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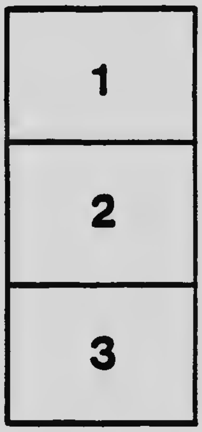
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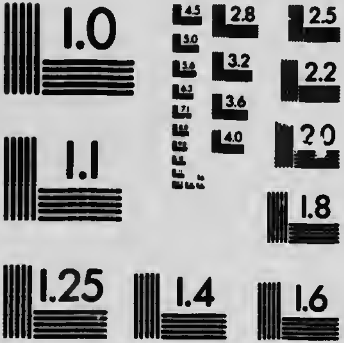

Possible Economies in Production of Minerals of Canada

AN ADDRESS DELIVERED BY DR. EUGENE HAANEL BEFORE THE FIRST ANNUAL MEETING OF THE COMMISSION OF CONSERVATION

Reprinted from the First Annual Report of
The Commission of Conservation, 1910

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POSSIBLE ECONOMIES IN PRODUCTION OF MINERALS OF CANADA

There is this difference between mineral resources and other natural resources, that while a forest cut down may be replanted, an exhausted soil, refertilized and a river or lake depleted of fish, restocked, an ore deposit once worked out can never be recovered.

We allow ourselves great latitude of language when we speak of this or that deposit as being inexhaustible. The economic mineral deposits accessible to man are finite in quantity, and the time required for their exhaustion depends solely upon the rapidity with which they are exploited.

The immense pressure exerted by the acquired needs of modern civilization, reinforced by the commercial spirit of the age, will render futile any effort that might be made to curtail the exploitation of the mineral resources of the world. We can pass no laws for a close season in mining, during which mines or smelters should cease operations. All that we can do is to employ such methods in mining that no waste [illegible] occur. The mine must be worked out; nothing valuable must [illegible]ft behind. Existing methods require to be perfected, or new ones invented, to enable us to discover new mineral deposits at present buried out of sight. The problem of successfully substituting for certain vanishing resources others which are still abundant and capable of taking their place, will have to be solved. Metallurgical investigation must be directed to the invention of processes which are capable of handling economically lower and lower grades of ore. Much is being done in these directions, as will appear later.

Only a few years ago ironmasters on this continent would hardly look at an iron ore if it contained less than 62% of metallic content; now an ore [illegible] 50% is gladly accepted.

Iron—The question of the world's supply of iron is of such grave importance that the International Geological Congress has invited some twenty-six different countries—Canada among the number—to prepare estimates of their respective iron ore resources to be presented at their meeting at Stockholm next summer. This action of the International Geological Congress is an indication of the general anxiety and uneasiness created by the enormous demand upon this resource, for which there is no substitute, and without which modern civilization cannot continue.

But, whatever the fears regarding the world's future supply of iron ore, this pessimistic outlook does not apply to Canada, for at the present time, we are dependent upon other countries to supplement our own product by importing of their iron in the crude and manufactured state to the value of about $62,000,000 annually. In 1908 it was $61,819,698. We thus see that conservation of Canada's own iron ore resources has, unfortunately, been practised only too successfully. We are, and will continue to be, industrially handicapped until our iron industry is developed sufficiently to meet the demands of our own country and render us independent of outside sources for this all-important metal.

What we need is not conservation of our iron ore resources, but vigorous development of our iron industry. The very fact that the Government has been, and is, giving a bonus on pig iron and steel produced in this country shows how great is the need for such an industry.

By the methods hitherto employed in the production of pig iron and steel, cheap metallurgical fuel was a necessity; hence blast furnaces could only be erected and do a successful business where iron ore, coal and flux could be cheaply assembled. This is possible, however, only in the extreme east and west of the Dominion.

The middle provinces, though possessing iron ore deposits and fluxes, lack the needed metallurgical fuel. The development of a vigorous iron industry, with coke at $5.00 to $6.00 per ton, could not be looked for in these provinces, if it was necessary to depend on blast furnace methods.

