Prof Gwillims

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A HAPPY NEW YEAR

For our subscribers, our contributors, our advertisers, and for the whole brotherhood of mining we wish a Happy and Prosperious New Year. May every legitimate ambition be fulfilled, may peace reign privately and publicly, and may all and sundry conspire to work out manfully the destiny of Empire and Nation.

THE YEAR 1912—A REVIEW

Attempting the role of prophet is dangerous. Twelve months ago, in estimating the probable total value of Canada's mineral output for the year 1911, we exceeded the mark by some millions of dollars. There was, however, some excuse for this. Labour troubles in the West, the re-organization of Amalgamated Asbestos, and other such incidents cut down the gross mineral production.

Despite our previous over-estimate, we venture now to assert that for the year that has just closed there will be recorded a considerably higher total value for the product of mine and smelter. The following paragraph will develop our reasons for so thinking:

Nova Scotia.—Once again has our easternmost Province exceeded all previous records in coal production. Actual figures are, of course, not yet available. But the increase has been considerable. The Springhill collieries, under the management of the Dominion Coal Company, have contributed steadily. Both the Dominion Coal Company's and the Nova Scotia Steel & Coal Company's Cape Breton collieries have yielded many thousands of tons more than during 1911. The former company's outputs are greater by at least half a million tons; the latter, by about sixty thousand tons. Except in the case of Springhill, where the output has been brought up by more than one hundred and fifty thousand tons, other changes of figures are mostly light recessions.

While the gold yield has presumably stood still, the fact remains that several important negotiations are pending that will, we hope, do justice to the real possibilities of the Province's extensive and largely improved gold fields.

Gypsum quarrying has been active. There is reason to believe (and here we quote from semi-official advices) that the shipments have been of greater bulk than before.

Manganese mining, though still carried on in a small way, shows signs of strength. Iron ore mining and concentrating have been established and will prosper. Other mineral industries are still awaiting intelligent exploitation.

The iron smelting and steel plants of Nova Scotia have had a good year. New equipment and a strong market have combined to keep up a more than normal pressure. The certain inception of a shipbuilding industry will warrant gradual expansion.

New Brunswick.—Only in a mild wiy is New Brunswick a mining Province. The iron property of the Canada Iron Corporation near Bathurst is equipped and producing. Gypsum is quarried in the southern part of the Province. Apart from these two industries the principal activities are the development of the most important gas and oil fields near Moncton, and the projected exploitation of the oil shales in and about the same district. New Brunswick possesses known deposits of antimony, copper, tungsten, gold, and coal. But there has been practically no effort made by the Provincial Government to advertise its resources. The Government includes no organized Department of Mines, and is, apparently, content to drift along, year after year, in stolid indifference to the industry of mining.

Quebec.—Far otherwise is it with Quebec. The Government of that Province has for some years taken the keenest interest in the industry. The laws have been revised and altered. The prospector has been encouraged, excellent annual reports are issued, and every encouragement is offered to the investor.

Asbestos mining has been placed on a much better footing during the year. In fact it appears probable that this branch of the industry has recovered from its late indisposition. Copper mining, or, rather, the mining of copper-bearing iron pyrites, is progressing. Gold dredging in Beauce county is being actively carried on. Other minor industries, such as the mining or quarrying of magnesite slate, building stones, etc., are in good condition. The past year, indeed, has brought to Quebec a marked measure of prosperity.

Ontario.—The outstanding feature of the year in Ontario has been the increasing importance of gold mining in Porcupine. While Cobalt has preserved the even tenor of its way, while the copper-nickel industry at Copper Cliff has flourished and is about to be much enlarged, and while other branches of mining have been active, Porcupine has occupied the centre of the stage. With an output of gold for about six months of the past year approaching two million dollars, the product of less than one hundred stamps, Porcupine is assuredly making good. Before the end of 1913 there will be at least two hundred stamps dropping. It is within limits to estimate the probable output for 1913 at, say, five million dollars. It is impressive and encouraging to know that other camps, Swastika, Michipicoten, Rainy River, and Lake of the Woods, will add considerably to this total.

While Cobalt's production of silver is slightly lower for 1912 than for 1911, the higher price of silver brings the gross value up to a larger figure. The year was marked by several important discoveries, and by great activity in leasing old properties. Gowganda has more than held its own, despite the closing of the Millerett, and there are signs of life in the Elk Lake region.

Whilst it is impracticable here even to mention all the branches of active mining in Ontario, it is well to touch upon certain facts that have changed and improved the position of certain regions. The re-opening of the old Belmont iron mine in Eastern Ontario is at once significant and inspiring. The operating company is a strong Buffalo concern. If success crowns their efforts much good will follow for the whole district. Equally significant is the re-opening of the long-abandoned Cordova gold mine. And here we may remark that it would be well, indeed, if more mining investors took pains to look into the gold regions of Eastern Ontario.

Talc milling has attained the status of an established and growing industry, and the Canadian product has a world-wide market. The mining of iron pyrite is also advancing.

Looking westward, there is tangible evidence of growth in Michipicoten and in other parts.

Alberta.—It is most satisfactory to note that the subbituminous coal mines have had an exceedingly satisfactory year. So strong has the market been that these collieries have been quite unable to meet the demand for their product.

The danger of a fuel famine seems to be less imminent than before, although the situation is by no means free from adverse possibilities. Lack of transportation facilities is alone responsible for this. The actual coal output of the Province has gone up by leaps and bounds. For the year 1912 it will be practically double the output of 1911.

British Columbia.—Like Ontario, British Columbia has experienced a singularly prosperious year in mining. The tonnage of ore mined was much larger than that recorded for 1911, partly on account of the labour troubles of 1911, and partly on account of strong expansion. Copper was produced to the extent of fifty million pounds, as compared with thirty-eight million pounds in 1910. This constitutes a high record. Comparison with 1911 would be meaningless. Gold production was nearly at record figures. The silver yield was the highest in five years. Lead reached the total of thirty-five million tons, closely approximating the yield of 1910, and exceeding that of 1911 by about nine million pounds. During the greater part of the year, no bounty was paid on lead as the London price was above the bounty limit.

The production of zinc and iron was negligible.

Coal outputs were within comparatively few thousands of tons of the highest mark attained.

Taken as a whole, the year was easily the most profitable in the history of the Province. Dividends to the amount of $1,200,000 were paid by metalliferous mines for the first time in some years.

General.

Technical Education.—Since the report of the Royal Commission on Technical Education has not yet appeared, there has been little change in the established order of things. Amongst the most important incidents are the extension of the metallurgical department of Toronto University and the completion of the new mineralogical building, Nicol Hall, at Queen's University. The Commission's report is looked forward to with eagerness. It will probably appear early in January of this year.

Legislation.—Nothing of importance has been enacted in relation to mining either in the Dominion or the Provincial Legislatures. The draft of a general mining law, drawn up by a committee of the Canadian Mining Institute, is still in "statu quo ante bellum." Nor does there seem to be much hope that Parliament will discuss the matter this winter. Naval affairs will probably cause a pronounced congestion, and other matters will be neglected. Should this be the case, the Dominion Government will have been guilty of an obvious direlection of duty.

The problem of workingmen's compensation has been discussed and reported upon in Ontario. The labour element has placed itself in an invidious position in its endeavours to organize a superfluous strike in Porcupine. It is a fact, a curious fact, that organized labour takes no steps to remedy evils. This is left to organized capital. The function of labour is apparently the black-mailings of the capitalist after he is committed to definite investment. It is just here that our laws are constructively deficient. If the Conciliation Act means anything it implies that a means is provided whereby differences as between employer and employee may be reconciled without recourse to the crude strike. Of late, the Act has been a dead letter. It has been used only when it suited the purposes of one or of both parties. It has never been a binding obligation upon either. In fact, it has resolved itself into a subterfuge rather than a remedy. That it should be the latter, no one will dispute. The difficulty lies, we think, in inducing employers to present the whole situation completely and sanely. As has been said frequently in these columns, the interests of employer and employee are ultimately identical.

Departmental.—In our next issue will appear complete accounts of the work of each Dominion and Provincial Department of Mines for the past year. Here we may be permitted to remark that only Nova Scotia, Quebec, Ontario, and British Columbia have adequate Departments. New Brunswick, Manitoba, Alberta, and Saskatchewan are entirely neglectful of the mining industry.

While the Dominion Government has not yet seen fit to erect a separate Department of Mining, there is hope that this will be done in the near future. The futile policy of tacking mining on to another Department as an adjunct should have been outgrown long ago.

The Canadian Mining Institute.—Harmony reigns in the Institute. Possibly too much harmony. We are neither anarchists nor disturbers of the peace. But we are firm believers in the moral value of an occasional disturbance. However, there does not appear to be a cloud of even the size of a man's hand upon the horizon. Yet our trust is in the membership of the Institute. We know perfectly well, that some kicker will arise before the next Annual Meeting. And we will trust to him to make an interesting cloud of dust.

The Profession.—A year ago we remarked that Canada had become the "popular hunting-ground for many mining engineers from foreign parts." This is yet true. It is is also true that Montreal, Toronto, Calgary, and Vancouver have had the names of many mining engineers added to their directorate during 1912. The two former cities are liberally supplied with mining talent. Most of the new arrivals, fortunately, have specific connections where with to occupy themselves. Otherwise Canada is hardly a promising field. The consulting engineer, sad to state, has not yet an established hold upon the Canadian public. Time will cure this condition.

Opportunities.—In drawing attention to mining opportunities in Canada there is every chance of being over-enthusiastic. Therefore it may be pursuing the safest course merely to point out the fact that in every mining Province, and in many unsuspected regions, there exist excellent chances forthe mining investor. It is necessary, however, to be fully seized of the fact that it requires money to find what is wanted. It is useless, for instance, to begin prospecting unless the prospector is provided with ample means to test his territory. Moreover, it is futile to break into the game at all without having the wherewithal to carry it to a definite conclusion. Foreign investors are singularly obtuse, almost as obtuse as the native variety. But history is being made. Canada is yet in its swaddling clothes as a mining country.

. . . .

The year 1913 should be one of monumental progress for the mining industry of Canada. Everything points to continued expansion. The past year has been wonderfully encouraging. This year, we believe, will be even more so.

EDITORIAL NOTES

Satisfactory preliminary reports from Quebec and British Columbia are printed in this issue of the Canadian Mining Journal. More complete reports from each Province will appear on January 15th.

The Hawthorne trial, for which a number of Canadian witnesses have been called, may be brought to a conclusion some time in January. United States procedure is singularly complicated and slow. But the tangled skein is almost straightened out. Many picturesque aspects of the promoting game have been re-

vealed. While it is not yet proper to make final comment, it appears safe to assume that justice will be meted out. Justice Hough, before whom the accused are being tried, is the official who sentenced Morse, the "Ice King," to penitentiary some years ago.

Dr. J. Austin Bancroft, of the Geological Department, McGill University, has reported upon the alleged discovery of diamonds near Matagami lake. The blue clays, according to Dr. Bancroft, are merely deposits of aqueous origin, and have not been derived from the communication of basic igneous rocks. He holds out no hope of existence of diamantiferous ground in the region.

Erroneous press despatches in connection with the Hawthorne trial have confounded the identities of Dr. Robert Bell, late acting-Director of the Geological Survey, and Mr. J. McIntosh Bell, mining geologist and engineer to Messrs. Ehrlich & Company, London, England. Mr. J. McIntosh Bell had no connection, either directly or indirectly, with the Hawthorne matter.

The insinuating oil promoter spares no pains. Not content with ordinary channels, an English firm of alleged bankers, Hatton, Morris & Co., inserts in the November Strand magazine (English edition) a dodger offering free 5 per cent. income certificates and a large amount of cash. The company owns, or pretends to own, 1,300 acres of oil lands. That is the only fact that can be gathered from the dodger. Readers of the Strand are invited to send in their names. "If you receive no reply you will understand that the whole of this wonderful cash and bonus offer has been over applied for." Just so! And the Strand allows its pages to be dirtied with this nonsense!

HOW TO TEST FOR FIREDAMP.

Acting on the recommendation of the chief inspector of mines for the province (Mr. Thomas Graham), Sir Richard McBride, premier and minister of mines for British Columbia, has had distributed among a number of men connected with coal mining in the province a pocket folding card on which has been printed brief instructions "How to Test for Firedamp," as follows:

"To test for firedamp the flame of the ordinary miner's safety lamp must be carefully turned down until only a faint line of blue is seen over the yellow eye or centre, as shown in the illustration.

"The presence of firedamp in the air is indicated by a pale triangular form—common called a 'cap'—which appears over the top of the blue line, varying in size and intensity according to the amount of firedamp. The 'cap' begins to appear when there is about one per cent. of firedamp, and if there is less than two per cent., only the lower part of the 'cap' can be clearly distinguished; but when the amount is about two per cent. the whole of the 'cap,' including the tip, is visible, though, as shown in Fig. 2, it is very faint. The greater the amount of firedamp present, the plainer becomes the 'cap.' With three per cent. (Fig. 4) it is longer as well as more distinct, and with higher percentages the 'cap' extends up into the lamp chimney.

"In testing for small percentages of firedamp, mistakes may easily arise unless the observer makes himself quite familiar with the appearance of the lowered flame as seen in the pure air of an intake road. If there is any petroleum spirit in the oil, particularly if the metal of the lamp is wet with it, a faint 'cap,' called a 'fuel cap' or 'oil cap' is sometimes seen, but by carefully examining the appearance of the lamp in places where the air contains no gas, one can readily learn to distinguish the 'fuel cap' from the 'firedamp cap.'

"If a complete 'cap' (such as is shown in Fig. 2) however faint, is visible on the lowered flame, men should withdraw at once from the working place, and inform the fireman or other official responsible for the ventilation."

The illustrations, which it is not practicable to reproduce here, show clearly the 'cap' mentioned, in several stages. The card is issued by the British Home Office; it can be purchased from Old Country booksellers at the price of three cents.

ELECTRIC SAFETY LAMPS IN COAL MINES.

Both the British and German Governments are offering prizes for miners' electric lamps suitable for practical use and provided with a reliable fire-damp indicator. A condition of the German competition is that both the lamp and the indicator shall be safe in presence of firedamp, even if damaged, and must be capable of continuous service for at least 12 consecutive hours. The lamps must be handy, durable, simple in construction, capable of being securely fastened, easily attended, and economical in use. The indicator must be at least equal to the benzine safety lamp in sensitiveness to methane and foul air. After burning 12 hours, muststill give a light equal to 1 Hefner unit. The prize offered is 25,000 marks.

A FEDERAL MINING LAW.

Dr. R. W. Brock, director of the Geological Survey of Canada, included the following comment on a proposed Federal mining law in the recently-issued "Summary Report" for 1911: "The Canadian Mining Institute for some years has been urging a Federal mining law to govern the acquisition of mining rights on lands under the control of the Dominion Government, on the grounds that the industry has now attained an importance deserving this recognition, and that a law would greatly stimulate the development of the mineral resources on Crown lands. It is also believed that the provinces having control of mining lands will make their mining laws conform closely to the Federal law, and thus secure, throughout the Dominion, uniformity in the mode of dealing with mining rights. At the suggestion of the Government, the Institute formulated the principles upon which it desired the law to be based. Mr. J. M. Clark was engaged to draft an Act based on these principles. Subsequently, Mr. F. T. Congdon and the Director of the Survey, were requested by the Committee on Mining Law of the Institute, to revise this draft. After spending several months on the work they submitted a new draft which, with a few minor changes, has been accepted and recommended to the Government by the Canadian Mining Institute."

THE MINING INDUSTRY IN THE PROVINCE OF QUEBEC DURING, 1911.

T. C. Denis.*

By far the greater proportion of the mineral production of the Province of Quebec is derived from non-metallic products. In fact, during the year 1911, the metal mines contributed but 3 per cent. to the total yearly mineral production of Quebec. This is very low and liable to give a false impression of the possibilities of our metalliferous resources. This low metallic output is not necessarily a matter for discouragement, for if we consider our sister province Ontario, we see that over 50 per cent. of the value of its total mineral production is extracted from two fields, which are only a few square miles in area, viz., silver from Cobalt, and nickel from Sudbury. In the immense territory which constitutes the province of Quebec, the greater part of which is practically untouched, there are numerous bands of rocks similar to those which have given rise to the celebrated metal mines of Ontario, and the presence of such deposits may be revealed at any time in our province.

According to the Mining Laws of the province of Quebec, the operators of mines and quarries are required to make returns of their production in the first ten days of January of each year. It is, therefore, impossible, at this early date, to give more than surmises as to the mineral production for 1912.

In 1911, the total value of the products of mines and quarries of the province of Quebec amounted to $8,679,786, and from all appearances, there will be a substantial increase in 1912.

After having passed through a rather critical period of two years, owing to over-production and glutting of the market, the asbestos industry is gradually resuming a normal state. At present, there appears to be a greater demand for the long fibre qualities and prices for grades of $60 and over are satisfactory. The prices for lower grades, however, are still below normal, and are not remunerative.

In consequence, only the mines which can produce a certain proportion of good fibre were operated during the year. In Thetford and Black Lake, great activity ruled during all summer and fall, and some difficulty was experienced in getting the necessary labour. All of the East Broughton mines were closed down, as the rock in that field is essentially milling rock and the fibre is short.

In 1911, the shipments of asbestos amounted to a value of over $3,000,000. The shipments of asbestos over the Q.C.R. for the first nine months of 1912 showed an increase in tonnage of some 12½ per cent., as compared with the corresponding period of 1911. From this it may be augured that, in spite of the closing down of the East Broughton mines, the value of the asbestos production for 1912 will be higher than in 1911.

The increase in the price of copper caused a renewal of interest in the Eastern Townships deposits of this metal. However, only two mines shipped ore; the McDonald mine and the Eustis mine.

The McDonald mine at Weedon is operated by the East Canada Smelting Company. It was in very active operation all year. During the early part of the year when the ore had to be teamed six miles to the railway, the shipments were at the rate of 2,000 tons a month. In the spring, this progressive company installed an aerial tramway, four miles long, of a capacity of 200 tons per 10 hours, which decreased the cost of hauling to about one-tenth, and the shipments for the last six months have increased tremendously. The development is kept well ahead of mining and they have a good reserve of ore blocked out.

The ore is a pyritous copper ore, running 40 to 45 per cent. sulphur, and averaging 4 per cent copper, some shoots of ore running much higher. The sulphur contents is used for the manufacture of sulphuric acid and the copper is extracted from the cinders.

The Eustis mine worked without interruption and also greatly benefitted from the improved conditions of the copper market. The ore there is of the same nature as at the McDonald mine, the deposit and mode of occurrence being similar.

It is very likely that the Eustis Mining Company will shortly install an Elmore oil concentrator to relieve their present mill.

Considerable work was carried on in re-opening the old Ives mine and the Huntingdon mine, both on the Eastman branch of the Canadian Pacific Railway. At the Huntingdon, a concentrating mill is being installed. No shipments were made from either of these two mines.

On Calumet Island, work was carried on, interruptedly, re-opening the old lead and zinc mines. A concentrating mill of a capacity of 150 tons a day has been built, but very little has been spent in development proportionately to the cost of surface construction.

At Notre Dame des Anges, in Portneuf county, a great deal of work was done on the lead and zinc deposits mentioned last year. The ore is found in a contact zone of crystalline magnesian limestone, which in places is strongly impregnated with zinc blende and galena. This zone, in places, is quite wide, forty feet or more, and it has been followed by trenching and outcrops for half a mile or more. A concentrating mill was built during the summer, but could not be completed to start operating this year.

The production of gold is still confined to the operations of the Champs d'Or Rigaud-Vaudreuil Company, near Beauceville, and to the gold contents of the pyritous ores of the Sherbrooke district. Although considerably larger than last year, the gold production will not probably be as high as was anticipated. There is no doubt, however, that the alluvial gold industry in Beauce will henceforth grow and improve yearly.

Discoveries of lode gold were reported from Lake Kinawisik, in Northwestern Quebec, in narrow quartz stringers.

No actual mining operations were carried on in the chromite deposits, but the Black Lake Consolidated did some exploratory work and diamond drilling, which are said to have given satisfactory results.

