not far distant from this, to the north-east, in that part of the seigniory of St. Giles known as the Handkerchief, the Chaudière Mining Co. opened up several quartz veins, of which eight were exposed in a breadth of 1,100 feet, two of which had a thickness of two to three feet, and could be traced for 1,200 to 1,500 feet. About \$5,000 were spent in these explorations, but owing to difficulties of various kinds, the work was shortly abandoned. Fine specimens of ore were obtained here, and the quartz is reported by Dr. Reed to have yielded him native and visible gold.

What was regarded as the eastern limit of the second belt was the seigniory of Ste. Mary, where ores similar to those just described

Chester.
The Viger
mine.

Austin Mining
Co.'s work.

Craig's Road
range.

Inverness.

Leeds.
Harvey Hill
mine.

St. Giles.
Chaudière Min-
ing Co.

Ste. Mary.

occur in red and green slates near ferruginous dolomite, not far from Ste. Mary's Church. From the aspect of the strata, it would, however, almost appear as if this deposit should be more closely related to the red slates and dolomite of the first area. Another mine at St. Sylvester, referred to in the report of the Geol. Survey for 1866, was that of Ste. Margaret. It was opened by the late Thos. Glover of Quebec, by whom a company was formed in New York, styled the Ste. Margaret Mining Co. Several shafts were sunk with an expenditure of about \$5,000, the amount of ore obtained being about fifty tons. The ore was mostly the variegated sulphuret, the country rock consisting of purple slates, green grits and quartzites. The mine was owned by Mr. Cromwell, but the ore appeared not to be in sufficient quantity for profitable extraction.

St. Sylvester.
Ste. Margaret's
mine.

The Harvey
Hill mine.

Discovery and
early history.

The most important of the mines in this section is that so widely known as the Harvey Hill, now the Excelsior, on lot seventeen, range fifteen of Leeds. This location, according to a paper by Mr. Herbert Williams read to the Literary and Historical Society, Quebec, 1865, was the second discovered in the province as carrying copper, the first found having been at Inverness. These discoveries did not appear to awaken very great interest for sometime, and Dr. James Douglas seems to be the first who appreciated their value, and through his agency the Megantic Mining Co. was formed for the purpose of exploring and working the copper deposits of Megantic county. Upon the discovery of the Harvey Hill deposit, the location was secured by this gentleman and his associates, who organized a company under the name of the Quebec and St. Francis Mining Co. But little further investigation was, however, undertaken by any others than by this company, who explored the Harvey Hill property in such a way as to bring it prominently to the notice of English capitalists, and by these a new company was formed in 1858, under the name of the English and Canadian Mining Co., by whom operations were commenced and carried on with varying success for a number of years. The history of the workings of this celebrated mine for some years is given in the Geol. Can., 1863, with considerable detail. From this we learn that the ores occur in two ways, first as a series of interstratified beds, of which three were clearly recognized, varying in thickness from six inches to six feet, or possibly more, and second, in quartz lodes or veins, composed of quartz, calcite, pearl-spar and chlorite, some of which carried the variegated and vitreous ores, others carried copper pyrites, in places in very rich pockets. The veins, which sometimes cut across the bedding, were exceedingly rich in certain parts, and in others comparatively barren, so much so that in actual value as a source of supply for copper, the beds were con-

Mode of occur-
rence of the
copper.

sidered the more important. In these the various ores were disseminated through the body of the slates, generally in lenticular masses, running with the bedding. These masses were generally small and thin, sometimes having a thickness up to three-fourths of an inch, with a length of six to twelve inches, in addition to scattered grains of the ore through the slate bed; the amount of copper in all being estimated at from three to five per cent.

The hill upon which this mine is situated was pierced by a number of shafts from twelve to forty-five feet deep, as well as by an adit and tunnels; the whole forming a very extensive series of workings. The principal adit was driven into the hill across the measures to a distance of 1,488 feet and intersected the several ore beds, the upper one of which had a thickness, when first worked, of three feet, which, in the lower workings, increased to ten feet and was estimated to carry five per cent. ore. From a prospectus issued by the Consolidated Copper Co. of Canada, limited, in 1872, the subsequent history of this mine is given to that date. The surface works of the company, including much of the plant, were destroyed by fire in 1866, with an estimated loss of £20,000, owing to which, operations were suspended till 1870, when Mr. James Douglass, one of the proprietors, took over the work again and resumed operations in the mine. The quantity of ore raised from the commencement of operations in 1858 to the end of 1862 was 322 tons of thirty per cent. copper, in addition to 1,000 tons at the surface of two and a half per cent. and 500 tons of four to five per cent. from the upper bed. The figures as to the output for the different years, as given by Mr. H. Williams, the manager, are as follows:—

	TONS.	CWTS.	QTRS.	LBS.	
1858.....	9	15	0	2	} of 30 per cent. copper.
1859.....	43	7	0	21	
1860.....	104	5	3	0	
1861.....	70	4	1	6	
1862.....	94	17	2	21	} of 26 per cent. copper.
1863.....	113	20	3	14	
1864.....	235	12	3	4	

The mining ton=21 cwts., or 2,352 lbs.

The falling off in the value or percentage is attributed to the fact that during the last years the mining was confined principally to the beds and not to the quartz leads. The ore in these beds was found by Mr. Williams, upon careful examination, to occur in lenticular masses, as already stated, varying in thickness from one-sixth of an inch to two or three inches, and in length from three to eighteen and even twenty-four inches. These masses overlapped each other and were disseminated throughout a thickness of five to six feet. This refers to the overlying or upper bed, which appears to be the one principally

worked. For 1865 the figures for the output appear to be wanting, but from the report of Mr. Harrold Douglas, superintendent of the mine, as given in the prospectus of the Consolidated Co. mentioned, it appears that for a part of 1866, in which year the works were destroyed, 265 fathoms of ore were taken from the bed, dressed to twenty-four per cent. and sold in Liverpool for \$35,420, at an average of fifteen shillings per unit. From a paper by James Douglas, jr., of Quebec, in the Lit. and Hist. Soc. of that city, 1870, in discussing the several beds from which the supply of ore had been principally derived, he considers that "there is no likelihood of these beds being of such great extent or of such uniform richness as was at one time attributed to them."

Mr. H. Douglas
quoted.

Origin of the
copper in the
beds.

The work of Capt. Williams on the main or upper beds showed that where quartz lodes cut the beds, deposits of ore, often of considerable size and great richness, were struck; that the beds gradually became less rich in copper as they were worked away from the lodes which had all along been supposed to derive their supply of ore from the beds with which they were associated; but certain features observed in driving an inclined shaft on a lode, reached from the Kent shaft, induced a change of belief in this respect, the evidence there presented going to show that the beds derived their supply of copper from the lodes by percolation into the contiguous slates, and subsequent operations appear to have confirmed this view.

The "Fanny
Eliza" lode.

The most important probably of the different lodes struck in the several shafts is that known as the "Fanny Eliza." This entered the bed near the intersection of the Kent shaft, and on this lode the greatest amount of work appears to have been expended. Where first struck, near the shaft, it was of small size, but rapidly widened as it was opened. Mr. Douglas says of it: "The lode is from twenty to twenty-four inches in width, and very regular, both in dip and strike, which is slightly to the west. The ore, as it comes to the surface, yields from eight to twelve per cent. copper. It separates in crushing, very perfectly from the gangue, and is therefore easily concentrated to from forty to fifty per cent. It consists of a mixture of grey and purple sulphurets. When the lode enters the bed it carries a good deal of yellow and no grey ore, but the yellow entirely disappears in depth. The ore occupies the centre of the lode, whose matrix consists of calcespar, some quartz and a good deal of bitter spar, in the composition of which iron replaces part of the magnesia."

"Tracing the lode upward, but beneath the bed and beyond the spot where it first attracted attention, it is seen, in the thirty feet cross cut, as a well defined lode of about eight inches wide, but carrying very little copper, and has been reached by a level driven upon it from the bottom of Kent's shaft, where, however, it is thin and irregular, though

highly charged with copper." From Mr. Douglas's paper we learn, further, that to the east of the Fanny Eliza two lodes enter the bed, on one of which some work was done. The lode runs parallel with the Fanny Eliza, and like it increases in size in the direction of the dip, but diminishes towards the rise." He says, also, that "the beds gradually decrease in richness in proportion to their distance from the lode." Mr. Douglas also maintains that the Fanny Eliza is a true lode maintaining its width and direction for forty fathoms with a regular dip, and holds that the veins which take their rise in the roof of the bed are also lodes and not lenticular masses. The vicinity of the lodes is indicated by an increase in the richness of the slates and the kind of ore which they carry. These mines, after having been idle for some years, have lately changed hands and are now being worked by the Excelsior Copper Co. From the notes of Mr. C. W. Willimott, who visited the spot in 1882, we learn that the mine closed work in 1879; The Excelsior Copper Co. operations being confined principally to the Fanny Eliza lode, or vein, and in the level and incline which had been sunk to a distance of 600 feet some rich pockets of ore had been found. The mines, in 1882, were owned by a New York company, but no work, other than taking the water out of the shaft, was going on. The Excelsior Copper Co. have been carrying on work during the last two years, but have not extended their underground operations to any great distance, having cleared the shafts of water, repaired the timbering and the buildings and erected a smelter, in which a considerable quantity of the ore lying about had been reduced, the coke for this purpose being obtained from Nova Scotia, the limestone from Dudswell, and the iron from McVeity's mine near Kinnear's Mills, but no returns of output nor of other results are to hand. The present manager is Col. Drew Gay.

On lot sixteen, range fourteen, adjoining the Harvey Hill property to the north, the Leeds Mining Co. began operations in 1863. The Leeds Mining Co. These were carried on for a couple of years, in anticipation of meeting the extension of the rich lodes and beds of the Harvey Hill mine, but in this their expectations were not realized, since the extension of these beds to this property was not found sufficiently rich in copper to pay for mining. These works were suspended in 1865. They were under the general supervision of Mr. Herbert Williams, and no attempt has since been made to develop the property.

The second range of mines in what was, in 1863, regarded as the eastern portion of the second synclinal, or that area east of the Sutton Mountain ridge, included those of Potton, Durham, Brome, Bolton, Oxford and Brompton. The rocks here, in places, differ markedly from those of the area just described, being very frequently black and other colored slates, with great areas of serpentines and diorites, but Area east of Sutton Mountain.

the character of the ore is, in some cases, similar to those from the west side of the Sutton ridge, though in certain of the mines, some features which are different are presented.

Potton.

In the township of Potton, the yellow sulphuret is the most abundant ore, the vitreous being rarely found. The rocks here are mostly slates and diorites with serpentines; the copper pyrites are largely mixed with iron pyrite, much of which is the magnetic variety or pyrrohotite. In no case yet observed in this township is the quantity of ore sufficient to warrant any great outlay in exploration, except, possibly, at the recently discovered mine on lot twenty-eight, range nine, on the west side of the Hog's Back Mountain, owned by the Memphremagog Mining Co. This mountain is a mass of diorite, rising to a height of about 800 feet above Lake Memphremagog, and surrounded on both sides by black and bluish grey slates. The deposit of ore, which is principally a pyrrohotite with a small quantity of copper pyrites, occurs on the west side, at the contact of the diorite and slates, in a bed of fifteen to eighteen feet thick, which extends along the side of the mountain for several hundred yards. It dips north-west at an angle of about forty degrees, having the diorite for its foot wall, and the surface above the vein and for some distance beyond is covered with a heavy bed of bog iron ore. The ore, in places, contains a considerable quantity of a dark colored or almost black calcite. On this vein several pits have been sunk at intervals along a distance of 1,000 feet, and, according to the manager, an inclined shaft has been put down on the vein for eighty-five feet. A cross cut has also been driven with the vein, so as to drain the pits. About 800 tons of the ore have been extracted and piled, waiting for shipment. From several assays by Dr. Wyatt of New York, and by Torrey and Eaton, the ore contains from different samples.—

The Memphre-
magog Mining
Co.

Iron.....	30 to 50 per cent.
Copper.....	2.80 to 5 "
Sulphur.....	37.75 to 42 "

A peculiarity of this ore is the readiness with which it spontaneously ignites when piled in heaps exposed to the weather; a feature not common to the ores from most of the other locations.

This mine is situated at 700 feet above the lake, connected by a good road of a mile in length with landing-stage, and good facilities for shipment, either to Magog or Newport.

Bolton.
The Hunting-
don mine.

In Bolton, the township adjoining to the north, the extension of the slates and serpentines is found, and mining operations were carried on quite extensively for some years at several points. Probably the most important of these was the celebrated Huntington mine, on lot

eight, range eight, and the Ives mine, a couple of miles further to the north, on lot two, range nine, and lot four, range eight. In the former, the ores are mostly copper pyrites, mixed with the magnetic pyrites or pyrrhothite, a large deposit of which occurs in chloritic slates in contact with serpentine and diorites. A band of more than three feet of solid granular copper ore occurs near the serpentines of the west side of the vein. A section of the metalliferous portion, going eastward from the western wall of serpentine is as follows:—

	Feet.	Section of ore beds.
* 1. Greenish diorites, with disseminated masses of copper pyrites and magnetic iron pyrites.....	2·0	
2. Compact granular copper and iron pyrites with disseminated masses of quartz.....	1·4	
3. Magnetic iron pyrites, interstratified with thin leaves of chloritic and mica schist.....	0·9	
4. Greenish diorite with disseminated copper and iron pyrites	1·0	
5. Compact granular iron pyrites, with disseminated small masses of quartz.....	2·6	
6. Green chloritic slate, with disseminated masses of copper pyrites, mingled with iron pyrites.....	8·0	

Work was begun on this property in August, 1865. From notes kindly furnished me by Capt. W. Warne, the present manager of the Memphremagog Mining Co's. works, the management was in the hands of Capt. Bennett of Lennoxville, who controlled operations till 1870-71, when the mine was sold to a Glasgow company and the name changed to the Huntington Copper and Sulphur Co., under the management of Mr. John Rudda, of Cornwall. The output under the old company's management is stated to have been from 200 to 300 tons of ten per cent. ore per month, part of which was shipped to England and part to the United States. Extensive buildings, etc., were erected, and under Capt. Rudda's management, the output was increased to 400 to 500 tons per month of seven per cent. ore.

In 1872, works were erected for carrying on the Longmaid or Henderson process, by which the ore was burnt in retorts to drive off the sulphur, but the process did not apparently meet with much success. The ore was then crushed, mixed with common salt, and calcined in furnaces and placed in vats with hot water and acid from the tower, and run off into other vats containing scrap iron, by which the copper was precipitated. Hundreds of tons of precipitate, containing 65 to 75 per cent. of copper, are said to have been made in this way.

In 1873, the works were destroyed by fire with a loss of \$75,000.

* Geol. Rep. 1866, p. 35.

They were partially rebuilt, and mining was carried on in a desultory fashion for several years, and the company finally closed operations in 1883. During the past year the property has passed into the hands of Messrs. G. H. Nichols & Co., of Capelton.

Extent of the workings.

In the working of this mine two deep shafts were sunk, one to the depth of between 500 and 600 feet, called the Huntington shaft, the other known as the Wright shaft, 200 feet deep. North of the Huntington mine, on lot six, range eight, were the works of the Canadian mine, presumably on an extension of the vein just described. Two shafts were here sunk, one to a depth of 100 feet, the other 50 feet, and some ore shipped to Capelton. The mine subsequently passed into the hands of the Eastern Townships Bank and has not been worked for some years.

The Canadian mine.

The Ives mine.

Further north, on lot two, range nine, Bolton, the Ives mine was situated. Two shafts were here sunk, the Ferrier and the Galt, the former to a depth of about sixty feet, the latter for 100 feet. This mine was opened in 1866, and worked for ten years, and a large quantity of from 10 to 14 per cent. ore was extracted and shipped to England. These three mines are situated on the east side of the Missisquoi River, south of what is now known as Eastman, and are all probably located on the same belt of ore. The serpentine rock is found at all these mines, with slates of various colors, differing, in this respect, from the rocks of the second area or that west of the Sutton Mountain. Very favorable reports on these deposits have appeared by Dr. T. Sterry Hunt and others, but the presence of the magnetic pyrites serves to distinguish the ores as a class from those already described.

Orford.

The copper deposits of Orford township were mined at several points. On lot nine, range A, yellow sulphuret occurs in a dioritic rock, near serpentine, of which six veins are found in twenty-five feet.

McLeod's mine.

This was exploited by Messrs. McLeod and others. On the third lot of range F, and on the eighth lot of the same range, similar ores, with a like association of rock matter, were found, but at none of these does systematic mining seem to have been carried on.

The King mine.

At the King mine, on the third lot, range thirteen, variegated ore, associated with magnetic oxide of iron, occurs in a four-foot band of dolomite and serpentine; and on the west side of Brompton Lake, on the east side of a high hill, called the Carbuncle, composed of diorite and serpentine, several small openings were made, from which in all about twelve tons of twelve per cent. ore are said to have been obtained. The difficulties of working this deposit, from its comparative inaccessibility, must have been very great, and the quantity of ore in the rock appears at present very limited, although a five foot vein of

The Carbuncle Hill mine.

solid yellow sulphuret is reported to occur there. This mine was styled the Carbuncle Hill mine and was located in the second lot of the fourteenth range of Orford. In the township of Brompton the only mine worked was on lots twenty-eight and twenty-nine of range nine, where the ores, which were of the variegated and vitreous varieties, were found in serpentine. According to Mr. Chas. Robb, the principal deposit was in a five foot vein, containing, according to his report, a promising quantity of ore. It has, however, long since been abandoned.

The Robinson mine.

In what we have styled the third area, viz., that of Ascot and Hatley, we find a great series of deposits which have of late years proved to be among the most valuable in eastern Quebec, not probably so much for the amount of copper contained as for their adaptability for the manufacture of sulphuric acid. In this respect the ores of this most easterly belt differ widely from those of the two areas already described.

Mines of the third or most easterly area.

The variegated and vitreous ores are, for the most part, wanting; the bulk of the ore being a chalcopyrite, with much iron pyrites. The amount of copper contained is not high, averaging, for the great bulk of the production, from four to five per cent., while in most of the ore there is an appreciable quantity of silver, reaching, in some portions, as much as twenty-five to forty dollars per ton of ore, but yielding, on the average, from four to five dollars. A certain amount of gold is also present, but, as no attempts have yet been made to save this, the quantity is unknown.

Character of the ore.

These mines are situated in what we now regard as the Sherbrooke and Stoke mountain anticlinal, and the rocks are chloritic, micaceous and talcose schists, with diorites. On this belt of rocks, southwest of Sherbrooke, and extending to the north line of Hatley, a large number of mines have been located, some of which have been worked for many years, while others, although containing valuable bodies of ore, have been idle for some time. In the township of Hatley the deposits appear to be much less numerous; the belt of schists becomes narrower, probably in part owing to the overlap of the black slates of the Cambrian system. The most southerly deposit of copper ore in this direction is near the upper end of Massawippi Lake, on the west side, on lot nine, range six. At this place there appears to be two kinds of rock, the soft blackish and bluish pyritous slates being in contact with the hard quartzo-felspathic rocks of the mountain series. The contact is probably along a line of fault, and the ore, which is scattered through a width of eight to ten feet, is in the form of the yellow sulphuret, but the shaft being filled with water, the quantity could not be ascertained; a large amount of iron pyrite appears to be mixed with the copper ore. This is the Parnell mine. The only other mine located in this town-

Situation and kind of rocks. Hatley.

Hatley.

The Parnell mine.

The Reid Hill mine.

ship is that on lot twenty-eight, range one, known as the Reid Hill mine. It has an elevation of 500 to 600 feet above the Massawippi River, and presents the appearance of six beds of the yellow sulphuret, with iron pyrite, in a space of a fourth of a mile in breadth. Similar ores appear on the lots to the west on ranges two, three and four adjoining. Considerable exploratory work was done at this place, and a level was driven in about 200 feet below the outcrop of the bed, but no details of the workings or subsequent exploration are to hand.

Ascot.

Beginning with this mine and passing into Ascot, there appears to have been an unusual development of this variety of ore, more particularly in that portion to the south-west of the St. Francis River, though large and very valuable deposits have also been discovered in the extension, to the north-east, of this anticlinal. The ores are apparently yellow sulphurets, and no less than fifty-five localities were at one time reported as copper-producing or giving good indications of the ore. In all, up to 1865, thirteen mines were operated, of which the localities may, for the sake of reference, be briefly noted as follows, but since that date several others have been opened:—

Mines south of Sherbrooke.

The Clark mine—Lot eleven, range seven.
 The Sherbrooke mine—Lot twelve, range seven.
 The Albert mine—Lot three, range eight.
 The Eldorado or Capel mine—S.E. $\frac{1}{4}$ lot four, range eight.
 The Victoria mine—N.E. $\frac{1}{4}$ lot four, range eight.
 The Ascot mine—W. $\frac{1}{2}$ lot eight, range eight.
 The Parks mine—W. $\frac{1}{2}$ lot twelve, range eight.
 The Short mine—Lot fourteen, range eight.
 The Lower Canada mine—Lot three, range nine.
 The Marrington mine—N.E. $\frac{1}{4}$ lot 6, range nine.
 The Hill mine—E. $\frac{1}{2}$ lot eight, range nine.
 The Belvidere mine—Lot ten, range nine.
 The Magog mine—Lot eleven, range nine.
 The Griffith mine—Lot three, range eleven.

Suffield, Howard, Hepburn and Moulton Hill mines.

These are the mines mentioned in the report for 1866, and in addition, several other areas, not distinguished by any particular names, occur, on which a greater or less amount of development work has taken place. Several mines have also since been opened, which promise well in view of the great present demand for sulphur ores. Among these may be mentioned the Suffield mine, on lot three, range eleven; the Cillis, now the "Howard," on lot five, range eleven; the Hepburn mine, on lot seven, range nine; and the Moulton Hill mine, north of the St. Francis River, on lots twenty-three and four, range three. The width of the ore lodes, or beds, in this section is very great, in places being considerably over fifty feet, and the breadth of the ore-bearing rocks, south of Sherbrooke, is about three miles, while from the

Parnell mine, on the south, to the Moulton Hill mine, on the north, the distance is about twenty miles. Still further to the north, again, in Garthby, large deposits of similar ore have been reported.

The first reference to the copper ores of this section is found in the report of the Geol. Survey for 1847, where an outcrop of a vein in the fifteenth lot of the seventh range, is mentioned as worthy of trial, which was found to contain, in addition to copper, small quantities of silver and gold; the latter, however, not in quantity to be of economic importance, but of interest as showing the possible presence of the precious metal in greater quantity in other veins of the vicinity. On the thirteenth lot of the same range, the continuation of this deposit carried copper pyrites in veins, distributed throughout a belt of thirty feet of chloritic slates. This lode, on lot fifteen, was at the time traced for a distance of about fifty yards, but further to the south, from half to one-third of a mile, could not be found. When first opened it had a breadth of from ten to twelve inches. Up to 1858 no further interest appears to have been taken in these deposits, only two places being referred to in the report for that year, viz., that just mentioned and on lot nineteen, same range, where a small vein of copper pyrites was seen in a railway cutting near Sherbrooke station on the Grand Trunk railway. In 1859 the Ascot mine was discovered by Thos. McCaw of Montreal, at Haskill Hill, and found upon examination to consist of a bed of copper pyrites mixed with iron pyrites, with a thickness of five to six feet, in a matrix composed of impure limestone and chloritic schist. This mine was, in the fall of 1863, purchased by an American company, who erected furnaces for smelting the copper ore at Lennoxville. In the Geology of Canada, 1863, reference is made to but three mines in this vicinity, viz.: the Ascot, or Haskill Hill, the Belvidere and that first discovered and already described. The ore was similar throughout, and the breadth in the Belvidere lode was estimated at six feet. What was afterwards the Marrington mine on lot six of the ninth range, shewed a vein of from two to three feet at the surface, with a large proportion of iron pyrites. During the next two years a very extensive development in mining took place; a large number of mines were opened and a very considerable quantity of ore extracted.

Early history of the Sherbrooke mines.

The Ascot mine.

The Belvidere.

The Marrington mine.

From notes kindly furnished me by Mr. T. Macfarlane and by J. S. Hunter, now of Belleville, I am able to present a few items in regard to some of these, not already generally made public.

The Clark mine is situated one mile and a half from the Lennoxville station, G. T. R., on lot eleven, range seven, Ascot. This was first opened in 1863, by Mr. Wm. Clarke, and was worked with more or less vigor for several years, principally by an American company, who

The Clark mine.

took out a large quantity of ore. The work was carried on for the most part by means of open cuttings upon a vein said to have a thickness of eighteen feet, (?) and containing three and a half per cent. metallic copper. This estimated thickness of ore bed is, however, doubtless exaggerated, since, on the most reliable authority, the thickness never exceeded seven to eight feet, and gradually decreased to eighteen inches. In addition to surface workings, a pit was sunk to a depth of forty feet and a shaft for seventy-three feet. Further explorations were carried on in 1866, but without success, and in that year the mine was sold at sheriff's sale. No returns as to quantity or quality of output are to hand, and the mine has apparently remained idle since the date mentioned.

The Sherbrooke mine.

The Sherbrooke mine immediately adjoins that just described, to the south, and is traversed by the same lodes as are found in the Clark mine. It has been quite extensively explored on the surface, though not yet opened up by underground exploration. Several valuable deposits of pyrites are reported on this property; one of which is said to have a thickness of eight feet, while another was stated to be no less than seventy feet in width. (?) Assays by several parties give from \$4.00 to \$5.00 of gold, \$11.00 per ton of silver, and from 30 to 40 per cent. of sulphur.

The Capelton mines.

A group of three mines, situated on lots three and four, range eight, and lot three, range nine, are worthy of special notice, not only from their early history, but from their great and growing importance at the present time. These comprise what were formerly known as the Lower Canada, or Hartford, now the Eustis or Crown mine, the Capel or Eldorado, and the Albert; the latter being now owned by the firm of G. H. Nichols & Co.

Their early history.

The Capel mine was so called from the name of the original owner of the property, Mr. Geo. Capel, and in 1863, chiefly through the agency of Mr. W. S. Hunter, three men, Mr. Hunter, Mr. Pierce and Mr. Capel, formed a company to develop the property on lots three and four of range eight. These gentlemen spent from eight to ten thousand dollars in exploratory work, and, finding the results satisfactory, divided the property into two portions; the eastern area, on range nine, being styled the Prince Albert mine. The property was soon acquired by Montreal capitalists, by whom mining operations were commenced, and have been carried on to the present day, though under change of ownership and management.

Changes of ownership.

From the Montreal firm the property passed into the hands of Taylor and Sons of London, who adopted the Henderson process for the extraction of the metallic copper. This, however, after a thorough trial, failed to give satisfaction, and the mine was closed. The pro-

perty subsequently changed hands, and was finally purchased by Messrs. G. H. Nichols & Co., an American firm of ability, by whom the ores have, for the most part, been shipped to the sulphur works at New York or vicinity, for the manufacture of acid. Within the last three years, however, a somewhat extensive plant has been erected at the mine for the manufacture of sulphuric acid on the spot as well as for that of superphosphate. Smelting works have also been still more recently started for the production of matte. The success of the present company is no doubt largely due to the saving of the sulphur and other by-products of the ore, in which the profit consists. The depreciation of the copper market at the time of the former management, combined with the loss of the sulphur, was such, that expenses apparently could not be met. The deposits at the Albert and Capel mines are doubtless a continuation of that found to the south-west at the Crown mine, formerly the Lower Canada. There the ore bed is an immense, but somewhat irregular deposit of chalcopyrite, with much iron pyrites, yielding an average of four to five per cent., some of the ore being very rich, and in addition contains an appreciable amount of silver; the lode varies in width from four to over fifty feet, and has been worked to a depth of over 1,600 feet. At the Eustis or Crown mine also, smelting works have been erected, in which a large amount of matte is made, the sulphur in this case being wasted, but a very large proportion of the ore still goes in the raw state to the sulphuric acid works in the vicinity of New York, while the residue is treated for copper at the smelting works at Bergenport, New Jersey. The owners of the latter are the Eustis Mining Co. The ore at this mine apparently occurs conformably with the bedding; the irregularities in size being due to local thickening of the ore mass. Dykes of diorite are met with in the different under-ground workings, and can also be seen at the surface in the immediate vicinity of the mines. The rocks containing the lode are schists, often highly micaceous and talcose, but generally chloritic, which are traversed by numerous quartz veins. The ore is delivered on the railway, about half a mile distant from the Albert mine, by an elevated cable tramway, carrying the ore buckets and from the Eustis property by a gravity tramway to the track, where it is dumped directly into the cars. From several assays of this ore the quantity of sulphur is found to vary somewhat, but averages 38 to 40 per cent. :—

Messrs. G. H. Nichols & Co.

The Albert and Capel mines.

The Eustis or Crown mine.

Iron.....	35
Copper.....	4 to 5
Silver, about one ounce per unit of copper, say 4 ounces per ton.	

The Lower Canada mine, or the Crown mine now so called, was

discovered in 1865. For two or three years thereafter it was worked for copper alone, but subsequently for copper and sulphur. This mine is well described in the Geological Survey Report for 1866, from which the following abbreviated extract may be made as illustrating the character of the workings and of the ore at that date.

Character of
the ore at the
Crown mine.

Earlier work-
ings.

The strata for a distance of 1,600 feet dip S. 30° - 40° E. $< 40^{\circ}$ - 60° , and in this distance five shafts have been sunk in micaceous schist, to the south-east of a dolomite band, and to all appearances in the same bed of ore. In shaft No. 1, the ore is ten feet thick, the lower four feet of which is apparently an almost compact mass of the yellow sulphuret of iron and copper, with a yield from this portion probably of eight per cent. of copper. Upon this are two feet of similar character, but yielding only about five per cent. of copper, and the upper four feet contain iron pyrites alone. No. 2 shaft is 125 feet south-west of this, sixty feet deep, and the ore bed is four and a half feet thick; the lowest part is similar to that in the first shaft, but said to yield fifteen per cent. copper, while the remainder yields only three per cent. The ore bed as shewn in the shafts Nos. 3 and 4, sunk to a depth of 75 and 132 feet respectively, is similar to that in No. 2, but in No. 5, sunk 90 feet, the bed is six and a half feet thick and vertical for eighty feet from the surface, thence dipping S. 40° E. $< 40^{\circ}$ - 50° . In the vertical part it contains only iron pyrites, but below this sufficient copper pyrites becomes mixed with it to cause the bed to yield between three and four per cent. of metallic copper. Other bands of copper ore occur in this lot, on both sides of shaft No. 1.

Subsequent
operations.

Subsequently to the date of this report mining operations were vigorously carried on, and in addition to the copper, which was originally the sole object of the enterprise, the large amount of sulphur contained in the ore was utilized for the manufacture of sulphuric acid, both in Canada and the United States. Up to June, 1869, about 20,000 tons were smelted to 40 per cent. regulus on the spot. A very large quantity was shipped to acid works, the amount of sulphuric acid obtained being stated at one ton of 66° acid to each ton of ore.

Output.

The yield of ore from these mines at present is very large and apparently annually increasing. The output for 1889, taken from the returns of the Mining Review, was, from the Eustis mine, 34,089 tons, including 1,773 tons matte, and from G. H. Nichols & Co. 36,000 tons.

Undeveloped
conditions of
certain loca-
tions.

Of some of the other mines alluded to in the list given in a preceding page, but little can here be said. On some of these a considerable amount of exploratory work was done and the promise of good sized ore beds seemed good, but, in most cases, this exploration was not pushed to a depth sufficient to decide as to the actual value of the property. This can be easily seen by reference to the great mines of

Capelton and by a comparison of the enormous size of the lode in the lower levels, with the comparatively limited extent at the surface. Among others, not noticed in the list of 1866, may be mentioned the Suffield mine, on lot two, range eleven; the Hepburn mine, on lot seven, range nine, at which a large amount of exploratory work appears to have been done; and the Cillis mine, on lot five, range eleven, which has, within the last year, been reopened to a greater depth, and the ore has been found to increase in quantity and quality so greatly that it is now considered an exceedingly valuable property. It has been purchased by an American syndicate and will be worked.

The Cillis mine.

From notes obtained by Mr. Willimott in 1882* the Hepburn mine was then being worked quite extensively. Like the Ascot and Suffield mines, it was the property of the Sherbrooke Mining and Smelting Co. A shaft was sunk to a depth of 156 feet, and at sixty feet a level had been driven for thirty feet, from which a north and south cross cut was made. The latter was carried 110 feet, at which distance a bed of yellow sulphide twenty-four feet thick was cut, averaging about seven per cent. metallic copper. The north cross cut was carried ten feet, where another bed of yellow ore was cut, said to be twenty-seven feet thick. No ore has been raised, the object of the company being to develop a large reserve.

The Hepburn mine.

About twenty men were employed at the mine. Work at this mine was shortly after abandoned. The quality of the ore in the dump, seen in 1885, looked well. Of the Suffield mine, Mr. Willimott says: "A shaft has been sunk 200 feet; at the depths of eighty-five feet, and at two hundred feet, levels have been driven to the east, the former 300 feet and the latter 100 feet, connected by a ventilating winze."

The Suffield mine.

The amount of exposed ore is reported at about 40,000 tons, of which 3,500 to 4,000 tons have been taken out with the intention of concentrating and smelting at the mine.

At this mine the drilling was done by compressed air driven by an engine of sixty horse power.

