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TWENTY-FIRST YEAR OF PUBLICATION

The Canadian Mining Review

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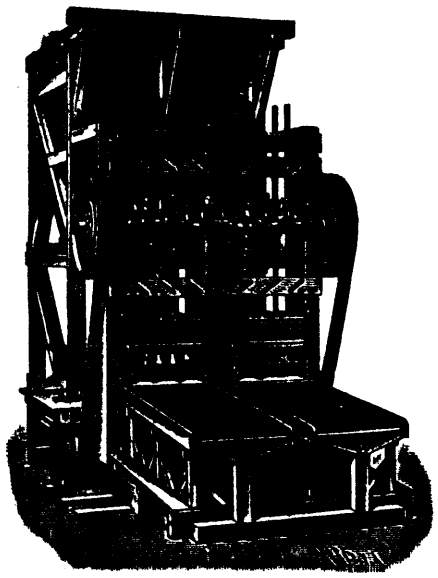

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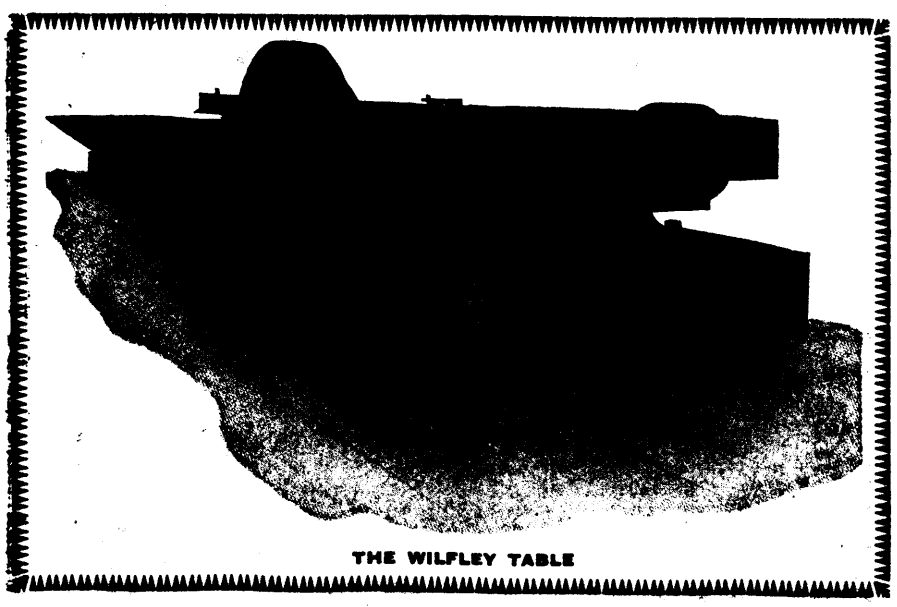

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BURNT OUT.

By the complete destruction of our printing plant in the great fire which occurred in Ottawa early in the month, the work of publishing the present number of the "Review" has been difficult, and we beg the indulgence of our readers for the shortcomings of the present number.

Ontario and the Iron Trade.

Ontario aspires to be the chief manufacturing Province of the Dominion, to fill in Canada the role which the New England States or Pennsylvania plays in the great Republic. There are vast markets looming up in the western prairies and ranches as well as in the forests of the north, where the thousands of pioneers will soon give place to millions of successors, who will demand manufactured goods in almost unlimited quantities. Textile fabrics in cotton and wool, furniture and woodenware, boots and shoes and leather goods of all kinds, machinery and manufactures of iron and steel all in a thousand varied forms will be needed to clothe the persons, do the work and meet the wants of this coming host whose skirmishing line is even now upon us.

Not the least in demand will be articles of steel and iron, without which forests cannot be felled, fields cultivated or reaped, houses built, or produce taken to market. Abundance of iron lies at the base not only of the special branches of manufacture of which it is the raw material, but of manufactures of all kinds, because they cannot be made without machinery.

The production of agricultural implements is a business which, in a farming country like Canada, is likely to come early to the front. For many years large firms, mainly in Ontario, have been not only supplying machinery to Canadian farmers, but have been exporting it in quantities to foreign countries. The location of a branch of the Deering manufacturing firm in Hamilton seems likely to lead to the erection of a plant which will put existing works in the shade, and to give the "ambitious city" a strong lead towards industrial primacy among Ontario cities. The motive for putting up a plant on Canadian soil, which when completed will, it is said, employ probably ten thousand men, is probably a double one—to take early advantage of western development, and to manufacture for foreign countries free from the disabilities to which retaliatory tariffs expose the manufacturers of the United States. The erection of sugar factories, cereal works, cement plants, steel works, shipyards, etc., in many Ontario towns and cities, encouraged as they have been in many cases by municipal bonuses, shows clearly the trend towards the business of manufacturing in Ontario.

Do the conditions in Ontario prevail in Ontario necessary for the development of a great manufacturing industry, especially in goods made mainly from iron and steel? The great lakes invite commerce and furnish the means of transporting commodities from the older parts of the Province where manufacturing can be most successfully carried on, right up almost to the threshold of the markets of Manitoba and the west. It is by reason of these unrivalled waterways that the trade between the older and newer States of the Union has developed to so enormous an extent, and there is no doubt that what is done on the southern side of the lakes can be repeated on the north. Iron ore can be brought down from the upper lakes from mines either north or south of the line just as easily to Ontario as to American ports, and if the volume of the trade should require it, loading and unloading and dockage facilities equal to those at American ports would be provided. Western bound coal destined for the Canadian side and manufactured goods would afford return cargoes, just as they do south of the line. The position of Ontario, thrust like a wedge into the heart of the American Republic, bounded as it is by the great lakes and within a a few hours distance of the great centres of population south of the border, confers upon it unique advantages for trade, commerce and manufactures. So far as transportation is concerned, there can be no doubt that Ontario is capable of becoming the seat of a great manufacturing industry.

As to supplies of iron ore, it is doubtful whether in any commonwealth of America so great an extent exists of rocks favorable for the occurrence of ore deposits. Already a number of important mines have been located both of hematite and magnetite, and there is every reason to believe that many more await the revealing touch of the prospector's pick or the diamond drill. It is premature to say that supplies of ore on a vast scale do exist, for iron range rocks often contain no iron, but the chances of so extended an area proving barren are practically nil, and it will not be surprising if within the next five or six years iron mines are developed in northern and northwestern Ontario on a scale comparable to almost any other locality.

The matter of fuel is an important one, and of course there is no denying that Ontario, at any rate older Ontario, is without coal mines, but coke and coal can be brought from Pennsylvania at very little greater cost to Canadian ports on the great lakes than to American ports, and the tendency appears to be growing to bring the coke to meet the ore, and not to carry the ore the whole way to the coke.

There is no good reason for instance why a blast furnace or steel works should not be as successful on the north side of Lake Erie as on the south, for the cars containing the coke can be ferried across and thus save handling, which tends to reduce the value of coke for smelting purposes.

The manufacture of charcoal iron ought to find northern Ontario a very favorable seat. There is abundance of wood and plenty of ore, and our iron masters would do well to examine carefully the possibilities of this branch of the industry.

Water falls for the production of electrical power are numerous, and can be utilized for mining and manufacturing operations with great economy and advantage. Indeed, a beginning has been made in this direction in some of the working mines of the Province.

To sum up, the conditions are, (1) an enormous market rapidly developing; (2) abundance of iron ore; (3) coal and coke at very little over U. S. prices, and charcoal *ad libitum*, with additional advantages in the way of cheap electrical power. We have not dealt with artificial aids such as tariff duties or bounties, as these are at the mercy of political changes, but on the strictly natural conditions there seems to be no reason whatever why with skill, energy and capital an iron and steel trade of very large dimensions should not come into existence in the Province of Ontario, and that within a very short time.

Production of Pig Iron in Canada.

The statistics of the production of pig iron in Canada in 1902 have been received from the manufacturers by the American Iron and Steel Association. They show an increase of 74,581 long tons, or over 30 per cent., as compared with the production in 1901.

The total production in 1902 amounted to 319,557 long tons, against 244,976 tons in 1901 and 86,090 tons in 1900. In the first half of 1902 the production was 157,804 tons and in the second half it was 161,753 tons, a gain of only 3,949 tons. Of the total product in 1902, 302,712 tons were made with coke and 16,845 tons with charcoal. A little over one-third of the total product was basic pig iron, namely, 107,315 tons. The Bessemer pig iron made amounted to about 9,000 tons. Spiegeleisen and ferromanganese have not been made since 1899.

The following table gives the total production of all kinds of pig iron in Canada from 1894 to 1902, the statistics for each year having been received directly from the manufacturers. Prior to 1894 the statistics of pig iron production in Canada were not collected by the American Iron and Steel Association:

Total production of all kinds of Pig Iron in Canada, 1894-1902.

Year	Quantity.
1894	44,791 long tons.
1895	37,829 "
1896	60,030 "
1897	53,796 "
1898	68,755 "
1899	91,077 "
1900	86,090 "
1901	244,976 "
1902	319,557 "

On December 31, 1902, the unsold stocks of pig iron in Canada amounted to about 20,000 long tons, as compared with 59,472 tons at the close of 1901 and 12,465 tons at the close of 1900. Of the unsold pig iron on hand on December 31, over 19,000 tons were coke pig iron.

On December 31, 1902, Canada had 14 completed blast furnaces, of which 7 were in blast and 7 were idle. Of this total, 9 were equipped to use coke for fuel, 4 to use charcoal, and 1 to use mixed charcoal and coke. In addition, 4 coke and 2 charcoal furnaces were being built or were partly erected on December 31, but work on some of these furnaces was suspended.

The Algoma Steel Company, Limited, of Sault Ste. Marie, Ontario, one of the constituent companies of the Consolidated Lake Superior Company, commenced the erection of 2 charcoal and 2 coke furnaces at Sault Ste. Marie in 1901. The charcoal furnaces were to be 70 by 14 feet and the coke furnaces 90 by 21 feet. Subsequently work on the coke furnaces was suspended, and one of the building charcoal furnaces was converted into a coke furnace, the size being changed from 70 by 14 feet to 80 by 15½ feet. The company now expects to have its charcoal furnace ready for blast in June and its coke furnace in July.

The Cramp Steel Company, Limited, has put in the foundations for a blast furnace at Collingwood, Simcoe County, Ontario. The company expects to have the furnace ready for operation in the fall of 1903. Coke will be used. Its daily capacity will be about 250 long tons.

The Nova Scotia Steel and Coal Company, Limited, of New Glasgow, Nova Scotia, broke ground in June, 1902, for a new furnace at Sydney Mines, Cape Breton, Nova Scotia. The furnace will be 85 by 17 feet, and will have a daily capacity of about 200 tons of basic and foundry pig iron. Coke will be used, and red and brown hematite ore will be obtained from Nova Scotia and Newfoundland. It is expected that the furnace will be completed in September, 1903. The company now has a furnace at Ferrona, with an annual capacity of 33,000 long tons.

The Londonderry Iron and Mining Company, Limited, of Londonderry, Nova Scotia, is rebuilding Furnace A, at Acadia Iron Mines, and expects to blow it in in May, 1903. The furnace will be 75 by 17 feet, and will have an annual capacity of 48,000 tons of foundry iron. The company does not contemplate blowing in Furnace B in the near future, but may rebuild it later on.

The total production of steel ingots and castings in Canada in 1902 was 182,037 long tons, against 26,084 tons in 1901, an increase of 155,953 tons. Bessemer and open-nearth steel ingots and castings were made in each year. Almost all of the open-hearth steel reported in 1902 was made by the basic process.

The following table gives the production of all kinds of steel ingots and castings in Canada from 1894 to 1902, in long tons:

Year	Quantity
1894	25,685 long tons.
1895	17,000 "
1896	16,000 "
1897	18,400 "
1898	21,540 "
1899	22,000 "
1900	23 577 "
1901	26,084 "
1902	182,037 "

The large increase in the production of steel in Canada in 1902 over 1901 was caused by the starting up of the new open-hearth steel plant of the Dominion Iron and Steel Company, Limited, at Sydney, Cape Breton, Nova Scotia, which first produced steel on December 31, 1901, and of the new Bessemer plant of the Algoma Steel Company, Limited, at Sault Ste. Marie, Ontario, at which steel was first made on February 18, 1902. The latter company has two 6-long-ton Bessemer convertors, which were operated for a few months in 1902, producing in all 44,537 long tons of ingots. The company has also a rail mill which first made Bessemer steel rails on May 5, 1902, and which also ran for a few months in that year, producing 32,858 long tons. In addition this company also produced 1,236 long tons of other rolled products in 1902. The Dominion Iron and Steel Company produced 99,425 long tons of basic open-hearth steel ingots and castings and 86,424 tons of blooms, billets, and slabs. It did not make steel rails.

Dominion Steel.

Since the publication of our article last month on the affairs and management of the Dominion Iron and Steel Company, we are in receipt of an exceedingly interesting communication from a gentleman who has been from the start prominently identified with the iron and steel industries of the Maritime Provinces. Whilst our correspondent's communication was not intended for publication, perhaps he will pardon us reproducing for the benefit of our readers the following extract:

"If the cost of producing pig iron at Sydney is between $10 00 and $11.00 it is a great deal more than it ought to be and considerably higher than Ferrona iron cost when using the same ore, with dearer coal, longer transportation and a small furnace. If there has been a marked decrease in the value of their Wabana ore, and metallic contents have fallen as low as 43 per cent., this is due entirely to the method of mining, and not to any change in the iron contents in the ore body *en suite*—that statement you can depend upon. The lower bed which they purchased, however, did not average 55 per cent. throughout—it did, however, average over 50 per cent. The falling off of the metallic contents of the ore as shipped to the furnace does not, of itself, involve the necessity of importing large quantities of high grade ore as stated. As a matter of fact, the Sydney people have never used foreign ore of any kind for the pr duction of Basic pig iron for open hearth purposes, the foreign ore imported was used exclusively for two purposes—in one case to mix with Wabana to gain a lower phosphoric iron for foundry purposes, and in the other case as a reducing agent in the open hearth furnaces.

With regard to what you refer to as the fundamental difficulty arising from an unsuitable ore and the consequent inability to produce a rail to come up to Mr. Fielding's requirements as to quality, I wish to say that the Sydney people in their open hearth furnaces, are making to-day and have been for months, from Wabana ore entirely, without any admixture of other materials whatever, billets which are filling the most exacting requirements for locomotive material, such as driving axles for the Baldwin Locomotive Company of Philadelphia, the physical and chemical specifications for which are much more severe than called for in any steel rails made either in the United States, Great Britain or elsewhere—of that fact there is no possible doubt whatever. All that is said in regard to their inability to make steel rails of the necessary quality from Wabana Ore, pure and simple, is nonsense. Briefly, what I say is, that there has been no deterioration in the ore *en suite*, and that from this ore alone, without any other material whatever, steel of the very highest grade has been, and can be made. That their costs are high there can be no question. This is due not only to one or two but to several reasons and it will take some time to bring them down."

Cost of Electric Drilling.

Mr. John B. Hobson, M.E., general manager of the Consolidated Cariboo Hydraulic Mining Company at Bullion, B.C., in his annual report, gives some interesting figures of costs of operating an installation of Gardner electric drills. The plant, which was an experimental one, included four Gardner No. 15 drills with two horse-power 110 volt direct current portable motors, one Gardner "B" drill, with one and a-half horse-power 110 volt direct portable motor, all complete, with seven-foot flexible shafts, adjustable tripods, drifting columns, the necessary flexible cables, working tools and five sets of drills of suitable lengths to drill holes, varying from two to eight feet deep. Mr. Hobson states that these drills proved a decided success, for they were run at low expense and proved more efficient than expected:—

STEAM POWER.

1 cord of Cedar wood, delivered	$2 25	
1 Electric Engineer	4 00	
Lubricants for Engine and Generator	0 35	
		$6 60

OPERATING THREE DRILLS.

3 Power Drill Men at $4.00 each	$12 00	
3 Helpers at $2.00 each	6 00	
1 Blacksmith	4 00	
1 Helper	2 00	
3 Bushels of Charcoal at 25c	0 75	
Lubricants	0 20	
		24 95
Total cost of running three drills 10 hours		$31 55

The duty attained by the Gardner drills used during the season, in advancing and lowering the bed-rock cut, averaged 312 feet of holes per 10-hour shift.

