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The Canadian Mining Review

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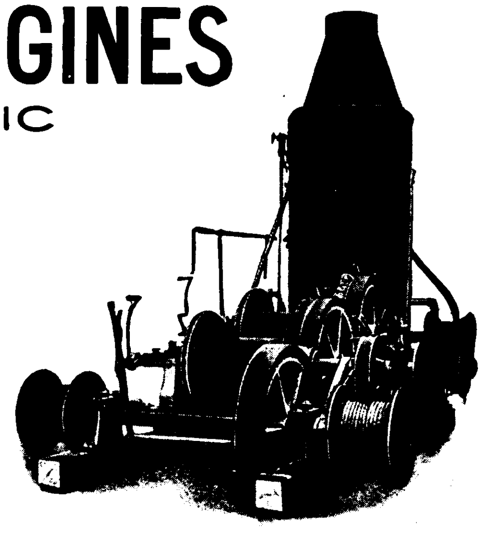

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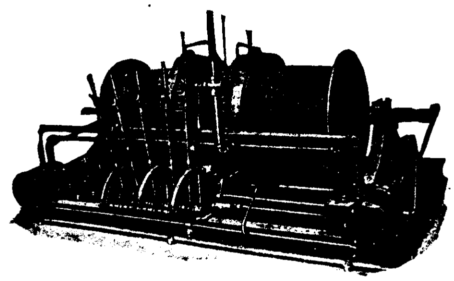

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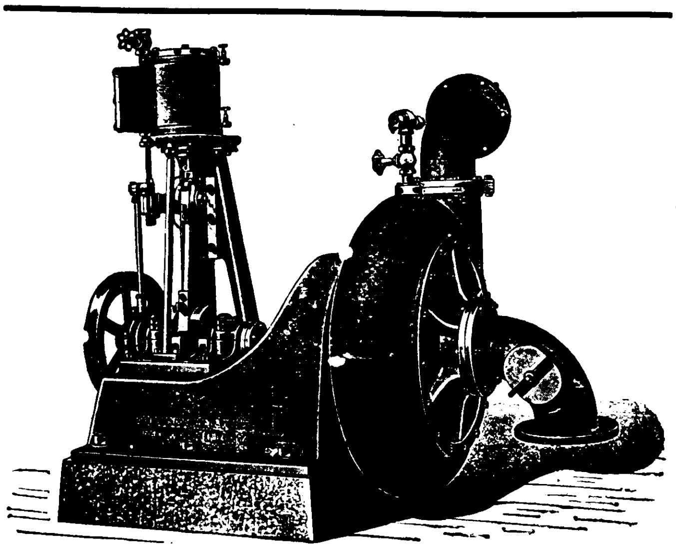

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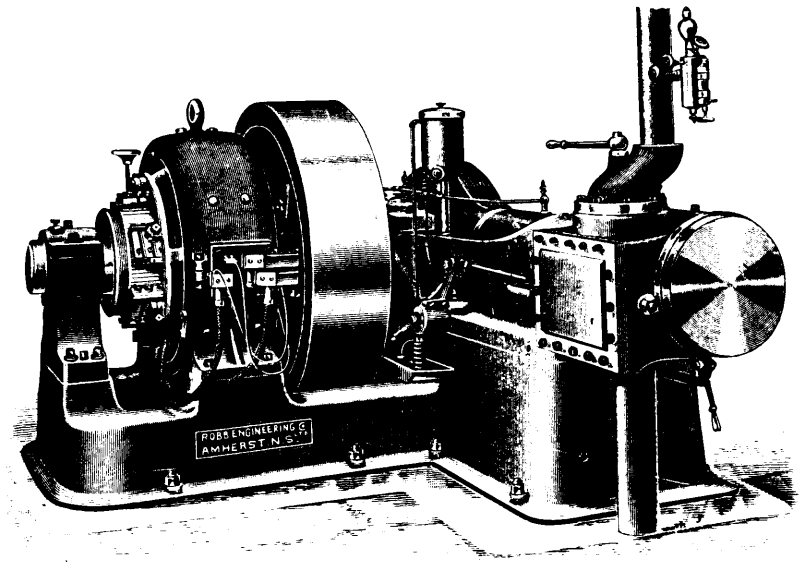

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Advertising rates on application.

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THE CHIEF GEOLOGIST OF THE GEOLOGICAL SURVEY.

Upon the recent filling of the directorship of the Geological Survey by the appointment of Mr. Low, there was created within that department the new position of Chief Geologist. This is an important step, in as much as it should facilitate the organization and correlation of field work, and it should, accordingly, go to strengthen the hands of the director. It was fitting too, that the first appointee to this position should be Dr. Robert Bell, the senior member of the staff, who for the past five years has filled ener-getically the position of Acting Director.

THE COPPER SUPPLY.

In a recent number of the *Engineering and Mining Journal*, Dr. James Douglas discusses the comparative quantities of pig iron and copper used during the last ten years. His careful statistical comparison shows that during that time one ton of copper has been consumed for every 83 tons of pig iron, and that this ratio was maintained very uniformly. In order therefore to meet the rapidly growing demands of the iron and steel industries a proportionately rapid increase in the production of copper is required. It is this demand which has given to the copper market its steady advance during recent years, an advance which Dr. Douglas' investigations would indicate to be a perfectly natural one, as there are no known copper reserves of great importance, the copper market is likely, accordingly, to continue active for some time.

PROVINCE OF QUEBEC CHANGE IN MINING LAWS.

The session of the Quebec Legislature, which ended last month, closed without the introduction of the new mining law, which the Minister had in contemplation in the early part of the session. That this deferring of a new mines act is a wise measure, there can be little doubt. In the meantime the Hon. Mr. Jean Prevost, it is announced, will visit the principal mining districts of the province during the coming season, to make personal observation of the requirements of the licensees and prospectors under the existing act. It is understood that the Superintendent of Mines, Mr. J. Obalski, will shortly issue a leaflet, or pamphlet, upon the Department's construing of the present Act, in relation to the remote mineral districts which were discovered last year in Northern Quebec. The trip of Mr. Prévost to the new Chibogamoo country has been postponed from

May until August, when conditions will be better for the observation of how the existing law has been construed by the different parties now in this northern field.

MINING IN NOVA SCOTIA.

The annual report of the Department of Mines of Nova Scotia was recently submitted to the Legislature. As a whole, it was an encouraging one, though there was a diminution in the production of coal and gold.

The amount of coal raised during 1905 was 5,150,420 tons, as compared with 5,247,136 tons in the preceding year, a decrease of 196,750 tons. Gold was produced to the amount of 15,500 ounces, a gain of 1,325 ounces over the production of the year 1904. Two hundred and seventy-four thousand tons of iron ore were imported into Nova Scotia during the year. The province derived royalties from minerals to the amount of $613,811.00, gross, from which, however, must be deducted $41,732.00, which sum was paid as a bonus to the Cape Breton steel companies, on account of provincial coal consumed in the manufacture of iron and steel.

During 1905, coal to the amount of 4,475,284 tons was sold, a decrease of 69,325 tons, from the sales of the previous year. To extract this coal the services of 10,780 men were required, who put in an aggregate of 2,743,528 days labour.

OXYGEN GENERATORS FOR UNDERGROUND USE.

The rescue of the French miners at Courrières, by their German comrades from Westphalia, emphasizes the value of suitable apparatus for supplying oxygen to miners employed upon such work. The most efficient types supply sufficient air to enable a man to breathe for two hours, which is as long as any one engaged upon laborious work would probably be able to stand the strain. It is not good practice, however, for a man to endeavour to remain for such a length of time, and in some of the latest oxygen-suppliers a signal is given automatically by the machine at the end of three quarters of an hour. Those used at Courrières supplied oxygen automatically, and the air, after being exhaled, passed through two generators, which freed it from CO_2, and rendered it again fit to support life, when mixed with a further supply of oxygen. The generators contained specially prepared caustic potash, which did not generate as much heat as the ordinary commercial article, thus rendering a cooling chamber unnecessary. The apparatus which proved so efficient upon the occasion that we have mentioned was designed by Director Meyer, of the Hibernia and Shamrock mines, in Westphalia. It required no helmet, or face mask, which was a decided advantage, as the men had hard muscular work to meet before they could rescue their entoombed comrades.

THE SAN FRANCISCO DISASTER.

In the face of such a calamity as that which befell San Francisco on one April morning, one realizes man's impotence. Although less disastrous, as far as the loss of human life is concerned, it resembles the disaster which overtook St. Pierre in its far reaching devastation. In the course of a few hours the labour of years was wiped out. First came the wholesale destruction caused by one of the heaviest earthquakes shocks that has been experienced on this continent; then a conflagration started, that was not quenched until the greater part of the magnificent city of San Francisco lay in ashes.

One of the heaviest sufferers was our valued contemporary, the *Mining and Scientific Press.* Owing to the hour at which the disaster occurred, shortly after 5 a.m., the library and plant were destroyed without a chance of even a small portion being rescued.

The CANADIAN MINING REVIEW tenders its sincere condolence to Mr. T. A. Rickard and his coadjutors of the *Mining and Scientific Press.* We believe, however, that the *Press* will rise phœnix-like from its ashes, and that, eventually it will be able to date the beginning of a period of greater success from that dismal day when the end seemed to have come for San Francisco and its inhabitants, A paper that has earned the confidence and respect of its subscribers and patrons is as indistructable as anything well can be

MINING SCHOOLS.

In a recent issue of *Mines and Minerals*, Prof. A. H. Purdue published an article on Mining Schools. As this subject has lately received some attention in these columns, the following abstract of Prof. Purdue's article is re-produced.:—

"Each locality has its own peculiar mining problems, which will be quicker met and solved by engineering schools near at hand than by those distantly situated, for the reason that they are near and convenient and it will be to their intersets to develop the mining industry of the locality. There are doubtless many deposits of economic worth lying idle, which need only the incentive that would come from a near-by mining school to make them paying property. There are others being worked by antiquated methods, eking out a precarious existence, that a little intelligent direction, coming from the influence of a school whose duty it is to look after the mining interests of the locality, would put on a paying basis.

The elective system that prevails in practically all of our state universities permits those students who take their degrees in other lines of engineering, to elect such courses in mining as their time and preparation will permit of. At my own school though the courses in mining have been offered less than a year, certain ones of them have been elected by the best students in engineering. While such students cannot be sent out as mining engineers, the small knowledge of the subject thus acquired may prove of inestimable value to them and their employers in the future. Futhermore, we fully expect within the next few years, to discover several mining engineers by students in other engineering lines electing our courses. A large percentage of boys who enter college have engineering tendencies and enter the departments of civil, mechanical, and electrical engineering, having never heard of mining engineering. By electing courses in the latter many will find that it is more to their liking than the course taken up, and will make the change.

The courses in mining engineering are the only ones offered in our schools that lay sufficient stress upon the estimation of the cost of work and plants. An immense building brings in profit from rent. A railroad bridge pays for itself and is a source of profit to the company because of the line it completes for ready transportation. *But every dollar that is put into a mine for labour, material, or machinery, must come out of the mine, and enough in addition to pay a profit on the investment.* This necessitates a most careful investigation into the probable size of the ore body, the cost of working it, the facilities for transportation, the cost of fuel, the cost of the plant, and the hundred other things that naturally suggest themselves to the cautious manager. Such a course of training is valuable not only for the mining engineer, but would be most valuable to students in other lines, especially in civil engineering.

In no other field are intelligent business men so often imposed upon as in "wild-cat" mining schemes. Men with good business judgment in most things are often easily led into these "sucker traps." The general diffusion of mining knowledge that would come from a large number of good mining schools would do more than anything else to prevent the floating of these fake schemes.

Many mining schools in close proximity would act as a stimulus for each other, just as the multiplication of universities has acted in the field of general education. We can well imagine the conservatism and air of self-satisfaction that would prevail in our universities if there were but a few of them. Would not the same conservatism, self-satisfaction, and non-progressiveness pervade our mining schools if they should remain but few in number? Under such conditions, would they not be teaching methods long ago discarded by the wide-awake, progressive miner in practical work? Sharp competition will keep us all abreast of the times."

THE WORLD'S GOLD SUPPLY.

It is probable that when the records for the year 1906 shall have been made up, the gold production of the world will be found to have reached four hundred million dollars. The growth has been wonderfully rapid since 1890, when the production was but some 120 millions of dollars. Up to that time the increase had been steady, but during the following five years it became larger by an average yearly increase of about fourteen million dollars. During the last ten years this increase has been exceeded, so that the average yearly growth has been about twenty million dollars. A careful study of the gold mining industry almost forces the conclusion that this four hundred million dollar production will, at least, be maintained, and probably increased. It is believed that the stock of gold available for currency is increasing at the rate of a million dollars a day.

The effect of this flow of gold is attracting the attention of financiers throughout the world. An increase in the supplyof the precious metals naturally tends to increase the price of commodities by putting more purchasing power in the hands of individuals, and hence increasing the demand. Whether such increase will be directly proportionate to the increase of gold in circulation is, however, a question upon which opinion is divided. Most writers on economic subjects argue that, in general, wages will not be likely to increase with the same rapidity as the prices of material, and it is held that salaries are the last items to advance. Whether the great increase in gold production which the last decade has witnessed will be a blessing, or the reverse, is something upon which men will continue to differ until the future shall have given us the answer.

THE NEW ONTARIO MINERAL ACT.

The mining bill that has been introduced in the Ontario Legislature, by the Minister of Mines, the Hon. Frank Cochrane, is still under debate as we go to press. We are, therefore, unable to say what will or will not be the mining law of the province for the next twelve months. As originally drafted, the new mining bill seeks to substitute one uniform system of acquiring mineral lands, in place of the complicated methods now in force. There are to-day no less than four ways by which a man may obtain the right to mine in the Province of Ontario: he may either purchase the land outright, or he may lease it, or he may stake it out in a mining division, or he may stake it in land that is outside a mining division. The conditions as to prices and amount of work required have been found to be beyond the comprehension of many prospectors, which is, perhaps, not surprising, seeing that a man may be a very excellent prospector and yet possess little or no education.

The new bill proposes a uniform system, which is, briefly, as follows: In the first place a person desiring to hold mining lands must pay $10.00 to the Province of Ontario for a miner's license, which will be valid for one year; the province will be divided into mining divisions, and in each division a mining record office will be opened, provided the demand for such an office shall make itself felt; a claim will be limited to a square of 20 chains, with north, south, east and west boundaries; the claim must be recorded in the office of the mining division in which it is situated, and the discovery will be subject to the approval and inspection of the mining inspector or his representative; should the report be favourable, the prospector will be required to do a certain number of days work within a certain specified, or shorter, time; after which he may buy the land at either $2.50 or $3.00 an acre, according to its situation, and he will then have an indefeasible title, without further working conditions.

It appears to us that there are several points to which objection may possibly be taken. The revenue from mining licenses, while it will amount to a considerable sum, is not to our mind a good source of revenue. It is a hardship to a poor man to take out a license, and is a discouragement, whereas the prospector should be encouraged to follow, what must be in any case, an arduous, and may possibly prove to be an unremunerative pursuit.

A little consideration will show the vast opportunities for fraud and litigation, that are opened by the *insistence of an inspection previous to the acceptance of a location as valid.* It is quite possible that occasions may arise in which an honest difference of opinion shall exist between the prospector and the inspector as to what constitutes "valuable" mineral. A mineral may be valuable, under certain conditions, although it has no quotation in the markets of the world. It might, for instance, be required for experimental purposes. Would it not be better to accept the statement of the prospector, made under oath, that the claim he had discovered was worthy of working from his own point of view? If he deems quartz, for instance, as sufficiently valuable *to him* to justify the expenditure of his time according to the regulations, and to warrant the payment of the many fees required by law, why should our inspector, human, and therefore fallible, prevent him from acquiring that quartz if he is willing to spend his time and money?

Special regulations are proposed for the regions north of the Height of Land, where there are some reasons to believe that petroleum, natural gas, salt, lignite and other minerals may eventually be found, yet which would not oftentimes show on the surface. In those regions prospecting permits may be granted, good for one year and covering 640 acres, for $100.00. The holder will be required to spend $2.00 an acre in actual work in developing his claim, and, upon making a discovery, may demand a lease at a rental of $1.00 per acre, and an expenditure of $2.00 an acre in work. These regulations appear to have been well thought out, as it is desirable to encourage the prospecting of the more distant parts of the province, and inducements should be held out to those who are willing to face the difficulties and arduous labours incidental to the explorations of our northern territories.

There are many other provisions in the bill which we hope to comment upon in a future issue.

During the debate on the new bill the Hon. Frank Cochrane stated that a discovery of anthracite had been made north of the Height of Land. Such a rumor has been made before, and not once but many times, but it seems to be totally without foundation or endorsement by competent authority. The CANADIAN MINING REVIEW has taken pains to investigate this rumor, and from the best information it has been able to get it would appear that this so-called coal is an imperfect lignite, occurring in the rocks of the quaternary era that has been more or less hardened through the proximity of eruptives causing the evaporation of volatile matter, until it has much the appearance of an anthracite or of anthraxolite instead of the lignite which it really is.

The Superintendent of Mines for the Province of Quebec, Mr. J. B. Obalski, who has seen some of the reported discoveries, informs the Review that it is an imperfect lignite, and not of an anthraxolitic character. The report made by Mr. J. M. Bell, who visited Northern Ontario some few years ago, indicated that the quantity of the substance, whatever it may be, is probably small, and that the quality is poor. The occurrence of this substance in formations as recent as that in which it is found makes it improbable that it will have any great commercial value.

THE TREATMENT OF TEMISKAMING LOW-GRADE ORES

By S. F. Kirkpatrick, Professor of Metallurgy, Kingston.

The deposits of the Cobalt district consist, essentially, of narrow but well defined veins of smalite and niccolite in a matrix of calcite, the whole vein being usually impregnated with native antimonide and sulphide of silver.

The width of these veins varies from over 12 inches to a mere fraction of an inch, and the method of mining is to break away one wall as carefully as possible, then breaking down the vein matter on canvas or other suitable material. The ore being afterwards subjected to a judicious handpicking.

In the case of large veins, unfortunately rarely met with, a fair result may be secured in this way, but even then some of the vein material may find its way to the dump and losses may also occur through the wall rock adjacent to the vein carrying mineral. In the case of small veins much more difficulty is experienced in making a good separation, and in many cases these veins break up into small stringers, and the country rock may be very heavily charged with mineral that cannot well be recovered by handpicking.

This rock material may be of very considerable value, as in certain sections of the district the small veins are particularly rich in silver, often assaying from 2,000 to 5,000 ozs. per ton.

It was, therefore, with a view to treating the ore or waste rock left after handpicking the high grade ore, that a number of tests were conducted in the laboratories of the School of Mining at Kingston, of ore supplied by three of the principal mine owners of that district.

The ores treated assayed from 25 ozs. to 125 ozs. silver per ton. The commercial concentration of the lower grades of these ores by smelting is not simple, on account of their refractory nature and hence, the large amount of flux and fuel that would be required. Moreover the cost of building and operating a small plant (if the ores were treated on the ground) might be prohibitive; and if they were not so treated the freight charges would be important items.

The following methods of treatment were therefore investigated on a laboratory scale, and also in most cases on ton lots:—

I. Amalgamation and Concentration. II. Straight Concentration. III. Straight Concentration with Cyaniding of Sands and Slimes.

A summary of the results obtained on four ores, given in approximate figures, may be of interest to the readers of the Canadian Mining Review.

I. Amalgamation and Concentration:—

The ores from the different properties, and even different grades of ore from the same property, showed a very considerable variation in the amount of silver they would yield to amalgamation. The ores were crushed, and treated in a silver amalgamation pan with mercury, with and without the addition of chemicals (salt and copper sulphate), and the residues were concentrated.

The results in a few cases were as follows:—

Ore No. I. assaying 87.0 ozs. silver per ton.
The silver recovered as bullion from the amalgam was of the total silver. 25%
The silver recovered in high grade concentrates was of the total silver. 45%
Total saving 70%

Ore No. II. assaying 60.0 ozs. silver per ton.
The silver recovered as bullion from the amalgam was of the total silver. 50%
The silver recovered in high grade concentrates was.... of the total silver. 25%
Total saving 75%

Ore No. III. assaying 122.0 ozs. silver per ton.
The silver recovered as bullion from the amalgam was of the total silver. 68%
The silver recovered in high grade concentrates was.... of the total silver. 12%
Total saving 80%

In every case, however, there was a heavy loss of mercury, and some difficulty was experienced in separating the heavy concentrates from the amalgam.

II. Straight Concentration:—

For these tests the ore was crushed in stamps or rolls, to from 20 to 40 mesh, and concentrated on a Wilfley table, giving the following results:—

Ore No. I. assaying 87.0 ozs. silver per ton.
The Silver saved in the concentrates assayed 1,200 ozs., and in the middles 500.0 ozs. Making 77% of total silver.

Ore No. II. assaying 60.0 ozs. silver per ton.
The silver saved in the concentrates assayed 1,200 ozs. and in the middles 300.0 ozs. Making 72% of total silver.

Ore No. IV. assaying 28.0 ozs. silver per ton.
The silver saved in the concentrates assayed 750 ozs., and in the middles 150 ozs. Making 55% of total silver.

These results showed that practically all the silver that could be recovered by amalgamation could be saved in the concentrates; of course, not in the form of bullion, but as a marketable product, with the advantage that the plant, required, could be erected and operated cheaply.

However, there is considerable loss of values, the greatest loss, as was expected is in the fines or slimes. The coarse tailings or sands from test I assayed and found to carry 14 ozs. silver, while the slimes assayed from 35.0 to 40.0 ozs.

Ore No. II. gave sands assaying 12.0 ozs., and slimes assaying 40.0 to 45.0 ozs.

Ore No. IV. gave sands assaying 10.0 ozs., and slimes assaying 25.0 to 30.0 ozs.

III. Straight Concentration with Cyaniding of Sands and Slimes.

We tested these products to get a further extraction, and obtained very satisfactory results with cyanide. In all cases from 60 to 75% of the silver values were extracted from the sands, or coarse tailings, with a cyanide consumption of from 1.5 to 3.0 lbs. per ton of ore, and the slimes when treated by agitation yielded from 80 to 90% of their silver, with a somewhat high consumption of cyanide, viz.: 5 to 10 lbs. per ton of ore.

The results obtained on the ores mentioned by the combined concentration and cyaniding of tailings were as follows:—

Ore No. I. assaying 87.0 ozs. per ton.

Silver saved in concentrates	77%	of total silver.
Silver recovered by cyaniding coarse tails	8%	of total silver.
Silver recovered by cyaniding slimes	10%	of total silver.
Total recovery of silver	95%	

Ore No. II. assaying 60 ozs. silver per ton.

Silver saved in concentrates	72%	of total silver.
Silver recovered by cyaniding coarser tails	10%	of total silver.
Silver recovered by cyaniding slimes	12%	of total silver.
Total recovery of silver	94%	

Ore No. IV. assaying 28.0 ozs. silver per ton.

Silver recovered in concentrates	55%	of total silver.
Silver recovered by cyaniding coarse tails	19%	of total silver.
Silver recovered by cyaniding slimes	18%	of total silver.
Total recovery of silver	92%	

Besides the silver value a considerable percentage of the nickel and cobalt would be recovered in the concentrates, and might be realized on, if the sale or treatment o. the high grade ores of this district is successfully settled from the producers point of view.

The mill required for the treatment of these ores according to this latter process would consist of a crushing device such as a stamp battery, a set of riffle tables, and a sand and slimes cyanide plant.

The cost of treatment would vary with the size of the plant but would be reasonable, and, probably, allow of the profitable treatment of ores containing 15.0 ozs. or less silver.

A NEW MATTE SEPARATOR.*

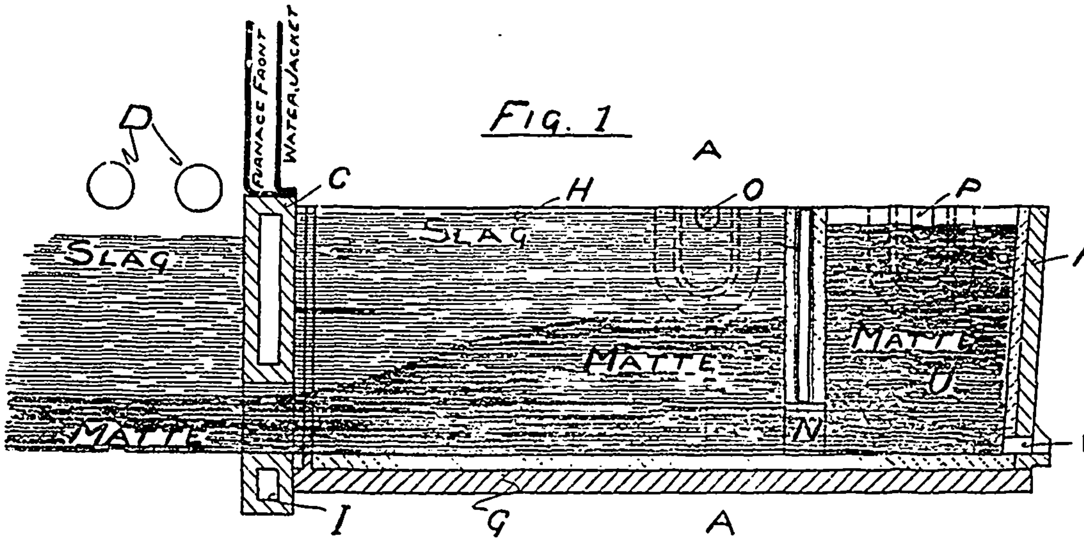
By R. R. Hedley, Nelson, B.C.

