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REPORT ON UNDEVELOPED MINERAL RESOURCES IN THE PROVINCE OF QUEBEC

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Text (reviewed) of a paper presented at the 1949 meeting of the Engineering Institute of Canada.

UNDEVELOPED MINERAL RESOURCES OF THE PROVINCE OF QUEBEC

by

Bertrand T. Denis (1)

INTRODUCTION.

Since 'Undeveloped Mineral Resources' is to be the object of our study, a procedure that seems simple and logical would be to inspect a few of these - figuratively speaking - and then to discuss our observations. If this is tried however, it will soon become apparent that undeveloped mineral resources present a characteristic which separates them sharply from undeveloped water power resources or undeveloped forest resources. Generally speaking, mineral resources are not open to inspection!!!

An explorer whose wanderings lead him close to a water fall can first hear it, then he can see it. If he considers it of some interest, he may add it to a list compiled from his observations and those of his predecessors and contemporaries. Later, as the frontiers of the unsettled areas are rolled back and centres of industrialization approach the location of the

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(1) Chief, Mineral Deposits Branch, Quebec Department of Mines.

fall, farsighted promotors or manufacturers will be tempted to investigate the site more closely; they will engage engineers and experts to survey this 'undeveloped resource'. The point that I wish to emphasize is that before the possible power site had become an 'undeveloped resource', someone had seen it, had noted it, and had probably described it. Whether or not to develop the site may be a very complex economic and engineering problem, but the fall itself is there for all to see. Its existence is common knowledge.

Similar remarks are applicable to our forest resources. The trees too are there for all to see. Nowadays we can even photograph them, with surprising accuracy and detail, from planes that travel at one hundred miles per hour. Study of the pictures supplemented by well chosen traverses run by expert timber cruisers permit at least preliminary appraisal of these 'undeveloped resources'.

Undeveloped mineral resources on the other hand, may (and I am sure do) exist, but <u>not</u> where all may see them. For in large part, our mineral resources are scattered here and there throughout the crust of the earth where they constitute concentrations extremely small compared to the total volume of the rock formations.

The surface of bedrock affords a single cross-section of these rock formations, and if the deposits in which we might be interested lie completely below this natural section, only most unusual luck or skill will ever

locate them. Still worse, in our Province, about ninety percent of this single available section is effectively concealed by surficial deposits - overburden, soil, moss and water.

All things considered, our prospectors have to meet very adverse conditions. The success so far achieved is remarkable and highly encouraging, but at the same time even slight acquantance with these conditions leads to the conviction that many more mines remain to be discovered even in areas that have most attracted the attention of prospectors. Perhaps this is just as well; it would be impossible to over stress the fact that developed mineral resources are wasting assets, and the deposits we mine are the cream of a crop that took a thousand million years to mature. Future generations will doubtless be grateful that nature has supplied a brake to our desire to reap more than our share of the harvest.

GEOLOGICAL SUB DIVISIONS.

The total area of the Province of Quebec is given as 594,534 square miles. Geologically this vast area may be divided into three regions or units that are remarkably distinct. These three geological units are also physiographic divisions. They are by no means equal in size, since the largest, the Laurentian Plateau, occupies about 93 per cent of the area of the Province, whereas the St. Lawrence Lowlands account for barely two per cent; the Appalachian region makes up the remaining five percent. The mineral resources, developed and undeveloped, of each of these are different and must therefore be treated separately.

LAURENTIAN PLATEAU.

The Laurentian Plateau in the Province of Quebec extends northward to Hudson's Bay and Strait. The southern boundary is a sinuous line extending from Ottawa to Quebec, and to the east of Quebec it follows the north shore of the St. Lawrence river; this southern boundary is well marked by an escarpment commonly referred to as the Laurentian Hills.

This Laurentian Plateau of Quebec forms part - almost one third in fact - of the Canadian Shield of which the mineral ressources are a factor of prime importance in the economy of the country. To appreciate this, it will suffice to call to mind the gold-copper and zinc deposits of Western Quebec; the gold mines of Porcupine, Kirkland Lake and Little Long Lac in Ontario; the silver deposits of Cobalt; the great copper-nickel mines of Sudbury; the iron deposits of the Lake Superior region and New Quebec; the iron-titanium deposits of the Allard Lake area; the silver-uranium and the gold deposits of the North West Territories; the zinc-copper deposits of Manitoba; all these and many other minor deposits lie in the Canadian Shield, nearly one third of which, I repeat, lies in the Province of Quebec. Furthermore, it is pertinent to point out that of this vast area - over half a million square miles - only the southern fringe has been partially explored; 85 per cent is virgin territory as far as the geologist or the prospector are concerned. It is tempting to speculate on the undeveloped mineral resources of this vast region, but the

simple truth is that they are unknown. There is, however, no reason why this unexplored part of the shield should be less well endowed than the rest; and only most unjustifiable pessimism could inspire doubt that it contains its share of major mineral deposits as yet undiscovered and undeveloped.

With the exception of very small areas of later sedimentary formations, all the rocks of the Laurentian Plateau are Pre Cambrian, the oldest of the earth's crust.