The graphite industry received quite a setback by the closing down of the Dominion Graphite mine and mill, of Buckingham, but this was offset to some extent by the uninterrupted operations of the Bell Graphite Company and by the work of a new company, the Quebec Graphite Company, in which it is said German capital is interested.

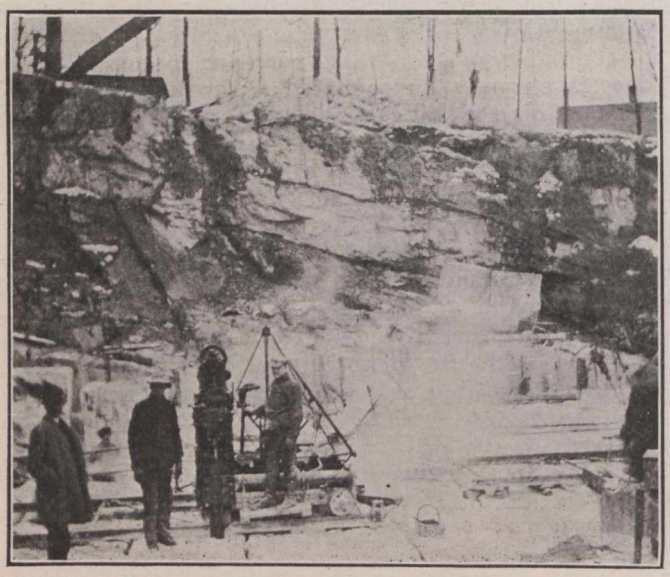
*Superintendent of Mines, Mines Branch, Quebec.

Beauce Hydraulic Co.

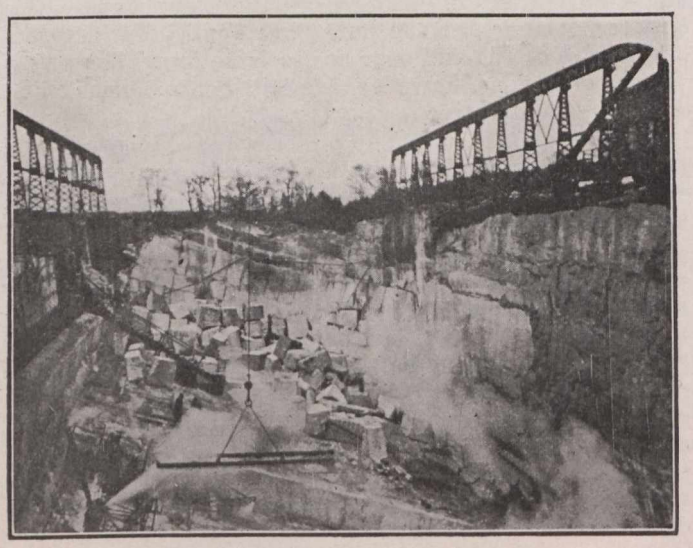
The prices ruling for mica were improved, and it is probable that the shipments will show a substantial increase over last year.

The general development of the province, and the growth of the urban centres will certainly be reflected in the figures of the building materials industry. The demand for building and ornamental stone has been very active. As an instance, two new marble quarries were opened this year and although no shipments from these were made, it is expected that, in 1913, they will be in shape to produce. One of these quarries is situated near Portage du Fort, in the Upper Ottawa region, and the other at St. Thecle, Champlain county. Both the Missisquoi Marble Company and the Dominion Marble Company, operating at Phillipsburg and South Stukely, respectively, have had a very successful year. Their products are in every way equal to the best foreign marbles.

The production of peat in the province of Quebec will probably amount to some 2,000 tons. Although small, it is the largest yearly production ever recorded. The Peat Industries, Limited, who have a modern plant installed at Ste. Brigitte, near Farnham, are responsible for the whole production.



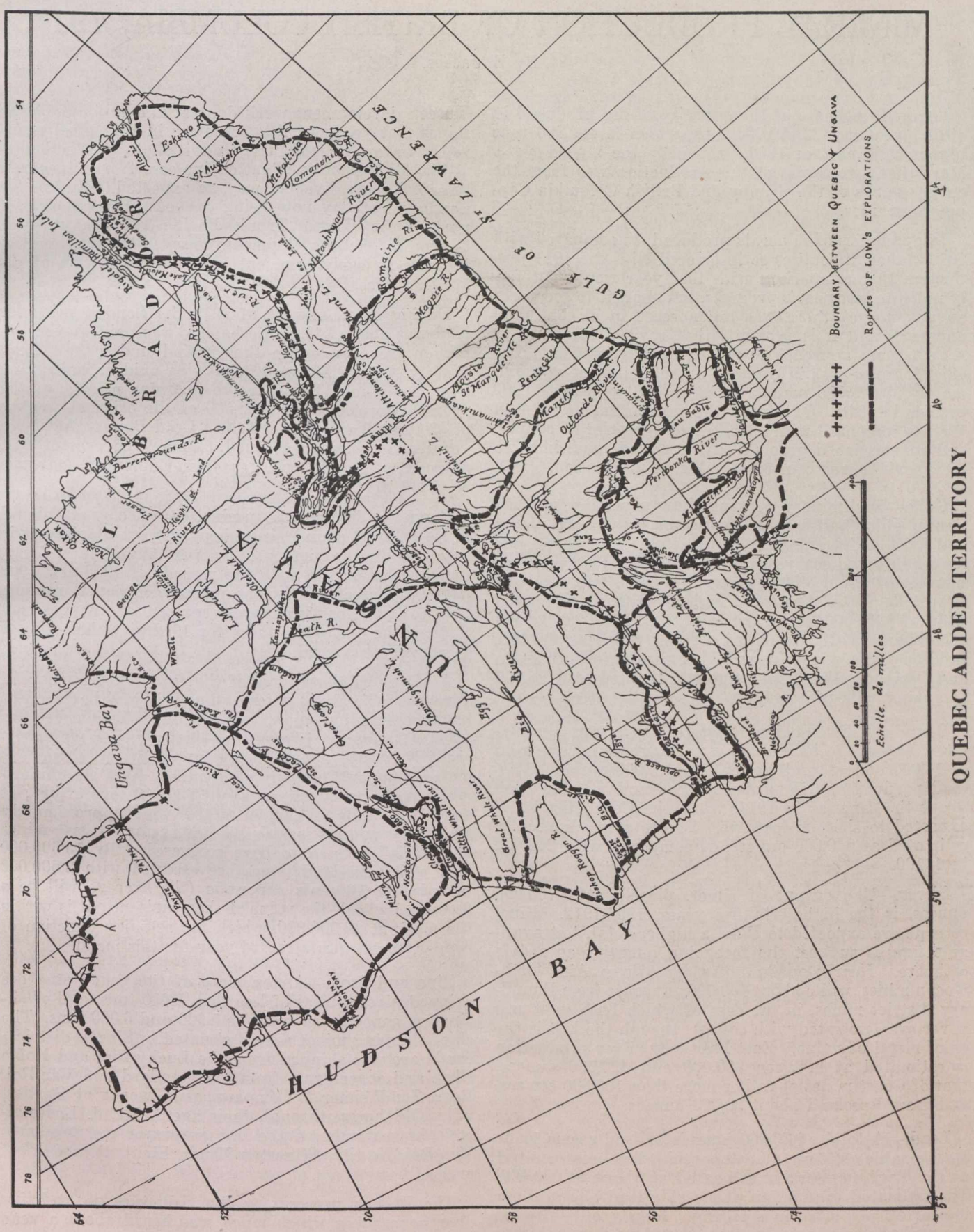
Dominion Marble Quarry, South Stukely, Quebec



View of Missisquoi Marble Quarry

In May, 1912, the boundaries of the province of Quebec were extended northward by the annexation of Ungava, and at the last session of the Quebec Legislature, this territory was officially erected under the name of New Quebec. This extension of boundaries more than doubles the area of the province which now embraces a superficies of nearly 707,000 square miles.

This territory is yet very little known. From the ex-



plorations which Mr. A. P. Low conducted for several years for the Geological Survey, it would appear to be underlain almost altogether by Archean rocks. The Laurentian formation of gneisses and granites occupy the largest portion of it, but the presence of large tracts of Huronian and Keewatin rocks have been observed and these can be regarded as offering great possibilities from the mineral standpoint.

MINERAL PRODUCTION OF BRITISH COLUMBIA, 1912.

By E. Jacobs.

A rough estimate of the quantity of ore produced in 1912 places it at 2,600,000 tons, which is 400,000 tons higher than that of 1910, previously the record year. More than two-thirds of this production was from the copper mines of the Granby and British Columbia Copper companies.

In quantities of minerals produced, as compared with 1910 (labor difficulties so interfered with the 1911 production that comparison with that year would not fair ly indicate last pear's progress, but show it to too great an advantage) there was an increase in all but gold and coal, and it is probable that revised returns will show a close approach to record figures in these. The chief increase was in copper—a production of approximately 50,000,000 pounds as compared with 38,000,000 pounds in 1910. Of course, the substantial increase in 1912 as compared with 1910 in average price of copper, and in smaller degree of silver, added materially to the year's increase in total value of production.

Gold.—Preliminary returns show a smaller production of gold than has been expected, as to both placer and lode gold. The 1911 yield of placer gold was the lowest in seventeen years; while that for 1912 gives an increase of about 3,500 ounces, it is much less than was expected. Atlin district is highest, with an estimated yield of $260,000, and Cariboo next with $200,000. All other parts of the province are put down at $15,000. Revised returns may show higher results in both Atlin and Cariboo. The total value is estimated at $485,000 as against $426,000 in 1911.

Boundary district, including Hedley camp, Similkameen, appears to have made a net increase in lode gold of 15,000 ounces, and Nelson about 3,000 ounces. Rossland production will probably be found to have been about the same as in 1911, while the Coast district is expected to show a decrease. The total production is estimated at 250,000 ounces, as compared with 268,000 in 19100.

Silver.—The output of silver, placed at 2,700,000 ounces, is the highest in five years, 1908-1912. Final returns are expected to show a higher total, but available figures suggest the foregoing quantity as a safe estimate. Nearly one-half has come from Ainsworth-Slocan mines, while about 400,000 ounces is from Boundary district mines, in the ores of which both gold and silver are associated with copper, though the last is the chief metal of value. East Kootenay silver production is estimated at between 350,000 and 400,000 ounces, that of Coast mines at rather more than 100,000 ounces, and from Rossland about 90,000 ounces.

Lead.—A total of 35,000 pounds of lead seems to be a reasonable estimate. Lead contained in ores received at the Trail smeltery is estimated at about 44,000,000. The estimated production of metallic lead allows for a loss of 20 per cent. in smelting. Nearly one-third of the lead produced was from the Standard mine, Slocan, while the Sullivan, East Kootenay, contributed a similar proportion. The Van-Roi and Rambler-Cariboo, in Slocan district, and the Emerald, in Nelson mining division, were the chief of the smaller producers, which included some 20 mines in all.

Deep development work done at half a dozen Slocan mines that produced litle or no ore in 1912 gives promise of an appreciably large addition to production in 1913. To a smaller extent an increase from mines near Salmo, Nelson division, may be expected, while in the northern country now being opened by completion of part of the Grand Trunk Pacific railway, through Skeena district, developments at several new properties indicate an early commencement of production of silver-lead ores.

During seven months of 1912 the London price for lead was above £18, so no bounty was paid by the Dominion Government in that period under the "Lead Bounty Act." About $65,000 was paid as bounty on lead in ore mined during the first five months of the year. Approximately $700,000 of the original amount of $2,500,000 voted under the "Lead Bounty Act" ten years ago remains unearned. Under the present Act, payment of bounty will "cease and determine on June 30, 1913."

Copper.—The year's production of copper, placed at 500,000,000 pounds, is without question the largest in any year in the history of copper mining in the province. Comparison with the records of 1908 and 1909 will not correctly show the increase in actual production, for some earlier figures represent the copper contents of the ore, while those for 1912 give the estimate of copper recovered.

A glance at the figures of the few larger mines will show that the above-given estimate is well based. For instance, Granby Company's ore output was more than 1,200,000 tons; at 18 pounds of copper to a ton recovered, 22,000,000 pounds is accounted for. British Columbia Copper Company (including New Dominion) mines made an output of about 620,000 tons of ore; at only 16 pounds of copper to the ton, approximately 10,000,000 pounds is also accounted for. Coast mines are officially stated to have recovered fully 15,500,000 lbs., while Rossland mines are credited with 2,500,000 pounds. At 16 cents a pounds (the average will be a fraction higher). the value of the year's output is within the mark at $8,000,000. which for actual production of copper, constitutes a record year for this metal.

Zinc and Iron.—An estimate of the crude zinc ore shipped gives a total of less than 3,000 tons, and of silver-zinc concentrate between 5,000 and 6,000 tons. The chief shipping mines are all situated in Slocan district; crude ore was shipped from the Lucky Jim and Noble Five, and concentrate from the Standard and Van-Roi. Beer, Sondheimer & Company, with works at Bartlesville, Oklahoma. through their agent, Mr. J. L. Retallack, have purchased the zinc output of the Standard, Van-Roi, Hewitt (Silverton Mines, Limited), and Monarch.

The French process for the reduction of lead-zinc ores, concerning which much was heard about a year ago, has not yet been advanced beyond the experimental stage.

While the development of deposits of iron ore on Vancouver island has continued, there was little, if any, production of iron in the province in a commercial way.

Coal and Coke.—The total production of coal was approximately 3,040,000 long tons gross or, deducting that made into coke, about 2,645,000 tons. The highest previous year's output was in 1910 with 3,139,000 tons gross and 2,800,000 tons net. The output of coke was 263,000 tons, with a single exception, (that of 271,000 tons in 1908), the greatest quantity yet produced in the province in one year. Labour troubles at two of the Vancouver island collieries interfered somewhat with production otherwise the total would easily have been higher than that of any other year. Vancouver island mines produced about 1,553,000 long tons of coal, gross; Nicola valley and Similkameen 191,500 and Crow's Nest Pass 1,296,000 tons. All the coke was produced in the Crow's Nest district, Southeast Kootenay. Three new mines are being opened on Vancouver island.

The new field—Groundhog—in which anthracite coal is stated to occur, situated in the northern Skeena country, was further explored, but it is without transportation facilities, so no production was made there.

Miscellaneous.—Platinum in Nelson mining division appears to still be a "will o' the wisp." No important progress has been made towards commercial production of this mineral. Gypsum deposits are being utilized. The demand for Portland cement has been in excess of existing manufacturing facilities in the province, so much has been imported. Output of building stone, clay products, etc., was larger than in any earlier year.

General.—On the whole, the year was the best in the history of mining in the province, and the outlook is for still further improvement. For the first time for a number of years companies operating metalliferous mines in British Columbia paid dividends aggregating nearly $1,200,000. These were the Hedley Gold Mining Company, Consolidated Mining & Smelting Company, Standard Silver-Lead Mining Company, British Columbia Copper Company, and Le Roi No. 2, Limited. In addition, the Granby Company made nearly $1,500,000 net profit in 1912. Important development work is being done and mine equipment is now such that increased production is confidently looked for.

Metallurgical Notes.

The quantity of ore and concentrate smelted at the Consolidated Mining & Smelting Company's works at Trail was between 300,000 and 320,000 tons, which was less than in the fiscal year to June 30, 1910 (487,000 tons) also than in the next following fiscal year (389,000 tons). The decrease was caused by the loss of the Snowshoe ore, of which there was 268,000 tons received in the two fiscal years just quoted. Improvements included an addition to flue chamber, to secure better results in settling of flue dust from copper ores; rebuilding of matte-handling plant, method of treating low-grade matte having been changed; alteration to lead-sampling plant, made necessary by increase in quantity of coarse lead ore received; more electrolytic tanks in lead refinery, to provide for larger output of refined lead; and numerous other changes, chiefly to facilitate handling materials. Experiments in reduction of zinc-lead ores were carried out, but no provision was made for production of spelter on a commercial scale.

The chief change at the Granby Consolidated M. S. & P. Company's smeltery was in the substitution of water-granulation blast furnace slag for dumping it molten. By a system of conveying belts operated by electric motors, the dewatered slag is conveyed up a long incline to a height of 120 feet and then discharged, this arrangement providing room for all slag that will be made here for six or seven years. The quantity of Granby mines ore treated at these works in 1912 was more than 1,200,000 tons. One notable feature of the year's work was that the full battery of eight blast furnaces was operated all the year, one run having been for 156 or 157 consecutive days—from June 5 to November 9—without interruption. The Granby company is purchasing materials and plant and other equipment for a 2,000-ton smeltery, hydro-electric power station, railway, shipping dock, etc., at Granby bay Observator inlet where its new copper mine is being developed with much assurance of large productiveness.

The British Columbia Copper Company operated its smeltery throughout the year. Ore receipts totalled between 650,000 and 700,000 tons. Much efficiency was secured, monthly totals of ore smelted having ranged up to as high as 65,000 tons, with three furnaces in blast. The greater part of the ores smelted came from the Mother Lode and Rawhide mines. There is in the company's Lone Star mine a large quantity of ore available, but owing to its high silica content concentration tests have been carried out with the object of determining how best to eliminate the excess of silica. This problem is now in a fair way towards being successfully solved.

Most of the copper ore and concentrate shipped from Coast district mines was treated at the smelting works at Tacoma, Washington. This includes the comparatively large output from the Britannia mine.

Gold Milling.—The largest stamp mill in operation in 1912 was that of the Hedley Gold Mining Company, at Hedley, Similkameen, at which about 70,000 tons of ore was crushed, as compared with 58,000 tons in 1911. Approximate value of gold recovered in 1912 was $760,000, as against $680,000 in 1911.

There were three stamp mills in operation in Nelson mining division in 1912. No information has been received concerning the Granite-Poorman and Queen mills, but the Motherlode Sheep Creek Mining Company's mill was worked during the latter half of the year. A new installation was that of a 10-stamp mill at the Inland Empire mine, west of Rossland camp. The Jewel 15-stamp mill was also running late in the year.

Lead and Zinc Ore Concentration.—The mills that made the largest output from concentration of lead and zinc ores were those of the Standard, Van-Roi, and Bluebell mines, respectively. The Rambler-Cariboo mill was started in December. The expectation is that in 1913 there will be several other concentrators in operation, with a proportionately increased output of both silver-lead and silver-zinc concentrates.

THE PRODUCTION OF AVAILABLE POTASH FROM THE NATURAL SILICITES.*

By Allerton S. Cushman, Ph.D., Member of the Institute, and George W. Coggeshall, Washington, D.C.

The great demand which has recently arisen for an American supply of potash in available form for agriculture has stimulated not only the search for new sources of this material, but also experiments of a large and practical scale of operation, in the attempt to develop a method of making the vast supply of potash locked up in feldspars and feldspathic rocks either directly water-soluble or sufficiently soluble in dilute acids to insure a product which shall be useful as a fertilizer. The natural silicites commercially available as sources of potash are chiefly orthoclase and leucite. Both of these minerals are potassium-aluminum silicates. The theoretical formula for orthoclase is written $K_2O.Al_2O_36SiO_2$, and for leucite $K_2O.Al_2O_3.4SiO_2$. The principal sodium feldspar albite has the theoretical formula: $Na_2O.Al_2O_36SiO_2$. It is well known that these feldspars run into and substitute each other in various proportions, so that the products from different quarries will vary widely in respect to their soda and potash contents. There is an enormous supply of feldspar in the United States, both East and West, which could be made economicaly possible as a source of potash supply, provided the cost of production can be made low enough to compete with the potash-holding manure salts which are at present so largely imported from Germany. Although it must be admitted that the imported potash salts are richer in potash than any product that can ever be made from American feldspars, it should also remembered that the crude German manure salts contain large quantities of chloride and sulphates of elements which are not only undesirable in the fertilizer, but which may do actual harm under certain conditions. It is this fact which gives encouragement to the attempt to produce from American feldspars a straight potash fertilizer which could be used in exactly the same way that hardwood ashes have been found useful.

Six general methods have been proposed for decomposing the natural silicates, in the effort to obtain water-soluble potash salts.