The comparatively recent investigations of the electro-thermic process for the smelting of iron ores have demonstrated that only one-third of the carbon necessary in the blast furnace is needed in electric furnaces. This brings the cost of the metallurgical fuel required for smelting down to a reasonable figure. The adoption, therefore, of this process would lead, not alone to the utilization of our domestic iron ores in the provinces of Ontario and Quebec, but would greatly conserve our fuel supply by substituting hydro-electric energy for the heat energy of two-thirds of the carbon required in the blast furnace.

It may be interesting to state briefly what has been accomplished up to the present time in the development of electric smelting processes. It is only five years since the Commission appointed by the Dominion Government to investigate the different electro-thermic processes for the smelting of iron ores and the making of steel, which were in operation in Europe, presented its report. There were then only five small electric steel furnaces in existence, and only two of these were seen in actual operation. To-day seventy-seven are in operation in Europe and a number have recently been erected in the United States, some of which are of fifteen tons capacity. Indeed, electric steel is rapidly pushing crucible steel out of the market. Italy and France have the honour of having been first in the field to apply electricity to the commercial production of steel. Germany, which had no part in the original invention of the electric steel furnace, has recently bee especially energetic in the adoption of the electro-thermic process fo the production of steel and in the modification and improvement of existing patents.

While engaged in superintending the electric smelting experiments at Sault St. Marie in 1906, I noticed that the yard adjacent to the rolling mill was covered with many tons of the waste ends of the Bessemer steel ingots used in the manufacture of rails. No use was made of them at the time, and they were allowed to accumulate and eat up interest. An electric steel furnace set up in the works of the Lake Superior Corporation—for which every facility existed—could profitably have converted this waste into high priced tool steel. I understand that these waste ends are at present being utilized in the open hearth furnaces lately erected.

A process that removes from steel, more perf y than any other, those deleterious ingredients which render it frag under shock, and deprive it of its lasting qualities, is manifestly the more economic process. This purificationis more effectively accomplished by the electric steel furnace than by any other metallurg al process; its introduction in steel plants is, therefore, in the interests of economy.

It has, within recent years, been demonstrated that, in steel manufacture, carbon is not the only substance which imparts valuable properties to the iron; but that tungsten, chromium, vanadium, nickel, molybdenum and manganese add special economic qualities to iron; and for some purposes, either separately or in combination, are far superior to carbon alone.

A tool made from these alloy steels, which will hold its edge longer under severe stress and do a greater amount of work than another, is the more economical tool. A rail which can stand up longer under severe shock and resist better than another the constant wear and tear of heavy traffic is undoubtedly the more economical rail. It is manifestly in the interests of economy, not alone to employ these alloy steels for the purposes for which they are best fitted, but to manufacture them in furnaces best adapted for their production, namely, the electric steel furnace.

The progress made in the application of electricity to the production of pig iron has been much slower than in the manufacture of steel, since it was feasible only in countries possessing water-powers which could be developed at a reasonable figure. The central provinces of Canada are in this position because they possess the ore, the fluxes and the needed water-powers.

With a view of testing the feasibility of introducing the electric smelting of iron ores into these Provinces, the Dominion Government authorized the making of experiments with Canadian ores. It was not alone proven by these experiments that excellent pig iron could be produced in the electric furnace, but the remarkable discovery was made that, from a refractory ore high in sulphur, a pig iron containing only 0·005 % of sulphur could be produced. This is an exceedingly important result, since, by this new process, the large number of sulphurous magnetite deposits which abound in Canada, and which have hitherto been useless, are now rendered available for the production of high grade pig iron and steel. The world's supply of useful iron ores will thus be greatly increased by this electro-thermic process of smelting. The experiments made under the auspices of the Dominion Government at Sault Ste. Marie have been productive of another important result. Roasted nickeliferous pyrrhotite, carrying 2% of sulphur, has been smelted in the electric furnace into a pig iron virtually free from sulphur and containing from 3 to 4% of nickel. About 165 tons of this nickel iron were produced. This is the first instance in the history of metallurgy where the iron content of the pyrrhotite has been saved. Iron pyrites cinders—the sulphurous iron residue of the roasting of iron pyrites in the manufacture of sulphuric acid—which so far have been useless, may now be smelted by the electric process into excellent pig iron. These two instances are brilliant illustrations of the conservation of our iron ore resources.