In the Province of Quebec, it is in the south western corner of the Laurentian Plateau that geological mapping has progressed most; the greater part of our population is concentrated in the southern portion of the Province, and quite naturally we have first sought to develop the mineral resources nearest to our door steps.

In this corner of the plateau, two distinct geological units have been distinguished, and designated respectively as the Temiscamian and the Grenville sub-provinces. In each are found characteristic formations that reflect different geological histories. The boundary between the two is a zone of deformation or faulting with granitic intrusions which in Quebec has been traced northeastward from the south end of lake Temiskaming to the area to the east of Mistassini Lake; beyond this the boundary loses itself in the realm of unexplored territory. Towards the southwest the boundary has been traced in the Province of Ontario as far as Georgian Bay. The Temiscamian sub-province

lies to the northwest of the contact-zone and extends northward to the 50th parallel of latitude; the Western Quebec mining belt in Temiskaming and Abitibi counties lies wholly within it. The Grenville sub-province lies to the southeast and includes Pontiac, the areas to the north of Ottawa, Montreal and Quebec, the Lake St. John district and the North Shore of the St. Lawrence; it occupies a much larger part of the Province than does the Temiscamian sub-province.

TEMISCAMIAN SUB-PROVINCE.

So far, more than forty producing metal mines have been developed in the Temiscamian sub-province in Quebec, and of these, 29 were in operation in 1948. Last year, these mines produced gold, copper, zinc and minor amounts of other metals having a value nearly 61 million dollars, or more than 40 per cent of the value of our total mineral production which has been estimated at 147.4 million dollars.

It is of interest to note in passing that twenty five years ago, before the development of the western Quebec mining belt, the value of our production of metals was 1¾ per cent of our total mineral production, valued at 19 million dollars. At that time, exploration on the Horne property gave indications of events to come, but this was the only occurrence in the whole belt that could be referred to accurately as an 'undeveloped mineral resource', and even there the estimates of the deposit were given as 600,000 tons of ore of a gross value of 12½ million dollars. By 1948, this great

mine had produced a cumulative total of 1,269,931,985 pounds of copper, 4,591,540 ounces of gold, and the management still could report ore reserves of 19,485,900 tons.

In the Western Quebec mining district there are three main types of deposits: 1) complex gold bearing sulphide masses mined for copper or zinc. Noranda is the largest of these. Two new ones, Quemont and East Sullivan, will soon join the ranks of the producers; 2) replacement deposits of irregular shape localized by shear or fracture zones, mined for gold, in which the accompanying sulphides - mostly pyrite - are disseminated and no attempt is made to recover them. The Beattie, in Duparquet township, and the Malartic group of mines in Fournière township, are typical examples; 3) gold bearing quartz veins. Most of the mines in the Val d'Or district, and the Belleterre in Guillet, belong to this group; so too do many of the mines in the Rouyn district.

The molybdenite deposits of Preissac and Lacorne townships constitute a fourth type of economic mineral occurrence in the district; two of these have been mined on a small scale.

At some places, the distribution of the deposits suggests that there is a genetic correlation between ore and certain intrusive rock types, but generally speaking no correlation has been established between ore and any particular rock type.

All but half a dozen of the producing mines both of base metals and of gold lie in a belt within a distance of a

few miles of the major Kirkland Lake - Val d'Or fault zone, which in Quebec extends from the Ontario boundary to beyond Val d'Or, a distance of about 125 miles. It appears to be terminated by the major northeast trending zone of disturbance that separates the Temiscamian and Grenville sub-provinces. The deposits are not necessarily localized in the fault zone itself, like beads on a string, but rather they appear to be related to the minor fractures subsidiary to the 'main break'. This of course greatly enlarges the field for search for other deposits since the belt of favourable prospecting ground is wide. As usual, overburden is the rule, rock exposure the exception. The deposits are commonly associated with zones of fracture, which are zones of weakness, most easily eroded to form depressions where the overburden is now the thickest. Thus the most promising areas are those in which conditions for exploration are the least favourable.

As a result of all these factors, the search for new deposits is expensive. The cost of appraisal of undeveloped forest resources with the aid of aerial photographs may be measured in tens of dollars per square mile , but in mining exploration it is not unusual to spend hundreds of dollars per acre to establish the existence of orebodies that constitute proven undeveloped mineral resources. This may explain in part why such resources seldom remain long undeveloped. By the time their existence is proven, the principals bend every effort to their rapid development so that they can get return on an invest-

ment that is already large. Fortunately, although the cost is high the reward to the successful is proportionally great.

It would be highly presumptuous of me to try to undertake here to point out the most likely places to look for new deposits. Many top notch geologists have devoted years to the specialized field of prospecting in Western Quebec, within the mining belt itself and in the area in general. The government geologists, whose function it is to aid and guide the prospector, are working on two long-term programmes, first to locate the major structural breaks in the region, with a view to the discovery and development of one or more new mining camps, secondly to compile detailed information on the distribution of formations and the fracture pattern along the main belt with a view to facilitating the most economical search for the new mines needed to maintain this established producing centre.