The duty attained by two miners drilling by hand, with ⅞ inch steel and 8-lb. hammers, averaged about 14 $\frac{6}{10}$ feet per 10-hour shift, and made the cost of drilling 312 feet of holes in bed-rock by hand as follows:—

42 Miners at $2.00 per day	$84 00
1 Blacksmith at $4.00 per day	4 00
1 Helper at $2.00 per day	2 00
4 Bushels of Charcoal at 25c	1 00
Total cost of drilling 312 feet of holes by hand	$91 00
Saving made in favor of power drills per ten-hour shift	50 45

Imports of Mining Machinery.

The imports of free and dutiable mining and smelting machinery for the first quarter of the present year compared with 1902, are as follows:—

Months	1903			1902		
	Free	Dutiable	Total	Free	Dutiable	Total
January	$ 77,298	$ 7,676	$84,974	92,984	2,549	95,533
February	30,106	1,587	31,693	43,123	2,380	45,503
March	83,535	11,534	95,069	55,255	2,629	57,884
April	104,967	4,638	109,605	61,227	5,087	66,314
Total	295,906	25,435	321,341	252,589	12,645	265,234

The principal sources from which this machinery has been imported were:—

Months	United States		Great Britain		Other Countries	Total
	Free	Dutiable	Free	Dutiable		
January	$75,235	$ 7,676	$ 417	—	$1,646	$84,974
February	29,467	1,587	639	—	Nil	31,693
March	82,680	11,534	158	—	697	95,069
April	104,902	4,638	65	—	Nil	109,605
Total	292,284	25 435	1,279	—	2,343	321,341

Crow's Nest Pass Coal Company.—It is estimated that the number of men employed at Michel will reach a thousand, being larger than at any time in its history. The rock for the new coke ovens is being brought from the quarry at the rate of seven cars per day. The company has a large force at work at Morrissey building a trestle to connect with coal bins shortly to be erected. Harry Oldland, of Jefferson, Pa., has the contract for the 250 coke ovens at Morrissey, and has a force at work.

Stamps and their Increasing Power.

Increased weight, high speed, the judicious use of screens, low discharge, and the norrowing of mortar boxes, are the chief factors that have been instrumental in bringing about the steady rise of stamp duties on the Rand. In 1885 the average rate of crushing was about 4·12 tons per head per day, whilst the figure had inereased to 4 86 during last year. This means that ·74 tons more were crushed by each stamp in 1902 th in by the heads of seven years ago. At the end of last year there were 2, 845 stamps at work on these fields. A 1902 head being equal in crushing capacity to 1·17 1895 stamps, it follows that these 2,845 stamps at work last year were equivalent to 3,328 stamps of seven years ago. By extending this comparison it will be seen that 2,845 heads crushing an extra ·74 tons pet day means some 2,105 tons per day more than 1895. Valuing each ton at about 42s., it means an additionul value of gold won to the extent of £4,420 per day, or about one and a-half million sterling per year. These figures speak for themselves. They indicate the Witwatersrand policy of extracting the largest amount of gold in the shortest time practicable. To meet the increased capacity of our mills other machinery has increased in efficiency in direct ratio. In 1895 the only 1,250 lbs. stamp batterp was the Modderfontein 4c heads, which was then probably the heaviest on record in a Californian mill. The average weight of the stamps in use on the Witwatersand Gold fields during 1894 was 850 lbs., whilst the Government Mining Engineer's report for last year shows that there were five 560 lbs. heads, two hundred and forty of 750 lbs., ten of 800, sixty-five of 850 lbs., three hundred and thirty of 950, one hundred and ninety of 1,000, one thousand eight hundred and ninety of 1,050, five hundred and eighty-five of 1,100, one thousand one hundred and seventy of 1,150, three hundred and sixty of 1,200, and one thousand nine hundred and ten of 1,250 on the Rand. For 1898 the duty per stamp was 4·561, so that an increase of 251 tons per 24 hours is recorded since the resumption of milling. Of recent years weight has been added to all parts of the stamps, except perhaps the tappets, the weights of which have remained practically constant Stems have been increased from 3 and 3¼ inches to 3½ and 3⅝, and are frequently 15 to 16 feet long. The weight and size of heads shoes and dies has been varied accordingly. screens have been more thoroughly considered in connection with the fineness of ore crushed, and improvements have been adopted in mortar boxes. There is, however, as yet plenty of scope for improvements which will be instrumental in raising the efficiency. Several of the Witwatersrand mines are recording high standards of efficiency in their batteries, and it seems that a six ton duty will be recorded at no distant date.

The following figures show that several mines are approaching this figure:—Rose Deep (March) 5·96, Crown Deep (March) 5·77, Lancaster West 5·75 (March) and 5·93 (April During April the average mill duty for the forty-seven mines working was 4·90 tons per 24 hours.

Mining in British Columbia.

Since our last REVIEW the annual report of the Minister of Mines for British Columbia has been received. The report, which covers the year ended 31st December last, is much on the same lines as its predecessors, and, if somewhat dilatory in publication, presents in handy form considerable information concerning the work done in the various districts and mining camps of that province. Mr. W F. Robertson, the Provincial Mineralogist, summarises the year's progress as follows:—

The progress made by the mining industry of the province has, during the year 1902, been less marked than usual. If the statistics of production alone are considered, it would appear that no advance has been made, as the gross value of the mineral production for 1902 is less than that of the preceeding year, the first time that such a thing has happened since lode mining became an industry of the province. While it is necessary to face this fact, it is also necessary to learn to what cause the fact is attributable, whether such causes are permanent or temporary, and whether they are removable or not. The diminished production is not due to any failure in the mines themselves, for no wide-spread failure has occurred, and, as a matter of fact, the mines are in a better condition than they were a year ago. The adverse conditions affecting the output appear to have been different in the various branches of the industry, but, as is the way with misfortunes, they came not singly.

The placer mines showed in 1902 an increased production over the previous year of about 10½ per cent. This is an exceedingly good showing, but is not nearly as good as it would have been had not the rainfull for the year been exceptionally light, causing a shortage of water supply, which sadly diminished the output of the hydraulic mining companies. This shortage of water is, however, only a temporary trouble, and should disappear with another year.

In the coal mining branch of the industry, the Coast collieries have had their principal market, California, invaded by fuel oil produced in that State itself, and yet, although this competition has come upon them suddenly, they have been able to dispose of within 8 per cent as much coal as last year, and a greater amount than in any year previous to 1901. The Crow's Nest collieries had an unlimited market open to them, but were met with, first, an explosion which crippled their principal mine, followed by strikes which diminished the output, causing the production for the year to be only about half what it should have been, and undoubtedly will be next year. Despite all this, the coal industry about holds its own, but, like the "placer," did not make that advance which the conditions of the mines and market would have justified.

The lode mining of the province has been the branch most sorely beset, and this not owing to any failure of the mines themselves, but to the unprecedentedly low market price of metals which has prevailed during the entire year, beginning, as it did, in the last month of 1901, while it is only in the early months of 1903 that the market has begun to recover. To realize what this drop in the market really was, it is necessary to make a direct comparison, as follows:—

Taking the average value for the whole of each year of the various metals, as quoted on the New York Metal Exchange, we find:—

	1901	1902	
Copper.....	16.11	11.62, a decreased value of	27.3%
Silver.....	58 95	52.16, " "	11.5%
Lead (in bond)...	2.165	1.94, " "	10.4%

Now these decreased percentages of market value represent just such a depreciation, as compared with the previous year, in the gross value of the mineral produced, namely, in the gross revenue of the mine, and such depreciation has in many cases wiped away, temporarily, any profit that there may have been in the enterprise. For example, a copper ore marketed in 1901 would have earned a net profit of 27.3 per cent. above all working expenses; if sold in 1902 it would have made no profit, merely paid expenses. With profits so diminished, the mine owner produced and sold as little ore as he could afford to, confining his efforts to development, and leaving his ore in the ground until such time as the market should improve, as it was bound to do soon; in fact, at the present writing, the rise in the market price is marked. This drop in the market values of the metals has had a double effect on the statistics, inasmuch as it has reduced the value of such ores as were mined and has constrained the miner to restrict his output. The actual statistics of the mineral production

are fully set out in tabular form in the preceding pages, but it may be advisable to briefly explain what these tables show.

Table I. summarises the total mineral production of the province up to the end of 1902, and shows what amounts of this total are to be credited to the various mineral products. The wealth thus created by the mineral industry amounts to the grand total of $189,728,538, of which some $86,677,415 was derived from gold—the chief product of the province—and $58,989,572 from coal and coke, with silver and copper following next in order of importance

Table II. shows the amount which has been contributed each year to the making up of the grand total, and illustrates the growth of the mining industry as far as statistics can. The percentage increases for each year over the preceding year have been—starting with 1896—33 per cent., 39 per cent., 4.33 per cent., 13.66 per cent., 31.8 per cent., and in 1901 23 per cent. For 1902 we have for the first time to record a decrease in value, and happily not a very great one, amounting to $2,600,000 as compared with 1901. This decrease is largely due to the lower market values of the various metals, as will be seen by referring to Table III,. in which if we were to credit this year's output at the prices prevailing in 1901, the decrease would nearly disappear, being only $565,742.

Table III. gives in detail the amount and value of the various mineral products for the last three years. As compared with the previous year, the production of 1902 shows, as to market values, for—

Placer gold	an increase of	10.4	per cent.
Lode gold	"	12.4	"
Silver	a decrease of	32.7	"
Copper	"	25.0	"
Lead	"	58.8	"
Coal	"	4.3	"
Coke	an increase of	0.71	"
Other metals and materials	"	15.0	"

It is to be noted that the copper products shows a decrease as to value on account of the low market price of the metal ruling during the year, but that, as regards the quantity of fine copper produced, the year 1902 really shows an increase of 7.4 per cent. over the previous year.

Table IV. shows the gross value of the mineral production of the various mining divisions and districts for the past three years, and illustrates the growth of productive mining in the various parts of the province. It is especially interesting to note how the output of the placer districts varies from year to year (caused by the weather), and how quickly the Boundary district has risen to prime importance.

Table V. shows the amount of placer gold that has been produced each year since its first discovery in British Columbia, in 1858, to date. The sum total of gold so produced amounts to $64,627,683.

Table VI. shows the yearly of the lode mines of the province since 1358. Lode mining or "quartz mining," as it is commonly called, has not made as good a showing as was anticipated during the first part of the year, a fact which must be admitted, although the reasons already given may be sufficient explanation. The drop in the price of metals has been already referred to, while the position of silver-lead producers will be spoken of in more detail later. The tonnage of ore mined in the province has been greater, amounting this year to 998,999 tons, as against 920,416 mined in 1901, an increase of 8.6 per cent.

This great increase is entirely due to Rossland and the Boundary, more particularly the latter, in which district 521,402 tons of ore were mined and smelted.

The following table shows the number of mines in each district that shipped ore during the year 1902, with the number of men employed:—

Table Showing Distribution of Shipping Mines in 1902.

	No. of Mines Shipped over 100 Tons in 1902	No. of Mines Shipping	Men Employed in these Mines		
			Below	Above	Total
Cariboo	1	....	3	2	5
Cassiar :					
Skeena	1	1	8	10	18
East Kootenay :					
Fort Steele	1	1	30	17	47
Other Divisions	4	1	23	8	31
West Kootenay :					
Ainsworth	12	5	75	44	119
Nelson	14	10	246	170	416
Slocan	40	25	476	161	637
Trail	10	8	710	281	991
Others	9	2	80	39	119
Lillooet	4	1	12	17	29
Yale :					
Grand Forks, Kettle River and Osoyoos	18	13	373	234	607
Yale, Ashcroft, Kamloops	2	1	24	11	35
Coast	8	7	159	132	291
Total	124	75	2219	1126	3345

It will be seen from this that the number of mines shipping over 100 tons is 3 less than in 1901. Of the non-shipping mines the statistics are very incomplete, as few of them report to the Department and most have no representatives who can be found to give details as to the number of men employed, etc. Returns have, however, been secured from 44 non-shipping mines, and these employed a total of 342 men; 158 above ground and 184 below ground.

COAL.

The coal mining industry has held its own during the year 1902. There is not an increase in production over 1901, but there is no appreciable decrease, and, considering the difficulties with which this industry has had to contend during the past year, this may be considered an extremely good showing. The gross output of coal for the the year 1902 was 1,641,626 tons, of which 244,232 tons were converted into coke, leaving a net output of 1,397,394 tons of coal and 128,015 tons of coke. This represents a slight decrease in the coal output and a slight increase in the coke production, as compared with the year 1901, the loss on the one hand just balancing the gain on the other. Of this net output Vancouver Island collieries produced 1,173,893 tons of coal and 20,178 tons of coke, a decrease of 87,851 tons of coal and an increase of 4,780 tons in coke. When it is considered that fully 75 per cent. of the output of the Coast collieries was exported to California, and that this last year has seen the introduction in that State of petroleum fuel to so great an extent, it is remarkable that the falling off in this market should only have diminished the coal output of Vancouver Island some 8 per cent. The increase of 30 per cent. in the coke output of the Coast has only partly been occasioned by the starting of two smelters on Vancouver Island, as it will be seen by a subsequent table that the greater proportion of the coke produced from the Island collieries was exported. As has been noted before, the output of the Coast collieries is limited only by the market, while with the Crow's Nest Pass collieries the market is in advance of the facilities of output and transportation.

The Crow's Nest Pass collieries produced in 1902 some 223,501 tons of coal for use as such, and manufactured, from an additional 170,460 tons of coal, 107,837 tons of coke, being a slight increase over last year as to net coal output, and a slight decrease as to coke production. These collieries have been exceedingly unfortunate during the past year, as in the month of May, just as the rush of spring shipments was on, a serions accident occurred at the principal mine,

the Coal Creek colliery, which has been practically unproductive since, pending repairs and alterations in connection therewith. Following this, there have been one or two "strikes," which have greatly reduced the production of all the three mines operated by the Crow's Nest Pass Coal Company. The company's plant at the Morrissey colliery, which will in all probability be the greatest producer of these mines, was only completed lately, and the output during the year 1902 was small. There is but little doubt that if the company had had a year of uninterrupted work the output would have been at least doubled.

Shortages of both coal and coke have occurred during the past year at the smelters and mines supplied by the Crow's Nest Pass Coal Company, and so frequent have these shortages been as to seriously interfere with the running of the smelters, and, consequently, of the mines. Sales of coal were as follows:—

	Tons Coast.	Tons Crow's Nest.	Tons Total Prov.
Sold for consumption in Canada.....	310,765	111,701	422,466
" export to U.S.....	673,524	101,776	775,300
" " other countries.....	1,508	.....	1,508

The sales of coke were:—

	Tons Coast.	Tons Crow's Nest.	Tons Total Prov.
Sold for consumption in Canada.....	3,998	81,073	85,071
" export to U.S.....	12,016	26,764	38,780
" " other countries.....	.....	.....	.....

The additional transportation facilities provided by the completion of the Great Northern Railway into Morrissey, giving direct communication with the United States, coupled with the fact that the import duty into the United States of 67c. per ton has been removed, would seem to guarantee a very much increased output for the coming year.

GOLD.

The total or combined placer and lode gold output has this year, as usual, maintained an increase, having reached the total value of $5,961,409, the highest gold output ever made by this province, being an increase over 1901 of $642,706 or about 12 per cent. This increase has been shared in equally by the placer and the lode gold mines of the province.

The placer gold output for 1902 was $1,073,140, an increase of $103,040 over the preceding year. It is to the small partnerships and individual miners that is due, not only the present increase, but the prevention of what promised to be a serious deficit, inasmuch as the large companies have this year made comparatively poor outputs, for reasons explained later. As an illustration of this fact, the Gold Commissioner of Atlin reports that out of a total sum on which royalty was collected of $261,985, some $190,652 was produced by the small or individual concerns, and only some $71,162 was produced by the larger companies. This statement is even stronger than appears on the face of it, inasmuch as it is far easier to collect royalty from companies, and it is highly probable that as much as $100,000 produced by individuals escaped taxation.