The problem of most efficiently separating matte from slag in blast furnace work has occupied the attention of metallurgists with results varying very widely.

In copper matte smelting it is more or less simply a question of settling by gravity; while in lead smelting, with base ores, the problem becomes more complex. The day of the conical pot with a tap hole is past, and large rectangular forehearths are used. Many conditions prevail, making it impossible to produce a slag sufficiently free from silver to discard, and in such cases it is customary to save and re-smelt the shells which chill rapidly on the pot and which carry a large proportion of the silver. In copper smelting, Nicholls and James of Swansea recommend a small reverberatory with independent fire-box, in which the slag is reheated, and Mr. Rhodes of the Arkansas Valley Works was using a large reverberatory in "97, into which the matte and slag were poured as taken from the blast furnace in slag pots. Many attempts have been made to take the matte direct from the furnace and thus avoid the intermixing with slag, but so far as I know these have not been economically successful.

I propose to describe the device successfully used for the past six months, in the Lead Smelting Works of the Hall Mining & Smelting Company, Ltd. at Nelson, invented and patented by Mr. Henry Harris, A.R.S.M.; and, if possible, to point out concisely and clearly its manifold and manifest advantages. First of all, it is manifest that a fairly complete separation of matte from slag takes place within the furnace where a very high heat is developed, and that if this separation can be maintained without the furnace, a vast advantage is gained over letting both matte and slag flow together to any receptacle where they must be again separated by gravity at a lower heat, or by reheating.

*A paper read at the annual meeting of the Canadian Mining Institute, Quebec, March, 1906.



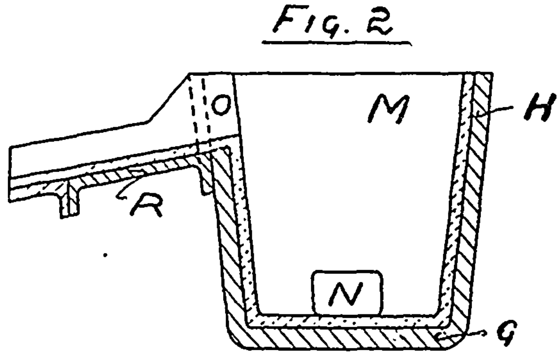


Fig. 1—Diagram showing manner of operation. Fig. 2—Cross-section on the line A A Fig. 1.

The Herreshoff forehearth has its greatest advantage from the application of this principle, carrying the slag overflow well above the tap hole of the furnace, and periodically tapping matte as it accumulates. In the early 80's, John L. Thomson, Superintendent of the Orford Works of New Jersey, adopted a form of forehearth, now known as the Orford syphon-tap, whereby on tapping the furnace a constant flow of matte and slag is maintained whilst no attempt is made to maintain the separation existing in the furnace. This is very successfully used for copper smelting where the matte fall is heavy, and I have used it on lead furnaces with satisfaction. This is simply a rectangular settling box with a division wall having an aperture at the bottom through which matte is permitted to flow, and rise in the second compartment, whence it flows at a level slightly lower than that of slag in the first compartment. In lead smelting, with ores such as the metallurgist of to-day is called on to treat, one has not only to contend with the prills or granules of matte, so difficult to separate completely from the slag when both flow intermittently from the furnace, but there is also that agglomeration, hardly matte, which chills so readily, and rapidly builds up the settler, necessitating so frequent change and such labour to break up; and again that elusive zinc sulphide which declines to settle, but floats gaily, carrying its quota of silver into the slag flume.

It was after enlarging our forehearths, using a secondary conical pot, and even a third, improvising an Orford syphon-tap, etc. that Mr. Harris thought out the device now in use and giving excellent satisfaction. It is patented under the name of the Harris Distributor, as it distributes the matte and slag already separated in the furnace. This distributor combines the essential principles of the Herreshoff forehearth and the Orford syphon-tap, improving on the former in that its first compartment is virtually a continuation of the surface of the furnace crucible, having a free flow through an orifice 10 inches long by 5 inches high instead of connected therewith by a small tap hole. I can best describe this apparatus by quoting from Mr. Harris as follows:—

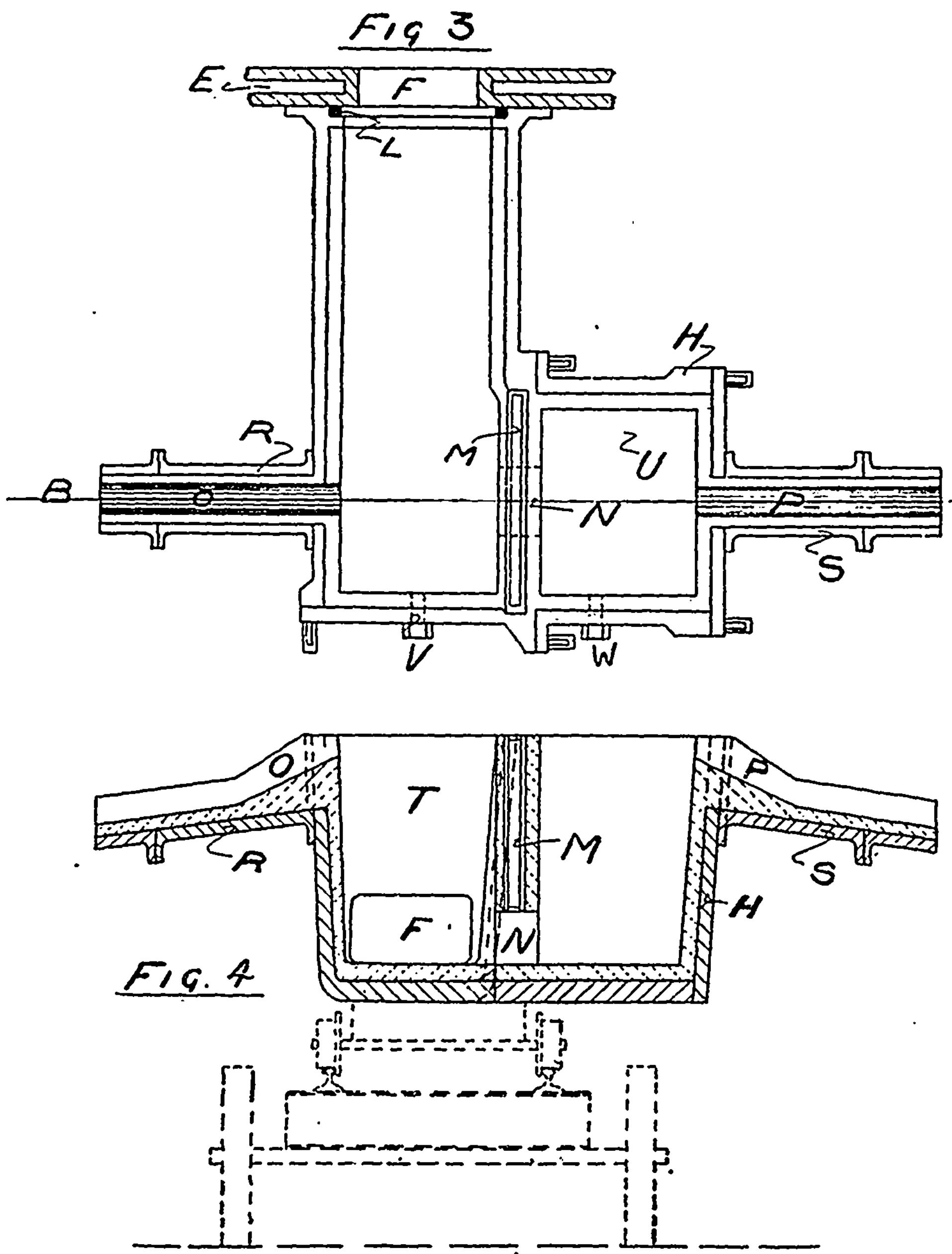


Fig. 3—Plan of Apparatus. Fig. 4—Vertical Section on the line B B, Fig. 3.

"It consists of an L shaped cast iron box about 30 "inches long. lined with tile or water jacketted to "suit conditions which is placed in free communica- "tion with the tap hole of the furnace, which should "be as wide as possible. The walls are deep enough "to afford a sufficient head to retain the amount of "slag and matte desired in the furnace. Placed in "this box at right angles to the face of the tap jacket "is a water jacket partition below which is an aper- "ture a few inches in height and which serves to "laterally divert the matte. Referring to the sketches:

"Fig. 1, is merely a diagram showing its manner of "operation.

"Fig. 2, is a cross section on the line AA in Fig. 1.

"Fig. 3, shows a plan of the actual apparatus.

"Fig. 4, is a vertical section on the line BB in Fig. 3.

"The manner of operation is as follows:—

"The apparatus is pressed closely against the tap "jacket E of the furnace, with its bottom on a level "with the bottom of the tap hole F.

"When the furnace is in full operation the matte "and slag will be maintained within the furnace at "levels corresponding to the head afforded by the "height of the slag and matte overflows O. & P.

"The slag from the double stream flowing from the "furnace will be arrested by the water jacket barriers "M and will be retained in the first division T to over- "flow at O, whilst the matte will flow through the space "N into the second division U and rise until its head "balances those of the matte and slag in the first "division of the box or the matte slag and blast pres- "sure in the furnace and overflow at P. It will thus "be seen that the levels of matte and slag in the furnace "will depend upon the weight of blast and the height "of the overflows O & P which may be varied con- "siderably at the will of the furnaceman.

"Its operation requires but little attention or skill, "and it will run for two or three weeks without change "which is quickly effected, the apparatus being mount- "ed on small wheels which run on rails on a truck "placed at a height corresponding to two short rails "at the furnace.

"It is not bolted in any way to the furnace, the "only connection necessary being made by tamping a "small quantity of fire clay in the groove L which when filled with slag, which chills between the surface "of the jacket and the flange, makes an extremely "efficient seal under the most stringent conditions.

"The tap hole V is provided to tap out any small "quantity of lead which may accumulate, and also "for tapping out the fluid contents of the furnace when "necessary.

"Where the production of matte falls extremely "low, the operator does not attempt a continuous "flow of matte for any length of time but builds up "the level of the matte overflow reducing it at regular "intervals. The oscillation of the contents of the "box due to the blast, prevents in this design the "solidification of the matte even when it is allowed to "stand for a reasonable time. Should however the "matte in the second division U become solidified, "it is easily removed without interfering in the least "with operation of the furnace."

Naturally, some time was occupied in perfecting this device and in becoming familiar with its operation, but it is now a recognized adjunct of the furnace, and the advantages gained by its use, in comparison with the discarded cumbersome settlers or forehearths, may be summarized briefly:—a better saving of lead and silver values in slags; a more perfect equilibrium within the furnace, conducing to more perfect metallurgical work and less tendency to irregularities producing troublesome crusts and accretions; less time lost in changing settlers; a saving of labour in handling the same and preparing the contents for resmelting; and a saving in iron and steel tools, as well as matte pots.

THE REVISION OF THE MINES ACT OF ONTARIO*

By J. M. Clark, K.C., Toronto.

Many resolutions have been passed and numerous recommendations made with reference to the revision of the Mines Act which is to be undertaken at the next session of the Ontario Legislature. These resolutions and recommendations have been varied, but it is noteworthy that at almost every meeting at which the Ontario Mining Law was discussed there was a demand for a mining law to be enacted by the Legislature and to be applicable to the whole of the Province. This demand is wise and fully justified. Sir Frederick Pollock has well said that the criteria of just laws in a civilized community are generality, equality and certainty, and few men are more competent to speak on the subject.

A good mining law must satisfy these three tests. It should be steadily kept in mind that our mining laws, like other laws, should be made by our legislatures and parliaments after full discussion by the representatives of the people. The function of a government and its officials should be to carry into effect the laws so made. The distinction between the law making powers of the legislature and the executive and administrative powers of the government is too often ignored. In view of the unanimity of the demand for a uniform mining law, it is to be hoped that in the interests of the mining industry a stable and well considered statute will be passed by the Ontario Legislature which shall not be subject to sudden alteration by Orders-in-Council.

The rights of explorers and prospectors should be clearly and distinctly defined, and also what has to be done to protect any discoveries they may chance to make. The mineral areas of Ontario have largely to be yet explored, and this will not be thoroughly done unless the pioneers are certain of protection and justice. The conditions upon which mining locations or claims can be held should also be clearly and plainly set forth.

It is for the Legislature to say what these conditions shall be, and for the Government to enforce the enactment of the Legislature.

In framing such a law for submission to the Legislature, the Government have many difficult questions to consider, many complicated problems to solve. The Government and the Legislature have to consider not only the prospector and discoverer, but likewise the miner and the investor in mining enterprises, and also the interests of other industries, such as, for instance, the lumbering industry, and of the public. The history of mining development in this Province has to be carefully considered, and it may be taken for granted that the best results will be obtained by making the necessary amendments and modifications of our existing legislation rather than by attempting an entirely new Act, although a new Act might easily be drawn that would be more perfect theoretically and more rigidly logical. The practical results of drastic and violent changes in our laws do not warrant the risks of such an experiment with our mining Act.

The main object is the development of our mining industry, which is of increasingly great importance.

*A paper read at the annual meeting of the Canadian Mining Institute, Quebec, March, 1906.

If this development is to be as great as it should be, there must be certainty and stability in our mining laws.

The history of our legislation shows that suggestion of gaining revenue by the imposition of royalties is a most unwise one.

Twice already has a system of royalties been introduced in this Province, and each time the results have been so disastrous that the royalties so imposed have been abandoned and repealed. There seems no doubt that like causes would again produce like effects. No one suggests that the mining industry should not bear its fair share of necessary provincial taxation; but no special or arbitrary burdens should be placed on it.

GENETIC RELATIONS OF SOME NICKEL-COPPER ORES.*

By Charles W. Dickson, M.A., Ph. D., School of Mining, Kingston.

Introduction.

Before discussing the ore-deposits of St Stephen, and Sohland in particular, it might be well to briefly review the geological relations of nickel ores, in general. Economically we have to deal with the following classes of Deposits.

(1) Compounds with arsenic, (more rarely antimony,) or with arsenic and sulphur.

(2) Sulphur compounds, including pyrrhotites, and pyrites.

(3) Oxidised compounds, mostly silicates related to serpentine.

Nickel is universally recognized as an associate of pyyrhotite. But it is also well known that in different pyrrhotites the percentage of nickel varies widely. And on this basis, pyrrhotites may be subdivided into two main classes, and this classification is intimately connected with the geological relations of the sulphides.

(1) Pyrrhotite occurs with more or less chalcopyrite and pyrite, as lenses in *acidic gneisses and schists*. These lenticular masses nearly always conform to the foliation of the gneisses, and are often repeated and connected by leaner zones, after the nature of the so-called "fahlbands". Such deposits are of world wide distribution, but the pyrrhotite is *always low in nickel*, seldom containing more than 0.5, and generally less than 0.25. per cent.

(2) The second class is also widely distributed, and from an economic standpoint, calls for special attention. These deposits are also lenticular in shape, but are associated with *basic igneous rocks*, usually of the gabbro type, or their metamorphic equivalents. There is always more or less chalcopyrite and pyrite present, and at times rarer minerals, and the characteristic minerals of the basic rock are always intimately mixed through the prevailing sulphides. Nickel is almost invariably present in the pyrrhotite, at times up to 10 per cent. or more, but on an average, (e.g. in Sudbury), 2 to 4 per cent.

To the latter class of pyrrhotites, the St. Stephen deposits belong.

Many writers in r cent years have attributed a direct igneous origin to this class of pyrrhotites. The sulphides are regarded as original rock constituents, and the theory is that they crystallized, from the cooling magma, in their present position, by a "magmatic segregation."

*A paper read at the annual meeting of the Canadian Mining Institute, Quebec, March, 1906.

A thorough investigation of the Sudbury deposits has led me to the conclusion, that this theory of a direct magmatic segregation is untenable. This must, however, not be taken to imply, that the sulphides may not have been, to a large extent, original constituents of the basic magma. Also there may have been a partial concentration, during the cooling of this magma. But from the studies of the Sudbury and St. Stephen ores, there seems to be only one explanation possible, as to their present position. Namely that the deposits are largely secondary replacements along more or less crushed and faulted zones, by means of circulating solutions containing ore, which has been deposited by a metasomatic interchange, with the rock minerals; that is, that the main concentration of the ore, as seen at present, is of a secondary nature, *after the solidification of the magma*, and is not an original direct segregation from the cooling, but still molten magma.

The study of a somewhat similar deposit near Sohland, Germany, has led Prof. Beck, and myself to a similar conclusion in this case also.

As work has been discontinued for the present at St. Stephen, it was impossible to gain access to the mines. I was however furnished with material through the kindness of Messrs. W. K. and A. D. Ganong, of St. Stephen, which has proved amply sufficient for the present investigations On the property from which these samples were taken, two shafts have been sunk, to the depth of 125 feet, and 80 feet respectively. Further prospecting has been done with a diamond drill, and though it is difficult to get exact information, I have been informed that a body of solid ore, 18 feet thick has been located.

St. Stephen, N.B.

While the nickel-copper deposits of St. Stephen have not as yet assumed the importance of producing mines, they are of more than passing interest. Aside from their possible economic value, they supply us with a great deal of information, which throws light on the genetic relations of this class of sulphide ores.

Mr. H. P. Brummel briefly sums up the geological relations of the deposits*, and Prof. L. W. Bailey gives us some further particulars in a later report.**

The Deposits.

Throughout the country north of St. Stephen, are large areas of diorite, with which are associated, more or less extensive deposits of pyrrhotite, and chalcopyrite, the former carrying nickel. The pyrrhotite masses are almost invariably capped by a gossan resulting from the oxidation of the sulphides. The rocks of the entire district consist of coarse and fine grained diabases, and diorites. They show the effects of severe metamorphism, and are often slickensided, and highly charged with sulphides in the vicinity of the ore-bodies.

Attention was first drawn to these deposits after the discovery of similar ores near Sudbury, and analyses showed that the St. Stephen pyrrhotites carried a small percentage of nickel. Numbers of test pits were sunk, showing the wide distribution of the pyrrhotite, and steps were taken to determine their value. Some of the ore bodies proved quite extensive, but the percentage of nickel was low and irregular, generally averaging 0.75 to 2%. In many cases only traces were found, though some samples showed as much as 4%.

*Geol. Sur. of Can., vol. V, new series, 1890-'91, p. 112 S.S.
**Geol. Sur. of Can., vol. X, new series, 1897, p. 27 M.

In 1897 Prof. Bailey made a careful examination of some of the more importan localities, and calls attention to some of the principal features of the deposits. Compared with Sudbury, they show many features of similarity. (1) The St Stephen beds like those of Sudbury, consist of basic intrusives, as diorite and diabase, with probably gabbro, and norite, associated with heavy beds of quartzite. (2) As at Sudbury the pyrrhotite would seem to be a normal constituent of the dioritic rock, and not an intrusion into the latter. (3) The St. Stephen rocks like those of Sudbury are referable to the Huronian system, and were probably formed under like conditions. On the other hand the average percentage of nickel in the St. Stephen ore, is much smaller than in Sudbury.

Nature of the Ore.

The St. Stephen ore consists of prevailing pyrrhotite with chalcopyrite and a very subordinate amount of pyrite. Through the ore are also small grains of magnetite. The magnetite does not however, so far as I have observed, occur in any considerable masses, but is present simply as an original residual, accessory of the enclosing rock. The pyrrhotite is nearly always finely granular and compact. At times it is nearly pure, without chalcopyrite, and having only isolated grains of silicates, as impurity. But these masses of pure ore are never extensive, and seem to be of comparatively local development. The pyrrhotite is mixed with more or less of the rock silicates, and also contains chalcopyrite. The amount of rocky inclusions varies considerably, as is the rule in such deposits, and in places may equal or exceed the sulphides. The chalcopyrite seems to be irregularly distributed. It seldom occurs in considerable masses, in any degree of purity, but is often closely associated with pyrrhotite, especially where the latter is mixed with a considerable amount of rock.

The relation of the chalcopyrite to the pyrrhotite is very interesting and significant. A number of polished sections of the mixed ore were made, and in all of them the same phenomena were noted. The ore-rock is traversed in various directions by small parting planes and fracture zones. These are apparently the result of a dynamic movement which shattered the rock to a considerable extent. The parting planes do not seem to be confined to any one part of the rock, and traverse both pyrrhotite and rock proper. But they are *most apparent along certain lines where large phenocrysts of feldspar are abundant.* Also in connection with the feldspar, the development of chalcopyrite is most pronounced. The chalcopyrite extends along these lines of weakness in the form of veins, often terminated abruptly against the side of a comparatively fresh feldspar crystal, and ramifying irregularly, between the neighboring minerals, in a network of fine veinlets. In cases where a feldspar crystal has been shattered, and more or less decomposed, the chalcopyrite can be seen, penetrating it in all directions, along the cleavages and partings, in the form of delicate apophyses.

The conclusions to be drawn from these relations are very significant. That the chalcopyrite is a *later introduction* is shown conclusively, and this is an important fact in considering the paragenesis of the ore. It is evident that a dynamic movement has taken place *after* the formation of the principal body of the ore, namely the pyrrhotite. And along these parting planes, due to the dynamic effect, solutions bearing the copper sulphide, have circulated, with the foregoing result.

The conclusions are important in helping to explain certain phenomena of other deposits. Prof. Beck has come to a very similar conclusion with reference to the Sohland deposits, where chalcopyrite is often found along planes of weakness and shear planes.

Already for Sudbury a similar idea was advanced, but here the relations are masked to a large extent by the massive nature of the ore. But with the additional evidence offered by Sohland and St. Stephen, it grows almost to a certainty, that the relations of the chalcopyrite to the pyrrhotite can be explained in the same way for Sudbury.*

Further proofs that the ore-bearing rocks have been involved in a process of dynamic metamorphism are not wanting. The rock has been more or less shattered and brecciated, and numerous cracks resembling faulting planes are present. The minerals in the neighborhood of these seams are often completely granulated and show a marked undulatory extinction. These relations are brought out still more clearly by the microscopical examination. The movement does not seem to have been on an extensive scale however, and has resulted in a brecciation of the minerals themselves, rather than of the rock as a whole. The force has no doubt acted while the rocks, now exposed, were under a considerable load, and the minerals have readjusted themselves, in a somewhat plastic condition, so that their continuity is as a rule preserved. This resulted in the formation of lines of weakness in certain directions, and a somewhat gneissoid structure of the rock, accompanied by a granulation of the minerals.

Besides this, other rocks in the immediate vicinity, show very definite results of movement, which has developed a slickensided structure, along the planes of which the rock parts easily.

The ore-rock itself exhibits a number of minor varieties. That most intimately associated with the ore, is a rather coarse grained variety of gabbro, shading to diabase. It is characterized by the presence of rather large feldspar individuals, often drawn out and compressed. The feldspar as well as the other minerals are in an advanced stage of alteration, especially where ore is developed.

Another variety, only slightly impregnated with ore, is much finer grained and fresher. In appearance the rocks resemble gabbro, and will be more minutely described microscopically.

Microscopical Structure of the Ore.

The method of examination employed is practically similar to that used for the Sudbury deposits. The study of the microscopical relations of the ore and ore-bearing rocks, affords the surest means of determining the true nature and origin of this class of ore-bodies. Taken in connection with the evidence afforded by the megascopic relations, the results have proven most successful, in this case, as well as for Sudbury, in solving the problem of the origin of the deposits.

A large number of thin sections have been examined, including pure ore, and ore associated with varying amounts of rock, so that the results can be taken as representative of the entire deposit.

(1) Specimens of a medium grained, holocrystalline, hypidiomorphic granular rock, carrying a small amount of ore.

The rock is very compact and even grained, of a prevailing dark grey color, with lighter spots of feldspar, and often shows the slickensided structure mentioned above.

*See page 59 reprint "The Ore Deposits of Sudbury, Ontario, Trans. Am. Inst. of Min. Eng., 1903.

