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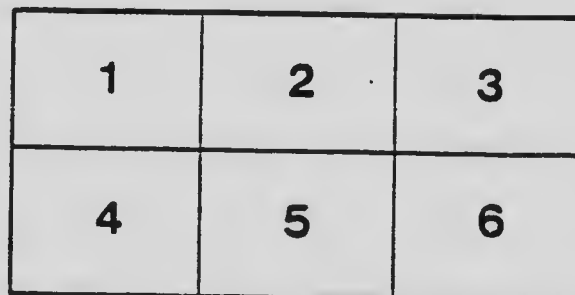
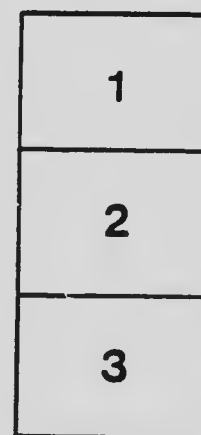
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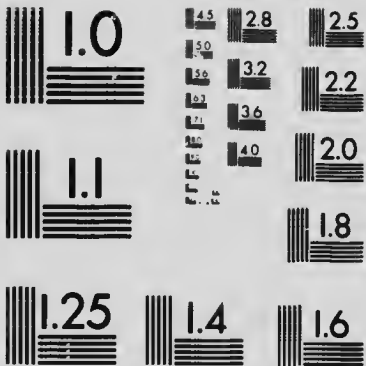
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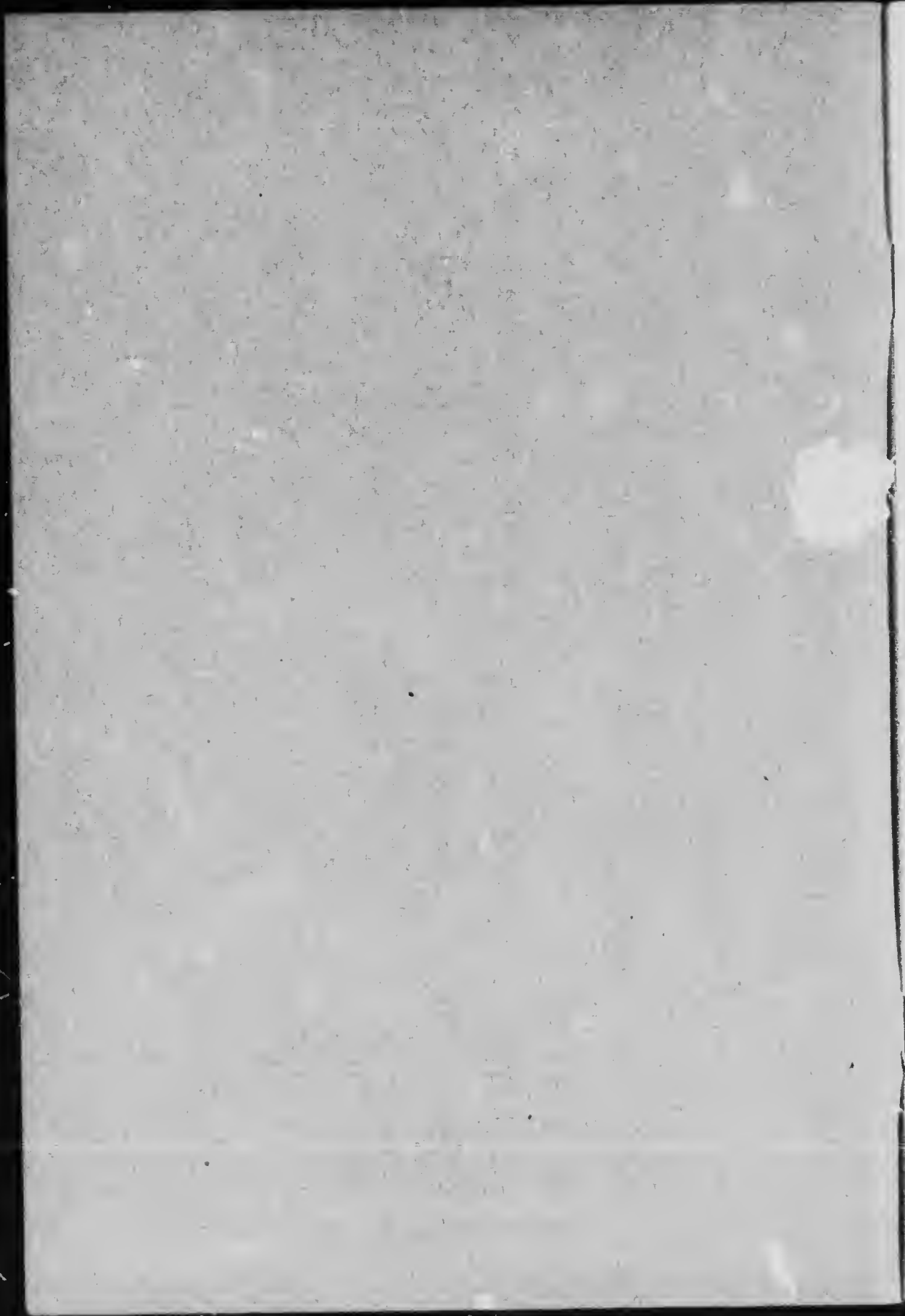