The ore resembled that from the Capelton and Hartford mine, an assay of which was made by Dr. Harrington in 1877, yielding 75.03 ounces of silver to the ton. Assays of the Suffield ore, by John Massey & Co., London, England, gave percentages of silver, varying from eight ounces to 235 ounces per ton and from four to twenty-nine per cent. of metallic copper.

Silver in the Capelton ores.

In the area north of the St. Francis deposits of ore occur precisely similar to that of Capelton, and in similar rocks. What has proved to be a very valuable deposit was found about three years ago by Mr. Burke, the owner of the land, on lots twenty-three and twenty-

The Moulton Hill mine.

* See Geo. Sur. Rep. 1882-3-4.

four of the third range of Ascot, which has since been somewhat extensively developed, and purchased by the same syndicate which acquired the Cillis mine. The bed of ore which dips with the slate south-easterly at an angle of 45° - 50° was found to rapidly increase from four to six feet at the surface to a reported thickness of not far from fifty feet, at a depth of seventy feet, revealing an enormous body of ore. This location was revealed by the uprooting of a tree, and is in the direct course of the Capelton deposit, which it so much resembles.

Ore beds probably repeated by folding of the strata.

In view of the fact that these several ore beds, which are found over a breadth of some three to four miles, resemble each other very closely, and from the crumpled and overturned character of much of the strata in which these are contained, it seems most reasonable to suppose that the greater part of these mines are located upon different portions of the same lode, repeated by folding from place to place, and that as large and valuable deposits of the ore have been found at widely separated portions of the same vein, both in the southern and northern portions of the township, and almost equally valuable deposits are known in the more western portion of the belt, as at the Cillis mine, it may be very safely predicted that the real value of many of the mines which were opened twenty-five years ago and speedily closed, has never been ascertained, and that other masses of ore, of equal importance to those so long worked, will, at some not distant date, by careful prospecting, be found. Much of the failure of twenty-five years ago was, doubtless, due to the speculative character of the work done. Mines were bought and sold on the flimsiest sort of evidence as to their value or worthlessness; often on samples which were obtained from an entirely different location from that represented. The growing importance of these ores as a source of supply for sulphuric acid is being very fully realized by the men interested in this industry in the United States; their superiority over most of the ore there found, for this purpose, being acknowledged. There are yet, in this eastern belt, many places thickly covered by forest growth, the prospecting of which is a difficult matter, but of the many mines already opened and abandoned it is highly probable, as in the case of those now worked, that deeper and more scientific testing would change the aspect of things greatly for the better.

Importance of the ores for sulphuric acid.

Garthby.

Further to the north, in Garthby, a considerable deposit of pyrites is found on lot twenty-two of range one. This deposit is described in the Geol. of Can. 1863, p. 733, as "a large mass of iron and copper pyrites, subordinate to the stratification of the enclosing rock which is a calcareous serpentine, dipping to the south-east at an angle of 50° . The extent of the deposit has not been determined, but there appears to be a breadth of about twenty feet, in which the two ores are more

or less mingled with rock. Large masses of the mineral consist of a fine-grained iron pyrites, without any copper, while in other portions the ore is such an admixture of copper pyrites as to afford eight per cent. of the metal."

The ore at this place occurs in rocks differing in age from those of the area just described, being more closely allied to the deposits of Bolton and Potton. The first opening was made by Mr. J. B. Coulombe, in 1860, and was nine feet long, five feet wide, and said to be sixty feet deep. No work was done on the property after 1861. An analysis of the iron pyrites apparently free from copper gave iron 42, sulphur 48, copper 1.1, silica 8.9.

This property is about four miles from the Quebec Central railway, and recent explorations, during the past year, in the southern part of the area, are said to have developed a large body of ore, the measures being traced into South Ham for a distance of three miles, but no definite information can be obtained on this point.

In the townships of Ham and South Ham, several mines were also at one time started, but these, apparently from an insufficiency of ore, have long since been closed. Among these may be mentioned the Nicolet Branch mines on lot twenty-eight, range four, where the variegated and vitreous ores were found scattered through a band of dolomite and chloritic schists, overlaid by glossy black slates. The ore is found in small veins only, disseminated through the rock, and by exploration over several hundred feet, several tons of rich ore were obtained. On range B, lots thirty-three to thirty-six, explorations were made; on the right bank of the Nicolet River on similar ores in green rocks, like the last, but without success, only small quantities apparently being found. In South Ham, in the serpentine and diorite rock of the south and east side of Nicolet Lake, small deposits, mostly of the yellow sulphuret, occur on lot twenty-two, range one, old numbering, or lot forty-four, range one, new numbering. This was styled the Nicolet Copper mine. A small amount of exploratory work was also done on lot fifty-two, range two, new numbering, but no returns are to hand.

Further north, in the township of Thetford, copper ore has lately been reported by Dr. Jas. Reed, as occurring on lots three, four, five and six of the first range, and on lot fifteen of the second range of Leeds, as well as lot nineteen of the second range of Thetford, but the quantity and character of the ore is unknown, as not yet explored.

GOLD.

Location.

The gold fields of Quebec, although now known for more than fifty years, have not, from various causes, attracted as much attention or come so prominently before the public, and the mining public in particular, as their actual importance would appear to warrant. They are, in so far as yet known, confined for the most part to that portion of the province lying east of the St. Lawrence, and more especially to that part contiguous to the boundary of New Hampshire and Maine or along those streams which take their rise in that region. The areas producing gold in Ontario, such as those of Madoc and Marmora, do not appear to have their counterpart east of the Ottawa, though possibly this may, to some extent, be due to the fact that much of the country in this direction, occupied by the Archæan rocks, is largely unexplored, but within the last few years, assays of some of the quartz veins from the

Gold of Ottawa county.

Ottawa county district have shown traces of gold, though no vein has yet been located carrying, as indicated by the assays, sufficient gold to be economically important. The rocks in the auriferous area of eastern Quebec were, for many years, regarded as of upper Silurian age. They were thus described in the Geological Survey Report on this district in 1847, when the presence of the gold of the Chaudière was first officially noticed, and at the same time the presence of gold in small quantity in a quartz vein carrying copper and galena near Sherbrooke was pointed out. Visible free gold has also been reported as occurring in certain quartz veins carrying copper, blende, etc., in the seigniory of St. Sylvester, and in the concession of the Handkerchief, as well as at several other points, but no attempt on a large scale has ever been made to test these veins for gold.

Visible or free gold.

While the rocks of the Chaudière district, where the gold of Quebec was first found, were supposed to be of upper Silurian age, the question of the source of the gold which occurred in the overlying gravels was long a mystery. By some it was held to be derived from the decomposition of quartz veins in the crystalline rocks of the Notre Dame range of hills, while by others it was thought to have been transported from long distances in the glacial drift from some unknown source. The great resemblance of the underlying slates and sandstones of this district to those of the gold-bearing rocks of Nova Scotia was pointed out by various observers more than twenty years ago, but it was not till the year 1886 that their probably Cambrian age was declared and their parallelism to the Nova Scotia rocks cloudy asserted, both as regards not only their character but their geological horizon.

Age of the gold-bearing rocks of Eastern Quebec.

The early history of the gold fields of Quebec has been given with

more or less detail by several writers on the subject. The discovery was first announced to the scientific public by General Baddeley, R.E., then stationed in Quebec, who in 1835 called attention * to the finding of gold in the Chaudiere. This was followed by numerous other papers, among which the following may be mentioned: "On the Gold Fields of Canada," by the Rev. James Douglas, read before the Literary and Historical Society of Quebec, 1863; Report to the Quebec Government, 1863, by T. F. Judah, Clerk of Crown Lands, "On the Gold Mines of the Chaudière;" "Report of the Select Committee appointed by the Quebec Government to ascertain the value of the Chaudière gold areas," 1865; and a paper by Mr. W. Chapman, "On the Gold Mines of Beauce," 1881. From these and other sources the writer has endeavored to prepare as complete a history as possible of this important mining field from the date of its first discovery to the present time, not only because of the large amount of work which has already been done in it, but in the hope that some wise provision may be made to encourage the further development of what should become one of the most important factors in the financial welfare of the province.

Early history of the Chaudière gold mines.

Sources of information.

According to Mr. Douglas "gold was first discovered some forty years ago by a woman near the mouth of the Touffe des Pins, now the Gilbert River, a tributary of the Chaudière; but it attracted no attention." As this statement was presented to the Society in 1863, it would place the first discovery of gold in the district about the year 1823-24. "In 1834 another woman, taking a horse to water near the same spot, perceived, as she supposed, a stone glittering in the bed of the river, and thinking it curious enough to preserve, took it home with her." This was the discovery announced by Gen. Baddeley in Silliman's Journal, 1835. The piece he described was said to weigh 10.63 grains; but he was unaware that this piece had been chopped off a larger nugget, the weight of which was 1056 grains. Owing to the smallness of the piece described by Gen. Baddeley but little attention was paid to the discovery, the only person apparently who manifested any interest being Mr. C. DeLery, the owner of the seigniority in which the discovery was made. Pieces of gold, several of which were of considerable size, of a value of over fifty dollars, were picked up from time to time, but no systematic attempt to work the gravel was made for some years, so that the total value of the gold obtained up to the end of October, 1846, was estimated at about three hundred dollars. From the assay of a specimen of gold from this river it was found to contain 13.27 per cent. of silver, the fineness being $20 \frac{1}{2}$ carats.

First discovery of gold. Mr. Douglas quoted.

* Silliman's Journal, 1835.

Mr. Chapman
quoted.

According to Mr. Chapman,* gold was found for the first time in the Gilbert River by a young girl named Clothilde Gilbert, daughter of Leger Gilbert, and now married to Mr. Oliver Morin, of St. George, Beauce. She was crossing a ford of the stream when she found in the sand a nugget about the size of a pigeon's egg. Her own account as given by Mr. Chapman is as follows:—"My father sent me on Sunday morning for a horse in the field to go to mass; when crossing the stream I saw something shining alongside of the water, and took it up to show my father. I never thought that such a pebble would make so much noise afterwards."

The DeLery
patent.

In 1846 Mr. DeLery obtained a patent from the Crown giving him the exclusive right *forever* to work for gold within the limits of his seignior, that of Rigaud Vaudreuil. Explorations were carried on by Mr. DeLery, and an examination and report on the value of the property was made by Mr. J. P. Cunningham. The letters patent to Mr. DeLery comprised an extent of nine miles along the River Chaudière in the seignior of Rigaud Vaudreuil and of six miles in depth on either side, the privilege of working the ores being granted upon the condition of a payment of ten per cent. royalty upon all the metal obtained from smelting in furnaces. No royalty was paid to the Government, however, since no gold was obtained in this way. In consequence of the uncertainty experienced in working the mines himself, Mr. DeLery very shortly leased all his rights to the Chaudière Mining Co., in consideration of receiving an improved royalty, amounting for the first portion of the leasehold term to twenty-five per cent., and for the latter portion to thirty-three and a half per cent, but this arrangement not being found satisfactory, the improved royalty was bought up for a fixed sum. The company also obtained the right of working in the fief La Barbe, through which the Famine River flows.

Leased to the
Chaudière
Mining Co.

The Chaudière
Mining Co.

The Chaudière Mining Co. began operations on the Touffe des Pins, or Gilbert, at a point about one mile from its mouth, where they worked for several years, but in such a reckless and unscientific way, that expenses were not met. They also operated on the Des Plantes River in 1847, and several rich deposits were struck. At one of these, just above the first fall, three to ten ounces of gold were obtained daily for several weeks. Dry digging from the gravel hills was also tried, but though gold was found in considerable quantity, the appliances for washing and collecting were so poor that the attempt was abandoned.

Mr. Cunning-
ham reports.

Of the two reports written by Mr. Cunningham, the first, in 1847, was addressed to the proprietors of the seignior Rigaud Vaudreuil, Messrs. Charles and Alexander DeLery, and related rather to the character of the rocks as compared with those of the mining areas of

* "The Gold Mines of Beauce, 1881."

Carolina and Virginia. He, however, refers to the finding of nuggets of gold weighing from thirty to fifty pennyweights, which had their angles rounded, and which he concluded had their source in close proximity to the spot in which they were found.

The second report was addressed to the Chaudière Mining Company in 1850, in which the results are given of two experiments in working the gravels of the Gilbert. The first of these extended from the 24th of June to the 6th of August. The work consisted in digging several pits or trenches, the largest of which was 150 feet in length, with an average width of twelve feet. In these the gravel directly overlying the slates was found to be auriferous, while an overlying stratum, directly beneath the soil, was also found to carry gold in places. Much difficulty was experienced from the water, and the work was at last abandoned for another portion of the deposit. The amount of gold obtained from the first trial is said to have been one hundred pennyweights.

Mr. Cunningham's second report.

The second trial lasted from the 8th August to the 20th September. The course of the stream was changed for a short distance, and the gold was collected from the old bed, amounting in all to 940 pennyweights, which is stated to have been the result of about two men's labour for that time. Further explorations of a similar character were made subsequently and good results obtained, the examination of a quartz vein at this place, which was stripped for 150 feet, showing several fine pieces, one of which weighed twenty-five pennyweights. In the construction of a canal and dam for the purpose of working a second portion of the river channel, one man is reported, in the six weeks in which the work continued, to have taken out, by panning, 380 dwts. of gold. Fine pieces of gold are reported to have been found at this place along the course of a fissure, caused by the decomposition of a vein of quartz, while the loose gravel lying upon the slates yielded upon several trials, more than three grains of gold per bushel of 100 lbs.

Early work on the Gilbert stream.

In the summer of 1851-52, the Canada Mining Company obtained the right to wash for gold on the flats, near the forks of the DuLoup and Chaudière, and somewhat extensive operations were carried on there during both summers, under the supervision of Capt. Richard Oatey, a Cornish miner. The results of his work are given in Mr. Oatey's report to Mr. James Logan, and incorporated in the report of the Geological Survey for 1851-52, and in the Geology of Canada, 1863. By this work the auriferous character of the gravel was well established, although the difficulties of mining were great, and the best results were probably not by any means attained. In these experiments, that of the trial made in 1851, on three-eighths of an acre of

The Canada Mining Co. Operations at the Forks of the DuLoup and Chaudière.

Results and
profits.

gravel two feet thick, yielded 2,107 pennyweights of gold, of which 160 were in the form of fine dust mingled in about a ton of fine black iron sand. Several pieces of gold were obtained of over an ounce in weight. The value of the gold was \$1,826, and the expenses, including \$500 lost by the bursting of a dam, were \$1,643, leaving \$182.00 as net profit, to which, under ordinary conditions, the \$500 should be added. In the second season, 1852, about five-eighths of an acre of gravel was washed and yielded 2,880 pennyweights, worth \$2,496.00, and of this 307 pennyweights were in the form of fine dust mixed with the iron sand. A number of nuggets were found, one of which weighed 127 pennyweights and the smallest eleven pennyweights. The washing lasted from the 24th of May to the 30th of October, and the expenses aggregated \$1,888.00, including a certain amount expended on permanent construction, equivalent for the season to seventy-two dollars, so that the actual profit should be placed at \$800.00. The total yield of gold, therefore, from an acre of gravel, two feet thick, at this place, was \$4,323.00, and the proper expenses \$2,957.00, so that the actual profits for that year were \$1,480.00. The result of a week's work, under the inspection of the Geological Survey, yielded 143 pennyweights of gold worth \$124.00, the expenses for the time being \$60.00, leaving a profit of \$64.00. From the assays made in recent years of black sand from this district, it seems very probable that a large amount of gold therein contained was not extracted, so that the profit might be largely increased. A list of nuggets with their weights, obtained from this second experiment, is given in Mr. Oatey's report as follows:—

		dwts.	grs.
Nuggets obtained.	June 7.....	126	19
	July 30.....	83	21
	August 25.....	10	20
	August 25.....	38	21
	September 7.....	98	21
	September 24.....	55	2
	September 30.....	23	20
	October 2.....	16	22
	October 9.....	13	2

The Napanee
Company.

Owing to some disagreement with the proprietor of the adjoining lands, this company, the Canada Mining Co., had to abandon its working. Later the Napanee Company endeavoured to sink a shaft at the same place through the slate, in the hope of finding a layer of auriferous gravel and sand beneath, but after two years' unsuccessful work they abandoned their attempt.

From 1855 to 1863, the gold mining was almost entirely abandoned and work was carried on for the most part by the habitants of the district in a very desultory sort of way. Among these the Poulin brothers, five in number, were the most persistent workers, and they took out apparently a large amount of gold in a very quiet way. The discovery of the rich gravels on the North Branch of the Gilbert was made by these men in the summer of 1863. This stream was thereupon set apart as a mining district for a distance of a mile above the forks, and a rush set in for that locality. Two spots were selected for work—the upper, on land owned by a man named Veilleux, the other, about half a mile lower down on the same stream, on a lot owned by a man named Rodrigue. Upon these claims, but more particularly upon the upper, a large number of people worked during the season of 1863, and a large quantity of gold was obtained. The largest piece reported, which was sold for \$22.00, was said to have been found by a woman named Parie. Among other instances quoted by Mr. Douglas was that of a party of six, including two of the Poulins, who acknowledged to finding fifteen ounces in three days, and another party of the same number found six ounces and a half in two days. These miners were all working without license, and upon the facts being reported to Mr. DeLery, bailiffs were sent and the crowd of workers driven off. On the lower, or Rodrigue property, according to sworn affidavit, given in Mr. Chapman's pamphlet, by the Poulin brothers before Mr. Belanger, N.P. of St. Francis, in 1880, three of the Poulins, with Rodrigue, washed, in tin pans, from the auriferous alluvium in one day, seventy-two ounces of gold. This party is said to have admitted finding ten pounds of gold in eleven days' work, with tin pans only. The largest piece found at this place during the season was sold for \$200.00. After exhausting the bed of the stream they washed the gravel from the banks in a sluice, and are reported to have found a pound of gold one day, and ten ounces another. Rodrigue, working with one man only, is said to have panned out in one day two ounces, two pennyweights and eight grains, valued at thirty-eight dollars. The earnings of this party, for twenty days in each month for four months during the summer, averaged sixteen dollars per day per man. But this success was not general, and many only cleared their expenses. The bed of the stream, at this place, is composed of a dark, highly cleaved slate, and the banks are made up of alternations of sand and gravel. The richest workings were where the gravel directly overlies the bed rock.

Although there appears to be a widespread notion that no visible gold has ever been found in the quartz veins of this district, Mr. Douglas says that, in a number of cases, specks of visible gold have

Mining from
1855 to 1863.

Discovery of
the rich gravels
on North
Branch of the
Gilbert.

The Poulin
brothers.

Large finds of
gold.

Rocks of the
Gilbert.

Visible gold.

been discovered in the quartz veins that cut the slates, and that handsome specimens have occasionally been found, and others, who are most familiar with the district, have made a similar statement. Considering the large quantity of alluvial gold that has been obtained, and mostly in close proximity to quartz veins, and from the assays that have been made of the quartz from different areas, it would be very strange if visible gold were not found at many points. In so far as I have been able to learn, however, but very few attempts have been made by anyone to examine the veins, and the workings have been entirely confined to the gravels.

Work practically confined as yet to the gravel.

Parker, Hagans & Co.

The lease from the DeLery Company to Mr. Douglas was transferred in 1863 to Parker, Hagans & Company of Quebec, who, however, did not meet with very great success, owing apparently to bad management and the loss incurred in removing débris, as well as to the fact of the local or patchy character of the rich deposits of gold.

The DeLery Gold Mining Co.

The thirty years lease.

Crusher at the Devil's Rapid.

The Reciprocity Co.'s work.

In consequence of the great success attained by the Poulins on the Gilbert River a rush set in, and the lots sixteen to twenty-one of the concession of DeLery were explored in all directions, generally by small parties, with very varying success. In 1864 the DeLery Gold Mining Company was formed to work the quartz veins as well as the alluvions in Rigaud Vaudreuil, under a lease for thirty years from the DeLery family, which granted the new company all the rights originally possessed by the owners of the seigniory. This company erected extensive works, comprising a crusher, at the place known as the Devil's Rapid on the Chaudière River, a short distance below the mouth of the Gilbert; and the claims and operations of the company prevented the explorations of private individuals for some years, over that portion of the seigniory covered by their letters patent. This crusher, however, proved to be an entire failure. In 1865 an American company styled "The Reciprocity," organized by Col. Rankin, leased from the DeLery Gold Mining Company the mining rights over several lots along the Gilbert. They constructed a wooden flume 1,800 feet long, with a dam at its head, in order to supply water for washing the gravels on the North Branch. This, although supposed to be well and strongly built, was not able to withstand the heavy freshets which occur on these streams, and was, for the greater part, swept away before any good results from its erection could be obtained, and consequently proved an almost total loss. This company, after the destruction of their flume, washed upon a trench dug along the river bed, from which the water had been diverted, and took out some \$2,500 in gold, the whole expenses, including the dam and flume, being from twelve to fifteen thousand dollars. The DeLery Gold Mining Company then granted permits to a few miners to work on the lots on the North

Branch already so celebrated, and in the summer of 1866 Mr. Henry Powers, with several miners, drove a tunnel across lots fifteen, sixteen and seventeen of the concession DeLery. A large amount of gold is reported to have been obtained along this tunnel, for the use of which, each company paid to Mr. Powers two dollars per day. In the official documents of the time it is stated that a value of \$142,581 was realized, and that two nuggets were found, one of which, found by Mr. Kilgour, weighed 52 ounces 11 pennyweights and 6 grains, and the other, found by Mr. Arch. McDonald, was worth \$821.56. In the following summer Mr. John McRae, on a claim of seventy-five square feet on lot fifteen, is said to have realized the sum of \$17,000.

Work by Mr. H. Powers.

Large nuggets from the North Branch of the Gilbert.

Among those who obtained leases from the DeLery Gold Mining Company was Mr. W. P. Lockwood, who acquired the mining right over three sections of the seigniorie of Rigaud Vaudreuil, and attempted to prevent any other mining company or private individual from carrying on mining operations in the concessions DeLery and St. Charles, where considerable mining was still being done, in large part, by the owners of the lots themselves. Mr. Lockwood opened a number of exploratory pits in the gravels of the Gilbert, and showed that the gold was abundant, not so much in the river itself, as in the ancient filled-in channels, which were proved to extend to a depth of over thirty feet below the present bed of the stream; the gravel being covered by a bed of clay, with a thickness of twenty-four feet or more, following the elevation of the gravel beds.

Discovery of the old river channel.

In the year 1876, the St. Onge Bros., with several others, made arrangements with Mr. Lockwood to work on the Gilbert. They experienced great difficulty in reaching the bed of gravel directly overlying the rock, owing to water and quicksands. The first shaft sunk was on lot eleven of the concession St. Charles. The difficulty of keeping out the water was such, that a ditch 1,800 feet in length was dug by which a water wheel connected with pumps was driven, and by this means they were enabled to carry on their mining operations. These works were prosecuted for several years, and from the statement in their books during the period in which they worked, though under great disadvantages, \$70,000 worth of gold was obtained; individual nuggets being found valued at from \$125 to \$740 each. Owing to various difficulties with which they had to contend, the company at last sold out to the Messrs. McArthur, of Toronto, for the sum of \$16,000.

The St. Onge Brothers.

Large returns by the St. Onge Brothers.

The success of the St. Onges induced others to enter the field, among whom were the following companies:—Payne & Chapman, Forgie, North Star, Victoria, Gendreau and others, who bought mining rights from the habitants, although these were supposed to be covered by Mr.

Trouble about mining rights.

Lockwood's leases, and that gentleman was led to request protection on the part of the Quebec Government in his rights, by force of arms if necessary. This, however, was refused by the Government, but he was advised to bring his case to the Civil Courts, in order that the validity of his leases might be established, a proceeding, however, which Mr. Lockwood would not consent to, and shortly after ceded his rights to the Canada Gold Company, England, represented by Mr. J. N. Gordon. Mr. Gordon, upon assuming control of the district, at once impeached several of those found mining on the property, covered by the lease, before the Inspector of the District, Mr. Duchesnay, the result of which was to so exasperate the men that serious trouble was with difficulty averted. The objectionable clause of the law, which declared that "whoever should be found searching for gold without the consent of the proprietor should be liable to a fine of \$5.00 for every such day of work," was repealed, and a special Act passed for the guidance of exploration in the district.

The Canada
Gold Co., Eng.

New regula-
tions.

New companies
and locations.

Owing to the favorable impression produced by this new law the interest in gold mining again revived. New companies were formed, among which were the Ainsworth Company of New York, to mine on lot thirteen, concession DeLery; and the Beauce Mining and Milling Company, on lot fourteen of the same concession, under the management of Mr. W. J. Smart, of New York. A short distance below these the Canada Gold Company, Limited, under Mr. Gordon, carried on operations under the direct supervision of Mr. W. Moodie, while the old St. Onge property under Messrs. McArthur was still worked. On the East Branch of the Gilbert, the East Branch Company was working on lot sixteen with very fair returns, and on the lot adjoining, Mr. Morey of New York was established; while on the North Branch Mr. Ascher of Montreal carried on some preliminary explorations by shafting. On lots twenty-nine and thirty of concession Chaussegros, Mr. Wilder of Boston succeeded in finding an ancient channel and obtained some good gold. The amount of gold obtained in October, 1880, by the three companies, the Ainsworth, the Canada and the Beauce, according to the returns of the Inspector of Mines, was 581 ounces.

Returns.

New companies
in 1880.

Among other companies who began operations or secured leases in this district about the year 1880, according to the statement of Mr. Chapman, were Messrs. Coupal on the North Branch of the Gilbert; Messrs. Poulin and Fortier on Slate Creek at St. George; Messrs. Home and Lionais at Bolduc Creek; Mr. P. A. Dupuy on lots sixteen and seventeen, concession DeLery; Messrs. Côté, Doris and Clouthier, concession St. Charles; Messrs. Cadot, Bernard and Company; The Eureka Company, comprising Messrs. Powers, Tomlinson and McDonald,

in the same concession; Messrs. Nicol and Osgood in the first range north-east of the Chaudière; Messrs. Poulin and Bernard at the Devil's Rapids; and Mr. Spaulding from Maine on the Gilbert River.

In 1879-80 the explorations along the Des Plantes and DuLoup were resumed, and the ancient beds of these streams are reported to have been found. On the former river Messrs. Mathieu, Bérubé and Gendreau found promising indications, and Mr. A. McKenzie of Montreal also commenced to work by hydraulic process on the bank of the same stream, about one mile above the road to St. Joseph. These workings were abandoned some years ago, owing to various reasons, but more lately Messrs. Bacon and H. Sewell commenced shafting at a point about half a mile above the St. Joseph road on the east bank of the river, and, at twenty-five feet from the surface, reached what appeared to be an old river channel, in which there was about four feet of well-washed river gravel, cemented with clay and sand. Owing to lack of proper appliances for mining and sluicing, or to other causes not known, this enterprise has in turn been abandoned.

About 1880 Mr. A. A. Humphrey began explorations on the DuLoup River, with an apparently ultimate intention of employing the hydraulic process in washing the gravel banks along its lower part. In 1881 a company of English and French capitalists was formed under his management, by whom a canal eleven miles in length, for a supply of water, was constructed along the bank of the stream. This was completed in 1882 and gave a head of not far from 150 feet. The washing of the gravel was continued for some months, but the work was closed down in the fall of 1883; the undertaking, apparently owing to poor management and lack of facilities for saving the gold, having been unsuccessful. Mr. Humphrey thereupon went into partnership with the St. Onge Brothers, who, after leaving the Gilbert, had established themselves on Slate Creek, a branch of the Chaudière at the village of St. George. The St. Onges had been prospecting this creek for several years prior to the advent of Mr. Humphrey, and several shafts were sunk at a point nearly one mile back from or to the north of the village. Great difficulties were encountered in sinking, owing to large quantities of quicksand, and four attempts were made before the bed rock was reached. The last shaft was 165 feet deep and consumed nearly a year in the sinking; the bottom being many feet beneath the bed of the present stream near by. A layer of auriferous gravel was found at the bottom lying upon the bed rock. Mr. Humphrey left the mine in 1886, it not having been found remunerative, and, after attempting to carry on the work by themselves, the St. Onges, at last, apparently from lack of funds to prosecute the work,

Work on the
Des Plantes
and DuLoup.

A. McKenzie.

Bacon and
Sewell.

A. A. Hum-
phrey on the
DuLoup river.
Hydraulic pro-
cess.

Slate Creek,
St. George.

Old channel.

- Famine river.** also abandoned the property, which has since been sold for debt. The St. Onges thereupon began operations upon the Famine, a short distance above the road, near the mouth, and are reported as having been successful in finding an old channel, which is said to promise well.
- Dr. James Reed.** In 1864 leases were granted on the Famine, in the township of Watford, to Dr. James Reed, on lot four, concessions three and four, and to Geo. Desbarats, on lot five in the same concession, the river traversing these areas. In the evidence presented before the Select Committee in 1865, mention was made of the presence of gold in considerable quantity on this river, as well as in most of the streams leading into the Chaudière and the DuLoup between this place and the boundary of the state of Maine. Quartz veins traverse the slates at many places; and from the fact that gold, some of which is of a coarse character, can be obtained from the gravels of most of these streams, there is no doubt that many of these are auriferous in paying quantity.
- Quartz veins.** On the Cumberland stream, which is a branch of the Famine from the west, explorations have been carried on by Capt. Richards for some years. Several shafts have been sunk to the bed rock, but no returns as to the amount of gold obtained are to hand.
- Cumberland stream.**
Capt. Richards.
- Pozer stream.** On the south side of the Chaudière work has been done at several places. Some exploratory work on the Pozer stream led to the finding of an old channel there by Mr. Humphrey, but no attempt has yet been made to ascertain its value. On the Gosselin stream in St. Victor de Tring, a shaft sunk by Mr. Kennedy is also said to have reached an ancient channel. Gold has also been found on the Mill stream in rear of the village of St. Francis, Beauce, and on the Noire and Meul Brooks, on the latter of which, at its forks with the Mill stream, Messrs. McArthur, Coupal & Company are at present engaged in mining on an old channel of that stream. As regards the old channel of the Gilbert, the width has been found at some places, where worked, to amount to 700 or 800 feet as compared with a width for the present stream of forty to fifty feet, and to have a depth below the present bed of nearly or quite 100 feet. Gold-bearing quartz veins are reported at the Devil's Rapid on the Chaudière, on Home and McDonald's property, concession St. Charles and St. Francis; on Humphrey's area, St. George; and on the Kennebec Road range, belonging to Messrs. Gibb, Ross and Campbell; also on the concession DeLery, lot eighteen, as well as at other points.
- Gosselin stream.**
- St. Francis, Beauce.**
- Old channel of the Gilbert.**
- Quartz veins.**
- Explorations of Mr. Michel.** The examinations of the Chaudière district in 1865, by Mr. Michel, on the part of the Geological Survey, the results of which appeared in the report for 1866, furnished very much important information in regard to the value of this area. While the report deals largely with the

alluvial workings, the question of the value of the quartz leads was also taken up, and, Dr. T. Sterry Hunt had a series of assays made of the quartz from different veins, which clearly showed that, in many cases, these contained gold in sufficient quantity to amply repay proper working. This opinion is supported by the fact that in the great majority of cases when profitable washings have been found, as on the Des Plantes and the Gilbert, the most satisfactory results have been obtained in close proximity to veins of quartz which traverse the measures. During the past season, owing to the low state of the water in the Chaudière, the vein at the Devil's Rapid, below which some years ago a very large quantity of coarse gold was obtained, was laid bare to such an extent, that very excellent results were achieved by working in its immediate vicinity. The assays of this vein also give a large yield of gold and silver.

Assays by Dr. T.S. Hunt.

Gold in the Devil's Rapid vein.

The character of the rocks in the Chaudière gold district have been very fully given in the earlier reports of the Geological Survey, and need but be briefly alluded to here. They consist for the most part of slates and hard sandstones, the former black, bluish gray and grayish in color. These are associated with dioritic and serpentinous rocks, and in places, as on the Bras du Sud-Ouest, are associated with bosses of granitic and whitish felspathic or garnetiferous rock. A great part of these strata were, for many years, regarded as the equivalents of the Gaspé limestone series, though their lithological resemblance to the Nova Scotia gold series was also recognized.

Character of the Chaudière gold series.

The rocks of the Ditton gold field are precisely similar in character to those between St. Francis and St. George, Beauce. In fact, the whole belt of rocks which flank, on the west, the crystalline masses of the chain of hills along the boundary of New Hampshire and Maine evidently belong to the same great series, till they become overlaid to the north-east by the Cambro-Silurian and Silurian rocks of the Upper St. John River series. In Ditton they are cut by numerous quartz veins, most of which are along the bedding planes, but others cut transversely across the stratification. The gold mining operations have, in this section, been confined to the Little Ditton stream, a branch of the Ditton River, which in turn falls into the Salmon River, the principal upper tributary of the St. Francis; and although such mining as has been here carried on appears to be of the rudest description, a large quantity of gold has been obtained, most of it very coarse, since no provision has apparently ever been made by which the finer gold could be saved. The richest washings here have been found in close proximity to the quartz veins which cross the stream; and from what is already known of this locality, as good results doubtless will be here obtained as ever were known in the Chaudière district. As this area

The Ditton gold field.

Unskilful mining.

Difficulty in obtaining returns from this district.

is entirely in private hands no returns are available, though desultory mining has been going on for a number of years, and the samples of gold obtained are very good, much of it being coarse and heavy.

Extent of explorations in the Chaudière district.

