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THE NICKEL COMMISSION'S REPORT.

The report of the Royal Ontario Nickel Commission is summarized in this issue. Our readers will agree that very valuable work has been done and that the Province has been well repaid for the expenditure undertaken. The work has been arduous, but of great interest to the Commissioners and those who have assisted them, and has been accomplished in a masterly way. The choice of Commissioners has proven to have been an unusually wise one.

Few men are so well qualified to report on the Sudbury nickel industry as are Dr. Miller and Mr. Gibson. They have for years followed the struggles of prospectors and operators in their endeavors to establish industries in Northern Ontario. They have not been satisfied with simply recording the progress made; but have played an important part in the progress. They have not only kept themselves well informed and performed well the work which their positions call for; but have been ever ready to assist and encourage the pioneers. Through their kindly sympathy, their clear grasp of the situations that have arisen and their ability and willingness to help in overcoming difficulties, these two men have been a big factor in developing Northern Ontario. Happily also they have regarded before all else the best interests of the Province they serve and have not allowed their sympathy with the pioneers to prevent them from viewing clearly the interests of other citizens. While guarding especially the interests of the mining fraternity they have guarded also the common interests of the people of the Province.

Mr. Holloway brought to the Commission little special knowledge of conditions in Northern Ontario; but he brought a wealth of experience in metallurgical problems. His painstaking study of the nickel industry since he was appointed chairman of the Commission has enabled him to place before the Canadian public a masterly treatise on nickel and to give advice of great value to the Legislative Assembly of Ontario.

Mr. Young brought to the Commission valuable experience in legal matters. It is not easy to identify his contributions to the report; but we have no doubt that his services were of great value and that his knowledge of company matters and his study of the titles to the properties, of the dealings between the companies and the Province and of the system of taxation have been of much assistance in the inquiry and in formulating opinions.

While the Commissioners and the Secretary as individuals are entitled to great credit it is not difficult to see that a great deal of the credit belongs to the Ontario Bureau of Mines. The members of the staff of this exceptionally efficient Government Bureau have ably assisted in the work.

CONSOLIDATED CO. HAS CLOSED ITS MINES AT ROSSLAND.

On March 31st, the Consolidated Mining and Smelting Company of Canada, Ltd., closed its mines in Rossland camp, British Columbia, for an indefinite period. This action is understood to have been taken for two reasons, first on account of the uncertainty of an adequate supply of coke being obtainable from the Crowsnest district of Southeast Kootenay, where the agreement between the coal-mine operators and the United Mine Workers of America, which controls the miners and other employees of the coal-mining companies operating in that district, and next in view of an expected concerted demand by the metalliferous miners throughout the district for an advance in wages of fifty cents a day.

In connection with the uncertainty of the supply of coke being sufficient for the continued operation of the company's copper blast-furnaces at Trail, it is manifest that no dependence can at present be placed on the Crowsnest district for the output of coke being maintained, for news was received in Victoria on April 2 to the effect that at the Crowsnest Pass Coal Co.'s colliery at Michel, the miners had stopped work, while similar action may be taken any day by those employed at the company's Coal Creek colliery. With the Michel mines and coke-ovens idle, the outlook for coke being obtained for the Trail blast-furnaces was less favorable; if the ovens at Fernie shall also be allowed to become inoperative, which must be the result if the miners shall suspend work at Coal Creek, whence comes the slack for burning into coke at Fernie, then the chances for obtaining coke for Trail, Grand Forks, Greenwood, and Northport smelting works will be small indeed.

In regard to the wages increase question, if the temper and attitude of the miners and smelter employees are correctly indicated by a "special" news despatch from Trail to the British Columbia Federationist, the "official paper of the B. C. Federation of Labor," printed on March 30, then the probabilities seem to be that the big mines in Rossland camp will not soon be reopened. That despatch follows:

"Trail, B.C., March 26.—In the territory of District No. 6, under the jurisdiction of the International Union of Mine, Mill, and Smelter Workers, is located the corporation known as the Consolidated Mining and Smelting Co. This company controls the greater part of the operations of mining and smelting ores in the Kootenay and Boundary country, and all of its properties are running full blast. During the last two years great changes have taken place in Trail. A zinc plant has been erected, which is turning out about thirty tons of refined metal every 24 hours, and a copper refinery has been added to the smelter, which was found to be too small. The manufacture of acid, which is necessary in the reduction process, is also carried on at the plant.

"Unionism Not Favored."

"A recent statement of the general manager noted that \$1,000,000 had been expended in improving the plant, and that this was done for the purpose of turning out more metal products, the demand for which had increased with the result of increased prices. In making the demands from the management it was said that the smelter was operated at a loss, in face of the fact that metals had gone up in prices more than 50 per cent. This company does not want to have anything to do with the organization of District No. 6 if it can possibly help it, but the chances of winning concessions from this corporation were never more favorable

to the men than just now, and the district is taking advantage of this opportunity.

"The shortage of labor on the market, the intense demand for metal goods at high prices, and the fact that the Consolidated pays lower wages than any other company in British Columbia for the same kind of work, are circumstances that are of benefit to the workers in this part of the country. As a result of the activities of the district organization, the company has granted a raise of wages to all its employees of 25 cents per day.

Strike Vote on Wages.

"The demands of the men are 50 cents per day increase, and the check-off system. A strike vote is being taken by the men on the enforcement of these demands. The sentiment of the men is to fight the issue to a successful conclusion.

"As a result of the construction work being about finished, a number of men have been discharged, and most of them have left for other fields to peddle their labor power.

"Full returns of the strike ballot are expected by April 1. It is advised that all men steer clear of the weaklings of the Consolidated until more remuneration for labor power has been arranged. The wages paid at Greenwood and Phoenix, where plants are operated by two different companies, are about 75 cents a day higher than is paid at Trail, and in the mines at Rossland, Kimberley, and other places controlled by the Consolidated."

Difference in Conditions.

The statement made above that the Consolidated Co. controls the greater part of mining and smelting operations in Boundary district is quite inaccurate. This is manifest when it is seen that in 1916 the Granby Co.'s mines at Phoenix shipped to the company's smelting works at Grand Forks more than 1,000,000 tons of ore, and the British Columbia Copper Company's mines, Boundary, shipped to that company's smelting works at Greenwood about 276,000 tons, while the Consolidated Co.'s mines in the district made an output of only 15,156 tons. No figures are at hand to show the respective wages scales at Boundary and Trail smelting works, but so far as the products of the mines are concerned there is this most marked difference: For five years, 1911-1915 (the 1916 figures are not yet available), the total value of the output from Rossland mines was about \$16,635,000, of which \$13,785,000 was in gold, the price of which does not change, and only \$2,545,000 was in copper, while out of a total value for Boundary mines for the same period of approximately \$24,610,000 (not including the Hedley Gold Mining Co.'s gold production of \$3,797,000) only \$5,873,000 was gold and \$17,829,000 was copper value, the latter having in 1915 at any rate benefited from War prices.

PORCUPINE MINERS DISCUSS WAGES.

Cobalt, April 10.—A meeting of the Porcupine branch of the Miners' Union was held Sunday in Timmins, and voting in that camp on the new wage scale is proceeding. In view of the fact that in other camps the vote is shaping up into a large majority in favor of the new scale, it is considered almost certain that the vote at Porcupine will fall in line. Complete returns are looked for by April 18. After that date it is understood the union will immediately take steps to acquaint the Government with their side of the question, and unless the increase is forthcoming in the meantime more drastic developments may be expected.

CORRESPONDENCE

MR. WHITE'S LEATHER MEDAL.

Editor, Canadian Mining Journal:

Sir,—I was very much pained on reading your reply to Mr. James White's letter concerning "Waste Through Duplication." You do not seem to be aware that although you do not appreciate his communication it has been honored in other quarters and has been the occasion of awarding a decoration. I am sure every one else but you, Mr. Editor, will consider that the decoration has been well bestowed and honestly earned. May it long decorate Mr. White's gallant bosom.

Your readers will be interested in hearing further particulars about this interesting event, although I have no doubt it will go against the grain with you to give recognition in any way to Mr. White's achievement. The Toronto Star Weekly has been in the habit of awarding leather medals to the "Perpetrators of Some of Life's Little Absurdities." These are awarded, to quote the words of that journal, "For the most ridiculous quotation from a Canadian newspaper, magazine, novel, advertisement, signboard, etc., due either to a typographical error, a bad English construction or somebody's blunder." The following quotation from Mr. White's letter in your issue of March 15th has been awarded a medal in the issue of the Toronto Star Weekly of 31st March: "This statement is essentially untrue and the fact that Dr. Frank D. Adams attached his signature to the report is sufficient to demonstrate its inaccuracy."

It is evident, Sir, that you have misunderstood Mr. White and also that he does not mean what he writes. Under these conditions would it not be possible to arrange terms of peace between you? I would be indeed proud if you would accept my good offices as mediator. Might I suggest that you would send me with the olive branch and a seasonable goodwill offering of colored Easter eggs (strictly new laid of course). This would no doubt lead to pourparlers and it is to be hoped the re-establishment of friendly relations. As you have not shown to advantage in this matter, I presume you will very likely not publish this letter. I am determined, however, that justice shall be done and will seek some other medium of publication if you decline to print this.

OBSERVANT READER.

ACTIVITY IN MANITOBA.

The Pas, Man., March 30.—The caterpillar tractor for use by the Mandy Mining Company went north on Tuesday afternoon, having in tow three sleigh loads of supplies for the mine. The tractor is equipped with a sixty-horse-power engine. She will make the return trip here with twelve tons of copper ore.

Jack Hammill, who has been handling the Flin-Flon properties for his partners, will arrive on Saturday, when all the parties interested in the big deal will assemble to meet Hammill and sign up on the new arrangement.

Zar Crittenden is busy helping Smith & Durkee, the diamond-drill men, and their crews, in getting started for Flin-Flon. Huge quantities of supplies are being forwarded. Ten teams have been secured, and a contract let for 2,500 cords of wood, so that the diamond drilling can be pushed as fast as possible.

Work is now being rushed on the road from Mile 85, H. B. R., to Herb lake, and by June travelling should be possible over the new trail. This will be a great advantage, and will enable work to be carried on at all the properties with comparative ease this summer.

OBITUARY.

At the annual meeting of the Canadian Mining Institute last month there was general regret that "Davy" Browne was unable to be present, for Mr. Browne has for years been one of the strongest men in the Institute. Illness prevented his attending the meeting, but we little dreamed that we were so soon to receive word of his death. The shock was keenly felt, for Mr. Browne had endeared himself to all who knew him well.

David H. Browne was a distinguished metallurgist and rendered great service to the industry. His work at Copper Cliff and New York was, however, not confined to metallurgical problems. He endeavored to brighten the lives of all those with whom he was associated, and in this he was exceptionally successful. While he will be remembered for his contributions to metallurgy, he will longer be remembered for his personal qualities and his love for his fellows. It is particularly to be regretted that this fine American, who spent so many years in Canada and was ever ready to fight for the rights of humanity, could not have lived to see the day when his native country should decide to defend those rights with all its power.

David H. Browne, metallurgist, author and speaker, was born June 8, 1864, at Hollymount, in the County of Mayo, Ireland. He passed successfully through the ordeal of the famous academy at Londonderry, and at the age of sixteen came to America, and continuing his scholastic career, graduated with the class of 1885 at the University of Michigan. Then followed a brief period of apprenticeship and training, first as chemist with the Joliet Steel Company, under Emmerton, then in a similar capacity at the Ludington mine, Iron Mountain, Michigan, and then back to the academic atmosphere of his Alma Mater as instructor in Inorganic Analysis, 1889-1890. There is no doubt that had he remained he would have been today a popular and successful professor, but luckily for the mining profession, the young Irish lad found the university life too tame, and, as he says himself, he couldn't stand the job, had to hear steam blow off and see the wheels go round, so worked till 1891 at the Andrews and Hitchcock blast furnaces, Hubbard, Ohio. In 1891 he entered the service of the newly organized Canadian Copper Company, as chemist, and since then his whole time had been devoted to the working out of the complex metallurgical problems, constantly occurring and persistently recurring in connection with the nickel-copper ores of the Sudbury field.

A published statement indicates the comparatively large amount of money now being paid out monthly at Butte, Montana, in connection with the mining industry. It gives the following information: The pay roll of the Butte district, including miners, clerical help, public service, corporations' employees, and others, for the month of February amounted to \$3,500,000. The Anaconda Copper Mining Co.'s pay roll for the shortest month in the year was \$1,638,182, and this was for Butte alone. It is estimated that the public service corporations, the corporations other than mining, the other mining companies, and the business houses together paid out an amount large enough to make up the remainder of the total of \$3,500,000. When it is considered that Butte has at present a population of 110,000, it means that the mines alone pay what amounts to an average of about \$24 a month for every man, woman and child in that city.

REPORT OF ONTARIO NICKEL COMMISSION.

The Royal Ontario Nickel Commission, appointed by the Ontario Government on the 9th September, 1915, to investigate the resources, industries and capacities of Ontario in connection with nickel and its ores, has presented its report. The Commissioners are Geo. T. Holloway, Associate of the Royal College of Science, London, and Vice-President of the Institution of Mining and Metallurgy, an English metallurgical expert of high repute; Dr. W. G. Miller, Provincial Geologist, and McGregor Young, K.C., a well-known barrister of Toronto. Thomas W. Gibson, Deputy Minister of Mines, acted as Secretary.

After references to the various countries they visited, including the United States, Great Britain, France, Norway, Cuba, Australia and New Caledonia, and to numerous mines, works, plants, smelters, etc., on this side of the Atlantic and on the other, and also to their interviews and conversations with Mr. Bonar Law, then Secretary of State for the Colonies, and other British Government officials, the Commissioners go on to say:

"The two questions that have been uppermost in the numerous discussions that have taken place concerning Ontario's nickel industry during the last twenty-five years, are: (1) Can nickel be economically refined in Ontario, and (2) Are the nickel deposits of Ontario of such a character that this province can compete successfully as a nickel producer with any other country. It will be seen that the Commissioners have no hesitation in answering both of these questions in the affirmative."

The Report goes on to state that the Commissioners are of the opinion:

"(1) The nickel ore deposits of Ontario are much more extensive and offer better facilities for the production of nickel at a low cost than do those of any other country. Nickel-bearing ores occur in many parts of the world, but the great extent of the deposits in this Province, their richness and uniformity in metal contents, and the success of the industry, point strongly to the conclusion that Ontario nickel has little to fear from competition.