Before leaving this Western Quebec mineral field, attention should be drawn to the progress of recent years in the exploration of the area between Senneterre and Chibougamau. There are fairly clear indications of a major break running through the Bachelor Lake section - it takes time to build up the picture to the point where hypotheses become confirmed facts - but the evidence is suggestive, and moreover at least two deposits have been outlined that are now undeveloped mineral resources. When adequate transportation facilities are available, the Dome and the O'Brien finds in Lesueur township should become

mines. Further afield, in McKenzie township, the Norbeau property is also the site of a deposit the development of which only awaits more favourable economic conditions. The completion of the road now under construction by the Department of Mines from St. Félicien to Chibougamau will reduce the handicaps to exploration and development of the mineral resources of the areas this road will serve.

GRENVILLE SUB-PROVINCE.

When we turn from the Temiscamian to the Grenville sub-province, we enter a field where the variety of useful minerals affords ample scope for the activities of the prospector-mineralogist. In addition to metals - such as the precious metal bearing lead and zinc deposits of Calumet Island and the Tetrault at Montauban-les-Mines, the molybdenite deposit at Quyon, - its mineral products include industrial minerals such as feldspar, magnesite, brucite, graphite, mica, ilmenite, apatite or phosphate rock, kaolin, silica, lime, and finally stone for building and construction purposes.

In addition, occurrences have been noted of asbestos, beryl, copper minerals, sillimanite, magnetite, garnet, rutile, fluorite, semi-precious stones and radio-active minerals; none of these so far has proven of economic importance.

Despite the wide variety of useful mineral substances found and mined in the Grenville, the value of the mineral production of this geological sub-province is a small proportion of the total for Quebec. Small to moderate scale operations are the rule.

The great majority of the producing mines are in the western part of the Grenville sub-province, close to the centres of population. The principal reason for this is that both in the field of non-metallic or industrial minerals, and in the marketing of stone for construction or ornamentation, competitition is extremely keen and prices are low. The cost of transport is therefore so important a factor that deposits in far away or inaccessible localities have received little attention.

The development of the mineral resources of the Grenville Sub-province presents unusually interesting and complex problems. The prospector, who finds a deposit of gold, copper, lead, zinc or of most metals, has a mineral product for which there is a world market at prevailing prices; generally speaking the processes of separation are known; he will still have problems a plenty to solve, but the critical phase of a successful development is the discovery of the orebody. The industrial mineral field offers more scope for the imagination, and opportunities for a different approach to the development of mineral resources. A recent example that has attracted much attention is afforded by the development of the Allard Lake ilmenite deposits. Ilmenite is an iron-titanium oxide associated with anorthosite, a highly characteristic rock type that occupies large areas in our Grenville sub-province. Within the last three years, probably the largest known deposits in the world have been blocked out on the North Shore of the

St. Lawrence, 27 miles from Havre St. Pierre. Plans have been announced for their exploitation and treatment of the ore at Sorel. Perhaps one of the most note worthy features of this enterprise is that the principals in this development spent a good deal more in laboratory research than it cost them to locate the deposits. This laboratory research was probably the critical phase of the development, for in this case the successful and economical processing of the ore had to be discovered. In my opinion, the metallurgists who carried out this research were prospecting just as truly as are the men who go into the bush with canoe and packsack to search for undeveloped mineral resources.

The Grenville sub-province with its varied assortment of useful minerals offers a fertile field for this approach to the development of mineral resources. The problems of processing, marketing and the economics of industrial minerals present at least as many opportunities as that of locating deposits. As examples, we might cite, research for methods of separating minerals having very nearly the same physical properties, such as the feldspars, or calcite, magnesite, dolomite and brucite; processes for the dry separation of finely pulverized materials such as silica and the iron oxides; economical methods for drying hydrous materials such as marl, peat, ochre; markets or uses for mine tailings; the extraction of potash from feldspars for use as fertilizer. These are only a few examples, and it is quite likely that the next important development will be

based on a new approach to some problem that no one has even thought of yet.

UNGAVA IRON.

Among the formations recognized in the Laurentian Plateau area, are a series of late Pre Cambrian or Proterozoic rocks, for the most part relatively unaltered well-bedded formations of sedimentary origin. During the past few years great interest has been awakened in an area of these rocks that occupies a geological unit known as the Labrador Trough which extends northwestwards from the headwaters of the Hamilton River to beyond the Koksoak, a length of over 300 miles; the width of the trough is about 40 miles.

Within this series of Proterozoic rocks are bands of iron formation, which, due to folding and faulting, are now repeated many times. Attention was first drawn to these in 1894 by officers of the Geological Survey of Canada and it has been common knowledge since then that the area contains immense reserves of iron formation. It is essential, however, to stress at this point that an immense reserve of iron formation does not necessarily imply a single ton of iron 'ore', i.e. of material from which iron may be profitably extracted. Iron is the fourth most abundant element in the crust of the earth, and concentrations rich enough to be termed iron-formation are common enough. Furthermore, the whole iron and steel industry is intensely competitive.