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**Undeveloped  
Mineral Resources  
of Ontario**



**By  
Willet G. Miller  
Provincial Geologist  
Toronto, Ont.**



**UNDEVELOPED MINERAL RESOURCES OF ONTARIO.**

BY WILLET G. MILLER, Provincial Geologist, Toronto, Ont.

*Toronto Meeting, March, 1904.*

Complaints, whether just or unjust it is not our province to determine, are often heard to the effect that our neighbors to the south have usually gotten the better of us in the various treaties and conventions which have been held between the two countries from 1776 onwards, but it is recognized by few that certain natural agencies, even before the time of Adam, were working in behalf of our neighbors, in an agricultural sense at least, and against us. A large part of the soil, which undoubtedly covered our now rocky areas at the end of the Mesozoic era, was transported to the southward, across what is now the international boundary, in the succeeding era by the ice sheet which completely covered the territory which we now call Ontario. What would have become, long ere this, prosperous homesteads and rich agricultural communities, were forever rendered impossible by the movements southward of the great glaciers, whose effects, greater than those produced by the greatest of invading armies, are to last through all time. While the Canadian agriculturist may regret that many a fertile plain and valley in the great Republic owes its prosperity to the stealing of our soil by the ice kings, his brother, the miner, rejoices that old mother nature in that far distant time was working for his benefit. By carrying away the soil she exposed the ore-bearing rocks to his view.

We hear a great deal of what heated waters and volcanic action have accomplished in the formation of ore deposits, but no one has yet come forward to champion the glaciers, to whose action in many parts of the world the mineral industry is so much indebted. They seem to have concentrated the gold in the far-famed Klondike; they have scoured many a mountain and plain, exposing the treasures in the rocks beneath; they have furnished

us with many a lakelet and waterfall, and have rendered picturesque many a region whose landscape would otherwise have remained monotonous and unattractive.

It is difficult to state definitely what part of the 220,000 square miles embraced in the territory of Ontario possesses a rocky surface that is not well adapted to agriculture. It probably is about one-half. Over this broken region there are what have been roughly classed as two great groups of rocks, the Laurentian and Huronian. We have been educated in the belief that the Huronian is *par excellence* the mineral-bearing system of the two, and that the Laurentian, with the exception of the crystalline limestone and associated rocks of the Grenville series, was to be considered of little economic importance. Much of what we call the Laurentian system is composed of acid plutonic and metamorphic rocks—granites, syenites and gneisses. We have been told that these particularly, which occupy vast areas, were of very little importance, as the storehouses of economic minerals. Prospecting and development work during late years have, however, disproved the old belief concerning this series; and I look forward to further interesting mineral discoveries being made in these maligned rocks. Mica, which, with the advancement in electricity is likely to become still more important, is found in what appear to be economic quantities in many coarse-grained granites. Heretofore the mica mined in this province has been practically all of the phlogopite variety, which is found associated with apatite, calcite and pyroxene. The greater part of the muscovite used on this continent has been imported from India. One of the chief electrical firms of the United States is now planning the development of muscovite deposits in Ontario to replace that from India now used by them. This promises to become an important industry, as white mica is found in many localities from the western boundary of Quebec to the eastern border of Manitoba. Micanite has brought about the use of smaller sheets of mica than could be used a few years ago, and many of the muscovite deposits, considered of no value at that time, now contain merchantable material. Then these Laurentian granites are known to be the



storehouses of many rare minerals, some of which have at present economic uses and others may be expected to have at no distant date. The only specimen of wolfram, the ore of the metal tungsten which is used in a steel alloy, ever found in this province was attached to a boulder of the heretofore much despised Laurentian granite. Again, the only deposit of columbite, a mineral which has recently come into commerce, occurs in a coarse grained granite dike. Within the last few years an important corundum industry has sprung up in one of these formerly so-called barren granite districts; the mineral has been found at numerous points in belts of these rocks, which have a known length in the province of about 100 miles. Other examples could be given to show that the larger, hitherto neglected, Laurentian granite areas are well worthy of the attention of the prospector. Enough has, however, been said to show that these rocky areas are not to be left unconsidered when estimating the value of our undeveloped mineral resources. They already furnish us with a greater variety of economic minerals than the Huronian and younger formations which in years gone by were the favorites of the prospectors. Our mineral-bearing areas are, therefore, much more extensive than they were formerly thought to be.