While in the early days of gold mining on the Chaudière district—for our remarks must, for the most part, apply to this district, owing to the fact that the Ditton area is inaccessible to the general miner and explorer—explorations were carried on very generally on the several branches as far east as the Quebec boundary, the principal work was done in three localities only, viz., the Gilbert, the Chaudière itself and the Des Plantes, though of late years much work has been done on the Mill stream and its branches near St. Francis, and on the DuLoup already referred to. The character of the gold obtained is very much the same at all of these places, much coarse gold being found, but without doubt the coarsest has been obtained on the Gilbert, owing doubtless to the fact that much more work has been done there, since the same run of beds and veins extends from the Mill stream on the

The old channel gravel chief source of supply of gold.

south side of the river across toward the former stream. The richest gold-producing areas are without doubt found in the old river channels which have been excavated long prior to the glacial period, to a depth of a hundred feet or more below the level of the present beds of the several streams, since the boulder clay is found resting upon the top of these ancient deposits of sand, gravel and clay, which make up the material now found in these old pre-glacial channels. The gold in these channels is confined almost entirely, or at least in paying quantities, to the belt of gravel at the bottom, lying directly upon the bed rock, though, in some of the reports of the early workings on the Gilbert, it is reported as also occurring in the clay where that rests upon the slates. The lowest gravel consists of well-washed pebbles cemented with sand and clay, and in the working of these beds it was found that some portions were enormously productive of gold, while others, on either side, were comparatively poor and did not more than pay expenses, though this latter fact may, to a large extent be due to the crude methods employed in its extraction. Lack of water seems to

Character of the gravel.

Lack of proper appliances for successful mining.

have been largely instrumental in causing the failure of mining operations in many cases; no proper provision having been made by which a constant and regular supply would be afforded in periods of dry weather, and in certain cases, quite recently, the same cause has led to a great loss of gold. Making due allowance for exaggerated statements as to the amount of gold obtained, there is no doubt that many areas yet exist, not only in the Chaudière district, but also in Ditton, which with proper appliances and right methods of working will yield very large returns to capital rightly invested, and it may be safely presumed that much of the old gravel so rudely washed contains yet a very large amount of fine gold.

From the trials made by Mr. Michel of certain Vots on the Gilbert, it would appear that certain localities did not possess sufficient gold to pay for the working by the methods then practised. It is probable, that in these cases, the areas in question were above or were too far removed from the quartz veins from which the gold is in large part undoubtedly derived, the character and courses of which should be carefully considered in carrying on explorations by the ordinary process of hand-washing. Another point noted by Mr. Michel was that when the gravel rested upon the clay it was poor, but when resting upon the slates under the clay became appreciably richer; while in the case of two layers of gravel, separated by a parting of clay, that on the bed rock contained more or less gold, while the upper stratum was generally without or contained but little.

Poverty of certain areas.

With regard to the valley of the DuLoup and its tributaries on either side, as well as of the Upper Chaudière below Lake Megantic, judging from the experience already obtained from the Gilbert and other streams, and from the character of the rocks along the upper portions of these rivers, it may be safely said that areas of rich gold-bearing alluvion will be found at different points, and possibly of equal value to those in the streams mentioned. Many quartz veins are found there, some of which have yielded gold in good paying quantity upon assay, while from the evidence presented to the Commission of 1865 good indications were obtained. The experiment at the mouth of the DuLoup by Mr. Oatey in 1851-52, already referred to, was attended with sufficiently good results to warrant the prosecution of further work with proper and modern appliances, while with the exception of the hydraulic experiment by Mr. Humphrey, which cannot by any means be accepted as testing the value of the gravels along this portion of the stream, no attempt has been made in this direction for nearly forty years. The occurrence of gold in the quartz veins of Risborough and Marlow, as shown by the assays of Prof. Donald of Montreal and by others, as well as that of Mr. Hoffmann, of a sample from a vein cutting the slates near Lake Megantic in which traces of gold were observed, is strong corroborative proof that in other portions of this area, along the eastern border of the province, gold-bearing veins will also be found; but perhaps the greatest confirmation of this view is in the fact that south-west of the Chaudière River, from the foot of Lake Megantic to the forks of the DuLoup, gold can be found in nearly every pan of gravel washed where trials have been made, as was ascertained by Mr. Arthur Webster of the Geological Survey during his exploration in 1880-81.

Distribution of the gold.

Risborough and Marlow.

Explorations by Mr. A. Webster.

While, then, it can be very conclusively shown that the true source of most of the gold, if not all, is in the quartz veins of the Cambrian

Probable true source of gold in the lower Cambrian rocks.

rocks, it is also a well-known fact that in the great basin, which extends between the Cambrian and pre-Cambrian rocks of the Stoke Mountain and Sherbrooke anticlinal, and the similar rocks found along the border of Quebec and Maine, fine gold can also be obtained in small quantity from the gravels of nearly every brook or river. In but few places, however, throughout this area has coarse gold been met with, and this may to a large extent be due to the fact that a considerable portion of the surface is occupied by slates, limestones and sandstones of the Cambro-Silurian system. While it would be presumptuous to state that gold-bearing veins do not occur in these newer rocks, the experience so far has been that the richest workings and presumably the most productive leads will be found in the rocks of the lower portion of the lower system.

Mapping of the district.

On the old geological determination by which much of this area was colored as belonging to the Upper Silurian, much confusion unavoidably arose, since what we now regard as the Cambrian, the Cambro-Silurian, the Silurian and even the Devonian were to a large extent included under one head. On the map of this district accompanying the reports for 1886-88 the rocks of these several systems have been separated as carefully and accurately as was possible in dealing with a series of rocks, most of which are devoid of fossil remains by which to identify them; and the prospective gold bearing belt of the Cambrian portion can be distinguished from the newer or Cambro-Silurian rocks; the Upper Silurian and Devonian occupying areas of very limited extent.

Gold fields south-west of Sherbrooke.

In addition to the areas of the Chaudière and in Ditton, reference may also be made to the section lying to the south-west of Sherbrooke along the valley of the Magog River, as well as in the valley of the St. Francis for some distance north of Lennoxville. Along the west flank of the Sherbrooke anticlinal at the Magog River, and about the shore of Little Magog Lake, certain black slaty beds occur, very similar in aspect to those of Ditton, and like these have recently been regarded as of Cambrian age. Trials by Mr. Michel showed that, in certain places, the gravels resting upon the upturned edges of the slate contained gold, while in the clays above the gravels, or where these clays rested upon the bed-rock, no trace of gold could be obtained. These results are also very similar to those obtained in the Chaudière gold district. Certain areas also on the east flank of the Stoke Mountain range in West Bury are reported as yielding gold in a similar manner, while on the east slope of the Massawippi Mountain, on the west side of the lake of that name, nuggets of fair size are reported to have been found. It is probable in all these localities that the gold, if found, will be in workable quantities only, in proximity to

Magog River and Little Magog Lake.

West Bury.
Massawippi mountain.

quartz veins traversing the slates as in Ditton, and that in places remote from these veins, as, for instance, over a great extent of the country lying east of the Sherbrooke anticlinal, the gold is so fine and so widely scattered that its mining will not, in the present condition of things, be attended with profit.

Fine gold of the upper St. Francis basin.

According to the reports of the Golconda Mining Company and the Ascot Gold Mining Company, good workings were found on lot eleven, range eleven, Ascot, and on lots two and three, range thirteen. Mr. Michel examined the ground and found the same sequence of stratified gravel and clay as on the Gilbert, but apparently did not strike any old channel of the Magog River. The succession of beds at this place was, at the surface, a yellowish clayey gravel containing grains of pyrites and a little fine gold; second, a stratum of large pebbles and masses of quartz and slate cemented by a blackish clay, without gold, and beneath, resting upon the slates, a layer of iron-stained gravel richer in gold than the above. The average thickness of the deposits was about six feet.

Golconda and Ascot Mining Cos.

Quartz of the Magog River.

As regards the Lambton area, which Mr. Michel also refers to in his report, 1866, the quantity of gold obtained was, in most cases, very small. This might be due to the general principle already stated, that the richest deposits will be found in what are regarded as the Cambrian rocks; those in which the Lambton explorations were made being on the belt of limestones and slates, which are classed as Cambro-Silurian and similar to those of Eaton and vicinity. A belt of Cambrian slates, however, cut by granite, crosses Lake St. Francis about midway, where the conditions for gold should be more favorable. This area has, however, never been tested, and certain portions of the Cambrian slates, along with the serpentines and diorites of Thetford, Broughton and Adstock, and extending thence northward to the Chaudière at the Bras and the Colway, present many features in common with the rocks of the gold-bearing districts on these streams.

Lambton.

Lake St. Francis.

Although reference has been already made in former reports to the presence and probable value of the quartz veins at various points, this report would be scarcely complete if it omitted all mention of the results of assays obtained by the officers of the Geological Survey and by other competent assayers. For, while the mere assay of a sample of supposed gold-bearing quartz may be but a very indifferent test of the value of the vein itself, the true worth of which can only be ascertained by trial of a large average sample, the presence of gold by assays of well certified samples, in which the result obtained by one assay is largely confirmed by that obtained by another conducted in a different way, at least proves that gold is present in the vein matter; and this is an important fact to have definitely settled, since the remark

Value of assays of gold quartz.

has frequently been made that the quartz veins of Eastern Quebec are not auriferous. Further, the gold is found by assay not to be confined entirely to the quartz veins of the Cambrian or gold-bearing series just described, but is known to occur also in connection with silver; the latter often showing a comparatively large percentage in many of the copper lodes or other mineral veins which traverse the crystalline schists, as in Ascot, Leeds, St. Sylvester, &c.

St. Sylvester,
St. Giles.

In the concession of St. Sylvester, seigniory of St. Giles, several specimens of visible native gold are reported to have been obtained from quartz veins in the Handkerchief location. Dr. James Reed informs me that he has broken these specimens himself from the vein.

Devil's Rapid
vein.

From the gangue of the quartz vein at the Devil's Rapid on the Chaudière, native gold has also been obtained. This vein is now broken down nearly level with the containing slates, and is without doubt the source of supply from which the largest quantity of the gold obtained from the bed of the stream in its immediate vicinity, was derived. A shaft in this vein for a few feet would be of great interest.

Haskell Hill.

The presence of native gold in the quartz and copper lode at Haskell Hill has already been referred to, and is of interest principally as confirming the fact of its occurrence in the copper-bearing veins.

Assays of gold
quartz for the
Chaudière
district. Con.
St. Charles.

While of course we cannot in many cases vouch for the accuracy of the assays that are reported, yet the accuracy of the statements that have been made as to the highly auriferous character of many of the veins can scarcely be questioned when published by reliable authorities. Thus in a quartz vein running north-easterly through lot twenty-one, concession St. Charles, in Rigaud Vaudreuil, certain portions assayed in Toronto are said to have yielded \$136 per ton. An assay by Mr. Calvin gave \$34; another by Dr. A. A. Hayes of Boston, a good authority, gave for the quartz from this vein \$77.56 of gold and a little silver; and from specimens collected by Mr. Michel himself for the Geological Survey in October, 1865, the average of five assays was \$26.66, the highest being \$101.29 a result due to the presence of a scale of visible gold in the sample assayed. There can, therefore, be little doubt as to the actual value of this vein. On lot

N.E. Chaudière
range.

eighty-three, range one, N.E. Chaudière, while samples of a quartz vein assayed in Boston gave \$37, and another sample assayed by Mr. Calvin gave \$106, a specimen tried by Dr. Hunt from the same vein gave no trace, although a mechanical assay by Mr. Michel gave five small particles of gold. Several assays of samples from a quartz vein on lot sixty-two, range one, N.E. Chaudière, having a breadth of four to five feet, made in New York and other places, gave from \$15 to \$106 per ton, but in a sample sent to the Survey laboratory no trace of gold was found.

A specimen from a vein of quartz, twenty-four inches thick on the outcrop, yielded on assay, by Dr. Hayes of Boston, \$70.95 of gold, while the mean of six assays by Dr. Hunt, of specimens from the same vein, gave \$24.71; the mean of four samples being \$5.03 and of two others \$64.07, a good confirmatory test of the auriferous nature of the vein, and which, if uniform throughout, should, from its large size, be an exceedingly valuable one. Quartz veins also occur on lot thirty-nine, range one, N.E.; on lot twenty-six, concession DeLery; also on lot fourteen, same concession. A mechanical assay of twenty pounds from lot twenty-six gave Mr. Michel no traces of gold.

On lot twenty, concession DeLery, a large vein from seven to eight Con. De Lery. feet thick, enclosed between slates having a south-east dip, was observed to cross the Gilbert River. Mr. Michel states that twenty pounds of the quartz from this vein were crushed and washed, from which twenty-two particles of gold visible to the naked eye were obtained. From an assay by Dr. Hayes of a sample from this vein \$16 to \$18 are reported, and the mean of two assays by Dr. Hunt gave \$15.15 of gold per ton. It is very possible, from the position of this quartz vein, that much of the very rich gravel found in the Gilbert River was derived from its decomposition and distribution. On lot twenty-one, same concession, quartz veins are also reported, though not tested, by Mr. Michel, owing in part to the fact that the excavation made on it had become filled up. A sample, however, tested by another assayer is said to have yielded \$40 to the ton of quartz.

From lot fifty-one to fifty-three, range one, N.E. Chaudière, near the Devil's Rapid. Devil's Rapid, several veins of quartz occur. From a mechanical assay of fifty pounds, from lot fifty-five, particles of gold were obtained, but that taken from lot fifty-three yielded nothing.

A vein on lot two, concession St. Charles, with a breadth of five Con. St. Charles
Con. Chaus-
segros. feet, was also slightly explored, but gave no results to a mechanical assay of twenty pounds of the quartz; but on lot sixteen, concession Chaussegros, a mechanical assay of twenty pounds gave five small particles of gold. No further assay was made of this vein, nor was any trial made of a vein of lot forty-nine A., range one, north-east.

On lot fifty-nine A, range one, north-east, near Bolduc Creek, a vein Bolduc Creek. of quartz, mixed with slate, can be traced for some distance. A mechanical assay of twenty pounds gave six small scales of gold, while an assay of a sample of quartz by Dr. Hunt gave no trace.

Among other localities where quartz veins have been observed may be mentioned lot nine, range one, Aubert Delisle; lot thirty, range one, Aubert Delisle
Aubert Gallion. and lot seventy-six, Aubert Gallion; but an assay of specimens by Dr. Hunt showed no gold in the portions tested, though of the last an assay by private parties in New York gave \$54 per ton; but on the

- Lineare.** second lot of range one, Lineare, a sample from one of several veins there found gave \$6.76 per ton. Other veins occur in this vicinity, and it is to be regretted that the examinations of Mr. Michel were at so late a date in the season that much of the country was covered with snow.
- Risborough.** An assay of a vein from the silver mine in range fifteen, Risborough, gave to Prof. Donald \$10 in gold per ton. An assay by Mr. Hoffmann in the Survey laboratory, of a sample from a vein in the same locality, gave traces of gold and forty-three ounces of silver. Further assays
- Whitton.** of a sample of quartz from Whitton, lot six, range eleven, gave also
- Ditton.** traces of gold. An assay of a quartz specimen from Ditton, mentioned in the last report of Mr. J. Obalski, according to the assay of Mr. Nahant, of Quebec, showed an appreciable quantity of gold.
- Magog River.** The quartz veins found in the slates of the Magog area south-west of Sherbrooke have received little attention. An assay of a sample by Dr. Hayes, of Boston, gave no satisfactory result, but according to Mr. Michel, the character of the quartz veins examined by him was such as to lead him to suppose they ought to be auriferous. A quartz vein
- Lambton.** from Lambton on lot eight, range A, gave by mechanical assay of a twenty-pound sample a small quantity of visible gold. Late assays of
- Bras du Sud Ouest.** a small piece of quartz from the Bras du Sud Ouest, near the Falls, gave to Mr. Hoffmann 0.117 of an ounce of gold to the ton. This result, owing to the presence of diorites, serpentines and granite among the slates of this stream, is important and sufficient to warrant further exploration in this direction, while a mass of white garnetiferous rock near this place is also reported to contain visible grains of gold.
- Ottawa and Pontiac counties.** The Laurentian rocks on the Upper Ottawa, in the province of Quebec, have not as yet yielded gold in paying quantities, in so far as the assays made in the Survey laboratory are a test of the value, with one or two possible exceptions. In the report for 1887-88 the results of the assay of eighteen samples of quartz veins are given, mostly from locations in the counties of Pontiac and Ottawa, in none of which was more than a trace of gold visible, though in some an appreciable quantity of silver was present. Several assays from the same locality are given in the reports 1882-83 and 1886, but these show the same almost barren character of the veins tested. In the report 1878-79, however, an assay of a small sample of a quartz vein from the township
- Wakefield.** of Wakefield, received through Mr. Vennor from Mr. A. Cotes of Peche village, gave to Dr. Harrington 11.725 ounces of gold to the ton of 2,000 lbs., and 52.323 ounces of silver.
- Whitefish Lake** The highest yield of gold obtained from the other assays by Mr. Hoffmann is from a sample said to be from near Whitefish Lake, which gave .058 of an ounce to the ton.

SILVER OR ARGENTIFEROUS GALENA.

The first reference to the occurrence of silver in Canada is found in a paper by General Baddeley, R.E., read to the Literary and Historical Society, Quebec, 1830, where the deposit of galena at Bay St. Paul is alluded to. The proportion of silver in the ore is not stated, but the quantity of galena was thought to be insufficient for successful working. Its presence was also reported in the galena near the Owl's Head Mountain, on Lake Memphremagog, in the township of Potton and near the Vermont boundary. Later, in the report of the Geological Survey, 1847, reference is made to the presence of silver with a small quantity of gold in the ores of copper in Ascot and Upham, while in an assay of a quartz vein from the Chaudière the presence of silver was also alluded to. In the report for 1849, the galena of Bay St. Paul is described and the quantity said to be small; but in 1854 the examination of a large quartz vein at the Devil's Rapid on the Chaudière showed the presence of silver in quantity sufficient to render the vein of importance; the other minerals present being quartz, blende, galena, arsenical sulphuret of iron, cubic and magnetic pyrites and native gold; the amount of silver from one assay equalling thirty-seven ounces per ton, and from a second portion of the same vein, 256 ounces, while the presence of gold was detected in a number of assays from this place. Attention was also early directed to the presence of silver in the galena of Gaspé Bay at Indian Cove and Little Gaspé, which were mined to some extent some thirty years ago, but the percentage of silver was small, and the extent of the veins of galena not sufficient to render profitable returns, and after attempts had been made for several years by different parties the property was apparently abandoned. An assay of galena from Indian Cove, where the mine was worked, gave only .146 of an ounce of silver to the ton.

Among the most important deposits at present known in Quebec is that in the townships of Risborough and Marlow on the DuLoup River, a branch of the Chaudière, and near the eastern boundary of the province. The country rocks of the district are the ordinary black and gray slates with hard sandstones of the lower Cambrian or gold-bearing series, which at this place are traversed by several dykes of diorite and intersected by a number of quartz veins, some of which follow the stratification of the measures, while others cut across the bedding. Some of these contain a large amount of galena, in much of which the percentage of silver is high. Several of these veins, more particularly on lots one, two and three, ranges fourteen, fifteen and sixteen, Risborough, and lot one, range seven, Marlow, were partly opened up by trial shafts in 1883-84. From a visit to the place in

First reference
Bay St. Paul.

Lake Mem-
phremagog.

Ascot and
Upham.

Devil's Rapid
vein.

Gaspé Bay.

Indian Cove.

Risborough
and Marlow.

Risborough
mine.

1885 it was seen that the main vein had a width of ten to twelve inches, carrying galena, blende and some pyrites, of which probably about half the vein carried ore in fair quantity. In this a shaft thirty feet deep was sunk, the vein being uniform in width for this distance. A second vein twenty feet further west, with a thickness of eight to ten inches, carried ore on the north side, of a peculiar character and very rich in silver, but this had not been sufficiently developed to determine its full value, only three or four shots having been fired. This is called the North vein. In the immediate vicinity yet another vein, similar in character to the main vein, had been opened by a shaft for a few feet and good ore found, while nearly a mile to the south-west two other veins were disclosed, styled the Senator and the Armstrong; the latter with a width of eighteen to twenty inches, the other much smaller; gangue and mineral contents resembling those first met. Similar veins from ten to twelve inches wide, carrying blende, galena and pyrite, are found on lot one, range seven, Marlow, while smaller veins intersect the enclosing slates.

Assays for the
several veins.

From all these outcrops of vein matter we have an area of considerable prospective value; at present accessible with difficulty, but which will be easily reached by the proposed extension of the Quebec Central railway to join the Canadian Pacific railway in Maine. Assays have been made by several parties to prove the value of the several lodes, in all of which good results were obtained. One specimen from the North vein, assayed by the Rev. E. Pagé of Laval University, gave at the rate of 430 ounces of silver to the ton of 2,000 pounds; one from the Main vein, by Prof. Richards, School of Technology, Boston, gave twenty-nine ounces from a large sample of several barrels. Assays from the Senator vein gave 260 ounces per ton, and one by Mr. Hoffmann of an ordinary sample from the Main vein taken from the dump gave 43.63 ounces with traces of gold. An assay of a piece from the Armstrong vein gave, in addition to the silver, half an ounce of gold to Prof. Donald, of Montreal.

Spaulding.

What is probably the extension of the same mineral belt to the south-west, in the direction of Ditton, is reported by Mr. Gordon, contractor, of Sherbrooke, in the township of Spaulding. From three to four miles north of the Canadian Pacific railway, though no particulars are to hand as to the exact location, the presence of the galena in quartz veins only being reported. Indications of galena were also observed in the quartz veins at several points in Emberton and Ditton, but no attention has yet been paid to the occurrence of silver in this quarter, partly because the amount observed was apparently not great, and because the property is entirely in private hands.

Emberton and
Ditton.

Among other localities where silver or argentiferous galena has been observed and worked to some extent is the hill in rear of the city of Sherbrooke. This vein was opened in 1888 by Mr. John Blue of Capelton, and a shaft sunk to a short distance. The surface indications were promising, but the percentage of silver upon testing was found to be insufficient to warrant the carrying on of operations, and the mine was abandoned. From an assay of a sample from this place by Mr. Hoffmann in the Survey laboratory, the amount of silver per ton of 2,000 lbs. was only 9.479 ounces, and of gold a trace. Assay.

From specimens of galena obtained in the county of Pontiac, assays, by Mr. Hoffmann, showed amounts of silver ranging from two to twelve ounces per ton. These amounts, if representing average samples of the ore, would scarcely repay the cost of extraction. Farther up the Ottawa, however, on the east side of Lake Temiscamingue, a very large deposit of argentiferous galena has been known for several years. This location is on lots sixty-one, sixty-two and sixty-three of range one, township of Duhamel, in what is known as blocks A and B, and owned by Mr. E. V. Wright, of Ottawa. Assays of the ore are given in the Geological Survey Report for 1879, by Dr. Harrington, of three specimens which contained of silver 18.958, 11.66 and 18.229 ounces to the ton of 2,000 pounds. Lake
Temiscamingue
Wright's mine.
Assays.

This property has been reported on by Prof. Marsan, late of the University of Ottawa, from whose statements it would appear that the deposit is very considerable. Prof. Marsan states that the breadth of the lode is eighty-five feet, the gangue mixed with the galena in almost equal portions. The vein occurs in rocks of supposed Huronian age. From the statements of the mining captain, Mr. John Wearne, the lode is said to have a breadth of sixty feet, with a vein or portion six feet wide carrying richer ore than the general mass. Two shafts have been sunk, one twelve feet deep, the other sixty-three feet on the lode, with a bore-hole to a further depth of sixty feet, which was still in the ore. Description.

The mean of two assays by Mr. Hoffmann gave of silver 13.58 ounces with a trace of gold; by Prof. Donald, of Montreal, silver \$21.17; by Dr. Baptie, Ottawa, silver 23 ounces; by School of Mines, London, 19 oz., 14 dwt. and 10 grs. per ton of 2,240 lbs., and lead 52 per cent. The percentage of silver in the galena itself was 26 oz. 7 dwts. and 21 grs. Assays.

In describing the silver ores of Quebec it would be unfair to make no mention of the percentage contained in many of the copper ores of the Ascot belt. Presumably silver enters into the composition of all or most of the copper ores of this district, in proportions varying from a very small amount up to ten to twelve ounces per ton, and even in places carrying a much higher percentage. The average, however, Silver in the
copper ores of
the Sherbrooke
belt.

obtained from the mines at Capelton is from three to four ounces per ton, or nearly one ounce to each unit of copper in the ore. Of the percentage of gold in this ore no returns have been made, though that it is present in small quantities is clear from the assays made. The silver, however, forms a very important factor in the profitable working of these deposits, and from the several assays of pyrites from different mines large percentages have been obtained. Thus, in the ore from the Suffield mine, assays, by John Massey & Company, of London, England, gave from 8 to 235 ounces per ton. From the Hartford mine, Capelton, an assay by Dr. Harrington gave 75.03 ounces of silver to the ton, and from a sample of ore from a locality near Sherbrooke, composed of copper and iron pyrites and quartz, 19.687 ounces of silver to the ton. From the specimen submitted by Mr. Vennor from the township of Wakefield, already referred to under gold, the yield of silver was at the rate of 52.323 ounces per ton.

Suffield and
Hartford mines

Wakefield.

ANTIMONY.

Although antimony was reported as occurring at Bay St. Paul and so recorded in General Baddeley's paper to the Lit. and Hist. Soc., Quebec, 1830, no importance ever appears to have been attached to the discovery, and presumably the quantity was found to be too insignificant for economic purposes. The only deposit at present known in the province of Quebec is on lot fifty-six, new numbering, range one, South Ham, which was discovered in 1863. Attempts were made to work it for several years, principally by the late Mr. Willis Russell, of Quebec, and machinery was erected for crushing, separating and concentrating the ore, and a shaft sunk to a depth of 100 feet. The ore occurs here in different forms, viz., sulphide or stibnite, kermesite or red antimony, and as valentinite, while beautiful specimens of native antimony are also obtained. This deposit is of commercial importance from the fact that good ores of antimony are comparatively rare, only two others deposits being at present known to occur in Canada, viz., that of Prince William, twenty-four miles west of Fredericton, in New Brunswick, and that of Rawdon, Hants county, in Nova Scotia. At both these places the ore is principally a sulphide of great purity. At the former several veins occur, one of which has been mined at irregular intervals for over twenty years. The vein at Rawdon is said to have a thickness of four to eighteen inches, and has yielded a large quantity of fine material, chiefly for the English market. At the South Ham mine in Quebec the width of the principal vein at the surface was from six to sixteen inches; the gangue consisting of quartz and dolomite, which intersects the magnesian slates and schists, presumably of pre-

First reference
Bay St. Paul.

South Ham
mine.

Size of lode.

Cambrian age. This mine was examined by Mr. C. W. Willimott in 1882, from whose notes we learn that the deepest shaft was 100 feet, and that several levels had been driven along the course of the vein for short distances only. From the examination of the vein and of the ore taken out Mr. Willimott estimated that the ore would assay about five per cent. of the whole, exclusive of some very rich pockets said to have been extracted. No returns as to the amount of antimony obtained from this mine, while worked, are available, but from the crude nature of the appliances for saving the metal it was evident a very large proportion of good ore was lost in the working. The vein matter was crushed in a set of stamps, then by a stream of water carried on to a broad revolving belt by which heavier portions were deposited in a receiving trough, while the lighter portions were carried along by the water. This property was acquired in 1886 by Dr. James ^{Explorations} Reed. ^{by Dr. Reed.} by whom an adit has been driven in from the base of the hill in order to tap the bottom of the 100-foot shaft. This adit is 304 feet long, and by it all the old workings can be easily drained, while the ore can be removed much more easily than by hoisting. A small amount of work has also been done of late years in driving drifts, but no returns of output are to hand. The country rock of the mine consists of black slates with talcose and micaceous schists. The property is about eight miles distant from the line of the Quebec Central railway at Garthby.

NICKEL.

The occurrence of nickel in small quantities, with cobalt, was Daillebout. pointed out in the Geol. Can., 1863, in association with iron pyrites in a vein of quartz, cutting Laurentian gneiss in the eleventh concession of the seigniory Daillebout, on the River Assumption; the amount of oxide of nickel contained being 0.55 per cent. Similar small quantities are found in veins traversing the magnesian rocks of the serpentine belt of the townships of Orford, Sutton, Bolton and Ham, but the amount of nickel in most cases is unimportant. The only place where any attempt to work this ore in the townships was made was on the sixth lot of the twelfth range of Orford, about three-fourths of a mile east of Brompton Lake, where a vein of calcite, holding chrome garnet, contains grains and crystals of the sulphuret of nickel (millerite) disseminated. The ore, which is soft and somewhat resembles copper pyrites, yields about sixty per cent. of nickel, but the quantity of millerite found was so small, not averaging more than one per cent. of the mass, that mining operations were suspended at this place some years ago. Two shafts were sunk to a considerable depth on the vein, which

Brompton Lake
mine.

was of large size, and smelting works were erected, but the extraction could not be profitably made. For the cabinet, magnificent specimens of chrome garnet, pyroxene and calcite are here obtained, of which large quantities have been removed by collectors both from Canada and the United States. It seems scarcely probable in view of the large quantities derivable from the Sudbury ores, that the extraction of such small percentages as occur in the rocks of eastern Quebec can now be successfully accomplished.

CLASS II.

MATERIALS USED FOR THE PRODUCTION OF LIGHT AND HEAT.

Coal seam at
Point St. Peter.

Of the materials embraced in this class the number is very few. Coal occurs in but one place, viz., the south shore of Gaspé Bay, near Point St. Peter, where in the Devonian rocks of that locality a thin seam of only three inches is seen. Bituminous shales are found in the Utica formation at several places along the St. Lawrence, but are not sufficiently rich to warrant any attempt at distillation. Petroleum is known to occur, in small quantity at least, about the shores of Gaspé Basin, and peat exists in immense quantities at various places throughout eastern Quebec.

COAL.

Former belief
in its occur-
rence in Quebec

Of the coal it may be said that, while it is generally acknowledged by the best authorities on the subject that no deposits of value can ever be found in the Province of Quebec, there are yet certain persons who do not hesitate to affirm, not only the possibility of its occurrence, but who make strong assertions to the effect that coal does really exist at several points. Possibly in most cases this belief is due to the fact that in some of the rocks about Levis, and on the Island of Orleans, as well as at various points along the south side of the River St. Lawrence, a coaly, or rather a pitchy, material is found filling cracks or seams, of which, from time to time, limited quantities have been obtained. In the earliest reports on the formations about Quebec by Dr. Bigsby these rocks were regarded as the possible equivalents of the Carboniferous of England—a conclusion, doubtless, to some extent founded upon the presence of this coaly matter. In the sandstone of the Sillery quarries also, a short distance above Quebec, thin seams or partings of what at first sight appears to be anthracite coal are seen and

Bituminous
matter in rocks
along the St.
Lawrence
River.

can be traced for several yards. These have at one place a thickness of from one to two inches.

The age of these rocks along the St. Lawrence has, however, for some years been known to be much older than that of the coal measures, and whatever carbonaceous matter may be found does not partake in any way of the nature of the coals of that formation anywhere at present known.

In one of General Baddeley's papers, 1831, an account of the finding of coal at Bay St. Paul or St. Urbain is given. This deposit was reported in Quebec on April 1st, 1829; and though the examination of the locality by General Baddeley proved conclusively that the coal there found was no other than Newcastle coal which had been deposited on the banks and in the bed of the stream in rear of St. Paul's Bay, the excitement over the reported discovery ran so high, and so many persons professed belief in the existence of coal in that vicinity, that Sir William Logan in his report for 1849-50 found it necessary to discuss the whole subject at length, and to point out clearly the utter uselessness of anyone attempting to mine coal at such a place. In Gaspé also, where an extensive coal field was at one time supposed to exist, he also clearly pointed out the impossibility of any such deposit ever being found there, since the highest rocks in the geological scale were proved to belong to the lower Carboniferous formation, which underlies the true coal measures everywhere. By some also the black bituminous shales of the Utica have been supposed to indicate the presence of coaly matter in large quantity—a supposition, however, in face of the known facts concerning the occurrence of coal all over the world, which need not here be refuted.

The coal of Bay St. Paul.

Entire absence of coal measures in the province.

PETROLEUM.

The only place in the province in which petroleum is known to occur, in any quantity, is near the extremity of the Gaspé Peninsula around the upper portion of Gaspé Basin. In the first description of this coast by Sir William Logan in 1844 the presence of several petroleum springs is noted, one of which was on the beach on the south side of the River St. John, about a mile and a half above Douglas-town; the other in a small branch of Silver Brook, itself a branch of the South-West arm, and about seven miles from its entrance into Gaspé Basin. The presence also of a peculiar dyke of trap which holds petroleum in drusy cavities, and which is seen on the beach on the north side of Point St. Peter, near Seal Cove, was at the same time pointed out. The strata in which these springs occur belong to the

Petroleum of Gaspé Basin.

Devonian system, in the rocks of which, at this place, a series of anticlinals occur, along the line of some of which, these springs are supposed to issue. In the *Geology of Canada*, 1863, reference is again made to these two springs, and the possibility pointed out that the source of the oil may be in the underlying rocks, as in the case of the oil regions of Western Canada. The great interest arising from the discovery of native oil in wonderful quantity in that section directed attention to the Gaspé district which resulted in the finding of several other springs similar to those already noted.