From the general mineralogical composition, the rock might be considered as an olivine-free gabbro. But from the prevalence of the ophitic structure, it must be classed as a transition form between a gabbro proper and a diabase. The basic nature of the feldspar however, as well as the nature of the inclusions, and the alteration products, belong more typically to a gabbro, than to a diabase.

Under the microscope the rock is seen to be made up largely of plagioclase feldspar, pyroxene, hornblende, and chlorite. Besides these minerals, there are small amounts of brown mica, apatite, quartz, magnetite, and secondary sulphides in varying amount.

The *feldspar* is as a rule fairly fresh, and nearly always builds sharply bounded crystals, about 2 to 4 times as long as broad. With reference to the pyroxene they are idiomorphic. The crystallization of the feldspar has apparently begun before that of the pyroxene, and extended through it, so that the feldspars appear to lie in a cement of pyroxene. (See Fig. 6.)

Twinning according to the albite law is universal, and at times is combined with a carlsbad twinning. Measurements of the extinction angle range up to 32 and 34 deg., showing that the feldspar belongs to the basic end of the group, that is, bytownite or anorthite. In the feldspar crystals themselves, are numerous, zonally arranged needles, of a highly refracting mineral, whose exact nature could not be determined, but which is probably rutile. There are also inclusions of a secondary nature, where alteration has begun.

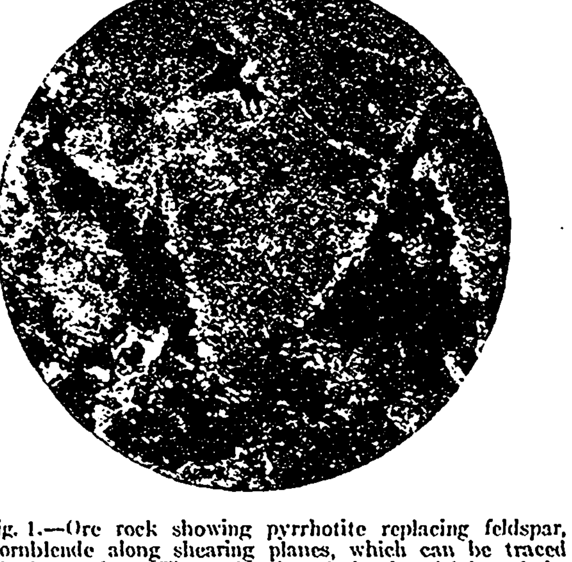


Fig. 1.—Ore rock showing pyrrhotite replacing feldspar, and hornblende along shearing planes, which can be traced through the section. The rock minerals in the vicinity of the ore are largely altered to aggregates of decomposed feldspar, fibrous, green hornblende and chlorite. There are a few grains of colorless epidote, and a small amount of fresh, regenerated feldspar.—Magnified about 70 diameters.

These consist of small centers, of highly refracting particles, of a saussuritic nature. The feldspar resists alteration much better than the other minerals.

The prevailing pyroxene is most closely related to diallage, but is peculiar in some respects. A few grains of other pyroxenes, resembling diopside, and an orthorhombic variety, were also noticed, but the amount is very subordinate. The diallage as stated is without crystal boundaries, and forms a cement for the feldspar. The color is light brown, often with a tinge of violet (indicating titanium). Pleochroism is very faint, and only observable as changes of shade. Besides the ordinary cleavages, which are well developed, the pyroxene is characterized, in that it possesses the peculiarity of a decided *fibrous structure parallel to the base.* The maximum extinction angle is high, corresponding to diallage, and reaches 39 to 40 deg. Regular intergrowths with diopside as well as with brown hornblende, are frequently noticed.

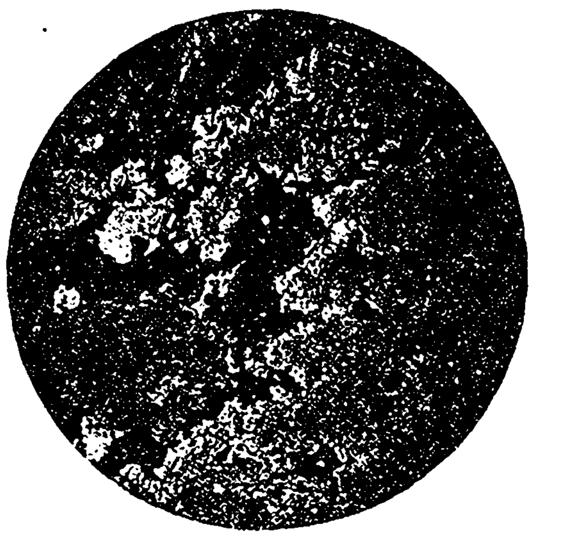


Fig. 2.—Ore-rock with considerable calcite, showing the etched borders of the epidote and hornblende, and ore along the cleavages and between the grains. A fragment of brown hornblende, partly bleached, and altered, is cut entirely in two by the ore, which is also seen along its cleavage planes.—Magnified about 70 diameters.

The pyroxene is always in a more or less advanced stage of alteration, which makes its exact determination at times difficult. In most cases it is filled with fine dust-like inclusions, of both a primary and secondary nature. The latter are highly polarizing and consist of calcite and epidote, with more or less of a talcose mineral. Again it is often pierced with numerous needles of a secondary green hornblende, or chlorite. In a further stage, a green fibrous horn-

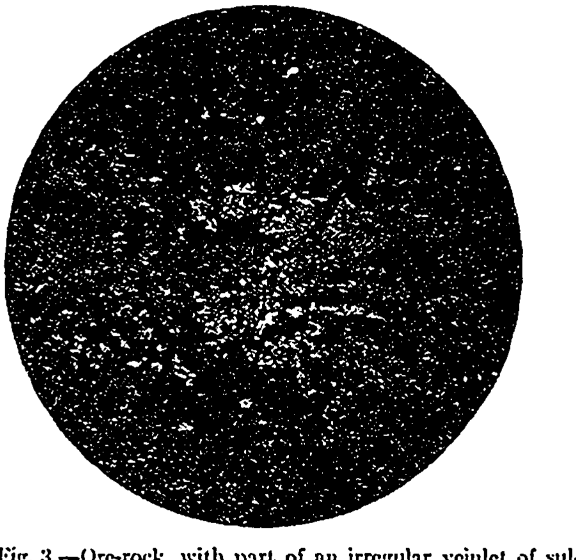


Fig. 3.—Ore-rock, with part of an irregular veinlet of sulphides, along a line of weakness, where the rock is much crushed and decomposed. Residues of epidote, pyroxene, etc., can be seen entirely surrounded by ore. The epidote is finely granulated, and shows the effects of a severe dynamic strain. It is also filled with decomposition products, and associated with calcite, while chlorite is also abundant. Small amounts of altered dornblende and diallage also remain, partly replaced by ore. Magnified about 65 diameters.

blende, resembling actinolite, results, commencing from the periphery and along cleavages. As the alteration proceeds still further, chlorite, (var. pennine,) results, which may color the surrounding minerals green for a considerable distance.

Besides the secondary green hornblende mentioned, a brown variety is quite abundant. In some cases it is undoubtedly primary, but may in part be derived from the diallage. The advanced decomposition of the dark silicates, often makes it difficult to decide which is primary and which is not. This hornblende is usually of a dark color, with a violet shade, when fresh, and the pleochroism is strong. A greenish color or bleaching, usually results as the first stage of chemical alteration, and it gradually passes to fibrous aggregates of green secondary hornblende, and finally to chlorite.

The small amount of quartz is apparently primary. It is mostly clear and fresh, but also contains small needle-like inclusions, and infiltrated hornblende. The amounts of apatite and brown mica are very subordinate, and the latter is evidently secondary. Magnetite as a primary accessory constituent, is in quite large amount, and in some cases the sulphides are important.

Relation of Sulphides.

In contrast to the primary magnetite, the relation of the sulphides to the rock minerals is striking. Besides the primary magnetite, however, is a small amount, in fine-dust like particles, which results from the alteration of pyroxene and hornblende. The *primary* magnetite is always in the form of more or less rounded grains, enclosed in the dark silicates and sulphides, with unaltered contours.

Fig. 4.—Ore-rock, showing part of a veinlet of chalcopyrite chalcopyrite and pyrrhotite, which extends across the section along a line of shearing. The epidote and pyroxene are granulated and strained by pressure, showing undulatory extinction and a curved cleavage. The sulphides replace the pyroxene and epidote in a typical manner, etching the borders of the grains and extending along the cleavage planes.—Magnified about 70 diameters.

The ore which is almost exclusively pyrrhotite, is largely confined to the neighborhood of the dark silicates. It is possible that it has in part, been formed in place, by sulphur-bearing waters reacting on the iron, resulting from the alteration of the silicates. But whether the sulphides originated in this way, or were introduced from external sources, they are certainly secondary.

Where the hornblende and peroxene are still fresh and compact, the sulphides form a border around them, sharply defined by the edge of the mineral. But as the rock minerals become more altered and fibrous, the change proceeds further. At first, fine threads of sulphides insinuate themselves, between the fibres and along the cleavages, and may finally replace the whole silicate fragment. This often results in a more or less complete pseudomorph, but the change has gone on so delicately, that the sulphides

Fig. 5.—Ore-rock, showing decomposed feldspar, with secondary hornblende and chlorite. About the centre can be seen an area of secondary, greenish, fibrous hornblende, which is largely replaced by ore, but in such a manner that the sulphides retain the orignial fibrous structure of the hornblende.—Magnified about 50 diameters.

preserve the *fibrous structure* of the replaced mineral. This change of course, is very often incomplete, but the principle is always the same, and the *greatest development of sulphides is always found, where the alteration of the rock minerals* is most prominent.

(2) Rock strongly impregnated with ore, taken from the shaft, at a depth of 30 feet.

The rock itself is a diabase gabbro, with a hypidiomorphic-granular structure; in places rather coarse grained, and with prominent feldspar crystals.

A somewhat gneissoid structure, and slickensided surfaces have been developed by dynamic stresses.

The principal constituents are: feldspar, epidote, pyroxene, hornblende, and chlorite, with apatite, magnetite, calcite, etc., as accessories.

The feldspar is a basic plagioclase, approaching labradorite, or bytownite, and when not too much altered, shows a typical albite twinning. As a rule the feldspar is in an advanced stage of decomposition, and the twinning structure may be entirely obliterated. It builds irregular grains and aggregates, but often presents good crystal outlines, in a ground-mass of pyroxene or hornblende, giving the section somewhat the appearance of a diabase. Most of the feldspar has passed to indistinct aggregates of highly polarizing secondary products, consisting of calcite, sericite, or saussurite, and colored greenish by migrated hornblende and chlorite. Fig. 1 shows such an altered feldspar individual. Around the edge of the altered grains can be seen a rim of clear "*regenerated*" feldspar, in optical continuation with the old.

One of the most prominent minerals is a clear variety of epidote, characterized by the fact that the plane of the optic axes is at right angles to the cleavage. It is always in the form of irregular grains, sometimes

Fig 6.—Comparatively fresh ore-rock, showing typical ophitic structure, with feldspar in excess, in a groundmass of diallage. Crossed nicols.—Magnified about 50 diameters.

quite large, with no approach to crystal form. Seen in ordinary light, the grains appear as one individual (See Figs. 2 and 4). But between crossed nicols, the mineral has a marked undulatory extinction, and the mass breaks up into a mosaic of small and irregularly oriented grains, showing the effect of severe crushing. The epidote is usually quite fresh, but where most crushed and granulated, it is intergrown with secondary hornblende and chlorite. (Fig. 3). The epidote stands in very close relation to the sulphides, and the origin of both is no doubt closely connected with the same metamorphic processes.

The chief pyroxene is diallage. It is usually in rather irregular plates, without crystal outline, and shows a more or less fibrous cleavage. A regular intergrowth with hornblende is common. (See Fig. 4). The diallage is in various stages of alteration, first changing to secondary hornblende, and then to the variety of chlorite, pennine. The alteration takes place along the cleavages, and from various centres. The brown color is bleached, the double refraction becomes weaker, and a fibrous aggregate of hornblende and chlorite results.

The next most important mineral is the brown hornblende. This is evidently primary, and shows the usual pleochroism and cleavage. In part it is quite fresh, but more often it is altered to secondary actinolitic and tremolitic hornblende, and finally to chlorite. (Hornblende, in various stages of alteration are seen in Figs. 1 and 2). The secondary green hornblende, which is very abundant, is derived from both the pyroxene and hornblende. It is partly in the form of irregular grains but more frequently in tufts, and fibrous masses, irregularly oriented. A further alteration ends in a confused mass of hornblende fibres and pennine, mixed with indefinite secondary products.

Calcite as a secondary product is often quite prominent, especially in connection with the ore and epidote. (Fig 2). The usual accessory minerals of gabbro occur in small quantities, but are not important.

Relations of the Ore.

The relation of the sulphides to the rock minerals is very characteristic. In all the sections belonging to this type of rock described above, they are identical, and fully demonstrate the secondary nature of the ore.

That the rock has been subjected to the forces of dynamic metamorphism, is borne out by the microscopical examination. The constituent minerals are brecciated and deformed, and the rock is crossed by many small breaks and cracks, both of a megascopic and microscopic nature. Along these lines of weakness, the effects of pressure and strain are most apparent. The granulation and alteration of the minerals is here most pronounced, and ore is always present in the form of veinlets, following the direction of the fracture planes. Under these circumstances, calcite and epidote are usually abundant, and from this it may be inferred that the ore has been formed in part later, by means of circulating waters, as well as during the actual metamorphism. Such veinlets are shown in Figs. 2 and 3; very typically in the latter. It is not likely that actual open fissures resulted, or ever existed. The effect of the dynamic stresses was to prepare a line of least resistance, along which the ore-bearing solutions found their way, and left the minerals in such a condition that they could be easily replaced. Fig. 3 shows this distinctly. The ore has replaced the brecciated minerals along such a fracture plane, and left small residual grains unreplaced and *surrounded by ore*. The veinlets often cross the entire section, but are never uniform. They expand and contract, and send out ramifications among the surrounding minerals, in a very typical way, and replace them to a considerable extent.

In connection with the epidote also, the sulphides are prominent. They form an irregular network, between the grains, which make up the larger aggregates. They force their way between the grains, etching them, and finally isolating them from the main mass. They find their way along cleavage cracks, and planes of weakness, so that the grains finally appear in a matrix of sulphides, which holds them together. (See Figs. 2 and 4).

Replacement has gone on most actively in connection with the epidote, pyroxenes and hornblende, and their alteration products. But where the feldspar has been crushed and broken, it is also attacked and is very frequently seamed with sulphides, though to a smaller extent than the bisilicates.

The rock contains a considerable amount of magnetite, of a primary nature, but as before, it presents a strong contrast to the sulphides. It is in the form of rounded or elliptical grains, and never has the numerous vein-like ramifications, which characterize the latter.

(3). A third variety of ore-rock is found in the shaft. It belongs to the gabbro type, but is much lighter in color than the others, owing to the prominence of large individuals of a whitish feldspar. Taken as a whole, the rock is very similar to the last, but with a number of interesting variations. Alteration has reached an advanced stage; the feldspars are composed of turbid masses of secondary products, and both hornblende and pyroxene are almost completely changed to secondary hornblende and chlorite. The epidote which was so prominent in the other variety is here lacking, and diallage cannot be identified with certainty. It is evident that a great deal of the secondary hornblende was derived from original pyroxene, but this could not be directly proved.

The most interesting mineral is the feldspar. Along its cleavages, and bordering the altered mass, is a clear, fresh, glassy feldspar, which is much more acid in composition than the main mass. That it is not a simple zonal arrangement, appears from the fact, that the fresh feldspar is found along the breaks as well as around the edges. We must therefore be dealing with a secondary feldspar, which has been formed during or after the metamorphism. This "regenerated" feldspar, as it may be called, is a regular growth through and around the altered variety, and in optical continuation with it, but of a much more acid nature. The new feldspar is clear, fresh and glassy, and contains no inclusions. This regenaration of feldspar is exceedingly interesting, and for a rock of this kind rare. That quartz grains, and at times feldspar, in sandstones and related rocks, are enlarged by secondary processes, is quite well known. That it should occur in other rocks, especially those subjected to the influence of dynamic metamorphism, is therefore not strange. At the same time it is so uncommon, as to deserve special mention. The other rock minerals, consisting now largely of secondary hornblende, and chlorite, (pennine), occupy the spaces between the large feldspar crystals.

The sulphides as usual are most intimately associated with the dark silicates, which they replace in a characteristic way. The feldspars, although strongly altered, have not been extensively replaced by ore, except where they have been crushed and broken, and then the ore is found filling the planes of fracture.

The replacement of hornblende and chlorite by ore, is typically developed, and a number of almost complete pseudomorphs can be seen. (Fig. 5.)

(4). Specimens consisting almost exclusively of ore, do not show anything new. The rock residue consists largely of feldspar, with a small amount of green hornblende, and chlorite. The minerals are all strongly decomposed, and are penetrated by threads of ore along all lines of weakness, and in some cases are almost wholly replaced.

Conclusion.

From the results given above it is possible to draw a number of conclusions, with certainty. Briefly these are as follows:—

(1). The deposits are *not* the result of a direct magmatic segregation from an original magma.

(2). The ores are largely of a secondary nature, deposited from circulating solutions, by a metasomatic replacement of the rock minerals.

(3). The relations of the rock minerals, can only be explained by such a replacement.

(4). Where the effects of metamorphism, in the crushing and alteration of the rock, are most apparent, the largest quantity of ore is developed.

(5). The ore has been introduced into the rock, *after* its complete differentiation and solidification.

(6). The ore first replaces the rock along planes of brecciation and least resistance, and finally extends, till it has replaced considerable masses of the rock.

(7). The ore is most prominently associated with secondary non-metallic minerals, namely hornblende and chlorite.

(8). The different relations of the magnetite and sulphides, to the rock minerals, gives additional proof that the latter are secondary.

(9). Pyrrhotite at first, probably formed the larger proportion of the ore, and chalcopyrite has been introduced still later.

(10). A comparison of this deposit with those of Sudbury and Sohland, show that the three are practically alike.

The ore-bearing rocks are of the same type, with only minor differences of local development. The underlying principles of the ore-formation are essentially similar. Whether the important concentration of the ore, took place during or after, the period of metamorphism, which crushed and sheared the rock, is not clear. It is very probable however, that the metamorphism had a more or less direct effect, in stimulating the circulation of the ore-bearing solutions, as well as rendering the rock permeable to these solutions. The ultimate source of the metals themselves is still problematical. As in the case of Sudbury, the associated basic rocks, can hardly be looked upon as capable of furnishing the necessary amount of ore, by a process of "lateral secretion". The only alternative is therefore, to ascribe a more distant source to the metals, which have received their *first* important concentration by means of *ascending* waters.

Considering our comparative ignorance of the laws governing the circulation of deep underground waters, a discussion of the actual processes, which resulted in the formation of the ore-body as it is to-day, would be purely theoretical.

As the object of this investigation has been to inquire into the *facts*, as presented by the actual occurrence and relations of the ore, and not to go into theoretical details, such a discussion will not be attempted.

The Pyrrhotite Nickel Deposits of Sohland, Germany.

The geology of the interesting nickel deposits near Sohland, Saxony, discovered in 1900, has been described by Prof. Beck, in a recent valuable paper.*

* "Die Nickelerzlagerstatte von Sohland a.d. Spree, und ihre Gesteine." Zeit. der Deutsch. geol. Gesell., 1903.

Other literature on Sohland.

Beck, R. Lehre von den Erzlagerstatten. I Ed. 1900, p. 47; II Ed., 1903, p. 46.

Beck, R. "Ueber eine neue Nichelerzlagerstatte in Sachsen. Zeit. fur prakt. Geol. Feb., 1902, pp. 379-381.

Beyer, O. "Die erste Erzlagerstatte der Oberlausitz." Wissensch. Beil. der Leipziger Zeit. Feb. 13, 1902.

Geology of the Ore Bodies.

The country rock of Sohland is the so-called Lausitzer granite, which is cut by numerous diabase dykes, and often shows the effects of metamorphism. Where the ore was discovered, the granite is fine grained; further east a middle grained variety is predominant. The ores are closely associated with diabase dykes, called "proterobase", striking in a general W.N.W. direction. The main dyke is about 30 to 60 feet wide, and has been traced for more than half a mile. Ore has been found in a number of test pits, and prospecting with a magnetometer, makes it probable that the ore-bearing rock extends at least a mile in length.

The Ore-bearing Rock.

The principal ore-bearing dyke is not uniform in character. It is most largely developed as the so-called "proterobase"; in part it takes the form of a biotite-diabase. Besides these, there are small basic segregations, containing spinel, corundum, and sillimanite.

(a). Proterobase. Without going into petrographic details, the proterobase is a fine to middle grained rock, consisting chiefly of plagioclase, augite, brown hornblende, and brown mica. The chief accessory minerals are, a colorless pyroxene, magnetite, ilmenite, hornblende, talc, chlorite, andr serpentine.
apatite, zircon and rutile, as well as secondary green

(b). Biotite-diabase. The biotite-diabase is much finer grained, and occurs as irregular nodules within the proterobase. Its microscopic structure is typically ophitic. Brown hornblende fails, otherwise it is very similar to the proterobase, with which it is connected by gradual transitions.

(c). The basic segregations are of two kinds. One (not found in place) is characterized by countless octahedra of a green transparent spinel, and a few grains of corundum. The other variety, which is found in the ore body, is made up largely of aggregates of sillimanite, and contains large numbers of spinel and sapphire crystals.

Besides these minor varieties, the proterobase contains inclusions of quartz and granite, the latter strongly altered.

Mineralogical Composition of the Ore.

Besides the magnetite and ilmenite mentioned as original components of the rock, the Sohland ore consists of pyrrhotite, chalcopyrite, and pyrite. The pyrrhotite is largely in excess of the others, and the mining activity is due to the nickel it contains, as the ore is too poor to work for copper alone.

The pyrrhotite is always massive, and two varieties can be distinguished. One is more or less granular and fine grained, the other more coarsely crystalline and platy. Chalcopyrite is always intimately intergrown with the pyrrhotite, especially the finer grained variety. The latter also contains many more inclusions of the proterobase, while the coarser is as a rule comparatively pure, and free from rock and copper.

Analyses of the Sohland pyrrhotite show an average of between 4 and 5 per cent. nickel, for nearly pure material. But in a number of cases I obtained as much as 7 per cent. Copper is generally rather subordinate, averaging between 0,5 and 1 per cent., but at times going as high as 2 to 3 per cent. Cobalt is present in very subordinate quantities, and traces of antimony and silver have been detected.

The Ore-Body.

The ore-bed proper lies in the proterobase at the granite contact. At the bottom of the shaft sunk where the discovery was made, it has a thickness of 6 to 8 feet, which, however, sinks to a foot or less. The granite itself at the contact is slightly impregnated with ore for a few inches. The pay ore ends rather abruptly and beyond is proterobase impregnated with diminishing quantities of sulphides.

The upper part of the vein (Fundschacht) is covered to a depth of about ten feet with clay and the alteration products of the proterobase. Below this, secondary oxidised copper ores appear, (malachite, bornite, chalcocite, etc.). The rock becomes gradually fresher and more strongly impregnated with sulphides, till at a depth of about 30 feet, massive ore is met.

Relations of Ore and Rock.

Examined more closely, the relations of the sulphides to one another, and to the rock minerals, present a number of interesting facts.

In the massive ore, the small amount of chalcopyrite, in part fills narrow clefts in the pyrrhotite, as though a later impregnation along planes of fracture. A bilateral arrangement of the sulphides is also characteristic, and is well illustrated by a number of polished sections in Prof. Beck's collection.

One section shows a narrow band of chalcopyrite, running through the proterobase, which is locally altered and somewhat talcose. On either side of this band, the proterobase is impregnated with chalcopyrite for 3 or 4 inches. Then follows a parallel band of pyrrhotite, which is marked off sharply on the inner side, and fades off gradually to barren proterobase on the outer side. Other sections show similar zonal structures, giving the ore a more or less vein-like appearance. At other times the sulphides are grouped regularly around elliptical or rounded rock masses, apparently along fracture planes. The inner zone is generally chalcopyrite, and is surrounded by pyrrhotite, which passes by a gradual transition to barren rock. The same phenomena have been noted in the Sudbury ore, and they afford one of the clearest proofs of the later introduction of the ore, especially when combined with the microscopic observations.

Microscopic Structure of the Ore.

From the examination of a large number of thin sections of ore, Prof. Beck draws the following conclusions.

(1). The sulphide ores fill a space originally occupied by primary rock constituents.

(2). The sulphides are principally associated with secondary, non-metallic minerals, viz. actinolite, and chlorite.

(3). The sulphides favor places where alteration is well advanced. They occur in all varieties of the rock, but especially in the predominant proterobase.