To worthily justify its title this paper should possess the size of a large volume. Our undeveloped mineral resources are extremely varied in character.

The writer showed in a paper published in Vol. V of the Journal of this Institute\* that Ontario produced as great a variety of minerals as probably any other area of the world of like extent. My object, however, is not to attempt a detailed description of these resources, even had time permitted, but to give a rough outline of the field that lies waiting for the mining man in this province. In order to do this systematically, but briefly, I shall use a classification, which has long been adopted by the Geological Survey, and divide the useful minerals and rocks into several groups.

\* Eastern Ontario: A Region of Varied Mining Industries, *Journal Canadian Mining Institute*, Vol. V, p. 233.

### 1. Metals and their ores:

The ores of the following metals have been profitably mined in the province: gold, silver, platinum, iron, nickel, copper, lead, zinc. A small amount of molybdenum ore has also been produced. Most of the other metals, both common and rare, which are used in the arts are found here. For example, the richest ore of aluminum, corundum, is found, as already stated, over a large territory. This substance, however, brings a higher price as an abrasive material than as an ore, and is consequently not used for the extraction of the metal. Titanium, which appears to be destined to play an important part in alloys, occurs in numerous, at present undeveloped, deposits. Tin has been found in small quantities in the vicinity of Sudbury, and in Renfrew county. Mercury has been found at one locality, Silver Islet, in very small amounts. The metal tungsten, as already stated, has been found only in a boulder. Arsenic, the chief use of which is not in the metallic form, and other metals which are employed in the arts in the form of oxides or other compounds will be discussed under other headings.

*Gold.*—Considering the extent of territory over which gold deposits occur in the province, and the numerous areas in which prospects have had more or less work done on them, it must be admitted that we have large undeveloped resources in this metal. The present state of our gold mining industry is due chiefly to incompetent management, stock-jobbing and other speculative factors—the parasites which attack the industry in all countries while it is in a weak, undeveloped state. It is to be expected, however, that after the epidemic has spent its force, like those which at times attack our bodies, the industry will be in a sounder condition, and will soon reach such a state of healthy development that parasites will be ineffectual to injure it. Our President has stated that the most promising gold prospect he examined while in the service of the Geological Survey, in the Lake of the Woods area, 21 years ago, has lain untouched ever since, being tied up through the belief of the owners that they could make a profit through someone else's expenditure. Mr. Carter shows in his paper

that we have nothing to fear from the deep development of our gold mines. Such factors give us confidence that the undeveloped state of our gold deposits is not due to the quality and amount of ore. We have, therefore, reason to place a value on our gold fields of the Hastings district, Wainapitae, Michipicoten, Thunder Bay and Rainy River, as promising to be important assets in the future. Then there are the placer deposits which stretch for many miles along the Vermilion River, and those of Sturgeon Lake which cover a large area. Under more favorable conditions some at least of these areas should be worked at a profit.

*Silver.*—In the district surrounding the head of Lake Superior we have had one great silver mine, and a group of others which have produced a considerable amount of the metal. Five hundred miles to the west of this, across a region much of which is difficult of access, and practically unexplored, very promising silver deposits have recently been discovered. Is it not reasonable to conclude that the great intervening region, over a large part of which similar rocks occur, probably contains numerous undiscovered deposits?

*Platinum.*—The metal platinum, which is frequently associated with the noble metals, gold and silver, in nature, is found in the Sudbury ores. Unfortunately the most promising deposit of this metal yet discovered has lain dormant since its discovery for 15 years or more, owing to differences among shareholders—a cause which is primarily responsible for the undeveloped state of other important ore bodies in this province.

*Iron, Nickel, Cobalt.*—The areas occupied by rocks which give promise of containing workable iron deposits occupy a greater extent of territory than those in which there are fairly definite indications of any other metal. Neglecting for present consideration the older explored areas in southeastern Ontario, the iron range formations which surround the Ontario side of Lake Superior and extend westward towards Manitoba, and eastward to the Quebec boundary, have an aggregate length of several hundred miles. As many parts of these ranges possess characteristics similar to those in the Lake Superior region of the United States it must be admitted that this

province in all likelihood possesses vast undeveloped iron resources. It is to be hoped that they will not be tied up like some other of our mineral deposits. In the northern and western parts of the province there is only one iron mine which has been a producer of importance. This deposit owes its development largely to a favorable situation. As facilities for transportation are supplied to more remote fields others will undoubtedly become producers.

Their magnetic properties distinguish iron, nickel and cobalt from all other elements. The iron-bearing formations of Ontario are not less in extent than those of any other part of the earth of equal area. The province has only one competitor as a nickel producer, and her undeveloped resources in this metal appear to be unequalled. The deposits which have been developed form only a small percentage of those known to exist in the Sudbury area.