Immediately after the publication of the results of our experiments at Sault Ste. Marie, Sweden—which has abundance of excellent iron ore and numerous water-powers, but, like Ontario and Quebec, lacks metallurgical fuel—was not slow to perceive the advantage which the introduction of electric smelting would prove in the development of its iron industry. Hence, without hesitation, it proceeded to take an active part in perfecting this method by the invention of a commercial furnace. In the report on the experiments at Sault Ste. Marie, definite suggestions were made as to the lines upon which a commercial furnace should be constructed; and these ideas were incorporated in a furnace designed by three young engineers of the Aktiebolaget Elektrometall of Ludvika, Sweden, who succeeded, after repeated trial constructions, and an expenditure of $102,000 in building a furnace which has proved satisfactory. To anyone who has seen a blast furnace, the construction of this furnace will easily be comprehended. The general design is similar to that of a blast furnace, with the tuyeres replaced by electrodes.

The fact that the output per electric horse-power year with the Swedish furnace did not reach our best results at Sault Ste. Marie is not due to faulty construction, but to want of the proper amount of energy. The capacity of the furnace was at least 1,200 H.P., whereas only about half that amount was available.

Several very important facts have been demonstrated during the summer run with this Swedish furnace. It has been found that it was possible to make an iron containing only 2% of carbon. The essential difference between pig iron and steel is that the former contains up to 4% of carbon, while any iron classed as steel contains from 0·6% to 2·3% of carbon. It will be seen, therefore, that the Swedes have succeeded in producing in the Domnarfvet furnace a high carbon steel direct from iron ore. It has, moreover, been demonstrated that, in the electric furnace, the process for producing iron of different compositions is under more exact control than in other processes. Mr. Yngstrôm, Vice-President of the Copparbergs Aktiebolag of Falun, and a distinguished ironmaster, in his report on the performance of the Swedish furnace after a three month's run, declares that, judging from the tests made at Domnarfvet, the production of iron from iron ore in electric furnaces is successfully accomplished, both technically and economically.

Shortly after the publication of my report on the investigation of an electric shaft furnace at Domnarfvet, Sweden, in December, 1908, I was informed that, at Tysse, Norway, a contract was let for the establishment, on a commercial scale, of an electric smelting plant consisting of two electric shaft furnaces of 2,500 H.P. capacity each, two steel furnaces of 600 H.P. capacity, and a rolling mill. This plant is to be increased by two additional shaft furnaces and two steel furnaces.

Some two months ago the Jernkontorets, an association of the ironmasters of Sweden, acquired the patents for the electric shaft furnace of the Domnarfvet type, and are erecting a 2,500 H.P. furnace of similar design, with a probable output of 7,500 tons annually, at Tröllhatten, Sweden, for the purpose of demonstrating to the iron ore owners and ironmasters the class of iron which can be produced from the different Swedish ores, and at what cost.

Mr. Boholm, of Trondhjem, Norway, writes me that he is desirous of erecting iron and steel works in Norway, and asks my Department to furnish him with an electro-metallurgist to take charge of the plant.

Canada has done all the pioneer work in connection with the process of electric smelting of iron ores, only, however, to benefit other countries, who have not been slow to perceive the advantages of this process. Italy, Hungary, Russia, Brazil, India, South Africa, Mexico and California—conditioned similarly to Ontario and Quebec as regards the iron industry—are becoming increasingly interested in the subject of electric smelting, judging from the persistent applications made to my Branch for reports and information.