I. Adaptation of Natural Agencies.

In the processes of Nature, the slow action of moisture and atmospheric agencies, including the action of carbonic acid gas, is known to have a decomposing or kaolinizing action upon the feldspars. Immense deposits of feldspar and granitic rocks have thus been decomposed, with the formation of large beds of kaolin and clays from which the potash has been leached into the surrounding valley. For this reason, the valleys between feldspathic and granitic hills are usually highly productive of the crops which require large amounts of potash, such as tobacco, potatoes, large fruits, berries, etc. There have been a few processes proposed, which depend principally upon the natural reactions hastened by pressure and other agencies. In 1904, Blackmore (U.S. patent 772,206) proposed the action of carbon dioxide gas under five hundred pounds pressure upon a cream of the ground mineral, repeated intermittently for several hours, in the attempt to produce a yield of carbonate of potash. Ten years earlier the same experimenter (U. S. patent 513,001) had proposed using lime, calcium chloride, and steam pressure in an autoclave to produce chloride. In 1910, Coate (U.S. patent 947,795) proposed the addition of bacteria for the decomposition of feldspar. In 1910, Carpenter (U.S. patent 59,841) proposed to heat the mineral intensely and cool suddenly by plunging in water. in the effort to render the feldspar amporhous, in the hope of making it more available for plant growth. None of the above processes have as yet been shown to possess industrial possibilities.

II. Wet Processes of a Chemical Nature.

Levi, in 1904 (French patent 344,246 and English patent 13,875), and Piva, in 1905 (French patent 351,-338), proposed methods ofr treating leucite by means of solutions of alkali or alkali earth hydrates, generally under increased pressure. The same general method for treating feldspar was claimed by Swayze in 1907 (U.S. patent 862,676) and by Giggs in 1906 (U.S. patent 910,662).

Also, Gibbs, in 1904 (U.S. patents 772,612 and 772,657), proposed a process of treatment with hydrofluosilicic acid, and subsequently with sulphuric acid, in order to produce potassium sulphate. In 1907, Cushman was granted U.S. patent 851,922, a public patent which proposed the sludging of finely-ground feldspar with water, the addition of a small amount of hydrofluoric acid, and electrolyzing the mixture in wooden cells provided with wooden diaphragms. Under this process both potassium and aluminum hydrate passed through the cell diaphragm into the cathode compartment. This process, although perfectly practical, has not yet been made commercially possible, owing to the high cost of hydrofluoric acid and the large amount of by-products formed in the process. None of the above processes have as yet been made commercial possibilities.

III. Dry Processes of a Chemical Nature, in which the Potash Salts are Volatilized.

In processes of this nature, fluxes, and in some cases fuel, for reducing purposes are ground and mixed with the feldspar, the mixture being subsequently heated until the potash salts are volatilized and collected either in the stack dust or partially collected from the gases by passing them through or over water. Swayze, in 1905 (U.S. patent 789,074), heated ground feldspar with gypsum and carbon, and proposed to collect the volatilized sulphate. Spencer and Eckel, in 1909 (U.S. patent 912,266), made a cement mixed with calcareous and silicious fluxes and green sand, a natural potash-bearing iron silicate, clinkered the mixture in a rotary cement furnace, and obtained a Portland cement, at the same time collecting the potash in the stack dust and the flue gases. In 1911, Eckel (U.S. patent 1,011,-172) proposed a somewhat similar method, but heated only high enough to drive off the potash salts and not high enough to clinker the mixture. Again, in 1911, Eckel (U.S. patent 1,011,173) melted a mixture of green sand, limestone, and fuel, tapped off the melted iron and slag and recovered the potash salts from the flue gases.

Some of the processes under this heading have been tried on a large scale. No great difficulty is recorded in driving off the potash in the furnaces, but obstacles were encountered in the attempt to collect the potash from the gases. As a by-product operation in the

*Paper read at the Eighth International Congress of Applied Chemistry.

manufacture of cement, these processes may yet come to be of some industrial importance.

IV. Dry Processes which Propose to Separate Potash as Hydroxide or Carbonate.

The old method of Bickell, proposed in 1856 (U.S. patent 16,111), which depended upon heating a mixture of feldspar, lime, and natural phosphate rock or guano to a bright red heat, has not as yet been proved practical or successful. The process of the Soc. Romana Solfati, in 1905 (French patent 352,275), which proposes the roasting of leucite with carbonate, hydrate, or nitrate of soda and lime, and subsequently the passage of steam through the roasted product to produce sodium aluminate and potassium carbonate, is possible from a chemical standpoint, but the high cost of operation has not permitted the process to come into commercial use.

V. Dry Processes Producing the Chloride.

In 1900, Rhodin (U.S. patent 641,406) and in 1901 (J. Soc. Chem. Indus., xx., 439) proposed fritting feldspar with lime and salt. According to the published results, this experimenter obtained good yields, although the process has not become a commercial success. In 1907, McKee (U.S. patent 869,011) suggested heating a potash-bearing material containing mica with lime, salt, and carbon in order to obtain a yield of potassium chloride. Cushman, in 1911 (U.S. patent 987,436), proposed mixing feldspar with lime and salts of a mineral acid capable of decomposing the silicate, giving the mixture special treatment previous to heating in a rotary furnace in order to produce the chloride. This method has been tried out on a large mill scale of operation, and the results obtained will be discussed later on in this paper.

VI. Dry Processes Producing Sulphates.

In 1911, Thompson (U.S. patent 995,105) proposed heating to a bright red heat mixture of feldspar, sodium acid sulphate, and sodium chloride, and subsequently leaching out the potassium sulphate produced. This experimenter claims that potassium chloride is first formed, which is subsequently changed to the sulphate by the action of the acid sulphate. It is stated that this process has recently been tried on a commercial scale of operation. Sodium acid sulphate is a by-product that is reasonably cheap, although a large quantity is not available. The lack of an abundnt supply of acid sulphite is perhps the greatest drawback to the commercializing on a large scale of this process, although it is possible that it may still become of some industrial importance. Hart, in 1911 (U.S. patent 997,671), proposed to fuse faldspar with some barium compound, such as the sulphate, together with carbon, to pulverize the cool melt, and subsequently to digest the product with sulphuric acid and thus produce in solution potash alum and a residue of barium sulphate and silica which is claimed to be useful as a paint pigment. Hart claims that some of the potash is volatilized during fusion. Since the fusion temperature is 1,500 deg. C., it is probable that a considerable portion of the potash does volatilize, and it is possible that this dufficulty may interfere with the commercial success of the process.

Wadman, in 1907 (U.S. patent 847,856), proposed heating lepidolite with potassium sulphate and leaching the product with sulphuric acid in order to obtain sulphates of lithium and potash.

A chronological list of the patents which have been granted for the treatment of the silicates for the production of available potash is given in Table. I.

It would appear that the most promising processes for making potash available from the natural silicates on a commercial scale of operation are those which are conducted in the dry way but without actual fusion of the reacting mixture. Potash salts volatilize readily at the high temperatures necessary for the fusion of the silicates, and the collection of the volatilized potash from the stack gas has not yet been carried out eco-

TABLE I.

Proposed Extraction Processes Chronologically Arranged.

	Patentee.	Year.	Process.	Product.
IV	Bicknell	1856	Lime, $ca_3 (PO_4)_2$ red heat	Caustic.
I	Blackmore	1894	Lime, powdered $CaCl_2$, H_2O, steam	KCl.
V	Rhodin	1900	Lime, salt, heat under melting	KCl.
II	Levi (leucite)	1904	$Ca(OH_2)$ or NaOH pressure 16 atmosphere	K silicate.
11	Gibbs	1904	H_2siF_6 and H_2SO_4	K_2SO_4.
I	Blackmore	1904	CO_2 500 pounds pressure repeating	K_2CO_3.
II	Piva	1905	(Leucite) K.O.H, NaOH, steam 25 atmospheres	K silicate. K aluminate
IV	Coc. Romana Solfati	1905	|Lucite) alkali, carbon, Ca.O red heat	K_2CO_3.
			heat	K_2SO_4.
III	Swayze	1905	Gypsum and carbon, fuse, volatilize	K_2SO_4.
VI	Wadman	1907	Lepidolite, K_2SO_4 H_2SO_4	K_2SO_4.
II	Cushman	1907	Water and HFl electrolysis	K.O.H.
II	Swayze	1907	Heat alone, then KOH solution	K silicate.
V	McKee	1907	"Containing mica" with CaO, NaCl, and C.	K aluminate KCl.
II	Gibbs	1909	$Ca(OH)_2$, steam 150 pounds	K.O.H.
III	Spencer and Eckel	1909	Green sand cement, mix, volatilize	K salts.
I	Coates	1910	Bacterial action	
I	Carpenter	1910	Intense heat, sudden cooling down	
V	Cushman	1911	CaO, $CaCl_2$, etc., clumps, red heat	KCl.
VI	Thompson	1911	$NaHSO_4$, NaCl, bright red	K_2SO_4.
VI	Hart a.	1911	Ba compound as $BaSO_4$ and C, fuse, H_2SO_4	Alum.
III	Eckel	1911	Cement mix but not over 900° C.	K_2O.
			with green sand volatilize.	K_2SO_4.
III	Eckel	1911	Green sand, $CaCO_3$ and C. melt iron volatilize.	K_2SO_4.

nomically. A considerable portion of the potash does not settle in the dust chamber, and if water sprays are used for washing the gases the potash solutions are very dilute and the cost of evaporation becomes prohibitive. Furthermore, water sprays are found to interfere with the draft regulation, even when the use of fans is resorted to. The maintenance of artificial draft is an expensive and difficult matter, and is very likely to infere with the proper control of the furnace temperatures. For work on the large scale of mill operation, a continuous process must be used, avoiding fusion and with the regulation of temperature to the exact point at which appreciable quantities of potash do not volatilize. The fluxes and reacting substances must be cheap, available in large quantity, and the yields of water-soluble potash salts must be high. The process which has seemed to us to give the most promise of successful adaptation to commercial ends is that of Cushman (U.S. patent 987,436), coupled with the method of preparation of the materials before furnacing, proposed and developed by Coggeshall (U.S. patent 987,554).

This process has recently been given extensive trials on a large scale and interesting results have been obtained. The process consists essentially in powdering 100 parts of potash feldspar rock, together with about 20 parts of lime and with or without 10 to 20 parts of rock salt. This powdered mixture is fed to the top of a moving drum about three feet in diameter, in a layer about half an inch deep. As soon as the layer is formed a strong solution of calcium chloride is applied from a series of small tubes. The $CaCl_2$ at once unites with the lime, forming a so-called oxychloride cement, and a large portion of the mixed powder is thereby at once formed into "clumps" or aggregates lying in a bed of surplus powder. As the drum revolves the bed is removed by a scraper to a belt which delivers the mixture to a screen which separates the clumps from the residual powder. The powder is returned by a screw conveyor and elevator to the hopper above the drum again. The clumps are about the size of peas and pass from the screen directly to a rotary kiln similar to those used in burning Portland cement. The kiln is heated by a blast of air and powdered coal in the usual manner.

The clumps pass regularly down through the increasingly heated portions of the rotating kiln and roll out at the end, practically without alteration in size and shape.

A large percentage of the total potash present in the feldspar is converted into potassium chloride during the heat treatment, and very little is volatilized. The dry clumps are of a pale-yellow color outside, due to the iron in the ash of the bituminous coal used, but they are snow-white inside. The clumps are finally ground, producing a pale-yellow material containing as much water-soluble K_2O as hardwood ashes, although the potash is in the form of chloride and the product also contains considerable free lime. Up to the present time no attempt has been made on a large scale to leach out the soluble potash. The ground material is being given field tests as a straight potash fertilizer containing lime.

A Resume of the Large Scale Experiments.

Potash feldspars were obtained from five different localities. Eleven carloads were used in the trials, amounting to a total of 385 tons. Each carload was ground and analyzed separately. The lowest in potash ran 6 per cent. K_2O and 3 per cent. Na_2O, the highest 11.3 per cent. K_2O and 3.1 per cent. Na_2O; the bulk of the spar 10 per cent. potash and 2 per cent. soda, and the results given in this paper were obtained on the 10 per cent. spar.

The lime was a high calcium quick-lime, running about 90 per cent. CaO and 5.6 per cent. MgO.

The salt was rock salt from New York State and ran about 98 per cent. NaCl.

The calcium chloride was obtained from the Solvay Process Company. It was in the solid form and contained about 75 per cent. $CaCl_2$ and 25 per cent. water.

All of the above materials are available in very large quantities and at low cost. The calcium chloride is a by-product in the form of a moderately strong solution, and but a small proportion is concentrated at the present time, as the chief use is for refrigeration purposes. Vast quantities are now run to waste. The solid form was used in these trials merely for convenience.

Many heats were made with mixtures of varying proportions, but the two mixtures used in the work here described were:

Feldspar	100	Feldspar	100
Lime	20	Lime	20
Salt	10	Salt	20

The feldspar, lime, and salt were separately crushed in gyratory crushers and rolls, and dried in a rotary drier. In continuous work the proper mixture would be made at this point by continuous weighing machines, but as a number of different mixtures were to be tried, each of the three raw materials was ground separately in Huntington mills and put into the bins. This preliminary grinding of the feldspar and salt was to about 65 per cent. through a 100-mesh sieve, of the lime about 83 per cent. through the 100-mesh. The weight per cubic foot of each powder of the above fineness was then ascertained, and measuring boxes were built so that the materials could be separately measured out and run together into a large mixing machine. Almost a ton was thus mixed each time. The mixture was then conveyed to a tube-mill and further ground to a fineness of from 97 per cent. to 99.5 per cent. through a 100-mesh sieve, and then conveyed to the bin over the clumper and kiln.

The calcium chloride masses were broken up and thrown on a perforated grid in a large tank holding about 48 tons. Water was run in and the chloride dissolved most readily. The solution was run out when about 42 deg. Beaume into two large sump tanks, and brought to a constant strength of about 42 per cent. $CaCl_2$. This was then pumped up to an elevated tank and piped from there through a constant-level tank to the dropper tubes of the clumper placed in a row above the drum. This drum is 15.5 feet long and 3 feet in diameter, and is horizontal. There are 15 valved pipes, each one feeding an adjustable pipe holding 38 short dropping tubes of brass 1/16-inch internal diameter and set 5/16-inch apart.

The finely-ground, mixed powder is taken from the bin by a chute, elevator, and screw conveyor and distributed in a long hopper trough over the drum. It is taken from the trough by a roll device and spread evenly on the moving drum at its topmost point. The drum has a surface velocity of about 1.6 inches per second, the layer of powder advancing at this rate.

It was found that by dropping the liquid very rapidly upon the powder the clumps could be made rapidly enough to give a full fed to the short rotary kiln when only one-third of the trough and droppers and drum is used. A clumper drum 5 feet long produces every hour almost two tons of fresh clumps and considerably over a ton and a half of burned product with the kiln used in these trials. The excess of powder passes through a screen and goes to the same elevator which lifts the original material from the bin. The amount of actual $CaCl_2$ in the fresh lime is regulated to about 20 parts

to each 100 parts of feldspar in the mixture. The clumps leave the screen in rounded form and flow directly into the kiln.

The reason for the above procedure will now be explained. In the first place, calcium chloride reacts very efficiently under these conditions with the feldspar by replacing the potassium with calcium, thus forming calcium silicate and potassium chloride. Anhydrous calcium chloride is expensive to produce, and it is impracticable to grind it into a mixture on a large scale on account of the rapid absorption of moisture. Even if such a dry mixture could easily be made, its use would present certain disadvantages.

When a reaction between an ore and solid fluxes is produced by heating up to the fusing temperature, the reaction takes place on the surface of the particles alone and only at the points where the ore is in actual contact with the flux particles. Finer grinding will produce a larger surface area and thus a greater number of actual contact points, leading to a larger yield. There is, however, a degree of fineness beyond which it is not wise to go on account of the cost of extremely fine grinding.

Another factor in the problem is brought out by the following experiments. A batch of ore and the theoretical amount of solid flux were ground together to just pass a 50-mesh sieve. This powder, when subjected to a certain heat treatment, gave a reaction yield of about 35 per cent. of the theoretical. The mixture was then ground to just pass a 100-mesh sieve and given the same heat treatment. A reaction yield was obtained of about 65 per cent. of the theoretical. The mixture was then ground to pass a 200-mesh sieve and again reheated as before. A smaller yield was obtained than when the material just passed the 100-mesh, although the particles were undoubtedly only half the average diameter with about four times the surface area and should, therefore, have had far more points of contact. Upon weighing equal volumes of the 50-mesh, 100-mesh, and 200-mesh powders, it was found that the latter contained far less material, and it became apparent that the 200-mesh powder consisted for over 54 per cent. of its volume simply of voids. Such finely-ground powders are well known to "surge"—that is, to show the tendency to flow like water through orifices in a manner resembling fountains. Material ground as fine as this is the cause of much trouble at spout slides and conveyors. Each particle of a material of this extreme fineness is undoubtedly surrounded by a film of air, the actual contact with the surface is lessened and friction almost eliminated. When allowed to flow into a bin, such a powder assumes an almost horizontal surface; there is practically no angle of repose. Unquestionably the lessened contact caused the low yields in the finely-ground mixtures. Some of the finer material was briquetted and the subsequent heat yield about 85 per cent. of the theoretical. Briquetting is, however, expensive and usually necessitates the addition of a binding agent foreign to the reaction.

As a result of these investigations, the method was developed for aggregating fine powders by dropping a suitable liquid upon an excess of the powder in such a way as to cause a temporary bond to form, thus practically eliminating the air films or voids around the individual particles and permitting actual surface contact. Under these conditions, with the same ore and flux used in the experiments described above, the same heat treatment yielded within 3 per cent. of the theoretical quantity present. This method of aggregating finely-powdered materials previous to furnacing has already been used in several different ways. For example, in an ore mixture in which the fluxing material is an alkaline carbonate, such as sodium or potassium, which forms crystalline salts containing water of crystallization, if the carbonate is used in the partially anhydrous condition and ground with the ore water alone dropped upon the mix in the manner described formed at once a crystalline carbonate which binds the particles of ore and flux into separate clumps, which are hard enough to withstand screening, while the air films are practically eliminated. Using such a mixture and process as this, a practically theoretical yield was obtained, although the flux was used only in the exact molecular proportion called for by the reaction.

By this clumping process a very intimate contact of reaction of surfaces is readily obtained at a low cost. The quantity of flux necessary to complete the reaction is greatly reduced, the duration and temperature of the heat treatment is lessened, and, working with rotary kilns, dusting and stack losses are almost entirely eliminated. The clumps are beautifully adapted to the feed mechanism of rotary kilns, as they flow easily, do not dust, and take the heat more evenly than fine powders. Now that the temperature conditions in rotary kilns can be accurately controlled, it would seem that many chemical and metallurgical reactions which are now performed by intermittent processes and with low yields could be much more economically carried out in continuous rotary kilns, taking advantage of this new method of forming aggregates previous to furnacing.

In the application of this method to the treatment of feldspathic rock, advantage was taken of the fact that a solution of calcium chloride acts upon dehydrated lime to form the oxychloride, which is a strong cementing compound. It was found that the formation of calcium oxychloride gave a sufficiently strong bond to enable the aggregates to withstand the operation of screening and the burden in the kiln.

The theoretical quantity of calium chloride flux required depends upon the total quantity of K_2O and Na_2O present in the mix, as it is evident that the soda must also be liberated in proportion to its content. The feldspar ore used ran 10 per cent. K_2O and 2 per cent. Na_2O, which required theoretically 15.5 parts of calcic chloride. In all our trials some slight excess of calcium chloride has been used. The strength of the solution and the method of treatment have been such that about 20 parts of actual calcium chloride are present in the fresh clumps to every 100 parts of feldspar. The 20 parts of lime used are for the purpose of forming the aggregates, and this lime remains practically unchanged in the finished product. The presence of lime in a potash fertilizer will be found advantageous to most soils, and it is generally admited that lime increases the manurial value of a fertilizer. If the object was to leach out the soluble potash salts from the product, a much smaller amount of lime could be used without interfering with the formation of hard clumps. The salt is added because it has been found to aid the heat reaction, probably mechanically, as will be explained later on. The fresh clumps contain from 16 to 20 per cent. of moisture, which is, of course, evaporated in the upper part of the kiln.