Cobalt does not come into commerce as a metal, but as an oxide. It is found in Ontario in deposits richer than are known to occur elsewhere. If the promise which the recently discovered deposits give is fulfilled, no country will be able to compete with this province in the production of cobalt. The market for the oxide of the metal is restricted, and our ores being so much richer than those found elsewhere should control the market.

Is there not something strange in the fact that this group of three metals—iron, nickel and cobalt—which possess properties different from all other elements should be found in unsurpassed quantities in this province? Have magnetic influences had something to do with their concentration? Or is it owing to the fact that in our province a large area of the oldest known rocks are exposed? Probably during the early period of the earth's history these magnetic metals occurred abundantly near the surface. More recent formations have been formed by the breaking down of these earlier formed rocks and the metals, especially nickel and cobalt, have been scattered. It may be said that our deposits of the three metals do not all occur in our oldest rocks. The eruptives, however, whether massive or fragmental, which are associ-

ated with the deposits, were formed, in all probability, from material which existed not far from the early surface and had not been worked over by agents of denudation.

*Copper.*—Copper deposits are numerous in the territory bounded by the lower end of Lake Superior and the upper end of Lake Huron. Considerable development work has been done on these deposits during the last few years, and it would appear that a fair percentage of them will become producers. During the last decade or more, copper has been produced in association with the nickel ores of Sudbury. All these nickel deposits carry copper, and Ontario will in the years to come be credited, from the nickel mines, with a considerable amount of the metal now so much in demand for electrical and other uses. Another copper mine, that of Massey Station, has recently become a producer and the province has, chiefly, to thank the tireless energy and skill of that veteran metallurgist of this Institute, Major Leckie, for this much to be desired consummation.

Outside of the district embraced in the southern portion of Algoma and Western Nipissing the only copper property which has received serious attention is that which is now known as the Tip Top mine, west of Port Arthur. This mine has reached a stage of development which the owners consider warrants them in erecting a smelter.

The success already achieved in the copper industry, together with the knowledge that many deposits over a large territory, are as yet untested, should lead us to conclude that the province has a good future ahead as a copper producer.

*Lead and Zinc.*—The metals lead and zinc are commonly found associated in nature. Most of the deposits of these metals throughout the world are in rocks younger than the Archean, and from what I have said concerning the magnetic metals it might be inferred that lead and zinc would not be found in the province in large amounts. These metals show a tendency, however, to make their abode in limestones, wherever they can find them. In our Grenville

series, crystalline representatives of these rocks are found, occupying large areas, and the metals occur at numerous points. The character of the deposits of these metals is, however, characteristically difficult to determine, and they are often hidden, owing to the softness and easy weathering of the limestone. Hence there is reason to believe that many of these ore bodies are yet awaiting discovery. Zinc deposits have been worked in both the eastern and western parts of the province. Work on the Lake Superior deposits ceased a couple of years ago, but a mine in Frontenac county has been producing ore in small quantities for two or three years, and can apparently continue as a producer for years to come. This latter mine illustrates what I have said about the difficulty often experienced in discovering deposits of the metal. It is situated in a cleared field in a part of the country which had been prospected for years without the deposit being located. That metamorphic or Archean areas are not to be avoided by those in search of zinc is shown by the fact that the great deposits of New Jersey are in limestone similar in character to those of our Grenville series. And although the great Missouri zinc-bearing rocks are not of Archean age still they are rather closely connected with these rocks. In that state, isolated knobs, representing peaks of mountains which rose from the Archean surface, project through the later sedimentary formations.

The lead deposits of Ontario are similar to those of zinc, and what has just been said will apply to them. We have, in Hastings county, one working lead mine, with a small smelter, and it is not unreasonable to suppose that other deposits, both known and unknown, will be worked in the future.

Having made this rapid survey of our metallic resources, I shall now briefly review the other groups of economic minerals found in the province.

## 2. Minerals used for grinding and polishing.

I have shown that Ontario has unsurpassed resources in iron and nickel, which form an alloy which is to be the metal of the 20th century. In the manufacture of machinery, utensils, and other articles composed of metal, a substance is needed to

smooth down the rough castings and forgings. Mother nature, in furnishing us with these great metal deposits, did not forget to supply us with the mineral needed to polish the metal and put it into marketable form. Hence, she gave us the great belt of corundum-bearing rocks that is found in south-eastern Ontario. Already two plants have been erected to extract corundum from these rocks, and there is room for others. One of these plants which is just completed is surpassed in size in comparatively few districts in which concentration is being carried on.

Formerly it was the custom to use the lathe almost exclusively in shaping up and reducing the parts of machinery and other metallic articles. The lathe is now being replaced by wheels of abrasive material, which do the work more cheaply and accurately. In working the harder metals and alloys corundum has been proved to have no equal, either among minerals or artificial abrasive materials. Hence it is natural to conclude, when we consider the development already done and the numerous deposits still lying dormant, that Ontario has very valuable assets in this abrasive substance.