(2) Any of the processes now in use for refining nickel could be successfully worked in Ontario, and conditions and facilities are at least as good in this Province as in any other part of Canada.

(3) In view of the fact that practically no chemicals are required, that there is a much more complete saving of the precious metals, especially platinum and palladium, and that electric power is cheap and abundant, the most satisfactory method of refining in Ontario will be the electrolytic.

(4) The refining of nickel in Ontario will not only benefit the nickel industry, but will promote the welfare of existing branches of the chemical and metallurgical industries, and lead to the introduction of others.

(5) The methods employed at the Ontario plants of the two operating nickel companies are modern and efficient, although there are differences in both mining and smelting practice. It is the consistent policy of both companies to adopt all modern improvements in plant or treatment. Even during the present time of acute pressure the Canadian Copper Company has materially increased its output without substantial enlargement of its plant, and the losses in smelting are less, both at Copper Cliff and the Mond plant at Coniston, than they were a year ago.

These companies have each had their experimental stage, neither has asked nor received any government assistance, and both have earned the success which they have achieved.

(6) The present system of mining taxation in Ontario is just and equitable and in the public interest, and is the best system for this Province. Any question of change is rather one of rate than of principle. This important question is dealt with at some length in Chapter XII.

Experiments have been undertaken by the Commission in the production of nickel-copper steel direct from Sudbury ore, and also in the electrolytic refining of nickel. Certain improvements in the latter process have been made the subject of application on behalf of the Government of Ontario for patents in Canada, United States and Great Britain."

The Commissioners are gratified at the assured prospect of the erection in Ontario of two large plants for the refining of nickel; one by the International Nickel Company of Canada, Limited, at Port Colborne, and the other by the British America Nickel Corporation, Limited, probably at Sudbury, if a supply of electric power can there be obtained.

There is reason to believe that the cost of refining in the International Nickel Company's new plant at Port Colborne will be less than at their existing works in New Jersey; and if so, the natural tendency will be to enlarge the refining capacity in Ontario from time to time. Provision for doubling or even quadrupling the initial output of 7,500 tons has been made in planning the refinery.

The question of a market for nickel ore or low grade or other matte by small producers, has received the attention of the Commissioners. Little ore is being mined at present, except by the large companies. Representatives of the British America Corporation have expressed their desire to discuss the subject of custom smelting and refining with the government. An arrangement for custom smelting and refining with this corporation, in which the British Government has a controlling interest, should serve all the needs that may arise.

The suggestion has been made that government ownership would solve many of the questions which have been raised in connection with these deposits. To appropriate the deposits and plants of the Sudbury nickel area would, judging from sales of company shares, probably cost not less than \$100,000,000. This is a sum approximately equal to the total paid-up capital stock of all the chartered banks in Canada. There does not seem to be any good reason why the people of Ontario should be asked to adventure so large a sum of money as would be required for the purchase of the nickel deposits and plants.

There is no certainty that large profits can be made every year from the nickel industry. The present activity is in part due to well understood causes, which it is to be hoped will never recur. In the past the output has had to be curtailed at times. If the price of nickel should fall, profits will naturally decrease. The nickel industry is to a considerable extent dependent for its success on the highly trained and specialized technical men who superintend it, and who command salaries far beyond those which are paid in the government service to the most highly placed employees. Besides, nickel is not a necessity of life nor an article of universal consumption or use, and the nickel business is in no way comparable to those connected with the operation of public utilities, where government ownership may be beneficial or expedient.

The Commissioners have had the advantage of consulting producers and leading consumers for different purposes in Great Britain and the United States. The opinion is general that the uses of nickel will be extended, and that when normal peace conditions are fully restored, the demand will be greater than it was before the war. A reduction of the price would undoubtedly enlarge the consumption and call for increased production.

The question of competition from other countries is of primary importance.

While competition is not to be feared, it would be futile to try to shut off the supply of nickel from almost any of the great nations. Nearly every important country has supplies of nickel ore which can be worked if the demand is great, thus ensuring a high price.

In the early years of the development of the Ontario nickel industry grave difficulties were encountered. Of the three pioneer companies, only the Canadian Copper Company has survived. The chief difficulties were the economical treatment of the ore, the prejudice of the trade against Canadian nickel, and the limited market. Gradually, and not easily, the obstacles were overcome, and from a weak and precarious infancy, the Sudbury nickel industry has grown to be one of the great metal industries of the world. The market for nickel is much more restricted than for iron, copper and other so-called common metals. Production has to be more closely considered in relation to consumption. Statistics show that at certain periods the output of nickel from Sudbury ores has not shown a normal increase; it has occasionally decreased. This has been chiefly due to the fact that consumption has not kept pace with production. Much has been done by the refiners of Ontario nickel by means of advertising and research to increase consumption and to enlarge the markets.

The proven, or positive, ore of the Sudbury area can be conservatively put at 70 million tons, while it is safe to say that the proven, together with the probable and possible ore supply, exceeds 150 million tons. The International Nickel Company's published estimate of their ore reserves is 57 million tons, which is for three mines only. Although the Sudbury deposits have been worked for twenty-nine years, there is vastly more ore proven in the district to-day than there was five years ago.

In the last few years the proven reserves in the Creighton, Frood and Crean Hill mines of the Canadian Copper Company (International Nickel Company) have been very largely increased. The historic Copper Cliff mine is not exhausted, but is lying dormant simply because the company can mine ore more cheaply from other properties.

Of the Mond Nickel Company's properties, neither the Victoria, the oldest mine of this company and the deepest mine of any kind in Ontario, nor the Garson, another of its older mines, shows signs of exhaustion. The great Levack property has been developed only within the last three or four years into a mine now known to have at least 4,500,000 tons of ore, and it may be added that the ore of this mine has been found to be of higher grade than was thought to be the case in any of the properties in the north nickel range. The Worthington mine, that lay unworked for years, has lately been reopened and possesses important reserves.

The Murray mine, now owned by the British America Nickel Corporation, was operated in the early years of the nickel industry in Sudbury and thought to be of little importance. This mine lies right on the

main line of the Canadian Pacific Railway, three miles from Sudbury, and is one of the best examples that can be cited of a great mine lying for years, after its discovery and after considerable work had been done on it, with its importance unrecognized. Several companies had options on it at various times after the Vivians ceased work over twenty years ago, but it is within only the last four or five years that its greatness has been determined. Diamond drilling has proved that it and the adjoining Elsie property contain at least 8,500,000 tons of ore.

The apparently important discovery by the Long-year syndicate, during the last few months, of nickel ore bodies underlying the heavy covering of drift in the township of Falconbridge, east of the Garson mine, should also be mentioned. The discovery was made by means of diamond drills and proves, what the geological conditions would suggest, that not all the nickel deposits of the district are exposed at the surface. The existence of the Alexo mine, Temiskaming district, in actual operation, so far from Sudbury, is significant of possibilities outside of that area.

No such vast deposits of workable ores, considered as a source of metallic nickel, are known in any other country, and there is no reason to believe that any competition will arise with which Ontario cannot cope.

The competition of New Caledonia calls for special mention. The question has received careful consideration from the Commission, and, in view of its importance, one of the Commissioners, accompanied by the Chief Inspector of Mines, visited and spent some time on the island, where, by the courtesy of the French Government and the officials of the operating companies, they were able to secure first-hand information in regard to its resources and prospects.

For many years New Caledonia dominated the nickel market of the world. With its accumulated experience, the financial support of the Rothschilds, a trade prejudice in favor of its product, and long and favored connections with the principal consumers in Great Britain and elsewhere in Europe before and after the advent of Ontario as a producer, New Caledonia has been unable to keep pace with her younger rival.

When the Sudbury industry began, practically the whole of the world's demand for nickel was supplied from New Caledonia. In 1900 about 65 per cent. of the world's nickel came from New Caledonia and about 35 per cent. from Canada. The world's output has increased fivefold since that time, and Ontario now produces over 80 per cent. of the whole. The production of Ontario in the last 15 years has increased ninefold; the production of New Caledonia by less than 20 per cent.

The chief factor that has enabled Sudbury to outdistance its only serious rival is the difference in the size of the ore bodies in the two countries. The principal Ontario deposits contain ore that is measured in tonnages of millions, while those of New Caledonia are reckoned in a few hundreds of thousands. The greatest of her deposits contained about 600,000 tons; few reached 250,000.

A determination of the ore reserves in New Caledonia is not possible owing to their uncertain character, but it is probably fair to say that the colony possesses at least as much high-grade ore as she has already mined in the forty years of her existence as a producer. This would give a total of, say, 160,000 tons of metal, which would represent about four years' output from Sudbury at the present rate of production.

There being many deposits for selection, the first mines to be worked were naturally the most accessible,

and usually those near a harbor. Many mines that were once worked are now abandoned, including the Borneo, which has the record of having been the largest producer. The production of the larger mines is decreasing, and mines such as the Emma, in more inaccessible situations are now being opened, necessitating the extension of the railways farther into the interior of the island. There is no evidence to show that any of the new nickel mines are larger than some of the old ones, or that ore can be produced more cheaply from them.

The essence of the whole matter in so far as competition from New Caledonia in the open market is concerned, is the cost of the refined nickel produced from its ores. More than a dozen years ago the cost was approximately 19 cents a pound. Immediately prior to the war it had not been lowered. At present with excessive freight rates and increased prices for supplies, the cost is much increased. As long as the price of nickel remains about the same as it has been during recent years, New Caledonia will have an important industry. It will probably expand to some extent, owing especially to the activities of the newer of the two companies that are shipping ore and smelting on the island. But there is no good reason for believing that the competition with Ontario will become any stronger than it has been in the past. Should the price of nickel fall to 25 cents a pound or less, New Caledonia will have difficulty in keeping her mines in operation.

While it is true that Ontario has no monopoly, it possesses many advantages over all competitors, even under the present conditions of the market as to prices and trade connections. In any keen competition as to prices it is doubtful whether any other locality at present known or suggested could compete with Ontario. It is a matter of record that at one time of low prices the leading New Caledonia company was compelled to suspend all dividends. It may be doubtful, further, whether anything but an arrangement of the market between the great interests can prevent the complete domination of the world's trade by the nickel industry of Ontario making the best use of its exceptional resources.

Refining Processes.

There are three processes, which may be described as standard methods, in use for the refining of nickel from ores like those of Sudbury. These are (1) the Orford process, employed for the treatment of the matte produced by the Canadian Copper Company, (2) the Mond process, and (3) the Electrolytic process. For all these processes, the production of a matte is essential. Matte is made by substantially the same method for all three.

The Orford Process.

The Orford Process is the oldest of the three. It is cheap to operate, and permits of a large output in a confined space, but it does not recover more than a small proportion of the precious metals present in the ores, and there is reason to think that losses of nickel and copper are heavier than in either of the other two processes.

In the Orford process, the matte is smelted with sodium sulphate and carbonaceous matter, such as coal or coke, so that a large proportion of the copper is separated as a double sulphide of copper and sodium, when tapped from the furnace; this separates as an upper layer above a matte which is much richer in nickel and poorer in copper than the original matte. A repetition of the smelting of this highly nickeliferous matte results in a further separation of copper in

the same way, so that finally, the bulk of the copper is obtained as a slag (which is smelted to produce blister copper) together with a matte so rich in nickel and so poor in copper that, after being roasted and leached with acid, to remove the remainder of the copper which it contains, it can be smelted in a reverberatory furnace, for the production of metallic nickel. The leaching processes result in the production of a considerable amount of copper sulphate and nickel sulphate. The former is treated for the production of metallic copper, but the latter is, to a considerable extent, crystallized out, and either treated electrolytically for the production of high-grade electrolytic nickel, or sold as nickel sulphate or as the double sulphate of nickel and ammonium for electro-plating and other purposes.

The Orford process, being partly chemical, produces large quantities of noxious effluents. At the Bayonne works over 150 million gallons are annually run into the sea. The plans for the new works at Port Colborne, Ontario, provide for the elimination of this discharge.

The Mond Process.

The Mond Process treats a matte of somewhat different composition, because, although it contains about the same total quantity of nickel and copper, the relative proportions of the two are very different. The matte from the Canadian Copper Company averages about 54 per cent. nickel and 25 per cent. copper, whereas that from the Mond Nickel Company is much richer in copper and averages about 41 per cent. nickel and 41 per cent. copper. These differences are due to the composition of the ores treated by the two companies. The matte is refined at Clydach in Wales. In this process there are probably the smallest losses either of nickel, copper, or the precious metals.

The process comprises roasting to remove the sulphur, leaching with sulphuric acid to obtain a large proportion of the copper, which is ultimately crystallized out and sold as copper sulphate, and the reduction of the oxides of nickel together with the small quantity of copper left in the roasted and leached matte with producer gas, which reduces the iron, copper and nickel to the form of finely divided metal. This material is next treated in a vertical chamber or tower with producer gas at a special temperature, by means of which the nickel is converted into a volatile compound known as nickel carbonyl. This passes to another chamber or tower, where it is exposed to a higher temperature, whereby it is decomposed so that the metallic nickel is deposited on a number of slowly descending grains of nickel previously added in the form of small shot. The residues from the first treatment are either again treated with sulphuric acid to remove the copper and iron, or are smelted again, after which the nickel they contain is recovered by repetition of the treatment. The residues are finally separated and sold for their precious metal contents. The nickel produced is of high purity, and has an excellent reputation.

It may be mentioned that the leaching described as being done upon the original roasted matte, dissolves a considerable quantity of nickel as well as of copper. This is recovered and sold as nickel sulphate, or as nickel ammonium sulphate, for electro-plating and other purposes. The Mond Nickel Company does not make or sell any metallic copper.

The Hybinette Process.

The Hybinette Process, employed in Norway, and about to be employed in Ontario by the British America Nickel Corporation, deposits the nickel electrolytically, using soluble anodes made from partly roasted nickel copper matte. The copper is obtained

as a crude blister copper, by treating it with the scrap anodes from the electrolytic nickel production. The copper thus produced is melted into anodes and electrolytically purified. Without going into details, it may be stated that the Hybinette and other electrolytic processes produce nickel and copper of high quality and with small losses, and that they recover the bulk of the precious metals.

One great advantage of the electrolytic process is that, although the plant occupies considerable space, it can be erected at short notice, and units can be added to the plant, to any extent, as the output requires.

No attempt is at present made in working any of the above-described processes to recover the sulphur, which all goes to waste as fumes, except a small portion which, in the electrolytic method, becomes converted into sulphuric acid and is used as such in the process.

The Province of Ontario is fortunate in possessing an abundance of water power. In the absence of coal mines this is a feature of great importance in connection with her mining and mineral industries.