This is also equally true of the Cariboo District, for in the Omineca Division only small concerns were at work this past year of 1902, yet the output of gold was about double that of 1901. In the Cariboo Division there were produced some $60,000 over the previous year, and this amount is certainly due to the small concerns as the big companies made little production during 1902. There are in this division, however, a number of small companies or partnerships, the efforts of which have been very successful during the past year. In the Quesnel Division, in which the yearly output is chiefly made up from the product of one or two large companies, there has been this year a decrease of about $80,000, due to the falling off in production of these companies, while the product of the individual miner remains about constant.

As to the placer gold output of the remainder of the province, it is almost exclusively produced by partnerships or individuals.

HYDRAULICING.

The past year has not been a successful one for the hydraulic miner, from causes entirely beyond the control of man. For instance, the largest hydraulic company in the province, the Consolidated Cariboo, this past year had only water sufficient to run 66 days and to move 690,442 cubic yards of earth, producing $61,395 in gold; while the previous year there was water for 104 days, and 2,420,288 cubic yards were moved, producing $142,274 in gold. The water-shed from which this water was collected was the same as in the previous year, and it is simply a case of insufficient rainfall. The rainfall for some three or four years past has been getting less each year, although it must be pointed out that this state of affairs is not expected to continue, for it seems that such occurrences run in cycles, and that a period of greater rainfall is now almost due. The output, then, of such a company as this, with a given plant, seems to be very nearly in direct proportion to the precipitation of the water-shed.

In the Atlin District, the report of the Gold Commissioner as to gold produced indicates that the hydraulic companies have not yet really settled down to business, and the hope entertained of a large output from this quarter is again deferred for another year. The Thibert Creek Company's property in the Liard Mining Division gave promise this year of being a considerable producer, but this hope was frustrated by a tremendous clay slide, which practically buried the pit. This slide has now been removed, and the gold should be recovered next year.

The auriferous black sands found on the Coast at various points have not been productive this year, for reasons unknown.

DREDGING.

Dredging for gold has not received the usual amount of attention this past year, only two or three dredges having been at work. On the Quesnel a prospecting dredge was operated for a portion of the year with good results, but made only a small output. Another dredge is reported to have been prospecting on the Thompson river, with what results has not been learned. At Lytton, the old Cobeldick dredge has been working. Here Mr. Turner, the director who was sent out from England to investigate for the company the working of the dredge, made the discovery that, of the gold dredged up from the bottom, less than 10 per cent. was recovered on the tables, the remaining 90 per cent. going off again with the tailings, although the gold-saving appliances on this machine were about the most complete of any in British Columbia. It certainly appears as though here is the point of failure in most of the dredging operations in British Columbia, and the realisation of this fact should soon lead to the removal of the difficulty, when, only, will this industry become the success which the conditions seem to warrant.

LODE GOLD MINING.

Lode gold mining has this year made a production of $4,888,269, being an increase of $539,666 over the previous year, or about 12½ per cent. This increase is attributable to the greatly increased tonnage of the mines of Trail Creek and the Boundary. The increased tonnage has brought with it lower values per ton of ore mined, but this has been more than compensated for by the cheaper smelting, mining and transportation rates thus rendered possible. Gold is the only

metal which may hope to escape the fluctuations of the market, and it is the gold contents of the ore that has enabled most of our copper mines to continue production in the face of a 27 pe. cent. drop in the price of the latter metal.

The product of lode gold mining in British Columbia has shown the steadiest and most regular increase, and this product is the most valuable which the province has It can, however, not be classed as even a separate branch of the industry of mining, inasmuch as the gold is mostly found in combination with other metals, such as copper or silver. A certain amount of this production is derived from stamped milling, etc., but chiefly it is due to smelting.

The following shows approximately that the gold has been derived from :—

Direct smelting of copper-gold ores	4,232,948
Combined amalgamation and concentration	655,321
Total	4,888,269

SILVER AND LEAD.

The total amount of silver produced by the province in 1902 was 3,917,917 ounces, valued at $1,941,328, a decrease as compared with the output of 1901, but practically the same as that of 1900. Of this total amount about 25 per cent. was mined in association with copper, while the remaining 75 per cent. was mainly derived from the silver-lead ores of the Slocan District and of East Kootenay. Included with the Slocan ores are the "dry ores" from the Slocan city division, which, while as yet forming a small proportionate part of the output of the district, are still ever increasing in volume and importance. Their importance consists in supplying to our local lead smelters an ore with which can be utilized the galena ores which are so plentiful in British Columbia, thus rendering the smelters the better able to meet foreign competition. The decrease in the silver production has been entirely confined to the silver-lead ores, and the drop in the output of this class of ore has been very great. In the Slocan the tonnage has decreased by 4,340 tons, with 1,000 tons further decrease in the Ainsworth Mining Division. It will be noted that the ore shipped from the Slocan Mining Division this past year is higher grade than in 1901, implying that the mines which have diminished shipments are the low grade properties. In the Fort Steel Mining Division, which for the last two years has been the heaviest producer of galena ore, this condition of low silver tenure is most extreme, since the silver occurs only to the extent of 1/3 to 1/4 ounce to the per cent. of lead. Here the mining of galena has been practically suspended, since the output of 1902 was only 3,600 tons as compared with 63,000 tons of the year previous (1901), and 87,000 tons in 1900. This is not due to the mines nor to local conditions, but is entirely owing to the condition of the market for such lead ores low in silver.

What relief may be had from this condition is very much a question, and even among the lead mine owners there is a wide difference of opinion on the subject. To the writer it seems that relief from that condition will come permanently only with the establishment and operation of smelters near the mines, at a central point, together with a customs refinery, in which the silver may be separated from the lead and shipped quickly to market, while the lead, which forms only about 30 per cent. of the value, but 99 per cent. of the weight of the crude bullion, finds its way by the cheapest, though slowest, freight to the most available market, which will probably prove to be the Trans-Pacific and which yet requires to be developed.

The lead production of the province in 1902 was 22,536,381 lbs., only about half of that of last year, owing to the suspension of the East Kootenay lead mines, but greater, nevertheless, than the production of 1899.

COPPER.

It was remarked last year that the particular feature of interest in 1901 was the great increase in the copper production of the province, and it might be said that the same feature remains of prime interest this year, or, perhaps, the feature of interest might be more correctly stated as the increased and increasing tonnage of copper ores, of extremely low grade, which are being treated with apparently a profit, at the various Boundary smelters. The interest which is being taken in the successful working of these ores, is more than local, and is causing much attention to be turned to other bodies of ore so low grade as to have been considered valueless. The output of copper for this year was 29,636,057 lbs., an increase of 2,032,311 lbs., or 7.4 per cent. over the preceding year, but owing to the drop in the market price of the metal, the value of the year's output was $1,000,290 less than was that of 1901. The Boundary still yields the greater part of the copper production, with an output of over half a million tons of ore, while Rossland makes the next largest output. The following shows the districts from which the copper output has been obtained this year :

Boundary	14,955,582 lbs.
Rossland	11,667,807 "
Coast	2,496,681 "
Nelson	491,144 "
Other Districts	24,843 "
Total	29,636,057 "

IRON ORE.

A good deal of iron ore has been mined on the coast during the past year, but the only shipments made have been from Texada Island, from which some 6,290 tons of magnetic iron ore, running over 50 per cent. iron, were sent to the iron furnace at Irondale, Washington. From the iron mines at Cherry Creek, near Kamloops, some 3,727 tons of magnetite were shipped to Nelson, for use there in the smelter as a flux.

OTHER MINERALS.

There was some $190 worth of platinum produced from the Similkameen District this past year. This is the only locality where the metal is saved. The black sands of the Quesnel River, Cariboo District, have been proved to contain considerable quantities of both platinum and osmiridium. Analysis of these sands will be found in the report on the Cariboo District, but so far little attention has been given to the saving of these metals, which are not retained by the ordinary riffled sluice but require under-currents or some similar appliance.

This department has recently received samples taken from a tunnel of a mine in the Cariboo District, and on examination these samples were found to contain tin in very distinct metalic particles. The rare occurrence of tin in the metalic state is recognized, and, while no doubt is felt as to the good faith of the sender of the sample, the discovery will require to be further investigated.

BUILDING MATERIALS.

Of building materials, under which designation are included stone, brick, lime, cement, together with fire clay, fire brick, drain pipe, etc., there are no returns available, and the amount credited to these materials has to be estimated. This has been done as carefully as possible. There are local lime quarries and kilns in almost all parts of the province, while on the coast there are a couple of companies making a most exceptionally pure lime from crystalline marble, and this has a considerable foreign sale. Clay for red brick is found everywhere, and local yards supply the local demand. The granite and sandstone quarries situated on the islands of the coast are splendidly located as regards transportation by water. Fire clay, bricks, drain pipe and tiles are manufactured on Vancouver Island and find a ready local market in the province.

GENERAL DEVELOPMENT OF THE YEAR.

The following is only a general review of the development of the year, the details of the work done in each district being found in the body of the report under the proper heading :—

In the Atlin District the past season has been very satisfactory, inasmuch as it has been demonstrated that the life of the camp is not to be measured by the life of the placers in the creek bottoms. The higher run of gold, noted in the report for 1900 as occurring under the benches in the triangle between Pine and Spruce Creeks, has, after thorough prospecting, been opened up by tunnels and shafts, and a number of claims have been worked as drifting propositions pretty well throughout the length of Pine Creek above Stephendike, including many of its tributaries, and also on Spruce Creek. Between 600 and 700 men have been engaged in mining during the summer and about half that number will be engaged during the winter on Pine, Gold Run, Otter, Spruce and Boulder Creeks. In certain places where the topography admitted of it, the high channel has been attacked by hydraulic methods, with very satisfactory results.

In the Bennett Division there are no placer claims, and little progress has been made on the mineral locations, with the exception of those on the Big Horn River.

The placer mines of the Chilkat District have failed to produce satisfactory results. The mineral claims of Rainy Hollow are still being prospected, but are of too low a grade to admit of being worked at such a distance from transportation.

Of the Teslin Lake Division there is nothing special to note; prospecting is being done in the division with occasional reported finds which seem most promising, but work has not proceeded sufficiently far to tell what the properties may be worth.

In the Stikine Division there are no new developments. A find of coal is reported on Lake Tahltan, and samples of the same, which have been received by this department, indicate it to be a good lignite but not a bituminous coal.

In the Liard Division tnere has been some activity in the neighborhood of Thibert Creek, where two or three companies are at work, but only one of these is sufficiently far advanced to be expected to produce as yet, and this company has suffered from a clay-slide which filled the hydraulic pit last summer, doing however, no very serious damage further than wasting the season.

In the Skeena Division there has been very active prospecting going on.

On Observatory Inlet and on the northern portion of the Portland Canal several properties have been worked, with considerable promise of ultimate success.

On Princess Royal Island certain properties have been developed and have made shipments of ore which have given surprisingly high assay returns.

Of the claims on and near Bornite mountain, on the Skeena River, very little news has been received this year.

On Queen Charlotte Islands, the coal fields, long known to exist have been receiving some attention, while in the southern islands of the group information has been obtained that very promising discoveries of bornite copper ore have been made, which received some development during the past season and will be thoroughly investigated this coming year.

No new development has occurred in the New Westminster Division. The Howe Sound copper properties have remained dormant, the low price of the metal not being a stimulant to new copper enterprises.

The copper properties on Texada Island have been doing well; the Marble Bay has shipped regularly and still has a good showing of ore in the bottom levels. The Copper Queen, Cornell, Loyal, etc., which had suspended shipments, were taken up under bond by Mr. Vaughan-Rhys, who, after much work, has been fortunate in proving up extensions of the old ore-bodies with depth, and has also been fortunate in finding exceptionally good gold values in a quartz vein just behind the Cornell engine house.

The Mt. Sicker camp has done little actual producing this past year, as each of the two important properties on this hill, the Lenora and Tyee, has been awaiting the completion of a smelter to treat its ores, and so has confined its efforts to development. As soon as the Crofton smelter was ready to take the Lenora ores, that mine got into financial troubles, since which no mining has gone on, and the Tyee smelter did not make returns until January of 1903, so that the results do not appear in 1902.

On the Alberni Canal the two copper properties have lain dormant since the drop in the value of copper, and it is not likely that shipments will be resumed until this metal has reached a higher price. As these properties carry little or no precious metals in connection with the copper, the ores feel the fluctuations of the copper market more severely.

The iron mines on Barkley Sound have received considerable development, but as yet no shipments of ore have been made.

On the West Coast of Vaucouver Island certain copper properties on Quatsino Sound have been opened up, equipped with suitable shipping facilities, and have begun making shipments of copper ore to a local smelter. Several other properties in this district have been under development, and it is reported that the results obtained have been very satisfactory.

In the Fort Steele Mining Division the most important mining operations are, of course, those of the Crow's Nest Pass collieries. These collieries have held their own this past year, and but for a sertous explosion and several strikes would have undoubtedly doubled their output.

As was noted last year, the condition of the lead ore market was such as to render the mining of lead ores, low in silver, of little or no profit. These conditions have prevailed to such an extent as to practically shut up every galena property in this division. The Trail Lead Refinery has been a success on a small scale, but has not yet come to the assistance of ores of the lower grades. The question of relief from the conditions has been laid before the Dominion Government, which has the matter now under advisement. The Slocan has suffered similarly, owing to the conditions of the lead ore market, but to a less extent, as the silver contents of the ore is higher. The development of "dry ores" in this district is distinctly promising.

In the Nelson Division the mines in the neighborhood of Ymir have maintained their usual output. The Yellowstone has been practically shut down, but a couple of new mines have been opened up in ts place.

The Silver King (Hall Mines) was shut down by the company, but has been taken under lease by the former superintendent, Mr. Davys, who seems to have been fortunate in finding further ore-bodies.

In the Trail Mining Division (Rossland) there were this year two less mines shipping than in 1901, but the output has increased from 283,360 tons to 329,534, an increase of 46,174 tons. This advance has been obtained chiefly through the increased shipments of the Le Roi and Le Roi No. 2. The Centre Star and War Eagle Mines only worked about three or four months out of the year, having been practically closed down the rest of the time for some reason. The average grade of the ore of the camp has been maintained throughout the year. The return this year indicate the same gold assay, a reduced

silver assay (which was never very important), and a slightly higher copper assay than last year.

The Boundary District has again this year been the centre of general interest. The immense size of the ore-bodies of the district has been recognized, and it has also been admitted that they are all exceedingly low grade, so much so that it has been a serious question whether they could be worked to a profit.

That this problem has been solved is indicated by the immense smelting plants of the Granby B. C. Copper (Mother Lode) and Montreal and Boston Companies, where the tonnage of ore treated has been so great as to reduce the costs of mining, smelting and marketing to a minimum. The very drop in the price of copper was met by an enlargement of the plants, and in one case a Bessemer converter plant was erected to treat the matter produced in the district.

These companies all claim that they are, and appear to be, making both ends meet on 11.6c. copper. Should the metal rise 3c. per lb., which it probably will, it would mean an additional earning to these companies of over half a million dollars a year. The state of the Boundary District does not differ from that described last year in these pages, but the condition of affairs has been prolonged and emphasized.

In the Similkameen prospecting has continued to be followed with success, but productive mining in that section will not be in advance of railway transportation.

Nova Scotia Collieries Limited.

This company has been formed to acquire certain mining leases conferring the right to win coal under areas covering twenty-six square miles in the County of Inverness, Cape Breton, Nova Scotia. The land is alleged to contain "many millions of tons of coal," and the original vendor and another are reported to have offered by cable, to enter into a contract to take 200,000 tons of the company's coal annually for ten years, at prices which it is assumed would yield the company a profit of £30,000 per annum. We do not know what this reported offer may be worth, but from an examination of the contracts, We venture to think that it would not be much. Mr. Ira Taylor, of New York, (the original vendor), is selling the land to the promoting syndicate (the B.D.L. Syndicate, of Star Chambers, Moorgate Street, E.C.), for £90,000, which would be a ridiculously low price if he were in a position to place coal contracts with this company which would produce to it £30,000 in profits annually. Then the B. D. L. Syndicate is transferring the undertaking to the company for £142,500 "wholly or partly in cash, at the option of the directors." Thus they have arranged to make a profit of over £50,000 on the transaction, the company being saddled with the preliminary expenses. But they are not content with this. They are going to take another £10,000 (partly in cash and partly in shares) for guaranteeing to obtain subscriptions for 50,000 preference shares (the minimum subscription on which it is proposed to go to allotment). That is to say, they have arranged to pocket £1 for every £5 received on these preference shares. The whole scheme is undoubtedly an excellent arrangement for the intermediaries, but it is one which is calculated to turn out disastrously for the members of the investing public who may be foolish enough to subscribe to it.