The current interest in the Labrador-Ungava district stems from the fact that an enterprising organization has located large concentrations of iron minerals of a grade favourably comparable to ores treated in the great iron producing centres of the continent. The blocking out of 300,000,000 tons of high grade iron deposits has been followed by announcement of plans to develop the deposits on a scale that suggests the Province of Quebec is approaching a turning point as eventful as the discovery and development of the Western Quebec mining belt. This happy result is the reward of a campaign of intensive (and expensive) exploration that is unique in the mining industry of Quebec - and perhaps of Canada. Other organizations with more irons in the fire, have devoted more energy and money over periods of years to the search for new mineral deposits, but I do not know of a more intensive effort put into a single project.

As for the rest of the Shield Area, the lack of available information imposes brevity in comments. Mineralization has been reported from several localited, and once again, there is no reason to doubt that this vast unexplored area has been endowed with the mineral resources favouring the establishment of major mining camps. Incidentally unless we step up the pace it will be 300 years before geological maps of the whole region are made at a scale of one inch equals one mile.

THE ST. LAWRENCE LOWLANDS.

Turning now from our largest geological unit, the Laurentian Plateau, to the smallest, - the St. Lawrence Lowlands, we meet quite different geological conditions, and mineral resources. The lowlands occupy a triangular area between Quebec City, Ottawa, and the outlet to lac Champlain; they are bounded on the north by the Plateau, and on the south by the great Champlain fault which separates the flat lying palaeozoic beds of the lowlands from the folded formations of the Appalachian Region.

The St. Lawrence Lowlands supply the bulk of our materials of construction, that useful if unglamorous portion of our mineral production that accounts for more than one fifth of the total value; this fraction in 1948 is estimated at 32,900,000 dollars. In order of relative value the principal products are cement; sand and gravel; limestone for building and construction purposes; clay products, brick and others.

These are the raw materials to the use of which engineers apply their talents the year round. Members of this Institute will hardly expect me at this time to say anything new about them.

The development of these mineral resources are closely dependent upon economics and human geography. The expansion of this section of our industry will necessarily follow the demands imposed by the growth and industrialization of the Province.

The deposits of suitable or usable material are widespread and abundant, but the choice of deposits of the best material that can be expected to yield products marketable at competitive prices requires careful study in each and every instance.

APPALACHIAN REGION.

In the Province of Quebec, the Appalachian region lies to the southeast of a line joining the outlet to Lake Champlain and Quebec City, from whence it continues along the south shore of the St. Lawtence River and Gulf. It includes the Eastern Townships, Beauce, Temiscouata and Matapédia, and the whole of Gaspé Peninsula. It occupies about five percent of the Province. The rock formations are palaeozoic sedimentary and volcanic beds that have been strongly compressed to form a series of folds trending from the southwest to the northeast. Intrusive rocks occupy a very small but economically important part of the region.

The Appalachian region is a mining district and its mines have been continuously exploited since the American Civil war. Until the development of our metal deposits in the Laurentian plateau, its asbestos mines were the mainstay of our mining industry. Today 70 years after the discovery of the deposits, asbestos heads the list, well above any other single item in the table of our mineral production arranged according to value. The value in 1948 set a new record at over 42 million dollars which is 28 percent of the total value of the mineral production of the Province.

The list of useful mineral products found in the Appalachians includes metals, gold, copper, chromite, lead, zinc; non-metallics, asbestos, talc, industrial limestone and oil; materials of construction, granite, marble, sand and gravel.

The Eastern Townships of Quebec has been termed the 'cradle of copper mining in Canada'. Since the Eustis mine at Capelton closed down in 1949 after 74 years of continuous operation, copper production has been reported from only one mine in the district; this was in 1944-45. Mineralization is widespread and occurrences can be numbered by the tens of dozens. Most of the surface outcrops have been prospected, but there are good possibilities that improvements in technique of prospecting will lead to the discovery of new orebodies.

Near the eastern end of the Appalachian region in Holland Township, Gaspé North county, a large body of low grade copper ore has been partially outlined by diamond drilling. The owners of the property recently announced that there are 35,000,000 tons of ore carrying 0.9 percent of copper. Exploration is continuing and the economics of development are under study.

The deposit has some features in common with the porphyry copper deposits of the Western United States, and the progress of exploration is being followed with great interest.

The lead and zinc deposits of central Gaspé, in Lemieux township, have also attracted much attention. Veins are numerous and some of then are very large. Exploration to date suggests that there are at least 600,000 tons of possible ore carrying about 5 percent of zinc and one percent of lead. Further exploration is required.

The asbestos deposits of the Appalachian region are mined at the two important producing centres of "Asbestos" and the Black Lake Thetford district. Despite the fact that the operators have successively stepped up production to attain new records for the past several years, they do not seem to have been able to keep up with the demand. In consequence, prospecting has been active, with the result that at least one new deposit of major importance has been discovered.

RESUME.

In 1948, the total value of the mineral production of the Province is estimated at $147,000,000. Twenty five years ago, the corresponding figure was about $20,000,000. A major factor in this increase was the discovery and development of the metal mining field of Western Quebec. At the same time however, great increases have been registered in the production from mining centres established at that time in the Appalachian region and the St. Lawrence Lowlands. In other words, new mineral resources have been developed both in new fields and in long established centres of mineral production.