The special bearing of this abundant and cheap supply of water power on the nickel industry, consists not only in the use of electric energy generated therefrom in the operation of mines, smelters, etc., but also in the fact that it enables the electrolytic method of refining nickel to be employed under advantageous conditions as to cost. The Hybinette electrolytic process is the one adopted by the British America Nickel Corporation for the refinery it is to erect at Murray Mine.

Costs of Refining.

There are three steps in the production of refined nickel, namely, mining, smelting and refining. Heretofore, as regards the Sudbury industry, only mining and smelting has been done in this country, the Mond Company refining in Wales, and the International Company, of which the Canadian Copper Company is the Ontario branch, in New Jersey.

The Mond Company have furnished the Commissioners, confidentially, a complete statement as to the costs in each of the three stages; the International Nickel Company have furnished a statement of costs for mining and smelting, but have declined to furnish costs for the third stage, namely, refining. The British America Nickel Company, now beginning operations in Sudbury, have supplied an estimate as to cost of refining nickel by their process, as well as the cost of operation of this process in Norway, where it has been employed for some years.

Regarding processes and costs of refining nickel, the enquiries made by the Commissioners have led them to the following conclusions:

The respective costs of producing refined nickel from the Sudbury ores by each of the three processes mentioned do not differ to such an extent as to give any one process a material advantage over the others in competition.

An electrolytic process has been a commercial success on lower grade ores in Norway. The use of electrolytic processes by all the companies operating in Ontario would not prevent their meeting competition from any other quarter.

The costs of production are gradually falling through increased efficiency and larger output, and may be still further reduced. War conditions, resulting in scarcity of labor and increased cost of supplies, are for the present exercising an influence in the opposite direction.

The International Nickel Company, until recently, contended on commercial grounds that the Orford process could not be profitably operated in this Province. These contentions were largely based on comparative costs as between New Jersey and Copper Cliff. Evidently they do not now apply to the north shore of Lake Erie, where, at Port Colborne, this company is building a refinery.

The Mond Nickel Company allege that by reason of the greater expense due to higher wages, increased cost of fuel and chemicals, and higher freight charges, refining in Ontario would make a material addition to the cost of their products, namely, refined nickel and sulphate of copper. The company have supplied the Commission with figures in support of this view. A special argument is based upon the necessity of quick delivery for copper sulphate, which is marketed in the vine-growing countries of the Mediterranean, and is required only during a limited season of the year for destroying blight on vines.

There is nothing to prevent the Hybinette process, of the British America Corporation, being operated as cheaply and as efficiently in Ontario as elsewhere. The costs at Sudbury will be less than they have been in Norway, owing to the larger scale of the operations in Ontario.

Price of Nickel.

At about the time mining began in New Caledonia, in 1875, the price of nickel, according to a report made to the government of France, was 18 francs a kilogram (\$1.58 per lb.). It fell successively to 10 francs, 5 francs (1892), 4 francs (1894), 3 francs (1895), and, owing to Canadian competition, to 2.40 francs a kilogram (21 cents per lb.) at the end of 1895. In 1902 the price was between 3.50 and 4.00 francs a kilogram (30 to 35 cents per lb.). During recent years the price has been about the same. A higher price has been charged in selling small quantities, and at times a considerably lower price for large quantities on long-term contracts.

The Commissioners were informed by the British Government in May, 1916, that it was obtaining all its supplies from four companies at £175 sterling per long ton. This is equal to 38.8c. per lb. The ruling price in England was then £225 sterling, about 49c. per lb. Prior to the war the price to the British Government was £160 sterling per ton (34.8c.); on the other hand, a user in Birmingham stated that in May, 1916, he was purchasing in five-ton lots at £200 per ton (43 1/2c.), and that the steelmakers paid less. Henry Wiggin and Company, Limited, of Birmingham, quoted before the war, in September, 1913, £165 per ton for hundred-ton lots, rising to £171 per ton for lots under five tons, or 1s. 8d. per lb. for smaller lots.

Since the war began there has been an increase in price, but not a large one compared with other metals, little, if anything, more than sufficient to cover the increase in cost of labor, freight and insurance. The influence of the long-term contracts, upon which nickel is usually sold, has no doubt tended, along with the elimination of Germany as a market, to keep down the price.

The statistics of value placed upon the nickel and copper contents of the matte in the returns of the producers to the Ontario Bureau of Mines, are merely nominal, being for the Canadian Copper Company, 10 cents per pound for nickel and 7 cents for copper, and for the Mond Nickel Company, 15 cents for nickel and 7 1/2 cents for copper. These figures remain stationary from year to year, not fluctuating with changes

in the prices of the metals. In the case of the Canadian Copper Company, they appear to have been adopted because they represent the price at which the company sold the matte to the Orford Copper Company before both concerns were merged into the International Nickel Company in 1902. The practical effect is to credit the entire profits of the business to the refining stage, and to eliminate them from the mining and smelting stages. This is a convenient method for the companies, since no real change of ownership takes place between the mine and the finished metal. The result, however, is to unduly depress the figures of value in the Ontario statistics, and in dealing with the figures for 1915 the Bureau of Mines adopted a valuation of 25 cents per pound for nickel and 10 cents for copper in the matte. The latter figure has been increased to 18½ cents for 1916, since the price of refined copper has risen to an unprecedented height.

Losses in Mining, Smelting, and Refining.

The losses in each department are considerable, but in mining and smelting, at any rate, they are well recognized by the two large operating companies. It may be taken for granted from what the Commissioners have seen of the efficient working of these companies, and from the analyses supplied, that everything is being done to minimize these losses, so far as meets the requirements of companies having large quantities of rich ore for immediate use and in reserve, and very large supplies of low-grade ore proved and ready for working when needed.

As to losses in refining, it may be said that there is more room for improvement in the treatment of a matte containing about 80 per cent. of metals, nickel and copper, than in the simple production of such matte.

The losses on the roast-heaps through leaching are not definitely known, although they have been estimated by the Canadian Copper Company at about 11½ per cent. of the total copper and nickel.

In addition to losses in mining, and the leaching losses on the roast-heaps, the losses by the Canadian Copper Company in the slags from the smelting at Copper Cliff amounted in the year ending March 31, 1916, to about 8.9 per cent. of the total nickel, and about 9.6 per cent. of the total copper. Although their work is carried on with great efficiency, and it is not suggested that these losses can be reduced, the total, reckoned on 1,227,187 tons of ore raised in 1916, reaching, as it does, 3,100 tons of nickel and 1,400 tons of copper per annum, indicates the importance of any improvement which can be made in metallurgical practice.

The smelting losses of the Mond Nickel Company may be taken as similar, except that their roast-heap losses are less, as they employ heap-roasting to a much smaller extent.

The Commissioners have to express their appreciation of the frankness with which both companies have discussed the question of losses, and their willingness to consider any possible means of lessening them. They point out, however, and the Commissioners agree, that there is no reason to anticipate much further saving on smelting operations, and that the losses in the smelting of nickel-copper ores are always likely to be greater than those inherent in ordinary copper smelting, with which the treatment of the Sudbury ore is fairly comparable.

The losses in mining will be gradually reduced as the grade of ore mined becomes lower. That processes of flotation will in the future be applied to the Sud-

bury ores there is good reason to expect, and it is most probable that such processes will enable a larger proportion of nickel to be obtained from a given mine than at present. This will be effected, however, rather by making it possible to treat low grade ores necessarily or conveniently raised while extracting those of better grade, than by stopping actual leaks now existing in any of the stages of treatment. These leaner ores are now left in the mine, or in some cases are stored in dumps, but as the cost of obtaining them is small, being largely covered by that of mining the better ores, they could probably stand the additional expense of concentrating by flotation. A positive gain of this kind is as beneficial as an improvement in metallurgical processes for the prevention of actual smelting and refining losses, and is quite in keeping with the tendency of modern metallurgical methods.

High Average Content of Sudbury Ores.

It may be added that although the amount of nickel and copper varies from time to time in the different deposits, the average of the ore from the several mines has not shown any serious falling off. The copper may have increased relatively to the nickel, or the reverse may have been the case, but any increase in the amount of copper, so far as the Canadian Copper Company's deposits are concerned, appears to have been due to the inclusion of more rock matter, which is richer in cupriferous mineral than the massive ore. The whole of the Sudbury deposits have shown wonderful continuity, and the ratio of nickel to copper, commonly given for the whole field as two to one, is remarkably near the truth. The Mond Nickel Company's ore averages more nearly one to one, but this is due to the fact that the company has acquired properties which are inherently richer in copper than nickel, and that it is actually desirous of having a larger proportion of copper in their ore, on account of the ready sale of the copper sulphate, which is one of the primary products of its process, as contrasted with that of the International Nickel Company.

Sulphur Fumes.

A chapter of the report is devoted to the discharge of sulphur, in the form of sulphurous acid, in roasting, smelting and refining the Sudbury ores. While the subject has received attention from the operating companies, it has not been found possible to make any economic use of the large quantities of sulphur that are thus wasted. Attempts are constantly being made to minimize the damage caused by the escape of sulphur. It is believed that in the not distant future smelting methods will be developed that will do away with conditions that now exist.

The roast heaps are the worst offenders both in quantity and in injurious results. Roasting during the winter months is less harmful than at any other season of the year. The Mond Nickel Company is not now roasting during the summer months, and is making arrangements with a view of discontinuing roast heap practice altogether if possible. The British America Nickel Corporation does not intend to use roast heaps. The Canadian Copper Company has roast heaps continuously in operation carrying a total of about 250,000 tons of ore. The injurious effects will be considerably lessened by the recent change in location of the roast yard. Apart from the question of nuisance and injury, the roasting of the ore in heaps is not the best or most efficient metallurgical practice, and involves unavoidable losses of both nickel and copper. The sulphur driven off at the roast heaps,

amounting to over half of the total discharge, cannot be recovered. The Commission estimates that the total yearly discharges from the heaps, smelters and refineries, is not less than 300,000 tons of sulphur discharged in the form of sulphurous acid gas, and capable of producing nearly a million tons of ordinary sulphuric acid. This is equal to about one-quarter of the total annual consumption of the United States, of which one-fourth (1 million tons) is produced from the discharged gases from smelters, and exceeds all probable requirements of Canada for many years.

In other countries the recovery of sulphur and other noxious gases has ultimately resulted in the development of important industries. Sulphurous acid gas could be utilized direct in pulp-making and other industries, but the present conditions are not favorable for such use, owing to the distance of such plants from Sudbury. Freight charges on sulphuric acid to points of consumption are considered to be too great to permit of the development of this industry at present. The most desirable method of recovering the sulphur, if feasible, would be as free sulphur, which can be easily transported and for which there is a good demand.

Precious Metals in Sudbury Ore.

The Sudbury ores contain minute quantities of the precious metals. Besides gold and silver, these include platinum, palladium and other rarer members of the platinum group. The ores cannot be profitably treated for these metals alone, but the smelting process automatically concentrates them in the matte, and thus makes it practicable to recover them.

In view of the usefulness and scarcity of platinum, the supply of which is being eked out by substituting palladium wherever the latter is suitable, every source of the metal is worthy of investigation, and every effort should be made within economic limits to obtain it.

Trade Conditions.

Prior to the war nickel was sold like any other metal to any country in which there was a market for it, and it was treated solely as an article of commerce without regard to international relations. The Commissioners found no evidence of any arrangement for dividing the markets between the great producing companies, although the International Nickel Company has the benefit of the United States duty on imports against its competitors.

The great French company, La Societe le Nickel, had a branch works in Germany at which it refined part of its New Caledonia output. The whole of the Norwegian supply of metal has been sent to Germany during the war. In the United States, where by far the greater part of the nickel refined is of Canadian origin, considerable nickel is produced from New Caledonia matte and as a by-product from the refining of crude copper, and scrap metal containing nickel is also available. Almost every great power has deposits of nickel ores which can be worked when the price of the metal is sufficiently high, and from which its requirements in time of war could largely be secured.

There has been much discussion concerning the possibility of Canadian nickel reaching enemy countries during the war. While the question is not within the jurisdiction of the Commissioners, it was referred to in the conferences with officials of the Imperial Government. For reasons of public policy the measures taken by the Government in regard to nickel, copper, rubber and other contraband materials cannot be disclosed.

BUILDING THE NICKEL REFINERY AT PORT COLBORNE, ONT.

A report on progress by the International Nickel Company on construction of the nickel refinery at Port Colborne, dated Feb. 5, 1917, contains the following information:

The site selected by The International Nickel Company of Canada, Limited, for its Canadian nickel refinery is at Port Colborne, Ontario, somewhat to the eastward of the entrance to the Welland Canal. The site consists of approximately three hundred and fifty (350) acres in extent, with a frontage on Lake Erie of approximately one (1) mile, this frontage immediately adjoining the Lake Erie frontage of the Canadian Furnace Company. Transportation facilities for the refinery will be provided by direct connection with the Grand Trunk railway, a branch line of which passes the northern boundary of the refinery site. The position of the site with respect to the Welland canal is such that recourse may also be had to transportation by water for such commodities as will be utilized in the refinery in large quantities, such as coal and coke, and where, owing to their points of origin, such water transportation may be deemed advisable.

This site was selected and options taken upon the property about the first of August last after examination of many possible sites in various parts of the Dominion. Preliminary engineering work, and surveys and testing of the suitability of the sites for foundation purposes were then proceeded with, concurrently with the examination of title, and certain necessary legalities with the local councils were arranged. Title was taken to this property early in October, and active construction on the ground immediately commenced. After the preliminary engineering work had shown the suitability of the site for the plant, a contract was entered into with The Foundation Company, Limited, of Montreal, which company has charge of the entire piece of construction. This company, in conjunction with the operating and engineering departments of The International Nickel Company, engaged actively in the preparation of the general and detailed plans of plant buildings and equipment, and by so doing, were in position by the time title to the property had been taken, to immediately commence construction and to let contracts for the more important building materials and equipment, on which delayed deliveries were expected.

The estimated cost of the completed refinery will be approximately \$4,000,000, and it is expected that the refinery will be completed and ready for operation in the autumn of 1917, provided no greater shortage of labor is experienced than that already apparent, and that the sub-contractors will be enabled to fulfil their promises of delivery.

On the construction work now in active progress, about four hundred men are being employed, and preparations have been made so that by next spring employment will be available for about one thousand men on this construction. The railroad connections, sidings and yard tracks, in which there are about 18,000 feet of track, requiring four hundred tons of rails, together with the grading, amounting to 270,000 cubic yards, are well under way. The excavating for foundations of buildings is well along, and many of the foundations of the permanent structures are already in place. This will ultimately amount to about 80,000 cubic yards.