The general conclusions are supported by concrete examples, and an examination of the slides I have made, fully corroborates the observations of Prof. Beck.

Origin of the Ore.

Prof. Beck's work, as well as my own, then make a number of points clear.

(1). Except for a small proportion of sulphides, which may have been original constituents of the ore-bearing rock, the pyrrhotite, chalcopyrite, and pyrite, have been introduced *after* the complete cooling and differentiation of the rock magma.

(2). Not only so, but a partial alteration of the silicates has taken place, resulting in the formation of actinolite, chlorite, talc, etc., *before* the formation of the ore-bodies.

(3). These relations can only have been brought about by means of solutions.

(4). The peculiar intergrowth of secondary hornblende and ore seems to indicate a previous metamorphic action. The fresher silicates are simply corroded and etched, while a part has been further altered during the action of the solutions and the contemporaneous deposition of ore.

(5). The ore-bearing solutions in all probability, were of a thermal nature, from considerable depths. They circulated along the border of the proterobase, along passages formed by cooling and shearing, and were no doubt closely connected with the latter stages of the proterobase eruption.

The ore-body itself indicates the thermal nature of the solutions, and their origin from the depths of the basic magma. If the process had been a lateral secretion of descending waters, which concentrated the nickel and copper, originally disseminated through the proterobase, it is difficult to understand why the ore is confined to the proterobase along its contact with the granite.

COMPARISON WITH SUDBURY AND OTHER DEPOSITS.

A short comparison of various sulphide nickel-copper deposits, indicates their essential similarity, both of geological relations, and method of origin.

(1). Regarding their origin, no example of this class of ore-bodies, which I have studied, can be referred to as a direct magmatic segregation from an original rock magma. On the other hand, all the evidence shows that the ores were introduced *after* the complete differentiation and solidification of the magma. Many facts point to the conclusion that the important concentration of the ore, took place *during* a regional metamorphism, probably connected closely with the eruption of the basic rock, and *later* by a stimulated aqueous activity, following the eruption.

(2). Considering the ore bearing rocks themselves, they are found to be essentially similar. They all belong to the gabbro family, and while showing minor points of difference, for practical purposes they can be considered as identical.

(3). The deposits while lying well within the limits of the basic eruptive, generally occur at or near its contact with other rocks, especially granites and mica schists.

The rocks show to a greater or less extent the effects of dynamic metamorphism, accompanied by brecciation and shearing. These are perhaps more apparent in the Subdury field than the others studied, but are never failing.

(4). The mineralogical relations are practically the same in all the deposits. P. .hotite containing nickel is predominant. Associated with it are varying amounts of chalcopyrite, pyrite, and magnetite, (usually very subordinate), and the rarer minerals (at times), pentlandite, sperrylite, etc.

(5). The ore frequently occurs as a cement for the brecciated rock fragments and along shear planes. This often gives to the ores a vein-like appearance or zonal structure, as is well seen in both the Sudbury and Sohland deposits.

(6). The rocks associated with the ore are strongly altered, and characterized by the presence of much secondary, green and amphobilitic hornblende, chlorite etc The effects of metamorphism and the development of secondary hornblende are most marked near the ore-bodies, and diminish away from them. And in general the more complete the alteration of the rock, the more complete has been its replacement by sulphides.

(7). Microscopically the relations of the ore and rock emphasize the fact that the sulphides are a secondary introduction. The relations of the magnetite and ilmenite, which are for the most part primary, are in striking contrast to the sulphides. While the latter are found in positions originally occupied by primary rock constituents, the former are in the form of grains and crystals in the midst of the sulphides, and dark silicates, apparently unaltered and with their original outlines. The sulphides on the other hand, replace both the fresh and altered rock constituents, often forming more or less complete pseudomorphs. The replacement takes place between the fibres of the secondary hornblende; along the cleavages of the fresher and more compact minerals, etching them and breaking them up into granular aggregates; between crystal fragments; and along planes or zones of shearing and parting.

The dark silicates, owing to their chemical composition, and susceptibility to metamorphic changes, are the first attacked. But as the effects of metamorphism become more pronounced, the more acidic minerals (feldspars) are partly or wholly altered, and replaced by ore.

Another interesting fact, noted especially in the Sudbury, Sohland, and Norwegian deposits, is that where the contact is along granitic or gneissoid rocks, the latter have been slightly mineralized. The change is usually accompanied by a migration of secondary hornblende into the acidic rock, and a replacement of its basic constituents by ore. The granite of the Sohland deposit is often sensibly altered and metamorphosed, both as a result of the eruption of the proterobase, and later by the ore-bearing solutions. The schistose and gneissoid contacts of many Norwegian deposits are often penetrated by ore for some distance, along cracks and planes of parting, which can only be explained as a deposition from solution.

Nickel in the Sohland Ore.

At the request of Prof. Beck, I made a number of experiments with Sohland pyrrhotite, in the endeavour to determine in what form the nickel was present. From the general similarity, both in geological relations and mineralogical composition, of the Sohland and Sudbury deposits, it was thought probable that the nickel might be in the form of a definite mineral, such as pentlandite. Both varieties of the pyrrhotite were examined, but no mineral resembling pentlandite was visible to the naked eye. Chalcopyrite in small nests and aggregates is intimately mixed through both the fine and coarse grained ore, and is very difficult to separate from the pyrrhotite.

After crushing, the ore was sized through Nos. 10, 20, 30, 40, and 80 mesh sieves. The various sizes were then magnetically separated by means of a small horse-shoe magnet. Practically none of the ore was *non-magnetic*, except the chalcopyrite, and rock minerals, and these were rejected as well as possible. Part of the pyrrhotite however, was not so susceptible to magnetic attraction as the rest, and this was carefully examined. It was freed from impurities as well as possible, and treated with dilute hydrochloric acid, to remove oxidation products. In appearance the grains were of a very light bronze-yellow color, but showed little trace of the characteristic parting of pentlandite. These were then picked over under a lens, and only the purest part selected. It was found however, very difficult to obtain a satisfactorily pure product, as small particles of chalcopyrite adhered very closely to some of the grains.

Both varieties of the ore were treated in this way, but from the massive fine grained variety, it was impossible to prepare even an approximately pure sample, so the residue from the coarse platy variety was taken. An analysis of the prepared material, showed that it contained 7,5% nickel, and 1,90% copper. As many samples of the purer pyrrhotite in their original state contain as much as 6 or even 7% nickel; and the particular piece examined, slightly over 7%, it is clear that no appreciable concentration has been effected.

In regard therefore to the condition of its nickel, the Sohland ore differs markedly from that of Sudbury. At the present moment it cannot be said that pentlandite *does not* exist in the Sohland ore. But if it do s, it must be in a very fine state of division, and intimately and uniformly distributed through the pyrrhotite, so that it cannot be separated by magnetic means.

As another alternative we may fall back on the assumption that the nickel is an essential constituent of the pyrrhotite, isomorphously replacing the iron. A third possibility is that the nickel is present in a definite mineral, which is itself magnetic, and so does not allow a separation from pyrrhotite by means of a magnet.

The results of these investigations, I submit in the hope, that they may throw some additional light on this interesting and important class of ore-bodies, and perhaps help to clear up some of the disputed points in the science of Ore-Deposits.

PROSPECTING FOR IRON ORE IN THE TORBROOK DISTRICT, NOVA SCOTIA.

By W. F. C. Parsons.

Extent.—The territory covered by the titles of The Annapolis Iron Company, Limited, extends practically from the County line between Annapolis and Kings, westerly to the Nicteaux River, a distance of slightly over five miles, and has a width throughout its entire length of about one and a half miles. It may very conveniently be divided into two sections, namely the north section and the south section. The veins run nearly east and west. The north section contains the outcrop of three veins, and the south section the outcrop of two veins.

The north and south outcrops run almost parallel to each other. There is every reason to believe they form the upper edges of a syncline of continuous veins of ore, that is, the outcrop on the north dips under the intervening territory and outcrops again in the south section along the South Mountain.

The northern section has been prospected very extensively. The eastern end has been exploited by the workings of the Leckie Mine, (now operated by the Londonderry Iron & Mining Co.) The main shaft of the mine has been sunk to a depth of 350 feet, levels being started 50 feet apart and extending to the east and west for many hundreds of feet. The lower levels Nos. 3, 4, 5, and 6 are being pushed to the westward in order to open up new territory. The plant at the mine comprises three 40 H.P. boilers and one 80 H.P. boiler, one Lidgerwood hoist and two 12″ x 18″, Allis-Chalmers Bullock Co. straight line air compressors, besides air drills, pumps, etc., as well as boiler, engine and dry houses, blacksmith and carpenter shops, office and superintendent's house.

About one mile west of the Leckie Shaft a new inclined shaft, called the Hoffman, was started upon what is known as the shell vein. The width of this vein is about 5½ feet, and its dip about 85 degrees. Sinking was commenced on this vein in December, 1905. At the latter end of January, 1906, it was sunk to a depth of 163 feet, at which point it was decided to cross-cut to the north of the Leckie Vein, which is about 82 feet distant. This work is now underway. The plant at this shaft consists of one 60 H.P. R.T. boiler, one 12″ x 18″ Allis-Chalmers Bullock, Ltd. straight line air compressor and one 14″ x 7″ x 14″ Knowles sinking pump. The size of shaft is 7′ x 14′. It was only necessary to permanently timber this shaft for the first 25 feet. The balance of shaft is timbered with stulls set about 6 feet apart on either side of the skip road. The walls being very hard and regular, very little water was encountered in sinking. It was handled by bailing except on Sundays, when pump was lowered to keep the water out. Sinking averaged over three feet per day, of three 8 hour shifts. The drills used were Ingersoll Sergeant "D" 24, supplied by Allis-Chalmers Bullock, Ltd. of Montreal. These drills proved suitable for this work.

Another inclined shaft, called the Wheelock, situated one mile west of the Hoffman was commenced in November, 1905. This also is sunk upon the shell vein. The width of the vein is 6 feet and its dip was 77 degrees for 63 feet. Then it flattened to 45 degrees for 15 feet. Then to 43 degrees for 16 feet. At the point where the vein flattened, it increased in thickness to 12 feet. At 94 feet the vein suddenly dipped to an angle of 75 degrees, narrowing again to 6 feet. This was followed to a depth of 116 feet, at which point it took another flatter pitch to the south. It was decided to continue sinking upon the line of the 75 degree pitch. This was sunk to a depth of 170 feet, the last 54 feet in rock. It was deemed advisable to sink in rock owing to the numerous changes in the dip. It would be difficult to operate a skip over these changes of grade. At a depth of 155 feet a cross cut tunnel was started to the north to intersect the Leckie Vein, which is estimated to be about 112 feet distant. This work is now underway. When completed a cross-cut will be started to the south to locate the lost vein. The sinking of this shaft was a comparatively difficult proposition, owing to the quantity of water encountered. Progress of sinking did not average over 2 feet per day. The size of the inclined shaft is 7′ x 14′. The plant is a duplicate of that at the Hoffman Shaft.

It is the intention as soon as the Leckie Vein is intersected at these two shafts to drift upon the veins east and west so as to prove the continuity of the same.

Two boreholes were put down by the Nova Scotia Steel Co. in this district. One, a diamond drill hole, is situated about 550 feet west of the Hoffman Shaft. From Government records, this hole proved the shell vein at this point to be 5′ 2″ wide and the Leckie about 6 feet. There is also a third vein about 2 feet.

The second hole is a 5″ Calyx, sunk to a depth of 387 feet on the farm of Josephine Wheelock, about 1,500 feet east of the Wheelock Shaft. The Government records show that at a depth of 330 feet from the surface, ore was intersected, and at a depth of 387 feet this hole was still in ore. It is estimated that the shell vein at this point is at least 9 feet wide and of good quality, iron tenor 49.5%. Messrs. Brookfield & Corbett, who owned the property at this time, continued this hole for another 7 feet. This core showed indications of approaching the foot wall. However, the analysis showed the ore to run considerably over 40% metallic iron.

A borehole was sunk some years ago by Messrs. Brookfield & Corbett on the farm of Fletcher Wheelock. This hole is about 350 feet east of the Wheelock Shaft and 40 feet south of the shell vein. The Nova Scotia Government records show that it cut the three veins, shell vein at 112 feet, width of vein 15 feet; Leckie vein at 330 feet, width 9 feet; 3rd vein 435 feet, width of ore 14 feet.

It should be stated that the shell vein from the Hoffman to the Wheelock Shaft is a magnetic ore due no doubt to the proximity of diorite.

The following analyses shows the quality of the ore in this district, that is, from the Leckie Mine to the Wheelock Shaft where the prospecting work has been confined. From the numerous samples taken from the Leckie Mine, the analysis may be stated as Metallic iron 52 00%, Phosphorus 1 15%, Sulphur 0 02%, Manganese 0.10%, Insol. 13.5%, Magnesia 0.30%, Lime 2.5%.

Hoffman Shaft on shell vein iron 47.47, phos. 1.32, insol. 17.23.

Wheelock Shaft on shell vein iron 49.00%, insol. 15 28, phos. 1.02, lime 3.35, magnesia 0.57.

Page & Stearns farm, shell vein, iron 50.00%, insoluble 16.00.

Leckie vein, iron 50.55%, insoluble 13.65.

George Holland, shell vein.

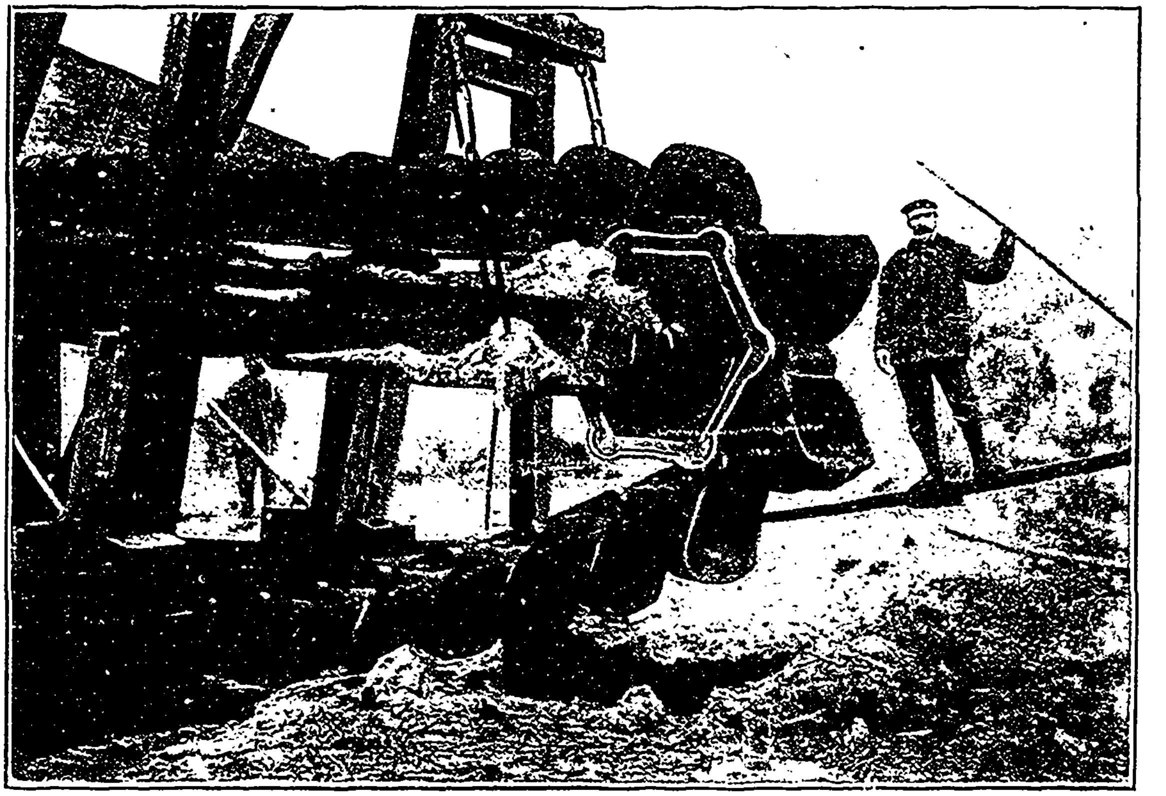
Leckie Vein, iron 51 95, insol. 11.57, phos. 1.517, lime 3,21.

Southern section This section, mentioned before as being the southern outcrop of syncline, extends three miles and contains an area of two and three quarter square miles. It has not been as thoroughly prospected as the northern one. The ore is a black magnetite of varying qualities, the western portion of the area being the better. Analyses of samples taken from surface pits, runs as high as 50% metallic iron and as low as 36%.

THE ROBINSON GOLD DREDGE.

We illustrate in this issue a new gold dredge designed by Mr. A. W. Robinson, M. Am. Soc. C.E., and which is now being built by the Atlantic Equipment Company, of 111 Broadway, New York. In view of the growing importance of gold dredging, this dredge merits more than a passing description.

The introduction of gold dredges into the United States on a commercial scale dates from 1895. In that year a small electrically-operated dredge was installed on Grasshopper Creek, at Bannack, Montana. This dredge was built from Mr. Robinson's designs and was the precursor of several others in the same locality, all of which did well and made money for their owners.



Buckets of the Robinson Gold Mining Dredge.

These early dredges represented a combination of a dredging apparatus with an hydraulic sluice-box, and in both these elements the original separate forms were adhered to. The dredge was of a type and detail which had been successfully used by Mr. Robinson for river and channel dredging, and the sluice-box was similar to that long used successfully by miners in hydraulic mining. A type was thus established which, improved in detail, has been a favorite.

The elevator type was soon recognized as the most successful one for gold dredging, and the history of many experiments with others is one of failure. Subsequently, the New Zealand type of dredge was introduced. This differed from the American type in having mooring lines instead of spuds, and a fine screen and tables covered with riffles or fibre for saving the gold, in place of the sluice-box. In New Zealand, however, the gold is fine, and the ground comparatively soft, or alluvial, and the early dredges were found to be too light for the harder service of this country, and were too cheaply built. Then followed a period in which the two types of dredge, American and New Zealand, were strengthened and improved by their respective makers, until some recent examples show such great size and weight of parts that the cost is greatly increased. That the durability and cost of repairs is still far from satisfactory in the average dredge, is shown by the report of the State Mineralogist of California for 1905, from which it appears that the cost of repairs frequently amounts to fifty per cent. of the whole operating cost. In a typical example, where three dredges were working together, the average operating cost for the three during the year 1903 was (in cents per cubic yard) as follows:—

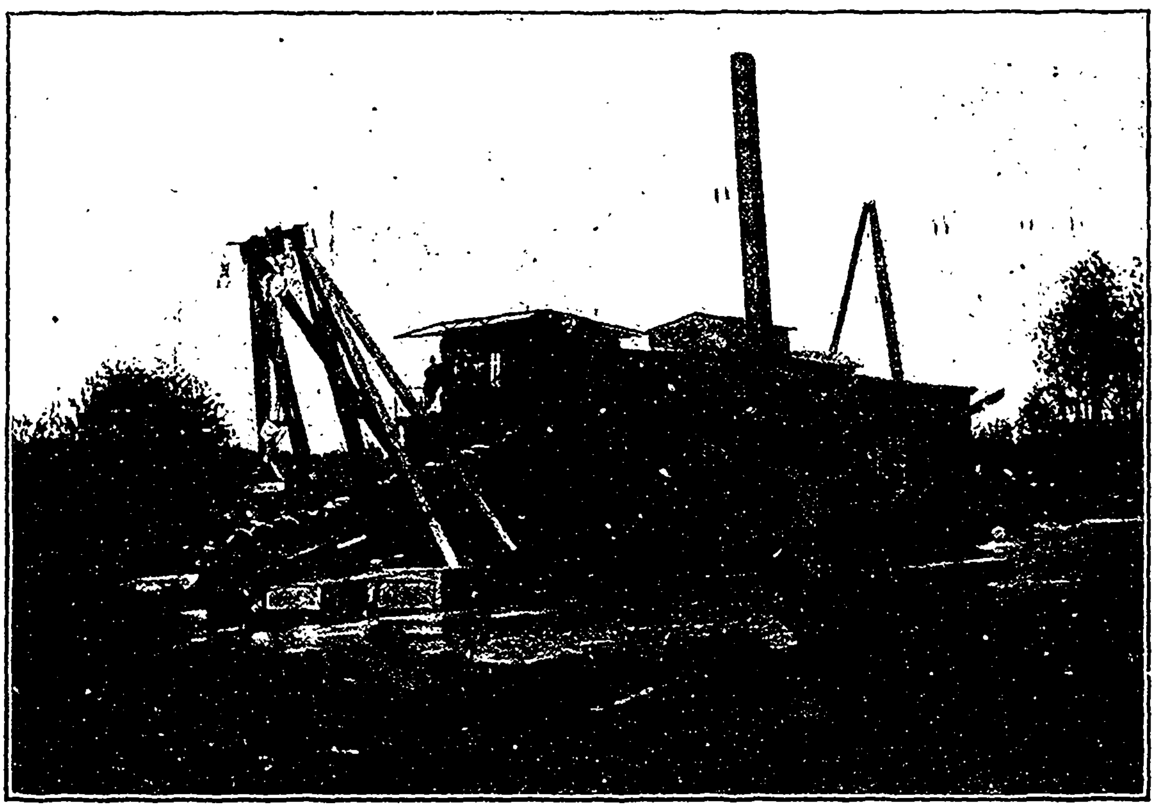
Dredge crew, power and operating supplies	2.52
Repairs, labor	.48
" supplies	2.58
Superintendence	.16
General expense	.15
Taxes and insurance	.24

In the present design the aim has been to produce the very simplest construction of working parts that will accomplish the desired result, and to maintain a large margin of strength as well as durability. All the best features of both New Zealand and American practice have been retained, and complications and weight reduced as far as practicable, by correct design and the use of high grade steels, with as little cast iron as possible. The result is a dredge that is light, strong, easily handled, economical to transport and erect, and that can be depended on to do its work continuously and with light repairs. This dredge made a run of 76 per cent. actual working time during her trial period of 30 days. The total delays thus amounted to 24 per cent. of the time, and included all the time lost in adjusting the new machinery, and in correcting small defects, which when once done would not occur again, so that it is expected that in regular work much better time will be made. Old established dredges on regular runs, seldom average more than 75 per cent. running-time on account of incidental and unavoidable delays.

The dredge herein illustrated and described is the property of the Gold Bond Dredging Company, J. B. Austin, president, Ransom's Bridge, N.C. It is at work in an alluvial flat forming the bottom of a low valley and through which runs a small brook which would readily pass through an 8 inch pipe, and which keeps the pond supplied. The ground is covered with heavy pine timber which when cut yields fuel for the dredge, and the stumps are readily dug out by the dredge itself. Gold is found in good paying quantities, and is of varying degrees of fineness.

The hull is of wood 94′ x 32′ x 7′. It is very strongly built, and the well sides are carried aft the whole length of the boat to form bulkheads. There are also steel hog-rods forming two fore and aft trusses. The ladder-frame is of steel and long enough to dredge in thirty feet of water. The buckets are of Robinson's Patent Improved Close-connected type of 3 cu. ft. capacity each. The back of the bucket is of cast steel. The pins are 3 inches diameter of steel, and the bushings are of manganese steel. These bushings are specially made to slip in or out of recesses shaped to a half circle, so as to be readily renewed. The lower tumbler shaft is of hammered steel and runs in enclosed bearings in the end of the ladder-frame; these bearings also have renewable bushings. The upper tumbler is of cast steel five-sided, and is fitted with Robinson's patent driving faces, by means of which the driving power of the tumbler is applied directly under the centre of the bucket-pins, instead of the usual over-hang due to the links working on the polygonal faces. The strain and wear on both buckets and tumblers is thus reduced. The buckets run at a speed of 24 per minute. This is equal to buckets of 6 cu. ft. capacity of the open-connected type, running at 12 per minute. The buckets discharge through a steel hopper into the revolving screen, which is 4 feet 6 in. by 16 feet. This screen is made with interchangeable, perforated plates on a steel frame, so that the plates may be removed without taking down the screen.

The head-frame and driving gear for the buckets and screen are strong and simple, there being but two working shafts and four bearings in the entire machinery, including tumbler and screen drives. These two shafts are the upper tumbler shaft, and secondary, or pinion, shaft. The main gearing is of steel, and a steel-rimmed pulley of large diameter on the end of the pinion-shaft is directly belted to the main engines on deck. The revolving screen is driven from the secondary shaft, which passes directly above it. On the screen is a cast steel spur gear of 2″ pitch and 6″ face, which also has a flange or roller-patch attached to it. The screen is mounted on adjustable steel rollers running in dirt-protected bearings. An adjustable friction clutch is provided at the main pinion, which will slip in case of sudden strain, but the bolt transmission also furnishes a safeguard.