Before leaving this subject, I would like to call your attention to a special method capable of wide application in the delimitation of magnetic ore bodies, which constitute our most abundant iron ore deposits. This method is described and explained in my report upon the location and examination of magnetic ore bodies by magnetometric measurements, published in 1904. By means of this system we are enabled to locate magnetic ore bodies buried out of sight by soil and to determine their general extent and inclination to the horizon. This latter information is especially valuable, since it enables the mining engineers to locate accurately their bore holes for the purpose of proving the deposit. Under favorable circumstances, if the ore body consists of compact magnetite and the surface is fairly level, it is also possible by this method to determine the extent of the ore body beneath the surface and the depth to which it descends into the earth.

This method has been applied by members of my staff for the past seven years, and has been of great service in determining the extent and probable value of the magnetite deposits examined. In one instance a deposit which had been condemned as of no value, proved, on examination by the magnetometric method, to be of considerable extent. Bore holes were located by our engineer, and it was found that the deposits, on the most conservative estimate, contained some eight million tons of ore.

The publication of our magnetometric survey maps has attracted the attention of iron ore experts in other countries, notably Dr. Leith, of the United States Geological Survey, and Dr. Phillips, of the Bureau of Mines of the University of Texas. Both these gentlemen have made application to the Department for the services of one of our experts to instruct members of their staff in the application of the magnetometric method. As this system becomes more generally known and practised, valuable magnetite deposits, which now lie hidden beneath the soil and forests, will be added to those already known, and will thus tangibly increase the general stock of this all-important metallic mineral.

When in the vicinity of magnetic ore deposits, the magnetic needle of surveyors' compasses is always disturbed, and its action becomes erratic. Such occurrences, whenever met with by the surveying staffs of the Government, should be reported to the Department of Mines, for there magnetometric surveys might be advantageously made.

Zinc—For some years the zinc ores mined in British Columbia found a ready market in the United States. The recently erected tariff of the United States has, however, virtually closed this market. If the ore mined is not to lie profitless on the dump, some method requires to be devised which will successfully treat these ores and enable the mine owners to export the output of their mines as a finished product, either as spelter or zinc oxide. In the hope of accomplishing this much desired result, a zinc smeltery was erected in Alberta, but proved unsuccessful. This failure was not altogether due to the character of the ores treated, but was due to inherent defects in the plant, introduced by the designer in an endeavour to improve upon the Belgian model. Prior to the erection of this plant, Mr. F. T. Snyder obtained a patent for an electric process and a furnace designed to treat these zinc ores. The first electric furnace was erected in Vancouver, but proved unsuccessful. The matter was not allowed to drop, however, for with commendable pertinacity a furnace of new design was erected in Nelson, B.C., and the experiments recommenced, but, up to the present time, they have been without success. While the parties interested in these experiments deserve much praise for their perseverance in trying to overcome a real difficulty, consuming valuable time and costing much money, it is to be regretted that the parties interested did not, first of all, investigate the electric process invented by Dr. de Laval, which has been in operation for some years in Tröllhatten, Sweden. The only proper course in experimentation, the only one likely to lead to success, requires that information be obtained not by reading patents, but by investigation and actual observation on the spot of all that has been accomplished in the direction in which improvement is sought to be introduced.

There are, at present, four processes invented in Europe for the production of metallic zinc or zinc oxide from complex zinc ores, which promise economic results:

(1) The De Laval process, in operation at Tröllhatten, Sweden, already mentioned;

(2) The improved De Laval process, a demonstration plant for the operation of which is being erected in London, England;

(3) The Côte-Pierron process, invented in France, and

(4) The bisulphite process. A demonstration plant to operate this process is being erected in Wales, Great Britain.

The first three systems are electric smelting processes; the last is a wet chemical process with a final product of zinc oxide.

Arrangements have been made by the Department of Mines for the investigation of these processes in the interests of the zinc miners of British Columbia.

If any one of the first three processes proves successful and can be introduced in Canada, the interests of economy will be served in a double sense: (1) because the electric process saves fuel, and (2) because the exportation of raw material and reimportation of finished product increases its ultimate cost. This unnecessary expense would also be saved.