The basis of the lay-out of the refinery provides that the buildings are so placed that various stages of

the process are segregated, and the economical handling of the labor and materials is obtained, liberal allowance being given to provide for future extensions. Practically all of the buildings are of steel and brick construction, 10,000,000 pounds of structural steel being estimated for this work. This structural steel will be supplied, fabricated and erected by the Dominion Bridge Company of Montreal. There will be 51,000 tons of concrete for building foundations, and 350,000 square feet of forms for concrete work. Contracts have been placed for the 6,000,000 bricks required, these being manufactured in the Hamilton district. The great bulk of general supplies is being purchased in Canada, and only under special circumstances are materials for construction and process equipment being imported.

The two main refinery stacks of radial brick construction will be amongst the largest yet built, being 350 feet high and 12 feet diameter at the top, the base of each of these stacks being of massive concrete construction 40 feet by 40 feet.

Special attention has been given to lighting and ventilation, there being 130,000 square feet of windows in the main buildings and 300,000 square feet, or over seven acres of roofing. The workshops are to be most complete and equipped with modern machine tools and labor-saving devices. The initial output of the refinery will be on the basis of 15,000,000 pounds of refined nickel per annum, but the company, in the design of the plant and process equipment, have kept in view the possibility of this output being doubled or even quadrupled, within a few years.

The operating force, on the initial basis of 15,000,000 pounds of nickel per annum, will be about 400 men, and the company has reserved a site 300 feet deep by 4,000 feet long to provide for housing of employees. An attractive club house and recreation hall, and a large residential club for single men, are now in course of construction, but in view of the building of houses in the vicinity by local interests, the company has decided not to proceed with building of workmen's cottages until next year, at which time any requirements not arranged for will receive attention.

In operating the nickel refinery, a large number of products come into use, but apart from the large tonnage of copper-nickel matte, which will be supplied from Northern Ontario, there will be bituminous coal, coke, cordwood, fuel oil, nitre cake, charcoal, silica rock salt, soda ash, nitrate of soda, sulphuric acid, fire clay and fire brick, estimated annually at about 100,000 tons.

USES OF NICKEL.

The Royal Ontario Nickel Commission report says in part: "Nickel steels and white metals, i.e., non-ferrous alloys containing nickel probably now use up to 90 per cent. of the total world production. They were largely and increasingly used before the war and, although war demands are mainly what may be described as temporary, they have emphasized the value of nickel, not only in steel but in cupro-nickel and other alloys, more highly than many years of active advertising propaganda would have done in times of peace. Those who are now using nickel steels in their manufactures for war purposes, or in their tools and machinery for producing the same, now appreciate the value of nickel steel, and will never go back to the use of the ordinary steel with which many of them were formerly satisfied except for very special purposes.

"The principal uses for nickel steel are those where increased strength or lightness without sacrifice of strength is required, i.e., where special tensile strength and elongation tests have to be passed. Such, for instance, are trusses and other strain-bearing parts in bridge building, etc., or rails where, as at curves, excessive wear and tear occur, or corrosion is likely to be excessive, or the cost of replacing rails is unusually heavy, as in railway tunnels. It is also largely used for special locomotive forgings, electric railway gears, marine and stationary engine works, and for an enormous variety of parts in automobiles, aeroplanes, etc. It is, in fact, employed for an infinity of purposes, including large castings and forgings such as crank shafts, but particularly the small parts of rapidly moving machinery which must be light but strong and resistant to shock. No special reference need be made to its use for ordnance, except to say that it is employed largely for armor-plate, large and small guns, gun shields and armor-piercing projectiles.

"Nickel for making steel is largely sold direct as commercially pure nickel, but sometimes in the form of an alloy with iron, and often with the addition of chromium, tungsten, molybdenum and other metals required in the ultimate composition of the steel. On this account, it is likely that the use of the electric furnace for the smelting of nickel ores and nickeliferous by-products will increase more rapidly in the future than it has done in the past.

"Ordinary nickel steels contain under 5 per cent. of nickel and commonly range near 3½ per cent., but highly nickeliferous steels carrying up to 40 per cent. nickel are used for special purposes where non-magnetic qualities, resistance to corrosion and above all, no expansion or contraction, or any desired expansion or contraction, with change of temperature, is important. These steels absolutely control the market for special purposes such as clock pendulums, measuring tapes and certain philosophical instruments, and, although the tonnage is small, it is a rapidly growing outlet for nickel. Such alloys are used in place of platinum as the leading-in wires for electric lamp bulbs, and for many other purposes where a metal having the same coefficient of expansion as another material is required."

Considerable quantities of nickel are used for plating other metals. Another important use is in nickel silver. As in the case of coinage these uses take small amounts compared with the use in making nickel steel.

The white, ductile triple alloys of copper, nickel and zinc, which are known commercially as nickel silver or German silver, are of somewhat widely varying composition, and are made in a number of different qualities, the most usual of which contain about 55 to 60 per cent. of copper, 15 to 20 per cent. of nickel, and 20 to 30 per cent. of zinc.

Nickel-chromium steel is the most important of the alloy steels used for structural purposes, as the tonnage used now far exceeds that of ordinary nickel steel.

BUFF MUNRO.

Work is to be started soon on the Buff Munro mine, situated about a mile from the Croesus. Two shafts will be sunk and other development work carried on. Surface showings are said to indicate good prospects.

THE CREIGHTON OREBODY.*

By C. W. Knight.

The Creighton is the largest nickel mine which is being worked in the world, and, at the same time, one of the greatest metalliferous mines of any kind. There are said to be 10,000,000 tons of ore in the mine, estimated by actual workings and diamond drill.

The oldest rock in the vicinity of the Creighton is what has been called greenstone. It is generally coarse-grained and looks like a gabbro or diorite; there are also fine-grained facies of the rock. The coarse-grained greenstone resembles somewhat the norite, but it appears to be more decomposed than the norite and has a greener shade, the norite having a grey tint.

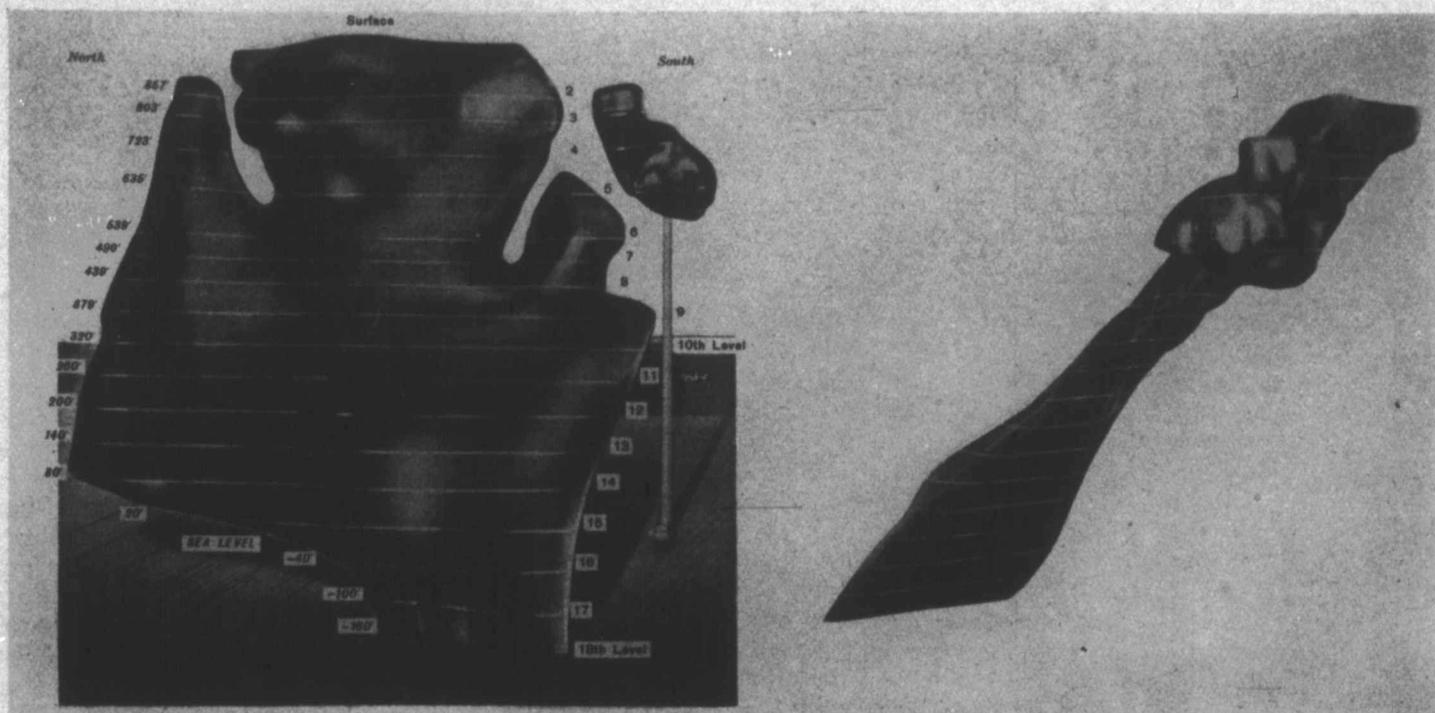
The eruption of the greenstone was followed by the great norite intrusion. That the norite is younger than the greenstone is shown by the fact that it has chilled against the latter. It also holds inclusions of the greenstone, one of these larger masses being shown on the map about 1,000 feet to the north of the open pit. Mineralogically and chemically, the composition of

the latter to some extent. Thus was the Creighton orebody formed.

After the formation of the orebody, fissures were formed in all of the rocks in the vicinity of the deposit, including the deposit itself, and dikes of trap were intruded into greenstone, norite, granite, and the orebody. Ore deposition had practically ceased before this took place, for the trap dikes are free from ore except for small veinlets along the edges. The dikes do not cut entirely across the ore-body, but appear to have penetrated it only a relatively short distance.

The final chapter in the history of this marvellous orebody was closed by the formation of another series of fissures through which were erupted coarse-grained olivine diabase dikes. These dikes cut the orebody and the trap dikes described in the previous paragraph. C. H. Hitchcock, of the Canadian Copper Company, first recognized these trap dikes as distinct in age from the later olivine diabase dikes.

The shape of the Creighton orebody is shown by a model constructed by officials of the Canadian Copper Company. The white, horizontal lines represent the



MODEL OF THE CREIGHTON OREBODY.

View of West Side.

View of South End.

the norite is very uniform for a distance of at least 3,250 feet northwestward from the Creighton pit.

After the norite had solidified, the granite mass, which occupies parts of Graham, Waters and Snider townships, was intruded. It broke its way through the crust of the earth along the norite-greenstone contact.

The next event, and the one which immediately preceded the formation of the Creighton orebody, was that which was represented by a period of tremendous crushing and brecciation along the norite-granite contact. A great crush-breccia and crush-conglomerate, of granite, greenstone and norite fragments, were formed.

A period of ore deposition closely followed the crushing and brecciation; and magmatic solutions, carrying sulphides, circulated upwards through the crushed rocks and deposited nickel, copper and iron sulphides in the spaces between the rock fragments, replacing

various levels, and the altitude of these levels above or below sea level are noted.

The upper part of the model was constructed from information obtained mainly from actual workings, while the lower part was outlined by means of information derived from diamond-drill cores. In July, 1916, there were but two crosscuts and no stopes in the orebody on the twelfth level. Three months later there were five crosscuts on this level and stoping had already begun. On the tenth and higher levels, however, the shape and extent of the deposit had been ascertained mostly from workings which consisted of crosscuts, drifts, and stopes.

From the model it is seen that the central part of the deposit is lenticular; that is to say, its length is much greater than its width, so that the ends "pinch" or taper out gradually. The upper and lower parts, on the other hand, are roughly oval in outline. It is further seen that its known depth is about twice its maxi-

* Extracts from a report to the Ontario Nickel Commission.

mum length. Of course it is not possible to say how much of the deposit has been eroded during past geological ages. And it may also be noted that the depth to which the deposit goes has not yet been ascertained.

The orebody had a known depth of about 2,000 feet measured along its average dip of 45 deg., but the model only shows the orebody to a depth of about 1,600 feet measured along its dip. Diamond drilling ceased about this point, but the last drill cores still showed the presence of ore. The maximum length is about 1,000 feet. The width on the surface is about 180 feet. Between the fifth and sixth levels its width becomes abruptly less, so that on the sixth and eighth levels it has only a width of about 50 feet. Below the eighth level, however, it again becomes wider, and on the tenth it has increased to about 130 feet. Below this the diamond-drill cores show it to be even wider; in fact, wider than in the great open pit on the surface.

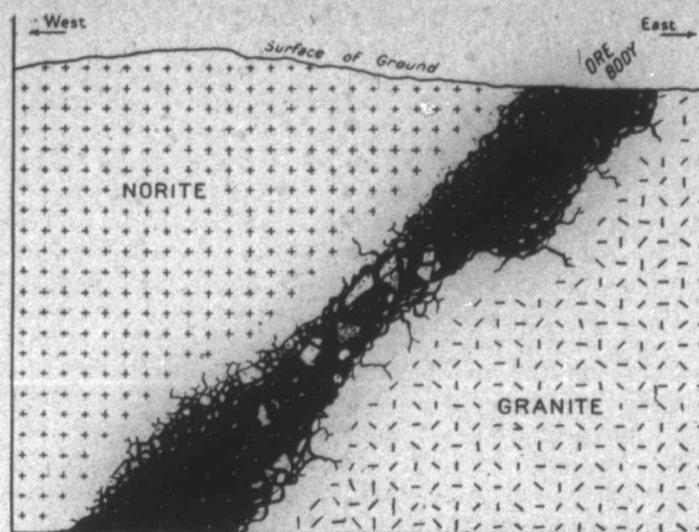
There is a small isolated orebody, near the surface, southward from the main ore. Its relative size and position are shown by the model.

The orebody occurs about at the contact between granite and norite, the latter forming the hanging-wall, the granite the footwall. It has been named a marginal deposit. The orebody, however, is found largely in the granite foot-wall, and it may be said that the limit of the commercial ore is met with when the norite hanging-wall is encountered. Sometimes, indeed, the commercial ore ends before the norite is met with, in which case massive granite forms not only the foot-wall but the hanging-wall. The strike of the orebody is about north and south—really a few degrees east of north. The exact strike on the third, fourth, fifth, sixth, eighth and tenth levels may be seen by consulting the composite plan facing page 144. The dip of the orebody is about 45 deg. to the westward, and there appears to be no change on the lowest parts of the deposit.