The rotary kiln used in these trials was one of the old bottle shape cement kilns with a total length of slightly over fifty-five feet, the upper twenty feet having a diameter of 4 feet clear inside the firebrick lining, the lower portion widening out to nearly 6 feet inside diameter. The pitch was ⅞-inch per foot, and the most suitable speed was found to be one revolution in about 2½ minutes.

The conditions of the heat treatment are very important. The kiln used was too short to yield the best results, and after the preliminary experiments changes were made which caused the material to take about 1½ hours to pass through the length of the kiln. The temperature of the gases issuing from the upper end of the kiln were read continually with a thermo-couple pyrometer fitted with a 15-foot fire end, and temperatures were also taken from time to time at the firing platform. A furnace wall temperature of about 1370 deg. C. is required for efficient burning of powdered bituminous coal. This is, however, much too high a temperature for potash work in a rotary kiln. This difficulty called for careful experimental investigations and adjustments of the heat treatment before the proper yields could be obtained. If a longer kiln had been available, there is every reason to believe that a more efficient use of the heat could have been obtained. The coal used was a fairly high volatile bituminous coal. It was ground to about 94 per cent. through a 100-mesh sieve and blown into the furnace under an air pressure of about ten pounds per square inch.

During the progress of the clumps down the kiln the following reactions probably take place: At the entrance to the kiln the water begins to evaporate. As the hotter zone is approached, the temperature rises high enough to melt calcium chloride and salt. Whether the calcium chloride is free to melt is not known to us, as the exact composition of the oxychloride compound formed has not yet been determined. The results of our work seem to prove that the reacting chlorine is more readily evolved from the oxychloride compound than it is from calcium chloride alone. The melting of the salt, however, continues the bond of the reacting particles, causing them to thoroughly "wet" each other, and from this point on the attack on the silicate proceeds rapidly. During the heating usually from 1 to 2 per cent. of Na_2O is volatilized.

When operating with no salt present, the yield of soluble potassium chloride was 47.5 per cent. of that originally present in the feldspar. On adding to the mixture 10 parts of salt to each 100 of spar, a test heat yielded 64 per cent., but of this 9 per cent. was lost by volatilization, giving a yield of 55 per cent. net in the final product. On adding 20 parts of salt to the mixture the yield grows to 69.2 per cent. with no volatilization and to 75 per cent. under heat conditions which caused a volatilization of 7 per cent., leaving a net yield of 68 per cent. of that originally present. In the case of clumps made from a mixture of 100 parts of feldspar containing 10 per cent. K_2O and 2 per cent. Na_2O, 20 parts of lime, 20 parts of salt, and 20 parts of calcium chloride, the theoretical composition if no volatilization loss takes place is shown compared with the actual results obtained in the following table:

	Theory.	Analysis.	
Total K_2O	6.25%	5.8%	
Water-soluble K_2O	.....	4.2%	Equals 6.65% KCl.
Loss of K_2O	.....	.5%	As KCl already formed.
Total Na_2O	7.62%	7.1%	52% made into NaCl.
Water-soluble Na_2O	6.37%	5.1%	Showing 1.79% vaporized as NaCl or 26% of that present.

This particular product contained 11.2 per cent. of free lime, and total lime by analysis 15.5 per cent. There was also in this sample about 5 per cent. of free unchanged calcic chloride. The amount of calcic chloride in the various runs made up to the present time has been reduced gradually to about 1 per cent., and it is felt that in the future better conditions of heat treatment will make complete use of the calcic chloride and at the same time raise the yields of soluble potash. In later runs, in which only 10 parts of salt were present in the mix, the theoretical and actual analysis of the product was as follows:

	Theory.	Analysis.	
Total K_2O	6.66%	5.62%	
Water-soluble K_2O	.....	4.5 %	Equals 7.12% KCl.
Vaporization loss of soluble K_2O	.....	1.04%	As KCl already formed.
K_2O insoluble in water	.....	1.12%	
Total Na_2O	.....	4.15%	
Water-soluble Na_2O	.....	3.7 %	Showing 0.45% vaporized as NaCl or 11% of that present.

This product contained 12.25 per cent. of free lime, the total potash rendered soluble was 5.45 per cent. of the product or 83.2 per cent. of the total quantity present, but as 15.6 per cent. had been volatilized the net yield in the product amounted to 57.6 per cent.

The material which was later made continuously according to the process described above carries 4.5 per cent. of water-soluble K_2O in the form of 7.12 per cent. potassium chloride, and in addition to this material carries only 1.12 per cent. K_2O insoluble in water. It is well known that a 2 per cent. citric acid solution will extract, when used according to the Wagner method, somewhat more K_2O than can be made directly water-soluble. This fact is of considerable interest when the product is to be used directly as a potash fertilizer.

Conclusion.

It is believed that under better conditions of heat treatment which can be obtained with longer kilns and with a somewhat different arrangement of the combustion chamber, slightly better yields than those reported can be obtained. It should be remembered that the kiln used in these experimental trials was originally designed for burning cement, but this type of kiln has long been superseded by improved forms. In order to get the proper heat treatment in the middle of the kiln to complete the reaction, it was necessary to have the upper part too hot. This condition will not maintain in a properly-designed kiln. It is also believed that the use of oil as fuel would have allowed an easier regula-

tion of the heat treatment, but the trials so far undertaken have been made conditions which were found available at the time.

The subject of the costs of this process and of the product cannot be gone into in detail at this time, but a few general statements may be made. The production of water-soluble potash in feldspathic work is essentially a low-grade proposition, and the commercial success of such a process depends upon the low cost of the various operations. The manufacture of a straight potash fertilizer containing as valuable ingredients only potash and lime must be carried out on a very large scale and by the most modern methods of continuous operation. With regard to the clumping process, the trials have shown that this operation can be practically carried out as a continuous process and at an exceedingly low charge per ton of product.

The process may be directly compared with that of the manufacture of Portland cement. It is little easier to grind feldspar and lime than the shales and limestones used in cement manufacture. Drying will cost no more. Chemical control of the raw mixes will not be more expensive, and perhaps much less. Clumping, as has been shown, adds a very small charge to the expense of treatment. The cost of furnacing the feldspar mix will be less than similar charges in the cement industry, as the temperatures required are much lower and less coal is consumed. The product from the potash kiln is comparatively soft and pulverizes easily in hammer mills, while the charges on the cement industry for grinding clinker are an important item. Again, the softer potash product merely requires to be ground fine enough for use as a fertilizer, whereas cement clinker must be ground very fine and costs rise rapidly with increasing fineness. Repair bills in the case of feldspar treatment should be much smaller than in cement manufacture. The charge for raw materials is somewhat larger than in the case of cement, but this is more than met by the smaller costs of operation.

The potash fertilizer as now produced should be the equal in fertilizing value of the ordinary grades of hardwood ashes. The product carries practically the same content of water-soluble potash and somewhat more lime than wood ashes. There is every reason to believe that if the process becomes an industry the yields of water-soluble potash can be considerably improved. The material yielded is not a fused product; it is friable as an ash and it has the physical texture to make it a valuable aid to soil structure. The success of the product must, of course, depend upon the results obtained under test conditions in its experimental use as a fertilizer. If results are obtained which are as good as, or better than, those which usually attend the proper use of high-grade wood ashes, it is believed that there should be no reason why this product cannot be successfully produced and introduced, especially in those parts of the country where potash feldspars, fuel, and shipping facilities are available.

Summary.

In this paper a summary is given of the various processes which have been proposed for making the potash in the natural silicates available as a fertilizer.

Experimental trials of a new rotary kiln process for treating feldspar are described, which depends upon a previous treatment before furnacing, consisting of a method of aggregating or clumping the mix so that chemical contact of the reacting substances is brought about during the subsequent processing. The qualitative and quantitative results obtained on a number of experimental trials on a mill scale of operation are presented and discussed. It is shown that it is possible to economically manufacture a potash fertilizer containing free lime from feldspar, and for a sufficiently low cost to make an industry based upon the method worthy of consideration.

MINING PROSPECTS.

(Written for the Canadian Mining Journal by an Examining Engineer)

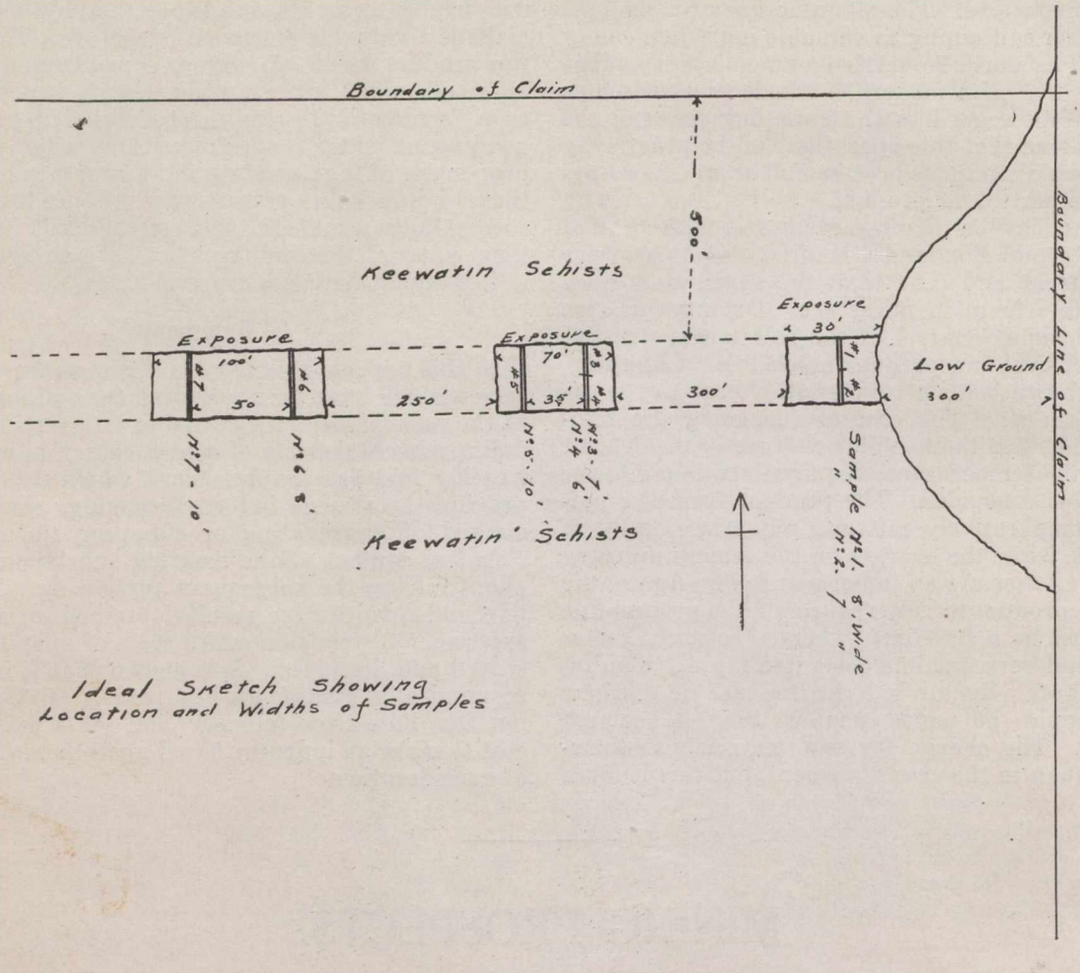
The examination of a prospect is one of the most difficult things that the average engineer has to undertake, as in many cases it calls for more qualifications than the examination of a developed or partially developed mine. The information available is usually so meagre that it is often extremely difficult to decide whether or not a property warrants the expenditure of money. In submitting a prospect for consideration it is, therefore, essential that the owner of the property gives as much information as possible. All engineers, and particularly those associated with development or exploration companies, have many prospects presented to them, and, in the majority of instances, they are not given any consideration on account of insufficient detail. Examinations of prospects are usually attended by considerable discomfort and expense and engineers are loth to undertake them without something definite to go on. In many cases, promising prospects are allowed to lie undeveloped because the owner has not taken sufficient trouble to present his property in proper form.

The usual method of procedure is to send a few selected specimens, accompanied by a glowing description of mineral wealth which only needs development to bring in immense fortune to the person lucky enough to acquire the property. Incidentally the owner usually asks an extremely high price and a substantial payment down. Selected specimens, are, however, of little value to the engineer and have a tendency to mislead him instead of giving valuable information. The writer recalls one instance in particular where the owners brought in some rich specimens of free gold, claiming that the vein averaged six feet in width, that it could be traced for a long distance, and that the lowest assay ever obtained was $6.00. The examination necessitated a two days' trip into the bush under most disagreeable conditions, and when the property was finally reached, it was found that the vein would not average more than fifteen inches in width and that the specimens brought to the office accounted for practically all the free gold there was. Outside of this single showing of gold, the highest assay from sections across every part of the vein was 80 cents.

In order to properly present his property, the owner should send as complete a description as possible. The accessibility of the property, together with the general

geological features should be stated, and particular pains should be taken to give clearly, the character and average width of the vein, the distance over which it can be traced, the number of exposures, and how far these have been stripped and how far apart. Samples from the various outcrops should also be sent. These samples can very easily be cut with a small prospector's pick and a moil and should weigh approximately two or three pounds per lineal foot of trench. The width of the samples should be carefully measured and each sample should be put in a separate sack with a separate number and sent to the engineer, accompanied by a sketch, no matter how rough, showing the location and width of each sample, and the distance apart of the different sections. Where a vein is much over ten feet wide, it is usually advisable to split the samples, taking not more than ten feet for each. In this way, the location of a possible pay streak can be determined, and it might show a profitable section of ore, which, over a greater width, would be unprofitable.

The work outlined above can be done by any man having a very slight knowledge of mining, and while, of course, an engineer would not purchase a claim on these results, it would enable him to obtain a fairly comprehensive idea of the width and assay value of the ore and would certainly entitle the seller to much more consideration than he would otherwise be likely to obtain.



Ideal Sketch Showing Location and Widths of Samples

TECHNICAL LITERATURE.

The Relation of the Horse-Power to the Kilowatt.—Prior to 1911, no precise definition of the horse power that was generally accepted and authorative, was current; and different equivalents of this unit in watts, are found in text books. The most frequently used equivalent in watts, both in the United States and in England, has been the round number 746 watts. The United States Bureau of Standards has issued a circular in which it is pointed out that it is obviously desirable that a unit of power should not vary from place to place, and the horse power thus defined as a fixed number of watts does indeed represent the same rate of work at all places. Inasmuch as the "pound" weight, as a unit of force, varies in value as g the acceleration of gravity varies, the number with the latitude and altitude. It is equal to 550-foot pounds per second at 50 degrees latitude and sea-level, approximately the location of London, where the original experiments were made by James Watt to determine the magnitude of the horse power. The "continental horse power," which is used on the continent of Europe differs from the English and American horse power by more than 1 per cent., its usual equivalent in watts being 736. These values, 746 and 736 watts, were adopted as early as 1873 by a committee of the British Association for the Advancement of Science. The value, 0.746 kilowatt

will be used in future publications of the Bureau of Standards as the exact equivalent of the English and American horse power. Both the Bureau and the Standards Committee of the American Institute of Electrical Engineers recommend the kilowatt for use generally instead of the horse power as the unit of power.

Dredging in the Yukon.—Dr. H. M. Payne describes, in the Engineering and Mining Journal of December 14th, the present method of dredging on Bonanza creek, the results of which, we understand, have during the past season, proved very gratifying. Here, whenever practicable, the dredging of the creek bottom precedes the hydraulicing in order to avoid handling the hydraulic tailings through the dredge, although in some instances it has been found profitable to wash these tailings again through the dredges. The gold-bearing gravel and overlying muck being frozen, it is first thawed by driving steam points down to bedrock. The points are spaced at intervals of from 8 to 10 feet, and driven from 5 to 30 feet down, depending on the depth of the frozen overburden. Steam is generated by portable boilers and transmitted through a main 3-in. pipe to 2-in. headers and 1½-in. goosenecks, with which the points are connected by rubber hose. These points are in varying lengths, like drill sets, and are advanced as thawing takes place by men standing on step ladders and wielding sledge hamers. It is aimed to thaw several weeks' in advance of the dredges in order that the ground may "sweat," and thus thoroughly disintegrate the frozen mass, the black muck on the surface acting as an insulator and retaining the heat introduced through the points. The dredges are of the regular type, with buckets averaging 7 cubit feet capacity, and a chain speed of 18 buckets per minute, giving a theoretical capacity of 6,720 cubic yards per 24 hours.

Asbestos in West Australia.—The Geological Survey of West Australia has issued recently a report by Mr. Torrington Blatchford on the asbestos deposits at Soanesville, in the Pilbarra goldfield. The rocks here are serpentine, which has been intruded by dolerite dykes. Asbestos has been found in several places within the area, but only two exposures have been prospected to any extent. Locally, these deposits are known as the "A" and "B" lodies. In the "A" deposit the fibre is short, and fit only for mill treatment. On the "B" lode, which has been developed to a depth of 149 feet, some very fine asbestos has been exposed, the fibre being in places several inches in length and of exceptional quality, but apparently the deposit is very narrow. The author thus concludes his report: "Up to the present the boundaries of the serpentine rock are hidden by the Nullagine series of altered sediments. This is unfortunate, as there should be more possibility of finding large formations of asbestos near the boundaries of the serpentine than anywhere else. . . . The total cost of producing the marketable product at Pilbarra aud pntting it on a local or foreign market, including labour of mining, cobbing and bagging, transport, etc., would probably not exceed £20 per ton. There is, therefore, a good margin of profit in working good crude fibre. In estimating the value of milling fibre, the difficulties are many. If the average price of all grades of mill fibre be taken, the Canadian price is £6 per ton. Taking the asbestos veins as they stand exposed in the workings, and after making due allowance for high mining costs under existing conditions, it would cost at least 20s. per ton to mine and mill the asbestos rock on the spot. If the percentage of recoverable fibre and milling rock be twenty, this would mean a cost of £5 to produce one ton o fmill fibre, exclusive of cartage, freight, realization charges, etc." The shipments of asbestos so far made represent 40 tons, valued at $1,600, sold in 1908, and 283 tons, valued at £154 sold in 1909.

The Care of Wire Rope.—A writer in the Engineering and Mining World remarks that the life of a rope is materially reduced if made to work round small drums and pulleys. When considering the size of pulleys for underground haulage, convenience of handling is the important factor, and, therefore, the ratio usually observed between the size of a winding rope and its pulleys is much reduced. For underground haulage a satisfactory workable minimum diameter for a sheave or pulley is 60 times the diameter of the rope. Thus a three-quarter inch rope would require a pulley 3 feet 9 inches in diameter. If the pulley is larger the rope is so much the better for it, but if made smaller it is done at the risk of injuring the rope, unless it be of special construction. A high speed of rope means a considerable amount of wear, and it is better to increase the load than the speed. Jerking is ruinous to ropes, and a careless engineman may easily, by picking up his load rashly, snap even a new rope. Ropes before use should be stored in a dry place, upon timbers; and if left a long time, oiled over occasionally. Where they are not galvanized ample protection should be afforded by a suitable oil, free from any ingredient that might set up corrosion. Hoisting ropes are usually well served in this respect, while haulage ropes are just as much neglected. The following test shows the importance of greasing ropes: Two lengths of rope, same size, same make, one oiled the other unoiled. The latter made 16,000 bends, and the former 38,700 bends over the same pulley before breaking. Again, similar pieces were tested over a 24-inch pulley. The unoiled stood 74,000 bends and the oiled 386,000 bends before breaking.

The Dry Cleaning of Coal.—The Mining and Scientific Press comments recently on a process for the dry cleaning of coal in use in Franklin county, Irrinois. The coal is first carefully sized on a series of gyratory screens, and then by a spiral separator which makes three products: coal, bone coal, and slate. The spiral separator consists of a centre column, with a series of spinal bands, down which the coal and slate slide. The coal maintains a fixed path as long as the friction of the coal on the chute and the centrifugal force balance. As the velocity increases, to where it overcomes the friction, the coal moves over the outer edge of the spiral plate and is carried off through a hopper. The slate, with a higher co-efficient of friction, follows the regular path down the spiral and at the bottom goes into the refuse pocket. The bone coal takes a path between the two and slides to the outer edge of the spiral, but does not follow the coal over the edge. It is delivered at the bottom through a special gate, and may then be conveyed to the boiler house.