Nickel—Whenever we speak of our mineral wealth we grow eloquent in describing our vast nickel resources, and we may well be proud of possessing the deposits of the Sudbury region. But really, of what particular and special benefit are these deposits to our country? We mine the ore, smelt it into matte and send it as such out of the country. If we want nickel or nickel steel we have to import it. The employment of an inconsiderable number of men is all we get out of these splendid deposits. Not alone are they of little material benefit to the country, as at present exploited, but the method practised is exceedingly wasteful. Anyone who has been in that region and examined the method of heap-roasting employed must have been struck with the wastefulness of this method. Part of the oxides of copper and nickel of the ore are, during roasting, converted into sulphates, and when rain falls some of these valuable contents are leached out. I have seen large pools, greenish-blue with dissolved sulphate of copper and nickel, which finds its way into the soil and is lost; while the valuable sulphur dioxide destroys all vegetation in the vicinity. In addition to these losses, the iron contained in the ore is slagged off and lost also.

A more rational process, saving all the contents, would be crushing and concentration of the iron and magnetic nickel contents by magnetic separation. The tailings would contain the copper, non-magnetic nickel compounds and all the precious metals contained in the ore. Roast the iron concentrates; save the sulphur dioxide as sulphuric acid; smelt the roasted nickeliferous pyrrhotite into nickel pig in the electric furnace; treat the tailings after roasting by the electrolytic method as it is practised at present in dealing with the matte; convert the nickel pig into nickel steel in the electric furnace; dilute with pig iron, if necessary, to bring the nickel content down to the required percentage, and add nickel, if required, to raise it.

Experiments are now being conducted for the Mines Branch to determine how much of the nickel remains in the concentrates and how much passes into tailings.

The introduction of such a process, which would treat tailings containing the copper and part of the nickel by the electrolytic process in operation at Fredericktown, Missouri, U.S.A., and patented by Mr. N. V. Hybinette, would be in the interests of economy. A refinery established in the Sudbury region on the plan outlined, would enable Canada to export finished products instead of the matte, as is now done.

Cobalt-Silver Ores.—In the case of our Cobalt-silver ores, the miners receive little more than the values of the silver contents in the high grade ore (small allowances are made on cobalt over 6%), and only a percentage of the silver contents in the low grade ore.

All low grade ore is shipped to the United States, where it is used as a silicious flux in the large lead smelters. The lead acts as a collector of the silver, and the cobalt and nickel is slagged off. It is impossible to treat economically the low grade ore in Canada, on account of the absence of large lead smelters in the vicinity of Cobalt.

The mine owners at Cobalt are handicapped by the following conditions:—

1. The smelters being situated some distance from the mines, high freight rates are charged by the railways for the transportation of the ore from the mines to the smelters.

2. The freight rate on coal is high. Coal costs $6.00 per ton at Cobalt. Of this, $3.25 represents freight rates from Black Rock to Cobalt, a distance of 448 miles. The *cost of the coal*, with *freight rates* from Pittsburg to Black Rock, a distance of 270 miles, is $2.25 per ton. This shows that the freight rates from Black Rock to Cobalt are disproportionately high.

3. Small payments are made for the cobalt contents of the ore, on account of the limited demand for that mineral.

4. The arsenic is of little value after being refined, on account of its being produced some distance from the market (the market is east of Chicago in the United States), and the United States railways give a

very much lower rate on arsenic produced in the Western states than the rates obtainable in Canada. Arsenic shipped from Canada is charged a fourth-class rate, while arsenic from Utah and Montana is charged 83.33% of the sixth-class rate. The latter rate is about one-half of the former.

I might say in this connection,, that, if the miner approached the Dominion Government and asked for assistance, much might be done to solve these difficulties and to help the mining industry in general. It would be of great benefit to Canada if the government would install a fully equipped metallurgical and ore-dressing plant, by means of which new methods could be devised for a more economical treatment of our ores. Each ore is practically a study in itself, and much money is lost annually by the installation of unsuitable plants, and by the necessary change in equipment brought about by the experience gained by the company after operating for a time. This could be avoided by having the government do the primary experimenting.