An examination of the stopes, crosscuts, drifts and other workings has shown that the orebody consists of a mass of rock fragments cemented together by sulphides. The hand-picked ore contains 4.44 per cent. of nickel and 1.56 per cent. of copper.

It is evident that the formation of the Creighton orebody was preceded by a period of tremendous brecciation and crushing along the contact of granite and norite. That this crushing took place largely in the footwall is shown by the fact that most of the rock fragments in the ore consist of granite and greenstone, while the norite fragments are confined mostly to the vicinity of the hanging-wall. In other words, the commercial orebody occurs in the granite footwall—not in the norite. Sometimes indeed the granite actually forms the hanging-wall as well as the footwall. Generally speaking, it may be stated that, when the norite hanging-wall is met with, the commercial ore comes more or less abruptly to an end.

In searching for an explanation of the origin of the Creighton orebody an observer is soon confronted with the fact that the gravity segregation theory does not appear to be a suitable one. It would seem that it is necessary to fall back on the time-honored theory of deposition from heated solutions. This theory requires little explanation. The crushed nature of the granite footwall and of part of the norite hanging-wall presented an ideal zone for the circulation of heated aqueous solutions. These solutions possibly carried little else than sulphides. It is supposed that they came from great depths, and nearer the surface the sulphides were precipitated, filling the spaces between



Ideal cross-section through Creighton orebody, from the surface to the proposed eighteenth level, showing the nature of the deposit. Black represents ore. The norite is "spotted" with "blebs" of ore, about the size of peas, for 2,000 feet beyond the orebody. This "spotted" norite is not indicated in the drawing except along the edges. The granite is also "spotted" with ore, but to a much less extent than the norite. While the commercial orebody occurs about at the contact of the norite and granite, nevertheless the commercial orebody is found largely in the granite footwall—not in the norite.

the fragments in the crush-breccia and crush-conglomerate. As might be expected, the hanging-wall and footwall and the fragments composing the crush-breccias and crush-conglomerates are more or less replaced or impregnated by sulphides.

THOMAS FROOD'S DISCOVERY.

One of the early prospectors in the Sudbury region was Thomas Frood, who had been a wood ranger in the employ of the Crown Lands Department, and was familiar with the physical features of the Sudbury area. Mr. Frood relates that having heard from one William Nelson, a trapper, that there were indications of mineral on a creek in the northern portion of the township of McKim, he set out on 18th May, 1884, accompanied by A. James Cockburn, another prospector, to examine the locality. He succeeded in locating a vein of pyrites on lot 7 in the sixth concession, and traced it across the boundary to lot 6. A dispute afterwards arose between the two prospectors, which they settled by allotting lot 6 to Cockburn and lot 7 to Frood. Cockburn's claim was transferred to J. H. Metcalf and W. B. McAllister, in whose names the grant issued on 16th July, 1884. Frood took out the patent for the south half of lot 7 in the same month. The mine subsequently opened on this deposit, though not containing the richest ore, has proven to be the largest of the great ore bodies of Sudbury so far developed, and bears the name of Frood, who was a man of education and ability. It is also known as No. 3 mine of the Canadian Copper Company, which now owns the bulk of the deposit. Another of Thomas Frood's discoveries was the Copper Cliff mine, located in 1885.

The first discovery of nickel in Ontario was at the Wallace mine, a short distance west of the point where the Whitefish river enters Lake Huron. No orebody of any consequence has been found there, however.

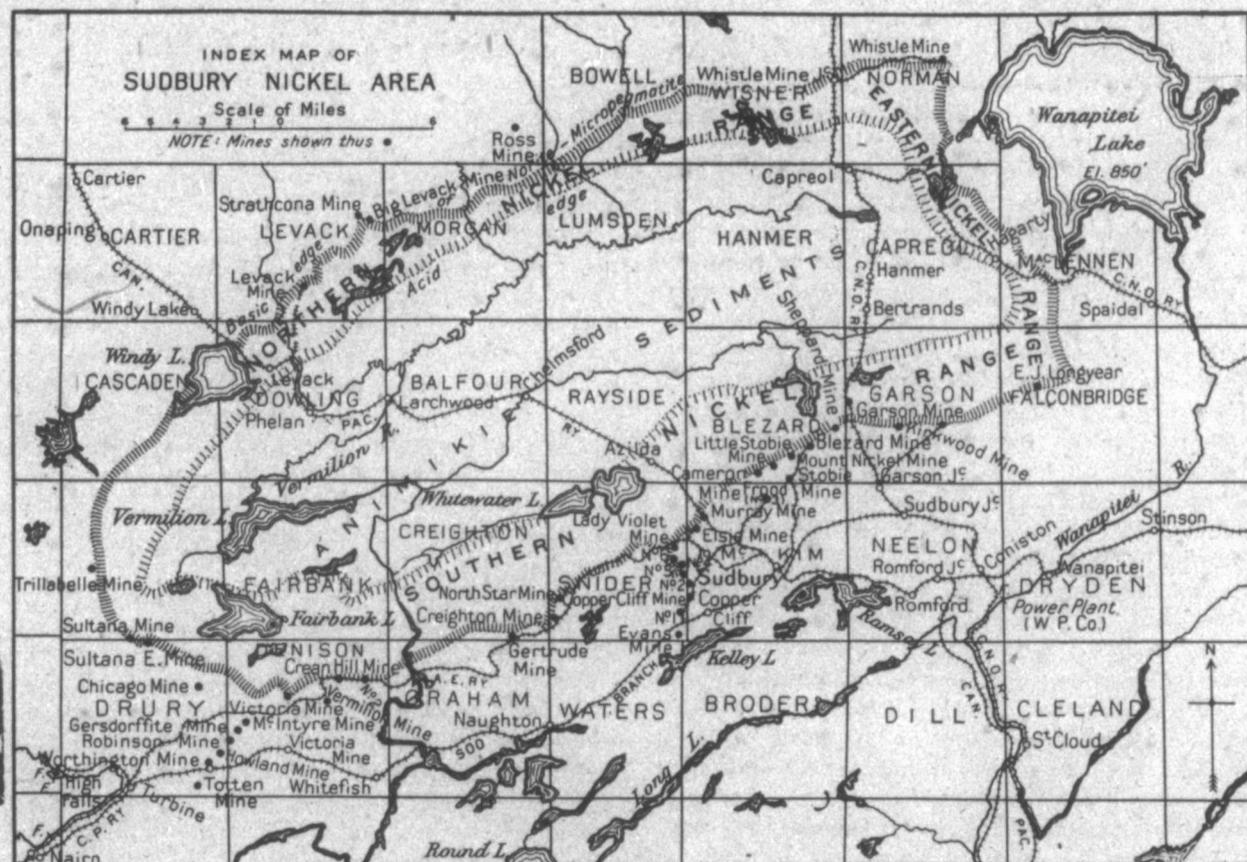
THE MURRAY MINE.

The Nickel Commissioners in a historical sketch of nickel discoveries say of the Murray mine:

"The building of the railway through the Sudbury region in 1883 quickly led to the discovery that it was rich in minerals. The first deposit of nickel ore to be actually found was what afterwards came to be known as the Murray mine. The right of way for the railway was cleared for some distance west of Sudbury in 1883, and in August of that year a blacksmith on the construction gang named Thomas Flanagan observed an area on the right of way cov-

liam, then well-known merchants of Pembroke. The former was a member for several terms in the Legislature at Toronto, and also sat for Pontiac county, Que., in the House of Commons at Ottawa.

"The patentees sold to H. H. Vivian and Company, of Swansea, Wales, who began mining operations in October, 1889, after having tested the quality and character of the Sudbury ores by smelting and refining them in their Swansea works. A smelter was erected and blown in, September, 1890; a second furnace was added a year later, and a third in 1892. These made a low grade matte, containing about 8 per cent. of nickel, which was bessemerized to a product carrying 35 or 40 per cent. nickel and 20 to 25 per cent. copper.



Map of Sudbury Nickel Area.

ered with gossan, and dug some holes in it which showed copper sulphide. When the "grade" reached the spot, a cutting in the rock was necessary, which exposed the deposit. A little later, the attention of John Loughrin, of Mattawa, afterwards for years member of the Legislature for Nipissing, who had a contract for making ties on that section of the line, was attracted by a deposit of "red mud" on the wagon road close by, and by the appearance of mineral in the rock cut. Doubtless others afterwards remembered that they, too, had noted the peculiar appearance of the place. This led to an application being made to the Department of Crown Lands by Thomas Murray on 25th February, 1884, for permission to purchase the lot 11 in the fifth concession of the township of McKim. It was accordingly patented to himself, William Murray, Henry Abbott of Brockville, and John Loughrin, on the 1st of October, 1884, the price paid being the statutory one of one dollar an acre. The mine received its name from the Murray brothers, Thomas and Wil-

Mining and smelting was carried on with more or less success until 1894, when the mine was permanently closed down. The property remained unworked until it was sold for \$75,000 to J. R. Booth, M. J. O'Brien and associates, who prospected it by the diamond drill, and were successful in discovering a very large tonnage of ore previously unknown—now placed at eight or nine millions of tons. Messrs. Booth and O'Brien in turn sold to the British America Nickel Corporation, Limited, which now owns and proposes to work the mine on an extensive scale.

COLOSSUS GOLD MINES.

Another property in Munro Township is being opened up with bright prospects ahead. This is the property formerly known as the Maloof claims, recently purchased by Mr. A. G. C. Dinnick, 12 King Street East, Toronto, and now to be operated under the name of the Colossus Gold Mines Limited. The property comprises the four original Maloof claims and three other claims known as the Eby claims, all of which adjoin the Burton Vet on the south and west.

MINING METHODS AT CREIGHTON.*

By T. F. Sutherland.

The orebodies of the Sudbury district vary greatly in size, dip and configuration, and the methods of mining are dependent on these factors. The ores are essentially pyrrhotite, chalcopyrite and pentlandite. The enclosing rocks are hard, like the orebodies, and but little timbering is required. They comprise norite, greenstones, quartzites, greywackes and granites. The orebodies dip at angles of from 36 degrees to 90 degrees.

The problem of extracting the ore after the size and configuration of the orebody is known, is a simple one owing to the nature of the ores and the enclosing rocks. Elaborate systems of timbering, caving, slicing or filling do not have to be considered. Where large stopes are to be worked out, pillars are left, and the backs are kept arched while the ore is being removed. Afterwards the pillars are robbed.

Ore was first mined in the Sudbury district by the open-pit method. The surface material was stripped off; the gossan, and overburden, the latter averaging up to ten feet in depth, was removed, and the open-pit method of mining followed. The ore was handled by derricks at first. Later a shaft was sunk adjacent to the open pit in the footwall, and connections were made with the open-pit at different levels. The ore was trammed to the shaft and dumped directly into skips. By this method about 3,000,000 tons were taken from the Creighton. Properties mined by this method were the Evans, No. 2, No. 4, No. 5, No. 6, Froot, Stobie, Crean Hill, Kirkwood, North Star, Victoria, Blezard, Murray and Creighton. Of these the Creighton was the largest pit, being about 670 feet long, 180 feet wide, and 200 feet deep. As the Creighton orebody dips at an angle of about 45 degrees, it was necessary to remove a large tonnage of waste from the hanging-wall. When all the ore, that could economically and safely be mined by the open-pit method, was taken out, the shafts were sunk to lower levels and overhand methods of stoping were adopted, a floor being left below the open pit. Where the ore bodies were narrow, the drifts were timbered over and the ore broken on the timbers. In wide orebodies, dry-wall drifts were used and circular pillars left where necessary.

As the nickel industry grew, and increased tonnages were demanded, it became necessary to more thoroughly prospect the orebodies and plan the work so that a constant large tonnage could be produced. The method of prospecting the orebodies was by means of magnetic surveys and diamond drilling, the relative importance of these two methods being governed by local conditions at each property. In general it may be said that the magnetic survey serves only as an aid in locating an orebody. The prospecting is done by means of diamond drilling. Properties thoroughly drilled were the Froot and Creighton, of the Canadian Copper Company, the Levack, of the Mond Nickel Company, and the Murray, of the British-America Nickel Corporation. In the latter property, for instance, the surface was divided into 200-ft. squares, and a vertical hole drilled at the corners of the squares. By this means the dip, strike, configuration, assay and tonnage are pretty thoroughly known before any ore is removed. This information is sufficient to enable the whole operation of mining the ore to be planned in advance. Power plants, hoisting and sorting arrangements, shafts and equipment are all planned for the most economical handling of certain tonnages.

The magnetic surveys are made by the companies themselves. The diamond drilling is done under contract by drill companies located in Sudbury. The price varies from \$2.75 to \$4.00 a foot, depending on the location and size of contract.

The Creighton orebody has a maximum length of about 1,000 feet, and has been proven to a depth of 2,000 feet measured along its dip, the present ore reserves amounting to about 10,000,000 tons. It dips to the west at an angle of about 45 degrees.

As mentioned before, a large tonnage was removed from this property by the open-pit method of mining, the ore being removed through a 3-compartment shaft sunk in the granite footwall at an angle of 59 degrees near the east end of the orebody. As the depth or workings increased, it became necessary to change from the open-pit method to underground mining.

A second shaft was therefore sunk in the footwall. This was a 4-compartment shaft comprising a manway, two skipways and a compartment for handling men and material. This shaft was sunk near the westerly end of the open pit, and was carried to a depth of 830 feet on an angle of 47 degrees. On the 6th and 10th levels of this shaft a Farrel jaw crusher, with a 30-in. x 42-in. opening, crushing to 6 inches is installed. These crushers are each driven by two 100-h.p. motors and discharge into storage pockets holding approximately 400 tons. The ore from the storage pocket passes into a measuring pocket at the loading station about 60 feet below the haulage level. By this method the skip is loaded in about 10 seconds and the time for a return trip from the 6th level loading station, including loading, is 1½ minutes. The skips, 5-ton capacity, are operated in balance, the hoisting speed being about 1,100 ft. per minute. On the main haulage levels 4½ and 5-ton storage-battery locomotives are used, hauling trains of four 56-cubic foot side-dumping steel cars, which are mechanically dumped at the crushers.

All the ore goes through these crushers, the ore from the upper level being passed down through ore-passes, which discharge into a crusher. Waste rock is handled through separate rock passes and storage pockets, which discharge into the skips 30 feet below the haulage levels.