Robinson Gold Mining Dredge Working in an Alluvial Flat.

The main engines are of 50 h.p. of vertical marine type. In this case they are double cylinder high pressure, for the sake of simplicity, as wood fuel costs only the labor of cutting it—about $1.00 per cord. For situations where greater economy of steam is important these engines can, of course, be made compound condensing. The main engines are handled entirely by the operator on the upper deck. Here he has a full view of his work, and can see the buckets for their whole length and the tailings conveyor as well.

The winch is on the main deck directly under the operator, so that the levers for its various motions can be conveniently placed. It has six drums each with independent friction clutch and brake, as follows:—One headline, one ladder hoist, two forward side lines and two after side lines. By means of these steel wire rope lines, the position and feed of the dredge is under perfect control.

The water supply for the screen and tables is furnished by an independent centrifugal pump with 10″ discharge, and having direct connection with the engine.

Steam is furnished by one boiler of the Worthington water-tube type of 125 h.p. It is, especially, adapted for burning inferior wood, as the firebox is large and roomy, and covers the entire bottom area of the boiler. The boiler has a steam and water drum of sufficiently large dimensions to prevent sudden fluctuations of pressure and water-level. The consumption of green pine wood will run from 2 to 2½ cords per shift of 12 hours, steady working. This is sufficient to show the remarkable economy of this dredge. Assuming the actual output of the dredge to be 1,000 cu. yds. per shift of 12 hours (which is half its theoretical rate, and is a low average in practice), and the cost of fuel to be 2½ cords of wood at $1.00 per cord, we have a fuel cost of one-quarter of a cent per cubic yard of material handled.

The gold-saving tables are arranged on both sides of the after deck, under a distributing-box of special design, by means of which the wash from the entire length of screen is mixed and distributed uniformly to the tables.

To save a high percentage of gold requires, first, thorough washing of the gravel; second, proper concentration; third, thorough mixing and even distribution of the concentrates over the tables; and fourth, a riffled surface on the tables, that in area, slope, and type of riffle are well adapted to the particular material to be dealt with. A correct understanding of the principles of gold-washing is necessary, as well as a correct diagnosis of the local conditions to be met. What will suit one locality may be a failure in another. The system of tables adopted in this dredge is a flexible one that can be adapted to any material and hold any kind of riffle. There are 28 tables, each 1½ ft. x 8 ft., or a total surface of 336 square ft. In addition, there are 94 sq. ft. of riffles in the distribution and tailings sluices, or a total of 430 square feet of riffle surface.

To carry off the coarse tailings a stacker or tailings conveyor 70 ft. long is employed. This is of the rubber belt type, driven by an independent engine. The belt is 30 inches wide and the end of the conveyor is 25 feet above the water level. The load of all the parts is well balanced on the hull so that it sits level at a uniform draft of 3 feet.

The increasing use of the dredge for working low-lying and low alluvial ground has opened up a wide field for this class of mining. Formerly ground that would not pay over 25 cents a cubic yard was not considered profitable, and this is probably still true in the far north and in localities where freight, fuel and labor are expensive, but under ordinary conditions ground which was formerly thought worthless can now be worked at a profit.

"THE EARLY USE OF IRON."*

By Bennett H. Brough.†

R.S.M., F.I.C., F.G.S. F.C.S., we have received an advance proof of his address before the West of Scotland Iron and Steel Institute, on "The Early Use of Iron." With the present remarkable development that is occurring in the iron industry of Canada, we reproduce the same, as being of, probably great interest to those of our readers who are keen followers of the fortunes of that industry.

In accepting the invitation with which I have been honoured by the Council to give a lecture to the West of Scotland Iron and Steel Institute, I feel that an apology is needed for having chosen a literary and antiquarian subject, that is inconsistent with the essentially practical nature of these meetings, and possibly with the very objects of the Society. At the same time, I think that many of the members will be willing to devote an hour to inquiring into the obsolete practices of their earliest predecessors, and to casting a glance backwards to the beginning of the great industry with which they are all so intimately connected. The subject of the early use of iron has already been ably dealt with in papers read before the Philosophical Society of Glasgow, by St. John Vincent Day in 1871, and by Professor A. Humboldt Sexton in 1900. Since the publication of these papers, however, much fresh light has been thrown on the subject by numerous archæological and literary researches. I propose, therefore, to give a brief summary of the results of these researches, and to set forth, as fully as possible in the time available, the existing knowledge of the metallurgy of iron and steel prior to the introduction of the blast furnace.

The date of the discovery of iron has long been a matter of controversy; and it is generally believed that the iron first used by man was of meteoric origin. In support of this view Mr. Otto Vogel has given quotations from the earliest Finnish poem; and Sir Henry Bessemer in 1895 adduced evidence to show that the tools used in the construction of the pyramids must have been made of a meteoric nickel-iron alloy. The theory is, however, open to considerable doubt, in view of the difficulty of working meteoric iron. Indeed, many authorities have denied that meteoric iron is malleable. The hypothesis is, nevertheless, an attractive one. Blocks of meteoric iron, though not very numerous, have been found in all parts of the world. The British Museum collection, which includes specimens of nearly all the meteoric irons known, numbers 229, one of which fell in Great Britain, at Rowton, Shropshire, on April 20, 1876. The most remarkable of the larger masses was found in West Greenland, whence it was transported in 1894 by Captain R. E. Peary to the American Museum of Natural History in New York. It is of very irregular shape, 11 feet long, 7½ feet wide, and 6 feet thick, and weighs nearly 50 tons. The knowledge that iron and stones from time to time fell from heaven is very old. The meteorite still revered by the Moslems as one of their holiest relics, of which the history goes back far beyond the seventh century, is the oldest preserved. A fall mentioned in old Chinese manuscripts happened about 644 B.C. The oldest undoubted meteorite still preserved was seen to fall on November 16, 1492, at Ensisheim, in Alsace, where it was long suspended by

*Advance copy.

†Through the courtesy of Mr. Bennett H. Brough, Assoc.

a chain in the parish church, and is now kept in the town hall. The ancient Greeks and Romans supposed the stars to be the home of the gods. Falling stones signified the descent of a god, or the sending of its image to earth. The envoys were received with divine honours. A meteorite which recently fell in India was decked with flowers, daily anointed with clarified butter, and subjected to ceremonial worship. From 400 B.C. to 300 A.D. coins were struck in honour of such divinities. As a rule the images were naturalistic in olden times, and became human-like afterwards. Among the meteorites in whose honour coins were struck were the Omphalos of Delphi, a black stone given to Uranos instead of the new-born Zeus, the stone of Astarte which fell as a star from heaven and was worshipped at Sidon, represented on a coin of the Emperor Elagabalus lying on a car, and the conical stone of Aphrodite Urania. The rarity of meteoric falls is opposed to the theory that meteoric iron was the material used by prehistoric man; and although some meteoric iron is malleable, and there are undoubted cases in which it has been successfully forged, the difficulty of obtaining tools suitable for cutting a meteorite makes it probable that this material was used only in exceptional cases, and that the first discovery of iron was due to the accidental melting of a rich iron oxide with charcoal.

The period of the first use of iron in Ancient Egypt has been warmly discussed. Some contend for its use in mythological times, while others would bring it as late as 600 B.C., and, disregarding all evidence of the discovery of iron remains, insist that stone, copper, and bronze tools were used exclusively up to that date, even in the building of the pyramids. These wonders of the world, the graves of Egyptian kings, were built 3000 years before Christ. Herodotus tells of the building of the Great Pyramid, stating that 100,000 men were employed for twenty years; and he expresses wonder at the amount that must have been spent on their board and clothing, and "on the iron with which they worked." The accuracy of the statements of Herodotus is borne out by the present condition of the Great Pyramid, which is built of granite blocks from the Upper Nile, lined with slabs of nummulitic limestone from Arabia. The magnificent temple at Thebes and the obelisks of a later period afford striking evidence of the technical skill, mathematical knowledge, and excellent tools possessed by the ancient Egyptians. The evidence of ancient Egyptian metallurgy and mining are not of less importance. Gold was, of course, the metal most prized. There is preserved in the museum at Turin a map, drawn 1400 years before the Christian era, showing the situation of some ancient gold mines—undoubtedly the oldest topographical plan in existence. Diodorus describes how these mines were worked by slaves, and gives a harrowing picture of the hardships they suffered in these ancient Egyptian penal settlements. That iron was known to the Egyptians, even in the earliest times, is evident from their conspicuous metallurgical knowledge, and from the facts that the working of granite and porphyry is scarcely conceivable without steel tools, that the oldest tombs have inscription referring to iron, and that sources of supply of manganiferous iron ore were found by Professor Bauerman in Upper Egypt. All possible doubt has been removed by remarkable archæological discoveries. An iron sickle, found by Belzoni under the feet of one of the sphinxes at Karnak, is deposited in the British Museum, and proves that the smith's art was practised at about 600 B.C. In 1837 a fragment of a wrought-iron tool was found in blasting operations in the Great Pyramid. This piece of iron, nearly 5000 years old, is also preserved in the British Museum. Analysis showed it to contain a small proportion of nickel: but as it also contained combined carbon, it was not of meteoric origin. In the British Museum there is also exhibited a lump of what is now iron rust, which was found wrapped up in a fabric with a mirror and tools of copper dating back to 3300 to 3100 B.C. Much stress is laid by supporters of the theory of the primitive use of meteoric iron on the interpretation of the Egyptian word for iron, "benipe," as "metal from the sky." In view of the fact that in Egyptian mural paintings blue is the conventional colour for iron, one cannot help suggesting that the word might be translated as "metal of sky-blue." Much of the metal used in Egypt was imported as finished material from Ethiopia, and later from Phœnician merchants. Indeed, it is probable that Ethiopia was the earliest centre of iron manufacture. The illustrations preserved of Egyptian iron manufacture show that the process was precisely the same as that still obtaining among Ethiopian races. On a stone, preserved at Florence, a negro slave is depicted working bellows from which the blast is conveyed by a bamboo pipe to a shallow pit in which the iron is smelted. In a second illustration is shown the forging of the iron by hammering it with a rounded stone on a stone anvil with wooden base. It is clearly proved by pictures on Egyptian tombs that bellows were in use in the fifteenth century B.C. This shows a distinct advance over the primitive method of smelting on a windy hillside; and it is curious to note that even at the present day furnaces with a natural air draught are used for lead-smelting in Bolivia. An idea of the relative value of iron in the fifteenth century B.C. is given by the story told by Herodotus (ii. chap., 135) of the beautiful Rhodopis, who, having amassed great wealth in Egypt, wished to leave a memorial of herself in Greece. She therefore determined to have something made, the like of which was not to be found in any temple, and to offer it at the shrine at Delphi. So she set apart a tenth of her possessions, and purchased with the money a quantity of iron spits, such as are fit for roasting an ox whole, which she presented to the oracle. Rhodopis lived in Egypt in the reign of Amasis (570 to 526 B.C.).

Turning to the eastern neighbours of the Egyptians, the Semitic peoples inhabiting the country between the Mediterranean and Persia, we find that iron was known to the Chaldeans from the earliest times. The action of rust has, however, prevented discoveries of much in the way of iron in the ruins of Babylon. Only iron rings and bracelets have been found. A cuneiform inscription in the British Museum is interpreted to mean "With an iron sword I slew another lion." In 1867 the discovery was made in the ruins of the palace of Khorsabad of a store of merchant iron perforated with holes to facilitate transport. It is evident that the kings of Assyria stored up in their treasure-houses masses of iron for building and war. The Assyrians were acquainted with steel, but, like all other ancient peoples, had no knowledge of cast iron.

In Syria the fame of the swords sold in the market at Damascus dates back to the earliest times. In the time of Abraham, Damascus was an important commercial centre. At a later date the Roman Emperor Diocletian had a sword factory there for his army; and even in the time of the Crusades the swords made of a combination of steel and wrought iron polished and lightly etched were prized throughout Europe. Iron was worked with skill; and long before Moses came to Canaan there was a high degree of civilisation in this promised land, that was inherited by the Children of

Israel and the Phœnicians. The latter traded throughout the world in the rich products of Palestine, and possessed greater skill in metallurgy than the Israelites, as is well shown in the Biblical account of the metal work of King Solomon's temple. Numerous Scriptural references show, however, that the Israelites had an intimate knowledge of the working of iron and steel. Iron was known in the days of Job (xxviii. 2). Moses mentions "Tubal-Cain, an instructor of every artificer in brass and iron" (Gen. iv. 22), and compares Egypt to "the iron furnace" (Deut. iv. 20). Og, king of Bashan, who lived about 1450 B.C., had a bedstead of iron (Deut. iii. 11). Joshua (ch. x., verse 20), it will be remembered, besieged Lachish, a city of the Amorites, which then became an important stronghold of the Israelites. It was finally deserted about 400 B.C. The mound has recently been explored by Petrie, who found in the remains of the Amorite city (probably, 1500 B.C.) large weapons of pure copper; above this dating 1250 to 800 B.C., appear bronze tools, which gradually become scarcer, until at the top of the mound there is little else than iron.

To our forefathers the Aryans in India iron was known at a very early date, and used for weapons and tools. Iron ore was abundant; and the lack of copper makes it probable that the iron age in India was not preceded by a bronze age. Indian iron and steel, even in very ancient times, were celebrated throughout the world; and the knowledge of metallurgy possessed must have been considerable. Evidence of this is afforded by the iron pillar at Delhi, which is 50 feet high and 16 inches in diameter, and appears to have been made of 50-lb. blooms welded together. It dates back to at least 912 years B.C. The primitive processes of iron and steel manufacture in India are described in detail by Dr. Percy; and in 1905 Dr. A. K. Coomaraswamy described the processes still surviving in Ceylon. The furnace is sheltered beneath the thatched roof of a shed open on all sides. The essential parts of the furnace are the well or furnace proper, a wall of sticks and mud to protect the bellows-blower from the heat of the fire, and the bellows behind the wall. The bellows consist of two hollowed logs of wood embedded in the ground, with a piece of deer-skin stretched over each, with a small hole near the centre to which a cord is attached. This is fastened above to a springy stick, the lower end of which is fixed in the ground. A small pipe conveys the blast into the furnace. The bellows-blower places a foot on each skin, and pressing his feet down in turn drives a continuous blast into the furnace; his foot acting as a valve, and the skin being pulled up by the tension of the cord. There is a bar for the blower to grip, and a strap to serve as a seat. The ore, limonite, is roasted previous to charging. The furnace is filled with layers of roasted ore and charcoal. When the bloom is ready it is taken out in long tongs made of green-wood sticks. Steel is sometimes made by a somewhat more delicate process. The wall and bellows are similar to those used for iron smelting, but the hearth is merely a semicircular depression filled with charcoal, into which the blast is conducted. Around this actual hearth is a low clay wall. The steel is made in clay tubes, each 8 inches long and 2 inches in diameter; the clay being 14 inches thick. Into it is placed a piece of iron and some chips of wood; the proportion being 12½ ozs. of iron to 5 ozs. of wood. The tube is then closed with a lid of clay, with small holes pierced for the escape of gas. The tubes are imbedded in the charcoal, and a fire started. Very soon the gases from the wood burn off; the blowing being stopped in the meantime. Then the blast is kept up continuously, while the tubes are turned about. When the steel is likely to be ready, a hole is opened in the front part of the hearth so that the blast goes right through the furnace, and the tubes are lifted up one by one in long iron tongs and shaken to ascertain if the steel is liquid. The tubes are then allowed to cool, and subsequently broken open and the bar of steel removed.

The Indian methods of iron and steel manufacture were brought to European knowledge in the Middle Ages by gipsies, who appear to have come originally from India. In Hungary at the present day they carry on iron smelting and forging.

Another classic land for metallurgy is Armenia, the land of the Chalybes, whence the kings of Assyria drew tribute of iron. The Chalybes were regarded by the Greeks as the inventors of steel, and the name of the people was applied to steel.

Recent researches on early Chinese history have brought to light references to the use of iron and steel dating back to 2357 B.C. MARCO POLO, the Venetian, in the thirteenth century refers to the use of coal in China; but he gives no particulars of Chinese iron manufacture.

Japan appears to have been colonised from China about 1240 B.C. Japanese copper has been famed from the earliest times, and iron ore has long been mined. The mining operations until the introduction of Western methods were of a primitive character; but considerable depths appear to have been reached. Swedenborg, writing in 1734 ("De Ferro," p. 194), states that the Japanese made their steel by forging iron into bars and burying these bars for eight or ten years in marshy ground; the unrusted portion then being steel. This process is described by several classic writers as being used elsewhere. It would be interesting to ascertain if there is any basis of truth in this description of the method of dealing with the mixture of wrought iron and steel produced by the imperfect smelting process used. The high quality of Japanese swords is far-famed; and the method of manufacture which enables them to be made still survives. The ore used was chiefly magnetic sand, which was obtained as far back as the year 1264. The ore was concentrated to about 60 per cent. of iron. The blast, which was worked by hand, was intermittent. The furnaces were rectangular, 10 feet long and from 4 to 6 feet high. The product is in part cast iron and in part a lump of malleable iron and steel. The antiquity of the Japanese iron industry has been proved by Professor Gowland, who has made a thorough study of Japanese metallurgy. In his investigations of Japanese dolmens, or stone burial chambers, dating from the second century B.C. to 700 A.D., he found iron swords, arrow-heads, spear-heads, and horse-furniture. In most countries the remains found in dolmens are of stone or bronze; but in Japan all belong to the iron age.

In Africa the metallurgical operations of the negro peoples who are regarded as the original inhabitants, present special interest. There was in Africa no bronze age, and the development of iron metallurgy was spontaneous. In Abyssinia the smith is looked upon with mingled dread and superstition. He is supposed to be able to communicate his magic power to others, and to turn himself into a hyena at will. The primitive African methods of iron and steel making in furnaces worked by natural draught have frequently been described. The most recent and most detailed account was that given by Mr. C. V. Bellamy in a paper read at the New York meeting of the Iron and Steel Institute in 1904, in which he described the process carried out in West Africa in the hinterland of the British colony of Lagos. The ore used is a siliceous hematite occurring in shale. It is roasted, and then pulverised in a wooden mortar. The pounded ore is then washed by women. A hole is dug in the ground about 2 feet deep and filled with water. In this a woman stands, and washes the ore in a tray about 18 inches in diameter. It is then subjected to a further and more careful washing by a second woman, seated on the ground near by. The ore is then conveyed to the furnace in a smelting shed, of which there are eleven in the village. Each shed is about 25 feet long and 16 feet wide, with a doorway at each end. The walls are built of clay, and are from 4 to 6 feet high. They are not carried up to the roof, but a space is left all round for light and ventilation. From the ground to the ridge of the roof the height is 25 feet. The furnace is in the centre of the shed. It is built of clay, and occupies a circular space 7 feet in diameter. Its height is 3 feet 9 inches. Opposite one of the doorways, a depression in the floor gives access to the furnace. The dome of the furnace is bound round by a rope of twisted vines. In the centre of the bottom of the furnace is an aperture 3 inches in diameter which communicates with a short tunnel below the floor of the shed, to which access is obtained by a pit inside the shed. The shed also contains a small kiln for firing the earthenware tuyeres, and an ore-bin; both being made of clay. The process of smelting occupies 36 hours; draught being supplied by nine pairs of earthenware pipes. These are only rudely shaped by hand around a stick, and but partly baked. The average diameter of each pipe is 1.4 inches. Selected slag from each successive smelting is used as flux. It is run off by opening the orifice in the bottom of the furnace. For removing the bloom, the clay seals over the six apertures are broken up, the earthenware pipes removed and thrown aside, and the doorway of the furnace opened. The contents of live charcoal are raked out, and the 70-lb. bloom removed in a red-hot state by a loop of green creeper. Subsequently it is broken up, with the aid of a stone, into convenient sizes, and sold to smiths. The metal produced in this way is a natural forged steel, which by reheating by the native smith is brought down to a tool steel with 1 per cent. of carbon. It is difficult to realize that in a part of the world which is within twenty days of the great European manufacturing centres, the smelting methods practised by the earliest ironworkers can still be seen in operation.

From western Asia and Egypt civilisation came to Greece. Cyprus and Crete were the oldest Phœnician settlements; and these islands were the starting-points of Greek metallurgy. Hephæstus (Vulcan) was, according to tradition, the first to work in iron; and he is often represented forging the bolts of Zeus. References to "iron wrought with much toil" are frequent in the poems of Homer (B.C. 880). Hardening steel by quenching is adopted as a simile in the description of the blinding of Polyphemus (Od. ix. 391). Iron is referred to as a treasure, and a bloom of iron is the valuable prize offered by Achilles at games (Ib. xxiii. 826). Evidently a considerable degree of skill in working iron had been attained. But the heroes used copper or bronze; metallurgy and mining being still in Phœnician hands. The silver mines at Laurium, in Attica, were even then being worked with slave labour by the Phœnicians. An iron knife and an iron dagger were found by Schliemann in his excavations on the site of Troy. The oldest mines worked by the Greeks were the iron mines of Eubœa (Chalcis). From the earliest times the Spartans wore iron rings, and used iron bars as currency—a practice that was not abandoned until B.C. 320. Little is known of the methods of iron smelting used by the Greeks, as the metallurgical treatises written by Aristotle (B.C. 384-322), and his pupil Theophrastus (B.C. 372-287), have not been preserved. Somewhat obscure passages in the latter author's book on stones indicate that the Greeks were acquainted with the coking of coal, with the use of coal, in iron smelting, and with the tinning of iron. Aristarchus, however, in the second century B.C., says definitely that iron cannot be melted or cast. Although written records are sparse, the numerous sculptures and painted vases that have been preserved throw some light on the metallurgical methods of the ancient Greeks.

Passing on to Italy and the Romans, we find that mining and metallurgy were early practised by the Etruscans. Copper and iron were mined in their own land, notably in Elba and in the Tuscan hills. Diodorus Siculus (a contemporary of Julius Cæsar) and Aristotle refer to the great antiquity of the Elba iron mines, which were originally started to work a copper vein. Among the Romans iron appears to have been used earlier than bronze. One of the oldest customs of the Romans was to wear iron rings on the right hand. Even the statues of the kings Numa Pompilius and Servius Tullius bear these rings. Pliny (A.D. 23-79) refers at length to the custom (xxxiii. 4, 5, 6). In the early days of Rome there was little scope for metallurgy; but with the Punic wars, culminating in the sack of Carthage, the foundation of the world's empire of Rome began. All the mines in Europe gradually fell into the hands of the Roman State, and were worked by slaves. The details of metallurgical practice supplied us by Latin authors are as sparse as those of the Greeks. Most information is supplied by Pliny's Natural History. Iron he describes as the best and at the same time the worst help to man, and, as the metal of foolhardiness, better suited than gold for war and murder. He gives interesting details of the manufacture of iron. He notes that the differences in iron are remarkable, and that on smelting the ore the iron becomes liquid like water ("mirumque cum excoquatur vena aquae modo liquari ferrum"). He describes the Bilbao iron-ore deposits, and refers to the medicinal value of iron. Next to the Elba iron, the Styrian (Noricum) iron is mentioned by him as the most celebrated at this epoch.

The wonderful mechanical skill of the Greeks and Romans is well shown in the works of Vitruvius (B.C. 46) and of Hero of Alexandria (B.C. 285-222). The water level of Vitruvius is a surveying instrument of great accuracy; and the automatic coin-in-the-slot machine and the toy steam turbine of Hero of Alexandria suggest how rapid might have been technical progress had not thirst for conquest on the one hand, and envy and revenge on the other, given rise to wars and massacres that caused the inventions and progress made to be swept away and ignored for five hundred years.

It is difficult to realise the mass of artistic treasures that were destroyed when the Asiatic barbarian Huns burst across the Volga in the year 374 A.D. Manufactories were also destroyed. The iron trade suffered; but iron weapons were needed, and the primitive furnaces in the forests remained untouched. There are no written records of these furnaces of prehistoric time; and all we have to guide us are the archæological discoveries which year by year add to our knowledge of the metallurgical practice of the ancient inhabitants of Europe.

Numerous iron objects of prehistoric date have been found in northern Europe, where iron was undoubtedly the first metal to be used. Iron weapons, too, have been found in the remains of pile dwellings in Switzerland. In that country the Bernese Jura abounds in remains of prehistoric iron smelting, which have been carefully investigated by Quiquerez, a scientifically trained mining official. The furnaces were in dense forests, in order to obtain an easy supply of wood. The workmen dwelt in caves, and charcoal was burned in piles. The furnaces were all similar, differing merely in size. On the natural ground, with no foundation, the hearth of fire-brick was laid. Lumps of the same material formed the walls, which were supported externally by undressed stones filled in with the earth. Two inches above the hearth a channel was left open, which had the entire width of the hearth, was arched over, and widened out at the exterior. It was made of fire-clay; the aperture consisting of several large stones which were covered with a stone slab. The shaft of the furnace was cylindrical, and inclined towards the top, so that charcoal and ore would pass down on one side, leaving the other free for the air-current. The shaft was 8 feet high, and the top was surrounded by a circle of stones. The furnaces were charged from above. The air entered at the base; no bellows being used. The opening at the base thus served as a tuyere, slag hole, and discharging hole for the blooms, which were from 30 to 50 lbs. in weight. At several of these prehistoric furnaces flint implements were found; showing that the Swiss iron industry dates back to the stone age, before bronze was introduced by foreign merchants.