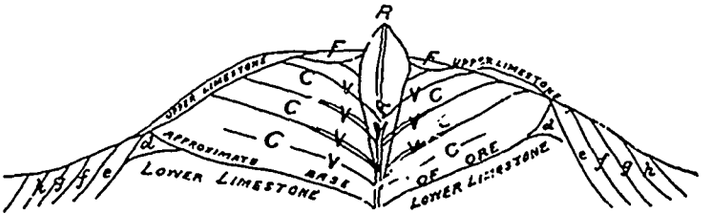
Mine Development Methods.

By B. J. Forrest, C. & M. E., Broad Cove, C.B.

Prospecting.—In coal formations have found outcrop indications first to prove. Secondly, drifting from outcrop if this exists; if not, thirdly, boring to or through the carboniferous measures and locating and finding dip, strike and contour, and number of seams, and if possible direction and throw (up or down) of faults, with a view of sinking to and opening out from dip side of measures or faults, and reducing future cost of development and working, such as getting and haulage of coal, pumping of water, intersection of faults, etc.

In iron formation, when stratified, similar methods will obtain, and in more stratified formations, survey with dip-needle, plane-table, aneroid (and cacheometer, if necessary), to locate strike and dip and contour; then area and thickness, by drifting, blocking and drilling. Drifting, the generally more expensive, I have generally found more trustworthy as regards testing of capacity and areas of deposits; drilling, though cheaper, is not so reliable or certain of satisfactorily proving iron formations or deposits, such as are commonly met with in Ontario and Nova Scotia, *e.g.*, magnetite interbedded with green schists, diorites and felsites, titaniferous magnetites mixed with eruptive rocks and conglomerates.

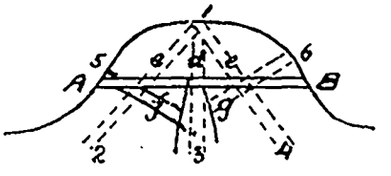
The upper and lower Cambrian measures, so far as I have been able to observe, appear to have the largest and most easily workable or conveniently placed bodies of ore for economical working or development, the ore-bodies or deposits occurring in post-glacial formations in Ontario appear to be more irregular than those in the Cambrian measures though this supposition requires further investigation as there appears to exist some intermediate iron formations between the Huronian and Cambrian series. The Bilbao iron ore formations in north of



Sketch of Bilbao, Triano, Iron Ore Formation.

Observations.—R. Rubio ore, cindery honeycombed appearance, containing about 56 per cent. metallic iron, with a large quantity of fireclay and silicious earths mixed with it. V. Vena, or soft vein of ore, running through centre of ore bodies, very rich soft ore averaging 65 per cent. of metallic iron. C. Campanil, or main body of ore, good hard hematite, about 60 per cent. metallic iron; these ores average about 0.02 to 0.08 phosphorous and from 2 per cent. to 8 per cent. silica. *d.* Siderites, in pockets and layers. *e, f, g, h.* Schistous grits, sidente, limestone and sandstone. F. Fireclay.

Spain (of hydro-thermal origin) are found associated with upper and lower cretaceous formations and deposits of limestone, clay and sandstone conglomerates—the Triano or central formation having approximately the following transverse contour (see sketch). In prospecting with drills the probabilities of intersection in a pockety or irregular bedded formation of iron ore vary considerably with class of deposit, lode, bed or spur, *i.e.*, the chances of satisfactorily proving extent area or capacity of irregularly stratified deposits vary more or less, as follows, *e. g.*, see sketch:—



1 to 2 drill holes through lode or seam *c*.—Vertical holes, depth 40% to 100%.
1 to 3 " " " *d*.— " thickness 0% to 50%.
1 to 4 " " " *e*. } At angle of 45° (right and left)—depth and
5 to 3 " " " *f*. } thickness from 20% to 30%, or the mean
6 to 3 " " " *g*. } average of chances of proving lodes by
A, B—Drift. [drill would be from 40% to 60% of actual areas.

By drift A, B—thickness 100%, depth 0% to 100%. By drift at angle of 45°= 40% to 100%, and proportional to depth below summit and level of line *A, B*.

The advantage of drifting in like deposits is that not only can strike, dip and capacity be proved, but class and extent of bed and hanging rock and adjacent strata—sampling, water-feed, etc. The

percentage of extent or capacity proved would also depend on amount or extension of cross and vertical drifting, drilling, sinking and blocking carried out from said level, a considerable extent of which might be proved by drilling of breast and flank holes from said levels.

Comparisons of Cost of Proving and Testing Deposits.—This would depend greatly on class of formation, extent of blocking, drifting and drilling carried out. The ratios of cost would vary—*e.g.*, drilling by diamond drill from $5 to $8 per lineal foot, increasing with length, depth and size of hole.

Shafts.—Would also vary with depth and area from $6 to $10 per lineal foot, increasing with depth, amount of water struck, and cost of winding, haulage and ventilation.

Drifting and Blocking.—From $6 to $9 per lineal foot, increasing with area, amount of propping or steining, distance and dip from shaft or main drift, length and angle of haulage, winding, ventilation, and water struck. Cross drifting and blocking from main shaft or level would cost from 15 per cent. to 20 per cent. more under similar conditions.

I have generally found drill work more satisfactory or suitable in testing of coal areas or similar formations, but not so effective in proving irregular lodes or deposits, except in those more extensive and regularly stratified, such as found in Newfoundland, Spain, Portugal and South America.

Developing.—If possible and convenient, and extent of overburden, spurs, faults or stripping too thick or interbedded, open cast cut or quarrying is preferable to mining, providing lifts and length and depth of working faces and levels are at a convenient and economical working height and distance, in relation to gravity and point of delivery, and the disposition of mining and transporting gangs, plant and machinery, such as air compressors or steam drills, crushers, transporting plant, tracks, chutes, bins, etc, and if conveniently situated and apportioned to area, length and output from working faces or levels, and number of men that can be economically employed on each face or working level and their position with regard to point of delivery, classification of ore, gravity, tracks, etc.

System of Transport and Haulage.—If distance short and gravity available, chutes and inclined planes would probably serve the purpose. If distance long and contour of ground regular, endless, or tail-rope, or Lidgerwood cable systems might serve. If distance long and contour of ground irregular or very steep and undulated, wire cable-ways, steam or electric trams or railways would serve better, and if fluvial transport available would be cheapest.

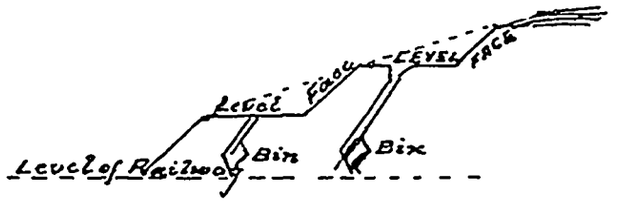
The approximate rates of cost of above named systems would vary more or less as follows, viz.:

Inclined Plane.—Transport, from 10 to 16 cents per ton mile. Cost, from $10,000 to $15,000 per mile.

Endless and Tail-rope Systems.—Transport, from 12 to 17 cents per ton mile. Cost, from $12,000 to $15,000 per mile.

Wire Cable-ways.—Transport, from 12 to 17 cents per ton mile. Cost, from $10,000 to $15,000 per mile.

Varying proportionally with single and double lines, self-acting or if driven by steam or electric power, and contour of ground traversed,

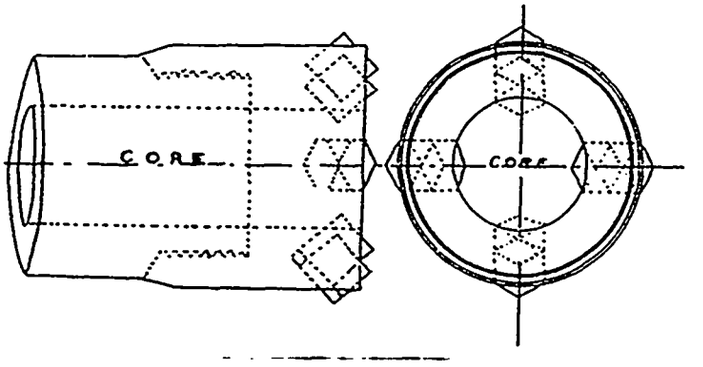


with the advantage that it is easily removed and re-erected if necessary. This system is generally suitable for mines and quarries difficult of access and working and of doubtful output and capacity. If mines or deposits are proved to be of large capacity and productive, would recommend running railway cars right into and under main working levels and faces, thus reducing cost of handling and transport of ore. If water transport available and point of delivery great, cost would be still less.

Drilling Plant and Machinery.—This depends on class and position of ore and work; generally compressed air is preferable to steam or hydraulic power in deep or irregular open-cast or underground work, shafts and drifts, on account of drainage, ventilation and non-formation of water, damp, heat and gases, loosening of cover and swelling of bottom; of top, bottom or side stripping, when sinking, drifting or blocking.

Class of Drill.—This depends on class, position and nature of ore and work to be dealt with, and whether under or over ground, vertical or under-cutting or holing work is to be carried out. The diamond drill, if true (not faked) Brazilian carbonates are used and carefully set in suitable bits, and experienced or skilled men employed, is well suited for any class of deep vertical or flank holing in hard irregular formations; though the Calyx drill has done some first-class work in hard rock, and the renewal of bits is not so costly and risky. With a view to reduce cost of replacing diamond drill bits, I have experimented a little with corundum crystals, which are next in hardness to diamonds, (viz: diamond, 10h; corundum crystal, 9). I think a fair percentage of boring done by diamond drill might be done with them; the main points to solve are the size and pitch, and setting and cutting angles, and fixing metal of bit and crystals used. So far, my experiments lay in the following lines (see sketch):—

DRILL BIT (FULL SIZE)



Nickel Deposits in New Caledonia.

By MAJOR R. G. LECKIE, Sudbury Ont.

New Caledonia is a large island lying in the Southern Pacific between 20° and 22° south latitude and 161° and 164° east longitude. Its greatest length, 248 miles, runs from northwest to southeast and its width at the narrowest point is a little over 30 miles.

The coast line is very irregular and is protected almost everywhere by a barrier of coral reefs more or less distant from the shore. Frequent openings through these reefs lead to good harbours and safe anchorage for vessels of the largest class.

The interior of the island being mountainous and roads very limited, transportation of goods and passengers is carrid on chiefly by small coasting steamers which find comparatively calm water behind the protecting reefs.

No systematic geological survey of the island has yet been made, and in this the Government appears to be unaccountably remiss.

The shipments of ores and minerals constitute fully one half of the total value of the island's exports, hence the development of the mineral industry is of the highest importance.

The gneises and mica schists of the older formation are strongly developed in the northwest and upon these rest the sericite and talc schists and crystalline limestone of the Silurian. The peridotite has overflowed these and in the derivative serpentine the ores of nickel, cobalt and chrome are found.

Dr. T. Sterry Hunt in describing the Canadian serpentines says: (Report Geological Survey of Canada, 1863, page 472) "The serpentines of the altered Silurian rocks in Eastern Canada, often form vast masses, almost without admixture. The almost constant presence of small portions of oxyd of chrome and nickel is to be remarked in the analyses, not only of these serpentines, but of the other magnesian rocks of the region." This description will also apply to the serpentines of New Caledonia, although they are more highly impregnated with these metallic oxides, than those of Canada, and both are characterized by the constant presence of grains of magnetic iron.

Olivine appears to be constantly associated with these ores in New Caledonia, Canada and Oregon But it also accompanies the nickeliferous iron of meteorites. Nordenskiold gives the analysis of a meteorite now in the Stockholm museum which contains 40.98 olivine. It was also determined in two meteorites which fell in Brazil as well as in that which fell in Kanzas in 1890.

Mr. F. Danvers Powers notes the presence of nickel in the olivine associated with the new Caledonia serpentines; "Certainly the nickel seems to favour the olivine, and that mineral on account of its numerous cleavage faces, is susceptible of attack." Dr. Sterry Hunt likewise remarks; "The olivine from this locality, like the accompanying magnesian minerals, contains traces of oxyd of nickel." So that the nature of the great serpentine band of the Eastern Townships, is in most respects identical with that of New Caledonia. Likewise the economic minerals found in both are the same; nickel, chrome iron and asbestos, but the latter in New Caledonia is too brittle and short in fibre, to be of any commercial value. On the other hand cobalt occurs in paying quantities in New Caledonia, but so far has not been discovered in the Canadian serpentines

In a paper read by Dr. A. R Ledoux before this Institute two years ago, he describes the occurrence of nickel ore in Oregon, under conditions precisely similar to those prevailing in New Caledonia. These deposits however cannot be compared in extent and richness with those of New Caledonia.

The rocks of New Caledonia have been subjected to severe seismic disturbances, in which the serpentines have been fissured and broken. This shattering has facilitated the disintegration and decomposition of the rock, into the cracks and crevices of which the original metallic constituents have segregated. From these the nickel ore of commerce is dug. Occasionally viens are met with having a width of from six inches to two feet but they are not found to be persistent in either length or depth. They are usually filled with boulders of the enclosing rock cemented together by a rather higher grade of the nickel silicate. In other places the ore forms a covering to the rock, which gradually gives place to the scattered seams, but in no place does the ore extend beyond a depth of from fifteen to twenty feet from surface.

Pisolitic iron occasionally forms a heavy covering to the ore. It yields when dried from 50 p.c. to 60 p.c. iron, 3 p.c. to 5 p.c. chromic oxide and is practically free from phosphorous and sulphur. Immense fields of this exist.

Mr. Thomas Moore, an accomplished chemist and metallurgist of Noumea, and Government Assayer, has made numerous analyses of these ores, which occur as a hydrated sesquisilicate of nickel, varying in nickel contents, as that metal is more or less replaced by magnesia, ferric oxide and alumina.

These ores were first discovered about thirty years ago by Mr. Jules Garnier and were shortly after named Garnierite. For some succeeding years attention was directed entirely to the green coloured ores and these were dressed up by hand to a value of 12 p.c. to 15 p.c. nickel. The brownish coloured, or what is locally called chocolate ore, has been thrown away as waste, but upon investigation it was discovered that this contained a large percentage of nickel and since then, it has constituted the bulk of ore shipped. The shipping ore is usually brought up to an average tenour of from 7 p.c. to 8 p.c. nickel, dry, that is after the hygroscopic moisture has been evaporated, which varies from 10 p.c. to 25 p.c. The following is an analysis of what may be considered a fair sample.

Silica	43.00	
Sesquoride of chrome	0.50	
Peroxide of iron	14.00	
Alumina	1.50	
Magnesia	21.00	
Protoxide of nickel	9.00	(metallic nickel 7 p c.)
Protoxide of cobalt	0.25	
Moisture	11.00	
	100.25	

Large quantities of much higher grade ore are mined, but these are mixed with the lower grade mineral to maintain something like a general average.

The rugged mountain range which forms the backbone of the island rises into peaks over 5,500 feet in height which are composed of serpentine and the original rocks from which it has been derived. Ore is not found on the higher elevations but on the flanks and spurs which descend to the coast on either side.

From the nature of the deposition of these ores, they are spread over a large area, but confined to a comparatively shallow zone; seldom going below an average depth of from fifteen to twenty-five feet. Therefore the extent of these individual deposits can be approximately ascertained by costeans and shallow trial pits. The ore occurs in a more concentrated condition near the tops of these mountain spurs. Hence the invariable custom followed in New Caledonia of attacking first the upper parts of these deposits, as they can be more readily worked and yield a larger proportion of shipping ore.