The situation is very similar today. The programmes for the development of the iron deposits of New Quebec and the ilmenite of the North Shore indicate that other mining camps are on the horizon. At the same time, new mines are being brought into production in Western Quebec and an important asbestos discovery has been made.

Undeveloped mineral resources are in the ground, not above it where they can be seen. Mineral occurrences are very numerous, but mineable deposits are rare. A great deal of work must be put into a deposit before it can be considered to be a worthwhile undeveloped mineral resource and as a rule, development follows rapidly.

Prospectors, using that term in its broadest sense, should remember that the initial phase of a new mining

development may be the discovery of new ore-bodies, or it may be the discovery of processes for the utilization of known but apparently worthless minerals.

The Province of Quebec produces at least fifty different mineral substances, but a very small number of these account for about 95 percent of the total production. These are the metals, gold, copper and zinc from Western Quebec; asbestos from the Appalachian Region; and materials of construction, cement, brick, limestone and sand, mostly from the St. Lawrence Lowlands.

The remarkable expansion of the mining industry in Quebec shows so far at least we have been able to locate progressively the necessary undeveloped mineral resources. 85 percent of our territory is still virgin; successful exploration is still underway even in the areas close to producing mines with long histories; plans have been announced that will bring into existence new mining camps. It seems to me therefore that we may be confident the progress of our mining industry will remain proportional to our efforts in the search for new deposits.

Text of a paper to be presented
at the 1949 meeting of the
Engineering Institute of Canada.

UNDEVELOPED MINERAL RESOURCES OF THE PROVINCE OF QUEBEC

by

Bertrand T. Denis (1)

INTRODUCTION.

First of all, I wish to express my appreciation of the honour attached to an invitation from your distinguished Institute to address one of your technical meetings, and to assure you that I consider it a privilege to be on this platform.

Since 'Undeveloped Mineral Resources' is to be the object of our study, a procedure that seems simple and logical would be to inspect a few of these - figuratively speaking - and then to discuss our observations. If this is tried however, it will soon become apparent that undeveloped mineral resources present a characteristic which separates them sharply from undeveloped water power resources or undeveloped forest resources. Generally speaking, ~~they~~ mineral resources are not open to inspection!!

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~~if he has experience, he can tell whether it is a large fall or a small fall; and~~ If he considers it of some interest, he may add it to a list compiled from his observations and those of his predecessors and contemporaries. Later, as the frontiers of the unsettled areas are rolled back and centres of industrialization approach the location of the fall, farsighted promotors or manufacturers will be tempted to investigate the site more closely; they will engage engineers and experts to survey this 'undeveloped resource'. The point that I wish to emphasize is that before the possible power site had become an 'undeveloped resource', someone had seen it, had noted it, and had probably described it. Whether or not to develop the site may be a very complex economic and engineering problem, but the fall itself is there for all to see. Its existence is common knowledge.

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All things considered, our prospectors have to meet very adverse conditions. The success so far achieved is remarkable and highly encouraging, but at the same time even slight acquaintance with these conditions leads to the conviction that many more mines remain to be discovered even in areas that have most attached the attention of prospectors. Perhaps this is just as well; it would be impossible to over stress the fact that developed mineral resources are wasting assets, ~~The existence of man is but a tick in the geological clock,~~ and the deposits we mine are the cream of a crop that took a thousand million years to mature. Future generations will doubtless be grateful that nature has supplied a brake to our desire to reap ~~more~~ more than ~~that~~ our share of the harvest.

Since, ~~for reasons that I have barely sketched~~, it is impossible ~~for us~~ to line up our undeveloped mineral resources, to inspect them and to appraise them directly, ~~I~~ it is ~~propose~~ by indirect approach to attempt to convince you of their existence, and to suggest to you that their discovery and development offers a field of interest to enterprising individuals and organizations.

GEOLOGICAL SUB-DIVISIONS.

The total area of the Province of Quebec is given as 594,534 square miles. Geologically this vast area may be divided into three regions or units that are remarkably distinct. These three geological units are also physiographic divisions. They are by no means equal in size, since the largest, the Laurentian Plateau, occupies about 93 per cent of the area of the Province, whereas the St. Lawrence Lowlands account for barely two percent; the Appalachian region makes up the remaining five percent. The mineral resources, developed and undeveloped, of each of these are different and must therefore be treated separately.

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So far, more than forty producing metal mines have been developed in the Temiscamian sub-province in Quebec, and of these, 29 were in operation in 1948. Last year, these mines produced gold, copper, zinc and minor amounts of other metals having a value nearly 61 million dollars, or more than 40 per cent of the value of our total mineral production which has been estimated at 147,400 million dollars.

It is of interest to note in passing that twenty five years ago, before the development of the Western Quebec mining belt, the value of our production of metals was 1½ per cent of our total mineral production, valued at nearly 19 million dollars. At that time, exploration on the Horne property gave indications of events to come, but this was the only occurrence in the whole belt that could be referred to accurately as an 'undeveloped mineral resource', and even there the estimates of the deposit were given as 600,000 tons of ore of a gross value of 12½ million dollars. By 1948, this great mine had produced a cumulative total of 1,269,931,985 pounds of copper, 4,591,540 ounces of gold, and the management still could report ore reserves of 19,485,900 tons.