In 1905 Mr. G. Arth and Mr. P. Lejeune made an investigation of a prehistoric mass of metal found near Nancy at a depth of 15 feet below the surface. The mass is 660 lbs. in weight, and was accompanied by fragments of charcoal and slag. It appears to have been the base of an ancient hearth in which the metal had been subjected to repeated and prolonged heating. The metal contains, in addition to iron, 1.21 per cent. of combined carbon, 0.04 per cent. of graphite, 1.67 per cent. of silicon, 0.026 per cent. of sulphur, 0.013 per cent. of phosphorus, and 0.18 per cent. of manganese. It is, therefore, a steel containing a higher percentage of silicon than that now usual. The slag contains 63.9 per cent. of silica. The microscopic examination showed that it belongs to Guillet's first group of silicon steels—pearlite steels consisting of a solid solution of iron silicide in iron. The low percentage of phosphorus indicates that the ore must have been obtained from the abandoned thick bed of ore, and not from the phosphoric "minette" now mined in the district.

The prehistoric cemetery at the salt-mining town of Hallstadt, in Upper Austria, has proved the most remarkable source of supply of bronze and iron implements. The number of graves opened was 993, and the number of objects found was 6084. Nowhere else has such a mixture of bronze and iron objects been found. Salt has been mined at Hallstadt since the earliest times; and modern mining operations have encountered the old workings of the prehistoric miners, and the objects found render it evident that salt mining was here carried on 900 B.C. The prehistoric mines reached depths of as much as 200 yards. Wedges of serpentine, tools of copper and bronze, numerous wooden articles, and remains of skin clothing, have been found, in good preservation. Specially noteworthy are two sacks for the transport of salt, preserved in the Vienna Museum. They are 30 inches long, and made of raw ox-hide. For carrying the sacks there is a leather strap that passed over one shoulder, and a wooden handle 15 inches long fastened by two straps to the upper part of the sack. With this handle the sack could be securely held when full; and on releasing the handle, the contents of the sack could be tipped backwards. A loop was provided for hanging up the sack. The finds at the Hallstadt cemetery have been classed by Montelius according to the swords discovered. The first period (850 to 600 B.C.) is characterised by bronze swords, and the second (600 to 400 B.C.) by iron swords. There are also transition bronze swords with iron blades.

The civilization of La Tène presents several important contrasts to that of the salt-mining community of the Austrian Tyrol. The site which has furnished a name for the second half of the early iron age (400 to 1 B.C.) has yielded an enormous number of antiquities. It lies in a small bay at the northern end of the lake of Neuchâtel; and the ancient settlement was built on piles. Among the relics from this station, exhibited in the British Museum, may be mentioned an iron brooch, an elaborated form of the modern safety-pin. The ring or collar which kept the end in position is characteristic of the locality. The La Tène swords also have characteristic scabbards; and some remarkable short swords, of this period, with bronze handles of the anthropoid type, are shown in the British Museum. They are named from the human head in the angle of the pommel. The handles are not of solid bronze, but have an iron core. In Spain iron swords of yataghan type are a peculiarity of the La Tène period. In East Yorkshire, Mr. J. R. Mortimer described, in 1905, the discovery of a sword of this period of a kind not previously found in Britain, and believes that it may date from 100 B.C.

Dr. Hjalmar Braune in 1905 published an analysis of a prehistoric iron object found at Castaneda, in Switzerland. It was the handle of a thin bronze water-jug; the iron having been protected by the bronze from rust. The iron remaining gave on analysis:—carbon, 0.14-0.18; silicon, 0.005-0.08; sulphur, 0.012; phosphorus, 0.057; nitrogen, 0.008. It contained no manganese, cobalt, nor nickel, and was evidently made from ore free from phosphorus, sulphur, and manganese—in all probability from Elba. This is borne out by the fact that bronze must have been made from a tin-bearing copper ore such as was produced at the Etruscan mines of Campiglia Marittima, on the mainland opposite Elba. An examination of a polished surface of the iron etched with dilute hydrochloric acid, shows that the metal consists chiefly of a very soft almost pure iron, with harder portions where carbon has been taken up. The oxidation has followed the lines of admixed slag. It is evident that the iron has never been in a molten condition.

In Britain development was slow. External influences did not change so rapidly as on the Continent; and consequently the Britons adhered longer to their flint weapons and implements, in the manufacture of which they attained remarkable skill. Indeed, the old flint mines at Brandon, in Somerset, are still worked for supplying gun-flints to savage tribes. In Ireland the use of stone implements was continued well into historic times. Nevertheless, Britain possessed in tin a metal that was sought after by all the world. The tin trade was monopolized by Phœnician merchants until 300 B.C. Then came the fall of Phœnicia, and the Phœnician colonies fell into the hands of the Greeks. When Cæsar invaded Britain in 54 B.C., he found the inhabitants, owing to Greek influence, not entirely uncivilized, and carrying on an active tin trade with Gaul. Iron manufacture was carried on; and Cæsar states that for currency copper or gold coins, or iron bars of given weight, were used ("*Utun-*

tur aut aere, aut nummo aureo, aut taleis ferreis ad certum pondus examinatis pro nummo"). This passage has suffered much at the hands of transcribers; and many authors, including Dr. Percy, have accepted the reading "annulis," and have accounted for the total disappearance of the iron-ring coinage by oxidation. A fresh ray of light has been thrown on the matter by Mr. Reginald A. Smith, of the British Museum, who, in a paper read before the Society of Antiquaries in 1905, described a remarkable series of iron bars that were undoubtedly the money described by Cæsar. They roughly resemble swords with a rude handle in a square end, averaging 2 feet 7½ inches in length, and have often been found secreted in a manner suggestive of hoards of coins. Several specimens are preserved in the British Museum. There are three series all of similar form. In the first the weight is approximately 4770 grains, in the second the weight is double (9540 grains), and in the third the weight is quadruple (19,080 grains). A convincing proof of Mr. Smith's contention is afforded by the fact that there is preserved in the Cardiff Museum a bronze weight of 4770 grains found in a hoard of Late Celtic bronzes at Neath. It is of a common Roman form, cheese-shaped with "I" cut on the top. A similar weight, but made of basalt (4767) grains, is in the museum at Mayence. As these British currency bars do not date earlier than 400 B.C., their use must have been due to Greek influence. We know that the Spartan money took the form of iron bars; and even at the present day in Central Africa iron bars, spearheads, and other forms with uncomfortable spikes, are used as currency.

Mr. Smith's theory appears to me to be borne out by the weights of 26 spindle-shaped iron blocks found in 1866 at Monzenheim, and now for the most part preserved in the Museum at Mayence. These blocks are on an average sixteen times as heavy as Mr. Smith's unit weight of 4770 grains, or 309.74 grammes. Eight of them, including the heaviest and the lightest, gave the following weights:—4,000, 4,050, 5,000, 5,000, 5,120, 5,470, and 5,700 grammes. Apparently they are blooms made in the forest forges, of a weight suitable for currency; there being no decimal system of weights in those days, when the advantages of continual bisection were fully appreciated. The form was convenient for the smith, as he held the bloom at one end and forged one half. The blooms would be convenient to transport, as the smith could carry them as miners often do their drills, with a strap on his back and breast, horizontally, leaving his arms free. The purchaser, too, could easily try the pointed end in his forge, to ascertain the quality of the iron. Analyses of two of the British currency bars (A and B), made by Professor W. Gowland, and of a Monzenheim bloom (C) by Dr. Ludwig Beck, gave the following results:—

	A	B	C
Carbon	trace	0.08	0.43
Silicon	0.09	0.02	0.36
Phosphorus	0.69	0.35	0.24
Manganese	nil	nil	0.48
Nickel	0.23	nil	——
Sulphur	——	——	0.25

Bar A when examined microscopically showed no slag patches, and may have been an exceptional case of the use of meteoric iron, although it contains less than 6 to 10 per cent. of nickel usual in such metal. Bar B appears to have been produced by the direct reduction of Forest of Dean ore. The bloom C is a soft iron containing a considerable proportion of impurities.

The shape of the currency bars, one cannot help thinking, must have been chosen so as to enable the owner, if necessary, to convert his money into a sword. The spindle-shaped blooms, however, were of a form that was frequently adopted in early times. Even the iron blocks in the treasure-houses at Nineveh had a similar form; but the Assyrian blooms were all perforated, for convenience of transport, with a strap. It will be remembered, too, that in Sweden, the "Järnbäraland," or "mother-land of iron," as it was called in the seventh century, the Osmund blooms obtained in the peasant furnaces were broken into from 24 to 29 pieces each weighing a pound; and these Osmund pieces served as currency even in foreign countries from the beginning of the thirteenth century, and continued to do so until their export was forbidden by Gustavus Wasa. The copper-plate money to be seen at the museum at Falun, in Sweden, is a further example of the use of heavy masses of metal as currency. The largest, a 10-dollar plate, dated 1644, weighed no less than 43½ lbs.

The Roman influence in Britain was considerable and lasting, but the subjection was not complete until the year 84. When the Emperor Hadrian came to Britain, in 120, he founded an arms factory at Bath, using iron from the Forest of Dean; and the mines there were worked until the year 409. Indeed, the enormous heaps of slag left by the Romans furnished the chief supply to twenty furnaces for nearly 300 years. Similar slag-heaps have been found in Sussex and elsewhere. From explorations made within the Roman fortifications at Wilderspool, near Warrington, Mr. Thomas May has been able to deduce the form of furnace used; and he published in 1905 an interesting account of his remarkable discoveries. Association with Roman pottery, and with a hundred coins dating from 27 B.C. to 337 A.D., shows that furnaces found are of the latest period of the Roman Occupation, A.D. 410. The furnaces consisted essentially of a cavity with a wall and covering of clay, with holes in the base for admitting the draught and for withdrawing the metal. They were usually placed on sloping ground. The remains are of special interest, inasmuch as they show that coal was used with charcoal for smelting—fragments of cannel coal having been found, and that some of the iron was obtained in a molten state. Indeed, Mr. May considers that there is evidence in support of the view that an indirect method of producing cast iron in one furnace, and of converting it into malleable iron in another, was practised by the Romans at Warrington. Interesting as Mr. May's discoveries are, his interpretation of them is not convincing. There is no proof that either bellows or clay moulds for casting were used. The plant appears to have consisted of a roasting kiln, a smelting furnace, and a smith's forge. The fact that some coal was used may explain why some of the metal, like the minute specimen found, collected in a fluid state on the furnace bottom. The metal, as in the direct process carried out at Lagos, was essentially a natural steel, which by reheating was brought down to a malleable iron with a very low percentage of carbon. The process was somewhat similar to that described by Agricola, who makes no mention of cast iron. The passage translated by Mr. May, "From such ore, sometimes once, sometimes twice roasted, iron is *melted* suitable for being reheated in the smithy furnace," should read, "From such ore, once or twice roasted, iron is made, which is again made hot in the smith's forge and is flattened out under the hammer, which is lifted by a water-wheel and cut in pieces with the sharp iron." The analysis of the supposed cast iron, given by Mr.

May, is so remarkable that it is to be regretted that no microscopical examination of the metal was undertaken. It might even be found that the 1½-inch cube of metal described as cast iron was a furnace accretion composed of metal with unconsumed particles of charcoal, appearing in the analysis as graphitic carbon. Owing to roasting, the analysis of ancient irons presents great difficulties; and these are notably the case with cast iron. A cast-iron cannon ball, for example, recently discovered, in making the Paris underground railway, under the site of the old Bastille, whilst retaining its original shape, was found to consist chiefly of iron oxide. Its specific gravity was 4.854, instead of 7.6; and under the microscope it was found that the pearlite, which, in admixture with cementite, usually constitutes ordinary white pig-iron was oxidised throughout, whilst the cementite had preserved its metallic state. An analysis of the cannon ball by Mr. A. Portlier gave 5.9 per cent. of carbon, 0.25 per cent. of silicon, 0.75 per cent. of manganese, 2.9 per cent. of moisture, 72.0 per cent. of iron, and 17.45 per cent. of oxygen. The high percentage of carbon shows that some of the iron had been expelled; the original carbon percentage in the pig having probably been below 4. It is interesting to compare these results with the analysis given by Mr. May of supposed Roman cast iron, that had been subjected to oxidising influences for one thousand five hundred years. His figures are as follows:—Iron, 94.08; combined carbon, 0.23; graphite, 3.0; silicon, 1.05; sulphur, 0.48; phosphorus, 0.75; and manganese, 0.40 per cent.

In the early Middle Ages, although little progress was made in iron smelting, great advances were made in the manipulation of iron and steel. The sword was the triumph of the smith's art; but the manufacture of defensive armour called for skill of no mean order. The value of iron was, however, fully recognised. Writing in 1260, Bartholomew the English Franciscan, says: "Use of iron is more needful to men in many things than use of gold; though covetous men love more gold than iron. Without iron the commonalty be not sure against enemies, without dread of iron the common right is not governed; with iron innocent men are defended; and foolhardiness of wicked men is chastised with dread of iron. And well nigh no handiwork is wrought without iron; no field is cared without iron, neither tilling craft used, nor building builded without iron."

The invention of gunpowder, somewhere about 1310 to 1320, had a remarkable influence on iron manufacture; and it is interesting, in tracing the history of ordnance, to see the advances in the iron industry occasioned by the increasing demands of the artillerist. Although the first cannon of Berthold Schwarz were cast in bronze, it was not long before far more durable cannon were forged of iron bars hooped together; and the huge cannon such as Mons Meg (1455) at Edinburgh and La Dulle Griète at Ghent are remarkable examples of the skill in forging attained. The furnaces in which wrought iron was made at this epoch —the Catalan hearth, the Corsican furnace, the Osmund furnace, and the German Stückofen—are fully described in the historical treatises of Beck (5 vols., Brunswick, 1884-1903) and of Swank (Philadelphia, 1892), as well as in the standard metallurgical treatises of Percy, Bauerman, and others. From these furnaces, in which the metal was obtained in the malleable state in one operation, to the blast furnace, the transition was gradual. The basis of modern metallurgy was afforded by the discovery of cast iron, and by the employment of water-wheels, in the year 1323, for working the blast. The works were then removed from the forests to the river-valleys. Iron cannon balls were cast by Ulrich Beham in Memmingen in 1388, but cast-iron cannon are not mentioned before the fifteenth century. In 1412 two cannon, each 45 lbs. in weight, were cast for the town of Lille, and in 1422 cast-iron cannon were in use in the Hussite wars. The explanation of the late use of iron for castings is undoubtedly to be found in the unsuitability of the white pig-iron originally made. It was not until the height of the furnaces was increased that silicon could be reduced and grey pig obtained.

All the metallurgical operations of the ancients were entirely empirical. Nothing was known of the assaying ores. Colour and weight were the only indications of the quality of an iron ore. The idea of the transmutation of metals, which formed the aim of the chemical operations of the middle ages, did not go back to classic times. Geber, in the eighth century, was the first to recognise a metal as a fusible and malleable substance. He taught that all metals consist of sulphur and quicksilver in varying proportions. Alchemy did nothing to advance the iron industry; but there were besides the alchemists other philosophers who cared nothing for these things. Pre-eminent among these were Theophilus, the priest and monk, and Leonardo da Vinci, the artist. The former was a German who lived in the second half of the eleventh century. He was not only an author, but also a skilled worker in metals; and his book contains, besides the usual superstitions of the age, many practical observations, and gives a good idea of the workshop practice of a mediæval metallurgist. Leonardo da Vinci, who lived 300 years later, was not only a great painter and sculptor, but also an engineer and philosopher, with an astonishing knowledge of physics and mechanics. He developed the idea of the artesian well, and constructed deep boring plant, pumps, water-wheels, hydraulic presses, canals, and locks. He made a steam cannon, and had a dim idea of many other late inventions. His metallurgical knowledge was considerable. Among the many drawings left by him, one of a file-cutting machine is specially remarkable.

Georgius Agricola, who wrote the first systematic treatise on mining, living in Saxony, where no iron was worked, says but little about iron smelting. His illustrations show the increased height of the furnace; but he makes no reference to melting or casting iron. The subject of iron founding is, however, noticed by Lazarus Ercker in his work on assaying, published in 1574.

With the discovery of cast iron and the introduction of the blast furnace, the first stage in the history of iron closes with the end of the fifteenth century. Epoch-making inventions and discoveries soon followed. The introduction of coal as fuel for smelting by Dud Dudley in 1618, the replacement of coal by coke, the building by James Watt of the first blowing engine at the Carron ironworks in 1760, of puddling by Henry Cort in 1784, of the hot blast by Neilson in 1828, of the Bessemer process in 1856, of open-hearth steel making in 1861, and of basic steel making in 1879, are a few of the great improvements that have led to the marvellous development of the iron trade in this and other countries, and have rendered it possible for the world to produce, as it is now doing, 45 million tons of pig-iron annually.

THE WINDY ARM DISTRICT.

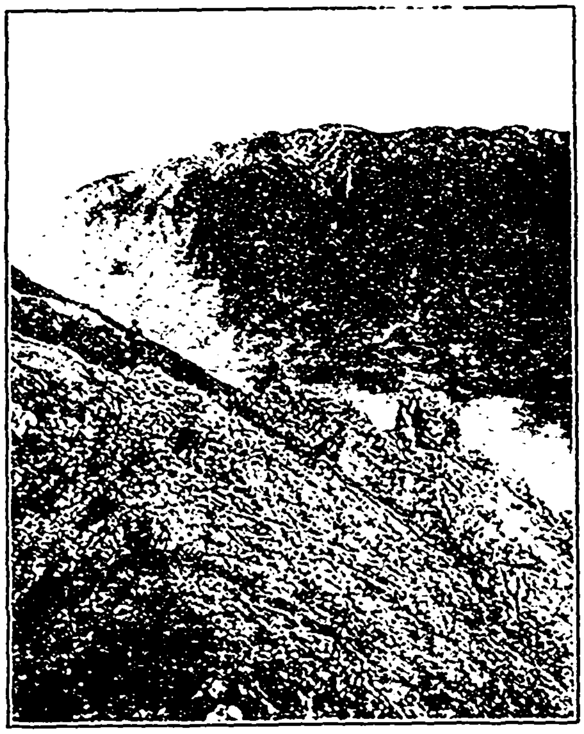
By J. J. Bell, Toronto.

The Windy Arm Mining District, in the Yukon territory, adjoining British Columbia, reports on which have appeared in the Mining Review from time to time, has a width of 3½ miles and a known length of 7 miles, in porphyry formation. It extends S. E. and N. W. but it is not known how far. It is, says Col. J. H. Conrad, unlike any other Mining Camp he

Camp at Montana Mine on Monarch Mt., Windy Arm, Y.T. Sept. 1st., 1905.

has ever been in. One can walk over the veins for miles. The ore instead of being in chutes is continuous. From 80 to 90 per cent of the values in most of the veins is silver, the balance principally gold. There are two veins where gold predominates.

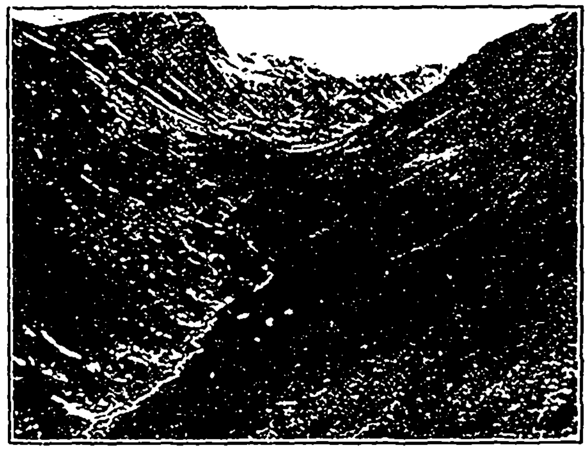
At the Montana claim a drift has been run on the strike 250 feet, with a stope about 50 feet above the level It passes through one fault but has been



Above Pooley's Canyon on Windy Arm Sept. 1st., 1905.

found on the other side. The Mt. Hero, the next claim, has been opened up. The vein averages 36 inches.

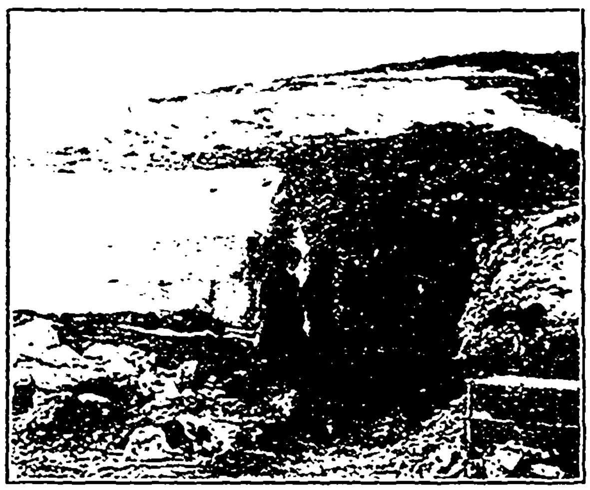
About 100 claims were located in the summer of 1905 by prospectors, and sold for the most part to mining men with money on the ground. One prospector sold a four-fifths interest for $105,000, which was considered a small price. During the winter development work was going on and it is expected there will be a large influx this summer. One thousand men will be at work on the Conrad properties. Operations can be carried on all the year.



Pooley's Canyon showing location of Uranus Mine of the Conrad Group. Sept 1st., 1905.

The White Pass Railway has surveyed the route for a branch from Cariboo Crossing to Conrad City, ten miles. It will be easy of construction, following the shore of the Arm all the way. It is to be built this summer.

The Montana Mine, which is 3,500 feet above the Arm and 5,800 feet above the sea, is connected with Conrad City by a winding trail 6 miles long and by an aerial tram 4¾ miles long. A stone house, 120 feet long, at the mine, furnishes accommodation for the workmen and stores.



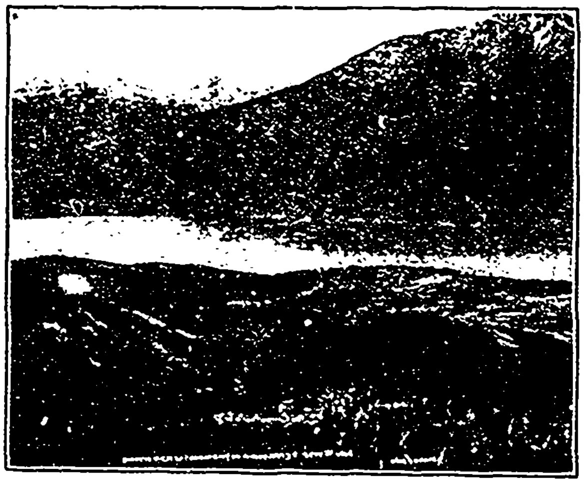
The Montana Mine of the Conrad Group of Mines on Windy Arm.

A smelter will be built this season, probably at Conrad City. It will treat all the ores of the district, including the copper ores of White Horse and will have a capacity of 4,000 or 5,000 tons a day.

Construction of Aerial Tramway to the Montana Mine from Conrad City, Y.T. Sept. 1st., 1905.

Mr. W. Feet Robertson, provincial metallurgist of British Columbia, who is conservative in his opinions, says the Montana vein is the best he has seen since taking office seven years ago.

The accompanying views of the Windy Arm district will be of interest.



Bird eye View of Conrad City on Windy Arm, Y.T. Sept. 1st., 1905.

CORUNDUM IN QUEBEC.

The large bodies of corundum known to exist in the province of Ontario, have a prospective importance of much significance to the northern part of Quebec. Corundum in Ontario occurs in the nepheline syenite rocks of the Laurentian formation. It has been found in a belt of these rocks running through eastern Ontario for a distance of some seventy miles to the boundary line between the provinces of Ontario and Quebec, where the work of the government geologists ended. Mr. W. G. Miller, who examined the district with great detail for the Ontario Bureau of Mines, was necessarily limited in the field of his work to that province, and Dr. Adams and Dr. Barlow, who made an elaborate investigation of the geological resources of the Hastings district for the Geological Survey, were confined to their particular map-sheets. The search for corundum, therefore, ended at the inter-provincial line, not because the deposits of that mineral, nor the peculiar rocks which contain them, were supposed to have all been found, but because the authority of the geologists making the examinations allowed them to go no farther.