History of the
Gaspé boring
operations.

A company was thereupon formed to test the locality by boring, and a large tract of land contiguous to Gaspé Basin was surveyed and set apart as an oil district. A company styled the Petroleum Oil Company secured land in the townships of Galt, Blanchet, La Roque and Baillargeon comprising about 40,000 acres, as well as mining rights at Sandy Beach, in York, Gaspé South and Douglastown, with a further area of about 30,000 acres, all of which belonged to W. B. Fowler & Company. These put down several holes at Sandy Beach and at Silver Brook, and spent a large sum of money; but as none of the borings penetrated deeper than 1200 feet, as far as can be learned, no definite results were obtained, and the company finally suspended operations.

Bore-holes.

From notes furnished by Mr. J. B. Simpson of the Audit office, Ottawa, the following additional particulars as to the operations of this Company may be given.—Three bore-holes were put down as follows; Douglastown, 1860, 200 feet, Sandy Beach, 1862, 400 feet, Silver Brook, 1861-62, 1200 feet. At Silver Brook, a pocket of oil was struck at 900 feet, which overflowed the stream, took fire, and burned the derricks and the surrounding forest over several thousand acres. This hole was continued downward 300 feet further, when a strong flow of salt-water occurred, and the work was abandoned. The logs of these were preserved with the samples taken out, for some years, but no record can now be found of them. The Company which carried on the principal boring operations was composed of the following gentlemen: Messrs. W. E. Mercer, Norfolk; D. Roblin, Belleville; James McLeod, Essex; John Simpson, Niagara; and Malcolm Cameron, Quebec. The amount spent by this Company during their three years' work was about \$40,000.

Company.

Recent
explorations in
Gaspé.

Very lately interest in the oil of this area has been revived, and two companies have commenced operations with the apparent determination of proving the lower measures. In these the old company's rights as regards lands, etc., are now represented by Mr. James Foley, of Boston, and boring operations have been resumed at Sandy Beach, near the site of the former bore-hole. Derricks have been built and a hole put down to the depth of 800 feet, in which several small shews of

oil are reported between the depths of 500 and 800 feet. At this depth salt water was struck, which necessitated piping. A little gas was also met with in the boring. It is the intention, after piping off the water, to continue the hole, if possible, to a depth of 2,500 feet as a test hole. Throughout the depth bored only a succession of sandstones and shales appears to have been encountered.

The second company engaged in boring is the "International of St. Paul, Minnesota." They have acquired lands in block forty-one, Galt, on a branch of the first fork (Martin's Fork), of the River York about eighteen miles from Gaspé Basin. The indications on the property are reported to consist of a gum bed and several shews of oil, one of which is stated to be an oil spring from which several gallons of oil can be collected in a day.

The boring on this property is reported to be down 240 feet through dark sandstone, in which depth no oil was found.*

Several other areas have been secured by different parties in the immediate vicinity of those already being operated on. The question of the occurrence of oil in the Gaspé limestone series of this place cannot therefore be said to be satisfactorily settled yet, but if the original company carries out its present scheme, something definite will be ascertained concerning the prospects from this area, more directly along the coast.

PEAT.

While deposits of peat are found at many points throughout the province of Quebec, but more particularly in the great stretch of comparatively level land lying to the east of the St. Lawrence, and have been referred to in the several reports of the Geological Survey since 1849, but few attempts to work these on a large scale have been made. In the Geological Survey report for 1855 Dr. Hunt gave much information of the highest value in reference to the economical working of these deposits, basing his observations upon the methods in use in France, where peat fuel is very extensively used and where the industries employment to a large number of persons.

The methods of manufacture there employed in the preparation of compressed peat and charcoal, and of the by-products which are derived in the several stages of the process, such as paraffine, ammoniacal salts, illuminating gas, oil, etc., are also stated, as well as the cost of the production of a very useful fuel, which appears to equal in value much of the coal or wood there consumed and with which it

* For much of this information I am indebted to the late Mr. Joseph Eden, of Gaspé Basin.

enters into close competition. The importance of the peat bogs as a source of supply for fuel was still further insisted on in the Geology of Canada for 1863, where much additional information was given, and in view of the scarcity and present high prices of coal, both bituminous and anthracite, in the provinces of Ontario and Quebec, and the great and rapidly increasing demand for imported fuel, owing to the yearly decrease in the supply of wood, the facility with which an excellent fuel can now be manufactured from peat is such as to warrant some little attention being devoted to this branch of our mineral wealth; more especially, if by improved methods of preparation, a fuel sufficiently hard and dense can be produced which may be used in the blast furnace for smelting purposes or can be readily converted into a firm and durable coke.

The prime difficulty in the utilization of peat as a fuel for the various processes of manufacture, or for domestic purposes, is apparently the large quantity of contained moisture and the great difficulty experienced in its removal. This difficulty arises in large part from the porosity or springiness of the material, and many trials and experiments have been made by which this tendency to absorb moisture could be checked when once it had been eliminated. As a result of these, the plan of pulverizing the peat as it comes from the bog, drying it as rapidly as possible, and then solidifying it under great pressure, has, in so far as yet tried, been found to yield the most satisfactory results. Applying in part these principles, Mr. Hodges, an English engineer, some years ago invented a machine, which by means of huge revolving disks, attached to the front of a large scow, cut the material of the peat bog, the surface of which had been previously prepared by clearing away the roots, and at the same time pulped the peat to a very fine and uniform mass. The pulp was then distributed by means of a long spout over the side of the scow upon the prepared surface of the adjoining bog and left to dry in the sun for some days. As soon as a skin formed on the surface of the drying peat the mass was divided into blocks of convenient size by cuts along the length of the bed, generally at intervals of about six inches apart, and subsequently upon further drying by a series of cuts at right angles to these at intervals of eighteen inches, so that in a comparatively short time, if the weather was favorable, the bed of prepared peat was resolved into a series of blocks, eighteen inches by six, which, as soon as sufficiently hard for handling, were carefully taken up and stacked for further drying, the final result being a very excellent quality of fuel at a very low cost. The peat by this process was not compressed. A practical application of the invention was made by Mr. Hodges in 1864-65 in a peat bog along the line of the Arthabaska branch of the

Peat machines
of Mr. Hodges.

Preparation of
dried peat by
this process.

Work on the
Arthabaska
branch of the
G. T. railway.

Grand Trunk railway. The machine, which has, however, subsequently been very greatly improved, required for its management six men, and was capable of digging, pulping and spreading over 14,000 cubic feet per day of ten hours. This was estimated to yield fifty tons of air-dried peat fuel, costing in the barges on the canal ninety-two cents per ton, and containing about twenty-five per cent. of water, which was lessened by further drying. Experiments with this fuel were made for some time in the locomotives of the Grand Trunk railway, both on the Arthabaska branch and on the main line to Montreal, with such satisfactory results, that a contract was made by the Company for a daily supply of 300 tons after the first year, and extending over a period of five years. The produce of such a bog per square mile, cutting the peat to a depth of five feet, was very nearly half a million tons. The cause of the failure of the enterprise has not been made public, but that the quality of the fuel was satisfactory may be inferred from subsequent operations in the same direction. From the description of this industry given in the "Catalogue of Economic Minerals," prepared by the Geological Survey for the Paris Exhibition of 1878, we learn that the Canada Peat Fuel Company subsequently engaged in the manufacture of the fuel prior to 1877, near St. Hubert, in Chambly county, ten miles from Montreal, and at Ste. Brigide ten miles east of St. Johns on the Richelieu; the machines employed being those of Mr. Hodge, two of which were at work at St. Hubert and one at Ste. Brigide. These in 1874 produced 20,000 tons of prepared peat, and in 1875 13,000 tons, of which the greater part was sold to the Grand Trunk for their locomotives. Upon the suspension of operations by this Company, Mr. Aikman, who for nine years had been their manager, undertook the business of peat-making on his own account near the same locality, but he substituted for the Hodge machine an improvement of his own invention, less costly, more simple, and giving better results. By the Aikman process the peat, after being pulped and freed from roots and other impurities, was artificially compressed and then dried in the air, the drying requiring only about six days. These machines were made in Montreal and cost about fifteen hundred dollars each, and had a capacity of twelve tons of compressed peat per day, the price of which in Montreal ranged from three to four dollars. The time of working extended from the first of May to the first of October. The operations of Mr. Aikman were, however, largely experimental, and no great output was obtained. In 1875 about 400 tons were taken from the bogs near Port Lewis, in Huntingdon county, by the Huntingdon Peat Company using a system know as the Griffin process.

Its use by the
G. T. railway.

Operations at
St. Hubert and
St. Brigide.

Huntingdon
county.

Anticosti.

A long list of localities at which peat bogs occur is given in the Geology of Canada, 1863, both for the north and south side of the St. Lawrence. In the island of Anticosti also very extensive bogs of apparently excellent peat occur, one of which is said to be twenty-four miles in length by two in breadth.

The following table, taken from the Catalogue of Economic Minerals above cited may be added as showing the analysis of four samples of peat prepared by the Aikman and Hodge process. Nos. I and II are by the former, III and IV by the latter :—

	I	II	III	IV
Analysis.				
Water.....	14.83	16.52	17.06	14.96
Combustible and volatile matter...	50.15	53.29	50.73	59.60
Fixed Carbon.....	28.18	22.48	25.95	22.20
Ashes	6.84	7.71	6.27	3.24
	100.00	100.00	100.00	100.00

Value of peat
as fuel.

There appears, with proper treatment, to be no difficulty in manufacturing an excellent quality of charcoal from peat, either from the air-dried or the compressed. From the figures quoted by Dr. Hunt as obtained from the Paris manufacturers, air-dried peat yields from thirty to forty per cent. of its bulk and twenty-five to thirty of its weight in charcoal, while from the compressed peat higher results were obtained. The price in Paris of peat charcoal and wood charcoal was about the same. Experiments were made with peat in Montreal some years ago in puddling iron, with very satisfactory results; and from the experience obtained from various places in Europe as well as in Montreal, it would appear that in a country like Quebec, where coal commands a high price, these peat deposits should be found very well adapted, not only for the manufacture of iron, but for many other purposes for which coal is at present used.

CLASS III.

MINERALS APPLICABLE TO CERTAIN CHEMICAL MANUFACTURES.

Of the minerals which naturally come under this head several have already been described in preceding pages, more particularly under the heads of ores of copper and ores of iron. The greater part of the copper and iron sulphides which are now mined in the province of Quebec is utilized for the manufacture of sulphuric acid, the residue being subsequently treated for the extraction of the copper and silver. Within the last three years extensive works have been erected for this purpose near the mines at Capelton, and the acid is largely used at the same works for the manufacture of superphosphate from the apatite of the Ottawa valley. No further reference is considered necessary here as regards the deposits of pyrites, as their distribution and their geological relations have been already stated.

APATITE OR PHOSPHATE OF LIME.

First reference,
1847.

The occurrence of apatite in Canada was pointed out by Dr. T. Sterry Hunt, in 1847, in the report of the Geological Survey for that year, and attention was at the same time directed to its great value as a fertilizing agent. The deposits described were found principally in the township of Burgess, Ontario, but in the Catalogue of Minerals and their Localities, published in the report for 1849-50, reference is also made, under the head of "Manures," to the occurrence of phosphate of lime in Hull, the lot and range not specified, but near Blasdell's mills, as also at Bay St. Paul and Murray Bay. But little importance appears to have been attached to the Quebec deposits, since in the list of economic minerals in the Exhibition Catalogue, London, 1862, the only sample mentioned is from Burgess, where fine crystals had been obtained. The occurrence of phosphatic nodules near the base of the Chazy limestones in Lochiel and West Hawksbury, opposite Grenville, on the River Ottawa, as well as in sandstone with green shale at the latter place, was pointed out in the report for 1851-52, and the opinion expressed that, if the sandstone in which the nodules were thickly distributed was burnt and ground, a very fine manure for stiff clay soil would be produced. Similar nodules were found to occur in a limestone conglomerate at Kamouraska and at River Ouelle Point, but these were apparently confined to limited areas of the rock, and are not likely to be of any economic importance.

Phosphatic
nodules on the
Ottawa.

Kamouraska.

In the *Geology of Canada*, 1863, pp. 757-61, much valuable information is given relating to the uses of ground or superphosphate; but even at that date, although the presence of the mineral was known in the Laurentian rocks of the Gatineau, the importance of the deposits had not begun to be realized; the principal examinations and work having been confined to the townships of Burgess, Elmsley and Ross, in the province of Ontario, and it was not till ten years later, or in 1873-74, that the examination of these areas in Quebec was taken up on the part of the Geological Survey.

Report of Mr.
H. G. Vennor,
1873-79.

In the first report by Mr. H. G. Vennor, the apatite openings in Burgess are very fully described, and the probabilities of the occurrence of the mineral in other portions of the Laurentian rocks considered, in so far as the information available at that date permitted. The rocks of Quebec in which the apatite was known to occur were held to belong to the same horizons as those of Ontario, and these consisted for the most part of gneiss, crystalline limestone, quartzite and pyroxenite, with mica schist and occasional masses of red syenite, which were regarded as of Laurentian age.

In the early history of the industry, many mistakes were made as to the nature of the mineral, the green granular pyroxenite rock being frequently regarded as phosphate and mined for the purpose of shipment. The interest now taken in this mineral had then scarcely begun to manifest itself, and but little further information can be obtained from the report quoted, except that veins or masses of apatite are found at several points along the Lievre River, in the townships of Buckingham and Portland, and that workings had been commenced at the Little Rapids in what was known as the Garrett mine.

H. G. Vennor,
1876-77.

In the report for the succeeding year, while Mr. Vennor goes quite fully into the history of the apatite industry in Ontario, no further mention is made of the deposits found in Quebec, but in that for 1876-77 the results of his examination of the apatite and plumbago deposits of Ottawa county appeared, and furnished the first authentic account of the progress of phosphate mining in Quebec. Mr. Vennor, in this report, divides the rocks which constituted the Laurentian of the apatite district into four parts, as follows:—

Rocks of the
apatite district.

1st. Red granitic gneiss and hornblende gneiss, with small bands of crystalline limestone, containing apatite only in small quantity, and that near the summit. This constitutes the lowest division.

2nd. Red orthoclase gneiss, quartzite and pyroxenic strata, with irregular deposits of apatite, largely in the form of crystals, with mica.

3rd. Rust-colored gneiss and pyroxene, and felspar rocks with small bands of crystalline limestone. This contains rich and numerous deposits of apatite associated with mica.

4th. Rust-colored garniferous gneiss, rust-colored quartz and orthoclase rocks, crystalline limestone with serpentine and pyralloolite, containing irregular deposits of apatite and mica.

Mr. Vennor expressed the opinion that the rocks which contained the apatite in quantity constituted a distinct horizon, and belonged to a higher portion of the series than those in which the iron ores of Hull, South Sherbrooke and Bristol are situated, as well as those which contain the plumbago of the same district. In Buckingham and Templeton the apatite was stated to be "confined to a belt of rocks averaging about one mile and three-quarters in width, which runs in a general north-easterly direction from Perkin's mill on the Blanche River, near the centre of Templeton, through the extreme north-western corner of Buckingham, and thence across the Aux-Lievres River, through the south-eastern corner of Portland, into about the central portion of Derry township. This belt is very productive, and yields a finer quality of apatite than I have met with in any other section of the country. On it are situated all the apatite mines of any importance which have so far been opened, and it will be on the repetition of it, on the opposite sides of anticlinal and synclinal folds of the strata, that other similar deposits will probably be discovered." These were the views held by Mr. Vennor in 1876.

H. G. Vennor,
quoted.

The deposits of apatite in the townships of Hull and Wakefield, which were at that date discovered, were held by him to occur in a repetition of the same belt of rocks as those just described. A very important paper, bearing upon the mode of occurrence of apatite in the Ottawa district, is found in the Geol. Rep., 1877-78, by Dr. B. J. Harrington. In this the resemblance between the apatite-bearing rocks of Norway and those of Canada is pointed out, as well as the points of difference. According to Dr. Hunt (see Geol. Canada, 1863), the workable deposits were, with few exceptions, at least in the Burgess district, confined to the veinstones, although the mineral did occur at times in beds. From the evidence observed by Dr. Harrington, the conclusion was reached that many of the apatite deposits were not beds, since they cut across the strike of the containing rocks, while in other places deposits that presented the aspect of interstratified beds in places were seen to give off lateral branches, which also cut across the strike of the rocks.

Dr. Harrington,
1877-78.

Apatite both as
veins and
bedded deposits

The rock containing the apatite veins is very frequently pyroxenite, though they occur also in gneiss. They are said by Harrington to be frequently characterized by a want of regularity in the arrangement of their constituents rather than by any degree of symmetry. Sometimes a true fissure vein occurs, and in some cases a regular alternate deposition of minerals from side to side. Sharply defined walls are rarely seen, the sides of the vein frequently merging into the contain-

Segregation
origin of the
veins.

ing wall. As to the mode of their formation, Dr. Harrington's conclusions were the same as those of Dr. Hunt, viz., that they were the result of the filling in of fissures or cavities by the deposition of material derived from the adjacent strata. While in this case the presence of the apatite is held to be due to the segregation of this and other minerals which accompany it from the surrounding rocks into lenticular or irregular shaped masses, without the existence of any true cavity or crevice, Dr. Harrington also holds that the views of the Norwegian geologists, as to the eruptive origin of apatite in that country, cannot apply to the Canadian deposits, since the composition and character of the mineral is found to vary as it passes from one kind of rock to another; those cutting limestone, or in proximity to that rock, being calcareous in a much greater degree, while, in those cutting pyroxenite, grains of apatite are found imbedded in the mass of the containing rock, and tend to show that the apatite was derived from these strata, probably by segregation.

Sir William
Dawson.

Sir William Dawson, in a paper, read before the Nat. Hist. Soc., Montreal, 1878. "On the Phosphates of the Laurentian and Cambrian of Canada" discusses the probability of the animal origin of the Laurentian apatite, and holds that there are certain considerations which point in this direction, although there is no direct testimony on the subject. Among these are the presence of the iron-ores, the graphite, and of *Eozoon Canadense*, which he, with others, holds to represent the earliest known forms of life. Sir William further, says, that the possibility of the animal origin of this phosphate is strengthened by the presence of phosphatic matter in the crusts and skeletons of fossils of primordial age, "giving a presumption that in the still earlier Laurentian a similar preference for phosphatic matter may have existed and perhaps may have extended to still lower forms of life." In this connection, Dr. Harrington remarks that, "if the apatite of these ancient strata, represents material, accumulated by organic agencies, then the connection of the pyroxene and the apatite may be, that the material of the former constituted an ocean bottom, particularly suitable for the life of the creatures which secreted the phosphatic matter."

Possible
organic origin
of apatite.

Extent of
deposits down-
wards.

The formerly received opinion, that the deposits of apatite were comparatively shallow or extended downward to a very limited depth, has, by the work of late years, been completely disproved. Shafts to a depth of over 600 feet still continue in good phosphate, and the vein matter, though irregular, is continuous. The occurrence of the apatite is somewhat peculiar in this respect, resembling strongly the ores of manganese and of iron, as found in the Carboniferous and Devonian rocks of Nova Scotia and New Brunswick. In places pockets of large size

are found, which extend irregularly for some distance, and gradually, or sometimes abruptly, diminish to mere threads, with a subsequent enlargement; and it is this great element of uncertainty as regards the permanence of the veins or beds which has acted so unfavorably in many cases, as regards the successful development of apatite locations. This irregularity in structure and mode of occurrence may be due to the great crumpling or pressure to which these rocks have been subjected, and which may, in some cases, have occurred subsequent to the formation of the vein itself. Some of the veins appear as if they had been disrupted by the effect of pressure, the mineral occurring in very irregularly shaped and disconnected masses.

Resemblance to the manganese ores of New Brunswick.

The apatite of Norway, where considerable quantities are found, presents some points of resemblance to that of the Ottawa district. The veins occur in granitic or gneissic rocks, and are frequently surrounded or enclosed by layers of black mica or hornblende. These veins are very irregular in their character, frequently thinning out, or at other times thickening into large pocket masses. They are sometimes suddenly broken and interrupted by masses of rock, after the nature of faults apparently, on the other side of which, by careful search, the vein can be again located, and is frequently of large size. The veins are often from one to two feet thick at the surface, but, in following them downward to a depth of fifty feet or so, they are often found to increase to five or six feet, below which they descend to an unknown depth.

The apatite of Norway.

The quality of the Norway phosphate is generally high, averaging 85 to 95 per cent. of tribasic phosphate of lime, and, though not quite uniform, its richness does not vary greatly, and it is said never to yield less than 85 per cent. The apatite of Norway varies in color, being rose-red, yellowish, green and sometimes whitish. A vein near Drammen is said to have attained a thickness of thirty feet at a depth of one hundred feet from the surface.

The geologists, Messrs. Brøgger and Reusch, in a paper on the occurrence of apatite in Norway, presented to the Geological Society of Germany, hold to the eruptive origin of these apatite veins, in which conclusion they differ from the opinion expressed by Hunt, Harrington and others, of the Canadian Geological Survey, * as applied to the Canadian mineral. The association of other minerals with the apatite is, however, very much the same in both countries, although

Messrs. Brøgger and Reusch.

Eruptive origin of apatite.

* My own examinations of the Canadian apatite deposits (veins, etc.) have led me to a conclusion respecting their origin corresponding with that of the Norwegian geologists. I hold that there is absolutely no evidence whatever of the organic origin of the apatite, or that the deposits have resulted from ordinary mechanical sedimentation processes. They are clearly connected, for the most part, with the basic eruptions of Archæan date.—A. R. C. SELWYN.

limestone is said to occur very rarely in the districts of Norway, where the apatite deposits are principally found. The gabbro, in which the veins are said to occur in Norway, is very similar to that which in the Canadian reports is described as blotched diorite, consisting of dark-green to black hornblende, with labradorite or oligoclase, and sometimes a little mica. According to Dr. Harrington, while veins of apatite have been found in this dioritic rock, they were apparently of but little value.

Resemblance of Canadian rocks to the Norwegian.

Present sources of supply.

Among the present sources of supply for phosphate of lime, one of the greatest is in the Southern States of America, more particularly in South and North Carolina, though similar deposits are found in Florida, Georgia and several other places. This mineral is of a different character and origin presumably to the Canadian and Norwegian apatite, being without doubt entirely organic in its nature. It occurs in nodules of phosphate of lime, often of very large size, distributed through marly clays, through which the streams of that section are excavated, and which belong geologically to the Tertiary or Cretaceous period. These are particularly well seen in the vicinity of Charleston, South Carolina, where they are extensively mined for shipment both to England and to other points in the United States. The average percentage of tribasic phosphate from the mineral shipped is from 53 to 60 per cent., among other ingredients present being sulphuric and fluoric acid, ammonia and sesquioxide of iron.

Mr. Hoffmann's assays.

The percentage of tribasic phosphate of lime in the Canadian mineral is tolerably uniform, as shown by a series of analyses by Mr. Hoffmann, and given in the Geological Report, 1877-78. The result of seven samples tested in the laboratory, including the townships of Storrington, Buckingham, North Burgess, Portland, Loughborough and Templeton, give percentages of tribasic phosphate ranging from 85.241 to 89.810, which compare very favorably with the analyses of specimens from Norway, Spain, Germany and Russia.

Report by Mr. Torrance.

The latest report on the apatite deposits of Ottawa county, on the part of the Geological Survey, is by Mr. J. Fraser Torrance, M.E., 1882-83. Mr. Torrance, after a careful examination of the several deposits, came to the conclusion that those in Portland and Buckingham were "irregular segregations from the country rock, and were confined to one or more zones of rock, that approximately followed the course of the Rivière du Lièvre in a general north-north-west direction, and are more or less heavily impregnated with apatite." In regard to the bedded character of some of the deposits, he says: "During the past season I often noticed in the same pit, patches of apatite, that might easily be taken for the contents of a fissure vein, if there were any casing rock on either side of it to separate it from the

country rock, and patches of flat-lying apatite, that might easily be called bedded, if they were of any great extent or approximately uniform thickness, and if the country rock showed any planes of bedding parallel to the longest axes of such patches; or else it might easily be assumed that the country rock had been more or less tilted and overturned since the deposit of the apatite, and that the vertical patches were interbedded and the more horizontal ones were veins, if their relations to the country rock were such as veins and beds respectively are wont to maintain, but unfortunately I failed to perceive these conditions." Mr. Torrance did not find the presence of the band of rusty-colored gneiss to be a guide to the richest deposits of phosphate, as supposed by Mr. Vennor, but found that these rocks were commonly associated with the graphite. From the description of the many pits and workings, as given in the report of Mr. Torrance, it would appear that, in "by far the greatest number of cases, the containing rock of apatite is pyroxenite, and that the veins are very irregular, consisting of large bunches or pockets of ore, yielding hundreds of tons, which suddenly pinch out, but soon reappear when followed on their course. The great depth to which several of these mines have been proved already shows that the mining of the apatite, when carried on in a scientific and systematic manner, can be profitably conducted. The loose and unscientific methods formerly pursued, while giving rapid returns for the time, since these were for the most part entirely confined to surface shews which rapidly became exhausted, will of necessity require to be changed, and the entire industry placed on a proper basis for future successful work, and the exploitation of the veins will have to be carried on in a proper manner. In this connection it will doubtless be found an advantage to have several pits in operation at the same time, so that in case of encountering dead ground, owing to the pinching out of the vein in any one, a supply of ore will still be at command in some one or more of the other workings, and prove sufficient to carry the mining in the poor ground into productive work again."

The increase in the production from the Quebec mines since 1877, when an output of only 2,823 tons was returned, has been for the most part constant, reaching in 1886 no less than 28,535 tons. * The estimated figures of the output for 1889, according to the Ottawa Mining Review, are 33,000 tons, including that from the Ontario mines, but a new feature has of late been introduced into the industry, viz., the increased demand in the United States market; the export to that quarter for last year having aggregated over 4,000 tons,

Progress of the industry.

* See report, E. Coste, Geological Survey, 1887.

Output.

most of it of a quality not sufficiently rich for the English trade. The introduction also of sulphuric acid works in Capelton and the manufacture of superphosphate, which is now being commenced in connection therewith, will also tend to provide a market for the lower grades, which in the past have been regarded simply as waste rock.

Crude phosphate.

The question of the utilization of the crude phosphate as a fertilizer is also receiving much attention. While it is recognized that the apatite itself is unacted upon in its raw state by the atmosphere, if finely pulverized it can be taken up by the little rootlets of the plant when brought into contact with these by admixture with the soil, though not so readily as in the shape of superphosphate. The report of the experiments conducted on the Central Experimental farm, on this subject, will be awaited with interest.

Further information on the subject of phosphate.

In addition to the reports of the Geological Survey, already referred to, several others of great importance, bearing on the question of the Canadian apatites, have quite recently appeared. As most of these are of later date than the latest views on the subject by the officers of Canadian Survey, a brief *résumé* of the principal ones is here summarized, more especially as they all have a practical bearing on the discussion of the mode of occurrence of apatite, together with its economic and commercial value, in order that the subject may be treated as fully and completely as possible.

Views of Mr. G. C. Brown, 1884.

In a paper on the apatite deposits of Ontario and Quebec, by Mr. G. C. Brown, read at the Montreal meeting of the British Association, 1884, it is stated that apatite occurs in different ways—first, as a constituent of the rock, much in the same sense that quartz is a constituent of granite, with the proviso that apatite-bearing rocks are in much smaller masses than granite. In such rocks apatite may vary from five or ten to fifteen per cent., in grains and particles from the size of peas to hazel nuts, enclosed in pyroxenite. Mica is not always present. In these cases the pyroxenite rock is said to sometimes occupy an area of several acres having the general strike of the country rock; the length of the areas being from four to five times the breadth. Mr. Brown holds that there are seldom clear walls of separation between the apatite and the enclosing rock, such as occur with crystals, and, in detaching a piece, some of the apatite may be left with the pyroxenite, or some of the latter come away with the apatite.

A further development of this type shows fewer but larger masses of apatite, sometimes of more than 1,000 tons in weight, having the same indistinct walls of separation and containing masses of pyroxenite. Massive iron pyrites occur in the larger deposits, but not in the disseminated grains. Where the wall is other than pyroxenite the apatite separates cleanly from it. The presence of the massive apatite was

held to indicate the presence of pyroxenite, but the latter frequently occurs without the former. In quantity the apatite deposits vary from a few hundreds of pounds up to several thousands of tons.

Deposits of apatite, on the surface soil being removed, have sometimes been found to have a length of ten times the breadth. Thus, one of four feet wide might be forty feet long; in which case, the deposit thins out at either end, and continues sometimes as a mere thread. The strike of these masses is generally that of the country rock, and the appearance, according to Mr. Brown, is as if the mass had been squeezed up and enfolded in a bed-like form.

In a paper by Mr. F. D. Adams, at the same meeting, the presence of rocks near Arnprior, on the Ottawa, is pointed out, which resemble very closely the Norwegian rock called "*apatit bringer*," in or near which the apatite of Norway is found. Slices of these rocks, under the microscope, showed the presence of scapolite, sometimes in large amount.

Dr. T. S. Hunt, in his paper in the "Transactions of the American Institute of Mining Engineers," 1884, on "The Apatite Deposits of Canada," makes a distinction between the character of the bedded and vein deposits. He says: "The gneissic rocks, with their interstratified quartzose and pyroxenic layers and an included band of crystalline limestone, have a general north-east and south-west strike, and are much folded, exhibiting pretty symmetrical anticlinals and synclinals, in which the strata are seen to dip at various angles, sometimes as low as 25° to 30°, but more often approaching the vertical. The bedded deposits of apatite which are found running and dipping with these, I am disposed to look upon as true beds, deposited at the same time with the enclosing rocks. The veins, on the contrary, cut across all these strata, and, in some noticeable instances, include broken angular masses of the enclosing rock. They are, for the most part, nearly at right angles to the strike of the strata, and generally vertical, though to both these conditions there are exceptions. One vein, which had yielded many hundred tons of apatite I found to intersect, in a nearly horizontal attitude, vertical strata of gneiss, and in rare cases, which appear from their structure and composition to be veins, are found coinciding in dip and in strike with the inclosing strata."

"The distinction between the beds and the veins of apatite is one of considerable practical importance—first, as related to the quality of the mineral contained, and second, as to the continuity of the deposit. The apatite of the interbedded deposits is generally compactly crystalline, and free from admixtures, though, in some cases, including pyrites, and more rarely magnetite iron-ore, with which it may form fine interstratified layers. . . . The veins present more

complex conditions. While they are often filled throughout their width by apatite as pure and massive as that found in the beds, it happens not unfrequently that portions of such veins consist of coarsely crystalline, sparry calcite, generally reddish in tint, holding more or less apatite in large or small crystals, generally with rounded angles, and often accompanied by crystals of mica, and sometimes of pyroxene and other minerals. Occasionally these mixtures, in which the carbonate of lime generally predominates, will occupy the whole breadth of the vein. These calcareous veins often carry so much carbonate of lime as to be worthless for commercial purposes, unless some cheap means of separating the apatite can be devised." While the thickness of the deposit in both veins and beds is very irregular, Dr. Hunt expresses the opinion that those in the bedded form are the most continuous and persistent throughout, and, as a whole, more likely to give more profitable returns, other things being equal.

Dr. Hunt, 1885. In a subsequent paper read by Dr. Hunt at the Halifax meeting of the same institute, in 1885, he states that "the crystalline apatite of the DuLievres district belongs to lodes of great size, which traverse the ancient gneiss of the region. These lodes include a granitoid felspathic rock, and a pyroxene rock with large masses of quartz, of carbonate of lime, of pyrites and of apatite. All of these show a banded structure not unlike that of gneiss, to which they are evidently posterior, and of which they often contain fragments."

Improved machinery for mining and systematic methods of work have greatly increased the output from these mines, so that Dr. Hunt says some of these have put out from 600 to 1,000 tons per month, yielding on an average 80 per cent. of phosphate of lime, and worth in Montreal \$18 per ton. This is for the summer of 1885. He also says: "The growing demand for high fertilizers on this continent, and the fact that the apatite of Canada may be shipped to the valleys of the Ohio and Mississippi much more cheaply than the phosphate rock of South Carolina, give a great importance to these Canadian mines."

Professor W.
Dawkins, 1884.

Professor W. Boyd Dawkins, in a paper presented to the Manchester Geological Society, 1884, on "Some Deposits of Apatite near Ottawa, Canada," after an examination of the Little Rapids and the Emerald mines, as well as of several others, held that these deposits occur in veins, formed either in the massive state or as large independent crystals, shooting from the side of the fissure, or sometimes perfect at both ends, and completely surrounded by calcite, but that these veins have no uniform direction. They occur in bright crystalline, massive schists, composed of pyroxene (augite) more or less altered, mica, orthoclase,

triclinic felspar and apatite, which, if not bedded, would pass for an eruptive rock; but from this fact, and in addition that it is associated with crystalline limestone and quartzite, he is of the opinion that the containing rock of the apatite at these places is an altered rock of the Laurentian series, and to be classed with the hornblende gneiss of that system.

The reasons for the vein structure of the apatite are summed up under five heads, which may be summarized thus:—

1st. The veins are in some cases sharply defined, and deposited in a series of fissures, striking across the rock in various directions. The vein stuff sometimes shades off into the pyroxenite, as might be expected on the hypothesis that these deposits took place under conditions of enormous heat and pressure in the presence of water.