This is a practice objectionable in two ways, as, at the beginning, the mine is robbed of its richest ore, which ought rather to be worked proportionately with the lower grade mineral. Then in operating, the waste and debris are thrown down below. where frequently these have to be moved again in order to open up the lower and poorer benches. It is evident that the proper way to work these ore deposits, is to prospect the ground thoroughly, then remove all available ore from the lowest bench first, after which the waste from the next bench above could be thrown into the lower excavation, and so on with each ascending bench or terrace. A certain proportion of the richer ore from the upper part of the deposits, could be mixed with the lower grade, to bring up the average tenour of shipment.

In mining these ores no blasting is required, as the shattered and decomposed rock yields readily to pick and shovel. The ore is gathered into piles, then sampled and analysed. A ticket is put on each pile showing its grade, so that when shipped a proper mixture may be made, ensuring an average of not less than 7 p.c. nickel The waste dumps usually carry 3 p.c. to 4 p.c. nickel, but from the nature of the ore, no mechanical means has yet been devised by which the metal can be saved. Smelting is the only successful method of so doing, but the cost of fuel, flux and labour limit this treatment to ores yielding not less than 5 p.c. nickel, while it does not pay to ship ores of less than 7 p.c. tenour.

The mines of Le Société Nickel have been worked for nearly 20 years and apparently the present output can be maintained for many

years. The International Nickel Company has acquired some extensive and valuable properties near Bouloupari; for instance one deposit on the Perle de Koa concession carries upwards of 400,000 tons of ore by actual measurement. Ten years ago, a few hundred tons were shipped from there which averaged 10 p.c. nickel and a sample taken from the remaining waste dump yielded 6 p.c. of that metal.

The Vorarlberg concession adjoining, has an area of 7,286 acres. It has been prospected by costeans aud trial pits over a considerable portion of its surface.

Samples from innumerable openings were taken which showed that almost inexhaustibe quantities of ore of shipping and smelting grades exist, capable of themselves to supply the present world's demands for many years to come.

The ore is taken from the piles referred to and dumped into a bin, where the various grades are pretty well mixed, so as to average about 7 p.c. nickel. From this bin two wire ropes are stretched to the tramway below. The buckets which travel on these ropes, are connected by a light wire rope, which passes over a horizontal pulley, regulated by a brake, so that the loaded bucket hauls up the empty one.

At the Simon Mine near Dumbea, a single wire rope is used. The ore is filled in sacks which are slung to the hook of a free pulley and let go. These travel at a terrific speed until nearing the end, where the sag of rope causes a slight upward incline and finally the sacks are arrested by a strong buttress of wild grass which forms something of an elastic cushion. The pulleys are returned to the mine by pack horses.

The production of nickel during the last few years has ranged from 110,000 tons to 140,000 tons which is all shipped to Europe and the United States. No ore is smelted in New Caledonia although experiments attended with considerable success have been made by M. Caulry of Noumea. The ore is particularly well adapted for the production of ferro-nickel, as it is entirely free from sulphur and phosphorous.

The fonde or alloy produced averaged 55 p.c. to 60 p.c, nickel, 4 p.c. to 5 p.c. carbon with a little silicon and the balance iron. The slag was practically a mono-silicate of magnesia, lime and iron, and although rather viscid from the amount of magnesia present (22.02 p.c.) proved fairly clean. The nickel ran from 0.10 to 0.40 p.c. The consumption of fuel was however high, being accounted for in some measure by small furnace and light burden. Cold blast was used.

The labour problem is the most difficult to solve. The Natives are quite useless as labourers, but the Kanakas from the Loyalty Islands are good workers and easily controlled. The French libérés, or ticket-of-leave men, form a very unsatisfactory class of employés. Coolies from Pondicherry, and Chinese from Tonquin have been imported, but they have proved inferior to the Chinamen from more northerly provinces. Japanese have been brought in by contractors in considerable numbers. The contracts are very exacting, and the inspectors sent over by the Japanese Government are a constant source of friction on account of their own requirements, and demands on behalf of their countrymen. Over a hundred Dalmatians have been engaged within the last two years. Although paid much higher wages their labour is more economical and altogether more satisfactory. Free white men are employed only as superintendents and foremen.

It may be added that from this same formation in New Caledonia there were exported in 1901, 2,872 tons (metric) cobalt ore, averaging 4 p.c., 16,585 tons of chrome iron and 132,098 tons nickel ore.

The population of the Colony according to the latest census returns is 54,415, made up of 12,253 free, 10,506 of the penal classes and 31,656 non-European.

Progress in Magnetic Concentration of Iron Ore.

By Mr. J. Walther Wells, Toronto, Ont.

Introduction.—The future supply of iron ore is a problem which far sighted iron masters are at present investigating, as the present available supply is not calculated to last for many years.

Already the English and German iron works are importing ores from Spain and Sweden. In the United States the present available supply of high grade ore is not calculated to last more than 40 years, while the supply in Canada is apparently no more abundant so that it becomes a proper subject of inquiry as to the best means of utilizing the immense beds of low grade iron ores.

The production of pig iron continues to increase rapidly, for example in 1901 the total production of pig iron in the United States was, according to official statistics, 15,878,854 long tons valued at $242,174,000, using 28,887,476 tons of iron ore, being nearly twice the production in 1896. In 1900 Canada produced 86,090 long tons of pig iron, while in 1901 the production rose to 244,976 tons, and is likely to increase rapidly. Iron ore cannot be said to reproduce itself in the same manner as forest or animal wealth. Iron masters are facing a constantly decreasing supply of high grade iron ore along with a constantly increasing consumption, so that sooner or later the low grade ores will be drawn upon. And it may be advisable to concentrate the low grade ores before using them in the furnace.

What is Concentration?—To the engineer concentration means the separation of the wheat from the chaff—the elimination of the worthless rock from the valuable ore. According to present practice in concentrating iron ores there must be some difference between the constituents of an ore either in hardness, specific gravity, or in magnetic permeability that is the relative susceptibility to a magnetic influence, in order to allow a separation of the particles. For example, it is comparatively easy to separate a granular hematite imbedded in a calcareous gangue. The calcite being softer than the hematite will crush finer for the same treatment, and as it is of relatively less weight than the hematite a system of crushing, sizing and treating in a pulsating jig removes the gangue from the ore.

Again, a hard dense magnetite associated with a soft schist would be amenable to concentration as the schist would crush finer than the ore, the resultant product after sizing in hydraulic classifiers being readily separated by jigs into heads consisting of pure ore and tails consisting of worthless rock.

Both the jig and the hydraulic classifiers depend on the difference in specific gravity of the different constituents. In the case of the common mixture of magnetite with pyrite both of about the same hardness and specific gravity, a system of water concentration would not give satisfactory results. But fortunately an electro-magnet has a greater tractive influence on the magnetite than on the pyrite so that we have a means of eliminating the pyrite from the magnetite when the grains of each constituents are entirely detached. How this may be done will be shown further on.

Reasons for Concentrating Iron Ores.—As iron ore cannot said to be reproductive the constantly increasing demand for iron along with a decreasing supply of high grade ore will force the smelters to use low grade ores or find some means of enriching them at the mine in order to meet requirements in the furnace. The iron master demands as pure an ore as possible in order to make a cheap and high grade pig. For example, the standard ore of Bessemer grade on which all payments are made by most of the American dealers carries 63 per cent. iron, 0.045 per cent. phosphorus, 0.05 per cent sulphur, and the per cent. of sulphur and phosphorus cannot exceed this limit without lowering the selling price of the ore. In smelting an ore high in iron contents less fuel, less fluxing material, and less labor are required than in using

a lean ore. Besides, the stock piles are likely to be more uniform so that less trouble is required in making up the charges for the furnace burden.

The blast furnace is practically a concentrating as well as a reducing machine. All of the constituents of the ore, except a portion of the metallic contents are separated into worthless slag, while the valuable pig iron is saved. Immense sums of money are annually spent in mining, transporting and fluxing in the smelter slag-making material in the ore.

A modern blast furnace costs considerably more than a modern concentrating plant both as regards original outlay and cost of maintainence. When the gangue or worthless part of the iron ore is treated in the blast furnace it must be transported, handled at least twice, melted and fluxed. By removing this gangue at the mine all of the expense of hauling, handling and eliminating in the furnace may be saved, and the ore will command a higher price at the smelter, as being a high grade uniform ore. According to present practice it takes one ton of coke to make one ton of pig iron. Most metallurgists will admit that about 400 lb. of the coke is sufficient to reduce the iron in the oxides, while the remaining 1600 lbs. are used up in melting the pig iron along with a mass of siliceous and earthly matter making up the slag. Of course a portion of this waste heat is saved in the form of gas used to heat the air blast, but a large quantity goes to heating, fluxing and getting rid of the extra amount of slag due to gangue matter in the ore. Hence it may be seen that it is better from the metallurgist's point of view to concentrate the ore at the mine rather than in the furnace.

The question may be resolved into a business proposition—will it pay to concentrate the ore at the mine?

If the extra price which the concentrated ore brings at the smelter together with the cost of hauling gangue material in the low grade ore is greater than the cost of concentrating the ore at the mine, then the operation will be a profitable undertaking. It cannot be profitable to deliver concentrated ore to the smelter in competition with an equally rich ore in the natural state, the costs of transportation being the same. But rich ores in the natural state are not abundant, so that there is always a chance for the concentrated ore to come into the market.

Methods of Concentration.—Hence it becomes a pertinent subject of investigation to determine the most efficient method of concentrating iron ore at the mine.

The simplest method of concentrating hard iron ores is by hand-cobbing, the laborer breaking up the ore to small sizes with a sledge hammer, picking out the good ore for use in the smelter, throwing the worthless rock to the waste heaps. In the case of soft iron ores intermixed with clay, different forms of washers are used. The log-washer commonly used in the Southern United States is a tilted cylinder rotating on its longer axis with side paddles forcing the ore upwards in a trough against a descending current of water washing away the clay and fine material through a screen at the lower end while the washed ore passes to the ore cars at the upper end.

In concentrating hard iron ores the product should have the coarsest possible size together with the highest possible purity to meet requirements of the market. The cost of crushing depends on the fineness of the desired product. The required fineness depends on the physical character of the ore—whether it is fine or coarse grained, whether the gangue is readily detached from the particles of ore. The cost of separating the ore per ton of finished product varies with the richness of the ore, that is the number of tons of crude ore which must be crushed to a certain size to obtain a certain concentrated product is an item of importance on the cost sheets. The richness of the ore depends on the amount of gangue material present, so that a complete petrographical examination of an ore will give you a fair idea of how it will work by any system of concentration. For example, an ore is shown in Plate I, will be easily treated as the coarse grains of iron ore can be readily detached from the segregations of rock without fine crushing. Plate II, shows a section of an ore which is amenable to coarse concentration for the same reason. Plates III and IV show samples of ore which require quite fine crushing in order to completely separate the ore from the rock, while Plates V and VI show ore that is not amenable to any cheap method of concentration, owing to the fine particles of ore being so intimately intermixed with rock matter that very fine crushing is necessary, the product requiring briquetting before use in the smelter. It often happens that pyrite or apatite occurs in an ore which carries high iron values, but yet the ore is of no commercial value owing to the objectionable constituents. These deleterious constituents may be separated by magnetic concentration, and it is only a matter of how fine is it necessary to crush in order to detach the grains of the ore from the grains of the other constituents. For example, Plate VII shows an ore in which the pyrite shows as light colored stringers and segregated masses while the ore shows dark colored. Such an ore requires only medium fine crushing to a size of about 0.25 inch diameter to separate the pyrite from the ore. Plate VIII shows a dark colored dense magnetite with finely disseminated particles of pyrite scattered through the mass to be seen in the photo as light colored particles. In this ore it is almost impossible to eliminate the pyrite without very fine grinding, as particles of ore of even 0.10 inch diameter will have particles of pyrite clinging to them. Although fine crushing would eliminate the pyrite it could not be a commercial success at present owing to cost of fine crushing and the consequent briquetting of the fine ore.

When by petrographical means the character of an ore is determined it is necessary to determine the best method of concentration adapted to a particular ore.

In discussing the merits of water concentration, local conditions in Canada are against its use, as iron ore requires handling in large quantity to be profitable, which entails a costly plant consisting of jaw crushers, rolls, screens, jigs, expensive water piping, heating arrangements and large power capacity. The product is not always high grade as the gangue may have the same specific gravity as the ore, and it is not always possible to eliminate sulphides and apatite.

If the iron in an ore occurs in such a state that it may be attracted by an electro-magnet, then we have a simple method of separating the valuable ore from the worthless rock. Magnetites are most readily attracted by magnets, hence such ores lend themselves most readily to treatment. By increasing the strength of the magnet hematite may also be separated out as a magnetic head. Local conditions in Canada favor magnetic concentration as there is abundance of cheap water power available in the iron districts, while no expensive plant is necessary. The electric power may be used in running hoists, pumps, lighting system, compressors for air-drills, crushing machinery and the product may be hauled to nearest shipping point by electric trams. Cold weather has little influence on electric power while condensation of steam, freezing of water and air-conveying pipes often give trouble during a cold season. Magnetic concentration depends on difference in magnetic permeability, that is, some minerals are more susceptible to the influence of a magnet than others, so that they may be attracted, held or drawn away from other minerals not so susceptible, thereby effecting a separation. The magnetic permeability of different minerals has been worked out by Walter Crane (Transactions of American Institute of Mining Engineers, 1901) who arranges the most magnetic minerals in the following scale in descending order of permeability, thus:—

Magnetite
Franklinite

Ilmenite
Pyrrhotite
Hematite
Siderite
Limonite.

The ideal method of crushing an iron ore for magnetic concentration would be to detach the different grains from each other without further crushing. Coarse crushing should be the rule rather than pulverization for two reasons (1) it is a waste of energy to reduce the ore finer than is necessary. (2) Fine ore as dust is not desirable for use in the blast furnace. Hence in any system of concentration the essential point is to find out what degree of fineness is necessary to release each individual particle from its neighbor. If the ore is crushed coarse, in many ores a magnetic portion will drag a non-magnetic portion attached into the heads thus lowering the quality of the heads. If the ore is crushed too fine there will be an adhesion of magnetic particles with the non-magnetic preventing a clean separation unless the ore is handled in water as by the Grondal-Delvik or Heberle separators or by air blast as in some of the dry separators. Besides, the iron master objects to using ore in the form of dust in the smelter. Hence it may be seen that each ore is a problem in itself, requiring careful experimental investigation to determine the best method of treatment, including the size of grain, the kind of separator best adapted, the pole, distance, etc. An encouraging feature of magnetic concentration is that sulphur in the form of pyrite and phosphorus in the form of apatite may be eliminated from many iron ores producing a Bessemer grade Sulphur in the form of pyrrhotite cannot be separated from magnetite nor can phosphate of iron and phosphide of iron be readily eliminated as they are more or less magnetic and go into the heads. Experiments conducted by the writer have shown that in some titaniferous ores the titanium may be eliminated, but in pure ilmenite it is impossible to reduce the percentage of titanium by magnetic concentration.

Present Status of Magnetic Concentration.—The application of electro-magnets as a means of concentrating ores is not a novel idea, but its use on a commercial scale for concentrating iron ores, has been extended within th last 15 years.

In 1866 the late Dr. Sterry Hunt, of the Canadian Geological Survey, showed that a concentration by magnets was successful on the iron sands on the north shore of the St. Lawrence River. A charcoal iron smelter was started at Moisie making a good grade of charcoal iron, but could not compete in price with Swedish iron and the project was abandoned. The different types of magnetic concentrators which have met with more or less commercial success may be divided into four classes :—

(1) Those with the ore on conveying belts passing a magnetic field. Examples are the Conkling, Wetherill, Chase, Hoffman, Kessler, etc.

(2) Those with the ore on a rotating cylindrical drum within which are magnets. Examples are the Ball-Norton, Heberli, Wenstrom, Buchanan, Sautter, Siemens, Payne, etc.

(3) Those in which the ore falls vertically past magnets. Examples are the Edison, Heberli, Grondal-Delwik, Rowand, etc.

(4) Those in which static electricity is utilized, materials conducting the charge being repelled from those which do not become magnetized. The only example is the Blake-Morscher type recently invented and used at Colorado Zinc Works for separating zinc from lead ores.