In the Western Quebec mining district there are three main types of deposits: 1) complex gold bearing sulphide masses mined for copper or zinc. Noranda is the largest of these. Two new ones, Quemont and East Sullivan, will soon join the ranks of the producers; 2) replacement deposits of irregular shape localized by shear or fracture zones, mined for gold, in which the accompanying sulphides - mostly pyrite - are disseminated and no attempt is made to recover them. The Beattie, in Duparquet township, and the Malartic group of mines in Fournière township, are typical examples; 3) gold bearing quartz veins. Most of the mines in the Val d'Or district, and the Belleterre in Guillet, belong to this group; so too do many of the mines in the Rouyn district.

The molybdenite deposits of Preissac and Lacorne townships constitute a fourth type of economic mineral occurrence in the district; ~~only one is at present being~~ two of them have been mined on a small scale.

At some places, the distribution of the deposits suggests that there is a genetic correlation between ore and certain intrusive rock types, but generally speaking no correlation has been established between ore and any particular rock type.

All but half a dozen of the producing mines both of base metals and of gold lie in a belt within a distance of a few miles of the major Kirkland Lake-Val d'Or fault zone, which

in Quebec extends from the Ontario boundary to beyond Val d'Or, a distance of about 125 miles. It appears to be terminated by the major northeast trending zone of disturbance that separates the Temiscamian and Grenville sub-provinces. The deposits are not necessarily located in the fault zone itself, like beads on a string, but they appear to be related to the minor fractures subsidiary to the 'main break'. This of course greatly enlarges the field for search for other deposits since the belt of favourable prospecting ground is wide. As usual, overburden is the rule, rock exposure the exception. The deposits are commonly associated with zones of fracture, which are zones of weakness, most easily eroded to form depressions where the overburden is now the thickest. Thus the most promising areas are those in which conditions for exploration are the least favourable. As a result of all these factors, the search for new deposits is expensive. The cost of appraisal of undeveloped forest resources with the aid of aerial photographs may be measured in tens of dollars per square mile, but in mining exploration it is not unusual to spend hundreds of dollars per acre to establish the existence of orebodies that constitute proven undeveloped mineral resources. This may explain in part why such resources seldom remain long undeveloped. By the time their existence is proven, the principals bend every effort to their rapid development so that they can get return on an investment that is already large.

Fortunately
~~Finally, I must remind you that~~ although the cost is high the reward to the successful is proportionally great.

It would be highly presumptuous of me to try to undertake here to point out the most likely places to look for new deposits. ~~I could name~~ many top notch geologists ~~who~~ have devoted years to the specialized field of prospecting in Western Quebec, within the mining belt itself and in the area in general. The government geologists, whose function it is to aid and guide the prospector, are working on two long-term programmes, first to locate the major structural breaks in the region, with a view to the discovery and development of one or more new mining camps, secondly to compile detailed information on the distribution of formations and the fracture pattern along the main belt with a view to facilitating the most economical search for the new mines needed to maintain this established producing centre.

Before leaving this Western Quebec mineral field, ~~I wish to draw your attention~~ attention should be drawn to the progress of recent years in the exploration of the area between Senneterre and Chibougamau. There are fairly clear indications of a major break running through the Bachelor Lake section - it takes time to build up the picture to the point where hypotheses become confirmed facts - but ~~as I was saying,~~ the evidence is suggestive, and moreover at least two deposits have been outlined that are now undeveloped mineral resources. When adequate transportation

facilities are available, the Dome and the O'Brien finds in Lesueur township should become mines. Further afield, in McKenzie township, the Norbeau property is also the site of a deposit ~~whose~~ the development of which only awaits more favourable economic conditions. The completion of the road now under construction by the Department of Mines from St. Félicien to Chibougamau will reduce the handicaps to exploration and development of the mineral resources of the areas this road will serve.

GRENVILLE SUB-PROVINCE

When we turn from the Temiscamian to the Grenville sub-province, we enter a field where the variety of useful minerals affords ample scope for the activities of the prospector-mineralogist. In addition to metals - such as the precious metal bearing lead and zinc deposits of Calumet Island and the Tetrault at Montauban-les-Mines, the molybdenite deposit at Quyon, - its mineral products include industrial minerals such as feldspar, magnesite, brucite, graphite, mica, ilmenite, apatite or phosphate rock, kaolin, silica, lime, and finally stone for building and construction purposes.

In addition, occurrences have been noted of asbestos, beryl, copper minerals, sillimanite, magnetite, garnet, rutile, fluorite, semi-precious stones and radio-active minerals; none of these so far has proven of economic importance.

Despite the wide variety of useful mineral substances found and mined in the Grenville, the value of the mineral

production of this geological sub-province is a small proportion of the total for Quebec. Small to moderate scale operations are the rule.

The great majority of the producing mines are in the western part of the Grenville sub-province, ~~this is~~ close to the centres of population. The principal reason for this is that both in the field of non-metallic or industrial minerals, and in the marketing of stone for construction or ornamentation, competition is extremely keen and prices are low. The cost of transport is therefore so important a factor that deposits in far away or inaccessible localities have received little attention.