2nd. The character of the vein stuff is such as is usually found in fissure veins, sometimes presenting a banded structure formed by layers of apatite and pyroxene.

3rd. That both rocks and veins most probably received their charge from some common deep-seated source by hydrothermal action, while both were sunk deep beneath the surface, and the heat and pressure were sufficient to allow of apatite and the other minerals in the veins being deposited by water.

4th. The surfaces of some of the crystals present traces of hydrothermal action in their rounded angles and honeycombed surface.

5th. That the vein was in a state of movement while in a pasty state, shown in the crumpling and distortion of crystals of mica there found.

From the opinion expressed by Prof. Dawkins, dissent was taken by Mr. G. A. Kinahan, who, after an examination of the Emerald and other mines, came to the conclusion that the structure did not resemble that of a true fissure vein or lode. He says: "There is an absence of continuity in any particular direction, and in cross sections there is no correspondence between deposits on opposite sides. Calcite occurs on the foot and apatite on the hanging wall." Views of Mr.
G. A. Kinahan.

The views held by Mr. Kinahan as to the origin of the deposit were that "it had resulted from the action of a solution, bearing fluorine and phosphorus (in what combination it was impossible to say) upon a bed of limestone." He held that this solution had traversed the main mass and been distributed by means of side fissures, the result of which upon the limestone of the bed was to convert a portion into fluorapatite.

Mr. G. Henry Kinahan, in a paper before the same society, on "The Possible Genesis of Canadian Apatite," also expressed the view that "it is possible the present Canadian apatites were originally limestone or" Mr. G. H.
Kinahan.

allied rocks, the change to apatite being due to paramorphosis which at present cannot be satisfactorily explained." No attempt to explain the source of the phosphoric acid was, however, made. Mr. Kinahan in his paper compares the Canadian apatite-bearing rocks with certain rocks of Ireland, and says, in relation to the change of the limestone to apatite, that "if in the Irish assembly of submetamorphic rocks there are found phosphoritic eruptive rocks and limestone associated, while in the Canadian metamorphic rocks, apatite and nonphosphoritic eruptive rocks are similarly related, it may be supposed that the additional action to which the latter were subjected was such as to allow the phosphoric acid to replace the carbonic acid."

Dr. R. Bell,
1885.

In a paper to the Engineering and Mining Journal, 1885, "On the Mode of Occurrence of Apatite in Canada," Dr. R. Bell states that the apatite is derived principally from the pyroxenite, and that there is no evidence whatever of the organic nature of the mineral. The pyroxenite is held to be probably derived from igneous sources, either as submarine injections, while the Laurentian rocks were being formed, or as subsequent intrusions, even though at present they exhibit much of the aspect of bedded rocks. While not as a rule regarded as occurring in true fissure veins, certain large deposits, as at the Little Rapids appear to have that structure. Dr. Bell holds, in this paper, that the lines of deposit mark approximately the original jointing of the rock, which occurred in three sets, two of which were nearly vertical, intersecting each other, and the third was nearly horizontal; the apatite being deposited in these joint planes by the usual processes of segregation. The apatite is held to be accumulated in the largest masses along the intersection of the planes of the joints, more especially where all three come together at one point. He further remarks that "the apatite sometimes follows only one set of natural joints, when it appears on the surface as parallel veins; at others it is mostly confined to the horizontal ones, when it forms a succession of 'flaws,' and again it may follow both of the vertical sets or even all three, in which cases it appears in a reticulated form which is of very common occurrence."

Dr. Bell also says that on this view "we should naturally expect to find the mineral most freely exposed when upward movements of the apatite-bearing rocks had occurred, and that the deposits of the mineral between the blocks of the country-rock would be widest above, and further, that in going downward they would become pinched toward the next horizontal joint below, where they would open out again; also that the successive bunches of the mineral would become smaller and smaller in descending. These conditions appear to correspond with the experience of mining so far."

Mr. F. J. Falding, M.E., in a paper to the Engineering and Mining ^{Mr. F. J. Falding, 1885.} Journal, vol. xlii, 1885, on "Notes on Canadian Fluor-Apatite or Fluor-Phosphate of Lime," in which much valuable information is contained, states his belief in the organic nature of the mineral; arguing from the standpoint of the organic origin of all other phosphates yet known, except possibly those of Norway and other similarly situated deposits, and from the fact that many of the remains of fossils from the primordial rocks are largely phosphatic in their character, and also that the presence of the Eozoon limestones, the magnetic iron ores and the graphite also indicate the presence in those rocks of living organisms. As to the mode of occurrence of apatite he claims that:—

1st. The apatite, pyroxenite and calcite were deposited in bed form.

2nd. That the phosphate of lime separated and concentrated, filling up fissures and breaks, the result of violent motion of the strata.

3rd. That although much contorted and disturbed, the formation of the principal deposits where the mineral may be said to be in place is still bedded."

Mr. Falding says: "If we consider these deposits to form part of an immense bed two hundred miles long and cropping up over a tract at least twenty-four miles in width, this bed consisting of banded gneisses, limestones, pyroxenites and apatites, crushed, contorted, broken up into synclinals, crystalline in all its constituents, it is easy to understand its practical occurrence, its varying thickness, its sudden cutting off, and yet its general persistency when followed. . . . If the deposits are the remains of original beds they are likely to be subject to the same laws that govern such deposits elsewhere; in short subject to demineralization and to faulting. The extreme action to which they have been subject will naturally make the occurrence of mineral more varied and even precarious than in beds of similar but less altered formations. Experience has shown that, while subject to all these vicissitudes, well defined surface croppings continue to produce an average quantity of mineral." According to Mr. Falding the supply is limited only by the demand.

In a paper by Dr. G. M. Dawson, read before the Ottawa Field ^{Dr. G. M. Dawson, 1884.} Naturalists' Club, 1884, on "The Occurrence of Phosphates in Nature," the view is expressed that the stratified rocks of the Laurentian series, in which the apatite largely occurs, are of sedimentary origin, which have become changed from the original mud and sands into the ^{Apatite both as veins and bedded deposits} crystalline rocks as we now find them, in which category is also included the contemporaneous volcanic materials. Dr. Dawson asserts his belief in the two modes of occurrence, viz., that the mineral occurs both in beds and as distinct veins and fissures, the former of which have apparently derived their apatite from the original presence of phosphatic

nodules or coprolitic matter which has become changed by the processes of metamorphism into true phosphate of lime or apatite, while the veins have been filled by "processes of segregation in which the mineral is found, either nearly pure or more frequently mingled with crystals of other substances."

Dr. Penrose,
1888.

Among the most recent publications on the subject of Phosphate may be mentioned a very valuable and comprehensive paper by Dr. Penrose, published by the U. S. Geological Survey, Bulletin No. 46, 1888, in which the author not only discusses the question of the mode of occurrence of Laurentian or Canadian apatite, but presents a very comprehensive outline of the phosphate industry in general. For convenience of reference the classification of the phosphates as expressed by Dr. Penrose may be given. They are divided into two general classes thus:—

Mineral phosphates.	{ Apatites. Phosphates.	{ Fluor-apatites. Chlor-apatites.
Rock phosphates.	{ Amorphous nodular phosphates. Phosphatic limestone beds. Guanos. { Soluble guanos. Leached guanos. Bone beds.	{ Loose nodules cemented or conglomerates.

This classification is stated to be intended simply as a matter of convenience in describing the various deposits, and as a consequence is, in some respects, somewhat arbitrary.

In this paper, which presents very clearly the greater part of the observations made by the officers of the Canadian Geological Survey, and includes many others, as well as the result of direct examination of the deposits by the writer, Dr. Penrose has included a number of very interesting sections of apatite deposits which show very clearly the different forms in which this mineral occurs, and illustrates the very great irregularity of its deposition. No new features as to its occurrence, other than those already stated, are presented. The pyroxenite is said to be "never found distinctly bedded, though occasionally a series of parallel lines can be traced through it, which, while possibly the remains of stratification, are probably often joint planes. Sometimes when the pyroxenite is weathered, apparent signs of bedding are brought out, which are often parallel to the bedding of the country rock." The presence of numerous trap dykes which occur in the Quebec district is pointed out, and their later age as compared with

Occurs both in
veins and beds.

the apatite is shown by the fact that these in places traverse the apatite veins. An instance of the bedded character of some of the deposits is mentioned as occurring in an old pit in Buckingham township, where the apparent lines of stratification in the pyroxene are marked by bands of apatite. The distinctly banded character of some of the veins is also pointed out. Good sections are presented of the Emerald and the North Star mines, in which the vein structure of the former is well shown, and the often pockety character of the mineral at the latter.

According to Dr. Penrose the deposits of apatite proper as at present known, are confined to three countries, viz., Canada, Norway and Spain. Of these the two former furnish a mineral very similar in character and mode of occurrence, though the views held by the geologists of the two countries as to its origin and mode of occurrence differ very considerably. From the series of assays presented by Mr. Hoffmann in the Geological Survey Report 1877-78, it would appear that the apatite of Norway and Spain contains a slightly higher percentage of tribasic phosphate of lime than the Canadian. The deposit in Norway was somewhat extensively mined a few years ago, the output being sent to the English market; but the difficulties presented in its extraction and shipment, together with the competition from the Canadian mines and from other sources, is said to have nearly driven it out of the market at present. The mode of its occurrence in Norway and its supposed eruptive origin have already been noted. The Spanish deposits, also a very high grade phosphate, occur principally in granite, but have never been mined to any very great extent, the shipment being limited to but a few thousand tons yearly.

Among the other sources of supply of phosphates mentioned by Dr. Penrose, and which may here be briefly stated for the sake of reference and as having a marked bearing on the commercial aspect of the question, although furnishing mineral of a somewhat different character, are the following:—For the variety of apatite known as phosphorite, those of Nassau in Germany; the Bordeaux phosphate from the south-west of France; and those of certain provinces of Spain. The mineral at the last locality occurs principally in well defined veins or as pockets. In the former case the veins are in the country slate near the junction of granite; in the latter the mineral occurs in large pockety veins largely composed of limestone and quartz, the masses of phosphorite being often of very large size. The French and German deposits differ in their mode of occurrence, in that they are frequently found to occupy hollows or fissures in the limestone rock underlying the clay covering, and not as regularly defined veins. The origin of these deposits is by most regarded as purely organic, although the presence of organic remains is of exceedingly rare occurrence. They are supposed by

Deposits of
Canada,
Norway and
Spain.

Other sources
of supply.

Phosphate of
Germany,
France and
Spain.

Their supposed
organic origin.

many authorities to be caused by the action of a phosphatic solution upon the limestone of the vicinity, and by others to have their origin in the action of phosphatic vapors arising from below and thus acting upon the limestone. They are, however, of comparatively recent date, and are generally referred to the Eocene period.

Rock phosphate
of North and
South Carolina
of organic
origin.

Among the phosphates of the second division, viz., that called rock phosphate, probably the most important at the present day are the nodular deposits of the States of North and South Carolina and Florida. These have already been referred to and their origin given as purely organic, the phosphatic matter having been derived from the carcasses, bones and other parts of animals, both terrestrial and marine, with which certain portions of the clay beds, in which they are now found, were impregnated. The enormous demand at present existing for this form of the mineral no doubt arises from the fact that it can be very cheaply mined and shipped; and even though the percentage of phosphoric acid is much less than is the case of the higher grade phosphate of Canada or Norway, this cheapness of production is such as to give it a very great present advantage over other and superior deposits not so advantageously situated. This is seen in the fact that from the South Carolina beds alone several hundreds of thousands of tons are shipped annually. In age these deposits belong to some portion of the Tertiary series, and probably are later than the Eocene.

Nodular
phosphate of
England and
Wales.

The phosphate deposits of England and Wales belong to two entirely different periods. Those of Wales are found in beds of the Cambro-Silurian formation or system, in the form of phosphatic nodules clearly associated with the Bala limestones. The nodules, which are very numerous are said to be cemented into a solid mass by a black matrix; the whole mass giving a yield of 46 per cent. of phosphate of lime, while the percentage in the nodules themselves is very much higher, or about 65 per cent. tribasic phosphate. In the mode of occurrence the phosphatic nodules resemble somewhat the deposits found in the shales and limestones of the fossiliferous Quebec group, along the south side of the St. Lawrence, already alluded to, although the quantity in the Welsh beds appears to be much greater than from any known deposit of the kind in Canada. The thickness of the bed is about ten to fifteen inches; the underlying limestone, however, for a thickness of six inches or so, contains from fifteen to twenty per cent. of phosphate of lime. The second series of deposits, or those found more particularly in England proper, is of the nodular variety belonging to the Cretaceous and Tertiary formations. In their mode of occurrence they much resemble those of South Carolina. The nodules are of organic origin, and are of various sizes from mere grains up to several pounds in weight. In phosphate of lime they range from forty to sixty per cent., in this re-

spect, also agreeing very closely with the best Carolina phosphate. The greater cheapness, of the latter combined with the fact that many of the beds in the English district are nearly exhausted, has seriously affected the output from these diggings; the figures given by Dr. Penrose for the three counties of Cambridge, Bedford and Suffolk, showing a falling off in 1875 from 250,000 tons to only 31,500 tons in 1881.

The deposits of Belgium, of France and of Russia in great part are very similar to those already described both for England and the Southern States of America. They appear to belong to the Cretaceous period, and to consist largely of phosphatic nodules, sometimes cemented to form a conglomerate, at others disseminated through the clays and marls of the Cretaceous formation. They may for the most part be classed as low grade phosphates, yielding from forty to seventy-five per cent., though much of the Russian phosphate is of very much lower grade.

Nodular phosphates of Belgium, France and Russia.

From the paper of Mr. Hermann Voss, read before the Chemical Manure Manufacturers Association, London, 1888, we are able quote some figures bearing on the commercial aspect of the question, which are of importance as affecting the possible future of the industry in Canada, and as showing the enormous demand on the part of the English market for phosphatic material of all kinds, much of which, under proper management and improved methods of mining and transport, Canada should be able to supply. The imports of bone and bone ash into the United Kingdom for the year 1887 were 52,519 tons, and for the nine years from 1879 the average was 73,000 tons.

Mr. Hermann Voss, 1888.

Statistics of output and consumption.

Of guanos, owing to the general exhaustion of the most important deposits, the importation has nearly ceased as compared with the large quantities of twenty years ago.

Guanos.

The production of coprolitic or phosphatic nodular matter from the deposits of Bedford, Cambridge and Suffolk have continued to decrease from 34,000 tons in 1879 to only about 20,000 tons in 1886.

English deposits.

The importation of crust guano, by which is meant a phosphate derived from the contact of the coral rock limestone with the extensive bird deposits of certain places in which, through the long continued action of the guano on the rock itself, the upper portion of the mass has been converted into phosphate of lime, from various sources has for the last nine years ending 1887, averaged over 52,000 tons yearly.

Crust guano.

Of Spanish phosphate the average of the nine years to 1887 has been 28,300 tons, while of Carolina phosphate the figures quoted by Mr. Voss show a total importation in that time of no less than 1,032,842 tons. the amount for 1887 being given as 165,275 tons.

Spanish phosphates.

Canada phosphate.

From Canada the imports from 1882 to 1887, both inclusive, are stated to have aggregated almost 100,000 tons, the figures for 1887 being given as 19,194 tons.

English imports

The total import of phosphate of all kinds into the United Kingdom for the three years, 1885-1887, are stated to be no less than 745,048 tons, or a yearly average of 248,366 tons.

Basic slag.

In addition to the various kinds of phosphate already described, mention may be made of the variety known as basic slag, a product of comparatively recent date, but which has rapidly risen to prominence, and to some extent is said to affect the market of the Canadian mineral. Of this it is stated that Germany in 1887 used no less than 300,000 tons alone, yet without materially affecting the established superphosphate industry of that country. This material is generally of low grade; good slag containing from seventeen to twenty per cent. of phosphoric acid, though some grades range several per cent. higher. The total production of the basic slag, or, as it is sometimes called, "Thomas slag," for the year ending October, 1887, is estimated at 494,300 tons, obtained from the manufacture of 1,702,252 tons of basic steel, of which Germany alone produced 262,000 tons. In the year ending 31st of December, 1886, 1,375,000 tons of basic steel were produced, representing more than 400,000 tons of basic slag, which contained on an average

Production of basic slag.

seventeen to twenty per cent. phosphoric acid, fifty per cent. lime, four per cent. magnesia, five per cent. of manganese, two per cent. of aluminum, fourteen per cent. of oxide of iron, and eight per cent. of silica. The cheapness of the material has made it exceedingly popular for fertilizing purposes; more especially in view of the fact that recent experiments in Germany, where this material is largely employed, have shown that the untreated slag as it comes from the converter, simply ground to a fine state of division, has been found, when applied to certain soils, to give very satisfactory results, and no injurious effects seem to have occurred from the presence of the contained iron. The soils to which this material appears best suited are those which are peaty, sandy, loamy and poor in calcareous matter. In such poor soils it is said, from the German experiments, to equal in productiveness the better grades of superphosphate.

Its advantage as a fertilizer.

Messrs. Stead and Ridsdale, 1887.

The material is derived as a by-product in the manufacture of steel from phosphoric pig, and is described in a paper by Messrs. Stead and Ridsdale in the Iron and Steel Institute, 1887. The quantity of basic slag produced is said to vary from one-third to one-half the pig iron used, and the process is thus stated:—"The basic or Thomas Gilchrist process is conducted in converters or furnaces lined with a base, generally lime and magnesia in varying proportions, with the

Basic or Thomas Gilchrist process.

addition of some more basic material, almost invariably lime, to the charge of molten iron, as contradistinct to the 'acid' process, in which the converter or furnace has an acid lining, such as silica fire-brick, and in which the slag is never basic.

"It is the lime, together with the solid oxidation products of the impurities, and of part of the iron, and together with the material worn from the furnace linings, which forms the 'basic' slag.

"It consists mainly of phosphate of lime, silicate of lime, free magnesia and the oxides of iron and manganese."

In a paper by Mr. Percy C. Gilchrist, in the same Institute, 1887, Mr. Percy C. Gilchrist, 1887. it is stated that the total amount of phosphatic manures used in 1886 in England, the United States, Germany, Austria and France was, by estimate, no less than 2,443,000 tons. The market therefore, from the foregoing statements, is practically unlimited.

In his presidential address in Section III, Royal Society of Canada, 1887, Mr. Thomas Macfarlane has given an excellent description of the Mr. Thomas Macfarlane, 1887. process for the manufacture of basic slag, and has pointed out its great value and importance as a fertilizing medium, as well as its relation to the production of apatite from the Canadian mines.

In regard to the increased output of the Canadian phosphate, it Increasing demand. is gratifying to notice the gradually increasing demand, more especially for the lower grades—that is, those containing less than seventy to seventy-five per cent. tribasic phosphate; since, in the present state of the foreign market, these low grades will scarcely warrant the expense of transportation. These can, however, it is Utilization of lower grades. found, be placed on the markets of the Northern and Western States at a cost which permits them to enter into active competition with the ordinarily low grade Carolina mineral, while the establishment of extensive works for the manufacture of superphosphate, either at the apatite mines or at the sulphuric acid works in the eastern townships, bids fair to still further utilize and to make valuable much of the product which, up to the present, has largely been regarded as waste. In addition to the increased demand on the part of the American market, which, according to the figures published in the Ottawa Mining Ottawa Mining Review, Dec., 1889. Review for December, 1889, amounted for that year to 4,176 tons, the lower grades of phosphate are now being shipped to the English market as well, and a considerable quantity of sixty per cent. apatite has already been sold there.

The output of Canadian apatite for the year 1889 is given by the Mining Review as 33,000 tons; the shipment from the Quebec mines to the English market aggregated 23,981 tons, and to the United States from the Quebec mines 2,810, while the balance of several thousand tons remained on hand awaiting shipment.

List of
phosphate
properties,
now companies,
and mining
phosphate.

The companies engaged in mining in the Templeton and Buckingham, Portland and Wakefield districts at present number about twelve, and may be enumerated from a list kindly furnished by Mr. Bell, of the Mining Review, the positions of the different areas being supplied by Mr. James White, who is engaged in the topographical survey of the district, as follows:—

NAME OF MINE.	LOCATION.
North Star.....Dominion Phosphate Co. (Limited)...	{ Lot 18, R. VII, Portland East.
High Rock.....Phosphate of Lime Co. (Limited)...	{ Lot 5, 6, 7 and 8, R. VII, and 1 and 2 R. VII, Portland West.
Union Mines .....Canadian Phosphate Co.....	{ Lots 3 and 4, R. VII, 3, 4, 7, 8, 9, R. VIII, 5, 6, 7, 8, R. IX, 1 R. X, Port- land West.
McMillan Mines.....Dominion Phosphate Co. (Limited), London, Eng.....	{ East $\frac{1}{2}$ Lot 7, R. II, East $\frac{1}{2}$ Lot 8, R. I, Portland East.
Little Rapids Mine..W. A. Allan.....	{ Lots 6, 7, R. I, Port- land East.
Ætna Hill,Lansdowne..Anglo-Continental Guano Co., of London, Eng.....	{ Lot 18, R. XII, Buckingham.
Emerald.....Ottawa Phosphate Co.....	{ Lot 19, R. XII, Buckingham.
Blackburn.....East Templeton District Phos- phate Mining Syndicate.....	{ N. $\frac{1}{2}$ Lots 7, 8, 9, 10, 11, R. XI, Gore of Templeton.
McLaurin.....McLaurin Phosphate Mining Syn- dicate.....	{ S. $\frac{1}{2}$ Lot 7, R. XI, Gore of Templeton.
Jackson Rae.....Jackson Rae Co.....	{ W. $\frac{1}{2}$ lot 9, R. X, Gore of Templeton
Thompson.....	{ Let 27, R. X. Tem- pleton.
Moore Mine.....Seybold & Gibson.....	{ Lot 18, R. II, Wake- field.

Among other prospectors are the

Central Lake Mining Co.....	Lots 7, 8, 9, 10, R. X, Portland West.
The Chapleau Lot.....	Lot 18, R. VI, Portland East.
The Grier Lot (East Templeton).....	Lot 7, R. X, Templeton.
Charles Lionais & Co.....	E. $\frac{1}{2}$ Lot 9, R. X, Templeton.

The DuLievre Basin Mining and Milling Company are at present engaged in the manufacture of ground phosphate only, and have no mining location.

Among other properties formerly worked under different names, but now apparently idle from some cause, may be mentioned, in order to

make the list of mining locations as complete as possible, the following, Properties formerly worked, now partly closed.
 taken from the reports of Mr. C. W. Willimott, 1882, and Mr. J. F. Torrance, 1883:—

NAME.	LOCATION.
The Moore Mine.....	Lot 17, R. I, Wakefield.
Haldane's Mine.....	Lot 12, R. I, Wakefield.
Wilson's Mine.....	Lot 17, R. II, Wakefield.
Moore's Mine.....	Lot 12, R. XVI, Hull.
Apatite Mine.....	Lot 7, R. VII, Templeton.
Post's Mine.....	Lot 9, R. X, Templeton.
Jackson Rae Mine.....	W. $\frac{1}{2}$ Lot 9, R. X, already noted.
Murphy's Mine.....	S. $\frac{1}{2}$ Lot 10, R. X, Templeton.
Mr. A. McLaurin's Mine.....	S. $\frac{1}{2}$ Lot 8, R. XII, Templeton.
Breckin's Mine.....	Lot 23, R. XIII, Templeton.

From Mr. Torrance's report, 1883, the following list is extracted. Several of these properties have since that date changed hands, and some have been abandoned. The list will be useful for future reference. The principal mines at that date were the High Rock, the Star Hill and the Emerald, the output of apatite for that year, 1883, being 19,666 tons. Of these the first two are apparently included under the present name of High Rock, already described; of the others may be mentioned:—

NAME OF MINE.	LOCATION.
The Fowler and Bacon Properties.....	Lot 3, R. 1, Portland.
La Companie Francaise des Phosphates du Canada.....	{ Lots 1, 2, R. III, Lot I, R. IV, Lot 16, 17, R. VII, Portland East.
Tamo Lake Mines.....	Lot 14, R. V, Portland East.
Major Chapleau's Co.....	Lot 16, 17, 18, R. VI, Portland East.
The Haycock Mine (now North Star)....	Lot 18, R. VII, Portland East.
The Watt Mine.....	Lot 6, R. I, Portland East.
Cameron Property (Philadelphia and Canada Phosphate Mining Company). {	Lot 27, R. VIII, Portland East.
McLaren's Mine.....	Lot 27, R. VIII, Portland East.
Croft's Mine.....	Lot 24, R. VII, Portland East.
The Ross Property.....	Lot 2, R. VII, Portland West.
Kendall's Mine.....	Lot 26, R. XI, Buckingham.
Vennor's Lot.....	Lot 26, R. XII, Buckingham.

Very full descriptions of these different mining areas, with the amount of work done on each up to the date of the report, are given by Mr. Torrance, which it is unnecessary to introduce here.

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MAGNESITE OR CARBONATE OF MAGNESIA.

The occurrence of magnesite was noted at several points in the eastern townships in connection with the serpentinous rocks, in the early reports of the Geological Survey. A deposit on the seventeenth lot of the ninth range of Bolton, and referred to in 1847, is stated to

have a breadth of twenty yards, a large portion being marked by light green stains of oxide of chromium. The analysis of a portion free from these stains gave carb. of magnesia 83.35, carb. of iron, 9.02, and silica 8.03. This mineral can be economically employed for the manufacture of Epsom salts. Other localities in which magnesite occurs are lot twelve, range seven, Sutton, in a bed one foot thick, in gray Sutton mica schist; and on lot twenty-four, range nine, Bolton, in a bed of unknown thickness, in argillites. This rock is also said to be well fitted for the manufacture of cement, and when sufficiently free from foreign matter or too large a percentage of insoluble silica is employed for the lining of crucibles for steel castings. Much of that in Sutton and Bolton contains a large proportion of insoluble matter, reaching in some places as much as 46 per cent.; this is from the Sutton bed. Two other analyses of the great Bolton bed gave: insoluble, 29.90, Analysis. 32.20; carb. of magnesia, 59.72 and 59.13; carb of iron, 10.31 and 8.32. The material is often difficult to distinguish from the crystalline dolomites of this section.

CHROMIC IRON.

This valuable mineral is found at many points throughout the serpentine belt of the eastern townships from the boundary of Vermont Distribution. to the Shickshock Mountains in Gaspé. In Vermont state adjoining, its presence in the serpentine of Troy and vicinity is also recorded. It was first described in the Geological Report, 1847-48, as occurring in the township of Bolton, on the twenty-sixth lot of the seventh range, in a vein said to be one foot thick, a sample of which gave Dr. Hunt on assay 45.90 oxide of chromium. A large block of 600 lbs. weight, picked up near the lower end of Memphremagog Lake, and indicating a vein of at least eighteen inches, gave also on assay 49.75 per cent.

From the mineral resources of the United States, 1883-84, we learn Manufacture of chromium. that the principal works for the manufacture of chromium, the successful extraction of which appears to be to some extent in practice a secret, are owned by the Tyson Bros. of Baltimore, who have almost entire control of the American output, though large amounts of the bichromate are also annually imported, principally from Scotland. The supply of ore for the chromium works is obtained from very widely separated points, probably the largest quantity now being derived from the Pacific coast, from certain deposits in California. In the eastern States the large deposits which have been worked for some years in Maryland and Pennsylvania appear to have become, to a large extent, exhausted.

Value of the
chromic iron.

The value of the ore depends upon the amount of oxide contained, and an ore of less than fifty per cent. is not considered sufficiently rich to warrant shipment to the English or Scotch market. The price of the ore has also greatly decreased within the last twenty years. The mineral occurs very irregularly, and frequently in a series of pockets in the serpentine rock, some of which may yield hundreds of tons, while others are speedily exhausted, and the miner has no assurance that this source of supply may not terminate at any time. In the eastern townships, while chromic iron is found at a number of places, the attempts to mine it have not been attended with much success. In the township of South Ham, on lot forty, range two, a lenticular mass, having a thickness of fourteen inches, was worked about thirty years since, and some ten tons of forty-four per cent. ore extracted by Mr. Leckie, when the supply apparently gave out and the locality was abandoned. In Wolfestown, on lot twenty-three, ranges two and three, several pockets occurred in the serpentine, and were mined by Mr. Wm. Grey, manager for Bell's asbestos mine, at that place in 1886, about twenty-five tons in all being obtained, but the ore still remains unsold, presumably owing to the fact that it did not contain the requisite per centage of chromic oxide. In Leeds, on lot ten, range ten, a deposit of excellent ore was mined, several years ago, by Dr. Reed of Inverness, and about fifty tons taken out, for which a ready sale was found, and in the township of Thetford, on lot seventeen, range four, there is apparently a very extensive deposit which has been slightly opened up. A sample of this assayed in the laboratory of of this survey gave chromic oxide 35.46. This location is also owned by Dr. Reed.

South Ham
mine.

Wolfestown.

Leeds.

Thetford.

Shickshock
Mountains.

In the exploration of the Shickshock Mountains, the serpentines of Mount Albert were found to contain certain small veins of this ore, and a considerable quantity of pieces, some of which were twenty pounds in weight, was picked up. It is possible that further exploration in this direction would result in finding workable deposits. As a rule, however, the ores found in the serpentine of the townships are not remarkable for their richness, though an assay of a sample from a loose piece in Bolton gave sixty-five per cent. of chromic oxide, and the greater portion will not repay the expense of mining and shipment, that is, in so far as the present discoveries are concerned. There are yet, however, large areas of these peculiar rocks so concealed by forest and soil that their examination cannot yet be accomplished. The opinion was expressed by Dr. Hunt in the Geol. Can., 1863, that the manufacture of bichromate of potash ought to be a profitable undertaking in this country; since while the quality of the ore might not, from its lacking a few per cent. of the required standard, be adapted for

transport to Scotland, large quantities might be utilized on the spot, which otherwise would be of no commercial value, and thus a fresh impetus be imparted to the search for this valuable mineral. The price quoted for the Leeds ore at the station on the Quebec Central railway was \$18.00 per ton.

MANGANESE.

The deposits of manganese in the province of Quebec are, in so far as Bog manganese yet observed, confined to the variety known as wad or bog manganese, which is a hydrated peroxide. The most important ores of manganese occurring in Canada are pyrolusite or psilomelane, of which large quantities are found in the provinces of Nova Scotia and New Brunswick. The wad of Quebec, though found at a number of places, is generally regarded as poor in quality and of but small commercial value.

This mineral was referred to by Sir Wm. Logan in the Report for Bolton. 1847 as occurring in the township of Bolton, lot twenty, range twelve, in a bed from three to six inches thick, resting on slates and with a superficial extent of several hundred square yards; the amount of pure peroxide in the ore being, according to assay by Dr. Hunt, 26 per cent.

In Stanstead also, on lot nine, range ten, a considerable deposit, esti-Stanstead. mated to cover about twenty acres, and with a thickness in places of ten to twelve inches is found; the yield of the ore, after being washed from the sand, was 37 per cent. of peroxide.

Other localities in which this ore has been observed at different times Localities. may be mentioned. A deposit on the road from Lambton to St. Francis, Beauce, near the eastern boundary of the township of Tring, yielded 25 per cent., and one on the west side of the Chaudière, opposite the mouth of the Famine River, yielded 20 per cent. Similar deposits occur in the seigniorship of Ste. Mary, but presumably unimportant in extent, as also in the seigniorship of Ste. Anne de la Pocatière in rear of the church. In the village of La Plaine, Cacouna, and on the St. Louis road about four miles from Quebec city, small deposits also have been observed. Other localities noted in the Report for 1866 by Mr. Jas. Richardson are in Cleveland, lot sixteen, range thirteen; St. Sylvestre, lot nine, range St. Charles; half a mile west of St. Apollinaire church, Gaspé seigniorship, and near the line between St. Antoine and Lauzon, about two miles south of the St. Lawrence.

In the Report of the Geological survey, 1877-78, Dr. Bell notes the Hudson Bay. occurrence of spathic iron ores in the chain of islands along the east coast of Hudson Bay, called the Nastapoka group, which are found to

contain upwards of twenty-four per cent. of carbonate of manganese and 25.449 metallic iron, constituting a very extensive band of not less than twenty feet thick. The high per centage of manganese in these ores will render them valuable for the manufacture of speigeleisen, and owing to their abundance and accessibility, they will probably some day be found to be profitably workable. This locality is, however, not within the limits of the province of Quebec.

CLASS IV.

MINERAL MANURES.

- Shell marl.** With the exception of the apatite, which when applied in its raw state may come under this heading, the only mineral of value yet known is shell marl. This is found at many places from the Ottawa River to the extremity of Gaspé, occupying the beds of lakes and marshes, and is so named from its containing, generally in considerable abundance, the shells of certain species of fresh water molluscs. It is generally white and earthy, and, unless containing foreign matter, is nearly a pure carbonate of lime, of great value as a fertilizer for certain classes of soils which are lacking in calcareous matter. It produces also, when burned, a white and very pure lime, well suited for building purposes, and is, in some places, largely used in this way.
- Argenteuil.** In Quebec, among other localities, marl is found on lot three, range one of Argenteuil, underlying a bed of peat nine feet thick. The marl is from five to thirteen feet thick, and is reported to cover an area of over twenty acres. On the twenty-second lot of the eighth range of
- Wentworth.** Wentworth, and on the fifth lot of the fourth range of Harrington, deposits of considerable extent also occur. In Vaudreuil, at Point à
- Vaudreuil.** Cavagnol, a bed of marl from twelve to eighteen inches thick extends over twenty acres, and has been largely used as a manure with very beneficial results.
- Montreal.** Near Montreal, marl is found underlying the peat along the St. Pierre River between the city and Lachine; also at Thornberry on the west side of Mount Royal, but this deposit is not regarded as very extensive. In the seigniory of St. Hyacinth, near the foot of Yamaska
- Yamaska Mountain.** Mountain, and near the road to Granby and St. Pie, a bed of marl one foot thick extends over seven acres and is covered by a thin layer of peat, also on lots one hundred and fifty seven and one hundred and
- St. Armand.** fifty eight of St. Armand there is an apparently extensive deposit,

covering from thirty to forty acres, which is in places seven feet thick, while on lots four and five, ranges ten and eleven, Stanstead, it appears at the margin of a pond, and is reported to be thirty to forty feet thick over an area of twenty acres. Stanstead.