It is beyond the scope of this paper to discuss the relative merits of the different machines, but a brief description of a few in commercial use may be of interest.

The Conkling separator is an endless travelling belt with three cross belts running at right angles to the main belt, underneath magnets of different strengths, as shown in Plate IX, delivering different grades of ore. The non-magnetic tails are carried along the belt. This machine does not appear to have had much success. An improved form as described in Transactions of American Institute of Mining Engineers, 1890, was used at the Tilly Foster Mine in New York State, with success.

The Wetherill separators are made in several different forms adapted to suit requirements. Two types used at the Magnetite mines of Witherbee, Sherman & Co., Fort Henry, New York, for concentrating a magnetite carrying siliceous matter and apatite may be described. The Rowand type designed for highly magnetic ores is shown in Plate X being a diagrammatic vertical section. The crushed ore falling from a zig-zag delivery spout thus shaking up the particles passes a revolving drum alternately composed of brass and iron and magnetized by induction from the permanent magnet. The non-magnetic particles fall past the magnet while portions are held to the periphery till the center of the lines of magnetic force between the magnets is reached and as this zone is neutral the particles fall. Provision may be made to classify the material into several grades by baffles as seen in the plate The construction of the rapidly rotating drum may be seen in plate IoA showing that a secondary concentration takes place, the magnetic material arranging along the bands of iron while the non-magnetic is thrown into the alternate spaces along the bands of brass. There is also a concentration of the lines of force at P owing to the point of the magnet projecting, and as all material passes through this field of strong magnetic forces it may be seen that there is little iron alloweed to escape in the tails, while only a weak current may be necessary owing to the concentration of the force. This type of concentrator is used at Port Henry, treating a crude ore carrying about 45 p c. iron and consisting of magnetite, apatite, hornblende, quartz, etc. The ore is crushed to 0.25″ size passed through the magnetite separator delivering heads carrying 69 p.c. iron. The tailings are passed through a Rowand (Wetherill system) cross belt machine removing the hornblende as a magnetic product leaving the tailings as almost pure apatite sold to fertilizer makers.

This machine designed for treating weakly magnetic material is shown in Plate XI. The cross-belts run under very strong magnets delivering material according to the strength of the magnet, while the non-magnetic material passes along the wide belt as tailings. The writer saw this machine remove ilmenite as one product from a sample monazite sand, cerite earths as a second product, leaving garnets, quartz, etc, as tailings. The separators made by the Wetherill Separating Co., in one form or another are able to remove garnets from corundum, siliceous matter, pyrite and apatite from iron ore, garnets from diamonds such as at Debeers Mines, Kimberley, South Africa.

The concentration of monazite sand by these machines gave an impetus to the industry of collecting rare earths for use in making incandescent mantles for lighting while the concentration of zinc ores such as franklinite at Franklin Furnace, New Jersey, is being done on a large scale. The machines will no doubt find still further industrial uses.

The Ball-Norton separator in practical use for the last 10 years has the following distinguishing features according to the inventor, Mr. C. M. Ball, Rockaway, New Jersey :—

(1) A stationary range of magnetic poles of alternately opposite polarity in the direction of the ore travel underneath while the drums enclosing the two groups into which the range of poles is divided may be rotated and may serve as carriers of the granulated ore, the iron particles being held upon the under side thereof by magnetic attraction.

(2) Means for applying a counter current of air to the moving mass of ore while it is suspended upon the under side of the rapidly running drums and being driven along through the machine.

(3) Provisions for differentiating the ore into three grades this being done by differential speed of rotation of the two drums assisted by relative adjustments of the strength of magnetism in the two groups of alternating magnets

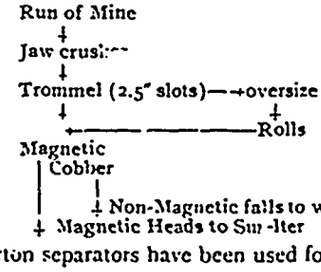
In Plate XII the operations of the machine may be seen, the diagram being a section. The crushed ore is fed into the hopper at the right, the tails falling directly underneath while the larger and stronger magnet carries magnetic material to the second or weaker magnet where a middle product consisting of ore mixed with rock matter attatched falls down while the heads go into the hopper at the left. A blower forces air in the opposite direction of the ore travel. The particles of ore are tumbled about while suspended on the underside of the drums by being passed through magnetic fields of successively opposite polarity Gravity, centrifugal force and a counter current of air act at the same time to eliminate the non-magnetic particles. The writer recently visited the concentrating plant of the Hibernia mines, New Jersey, as shown in Plate XIII, where the Ball-Norton machines are in use. At this mine there is some 80,000 tons of refuse ore consisting of magnetite, hornblende, quartz, etc., being the result of several years of hand cobbing. The refuse ore carrying 40.34 p.c iron as per samples taken by the writer, is crushed in jaw crushers, passed through rolls and trommels with slots of 0.25 inch diameter, the oversize passing through finer rolls. The whole product from the rolls goes to Ball-Norton separator delivering 3 products, samples of which taken by the writer show as follows :—

(1) Tails carrying 7.08 p c. iron.
(2) Middles " 48.03 "
(3) Heads " 63.40 "

The heads are delivered to ore cars going directly to the smelter. The middles are recrushed by finer rolls and re-treated. The waste rock worth 25 cents a ton at the mine is sold for concrete and building purposes. At this mine there is also in operation a magnetic cobber built by Mr. C. M. Ball, which cobs the ore classed as run of mine. The ore is fed from the skips to large jaw crushers, through trommels with slots of 2.5 inch diameter and to the cobber consisting of a cylindrical magnetized drum around which an inclined belt travels. The crushed ore, consisting of coarse and fines, falling on the belt is divided into non-magnetic tails falling directly down past the end of the drum to cross travelling belts leading to the waste piles. The magnetic particles cling to the belt till they reach the lowest point of the cylinder where the magnetism ceases, and fall on cross conveying belts leading to ore cars. Samples from the magnetic cobber taken by the writer show thus

HEADS.	IRON P. C.
Coarse ore—2.5 inch diameter -	43.87
Fine ore— - - - - - - - -	53.43
TAILS.	
Coarse rock—2.5 inch diameter	6.82
Fine rock— - - - - - - -	13.45

The scheme for cobbing may be shown by diagram thus :



The Ball-Norton separators have been used for some years at the Chateaugay Mines in northern New York where about 12,000 tons are being treated per month. The ore at this mine carries only 38 p. c. iron, is difficult to mine, while the smelter is some distance away, so that costs run up considerably. The one saving condition is that the concentrated ore is uniformly high grade, running 66 p.c. iron. Several water concentration systems have been tried, including Hartz jigs, and found to be of little use as about ⅔ of the ore was lost in treatment producing 1 ton of shipping ore from 3 tons of crude ; also hydraulic clasifiers giving no better results.

Magnetic concentration proved successful from the start and there are now installed 10 Ball-Norton separators, producing 1 ton of concentrates carrying 66 p. c. iron from 2 tons of crude ore carrying 38 p. c. iron which is crushed and sized to 0.25 inch for treatment. This separator has also given successful results at Benson Mines, Mineville, Arnold Hill and Ferronia in New York State, also at Svarto Mine in Sweden.

The Buchanan separator originally consists of double rolls revolving in opposite directions and forming the ends of a horse-shoe magnet as in Plate XIV. The ore entering at the top is divided into tailings falling vertically which the magnetic concentrates are deflected as in the photograph.

An improved form is used for coarser material about 0.5" diameter as shown in Plate XV The magnetic fields are on each side of the drum. The large drum is ratated to the left carrying ore fed on the the right side upwards against gravity and centrifugal force.

The magnetic particles clinging to the ascending surface are carried over the top and pass a second magnet holding the magnetic particles, here they read the bottom of the drum while the non-magnetic fall vertically.

The rich tailings falling on the right side of the drum are passed to a smaller drum of intense magnetic power separating non-magnetic material from the magnetic in a similar way as the large drum. The Buchanan separator has been used at Hibernia mines, in New Jersey, Croton mines in New York State, Michigamme mine in Michigan, etc.

The Wenstrom separator is a single cylinder with alternating strips of magnetic and non-magnetic material forming the periphery, as may be seen in Plate XVI. The ore falling on the travelling belt comes in contact with magnetized periphery holding the magnetic part of the ore while the non-magnetic fall vertically. The ore travels underneath the cylinder till it meets a demagnetized portion where it falls as shown in the cut.

This separator has met with long continued success in Sweden, being first installed at Hjuljern in 1885 and has been used at Grangesberg, Dannemora, Lulea, etc. In America it has been used at Mineville, Cranberry Lake, Michigamme and elsewhere.

The Heberli separator as shown in Plate XVII, is in use in Germany for treating complex magnetic ores. The crushed ore enters at A with a stream of water and the non-magnetic particles fall vertically through a column of water into E. and pass out at F.

The magnetic particles are attracted by the magnet M and fall down into C passing out at D. An endless travelling belt carries magnetic particles past the magnet.

The Heberli has not been yet introduced into American mines.

The Edison separator is essentially a stationary magnet past which the ore falls by gravity from a hopper as shown in Plate XVIII. The magnetic particles are deflected separating them from the non-magnetic which fall vertically into separate receptacles. The writer recently visited the mines near Edison, New Jersey, where a plant was in operation in 1897 on an immense scale but found the plant dismantled although accurate information regarding the method of concentration was obtained.

The problem which the inventor, Mr. T. A. Edison, undertook to solve was the enormous one of quarrying rock carrying 25 p.c. magnetite, crushing it fine, separating magnetically the particles of magnetite from the ore by air blast, forming the clean pulverized ore into solid briquettes, loading and shipping the product to local furnaces at cost below that at

which Lake Superior ores could be delivered at the same furnaces in order to enable them to compete with the Pittsburg furnaces.

The ore body may be classed as country rock. It was quarried by blasting 2 inch holes 8 feet apart, 20 feet deep and 12 feet back from the working face.

The crude ore, thrown out in blocks often weighing 5 tons, was loaded by a steam shovel to skips dumping into giant rolls 6 feet in diameter and 6 feet face crushing the ore which was passed to 3 successively finer rolls, delivering ore crushed to 0.50" size and finer which was elevated to a vertical dryer 9 feet square and 50 feet high having alternate shelves of cast iron tilted at 45° downwards.

The dried ore was elevated to a stock house and conveyed to rolls and screens of about 0.10" size of holes the oversize returning to the rolls while the fines were allowed to fall past a series of horizontal magnets deflecting magnetic particles carrying 40 p.c. iron and allowing the tailings to fall vertically into conveyors leading to waste heaps. The concentrates were dried, crushed to about 0.05" size and treated by a second series of magnets delivering concentrates carrying 60 p.c. iron which were subjected to an air blast removing apatite as a finer dust and passed to a third series of magnets making a final concentrates of Bessemer grade carrying 68 p. c. iron and tailings which were reground and returned to the separator. The final concentrates were mixed in cylindrical machines with rosin soap and compressed into briquettes 3" by 1.5' which were heated in drying ovens to 600° F to render them waterproof, hard to endure handling, porous to enable furnace gases to penetrate, and non-friable to resist the action in the blast furnace.

The capacity of the plant was 300 tons of rock per day, one-quarter of which was made into briquettes, the remainder being sold for building purposes.

The system was a marvel of engineering skill, automatic from start to finish, but was not continued as it did not prove profitable. A drawback was the friability of the briquettes in the blast furnace. Local iron men appeared to be satisfied that the operation would be profitable if the price of Lake Superior ores should rise 75 cents a ton.

It is proposed to use the Edison system on low grade Norwegian ore owned by the Dunderland Iron Ore Co. shipping the concentrates to English furnaces.

The Grondal-Delvik separator is adapted to finely crushed ore employing water as a means of cleaning dust from the ore.

Plate XIX shows a diagram section. The ore enters at N together with water from N to L and passes along side the cast iron drum A B which has coils of copper wire carrying electric current so that magnetic particles are held to the iron rings while non magnetic particles are washed down into P.

The wooden drum C C revolving 3 times faster than A B has steel pegs on its periphery which become magnets by induction causing particles to hop across carrying them around to the demagnetized portion where they are worked down by water from K.

This separator has been working since 1894 at Pitkaranta, Finland, treating a low grade magnetite carrying 25 p c. iron mixed with chalcopyrite and zinc blende.

The Blake-Morscher system of ore-dressing by static electricity is the recent invention of Prof. L. J. Blake, of the University of Kansas, and is said to have met with success in treating zinclead ores at the Colorado Zinc Works, Denver, Colorado.

The method consists in bringing a mass of ore particles into contact with a statically changed metallic surface, such materials as passes conductivity are instantly repelled while those of low conductivity are not so rapidly repelled allowing them to be pulled out of the path and caught in a separate receptacle.

It is said to work well on iron ores.

USE OF FINELY DIVIDED ORE IN THE BLAST FURNACE.

An argument often brought forward against concentration of iron ores is that the concentrated product is too fine for use in the blast furnace. The writer visited many smelters and has ascertained that the present practice favors the use of finely divided ores as it is cheaper to smelt the fine ore.

Of course any ore less than 0.10" diameter should be briquetted but concentration methods generally avoid crushing finer than this size owing to greater cost so that concentrated ore is generally acceptable at the furnace.

OPPORTUNITY IN CANADA FOR CONCENTRATION OF IRON ORES.

The writer is at present making experimental investigation of different Canadian ores and regrets that the matter is not yet ready for publication. This paper is only a preliminary study of the present practice and if any new points have been brought forward of benefit to Canadian mining men, the writer will be satisfied.

In general it may be said that magnetic concentration can only be profitable where local conditions favor it, such as cheap labor, lack of competition with naturally rich ores, cheap power, etc.

Granby Consolidated.

During the month the mines and smelting plant at Phœnix of the Granby Consolidated Mining, Smelting and Power Company were inspected by a number of the New York directors representing the Nichols end of the enterprise. In an interview Mr. Luther stated that the chief impression made upon him, and he thought upon the rest of the gentlemen of the party, was the immense size of the ore bodies to be handled. The Granby Co. had an unlimited supply of ore, practically, of an even value per ton. With a good market, which is assured, plenty of capital and an economical management, this was the secret of the success of the Granby Co., which was properly handling the raw material and turning it into a marketable commodity. Every indication here in the way of construction and development showed plainly that those in charge understood the problem, and the results in time could not be otherwise than those hoped for. He had been told how large the ore bodies were in feet, but the impression was different from what he actually saw; large as he believed it to be, he found it immensely larger. Practically all the ore produced so far was in the process of development—getting ready to do work.

Mr. Herreshoff did not think there was any need for him to make any comment on the Granby Smelter, as it spoke for itself. The results now being achieved on low grade ores were most remarkable. Ordinarily some persons might be disposed to hesitate to handle or develop a proposition with such low grade ore, but the conception of this enterprise, in its magnitude showed great depth of thought and remarkable attention to details. Had it not been for the economical methods in use it is a question whether it could have been made a commercial success. In its smelting operations the Granby Co. was favored by the fortunate composition of the ores. The bessemerizing was up to date in every respect, and he believed the company would become one of the leading factors in the copper industry on the American continent.

The Granby Smelter this week treated 4808 tons, making a total of 140,139 tons for the year.

	Week.	Total.
Granby	4,012	148,464
Mother Lode	3,706	42,274
Snowshoe	2,100	19,590
B. C.	1,200	12,445
Emma	300	9,206
Sunset	.....	4,305
Providence	.....	551
	11,318	236,835

Velvet Rossland Mine.—The manager cables: "South drift of level No. 2 have drifted 50 ft.; the ore is 5 ft. thick entire distance. Drift is looking exceedingly well. Will be able to ship 20 tons of ore daily, if able to obtain teams; 350 tons are now ready for shipment. South drift of level No. 3, the ore is coming in. Mine promises exceedingly well for the future.

Coal Cutting Machinery.

A paper was read by Mr. Owen Hughes, at a meeting of the Manchester Geological Society, held on April 21st, on "Coal-cutting by Machinery," which recorded the operations extending over a considerable period. The advantages claimed for coal-cutting machines were as follows :—

1.—Increase in the proportion of round coal.

2.—Smaller loss in working.

3.—In most mines a reduced working cost.