The development of the mineral resources of the Grenville sub-province presents unusually interesting and complex problems. The prospector, who finds a deposit of gold, copper, lead, zinc or of most metals, has a mineral product for which there is a world market at prevailing prices; generally speaking the processes of separation are known; he will still have problems a plenty to solve, but the critical phase of a successful development is the discovery of the orebody. The industrial mineral field offers more scope for the imagination, and opportunities for a different approach to the development of mineral resources. A recent example that has surely attracted your attention is afforded by the development of the Allard Lake ilmenite deposits. Ilmenite is an iron-titanium

oxide associated with anorthosite, a highly characteristic rock type that occupies large areas in our Grenville sub-province. Within the last three years, probably the largest known deposits in the world have been blocked out on the North Shore of the St. Lawrence, 27 miles from Havre St. Pierre. Plans have been announced for their exploitation and treatment of the ore at Sorel. ~~The feature to which I specially desire to draw your attention~~ is that the principals in this development spent a good deal more in laboratory research than it cost them to locate the deposits. This laboratory research was probably the critical phase of the development, for in this case the successful and economical processing of the ore had to be discovered. In my opinion, the metallurgists who carried out this research were prospecting just as truly as are the men who go into the bush with canoe and packsack to search for undeveloped mineral resources.

The Grenville sub-province with its varied assortment of useful minerals offers a fertile field for this approach to the development of mineral resources. The problems of processing, marketing and the economics of industrial minerals present at least as many opportunities as that of locating deposits. As examples, we might cite, research for methods of separating minerals having very nearly the same physical properties, such as the feldspars, or calcite, magnesite, dolomite and brucite; processes for the dry separation of finely pulverized materials such as silica and the iron oxides; economical

methods for drying hydrous materials such as marl, peat, ochre; markets or uses for mine tailings; the extraction of potash from feldspars for use as fertilizer. These are only a few examples, and it is ~~more than likely~~ quite likely that the next important development will be based on a new approach to some problem that no one has even thought of yet.

UNGAVA IRON.

Among the formations recognized in the Laurentian Plateau area, are a series of late Pre Cambrian or Proterozoic rocks, for the most part relatively unaltered well-bedded formations of sedimentary origin. During the past few years great interest has been awakened in an area of these rocks that occupies a geological unit known as the Labrador Trough which extends north westwards from the headwaters of the Hamilton River to beyond the Koksoak, a length of over 300 miles; the width of the trough is about 40 miles.

Within this series of Proterozoic rocks are bands of iron formation, which, due to folding and faulting, are now repeated many times. Attention was first drawn to these in 1894 by officers of the Geological Survey of Canada and it has been common knowledge since then that the area contains immense reserves of iron formation. It is essential, however, to stress at this point that an immense reserve of iron formation does not necessarily imply a single ton of iron 'ore', i.e. of material from which iron may be profitably extracted.

Iron is the fourth most abundant element in the crust of the earth, and concentrations rich enough to be termed iron-formation are common enough. Furthermore, the whole iron and steel industry is intensely competitive.

The current interest in the Labrador-Ungava district stems from the fact that an enterprising organization has located large concentrations of iron minerals of a grade favourably comparable to ores treated in the great iron producing centres of the continent. The blocking out of 300,000,000 tons of high grade iron deposits has been followed by announcement of plans to develop the deposits on a scale that suggests the Province of Quebec is approaching a turning point as eventful as the discovery and development of the Western Quebec mining belt. This happy result is the reward of a campaign of intensive (and expensive) ~~exploitation~~ exploration that is unique in the mining history of Quebec - and perhaps of Canada. Other organizations with more irons in the fire, have devoted more energy and money over periods of years to the search for new mineral deposits, but I do not know of a more intensive effort put into a single project.

As for the rest of the Shield Area, ~~the available time and~~ the lack of available information ~~both~~ imposes brevity ~~in my~~ in comments. ~~I wish to point out, however, that~~ Mineralization has been reported from several localities, and ~~to repeat that~~ once again, there is no reason to doubt that this vast unexplored area has been endowed with the mineral resources favouring ~~necessary to~~

the establishment of major mining camps. Incidentally ~~Perhaps I may add that~~ unless we step up the pace it will be 300 years before geological maps of the whole region are made at a scale of one inch equals one mile.

THE ST. LAWRENCE LOWLANDS

Turning now from our largest geological unit, the Laurentian Plateau, to the smallest, - the St. Lawrence Lowlands, we meet quite different geological conditions, and mineral resources. The lowlands occupy a triangular area between Quebec City, Ottawa, and the outlet to lac Champlain; they are bounded on the north by the Plateau, and on the south by the great Champlain fault which separates the flat lying palaeozoic beds of the lowlands from the folded formations of the Appalachian Region.

The St. Lawrence Lowlands supply the bulk of our materials of construction, that useful if unglamorous portion of our mineral production that accounts for more than one fifth of the total value; this ~~value~~ fraction in 1948 is estimated at 32,900,000 dollars. In order of relative value the principal products are cement; sand and gravel; limestone for building and construction purposes; clay products, brick and others.