A third shaft, known as No. 3, is being sunk in the footwall 145 feet southwest of No. 2. It dips at an angle of 55 degrees and is to be continued to the 16th level. This shaft measures 8 feet by 33 feet, and is divided into five compartments, which consist of a manway, two skip compartments, and two cage compartments. The shaft is concreted for a distance of 40 feet below the collar. The skip-track consists of 85-pound rails, resting on wall-plates, which in turn are supported on concrete piers. It is planned to place a crusher below the 14th level station with storage and measuring pockets of the same type as used in No. 2 shaft. Ore-passes will extend downward from the upper levels to this crusher. Skips of 8-ton capacity, hoisting in balance, are to be used. The hoist will have 12-foot drums and a rope speed of 2,500 feet per minute. Stations have been cut in this shaft at the 6th, 8th, 10th, 12th and 14th levels. The first three levels correspond with the similarly numbered levels from No. 2 shaft. The distance between levels is 150 feet measured along the incline. Intermediate or sub-levels are to be driven halfway between these main levels in the footwall and will be numbered 7, 9, 11 and 13. These sub-levels are necessary to remove the broken ore from the footwall owing to the low angle at which the orebody lies.

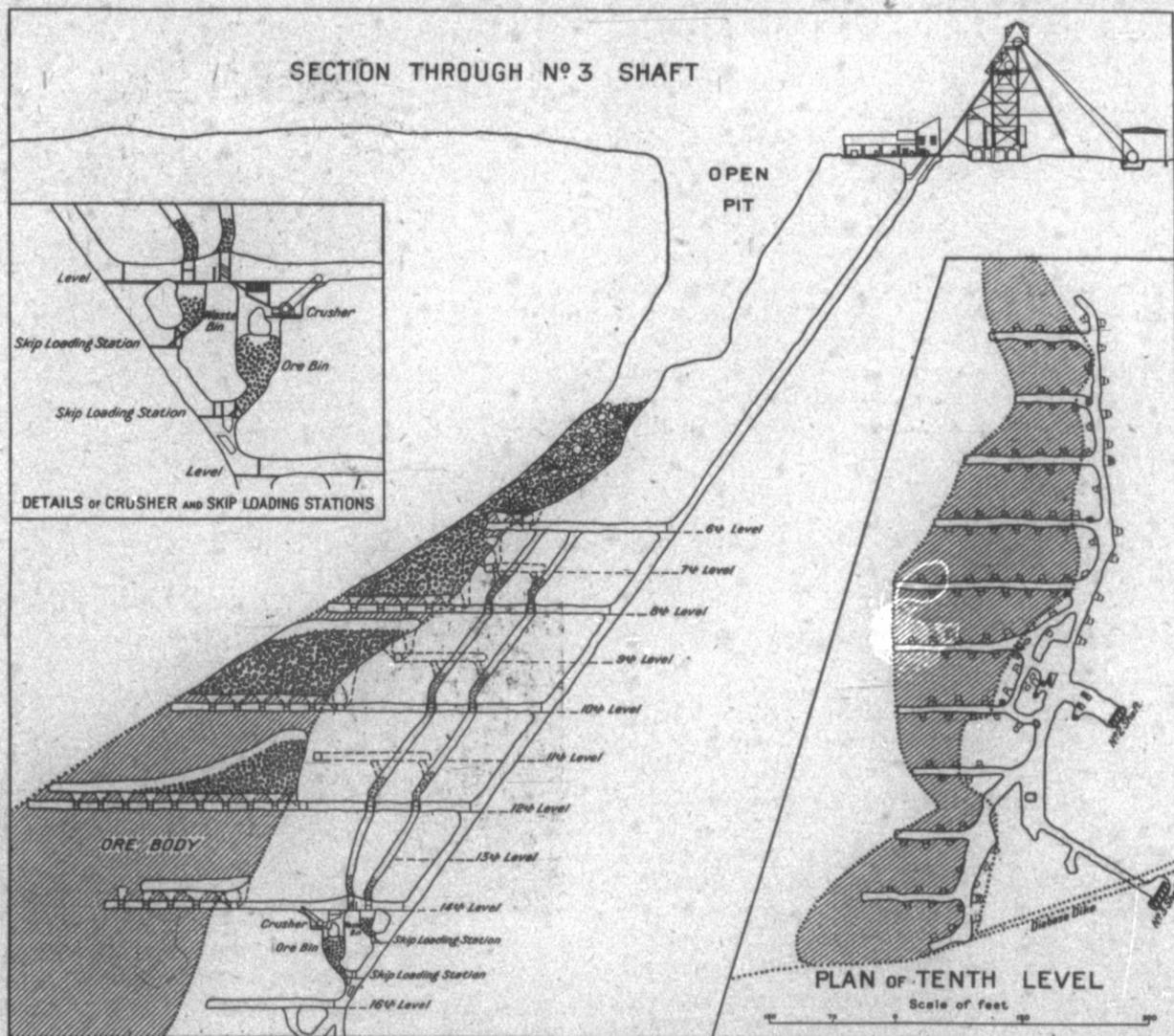
* Extracts from a report to the Ontario Nickel Commission.

The main level stations are 25 feet wide and are cut in the footwall. The main drifts are driven in the footwall parallel to the orebody. Levels Nos. 6, 10, 12 and 14 and motor-haulage levels are driven 10 feet wide and 9 feet high, laid with 40-lb. rails and have 1/2 of 1 per cent. grade to the crusher station. The other levels are driven the ordinary size, 8 ft. by 8 ft., and are laid with 25-lb. rails, with a grade of 2/3 of 1 per cent. to the ore-passes which lead to the crusher on the first haulage level below. Rib pillars, 15 feet wide, are left every 75 feet approximately at right angles to the strike of the orebody. In these rib pillars crosscuts are driven from the main levels to the hanging side of the orebody. These crosscuts are carried on a 2/3 of 1 per cent. grade. This gives a series of parallel stopes

ried up along the footwall in the pillars and connected with the stopes every 25 feet. All pipe-lines, etc., are carried in these manways.

For development work 3 1/8-in. piston drills are used, and for stoping both piston and Leyner drills are employed, 8-ft. to 10-ft. holes being the rule. Block holers follow the big machines in the stopes. The drills are supplied with air at a pressure of 90 pounds and 40 per cent. forcite is used for all blasting operations.

In the rock house the skips dump over grizzlies and the coarse material is fed through 18-in. by 30-in. jaw crushers, which discharge upon travelling picking belts, where about 17 per cent. of waste material is removed by hand-picking. The ore falls into ore bins,



Sketch Showing Method of Mining Creighton Orebody.

60 feet wide traversing the orebody throughout its entire length. From each side of the crosscuts box holes are cut at 30-foot centres up into the stopes. As far as possible these box holes are staggered in the crosscuts and also as regards the stope. The box holes are carried up about 15 feet, then chambered out and stoping commenced. A 15-foot floor is left in the bottom of each stope. The chutes are 4 1/2 feet wide and are built of 12-in. by 12-in. timbers. They are lined with 6-in. by 6-in. or 6-in. by 8-in. timber, the bottom sloping at an angle of 25 degrees, and protected by a 1/2-in. steel plate. Formerly steel arc gates, air-operated, were used on the chutes, but these have been discarded and a stop log is now used.

In the stopes the shrinkage method of mining is followed. As soon as a stope is started manways are car-

ried up along the footwall in the pillars and connected with the stopes every 25 feet.

The equipment comprises the following: One Bellis and Morcom compressor, 2-stage, 42-in. and 25-in. by 21-in., 5,000-cubic foot capacity at 100 lbs. pressure and 187 1/2 r.p.m., driven by a 900 k.v.a., 3-phase, 2,400-volt, 187 1/2 r.p.m. auto-synchronous motor with a 22 k.w. 25 to 35-volt direct-connected exciter.

One Canadian Rand 1,600-cubic foot machine running at 120 r.p.m. with direct-connected motor drive. The cylinders are 25-in. diameter by 24-in. stroke and 16-in. diameter by 24-in. stroke. The motor is a 300-h.p. A.C.B., 125 r.p.m., 3-phase, 550-volt, 25 cycles.

One Canadian Rand 2,500-cubic foot machine, 2-stage, 17 inches and 28 inches by 24 inches, with inter-cooler and after-cooler, driven by a 425-h.p. Canadian

Westinghouse motor, 360 r.p.m., 550 volts, 3-phase, 25 cycles.

One Canadian Rand 2-stage compound, 1,200-cubic foot machine, 12 inches and 20 inches by 18 inches, driven by a 200-h.p. Crocker Wheeler motor, 500 r.p.m., 550 volts, 3-phase cycles.

Hoisting through No. 1 shaft is done by a 2-drum hoist of the Denver Engineering Works, motor-driven. The drums are 4-ft. 9-in. by 4-ft. 10-in. wide, with friction band brake. The hoisting speed is 500 feet per minute. The motor is a 150-h.p. A.C.B., 550 r.p.m., 550 volts, 3-phase, 25 cycles.

At No. 2 shaft ore is hoisted by a double-drum electric hoist, built by the Nordberg Manufacturing Company. The drums are 7-ft. diameter and 4-ft. face, using a 1 1/8-in. diameter rope. The hoist is equipped with parallel-motion post brakes operated by oil-thrust cylinders. The hoisting speed is 1,100 feet per minute with a 5-ton load of ore. The hoist is operated by a 350-h.p. 500-480 r.p.m., A.C.B., 25-cycle motor with limit switches positively geared to each drum.

The man-cage hoist at this shaft is one drum of a 3-drum hoist built by the Denver Engineering Works, driven by a 250-h.p., A.C.B., 500 r.p.m., 550 volts, 3-phase, 25-cycle motor, and equipped with both band and post brakes. The drum is 4-ft. 9-in. diameter by 4-ft. face. The hoisting speed is 690 feet per minute. At No. 3 shaft a Wellman Seaver Morgan Company double-drum electric hoist is in use temporarily during construction. The drums are 72-in. diameter by 48-in. face. The brake is a post brake air-operated. The hoisting speed is 800 feet per minute with a load of 11,700 lbs. The hoist is driven by an A.C.B., 250-h.p. motor 500-480 r.p.m., with limit switches and brake solenoids.

RINALDO McCONNELL'S DISCOVERY.

Among the early prospectors at Sudbury was Rinaldo McConnell, and in point of time his discovery of what was afterwards called by the Canadian Copper Company No. 4 mine, situated on the south half of lot 1 in the fourth concession of the township of Snider, was the second ore body to be located in the Sudbury area. McConnell on 16th May, 1884, applied on behalf of himself and Joseph Riopelle for this parcel and also for the southeast quarter of lot 2 adjoining, and the land was patented to them 25th July of the same year.

Rinaldo McConnell's connection with the Sudbury nickel region, begun at this early date, has continued until today. Physically robust and a man of energy and intelligence, Mr. McConnell in the capacity of prospector and middleman has played no small part in the development of the nickel-copper industry.

Late on the night of March 18th, or early in the morning of the 19th, robbers got away with gold to the value of about \$20,000, which they stole from the Chicagoff mine, Alaska.

It is stated that some fine copper ore has been shipped from the O. K. mine, Oroville, Washington, to the Granby Consolidated Co.'s smelting works at Grand Forks, B.C. A lot of 52 tons netted about \$1,500 after all charges had been deducted. The proportions of the value per ton were: Copper \$37.80, silver \$3.19, and gold \$1.80.

OBITUARY.

Mining men who knew Mr. A. C. Bailey of Cobalt were shocked to learn of his sudden death on March 21st, after an illness of only a few days. Mr. Bailey had lived for ten years in the Cobalt district and had made many friends there and throughout Ontario. An attack of pneumonia took him off with startling suddenness.

Mr. Bailey was born in Toronto in 1881, and lived there until 1886, when his parents moved to Sault Ste. Marie, Michigan. He received his early education at the "American Soo" and graduated from the Michi-



gan College of Mines in 1906. He had during his college days spent some time in mining work at the Canadian Soo and at Michipicoten.

Mr. Bailey at Cobalt managed the Abitibi Cobalt property. Later as manager of the Cobalt Townsite and consulting engineer of Casey Cobalt he brought these two properties to a profitable stage after others had failed. He was similarly successful in managing the Wettlaufer. Recently he had been in charge at the Casey-Seneca and Mercer.

In the ten years he resided at Cobalt, his sterling personal qualities endeared him to everyone with whom he was associated. Few equalled and none surpassed Mr. Bailey in the esteem of all those who knew him. It was significant of his kindly nature that he spoke ill of no one, and always saw the best in everyone. He had no enemies. In his professional work, he was distinguished by an unswerving loyalty to the interests he represented. Mr. Bailey's death is a distinct loss to the profession and a greater loss to his many warm personal friends. The place he held in their hearts can never be filled.—W. E. Segsworth.

PERSONAL.

Mr. W. E. Segsworth has resigned as managing director of Feldspars Limited.

Mr. D. L. H. Forbes has returned to Toronto from Chile.

Mr. C. M. Campbell, superintendent of the Granby Consolidated Co.'s big copper mines at Phoenix, Boundary district of British Columbia, was in Spokane, Washington, at the end of March, receiving special medical attention.

Mr. Henry C. Carlisle has been appointed superintendent for the Mandy Mining Co., with headquarters at The Pas, Manitoba. The Mandy company is a subsidiary of the Tonopah Mining Co., of Nevada.

Mr. J. J. Fingland, for some years practising assaying at Kaslo and other parts of West Kootenay, B.C., and latterly Provincial road superintendent in Kaslo district, has joined the staff of the Consolidated Mining and Smelting Company of Canada at Trail, B.C., where he will do laboratory work.

Mr. Alexander Smith, one of the owners of the Surprise mine, near Cody, Slocan district of British Columbia, has returned to Kaslo, Kootenay lake, from Toronto.

Mr. Thomas Graham, for five years chief inspector of mines for British Columbia, has resigned that office to accept the position of general superintendent for the Canadian Collieries (Dunsmuir), Limited, which has large collieries in Comox and Extension districts of Vancouver island, British Columbia.

Mr. Clyde A. Heller, of Philadelphia, Pa., president of the Tonopah-Belmont Development Co., last month visited the gold mine the Belmont Canadian Mines, Ltd., is developing at Surf Inlet, Princess Royal island, B.C. On his return journey he was accompanied as far as Prince Rupert by Mr. F. W. Holler, superintendent of the latter company.

Mr. A. Ikeda has returned to Ikeda bay, Moresby island, of the Queen Charlotte group, off the British Columbia coast, to continue work at the Ikeda copper mine in that locality.