4.—A reduced necessity for the use of explosives, amounting in some mines to entirely dispensing with shot-firing, thus removing a great element of danger.

5.—A larger output from a smaller area in a given time.

6.—Reduced loss and cost of timber, together with fewer accidents from falls.

7.—A larger daily wage for the collier, whilst relieving him from the most dangerous and laborious part of his work.

Mr. Hughes then proceeded to give details of the results attained by using both rotary and percussion machines worked by compressed air.

In the course of a discussion the Chairman (Mr. Hy. Hall) said that if Mr. Hughes's statement that he gained an advantage of from 10d. to 1s 9d. per ton by the use of these machines was correct, it was a wonder that they were not in every colliery? With regard to the increased quantity of round coal he thought it came from the fact that the coal-cutter holed in dirt, whereas the man holed in coal. He wanted to know why the coal-cutter could hole in dirt when a man could not. Was it too hard for the man and not so for the coal-cutter? Another point was with regard to the quality of the slack. The slack made by the machine was almost worthless, whilst that made by the man might in many cases be sold as nuts.

Lead Smelting Costs.

Mr. S. S. Fowler, S.B., Mining Engineer and Resident Manager of the London and British Columbia Goldfields, Limited, contributes to a recent issue of the Nelson *News* an interesting letter on the question of lead smelting costs which we take pleasure in reproducing :

I learn from Eastern Canada that the impression is going abroad there, as a result of articles that have appeared in some of our papers, that the B. C. lead miners are just finding out that they have been on the wrong scent, and that a reduction of smelter and freight charges is the natural and easy way to make lead mining profitable in British Columbia, and that, if this were done, duties and bounties would not be needed. If this be so, and the government be influenced by such irresponsible statements, more than by the representations made by our delegates and the speech made by our member in the house, in which he stated that the smelting and freight rates had been investigated and found reasonable, it will have little excuse, but, nevertheless, it is most regrettable that public sentiment should be educated in the wrong direction instead of the right when we have still to win our fight for lead duties, at least conforming to the general tariff of Canada.

It would be difficult in a brief letter to go fully into the question of smelting costs in different places and under different circumstances, and to make clear the effect upon the smelting rate for lead ore, of the supply of other ores necessary to flux with it, and other matters of a somewhat technical nature. For this I have little time, and you perhaps hardly space enough.

It seems to be the impression of some, in discussing the rate question, that a smelting rate can be arri ed at like a milling or manufacturing rate, but this of coure is very wide of the mark. With the same prices for wages and material, and with equally well equipped plants and able metallurgical supervision, the cost of smelting one assortment of ores may be double what it would be with another. It would seem strange indeed, if there is a good margin of profit in lead smelting, that none of the talked of smelters have materialized, and that the Trail smelter is smelting no lead ore, and the Nelson plant running at, perhaps, half capacity, when by a reduction in rates they could produce business enough to keep them fully occupied. I certainly hope for lower rates in the near future, with the increasing development of mines supplying larger quantities of ore, and a more nearly self-fluxing combination than is the case at present.

Mr. Cavanaugh, in his letter published in *The Daily News* of June 10th, shows that he is under an evident misapprehension, which has naturally led to the belief that the smelting rates could be materially reduced without giving the smelters and railways a smaller earning than they had some years ago. That is due to Mr. Cavanaugh's not knowing, apparently, that the lead from ore bought in Canada was not used for domestic consumption in the United States, for the American mines have been, for several years past, supplying the domestic lead for the United States. The foreign lead was smelted and refined in bond, and 90 per cent. of the assay contents of the ore or bullion exported, leaving a small amount which might be sold at home without payment of duty. The smelter therefore had, in addition to his freight and treatment charge, a profit on his lead over the price paid the Canadian miner based on the New York price less brokerage, and duty on the lead paid for and on the lead not paid for, i.e., payment was made for 90 per cent. assay contents and duty charged on 100 per cent. When we sold ore to American smelters the brokers' price paid to the miner was always from 15c. to 30c. per one hundred pounds less than what the refiner received in New York.

To make clear the improvement there has been in smelter rates since 1896, I have taken examples of Whitewater product for different periods, and made comparisons, showing on the one hand what we received, and on the other what we would have received if we had had the advantage of settlement on the basis of London price less $1.00 per 100 pounds and the present freight and treatment rate :—

OLD METHOD.

Date	% Lead	Gross Lead Contents per ton lbs.	N.Y. Price Less 20c	90% of Total Value Lead in Ore	Freight and Treatment	Duty 1½c per lb	Net Value Lead per Ton Ore
1896.....	30.8	616	$2.78	$15.41	$22.50	$ 4.62	$11.71 loss
Jan. 1897.....	33.7	674	2.84	17.23	18.75	5.06	6.58 "
						Duty 1¼c	
Dec. 1897.....	33.7	674	3.50	21.23	18.75	$10.11	7.65 "
1898.....	30.9	618	3.58	19.91	18.75	9.27	3.11 "
1899.....	46.6	932	4.27	35.82	20.00	13.98	1.84 gain

NEW METHOD.

Date	% Lead	Gross Lead Contents per ton	Average London Price	Equivalent in $ Less $1	90% of Total Value Lead ton Ore	Freight and Treatment	Net Value Lead Ton Ore
1896.....	30.8	616	11- 3-9	$1.417	$ 7.86	$13.16	$5.30 loss
Jan. 1897.....	33.7	674	11-15-0	1 539	9.33	13.74	4.41 "
Dec. 1897.....	33.7	674	12-12-6	1.728	10.49	13.74	3.25 "
1898.....	30.9	618	13- 0-0	1.809	10.06	13.18	3.12 "
1899.....	46.6	932	14-18-9	2.228	18.69	15.00	3.69 gain

The question of the 10 per cent. deduction from the lead and the 5 per cent. of silver is sometimes introduced in consid ring rates, but there is little ground for this. Hixon says on pages 56 and 57 :

"The losses in lead smelting are generally estimated at 5 per cent. Ag. and 10 per cent. Pb., and in making purchases of ore it is customary to make this deduction from the metallic contents of the ore in making payment. The actual losses, or such as are known in statements vary according to local conditions of charge, plant, and ability of the metallurgist...."

"Properly speaking, the losses in lead smelting can be kept within the allowed limits of 5 per cent. Ag. and 10 per cent. Pb., but to do this it is necessary that the furnaces shall not, etc....."

"The writer has had returns from months during which the results on accurate charging of all contents represented a loss of 4 per cent. Ag. and 8 per cent. Pb, and in other months 7 per cent. Ag. and 14 per cent. Pb."

The figures quoted from Hoffman by Mr. Campbell-Johnston giving smelting costs, do not include management, clerical expense, interest on ore and other items which must be taken into account. For various reasons, which I would be quite willing to go into at length, if necessary, I do not give the information necessary to determine what a reasonable charge for treatment would be here. From my knowledge of the conditions and my past smelting experience, I do not think the present rates excessive.

Maritime Coal Company.—This company, which purchased the Chignecto colliery of the old Londonderry Iron Company, has spent about $100,000 in pumping out the old workings, in development and in the construction and equipment of a line of railway from Chignecto to Maccan on the Intercolonial Railway. They are now down a distance of about 1400 feet and have levels run off at 600 ft. and 1000 ft. The plant has been greatly improved, and the output, it is expected, will shortly be increased to 400 tons per day. The coal from the lower levels has given excellent results from tests made on the Intercolonial and Quebec Central Railways. Mr. James Baird, one of the oldest active colliery managers in Canada, and one of the most capable, is in charge of the property.

Canadian Graphite.

By H. P. H. Brumell.

Notwithstanding the present activity of mining in the Provinces of Ontario and Quebec, but little seems to be known of the extent and richness of the ores of graphite, the value of the industry or the variety of uses to which the mineral is put. Without going into details it may be stated that by far the most important use of graphite is in the steel, copper and copper-alloy industries as a refractory material in making crucibles, retorts, muffles, boxes, stirrers, etc. Other important uses are for lubricating, foundry facings, stove-polish, paints, electrotyping and pencils.

The two well-defined trade divisions of this mineral are "amorphous" graphite and "crystalline" graphite. The former is usually of lower grade and more suitable for facings, paint, pipe-joint grease and stove-polish, although the better qualities, particularly from Bavaria and Mexico, are used also in the manufacture of pencils and electrotyping, while for crucible making, lubrication, high grade stove-polish and electrotyping, the purer or crystalline variety is generally necessary. The principal source of supply of crystalline graphite is the Island of Ceylon, from whence the ore is shipped in its crude form, after being sorted and sized, the grades being "lump," "chip," "dust" and "sweepings." The first two sizes form the bulk of the output used by crucible makers, while the "dust" and the "sweepings" are utilized for lubrication stock.

Amorphous graphite is found principally in Nova Scotia and New Brunswick, where it occurs as graphitic shale and clay. The most important deposits are those in the vicinity of St. John, N.B., others of lesser note occurring in Kings and Westmoreland Counties, N.B., and at Lochaber, N.S. In Ontario several deposits of amorphous graphite have been found in Haliburton and Hastings Counties, while in Brougham Township, Renfrew County, a very extensive deposit occurs, having associated with it a considerable proportion of flake or crystalline graphite. This property is being operated by the Ontario Graphite Company, which has lately installed an expensive plant, and is now refining and shipping the product.

The largest known deposits of crystalline graphite are in the Counties of Ottawa and Argenteuil, Quebec. Smaller deposits occur in Lanark, Leeds and Frontenac Counties, Ontario. Of this quality there are two distinct classes of ore, "lump" and "disseminated," the former usually occurring in limestone, as nodules, or filling pockets and small veins. There are also many minor occurrences where the lump ore constitutes small veins in diorite or other igneous rocks. As yet no discovery of lump has warranted systematic mining. Disseminated graphite ore is practically a Sillimanite or other gneiss carrying graphite in a flaky or crystalline form, and varying in graphite content from a trace to 35 per cent. These bands of gneiss are found in the Townships of Buckingham and Lochaber, Ottawa County, many beds having a thickness of over 20 ft., and assaying on an average about 20 per cent. of graphite. A number of beds have been opened and ore extracted and treated at the different mills in the district, more especially in later years at those of the North American Graphite Company, the Buckingham Company, and the Walker Mining Company.

As in many other industries the process of manufacture adopted by the different producers has been jealously guarded, the different "secrets" being considered the individual property of the refiner. Irrespective of secret methods, the practice adopted may be divided into wet and dry processes. No mill confining its operations to the dry or air method has as yet been commercially successful, because the similar gravity of the component minerals prevents a satisfactory separation. Several pneumatic separators lately put on the market have been partially successful, although they have not been able to eliminate the mica.

The wet or water separation method has been successful to a marked degree and high-grade graphite is being produced in this manner by the North American Graphite Company, of Buckingham, which is, at present, the only company in operation in the Province of Quebec. It is expected that the plant of the Walker Mining Company will soon be at work. In the process of concentration used by these companies the ore is crushed and stamped wet, and a coarse separation made by stationary buddles. The concentrates are then dried, ground by buhr-stones and screened. An improvement, resulting in a saving in cost of about 25 per cent. has lately been made by the use of the Brumell separator, which treats the ore after drying by flotation upon, rather than immersion beneath, the surface of the water. By the wet method a higher degree of concentration is obtained than by the dry process, and the ground and finished concentrates retain their size of particle to a marked degree. As a consequence, those companies, which employ wet methods are enabled to put upon the market the largest sized and purest flake crucible and lubricating stock.

Analyses of picked samples of graphite made by the Geological Survey of Canada have shown the following results:

Locality.	Carbon per cent.
Buckingham Township, Quebec (foliated)	99.675
Buckingham Township, Quebec (columnar)	97.626
Grenville Township, Quebec (foliated)	99.815
Grenville Township, Quebec (columnar)	99.757
Ticonderoga, N.Y. (foliated)	99.656
Ticonderoga, N.Y. (columnar)	97.422
Ceylon (foliated)	99.679
Ceylon (columnar)	99.792

It is a generally accepted fact that the world's supply of crystalline graphite needs to be increased because of the growth of the iron and steel industry, the largely extended use of copper and its alloys, the wider application of electricity and the increased needs for graphite lubrication. Flake graphite is known to exist only in crystalline rocks which, in the Laurentian series, has the greatest development in Canada, a feature which presents a promising future for the graphite industry of the Dominion.

Cape Breton Coal, Iron and Railway Company.—This company is preparing to develop its coal areas at Cochrane's Lake and Black Brook, Mira. The company controls 57 square miles of territory, containing seams of coal of various thicknesses, 12 square miles have passed Government inspection as being 5.5 ft. thick. The coal is pronounced of excellent quality. The company is capitalized at $1,000,000, the shares being $100 each. There is considerable American capital back of the company, but it is understood that the Royal Bank of Canada will take the bulk of the stock.

COMPANY NOTES.

New Fairview Corporation.—This company is installing a cyanide plant of a capacity of 200 tons per day.

Crow's Nest Pass Coal Company.—The output from the company's collieries for May was as follows:—Coal Creek, 17,796 tons; Michel, 28,849 tons; Morrissey, 15,081 tons. The output for June is expected to reach quite 75,000 tons.

Le Roi.—Cabled returns for May:—"Shipped from the mine to Northport smelter during May, 1903. 10,665 tons of ore, containing 4,715 ozs. of gold, 5,001 ozs. of silver, and 236,9[illegible] lbs. of copper. Estimated profit on this ore, $14,500."

New England Canadian Asbestos.—This company which acquired the Beaver and other working properties at Thetford Mines, Que., has suspended operations. The company, which worked at one time Vermont asbestos, appears to have been a failure all along the line.

Canadian Amber Mica Company, Ltd.—Registered June 5. Capital, £5,000, in 5s. shares. No initial public issue. The first directors (to number not less than two nor more than seven) are to be appointed by the signatories. Registered office: Tower Chambers, Finsbury Pavement, E.C.

International Coal and Coke Company.—This enterprise, practically a subsidiary company of the Granby Consolidated Mining Smelting and Power Co. is proceeding with the development of its colliery, near Blairmore Alta. The authorized capital is $3,000,000 in shares of a par value of $1.00. The officers are:—A. C. Flumerfelt, president; H. N. Galer, treasurer; and W. G. Graves, secretary. At date there are about 600 feet of drifts on the various seams. The coal is of good coking quality, and when the coking plant is completed the company will be in an excellent position to supply the Granby Smelter.

Tyee Copper Company.—This company had a very successful month during May. The report to the head office at London, England, shows most gratifying returns. There has been in May 4,260 tons of ore smelted. The company ships its matte to the Tacoma smelter, and the receipts for the present month have been $63,500. The output from the Tyee has continued very steadily since the smelter was installed at Ladysmith. For March, with only 25 days' smelting, there was a yield of $52,336; in April 4,550 tons of ore were smelted 418 tons of matte produced. The value of the products for April was $60,313. The month of May has followed with a production similar to that of the preceding months.

Snowshoe Gold and Copper.—For several weeks past the tonnage from the Snowshoe has been steadily getting larger, and it is fully expected that, with normal conditions, it will soon be enlarged to 500 tons daily, which could be maintained from the property without trouble. General work at the Snowshoe has also been progressing most favourably of late, ore being shipped from several parts of the mine, including the new glory hole, near the end of the No. 2 railway spur, which is said to be some of the best in the mine. On the main incline shaft the work of timbering it to the third level and below is completed, and the pocket at the foot is also finished, so that as soon as the rails are laid for the two-ton skips to run on, the shaft will be ready for use. The new 150 h.p. electric hoist, the first of its kind and the largest of any kind in the Boundary country is all ready for use, and will probably be placed in commission on or about the 1st of July. The new 150 h.p. boiler, the largest yet brought into the Boundary, is expected to arrive before long and will largely augment the boiler capacity of the mine.

Nickel Plate Mine.—Development on this mine has continued during the year with a force of 25 to 50 men, and about a mile of underground work has been completed in all, and 350 feet in depth has been attained. During the year it was decided to build a plant for the reduction of ore, and the erection of a 40-stamp mill, with concentrators and cyanide plant, is now in progress. The works are situate at the junction of Twenty-Mile Creek and the Similkameen River. The motive power for the mill will be taken from Twenty-Mile Creek at a point about 3 miles distant from the mine. A tramway to carry the ore from the mine to the mill was begun during the latter part of last year, and it is expected the completed plant will be in operation by the latter part of the present year.