On the other hand, the geological indications that the corundum belt extends into Quebec could hardly be stronger than they are without reaching actual proof. The great Laurentian formation, which forms the larger portion of the northern part of both provinces, is continuous from the county of Renfrew, in the corundum belt of Ontario, through the adjacent county of Pontiac, in Quebec.

Furthermore, Mr. Miller, in an article in the American Geologist, (Minneapolis, January 1901) announced that he had observed nepheline syenite, the characteristic corundum-bearing rock, at several places on the Quebec side of the boundary line, from Hull to Kippewa. There is, therefore, apparently, every reason to conclude that when corundum has been as carefully sought for in Quebec as in Ontario, the results may be equally successful.

It may also be noted in this connection that Dr. F. D. Adams has indicated in a recent paper in the Jour. of Geology the probability of finding a large area of nepheline syenite somewhere on the north side of Lake Superior.

RAILWAYS AND MINING.

In a thoughtful and interesting speech before the Mining Institute, at the recent annual banquet in Quebec, Dr. James Douglas strongly emphasized the importance of the railway development of the country by railways, and especially of their necessity to the mining industry. (In effect, Dr. Douglas said, that the railway must precede the substantial establishment of a mining industry.) This he illustrated by detailed accounts from his own experience in Southwestern United States. In this connection it is interesting to note how several Canadian Mining districts have opened up as a direct result of the incoming of the railway. The development of the nickel deposits of Sudbury resulted from the building of the Canadian Pacific Railway; the Coal mines of the Crow's Nest Pass, from the incoming of that branch of the same road; the discovery of the remarkable deposits of silver, nickel and cobalt, at Cobalt, from the construction of the Temiskaming and Northern Railway, as has been commented on by Prof. Miller in a recent report; also the asbestos deposits of Thetford, in like manner, owe much of their development to the Quebec Central Railroad. Many other cases of similar import might also be mentioned. These, however, are sufficient to suggest, if suggestion is necessary, the great possibilities to be connected with the construction of the new Transcontinental Railway through Northern Ontario, Quebec and New Brunswick, and of the Grand Trunk Pacific through Northern British Columbia. This line, most of it through a new country, together with the many smaller lines, which will doubtless soon appear as feeders to it, must undoubtedly open a new era of development for the provinces whose natural resources are chiefly in their mineral wealth, as well as for the wheat fields of the prairie. Incidentally, too, it is for the Government to make known the possible resources of these districts through which the railway passes, as accurately and as promptly as possible.

MINING NOTES.

ONTARIO.

The cancellation of mining leases in Ontario goes on apace, one hundred being cancelled weekly during the month of April. These leases were situated in the districts of Rainy River North, Rainy River South, Thunder Bay, Algoma, and Parry Sound.

The Breton Coal Co. has ordered a 120 h.p. Robb-Mumford boiler for their new mine at Port Malcolm, C.B.

A by-law has been passed by The Mineral Range Iron Mining Co., Limited, changing its head office from the city of Windsor to the village of Bessemer, in the County of Hastings.

The Canadian Northern Railway is completing its arrangements for a branch line into the Atikokan iron range. The mine is now equipped with buildings and machinery, and operations have commenced, so that ore will be ready to be shipped so soon as the C. N. R. is in a position to carry it.

A blast furnace, capable of producing 200 tons of pig iron per day will, it is expected, be built shortly on the Niagara Peninsula. The gentlemen connected with this venture are said to be also interested in the Canada Foundry and Canadian General Electric Companies. It is said that the capital of the company will be $1,000,000.00.

The Canadian Goldfields Syndicate, Limited, has declared a dividend of 1¾ per cent. on its $600,000 of issued capital stock. The dividend is for the quarter ending March 31, and is payable May 1. The dividend amounts to $10,500, and the total of its dividends to date is $93,000. The Canadian Goldfields Syndicate is the owner of 4,260 shares of the Consolidated Mining and Smelting Company of Canada, Limited, which at the present valuation of the shares is equal to about $600,000.

The Dominion Gold Mining & Reduction Company's works, at Kenora, were recently destroyed by fire. The works comprise a 20 stamp mill, cyanide and chlorination buildings, valued at between $20,000.00 and $30,000.00. No insurance was carried. The works were built by Messrs. Powers and Linn, who subsequently sold them to the Dominion Gold Mining and Reduction Works Company, in which many local men were interested.

According to the Portland, Oregon, *Telegram*, Dr. David T. Day, chief of the division of Mining and Mineral Resources of the United States Geological Survey, has found platinum to exist in paying quantities in sands brought from the Hootalinqua, Y. T. Should these reports be verified, it may well be that the platinum in these sands will be well worth mining for on a large scale. The present price of platinum is very high, and the demand exceeds the supply.

Principal Galbraith, of the School of Practical Science, Toronto, gave a very interesting address recently before the Canadian Institute, on "The Microscopic Structure of Iron and Steel," illustrating his remarks by the aid of lantern slides. He touched upon the testing of iron and steel, describing briefly both the chemical and physical methods. The speaker gave credit for the first micorscopical examinations to Dr. Sorby, of Berlin, whose initial experiments were carried out in 1864. Notwithstanding the Doctor's undoubted success, his first paper on the result of his examinations received but scant attention; later the soundness of his deductions was verified, and the system he advocated is now in use everywhere.

Professor Galbraith's address was well received, and was pronounced by all those present to have been one of the most interesting ever delivered before the members of the Canadian Institute.

NOVA SCOTIA.

The Warren Creek Copper Company at Spillimachene has recently changed hands. Development work will probably be started at once.

An occurrence of molybdenite in important quantities is reported from the Upper Gatineau region. The location is in the Township of Egan, about 80 miles from the Ottawa River, and the indications for the mineral are said to be promising.

Mr. John Macintosh, of Ottawa, is reported to have recently bonded the well-known Union Asbestos Mines of Black Lake. These mines, commonly known as the Wertheim property, have been controlled by German capitalists for several years. The milling plant has a capacity of 100 tons per day, and the property has been vigourously worked for several years past, under the efficient management of Mr. T. H. Crabtree.

The first mining claim to be staked out on Hudson Bay has just been registered with the Dominion Government by Mr. William Beech, of Winnipeg. Mr. Beech has discovered, in the vicinity of Fort Churchill, deposits of mica, iron ore and graphite, which are the cause of his making the location. Gold and copper are also reported from the same region, and Mr. Beech intends to do further prospecting in the Hudson Bay region during the early summer.

Considerable improvements are being made at the Reserve mine, Cape Breton, which look toward an increased output at that mine. In the boiler house two Babcock-Wilcox boilers have been installed. Each boiler has a capacity of 250 h.p., which, together, will make up a total capacity of 1,800 h.p., an increase of about 40%. The compressor plant has also been enlarged, so as to give a capacity of 10,000 cubic feet of air per minute. A hoisting engine of 100 h.p. has been installed on the Emery seam.

The following are the figures of the German consumption of foreign copper for the months of January and February, 1905 and 1906, as given by L. Vogelstein & Co., 90-96 Wall Street, New York, agents for Aron Hirsch & Sohn, Halberstadt, Germany:—

	1906	1905
Imports	22,770 tons	15,884 tons
Exports	2,509 "	1,937 "
Consumption	20,261 "	13,947 "

Out of the above 16,968 tons were shipped from the United States.

The Crow's Nest Pass Coal Company has paid its second dividend for 1906, the first having become paid on January 1. The dividends, which are looked for quarterly, have thus far amounted to $87,500.00. The output of coal (for the month of March) from the Company's mines was 81,273 tons. The highest previous record was made in January of this year when the output reached 73,303 tons. The March output was divided amongst the three principal collieries as follows:—

Coal Creek	43,701 tons.
Michel	29,667 "
Carbonado	7,904 "
	81,273 tons.

The coke production for the month was 25,451 tons, which is considered a very satisfactory record.

BRITISH COLUMBIA.

A. H. A. Robinson has been appointed inspector of mines for the Temiskaming district.

It is announced that in consequence of the advance in the price of arsenic the Deloro mine, in the County of Hastings, once a large producer, is to be operated again.

A large deposit of foundry sand has been found on the farm of H. J. E. Wilcox, near Niagara Falls. Much of the silicious sand used hitherto has been imported.

Work has been commenced on mining location J.E.S. 22, Lake of the Woods, and ore yielding $8 to the ton is being taken out. The owners claim to have the Sultana vein.

Considerable activity is being shown at the Canada Corundum Co.'s works at Craigmont. The output is about 300 tons a month.

In the April number of the REVIEW a reference was made to the deposit of sodalite near Bancroft. A car load recently sent to Great Britain is said to have netted $30,000.

The Government of Ontario has announced its intention to appoint a Provincial Assayer, who will be an official of the Bureau of Mines.

Hon. F. Cochrane, Minister of Lands and Mines, has given his decision in the dispute over the ownership of the Velvet mine, in favour of J. O. Handy, of Pittsburg, who has been in possession and working it for some time.

Active operations were commenced April 1 at Windy Arm, B.C., by the syndicate of which Mackenzie & Mann are prominent members. Supplies have gone in, and about $20,000 a month is being spent in development.

The Consolidated Mining and Smelting Company of Canada, Limited, operating under a Dominion charter, has been licensed to do business in Ontario. W. D. Matthews, president of the company, is its authorized attorney.

A gold mine on the farm of John Rhodes, in Elzevir Township, County of Hastings, is being operated by a Buffalo syndicate. A shaft has been sunk 70 feet, and a 20 ft. vein opened up, which is said to assay $130 to the ton.

The new board afterwards held a meeting and elected the following officers: W. E. Gosnell, president; S. M. Brydges, vice-president; F. W. Swannell, secretary; F. E. Morrison, treasurer.

The North Star mine recently made a shipment of 448 tons in one week, thus bringing the production for the year up to 1,500 tons, in round numbers. The Aurora has also entered the shipping list. The total shipments of silver-lead ores for Southeast Kootenay seem to be steadily on the increase.

The Act to reorganize the Department of Lands and Mines for Ontario is now in force. The Department presided over by Hon. Frank Cochrane will henceforth be known as the Department of Lands, Forests and Mines. It will have two deputy heads; Aubrey White having supervision of lands and forests, and T. W. Gibson, late director of Mines, of the Mining Branch.

The B. A. Pyrite mine, at Queensboro, Ont., which was shut down for a month while a compressor was being installed, is again working, and shipments of two or three cars a day are being made. The compressor has a capacity of four drills with provision for four more. Hoisting and other machinery have also been added.

Nelson.—It is reported on the authority of Mr. Turner, of Spokane, that the Sullivan mine at Marysville, East Kootenay, made a profit of $17,000.00 last month. The shipments from the Sullivan for the week ending April 14th, were 500 tons, and for the year thus far 6,920 tons. The Sullivan is the largest producer in the district, next to the St. Eugene.

Lardeau.—Some important development work was done during last season on the Grand Solo group, which consists chiefly of two claims near the head of Canyon Creek. Development consists of a drift of 125 feet along a four foot ledge, which has a pay streak of 22 inches of quartz and grey copper. One streak of four inches is said to carry 1,500 oz. of silver and 12% of copper.

The Bruce Copper Mines, which recently passed into the hands of the Copper Mining and Smelting Co. of Ontario, composed principally of English capitalists, are about ready to start work, after a four year close down. It is understood that a smelter is to be built. The Ontario Legislature will be asked to pass an act to validate a by-law of the municipality, fixing the assessment of the property for a period of ten years.

The fifth annual meeting of the Similkameen Valley Coal Company was held recently at Nelson. The reorganization of the Company was proceeded with. The former board of directors was retired by resolution and the following gentlemen were duly elected to the positions thus made vacant: W. E. Gosnell, S. M. Brydges, F. E. Morrison, G. Tierney, H. G. Goodeye, I. G. Nelson and F. W. Swannell.

Kootenay.—The Canadian Metal Company has bonded the Giant mine at Spillimachene. This is a low grade zinc and silver-lead property, having a large amount of ore developed. The ore body is about 200 feet in width, and is exposed for about 400 feet. The ore will be mined by quarrying, a concentrator built, and the concentrates shipped to the company's smelters at Frank and Pilot Bay. The property is valued at $100,000.

Advices from Northport state that the Le Roi smelter will resume operations on May 1st. A considerable amount of custom ore is said to have been promised the smelter from mines in the vicinity. As much of the ore which goes to Northport has to be roasted, the time required for this operation (as well as for the accumulation of a reasonable reserve before beginning work) will probably cause some time to elapse before the furnaces are actually blown in.

The Canada Gold and Hydraulic Dredging Co., in which a number of Toronto people are interested, obtained recently a British Columbia charter, and the right to operate on the Fraser River, where they have secured three claims opposite Cayoosh Creek. These claims extend 1,500 yards on the face and run back 700 yards and go two feet below low water mark. The Iowa Company is operating the adjoining property and paying handsome dividends.

At a meeting of the Engineers Club of Toronto, a paper on the Electrical Production of Iron and Steel, by J. W. Evans, of Deseronto, was, in the absence of the author, read by Prof. G. R. Mickle. At its close the conclusions arrived at were severely criticised by Mr. Samuel Groves, editor of the *Canadian Engineer*, who declared them to be wholly fallacious. A lively discussion ensued. Mr. Evans does not think that on the ground of economy the electric furnace can as yet compete with the blast furnace.

The Moose Mountain iron deposit, to which the James Bay Railway is being extended, is said to be one of the largest and best known. It was not intended to build the railway north of Sudbury at present, but a personal inspection by D. D. Mann led to an agreement with the Moose Mountain Mining Co. to extend the road to a point 25 miles north, with a spur to the mine. A short line will also be built from the vicinity of the crossing over French River to some point on the Georgian Bay, probably The Key, where there is a good harbour.

The Ontario Government has determined to appoint a Mining Commissioner, who will be free from political influence, and relieve the Minister of Lands, Forests and Mines of work which now takes up much of his time. The Commissioner will hear appeals from the findings of inspectors and mining recorders, disputed claims, etc., visiting the localities involved when necessary, and obtaining information by personal inquiry and observation. His work will be largely judicial. Appeals from his rulings to the Divisional Court at Toronto will be possible.

The Thorold Natural Gas Co., incorporated some time since, has been prevented from carrying on operations by the action of the St. Catharines Natural Gas Co., which obtained an injunction to prevent an agreement entered into with the Niagara Peninsula Co. from being carried out. The Thorold Co. had agreed to take over the pipe line to, and the services in Thorold, and to supply that town with gas, but in consequence of the injunction has, beyond becoming incorporated, done no business. In the meantime, though the pipes are laid, Thorold is without natural gas. The matter may come before the courts.

Boundary.—The monthly statement of the Granby Consolidated, for March, shows some interesting figures in its cost sheets. Its mining costs were 3.76 cents a pound; freight 1.18 cents; smelting 6.64 cents; general expenses ·72 cents:—total 12.2 cents; foreign ore cost 1.08 cents, making a total cost 13.28 cents a pound. Deducting gold and silver values of $6.94 the net cost of the smelter in British Columbia was $6.34. The cost landed in New York was 8.34 cents, and the profit for the month 9.71 cents per pound on the copper output. The present monthly output may be stated at 1,750,000 lbs. of copper 30,000 oz. of silver, and 5,300 oz. of gold.

While excavating for the compressor a new vein, six feet wide, of rich ore was struck. This will be followed up. Inquiries have been received from a number of places, including Glasgow, Scotland, for the ore. The company has shipped 750 tons to Buffalo, and more is demanded. The company expects to be shipping ten car loads a day within a year. A survey has been made for a spur line of the Bay of Quinte Railway to the mine. It is in contemplation. The installment of an electric plant is one of the probabilities of the future, as water power about three miles distant being available. The company expects to open up other pyrites mines in the Hastings district as the demand for their product is growing.

Mr. E. T. Corkill, inspector of the Bureau of Mines for Ontario, is responsible for the following:—In the Lake of the Woods district four mines are working—the Sultana, Bully Boy, Combine, and Olympia. The Sultana's is the only stamp mill running. At Gold Rock, Upper Lake Manitou, extensive works are being put in at the Laurentian mine. The stamp mill is about ready to go into operation. The reports which have found their way into the newspapers about seams of gold three inches thick at this mine are, of course, very much exaggerated. The Paymaster, Little Master and two or three others are getting in machinery. On Eagle Lake the Eldorado is working on development, and has a two stamp mill.

A suit of some interest, in which the Mines Contract Co. is plaintiff and the Great North West Mining Co. is defendant, is before the courts. The plaintiffs sold to the defendants a number of claims, taking part in cash and part in paid-up stock, and undertook to act as agents for the defendants. Certain moneys were also advanced. In consequence of disagreements among the defendants these sums have not been repaid, and action was brought to obtain a settlement. Among the properties handed over was the Indian Joe mine, four miles north of the Mikado, on the Lake of the Woods, where defendants have about 2,000 tons of ore on the dump, and a full equipment of machinery, and were arranging to put in a forty-stamp mill when the difficulties arose. The matters in dispute have been allowed to stand till the annual meeting of defendants company, when it is hoped an arrangement will be arrived at.

According to the Fernie *Free Press* of April 27th, the payroll of the Crow's Nest Pass Coal Company for March was as follows:—

Coal Creek mines	$67,472.70
Fernie ovens	6,709.00
Michel	52,422.95
Carbonado	12,549.20
M., F. & M. Ry	2,210.70
Wardrop	1,341.40
Total	$142,705.95

This pay roll is considerably in the lead of the previous record. The highest sum reached in 1905 was in July, when the pay-roll was $134,278.40.

TRAIL.—The lead returns of the Trail smelter for March show an increase in the total shipments, but a reduction in the number of shippers. The returns are as follows:—

Mine.	Ore, Lbs.	Lead, Lbs
American Boy	37,988	15,369
Lone Bachelor	73,542	33,818
North Star	772,610	297,970
Rambler	41,209	1,854
St. Eugene	3,341,250	1,936,672
Total	4,266,799	2,285,683

ROSSLAND.—Shipments from the Rossland camp for the week ending April 7th, were as follows:—

Centre Star	3,000 tons.
Le Roi	2,400 tons.
Le Roi No. 2	530 tons.
Le Roi (milled)	1,200 tons.
Total for the week	7,140 tons.

and for the year, 84,065 tons.

BOOK REVIEWS.

We are in receipt of a copy of the 6th edition of "A Treatise on Ore and Stone Mining," by Foster, revised and enlarged by Bennett H. Brough. When the fifth edition of this standard work was published in the spring of 1904, Sir Clement Le Neve Foster stated that he had made good a few defects, but that he hoped to re-write the work before another edition should be required. This hope was destined not to be fulfilled, as the author passed away very shortly after he had penned these words. The new edition was brought out under the editorial supervision of Mr. Bennett H. Brough, and he is to be congratulated upon the very excellent and careful work he has put into it.

The book is so well known to mining men that nothing would be gained by a detailed review of its contents, suffice it to say, that the additions and illustrations describing recent changes and improvements in the mining industry have been considerable, and such, as it is believed, the author himself would have made had he survived to carry out the work. An especial attempt has been made to include comprehensive information that would be useful to mining engineers in distant regions, where reference libraries are not accessible. The main divisions of the work are; the occurrence of minerals, boring, breaking ground, supporting excavations, exploitation, haulage, hoisting, drainage, ventilation, lighting, access, dressing, legislation, condition of the miner, accidents and the principles of employment of mining labour—from which it will be seen that the scheme of the work is ambitious. It should be on the shelves of every mining engineer. This book is published by Messrs. Charles Griffin & Co., London, the price being thirty-four shillings sterling.

COMPANY MEETINGS AND REPORTS.

At the April meeting of the directors of the Granby Consolidated, held at the company's office New York City, a three per cent. dividend was declared on the outstanding shares of the company, which amount to 1,350,000 shares. This makes the dividend equal to that paid in January, namely, $405,000. No statement was given out as to whether this is a semi-annual or a quarterly dividend. The dividends thus far paid by the Granby are as follows:—

December 16th, 1903	$133,630.00
January 15th, 1906	405,000.00
May 15th, 1906	405,000.00
	$943,630.00

It is intimated that, by the end of the current year, the Granby will have raised its output to 2,800,000 lbs. of copper per month.

Notice has been received of the declaration of a dividend by the directors of the Consolidated Mining and Smelting Company of Canada, Ltd., for the first quarter of the year 1906. The dividend is 2½ per cent. The directors state that it is one of a series of quarterly dividends that will be paid at the rate of not less than 10% per annum. The Consolidated Mining & Smelting Company is reported to be in good condition, inasmuch as it does not depend on any single mine, or upon any single mining district, but "its interest and business is so diversified as to minimize, as far as possible, the speculative element." A policy of the company, which will do it much good in the future, and which should expand its sphere of operation and increase its dividends, is to acquire new properties where they have been favourably reported on by reputable experts.

DALHOUSIE UNIVERSITY SUMMER SCHOOL OF MINING.

The Summer School of Mining of Dalhousie University began its session of 1906 on Saturday, April 28th, at Clementsport, Digby Co., N.S. It will last for five weeks, closing at Stellarton, Saturday, June 2nd. The students of the third year in Mining Engineering at Dalhousie are accompanied by Profs. J. E. Woodman and F. H. Sexton. The first ten days will be spent in geological field work in the Bear River Basin, correlating other parts of the Basin with the sections on Bear River surveyed by the Summer School in 1904. Iron ore deposits are to be studied at Torbrook, Nictaux, Brookfield, and Londonderry. Blast furnace practice, foundry work, open hearth manipulation, and rolling mill methods will be observed in Londonderry and Ferrona. Gold mining and milling will be studied in various camps—Caribou mines, Harrigan Cove, Isaac's Harbor, Seal Harbor, and Forest Hill. Coal mining methods will be examined in Stellarton, Westville and Thorburn.

A USEFUL MACHINE.

Recognizing the need of a portable blacksmithing forge suitable for prospecting parties going into the bush, Messrs. W. H. C. Mussen & Co., of Montreal, have put in stock a new compact and light-weight fan forge which is entirely enclosed in a stout sheet iron casing having no projecting parts.

This outfit is a new departure and is designed to meet the requirements of Railroad and Bridge Contractors, as well as Prospectors. The latter will find the smaller size very convenient as it measures only 18" high and has a hearth 18" x 18" and weighs only 94 lbs. In addition to this the design is such that breakage is practically impossible. This feature we feel will particularly appeal to those engaged in outdoor work, as so many of the Forges now in use are easily broken through being up set or being struck by some article. The fan arrangement of the Blower is similar to the general type and the lever is direct connected to the 12" fan, which gives a powerful and steady draft.

This forge can be put in a canoe, packed on the back, or on a mule, or otherwise transported without difficulty or damage. It is warmly commended to the attention of prospectors and others.

NOVA SCOTIA MINING.

A considerable number of areas were taken up during the month of April, particularly in the Wagamatkook District.

The following is a summary of areas applied for during month:—

DISTRICT.	AREAS.
Lawrencetown	45
Millers Lake	94
Liscomb Mills	12
Harrigan Cove	71
South Uniacke	12
Wagamatkook	409
Voglers Cove	16
Leipsigate	15

Gold River	5
Mt. Uniacke	15
Ovens	12
Cow Bay	37
Stormont	117
Lochaber	16
Brookfield	35
Whycocomagh	60
Renfrew	6
Shelburne	66
Waterville	12
Salmon River	73
Montague	2

The only crushings to hand for the month are as follows:—

MILL.	Tons	oz.	dust	grs.
Oldham Sterling Gold Co.—Oldham District	160	212	0	0
J. A. Crease Mill—Mt. Uniacke	29	21	5	0

THE DOMINION COAL COMPANY'S OUTPUT.

The output of the Dominion Coal Company for the month of april was as follows:—

No. 1 Colliery	47,957
" 2 "	48,697
" 3 "	30,802
" 4 "	43,995
" 5 "	55,472
" 6 "	6,499
" 7 "	14,487
" 8 "	15,872
" 9 "	32,636
Total	296,417 tons

Shipments; 203,349 tons.

THE MINING AND INDUSTRIAL SHARE MARKET

(Specially reported for the Canadian Mining Review, by Robert Meredith & Co., Mining Brokers, 57 St. Francois Xavier Street, Montreal.)

The prices of mining stocks have been receding during the past few days. Transactions have not been large; but the demand has been largely withdrawn, owing to the fact that it has been impossible to procure any fairly large amounts of stock by bidding.

The Mining Exchange has experienced considerable difficulty in forming a list of stocks which will receive official sanction, from the fact that popular favor seems to be turning to the Cobalt stocks, and these stocks are as yet little known.

British Columbia properties are improving and there is more "*bona fide*" mining going on in that province than ever before, but the public interest is not at present centered on British Columbia.