Electrolytic Extraction of Copper.—The United States Consul at Christiania reports that for several months past a company at Aamdal, Norway, has been extracting copper successfully from the crude ore by means of an electrolytic process invented by Victor Hybinete, a Norwegian engineer. The treatment, which is done at the mine, thereby effecting considerable economies in shipping costs, consists in leaching the crushed ore with a solution of sulphuric acid which dissolves out the copper; a strong current of electricity is then passed through this solution and the pure copper

is precipitated. Experiments on copper pyrites, elsewhere in Norway, have proved equally successful.

A New Nickel Extraction Process.—The Engineering and Mining Journal describes a new process for which a patent has been granted to Horace L. Wells, of New Haven, Conn., for the extraction of nickel from nickel-copper matte by means of hydrochloric acid. The matte is pulverized to 60-mesh, or finer, and treated with 18 to 25 per cent. hydrochloric acid at a temperature between 110 and 212 F. The first solution is then decanted or filtered off, and the residue is again treated with further amounts of acid. This is done because one treatment will not extract all the nickel, no matter how long continued or how strong the acid. The acid used in the second treatment is not exhausted and is available for use as the first leach in treating a succeeding batch of nickel matte. The matte is agitated during this treatment. The solution of nickel chloride thus obtained is treated for nickel or for nickel salt, as provided for in the various other patents of T. C. King and H. L. Wells.

The Study of Earthquakes in Germany.—The Colliery Guardian calls attention to a recent description of the appliances used in the magnetic observatory and earthquake station connected with the Bergewerkschaft at Bochum. The object of the station is to observe and to record the phenomena of natural and "artificial" earthquakes and to study them in their bearing upon mining. The Bergewerkschaftkasse, it may be mentioned, is a common fund to which all the mine proprietors of the district have to contribute. Prof. Heise is the director of the schools. The equipment consists of three astatic Wiechert pendulums, two suspended so as to record the horizontal components, and one for registering the vertical component. There are also two portable horizontal pendulums, each for two components, of the Rebeur type, for recording gradual changes and inclinations and depressions caused by excavations in mines. The third set of instruments comprises two highly sensitive portable seismometers for photographic records, the one a horizontal pendulum of the Weichert-Mintrop type, the other a universal pendulum of Dr. Mintrop. The records are produced in kinematograph fashion. With these instruments the movements of the ground are being observed continuously at Bochum.

METHODS OF PROSPECTING AND DEVELOPING DEPOSITS IN MICHIGAN.

By R. E. Hore.

The method of prospecting in the copper country is now in almost all cases diamond drilling and trenching. The outcrops have long since been carefully looked over, but there still remains to be prospected a very extensive area, which is covered with glacial debris. The most notable new discoveries during the past few years have been made by drilling in such covered areas.

Exploration is also carried on underground at several mines. It is usual near an important lode to find parallel lodes which are not regular enough to be worked alone, but which carry at intervals copper in quantities sufficient to pay for extraction. In some mines prospecting for such deposits is carried on by systematic drilling into the foot or hanging from the workings on the main lode. In others, cross-cuts are driven at less frequent intervals for the same purpose. In mines where a filling system is used, the rock cuts into hanging and foot are run far enough to explore other lodes.

In putting down the first drill hole in an exploratory campaign in drift covered areas it is the usual practice to set the drill at an angle normal to the dip as determined on neighbouring properties. If the hole proves to be approximately normal to the bedding, other holes are bored at such distances that each will give a slight overlap over the section obtained in the next one. Many of the holes are drilled 1,000 feet to 2,000 feet. Where there is little known concerning the stratigraphy, the most satisfactory results are often obtained by vertical holes.

The cores drawn are closely examined for copper; and also for the purpose of correlating the various strata cut. Commonly all the core is kept regularly arranged in boxes. At intervals in the core-box a mark is made to indicate the depth from which the core was taken. After examination the cores are usually stored and kept for future reference.

Development.—When a lode has been located, development is usually begun by sinking an inclined shaft in the lode or in the foot-wall. Exploration is carried on by drifts at levels about 100 feet apart. As a rule it has been found advisable in running these drifts, to follow the hanging or the foot-wall rather than to take straight courses. On the Calumet conglomerate the drifts are on the foot, but on most of the amygdaloid lodes the hanging wall is followed. This practice enables the miner to keep to a definite horizon, as the contact of the hanging wall trap with the lode is usually rather distinctly marked. Moreover, a bed that is cupriferous usually shows most regular ore shoots close to the hanging, so in keeping to the hanging the miner is, most of the time at least, following the ore. In a few mines the hanging is not very closely followed, but this is largely because in these mines the contact is not easily recognized. In another mine thousands of feet of drifts run in regular courses in the copper-bearing bed disclosed very little ore, while subsequent drifts following the hanging proved up very large deposits. The wisdom of keeping to the hanging was early recognized, and with a few exceptions the best results are still obtained in this way. There are some cases, however, in which it is perhaps just as well to follow the foot. In wide lodes there is usually much copper close to the foot, as well as close to the hanging. If then, the foot-wall is more easily identified than the hanging, as sometimes though rarely happens, it may be preferable to follow the foot. In the conglomerate mines the foot is followed because it presents a good fact to draw the cut to, rather than on account of the values there. As a rule drifts run without following closely the foot or hanging, soon get away from the ore, and are of comparatively little use in estimating the value of the deposit. There are, however, a few cases where the broken nature of the ground makes it prac-

tically impossible to follow foot or hanging closely, and then courses are run along the strike of the bed.

When it is desired to explore at depth the underlay of a lode productive on adjoining property, vertical shafts, are sunk and at various levels cross-cuts run into the lode, which is then developed in the usual way. At some mines similar "deep' ore is reached by starting the shaft down at an angle of about 80 degrees and curving at depth into the dip of the lode.

There are in Houghton county three vertical shafts that are very nearly one mile in depth, and several shafts on the slope of the lodes that are down over one mile on the incline. The deepest vertical shaft is 5,308.5 feet and the longest inclined shaft is 7,995 feet measured on the dip.

The ore cannot be satisfactorily sampled in the mine. After considerable ground is blocked out it is tested by a mill run extending over a few months. The usual practice is to rent a stamp at one of the mills and test the ore thoroughly before erecting a new stamp mill.

Methods of Mining.

As all the deposits being worked are in the form of inclined beds there is a marked uniformity in the way in which the lodes have been opened up. The method of mining the ore, however, is by no means the same for all the mines. The method adopted depends chiefly on the geological conditions, especially on the dip and thickness of the deposit and firmness of the lode and wall rocks. As a rule the copper deposits are in unusually uniform and firm rock that is easily supported. There are, however, some mines in which the lode or hanging wall is full of seams and joints, and the necessity of providing support has then then made it advisable to use a different method of mining. The greatest similarity in methods is found in mines working the same lode.

There are also, however, notable differences in method which do not result from the geological conditions, and which may be seen on the same lode and often in the same mine. Very often stoping has been started near the shafts and advanced toward the boundary, while in other cases stoping has been begun at the boundary and advanced to the shaft pillar. The latter makes less support necessary, thus making it possible to allow the ground to cave soon after a stope is cleaned out, and at the same time renders protection for levels necessary only under the one stope being worked.

In some mines drifts are run of ordinary size 7 feet by 7 feet, while in others the opening is carried forward as a drift stope, by cutting the full width of the lode and taking a few cuts off the back. The drift stope method gives a better opportunity to follow sinuosities of a lode closely, thus making possible a more definite estimate of its contents; but unless the lode is very uniform in grade there is likely to be broken rock that might be better left standing. In long drifts the better ventilation in the large opening is a decided advantage.

In wide lodes the ores is not as a rule evenly distributed, and a considerable percentage of the lode is worthless. There is then to be decided whether it is better to break the full width of the lode and sort out the waste, or to make the selection before breaking, and as far as possible leave the poor rock standing. The mines on one lode use the former method, while on another wide lode the latter system is utilized.

Methods of handling the ore differ largely according to the nature of the deposit and also for other reasons. In some mines mechanical scrapers are used in stopes, while hand shovels are used in others under similar conditions. In one mine chutes are used to load tramcars, while in another mine where the dip of the lode is practically the same, the ore is allowed to run down to the track level and then is shoveled up into the cars. In most mines the men themselves push the tramcars, while in others rope haulage or electric locomotives are used. In most mines the ore is dumped directly from tramcar into skip, while in a few, ore pockets are used. In most of the mines ore is hoisted from every level; but in some the ore from four or five levels is run down in chutes and hoisted from one level.

The methods of mining in use will be best understood from brief descriptions of the practices in individual mines. The variations dependent on the nature of particular deposits will be brought out by taking as examples mines that are on different lodes. For the conglomerate lode we can take the workings tributary to one shaft at the Calumet and Hecla mine; for an amygdaloid 14 feet thick and with dip of 40 degrees; for a narrow amygdaloid at a steeper angle (45 degrees), the Hancock; for deeper workings on a narrow amygdaloid dip 38 degrees to 45 degrees, the Quincy; and for a wide amygdaloid of steep dip (73 degrees), the Baltic.

The Calumet and Hecla Mining Method.—The Calumet and Hecla conglomerate is now being mined at great depth from several shafts, one of which is vertical and the others inclined. The lode averages 15 feet in thickness, and dips usually at an angle of between 37 degrees and 38 degrees.

The incline shafts are sunk in the lode, and levels established at intervals of about 100 feet. Drifts 8 feet by 8 feet are run each way from the shafts to the boundary. A raise is put through for ventilating, and to provide a stoping face, and stoping is begun first at the boundary. A cutting out stope is run for 100 feet by cutting a slice off the back for the full width of the lode. Then heavy timbers are put in to support the hanging and protect the level. No square sets are used. Heavy timber is placed as stulls, three large sticks being placed close together and forming a so-called battery. Batteries of stulls are placed about eight feet apart, leaving a space of about five feet. In this space a chute is built at sufficient height to deliver the ore into tramcars. Above the chute the foot is covered with an iron plate 8 feet by 4 feet to enable the ore to run readily.

When stulls and chutes are in place heavy lagging is placed across the stulls, planks are placed over the timbers for the drillers, and regular stoping is commenced by breast cuts taking off 8 feet to 12 feet at a time. In each 100-foot stope two or three drills work a short distance apart. As each cut is taken off the back, additional stulls are placed in line above the others. The broken ore falls down between the rows of stulls, and with some assistance from shovellers runs down to the chute and is loaded into tramcars. As the process goes on the ore is replaced by regularly spaced rows of stulls up to within a short distance of the next level. Stoping is carried on until all the ore is broken, no pillars being left anywhere in the stope. There are no arch pillars to support the levels above. The whole section of the lode is broken and swept down between the rows of stulls into the tramcars, mechanical scrapers being used to drag the ore down.

When the stope has been cleaned out, a solid row of heavy stulls is set across the foot of the stope, a considerable portion of the timber in the stope being robbed. The stope is then allowed to cave, the car-tracks are taken up, and the thoroughly worked out part of the mine immediately abandoned. The 100-foot block next towards the shaft is then attacked in the same

way, and at the same time in the next lower level, stoping is begun at the boundary. Stoping is always done at several successive levels at the same time, and in any one level stoping is always being done in a block 100 feet nearer the shaft than the work in the next lower level. At the shaft a pillar 100 feet wide is left on each side.

To work out a stope takes about eight months. Hence, stulls across the foot of the stope, while necessarily heavy, do not need to be of long-lived wood. Consequently the heavy stulls are not of very valuable wood; but of timber common in the district—hemlock, birch and maple being generally used. The hardwood is used green and does not last long after it dries. Sometimes before a stope is worked out, caving starts in the level above, and small quantities of rock fall down onto the row of stulls. No damage is done, as the timber is still strong and the amount of caving slight. In a year or two the timbers have become weak, but by this time there are no miners in the stope below. At intervals there occur caves in the hanging and ultimately the stope is filled with the broken rock.

There is no sorting of the broken ore in the mine. Sometimes blocks of poor ground are left standing; but everything broken is hoisted. The tramcars are pulled to the shaft by air-engine rope haulage, and the ore emptied directly into skips. A seven ton skip makes seven or eight trips an hour to surface from a depth of 7,000 feet. At surface a little rock is picked out, as the ore is fed to the crushers.

The Wolverine[3] Mining Method.—The Wolverine mine works a section of the Kearsage lode, which here dips at an angle of 40.5 degrees to 41.5 degrees and averages 14 feet in thickness. Shafts are sunk in the foot-wall and levels established at intervals of about 100 feet. Drifts are carried forward as drift stopes. The drift itself is about 6 by 7 feet and the lode is cut out for its full thickness for a distance of 19 feet from the foot rail. When the drift stope has been advanced a few hundred feet a block of ground 75 feet long is marked off, and this is stoped out by four men on contract. The whole block is drilled by only one machine. A block is stoped out in about four months. The first block being raise and stope requires several weeks longer.

Owing to the dip there is no difficulty in rigging up drills on the foot, and at the same time the inclination is sufficient to allow all but the finest ore to run down to the level. No protection at the level is necessary. and no timber is used in the stopes. Rock pillars are left along the foot of the stope and a 8-foot to 10-foot floor pillar in the back. The ore runs onto a sollar beside the track, and is shovelled up into the cars. At the Mohawk mine where similar methods are used, the dip is in places not sufficient for the ore to run, and iron chutes are used in cleaning the stopes. A large number of cars are used at each level, and the trammers leave their loaded cars at the shaft. A special crew of workmen load all the ore into the skip, working their way down from level to level, and then riding up and going over the ground again.

Hancock Mining Method.—At the Hancock mine is illustrated an economical method of mining a narrow lode dipping at an angle of about 45 degrees. In mining this lode use is made of a vertical shaft which is being sunk to open up the Pewabic lode at greater depth. In early workings an inclined shaft was sunk to the thirteenth level and three lodes opened up. The present method is in use below the thirteenth level on No. 3 lode.

A winze was sunk in the lode for about five hundred feet, and the lode worked from levels about 100 feet apart. At the eightheenth level connection was made with the vertical shaft by a long cross-cut. The winze was then no longer used for hoisting, but was converted into a chute, and all ore from upper levels brought down to this level.

Drifts are run 6 feet by 7 feet. A cutting out stope follows enlarging the opening to 24 feet. A row of stulls 4 feet to 6 feet apart is set above the level and lagged over with cedar poles 4 inches to 6 inches diameter. At intervals of about 25 feet a hole 2 feet by 4 feet is left in the lagging, and a high sollar built about 4 feet above the car rails. When the level is thus protected and provision made for handling the ore, stoping is commenced. In the first cut care is taken not to shoot the rock directly against the timbers. After a few feet of broken ore lies on the lagging, the remainder of the ore can be broken with wet holes. Enough ore is left in the stopes to support the miners and the rest drawn off. The ground is firm and no timber is used in the stopes. Rock pillars are left where poor rock is found, and an arch pillar, 6 to 10 feet thick, is left in the back of the stope to support the level above. The ore is drawn out of the stopes onto the sollars and there sorted and loaded into tramcars. The cars are pushed by hand to the converted winze, which is now a chute having two compartments, one for ore and one for rock. At the bottom of the chute the ore is loaded into saddleback tramcars, each holding about three tons, and drawn by electric locomotive to the vertical shaft. Here the cars are run over bins into which their contents are emptied. From the bin the rock is let into the skip by raising a heavy gate, and dropping an iron lipped chute over the edge of the skip.

Quincy Mining Method.[4]—At the Quincy mine narrow amygdaloid lodes, dipping at an angle of from 54 degrees to 38 degrees, are being worked at great depth. The conditions are somewhat similar to those at the Calumet and Hecla conglomerate mine, but comparatively little timber is used. Support is chiefly by rock pillars, and by heavy stulls loaded with broken rock. Drifts, 7 by 6 feet, are run in the lode. Commonly the drifts are partly in the foot-wall. The miners driving the drift are closely followed by others cutting out the lode for a width of 18 feet from the foot-rail. Following the miners making the cutting out stope come timbermen who protect the level and make provision for drawing off the ore into tramcars. When a cutting-out stope has been timbered and the levels ready, drills are started in the stope. The several groups of men are all gradually working their way from the shaft to the boundary.

The level timbering was formerly of stulls placed about 4 feet apart and covered with cedar poles. The present method differs in the absence of lagging consequent on close spacing of the stull timbers. This gives better protection from falling rock and is said to be cheaper. The stull are logs of peeled hemlock, maple and birch, averaging 15 inches to 24 inches in diameter —some are 3 feet in diameter. These are set in a row at the foot of the stope, and are only four or five inches apart. At intervals of 15 feet a 5-foot space is left and a high sollar is built. A 2-foot hole is left so that the ore can be run out onto the sollar. In some parts of the mine the ore is run out on timbers over the level and dropped into the car.

In stoping there are numerous pillars left scattered irregularly in the stope wherever the lode is poor or where support is especially required. Many are in

places where the hanging bellies down. In places stulls are set in the stope for support, either as single sticks or in batteries of three. In some stopes the workmen stand on rock-covered platforms supported by stulls and work down the stope from either side of a raise.

A common practice is to have three drills working on the face towards the boundary. Each takes off a slice by five or six breast cuts in descending order, and then goes up in the stope and works down again, taking off another similar slice.

When the stope is mined out, the row of heavy stulls at the foot is heavily loaded with rock. This "poor rock" is commonly obtained by breaking into the foot-wall, as it is desirable to disturb the hanging as little as possible. Rock is piled onto the stulls to a depth of 30 or 40 feet. Later, as the hanging settles down, the stulls are compressed—often splitting longitudinally, and shortening 6 or 8 inches—and then the rock filling wedged tightly into place, takes up the pressure.

The ore is drawn off onto the high sollars and loaded into tramcars. For short distances, 500 to 600 feet, the cars are pushed by men. After the distance becomes greater, electric locomotives are used to haul trains of 4 or 5 cars loaded with about 3 tons each.

The ore is not loaded from tramcars into skips, but is emptied into ore pockets near the shaft. From these pockets, some of which hold 100 skiploads, the ore is drawn off[5] at a lower level into the skip.

The Baltic Mining Method.—The Baltic is one of several mines on the Baltic lode, which is wide, 15 feet to 60 feet, and has an unusually steep dip—73 degrees.

Shafts are sunk in or near the foot-wall, and levels are about 100 feet apart. Drifts are either run 8 feet by 8 feet and then cut out the full width of the lode, or else run the full width at once. Then another cut is taken off the back, the drills being mounted on broken ore. There is then an opening 16 feet high for the width of the lode. The ore is drawn off, and the broken waste rock left in piles in the drift. The levels are now enclosed by "dry" walls built of rock, and a cover of lagging laid on heavy timber caps. Openings are left at intervals in the wall for chutes to draw off ore through mill holes. The mills are built up with a circular wall of rock, leaving an opening about 4 feet in diameter. Iron lips are placed at the chute, so that the ore can be drawn off from the flat bottomed mill holes into tramcars.

When walls are built and mill holes started, the remaining space is filled with poor rock. Then stoping is started, the drills being rigged up on the waste. Where the amount of poor rock broken is too small for the filling required, additional rock is broken from the foot or hanging in "poor rock stopes." The ore broken is sorted where it falls. The waste is left to fill in the stope, and the ore is thrown into, or carried in small cars to the mill holes. Stoping proceeds in this way, the mill holes being built up and the stope filled with waste while the ore is being drawn off.

When the stope has been carried up to within 30 feet of the next level, a so-called caving method is used to remove the arch. A raise is carried up to the level, and numerous holes drilled in the ground on either side of the raise. When the level is no longer needed, a wide opening is made by firing all these holes, and the waste rock filling in the stope aove follows the ore down into the stope below. The ore is sorted out and trown into the mill holes and then drills are rigged upon the waste filling in the stope, and slices are taken off the arch. When only a few feet remain a large number of holes are drilled nearly through to the level, the stope is well cleaned of ore, and then the holes fired. The broken ore falls down into the stope, and is followed by a pile of waste from the stope above. As much of the ore as possible is sorted out and thrown in the mill holes. When all readily reached is sorted out, the drills are rigged up on the side of the pile of waste and another cut is made across the lode. Then again the stope is well cleaned of ore, and the last few feet of back is drilled with numerous holes. These are fired, and another cave of waste takes place. In this way all the lode is broken and most of the ore is saved.