### 3. Refractory materials.

Possessing the wealth in water powers that we do, it is fortunate that there are found in the province large deposits of graphite or plumbago, a mineral which is of great importance as a furnace lining. Deposits of this substance are known to occur in several localities. Two are being worked and others have had preliminary tests made on them recently. Soapstone and other substances used to withstand heat are also to be found. Ontario's graphite exhibit was one of the striking features in the mines building at the Buffalo exposition.

### 4. Minerals used as pigments.

Pigments or paint materials are produced from a number of minerals, some of which, lead and zinc, have already been mentioned. Our cobalt deposits, however, promise to give us the highest standing as producers of material, metallic, used for coloring purposes. The ore bodies recently found in the vicinity of Haileybury contain ore running as high as 16 per cent. in cobalt.

The present supply of the metal comes chiefly from New Caledonia, and the ore as mined there does not run a quarter of this percentage. Other mineral pigments occur in the province, but do not need special mention.

5. Gem stones.

Stones of this class have not been found in the province, although the opaque variety of the ruby and sapphire, corundum, as already shown, is abundant. Common beryls are also found, but, as yet, not the gem varieties, emerald and aqua marine. Several minerals which, when cut and polished, have a handsome appearance have been used to some extent. Several writers have drawn attention to the fact that diamonds likely occur in our northern districts. Judging from the fact that these stones are found in drift deposits to the south of the international boundary, and that carbon, e.g., the Sudbury coal and graphite elsewhere, is found in close association with basic eruptives, there seems to be good reason to believe that diamonds may yet be discovered in northern Ontario.

6. Minerals used in certain chemical manufactures.

Probably no chemical manufacture is more important than that of sulphuric acid. There are two working iron pyrites mines in Hastings county. These mines are on deposits which have been known for years, but lay dormant till recently. The mineral is found in promising amounts in many other localities. The great length of our iron-bearing ranges has been mentioned. Belts of rock carrying iron pyrites run parallel to these and appear to carry pyrites in important amounts. Near the Helen mine a large deposit of pyrites has been tested by the diamond drill. Some hundreds of miles to the north-westward a pyrite deposit, situated near an iron claim on Steep Rock Lake, has also been drilled into. Pyrite is found in considerable abundance near Lake Temagami. Mr. Sjöstedt, in a paper read at this meeting, describes a method of manufacturing sulphuric acid from pyrrhotite, our deposits of which are of large size and numerous.



Molybdenum and other minerals which have been mentioned come under this heading to some extent, as they are used in chemicals.

7. Minerals used in agriculture.

Our phosphate deposits, which are found over a large area in south-eastern Ontario, have lain idle since the discovery of the lower grade, but more cheaply worked, deposits of the southern states. A large supply of gypsum, another mineral of value to the agriculturist, is found in abundance along the Grand River in older Ontario, and on the banks of the Moose, in the north, the substance appears to occur in considerable quantity.

8. Fuels and illuminating materials.

For years past the south-western peninsula of Ontario has been an important producer of petroleum. During the last two or three years the supply has declined. That this part of the province still has important deposits of oil admits of little doubt. Heretofore this substance has been looked for practically only in the Corniferous formation, in which the first wells drilled happened to occur. Within two or three months oil has been struck in promising quantities in two other formations, which up to the present have received little attention from those interested in the industry. One of these formations lies 700 or 800 feet below the horizon from which oil is now obtained, and the other is still older.

In that great, practically unexplored, region of the province which occupies the James Bay slope, the Corniferous rocks are said by Dr. Robert Bell to occupy a greater extent of territory than is embraced in the whole of the south-western peninsula of Ontario. Is it not more than likely that both oil and gas will be found in this northern region when it is rendered accessible by the building of railways? Niagara and other formations also occur there. In fact it presents practically the same geological conditions, but on a larger scale, as the older part of the province which has already proved to be productive.

New gas pools have been exploited recently, and what has been said concerning oil applies to this very useful substance.

After years of experimenting, the problem of briquetting peat in a form suitable for our market seems to have been solved. If this is the case the numerous large deposits of this fuel in older Ontario will add very materially to our annual income. When the more northern territory is opened up deposits enormous in extent will be rendered available.

It will be admitted, I think, from what I have said that the province has very large undeveloped resources in these three important substances.

9. Materials for brick, pottery and glass.

Materials suitable for brick making are found in abundance in older Ontario, and beyond the height of land, in the great clay belt of 16,000,000 acres, brick should be a very popular material in the settlements that are to come.