In eastern Quebec marl is found in the basins of a number of lakes along the north side of the Bay of Chaleur, in the counties of Bonaventure and Gaspé. On the west side of the Cascapedia River, from three to five miles back from the shore of the Bay, there are several lakes, called from their peculiar tint the "Blue Lakes," the color being apparently due to a considerable deposit of marl over their bottoms. In rear of New Richmond also and of Paspebiac and New Carlisle other large deposits occur. On the north side of the peninsula, about five miles below the Matane River near the St. Lawrence, a deposit underlies a marsh with an area of sixty to seventy acres and about fifteen inches thick. Bay of Chaleurs.
Matane.

On the island of Anticosti, Mr. Richardson, in the Report of Progress for 1857, in speaking of the marl says that "the bottoms of all the lakes and ponds examined, with the exception of those surrounded by peat, were more or less covered with it. Marl Lake is one of these; its area is about ninety acres, and though the thickness of the marl was not ascertained, it appeared to be considerable. The brook which empties the lake into Indian Cove at the west end, carries down a large quantity of the marl to the sea, where it becomes spread out for a considerable distance over the rocks in the vicinity." An assay of a marl from Anticosti, by Mr. F. D. Adams, shewed the presence of 0.0137 per cent. tribasic phosphate of lime.* But little attention is, however, apparently paid to these deposits at the present time. Anticosti.

CLASS V.

MINERAL PIGMENTS.

These, in the province of Quebec, are practically confined to iron and manganese ochres. Veins of sulphate of baryta occur, however, in the rocks of the south side of the Gaspé peninsula, and at Port Daniel a vein nine inches thick is reported in the Niagara limestone. Other smaller veins occur on the beach along the streams flowing into Gaspé Basin, and on lot twelve, range twelve, of Templeton, a vein of impure baryta is found; but these do not appear to have any economic importance. The deposits of iron ochre in the province are, however, large and valuable, and some of them have been worked for many years. Sulphate of baryta.

*See Report Geological Survey, 1886, p. 41 T.

Iron ochre.

This material is a hydrated oxide of iron, very similar in composition to bog iron ore or limonite. The ochre, however, lacks generally the coherence of the bog ores, being, for the most part, soft and easily powdered, and contains frequently a considerable amount of organic matter and earthy impurities. In color, the ochres are generally reddish, brownish or yellowish, though purple or dark brown tints are sometimes found. By burning, the contained water and organic matter are eliminated, the ochres change color and become frequently a dark red. They can be used, however, either raw or burned, mixed with oil or water as paints or as stains of various colors for furniture; for which purpose some of them are well adapted and quite extensively used. The value of an ochre depends very much upon its facility of mixing with oil when ground, so as to form an easy flowing and durable paint; a great difference being found in this respect.

North side of
the St.
Lawrence.

Many of the deposits of this province exist in the vicinity, or near the foot, of the Laurentian hills along the north side of the St. Lawrence River, where also the largest beds of bog iron ore are found. In places these ochres contain a certain amount of manganese, which, when burnt, tends to impart a brown or umber tint instead of a red color, as is generally the case in ochres free from this mineral. Among other numerous deposits of ochre may be more especially mentioned one of three feet in thickness, extending over several acres, on lot fifteen,

Hull.

range ten, Hull. Among the deposits described in the Geology of Canada, 1863, two of special importance may be noted as having been quite extensively worked for some years. Of these, that found in the seigniory of Pointe du Lac, range St. Nicholas is said to cover about four hundred acres, and to have a thickness of from six inches to four feet, averaging about eighteen inches. The prevailing shades are red and yellow, but in some parts the ochre has a dark purple tint; when burned, it assumes a dark red color. A blackish brown variety is also found, which, when burned, becomes a lighter brown.

Pointe du Lac.

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Manufactures.

An attempt was made in 1851 by a New York company to work these ochres on a large scale, and furnaces were erected for their calcination. They are said to have produced as much as twelve barrels per day for some time, worth in New York about five dollars per barrel. Eight different tints were made from the ochre, a rare blackish brown variety being the most valuable, which was sold under the name of raw sienna, in the raw state, or calcined as burnt sienna. The manufacture has long since been abandoned.

Cap de la
Madelaine.

Another large deposit, said to extend over six hundred acres, occurs in St. Malo range in the seigniory of Cap de la Madelaine, about two miles below the parish church and the same distance back from the

St. Lawrence. It is here interstratified with peat in an old lake basin, the bottom of which is occupied with shell marl. The presence of the peat here might prove advantageous in calcining the ochre which has a thickness, in different portions of the deposit, of from six inches to two feet, and is capable of yielding a very large quantity if required. In the vicinity of Three Rivers also ochre is found in considerable quantity.

The most extensive deposit probably as regards thickness is that near the Ste. Anne de Montmorency River, which has a depth in places of from four to seventeen feet, and extends over an area of four square acres. This deposit is very fully described in the *Geology of Canada*, 1863, pp. 511-12. The color is said to vary in different parts; being yellowish brown at the surface, reddish or purplish brown where most exposed to the light and air, and at a little distance beneath the surface a greenish or greenish white. The mineral has been carefully assayed by Dr. Hunt and contains peroxide of iron 59.10, organic acids 15.01, water by difference 21.14, soluble silica 1.15, sand 3.60. The deposit is very favorably situated for working, being on the top of a bank overlooking the road, so that by beginning on the lower side the working could be so carried on as to obviate the necessity of further drainage. This deposit was referred to in the *Geological Survey Report*, 1851-52.

Ste. Anne de
Montmorency.

Analysis.

Other deposits of greater or less extent are found at Ste. Rose, on the fourth lot of the fourth range, Durham, having a thickness of four feet and an area of some 1500 square yards; on the sixteenth lot, range nine, Ascot; lot twenty-four, range three, Stanstead; and in the seigniory of Lotbiniere, near the mouth of the Grande Riviere du Chene.

Durham.
Stanstead.
Ascot.

A similar deposit of very good ochre occurs on lot twelve, range fourteen, Stoke, on property of Mr. Gansby. The ochre is of two shades, a yellow and a brown, burning to a chocolate tint; the ochre contains a few roots of plants, but appears to be otherwise remarkably pure. The brown deposit has been dug to a depth of three feet, though the whole thickness is unknown, and the superficial extent is very considerable; being traceable into the woods on the adjoining lot. The burned and raw ochre has been tested with very satisfactory results; showing it to constitute a valuable pigment when properly prepared.

Stoke.

In addition to the ochres, other sources of supply for the mineral paints are found in many of the highly colored slates of the Sillery formation, where red, green, and gray shades are obtained. Serpentine also are very common, and in one of the islands in Brompton Lake the variety diallage forms large masses which could be easily ground for paint. Large deposits of steatite or soapstone occur at many places in

Serpentine
and soapstone.

Bolton, Hatley, Ham, Wolfstown, Broughton and Leeds, which are easily and cheaply ground, and which, when mixed with the prepared ochres and with white lead, are said by actual trial to give a paint of great durability.

Stanstead.

In Stanstead, lot thirteen, range nine, a soft talcose slate, which shows different bands of yellow and greyish white, the former being due to the hydrated peroxide of iron, has been locally used, when mixed with oil, for painting houses and outbuildings, and a similar rock occurs in Leeds on the seventeenth lot of the thirteenth range. Certain low

Asbestus.

grades of asbestus also are used for the manufacture of a fire proof paint, and deposits of actinolite on the fourth lot of the fourth range of Bolton, and in St. Francis, Beauce, described by Dr. Hunt in the early reports of the Survey, might also be found useful for this purpose.

CLASS VI.

SALT, BRINES AND MINERAL WATERS.

**Importance of
mineral springs**

While in the province of Quebec we have, in so far as known, no considerable deposits of salts or brines, mineral waters occur at a number of places, and although these may not be classed as minerals in the true sense of the term, they present many points of interest and have a very considerable economic value, more particularly from the medicinal standpoint; since the presence of a mineral spring of recognized therapeutic properties tends to draw to the vicinity a large amount of wealth, not only by the erection of sanitariums, but by the influx of a very considerable transient population; so that in this way such a spring may be regarded as a source of very considerable revenue to an entire neighborhood. Further, certain springs obtain such a reputation for the cure of disease that they are greatly sought after from abroad, and the waters when bottled are shipped to remote portions of the country, and may even acquire a much wider celebrity than a merely local one.

**Dr. Hunt's
analysis.**

In the Survey Report for 1847-48, Dr. T. Sterry Hunt published the first results of a very careful and extensive series of examinations of the waters from many localities both in Ontario and Quebec. These were regarded as of such importance that in the subsequent report of 1853, additional analyses were presented, so that the greater part of the mineral springs in the two provinces were very thoroughly examined. In consequence of these analyses, practical results followed in the establishment of large sanitariums at the Caledonia Springs, at

Plantagenet, at St. Leon, and at other points, and in later years at Bolton. Dr. Hunt arranged the waters from the different springs into six classes, according to their chemical composition; the details of which are presented in the Geology of Canada, 1863. Those which relate to the province of Quebec may be briefly summarized.

In the first three classes chlorides predominate, in the fourth carbonates, and in the fifth and sixth, sulphuric acid and sulphates. The waters of the first, second and sixth are neutral; of the third and fourth, alkaline; and of the fifth, acid.

Classification
of mineral
waters.

The springs of the province of Quebec belong for the most part to the second, third and fourth classes, of which the second class comprises saline waters, which include considerable portions of bicarbonate of lime and magnesia, in addition to the chlorides of sodium, calcium and magnesia.

The waters of the third class include those saline waters which contain also in addition to the chloride of sodium a portion of carbonate of soda with bicarbonate of lime and magnesia. Small amounts of baryte, strontia and of boracic and phosphoric acid are also present, as well as of bromides and iodides. The fourth class contain but a small amount of chloride of sodium, with a large relative quantity of carbonate of soda, and have no marked taste, unless evaporated, when they are strongly alkaline.

These springs have been so well described in the Geology of Canada, 1863, that it will serve here simply to enumerate the principal ones and indicate their class.

Assumption.—Saline spring of the second class; the "Aurora Spring," containing 7.86 parts of solid matter in the 1,000, gives off large volumes of carburetted hydrogen gas, contains small quantity of strontia. Localities.

Baie du Febvre.—Four springs examined, two of the second class containing strontia; one of which, near the line of Nicolet in the Grand Range, on land of Antoine Loizeau, contains 5.44 parts of solid matter and 4.54 of alkaline chlorides in 1,000, two of which latter are chloride of potassium; the other, in the same range on land of Mr. Lafort, about one mile above St. Antoine church, contains 15.94 parts solid matter, with a little boracic acid. The two other springs belong to the third class, and also contain small portions of strontia and give off carburetted hydrogen gas. One of these, on land of David Houle, adjoining Loizeau's, contains 4.96 parts solid matter; the other, on Ignace Courchese, half a league east of the church, contains carbonate of soda and magnesia, in addition to the chlorid of sodium; the chlorid of potassium equalling 0.92 per cent of the chlorid.

Bay St. Paul.—A bitter saline spring of the first class, containing 20.68 parts solid matter to 1,000.

Belœil.—Saline water, third class, contains notable proportion of strontia; the iodides and bromides not determined.

Berthier en haut.—Saline spring, second class, on land of Chas. Boucher, on the Bayonne River, contains 8 parts solid matter to 1,000, including carbonate of magnesia 0.8354.

Bolton.—Sulphur spring, analysis not yet made.

Caxton.—A saline spring of second class, containing 13.65 parts of solid matter to 1,000, of which carbonate of magnesia is 1.059.

Chambly.—One league north of the village, in the Rang des Quarantes, on land of Mr. Chevrier; two saline springs of the third class, solid matter 5.74 per 1,000, with baryta and strontia present in considerable quantity.

Champlain.—Two springs, which have a local reputation, belong to the second class.

Jacques Cartier River.—Strongly sulphurous spring, Marcotte's Mill, of the fourth class. The amount of solid matter is small, carbonate of soda making up the largest part. Holds a considerable quantity of borates.

Joly.—A sulphurous spring of the fourth class, on the banks of the Magnenat Brook, five miles from Methot's Mills; feebly saline, contains a portion of boracic acid, with sulphuretted hydrogen gas equal to 7.5 cubic inches per litre.

Lanoraie.—Saline spring, second class, midway between the villages of Industry and Lanoraie, gives off large volumes of carburetted hydrogen gas, and contains a considerable quantity of salts of strontia and baryta.

Nicolet.—Concession of Quarante Arpents, near the line of St. Gregoire; two springs, one on farm of widow Honore Hebert, and one on land of Olivier Roy, in Nicolet. Both of the fourth class; alkaline when evaporated.

Quebec.—A sulphurous spring of the fourth class, in St. John, situated on the property of Mr. Joseph Hamel, contains, in addition to common salt and carbonate of soda, a portion of sulphates.

River Ouelle.—Third concession, on the south side of the river; water strongly saline and bitter, belonging to the fourth class, yielding 13.36 parts solid matter to 1,000.

Sabrevois.—Near the village of Pike River, several mineral springs of the second class, two of which are known as the Saline and the Sulphur Spring. The first containing salts of baryta and strontia; the second, soluble sulphates.

St. Anne de la Pocatiere.—Two springs. One in the second concession, on land of Nicholas Rouleau, slightly sulphurous, containing 0.36 of a part solid matter to 1,000, belonging to the fourth class; the other, one mile south of the college, small spring of bitter saline water, containing, besides chloride, an abundance of sulphates of lime and magnesia and a small portion of carbonates, and yielding 5.06 parts solid to 1,000.

St. Benoit, Two Mountains.—A spring of the first class, with 6.0 parts of solid matter to 1,000; traces of carbonates, and a large amount of calcareous and magnesian salts.

St. Eustache, Two Mountains.—A spring of the second class, feebly saline, yielding 1.85 parts of solid to 1,000.

St. Genevieve.—In the Batiscan River, contains several strongly saline springs of the second class, two of which were analysed, and were remarkable for their large proportion of iodide.

St. Hyacinthe.—The Providence spring, a saline water of the third class, strongly alkaline, and containing a portion of strontia; solid matter 5. to 1,000.

St. Leon.—Strongly saline, second class, gives off large quantities of carburetted hydrogen gas, and contains small portions of strontia, with sufficient carbonate of iron to give it a chalybeate taste.

St. Martine, Beauharnois.—Feebly saline, belongs to the third class, with 1.98 solid matter to 1,000, contains small portions of sulphates.

St. Ours, Richelieu River.—Spring of the fourth class, contains only 0.53 solid to 1,000, with large percentage of potash salts.

Varennnes.—Two saline springs, one mile and a half below the church, and near the St. Lawrence. One, styled the "Gas Spring," from the quantity of carburetted hydrogen gas given off; the other, called the Saline Spring. They contain carbonates of soda, lime and magnesia, and belong to the third class; the Saline Spring is also slightly chalybeate.

The analysis of several of these waters, as determined by Dr. T. S. Hunt, will be found in the *Geology of Canada*, 1863, pp. 547-550.

CLASS VII.

MATERIALS APPLICABLE TO COMMON OR DECORATIVE CONSTRUCTION.

Wide
distribution.

While there is no lack of valuable material for building purposes at many points throughout the province, the absence of suitable means of transport at present existing prevents many of these deposits from being utilized. Large and valuable quarries of granite, limestone, sandstone and quartzite exist, while unlimited quantities of gneiss, marble, serpentine and other rocks could be easily reached at no very great expense. At the present time the material most commonly employed in ordinary building construction is limestone, more particularly that of the Trenton or Chazy formations. This occurs at so many points throughout the province, more particularly along the west side of the St. Lawrence River, that it is scarcely necessary to enumerate them; while of limestone, for other purposes, such as burning for ordinary lime and for the manufacture of hydraulic cements, great deposits are found in the palæozoic rocks to the extremity of the Gaspé peninsula.

Trenton and
Chazy
limestone.

While there is a great variety in the texture and quality of the stone employed for the different purposes, certain beds are specially worthy of notice from their purity and fitness for the use intended. Among building materials, probably that most extensively employed is from the Trenton division of the Cambro-Silurian, as seen in the buildings of the cities of Hull, Ottawa, Montreal, Quebec and Levis. This may, to a large extent, be due to the fact that the beds of this formation lie in a generally horizontal position, and are of convenient thickness for the purpose required, the stone is easily obtained and readily dressed, and most of the cities named lie either in close proximity to the rocks, or in some cases being built directly upon the spot where it is quarried. As a source of lime, also, the Trenton formation is very extensively used at many points, and yields a very excellent material, though in some cases the rock contains a considerable proportion of argillaceous matter. A limestone, which is really a marble, occurs in connection with the crystalline series in the eastern townships, and has been used to some extent in construction. Examples are seen in the beautiful marble church of North Stukely; the rock being derived from a very good quarry near South Stukely, where quite extensive beds of this stone are found, which have been quarried both for building purposes and for lime burning.

South Stukely.

A good limestone from the Chazy formation, obtained from the St. St. Dominique. Dominique quarries not far from St. Hyacinthe, is somewhat extensively used, and certain beds of the lower Chazy and Calciferous, near Philipsburg and at St. Armand, of a dove grey color and partly crys-St. Armand. talline, are capable of furnishing large quantities of excellent building material.

In the eastern portion of the province the massive limestone of Port Port Daniel. Daniel, on the south side of Gaspé Peninsula, is quite extensively quarried for shipment to P. E. Island and the adjacent shores of New Brunswick, where it is burnt for lime. In Dudswell, and at various Dudswell. points on the St. Francis River north of Lennoxville, the Silurian limestone, nearly the same age as that of Port Daniel in Gaspe, produces, when burned, a lime of great purity and value, and specially adapted for use in factories for the manufacture of chemical pulp, and for paper mills, where large quantities are employed. So excellent a reputation has this lime of Dudswell now acquired, that the product from the kilns of this place, which have at present a possible capacity of about 3000 bushels a day, is shipped over the greater part of eastern and southern Quebec and the adjacent States, as well as over a large portion of eastern Ontario.

The Devonian limestones on the Chaudière are burned locally for lime, and the semi-crystalline limestones of Thetford, Broughton and Ste. Marie also furnish a small quantity for local consumption, but the competition of the Dudswell works has had the effect of nearly closing these smaller industries.

In the manufacture of hydraulic cement, a limestone is required Hydraulic cement. which contains a certain amount of argillaceous matter. The qualities of a good cement include that of rapidly setting or becoming solid under water. Experiments have been made at a number of places in Quebec to produce a first class article, but as this necessitates a series of tedious and somewhat costly experiments, the works at present in operation are apparently confined to only two localities, viz., Hull and Quebec. The rock at Quebec is taken from a dark or black argillaceous Quebec. limestone found in the Trenton-Utica formation of the city, and of the north side of the Island of Orleans. The same material also occurs at various points along the north side of the Gaspé Peninsula, where a similar series of beds occurs. The black matter of the Quebec rock, being carbonaceous, disappears in the calcining; the rock becoming yellowish, and the cement is said to be of excellent quality. The cement made in Hull, by Mr. C. B. Wright, is from rock brought from Hull. the township of Nepean, Ontario; though precisely similar bands occur on the Quebec side of the Ottawa. The limestone contains about twelve per cent. of carbonate of magnesia, and belongs to the Chazy

formation and can be traced for a considerable distance. The cement manufactured from this stone does not harden so rapidly as the "Portland," but is otherwise a very excellent article.

Granite of the
eastern
townships.

Building Stones.—These have been partly referred to under the head of limestone. Of the other materials employed in construction, granite is found in inexhaustible quantities in the south eastern portion of Quebec, more especially in connection with the area of Cambro-Silurian rocks lying to the east of Sherbrooke anticlinal. Great mountain masses occur in the Little and Big Megantic Mountains, and along the boundary from Memphremagog Lake, nearly to the Hereford and Connecticut Valley railway, while extensive areas are seen to the east and along the shores of the upper end of Lake Megantic. At Barnston also and in Stanstead, as well as on the shores of Lake Memphremagog, quarries have been opened from which a very fine quality of stone has been obtained. The rock is of the variety known as white granite, composed of quartz, whitish felspar and black mica. This granite is comparatively free from pyrites, and is but little affected by the action of the atmosphere. It splits readily into blocks of almost any desired size, and has been used in the public buildings in the city of Sherbrooke and in the Eastern Township Bank of that place, as well as in the magnificent wall which now surrounds the grounds of the Parliament buildings at Quebec.

Syenites of
Grenville.

The syenites are for the most part confined to the rocks of the Laurentian system. They differ in color from the granites just described, having for the most part a reddish tinge due to the color of the felspar; the rock, like the granite, splits readily, and dresses with comparative ease. It has been worked for some years extensively near Gananoque on the St. Lawrence, by Mr. R. Forsyth of Montreal, but excellent stone can be obtained from Grenville, and at many points throughout the Laurentian belt of the north side of that river.

Gneiss.

Gneiss, which is very often scarcely distinguishable from syenite or granite, occurs as a very important factor of the Laurentian rocks, and can be well seen in the township of Grenville, Chatham and Wentworth, while among other locations mentioned in the Geology of Canada, 1863, as affording fine material for building purposes, and easily accessible, are Jeune Lorette, on the St. Charles, near Quebec city; on the Batiscan, near the old blast furnace; and at Bay St. Paul. Of sandstones, several varieties are found well adapted for construction. Probably the most durable of these occur in the Potsdam formation at Beauharnois, Vaudreuil, Grenville, and along the lower Ottawa. The rock is generally white or yellowish-white in color, and frequently free from stains. It is hard and very durable, not only readily resisting the weather, but the fire as well; but this feature of hardness

Potsdam
sandstone.

and toughness renders it more difficult to work than the softer calcareous beds of the Trenton and Chazy. The strata, however, are readily separable and easily quarried. Good beds for quarry purposes are obtained at St. Scholastique and at Hemmingford, as also at various places between Lachute and St. Jerome, where this formation rests directly upon the Laurentian gneiss. The stone has also been used for the lining of blast furnaces, and found to be well adapted for that purpose. It enters somewhat largely into the construction of the magnificent Parliament and Departmental buildings at Ottawa; a large part of it being obtained from the township of Nepean. It has also been used to some extent for building purposes in Montreal.

The Sillery sandstone, found largely developed near the city of Quebec and to the south and east of Lévis on the upper side of the River St. Lawrence, is extensively used in construction at both cities. Much of the city wall is built of this stone, as well as the Citadel, while it enters largely into the structure of both private and public buildings. It is for the most part a green or greyish-green rock, which in some places becomes highly quartzose, passing into a whitish weathering, yellowish-brown quartzite. The rock frequently contains small pebbles of quartz and pieces of shale of various colors; the quartz pebbles sometimes becoming sufficiently numerous to constitute a fine conglomerate. Certain portions of the rock quarry readily, but it is said not to weather uniformly, and does not resist atmospheric influences so well as the Potsdam sandstone. Used by itself in large buildings, its dark-green shade tends to give the structure a heavy, and not pleasing, aspect, but the dark color blends well with lighter materials. This rock is very widely distributed along the south side of the St. Lawrence, below the mouth of the Chaudière, and is found at many places inland. Quite extensive quarries exist at Sillery, about four miles south-west of Quebec, and also from one to two miles south-east of Lévis, where large quantities of stone of almost any desired size can be obtained. About St. Raphael and Armagh, and at certain points near the coast below L'Islet the beds are highly quartzose, and often have a purplish-red color, which contrasts well with the sombre tint of the typical Sillery rock.

Among the Devonian beds of Gaspé basin and the interior of the peninsula of Gaspé, greyish sandstone forms an important feature, and, where of suitable thickness, should constitute an excellent building stone. As, however, this is not so readily available as the freestones of the Millstone Grit formation on the south side of the Bay Chaleur, it is doubtful if it could compete with these as a source of supply for building blocks of large size. Certain whitish, hard sandstones,

Sillery
sandstone.

Devonian and
Silurian
sandstones of
Gaspé.

highly quartzose, also occur in the Silurian along the base of the Devonian basin, in the interior of Gaspé, and are well seen on the Matane and Metapedia—at the latter place having been quarried some years ago for the Intercolonial railway. They again appear on the shore of Lake Temiscouata, and should furnish a good and lasting stone for building purposes. Between Montreal and Quebec the Trenton limestone is quarried somewhat extensively at several points, as at the village of Industry and at Chevrotière, on the St. Alban road, about four miles from the River St. Lawrence, where very extensive quarries are situated which supply stone to Quebec and Montreal. At Pointe aux Trembles the same formation furnishes stone similar to that of the Montreal quarries, and has been extensively used in Quebec. At Chateau Richer, below that city, several important quarries also exist, from which quantities of stone were obtained for the Lévis forts, as well as for the city of Quebec. Similar limestones occur at St. Paul's Bay, and have been quarried for local use, as have also the beds about Lake St. John. The limestone at Philipsburg has already been referred to. Above Montreal, quarries in the Chazy limestone occur at Caughnawaga, Pointe Claire and St. Genevieve, near the upper end of the island of Montreal. A large portion of the stone for the piers of the Victoria bridge was obtained from the Pointe Claire quarries; from this place some blocks of large size are obtained. Chazy limestones are also found at Grenville and Carillon which have been quarried for building purposes, while the stone for the Carillon and Grenville canal was, for the most part, obtained from quarries in the same formation, situated across the river at Hawksbury. Excellent limestone also occurs in the Island of Anticosti, at the south-west point at Cape James and at Table Head, from which much building material could be easily obtained.

Trenton
limestone.
north of the
St. Lawrence.

Chazy
limestone.

Anticosti.

Trachytic rock.

The several trappean or trachytic hills, which rise out of the level country east of Montreal, and of which the Montreal Mountain furnishes a very good example, yield at times very good material for ordinary construction work, though some of it is coarse in texture, and, from the lack of quartz, does not resist the influence of the weather as well as could be desired. In many places, however, the rock mass is intersected by joints, and blocks of good size are readily split out. These rocks are very well suited for paving blocks, and for road metal, answering much better for this purpose than the limestone of which the macadam is so generally composed. Quarries for paving stone are opened on the west side of Yamaska Mountain, and for building stone on Shefford Mountain.

In the valley of the Chaudière several of the churches are built largely of drift blocks, which lie scattered quite thickly at some

points. These consist of gneiss, quartzite, syenite, crystalline lime-stone, labradorite, etc., and in the church of St. Joseph, Beauce, many different kinds of these rocks are seen, the whole presenting a pleasing effect. - Drift boulders.

Marbles are found in the Laurentian series, and in the newer formations as well, at different points. The Laurentian marbles are quite extensively worked in that portion of Ontario to the south of the Ottawa, at Renfrew, Arnprior and Fitzroy Harbor. From these places large quantities of excellent stone have been obtained, some of which has been employed in the interior construction of the Parliament buildings at Ottawa. In the township of Hull, lot eighteen, range eight, a quarry in Laurentian limestone furnished very good stone, and in Grenville, lot sixteen, range three, works for the preparation of similar rock were also erected. The limestone of the metamorphic rocks of the eastern townships at Stukely has already been referred to. Among marbles of newer horizons the deposit at Dudswell has long been known. This belongs to the Silurian system, and certain beds are entirely composed of organic remains; large corals being abundant, which, when polished, present a beautifully marked surface. Several varieties of this stone are found in this quarry, among others a kind showing bandings and mottlings of yellow upon a dark or black mass, presenting a very attractive appearance when polished. The extent of this quarry is considerable, and several years ago it was opened to a depth of five feet by the removal of the surface bench, the lower portion being found to be comparatively solid and capable of yielding large blocks which readily took a fine polish. Work has, however, been suspended in this quarry for the last two years, owing probably to lack of capital on the part of the company, who were largely engaged in lime burning on a portion of the same formation. Near Philipsburg several of the limestone bands offer a good variety of marble, but little has been done to develop the industry in this direction. On the Chaudière River in Beauce, about three miles above the village of St. Joseph, near the mouth of the Colway, a very pretty reddish variety, veined with calcite, is found, which, when polished, has a rich and handsome appearance, but the band is not very extensive, and a similar variety is found near the St. Francis River, about four miles below Richmond, but nothing has ever been done to test their real value as a source of supply for marble. - Marbles of the Upper Ottawa.

A very handsome variety of marble is found in the Laurentian at several places, as at Grenville, St. Andre Avelin, and the augmentation of Grenville; the limestone being mixed with greenish or yellowish green serpentine, in clouded markings or in bands. This constitutes the variety known as Eozoon limestone, and when polished the different - Dudswell marble.

colors and markings of the supposed fossil have a very handsome effect. The Grenville bed has a thickness of some hundreds of feet. Some of the limestones of the Chazy and Trenton are sufficiently metamorphosed to polish well, and very handsome marbles are obtained from some of these in which the organic structure is beautifully displayed. These are found at Caughnawaga, St. Lin, Terrebonne, Montreal, St. Dominique, St. Armand and other places.

Serpentine.

Serpentine.—This rock occurs in connection with the Laurentian limestone of Grenville and at other points already referred to, but more particularly in great masses in the eastern townships, where it is found associated with slates, diorites and sometimes granitic and schistose rocks. It presents several interesting features, not only as a source of supply for asbestos and chromic iron, but as a material for indoor decoration. Unfortunately it is easily affected by atmospheric agencies, and is not therefore adapted for outside work, since the polished surface speedily becomes tarnished by weathering. During the last few years attempts have been made to obtain good sized blocks from the serpentine of the townships, but, while these can be extracted in large masses, the stone appears in many cases to be affected by joints and seams, which, in the dressing, interfere very seriously with the efforts to secure good solid pieces for polished work. Slabs can, however, be readily sawn, which, when well polished, have a very rich and pleasing effect for interior decoration, and present a considerable variety, not only in color, but in the markings. In Vermont these serpentines have for some years been quarried and sold under the head of verde antique marble. In Italy, France and England also, a similar rock is extensively worked for decorative purposes, such as mantels, tables, etc. The Eozoon or serpentine limestone of the Laurentian in which the serpentine which has filled the chambers of the supposed fossil structure, has a yellowish tint, presents when polished a very handsome appearance. The stone from Grenville has been referred to under the head of marbles. A similar rock from Templeton has been worked to some extent by the Canada Granite Company of Ottawa with apparently good results.

Difficulty in getting good blocks.

Eozoon limestone.

Slates.

Slates of good quality are found at many points in Quebec, east of the St. Lawrence, more particularly in connection with the Cambrian rocks, and a number of quarries have been opened at different times. In some of these red, green and purple tinted slates are obtained, but in those at present worked the prevailing shade is dark or bluish grey. These quarries are now confined to only three, viz., one at New Rockland in the township of Melbourne; one at Shipton, known as the Danville School Slate quarry, on lot seven, range four, and in Cleveland, formerly Steele's quarry, but lately re-opened by Mr. J. C. Bedard

of Richmond, on lot six, range fifteen, about three miles south-east of Richmond and near the line of the Grand Trunk railway. These three quarries produce slates of the same general color, and are presumably from the same belt of rock or from a repetition of the same by folding, as well as the slates of the old Walton quarry on lot twenty-two, range six, Melbourne, which was worked some years ago, but subsequently abandoned. On the Grand Trunk railway, about four miles east of Acton station, on lot twenty-six, range five, Acton, a quarry in red slates, with large patches of green, is located. This is the Rankin Hill quarry. The rock is said to be easily quarried and belongs to what is called the Sillery portion of the Quebec group. It was opened in 1875 and was worked for two years, when it was closed, owing it is said, to a lack of market and the low price at that time of the output. This quarry had, in 1877, a length of one hundred and fifty feet by sixty in breadth, and with a depth in one place of thirty-five feet, and in 1877 produced about 600 squares of slate.

Three quarries at present worked.

Rankin Hill quarry.

*Redmond
Sillery
Wolfe*

Slates also are found in Kingsey, lot four of the first range; in Orford, lot two, range five, and in Tring and Westbury. Good deposits are also found in Brompton on lot twenty-nine, range five, where there is a quarry from which flagging stone has been obtained; and in Garthby on the road to Ham, about four miles from Garthby station on the Quebec Central railway, lot fifteen, ranges eight and nine, same township, the last in the red and green slates of the Sillery. North of the Chaudière an old slate quarry long abandoned is found on lot two, range ten, of Frampton, in purple rock; and bands of purple, red and green slates occur at many other points in the slaty series to the west of the main anticlinal of crystalline schists, some of which, were the market sufficient, should yield slates of good quality. The largest slate quarry at present in operation in Quebec is that of the New Rockland Company. This was first opened in 1868 and has been worked almost continuously ever since. It is situated on a rise with an elevation of about 500 feet above the St. Francis River, which is four miles distant to the north, and has at present a working bench 200 feet deep. The slate cleaves readily, is very free from pyrites, impervious to water and equal in every respect to the celebrated Welsh slates. The quarry is equipped with the most improved machinery for cutting, sawing and dressing the rock and for making roofing slates of any required size. The motive power consists of a turbine wheel, placed in the river half a mile above the works, to which the power is transmitted by cables. Four travelling derricks raise the rock from the pit, while inclined tracks transfer the finished products to a line of narrow gauge railway which connects the quarry with the line of the Grand Trunk railway at a point about three miles south of

Abandoned quarries.