Canadian Mining Institute

INCORPORATED BY ACT OF PARLIAMENT 1898

AIMS AND OBJECTS.

(A) To promote the Arts and Sciences connected with the economical production of valuable minerals and metals, by means of meetings for the reading and discussion of technical papers, and the subsequent distribution of such information as may be gained through the medium of publications.

(B) The establishment of a central reference library and a headquarters for the purpose of this organisation.

(C) To take concerted action upon such matters as effect the mining and metallurgical industries of the Dominion of Canada.

(D) To encourage and promote these industries by all lawful and honourable means.

MEMBERSHIP.

MEMBERS shall be persons engaged in the direction and operation of mines and metallurgical works, mining engineers, geologists, metallurgists, or chemists, and such other persons as the Council may see fit to elect.

STUDENT MEMBERS shall include persons who are qualifying themselves for the profession of mining or metallurgical engineering, students in pure and applied science in any technical school in the Dominion, and such other persons, up to the age of 25 years, who shall be engaged as apprentices or assistants in mining, metallurgical or geological work, or who may desire to participate in the benefits of the meetings, library and publications of the Institute. Student Members shall be eligible for election as Members after the age of 25 years.

SUBSCRIPTION.

Members yearly subscription.....$10 00
Student Members do 2 00

PUBLICATIONS.

Vol. I, 1898, 66 pp., out of print.
Vol. II, 1899, 285 pp., bound red cloth.
Vol. III, 1900, 270 pp., " "
Vol. IV, 1901, 333 pp., " "
Vol. V, 1902, 700 pp., " "
Vol. VI, 1903, 600 pp., now in press.

Membership in the Canadian Mining Institute is open to everyone interested in promoting the profession and industry of mining without qualification or restrictions.

Forms of application for membership, and copies of the Journal of the Institute, etc., may be obtained upon application to

B. T. A. BELL, Secretary,
Orme's Hall, Ottawa.

PROVINCE of QUEBEC

The attention of Miners and Capitalists in the United States and in Europe is invited to the

GREAT MINERAL TERRITORY

Open for investment in the Province of Quebec.

Gold, Silver, Copper, Iron, Asbestos, Mica, Plumbago, Phosphate, Chromic Iron, Galena, Etc.

ORNAMENTAL AND STRUCTURAL MATERIALS IN ABUNDANT VARIETY.

The Mining Law gives absolute security to Title, and has been specially framed for the encouragement of Mining.

Mining concessions are divided into three classes :—

1. In unsurveyed territory (*a*) the first class contains 400 acres, (*b*) the second, 200 acres, and (*c*) the third, 100 acres.

2. In surveyed townships the three classes respectively comprise one, two and four lots.

All lands supposed to contain mines or ores belonging to the Crown may be acquired from the Commissioner of Colonization and Mines (*a*) as a mining concession by purchase, or (*b*) be occupied and worked under a mining license.

No sale of mining concessions containing more than 400 acres in superficies can be made by the Commissioner to the same person. The Governor-in-Council may, however, grant a larger extent of territory up to 1,000 acres under special circumstances.

The rates charged and to be paid in full at the time of the purchase are $5 and $10 per acre for mining lands containing the superior metals* ; the first named price being for lands situated more than 12 miles aud the last named for lands situated less than 12 miles from the railway.

If containing the inferior metal, $2 and $4 according to distance from railway.

Unless stipulated to the contrary in the letters patent in concessions for the mining of superior metals, the purchaser has the right to mine for all metals found therein ; in concessions for the mlning of the inferior metals, those only may be mined for.

*The superior metals include the ores of gold, silver, lead, copper, nickel, graphite, asbestos, mica, and phosphate of lime. The words inferior metals include all other minerals and ores.

Mining lands are sold on the express condition that the purchaser shall commence *bona fide* to mine within two years from the date of purchase, and shall not spend less than $500 if mining for the superior metals ; and not iess than $200 if for inferior metals. In default, cancellation of sale of mining lands.

(*b*) Licenses may be obtained from the Commissioner on the following terms :—Application for an exploration and prospecting license, if the mine is on private land, $2 for every 100 acres or fraction oi 100 ; if the mine is on Crown lands (1) in unsurveyed territory, $5 for every 100 acres, and (2) in unsurveyed territory, $5 for each square mile, the license to be valid for three months and renewable. The holder of such license may afterwards purchase the mine, paying the prices mentioned.

Licenses for mining are of two kinds : Private lands licenses where the mining rights belong to the Crown, and public lands licenses. These licenses are granted on payment of a fee oi $5 and an annual rental of $1 per acre. Each license is granted for 200 acres or less, but not for more ; is valid for one year, and is renewable on the same terms as those on which it was originally granted. The Governor-in-Council may at any time require the payment of the royalty in lieu of fees for a mining license and the annual rental - such royalties, unless otherwise determined by letters patent or other title from the Crown, being fixed at a rate not to exceed three per cent. of the value at th mine of the mineral extracted after deducting the cost of mining it.

The fullest information will be cheerfully given on application to

THE MINISTER OF LANDS, MINES AND FISHERIES,

PARLIAMENT BUILDINGS, QUEBEC, P. Q.

PROVINCE OF NOVA SCOTIA.

Leases for Mines of Gold, Silver, Coal, Iron, Copper, Lead, Tin

—AND—

PRECIOUS STONES.

TITLES GIVEN DIRECT FROM THE CROWN, ROYALTIES AND RENTALS MODERATE.

GOLD AND SILVER.

Under the provisions of Chap. 1, Acts of 1892, of Mines and Minerals, Licenses are issued for prospecting Gold and Silver for a term of twelve months. Mines of Gold and Silver are laid off in areas of 150 by 250 feet, any number of which up to one hundred can be included in one License, provided that the length of the block does not exceed twice its width. The cost is 50 cents per area. Leases of any number of areas are granted for a term of 40 years at $2.00 per area. These leases are forfeitable if not worked, but advantage can be taken of a recent Act by which on payment of 50 cents annually for each area contained in the lease it becomes non-forfeitable if the labor be not performed.

Licenses are issued to owners of quartz crushing mills who are required to pay Royalty on all the Gold they extract at the rate of two per cent. on smelted Gold valued at $19 an ounce, and on smelted Gold valued at $18 an ounce.

Applications for Licenses or Leases are receivable at the office of the Commissioner of Public Works and Mines each week day from 10 a.m. to 4 p.m., except Saturday, when the hours are from 10 to 1. Licenses are issued in the order of application according to priority. If a person discovers Gold in any part of the Province, he may stake out the boundaries of the areas he desires to obtain, and this gives him one week and twenty-four hours for every 15 miles from Halifax in which to make application at the Department for his ground.

MINES OTHER THAN GOLD AND SILVER.

Licenses to search for eighteen months are issued, at a cost of thirty dollars, for minerals other than Gold and Silver, out of which areas can be selected for mining under lease. These leases are for four renewable terms of twenty years each. The cost for the first year is fifty dollars, and an annual rental of thirty dollars secures each lease from liability to forfeiture for non-working.

All rentals are refunded if afterwards the areas are worked and pay royalties. All titles, transfers, etc., of minerals are registered by the Mines Department for a nominal fee, and provision is made for lessees and licensees whereby they can acquired promptly either by arrangement with the owner or by arbitration all land required for their mining works.

The Government as a security for the payment of royalties, makes the royalties first lien on the plant and fixtures of the mine.

The unusually generous conditions under which the Government of Nova Scotia grants its minerals have introduced many outside capitalists, who have always stated that the Mining laws of the Province were the best they had had experience of.

The royalties on the remaining minerals are: Copper, four cents on every unit; Lead, two cents upon every unit; Iron, five cents on every ton; Tin and Precious Stones, five per cent.; Coal, 10 cents on every ton sold.

The Gold district of the Province extends along its entire Atlantic coast, and varies in width from 10 to 40 miles, and embraces an area of over three thousand miles, and is traversed by good roads and accessible at all points by water. Coal is known in the Counties of Cumberland, Colchester, Pictou and Antigonish, and at numerous points in the Island of Cape Breton. The ores of Iron, Copper, etc., are met at numerous points, and are being rapidly secured by miners and investors.

Copies of the Mining Law and any information can be had on application to

THE HON. A. DRYSDALE,
Commissioner Public Works and Mines,
HALIFAX, NOVA SCOTIA.

DOMINION OF CANADA

SYNOPSIS OF REGULATIONS

For Disposal of Minerals on Dominion Lands in Manitoba, the North-West Territories, and the Yukon Territory.

COAL.

Coal lands may be purchased at $10.00 per acre for soft coal, and $20.00 for anthracite. Not more than 320 acres can be acquired by one individual or company. Royalty at such rate as may from time to time be specified by Order-in-Council shall be collected on the gross output.

QUARTZ.

Persons of eighteen years and over and joint stock companies holding Free Miner's certificates may obtain entry for a mining location.

A Free Miner's Certificate is granted for one or more years, not exceeding five, upon payment in advance of $10.00 per annum for an individual, and from $50.00 to $100.00 per annum for a company, according to capital.

A Free Miner having discovered mineral in place may locate a claim 1500 x 1500 feet by marking out the same with two legal posts, bearing location notices, one at each end of the line of the lode or vein.

The claim shall be recorded within fifteen days if located within ten miles of a Mining Recorder's Office, one additional day allowed for every additional ten miles or fraction. The fee for recording a claim is $5.00.

At least $100.00 must be expended on the claim each year or paid to the Mining Recorder in lieu thereof. When $500.00 has been expended or paid the locator may, upon having a survey made and upon complying with other requirements, purchase the land at $1.00 per acre.

Permission may be granted by the Minister of the Interior to locate claims containing iron and mica, also copper in the Yukon Territory, of an area not exceeding 160 acres.

The patent for a mining location shall provide for the payment of royalty on the sales not exceeding five per cent.

PLACER MINING, MANITOBA AND THE N.W.T., EXCEPTING THE YUKON TERRITORY.

Placer mining claims generally are 100 feet square; entry fee, $5.00, renewable yearly. On the North Saskatchewan River claims are either bar or bench, the former being 100 feet long and extending between high and low water mark. The latter includes bar diggings, but extends back to the base of the hill or bank, but not exceeding 1,000 feet. Where steam power is used, claims 200 feet wide may be obtained.

DREDGING IN THE RIVERS OF MANITOBA AND THE N.W.T., EXCEPTING THE YUKON TERRITORY.

A Free Miner may obtain only two leases of five miles each for a term of twenty years, renewable in the discretion of the Minister of the Interior.

The lessee's right is confined to the submerged bed or bars of the river below low water mark, and subject to the rights of all persons who have, or who may receive entries for bar diggings or bench claims, except on the Saskatchewan River, where the lessee may dredge to high water mark on each alternate leasehold.

The lessee shall have a dredge in operation within one season from the date of the lease for each five miles, but where a person or company has obtained more than one lease one dredge for each fifteen miles or fraction is sufficient. Rental $10.00 per annum for each mile of river leased. Royalty at the rate of two and a half per cent., collected on the output after it exceeds $10,000.00.

DREDGING IN THE YUKON TERRITORY.

Six leases of five miles each may be granted to a free miner for a term of twenty years, also renewable.

The lessee's right is confined to the submerged bed or bars in the rivers below low water mark, that boundary to be fixed by its position on the 1st day of August in the year of the date of the lease.

The lessee shall have one dredge in operation within two years from the date of the lease, and one dredge for each five miles within six years from such date. Rental, $100.00 per mile for first year, and $10.00 per mile for each subsequent year. Royalty ten per cent on the output in excess of $15,000.00.

PLACER MINING IN THE YUKON TERRITORY.

Creek, Gulch, River, and Hill claims shall not exceed 250 feet in length, measured on the base line or general direction of the creek or gulch, the width being from 1,000 to 2,000 feet. All other Placer claims shall be 250 feet square.

Claims are marked by two legal posts, one at each end bearing notices. Entry must be obtained within ten days if the claim is within ten miles of Mining Recorder's office. One extra day allowed for each additional ten miles or fraction.

The person or company staking a claim must hold a Free Miner's certificate.

The discoverer of a new mine is entitled to a claim 1,000 feet in length, and if the party consists of two, 1,500 feet altogether, on the output of which no royalty shall be charged, the rest of the party ordinary claims only.

Entry fee $15.00. Royalty at the rate of 2½ per cent. on the value of the gold shipped from the Territory to be paid to the Comptroller.

No Free Miner shall receive a grant of more than one mining claim on each separate river, creek, or gulch, but the same miner may hold any number of claims by purchase, and Free Miners may work their claims in partnership, by filing notice and paying fee of $2.00. A claim may be abandoned and another obtained on the same creek, gulch, or river, by giving notice, and paying a fee.

Work must be done on a claim each year to the value of at least $200.00, or in lieu of work payment may be made to the Mining Recorder each year for the first three years of $200.00, and after that $400.00 for each year.

A certificate that work has been done or fee paid must be obtained each year; if not, the claim shall be deemed to be abandoned, and open to occupation and entry by a Free Miner.

The boundaries of a claim may be defined absolutely by having a survey made, and publishing notices in the *Yukon Official Gazette*.

HYDRAULIC MINING, YUKON TERRITORY.

Locations suitable for hydraulic mining, having a frontage of from one to five miles, and a depth of one mile or more, may be leased for twenty years, provided the ground has been prospected by the applicant or his agent; is found to be unsuitable for placer mining; and does not include within its boundaries any mining claims already granted. A rental of $150.00 for each mile of frontage, at the rate of 2½ per cent. on the value of the gold shipped from the Territory. Operations must be commenced within one year from the date of the lease, and not less than $5,000.00 must be expended annually. The lease excludes all base metals, quartz, and coal, and provides for the withdrawal of unoperated land for agricultural or building purposes.

PETROLEUM.

All unappropriated Dominion Lands shall, after the first of July, 1901, be open to prospecting for petroleum. Should the prospector discover oil in paying quantities he may acquire 640 acres of available land, including and surrounding his discovery, at the rate of $1.00 an acre, subject to royalty at such rate as may be specified by Order in Council

JAMES A. SMART,
Deputy of the Minister of the Interior.

OTTAWA, 9th Dec., 1901.

CONTRACTORS TO H. M. GOVERNMENT

Allan, Whyte & Co.

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Rutherglen, Glasgow, Scotland

MANUFACTURERS OF

WIRE ROPES for Collieries, Mines, Aerial Tramways

Transmission of Power, Logging and general Hauling and Hoisting Purposes.
Wire specially selected for own exclusive use.
We have made many records with our Winding, Haulage and Crane Ropes.

Illustration of ¾" diar. Special Improved Patent Steel Wire Rope, 1760 yards long, supplied to Dalzell Colliery, Motherwell, Scot., which ran two years and 8 months, shewing condition when taken off. Previous rope from another maker lasted 1 year and 9 months

TELEGRAMS—"Ropery Rutherglen." A B C, A I and Lieber's Codes used.

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W. H. Thorne & Co. Ltd., Saint John, N.B.

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John Burns, Vancouver, B. C.

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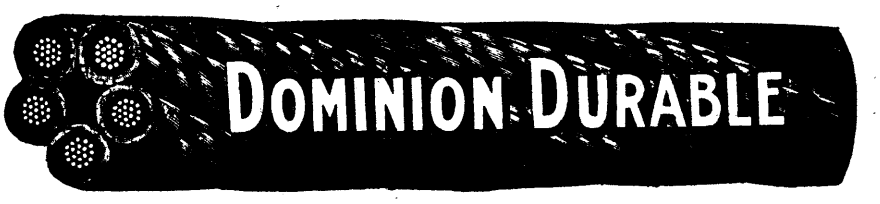

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The Wearing Surface of Hemp. **The Strength of Wire.**

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UNEXCELLED FOR TRANSMISSION AND PILE DRIVING PURPOSES

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RELAYING RAILS 30 lbs., 45 lbs., 56 lbs., 65 lbs. per Yard

IMMEDIATE SHIPMENT.

LIGHT MINING RAILS

12 lbs., 16 lbs., 25 lbs., 30 lbs., per Yard

..IN STOCK..

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