Industrial shares have been fairly active, but on comparing prices with those obtaining last month, it is found they are in the main a shade lower. This is due to their being mostly of a speculative character, and are, hence affected, by the money market, which of late has been stringent.

The latest quotations are as follows:—

	Bid.	Asked.
Can. Consolidated Mines	130	132
Can. Gold Fields	7	7½
Granby Consolidated	13	13½
Rambler Cariboo	32	34
North Star	03	05
Monte Cristo	2	3
White Bear	1½	2½
California	1½	3
Virginia	2	5
Deer Trail	1½	2½
International Coal	34	36
Sullivan	2	3¾
Jumbo	23	25
Cariboo-McKinney	1½	—2½
Dominion Coal. (common)	74	77
Dominion Coal. (preferred)	116	119
Dominion Iron & Steel. (common)	28¾	29
Dominion Iron & Steel (preferred)	74½	77
Intercolonial Coal (common)	80	86
Intercolonial Coal (preferred)	98	100
Nova Scotia Steel & Coal	62	63½
Nova Scotia Steel & Coal (preferred)	118	120

THE ELECTRIC SMELTING OF IRON.

The Engineering supplement of the London *Times*, published recently a criticism upon the electric smelting of iron, as reported by the Canadian press. Referring to Dr. Haanel's experiments at Sault Ste. Marie, it said:

A considerable amount of glorification appeared to be manifested in the Canadian press on account of the success of Dr. Haanel, Canadian Superintendent of Mines, in turning out some 50 tons of pig iron by electricity. It is stated that the following (among other) facts have been fully established by the experiments at Sault Ste. Marie:—

1. Canadian ores, chiefly magnetite, can be economically smelted by the electro-thermic process.
2. Ores of high sulphur content can be made into pig iron containing only a few thousandths of sulphur.
3. The silicon content can be varied as required for the class of pig to be produced.
4. Titaniferous iron ores containing up to 5 per cent. can be successfully treated by the electro-thermic process.

We are informed that the consequence of the recent electric smelting operations would be "that Canada can undertake for itself the iron and steel industry, and will not in future have to import coal or ore for that purpose; that Canadian Manufacturers will make from Canadian products tools and agricultural implements, build bridges, boats, and railways, and make the machinery to be used in thousands of busy factories." Without the slightest wish to decry the value of Dr. Haanel's researches, it may be pointed out that the premises are rather slender for the bold assumptions contained in the foregoing and other newspaper articles. Dr. Haanel, we believe, has no practical acquaintance with steel manufacture, and, although an able man in his own sphere—that of a pure physicist—would find great difficulty (at all events, anywhere away from Canada) in obtaining any credit as an authority on the manufacture of iron or steel. There is no doubt that something on a large and, perhaps, even a commercial, scale will be set on foot in Canada for the electric smelting of ores. It is stated, in fact, that the Lake Superior Power Corporation have decided to acquire the Government plant for the purpose of converting their stock of briquetted ore into marketable ferro-nickel pig. But altogether it may be said that the experiments so far have been conducted on much too small a scale to warrant any definite conclusion as to the results of a trial on an actual commercial basis.

THE SILVER MARKET.

Most notable features in the Market for bar silver in the last year was a steady increase in price, until, on December 20th, silver was sold in New York as high as 66 cents troy ounce and the London quotation reached 30 5-16d a standard ounce. This was the highest price obtainable for silver since 1896. There has, however, been a steady improvement in price during the last four years. The average New York quotation for 1902 was 52.16 cents an ounce; for 1903, 53.57 cents; for 1904, 57.32 cents, and for 1905 the average will exceed 60 cents. The lowest monthly average in 1902 was 49.07 and the highest 55.56. In 1903 the lowest monthly average was 48.72 and the highest 60.37. In 1904 the lowest overage was 53.43 and the highest 60.56. In 1905 the lowest monthly average was 56.60, and the average for the month of December will exceed 65 cents. Increased wealth and population of the world are continually requiring increased coinage of silver, both for countries using silver alone and for subsidiary coinage of so-called gold countries. In the last ten years consumption of silver in arts and manufactures has increased from about 16 per cent. of the world's production to 30 per cent. The result has been a consumption of silver in the last year largely in excess of production, and as no stocks of bar silver are held or have been held in any market for several years, this over consumption has been supplied by denuding silver using countries of their coinage. In the last few months there has been sold from the Mexican circulation and Mexican reserve held against paper circulation probably $20,000,000. This seems to indicate that the Mexican Government intends to issue gold certificates to take the place of currency, which must be retired through sale of silver dollar reserves. So long as this process continues and this supply is upon the world's market at approximately the currency ratio adopted by Mexico, namely 50 cents gold for a silver dollar, the silver market cannot advance too much, if any, beyond the present market price of 65 cents to 66 cents; but as soon as this supply is exhausted or withdrawn from the market there seems no reason to doubt that the price prevailing before the closing of the India mints can be confidently expected.

SUMMER SCHOOL OF MINING, McGILL UNIVERSITY.

The Summer School of Mining of McGill University opened on April 19th, and will be conducted chiefly in the mining districts of Nova Scotia. The class, which is a large one, will first visit the gold mining region of Oldham, N.S., after which the coal district about Sydney will be studied with some care, and a visit made to Newfoundland. The party is in charge of Dr. Adams and Dr. Porter. The entire trip will occupy about six weeks.

MINING INCORPORATIONS.

ONTARIO AND QUEBEC.

"Coppers Limited." Capital, $2,000,000.00, in shares of $100.00 each. Head Office, Montreal.

Canadian Yukon Mining Company, Limited.—Capital, $100,000.00, in shares of $10.00 each. Head Office, Toronto.

International Gold Dredging Company, Limited.—Capital, $1,000,000.00, in shares of $100.00 each. Head Office, Ottawa, Ont.

Wonderland Silver Mining Company, Limited.—Capital, $250,000.00, in shares of $1.00 each. Head Office, Windsor, Ont. Provisional Directors: Messrs. Frank Shoonmaker, Edmond Peabody, William Stone, Halda Irish and Elias Sellers.

The Mines Publishing Company, Limited.—Capital, $40,000.00, in shares of $50,00 each. Head Office, Toronto. Provisional Directors: Messrs. John Michael Ferguson, James John Harpell and James Edward Day.

The Sterling Silver Cobalt Mining Company, Limited.—Capital, $600,000.00, in shares of $1.00 each. Head Office, Toronto. Provisional Directors: Joseph Gonder Beam, John Robertson and Thomas Ernest McCracken.

The Silver City Mining Company, Limited.—Capital, $350,000.00, in shares of $1.00 each. Head Office, Windsor, Ont. Provisional Directors: Messrs. Harry Sydney Pritchard, John Lewis and Frederic Watt.

The Florence Mining Company, Limited.—Capital, $100,000.00, in shares of $1.00 each. Head Office, Toronto. Provisional Directors: Messrs. Harry Sydney Pritchard, John Lewis and Frederic Watt.

Cobalt Silver Queen, Limited.—Capital, $1,500,000.00, in shares of $1.00 each. Head Office, Cobalt, Ont. Provisional Directors: Messrs. Francis Robert Latchford, Frank L. Culver and Robert Wm. Gordon.

Silver Horn Mining Company, Limited.—Capital, $50,000.00, in shares of $50.00 each. Head Office, Toronto. Provisional Directors: Messrs. Alfred Bicknell, James William Bain, Gerhard Brackenridge Strathy, Leigh Clow Todd and Joseph Edward Riley.

Cobalt Townsite Mining Company, Limited.—Capital, $100,000.00, in shares of $1.00 each. Head Office, North Bay, Ontario. Provisional Directors: Messrs. Jno. Mackay, Rupert Simpson, Alfred James Young, Andrew Santerre, Clement Albert Foster and Geo. Taylor.

The Douglas Milling Company, Limited.—Capital, $40,000.00, in shares of $10.00 each. Head Office, Douglas, Ont. Provisional Directors. Messrs. John Knight, Charles McGaghran, Silas Shaver Stitt, Thomas Monaghan Thrasher, Alex. McEachen and Owen Enright.

The Silver Bell Mining Company, Limited.—Capital $250,000.00, in shares of $1.00 each. Head Office, North Bay. Provisional Directors: Messrs. John William Richardson, Thomas Charles Begg, Edgar Brandon, Arthur Cecil Rorabeck and Geo. Brown McConachie.

The Silverland Development Company, Limited.—Capital, $1,000,000.00, in shares of $1.00 each. Head Office, Toronto. Provisional Directors: Edwin James Hardy Pauley, Ernest Reginald Clarkson, Blanche Bishop Pauley, Colonel Wm. Wylie Rice and Frederick Ashdown Fenton.

Montreal Cobalt Mining Company, Limited.—Capital, $500,000.00, in shares of $1.00 each. Head Office, Toronto. Provisional Directors: Messrs. Hamilton Bender Wills, Whitford Vandusen, Wm. David Scott, John Charles Colling and John Samuel Humberston.

The Shakespeare Development Company, Limited.—Capital, $300,000.00, in shares of $1.00 each. Head Office, Sault Ste. Marie, Ontario. Provisional Directors: Messrs. James Miller, Harry William Evenden, Wm. Howard Hearst, John McKay and James Leland Darling.

Peterson Lake Silver Cobalt Mining Company, Limited.—Capital, $3,000,000.00, in shares of $1.00 each. Head Office, Toronto. Provisional Directors: Messrs. Bartle Edward Bull, Joseph Montgomery, James Geo. Shaw, James Graham Strong and William Roland Williams.

Star Silver Cobalt Mining Company, Limited.—Capital, $2,000,000,00, in shares of $1.00 each. Head Office, Toronto. Provisional Directors: Messrs. John Meen, John Arthur Shaw, Joseph Montgomery, William Roland Williams and Bartle Edward Bull.

BRITISH COLUMBIA.

Bear Hydraulic Mining Company, Limited.—Capital, $250,000.00, in shares of $1.00 each.

The Canada Gold Hydraulic and Dredging Company, Ltd.—Capital, $250,000.00, in shares of $1.00 each.

The Canada Mine and Smelter Supply Company, Limited. Capital, $150,000.00, in shares of $1.00 each.

The Islands Copper Company, Limited.—Capital, $1,000,000.00, in shares of $1.00 each.

Prince Henry Mining Company, Limited.—Capital, $500,000.00, in shares of $1.00 each.

MINING MEN.

Mr. A. J. MacMillan, Managing Director of the Le Roi, has recently returned to Rossland from London.

Dr. A. W. G. Wilson, who for the past four years has been senior demonstrator in geology at McGill University, has severed his connection with that institution, in order to devote his time to his private practice as Mining Geologist, etc. Dr. Wilson's address is 197 Park Avenue, Montreal, Dr. Wilson will spend the summer in investigating the economic geology of regions lying between the line of the Transcontinental Railway and James Bay, in which work he will be assisted by Prof. John A. Dresser, of Montreal, whose thorough knowledge of the Huronian System in the Eastern Townships will be of great value to Dr. Wilson.

COAL NOTES.

The following were the Dominion Coal Company's output and shipments for March, 1906:—No. 1, 47,748; No. 2, 53,557; No. 3, 32,612; No. 4, 48,186; No. 5, 60,120; No. 6, 7,632; No. 7, 13,567; No. 8, 14,367; No. 9, 32,431. Total output, 310.220, The shipments were 178,182 tons.

CONNORS v. DOMINION COAL COMPAGY, LIMITED.

The action in this case was brought against the Company by an employee for retaining wages due, the latter owing money at the Company's store. The decision was given by Magistrates J. J. MacDonald and Hector McDonald, of Glace Bay, in favour of the plaintiff, and a minimum fine, $50.00, was imposed on the Company. It is understood the company will not carry the case to a higher court. This is the first case that has been decided against the Dominion Coal Company.

INDUSTRIAL NOTES.

A number of machines of similar capacity are being built by The Westinghouse Machine Company for large power houses in New York, Brooklyn, and other cities.

The Jenckes Machine Company, Limited, of Sherbrooke, Que., has recently shipped a 250 h.p. electric hoist to the Granby smelter at Phœnix. B.C.

The Alaska Treadwell Gold Mining Company, Treadwell, Alaska, recently ordered a 20 x 48 double drum, direct acting hoisting engine from the Allis-Chalmers Company, Milwaukee.

The infringement, which formed the basis of this suit was the using of Sheefer Alternating Current integrating wattmeters manufactured by the Diamond Meter Company of Peoria, Ill. This is the same patent on which E. B. Latham & Company of New York City, dealers in Sheefer Wattmeters, was enjoined on November 4th, 1905.

The Sullivan Machinery Company, of Chicago, which was one of the sufferers by the recent upheaval in San Francisco, has now opened temporary offices at 1010 Washington Street, Oakland, Calif. Far from being daunted by the recent disaster, they will now carry an increased stock of rock drills and air compressors, together with the separate parts of these machines. The manager is Mr. H. T. Walsh.

The Westinghouse Machine Company, during the months of February and March, received orders for 35 steam turbines aggregating approximately 50,000 Brake Horse Power capacity, to be used by transportation companies chiefly.

The largest is of 7,500 K.W. capacity, or 11,000 Brake Horse Power, and will be installed by the Transit Development Co., of Brooklyn.

The United States Circuit Court for the Northern District of New York, a few days ago, filed a decree enjoining the defendant in the case of the General Electric Company vs. the Madison County Gas & Electric Co. from using alternating current integrating wattmeters or other motor devices embodying a provision for securing an approximate 90 phase adjustment by induced circuit.

We are in receipt of one of a series of fifty multichrome cards, giving views of Swiss scenery, which the Allis-Chalmers Company are sending to their customers, as an advertisement of the Schindler Bolting Cloth, which they furnish to millers. These views are the finest specimens of their kind that the company has found it possible to procure, and are certainly examples of most excellent work.

The annual report of the Bell's Asbestos Company, Limited, London, England, for the year 1905, is to hand. The result of the year's operations is a net profit of £18,575 15s. 2d. At the annual meeting the directors recommended the payment of a dividend of 12½% per annum, free of income tax, on the 30th of April. The affairs of the Company are in a flourishing condition. Additions to the buildings and plant at the Greenwich factory have been completed, and the sale of the company's estates in Canada effected, the company's requirements of raw material having been amply protected.

The Westinghouse Machine Company has begun a third suit against the Allis-Chalmers Company, in which infringement of another Westinghouse-Parsons steam turbine patent is alleged. The bill was filed in the Circuit Court for the District of New Jersey, and the Westinghouse Company charges the Allis-Chalmers Company with infringement of patent No. 788,830 owned by the Westinghouse Machine Company.

This patent covers the construction of the rotating element of the turbine as used by the Westinghouse Machine Company and the Allis-Chalmers Company. The suit was filed on Wednesday, April 11th.

The Westinghouse Machine Company, of East Pittsburg, Pa., has recently contracted with the Olean Street Railway Company to install in their power house at Ceres, N.Y., two gas engines for supplying current to the Olean Street Railway, serving Olean, Ceres, Boliva, etc. In the near future, power will also be supplied to an interurban railway system between Olean and Salamanca, N.Y., a distance of 15 miles. They will operate on natural gas having a calorific value of approximately 1000 B.T.U., which fuel is very plentiful in this territory. At present the Olean Street Railway Company has a steam power plant in service, burning gas under boilers, and a large saving is expected in using gas power.

The Canadian Westinghouse Company, Ltd., has secured several important contracts recently, among which are:—

One for supplying the Provincial Light, Heat & Power Company with apparatus to be used in the development of another large water power plant near Montreal. The initial installation will consist of three 3750 K.W., revolving field, alternating current, water wheel driven generators of 4,000 volts, three phase, 7,200 alternations; also twelve 2,500 K.W., 44,000 volts, oil insulated, water cooled transformers. This new power station will be used for supplying additional power to the Montreal Light, Heat & Power Company at Montreal. The step-up transformers will be wound for 4,000 to 44,000 volts, and the lowering from 40,000 to 12,500 volts. The transmission line is about 40 miles in length.

The Washington Portland Cement Company's new plant, located in Skagit County, Washington, on the Skagit branch of the Great Northern Railway, between Anacortes and Rockport about 104 miles northwest of Seattle, which was begun early last spring, is expected to be ready for operation by the end of April. The equipment, both for power and cement making, is, in many respects, worthy of note, being furnished by a single concern, the Allis-Chalmers Company of Milwaukee, whose hydraulic turbine will furnish power to a generator, which in turn will supply current for a full equipment of motors, mounted directly on the various machines used in the modern process of Portland Cement manufacture. It is the intention of the building company to bring the capacity of the plant up to the capacity of 3,000 bbls. per day by adding two kilns at a time.

One for the Northern Electric & Mfg. Company, of Montreal, for a second 300 K.W., Westinghouse-Parsons turbo-generator unit, to be installed alongside of one of the same capacity now in service. The generator is a 220 volt, three phase, 7,200 alternation machine, operating at 3,600 r.p.m. while the turbine will operate at 150 pounds steam pressure with 100 degrees superheat. Also, The Yukon Consolidated Company, Ltd., have placed a contract for the following: Three 100 H.P. 3-phase, 60 cycle, 400 volt, type F motors; three 15 H.P., 3-phase, 60 cycle, 400 volt, type F motors; three 50 H.P. 850 r.p.m., 3-phase, 60 cycles, 400 volt, constant speed induction motors; three 30 H.P. motors; three 20 H.P., 1,120 r.p.m. motors; three 15 H.P. 850 r.p.m. motors; three 7½ H.P., 1,700 r.p.m. motors; nine 75 K.W., oil insulated, self cooling transformers; two 625 K.W., 3-phase, 60 cycle, 2,000 volts, 415 r.p.m., A.C. generators, and two 17 K.W., type S exciters for same; one 4 panel switchboard for controlling the above; four 250 K.W., oil insulated, oil cooled transformers and four 200 K.W. transformers, same type.

COBALT NEWS.

Two more compressor plants are being installed at Cobalt—at the Drummond and Jacobs properties at Kerr Lake.

Machinery is being installed by the Cobalt Silver Queen Co., at the Stormont mine, and the Company expects to have its first car load of ore on the market by May 15.

The Toronto Cobalt Mining Co. is developing its property on Sasaginaga Lake adjoining the Trethewey mine. The Buffalo and Hudson Bay mines are on adjacent properties.

The Cobalt Hotel Company (Limited) has been incorporated, to carry on an hotel business at Cobalt. It has a capital of $30,000.

The report of a find of Cobalt ore at Montreal River has been confirmed. The property has been purchased by Mr. C. L. Hanson. It is situated 1½ miles from Latchford station on the T. & N. O. Railway.

It is reported at the Bureau of Mines that a vein of Asbestos, ten feet wide, has been discovered in the township of Coleman near the boundary of Bucke, but the quality has not yet been determined.

The second edition of part II of the Ontario Bureau of Mines, Report, dealing with Cobalt wire, contains a description of the Cobalt ores of Saxony and a copy of a French Map of Canada published in 1744, showing a part of the Temiskaming district.

The Wright silver-lead mine, six miles from Haileybury, on the east side of Lake Temiskaming, is reported to have been sold to McMartin Bros., of the La Rose mine, for $50,000. Fifty men will be employed. This is one of the oldest silver mines in Canada. It has a 38 foot ledge.

The Glendinning or University mine at Cobalt, owned by three students of the School of Practical Science at Toronto, which made its first shipment of ore in November, has produced up to date about $100,000. It is now well equipped for economical work.

Professor W. G. Miller, provincial geologist, left Toronto with a party, the first week in May, to make a thorough examination and topographical survey of the Gillies limits, which the government has announced its intention of holding and working for the benefit of the province. Prof. Miller expects to be engaged on the work a good part of the summer.

Another sale of mining property reported from Cobalt is that of the Nova Scotia mine to a syndicate composed of Messrs. Jas. A. Ogilvie and J. A. Jacobs, of Montreal, A. F. Maclaren, M.P., of Stratford, Corrie, of Toronto, Clarkson, of Hamilton and Steindler, of New York, the consideration being in the neighbourhood of $400,000.

It is not true that applications to drain two of the lakes in the Cobalt district have been granted. Applicants cannot secure claims under the lake until they have made a discovery of mineral *in situ*, which would be a difficult thing to do. Some parties did attempt to make tests with the diamond drill when the lakes were frozen, but they were prohibited.

A town has been laid out by a Toronto and Winnipeg syndicate, at Argentite, about two miles north of Cobalt. The town site extends from the T. & N.O. Railway to Lake Timiskaming, a distance of two miles, and it has been subdivided into about 4,000 town lots, which will be offered for sale at auction in Cobalt and Toronto. The land is fairly level. The town has been named North Cobalt.

Discoveries of gold bearing quartz have been made in the township of Playfair, about 70 miles north of Cobalt, by Charles Hurd, a surveyor. There are many rock exposures in the township, and many quartz veins. Cobalt bloom has also been found in the north western part of the township. Silver is reported to have been found at Iroquois Falls, 80 miles north of Cobalt.

Leading mine operators at Cobalt have decided not to employ union men, and an attempt to organize a miner's union has failed. A Montana miner, in the employ of the Nipissing Mining Co., who was the prime mover, was discharged. A scale of pay has been agreed upon by the mine owners, as follows:—Miners, machine men and hammer men, $2.25; underground laborers, $1.75; surface laborers, $1.25, with board in all cases.

A discovery of gold on the Montreal river has lately been announced. The locality of the find is some 70 miles above Latchford. The finder is a Port Arthur man named Quebel, who has been in the district since January last. The gold, it is said, is in quartz, and the vein about 4 feet wide. On the announcement of the discovery some 50 men left Cobalt for the new field.

The Mining exchange recently operated at Cobalt has been incorporated and will work under a provincial charter. Its official name is The Cobalt Open Call Mining Exchange, Limited. It has a capital of $40,000 and its provisional directors are Horatio C. Barber, Wm. A. Marsh and R. H. C. Browne, all of Cobalt. The first 25 seats were sold at $50 and the next 25 fixed at $100. Evening meetings will be held.

Dr. Robert Bell, Chief Geologist of the Geological Survey, has recently made a brief inspection of the Cobalt district, and reports indications of cobalt nearly 50 miles northwest of the present area. These indications appear to be based on the discovery by Mr. W. J. Wilson, of the Geological Survey during the last season's field work of some loose rock specimens between Sturgeon river and Lady Evelyn river. The country in which the specimens were discovered is a heavily timbered one.

The Columbus mine, near Giroux Lake, township of Coleman, has been sold to the Columbus Cobalt Silver Co., of which Hon. R. Harcourt is president, and Jas. Tudhope, M.P.P., John Flett, Daniel Simpson and Joseph Columbus, directors, the vendor, M. Columbus, taking his pay in stock. The mine is capitalized at $450,000. A force of men has been put to work. The mine was staked by Joseph Columbus, who has been prospecting in the district for 20 years, and whose perseverance has at last been rewarded.

The first general meeting of the North American Cobalt Refining Company was held at Toronto, April 25. The following board was elected: John Mc Martin, president; W. G. Trethewey, Vice-president; D. A. Dunlop, Secretary-treasurer; Milton, L. Hersey, R. W. Leonard, J. A. Jacobs, John Blair, E. R. Clarkson and Clarence Foster, directors. Practically all the prominenet mine owners of the Cobalt district have taken stock, and machinery is being installed in the works at Hamilton, where cheap power, cheap fuel and low freights can be secured. The works are expected to be in operation very shortly. It is believed that the refiners will pay for 95% of the silver values and make an allowance for the cobalt and nickel.

DOMINION OF CANADA

SYNOPSIS OF CANADIAN NORTH-WEST MINING REGULATIONS.

COAL—Coal lands may be purchased at $10 per acre for soft coal and $20 for anthracite. Not more than 320 acres can be acquired by one individual or company. Royalty at the rate of 10 cents per ton of 2,000 pounds shall be collected on the gross output.

QUARTZ—A free miner's certificate is granted upon payment in advance of $7.50 per annum for an individual, and from $50 to $100 per annum for a company, according to capital.

A free miner having discovered mineral in place, may locate a claim 1,500 feet x 1,500 feet.

The fee for recording a claim is $5.

At least $100 must be expended on the claim each year, or paid to the mining recorder in lieu thereof. When $500 has been expended or paid, the locator may, upon having a survey, made, and upon complying with other requirements, purchase the land at $1 an acre.

The patent provides for the payment of a royalty of 2½ per cent. on the sales.

Placer mining claims generally are 100 feet square ; entry fee $5, renewable yearly.

A free miner may obtain two leases to dredge for gold of five miles each for a term of twenty years, renewable at the discretion of the Minister of the Interior.

The lessee shall have a dredge in operation within one season from the date of the lease for each five miles. Rental $10 per annum for each mile of river eased. Royalty at the rate of 2½ per cent. collected on the output after it exceeds $10,000

W. W. CORY,

Deputy of the Minister of the Interior.