New Rockland.

Plant.

Output.

the Richmond station. The output embraces, in addition to roofing slates, billiard table tops, mantels, wash tubs, etc.; the demand fully keeping pace with the supply. An analysis of the slate was made by Dr. B. J. Harrington of McGill College, and shows the excellent quality of the material to be as follows:—

Analysis.

Silica.....	65.39
Alumina.....	15.97
Ferrous Oxide.....	4.66
Manganous Oxide.....	0.39
Lime.....	0.67
Magnesia.....	2.99
Potash.....	3.60
Soda.....	3.33
Loss by ignition.....	3.26
	100.26
Specific gravity.....	2.75

A number of tests were made at the testing laboratory of the Dominion Bridge Company, Lachine, P. Q., on an emery testing machine, the result of which may be given as presenting a fair idea of the character of the slate of this belt,

Slate tests.

- 1st test. Crushing. Strain perpendicular to the lamination. A 2" cube failed at 108,570 lbs.=26,574 lbs per square inch.
- 2nd test. Crushing. Strain perpendicular to lamination. A 2" cube failed at 129,880 lbs.=32.069 lbs per square inch.
- 3rd test. Crushing. Strain parallel to the lamination but perpendicular to the grain, i.e. edgewise. A 2" cube was not crushed at 150,000 lbs.=36,581 lbs per square inch.
- 4th test. Breaking. Strain perpendicular to the lamination. A piece of slate 3' long, 4" wide and 1" thick, on bearers 30" apart, failed by splitting at 950 lbs; modulus of rupture 10,000.
A beam 12" long and 1" square, supported at both ends, and loaded in the centre, failed at 556 lbs.
- 5th test. Breaking. Strain perpendicular to lamination. A piece of slate 3' long, 4" wide and 1" thick, on bearers 30" apart, failed by splitting at 1,092 lbs; modulus of rupture 11,667.
A beam 12" long, 1" square, supported at both ends and loaded in the centre, failed at 558 lbs.
Deflection with pressure at 690 lbs was 7-10 of 1".

The average production per month of this quarry for the past year to the end of September was about 2200 squares of roofing slates, and 3300 feet B. M. of slate slab work. The quarries are worked all the year round and about 200 men are employed. The pit at the deepest end is 200 feet, and a further depth of sixty feet is now being sunk in

addition to the widening and lengthening of the quarry as the work of extraction goes on. ✓

To the north-east of this is situated the old Melbourne or Walton ^{Walton quarry.} quarry, on lot twenty-two, range six, Melbourne, about two miles distant from the St. Francis River. This quarry was opened by the late Mr. Walton in 1860, and was worked for about eighteen years, when it was closed. A very large quantity of slate was extracted of a quality similar to that of the New Rockland quarry, and the workings were of very considerable size, being stated, in the catalogue for the Paris Exhibition, to be 150 feet deep, 300 feet long and 100 broad. The failure of the industry at this place was to a large extent due to the depression of the market at that time, and a lack of capital necessary to carry out the work with the modern equipment necessary. Both these quarries are in contact on the west side with large masses of serpentine. The slates here found are continuous across the River St. Francis into Cleveland and Shipton. The oldest quarry in this belt is that already referred to on lot six, range fifteen, formerly known as the Steele quarry, which was opened in 1854. No returns are to hand from this quarry under its new management, but the quality of the slate extracted is excellent in so far as yet tested. The output of the ^{Danville school slate quarry.} Danville quarry is as yet almost entirely confined to school slates, for which a ready market is obtained.

It may be said generally of all these slates that their quality is unsurpassed. Their chemical composition is very similar to that of the slates from Angers, in France, which have been in use in buildings in Montreal for considerably more than one hundred years.

Within the last two years a new quarry in purple slates has been ^{Brompton Gore} opened on lot eighteen, range ten, Brompton Gore. This is about two miles north-west of the lower end of Brompton Lake, and about seven miles south-west from the New Rockland quarry; but no particulars are yet to hand concerning its prospects. The owners are Messrs. Jenkins & Davis.

The analysis of slates from Kingsey is here submitted, along with that for the Welsh and Angers quarries in France, for the sake of comparison. They are taken from the Report of Progress, 1852-53, and are by Dr. T. S. Hunt.

ANALYSIS OF SLATES.

Analysis.	Kingsey.	Westbury.	Wales.	Angers.
Silica.....	54.80	65.85	60.50	57.00
Alumina.....	23.15	16.65	19.70	20.10
Prot. Iron.....	9.58	5.31	7.83	10.98
Lime.....	1.06	0.59	1.12	1.23
Magnesia.....	2.16	2.95	2.20	3.59
Potash.....	3.37	3.74	3.18	1.73
Soda.....	2.22	1.31	2.20	1.30
Water.....	3.90	3.10	3.30	1.40
	100.24	99.50	100.03	100.13

Flagstones.

Flagstones of varying degrees of excellence are obtained from rocks of different formations. Thus, good flags are to be found in the thin hard bands, interstratified with the dark slates, near Cape Rouge, in the Cambrian rocks, and in the lowest Sillery formation; also in the sandstones of Point Levis, and at Cap à l'Aigle, Murray Bay. In the Cambro-Silurian slates of Brompton and Orford, on the south side of the St. Francis River, and about five miles west of the city of Sherbrooke, several quarries are found, from which large flags were obtained and were used in that city. These have not been worked for some years; while in the Silurian sandstones and calcareous slates on the east side of Lake Memphremagog, between Magog and Georgeville, certain beds yield large and smooth surfaced slabs of almost any required size. Similar stones can also be found near Knowlton Landing, in a band of slates and limestone of the same age, which occurs at that place. Of late years quite extensive quarries of flagstones have been opened in a dark colored limestone at Dudswell, the rock splitting out into sheets of very large size, and having a thickness of from one to eight inches. These were shipped to Montreal, and largely employed there for several years, but within the last year or so do not appear to have given entire satisfaction, and the American stone is again being employed. In Gaspé, the sandy beds of the Devonian also furnish flags of good size and of almost any required thickness, but these have not as yet been worked to any extent. Near St. Maurice, at Three Rivers, the Potsdam sandstones also furnish a considerable thickness of hard flaggy rock, which should possess great durability and be available as a source of supply; as also should much of the rock of the

Lake Memphremagog.

Dudswell.

Gaspé.

St. Maurice.

same formation in the vicinity of the city of Montreal. In the Report of Progress, 1847, page 82, Sir William Logan refers to the mica schists of Sutton Mountain as probably affording good material for this purpose. He says:—"Plates were observed showing a superficies of six feet by three, under six inches thick, and I was informed they might be obtained measuring ten feet by five." Sutton Mountain.

Similar mica schist, or a schistose micaceous gneiss, is found in the Cambrian rocks of the Upper Ottawa, on Lake Temiscamingue, from which good flagstones of large size can be obtained. On the fifth lot of the second range of Inverness, a greyish green talcoid and siliceous slate is found, which was quarried some years ago, and which furnished a very excellent stone; and on the Upper Chaudière the sandy slates of the Cambro-Silurian or Upper Cambrian, both on the Du Loup and Chaudière itself, contain many thin beds of fine dark-blue sandstone, which split out readily and furnish very excellent slabs for this purpose. Lake Temiscamingue
Inverness.
Chaudière River.

BRICKS AND BRICK CLAYS.

While in Ontario brick clay of two kinds is found, from which brick of two shades can be made, viz., red and white, in the province of Quebec the deposits principally worked are confined to a marine deposit, known as the Leda clay, and which overlies the boulder clay deposits. These marine clays frequently contain organic remains in the shape of shells, and the bones of fish, as well as of seals and whales; and when burned yield bricks of a red color. They are so extensively distributed throughout the valleys of the St. Lawrence and Ottawa that it is needless to particularize localities. Other deposits of apparently a similar clay, but which have not yet yielded organic remains, are found in the eastern townships, at Sherbrooke, Lennoxville and Ascot, and even at much more elevated points, which also yield an excellent red brick; but no white brick clay has yet been observed, or at least burned. Red brick clay.

An inexhaustible supply of excellent material for the manufacture of brick exists in the waste from the slate quarries. This, when ground, makes a clay which, when properly mixed and burned, yields a brick of much greater value than that obtained from ordinary clay. The Rockland Slate Company, it is understood, had the manufacture of these bricks in contemplation for some time; but has not yet been able, owing to the pressure of other work, to undertake the industry. The most extensive brick yards in the province are those in the vicinity of Montreal, but a clay of the same character is very extensively used at St. Johns for the manufacture of pottery and drain tiles, as well as at St. Sauveur, near Quebec, where also drain tiles are made; but outside the principal cities the industry is not carried on to any extent. Clay from ground slates.

CLASS VIII.

REFRACTORY MATERIALS.

The principal minerals under this heading found in the province of Quebec are plumbago, mica, asbestos, soapstone and potstone and sandstone, of which the three first named are of the most economic importance.

GRAPHITE.

Graphite.

Graphite or plumbago is referred to in the earlier reports of the Geological Survey of Canada for 1845-46, by Sir William Logan, as occurring in Grenville, on the south half of lot ten, concession five, "in a vein with felspar, quartz, pyroxene and sphene, with carbonate of lime and serpentine, cutting the white micaceo-plumbaginous limestone of the metamorphic rocks." The deposit was worked some years by the Hon. Mr. Harwood of Vaudreuil, and in the excavation the mineral was found to be confined to three small strings, each about five inches thick, and comprised in a space of four feet and a half. Thin veins were also reported on the thirteenth and fourteenth lots of the fourth range of the same township.

Grenville.

Westmeath.

On lot twenty-one, front A, Westmeath, plumbago of excellent quality was seen, but the extent of the deposit could not be ascertained. In the Geological Survey Report for 1847 Dr. Hunt reported plumbago as occurring on the north half of the same lot as Mr. Harwood's mine, in three strings from two to eleven inches wide, which were stated to unite in one vein with a thickness "of eighteen inches, and quite free from any foreign substance." The mineral was described as being quite soft and pure, and the locality as worthy of further exploration. In the Report of Progress for 1853 additional deposits are noted in the north half of the second lot, range ten, of Grenville, and on the fifth lot of range four, Chatham Gore. It is here described as "associated with the Laurentian limestone, and of a grey color and foliated structure, resembling that of Ceylon; its price would not exceed from £3 to £5 per ton when clean." Further reference is made to these areas in the Geology of Canada for 1863, p. 793, and other localities are noted in the vicinity, among which are the township of Lochaber, lot twenty-four, range seven, which furnished some excellent graphite; the seigniory of Petite Nation and in Buckingham. In these two townships this mineral occurs at a great num-

Lochaber.

ber of points, and quite extensive works were erected by the Lochaber Plumbago Company on the twenty-eighth lot of the tenth range for crushing and separating the plumbago from the gangue. These works were under the management of Mr. S. T. Pearce, and a large quantity of good material was obtained and cleaned, not only from the lot mentioned, but from several others in the neighborhood. The graphite occurred principally disseminated in bands of limestone, though well defined veins were also found.

The largest quantity of graphite obtained in this vicinity was apparently from McCoy's mine on lot twenty-four of the eighth range, where the mineral occurs as usual in a coarse grey crystalline limestone, having a breadth of twenty-five to thirty feet; a shaft was sunk on it and from the several veins, which seemed to traverse the rock in all directions, about 620 tons of crude ore for dressing was raised. In the eleventh range of Lochaber, on the line between lots twenty-three and twenty-four, similar ore was found in a band from ten to twelve feet thick, from which about 150 tons, giving about twenty per cent. of pure graphite, were sent to the mill.

In Buckingham graphite was found at a number of places, both as lenticular masses in the limestone and as disseminated in smaller grains, as well as in veins as already described. Several attempts to work these deposits were made at different times. On the nineteenth lot of the fifth range Mr. Labouglie opened the Ste. Mary's mine from which several tons of pure graphite were obtained, as well as a large quantity of disseminated ore for crushing. About two hundred yards east of this opening the graphite was found over an area thirty feet by eight in a series of reticulating veins, as at McCoy's mine in Lochaber, and about 500 lbs. of pure graphite were obtained without the use of powder. On the twenty-second and twenty-third lots of the fifth range graphite also shows in considerable quantity, occurring in a similar manner, and on the twenty-fourth lot of the same range several shafts were sunk, and over one hundred tons of ore extracted. This is called the St. Louis mine. Veins of graphite also occur in the sixth range, on lots twenty-two and twenty-eight; the thickness of pure graphite being from three to six inches, and in one place from fifteen to twenty inches. Several openings have been made in these veins, but no returns of output are available.

In Wentworth, on the west half of lot one, and the east half of lot two, in the third range, similar outcrops occur, as well as on the twenty-second lot of the seventh range, and on the seventeenth lot of the ninth range. These lots have been acquired by the New England Plumbago Company.

Mr. Vennor's
report, 1873-74.

In the Geological Survey Report for 1873-74 further details of the occurrence of graphite are given by Mr. Vennor, more particularly with reference to the Ottawa county deposits. He states that the mineral occurs "in three distinct forms, 1st, as disseminated scales or plates in the limestone, gneisses, pyroxenites, and quartzites, and even in some of the iron ores, as at Hull; 2nd, as lenticular or disseminated masses, embedded in the limestone, or at the junction of these and the adjoining gneiss and pyroxenite, and 3rd, in the form of true fissure veins, cutting the enclosed strata." Of the relative importance of these different deposits he says: "The first form is that most commonly met with, and it is in the limestone that the graphite is most abundantly disseminated, oftentimes to such an extent as to constitute deposits of great economic value. The second form, viz., that of embedded masses, is of common occurrence, and in a number of localities in Buckingham, Lochaber and Grenville, such deposits have been met with and worked to a small extent. The third, or last form, that of fissure veins, is not so common, and does not appear to be of as great importance as the bedded deposits, although many such veins exist and have been worked to some extent in the townships already named. In these veins the graphite is very brilliant, often lamellar and of great purity."

Disseminated
graphite most
important.

Of these three modes of occurrence, Mr. Vennor inclines to the belief that the first will prove of the greatest economic importance. In addition to the localities where mining operations have been carried on and already referred to, others are given in this report. Of these, lot twenty-seven, fifth concession of Buckingham was opened by Messrs. West & Co. by a pit ten feet square and ten feet deep on three veins of graphite ranging in thickness from six inches to two feet. From these twenty barrels of pure graphite are reported as having been shipped. On lots fifteen and sixteen of the sixth concession (Crosby Newton's) a little mining was also done. On lot twenty-three, concession five, the "Castle property," the size of the veins is not stated; on the west half of lot four, concession seven, graphite also occurs, and on the south half of lot twenty-one, same concession, known as the "Pennock lot," a vein of very fine material, from a foot to a foot and a half in thickness, has been opened and worked to some extent; the quality of the graphite being said to compare favorably with that from Ceylon.

West & Co.'s
mine.

The Castle
property.

Pennock's lot.

Pugh & Wort's
mine.

On the twenty-seventh lot of the sixth concession is the mine of Messrs. Pugh & Wort, consisting of a shaft forty feet deep on a bed of about three feet, which has also been worked by an open cutting for over sixty feet from which a large amount of fine graphite was obtained. In the vicinity of Donaldson's Lake several other openings have been made at different times, and on some of the lots, more especially on lots four and five of the ninth concession, very promising indications were found, but no details of the output are to hand.

VENNOR
REPORT

In the Report of Progress of this Survey for 1875-76 the results of the analysis of four samples of graphite from the township of Buckingham was given; this was followed in the report for the next year, 1876-77, by a very valuable series of analyses by Mr. Hoffmann, including in all eighteen specimens of graphite from Buckingham and Grenville made in order to institute a comparison with the Ceylon, graphite. The Canadian mineral was obtained from various deposits among which were the Montreal Plumbago Mining Co.'s, on the twenty-eighth lot of the sixth range of Buckingham, where a bed of disseminated graphite eight feet in width occurs, the percentage of the graphite in the rock being 29.518; from the twentieth lot of range eight, belonging to the Dominion of Canada Plumbago Company, where there is a large bed of similar character, the percentage of the graphite being 23.798; and from the twenty-second, and twenty-third lots of the sixth range, belonging both to the Buckingham Mining Company, which contained 22.385 and 30.516 per cent of graphite. The percentage of rock matter insoluble in hydrochloric acid from the first three samples averaged 55.094; and of rock matter soluble in hydrochloric acid, 19.430. In the last sample the soluble rock matter was 2.475 per cent, the insoluble 66.874 per cent. Seven specimens of dressed graphite from the Dominion of Canada Plumbago Company were examined, and the amount of ash determined. The samples were of different grades, and the ash ranged in amount from 17.682 to 3.638 per cent. All the samples contained certain proportions of carbonate of lime and oxide of iron, features objectionable in the manufacture of crucibles; but these, together with other injurious foreign matters, were removed by digesting the graphite with hydrochloric acid, so that the resulting graphite, according to Mr. Hoffmann's exhaustive tests, contained nothing that would in any way be prejudicial to the manufacture of crucibles from the purified material.

Mr. Hoffmann's
analysis, 1876-77

Excellent
quality of
Canadian
graphite.

Four assays of vein graphite were also made; two from Buckingham, a foliated vein occurring on lots twenty-one and twenty two, seventh range, containing 99.675 per cent carbon, with .147 of ash, and a columnar variety from the twenty-seventh lot of the sixth range which contained 97.626 per cent carbon and 1.780 ash; and two from Grenville; a foliated variety from the north half of the second range of the augmentation, formerly mined to a small extent, which contained carbon 99.815 per cent, with only .076 ash, and a columnar variety from lot one of the sixth range of the augmentation which showed carbon 99.757, and ash 0.135; nearly sixty per cent of the latter being silica.

Analysis by
Mr. Hoffmann.

Respecting the character of the Canadian graphite as determined by Mr. Hoffmann, he remarks that "From these experiments it will be

Conclusions of
Mr. Hoffmann.

seen that in respect to incombustibility, the Canadian graphite may claim perfect equality with that of Ceylon; and that consequently, apart from any consideration of the proportion and nature of the associated foreign matter, it is in no wise inferior to the latter as a material for the manufacture of crucibles." Mr. Hoffmann further remarks that "prepared according to the present process, the dressed graphite, obtained from the beds of the disseminated mineral, is apt to contain more or less carbonate of soda and oxide of iron." He, however, points out that these can be easily removed by a simple process, and the graphite be left "with a very small amount of ash, and that of a nature in no wise prejudicial to its application for the purpose here under consideration."

Mr. Torrance's
report.

Mr. Torrance, in the Report of the Geological Survey for 1882-83, in referring to the quality of the Canadian plumbago for the market, cites the opinions of those who have used it, to the effect, that its bad reputation abroad is due to the uncertain quality of the article shipped, and to the fact that it contained certain impurities pointed out already in the report of Mr. Hoffmann as easily removable, but which apparently had not been done by the company which worked the mines. The hydrochloric treatment is also referred to, and Mr. Torrance says that "until acid chambers are erected in Ottawa county, or at Montreal, the best plan of working the plumbago deposits would be to dress the plumbago at the mines as completely as mechanical skill can accomplish, and then ship it to Brockville in barrels for the further treatment with acid, before its export;" and further, that "so long as the price of dressed plumbago does not fall below forty dollars per ton, many of our Canadian deposits could be profitably worked, always provided that they are managed by competent engineers. No mining company need hope to succeed in Canada, or any other part of the world, unless its manager has had a careful technical training, or the ore is of a phenomenal richness."

Present
condition of
the industry.

No graphite has been mined in Ottawa county now for several years. The property formerly owned by the Dominion of Canada Plumbago Company has lately passed into the hands of Mr. W. H. Walker, of Ottawa. The areas embraced in this property, which amounts to about 2,000 acres, are the north half of lots nineteen and twenty-one, range twenty-three, Buckingham; lot twenty-four, range seven; lot nineteen, range eight; the south half of lots twenty and twenty-one, range eight; the south half of lot nineteen, range nine, and lot twenty-one, range nine. A large amount of work was done here in former years; but at present the industry is confined to the utilization of the refuse of the mine for the manufacture of stove polish, much of which is obtained by draining a lake on the property.

Recently a vein of disseminated graphite about three feet thick has been found, according to Mr. Willimott, on lot nine of range eleven, Hull, near Cantley, on land owned by Mr. Davis of that place. This has not yet been opened. The property in Grenville, lot ten, range five, formerly known as the "Miller Mine," has recently been bought by Messrs. Rae & Co., of Montreal. The veins, of which there are five, occur in a band of white crystalline limestone. They have a breadth of five to eight feet, and have provided a fair amount of graphite. The mine has been opened for sixty feet in length to a depth of thirty feet, but nothing is at present being done at the place.

MICA.

At present there are no deposits of this mineral being worked in Quebec. The most important location probably is that of Villeneuve, lots thirty and thirty-one, range one, which has lately been acquired by Messrs. Franchotte & Co. of Buckingham. A considerable quantity has been mined at different times, but the deposit is now said by Mr. Willimott, who has lately visited the spot, to be worked not for the mica but for felspar, which is employed in the manufacture of porcelain. Among other localities referred to in the Geology of Canada, 1863, in which mica occurs in sufficiently large masses for economic purposes, is the ninth lot of the sixth range, Grenville, from which one crystal was obtained furnishing sheets twenty-four by fourteen inches. Also on the tenth lot of the fifth range, and on the first lot of the tenth range. Mica has also been reported within the last four or five years from the north side of the Gulf of St. Lawrence, in the Watsheeshoo peninsula, and some very fair sample sheets have been exhibited as coming from this area. The rocks are of the usual character of the Laurentian found in Grenville and Buckingham, and it is said the deposit bids fair to be of considerable importance, though no reliable details are to hand.

ASBESTUS.

There is probably no mineral in Canada which has assumed so much economic importance in so short a time as asbestos. Prior to 1880 its use in this country was comparatively limited, while the value of the imports into the United States for that year, according to the mineral statistics of that country, was less than \$10,000. Although the presence of this mineral in Canada has been known for more than forty years, reference being made to it in the Report of the Geological

Survey for 1847-48 as occurring with the serpentines of the magnesian belt in Bolton, but little value was attached to the discovery, the uses for the mineral and the market being exceedingly limited. At the exhibition in London in 1862 a specimen of asbestos from the seigniority of St. Joseph was on view, which probably came from outcrops of serpentine on the Des Plantes River, or the Bras, between St. Joseph and St. Francis villages; but while the extension of the belt of serpentine rocks in which this mineral is known to occur had been traced with some care from the Vermont boundary in the township of Potton to and beyond the Chaudière River, the deposits of asbestos observed were comparatively limited. In the United States veins, generally of short and harsh fibre, were found at several points, and a considerable quantity of a tremolitic variety was mined, which, while ill-adapted for the purposes to which asbestos is now generally applied, was used for the manufacture of fire-proof paints, cements, etc. The chief source of supply for fibrous asbestos was the mines of Italy, where deposits of irregular extent occur the mineral often possessing a long and silky fibre which well adapted it for spinning, and from this source the material for fire-proof curtains and such like manufactures was obtained. But in 1877-78 asbestos was discovered in the serpentine hills of Thetford and Coleraine; the size of the veins, often several inches thick, leading to the expectation that deposits of value might exist there, though their true importance was not ascertained for several years. The credit of the discovery in this locality is claimed by Mr. Robert Ward, though by others it is stated that the first find was made by a French Canadian named Fecteau. Following closely upon the discovery several parties secured areas both at Thetford and Black Lake in Coleraine township on the line of the Quebec Central railway, which for some miles, or from Coleraine station to a short distance beyond Thetford station, runs between high ridges of serpentine, in which, the timber having been burned off, the veins were observed at the surface by the weathering and felting of the mineral on the surface of the bare rock. In the first year of mining operations, 1878, only fifty tons were taken out, for which it was difficult to find a ready sale at remunerative figures. The value of the mineral was, however, speedily ascertained, and in a short time additional areas were secured from the Government. The land was considered of no value, either for agricultural or any other purpose, and the mining was rapidly extended. The principal areas in which the asbestos bearing serpentine was found to occur were on lots twenty-six, twenty-seven and twenty-eight, near the line between ranges five and six of Thetford; and, in the township of Coleraine, near the Black Lake station, four miles south-west of Thetford station, in an area previously unsurveyed,

Exhibited in
London, 1862.

Asbestos in the
United States.

Italian
asbestos.

Discovery of
the Thetford
deposits.

Beginning of
the industry.

Mining areas.

but adjoining, on the south-west, range B, and called block A, as also on lots twenty-seven and twenty-eight, range B, and on lot thirty-two, range C.

All these areas were speedily secured, as well as most of the serpentine-bearing ground extending south-eastward from the Quebec Central railway toward Caribou Lake from and along what was known as the Poudrier road for several miles. In the south-west portion of Coleraine, and in the portion of Ireland adjoining, a large ridge of serpentine extends from Black Lake to the Wolfestown road, where it apparently terminates, the road to Wolfestown passing through a deep depression; but a second mountain mass of similar rock rises directly beyond the road, and extends for some miles in a south-westerly direction into the townships of Garthby and Ham. Upon the first of these two ridges, or that south-west of Black Lake, four mines have been lately opened, while in the ridge beyond the Wolfestown road the first works of the Bell Company of London were commenced in 1875 on lots twenty-three and twenty-four of range two of Wolfestown. Further west also, on the south-west face of the same hill, some three miles distant from the Bell Company's opening, other explorations have lately been made, but these have not, in so far as yet learned, given such promising results as those of Thetford and Coleraine.

All these mining locations are situated on areas of serpentine which is associated with green, grey, black or reddish slates, and quartzose sandstones and conglomerates. The serpentine is more particularly related to considerable masses of dioritic and whitish granitic rock, and is apparently due to the alteration of portions of these masses. The country is very rough and unpromising for anything other than mining enterprises. These slates and associated rocks for the most part are supposed to belong to the Cambrian system, though the serpentine is sometimes connected with areas of older rocks, such as chloritic and talcose schists, and considerable masses of soapstone. In the serpentines which are found with the older rocks the asbestos appears to be in very limited quantity, and no attempt has yet been made to work any such deposit.

In connection with the Laurentian rocks of Ottawa county the serpentinous limestones sometimes carry veins of a pale yellowish asbestos, generally of short fibre, but at times having a length of three-fourths to one inch. In some pieces of rock several of these, six, eight or more, are found, occupying a breadth of ten to twelve inches, the thickness of the veins ranging from one-fourth of an inch upward. Few attempts have, in so far as can be learned, been made to work these asbestos veins, some of which, as in Templeton, range seven, lot two,

Unlike that of
the townships.

might, if they were continuous to any extent, afford material of second and third quality, the fibre having scarcely a sufficient length to class it as first. Both the serpentinite and asbestos of the Laurentian rocks differ in quality from that of the eastern townships, as might indeed be supposed from their mode of occurrence and from the associated rocks. In connection with some of the phosphate deposits, as at the Emerald mine on the Du Lievre in Buckingham, considerable masses of the variety of asbestos known as mountain cork are found, but this has as yet no economic value.

Growth of the
industry.

The history of the asbestos industry has already been very fully given in the Report of Progress of this survey for 1886 and 1887-88, as well as in various articles in the Ottawa Mining Review. The growth of this industry has been constant and rapid, as can be seen by the greatly increased output from year to year; that for 1889 reaching over 6,000 tons. There is also a great and constantly increasing demand for the material itself—a demand in fact so great that, with the present appliances and conditions of mining, the supply cannot keep pace with it. The reputation which the Canadian asbestos has already acquired in foreign markets is such that the principal manufacturers have either already obtained asbestos producing areas of their own, or are striving to purchase them. Of those the most prominent already in the field are the Bell Company, of London; the United Asbestos Company, also of London, and the American Asbestos Company, controlled by the Wertheims, of Frankfort, Germany.

The Thetford
mines.

The companies now working at Thetford, are the King Bros., on lot twenty-six, range five; the Bell Company, on east half of lot twenty-seven, same range; Ross, Ward & Co., on west half of same lot and range; Irving Johnston & Co., on lot twenty-seven, range six; the Thetford Asbestos Mining Co. (A. H. Murphy & Co.), on lot twenty-eight, range six; and the King Bros. also on lot twenty-eight, range five—on which some new development work is being carried on. The four mines of King Bros., the Bell Company, Irving, Johnston & Co. and Ross, Ward & Co. are all situated on parts of a small knoll of serpentinite lying directly to the south-east of the Quebec Central railway, which traverses the area. The serpentinite, however, extends to the Thetford River, about a fourth of a mile to the north-west of the railroad. Some of the openings are situated to the west side of the railway, but the greatest amount of asbestos is taken from open pits in the sides and from the top of the knoll mentioned.

Extent of the
serpentinite at
Thetford.

It seems not improbable that the whole of these magnesian rocks are of the pre-Cambrian age. They constitute "The Volcanic Group" Report of the Geological Survey for 1877-78. No fossils have been found in them, and their mineral character seems to ally them more closely to the pre-Cambrian (Huronian system) than it does to any known Cambrian terrane.—A. R. C. Selwyn.

In Coleraine township, adjoining Thetford, Messrs. Lucke, Mitchell & Co. have a mine on lots thirty-two and thirty-one of range C, also traversed by the Quebec Central railway, and showing excellent fibre. In range A of this township prospecting work has been done on lots twenty-seven, twenty-eight and twenty-nine by Dr. James Reed, and some good veins of asbestos disclosed, and mining has lately commenced on these. On lot twenty-six H. W. Johns several years ago made an opening in the face of the hill, about one-fourth of a mile east of the Poudrier road, and found some small veins, but no further attempt to prove this property has since been made. In range B, lot thirty-two, Mr. Williams of the Rockland Slate Quarry opened up a pit in 1888 on land leased from Mr. A. H. Murphy from which about thirty tons mostly of second and third grades were obtained. On lots twenty-seven and twenty-eight, the south half of which was formerly Dr. Reed's, and was obtained two years ago by the American Asbestos Co., and the north half (which was formerly Hayden's) by the Bell Co., work has been going forward very extensively, especially on the former. Further to the rear, on lot twenty-four, Mr. D. Blacklock of Glasgow, Scotland, opened several pits in 1889, but the quantity of asbestos found was not great, the veins being of short fibre.

Mining
companies in
Coleraine
township.

The principal workings of the Black Lake district are situated on block A, adjacent to the south line of range B, and are the Scottish-Canadian, formerly the Eureka and Emilie mines; the United Asbestos Company, of London, formerly the Frechette-Douville; and the Anglo-Canadian, controlled by Hopper, Irwin & Co., of Montreal. To the south-west of this last and directly adjoining is the property of the Laurier Mining Company of Arthabasca, and further down the line of the Quebec Central, nearly one mile from the Anglo-Canadian, is the property of Loomis and Johnston, opened in 1888, which is flanked on the north-east by that of Wood & Co., and on the south-west by that of the Black Lake Asbestos Mining Co. Across the upper end of Black Lake Messrs. Grundy and Steele of Sherbrooke have opened an area on the southern flank of the Silver Mountain. Further to the south-west, on the southern extremity of the great Coleraine and Ireland serpentine ridge, Messrs. Fenwick and Selater own the Megantic mine, situated one mile and a half north-west of Coleraine station on the Quebec Central, and adjoining this on the north-east is the area of Lambly & Company of Inverness; the latter commencing work in 1889.

The Black
Lake mines.

New companies

On lots twenty-four and twenty-five of the third range of Ireland Messrs. King Bros. have commenced operations, with good prospects, on the western flank of the serpentine ridge. The former workings of the Bell Company are situated on the north end of the Wolfestown and

Ireland—King
Bros. mine.

- Wolfestown Garthby serpentine ridge, on lots twenty-three and twenty-four of Wolfestown, range two. These have not been operated since 1888. On the south-west extremity of this ridge, on lot twenty-four, range four, further openings were made in 1885, but soon discontinued. Among other companies, who have taken up asbestos locations and carried on mining operations, are the White's Asbestos, 1889, who own several widely-scattered areas in Garthby and Coleraine; the McDonald Bros., of Sherbrooke, who worked for some time on lot eight, range twelve, Coleraine, near Little Lake St. Francis, but apparently without much success; and the Brompton Lake Mining Company, formed in Montreal in 1889, who last year acquired the old Noel mine, on lot twenty-six, range nine, Brompton, near the lower end of the lake on the east side. This property was first opened by Mr. Noel, of Richmond, in 1886, who sold to Messrs. McDonald Bros., of Sherbrooke, by whom it was sold last year to the present company. Sufficient work has not yet been done to pronounce definitely upon its real value; but a somewhat extensive plant is now being placed there, and its importance, as an asbestos belt, will soon be known.
- Bolton. Further to the south-west, on lot eight, range seven, Bolton, a company attempted last year to work asbestos in a knoll of serpentine, one of a chain which extends for several miles between Trousers Lake and Eastman. The indications of large and profitable veins were, however, very few. Some small local veins of one-fourth to half an inch only were found, and the company abandoned operations early in the season. This is the only attempt to work asbestos in the south-western area, that is south of Orford Mountain, but on one of the outcrops on the Montreal road, about one-eighth of a mile west of Long
- North Stukely. Lake, in North Stukely, several shallow pits were sunk in a soft, shattered slaty serpentine, where a small vein of a fourth of an inch only was visible. The serpentines are in contact with the black and grey slates a few feet south of the opening, and, with the exception of the small vein noted on the road, no other indications of asbestos were visible. This serpentine differs in character from that of the areas worked in Coleraine and Thetford, being for the most part slaty and much scattered, while that of Thetford is generally massive or traversed by large joints.
- Shipton. Jeffrey's mine. The most westerly area in which asbestos is mined is at Jeffrey's location, four miles east of Danville village, on lot nine, range three, Shipton. The asbestos here occurs in a rounded knoll, one of a series which extends from Melbourne through Cleveland into the south-east corner of Tingwick, and is the only one in which valuable veins have yet been found in this direction. This was first worked in 1884, and has yielded a large amount of asbestos of excellent quality, though the

veins are not of large size. In Melbourne, on the south side of St. Melbourne-
Francis River, near the slate quarries, the hills of serpentine contain
small veins of asbestos, but these have never been found of sufficient
size to extract with profit. So also in Cleveland, near the slate quarry ^{Cleveland.}
of Mr. J. S. Bedard, small veins can be seen, but no attempt has yet
been made to work them.