In the case of complex ores, much could be done towards the economical saving of two or more of the valuable minerals present.

I do not think that there would be any doubt but that the mine owners, as a matter of business, would utilize the methods devised by such a department after they had been shown to be successful.

Peat—In the central provinces of Canada the high price of imported coal, on the one hand, and the depletion of our forests, on the other, with consequent rise in the value of wood, due to its increasing scarcity for constructional purposes, together with the possible suffering which would be entailed in the event of the supply of coal being diminished, or even cut off, by a coal strike, or some other cause, in the United States, makes the question of substituting peat for imported coal one of supreme importance.

The cost in Winnipeg of the poorest quality of wood (spruce and tamarack) is from $6.00 to $8.00 a cord; while coal is $10.50 a ton. In Ontario, Quebec and New Brunswick, wood and coal are somewhat cheaper, but still too dear for both domestic use and economic manufacturing purposes. And considering the fact that we imported, during the year 1908, coal to the value of $28,500,000, constituting an enormous and increasing drain on the wealth of the country, every effort should be made to retain a portion of this money at home, not only to give employment to our own people, but also to lessen our dependence upon outside sources. This much-desired economy may be largely effected by the establishment of a peat industry on a sound basis.

It has been estimated that the known peat bogs of Canada cover approximately an extent of 36,000 square miles. This area would produce about twenty-eight billion tons of air-dried peat, which would be equal in fuel value to about fourteen billion tons of coal. The comparative fuel value of peat, coal and wood is: 1 ton of the best coal is equal to 1.8 tons of peat or 2.5 tons of wood.

The attempts made so far in Canada to manufacture a commercial peat fuel have been failures, and very little peat-fuel is at present available. The chief cause of most of these failures has been in the ignorance of the nature of peat on the part of those who have engaged in the production of peat-fuel. In several instances the bogs chosen for the work have been unsuitable for the purpose in view. A proper investigation of the bog previous to the commencement of operations was seldom made; consequently, methods entirely unsuitable for the utilization of the bog in question have been employed, and the result has been failure. These failures, involving as they did considerable loss of capital, have created a profound distrust of everything connected with peat and the utilization of peat bogs, with the result that, at the present time, the peat industry in Canada is practically dead. With a view to assisting Canadian manufacturers of peat products, a member of my staff was commissioned to proceed to Europe to investigate and report upon the peat industry in those countries in which it is in successful operation. Armed with the practical knowledge thus gained, the Mines Branch is attacking the peat problem in this country, and a systematic investigation of the Canadian bogs has already been started with a view to ascertaining the quantity and quality of peat contained in them.

Up to date about twelve bogs have been examined, mapped and reported upon. Any person desiring to start a peat plant can, upon application, have his bog investigated, and it is hoped that such failures as have been due to the choosing of bogs unsuitable for the purpose to which the product was to be applied, will, in future, be avoided.

Another object of this investigation is to protect the public, as far as possible, by preventing the expenditure of capital in the exploitation of worthless bogs.

It was conceived that the most practical manner in which to awaken public interest in the utilization of our peat resources would be the establishment of an experimental plant where peat-fuel could be manufactured on a commercial scale and by methods which have already proved successful in European practice. At such a plant, interested parties would have an opportunity of ascertaining for themselves the working of the bog, as well as the suitability of the peat-fuel produced.

With this object in view, the Government has acquired a peat bog of 300 acres, located at Alfred, near Caledonia Springs, Ontario, having an average depth of eight feet. Actual work was begun during last summer in surveying, levelling and draining the bog. About five miles of ditches have been dug; a storage shed to hold 300 tons of air-dried peat, a blacksmith's shop and an office have been built, and the necessary tracks and auxiliary machinery for supplying the Anrep peat machine have been installed. It is the intention to begin work in the manufacture of peat at the end of next April.