Mr. R. P. Trimble, of the Great Ohio mine on Rocher Debole mountain, in Omineca mining division of British Columbia, has returned north from a visit to Portland, Oregon.

Mr. D. J. Williams, superintendent for the Rocher Debole Mining Company, has returned to the Skeena country from a trip to Seattle, Washington.

Mr. Oscar Lachmund, general manager, and Mr. F. S. Norcross, superintendent of mines, for the British Columbia Copper Co., left Greenwood, Boundary district of British Columbia last month for New York City to attend the annual meeting of shareholders in the company.

Special correspondence from Republic, Washington, to Mining and Scientific Press, San Francisco, includes the following. The demand for Republic siliceous ores is increasing and leads to the impression that considerable activity will result in that camp the coming summer. The Consolidated Mining and Smelting Co. of Trail, B.C., has had Mr. P. W. Racey here for ten days; he has sampled the Mountain Lion mine and is now sampling the Great Republic mine. For several months a deal has been on for the sale of the Republic mine, and experts believe in the probability of ore of at least good shipping grade being found below the deepest workings, now 731 feet lower than the outcrop. The rich ore shoot feathered out at a depth of about

625 feet. A winze follows the vein 125 feet below the No. 4 adit-level, and drifts both north and south on the 700-foot level follow the hanging wall, from which crosscuts were driven by the Republic Consolidated Gold Mining Co., but no payable ore was found at that depth. Mr. R. G. Edwards Leckie, who was then in charge, advocated the sinking of a vertical shaft to strike the hanging wall of the vein at a depth of about 1,000 feet. I think Mr. D. C. Jackling favored Mr. Leckie's view, but the company was short of funds at the time. Transportation and treatment charges by the Granby Company at Grand Forks, B.C., were then \$7.50 a ton, and the reduction of more than one-half of that expense is of itself a good reason for renewed activity in development in the mines of Republic camp.

PROSPECTORS' CONVENTION AT PORT ARTHUR.

Sudbury, April 2.—Plans are well forward for a prospectors' convention, to be held at Port Arthur, April 9th to 13th, under the auspices of the City Council and the Board of Trade.

The Bureau of Mines of the Department of Lands, Forests and Mines is giving all possible help to make the convention of practical value to the prospector, by sending an expert mineralogist to make demonstrations at the chemical laboratory of the Port Arthur Collegiate Institute.

Mr. A. G. Burrows was to have been the lecturer representing the department, but owing to serious illness his place will be taken by Prof. A. L. Parsons of Toronto University.

The subjects to be discussed at the evening sessions will be: "Staking out and recording claims," by J. W. Morgan, mining recorder for Port Arthur and district; "Phases of prospectors' work in land surveying," by S. E. Flook, D.L.S.; "Principles of geology," by Mr. J. Cross of McGill University; "Formations and surface indications," by Captain H. E. Knobel, M.E.; "Elementary tests and analyses," by Professor A. L. Parsons of Toronto University; "Mining policies and their bearings on our mineral resources," by Peter McKellar, F.R.S.

There will be a Board of Trade luncheon in honor of the government lecturer on Tuesday, April 10, and a dinner to wind up the convention on Friday, April 13.

The city councils and boards of trade of both Port Arthur and Fort William are helping to make the convention a success, and although the initiative has been taken by Port Arthur, Fort William citizens and officials are heartily responding. It is expected that prospectors and mining men from Kenora, Fort Frances and Rainy River will be at the convention.

There has been considerable activity in mining in this district during the last three months, and the coming months promise to be very busy in mining matters.

The Similkameen Star, Princeton, B.C., referring to published reports of a deal for the Voigt copper-mining properties, in Voigt's camp, about ten miles from Princeton, the purchase price having been stated as \$3,000,000, with \$8,000,000 or \$9,000,000 to be spent in construction of a railway to the properties and in their development, said: "The fact is the deal has not yet been closed, nor is it likely to be for a time yet. . . . However, there are hopeful indications that the deal will eventually be made."

SPECIAL CORRESPONDENCE

BRITISH COLUMBIA

While in some parts of the Province the lateness of the Spring is proving unfavorable to mineral production, chiefly owing to lack of power where water is largely depended on for driving machinery, the heavy snowfalls that have been experienced during the latter part of the winter promise an abundant water supply for washing gold-bearing gravels and for placer-mining uses generally.

Several metalliferous mining companies engaged in mining and ore reduction in the Province have declared dividends for the first quarter of the current year. These are the Consolidated Mining and Smelting Co.; the Granby Consolidated Mining, Smelting and Power Co.; the Hedley Gold Mining Co., and the Le Roi No. 2, Ltd. The respective totals of these dividend disbursements are as under:

Consolidated M. and S. Co.	\$260,445
Granby Consolidated Co.	374,563
Hedley Gold Mining Co.	60,000
Le Roi No. 2, Ltd.	29,220

The Standard Silver-Lead Co.'s dividend for the quarter has not yet been ascertained.

The uncertainty as to the coke supply, now that the agreement with the Crowsnest district coal mine employees has terminated by effluxion of time, is causing much uneasiness. Unless sufficient coke shall be obtainable for the blast furnaces of the several smelting works in Kootenay and Boundary districts, it will not be practicable to continue ore production. While some men will continue to be employed in doing development work in mines where this can be done to advantage at this time, it is to be expected that the larger number of the miners will be discharged. A report from Rossland indicates that this has already resulted, the news printed being in effect that eighty men have already been laid off at the War Eagle and Centre Star mines in that camp. In any case, there is little inducement, under existing cost conditions, to continue mining ore from those mines, since its chief value is in gold, so it may well be left in the mines and effort be concentrated in extracting ore having a greater copper content, such as occurs in parts of the Consolidated Mining and Smelting Co.'s neighboring Le Roi mine, and to some extent in the Le Roi No. 2 company's Josie group, nearby.

East Kootenay.

Thirty men are employed in the St. Eugene lead-silver mine, near Moyie, owned by the Consolidated Mining and Smelting Co. The ruins of the concentrating mill, destroyed recently by fire, are being cleared up. Meanwhile fifteen to twenty families, nearly all recent arrivals, following the company's decision to again operate the concentrator, are anxiously waiting to learn whether or not the company will rebuild the mill at Moyie. Already, it is stated, forty men have removed to other places, there not being any work for them to do after the destruction of the mill.

From the Cranbrook Herald it is learned that reliable mining report says that the Dibble group of mines near Mouse creek in Fort Steele mining division has been leased to a strong syndicate in which Sir George Foster has a large share. Active mining operations will be commenced as soon as supplies shall have been got up to the property. The further statement is made that the Victor Silver Leaf Mining Co., working the Victor claims on Mouse creek, has found them well

worth developing, the ore encountered being "splendid." From good authority it comes that the company contemplates soon building a concentrator.

News from Calgary, Alberta, where representatives of the Western Coal Operators' Association and of District 18, United Mine Workers of America, have been negotiating for some time relative to the terms on which a new agreement between the parties shall be made, is not encouraging as March draws to a close. Press despatches state that the representatives of the miners demand what amounts to a 25 per cent. increase in wages and a 20 per cent. reduction in hours of labor. Another reported demand is that the miners shall be granted 38 holidays in the year instead of eight provided for under the old agreement. It is asked that every pay day be made a holiday and that the men be granted a week off during the hot weather in July. Notwithstanding that no agreement appears to be in sight at the time of writing, there is said to be a disposition on both sides to compromise

West Kootenay.

Ainsworth.—For two weeks in March ore receipts at Trail from mines in Ainsworth mining division were light, having been only 83 and 82 tons, respectively. The Bell mine, in Jackson basin, has been sending zinc ore to Trail, but other shipments are generally silver-lead ore, the shippers prior to the end of the first week in March having included the Bluebell, Highland, and Utica. No word has yet come concerning the Florence Mining Co.'s new concentrating mill, but it is likely shortness of water prevents sufficient electric power being generated for working the mill machinery, and probably there is also an inadequate quantity for milling purposes generally.

Slocan.—Water for operating concentrating mills is still short in the Slocan district. The Silverton correspondent of the Kaslo Kootenayan states that lack of water continues to prevent a resumption of milling at the Galena Farm mine, and the Sandon correspondent states that those who are operating mills are waiting patiently for the Spring freshet to allow of more power being developed for the mills. There are three concentrating plants in the immediate neighborhood of Sandon, namely, those of the Ruth, Slocan Star and Surprise mines. In the vicinity of Slocan lake there are the mill at Roseberry, the Galena Farm and Standard mills, near Silverton, and the Hewitt mill, up Four Mile creek. Three others affected by the short supply of water are the Rambler-Cariboo mill, above Three Forks; the concentrator at Kaslo, and the Florence Mining Co.'s mill, near Ainsworth. Across the lake from Ainsworth, the New Canadian Metal Co.'s mill at Riodel, when conditions are favorable, concentrates lead ore from the Bluebell mine.

A small lot of ore, 37 tons, was recently received at Trail from the owners of the Surprise silver-lead-zinc mine, situated near the summit of the mountain above Cody, Slocan. This was the first ore received at the Consolidated Co.'s smelting works from that mine for about two and a half years. Ore production from the Surprise was curtailed when the Ivanhoe concentrating mill was destroyed by fire in the summer of 1915, at which time both silver-lead and zinc concentrates made from Surprise ore at that mill were shipped to the United States. For a while, in the latter part of 1915, the ore mined was concentrated at the Rambler-Cariboo Co.'s mill, distant from the mine six or seven miles,

but eventually production was suspended until, late in 1916, concentrating operations were commenced at the rebuilt Ivanhoe mill, Sandon. The Surprise mine is owned by Congressman William Kent, of Kentfield, Marin county, California, and Mr. Alex Smith, of Toronto, the latter having been in charge of development work for about twelve years until the mine was established on a producing basis.

Production of concentrates at the Slocan Star mill has been resumed. For some months the water supply has been short for power drills in the mine and the enlarged concentrating mill, but it is expected this difficulty will shortly be overcome, a new water-line having been put in. It is reported that some 70 tons of silver-lead concentrate of an average value of \$150 a ton, and 150 tons of zinc concentrate, worth about \$25 a ton, have been shipped lately.

Vancouver Island.

Mr. J. M. Savage has assumed charge, in the capacity of general manager of the affairs of the Canadian Collieries (Dunsmuir), Limited, operating the Extension and Comox collieries on Vancouver Island. Several years ago he was actively associated with Mr. John Arbuthnot, formerly of Winnipeg, Manitoba, in the business of the company known as the South Wellington Coal Mines, Ltd., afterward reorganized as the Pacific Coast Coal Mines, Ltd., and in the operation of the company's coal mines a few miles south of Nanaimo, V.I.

The Valdes Copper Co. has arranged to ship about 400 tons of ore from its property on Quadra island, of the Valdes group, situated on the east side of Discovery passage, between Vancouver island and the Mainland. Some time since the company let a contract for doing development work on some of its Copper Mountain group of ten mineral claims, and now sufficient ore has been opened to admit of shipments in bulk being made to the extent above indicated.

One of the Island metalliferous properties that is expected to benefit as a result of the intended early reopening of the smelting works at Ladysmith, V.I., is the Blue Grouse mineral claim, Cowichan lake, Victoria mining division. The property is situated on the west side of the lake, about seven miles from the end of the railway and three-quarters of a mile back from the water, the elevation above the lake being 500 to 800 ft. One carload of ore was shipped to the Trail smeltery last January for test purposes; recently two cars were shipped to Ladysmith, and it is intended to get out about two cars a week. The ore is taken from a big open cut; it runs from 5 to 8 per cent. copper. It is hauled down to the lakeside and taken thence to the railway terminus in a scow. The expectation is that when the snow shall have melted, and the smelting works be in operation, the output of ore will be increased.

The Canadian Collieries (Dunsmuir), Limited, is building more coke ovens at Union bay, V.I., where are situated the company's bunkers and shipping wharves for coal from the several mines of its Comox colliery, a coal-washery, and a brickyard for making fire-brick. The existing 100 ovens were built in 1895-6, and thereafter up till 1911 coke was made in them. Following the closing of the Tyeé Copper Co.'s smelting works in the last-mentioned year, coke-making ceased until the latter part of 1915, when a contract was entered into to supply coke for the Granby Consolidated Co.'s new smelting works at Anyox, Observatory inlet. By the end of 1915 the output of coke for that year was 5450 long tons, and for 1916 it was 28,044 tons. Now that smelting is to be resumed at Ladysmith, provision is being made, by building additional ovens, to meet the increased demand for coke for the blast furnaces.

NORTHERN ONTARIO.

Elliott-Kirkland.

The extension of the power line from the Teck-Hughes to the Elliott-Kirkland Mines is now completed, resulting in development work at the latter property being greatly facilitated. At present the main shaft at the Elliott-Kirkland has reached a depth of ninety feet, and will be carried to the 125-ft. level, where a crosscut will be run in an endeavor to encounter the Kirkland Lake gold vein, which was located on the property near the western boundary of the Kirkland Lake Gold, where, however, the low-lying nature of the ground made it impossible to sink a shaft from the surface. It is anticipated that very little difficulty will be encountered in locating the vein at depth on the Elliott-Kirkland, owing to results obtained on the Kirkland Lake Gold, where the working on the same vein has reached a depth of 500 ft.

Boston Creek.

The recent spring weather has brought a decided feeling of optimism to the Boston Creek gold district, where growing faith is being exhibited by prominent mining men. At present among the properties in this section which are receiving more or less attention, with very favorable results, are: The Boston Creek, R. A. P. Syndicate, O'Donald, Boston, Hollinger, Miller-Independence, Gold Leaf, McRae, Hill and Currie properties. A number of important discoveries have been made and it is understood some diamond drilling will be done on a number of the properties this spring and summer. The O'Donald claims are under option by the Crown Reserve Mining Company of Cobalt, and the McRae claims were purchased by strong Montreal financial interests a short time ago, and active development work will be proceeded with on these in a very short time on an extensive scale.

Staking in Thackeray.

Free gold was found in a vein from five to seven feet in width in the Township of Thackeray late last fall, with the result that about forty claims were staked in this vicinity and a number of very promising veins are awaiting the disappearance of the snow when further exploration work will be undertaken. The scene of the new discovery is about twelve miles north of the Townships of Teck and Lebel, in which are located the Kirkland Lake gold area. The formation is Keewatin, and the veins are said to contain some molybdenum. There are two trails leading into the township. The shortest one is from Scottish Springs at Mileage 188 on the T. & N. O., a distance of about twelve miles, eight of which can be traversed by canoe in the summer time. The other route is by trail north-east from Bourke's Siding, a distance of about seventeen miles.