The pottery industry is only in its infancy in Canada, and there is likelihood of great development. Feldspar is a mineral which is in great demand for use in the manufacture of pottery. During the last three or four years one of the largest known deposits of feldspar has been opened up in Frontenac county. The quality is such that it is in much demand in the United States. It may be added that feldspar, of which there are many promising undeveloped deposits in the province, is one of those minerals which are found in the formerly much despised Laurentian.

Our glass industry is in much the same position as that of pottery. Even the common raw materials, such as lime and quartz sand, have always been imported for use in our only two working factories, although raw materials of the right quality are to be found here.

10. Cement.

The Portland or artificial cement industry has made rapid strides in this province within the last decade, and there now seems to be little need of drawing on foreign supplies of this material. All of our working cement factories use marl as the raw material for the lime in their mixtures, although a high percentage of the factories in New York State and elsewhere employ solid

limestone, which it is said makes a saving in the cost of manufacture. It apparently was not known that Ontario had limestone in abundance pure enough for use in cement. One of the factories now being erected is to use limestone. The norther, unsettled agricultural region tributary to James Bay is well supplied with this raw material required in the cement industry.

Cement is affecting some of the older industries and trade in some materials is now in a transition state. Cut stone for use in canal work and other structures is being largely replaced by concrete. Lime for use as a mortar is of less importance than formerly. Portland cement is taking its place, especially in buildings which are erected in frosty weather. It is said that in Germany Portland cement has entirely replaced natural rock cement, and it is probable that the same thing will occur here. Cement blocks, when further improved, will also affect the brick industry.

## II. Stone.

The stone industry of the province is in what may be called a pioneer state. We import all our granite for monumental and most other purposes, although there is probably no country which possesses a greater variety of granite, either as to size of grain, color or other qualities, than Ontario. Trade prejudices are to some extent responsible for this. Scotland has for years been an important producer of granite for monumental purposes, and it has been the ambition of most Scotchmen to be buried under an Aberdeen stone. Of late years the Scottish granite has met competition in New Brunswick and elsewhere, but the stone is probably passed off as the Aberdeen, and many a son of old Scotia sleeps his long sleep as peacefully under one of these as if it were the genuine.

Marble stands in about the same category as granite. Trade prejudices and the competition of large foreign quarries have prevented the development of the numerous and varied resources in this material which are to be found in eastern Ontario. Attempts have been made to work marble at a number of points in the province, but the works have never got down to depths sufficient to be below the influence of surface agencies, and the quarries

have been given up practically untested. Renfrew is the only locality which produces marble at the present time. Some wealthy and patriotic citizen of Toronto or of some other of our cities would be doing a good service to the country if he would erect a residence of marble, and thus show that we have material as good as is to be found elsewhere. There is a marble residence in Brockville, but the material was brought from New York State. Marble should also be used in some of our public buildings. What an advertisement it would be if considerable marble had been used in the Science Building now being erected in this city! How long, having the resources we do, shall we continue to import our marble from Maine, Georgia and other states?

Jasper, agates, porphyries and other rocks and minerals used for decorative purposes are found in considerable variety here, but little use is made of them. The tourist on Lake Superior who buys a polished agate, for the reason that it is said to be found on the shores of that inland sea, and he desires it as a memento of his trip, often "gets taken in." Most of these agates originate in South America. They are taken to Germany, where they are polished and stained, and shipped abroad to be sold to gullible tourists. These agates are about on a par with specimens that formerly were sold to tourists at Niagara Falls. The hawkers used to solemnly affirm that the rock represented the solidified foam which gathers at the base of the Falls.

Limestones enter into probably more industries than do any other rock or mineral. The uses to which they or their constituents are put are almost innumerable, and the varieties of these rocks which are required by one industry or another are numerous. The older part of Ontario contains limestones adapted to use in any industry. We have those which are practically pure calcium carbonate. These are found among the rocks of the Laurentian series, the Grenville, and in the Cambro-Silurian, the Chazy, Bird's Eye and Black River, and Trenton, being normally of this character as are those of the Devonian, the Corniferous and Hamilton, and recent marls. While others of the Grenville series and of the Upper Silurian system—the Clinton, Niagara, Guelph

and Onondaga—contain magnesia in varying percentages up to the highest amount possible for a limestone, as distinguished from magnesite.

Limestones carrying a high percentage of calcium carbonate are a necessity in an important group of industries which have already been started in the province, and are sure to reach large dimensions in the future. Having no domestic coal, some of our metallurgical industries, especially in the north, will be dependent to a considerable extent on charcoal, in the manufacture of an important by-product of which a pure limestone is a necessity. In beet sugar manufacture pure lime is also an essential. Portland cement manufacture requires limestone free from magnesia and certain impurities. In the manufacture of calcium carbide, an industry which is peculiarly adapted to this country, and as a flux for furnaces, a pure limestone is also desirable. In the manufacture of sulphite pulp, on the other hand, a rock as high in magnesia as it is possible to obtain it is the most suitable. The fact that such rock is to be found here is important when we consider the field there for the manufacture of pulp in the province.