The recent improvement in gas producers and gas engines has opened up a new field for the use of peat and lignite. It is a well established fact that the most efficient steam plant utilizes only about 15% of the calorific value of the fuel, while a gas producer-plant utilizes about 18 to 22%. The saving in fuel effected by the gas producer has not, hitherto, been duly appreciated in Canada. A power plant located at the peat bog and using producer gas derived from peat can furnish electric energy which may be transmitted to the market in the same way as electric energy generated by water-power.

A Government fuel-testing station has already been built in Ottawa by the Department of Mines, with the object of testing the efficiency of the various classes of fossil fuel and to determine their adaptabliity for the different uses to which fuel is applied.

The first use to be made of this plant will be to demonstrate that peat containing up to 35% of moisture may be economically employed in a producer to furnish power gas for gas engines.

The machinery which is being installed consists of a gas producer and a 50 H.P. gas engine of the Körting type, a dynamo of 50 H.P. capacity, and a wire rheostat to absorb the power developed. About 70 tons of air-dried peat are in the shed adjacent to the power plant. It is expected that the plant will be in working order by the end of February next, when interested parties may inspect the plant and inform themselves with regard to its operation, efficiency and the cost of the power produced.

Many applications have already been received from parties desirous of visiting the power plant at Ottawa and the peat plant at Alfred.

The transportation to great distances of low grade fuel such as air-dried peat, is not recommended, either for domestic or power purposes. But, inasmuch as the expense for the erection of a peat plant of 30 tons daily capacity would not exceed $7,000, and, since workable peat bogs are scattered throughout the farming regions of Ontario and Quebec, the most economical plan for utilizing this fuel would be the erection of a number of plants at strategic points, to be operated in the interests of the neighbouring communities.

Further, peat-fuel is not only a valuable asset as a substitute for coal, but those classes of peat which are practically useless for fuel are extensively utilized by European farmers as moss litter. In fact, the manufacture of this litter and its by-product, "peat mull," has become a well-established industry in Sweden, Germany and Holland.

Peat mull, obtained as a by-product in the manufacture of moss litter, is an excellent material for packing fruit and plants and for storage and shipping. Its antiseptic properties and great affinity for moisture render it invaluable as a preventive of decay in fruit.

In Norway some 200, and in Sweden between 300 and 400, small plants are manufacturing this material; while in Germany and Holland, where there are a number of large plants, the manufacture of moss litter has become a flourishing industry. Most of the smaller plants are owned by groups of farmers, who work the bogs themselves.

Inasmuch as moss litter is, in many cases, a by-product in the making of peat fuel, its exploitation would materially reduce the cost of manufacturing peat-fuel if placed on the market commercially in conjunction with peat mull. Several shipments of moss litter from Holland have been made to the United States—at $16.00 per ton.

The different Departments of Agriculture in European countries very strongly urge farmers to use moss litter. Seeing that Canada is fast becoming an important fruit exporting country, it is evident that the use of peat mull as a packing material would be a great economic advantage.

Before passing finally to the important question of coal mining, I would conclude my plea for the economical exploitation of our abundant peat-fuel resources, the importance of which cannot be overestimated, by warning my hearers that the introduction of a fuel like peat is an undertaking that cannot be accomplished in a year or two, but will require an aggressive educational campaign in order to demonstrate the value of the products as well as the manner of manufacture.

Coal—In England and Germany every effort is made to prolong the life of the coal mines by the adoption of mining methods which insure a more complete extraction of the coal than do the methods practised in the United States and Canada.

The system employed in England is known as the longwall method.* By this method practically the entire coal in a seam is extracted, leav-behind no pillars and barriers; only the coal of pillars and barriers in the air and passage ways is left behind and sacrificed. The percentage of available coal left in these pillars and barriers is about 2·8%; the amount lost through faults and bad coal, 3%; making a total of irrecoverable coal equal to, say, 6%. Although, by the use of this method, the actual cost of extraction per ton of coal is increased, the productive life of the mine is greatly prolonged.