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[1]From Publication 8, Michigan Geological and Biological Survey. This section was written by Reginald E. Hore.

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[2]A description by W. A. Parnall, Jr., of the No. 5 Tamarack shaft was published in proceedings of the L. S. M. Inst., Vol. VII, 101, pp. 50-61.

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[3]A description of the Wolverine method will be found in Rickard's Copper Mines of Lake Superior and Crane's Ore Mining Methods.

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[4]The Quincy method has been described by T. A. Rickard in Copper Mines of Lake Superior, and by G. R. McLaren, Journal of the Canadian Mining Institute, 1907, pp. 399-417. The methods have been somewhat changed since their descriptions were written.

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[5]Diagrams illustrating arrangement for loading skip will be found in T. A. Rickard's "Copper Mines of Lake Superior," pp. 68 and 69.

WATER POWERS IN THE PORCUPINE AREA*

By W. R. Rogers.

For the last report of the Bureau of Mines the writer prepared a few notes on the subject of water powers in the vicinity of Porcupine. This article was incorporated in Mr. Burrows' report on the Porcupine Gold Area.

Since last writing the hydro-electric plant at Sandy Falls has been completed, and electric energy supplied to the mines since June, 1911. Another water power is being harnessed at Wawaitin Falls. Both of these powers, situated on the Mattagami river at distances of 6 and 11½ miles respectively from the Hollinger mine, are shown on the geological map of the Porcupine area.

Other water powers within a radius of 25 miles from Porcupine are: High Falls on the Frederickhouse river in the Township of Mann; Grassy Falls on the Price-Fripp township boundary; and Sturgeon Falls on the Mattagami river in the Township of Mahaffy. Applications have been made for permission to develop all of these. However, no actual development work has been carried beyond the stage of preliminary surveys.

*From the 21st Annual Report of the Ontario Bureau of Mines.

A copy of the regulations stating the conditions upon which water powers are leased may be had on application to the Department of Lands, Forests and Mines.

Importance of Accurate Data.

Hydrographic work in Canada, or rather the branch of it pertaining to stream measurements, was initiated by the Department of the Interior, Ottawa in 1909. Work, however, has been confined almost exclusively to Dominion lands in the Province of Alberta. A valuable report was issued in 1911 by the Conservation Commission entitled "Water Powers of Canada." In this volume emphasis is laid on the necessity of obtaining more accurate data in regard to water powers before proceeding with their development. The only safe basis for estimating the maximum amount of power available is the minimum flow of the stream throughout the year. In some cases storage facilities will help to raise this minimum. In order to secure the necessary data, metering and gauging stations should be established, and to ascertain the maximum, minimum and mean discharges accurate records for a period of years are necessary. The importance of winter observations must not be overlooked as the minimum flow occurs during that season and should be determined for use in considering power schemes. From the power user's point of view contracts should not be entered into for the supply of more power than is justified by low water records for a period of ten years or more. As such data respecting water powers in Northern Ontario is not available, a very conservative estimate should be made the basis of hydraulic and electrical installations.

A case in point is that of the Porcupine Power Company. Extreme low water and ice troubles in March, 1912, combined to tie up the Sandy Falls power plant and to greatly inconvenience customers. A year previous, at the Ragged Chutes compressed air plant on the Montreal river, a similar condition developed, which resulted in many of the mines at Cobalt shutting down for lack of air to run the drills. This difficulty has been overcome by the construction of storage dams to retain flood waters, in order to increase the flow at low stage periods.

The drainage area of the Mattagami river at Wawaitin Falls is approximately 1,000 square miles. At Sandy Falls the drainage area has been increased to 2,500 square miles by the additional territory supplying tributary feeders, namely, Mountjoy creek and the Grassy and Lost rivers. Assuming a run-off of 0.4 cubic feet per second per square mile, the discharge at these points would be 400 and 1,000 cubic feet per second, respectively. The effective head at Wawaitin is 118 feet, and at Sandy Falls 34 feet. Figuring on this basis and assuming for turbines 80 per cent. efficiency under natural flow, the minimum 24-hour horse-power is 4,300 and 3,100 respectively. The only definite metering records available give the following:—

Wawaitin Falls.—March 1910, 366 cubic feet per second.

Sandy Falls.—January 20th, 1910, 1,654 cubic feet per second.

A director of the Porcupine Power Company states that the extreme low water flow per second at Sandy Falls was 1,600, 1,200 and 600 cubic feet respectively for the years 1910, 1911 and 1912. It will be seen from the above records that an exceptional year like 1912 emphasizes the necessity of continuous records for a period of years to ascertain the extremes of flow as well as a reliable mean. Extreme cold weather, with no thaws of consequence throughout the winter, produces an acute situation in Northern Ontario. Controlled storage is the only remedy for increasing the minimum flow, and it is proposed to dam the headwaters of the Grassy river for this purpose. In this part of the Province of Ontario February and March is the season of extreme low water.

In the case of the Wawaitin plant, Kenogamissee lake forms a small storage basin. Kenogamissee Falls, 25 miles south, affords facilities for storage and regulation. In addition it would be possible to divert the Lost or Redsucker river by means of a small dam and a shallow cutting about 1½ miles in length through sandy soil.

Porcupine Power Company.

The Porcupine Power Company's plant at Sandy Falls consists of two 25-cycle, 3-phase, 12,000-volt 214 revolutions per minute, 950-k.w. generators, directly connected to S. Morgan Smith turbines. A third unit of similar capacity is being installed. The electric equipment is of Canadian Westinghouse manufacture. Each unite requires 450 cubic feet of water per second to develop full power under an effective head of 34 feet.

Turbine runners are 54 inches, and intake pipe 10 feet in diameter. The turbines were specially constructed to admit of sections being teamed on sleighs a distance of 45 miles from Kelso before the Porcupine branch of the T. & N. O. railway was built. The power house is a timber structure sheeted with galvanized iron, and is equipped with a 15-ton travelling crane. The timber flume, 13 by 16 feet in section, and 700 feet long, is provided with electric heating wires running through the upright studs in case it should be found necessary to use a heating appliance to prevent ice formation in extreme winter weather.

The dam is of cribwork construction, stone filled, sheet piled, and has 10 sluice-ways, varying in width from 12 to 16 feet. Spillway, fishway, and a combination ice run and log chute are also provided.

The plant was designed and constructed by H. D. Symmes of Niagara Falls, who is a director of the Porcupine Power Company.

Wawaitin Power Company.

Construction work at Wawaitin Falls started in the summer of 1911. Supplies, machinery, etc., were loaded on scows and pointers and towed up the Mattagami river by gasoline boats from Mattagami Landing. Messrs. Ross and Holgate, of Montreal, are consulting engineers for the company.

The Falls are in Thornloe township, their position being shown on the map of the Porcupine Gold Area. It is proposed to use a head of 118 feet, carrying the water from a higher level to a lower by means of an open flume and pipe lines. The open flume or canal is about 1,400 feet long, 40 feet in width, and the greater part is in rock. A 12-foot diameter penstock leads from the flume for a distance of 1,500 feet, where it subdivides into two, each 8 feet in diameter and 1,200 feet long. The surge tank at the junction of the penstock is 40 feet in diameter and 38 feet high. These 8-foot penstocks terminating at the power house supply two units, each Westinghouse generator being 2,500-k.w., 12,000-volts, 3-phase, 25-cycle, running 375 revolutions per minute, with an overload capacity of 3,120 k.w. Provision has been made for a duplication of the pipe line and power house installations. The power house is of reinforced cement construction, with cement roof.

The location of the dam is at the head of a small island, at the point where Kenogamissee lake contracts to river width. This dam, 1,000 feet long is provided with log chute 150-foot spillway, and has 16 stop-log

sluiceways for the purpose of maintaining a uniform head above the dam.

E. A. Wallberg has leased this water power, and under the conditions must develop electrical energy to the amount of 4,000 horse-power by September, 1912. During the past winter, 1911-1912, progress has been checked for financial reasons. However, at the time of writing, May, 1912, work has been resumed and indications point to completion of the work before the time required by the lease from the Crown. An interest in the power company has been acquired by the Dome Mines, Limited. They will require 3,000 horse-power for the first year's work.

The Sandy Falls plant of the Porcupine Power Company is already taxed to the limit of its capacity, and further power must be provided to meet the demands of Porcupine mines as development proceeds.

Thanks are due Mr. Robert Laird, resident engineer of the Wawaitin Power Company, for furnishing construction data. Mr. J. H. Thornley, resident engineer of the Porcupine Power Company, kindly supplied photographs of the power house and general layout, and also explained the main features of construction.

EAST KOOTENAY

Now that the St. Eugene mine is no longer a large producer of lead ore, much interest is taken in the Sullivan mine, to which brief references were made in several annual reports of the Consolidated Mining & Smelting Company of Canada, Limited, as follows:

Sullivan Mine.

As at June 30, 1910: "A lease has been taken upon the Sullivan mine, near Kimberley. A royalty is paid upon all ore shipped, and the Consolidated company has undertaken to perform $10,000 worth of development work. The mine is producing monthly 2,500 tons of ore containing, approximately, lead 18 per cent., and silver 6 ounces a ton."

As at June 30, 1911: "During the year the company has acquired a majority of the stock of the Fort Steele Mining & Smelting Company, Limited, owner of the Sullivan mine. The lease to the Consolidated company expired on June 30, and the Fort Steele company is now operating the property and shipping ore to Trail. The mine is producing between 2,000 and 3,000 tons a month of ore containing, approximately, lead 20 per cent., and silver 6.6 ounces to the ton. The loss of the St. Eugene tonnage has been serious, but will be partly overcome by the operation of the Sullivan, in which the mineral-bearing area has not yet been thoroughly prospected."

As at June 30, 1912: "The properties of the Consolidated company surrounding the Sullivan group have been prospected to a small extent with a diamond drill, with promising results. The Sullivan lease having expired, the property has been operated by the Fort Steele Mining & Smelting Company, and the ore shipped to Trail for treatment. The mine shipped during the year 21,189 tons of ore, containing 205,654 ounces silver, and 10,569,211 pounds of lead."

Statistics published by the Consolidated company show that up to June 30, last, the aggregate production of the Sullivan mine had been 147,364 tons of ore, containing 1,246,023 ounces of silver, and 63,049,962 pounds of lead, together having a gross value of $3,083,655.

Economic Geology of Kimberley Areas.

The last-published "Summary Report" of the Geological Survey of Canada includes a report by Mr. S. J. Schofield on his 1911 season's work in East Kootenay. Under the sub-head "Economic Geology" he gives the following information relative to the Sullivan and neighbouring Stemwinder mines, in the Kimberley area:

"The area is situated near Kimberley, the terminus of the Canadian Pacific Railway Company's branch line from Cranbrook to Kimberley, and includes the Sullivan, Stemwinder, North Star, and several minor properties. It is underlain by a series of argillaceous quartzites and pure heavy-bedded quartzites, which are identical in lithological and physical characters with those described in the Moyie district, and hence belong to the lowest-known subdivision of the Purcell series. About one-half mile above Kimber, on Mark creek, a few diorite sills are exposed in the valley walls.

"Sullivan Group.—This group was discovered in 1895; it is situated on Sullivan hill, about two and one-half miles by road north of Kimberley, at an elevation of about 4,600 feet above sea-level. The deposit lies in the lowest-known subdivision of the Purcell series, which here strike about north and dip from 10 to 60 degrees to the east. The country rocks consist of thin-bedded, argillaceous quartzites, and heavy-bedded, purer quartzites. The ore-body conforms in dip and strike with the quartzites and cannot be called a true fissure vein, but a replacement deposit in which the sulphides have replaced the fine-grained quartzites. The hanging and footwalls are, in general, not well defined, but the ore gradually passes into the normal country rocks so that the distinction between country rock and ore is commercial rather than structural. Exceptions to this occur where the walls consist of the thin-bedded, slaty quartzites, which are evidently difficult to replace. In the upper workings, close-folding later than the ore-deposition increases the apparent width of the deposit. On the 60-foot level the dip of the ore-body in places approximates 25 degrees, and on the 100-foot level it increases to 70 degrees, which is also the dip of the surrounding quartzites. As far as exploited, the maximum stope width is 120 feet and the maximum stope length 325 feet. There are nine levels, the deepest being 100 feet below the surface. The deposit is a lens-shaped mass, striking about north and south, with a dip to the east.

"The ore-body is arranged in distinct zones which grade imperceptibly into each other. The centre of the body is occupied by a fine-grained mixture of galena and zinc blende in which masses of purer galena occur as lenses. The gangue is absent from this inner zone, except for a few well-formed crystals of pink garnets. This inner portion gradually passes exteriorly into a fine-grained mixture of pyrite, pyrrhotite, and zinc blende which contains as a gangue numerous crystals of a clear, colorless garnet with some grains of anthophyllite and possibly diopside. The sulphides gradually diminish in amount and finally give way to a fine-grained chert which is present where the country rock is a heavy-bedded, purer quartzite, and is absent where a more argillaceous, slaty member constitutes the wall-rock. No garnets nor anthophyllite are present in this zone. The chert gradually passes into the normal quartzite. The contact minerals occur only in the ore-body and are entirely lacking in the country rock sur-

rounding the deposit. The presence of the minerals, garnet and diopside, so characteristic of contact deposits, is not due to any intrusion of igneous material at present visible, for the nearest outcrop of granite is four miles away, near Wycliffe, on the St. Mary prairie. The presence of the minerals garnet,, pyroxene, and pyrrhotite warrants the conclusion that the Sullivan ore-body was formed under conditions of high temperature and pressure, and in origin was connected with some deep-seated intrusion of granite which has not yet been exposed by erosion in the neighbourhood of the Sullivan mine. The Stemwinder property, occurring on Mark creek and apparently in a lower horizon than the Sullivan, indicates that ore-bodies might be expected below the Sullivan deposit.

"The Sullivan ore is shipped to Trail for treatment and is smelted without any preliminary concentration. Development and construction work are being rapidly carried on, and about 100 men are employed.

"Stemwinder.—The Stemwinder is situated one mile northwest of Kimberley, on Mark creek. The country rocks consist of argillaceous quartzites intruded by several sills of diorite. The ore-body is enclosed entirely by the quartzites and closely resembles the Sullivan deposit in its occurrence and mineralogy. The interior of the ore-body consists of a fine-grained mixture of galena and zinc blende passing exteriorly into a fine-grained mixture of pyrrhotite, pyrite, and zinc blende. This is succeeded by a cherty layer which in turn passes into normal quartzite. The amount of development so far accomplished was not sufficient to expose the relation of the ore-body, but it is evidently of large size. Three short tunnels and a shaft 75 feet deep open the deposit. Experiments are in progress to determine the best method for the treatment of this refractory ore."

PERSONAL AND GENERAL

Mr. R. C. Sweezy has been retained by banking interests to examine mining properties. He has returned recently after spending three months in Western Canada, and leaves shortly for Mexico.

Mr. R. H. Stewart, general manager of the Consolidated Mining & Smelting Company of Canada, passed throught Montreal recently, having spent some weeks in England on business for his company. Mr. Stewart is very hopeful concerning the future of mining in British Columbia, believing that great activity will result directly the problem of treating the complex ores, particularly those in which zinc is a major constituent, shall have been satisfactorily solved. He is of the opinion the solution of these problems will be found very shortly.

Mr. Charles Fergie was in New York on business last week.

Dr. A. E. Barlow delivered a lecture on the Cobalt District before the New York Section of the American Institute of Mining Engineers on December 20th.

Mr. Moses Jones, assistant underground manager at the Springhill mines, Nova Scotia, was killed on December 19th by being struck by a train of cars passing up the slope.

Mr. J. H. Plummer, president of the Dominion Steel Coporation, who was interviewed in Montreal the other day, stated that conditions now obtaining in the steel trade are very satisfactory. The company has now its fifth blast furnace in operation, while the output of the nail mill has been considerably increased.

Mr. David H. Browne, metallurgist of the Canadian Copper Company, was in New York recently in connection with the arrangements now being made by the company to double the capacity of its reduction works in the early future.

Mr. Herbert Carmichael, of Victoria, B.C., for about twenty years provincial Assayer for British Columbia, has resigned that Office and will hereafter give his attention wholly to his own affairs.

Dr. De Lorme D. Cairnes, of the Geological Survey of Canada, has contributed to the "Bulletin of the Geological Society of America" a paper entitled "Differential Erosion and Eqiplanation in Portions of Yukon and Alaska."

Prof. W. A. Carlyle, professor in metallurgy at the Imperial College of Science and Technology, London, England, recently returned to that city from Mazapil, Mexico.

Preliminary announcement has been made of the intention to hold the next Annual Meeting of the Canadian Mining Institute in Ottawa, Ontario.

Mr. C. D. Emmons, under whose advice the British Columbia Oilfield, Ltd., of Vancouver has been drilling for oil on Graham island of the Queen Charlotte group, British Columbia, is convalescent after having been ill two weeks in a hospital in Victoria.

Mr. Geo. Watkin Evans, of Seattle, Washington, who had been ill after having spent the greater part of the last field season in the Groundhog coal field, in the northern part of Skeena district, British Columbia, has now recovered his usual good health.

Mr. Henry Harris, some years ago assistant superintendent of the smelting works of the Hall Mining & Smelting Company,at Nelson, B.C., and afterwards filling a similar position at the Brown Alaska Company's smeltery at Hadley, Prince of Wales island, southeast Alaska, sends greetings to his friends in Canada from Zeehan, Tasmania, where for several years he has been manager of the Tasmanian Smelting Company.

Mr. W. Pellew-Harvey, for years activity connecetd with the mining industry of British Columbia, but now of Pellew-Harvey & Company, mining engineers, London, England, was recently at Tiflis, Caucasus.

Mr. W. S. Hawley of Spokane, Washington, manager of the Silver Hoard Mines Company, operating a silver mine in Ainsworth camp, British Columbia, has received from Prof. F. A. Thomson, head of the mining engineering department of the State College of Washington, Pullman, Washington, a report on that property, which during recent months has shipped to the Consolidated Company's smeltery at Trail, B.C., between 200 and 300 tons of ore averaging about 61 ounces silver to the ton and 3 per cent. lead.

Mr. Robert R. Hedley, of Vancouver, B.C., was one of the examiners at a recent examination of applicants for certificates of competency and license to practise assaying in British Columbia under the "Bureau of Mines Amendment Act of 1899."

Mr. Jules Labarthe, formely superintendent for a number of years of the Consolidated Mining & Smelting Company's smeltery at Trail, West Kootenay, British Columbia, and now general manager of the Mason

Valley Mines Company, with mines and smelting works in Nevada, when met in Spokane, Washington, recently, stated that Mr. A. J. McNab, who succeeded him in charge of the Trail works and afterward accepted the position of metallurgist for the Mason Valley Mines Company is doing excellent work in Nevada, where his company's mining and smelting enterprise is in a flourishing condition.

Mr. Douglas C. Livingston, one of the professors of mining engineering at the Idaho University, Moscow, Idaho, formerly with the Tyee Copper Company on Vancouver island, B.C., and later for several years engaged in mining in Mexico, has been taking part in a discussion, printed in "Mining and Scientific Press," of San Francisco, California, of an article on "Ore Reserves and Life Extension," contributed to that journal by Mr. Morton Webber.

Mr. R. Machin, well known in British Columbia mining districts six or seven years ago as the provincial representative of several British manufacturers of mining machinery and supplies, is again resident in Victoria after having been for a time in Western Australia on business matters.

Mr. J. W. D. Moodie, vice-president and general manager of the Britannia Mining & Smelting Company, with mines and concentration works near Howe Sound, British Columbia, has been on a visit to New York city, where are resident some of the larger shareholders in the Britannia company, the operations of which are becoming increasingly important, while its property holdings have been considerably added to of late.