In many other industries lime or limestone is essential, and our supply of this rock, of all kinds, is of greater economic importance than most people probably realize.

CONCLUSION.

That we should be optimistic of the future is shown by what has been accomplished in the mineral industry during the last decade. I shall conclude this paper by giving a comparative table, which speaks for itself, of our mineral production ten years ago and at the present time.

ONTARIO'S MINERAL PRODUCTION.

A RECORD OF TEN YEARS.

	1893	1903
Iron Ore .....	None	\$ 450,000
Pig Iron .....	do	1,401,606
Steel .....	do	304,580
Corundum .....	do	87,600

	1893	1903
Arsenic .....	None	\$ 15,420
Feldspar .....	do	20,046
Iron Pyrites .....	do	21,693
Graphite .....	do	20,630
Zinc Ore .....	do	17,000
Pig Lead .....	do	1,500
Talc .....	do	2,025
Molybdenite .....	do	1,275
Calcium Carbide .....	do	144,000
Nickel .....	454,702	2,499,068
Copper .....	115,200	710,726
Gold .....	32,960	188,036
Silver .....	2,500	8,949
Bricks, etc. ....	1,684,873	2,012,509
Stones, etc. ....	721,000	845,000
Rock Cement .....	63,567	69,310
Portland Cement .....	63,848	1,182,799
Gypsum .....	7,363	7,910
Lime .....	364,000	520,000
Mica .....	8,600	102,205
Natural Gas .....	238,200	196,535
Petroleum, etc. ....	2,188,690	1,586,674
Salt .....	149,850	388,097
Unclassified, etc. ....	9,600	4,950
Total.....	\$6,105,953	\$13,306,947

NOTE BY THE SECRETARY.—Comments, criticisms or discussions upon all papers are earnestly invited and will be promptly published as soon as accepted by the publication committee.

## DISCUSSION.

MR. GIBSON—I cannot add much to the comprehensive statement which Professor Miller has made as to the undeveloped resources of our province. There is no doubt that in the newer and almost unprospected regions lying to the north, both on this side and on the other of the Height of Land, there are many areas underlaid by mineral bearing rocks which are waiting the prospector, and where in the future we may expect to find large deposits of valuable minerals of various kinds. In the older portions of the province, which have long been used for agricultural purposes, there are undeveloped resources which will yet prove of great value. I cannot but think that we have yet undiscovered reservoirs of petroleum and natural gas in the rocks far beneath those from which our present supplies are obtained, and indeed

as Professor Miller has remarked, we have proof of that of very recent date. I had the pleasure of seeing some petroleum taken from one of the formations underlying the Corniferous not longer than a week or ten days ago, and from a formation which has not heretofore yielded petroleum in commercial quantities in this province. I would like to add one remark in regard to a non-metallic substance which I think is likely to be of great importance. We are situated in a coalless country. I mean that in the older portions of Ontario we can never hope to find coal seams of value. What there may be north of the Height of Land in the shape of deposits of lignite is another story, and I believe we have lignite bodies there that will yet be of economic value. But in the peat bogs of this province there are large stores of carbon which will undoubtedly yet be used for domestic and other purposes. The problem of manufacturing a satisfactory peat fuel from the bogs of Ontario is one which has presented no small difficulty. The main difficulty is the economical extraction of the water, which the peat fibre so tenaciously retains. That has been the stumbling block in the many attempts which have been made to manufacture a satisfactory fuel from the peat bogs, not only of this country but of other countries. However, there are very few difficulties in this matter, as in almost any other, which the ingenuity of man will not overcome when seriously exerted. I believe that peat processes have been perfected which now give satisfactory results. At any rate that applies to certain kinds of bogs, and as the proof of the pudding is in the eating of it, I want to tell my experience. I learned that briquetted peat fuel was being manufactured and sold, I determined to make a trial of it in my own house, so I laid in a considerable supply last fall, and have been burning it in the kitchen range for the greater part of this winter. I can assure you, Mr. President, that it has given to myself and the inmates of my household the greatest satisfaction. Not only does the fuel give a strong steady fire, but it makes little dirt, is easy to handle and is almost absolutely certain of prompt ignition; in this respect being better than wood, and better also than anthracite. Some people are using this fuel in their furnaces. I did not use it much in the heating furnace,

but I know that if your fire in the furnace becomes low and sluggish, and you throw a shovelful of peat upon it and cover it with anthracite, in five minutes the coal is glowing hot. My observation is that peat is best adapted for the kitchen range, and is as good a fuel as we know of for domestic purposes, with the possible exception of gas. You cannot alter the nature of a bog after it has been formed, and if you get a fuel that is high in ash there is a good deal of waste; unfortunately that has been the case with some of the peat bogs that have been experimented upon in the past. Another difficulty is that our present furnaces have not been adapted to the burning of peat, and consequently there is a considerable loss on account of the unconsumed particles falling through the grate. I am in hopes that in the peat bogs of Ontario and Quebec and other portions of Canada, we have what will yet be a most important asset. Instead of our looking upon these bogs as being waste, as we do to-day, I believe we will yet come to regard them as a valuable portion of the country's natural resources.