Much of the serpentine of the smaller areas in Potton, Sutton,
Bolton and Orford is as yet covered by forest growth, or by drift, so
that while the search has hitherto been unsuccessful in finding large
deposits like those of Thetford and the vicinity, it is possible that such
areas may exist.

To the north of the Thetford mines serpentine occurs at several places, <sup>Area north of
the Thetford
mines.</sup>
and has been already opened to some extent. In the fourth range of
Thetford, on lots sixteen, seventeen and eighteen, knolls are found con-
taining both chromic iron ore and asbestos; the latter in veins of half
an inch to an inch; the former of a quality, in so far as tested, too
poor for shipment to a foreign market. Near Robertson station, on
lot thirteen, range five, several outcrops of serpentine are visible, and
on the road from Broughton station to Harvey Hill a number of knolls
of serpentine and soapstone are seen. In some of these, small veins of
asbestos have been recognized, but none of sufficient size to be as yet
economically available. Near East Broughton station, Quebec Central <sup>Broughton
mine.</sup>
railway, on lot fourteen, range seven, Broughton, another area occurs
in which the Broughton mine is situated.

In Leeds also, near Kinnear's Mills, several outcrops of serpentine ^{Leeds.}
are found, but these appear to be barren of asbestos, and in the con-
cession of St. Catherine, on the road leading east from St. Sylvester, a
knoll of some acres in extent has been mined by Mr. Fahey of the ^{St. Sylvester.}
latter place, but without obtaining anything of importance.

East of the line of the Quebec Central railway serpentine occurs in ^{Thetford.}
Thetford, on lots ten and eleven, range seven; lots fourteen, fifteen and
sixteen, range eight; lots fourteen and fifteen, range nine; and five,
seven, nine, ten, range ten. These areas have been examined by Mr.
Obalski, but no important veins discovered. In Adstock considerable ^{Adstock.}
areas of serpentine occur in the south-west corner of the township
adjoining Thetford, but these also seem to be, for the most part at least,
in the barren belt.

As regards the serpentines of Little Lake St. Francis, while there is <sup>Little Lake St.
Francis.</sup>
apparently a considerable development in this direction, much of it
appears to be too hard and siliceous to be asbestos producing, and no
veins of any value have yet been observed in this quarter, though the
ground has been thoroughly prospected.

In the township of Tring several outcrops occur. That on the Tring.

- thirteenth lot of the first range was opened several years ago, but only small and irregular veins were found. In the vicinity of St. Victor de Tring similar outcrops are seen, but the veins are small, being only a fourth of an inch or so in length of fibre. On the Bras du Sud-Ouest, a branch of the Chaudière, a mass of serpentine occurs at the falls, about three miles from the mouth, but though carefully prospected, has also as yet yielded nothing of importance; and on the Des Plantes, near the road to St. Francis from St. Joseph, several openings were made, some years ago, but the veins found were small and not continuous for any distance. This serpentine has the soft greasy look of much of that in the Orford and Bolton area, and is very much shattered. At the falls of the Des Plantes, between one and two miles from the mouth of the river, a considerable bed of serpentine occurs, apparently of the barren sort; and near the boundary between Vaudreuil and St. Joseph, about four miles from the Chaudière, an area of similar rock contains a large deposit of titaniferous iron ore, but has not yet been prospected for asbestos, or if so, none is yet reported. On the east side of the Moose Mountain, in Cranbourne, on lot twenty-three, range five, on the west side of the Etchemin River, a small area occurs with the trappean rocks, but no veins larger than half an inch in thickness have yet been seen.
- Several small areas occur in the township of Rolette, range four, and Talon, range six; but of these not much is known. No asbestos has yet been reported; the country in this direction being almost entirely unopened.
- In the Gaspé Peninsula the great serpentine areas of Mount Albert and the South Mountain, which mark the western prolongation of the Mount Albert ridge to the Salmon Branch of the Cascapedia, have long been known. The western portion is too hard and siliceous to give much promise of asbestos, but some portions of the Mount Albert areas have shown small veins along with deposits of chromic iron. In the eastern portion of the peninsula, at Mount Serpentine, on the Dartmouth River, a few miles from its mouth, a band of this rock associated with hornblende rock occurs, in which some small veins of asbestos were observed by Mr. Obalski; but owing to the covering of soil and forest, the full extent of the deposit could not be ascertained. This mountain, which rises, according to Mr. Obalski, to a height of 1,600 feet above the sea, was named Mount Serpentine by an officer of the Geological Survey thirty years ago. It is surrounded by the sandy and calcareous beds of the Siluro-Devonian system of that region, and probably marks the most easterly exposure of the older rocks of the Green Mountain range.
- The Chaudière River.
- Des Plantes River.
- Cranbourne.
- Rolette and Talon.
- Gaspé Peninsula.
- Mount Albert.
- Mount Serpentine.

In the south-eastern part of the province areas of serpentine are few, Gayhurst. the only one reported being in Gayhurst; but the exact location is not known, the difficulty of access being considerable. Several samples of short-fibred asbestos said to be from this locality were sent to the Geological Survey office several years ago; but nothing definite has been heard on the subject since. The quality of the sample sent does not indicate it to be of much economic importance, while the present inaccessibility and distance from the railway would seriously interfere with its development, even though the veins were of considerable size. A somewhat peculiar development of asbestos is found in the serpentine of Big Island, Nicolet Lake, in South Ham. South Ham. Nicolet Lake. Explorations were carried on there for some weeks in 1885-86, but no large veins of good fibre were obtained. The property was carefully examined by Mr. C. W. Willimott, in 1882, who reports that four varieties of the mineral occur. The first, or workable asbestos, is found in veins, the fibre of which is rarely half an inch in length, and not easily separable; the second was the coarse variety, the fibre having sometimes a length of three feet, which is apparently of very little economic value. The third variety is somewhat finer in texture, and like that which occurs along the joints of the serpentine in the mines worked elsewhere; while the fourth is a steatitic rock, in masses containing concretionary pellets of asbestos, the centres of which show a nucleus of serpentine. In the serpentine of the west shore of the lake, a large and important vein of magnetite, containing a small percentage of chromite, is found. No attempt has yet been made to work the asbestos of this district, though some money has been spent in developing a large stratum of soapstone in the vicinity, near the south end of the lake.

From a careful examination of the serpentine, extending over a Different kinds of serpentine. stretch of country for some hundreds of miles, several varieties of the rock can apparently be recognized, differing in importance as sources of supply for asbestos. Two of these varieties seem to be very nearly barren, viz., the hard reddish-brown siliceous rock, often of a greyish Barren rock. color on fresh fracture, similar to much of the Wolfestown ridge, and to that portion of Coleraine lying in the vicinity of Caribou Lake, Lake St. Francis and Adstock, as well as in the Shickshock mountains. Areas of this hard barren looking rock, of considerable extent, occur in the heart of the productive belt itself, at Thetford and Black Lake. Small, but very irregularly distributed veins are frequently seen in this rock, but they are not thick enough to repay the cost of their extraction. The second variety, which has likewise been found generally barren, is the slaty rock seen about the south side of Long Lake in Orford, and in Bolton and Potton. This rock frequently has a peculiar

greasy, or talcose aspect, and generally is much shattered. Here small veins also occur, sometimes only a few inches in length, but no well defined veins have yet been seen in this rock. In areas of serpentine associated with soapstone in quantity veins of asbestos of workable size are generally absent, though the Broughton mine furnishes an exception; the hanging wall being for some distance composed of soapstone, the foot wall of serpentine, but the deposit was, in this area confined to but one vein, as far as yet ascertained. About Long, Webster, Orford, Brompton and other lakes to the north of the Orford Mountain ridge, the serpentine is largely associated with masses of dioritic rock. This admixture is well seen about Long and Brompton Lakes; on the west side of the latter several high hills, known as Bear and Carbuncle mountains, rising from 500 to 750 feet above the surface of the lake. These serpentines have been very carefully explored for asbestos; but as yet have not yielded any satisfactory results.

Serpentines
north of Oxford
Mountain.

Irregularity of
the asbestos
veins.

Danger from
rock slides.

Faulted nature
of the
serpentine.

The irregularity of the asbestos veins, even in those areas where most abundant, should not be lost sight of. The serpentine is very greatly affected by fissures, some of which constitute faults of considerable extent. These intersect the rock in every direction, and not only frequently destroy the value of the veins by crushing or cutting them off directly, but are a great source of danger in working the quarries, especially where these have reached a considerable depth, as is the case now with most of the workings, both at Thetford and Black Lake. An unlucky blast may send hundreds of tons of rock into the pit at a moment's notice, as happened last year in the King Bros.' mine at Thetford by which great loss of life would have resulted, had not the men, a short time before the slide occurred, left the pit. The sides of these fissures, or faults, are generally smooth and slippery, and along the joints there are long strips of fibrous serpentine styled hornblende by the miners, which can be stripped off in pieces several feet in length. The occurrence of the veins of asbestos in the mines now being worked is by no means uniform—large portions are intersected by veins in all directions, some of which reach a width of four inches or more, and pass through a band of this sort to a fissure, where they end against a wall of apparently barren rock. In nearly all the mines, dykes of a whitish-grey granular rock penetrate the serpentine, shattering and otherwise altering the sides adjoining, and in some of these mines have exerted a bad effect upon the veins of asbestos; while in others, the rock in their vicinity is so shaken and seamy that water enters in such quantity as to require heavy pumping to keep the pits clear.

Although these mines have been in operation scarcely more than ten years, so rapid has been the increase in the demand and, in consequence,

the output, that the present conditions of mining as contrasted with those of even five years ago are completely changed, and in no case have the necessary provisions been made for a future regular supply. Owing to the fact, at Thetford more particularly, that the principal workings are located in a small knoll of serpentine surrounded largely by drift-covered rock of uncertain value, when first worked the large amount of waste rock which goes to the dump has been left in too close proximity to the pits. This, so long as the pits were not of too great depth to be easily worked and drained, or the demand was not too great to be easily supplied, did not so much matter, but the demand has increased so rapidly, that it is with difficulty met with the present appliances, and the inconvenience experienced from the inauguration of such a system of mining and disposition of waste rock is becoming so great as to necessitate a radical change in this respect, and that very speedily. It will soon be found impossible to carry the system of quarry working to a much greater depth, owing to the danger arising from slides, and from the cramped character of the openings. The plan, which should have been adopted at first, of removing the waste material to some portion of the area of no economic value will, therefore, have to be adopted, and the sooner the better, since, at the present rate of output, each additional year but adds to the trouble by increasing the amount of rock which must at last require to be removed.

Character of the workings at Thetford.

The Black Lake areas are in this respect rather more fortunately situated, since the principal mines are on the face of a bold ridge, and there are areas of barren rock or granitic masses at a convenient distance on which the refuse can be dumped; although here, at several of the mines, the same difficulty is experienced as at Thetford.

The Black Lake mines.

The output of Canadian asbestos when graded is divisible into four portions, numbers one, two and three and waste. The first includes the long fine silky fibre, over one inch or thereabouts in length or a little less, well adapted for spinning and manufacture into yarn, rope and similar products. The price of this fibre has rapidly advanced from eighty dollars, at which it was quoted three years ago, to one hundred and seventy or more, with an upward tendency. For many purposes it is found to be quite equal to the Italian product, while for others it is even regarded as superior. The second grade includes much good fibre, but shorter and from smaller veins; the third kind includes material very often with but little continuous fibre, or discolored and with the vein matter broken by bits of rock or grains of iron ore, while the waste includes a considerable quantity of fibre and other asbestos-like material that accumulates about the pits and sheds.

Four qualities of asbestos.

Price.

Grading of output.

The lower grades, which do not possess the requisite length of fibre for spinning into yarn, are used for felting, while the still lower grades are ground and manufactured into paints, etc. .

Economic
value of the
material.

The great value of the material, as every one at all interested now knows, consists in its capacity for resisting heat without changing its character, certain grades having successfully withstood a temperature of 4500° to 5000° Fahr. The most important of the manufactures made from the material are paints of different colors (the colors being due to the admixture of other materials with the ground asbestos), roofing and other felts, as for lining safes, ranges, etc., asbestos paper, mill board, rope, yarn, packing, etc. Of these, the paints, while not regarded as perfectly fire-proof, are largely used both for inside work and for roofs, having the power of resisting sparks or light flames; the felting is employed for the covering of steam pipes, boilers, stills, furnaces, etc.; the yarn, either as packing or rope, for packing steam cylinder pistons, flange joints, hot air-joints, cylinder heads and for other purposes, not only about steam engines, but in gas piping; mill board is also largely employed for the same purposes. Sometimes in weaving the asbestos into rope, fine copper or brass wires are incorporated therein to give it greater firmness or strength. In its manufacture, the asbestos is first torn asunder, teased out, carded, spun and woven either into sheet or rope, which varies in size up to several inches in diameter.

Uses to which
applied.

Superiority of
the Canadian
mineral.

The great excellence of the Canadian mineral is now universally acknowledged, and the fact that the serpentine of Canada contains the largest and most readily available quantity of this mineral at present known, places these mines in the province of Quebec in a very desirable position. For although its presence is known at many points in the United States, the amount is in most cases not sufficient to warrant the necessary outlay in opening up the deposits. The amount of asbestos produced in the United States in 1883 and 1884 averaged about 1000 tons, which decreased in 1886 to 200 tons, the market being largely supplied by the Canadian mineral.

In order to give a better idea of the rapidity of the growth of this industry, the figures of the output from its inception may be stated, the data being obtained from the managers of the several mines, and published in the Geological Survey Report for 1887.—

Growth of the
industry.

OUTPUT.	TONS.	VALUE.
1878.....	50.....	
1879.....	300.....	19,500
1880.....	380.....	24,700
1881.....	540.....	35,100
1882.....	810.....	52,650

1883.....	955.....	68,750
1884.....	1141.....	75,097
1885.....	2440.....	142,441
1886.....	3458.....	206,251
1887.....	4219.....	
1888.....	4404.....	255,007
1889.....	6014.....	424,350

From information kindly furnished me by Mr. Wm. King, and others, the following dates are given for the opening of the several mines at Thetford and Black Lake :—

Boston Co., on Ward's opening.....	1878	Dates of the several mining companies.
Johnston & Co.....	1878	
King Bros.....	1879	
Mr. Noel.....	1880	
Mr. Lionais (Anglo Canadian).....	1883	
Jeffrey's, Danville.....	1884	
The Bell mine, Wolfestown.....	1885	
Mr. Lionais (Scottish Canadian).....	1885	
Douville (United Asbestus Co.).....	1886	
Fenwick & Sclater, Coleraine.....	1887	
A. H. Murphy.....	1887	
Lucke & Mitchell.....	1889	
Lambly & Co., Coleraine.....	1889	

SOAPSTONE.

Soapstone, or steatite, is a rock largely composed of a talc which is rarely found in the rocks of the Laurentian of Canada, but occurs chiefly in connection with the slates and schists of the eastern townships, often in association with serpentine. An analysis of this rock from Potton township, made by Dr. Hunt, shows the composition to be a hydrous silicate of magnesia; the composition varying somewhat in different specimens—being in one case silica 59.60, magnesia 29.15, protoxide of iron 4.50, alumina 0.40, oxide of nickel, traces, and volatile matter 4.40=97.95. A second variety contained a marked decrease in the percentage of silica and magnesia, but had a considerable amount of lime with peroxide of iron and alumina. The rock is soft and is easily cut or sawn into any required shape, and as it is of a highly refractory nature it is admirably adapted for linings for stoves, furnaces and such like uses. Certain pure varieties are in demand for the manufacture of gas burners, while, when ground and purified, it answers admirably as a lubricant. It is also used, when finely ground, as a filler for paper, and enters into the composition of certain paints, being said, when mixed with oil and white lead,

Mode of occurrence.

Analysis.

Uses.

to form a durable compound of very considerable value for ordinary work.

Distribution.

Though soapstone occurs at many points throughout the belt of magnesian rocks of the townships, it is at present but little worked. In Bolton and Potton it has in past years been quarried for local uses, but the only deposit now being utilized for purposes of shipment is on the road from Coleraine to Wolfestown Corner, at the crossing of the White River, on lot nineteen, range two, Wolfestown. This is owned by Fenwick & Sclater of Montreal, formerly by Mr. Calvin Carter. According to Mr. Obalski's report this company took out and shipped to Montreal during the past year one hundred and fifty tons. It is there ground in a cyclone pulverizer and used for paints and as a lubricant. The value of the mineral at the Coleraine station on the Quebec Central railway is from six to eight dollars per ton. The bed of soapstone which is worked is near the contact of the crystalline schists and lower black Cambrian slates, and has a width of from one to ten feet where quarried on the bank of the stream.

Fenwick &
Sclater's mine.
Wolfestown.

Clark's mine.
South Ham.

In the township of Ham large quantities of this rock are found on lots forty-three and forty-four, range one, owned by the late Mr. E. Clark of Sherbrooke, and on lots forty-nine and fifty same range, owned by Dr. Reed. Mr. Clark opened the deposit on his property to some extent several years ago; but, as the distance to the railway is considerable, very little was shipped. In Hatley, on the west side of the Massawippi Lake, on lots nineteen, twenty and twenty-one, range five, it occurs in areas of considerable extent, and much of it is of excellent quality. It has been quarried to some extent, but for local purposes only.

Broughton.

A very pure soapstone, to a limited extent, is found at the Broughton asbestos mine, on lot fourteen, range seven, which has been shipped; and on the road from Broughton station, and the Quebec Central railway to Harvey Hill, the rock appears in a number of knolls, and is of good quality, massive, but not so translucent as that of the Broughton mine.

Potton.

The principal masses in Potton occur on lot twenty-four, range six, and on lot twenty of the fifth range, where a band of three feet thick is seen. In Bolton it is found on lot twenty-four, range six, in several bands interstratified with chlorite and dolomite, the soapstone beds being from three to five feet thick; also on lot sixteen, range five, and on lot seventeen, range nine, where it is connected with the bed of magnesite already described. In Sutton it is found on lot twelve, range seven, but is here not of very pure quality, being mixed with crystals of bitter spar, pyrites and a little chromic iron ore. This impure variety is also found near Knowlton, and in Bolton, in bands of

Bolton.

Sutton.

great size, reaching a width of from twenty-five to fifty yards. On the fourth lot of the fourth range of this township it contains asbestos, actinolite and talc. These minerals have not yet been found in this direction in sufficient quantity to be commercially valuable.

Steatite also occurs at the falls of the Bras in the Chaudière district, ^{The Chaudière River.} about three miles from its mouth, along with the serpentine of that locality, and with dolomites in slates. It is not, however, sufficiently pure to be of great importance for the purposes for which it is generally employed at present.

Potstone, or compact chlorite, is found also at several places in the ^{Potstone.} magnesian belt, more particularly in the townships of Bolton, Potton and Broughton. It differs from the soapstone in the smaller percentage of silica, and the greater quantity of alumina and water. It is soft like the preceding, and can be easily cut or turned into different shapes, forming culinary vessels of great usefulness. A large bed is found in Bolton, on lot twenty-six, range two, having a reported thickness of twenty feet; also on lot twenty-six, range six of Potton, and on lot four of the twelfth range of Broughton. It occurs also in Garthby, but has not been worked at any of these localities, except very locally. The assay of the rock from Potton, by Dr. Hunt, gives ^{Analysis.} silica 29.60, magnesia 25.95, protoxide of iron 14.49, alumina 19.70, water 11.30=101.04.

Among the other refractory materials found in the province, though ^{Mica rock, Shipton.} not at present utilized to any considerable extent, may be mentioned a mica rock in Shipton, lot eighteen, range five, resembling in some respects a potstone, being a compact hydrous mica, but which has not been quarried, or at least recently. A fire clay from Joliette was also exhibited at the London Exhibition of 1886, by Mr. Dupuis, who, however, did not furnish any details as to its mode of occurrence or exact locality. ^{Refractory sandstone.} Refractory sandstones for furnace linings have been obtained for many years in the vicinity of Three Rivers, and were used as hearths for the St. Maurice forges. These are apparently from the flaggy beds of the Postdam formation, and have been referred to elsewhere. The same formation in Ontario has furnished similar refractory slabs, which have also been used in blast furnaces.

CLASS IX.

GRINDING AND POLISHING MATERIALS.

- Grindstones.** These occur in various forms and at a number of places. They embrace grindstones for cutlery and edge tools, millstones, whetstones and infusorial earth, with marls from which whiting can be obtained. Grindstones are rarely manufactured in the province, the superiority of those from the sandstones and grits of New Brunswick and Nova Scotia, together with the low rate of water carriage, being such as to give them the preference. Certain bands of the Chazy formation on the Ottawa, however, produce grindstones that answer well for edge tools; and some of the finer varieties of the Sillery sandstones might be found suitable for this purpose.
- Millstones.** Millstone rock is found in the Laurentian series on the first lot of the sixth range of Grenville. It is a sort of cellular chert occurring in veins in the syenite, which extend from the lot mentioned to the third lot of the fifth range. The stone much resembles the French buhrstone in character, and is said to be equally adapted for the manufacture of millstones, though it is somewhat difficult of extraction. In certain parts of the country some of the bands of the gneiss of the Laurentian are found to answer very well. Along the contact of the Trenton formation with the Laurentian a band of quartz conglomerate seen at many places below Quebec is found to yield good millstones; and on the Chaudière a granitoid gneissic rock associated with the serpentine of that district between St. Joseph and St. Francis has been used successfully for years.
- Whetstone.** There are whetstone bands on Whetstone Island, Memphremagog Lake; on lot four, range nine, Stanstead; near the upper end of Massawippi lake, on the west side; on lot twenty-three, range six, Bolton; in lot seven, range two, Kingsey; and lot nine, eighteenth range of Orford; as well as at other points in the slate and serpentine belt of the eastern townships. A quarry of honestone has more recently been opened in Ham by Mr. E. Richard of Arthabaska. Though but little attention seems to be directed to the whetstones of this district at present, there is no apparent reason why they should not be worked at a profit. The rock is, for the most part, a fine grained, micaceous and siliceous slate or schist, and some of the bands yield a stone of a very fine quality; while certain bands of mica schist associated with the pre-Cambrian rocks of the Sutton Mountain axis should also be well adapted to the manufacture of scythe stones, &c.
- Honestone.**
- Scythestones.**

Polishing powders, deposits of infusorial earth or tripoli c, are known at but few places. On the north side of the St. Lawrence, in range seven, Gosford, near the north branch of the Ste. Anne river, on land of Mr. Lorette, a small area is reported by Mr. A. P. Low, of about one acre in extent; and samples of excellent quality have been received from some point near Quebec, but the exact location has not been disclosed. A sample has been forwarded by Mr. Obalski from the Rev. Mr. Gerin Lajoie, curé of St. Justin, Maskinonge county, Three Rivers. A polishing powder is also prepared in Westbury township, but the material from which it is derived is at present unknown.

Whiting can be prepared from shell marl, the deposits of which have already been alluded to, by simply mixing the marl with water and allowing it to settle in vats. As these deposits of marl are numerous, and the price of good whiting from six to ten dollars per ton, it should be manufactured at a profit. Most of the whiting of commerce is, however, prepared from ground chalk. The marl is manufactured into whiting in Hastings county, Ontario, by W. G. Allen & Sons of Marlbank.

CLASS X.

MINERALS APPLICABLE TO JEWELRY AND THE FINE ARTS.

Under the heading of Materials for Ornamental Purposes, attention is directed in the Geology of Canada, 1863, to the occurrence of various minerals, sometimes occurring in large masses as the phorpyries, serpentines, and labradorites, but in others in comparatively limited quantity. These, when cut and polished, furnish stones well adapted for ornamentation on the large scale, as for table tops, mantels, etc., while of some of the rarer minerals it may be said that at times specimens of great beauty occur, which when cut and polished, constitute gems of considerable value. Attention has been called to this branch of industry by the establishment in Ottawa, within the last year, of the lapidary firm of C. P. Willimott & Co., which, in showing what material Canada can furnish for decorative purposes, is doing a very excellent work.

While precious stones, properly speaking, cannot be said to be found in the province of Quebec, some of the quartz veins which traverse the Laurentian rocks of the townships of Hull and Wakefield, and presumably of other localities which have not yet been closely examined, yield small pieces or pellets which separate easily from the surrounding quartz mass. These, when cut, furnish beautiful stones of the class

- Quartz Asteria.** called by Dana "Quartz Asteria," and by Tiffany "Star Quartz," from the peculiarity possessed by the cut specimen of showing a star of six rays. When the cut stone is turned, these six rays have the property of merging into one somewhat resembling a cat's eye. In the same quartz vein from which these specimens are obtained are also found specimens of a bluish amazon stone, while from other portions the variety known as the hair stone is obtained, a greenish transparent quartz penetrated by hair-like filaments of actinolite.
- Hair stone.**
- Agates.** Of agates, while it may be said that these occur in the district, the specimens obtained are generally of inferior quality, not comparing with those from Lake Superior or Nova Scotia.
- Jasper.** Jasper occurs in veins or beds in the township of Hull, the principal workable deposit being a vein from one to two feet thick of red and yellow and red mottled shades, which when polished presents a very handsome appearance. Blocks of large size can be obtained from this locality. The porphyry of Grenville and of Chatham has been described in the earlier reports of the survey. Of these, it is remarked in the *Geology of Canada*, 1863, p. 832, that on the fourth lot of the sixth range of Grenville there is "a great mass of this porphyry which varies in color from leek-green to blackish-green, and is marked with red, brown and black spots. It is very compact and has a conchoidal fracture. This green porphyry is here about fifty feet in breadth, and to the northward it passes into a chocolate-brown variety, which is still more abundant. Specimens of several varieties of these porphyries have been cut, all of which receive a fine polish, and are very beautiful. They may be obtained in large blocks, and do not appear to be much harder than the granites of Aberdeen and of other regions which are now cut and polished on a large scale, while they would far surpass the latter for beauty."
- Porphyry.**
- Garnets.** Garnets are found in the Laurentian rocks in considerable quantity, but rarely of a quality suitable for cutting for gems. Chrome garnet is found in the eastern townships, but not in crystals or size sufficiently large for cutting. Crystals of garnet have also been reported from the township of Wakefield, and this locality also affords small crystals of a lemon or brownish-yellow variety, which when polished are very transparent and brilliant.
- Tourmaline.** Tourmaline occurs generally in long crystals imbedded in the vein matter of the rocks of Wakefield, and is generally not of a quality fitted for gems, but occasionally pieces are found sufficiently clear for this purpose.
- Peristerite.** Several varieties of felspar are known. A mixture of albite and quartz, called peristerite, occurs at Villeneuve, in which the felspar has a beautiful play of color. A bluish variety of the albite is said to

have the same hardness as the Ceylon moonstone, and furnishes géms Moonstone. equal in appearance to those from Ceylon, the reflection being blue instead of white. Of the orthoclase variety, that known as adularia furnishes handsome gems equalling the Ceylon stone in beauty.

Labradorite, or Labrador-felspar, presents, when polished, beautiful Labradorite. opalescent tints of blue, green, gold and purple. Though there are great masses and areas of Labrador rock, but a small proportion of the mass is available for the cutting of ornamental stones, the beautifully tinted variety generally occurring as small imbedded portions. Towards the peninsula of Labrador, from which the rock takes its name, large masses of the precious variety are known to exist at certain points, among which may be mentioned Paul's Island in the Strait of Belleisle. This, when cut, forms, from its flashing tints, a very handsome stone, either for gems, or for interior decorative work.

The Amazon stone, which was for some years supposed to be confined Amazon stone. to Colorado, has recently been found in the townships of Hull and Wakefield. It occurs in a coarse granite vein as large imperfect crystals, the angles in most cases being rounded. The stone is, however, quite equal in tint to that originally obtained from the Pacific slope.

Among other minerals may be mentioned Scapolite, found in Scapolite. Grenville, and from which large slabs of a beautiful yellow can be obtained; Rensællerite or Pyralloite, also from Grenville, which will yield either slabs or columns, and which, when dressed, are exceedingly handsome ornamental stones. The serpentine has already been referred to. The so-called Quebec diamonds, which are occasionally cut and polished, are merely crystals of quartz, which are often found Quartz crystals. of large size; while along the shore of Bay of Chaleurs and Gaspé Basin beautifully colored pebbles of Jasper and other stones, which have been derived from the disintegration of the Devonian conglomerates of those shores can be picked up in great numbers, and are susceptible of a high polish.

CLASS XI.

MISCELLANEOUS.

In addition to the minerals of economic importanee described in the preceding pages, several others already indirectly alluded to may be mentioned. Of these, the most important are those applicable to the manufacture of porcelain and of glass, and for the lining of furnaces, as well as for moulding sands, &c.

Felspar.
Villeneuve
mine.

The deposit of felspar from the Villeneuve mica mine, on lots thirty-one and thirty-two, range one, Villeneuve, occurs in a vein of considerable size, which has been traced for several hundred yards. This has been mined and shipped to England and the United States, and has been used in the manufacture of porcelain, for which it appears well adapted. From the report of Mr. Obalski, M.E., Quebec, in the report of the Crown Lands Department of that province, 1889, we find that this rock is a nearly pure or orthoclase felspar, the analysis of two samples being given, thus:—

Silica.....	64.7	63.96
Alumina.....	18.4	19.16
Potash and Soda.....	....	16.88
Iron.....	....	traces.
Magnesia.....	0.3	.....

The amount of felspar shipped from this mine for the past year was 250 tons, according to Mr. Obalski's report; but according to the Mining Review the amount produced was 411 tons.

Sandstone for
glass-making.

In the Geology of Canada, 1863, p. 798-800, reference is made to the presence of sandstones suitable for glass-making, and for the linings of blast furnaces or other refractory purposes. Of the former, deposits of sandstones of the Potsdam formation are found on Isle Perrot (Vaudreuil), at Lachute, Ste. Scholastique and Beauharnois. These are very free from iron, and have been employed in the manufacture of glass in former years both at the old works near St. Johns and at Vaudreuil. The blast furnaces of St. Maurice and Batican obtained their linings from beds of sandstones of the same age as the above, which were found to answer admirably. In Pittsburg, Frontenac county, Ontario, a friable bed of this sandstone is easily powdered, and is shipped to Montreal and Toronto, where it is used to protect the sides and bottom of furnaces,* and which is worth in Montreal about three dollars per ton.

Sandstone for
furnace lining.

SULPHURIC ACID.

Sulphuric acid
works,
Capelton.

The only works at present in operation in Quebec are those belonging to G. H. Nichols & Co., Capelton. Though only in operation about three years, the amount of acid produced during the past year was over ten million pounds. The acid at this place is made from the pyrites of the copper mines adjacent to the works, and in connection therewith, the same firm has introduced the manufacture of superphosphate of lime from the phosphate or apatite of the Ottawa

* See Geology of Canada, 1863, p. 800.

district. This industry has rapidly increased since its inception, and promises to develop shortly into one of the most important in Canada. It is understood that a powerful English company is shortly to commence the manufacture of phosphate on a large scale by erecting works near Buckingham and at Capelton also.

The Ottawa county phosphate is also employed to some extent in the fertilizer works owned by Mr. R. J. Brodie & Co., at Smith's Falls, <sup>Brodie's works,
Smith's Falls.</sup> though the acid used is manufactured by the firm from sulphur obtained from Italy and from Japan.

In connection with the deposits of peat in the St. Lawrence Valley, <sup>Peat moss
litter.</sup> a new industry which has lately been developed in New Brunswick, where peat bogs are also found, viz., the preparation of moss litter for stable use, is worthy of consideration. The process is referred to by Mr. R. Chalmers in his summary report for 1889. The material owes much of its value to the great power of absorption it possesses when dry. The top of the peat bog is removed, with the living growth of bushes, &c., and the second layer or that lying upon the fuel peat, also. This litter is passed through a set of rollers by which a greater part of the contained water is extracted, the remainder being removed by evaporation, after which it is packed in bales for shipment, the market at present being principally in the United States. The price per ton of this moss litter is, according to Mr. Chalmers, from \$15.00 to \$17.00. As a litter for stable bedding it is of great value, absorbing all the liquid matter and ammonia, while it is much more cleanly than most of the preparations heretofore employed for this purpose. A large market should be created for this material when once its excellent properties are recognized.