Mr. M. E. Purcell, superintendent of the Consolidated Mining & Smelting Company of Canada's Centre Star group of mines, in Rossland camp, British Columbia, has returned from Spokane, and the Coeur d'Alene district of Idaho, after having attended the American Mining Congress, and visited several of the larger mines and concentrating mills in the Idaho Panhandle.

Mr. Byron Riblet, whose name is well known in British Columbia and adjacent parts in connection with the Riblet system of aerial tramways, has been granted a patent for a landing stage for aeroplanes.

Mr. James Rutherford, representing British investors in land and mining properties in Western Canada, has returned to Victoria, B.C., for the winter after having again spent several weeks in the Peace River country.

From the London "Mining Journal" it is learned that Mr. Ernest H. S. Sampson had recently been appointed assayer and surveyor for the New Canadian Metal Company, Limited, at Riondel, British Columbia. This company, of which Mr. S. S. Fowler is general manager, is working the well-known Bluebell mine, situated across Kootenay lake from Ainsworth, West Kootenay, and has, too, a well-equipped concentrating mill there.

Mr. Robert H. Stewart, of Trial, British Columbia, general manager of the Consolidated Mining & Smelting Company of Canada, Limited, who about two months ago left on a trip to Europe, is understood to have been investigating some of the zinc reduction processes in operation on that continent. Interested persons continue to make much of the allegation that the Consolidated company has purchased the Canadian rights to the French process for reducing zinc-lead ores, but so far as can be ascertained that company is doing little, if anything, towards using that process for the attempted saving of the spelter content of ores in any considerable quantity.

Several months ago the Canadian Collieries (Dunsmuir) Limited' operating the Cumberland and Extension collieries, on Vancouver island, British Columbia, created a new office in connection with their operations at Union bay, namely that of superintendent there of workshops, coal-shipping plant and appliances, coke ovens, etc., and appointed Mr. J. A. Tompkins to fill the position. There is a prospect of the company establishing a coal-briquetting plant at Union bay, and in connection with this prospective enterprise much information is being obtained.

Mr. Bruce White, for years actively connected with mining in West Kootenay district of British Columbia, has returned to that district after having spent several weeks in the provincial coast cities and in Spokane, Washington. His name was lately associated in a district newspaper with the staking of mineral claims in the vicinity of Kootenay lake, on which claims the occurrence of ore containing platinum was alleged. Mr. White himself is authority for the statement that there is still serious doubt as to the correctness of the report that platinum occurs there, as alleged, since an assayer of long experience and excellent standing has been unable to confirm assurances given by another that the ore is platinum-bearing.

Mr. W. E. Zwicky, of Kaslo, B.C., manager of the Rambler-Cariboo Mines, Limited, with a largely developed silver-lead mine in Slocan district of British Columbia, has been quoted by the Nelson "Daily News" as authority for the statement that the operation of the company's new concentration mill has been commenced. This company, after having previously sunk to a depth of 800 feet from the apex of the vein, in 1904, commenced to drive a 4,500-foot cross-cut adit with the object of cutting the vein at about 600 feet deeper. Eventually this was done, and after many delays, caused by fire and other adverse circumstances, production on a comparatively large scale is about to be begun. The vein has been explored on half a dozen levels down to the 1,400, and on each of these stoping can be done, so that there is little probability of the supply of ore running short for the next year or two.

Zinc mining is receiving increasing attention in British Columbia, and in this connection, Mr. J. L. Retallack, of Kalso acting on behalf of Messers. Beer Sondheimer & Company, with works at Bartlesville, Oklahoma U.S.A., has purchased the zinc-concentrate output from the concentrating mills of the Standard, Hewitt, and Van-Roi mines,in Slocan district, and the Monarch, near Field, on the C.P.R. transcontinental line. Other shippers are the Lucky Jim and the Noble Five both in Slocan district, the former in comparatively large and the latter in smaller quantity. In addition, there is a little British Columbia zinc ore concentrate being sent to Kansas and elsewhere in the United States.

QUEBEC.

Some attention is again being directed to phosphate mining in the province in consequence of the improvement in prices permitting of profitable operation. At one time phosphate commanded $25 per ton, but the discovery of large and easily mined deposits in Florida reduced the price to $5 per ton, killing the local industry. The present price ranges between $11 and $14, and there is a good demand for the product. Phosphate is manufactured into fertilizer at five works in Canada, of which three are established in the Province of Quebec.

THE SWASTIKA GOLD AREA*

By E. L. Bruce.

The Swastika gold area centres about the Town of Swastika at mileage 164 on the Temiskaming & Northern Ontario Railway. The area examined comprises the southern half of the Township of Teck and the northern half of the Township of Otto. This area was first described by Mr. W. J. Wilson, who made a reconnaissance survey of the Blanche river for the Canadian Geological Survey, and later by Mr. L. L. Bolton, who accompanied Speight's survey party in 1904 and reported on the geology of the country from Round lake to Abitibi for the Ontario Bureau of Mines.

At the time of the gold rush to Larder Lake a number of claims were staked in the Swastika area, and some work was done upon them. The claims now held by the Lucky Cross Mining Company and those of the Swastika Mining Company were located at that time. In the depression which followed operations were continued only on the latter group. The first development was done on the big quartz vein on the west side of Otto lake. A shaft was put down about sixty feet and some drifting done. Surface prospecting on the north side of the lake uncovered No. 1 vein, containing visible gold, and with the discovery of other veins near this one the work on the west side was abandoned. A shaft was sunk and a five-stamp mill was installed on the north side. This mill turned out several small bricks before being dismantled in 1911 to make room for the present plant.

The discovery of gold at Porcupine led to renewed interest being taken in the older area, and the summer of 1911 saw most of the old claims restaked and development work started on many properties.

Topography and Drainage.

The area lies just south of the height of land between James Bay and the Ottawa river, and while the difference of elevation is seldom more than two hundred feet the country is rather rugged and broken. Rock outcrops are numerous, and the areas of swamp are neither large nor continuous. The hills are arranged in roughly parallel east and west ridges in conformity with the strike of the formations. East of the Blanche river, however, the regularity is not so pronounced, and the hills are more or less isolated.

The Blanche river which flows through this area, turns sharply east about a mile below Kenogami station and runs between two of these ridges until it breaks across the southern one in a series of rapids at Swastika. Just south of these rapids it is joined by Amikougami creek, which forms the outlet of Amikougami lake north of Swastika, and which flows in a fairly straight north and south course. Below the junction of the two streams is a broad valley, in which the river meanders considerably before entering Otto lake. Leaving the lake, the river again forms a series of rapids, below which there is a long stretch of quiet water broken only where it crosses the syenite ridge in concession IV. In concession V. the Blanche receives another tributary from the north, known as Murdock creek. This stream, like Amikougami creek, flows south in a fairly straight course. The lower part is shallow and rapid, but the upper reaches are rather sluggish. The Amikougami is broken by a few rapids but forms a good canoe route to the lakes lying to the north.

*From the 21st Annual Report of the Ontario Bureau of Mines.

Geology.

The rocks of the area may be classified as follows:—

Recent and Glacial—

Stratified clays, peat, sand and gravel.

Pre-Cambrian—

Post Huronian—Diabase, red feldspar-porphyry, augite, lamprophyre.

Igneous Contact.

Huronian—Conglomerate and greywacke.

Unconformity.

Laurentian—Augite syenite.

Igneous Contact.

Keewatin—Gral feldspar-porphyry basic intrusives, iron formation and epidotic rocks, greenstones and schist.

Keewatin.

Greenstone and Greenstone Schist.—The greater part of the Keewatin rocks are massive greenstones or their schistose derivatives. Where stil lmassive, the greenstones show an ellipsoidal structure. This characteristic is pronounced in the rocks of the northeast corner of Otto. It is also seen especially well on the hill to the east of mile-post 170, and on the face of the cliff near Kenogami station. Massive greenstones grade into rocks of schistose character. The schistoity become more pronounced near the contact with the later acidic intrusives, and the strike of the schists is usually parallel to the strike of the contact. The layers of schist are not at all regular, but often the rock shows a columnar structure, with twisted blocks whose surfaces are serpentinized and highly polished. Rocks of this type outcrop along the railroad east of Amikougami creek. Between this stream and Murdock creek, railroad cuttings show an anticlinal arrangement of these schists. At the western side they have a strike S. 45 W., dip 70 degrees N.W. The dip gradually becomes less steep, until the schists are almost flat. Then the dip increases towards the S.E., and at a point two miles east of Swastika the strike is S. 64 degrees W., dip 80 degrees S.E.

The greenstones and schist extend in a broad belt across concessions IV., and V., Otto and after crossing the Blanche river at Swastika the northern boundary follows Amikougami creek for some distance, and then swings northeast across the southern part of the Township of Teck.

A chistose greenstone east of Swastika consists entirely of actinolite needles, along with sericite and magnetite. A rather more massive rock at the west end of Pike lake has altered to chlorite, with a considerable quantity of carbonates, and has fine particles of sulphides scattered through it. In neither case is any trace of the original structure or minerals left.

At mileage 162 on the Temiskaming & Northern Ontario Railway there is a cutting through a very dense black basaltic looking rock that carries many small lenses of sulphides. Under the microscope the rock shows grains of quartz and a dark sooty material. The rock suggests a baked bituminous shale.

Carbonate Rocks—Carbonates occur at several places in the area. Along the north side of Pike lake a narrow more or less continuous band of a much rusted carbonate rock separates the conglomerate from the grap feldspar-prophyry. This band is so altered and its character so masked by the rusty weathering that it is impossible to determine its original nature. In parts the unweathered portion is light green in colour, prob-

ably consisting largely of the chrome-bearing mica, fuchsite. Carbonate rocks also outcrop farther west, in lot 12, concession VI., Otto. They are fractured and the fractures are filled by quartz, producing a network of intersecting veinlets. Other small outcrops of carbonate rocks occur in the eastern part of Teck.

Serpentine.—The greentones are often much serpentised along slip planes and on the surfaces of the layers of schist. An outcrop of massive serpentine of small extent was observed on the Crawford claims, about two miles north of Swastika.

Iron Formation and Epidotic Rocks.—Banded iron formation, consisting of alternate bands of magnetite and silica, occurs at several points along the southern edge of the Keewatin belt. A rock that seems to be related to it is exposed in the railway cuts in concession V., Otto. This rock consists of interbanded epidote and silica. Iron formation lies a few chains farther south.

Keewatin Intrusives.—A large number of dikes of varying character cut the Keewatin greenstones. Some of these are so much altered that they suggest very early intrusions, and probably belong to the latter part of the Keewatin complex. Others, however, are much fresher, and may be of much later date. These are relatively small in area and have been mapped as Keewatin, since their relationship to later rocks is not known.

Diabase dikes are very numerous in the greenstones. In most cases the rock is very badly altered, and there is little doubt that it belongs to the Keewatin complex. Other dikes are, however, quite fresh in appearance, and some of these may belong to the post-Huronian series but at no place was any intrusion of diabase into conglomerates or greywackes observed. A considerable area of a massive igneous rock outcrops in concession V., lots 1 and 2, of the Township of Eby. It is somewhat altered, but still retains phenocrysts of a bronzy colour. Farther north a thin section shows a rock that has evidently resulted from the metmorphism of an igneous rock of a porphyritic type. Some original minerals are still recognizable, and the original structure is not much affected. Feldspar phenocrysts are present and can still be determined as near albite in composition. A few shreds of green hornblende are left, but most of this mineral, which apparently formed the largest number of phenocrysts, has changed over to chlorite. Sericite is also abundant due to the alteration of the feldspathic constituents.

Feldspar-Porphyry.—Intruding the greenstones near Otto lake and again on the eastern side of Murdock creek is a gray feldspar-porphyry, which has been included in the Keewatin series. The feldspar phenocrysts show distinctly on the surface. Under the microscope the rock is distinctly porphyritic. The phenocrysts are blagioclase feldspar, near the albite end, set in a groundmass of quartz, feldspar, and hornblende. Considerable alteration has taken place, producing chlorite, sericite, kaolin, carbonates and epidote. Magnetite and chalcopyrite are present. The phenocrysts make up a large part of the rock, the areas of groundmass being narrow.

A thin section of the rock in the railway cut near the water tank at Swastika shows a rather abnormal facies of this rock. Here the ferro-magnesian minerals are altogether lacking, the whole rock consisting of albite, quartz and alteration products such as carbonates, sericite, chlorite, epidote and magnetite. The ordinary type is a quartz diorite-porphyry. This abnormal type approaches a quartz keratophyre.

Hornblendite.—Crossing the eastern boundary of Teck is an outcrop of porphyritic hornblendite. It is roughly elliptical in outline and is entirely surrounded by drift, hiding the contact with the Keewatin rocks around it. Near the centre of the exposure, the bornblende crystals are large, often being an inch in diameter, and the whole rock consists of dark minerals. Towards the margin it becomes finer grained, and more light coloured constituents appear. The rock is made up of phenocrysts of green hornblende and brown biotite, with a little magnetite, apatite and titanite. Inclusions of light pyroxene, of the variety diopside, occur in the hornblende crystals. There is very little alteration, and the hornblende is undoubtedly primary. The little secondary material present is epidote apparently from feldspar. The unaltered character of the rock suggests that it may be much later than the Keewatin series, possibly a basic segregation from one of the acidic intrusives.

Other Intrusives.—Many other smaller dikes cut the Keewatin at different places in the area. Basaltic dikes from an inch up to sixty feet in width are to be seen in the railroad cuts east of Swastika. In one of these cuts a dike of andesite-prophyry six feet in width intrudes the serpentinized greenstones. It has a very striking porphyritic structure. The phenocrysts are feldspar and hornblende. The former are well bounded tabular crystals of albite showing zonal structure. The hornblende is of the ordinary green variety, occurring in prismatic crystals much elongated. Cross sections of these have diamond shaped or hexagonal outlines, and some of the crystals show distinct zonal growth, an uncommon feature in hornblende. Fragments of biotite, now light green in colour from alteration, and, in some places, completely altered to chlorite and magnetite, occur. Apatite is also present.

A dike of similar rock but showing more alteration occurs on the Reeves claims north of Pike lake. This dike is cut by a narrow mica-lamprophyre consisting almost entirely of greenish biotite, with a little magnetite.

Laurentian.

All those rather fresh, acidic rocks of the area, whose relationship to the conglomerate is not known, are included in the Laurentian series. In the northwestern part of the district conglomerates were found overlying acidic igneous rocks, although not directly in contact, and containing pebbles very similar to the underlying formation. In other places no relationship was observed. The character of the feldspar, and the presence of augite in the syenite classed as Laurentian, suggests that it may be one member of a series of differentiation products of a parent magma, of which red feldspar-porphyry and augite-lamprophyre, to be described later, are other facies. In the absence of any observed field relationship, however, it has been mapped as Laurentian.

There are three areas of such rocks in the district. The largest of these forms a prominent ridge lying between concession 4 and 5, Otto, and extending east and west. A boss-like mass intrudes Keewatin rocks north of the railway with its centre in H. R. 737. The third is a small exposure south of Perron lake, in the northwestern part of the area.

The contact of the first of these with the Keewatin can be seen in the western part of the township, forming a broad zone. Towards the centre and east, however, the Laurentian ridge is separated from Keewatin

rocks by a wide drift-filled valley. The rock consists largely of feldspar, and is often very coarse in grain, the feldspar reaching a diameter of an inch or more. The coarse grained rock is cut by finer grained stringers of the same character, excepting for the size of the constituents. These withstand weathering rather better and stand out from the surface. The cleavage of the feldspars causes the rock to break down rather easily. In thin section the rock exhibits a tendency towards porphyritic structure. It consists of feldspar, augite, biotite, hornblende, magnetite, zircon, apatite and titanite. Quartz is present in the small areas of groundmass that separate the feldspar phenocrysts, but is not very abundant. Chlorite, epidote and secondary hornblende occur as alteration products. The augite is the oldest of the more important constituents, occurring as well formed crystals (Fig. 3), and sometimes as inclusions in the feldspar. The pyroxene is often fringed with uralite. The most striking characteristic of the rock sections is the structure of the feldspar. It has a peculiar ragged, almost brecciated, appearance, which seems to be due to a crude micro-perthitic intergrowth.

The rock is essentially an augite syenite-porphyry.

The second Laurentian area consists of syenitic rocks of similar character, but the feldspars do not attain so large a size. The rock of the third area is not so coarse in grain as that of either of the others, and shows a more distinctly porphyritic texture.

Huronian.

Huronian rocks occupy the western part of the township of Teck from the boundary line north to the limits of the map sheet and east as far as Swastika. Northeastward from Swastika the contact with the Keewatin is along the course of the Amikougami creek. It then swings eastward again. The Huronian forms a rather high area, rising gently to the north for a mile and a half from the Blanche river, and then breaking into a series of east and west ridges.

For the most part, the series consists of conglomerate and greywacke. These are fresh and unsqueezed away from the contact, but along the borders of the formation, the rock is a slate standing at a high angle and much rusted and altered. At a short distance from the contact, a conglomerate and greywacke are quite fresh in appearance. It may be possible that the highly titled slates represent a series older than the fresher conglomerate, or the relation of the Huronian to the Keewatin may be that of a fault contact.

The conglomerate is massive and shows no bedding. It varies considerably even in short distances, being crowded with pebbles at one place, while a few feet away pebbles are so rare that only careful search will reveal them. Most of the pebbles are well rounded, evidently water worn, fragments of feldspar-porphyry, similar to the gray feldspar-porphyry already described. Reddish, felsitic pebbles also occur and a few pieces of granite were found. Greenstones are common, and fragments of smooth serpentinized rock like that east of Swastika also occur. The most striking constituents of the conglomerate, although less in number than the others, are the pebbles or jasper varying from the size of a pin-head or less up to a diameter of four or five inches.

Where pebbles fail, the rock passes into a typical massive greywacke. Near the western boundary of Teck, the typical greywacke grades into a reddish coloured rock of an arkose type. Thin sections of a typical variety show fragments, most of which are porphyry, with feldspar or green hornblende phenocrysts. Along with these are fragments of minerals, consisting of albite, quartz, hornblende and magnetite set in a matrix of finer material of the same kind. Secondary minerals, chlorite, sericite, and kaolin are present.

Post-Huronian Intrusives.

There are at least two igneous intrusives that are later than the sedimentary rocks. These are of distinct types and their relation to each other is not known. Both ocuer as dikes cutting greywacke and conglomerate, and sometimes as masses of considerable area.

One of these is a light reddish rock with a tendency to develop feldspar phenocrysts. A small knob of this rock is encountered in the first railway cut west of Swastika. It extends but a short distance south of the railway, and sends off a tongue along the base of the hill of conglomerate that rises south of the right-of-way. The conglomerate along the contact is considerably altered and the pebles squeezed and drawn out. East of Amikougami creek is another small exposure of similar rock, and on the Costello claim a small exposure of greywacke is cut by at least three different dikes of this rock. Many other small dikes of the rock occur at different places in the conglomerate.

A specimen from the cut west of the station shows under the microscope a rather granitoid texture, and consists almost entirely of an acidic plagioclase feldspar with a considerable quantity of secondary products. Dolomite is the chief of these, occurring in small rhombohedrons massed together, or in veinlets through the feldspar.

Aggregates of epidote and other secondary minerals are present and a little chalcopyrite is scattered through the section.

The small quantity of orthoclase probably unites with some of the soda to form anorthoclase. Hornblende does not occur in the sections examined, and that shown in the norm represents minerals such as epidote, chlorite, and other secondary products.

Augite Lamprophyre.—The other post-Huronian intrusive is basic in character. It is black and weathers with a pitted surface. On a fresh fracture it sometimes shows a faint purple shade. Parts of the rock show aggregates of secondary minerals which give it the appearance of having an amygdaloidal structure. This general character suggests rock of the Keewatin complex, but on a small point on the south shore of Elsie lake, near the west end, a narrow dike of this rock striking northeast cuts the greywacke. Other dikes of the same rock occur at points on the trail north to this lake, and some of these include fragments of Huronian in them.

On the north bank of the Blanche river in the township of Eby, augite lamprophyre forms the face of the high bluff for some distance. The contact is on the top of the ridge and near it the lamprophyre is bracciated and recemented by the same kind of rock.