These are the raw materials to the use of which ~~your~~ their engineers apply ~~your~~ talents the year round. ~~You will not~~ Members of this Institute will hardly expect me, ~~in the few minutes at my disposal~~ in so at this time to ~~tell you~~ anything new about them ~~that you do not already know.~~

The development of these mineral resources are closely dependent upon economics and human geography. The expansion of this section of our industry will necessarily follow the demands imposed by the growth and industrialization of the Province.

The deposits of suitable or passable (usable?) material are widespread and abundant, but the choice of deposits of the best material that can be expected to yield products marketable at competitive prices requires careful study in each and every instance.

APPALACHIAN REGION

In the Province of Quebec, the Appalachian region lies to the southeast of a line joining the outlet to Lake Champlain and Quebec City, from whence it continues along the south shore of the St. Lawrence River and Gulf. It includes the Eastern Townships, Beauce, Temiscouata and Matapédia, and the whole of Gaspé Peninsula. It occupies about five percent of the Province. The rock formations are palaeozoic sedimentary and volcanic beds that have been strongly compressed to form a series of folds trending from the southwest to the northeast. Intrusive rocks occupy a very small but economically important part of the region.

The Appalachian region is a mining district and its mines have been continuously exploited since the American Civil

war. Until the development of our metal deposits in the Laurentian plateau its asbestos mines were the mainstay of our mining industry. Today 70 years after the discovery of the deposits, asbestos heads the list, well above any other single item in the table of our mineral production arranged according to value. The value in 1948 set a new record at over 42 million dollars which is 28 percent of the total value of the mineral production of the Province.

The list of useful mineral products found in the Appalachians includes metals, gold, copper, chromite, lead, zinc; non-metallics, asbestos, talc, industrial limestone and oil, materials of construction, granite, marble, sand and gravel.

The Eastern Townships of Quebec has been termed the 'cradle of copper mining in Canada'. Since the Eustis mine at Capleton closed down in 1939 after 74 years of continuous operation, ~~there has been no copper mining in the district~~ during 1944-45. Mineralization is wide-spread and occurrences can be numbered by the tens of dozens. Most of the surface outcrops have been prospected, but there are good possibilities that improvements in technique of prospecting will lead to the discovery of new orebodies.

Near the eastern end of the Appalachian region in Holland Township, Gaspé North county, a large body of low grade copper ore has been partially outlined by diamond drilling.

The owners of the property ~~Gaspé Copper Mines Limited, a subsidiary of Noranda Mines Limited,~~ recently announced that there are 35,000,000 tons of ore carrying 0.9 percent of copper. Exploration is continuing and the economics of development are under study.

The deposit has some features in common with the porphyry copper deposits of the Western United States, and the progress of exploration is being followed with great interest.

The lead and zinc deposits of central Gaspé, in Lemieux Township, have also attracted much attention. Veins are numerous and some of them are very large. Exploration to date suggests that there are at least 600,000 tons of possible ore carrying about 5 percent of zinc and one percent of lead. Further exploration is required.

The asbestos deposits of the Appalachian region are mined at the two important producing centres of Asbestos and the Black Lake Thetford district. Despite the fact that the operators have successively stepped up production to attain new records for the past several years, they do not seem to have been able to keep up with the demand. In consequence, prospecting has been active, with the result that at least one new deposit of major importance has been discovered.

Prospectors, using that term in its broadest sense, should never remember that the critical phase of a new mining development may be the discovery of new ore-bodies, or it may be the discovery of processes for the utilization of known but apparently worthless minerals.

RESUME

In 1948, the total value of the mineral production of the Province is estimated at $147,000,000. Twenty five years ago, the corresponding figure was about $20,000,000. A major factor in this increase was the discovery and development of the metal mining field of Western Quebec. At the same time however, great increases have been registered in the production from mining centres established at that time in the Appalachian region and the St. Lawrence Lowlands. In other words, new mineral resources have been developed both in new fields and in long established centres of mineral production.

The situation is very similar today. The programmes for the development of the iron deposits of New Quebec and the ilmenite of the North Shore ~~major~~ indicate that other mining camps are on the horizon. At the same time, new mines are being brought into production in Western Quebec and an important asbestos discovery has been made.

Undeveloped mineral resources are in the ground, not above it where they can be seen.

Mineral occurrences are very numerous, but mineable deposits are rare. A great deal of work must be put into a deposit before it can be considered to be a worthwhile undeveloped mineral resource and as a rule development follows rapidly.

The Province of Quebec produces at least fifty different mineral substances, but a very small number of these

account for about 95 percent of the total production. These are the metals, gold, copper and zinc from Western Quebec; asbestos from the Appalachian Region; and materials of construction, cement, brick, limestone and sand, mostly from the St. Lawrence Lowlands.

The remarkable ~~progress~~ of the mining industry in Quebec shows that so far at least we have been able to locate progressively the necessary undeveloped mineral resources. 85 percent of our territory is still virgin; successful exploration is still underway even in the areas close to producing mines with long histories; plans have been announced that will bring into existence new mining camps. It seems to me therefore that we may be confident the progress of our mining industry will remain proportional to our efforts.