The method employed in the United States is less expensive and permits the extraction of the largest tonnage at the lowest possible cost, irrespective of the loss of life entailed, or the amount of coal left behind. This affirmation applies also to the methods of coal mining practised in Canada. By this system—the room-and-pillar method—only 50% of the original coal is extracted, leaving 50% to be taken out afterwards by the removal of pillars, which is a dangerous operation and which, both in quality and quantity, entails great loss of coal, amounting, at least, to 15% and sometimes double this figure. If the companies operating the coal mines of North America were forced to pay compensation for loss of life and accidents, as under the English law, they would have incurred an expenditure of $7,656,000 during 1908.† If this amount of money had been expended in more economic and safer methods of mining, the number of lives lost would have been greatly decreased and the available fuel supply greatly increased.

But while the conservation of coal by economic methods of mining is of great national importance, the conservation of human life is of still greater importance. The lamentable loss of life and the occurrence of accidents in our coal and metalliferous mines reflects seriously upon mining conditions in Canada.

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* "Our investigations and recommendations relate primarily to questions of safety in mining, but in this connection we have been greatly impressed with another closely associated phase of the industry, viz.: the *large and permanent loss of coal* in mining operations in many portions of the United States.

This is a *serious*, *permanent*, and *national* loss. It seems to be a natural outcome of the ease with which coal has been mined in the United States, and the enormously rapid growth of the industry.

The active competition among the operators and the constant resulting effort to produce cheaper coal has often naturally led to the mining of only that part of the coal which could be brought to the surface most easily and cheaply, leaving underground, in such condition as to be *permanently lost*, a considerable percentage of the total possible product.

Certainly, much of this loss can be prevented through the introduction of more efficient mining methods, such as the *Longwall* system, more or less modified, and the flushing method." Extract from report of "Foreign Experts" to the United States Government.

† See report by Frederick L. Hoffman, statistician of the Prudential Insurance Company of America, Newark, New Jersey.

In England the average loss of life per 1,000 men employed during the years 1903 to 1907 was

Coal mines	1.29
Metalliferous mines	1.08

Contrast with this the average men employed in Canada, per 1,000, for the ten years, 1899-1908:—

British Columbia: coal mines	9.21
Nova Scotia: coal mines	2.67
British Columbia, 1908: metalliferous mines	5.93
Ontario, 1907: copper and nickel	2.19
silver and iron	7.36

The actual death rate per 1,000 men employed at Cobalt in 1908 is difficult to obtain, on account of many mines not sending in returns of the number of men employed, but it is safe to say that the death rate was about 12 per 1,000 men employed underground, 36·6 per cent. of which was due to explosives.

If, therefore, stringent laws have been enacted for the protection of even the low type of labour employed in the South African mines, surely Canada should lose no time in giving its sanction to a code of laws and regulations that will effectually conserve and preserve the valuable lives of its citizens. Canada at the present time, is without such laws and, in this respect, stands unique, for in every other mining country, laws relating to explosives have been enacted. Legislation on these lines would manifestly be in the direction of the highest economy.

Such is a brief generalized view of some of the possible economies in the production of the mineral resources of Canada. I have set forth the economic advantages to be gained (1) by the adoption of the electric furnace in the smelting of our immense deposits of refractory iron ores; (2) by the introduction of more effective metallurgical processes for the treatment of zinc, nickel, and silver-cobalt ores; (3) by the utilization of peat and lignite as substitutes for coal fuel, especially in gas producers; (4) by the manufacture of peat by-products into moss litter and peat mull, in the interests of farmers and fruit growers; (5) by the adoption of the longwall system in coal mining in order to avoid unnecessary waste; and finally, in the conservation and safeguarding of human life by the adoption of a stringent code of laws regulating the use of explosives.

When these economies have been translated into actual fact, doing away with wastefulness on the one hand, and conserving our national resources on the other: when we shall have succeeded in sending out to the foreign markets finished products instead of raw material, as at present, then, not only will the industrial progress of the country be accelerated, but Canada will have taken its place among the great commercial and industrial nations of the world.