Thin sections show numerous phenocrysts of augite set in a groundmass made up of needle-like feldspars and smaller augite crystals. Magnetite is scattered throughout in considerable quantity, also apatite, both as inclusions in the phenocrysts and the groundmass. Chlorite and epidote occur as alteration products. The augite is green in colour and occurs in well formed blocky crystals (Fig. 5 and 6). The feldspars are too small to be determined optically. The apparently amygdaloidal portions mentioned before are areas of secondary minerals, but they seem to be replacements of certain parts of the rock rather than fillings of vesicular spaces.

Since the kind of feldspar could not be determined, the relation of augite to anorthite as calculated may not represent the true proportions of the rock.

Pleistocene and Recent.

The Pleistocene is represented only by unsorted sands and gravels, and these do not exhibit great development in the area. Since Pleistocene time the streams have formed alluvial plains in favourable places along their valleys. The largest of these is along the Blanche river in concession 5, Otto. In the swampy and marshy areas between the rock exposures peat has formed to some depth. South of the area, towards Round lake, the Pleistocene and recent deposits are a much more important formation.

Economic Geology.

The rocky and broken character of the country makes it quite unsuitable for agriculture, excepting in the limited areas where streams have formed alluvial flats. Farther south, near Round lake, some farms have been taken up.

Fires have destroyed the original forest, but the part north of the Blanche river supports a considerable second growth, mostly of birch and poplar. This is rather light near the river, but becomes denser farther north.

Gold.

Visible gold occurs in quartz veins in at least two parts of the district. One lies near Otto lake and includes the Swastika mine and the Reeves claim. The other lies east of Amikougami creek, on the Lucky Cross Mining Company's claims.

The veins are of the usual rather lenticular type, as a rule with steep dips. The quartz is of the white crystalline variety, with dark streaks showing in it. A slight fracturing follows the first quartz deposition, and tiny veinlets of a more transparent variety cut across the older quartz, like water lines on paper. Sulphides occur in the veins, as chalcopyrite and pyrite. The gold is very often associated with the sulphides or with the dark lines in the quartz, but occasionally is found in the clear quartz. On the Swastika claims the veins cut greenstone and gray feldspar-porphyry. On the Reeves and neighboring claims the wall rock is feldspar-porphyry and the rusty carbonate rock. The relationship on the Lucky Cross veins is similar to that on the Swastika. The porphyry is in small dikes and sometimes forms one wall, occasionally for a short distance both walls, of the vein, which does not seem to vary with change of country rock.

Veins of very similar physical characteristics are found in the conglomerate and greywacke, but, so far as known, no values have been found in them. It may be possible that they are of different age than the veins found in the Keewatin rock, or, if of the same age, the Keewatin rocks have favoured precipitation of values where veins cut them. If the latter explanation is correct, it seems likely that the fracturing of the rock and deposition of the vein material and gold values is due to the post-Huronian intrusive rocks, and probably more to the acidic type than to the augite-lamprophyre.

Active Properties.

The Swastika Mining Company has done most of its development work on three veins on the north side of Otto lake. The largest of these is eight to nine feet wide, striking north and south. This is intersected by two other veins, the smaller having eight to nine inches of quartz. Most of the ore already stoped has come from the large vein above the thirty-five-foot level. The mine now has a three-compartment shaft down two hundred feet, the old shaft being used merely for ventilation. Considerable drifting has been done. A new equipment has been installed, consisting of two 125-horse power Jenckes boilers, a 10 by 12 double drum hoist and a 12-drill Sullivan compressor.

On the Reeves claims north of Pike lake, two veins, eight and nine feet wide, have been stripped for a hundred feet or more. These veins strike N.E. and S.W., and are about fifty feet apart. In the larger of the two, visible gold occurs at its junction with the small quartz vein.

On the Lucky Cross claims visible gold was found first in a small vein that shows in the railway cut just east of Amikougami creek. North of the right-of-way this vein is about eight inches wide and carries visible gold in a band crossing the vein at an angle from wall to wall. Later prospecting has uncovered other veins north of this, one of which has a width of twelve feet. A plant including a 6-drill compressor has been installed.

The Homestead Mining Company has a vein in the rusty carbonate rock near the Huronian contact, on which they are driving an adit into the hill.

The observations on the area were made under the general supervision of Mr. A. G. Burrows, who spent a few days with the writer in the field. Mr. R. M. Smith acted as assistant during the season. Valuable advice and assistance in the petrographic determinations were received from Prof. C. P. Perkey, while the data were being worked up in the Department of Geology and Mineralogy at Columbia University.

SPECIAL CORRESPONDENCE

ONTARIO.

COBALT, GOWGANDA AND ELK LAKE

ORE SHIPMENTS OVER THE T. & N. O. RY. FOR THE MONTH OF NOVEMBER, 1912.

Cobalt Proper—

Mine.	Tons.
Beaver	64.37
City of Cobalt	42.00
Cobalt Lake	151.43
Crown Reserve	19.61
Coniagas	215.38
Cobalt Townsite	87.65
Hudson Bay	93.26
Kerr Lake	92.00
La Rose	260.62
Nipissing	31.62
McKinley-Darragh	135.44
O'Brien	64.79
Penn Canadian	34.46
Peterson Lake (Seneca Superior)	191.63
Temiskaming	66.22
Trethewey	58.00
	1,608.48

Gowganda—	
Millerett	10.00
Silver ore shipments, total	1,618.48
Iroquois Falls—	
Alexo Mine(nickel)	300.65
Total	1,919.13

Silver ore was shipped as follows: Canada, 31.86 per cent.; United States, 68.14 per cent.

Fire Losses.—Two companies lost their plants by fire during the past two weeks. The Seneca Superior, after shipping five cars of ore, one high grade and four low, had the misfortune to lose the whole of their surface equipment and development, will be delayed a little. The other victim was the Twentieth Century, a little company operating a small plant on some claims between North Cobalt and Cross Lake. Two years ago it is stated a diamond drill core contained high silver values, and they were cross-cutting for the vein when the catastrophe occurred. Both plants will be re-built.

Mutual Benefits.—It is probable that La Rose will benefit almost as much by the discovery of another vein of high grade ore on the Right-of-Way, as the Right-of-Way itself since the vein has been drifted on right up to the boundary and here it is three or four inches wide and high grade. The Right-of-Way is drifting to tap it at the 140-foot level, while the La Rose is also cross-cutting for it. They cannot fail to find it and should have an entirely new ore shoot about 100 ft. long on their own property.

Buffalo Property.—The Buffalo mine has already made three "pours" from the new high grade mill, and the mill seems to be working efficiently with the least possible delay. The third "Pour" just shipped to England consisted of 64 bars of bullion, containing 60,628 ounces of silver worth at the market $38,500. In the last three months the Buffalo has produced more ore than at any previous time in its history. Everything is now being converted to bullion, both the concentrates from the mill and the high grade, hand-picked from the stopes. The new vein at the 460-foot level of the Beaver mine is improving as more work is done on it. It has now widened to four inches of high grade ore. It is in virgin country and open possibilities for country that has not heretofore been considered favorable for prospecting.

Lake Rumours.—It is stated that an English syndicate connected with the same group operating the Cobalt Townsite and the Casey Cobalt has taken options on a large quantity of stock of the Cobalt Lake Mining Company. The options extend over a period of thirteen months and prices vary from 43 cents for the first twenty per cent. to slightly more than par. The Casey Cobalt will resume shipments as soon as the roads between the mine and the railroad are good for sleighing. Considerable shipments from mill and mine should be made before the end of the year.

Sterling Silver.—The Sterling Silver Mines, Limited, has just been organized with a capital of $1,500,000. They will take over the Haentchel claims on Hubert lake, near Elk lake, and will commence operations at once. It is stated that $13.000 has been spent on these claims already.

A Slow Start.—The big low grade mill at the Nipissing dropped only ten to thirty stamps in November and will not add very materially to the Nipissing total this year. In prospecting at the old Kendall vein another good shoot of high grade ore has been cut and is now being drifted on. Under the open cut at the Little Silver vein an ore shoot one hundred and fifty feet long has been opened up. The vein is very high grade, but only an inch wide. In the intermediate raise at the 64 shaft the vein where it is now being stoped shows twelve inches of high grade ore. As a direct consequence of the new vein on the Seneca Superior lease the Nipissing is sinking its old 86 shaft in order to cross-cut the territory in the vicinity, for this vein. All the silver shipped last month was in the form of bullion.

Gillies Limit Active.—There is considerable activity on the claims staked in August in the Gillies Limit, all prospectors believing now that the danger of dispute is past. So far there has been no find of any magnitude. On the Ryan claim some leaf silver has been discovered in a heavy smaltite and niccolite vein, but that is the extent of the bag so far.

However, They Are Found.—Two prospectors have set up with a team of dogs for Moose Factory, where they hope to hear tidings of the Donaldson party. Some six or seven members of this party (Cobalt men in charge of a McGill graduate) should have been out some months ago. It is hoped that they are safe at Moose Factory waiting for the ice to become safe on the Mattagami River, but their friends are nervous. They were last seen at Great Whale River on the east shore of Hudson's Bay and they were then making their way south in a sail boat.

PORCUPINE AND SWASTIKA

Strike Dragging.—The strike still trails its weary length. For the most part, under the protection of the Provincial Police, the mine operators have been enabled to get in strike breakers, but in several occasions the strikers have induced them not to go to work. The McIntyre mine thus lost most of a shipment of men. The Hollinger has now almost a full complement of men, but the efficiency of the miner who has taken the place of the striker is not very high. However, both mine and mill are running and will no doubt do so. At the Dome the effects of the strike are vanishing. Under a strong guard of private detectives the pipe line from the Dome mill to Porcupine lake is being laid. Otherwise work is going ahead much as usual and as a matter of fact owing to the running into a patch of high grade ore the bullion shipment for November was higher than for any previous month in the history of the Dome. The Pearl Lake, Three Nations, and Schumacher have made their peace with the union and are working. The Dome Lake has a full force of carpenters at work on the mill and the McEaneny are also proceeding rapidly with the work of construction interrupted by the strike. Nowhere apart from the Dome and the Hollinger is there much attempt to continue underground work, with the exception of the McIntyre, and here, too, the chief desire is to complete the new mill. The Vipond, Jupiter, and Plenaurum have allowed their workings to fill up and have resigned themselves to a winter of idleness and no doubt if a settle is not soon effected, others will follow their example. The strikers are no longer molesting workmen engaged in assessment and in this respect the camp is quite active. It would have been very active, indeed, but for the strike. All the cases brought against the Hollinger workmen under the Lemieux Act, have been put over until January 6. A number of men on both sides have been fined for minor acts of violence and the situation is generally very peaceful. The chief sufferers by the strike are undoubtedly the merchants in the settlements at Tim-

mins, Schumacher, and South Porcupine. They were just beginning to recover after a very slow summer and this setback will be fatal to many of them. Hundreds of the best miners have left the camp.

Tough.—Mr. C. A. Foster, who is operating the Tough claims near Kirland lake, Swastika is assembling a carload of high grade gold quartz ore for shipment. It is understood that twenty tons will be sent out at the end of this week or the beginning of next. The shipment will certainly cause considerable interest, and as it will be the richest shipment of gold quartz ore that has ever left the north country for a smelter. The vein still looks very good where the ore has been open cut and work is proceeding, a shaft being sunk in order to cut the vein at depth. There are also other properties that exhibit indications of making good around Kirkland lake. Jim Hughes and Sandy McIntyre, who are working the Reamsbottom claims state that they have opened a fine looking vein eight feet wide. The assays are said to be good.

Morrisette Township.—Claims in Morrisette township, east of Kirkland lake, owned by Dr. Dorsey and Dr. Fisher, of New Liskeard, have been optioned to a syndicate who are bound under the agreement to spend a considerable sum of money on them to open them up.

It is said that the result of diamond drilling at some of the properties of the Dane Mining Company, between Dane and Swastika, has not been unfavorable, and it is understood that mining operations which were suspended for some time will be resumed for the winter.

The Alexo mine at Iroquois Falls continues to output a good tonnage of nickel each month. Last month there was despatched over 300 tons. A small plant will be installed this winter, all the work so far being done from the surface and by hand.

BRITISH COLUMBIA.

With December half gone at the time of writing, and the chief interruption in the mineral production of the year being only the strike of coal miners at the coal mines, on Vancouver island, of the Canadian Collieries (Dunsmuir), Limited, there appears to be good reason for thinking that the estimate of total value of the year's production, as printed in The Canadian Mining Journal of June 15, last (see p. 446) will be found to have been a reasonable one—in fact, it is quite probably final returns, to be received during the first quarter of 1913, will show that it was somewhat under what the actual total value will have been. In detail the estimate will be too high in regard to some of the minerals, but this has been compensated for by a larger production of others than was expected, or possibly a little higher average price. The position appears to be, however, that the total value, then placed at $31,500,000, will have been reached, and probably passed.

SOUTHEAST KOOTENAY

The following news notes of Southeast Kootenay have been taken from the "District Ledger," Fernie, Crow's Nest Pass:

The C.P.R. are keeping Corbin stocked with cars, and the mines are turning out more coal than ever, which speaks well for the quality of the coal being dug at present.

The employees of Michel collieries have decided to ask the chief inspector of mines to appoint inspection committees for the various mines in Michel.

Norman Henderson, master mechanic at Michel, has resigned his position. He has some good positions offered elsewhere, but as yet has not made up his mind where to go.

Mr. P. L. Naismith and Mr. Lewis Stockett, of the C.P.R. Department of Natural Resources, were in Hosmer from Calgary recently.

Surveyors working under instructions from Mr. Jas. T. Laidlaw, Cranbrook, have been surveying claims in the Flathead district for Mr. John Livingstone, Cranbrook, and a lot of the McLean properties situated in the valley.

The British Columbia Oil and Coal Development Company is still hard at work freighting its boring apparatus into the Flathead country, where its property is situated, up in Sage Creek district.

It is looking promising for a railway being built and a mine or two opened next year. The Southeast Kootenay Railway, which may be better known as the Davis Railway, is going ahead. Mr. Simonds is in charge out at the townsite, where they have built some fine shacks for their camp for the winter. They are going to cut the right-of-way of the railway throughout the winter. Mr. Jas. Macdonell, "Big Jim," has the contract, and his teamster, who has had charge of the freighting for the last three or four months, has got in a full supply of stores, ta last all winter.

AINSWORTH DIVISION

The Eureka group, situated about a mile and a half north of Sproule, a stopping place on the Kaslo and Slocan Railway, is being worked by the Eagle Lode Mining Company, of Spokane, which company is stated to have spent on the property during the last twelve months about $15,000. Work under the present auspices was commenced about November, of 1911. Six men are employed now, and it is intended to work throughout the winter. The Eureka camp is about 3,000 ft. above the railway, and 6,100 ft. above sea-level.

After driving a cross-cut tunnel 340 ft. to the vein, and then drifting 100 ft. on the vein, the company put in track and prepared to work the lower tunnel of the old workings, from which a drift had been driven 200 ft. Work has had to be suspended in these old workings for the winter, but will be resumed next spring. Meanwhile development is being continued in the new workings. It is intended to next year make such arrangements as will permit of work being carried on in both old and new parts of the mine—in winter as well as in summer. There is reported to be here a well-defined vein of high grade silver-lead ore, two to eight ft. in width traced for 4,500 ft.

SIMILKAMEEN

The Hedley Gazette has lately been reprinting a description of "B. C.'s Banner Gold Mine"—the Nickel Plate group, near Hedley. Concerning haulage of ore, it says: "The ore is loaded into two-ton cars in the mine and hauled from the stopes about two miles on an electric railway, 3-ft. gauge, in trains of about 25 tons each; maximum grade, 5 per cent. The electric locomotive weighs 10 tons. The ore is then dumped by automatic dumper into the ore-bin at the head of the gravity tramway, which is a three-rail tramway, about 10,000 feet long, and the difference in elevation between the upper and lower terminals is about 4,000 ft. The loaded skip of seven tons going down draws the empty skip up. The tramway is operated in two sections by two men who handle about 200 tons in eight hours. This is probably one of the longest three-rail gravity tramways in the world. It is operated continuously throughout the winter."

STATISTICS AND RETURNS

COBALT ORE SHIPMENTS

The shipments from the Cobalt camp for the week ending December 27 were:

	High.	Low.	Tons.
Townsite	2	..	121.17
La Rose	1	2	121.17
Cobalt Lake	1	..	30.10
Nipissing	..	1	43.97
Crown Reserve	1	..	19.94
Trethewey	1	..	27.01
Buffalo	2	..	59.71
Colonial	1	..	23.33
Wattlaufer	2	1	50.00
Peterson Lake (Seneca-Superior lease)	..	1	41.18
Drummond	1	..	30.08
Bailey	1	..	20.00
Total	13	5	534.24

Bullion shipments:

	Ounces.	Value.
Nipissing	58,464.00	36,756.00
O'Brien	15,736.00	9,722.00
Buffalo	10,550.00	6,600.00
Miller Lake, O'Brien	946.00	788.00
	85,696.00	$53,866.00

B. C. ORE SHIPMENTS

Ore production for the week ending December 21st totalled 53,064 tons, an increase of about 1,000 tons over the previous week, making the output for the year to date 2,478,767 tons. Smelter receipts for the week were 45,749 tons, and for the year to date 2,202,872 tons.

The Rio mine in the Slocan, which is being operated by a Spokane company, under the management of W. E. Zwicky, of the Rambler-Cariboo, made its second shipment of the year, sending 12 tons to the smelter. With a shipment of 97 tons the Rambler-Cariboo appeared on the list after having been absent for several weeks.

Among the Sheep Creek district silver-lead mines the Emerald and the Hudson Bay resumed shipments, the former sending 104 tons to the smelter. Roads throughout the district are now said to be in excellent condition for sleighing and ore shipments are consequently expected to increase materially in the next few weeks. Rawhiding is commencing. Ore production in detail:

Boundary.

	Week.	Year.
Nickel Plate, milled	1,500	74,600
Jewel, milled	200	3,800
Snowstorm	219	883
Ben Hur	381	883
Jewel	31	31
Knob Hill	26	2,148
Granby	24,040	1,232,650
Mother Lode	7,268	362,491
Unnamed	28	11,041
Rawhide	6,075	250,379
Napoleon	599	13,705
Other mines	....	29,301
Total	40,367	1,981,898

Nelson.

Queen Victoria	181	394
Granite-Poorman, milled	250	13,600
Mother Lode	500	15,250
Queen, milled	400	14,500
Milly Gibson, milled	300	9,000
Second Relief, milled	250	6,500
Hudson Bay	31	299
Second Relief	34	106
Yankee Girl	79	587
Emerald	104	1,546
Other mines	....	9,891
Total	2,129	71,673

Other Kootenay Mines.

Nettie L.	27	27
Other mines	....	284
Total	27	311

East Kootenay.

Monarch, milled	425	12,925
Sullivan	464	29,988
Other mines	....	2,313
Total	889	45,226

Slocan and Ainsworth.

Total	4,244	143,386

Rossland.

Le Roi No. 2, milled	300	10,100
Inland Empire, milled	90	2,250
Nickel Plate	27	102
Centre Star	3,140	154,869
Le Roi	953	43,912
Le Roi No. 2	628	24,835
Other mines	....	265
Total	5,408	236,333

Consolidated Co.'s Receipts.
Trail, B.C.

Total	7,558	312,838

B. C. Copper Co.'s Receipts.
Greenwood, B.C.

Total	14,151	657,384

Granby Smelter Receipts.
Grand Forks, B.C.

Granby	24,040	1,232,650

SILVER PRICES.

	New York. Cents.	London. Pence.
December 7	64⅛	29 11/16
December 9	..	..
December 10	64⅛	29 11/16
December 11	64	29⅝
December 12	63⅞	29½
December 13	64	29 5/16
December 14	63⅞	29½
December 16	63⅜	29¼
December 17	63½	29 5/16
December 18	63¼	29 3/16
December 19	63¼	29 3/16
December 20	63	29⅛
December 21	62¾	29
December 23	62¼	28¾
December 24	62⅛	28 13/16