Elk Lake.

The Taylor property in the McKenzie Lake section of the Elk Lake district has closed down. It was generally understood that the company were starting on an extensive development program and the news that the work was being discontinued came as a big surprise. Financial difficulties was given as the reason for the shutting down of the property, and it is not definitely known when operations will be resumed.

Larder Lake.

Work on the Larder Lake Goldfields property at Larder Lake is being energetically pushed at the 300-ft. level and the vein at this point is said to be well mineralized and carries considerable free gold. Among the other properties in this district which are contemplating opening up in the near future are the Larder Lake Combine on Larder Lake, and the Lincoln-Nipissing in Skead Township. One reason for the

increased activity in this section is the fact that the addition to the power plant at Little Windigo is being pushed to completion and when it is completed, the power question for a number of these properties will be satisfactorily solved and development made a great deal easier.

Newray.

It is expected that the crosscut at the 400-ft. level of the Newray will encounter the Anchor vein almost any round now, as, according to the diamond drilling operations in which it was located, the drift is very close to it now. An extensive plan of diamond drilling on the property is being carried out and it is understood more than ordinarily good results are being obtained. The south-west corner of the Newray touches the north-east corner of the Plenaurum, and is in direct line with the strike of the vein systems of the Hollinger and McIntyre mines. It is the intention of the management to start up the small stamp mill on the property before the end of the present month, and if satisfactory results are encountered an enlargement of this will be made in a short time.

McIntyre.

The capacity of the McIntyre Porcupine mill has been brought up to 600 tons per day and the mill is running almost to the limit of its capacity, with the result that a decided improvement is expected in the tonnage milled and the recovery made. The grade of ore being sent to the mill is said to average around \$10.50 per ton. The figures for the past month are not up to expectation, but April will probably be a record-breaking period for this property. McIntyre seems at last to be striking her proper stride.

Colossus Gold.

The Colossus Gold Mining Company in Munro Township, less than one mile from the famous Croesus Mines, have let a large diamond drilling contract with the intention of proving the values at depth in a series of veins which carried good values on the surface. The claims of this company are 280 acres in extent and were formerly owned by Messrs. Malouf and Carter. Lumber for camp buildings has been ordered and the work of diamond drilling will be commenced before the end of the present month.

Kenabeek and Hitchcock.

The consolidation of the Kenabeek Mine and the Hitchcock veteran claim has been consummated and work on this new consolidation of properties will be energetically pursued. At the present time the shaft on the Kenabeek property has reached a depth of 120 ft. and a small vein carrying high grade silver values is showing at this depth. It is the intention of the company to continue the working to the 125-ft. level and then run a crosscut to encounter the parallel veins which were encountered on the surface of the property.

Silverado.

Machinery and supplies have been taken in over the winter road to the Silverado property at Gowganda and an extensive development program will be carried out this spring and summer. A seven-drill compressor and 100-h.p. boiler, together with other accessories for sinking the shaft and drifting were taken in. Considerable development work was accomplished last summer, and a number of promising veins encountered on the surface. Some sinking was done by hand steel, but late in the fall this was discontinued. This work will be resumed after the installation of the new plant and the veins discovered on the surface will be tapped at depth. The property lies along the Hudson Bay

Mining Company's property, on which a considerable amount of good ore has been discovered.

Kirkland Lake Gold.

It is stated on reliable authority that the Kirkland Lake Gold Mines, Limited, which has now reached a depth of 600 ft., will continue the main shaft to the 1,000-ft. level, establishing a station at every one hundred feet. This will be by far the deepest working in the Kirkland Lake camp. It is also reported that the company is planning the installation of a mill similar to the one which is giving such good results on the Schumacher property.

Slade-Forbes Asbestos.

The Slade-Forbes Asbestos Company, in Deloro Township, about three miles from Timmins, is meeting with considerable success in the development of claims. A short time ago a shipment of one ton of ore was made to Cincinnati. The product is sorted on cobbing tables and bagged and shipped. The shipment was valued at \$600. It is said the company intend installing a mill to treat the ore on the property in the near future.

Sylvanite.

Work has been commenced on the Sylvanite Company's property at Kirkland Lake and the contract has been let for 75 feet of sinking. This property has an up-to-date electrically driven plant and is located between the Tough-Oakes and the Wright Hargraves. A number of promising veins, some carrying free gold, have been uncovered in surface work, and will now be developed to depth.

Dome.

Driving east on the big drift at the 700-ft. level of the Dome Mines, the miners have crossed the line of the Dome Extension property and are now about 200 feet in on the latter property, on which Dome has an option. Considerable diamond drilling has been done on the Dome Extension and a large quantity of ore has been located. It is expected that the next annual report of the Dome Mines will contain a statement regarding developments on the Dome Extension.

Porcupine Crown.

The Porcupine Crown mining company is testing the property to a depth of 2,000 ft. by the aid of a diamond drill. Additional hoisting apparatus has been installed in the winze below the 500-ft. level, making it more economical to mine at this depth than heretofore.

Moneta.

It is reported that the Moneta Porcupine Mines, Ltd., will re-open in the near future. This property is located adjacent to the Miller-Middleton claims of the Hollinger-Consolidated and is comprised of three 40-acre claims, on which results were very encouraging in the limited amount of development work done.

Pittsburg-Lorrain.

Diamond drilling on the Pittsburg-Lorrain in South Lorrain is now under way, one hole being down around 500 ft. at the present time. It is the intention of the company to put down a number of holes to the eight or nine hundred foot depth, which will be the deepest point ever reached by diamond drilling operations in this district. A vein of calcite has been discovered in crosscutting around the 200-ft. level, and is being drifted on. This vein is about five inches in width and while it was not found to contain silver values, it is the hope of the management that better results will be encountered before much further work is done.

Temiskaming.

The shaft on the Temiskaming has reached a depth of 1,600 ft., and the working at this level has been

connected up with the Beaver, thus creating a better ventilation system for both the properties at this level. It is understood that developments on the winze at the 1,600-ft. level of the Beaver are very satisfactory. It is the intention of the Temiskaming to sink to the 1,800-ft. level before undertaking much development work, but when this level is reached much crosscutting and drifting will be done on any veins which the management encounter. It is highly probable the same vein system encountered on the Beaver will extend to the Temiskaming.

Ophir.

On the 300-ft. level of the Ophir mines at Cobalt, a crosscut six hundred feet in length has cut ten separate veins and is now very close to the Diabase-Keewatin contact. None of the veins so far encountered have been found to contain any great amount of silver, although they are all very strong and well defined and give promise of better results with more development work. Much interest centres in the work going on at No. 2 shaft at the 410-ft. level, where the large vein should be encountered any day now, and the result of this work is being watched with interest.

Adanac.

A new vein has been encountered in the crosscut on the 400-ft. level of the Adanac mine at Cobalt. A small amount of native silver is in evidence in the vein and drifting will be continued in an endeavor to locate more extensive deposits of the precious metal. The crosscut has been in the diabase below the contact and the broken-up nature of the last vein tapped, would lead to the belief that the contact is only a few feet above the drift. It is the intention of the management to raise on all the promising veins as it is expected ore of a commercial value will be found to exist in the overlying Keewatin. The crosscut is to be continued further west at an early date.

McKinley-Darragh.

The McKinley-Darragh mine at Cobalt intends installing a second flotation plant with a capacity of 200 tons per day, to treat the tailings from previous operations. The tails will be reground in a Marathon mill, which will be the first of its kind to be installed in the Cobalt camp; the mill is 4 x 8 ft. and a series of steel rods is used for the grinding process instead of balls or pebbles. The machinery has been ordered and the new building is being constructed. After grinding in the new mill the ore will be treated by the Callow flotation process. The installation of the new plant will bring the treatment of tailings up to 400 tons per day, just double the present capacity.

Calumet and Montana.

A two-inch vein has been found on the old Airgoid property, leased to the Calumet and Montana company, near the Dominion Mines line. Promising silver values are in evidence in the vein and it is being drifted on in the hope of encountering better values. The vein is supposed to be an extension of one of those located on the property of the Dominion Mines.

Green-Meehan.

A movement is on foot to recommence operations at the Green-Meehan property. A carload of ore will be shipped from the dump to one of the customs mills at Cobalt and if the returns are satisfactory it is understood the several thousand tons of ore on the dump will be treated, and the mine dewatered again.

Hargraves.

An ore shoot on the 375-ft. level of the Hargraves mine is proving very consistent and considerable ore

is being taken out. Shipments are being made from the dump to the Dominion Reduction mill and it is said a fair amount of profit from this source is being shown.

Murray-Mogridge.

Work on the Murray-Mogridge at Wolfe Lake, three miles from Bourke's Siding, is progressing satisfactorily by the use of hand steel, pending the arrival of the machinery which is expected to arrive any day now. A complete plant is being installed. The shaft has been sunk to a depth of sixty feet and the vein has been tapped at intervals. It is understood results look very promising.

The Sullivan Machinery Co., Ltd., of Canada, will remove its office on or about that date from Shaughnessy Building, Montreal, to No. 37 Colborne Street, Toronto. Air compressors, rock drills, hammer drills, and their parts will be carried in stock. The company announces that: "This change is made on account of the improved service we expect to give our Canadian patrons from Toronto, which seems to be more central than Montreal for our business."

Mr. Herbert C. Hoover, who has been in charge of Belgian relief work in London, will be asked by Council of National Defence to return to United States and take chairmanship of a committee on food supply and prices.

The Washington, D.C., correspondent of the Engineering and Mining Journal lately wrote: "There is a movement on foot to put the United States Bureau of Mines in the Department of Labor, removing it from the Department of the Interior, where it has always been. This would probably totally destroy its usefulness and would result eventually in decay of the organization, not through any fault of the Bureau, but because it would be placed in such an attitude to the mining business that it could not expect to receive the support and co-operation extended to it now."

The Daily Alaskan, Skagway, said on March 15: Locally, conditions have never been more favorable than at present. All the big mining industries in the vicinity and contiguous to the vicinity are working full time and employing practically all-comers, and will continue to do so until the time comes when the demand for labor will have been met, and it is doubtful if that condition will be reached this year.

SILVER PRICES.

	New York.	London.
	cents.	pence.
March—		
21.	72½	35½
22.	72½	35½
23.	72½	35½
24.	71½	35½
26.	71½	35½
27.	71½	35½
28.	72½	36½
29.	72½	35½
30.	72½	36
April—		
2.	74½	36½
3.	74½	36½
4.	74	36½
5.	73½	36½

MARKETS

TORONTO MARKETS.

Cobalt oxide, black, \$1.05 per lb.
 Cobalt oxide, grey, \$1.15 per lb.
 Cobalt metal, \$1.25 to \$1.50 per lb.
 Cobalt anodes, \$1.50 to \$1.75 per lb.
 Nickel metal, 45 to 50 cents per lb.
 White arsenic, 5½ to 6 cents per lb.

April 10, 1917—(Quotations from Canada Metal Co., Toronto)

Spelter, 14 cents per lb.
 Lead, 12¼ cents per lb.
 Tin, 58 cents per lb.
 Antimony, 36 cents per lb.
 Copper, casting, 37 cents per lb.
 Electrolytic, 39½ cents per lb.
 Ingot brass, yellow, 23 cents; red, 25½ cents per lb.

April 10, 1917—(Quotations from Elias Rogers Co., Toronto)

Coal, anthracite, \$9.00 per ton.
 Coal, bituminous, nominal, \$8.50.

NEW YORK MARKETS.

Connellsville coke—

Furnace, spot, \$8.00.
 Contract (nominal), \$7.00 to \$8.50.
 Foundry, spot, \$10.00.
 Contract, \$8.50 to \$9.00.

Straits Tin, spot, f.o.b., nominal, 54.75 cents.

Copper—

Prime Lake, nominal, 34.00 to 34.50 cents.
 Electrolytic, nominal, 33.75 to 34.25 cents.
 Casting, nominal, 30.75 to 31.25 cents.

Lead, Trust price, 9.00 cents.

Lead, outside, nominal, 9.25 to 9.50 cents
 Spelter, prompt western shipment, 10.30 to 10.55 cents.
 Antimony—Chinese and Japanese, nominal, 36.00 cents.

Aluminum—nominal—

No. 1 Virgin 98-99 per cent., 59.00 to 61.00 cents.
 Pure, 98-99 per cent., remelt, 55.00 to 57.00 cents.
 No. 12 alloy remelt, 39.00 to 41.00 cents.
 Powdered aluminum, 85.00 to 90.00 cents.

Metallic magnesium—99 per cent. plus, \$3.00 to \$3.50.

STOCK QUOTATIONS.

As of close April 9, 1917.

(By courtesy of J. P. Bickell & Co., Toronto.)

New York Curb.

	Bid.	Asked.
Boston & Montana	.60	.63
Butte-Detroit Copper	.62	.75
Canada Copper	1.81	1.87

Dome Extension	.20	.22
Hargraves	.16	.18
Inter. Petroleum	14.25	14.50
Kerr Lake	4.25	4.50
La Rose Con.	.50	.62
McIntyre	1.81	1.87
N. Amer. Pulp & Paper	5.00	5.25
Nipissing	7.75	8.00
Superstition	.35	.37
Temiskaming	.50	.52
Vipond	.45	.50

Ontario Gold Stocks.

	Bid.	Asked.
Apex	.08%	.08%
Boston Creek	1.02	1.06
Dome Extension	.21½	.21½
Dome Lake	.19	.20
Dome Mines	17.00	18.00
Hollinger Cons.	5.20	5.30
Jupiter	.30
McIntyre	1.83	1.84
Moneta	.12	.12½
Newray	1.36	1.38
Porcupine Crown	.63	.64
Porcupine Imperial	.03½	.03%
Porcupine Tisdale	.01%	.02
Vipond	.46½	.47
Preston E. D.	.04%	.05
Teck-Hughes	.68	.71
West Dome	.27½	.28

Cobalt.

	Bid.	Asked.
Adanac20
Bailey	.05½	.06
Beaver Con.	.39½	.41
Chambers-Ferland	.13	.13½
Coniagas	3.60
Crown Reserve	.33	.34½
Great Northern	.13
Hargraves	.17¼	.17½
Hudson Bay	40.00
Kerr Lake	4.30	4.50
La Rose	.50	.55
McKinley-Darragh-Savage	.48
Nipissing	7.80	8.00
Peterson Lake	.11¼	.11¾
Shamrock Cons.	.22	.23
Temiskaming	.50	.50½
Trethewey	.16½	.17½
Wettlaufer	.07	.08½

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