DR. BELL—Notwithstanding the new views put forward by some, I am far from being converted to the theory that petroleum is of volcanic origin. As to our petroleum field in southwestern Ontario, from the first time I looked into this matter I did not consider it certain that petroleum originated in the Corniferous limestone. In 1887 I wrote a paper on the subject and presented it to the Royal Society of Canada, in which I set forth very distinctly the idea that the petroleum might not originate in this formation, but probably came up from the Trenton limestone far below; that there is some natural way in which it comes up, probably by numerous fissures filled with water, and that we have a comparatively inexhaustible supply of petroleum in this formation. We have pumped our Ontario petroleum fields for forty years, and we have taken out more petroleum than would form the whole bulk of the Corniferous limestone in the area worked. If it comes up from a great depth, from the Trenton below, there is hope that not only more petroleum will be obtained there, but that new fields will be found in this province, where the Trenton limestones occur under the other formations, and where a low



anticlinal or dome structure exists, together with other necessary conditions, such as impervious strata to hold down the oil.

PROF. MONTGOMERY—The people of this province are taking a great interest in our mineral development, which affords so much hope for the future. We are all very glad to know from the Provincial Geologist that there is so much ground for hope that there will be very important mineral development in Ontario in the future. Our disappointment in the past has been probably caused by other reasons than the absence of good mineral ore. It is some years since I was present at a meeting of the Institute and I notice many changes, the greatest one being the absence of our friend Mr. Bell. I would like to ask if there has been similar work done upon the pyrrhotite of other localities in Pennsylvania, California and elsewhere, as compared with British Columbia and Ontario. I would like also to know with regard to our zinc, the mode of occurrences and the reduction of this zinc ore in Ontario as compared with the zinc ores of Missouri and other places. I thought I might ask also whether there is sapphire in the deposits at Peterborough and Hastings. I collected several very pretty specimens of blue corundum in Mettuen township, county of Peterborough, in 1897 and 1898, but I could scarcely regard them as true sapphires. Some eight years ago I found uraninite in Quebec not far from the Ottawa River, and I presume it may have been found in Ontario localities. I should like to get more information about the celestite near Marmora, and about the idocrases and zirconous near the Ottawa.

We are all much indebted to Prof. Miller for the splendid paper he has given us and the trouble he has taken to present it to this Institute.

DR. ADAMS—In the presence of so many eminent authorities on the mineralogy of Ontario, I feel that I am unwise in accepting the chairman's invitation to speak. I may say, however, that there are very large deposits of pyrrhotite in the townships of Galway and Somerville, which we found in making the geological survey of that district and which have so far been considered of little value on account of the fact that it has been impossible to obtain sulphur from them. If they could be worked on an economic

basis there should be large supplies of sulphur in that district. In our work in Eastern Ontario, Dr. Barlow and I have succeeded in finding in the Laurentian limestones of this part of the province within two of the total number of minerals that have hitherto been found in the limestones of this age on the whole continent. It is true that most of these are not of economic value, but the fact shows how rich Ontario is in minerals and the importance of the services which Professor Miller is rendering to the province. The province of Ontario was placed in very good hands when its interests were confided to Professor Miller, who will ably guide it in the systematic exploration of its valuable resources. I congratulate the province of Ontario in having secured the services of Professor Miller.

DR. BARLOW—No deposit of hematite of economic importance has yet been located in connection with the Temagami iron range. Two of these however have been accurately outlined and during the coming summer Canadian capital will be used in prospecting for the large secondary deposits of hematite which it is hoped will be found. The geological horizon of these iron ranges is the same as the famous Vermilion iron range of Minnesota.

THE PRESIDENT—An important point has been brought out by Professor Miller, and that is that the Laurentian was not to be despised as bearing minerals of economic value, and was in that respect perhaps as valuable as the Huronian.

As regards the future prospects in the province of Ontario for new oil and gas fields, I have no hesitation in saying that they are very bright along certain faulted and fissured belts or zones in the province. Along these belts many porous rocks of the sedimentary strata (sandstone, limestone, etc.) will be found impregnated and filled in places with these valuable products which are volcanic emanations from below. Not only the Corniferous, but the Hamilton, the Onondaga, the Guelph, the Niagara, the Clinton, the Medina and the Trenton are already and will be productive in many fields in the province.

